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November 1, 2018

Awearable Apparel, Inc.
19 Morris Avenue, Building 128
Brooklyn, NY 11205

Dear Drew Lauter,

Enclosed is the EMC Wireless test report for compliance testing of the Awearable Apparel, Inc. LynQ Smart Compass as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Awearable Apparel, Inc.\EMC101072-FCC247 DSS Rev. 1)

Electromagnetic Compatibility Criteria
Test Report

for the

Awearable Apparel, Inc.
LynQ Smart Compass

Tested under
the FCC Certification Rules contained in
Title 47 of the CFR, Part 15.247 Subpart C
for Intentional Radiators

MET Report: EMC101072-FCC247 DSS Rev. 1

November 1, 2018

Prepared For:

Awearable Apparel, Inc.
19 Morris Avenue, Building 128
Brooklyn, NY 11205

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

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Donald Salguero, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures 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 measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	October 24, 2018	Initial Issue.
1	November 1, 2018	Editorial & Engineering Corrections

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Awearable Apparel, Inc. LynQ Smart Compass, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the LynQ Smart Compass. Awearable Apparel, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the LynQ Smart Compass, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Awearable Apparel, Inc., purchase order number 1711. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Not Applicable
Title 47 of the CFR, Part 15 §15.247(a)(1)	20 dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Number of RF Channels	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RF Channel Separation	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Conducted Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Specific Absorption Rate (SAR)	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Awearable Apparel, Inc. to perform testing on the LynQ Smart Compass, under Awearable Apparel, Inc.'s purchase order number 1711.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the LynQ Smart Compass.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	LynQ Smart Compass	
Model(s) Covered:	LynQ Smart Compass	
EUT Specifications:	Primary Power: 3.3V Rail on device, Battery operated - 4.4 – 3.2VDC	
	FCC ID: 2ARHMLYNQ01	
	Type of Modulations:	LoRa
	Equipment Code:	DSS
	Peak RF Output Power:	21.31 dBm
	EUT Frequency Ranges:	902.3 – 927.3 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Donald Salguero	
Report Date(s):	November 1, 2018	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 447498 D01	General RF Exposure Guidance v05r01

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

MET Laboratories is an ISO/IEC 17025 accredited site by A2LA. (Baltimore #0591.01)

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The Awearable Apparel, Inc. LynQ Smart Compass, Equipment Under Test (EUT), is a wearable, one-button device with a carabiner. This Outdoor Device provides real-time location of your friends/family in a range of 3 miles. The location information is presented in simple distance and arrow on a screen.

The intended use case is anywhere outdoors for group of people who intend to stay together especially skiing, hiking, amusement parks, festivals etc.

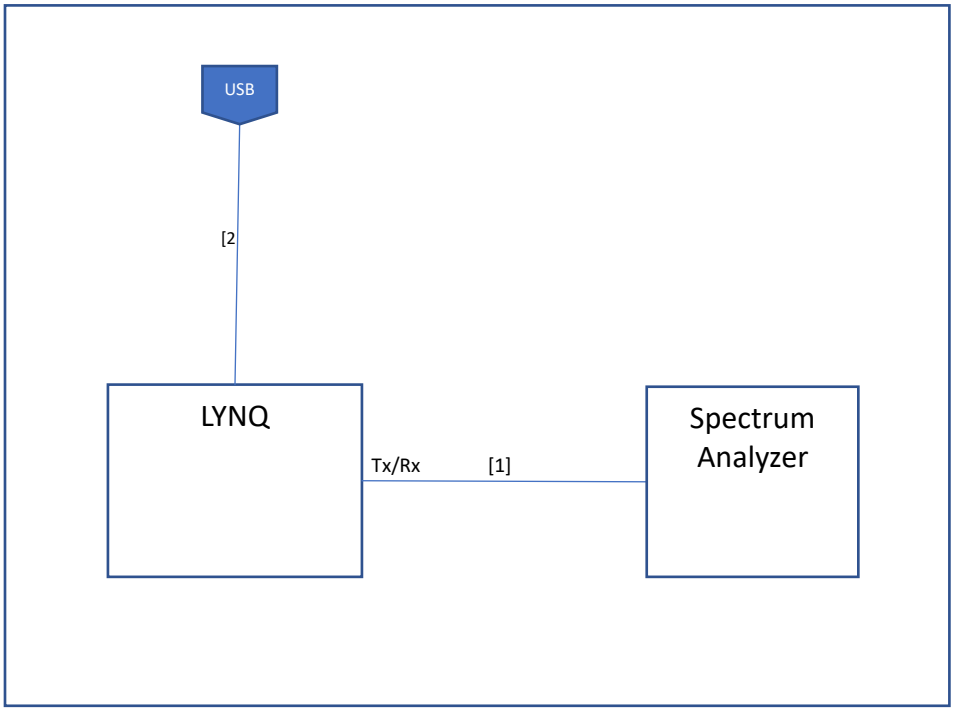


Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Part Number	Serial Number	Revision
1	LynQ Device	Lynq R12	12 G/E	N/A	12

Table 5. Equipment Configuration

G. Support Equipment

The EUT did not require any support equipment for operation or monitoring.

H. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length as tested (m)	Shielded (Y/N)	Termination Point
1	UFL Port/Antenna	UFL Connector/ Air (over the air measurements)	1	--	--	--
2	USB Input (not needed)	Micro USB wire for charging	1	1	Yes	5V

Table 6. Ports and Cabling Information

I. Mode of Operation

Pairing Mode: This mode is used to form Squad/Group for the LynQ device application. This mode is activated only once in the group forming stage by going to menu and selecting it using the button on the device. In this mode the devices sends/receive packets from other devices using LoRa modulation over the air. This mode lasts about 30 – 60 seconds and the result is shown on device whether it succeeded or failed.

Normal Mode: Once the device has passed the pairing mode the device switches to Normal Mode of operation. In this mode the device frequency hops and using LoRa modulation transmits and receives packets. There would be >50 channels used for this mode.

There is radio Test mode that can be accessed in the menu. This mode

J. Method of Monitoring EUT Operation

As it is an over the air method of transmission/reception there is following ways that can be used to monitor:

1. A counter on the screen of the device that denotes the number of packets sent and another counter for packets received.
2. A green LED will blink when a error-free packet is received on the EUT device.

K. Modifications

a) Modifications to EUT
No modifications were made to the EUT.

b) Modifications to Test Standard
No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Awearable Apparel, Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. EUT uses a built-in antenna

Test Engineer(s): Donald Salguero

Test Date(s): October 4, 2018

Gain	Type	Model	Manufacturer
0dBi	Spiral Antenna	Custom	

Table 7. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT was not applicable with this requirement. While the radio is under operation, it runs on its battery.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) 20 dB Occupied Bandwidth

Test Requirements: **§ 15.247(a):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Procedure: The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

Test Results The EUT was compliant with § 15.247 (a)(2).

Test Engineer(s): Donald Salguero

Test Date(s): October 5, 2018

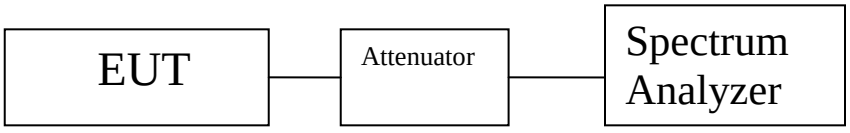
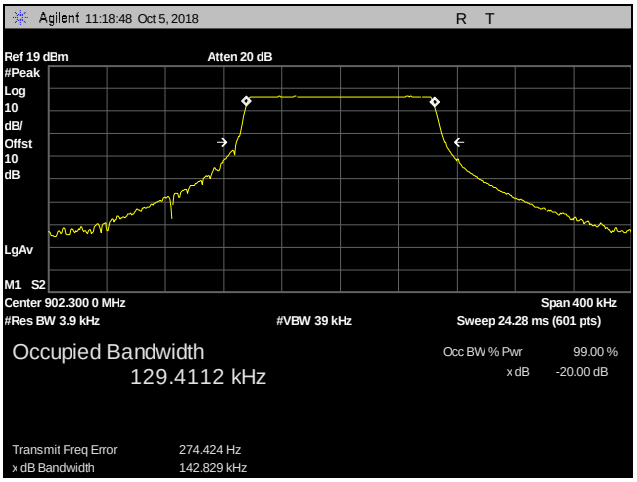


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

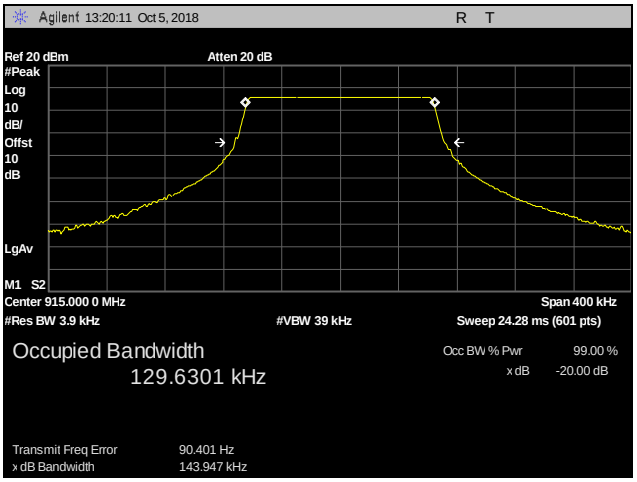
Center Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
902.3	142.829	129.4112
915	143.947	129.6301
927.3	144.387	129.5631

Test Results, Occupied Bandwidth

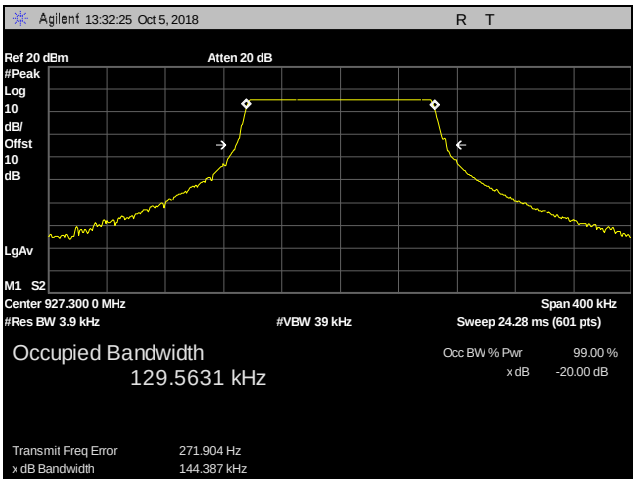
20 dB Occupied Bandwidth Test Results



Plot 1. 20 dB Occupied Bandwidth, Low Channel



Plot 2. 20 dB Occupied Bandwidth, Mid Channel



Plot 3. 20 dB Occupied Bandwidth, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Average Time of Occupancy (Dwell Time)

Test Requirements: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.4 from ANSI C63.10 – 2013 was used to compute the unit's dwell time.

