
Project 21640-15
(Including 21641-15)

**Hetronic
CSM800FH**

Wireless Certification Report

**FCC 15.247
Including Australia**

Prepared for:

Hetronic
3905 NW 36th St.
Oklahoma City, OK 73112
USA

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

18 Aug 2020

Reviewed by



Larry Finn
Chief Technical Officer

Written by



Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
Final 01		18 Sep 2020
Final 02	Add hopping mode band edge, correct IDs.	13 Oct 2020

Errata:

None

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Compliance Certificate

FCC MRA Designation Number: US5270

NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification
Hetronic 3905 NW 36th St. Oklahoma City, OK 73112 USA Certificate Date: 18 Aug 2020	FCC ID: LW9-CSM800FH IC: 2119B-CSM800FH Model(s): CSM800FH Laboratory Project ID: 21640-15

The device named above was tested utilizing the following documents 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>902-928 MHz</u> , 2400-2483.5 MHz, and 5725-5850 MHz.
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 OET Bulletin 65*	Edition 97-01, supplemented by KDB 447498	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, with supplements
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)*
Australia	ASNZS4268-2012+A1	Table 1, Row 52 (Notes 4 and 5), Appendix A Frequency Hopping transmitters, Section A1 900 MHz Frequency Hopping Transmitters

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

I, Eric Lifsey, for Professional Testing (EMI), 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.

Eric Lifsey
EMC 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

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.

Professional Testing (EMI), Inc., (PTI) 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

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	Serial #	Description
Hetronic Model: CSM800FH	None	902 – 928 MHz frequency hopping transceiver module.

Table 1.2.2: Support Equipment		
Manufacturer / Model	Serial #	Description
Hetronic	None	Programming/power base board to exercise EUT.

This modular device is installed in various industrial systems also made by the module manufacturer. These includes systems as cranes to provide wireless remote control. This module is only for use in the manufacturers systems and is not offered for sale.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. Firmware was employed that allowed operation on the needed channels with or without modulation.

Additional measurements are included to support localization where a smaller frequency range applies.

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, 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.

1.6 Radiated Measurements

Table 1.6 1 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 and Clauses

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-Gen Issue 5	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ASNZS4268-2012+A1	Radio equipment and systems – Short range devices – Limits and methods of measurement

Table 1.7.2: Applicable Clauses		
Parameter	FCC Part 15 Rule Paragraphs	IC RSS References
Transmitter Characteristics	15.247	RSS-247 5.2 (DTS) & 5.4, RSS-Gen
Bandwidth	15.247(a)(1), 2.1049, KDB 558074 D01	RSS-Gen 4.6
Spurious Emission	15.247, 15.209, 15.205	RSS-247 5.5, RSS-GEN 4.9, 4.10
Band Edge	15.247, 15.205	RSS-247 5.5, RSS-Gen 4.9
Antenna Requirement	15.247, 15.203	RSS-Gen 8.3

2.0 Fundamental Power

2.1 Test Procedure

Peak power is measured using conducted means and with modulation.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(a)(3) // RSS-247 5.2	Fundamental Power Conducted Limits 1 W Limit Restated as Field: 125.23 dB μ V/m @ 3 m	14 May 2020

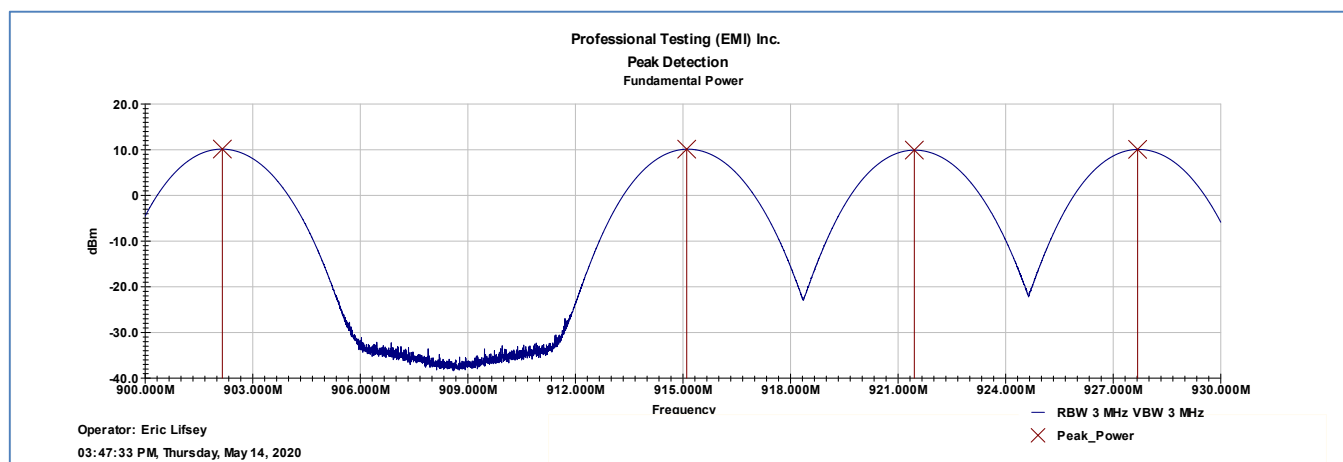
2.3 Test Results, Peak Power

The EUT was measured for conducted power by connection directly to a spectrum analyzer.

Table 2.3.1 Power, Peak, Conducted		
Frequency MHz	Measured Peak Power in dBm	Measured Peak Power in mW
902.1750	10.1	10.2
915.1750	10.1	10.2
921.4540	9.9	9.8
927.7224	10.1	10.2

Measured in 3 MHz RBW, 8 MHz VBW.

The EUT was satisfied the requirements. (Note that the additional measured channel is for the center channel for Australia.) For power measurement the channel frequencies are spaced more widely apart in frequency than normal channels to cover all possible channel groupings (networks).



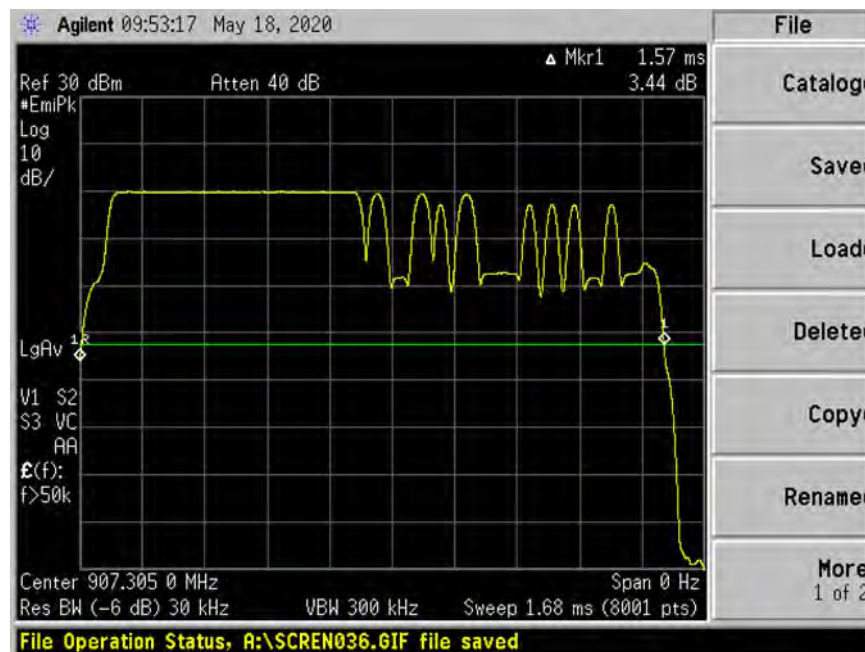
2.4 Test Results, Duty Cycle

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.

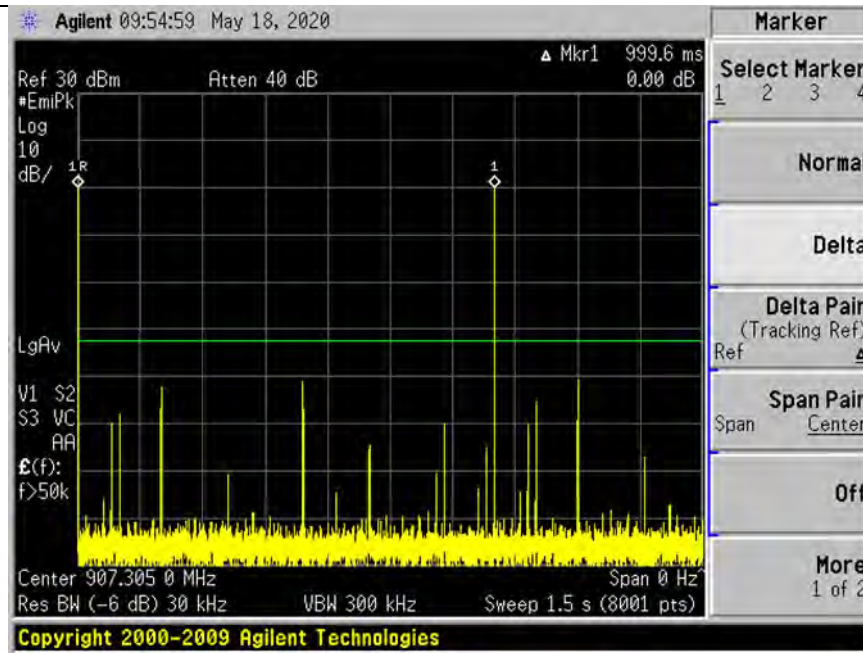
Table 2.5.1 Duty Cycle Results and Average Duty Cycle Factor Result

Total Measured On Time (ms)	Measured Time Interval (ms) Max 100 ms	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB) Max 20 dB
1.57	100	$= 20 * \log_{10} (1.57 \text{ ms} / 100 \text{ ms})$	-36.1	-20

Plotted results appear below.



Transmit Event Time



Time Interval
(Return to channel time.)

