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January 30, 2021

Paragon Robotics
5386 Majestic Pkwy, Suite 2
Bedford Heights, Ohio 44146
USA

Dear Augustus Engstrom

Enclosed is the EMC Wireless test report for compliance testing of the Paragon Robotics, NG1 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 Eurofins E&E North America. If you have any questions regarding these results or if we can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

Arsalan Hasan
Wireless Laboratory

Reference: (\Paragon Robotics\WIRS108120-FCC247 (Whip) Rev 2)

ACCREDITED
TESTING CERT #0591.02

Electromagnetic Compatibility Criteria
Test Report

for the

Paragon Robotics
NG1

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

Report: WIRS108120-FCC247 (Whip) Rev 2

January 30, 2021

Prepared For:

Paragon Robotics
5386 Majestic Pkwy, Suite 2
Bedford Heights, Ohio 44146
USA

Prepared By:
Eurofins E&E North America
3162 Belick Street
Santa Clara, CA 95054

Electromagnetic Compatibility Criteria
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contained in
15.247 Subpart C for Intentional Radiators

Joseph Fale
Engineer, Wireless Laboratory

Arsalan Hasan
Manager, Wireless Laboratory

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.

Eleazar Zuniga, PhD.
Director, Wireless Technologies

Report Status Sheet

Revision	Report Date	Reason for Revision
0	December 7, 2020	Initial Issue.
1	January 13, 2021	TCB Updates
2	January 30, 2021	TCB Updates

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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**ertz
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**tz**
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	**micro**henry
µ	**micro**farad
µs	**micro**seconds
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

1.1 Purpose of Test

An EMC Wireless evaluation was performed to determine compliance of the Paragon Robotics, NG1, 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 NG1 Paragon Robotics should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the NG1, has been **permanently** discontinued.

1.2 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 Paragon Robotics, purchase order number 1589506678361. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
§15.203	Antenna Requirement	Compliant
§15.207(a)	Conducted Emission Limits	Compliant
§15.247(a)(1)	20dB Occupied Bandwidth	Compliant
§15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)	Number of RF Channels	Compliant
§15.247(a)(1)	RF Channel Separation	Compliant
§15.247(b)	Peak Power Output	Compliant
§15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
§15.247(d)	RF Conducted Spurious Emissions Requirements & Band Edge	Compliant

Table 1: Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

2.1 Overview

Eurofins MET Laboratories, Inc. was contracted by Paragon Robotics to perform testing on the NG1, under Paragon Robotics purchase order number 1589506678361.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Paragon Robotics, NG1.

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

Model(s) Tested:	NG1	
Model(s) Covered:	NG1	
EUT Specifications:	Primary Power: 5 VDC (AC/DC Power Adaptor 100-240VAC 50/60Hz)	
	FCC ID: 2AAA2-NX1W	
	Type of Modulations:	GFSK
	Equipment Code:	DSS
	Peak RF Output Power:	20.74 dBm
	EUT Frequency Ranges:	902 – 928 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Arsalan Hasan	
Report Date(s):	January 30, 2021	

Table 2: EUT Summary Table

2.2 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

Table 3: References

2.3 Test Site

All testing was performed at Eurofins MET Labs, 3162 Belick St., Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Eurofins MET Labs is a ISO/IEC 17025 accredited site by A2LA, California #0591.02.

2.4 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. Measurement Uncertainty

2.5 Description of Test Sample

The NG1 is a wireless transceivers designed to allow peer-to-peer communication between equipped devices on a wireless network. The NG1 is intended to be installed as a component module or daughter board on a parent device, typically a PCB. The modules are programmed with proprietary firmware which provides mechanisms for wireless connectivity, as well as various electronic input/output capabilities. The NG1 module's operation can provide extended wireless range, high data rates of up to 1Mbps, while having low power consumption.

2.6 Equipment Configuration

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Revision
1	NA	Wireless Transceiver	NG1	NA	NA	0
2	NA	Power Adaptor	PT-WC-08	NA	NA	0

Table 5: Equipment Configuration

2.7 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
NA	NA	NA	NA	NA

Table 6: Support Equipment

2.8 Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
NA	NA	NA	NA	NA	NA	NA	NA

Table 7: Ports and Cabling Information

Note: Any ports are not accessible to the end user and are used for debug / programming only on the device test sample.

2.9 Mode of Operation During Testing

The EUTs are loaded with a special test firmware which allows selection of all necessary test modes for full RF evaluation. Navigate through the menus by pressing the 4 arrow keys on the unit, with the "right" key always selecting or advancing through a menu item. The menu options are explained below:

BAND -> FCC/IC: Selects the 902-928MHz operating band (applies to all other test modes, and can only be toggled to CE mode)

BAND -> CE: Selects the 868MHz operating band (applies to all other test modes, and can only be toggled to FCC/IC mode)

TESTTONE -> OFF : Turns off test tone mode and device operates in normal beaconing mode
TESTTONE -> LOW : Uses an unmodulated test tone on channel 0 (lowest channel available)
TESTTONE -> MID : Uses an unmodulated test tone on channel 12 (FCC/IC mode) or 23 (CE mode)
TESTTONE -> HIGH : Uses an unmodulated test tone on channel 24 (FCC/IC mode) or 46 (CE mode)
TESTTONE -> REDUCEDPWR : Uses an unmodulated test tone on channel 12 (FCC/IC mode) or 23 (CE mode), but at approximately 20dBm less power (used to measure output power equivalent to the TX sensitivity mode (see below))

SENSITIVTY -> OFF : Turns off sensitivity mode and device operates in normal beaconing mode
SENSITIVTY -> TRANSMIT : Transmits a 500 byte packet every 1 second at approximately 20dBm reduced power (same as TESTTONE -> REDUCEDPWR) on mid channel
SENSITIVTY -> RECEIVE : Listens for valid packets and makes audible beep for each successful reception

LBT -> OFF: Turns off LBT mode and device operates in normal beaconing mode
LBT -> TRANSMIT : Same as SENSITIVTY -> TRANSMIT, except packet will not be sent if LBT senses signal strength above -60dBm

OTHER -> OFF : Turns off OTHER mode and device operates in normal beaconing mode
OTHER -> CYCLE-ALL : Same as SENSITIVTY -> TRANSMIT, except packets will be quickly sent on each successive channel in order to map out all FHSS channels used

CONFIGURATION 1: Directly connect EUT to spectrum analyzer (use for most tests)
CONFIGURATION 2: Directly connect EUT to another EUT to test sensitivity modes and LBT operation
CONFIGURATION 3: Directly connect EUT to another EUT via a splitter, and connect third splitter port to a signal generator to transmit signal on adjacent channel (used for CE blocking test)

2.10 Method of Monitoring EUT Operation

The signal will be displayed on a spectrum analyzer.

2.11 Modifications

2.11.1 Modifications to EUT

No modifications were made to the EUT.

2.11.2 Modifications to Test Standard

No modifications were made to the test standard.

2.12 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Paragon Robotics 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 **completed testing** to the criteria of §15.203.

Test Engineer: Joseph Fale

Test Date: October 30, 2020

Antenna Type:	Manufacturer	Gain (dBi):	Impedance	Polarization
Whip	Siretta ANTA2000A0200BR11	900MHz Band: 1 dBi	50 Ω	Vertical

Table 8: Antenna Requirement, 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 Σ 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 9: 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 compliant with this requirement.

Test Engineer: Joseph Fale

Test Date: October 30, 2020

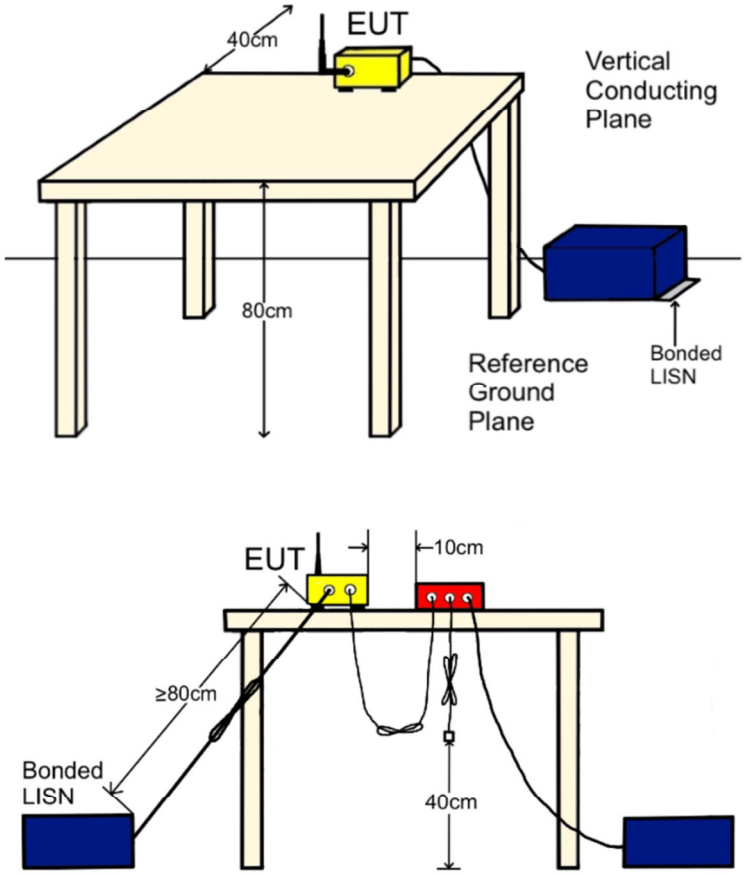
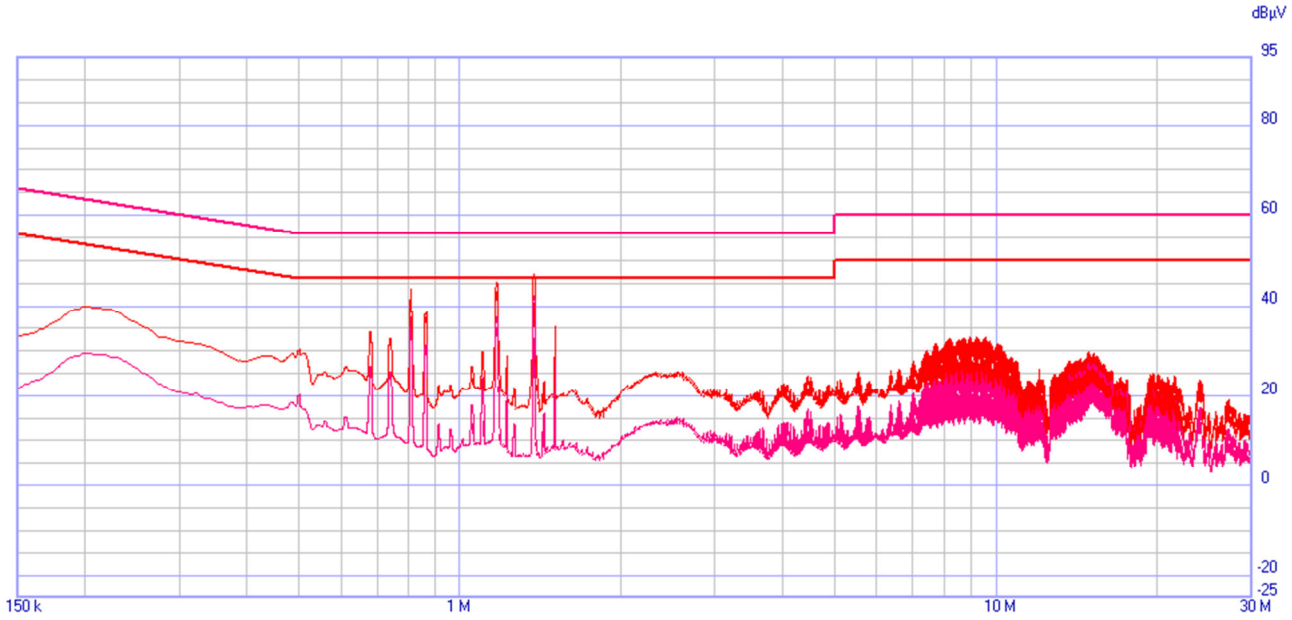