Remarks: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

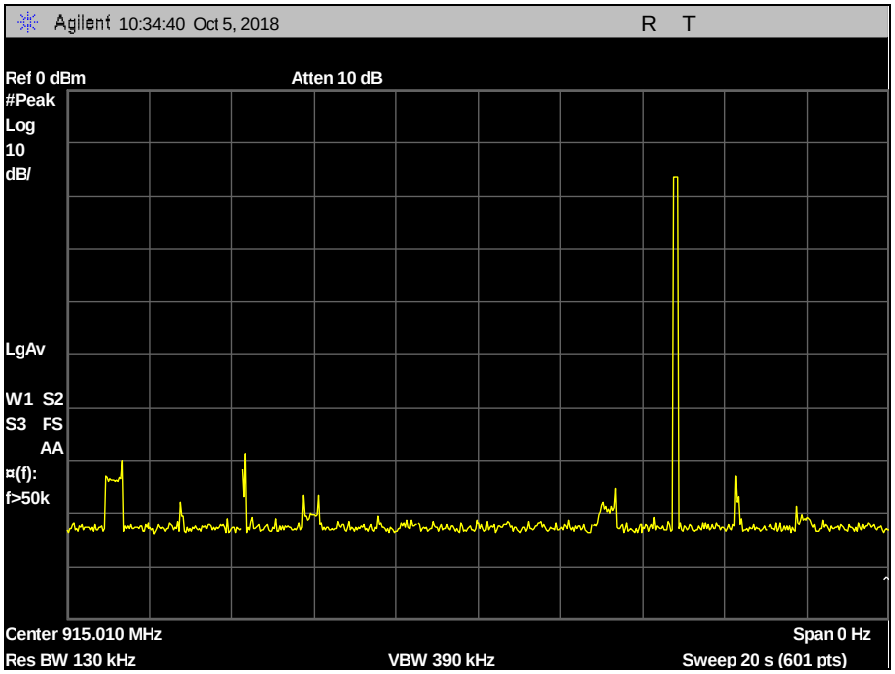
Test Engineer(s): Donald Salguero

Test Date(s): October 5, 2018

Dwell Time							
Frequency Range (MHZ)	**No. of Channels**	**Hopping Period (s)**	**No. of Burst per Period**	**Burst duration (s)**	**Dwell Time (s)**	**Limit (s)**	**Margin**
902-928	51	20	1	0.07901	0.07901	0.4	-0.32099

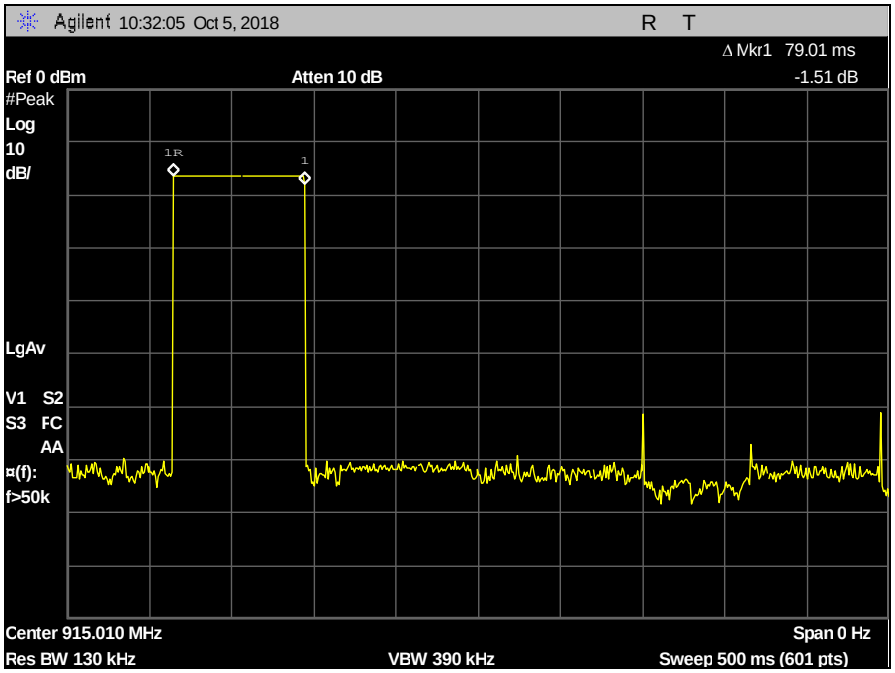
Table 9. Average Time of Occupancy

Dwell Time



Plot 4. Dwell Time, Burst Per Period

Number of Pulses



Plot 5. Pulse Width

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Number of RF Channels

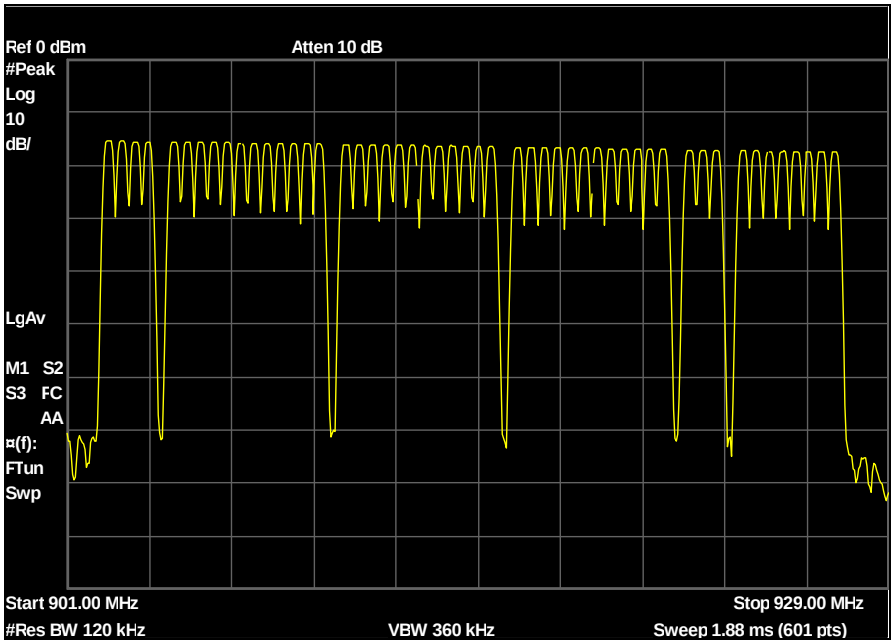
Test Requirements: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.3 from ANSI C63.10 – 2013 was used to count the number of hopping channels.

Test Results The EUT was compliant with § 15.247 (a)(1)(i). No anomalies detected.

Test Engineer(s): Donald Salguero

Test Date(s): October 5, 2018



Plot 6. Number of Channels, Hopping ON 50+ Channels

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) RF Channel Separation

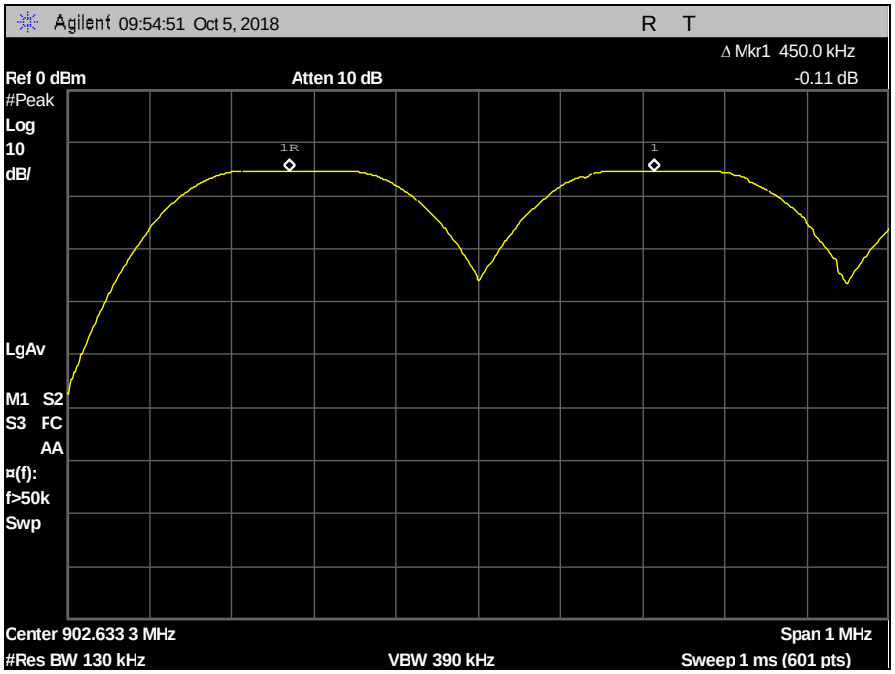
Requirement: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Procedure: The EUT had its hopping function enabled. Procedure 7.8.2 from ANSI C63.10 – 2013 was used to measure the channel separation.

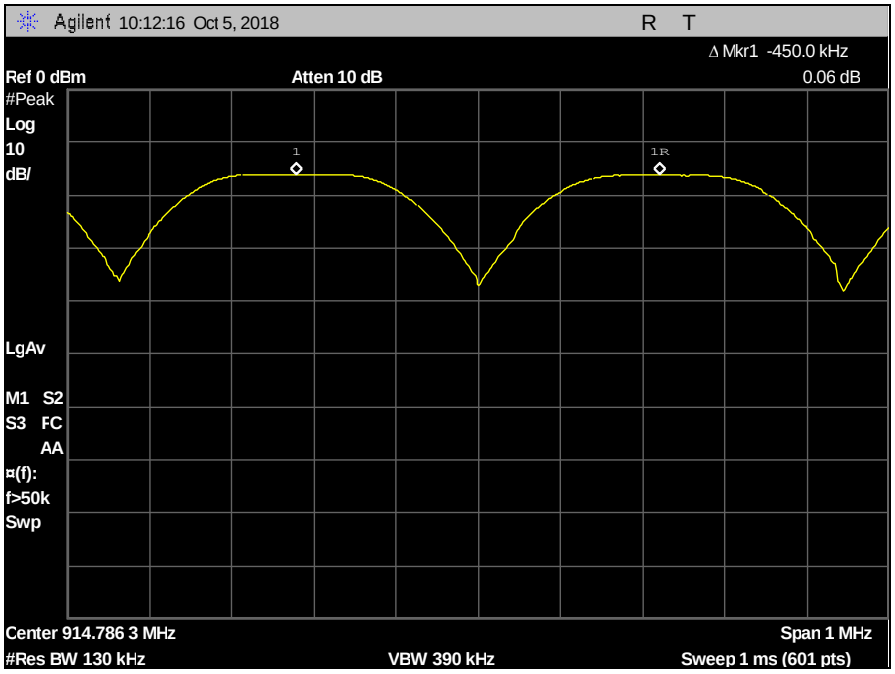
Test Results The EUT was compliant with § 15.247 (a)(1). No anomalies detected.