3.0 Power Spectral Density

3.1 Test Procedure

A spectrum analyzer is either connected directly to the EUT or used by radiated means to measure the fundamental emission. It is adjusted to measure the power spectral density in the specified resolution bandwidth.

3.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dB μ V/m at 3 m	Not Applicable

3.3 Test Results

This test does not apply to frequency hopping devices.

4.0 Occupied Bandwidth

4.1 Test Procedure

Bandwidth is measured by radiated means. A recording of the results is included.

4.2 Test Criteria

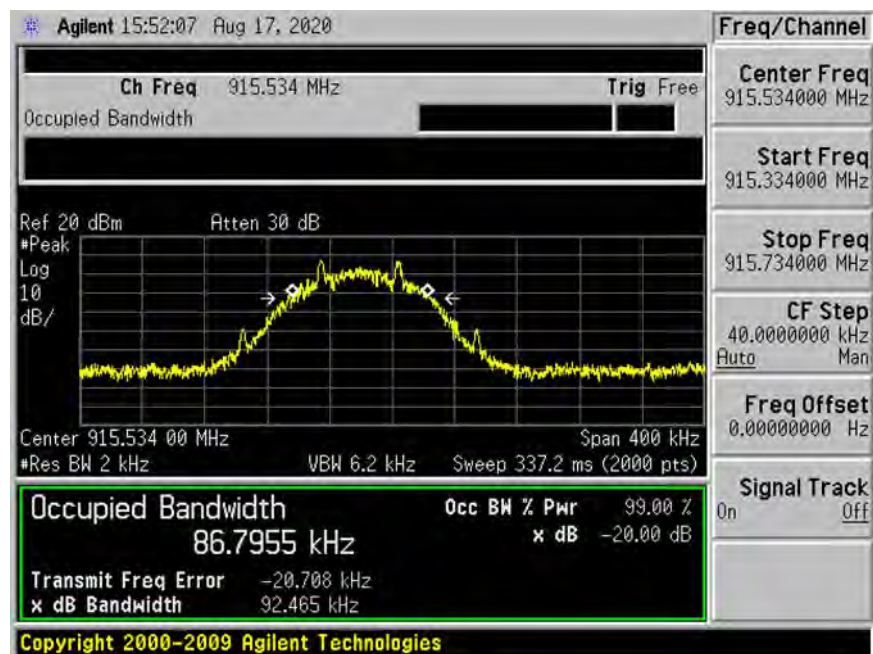
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
14.247(a)(2), 2.1049, KDB 558074 D01 // RSS-Gen 4.6	Bandwidth, 20 dB, 99%	14 May 2020

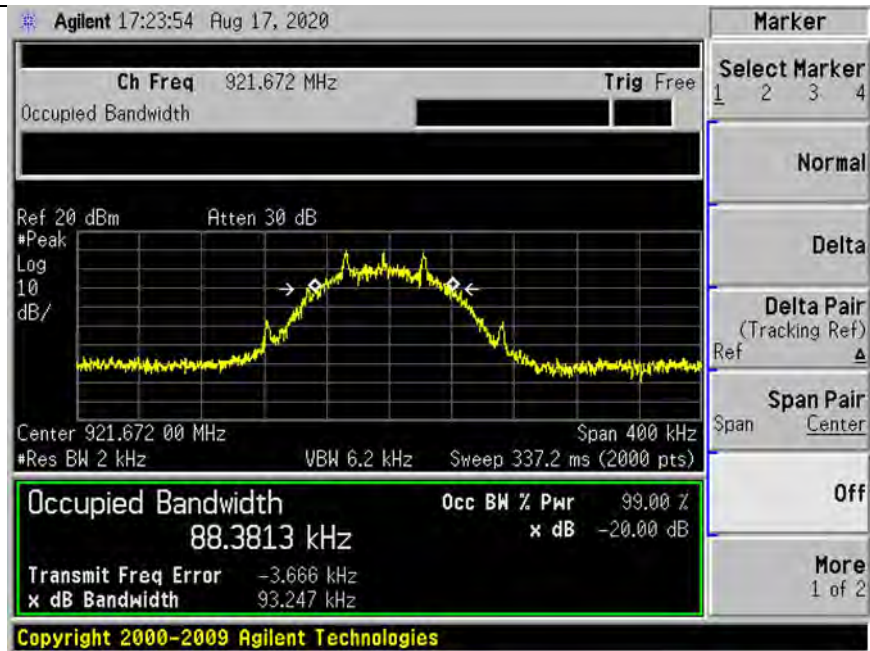
4.3 Test Results

The bandwidth measurement is used to verify DTS/FHSS characteristics and/or for general reporting for agency application. Measured in hopping mode. An additional alternate middle channel is measured for other localization purposes.

The EUT satisfied the requirements.

Table 4.3.1 Bandwidth				
Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW				
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	Alternate Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Minimum BW (kHz)
<i>6 dB does not apply to frequency hopping devices.</i>				
Bandwidth 20 dB, Measure and Report				
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	Alternate Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Minimum BW (kHz)
92.60	92.47	93.25	101.6	92.47
Bandwidth 99%, Measure and Report				
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	Alternate Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Maximum BW (kHz)
87.38	86.80	88.38	89.31	89.31





5.0 Band Edge

5.1 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.

5.2 Test Criteria

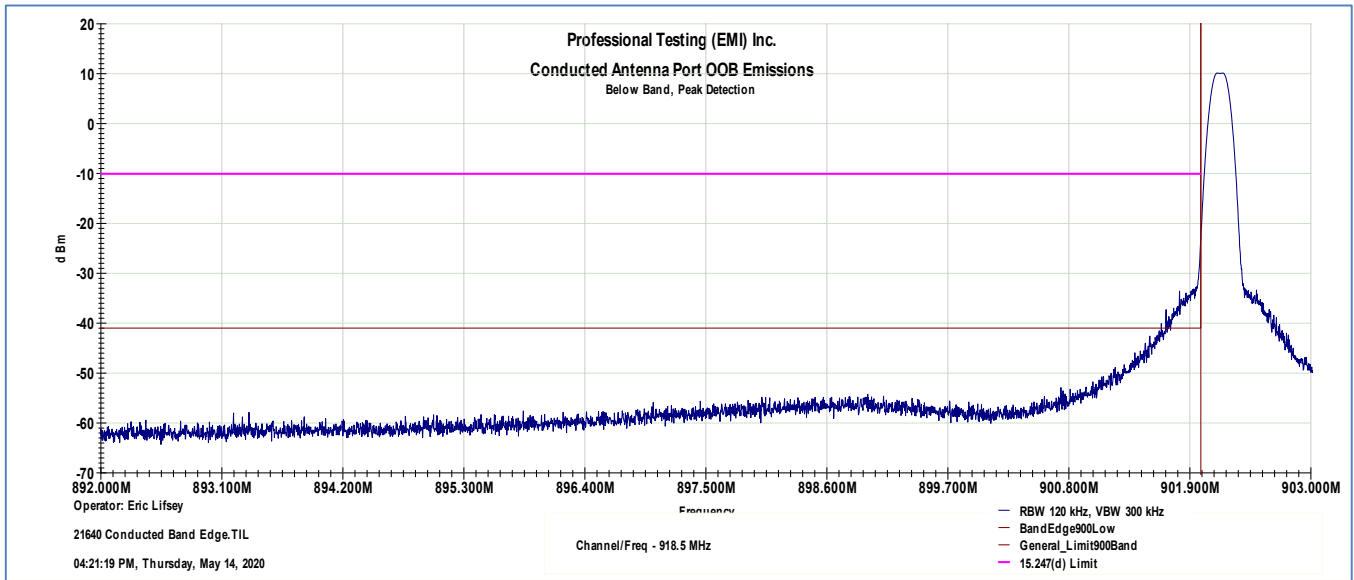
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.205 // RSS-247 5.5, RSS-Gen 4.9	Unwanted Emissions Adjacent to Authorized Band	14 May 2020 13 Oct 2020

5.3 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.

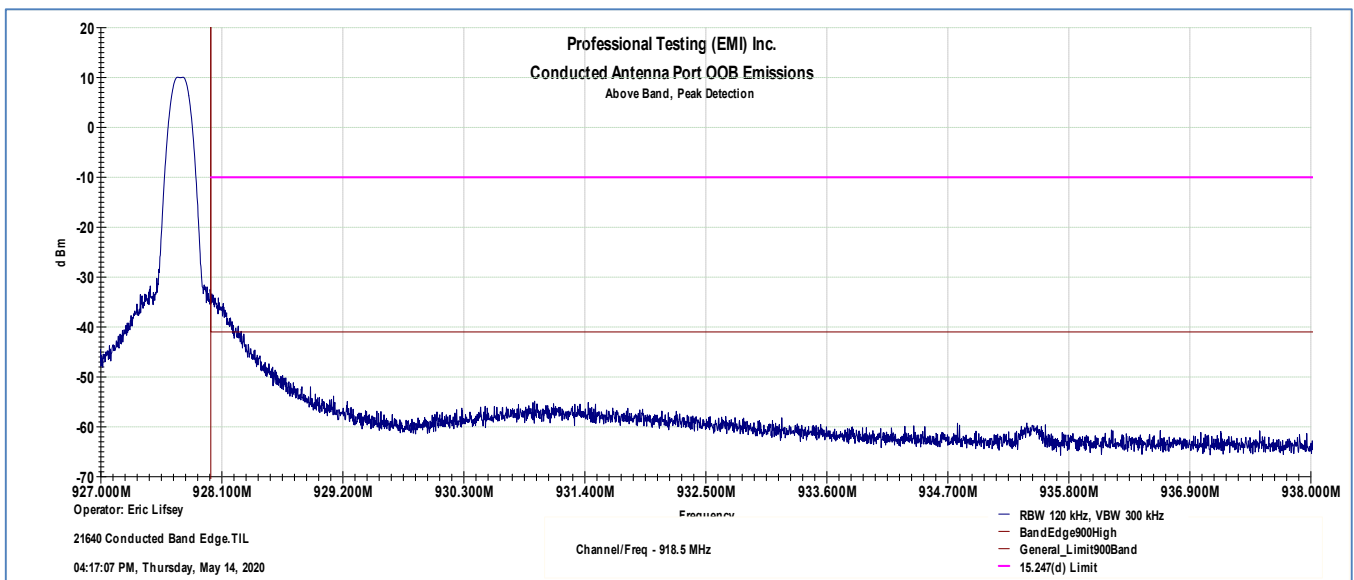
The EUT satisfied the criteria. Plotted results appear on the following pages.