Figure 1: Conducted Emissions Voltage, Test Setup

Conducted Emissions - Voltage, AC Power, Line (120 VAC) Whip Antenna

	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line1	0.201125	41.4	63.571	-22.171	Pass	29.71	53.571	-23.861	Pass
Line1	0.810535	43.53	56	-12.47	Pass	36.29	46	-9.71	Pass
Line1	0.859615	38.42	56	-17.58	Pass	29.64	46	-16.36	Pass
Line1	1.170455	45.37	56	-10.63	Pass	36.98	46	-9.02	Pass
Line1	1.370865	49.1	56	-6.9	Pass	42.21	46	-3.79	Pass
Line1	1.4997	34.71	56	-21.29	Pass	26.89	46	-19.11	Pass

Table 10: Conducted Emissions - Voltage, AC Power, Line (120 VAC) Whip Antenna

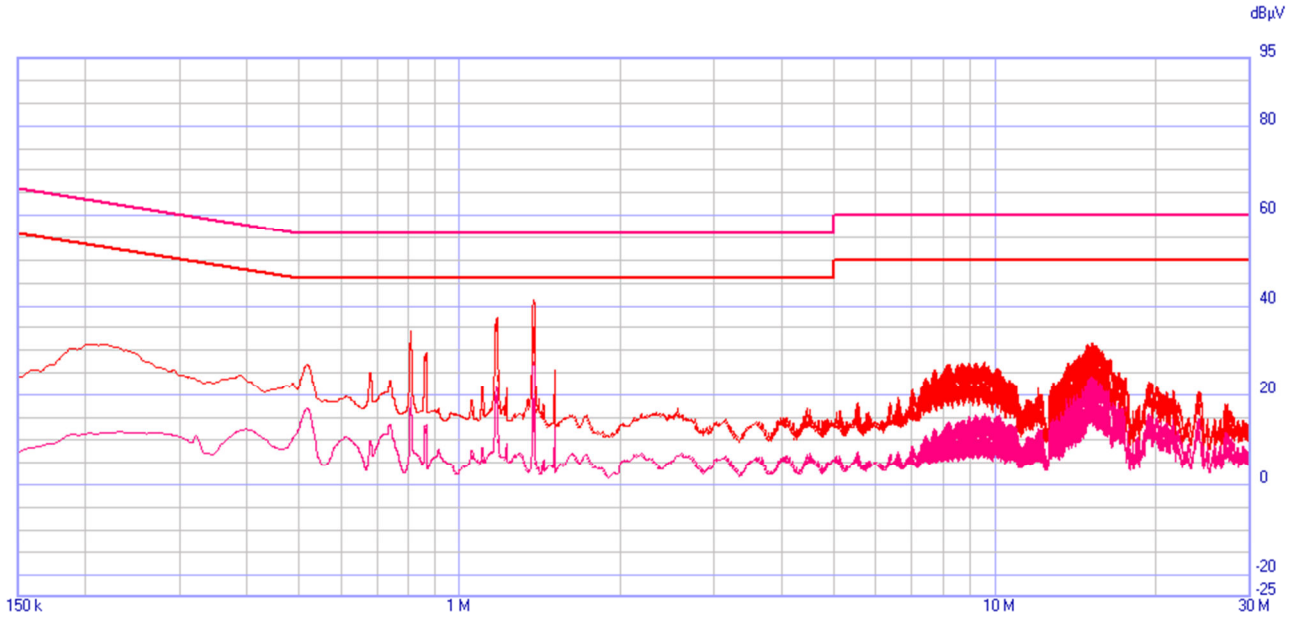


Plot 1. Conducted Emission, Line Plot - Whip Antenna

Conducted Emissions - Voltage, AC Power, Neutral (120 VAC) Whip Antenna

	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral	0.20317	32.18	63.487	-31.307	Pass	14.95	53.487	-38.537	Pass
Neutral	0.810535	35.59	56	-20.41	Pass	20.41	46	-25.59	Pass
Neutral	0.86166	30.83	56	-25.17	Pass	15.49	46	-30.51	Pass
Neutral	1.170455	38.14	56	-17.86	Pass	22.11	46	-23.89	Pass
Neutral	1.370865	41.98	56	-14.02	Pass	27.55	46	-18.45	Pass
Neutral	15.12349	30.85	60	-29.15	Pass	23.92	50	-26.08	Pass

Table 11: Conducted Emissions - Voltage, AC Power, Neutral (120 VAC) Whip Antenna



Plot 2. Conducted Emission, Neutral Plot – Whip Antenna

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 radiated using 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 **completed testing** to the requirements of § 15.247 (a)(1). No anomalies noted.

Test Engineer: Joseph Fale

Test Date: November 3, 2020

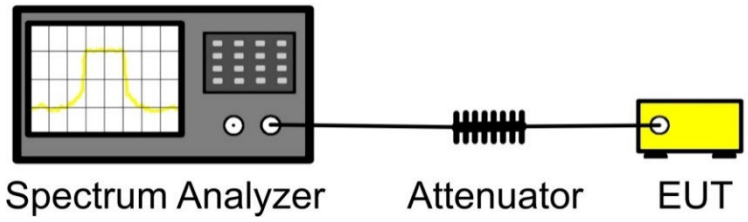
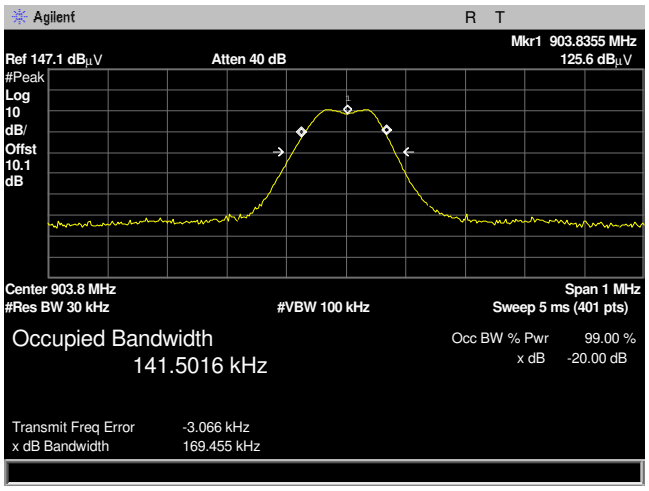
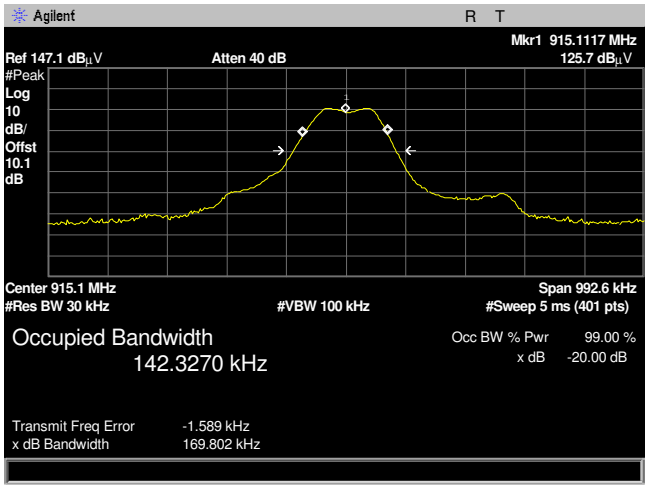


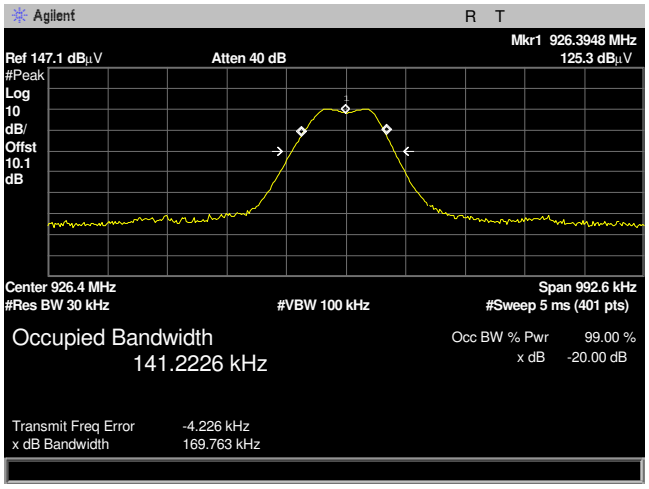
Figure 2: Block Diagram, Occupied Bandwidth Test Setup



Plot 3: 20 dB Bandwidth, Low Channel



Plot 4: 20 dB Bandwidth, Mid Channel



Plot 5: 20 dB Bandwidth, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Number of RF Channels

Requirements: 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 Results The EUT **completed testing** to the requirements of § 15.247 (a)(1). No anomalies noted. EUT has 25 hopping channels.

Test Engineer: Joseph Fale

Test Date: November 3, 2020

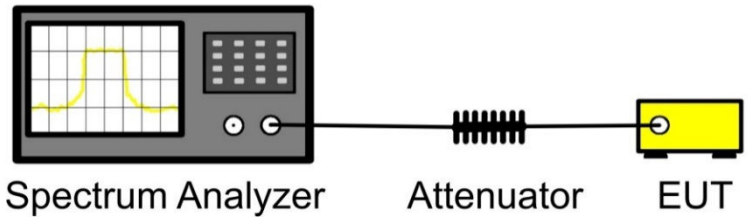
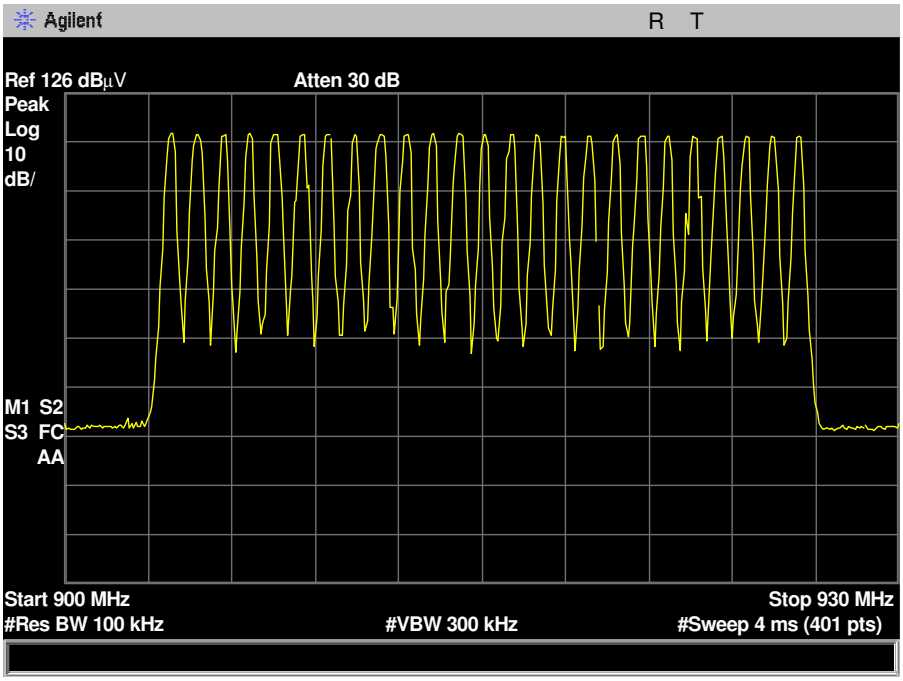


Figure 3: Block Diagram, Number of RF Channels Test Setup



Plot 6. Number of 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.

Test Results The EUT **completed testing** to the requirements of § 15.247 (a)(1). No anomalies noted.