Test Engineer(s): Donald Salguero

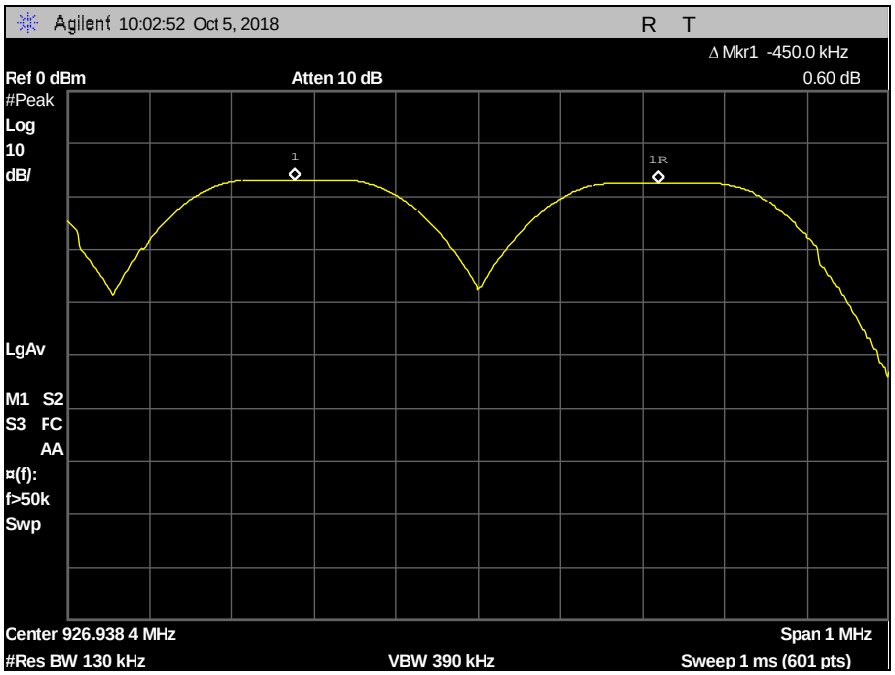
Test Date(s): October 5, 2018



Plot 7. Channel Separation, Low Frequencies



Plot 8. Channel Separation, Middle Frequencies



Plot 9. Channel Separation, High Frequencies

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b)(1):** The maximum peak output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Test Procedure: The transmitter was placed on top of a RF invisible turn-table inside a semi-anechoic chamber. The receive antenna was located 3m away from the EUT. The receive antenna had its height varied and the turn table was rotated until the max emission was found. The field strength was measured at the low, mid and high channels. Subclause 11.9.1.1 of ANSI C63.10 was used to measure the peak field strength.

Test Results: The EUT was compliant with the Peak Power Output limits of **§15.247(b)**.

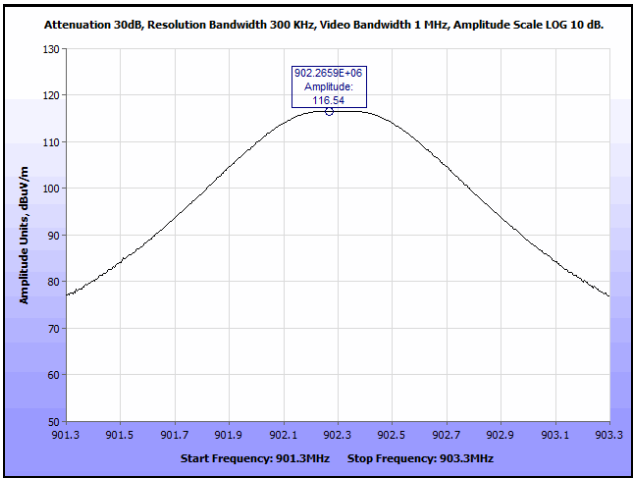
Test Engineer(s): Donald Salguero

Test Date(s): October 8, 2018

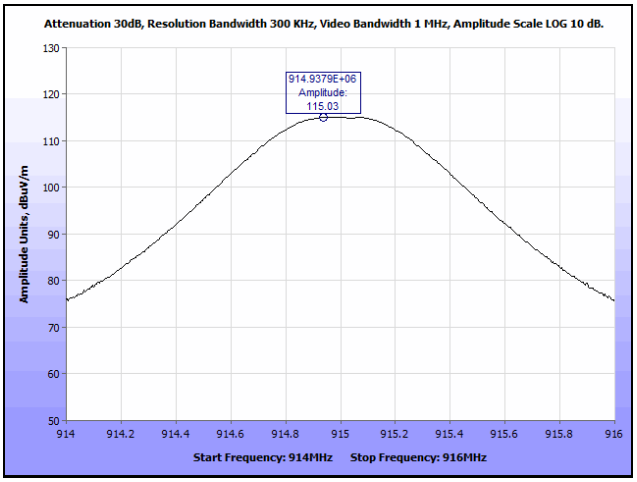
Center Frequency (MHz)	Measured Field Strength (dBuV/m)	EIRP (dBm)	Antenna Gain (dBi)	Conducted Power (dBm)
902.30	116.54	21.31	0.00	21.31
915.00	115.03	19.80	0.00	19.80
927.30	114.45	19.22	0.00	19.22

Table 10. Peak Power Output, Test Results

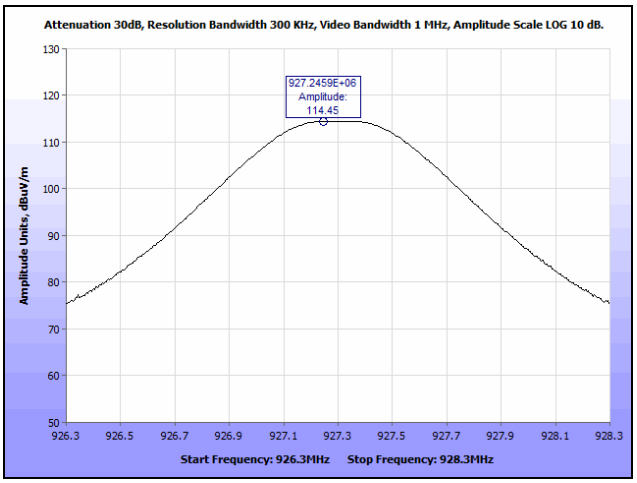
Peak Power Output Test Results



Plot 10. Peak Power Output, Low Channel, EIRP



Plot 11. Peak Power Output, Mid Channel, EIRP



Plot 12. Peak Power Output, High Channel, EIRP

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Table 11. Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 12.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 12. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedure: The transmitter was set to its low, mid, and high channel at the highest output power and placed on a 0.8 m high wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurements were repeated at the lowest and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor.

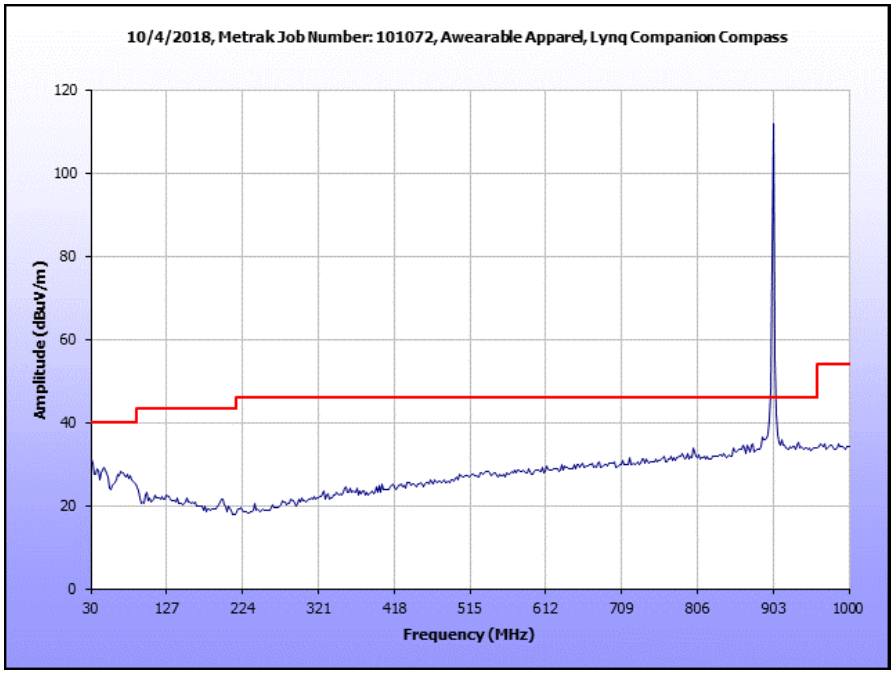
At the bande edges, since they do not fall on restricted bands, then as per 15.247(d) attenuation below the general limits specified in § 15.209(a) is not required.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