5.3.1 Low Channel Band Edge – Not Hopping



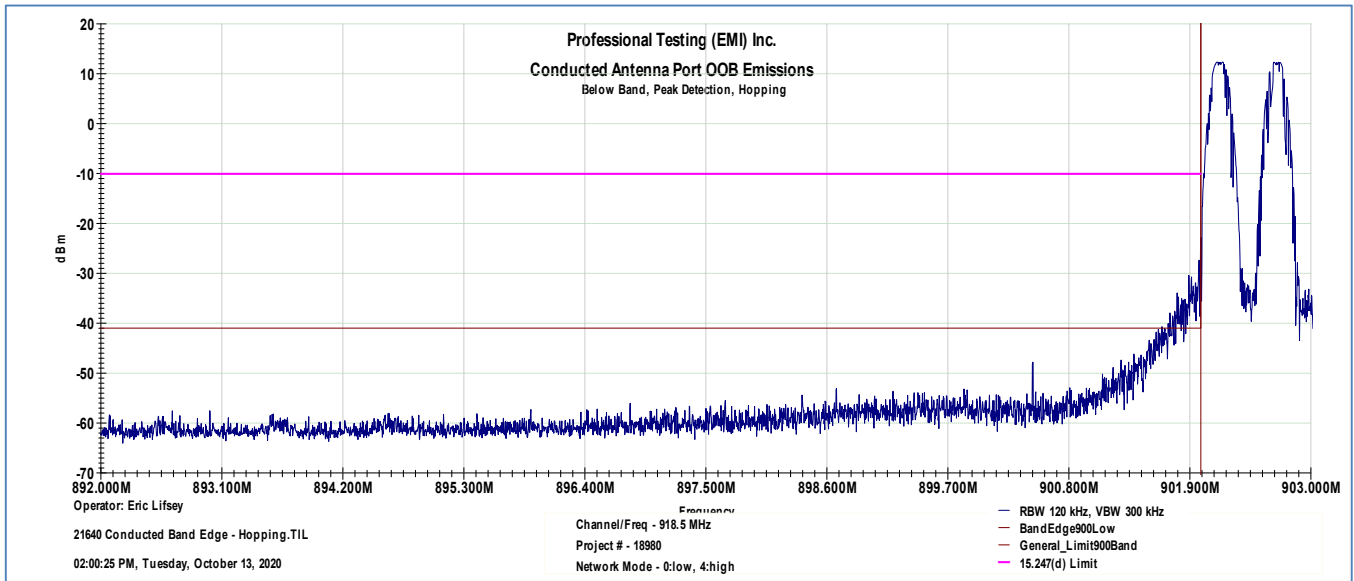
The 15.247 (-20 dBc) is the upper limit shown.

5.3.2 High Channel Band Edge – Not Hopping

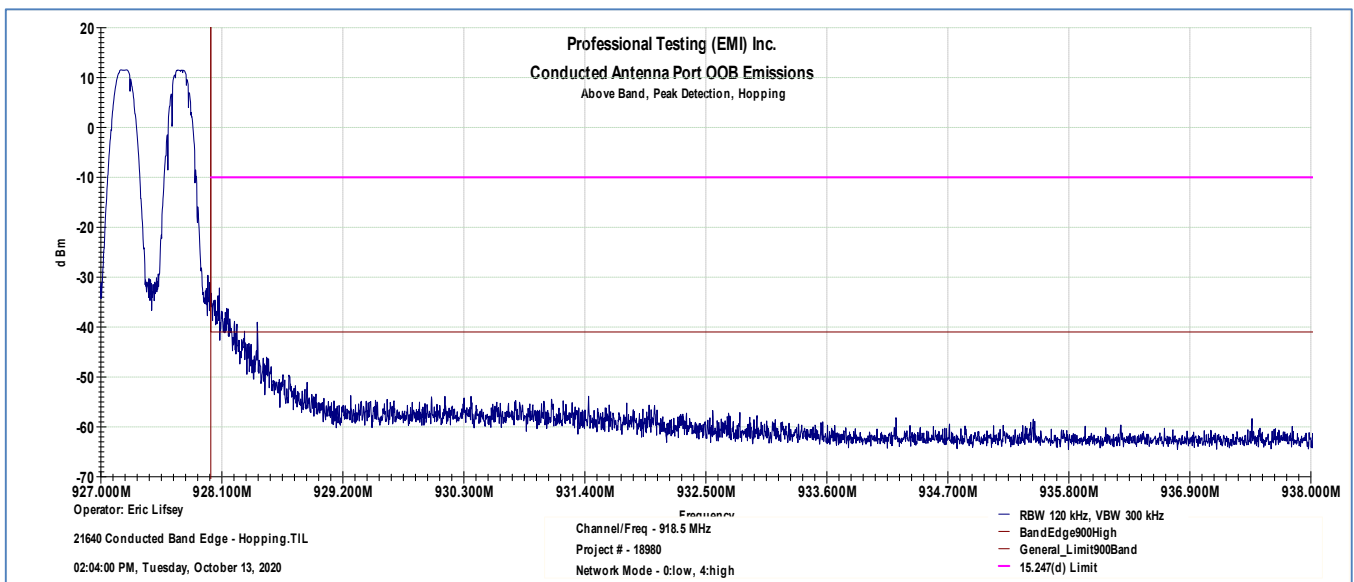


The general emission average and peak limits are shown.
The averaging factor is -20 dB.

5.3.3 Low Channel Band Edge –Hopping



5.3.4 Low Channel Band Edge –Hopping



6.0 Conducted Spurious Emissions, Receive Mode

6.1 Test Procedure

The EUT was placed into receive operation with a direct connection to a spectrum analyzer.

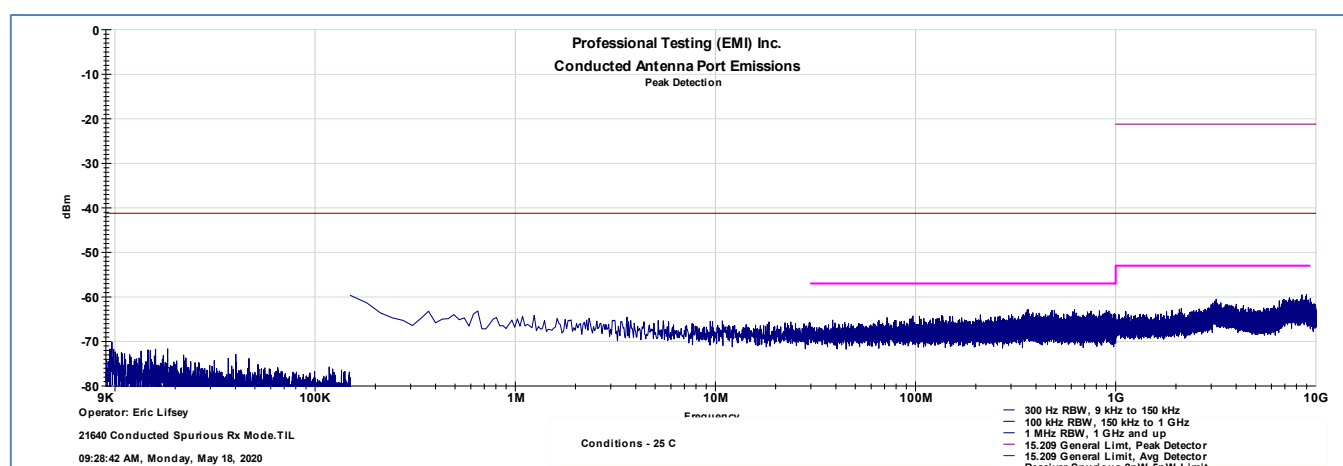
6.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 7.4	Conducted Spurious/Harmonic Emissions, Receive Mode 2 nW < 1 GHz, 5 nW > 1 GHz	18 May 2020

6.3 Test Results

The EUT was tuned to the center channel and placed in receive mode.

The EUT satisfied the criteria.



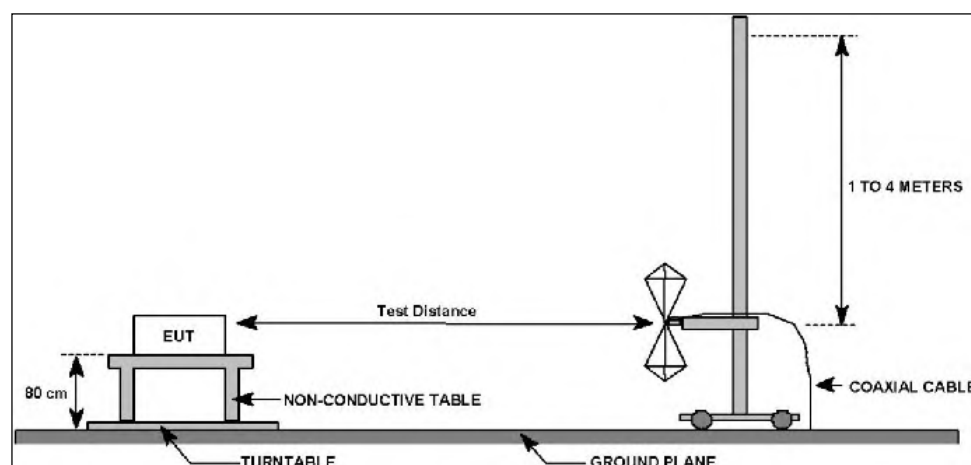
Recorded Antenna Port Emissions Receive Mode

7.0 Radiated Spurious Emissions, Transmit Mode

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate using 1 MHz resolution bandwidth.