Test Engineer: Joseph Fale

Test Date: November 3, 2020

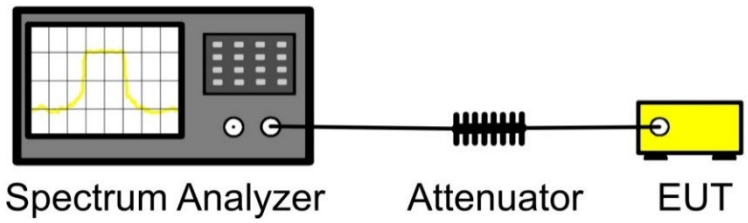
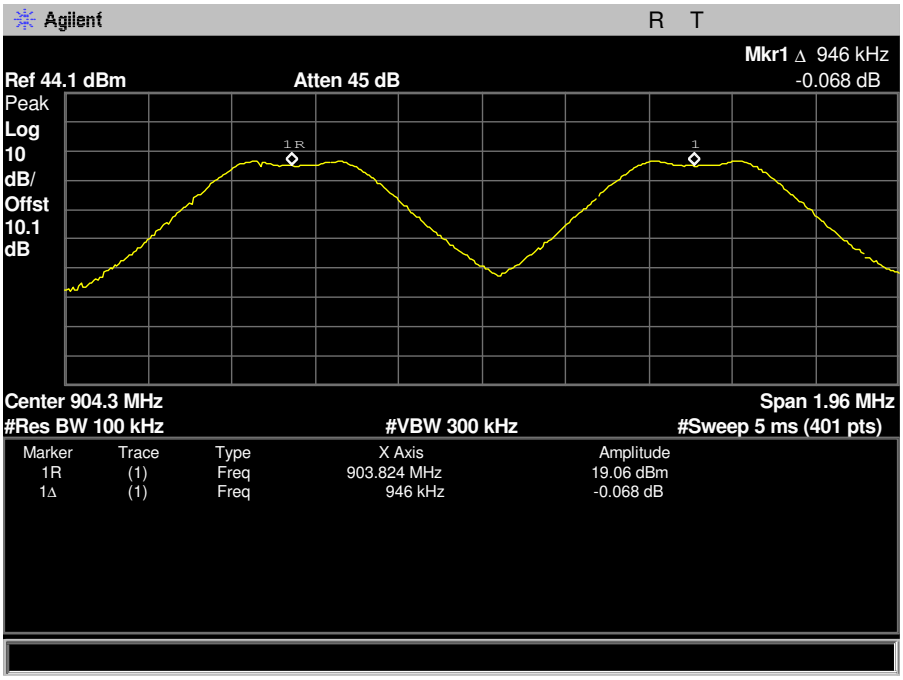
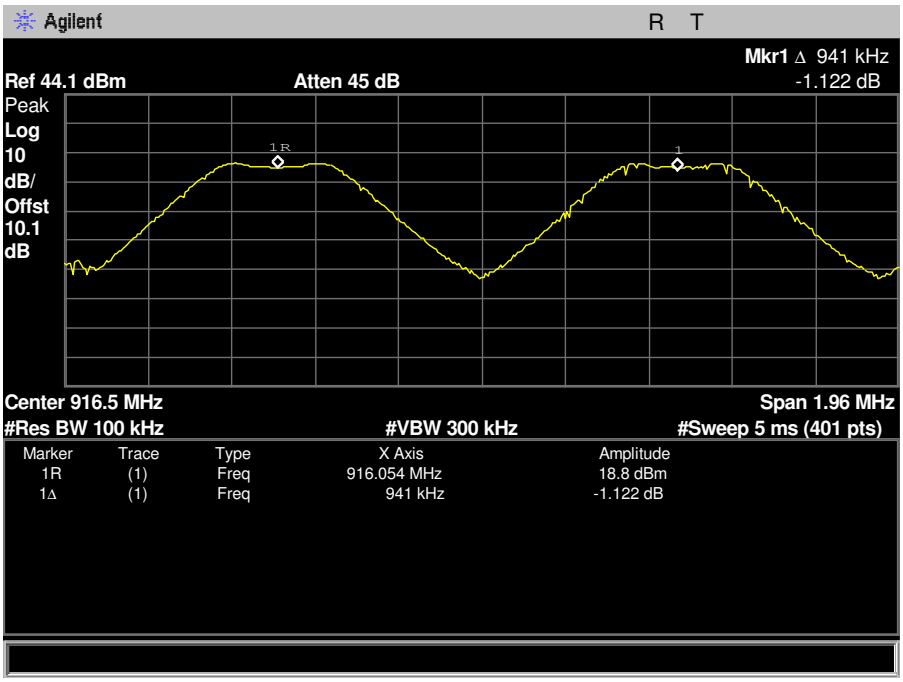


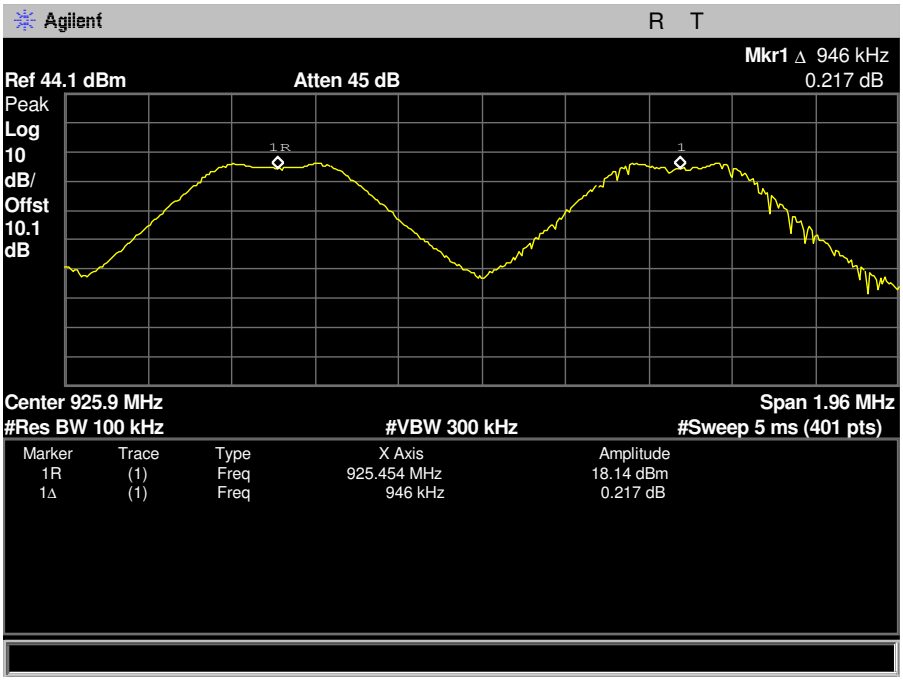
Figure 4: Block Diagram, RF Channel Separation Test Setup



Plot 7. Channel Separation – Low Channel



Plot 8. Channel Separation – Mid Channel



Plot 9. Channel Separation – High Channel

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.

Digital Transmission Systems (MHz)	Output Limit (Watts)
902-928	1.000
2400–2483.5	1.000
5725– 5850	1.000

Table 12: Output Power Requirements from §15.247(b)

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

Test Results: The EUT **completed testing** to the requirements of **§15.247(b)**. No anomalies noted.

Test Engineer: Joseph fale

Test Date: November 3, 2020

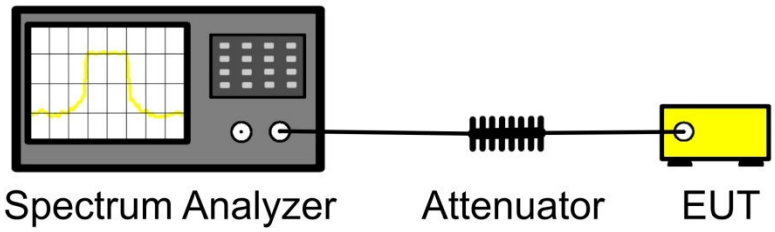
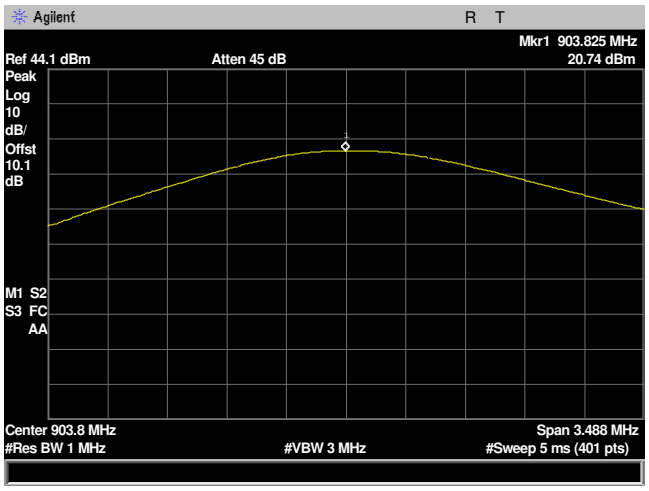


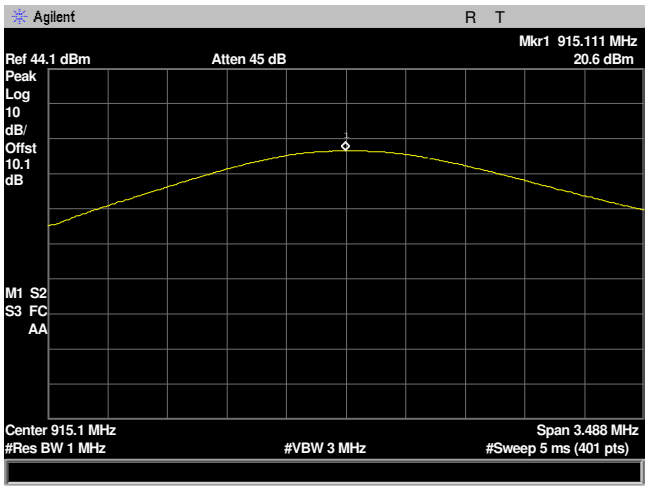
Figure 5: Peak Power Output Test Setup

Output Power			
Carrier Channel	Frequency (MHz)	Measured Conducted Power (dBm)	Limit (dBm)
Low	903.825	20.74	≤ 30
Mid	915.11	20.63	≤ 30
High	926.375	20.25	≤ 30

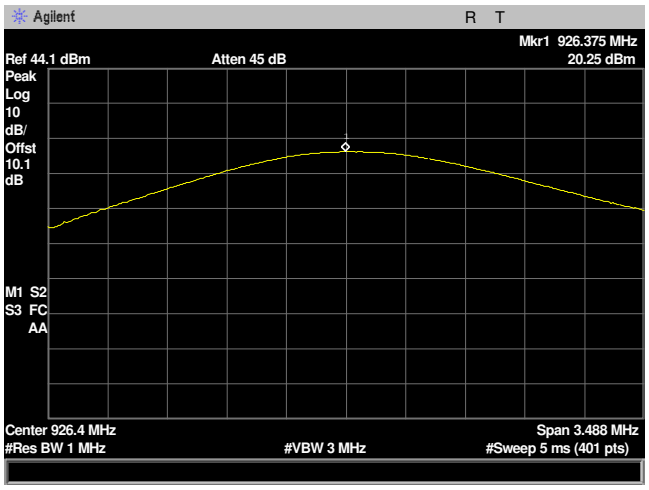
Table 13: Peak Power Output, Test Data



Plot 10: Peak Power Output, Low Channel



Plot 11: Peak Power Output, Mid Channel



Plot 12: Peak Power Output, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements

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 14: 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 15:

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 15: Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured below 30 MHz and above 18 GHz.

Test Results: The EUT **completed testing** to the requirements of **§ 15.247(d)**. No anomalies noted.