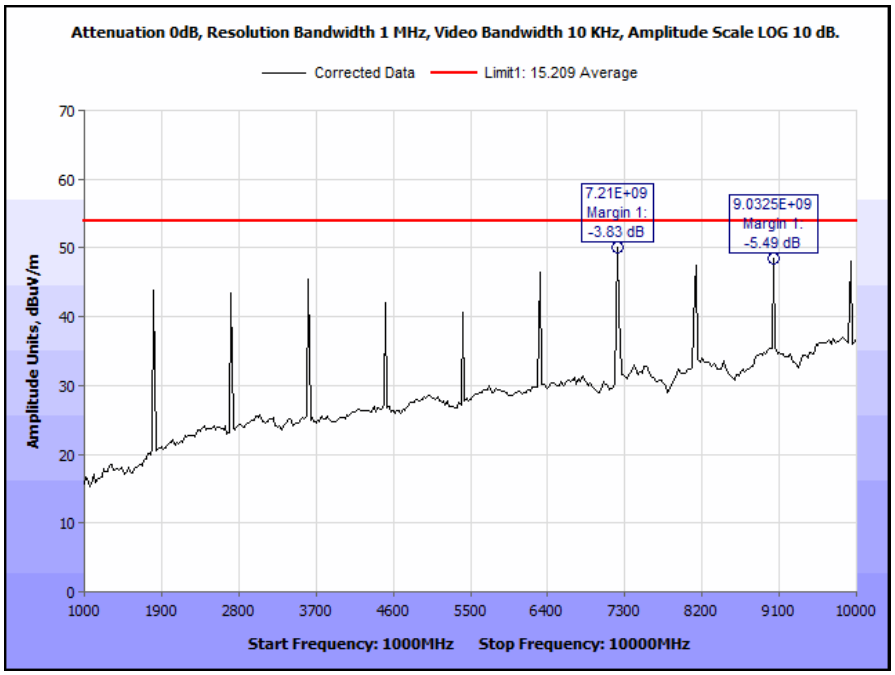
Test Engineer(s): Donald Salguero

Test Date(s): October 8, 2018

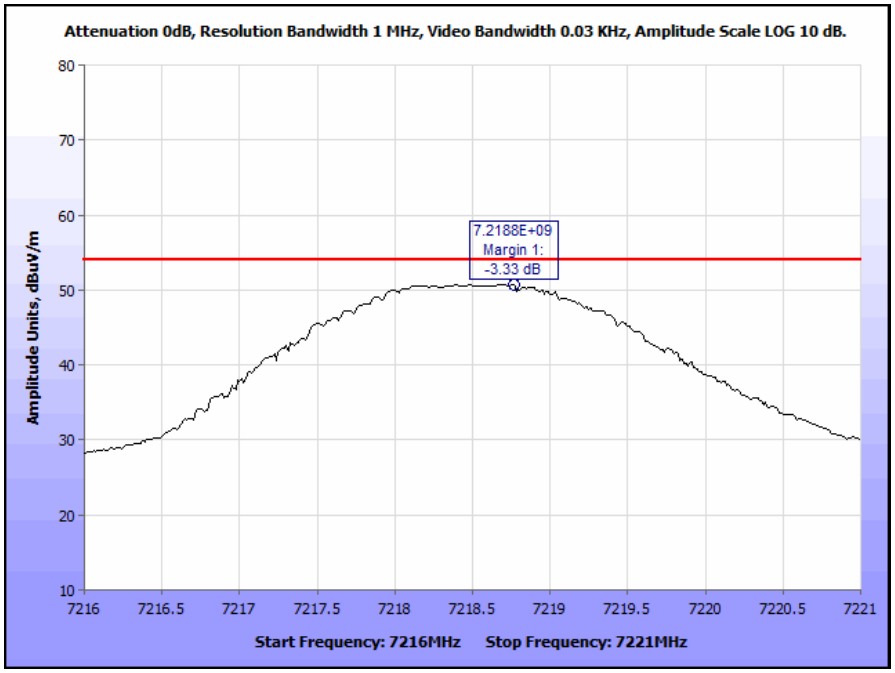
Radiated Spurious Emissions Test Results



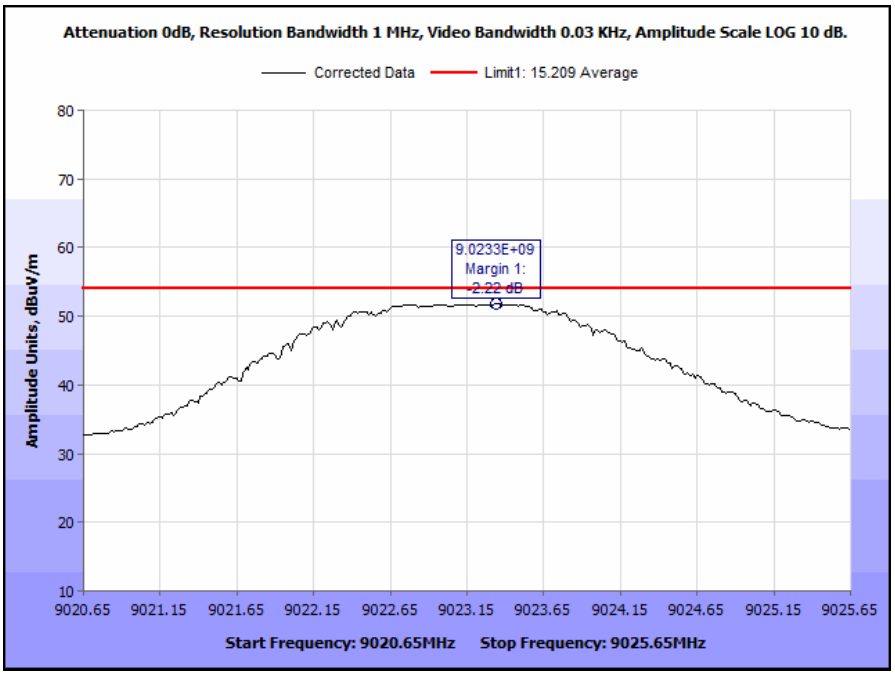
Plot 13. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz



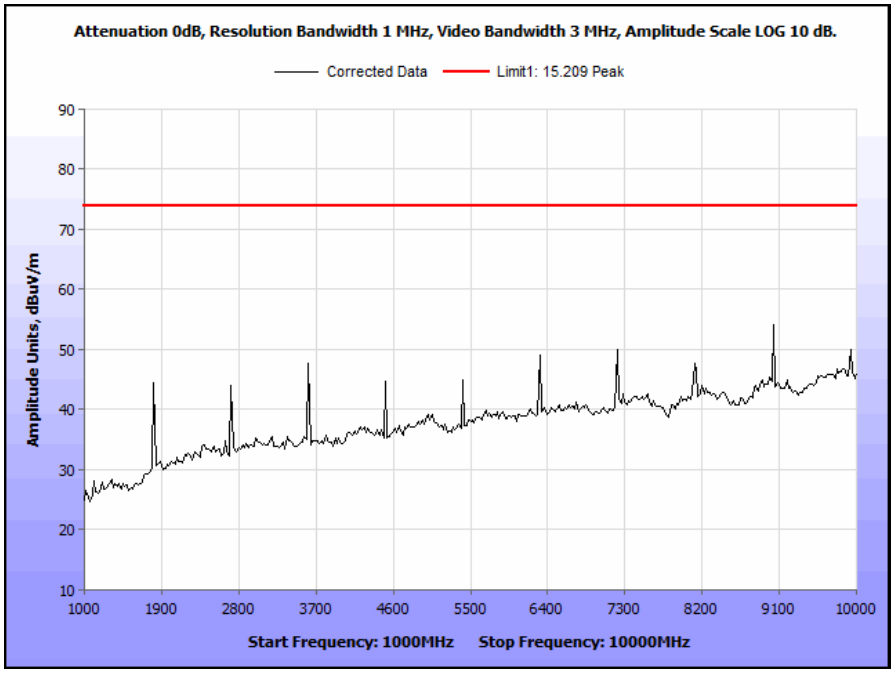
Plot 14. Radiated Spurious Emissions, Low Channel, 1 GHz – 10 GHz, Average



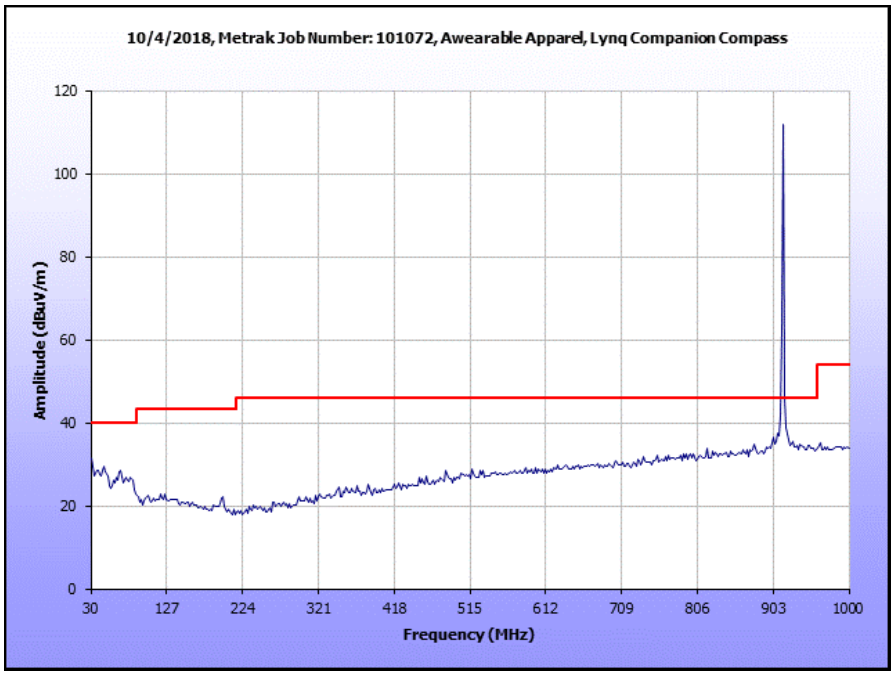
Plot 15. Radiated Spurious Emissions, Low Channel, 7.218 GHz Spur, Average



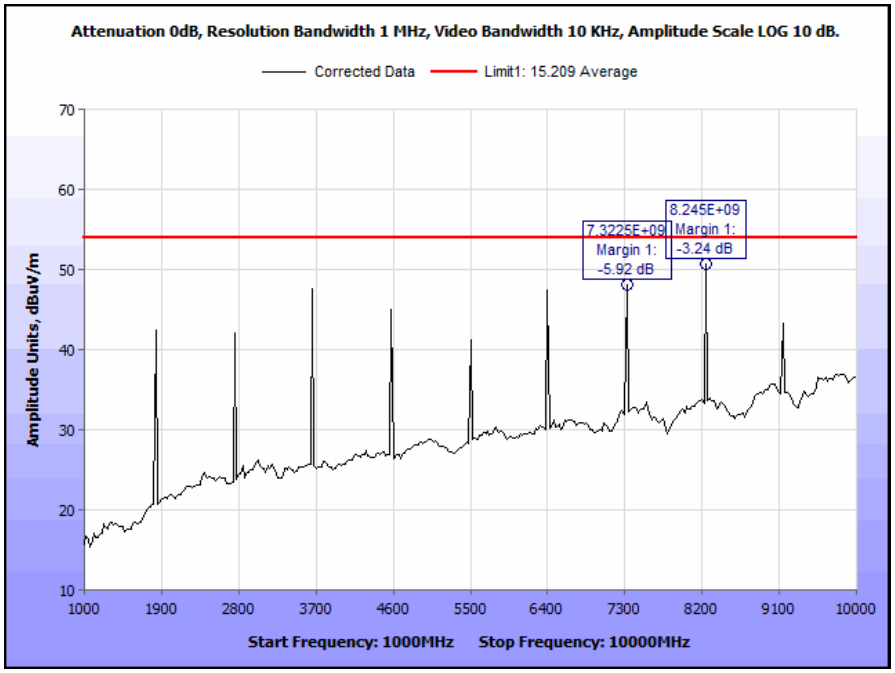
Plot 16. Radiated Spurious Emissions, Low Channel, 9.023 GHz Spur, Average