7.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	11, 18 May 2020

7.3 Test Results

The EUT was tuned to the each of the three test channels and placed in modulated transmit mode.

Duty cycle factor applicable to all spurious peak measurement is -20 dB such that all spurious satisfying the peak limit also satisfy the average limit.

The EUT satisfied the criteria. Recorded data is presented below.

7.3.1 Bottom Channel, Up to 10 GHz

Professional Testing, EMI, Inc.								
Test Method:		ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices						
In accordance with:		FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits						
Section:		15.209						
Test Date(s):		5/18/2020		EUT Serial #:		0		
Customer:		Hetronic		EUT Part #:		0		
Project Number:		21640		Test Technician:		Eric Lifsey		
Purchase Order #:		0		Supervisor:		Shakil Murad		
Equip. Under Test:		CSM800FH		Witness' Name:		0		
Radiated Emissions Test Results Data Sheet								
EUT Line Voltage:		5 VDC		EUT Power Frequency:		0 N/A		
Antenna Orientation:		Vertical		Frequency Range:		30MHz to 1GHz		
EUT Mode of Operation:					FCC Bottom Channel			
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
31.484	10	291	1.3	Quasi-peak	11.206	29.5	-18.3	Pass
59.993	10	197	1.28	Quasi-peak	11.764	29.5	-17.7	Pass
314.305	10	354	1.28	Quasi-peak	15.287	35.6	-20.3	Pass
Professional Testing, EMI, Inc Radiated Emissions 30MHz - 1GHz Vertical Polarity Measured Emissions Operator: Eric Lifsey 21640 051120 2019RE\IntT7v1.3\Spur\Run01902M175.tif Current Time -02:04:00 PM, Monday, May 11, 2020 — FCC Peak Limit — FCC Quasi-peak Limit — Pre-scan Emissions △ Peak Reading ▽ Quasi-peak Reading * LPRF Verification Limit ▽ Verified LPRF QP Reading EUT: CSM800FH Project Number: 21640 Client: Hetronic								
≤ 1GHz Vertical Antenna Polarity Measured Emissions								

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

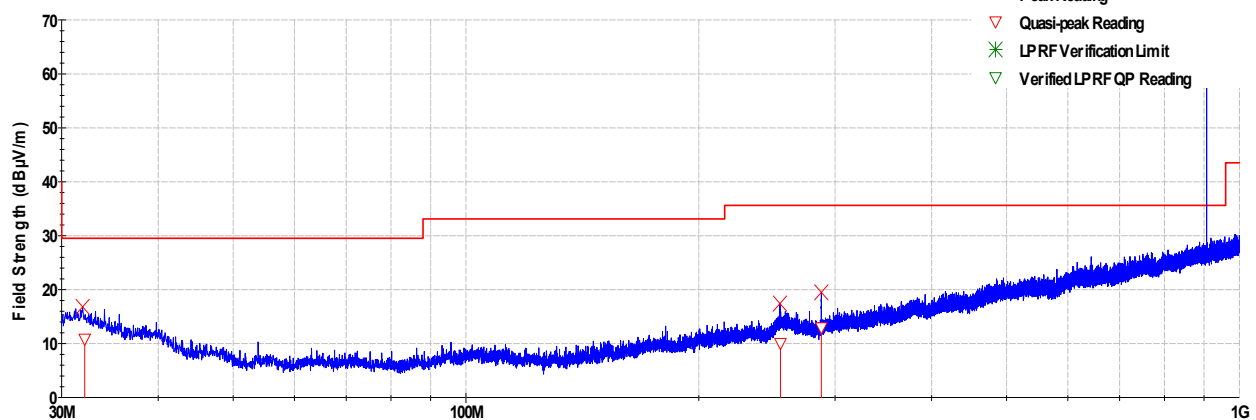
Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

FCC Bottom Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
32.134	10	161	1.26	Quasi-peak	10.883	29.5	-18.6	Pass
255.022	10	2	1.26	Quasi-peak	10.073	35.6	-25.5	Pass
288.02	10	328	1.26	Quasi-peak	12.964	35.6	-22.6	Pass

Professional Testing, EMI, Inc
Radiated Emissions
30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

21640 051120 2019RE"Int"TV1.3'Spur'Run01'902M175.tif

Current Time -02:13:06 PM, Monday, May 11, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Vertical

Frequency Range: Above 1GHz

EUT Mode of Operation:

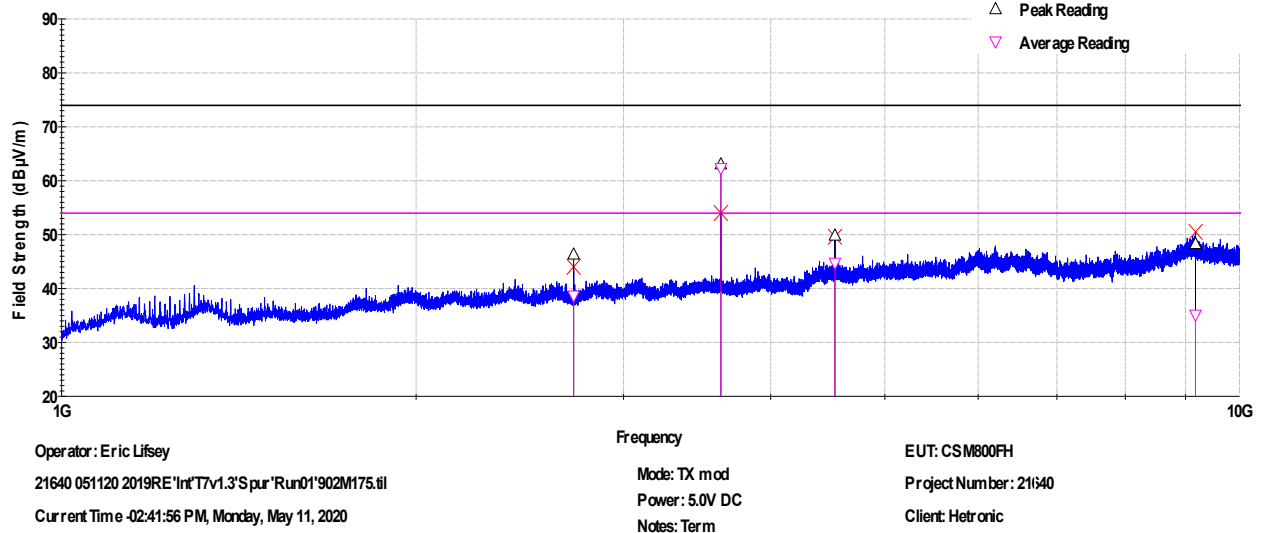
FCC Bottom Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
2721.31	3	234	2.45	Peak	46.313	74.0	-27.6	Pass
3628.45	3	160	1.82	Peak	63.05	74.0	-10.9	Pass
4535.62	3	2	1.6	Peak	49.822	74.0	-24.1	Pass
9176.88	3	56	1.01	Peak	48.266	74.0	-25.7	Pass

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Radiated Emissions

1-18GHz Vertical Polarity Measured Emissions



> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:

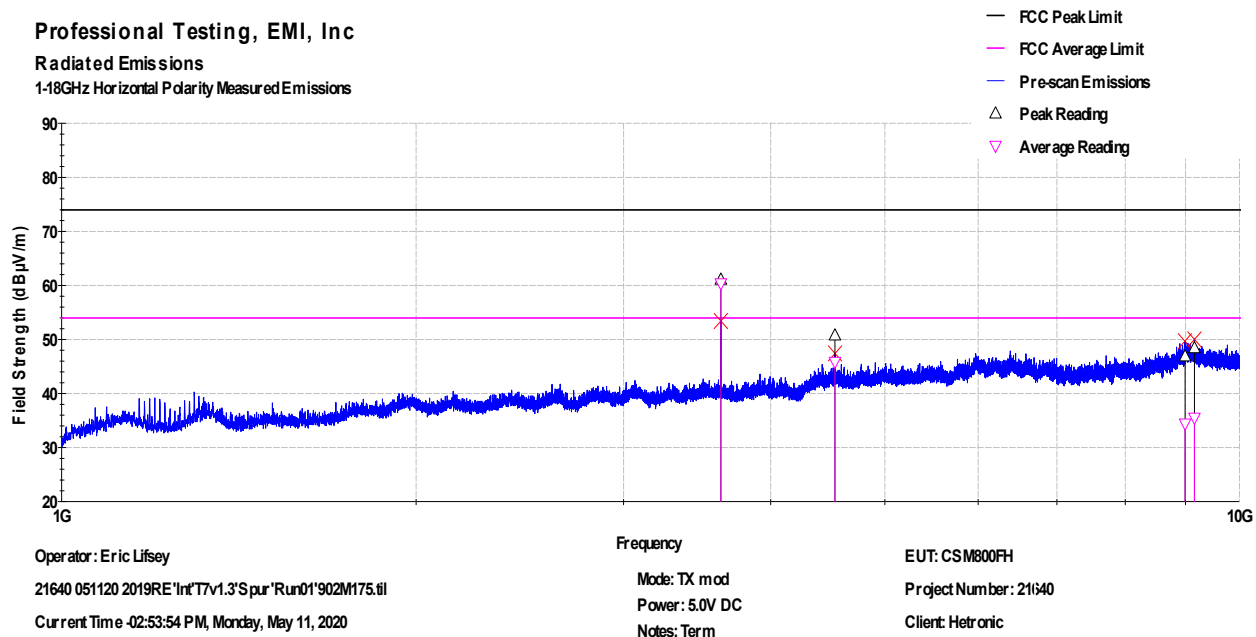
FCC Bottom Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
3628.42	3	197	1.95	Peak	61.075	74.0	-12.9	Pass
4535.54	3	203	1.79	Peak	50.751	74.0	-23.2	Pass
8993.08	3	181	1.62	Peak	46.886	74.0	-27.1	Pass
9159.73	3	358	3.51	Peak	48.403	74.0	-25.6	Pass

Professional Testing, EMI, Inc

Radiated Emissions

1-18GHz Horizontal Polarity Measured Emissions



> 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.2 Middle Channel, Up to 10 GHz