Test Engineer: Joseph Fale

Test Date: November 5, 2020

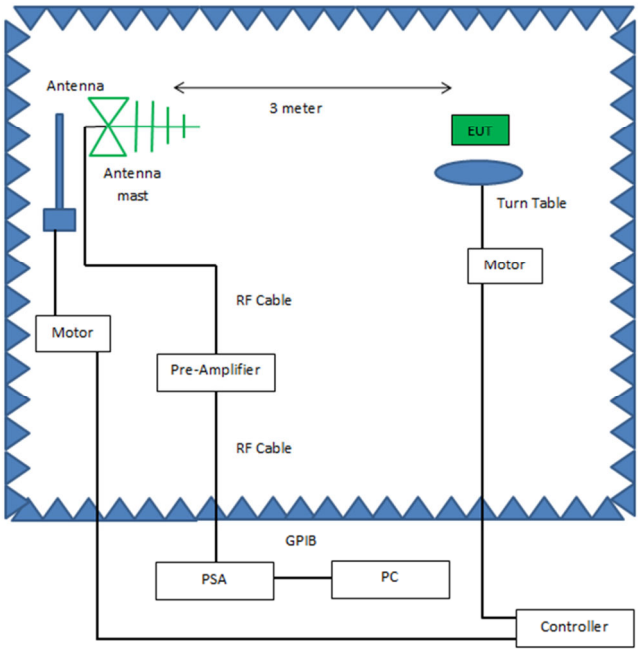


Figure 6: Radiated Emissions, Below 1GHz, Test Setup

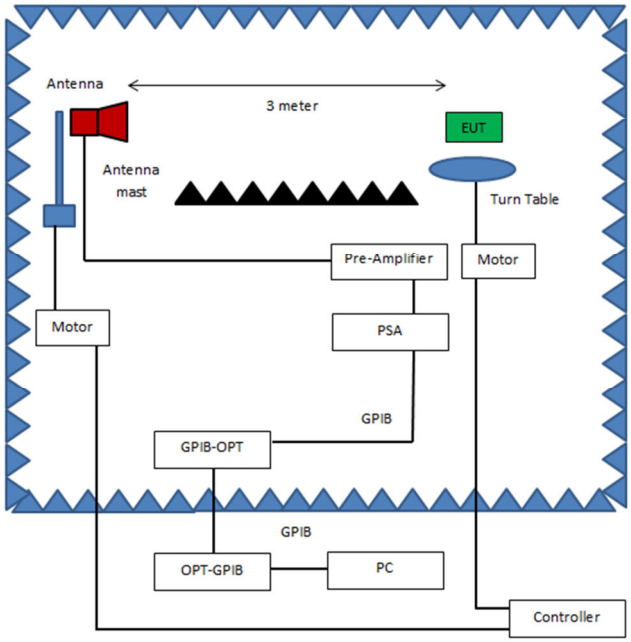
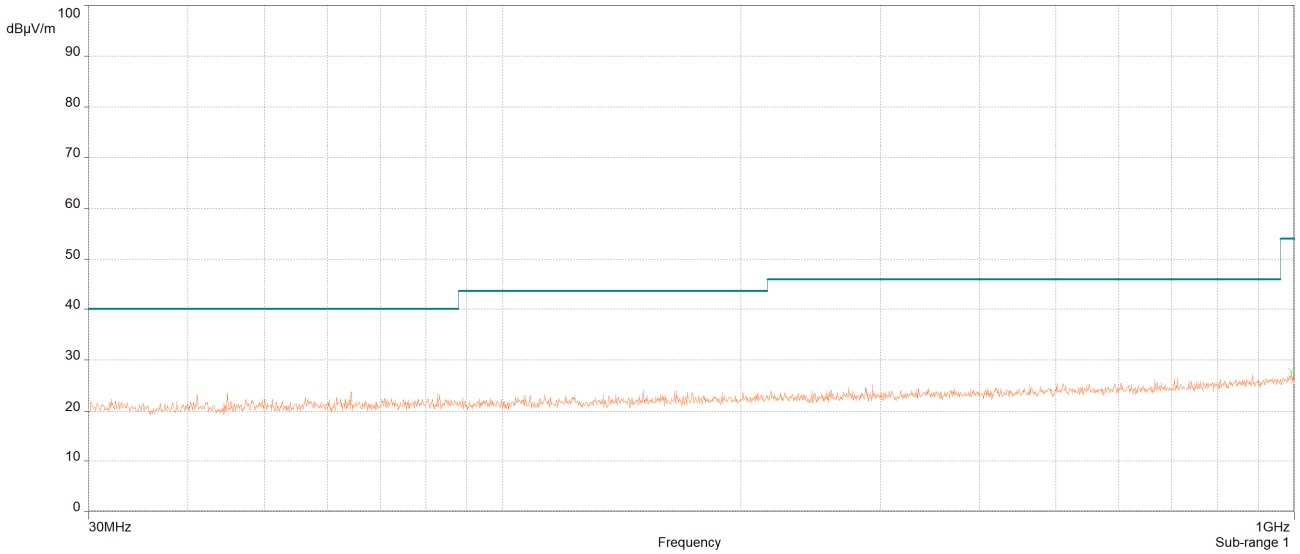
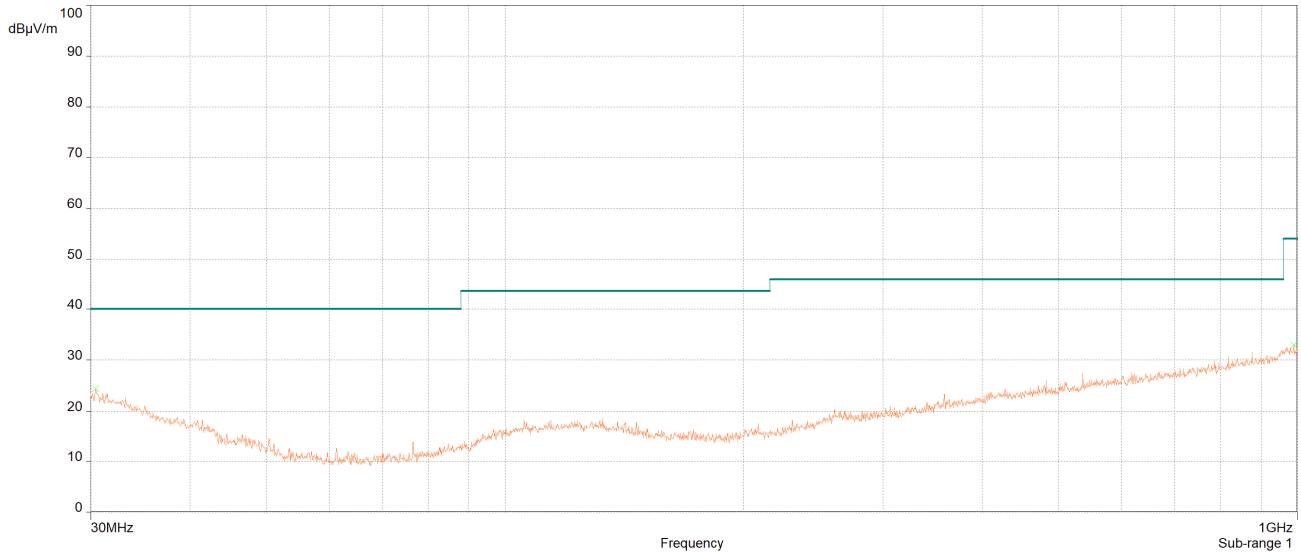


Figure 7: Radiated Emissions, Above 1GHz, Test Setup

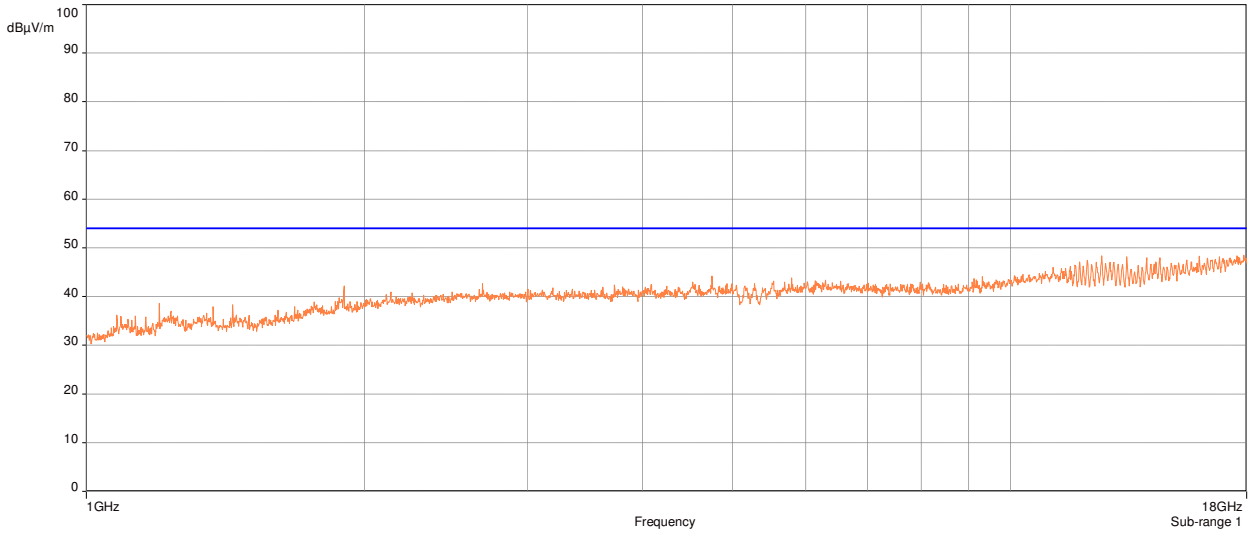


Vertical

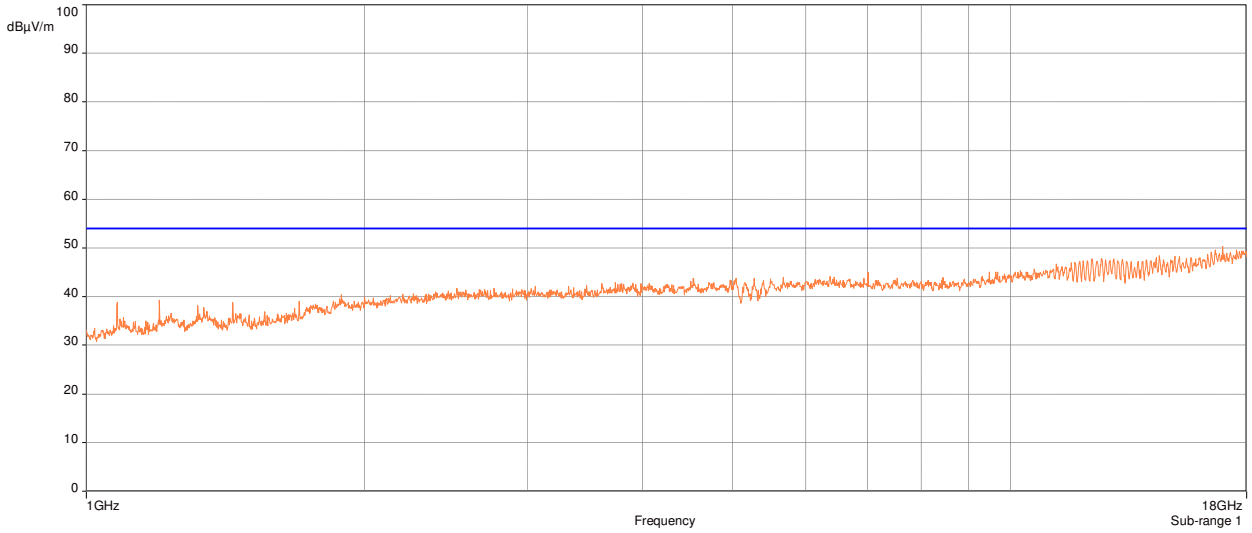


Horizontal

Plot 13: Radiated Emissions, 30 MHz - 1 GHz, (worst case)