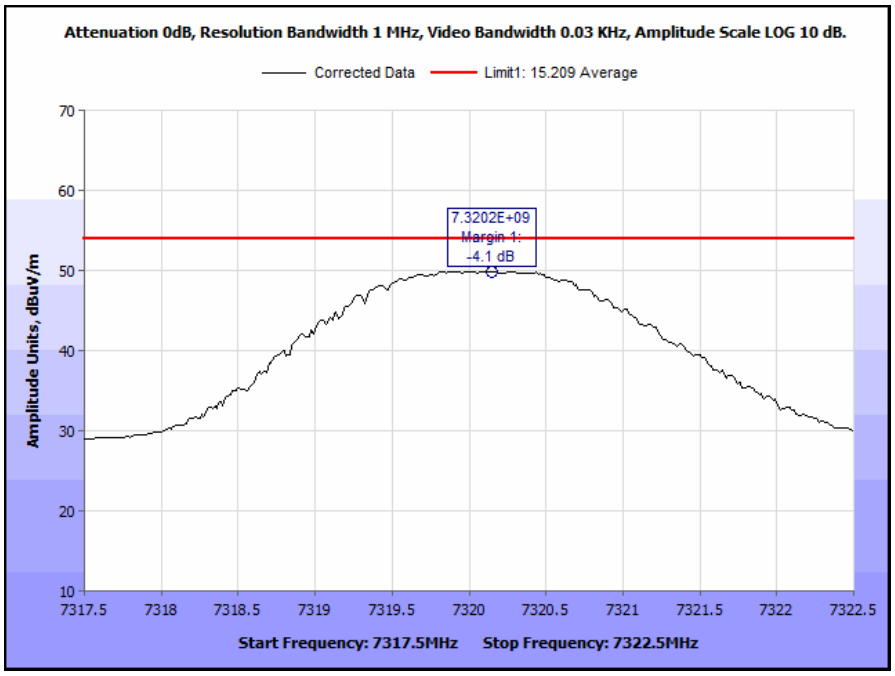
Plot 17. Radiated Spurious Emissions, Low Channel, 1 GHz – 10 GHz, Peak



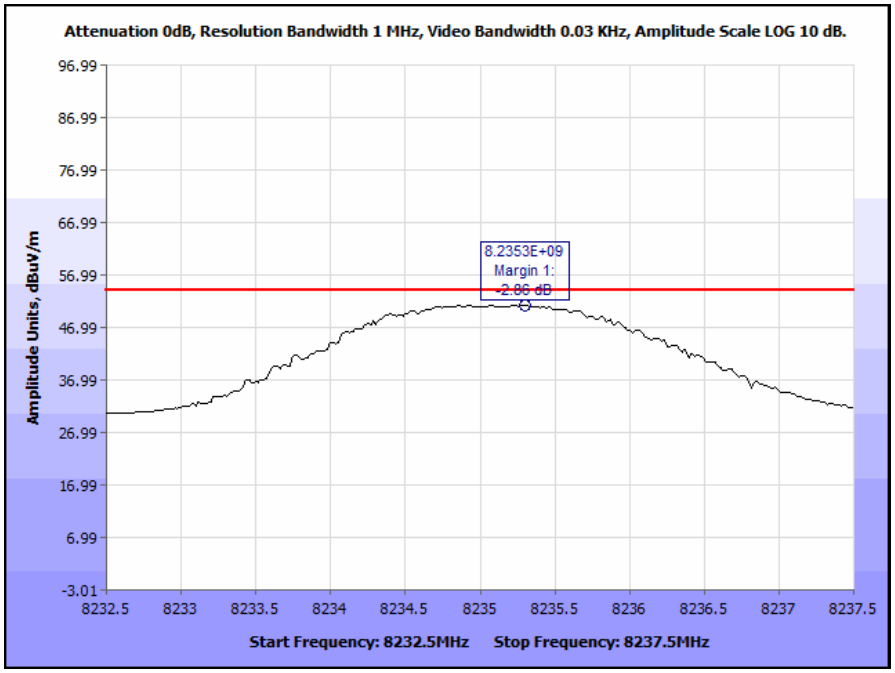
Plot 18. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz



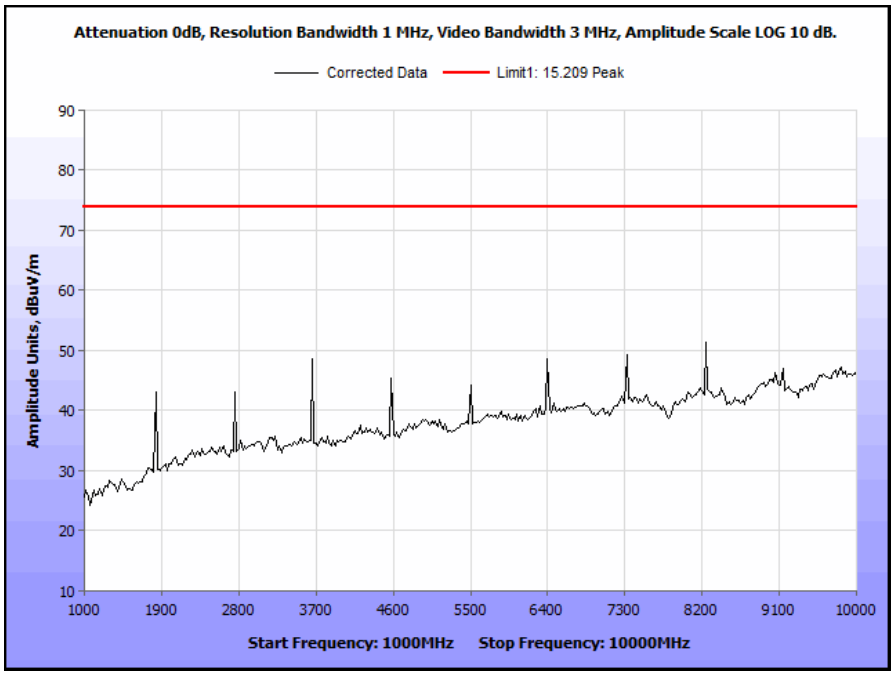
Plot 19. Radiated Spurious Emissions, Mid Channel, 1 GHz – 10 GHz, Average



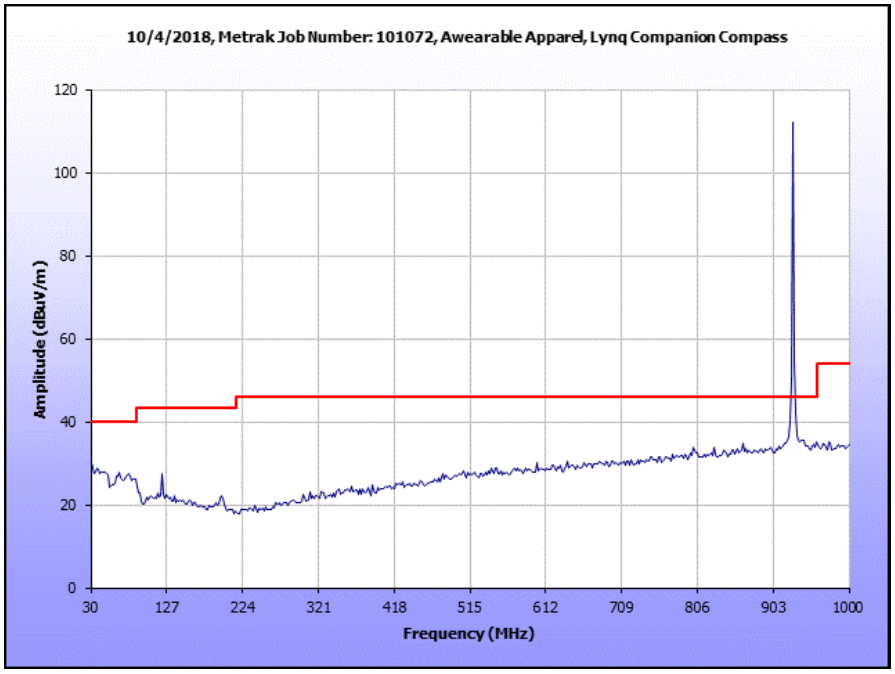
Plot 20. Radiated Spurious Emissions, Mid Channel, 7.32 GHz Spur, Average



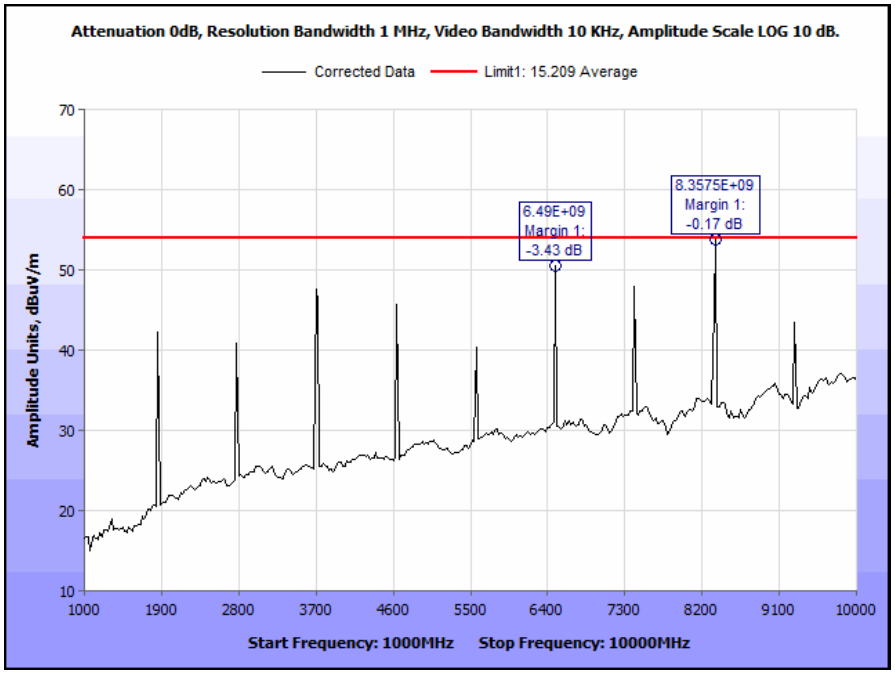
Plot 21. Radiated Spurious Emissions, Mid Channel, 8.235 GHz Spur, Average