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Vertical

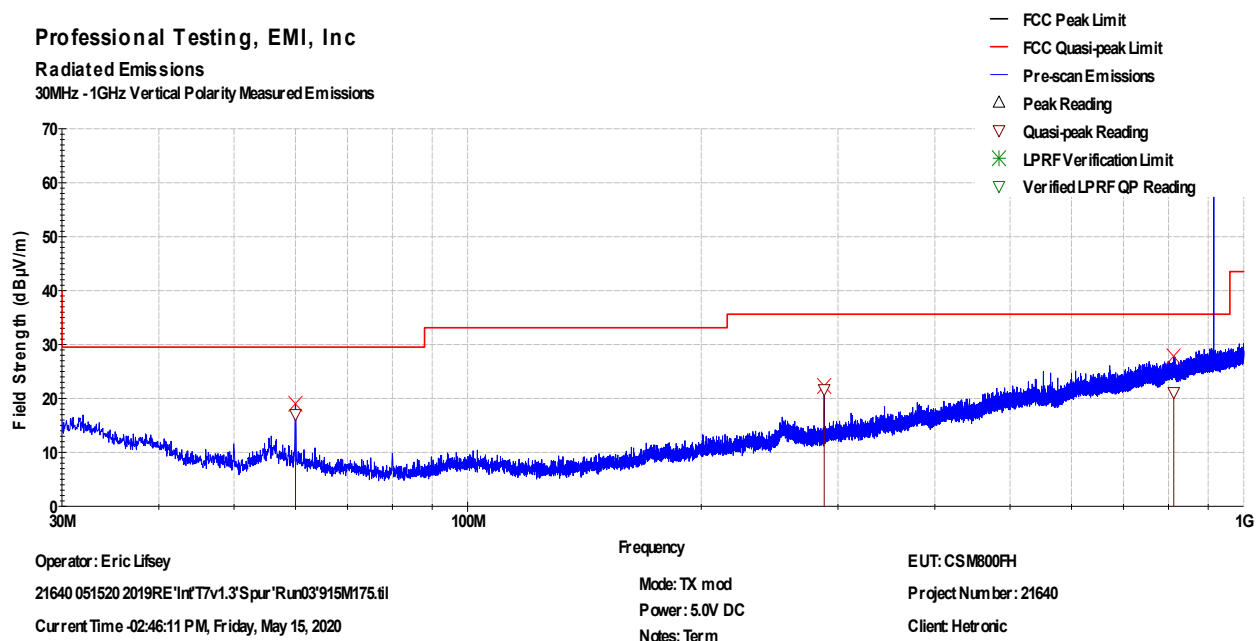
Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

FCC Middle Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
60.007	10	357	1.29	Quasi-peak	17.059	29.5	-12.4	Pass
288.03	10	261	1.28	Quasi-peak	21.666	35.6	-13.9	Pass
812.632	10	354	1.27	Quasi-peak	21.136	35.6	-14.5	Pass

Professional Testing, EMI, Inc
Radiated Emissions
30MHz - 1GHz Vertical Polarity Measured Emissions



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

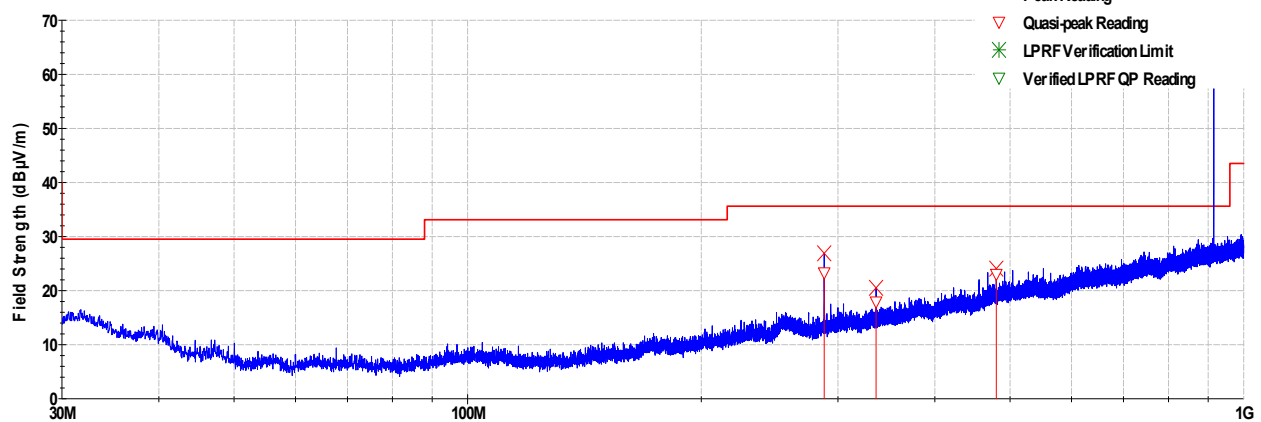
FCC Bottom Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
288.029	10	235	1.26	Quasi-peak	23.338	35.6	-12.3	Pass
336	10	263	1.26	Quasi-peak	17.955	35.6	-17.6	Pass
479.99	10	329	1.02	Quasi-peak	23.066	35.6	-12.5	Pass

Professional Testing, EMI, Inc

Radiated Emissions

30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Int'l7v1.3'Spur'Run03'915M175.ttl

Current Time -02:55:58 PM, Friday, May 15, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Vertical

Frequency Range: Above 1GHz

EUT Mode of Operation:

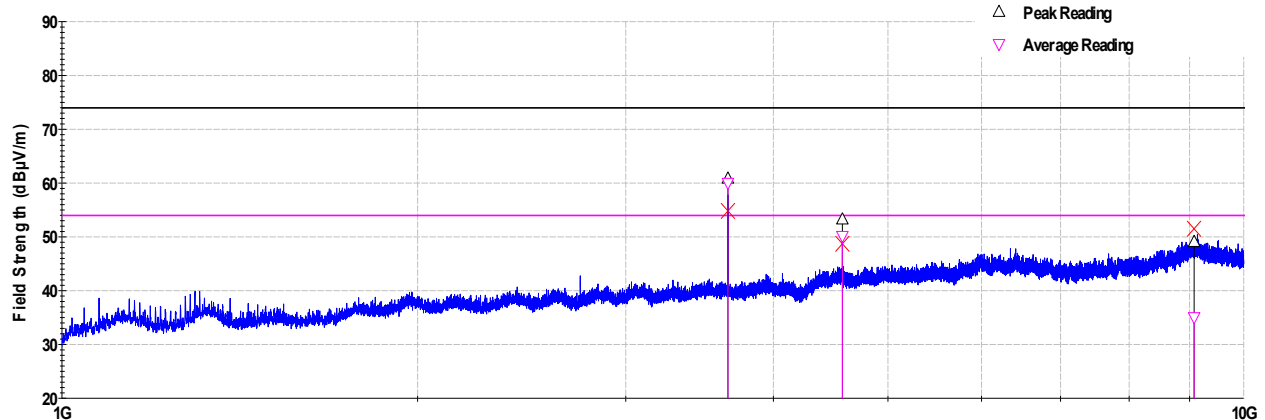
FCC Middle Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
3660.63	3	134	1.64	Peak	60.846	74.0	-13.1	Pass
4575.7	3	161	1.51	Peak	53.248	74.0	-20.7	Pass
9080.15	3	0	1.34	Peak	49.063	74.0	-24.9	Pass

Professional Testing, EMI, Inc

Radiated Emissions

1-18GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Inf'T7v1.3'Spur'Run03'915M175.tif

Current Time -07:47:45 AM, Monday, May 18, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:

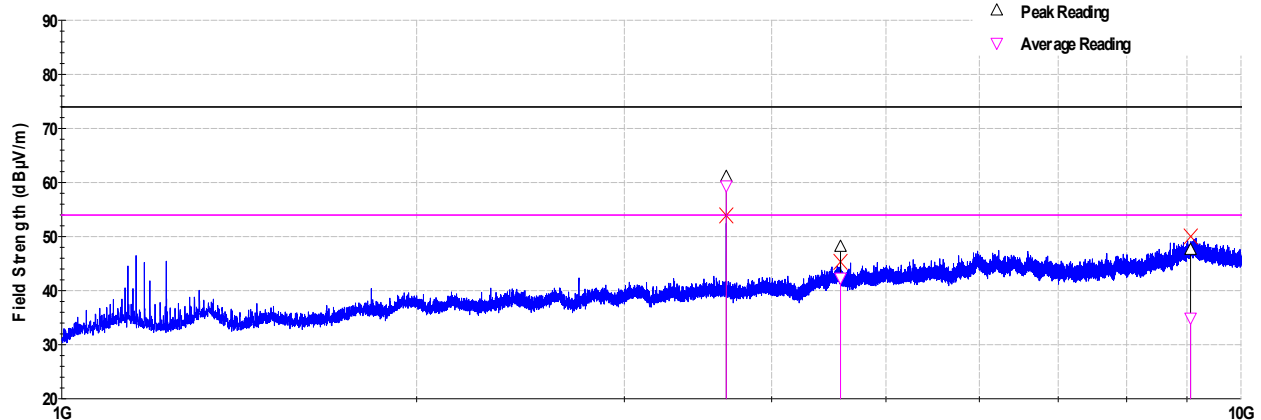
FCC Middle Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
3660.8	3	202	1.95	Average	0	54.0	-54.0	Pass
4575.64	3	360	1.95	Average	0	54.0	-54.0	Pass
9063.17	3	44	3.5	Average	0	54.0	-54.0	Pass

Professional Testing, EMI, Inc

Radiated Emissions

1-18GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Int'l7v1.3'Spur'Run03'915M175.ttl

Current Time -07:47:45 AM, Monday, May 18, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.3 Top Channel, Up to 10 GHz