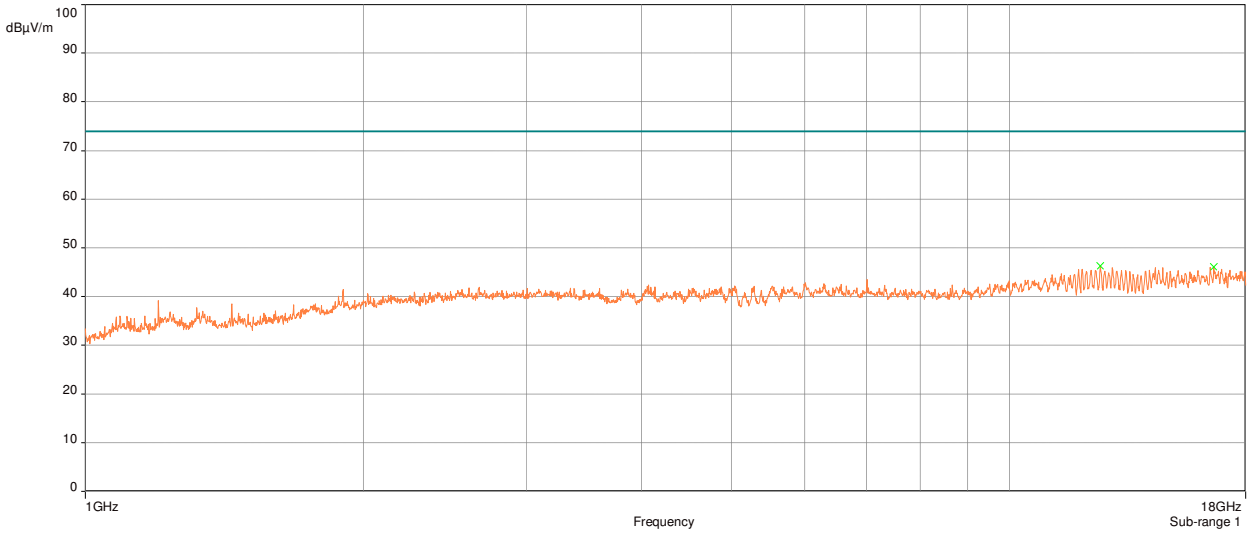


Vertical

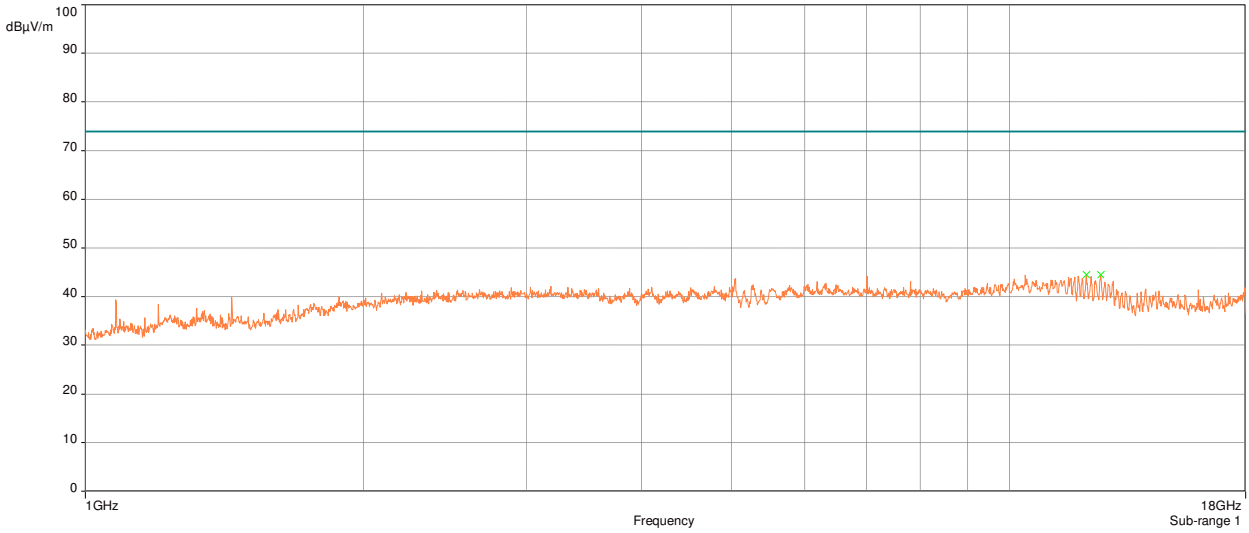


Horizontal

Plot 14: Radiated Spurious Emissions Requirements, Low Channel, Average (Whip Antenna)

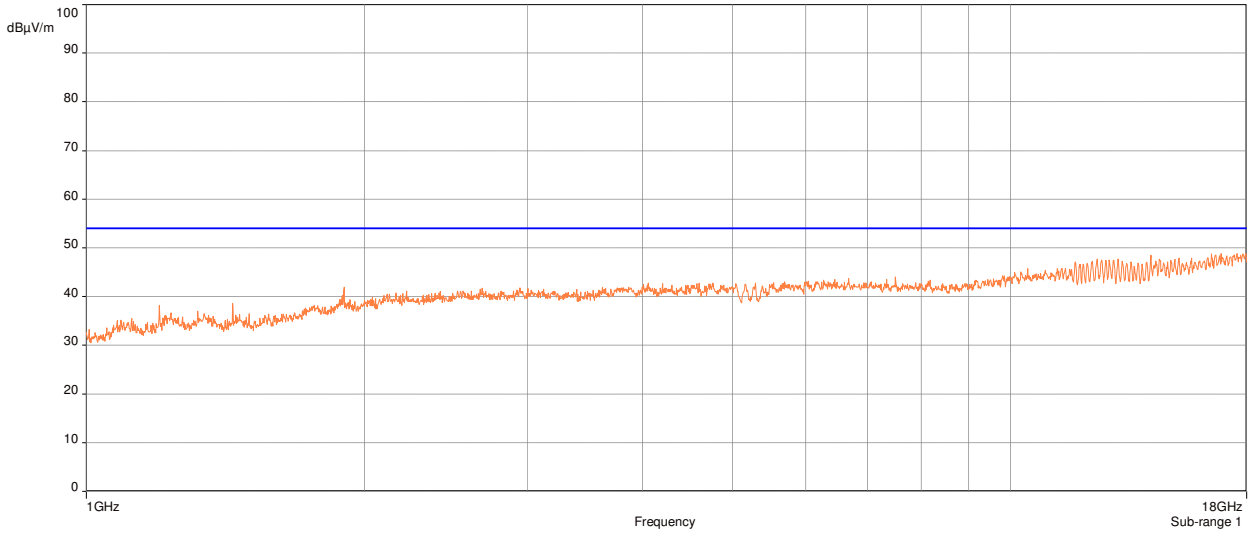


Vertical

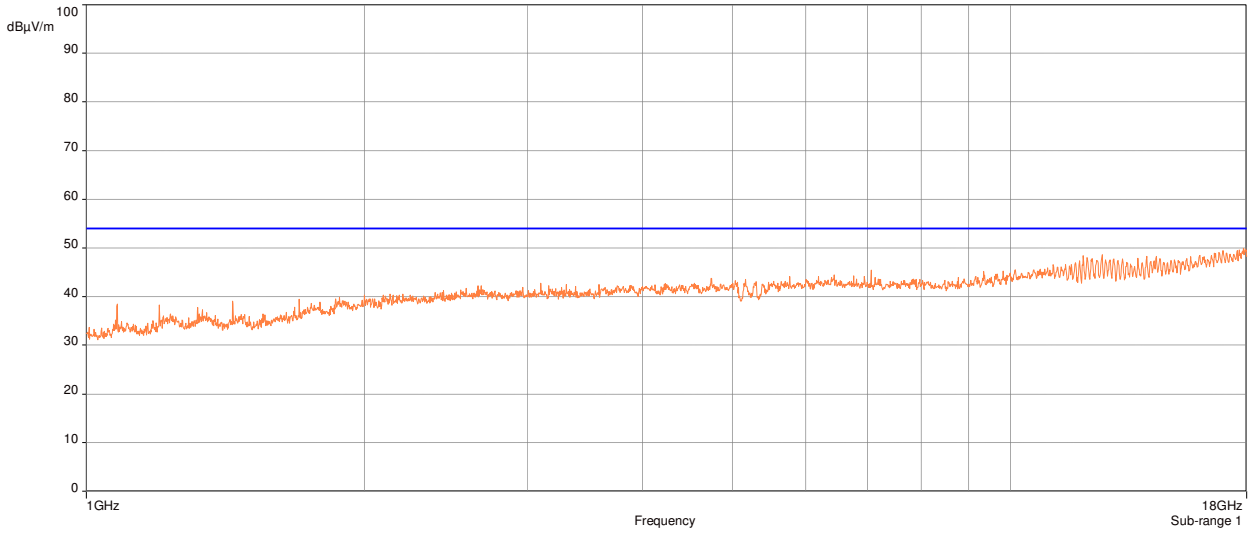


Horizontal

Plot 15: Radiated Spurious Emissions Requirements, Low Channel, Peak (Whip Antenna)

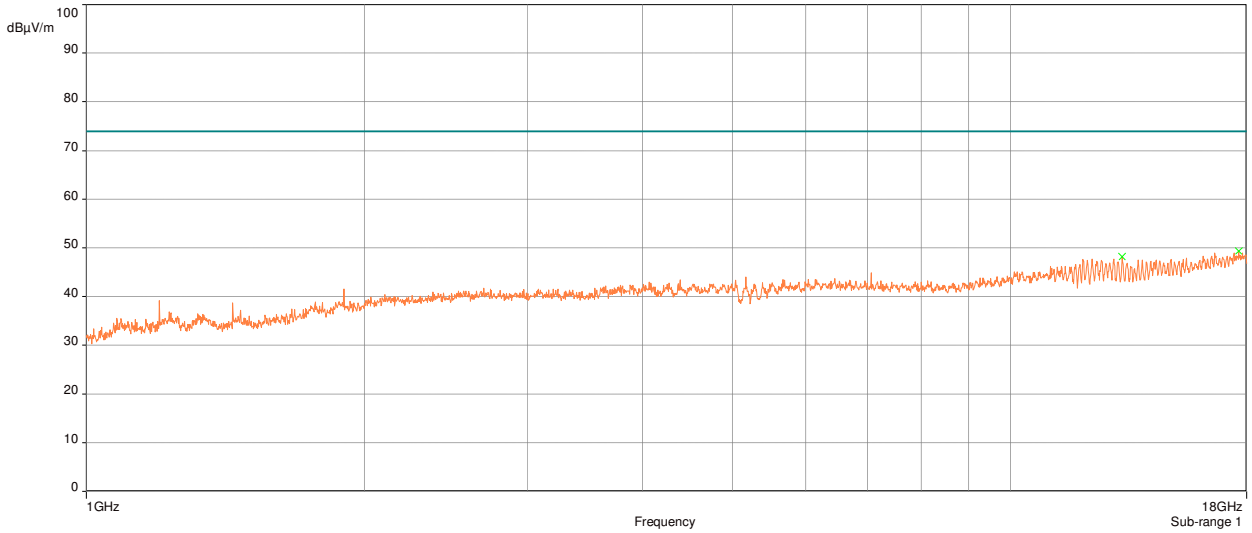


Vertical

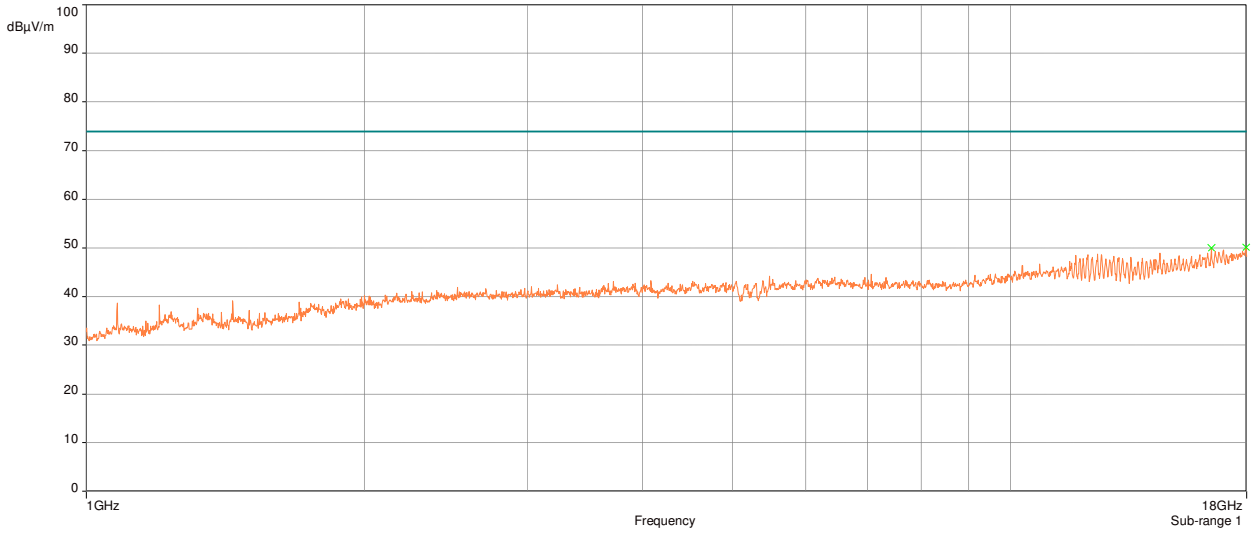


Horizontal

Plot 16: Radiated Spurious Emissions Requirements, Mid Channel, Average (Whip Antenna)