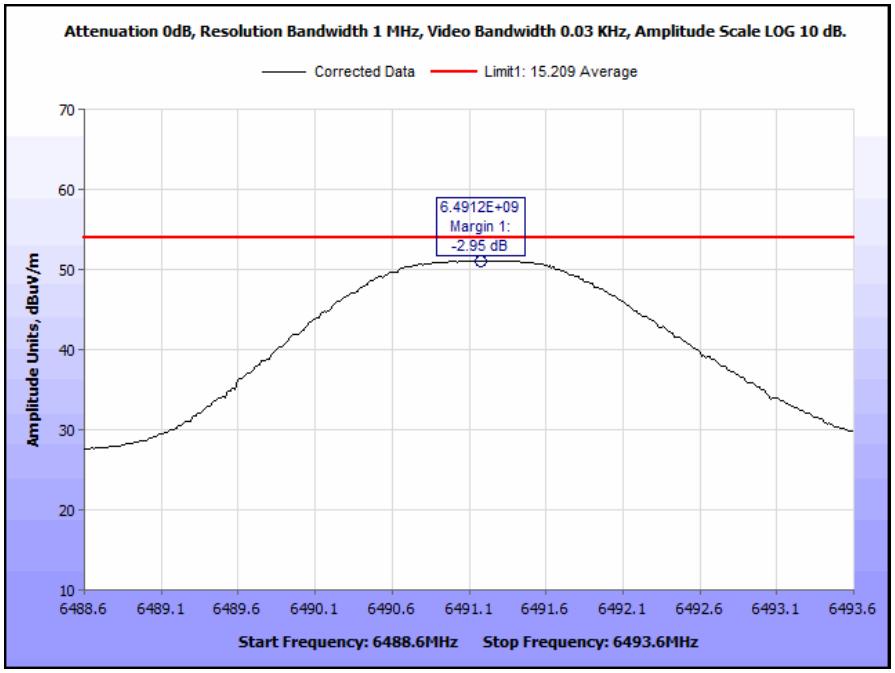
Plot 22. Radiated Spurious Emissions, Mid Channel, 1 GHz – 10 GHz, Peak



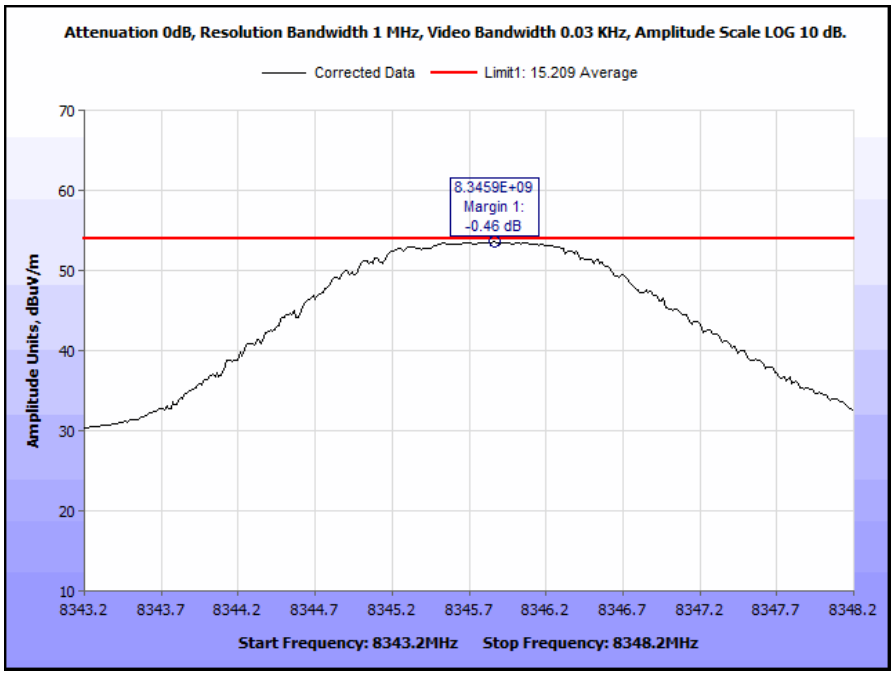
Plot 23. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz



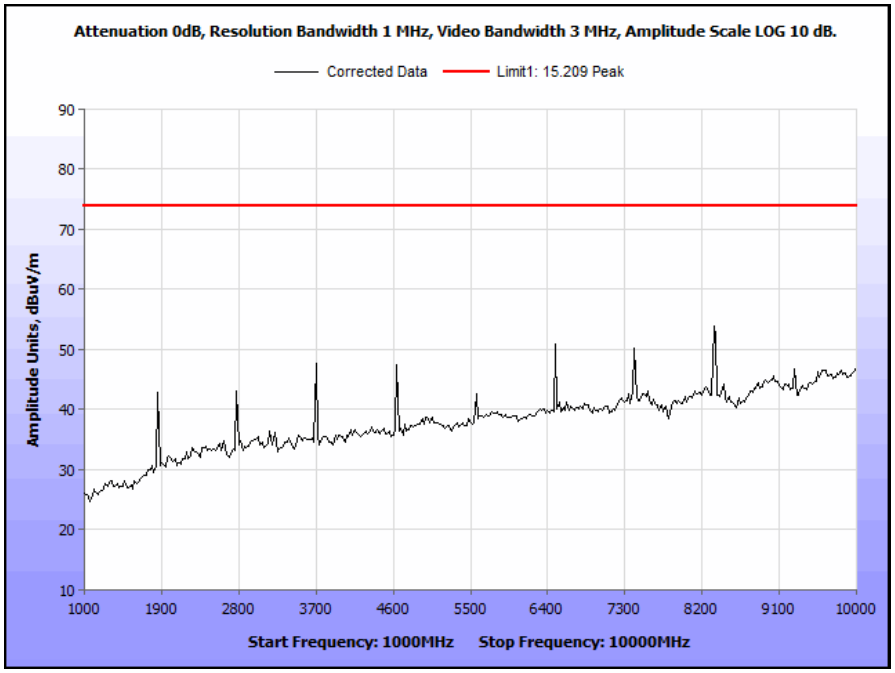
Plot 24. Radiated Spurious Emissions, High Channel, 1 GHz – 10 GHz, Average



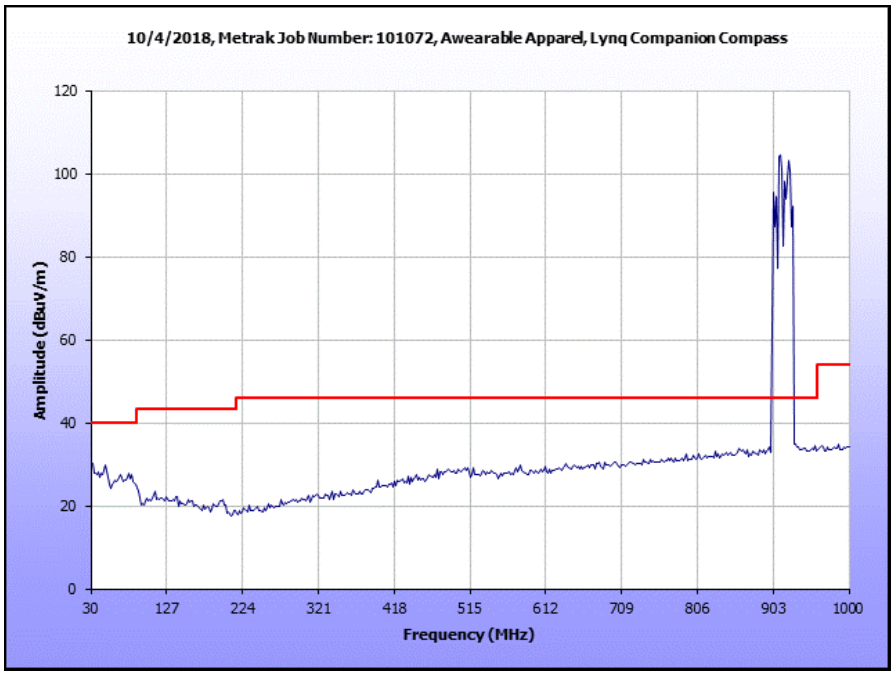
Plot 25. Radiated Spurious Emissions, High Channel, 6.491 GHz Spur, Average



Plot 26. Radiated Spurious Emissions, High Channel, 8.346 GHz Spur, Average



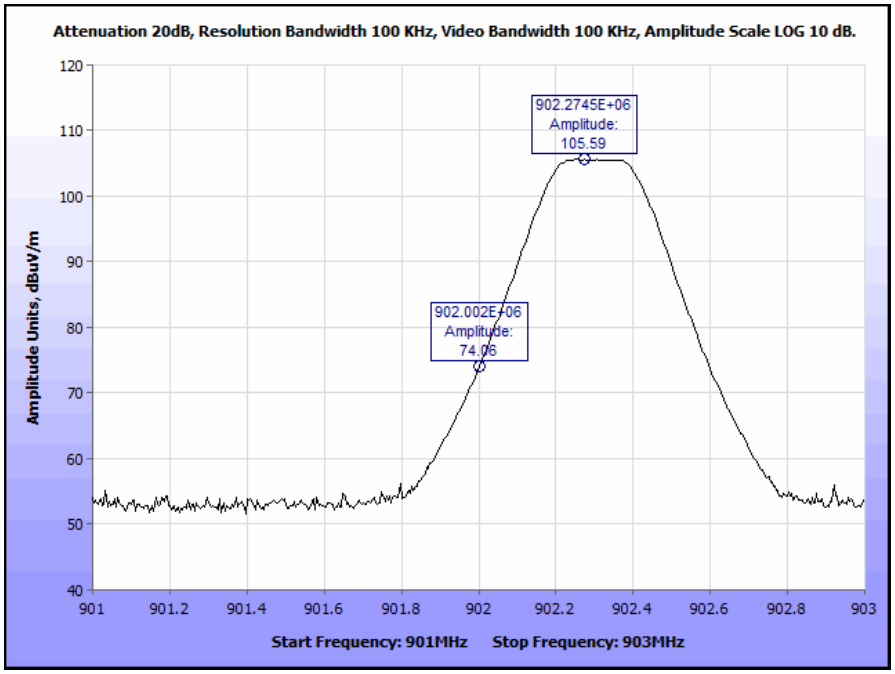
Plot 27. Radiated Spurious Emissions, High Channel, 1 GHz – 10 GHz, Peak