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Vertical

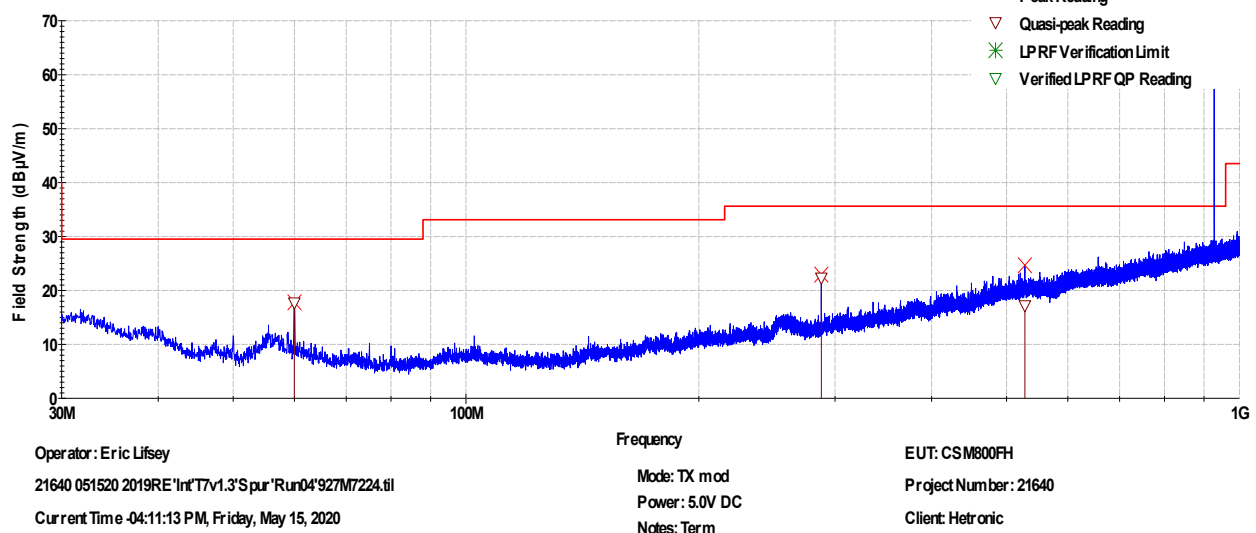
Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

FCC Top Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
59.99	10	358	1.28	Quasi-peak	17.737	29.5	-11.8	Pass
288.057	10	252	1.28	Quasi-peak	22.349	35.6	-13.3	Pass
527.964	10	196	1.28	Quasi-peak	17.221	35.6	-18.4	Pass

Professional Testing, EMI, Inc
Radiated Emissions
30MHz - 1GHz Vertical Polarity Measured Emissions



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

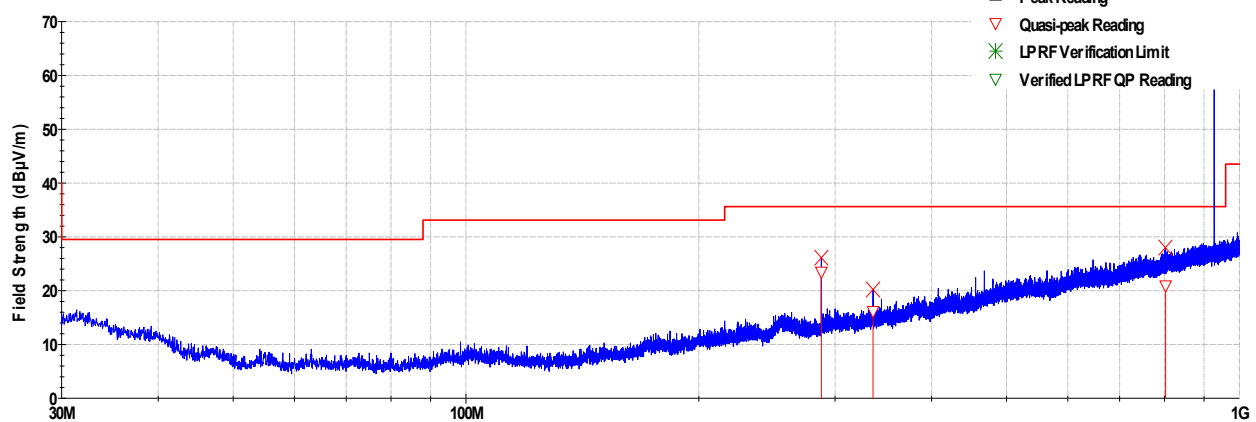
Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

FCC Bottom Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
288.051	10	246	1.27	Quasi-peak	23.497	35.6	-12.1	Pass
335.994	10	307	1.26	Quasi-peak	16.174	35.6	-19.4	Pass
802.733	10	171	2.73	Quasi-peak	20.939	35.6	-14.7	Pass

Professional Testing, EMI, Inc
Radiated Emissions
30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Int'T7v1.3'Spur'Run04'927M7224.til

Current Time -04:20:46 PM, Friday, May 15, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Vertical

Frequency Range: Above 1GHz

EUT Mode of Operation:

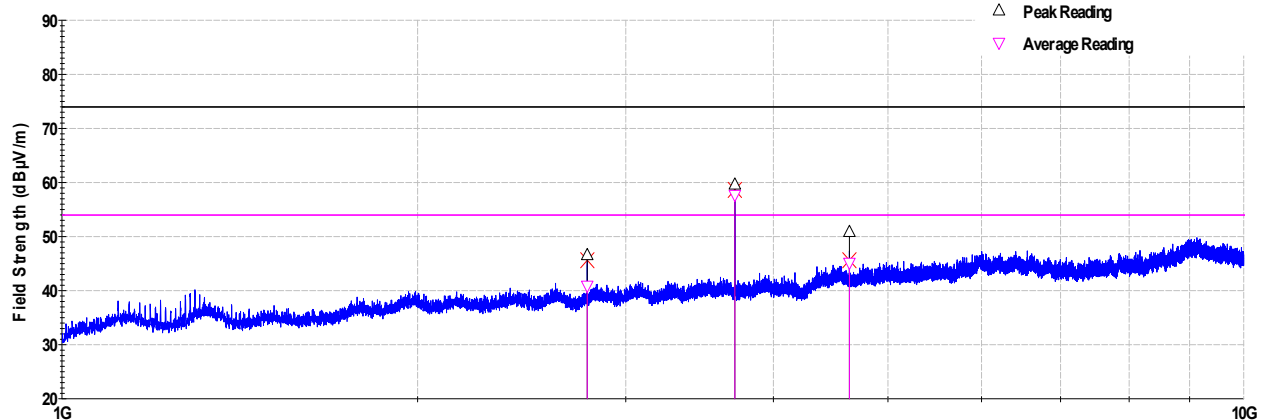
FCC Top Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
2783.06	3	247	3.32	Peak	46.578	74.0	-27.4	Pass
3710.91	3	176	1.48	Peak	59.624	74.0	-14.3	Pass
4638.59	3	250	1.02	Peak	50.864	74.0	-23.1	Pass

Professional Testing, EMI, Inc

Radiated Emissions

1-18GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Int'l7v1.3'Spur'Run04'927M7224.ttl

Current Time -04:53:17 PM, Friday, May 15, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

In accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits

Section: 15.209

Test Date(s): 5/18/2020

EUT Serial #: 0

Customer: Hetronic

EUT Part #: 0

Project Number: 21640

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Shakil Murad

Equip. Under Test: CSM800FH

Witness' Name: 0

Radiated Emissions Test Results Data Sheet

EUT Line Voltage: 5 VDC

EUT Power: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:

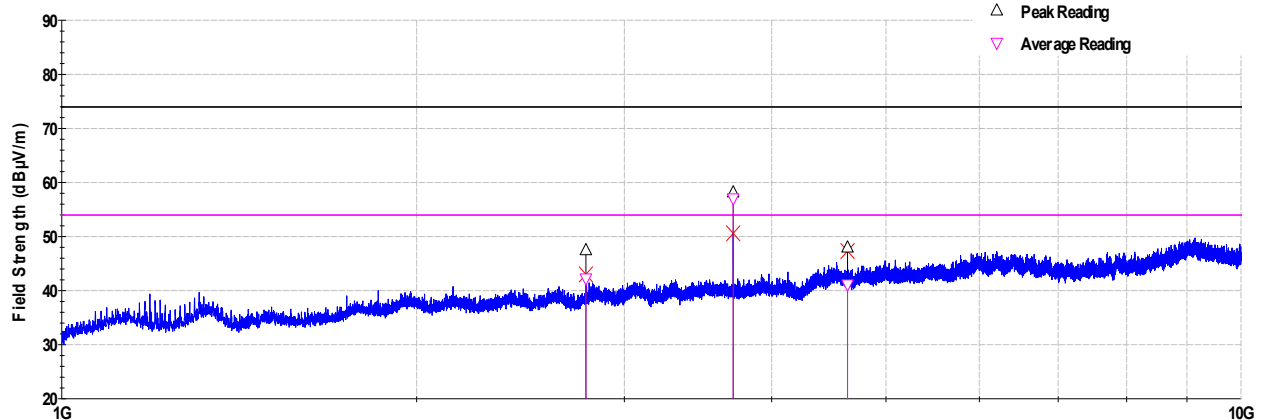
FCC Top Channel

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
2783.3	3	287	3.32	Average	0	54.0	-54.0	Pass
3710.91	3	288	2.4	Average	0	54.0	-54.0	Pass
4638.41	3	207	1.26	Average	0	54.0	-54.0	Pass

Professional Testing, EMI, Inc

Radiated Emissions

1-18GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

21640 051520 2019RE'Int'l7v1.3'Spur'Run04'927M7224.ttl

Current Time -05:02:23 PM, Friday, May 15, 2020

Frequency

Mode: TX mod

Power: 5.0V DC

Notes: Term

EUT: CSM800FH

Project Number: 21640

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

8.0 Conducted Spurious Emissions, Transmit Mode

8.1 Test Procedure

The EUT was placed into transmit operation with a direct connection to a spectrum analyzer.