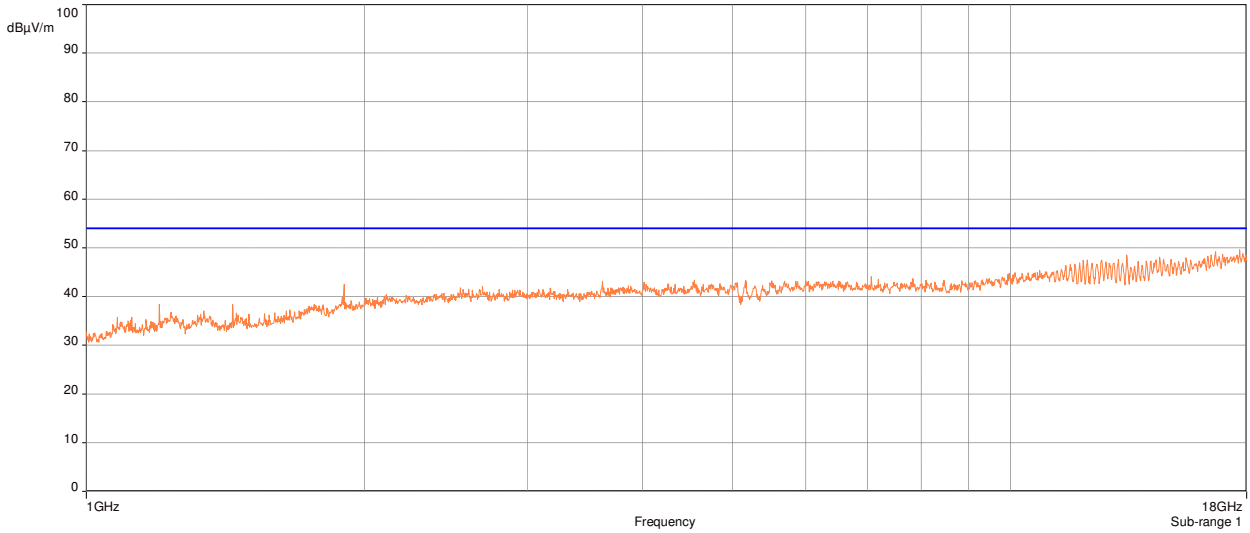


Vertical

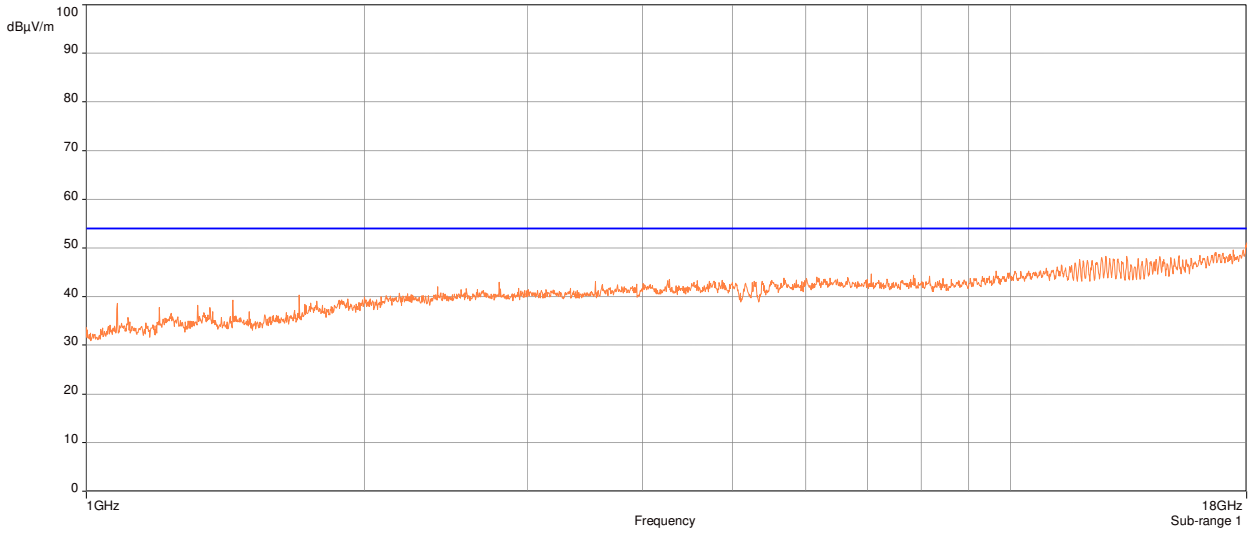


Horizontal

Plot 17: Radiated Spurious Emissions Requirements, Mid Channel, Peak (Whip Antenna)

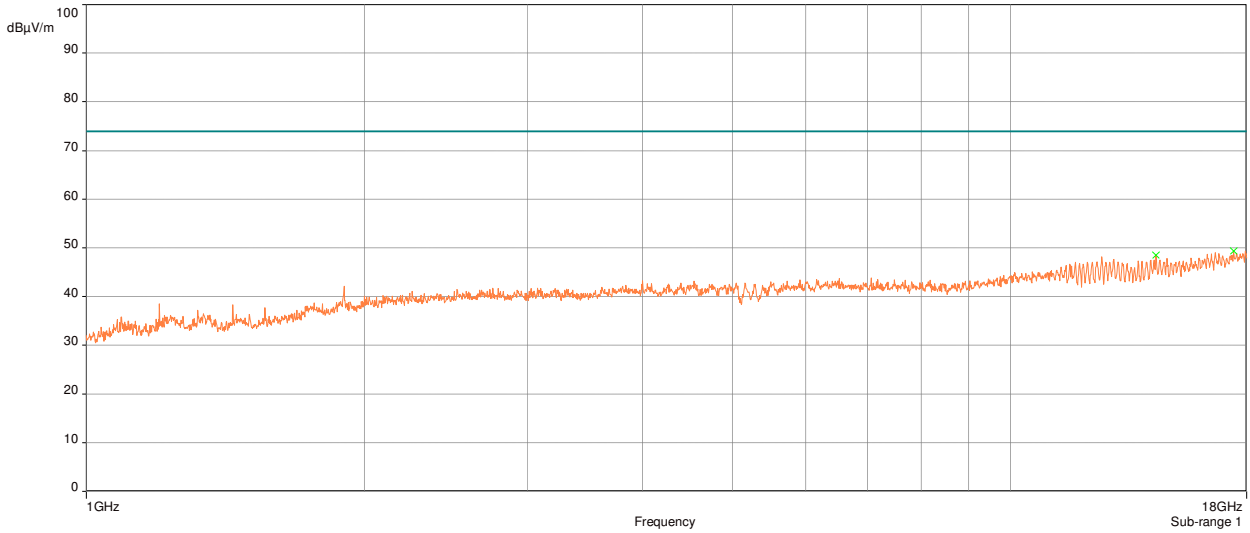


Vertical

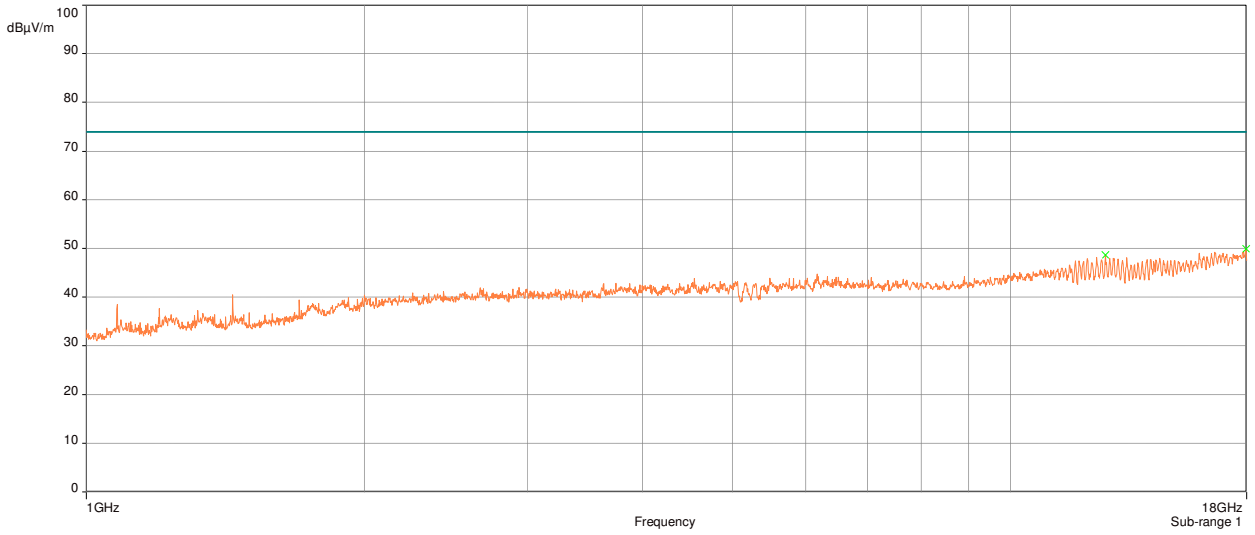


Horizontal

Plot 18: Radiated Spurious Emissions Requirements, High Channel, Average (Whip Antenna)