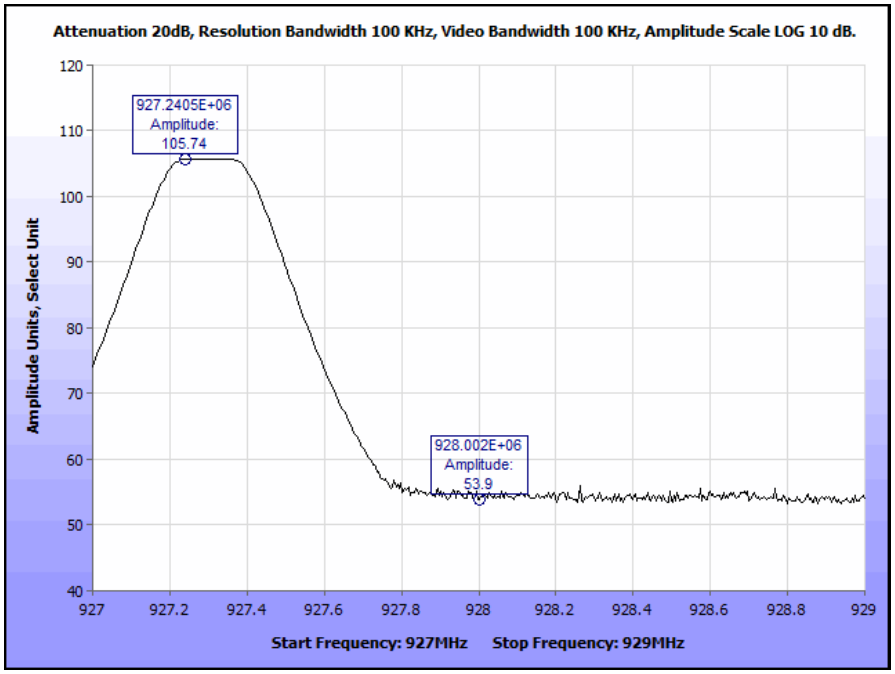
Plot 28. Radiated Spurious Emissions, Hopping On, 30 MHz – 1 GHz

Radiated Band Edge Measurements

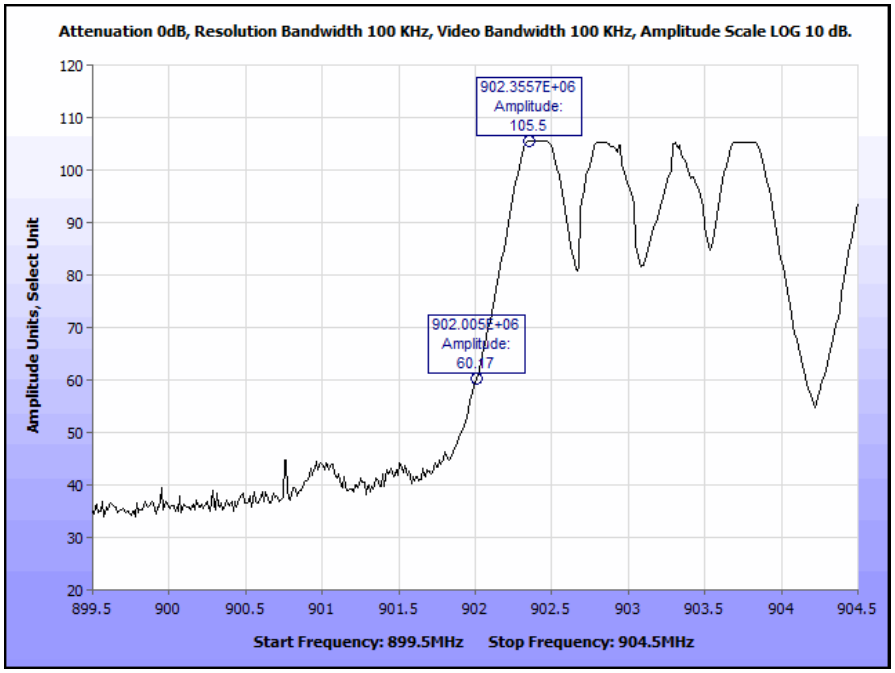
Test Procedures: The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.



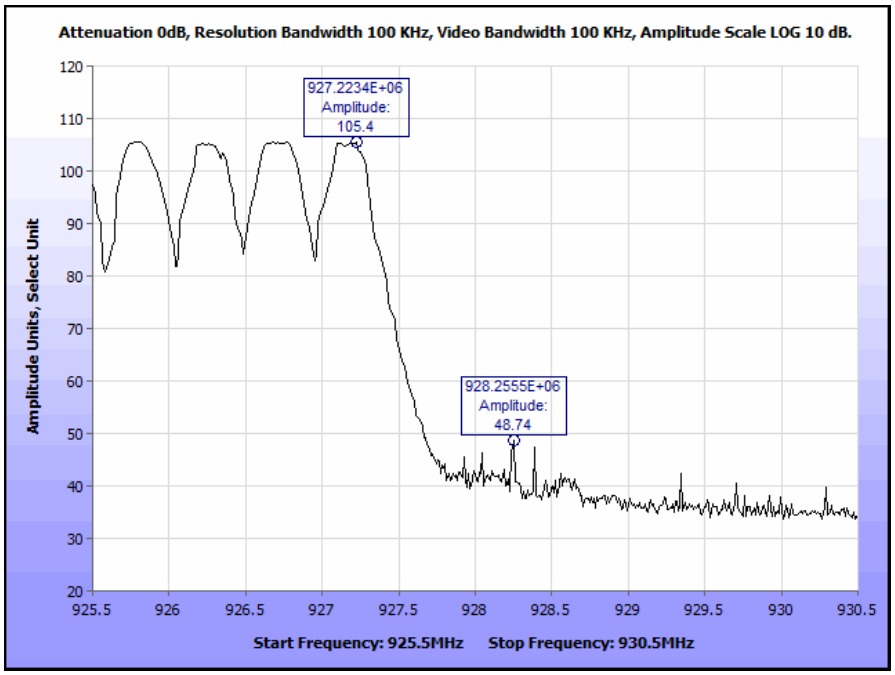
Plot 29. Radiated Restricted Band Edge, 125 kHz BW, Low Channel



Plot 30. Radiated Restricted Band Edge, 125 kHz BW, High Channel



Plot 31. Radiated Restricted Band Edge, Hopping On, Low Channel



Plot 32. Radiated Restricted Band Edge, Hopping On, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Test Results: The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

Test Engineer(s): Donald Salguero

Test Date(s): October 5, 2018

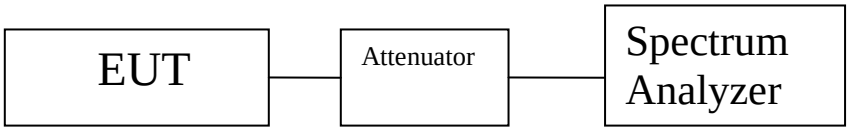
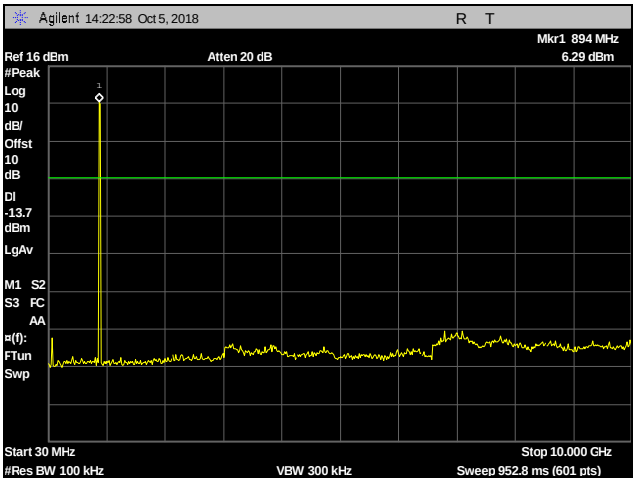
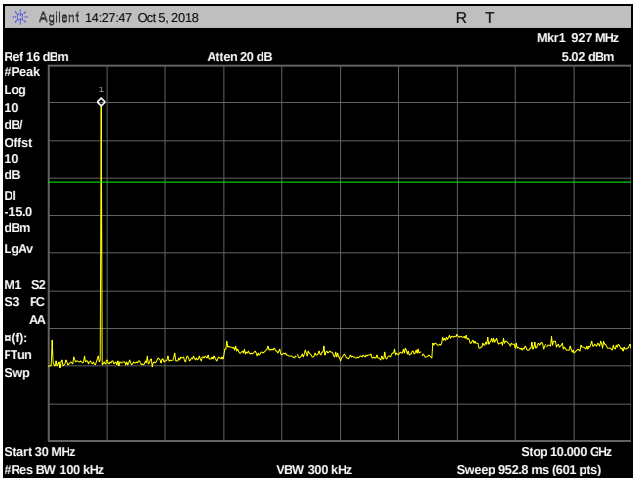


Figure 3. Block Diagram, Conducted Spurious Emissions Test Setup

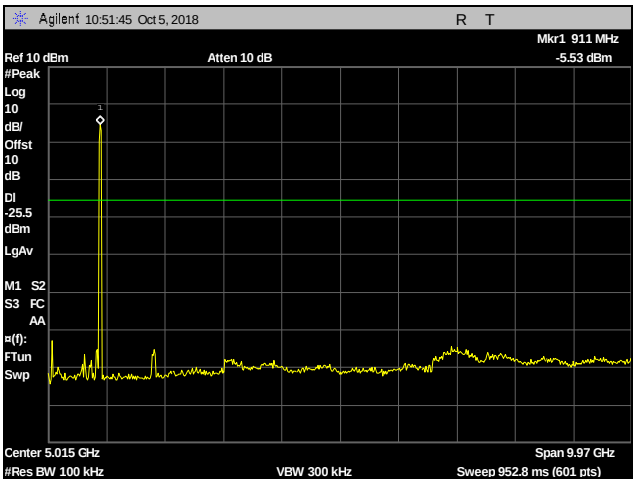
Conducted Spurious Emissions Test Results