8.2 Test Criteria

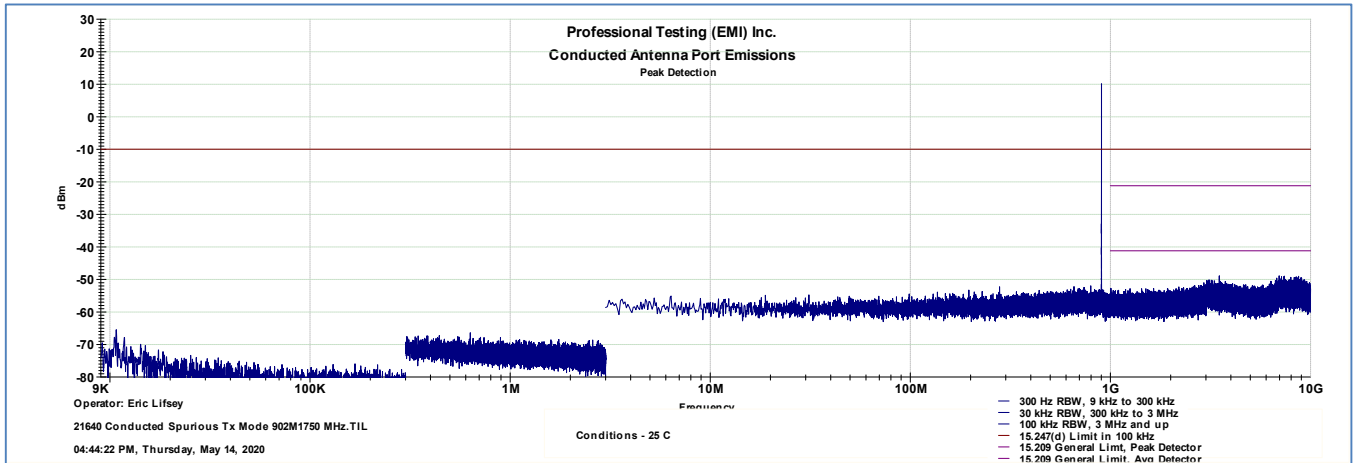
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Conducted Spurious/Harmonic Emissions Transmit Mode	14 May 2020

8.3 Test Results

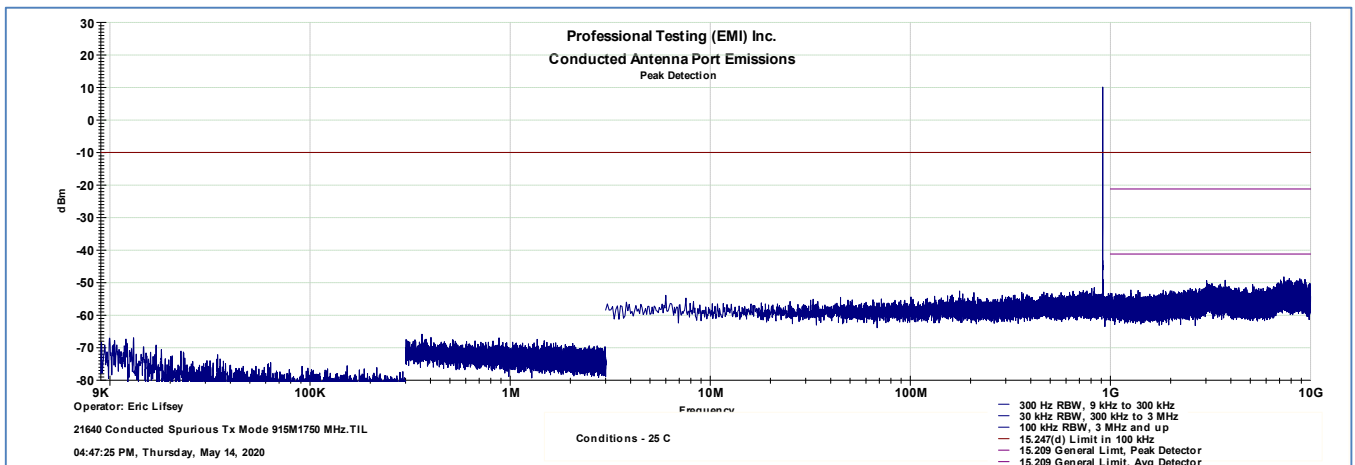
The EUT was tuned to the specified channels and placed into transmit mode.

Recorded peak levels were several dB below the general emission limit.

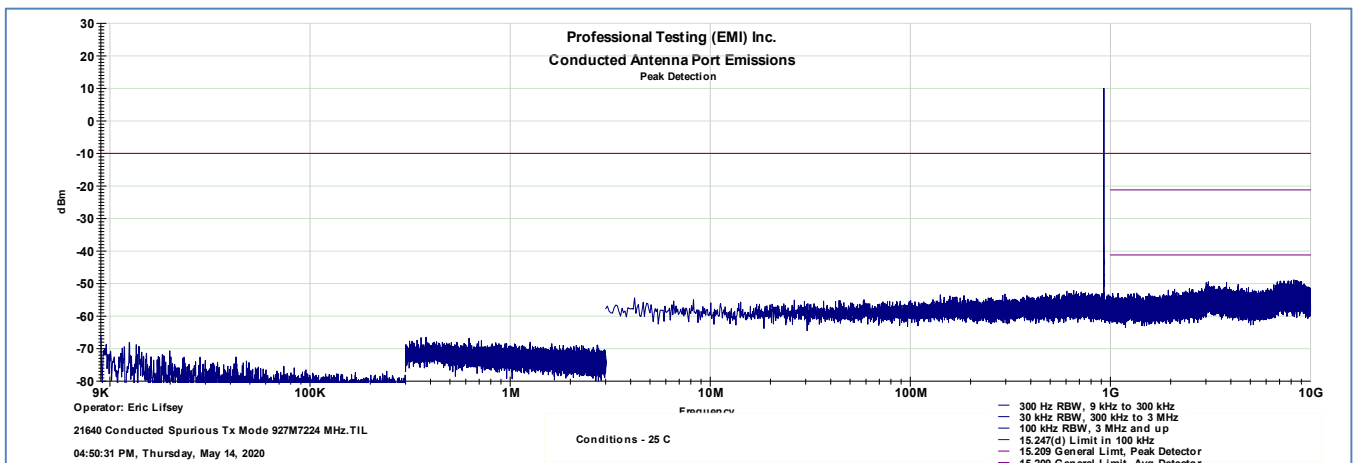
The EUT satisfied the criteria.



Bottom Channel



Middle Channel



Top Channel

9.0 Antenna Construction Requirements

9.1 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 and satisfy any limits on gain.

9.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203, 15.247 // RSS-Gen 8.3	Antenna Construction and Gain	1 June 2020

9.3 Results

Table 8.3.1 Antenna Construction Details
External RP-TNC Connector
Manufacturer: Gainflex Model/PN: GK-442TF-R Dipole type (for operating frequency of dual band design) TNC-Plug Rev. Polarity Length 207 mm Antenna gain -0.95 dBi. https://www.hetronic.nl/en/antenna-dual-band-type-gk-442tc-tnc-plug-420-480mhz-850-950mhz-l207-0mm/
Manufacturer: Laird Model/PN: EXC806TNX Monopole ¼ wave type TNC-Plug Rev. Polarity Length 10 mm (4 inches) Antenna gain estimated 1.2 dBi
Manufacturer: Terrawave Model/PN: MX202020R 10007 Monopole ¼ wave type N male with adapter to TNC-Plug Rev. Polarity Length 190 mm antenna, 225 with adapter Antenna gain 2.0 dBi.

The antenna designs above satisfies the requirements of the rules.

10.0 Frequency Hopping

10.1 Procedure

Measure frequency hopping performance to compare to requirements.

10.2 Criteria

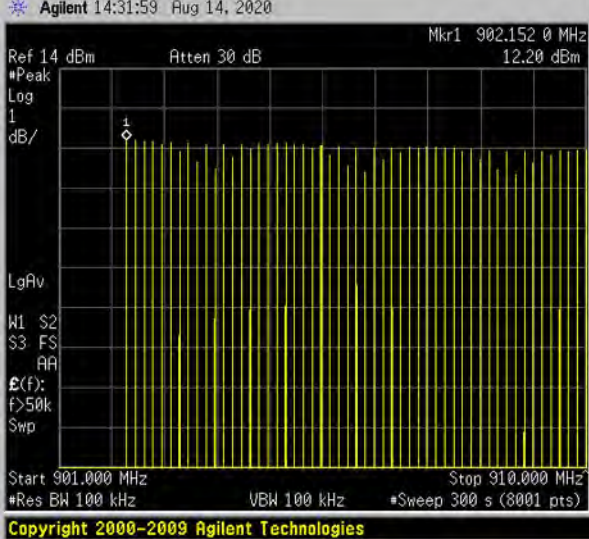
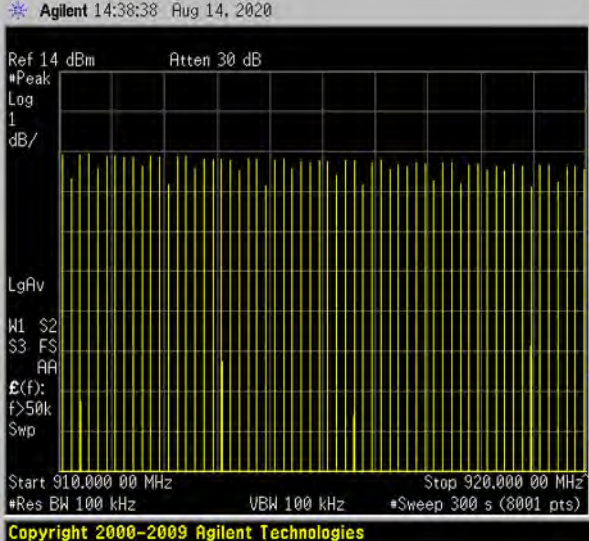
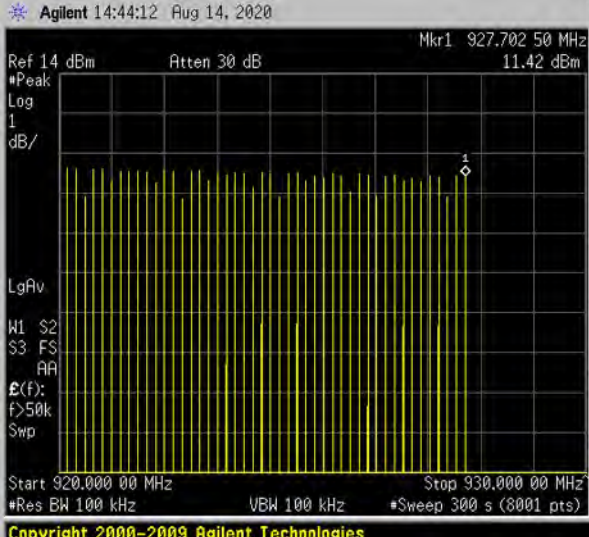
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203, 15.247 // RSS-Gen 8.3	Antenna Construction	18 Aug 2020