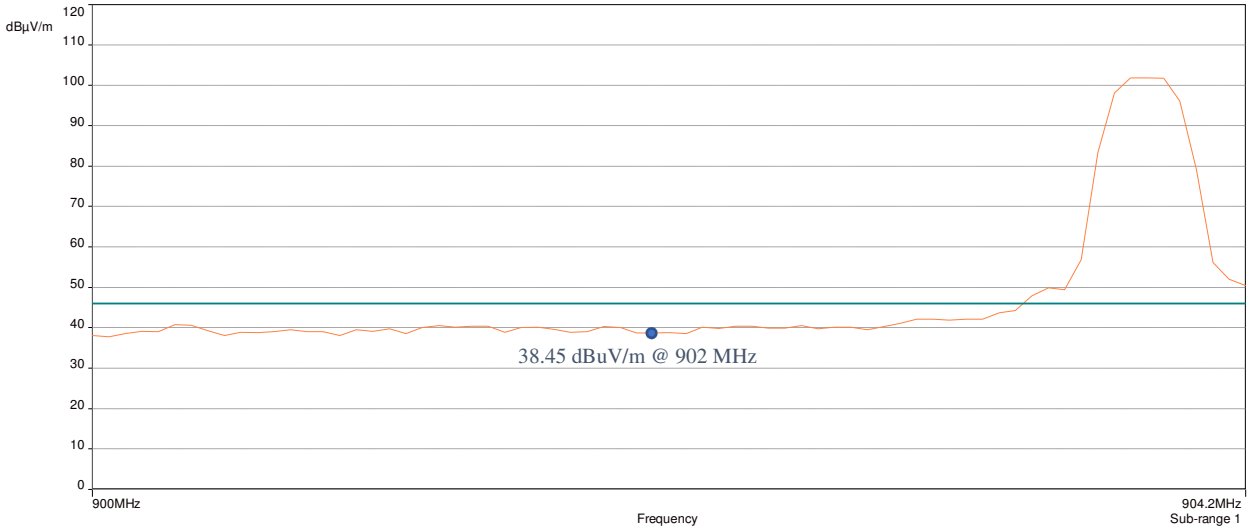


Vertical

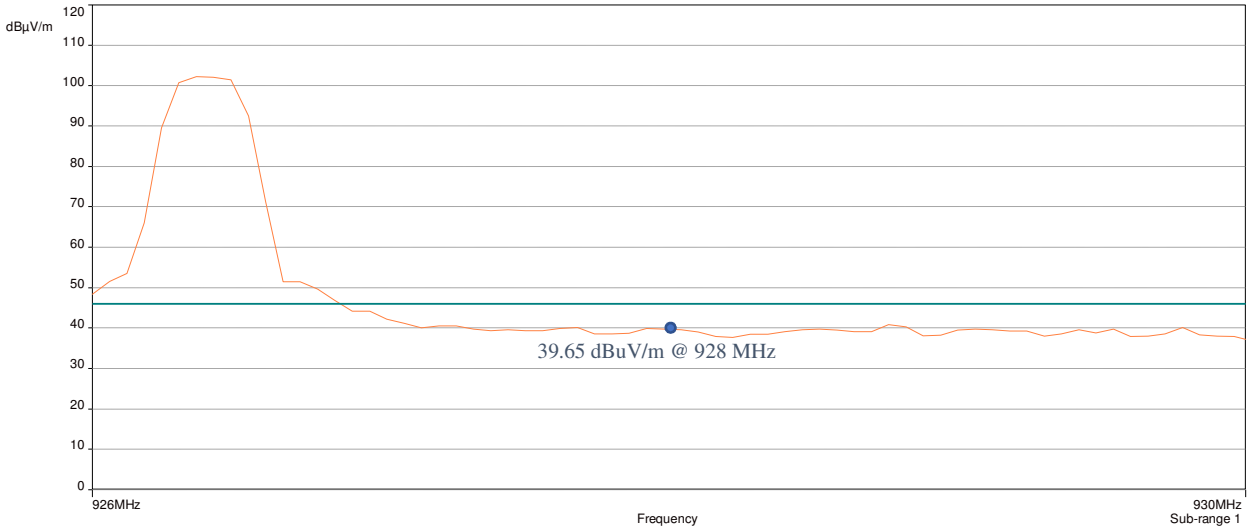


Horizontal

Plot 19: Radiated Spurious Emissions Requirements, High Channel, Peak (Whip Antenna)



Plot 20: Radiated Band Edge, Low Channel, Whip, Worst Case



Plot 21: Radiated Band Edge, High Channel, Whip, Worst Case

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.

Since the EUT had an integral antenna, conducted measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable lost.

See following pages for detailed test results with RF Conducted Spurious Emissions.

Test Results: The EUT **completed testing** to the requirements of **§15.247(d)**. No anomalies noted.

Test Engineer: Joseph Fale

Test Date: November 7, 2020

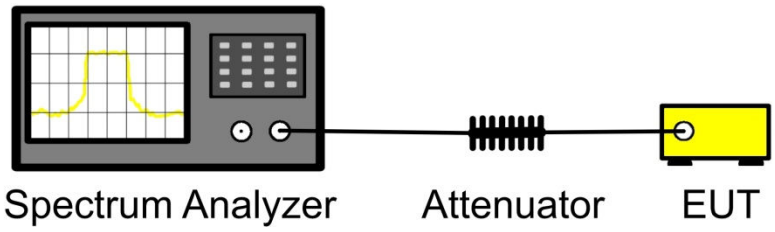
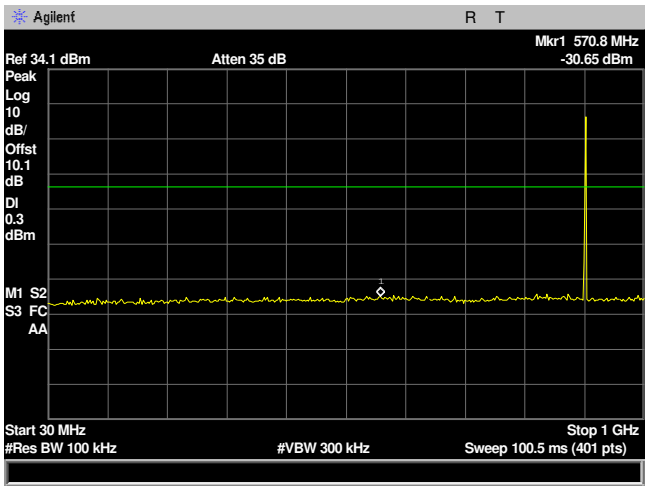
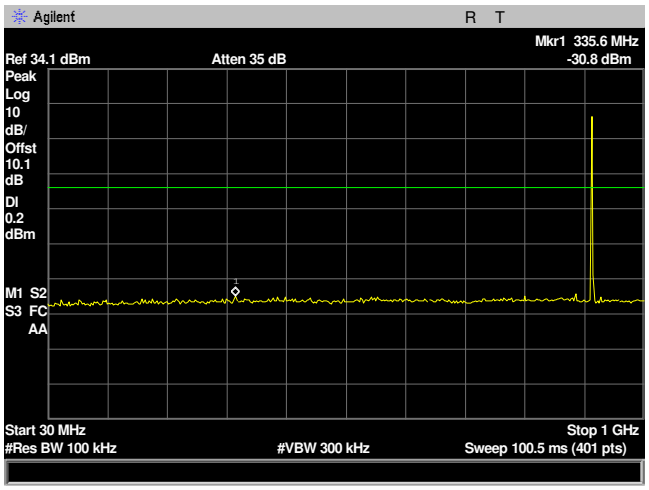


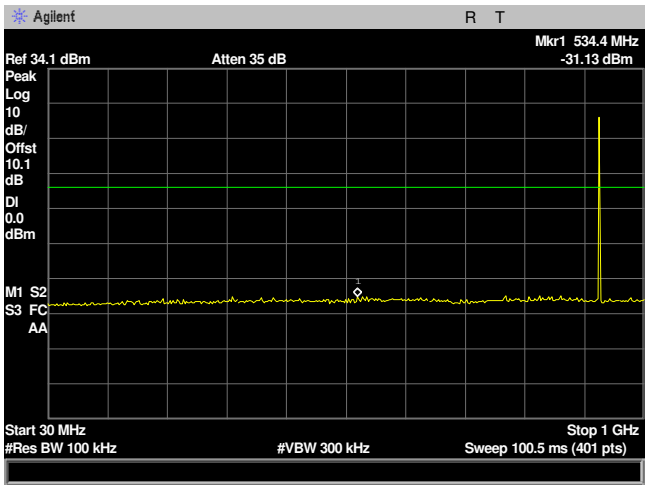
Figure 8: Block Diagram, Conducted Spurious Emissions Test Setup



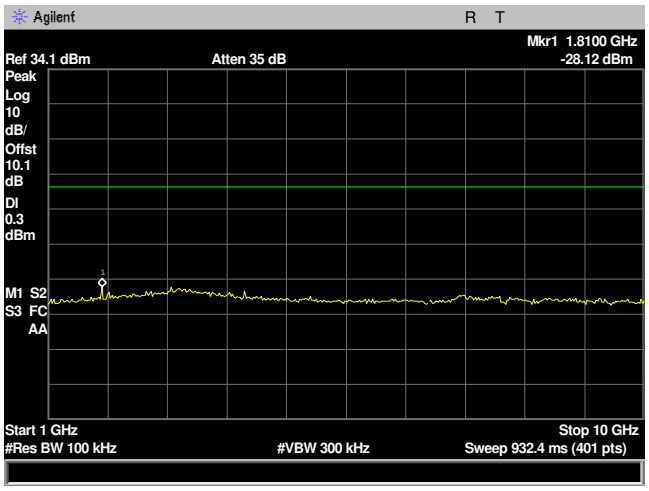
Plot 22: RF Conducted Spurious Emissions Requirements, 30MHz-1GHz Low Channel



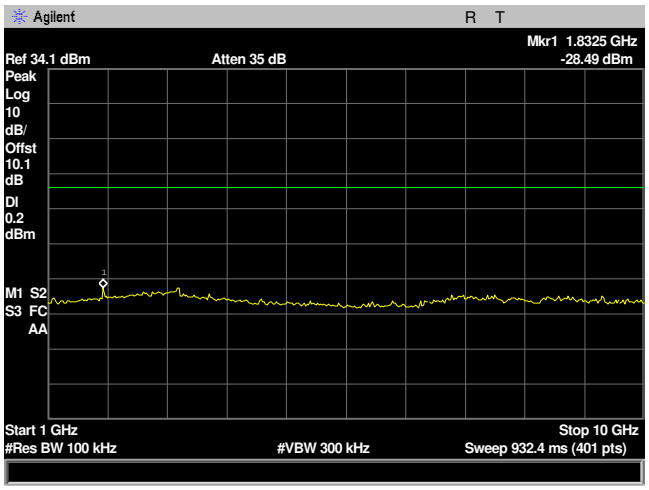
Plot 23: RF Conducted Spurious Emissions Requirements, 30MHz-1GHz Mid Channel



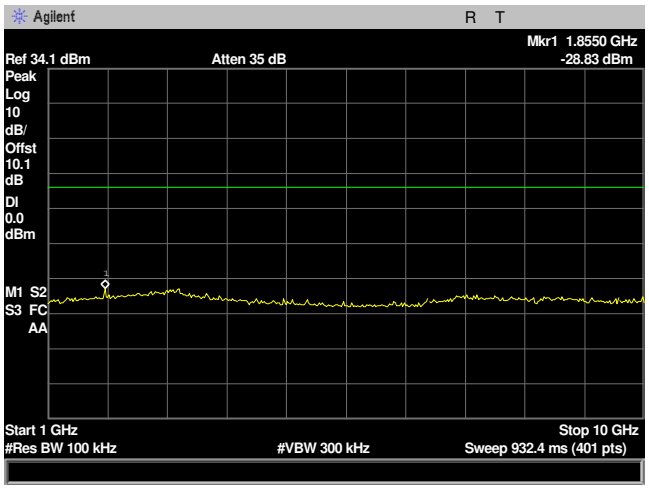
Plot 24: RF Conducted Spurious Emissions Requirements, 30MHz-1GHz High Channel



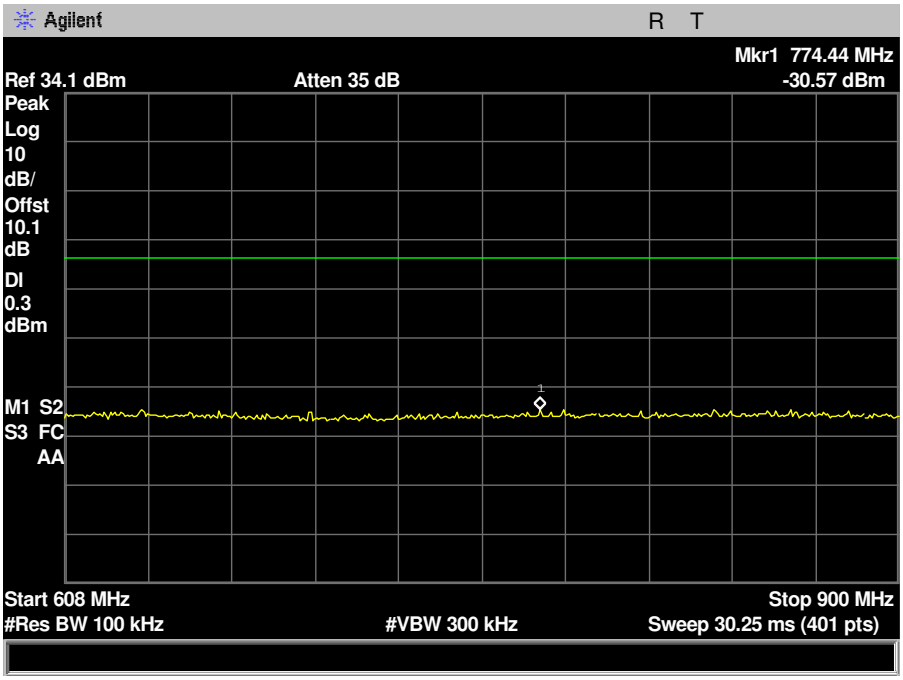
Plot 25: RF Conducted Spurious Emissions Requirements, 1GHz-10GHz Low Channel