Plot 33. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz

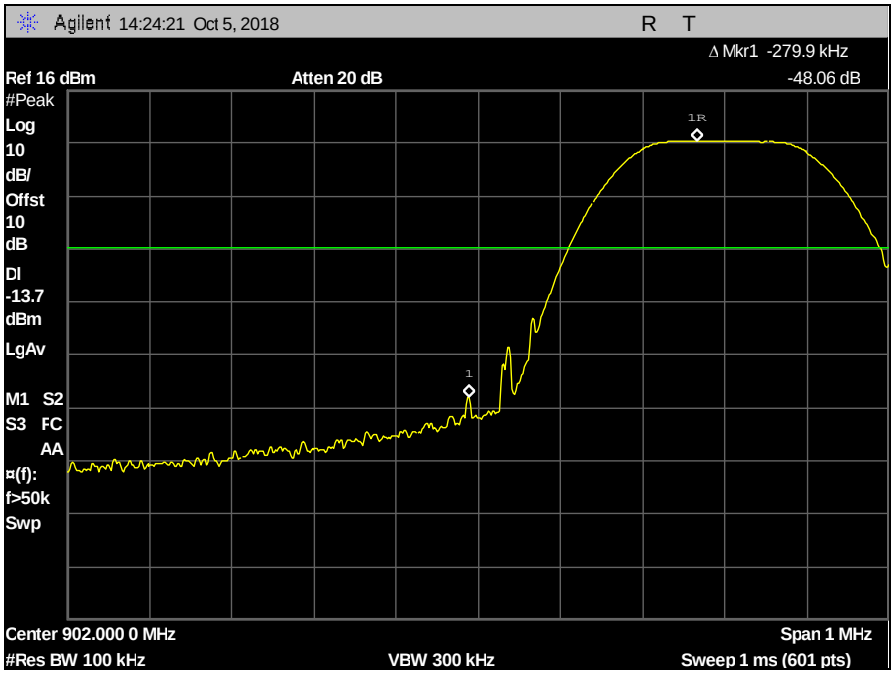


Plot 34. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz

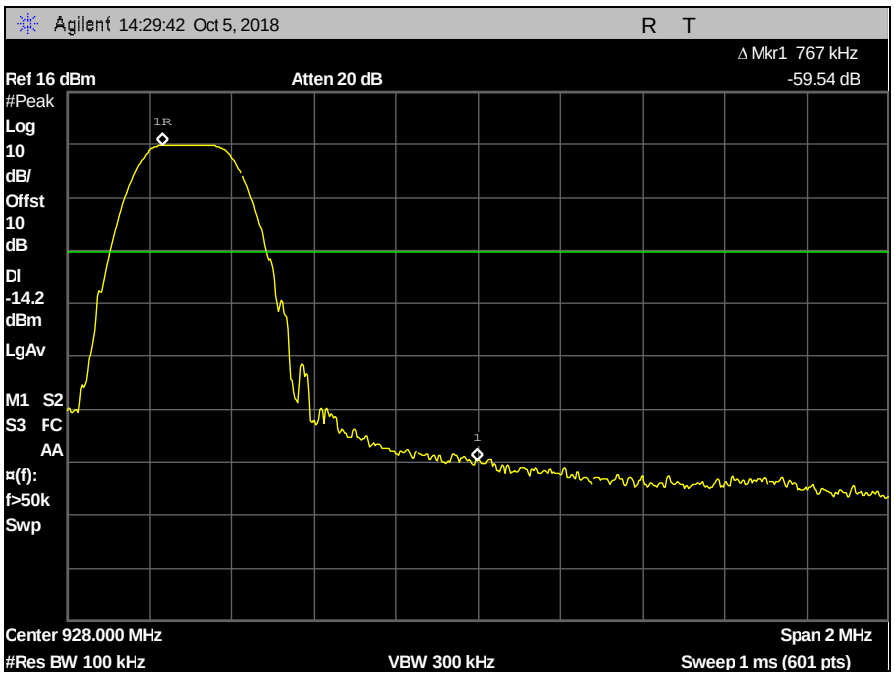


Plot 35. Conducted Spurious Emissions, Hopping On, 30 MHz – 1 GHz

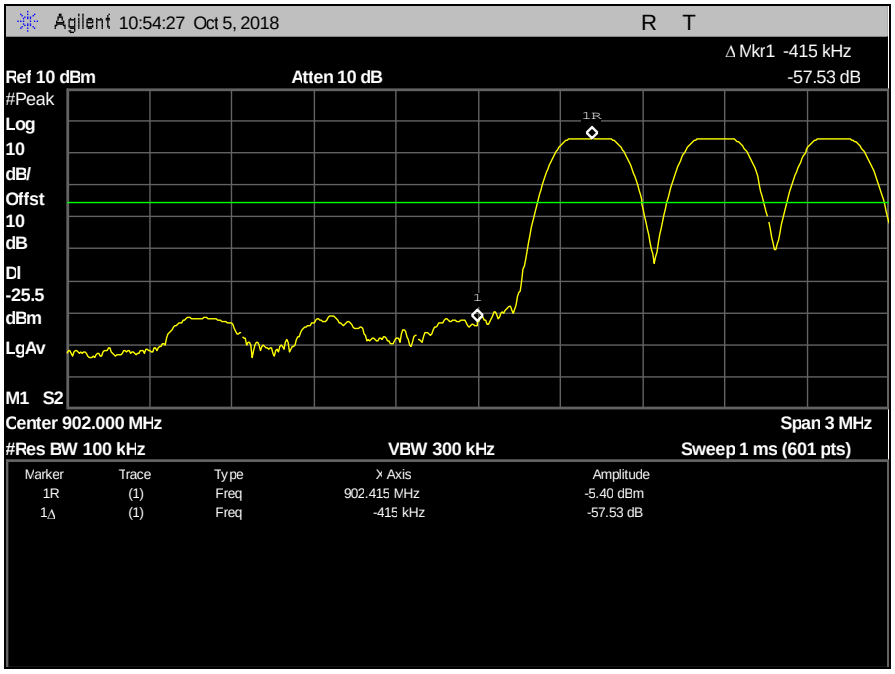
Conducted Band Edge Test Results



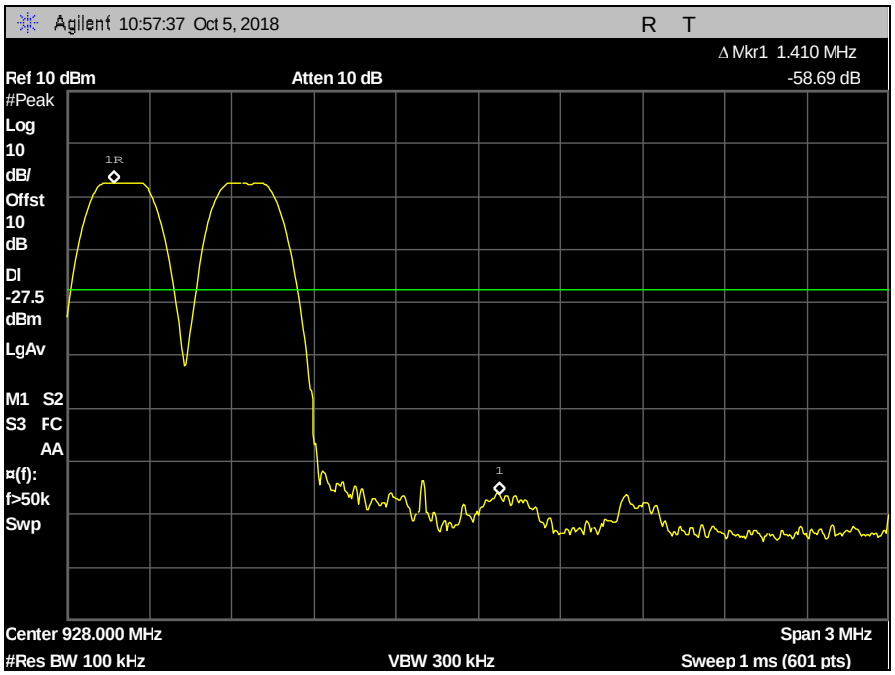
Plot 36. Conducted Band Edge, Low Channel



Plot 37. Conducted Band Edge, High Channel



Plot 38. Conducted Band Edge, Hopping On, Low Channel



Plot 39. Conducted Band Edge, Hopping On, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(g)(h) Declaration Statements for FHSS

LynQ - FHSS Statements

1) Section 15.247(a)(1):

i) Pseudorandom frequency hopping sequence

The device LYNQ is a group-based device. During Group Forming (pairing mode) stage, each member exchanges a randomly generated ID to each other. Using these randomly generated values a unique key value is selected/generated and shared with all the devices in the group. This key is used to generate the Frequency Hop Sequence of the group.

Each hop sequence has no less than 51 channels. The actual number of channels is dependent on the number of members in the Group. Using the Frequency Hop Group Sequence each device transmits in turn using a TDMA approach.

The hop sequence is derived from a list of equally spaced channels in the 902-928 MHz band, the spacing being dependent upon the bandwidth required. Using the randomly generated key as an initial offset, the set of hopping channels (the 'hop set') is established and shared with all units in the group. Frequency-hopping is achieved by all the units in a group tuning to each frequency in this hop set in turn after a predefined interval.

ii) Equal hopping frequency use

Each of the devices in a group has a GPS receiver, which can be used to align all units in a group onto a common time base. This common time base is used to implement a Time Division Multiple Access (TDMA) method. Each device uses this time base to establish a local clock which is synchronized to the other units. This local clock, along with the hop set table, determines which frequency to tune to, and whether a unit is to transmit or receive. After a certain interval, the all devices tune to the next frequency in the hop set.

iii) System receiver input bandwidth

In FHSS mode, each EUT has the circuitry to be programmed with a bandwidth of 64, 125 or 250 KHz. For our application in FHSS mode, the EUT is hard programmed to use one bandwidth only (125 KHz). The devices only transmit and receive this bandwidth. All the other signals with different bandwidths are disregarded.

iv) System receiver hopping capability

As Stated earlier, each device uses a TDMA approach, in this device is aware of when to transmit and receive a transmission. As the Hop set is shared to the group members in pairing mode. Each device is aware which frequency to listen to with a bandwidth (125 KHz) for the maximum period of time which is less than maximum dwell time stated by FCC (400 ms)

2) Section 15.247(g):

In FHSS mode, all transmissions of the EUT have a transmit time less than the maximum dwell time defined in the FCC regulations for the 900 ISM band (400mS). Following each transmission, all devices in the system jump to the next communication frequency in the hop set described above. The specific frequency selected is a function of the current time, the number of EUTs communicating with each other, as well as the key seed value, which is exchanged when the devices are first connected to each other.

3) Section 15.247(h):

The EUT receiver circuitry is limited in such a way that it may listen to, at most, a 500 kHz-wide portion of the 902-928 MHz ISM band at any given time. As such, our device lacks the means of ascertaining the

FHSS behavior of another device operating in the same band: even if EUT were to intercept a single transmission from such a device, it would not be able to detect enough additional transmissions made on subsequent hops by the other device to define a pattern, as these would be spread throughout the band, and therefore outside EUT's ability to receive.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Specific Absorption Rate (SAR)
§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices

RF Exposure Requirements:	**§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.
RF Radiation Exposure Limit:	**§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.
Remark:	EUT is portable, SAR evaluation required.
Criterion:	Compliant, referring to SAR report (Report Number:SAR.20181010)

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4483	Antenna; Horn	ETS-Lindgren	3117	4/19/2017	10/19/2018
1T8743	Preamplifier	A.H. Systems, Inc.	PAM-0118P	See note	
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	12/7/2016	12/7/2018
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	8/30/2018	8/30/2019
1T4300A	SEMI-ANECHOIC CHAMBER # 1 (FCC)	EMC TEST SYSTEMS	NONE	1/31/2016	1/31/2019
1T8818	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	6/4/2018	6/4/2019
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	5/4/2018	5/4/2019

Table 13. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report