10.3 Results

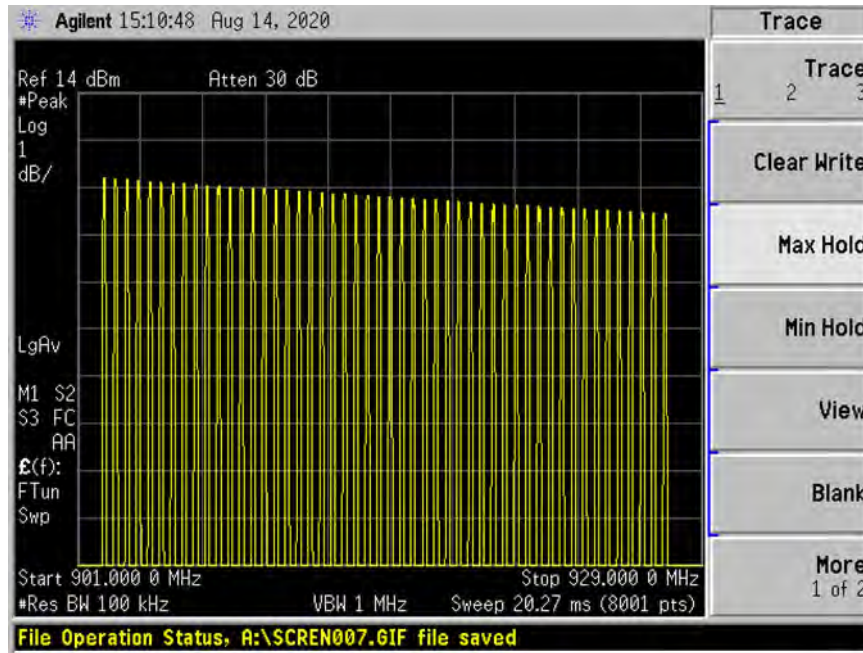
The requirements are satisfied.

The EUT utilizes a 50 channel (North America) and 25 channel (Australia) hopping scheme that is based on selection of a normal-spaced working channel set from an available more closely spaced base set of 159 channels. The normal spaced working channel set is selected by programming a “network” parameter at the factory. This further enhances the isolation between the industrial control systems located within wireless range of one another.

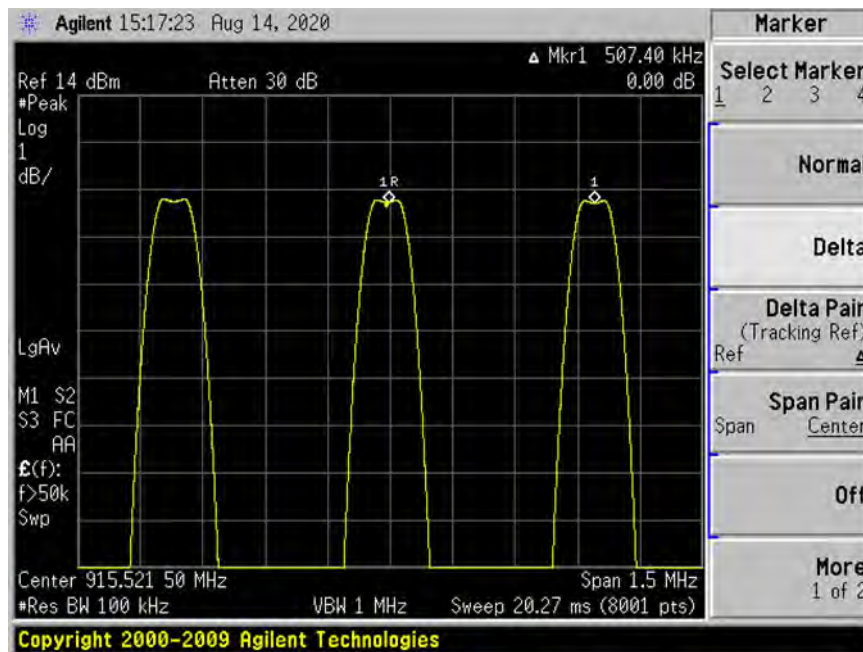
10.3.1 Base Set of Channels for All Networks

53 of 159 Channels	
60 of 159 Channels	
46 of 159 Channels	

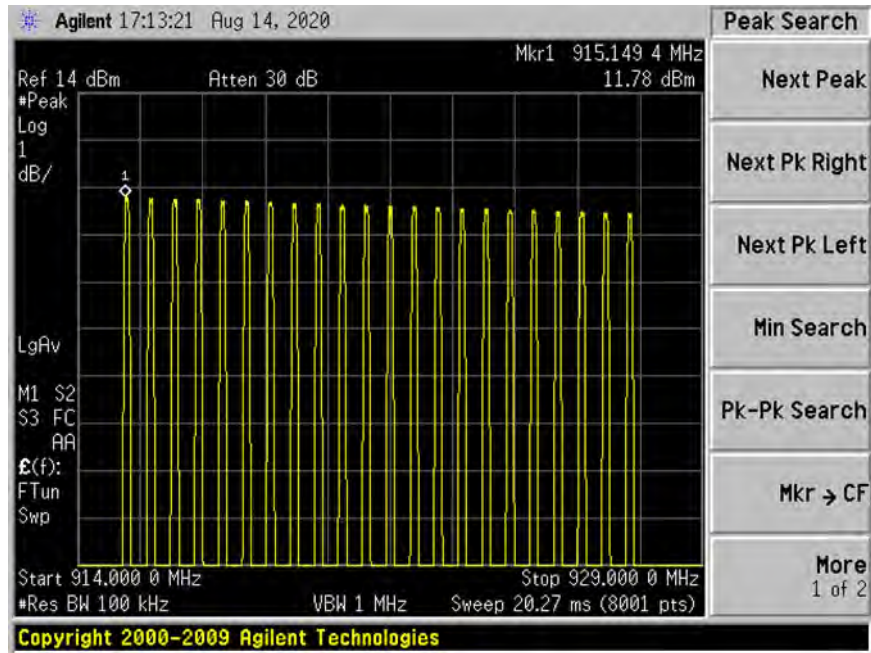
10.3.2 Working Set of Channels for North America



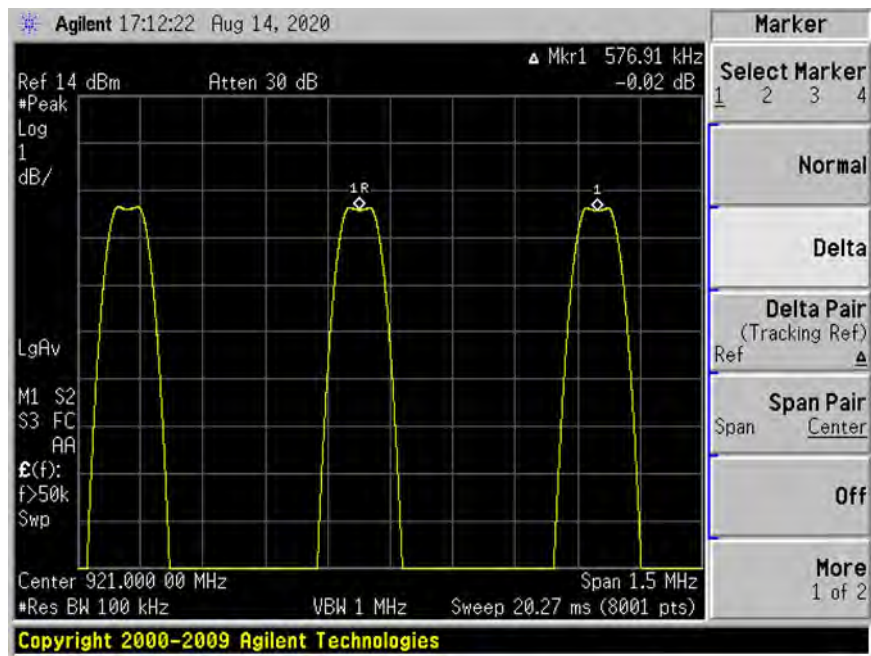
10.3.3 Channel Spacing for North America: 507.4 kHz



10.3.4 Working Set of Channels for Australia: 25



10.3.5 Channel Spacing for Australia: 576.91 kHz



11.0 Equipment

11.1 Radiated Emissions 30 MHz to 10 GHz

Radiated Emissions Test Equipment List					
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_v2.7.til Intentional Radiated Emissions_TILE7_v1.3.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	9/17/2021
1890	HP	8447F-H64	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/9/2022
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	11/6/2020
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	3/11/2021
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/9/2020
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	TDK 10M	TDK 10M Chamber, sVSWR > 1 GHz	DAC-012915-005	9/21/2021
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/9/2020
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	3/11/2021

11.2 Power, Bandwidth, Timings, Band Edge, Hopping Measurements, Conducted Spurious Transmit & Receive

Asset #	Manufacturer	Model #	Description	Calibration Due
1937	Agilent	E4440A	Spectrum Analyzer	8 Nov 2020
1443	HP	6215A	Power Supply	CIU
0463	Fluke	77	DMM	10 Jul 2020

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.				

Other measurements may use bandwidth settings as needed.

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 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 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