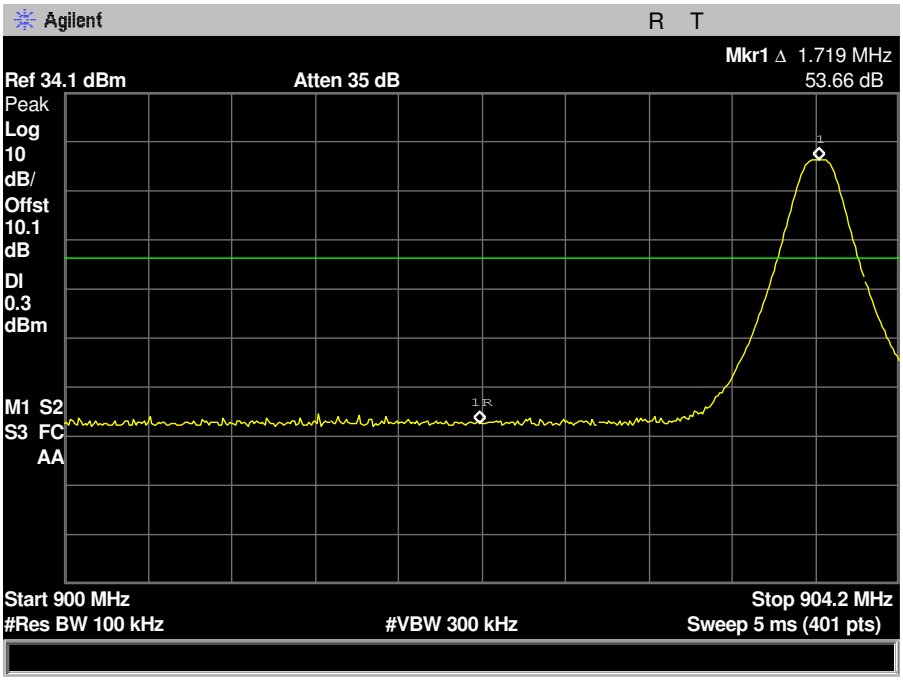
Plot 26: RF Conducted Spurious Emissions Requirements, 1GHz-10GHz Mid Channel



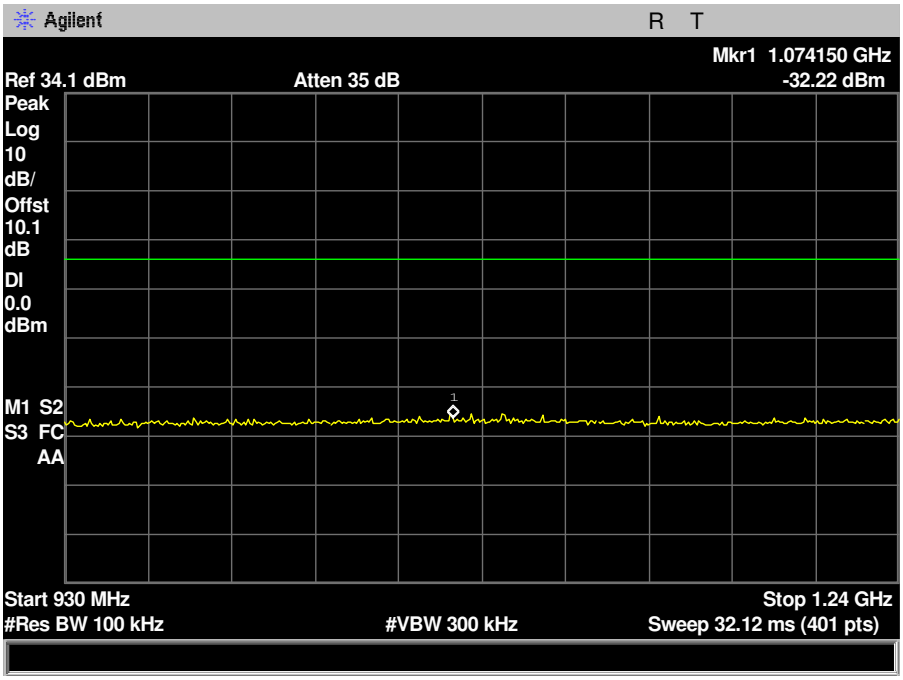
Plot 27: RF Conducted Spurious Emissions Requirements, 1GHz-10GHz High Channel



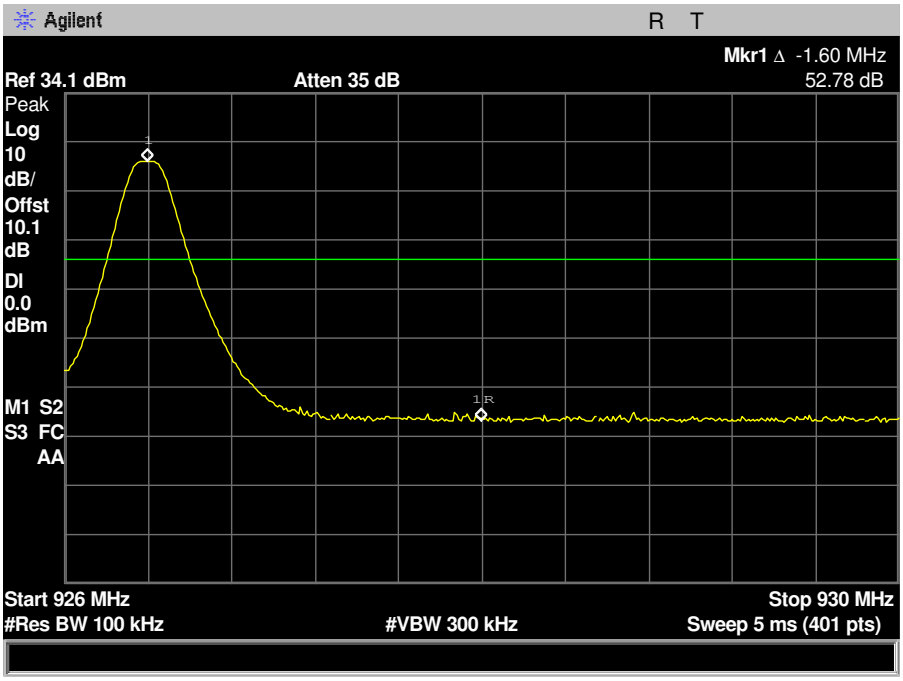
Plot 28: RF Conducted Band Edge, 608MHz-614MHz Restricted Band, Low Channel



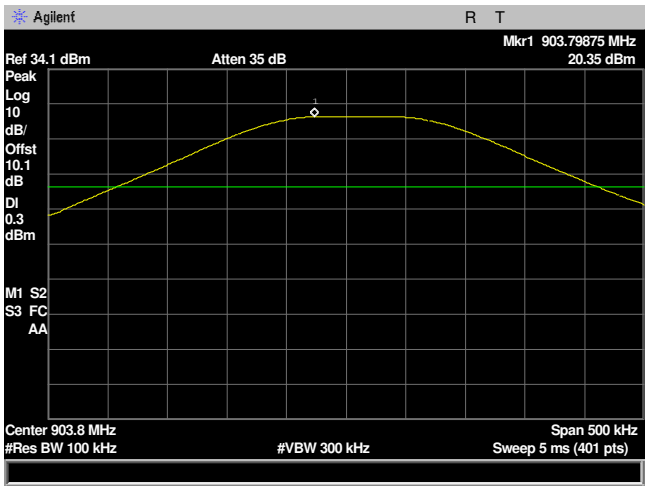
Plot 29: RF Conducted Band Edge, Low Channel



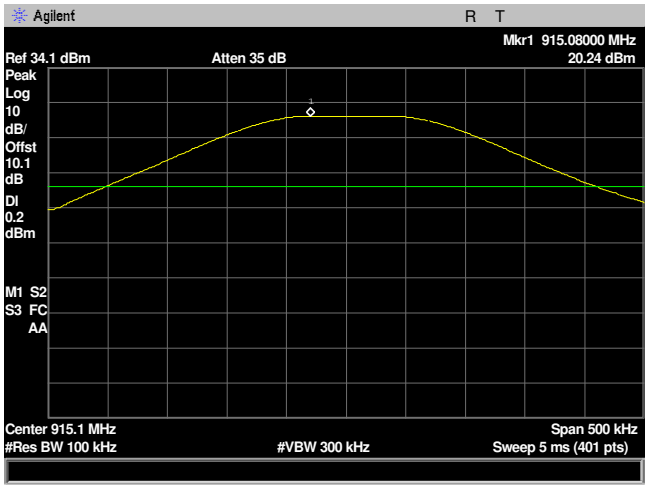
Plot 30: RF Conducted Band Edge, 960MHz-1240MHz Restricted Band, High Channel



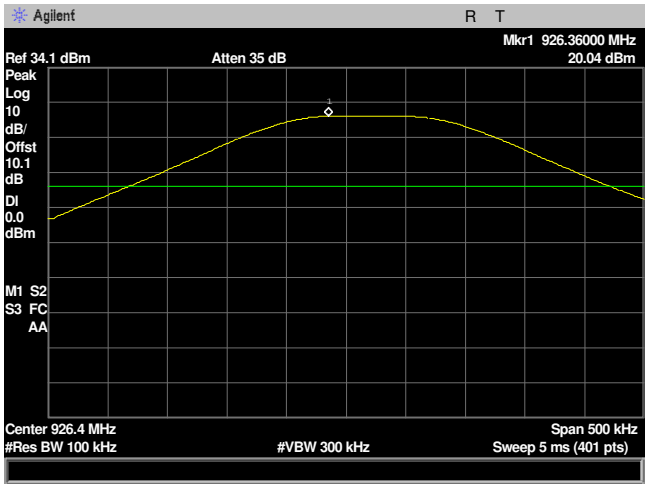
Plot 31: RF Conducted Band Edge, High Channel



Plot 32: RF Conducted Band Edge, Reference Level Low Channel



Plot 33: RF Conducted Band Edge, Reference Level Mid Channel



Plot 34: RF Conducted Band Edge, Reference Level High Channel

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 17025:2017.

ASSET #	NOMENCLATURE	MANUFACTURER	MODEL	LAST CAL	CAL DUE
1S2399	TURNTABLE CONTROLLER	SUNOL SCIENCE	SC99V	FUNCTIONAL VERIFY	
1S3928	EMI TESTER RECEIVER	ROHDE & SCHWARZ	ESR26	03/04/2020	03/04/2021
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	03/19/2019	03/19/2021
1S2486	5 METER CHAMBER CONTROL ROOM	PANASHIELD	5 METER CONTROL ROOM	FUNCTIONAL VERIFY	
1S3926	1MHZ STEP, 1GHZ COMBO GENERATOR	COM-POWER CORP	CGO-501	FUNCTIONAL VERIFY	
1S4067	DIGITAL BAROMETER	CONTROL CO	6530	06/22/2020	06/22/2022
1S2481	10 METER CHAMBER	ETS-LINGREN	DKE-8X8 DBL	FUNCTIONAL VERIFY	
1S406	DIGITAL BAROMETER	CONTROL CO	6530	6/22/2020	06/22/2022
1S380	EMI RECEIVER	NARDA SAFETY TEST SOLUTIONS	PMM 9010F	8/23/2020	8/23/2021
1S2678	LISN, DUAL LINE V-NETWORK	TESEQ	NNB 51	8/16/2020	8/16/2021
1S245	COMB GENERATOR (RADIATED)	COM-POWER	GG510	FUNCTIONAL VERIFY	
1S2599	LASER PROBE INTERFACE	AMPLIFIER RESEARCH	F1700	FUNCTIONAL VERIFY	
1S2603	DOUBLE RIDGED WAVEGUIDE HORN	ETS-LINDGREN	3117	09/18/2020	09/18/2022
1S2000	SPECTRUM ANALYZER	AGILENT	E4448A	11/06/2019	11/06/2020
1S3818	DRG HORN ANTENNA	A.H. SYSTEMS, INC	SAS-574	09/24/2020	09/24/2022

Table 16: Test Equipment List

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

End of Report