MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

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March 27, 2017

TrackMan A/S
Stubbeled 2
Vedbæk, DK-2950

Dear Claus Nilsson,

Enclosed is the EMC Wireless test report for compliance testing of the TrackMan A/S, TMA4A as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), FCC 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.

Joel Huna
Documentation Department

Reference: (\TrackMan A/S\EMC88710-FCC245 Rev. 7)

Electromagnetic Compatibility Criteria
Test Report

for the

TrackMan A/S
Model TMA4A

Verified under
the FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.245 Subpart C
for Intentional Radiators

MET Report: EMC88710-FCC245 Rev. 7

March 27, 2017

Prepared For:

TrackMan A/S
Stubbeled 2
Vedbæk, DK-2950

Prepared By:
MET Laboratories, Inc.
914 West Patapsco Avenue,
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

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TrackMan A/S
Model TMA4A

Tested Under
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contained in
Title 47 of the CFR, Part 15.245 Subpart C
for Intentional Radiators

Djed Mouada, Project Engineer
Electromagnetic Compatibility Lab

Joel Huna
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 15.245 under normal use and maintenance.

Asad Bajwa, Director
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	December 28, 2016	Initial Issue.
1	January 20, 2017	EUT information typo and addition of spurious emissions testing data
2	January 31, 2017	Units, Equipment Code, FCC and IC ID, and caption corrections
3	February 28, 2017	Customer Corrections
4	March 3, 2017	Engineer corrections.
5	March 20, 2017	Engineer corrections.
6	March 24, 2017	Updated OBW section.
7	March 27, 2017	Updated Field Strength of Fundamental, Spurious Emissions, and OBW sections

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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
µF	**Microf**arad
µs	**Micros**econds
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 TrackMan A/S TMA4A, with the requirements of Part 15, §15.245. 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 TMA4A. TrackMan A/S should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the TMA4A, 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, §15.245 in accordance with TrackMan A/S, purchase order number KO4331. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference	Description	Results
§15.203	Antenna Requirement	Compliant
§15.207	AC Power Line Conducted Emissions	Compliant
§15.245 (a)	Operational Requirements	Compliant
§15.245	Field Strength of Fundamental	Compliant
§15.245	Spurious Emissions	Compliant
§15.215 (c)	20 dB Bandwidth	Compliant

Table 1. Executive Summary of EMC ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by TrackMan A/S to perform testing on the TMA4A, under TrackMan A/S' purchase order number KO4331.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the TrackMan A/S, TMA4A.

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

Model(s) Tested:	TMA4A	
EUT Specifications:	Primary Power: 19VDC	
	FCC ID: SFX-TMAN4 IC: 10140A-TMAN4	
	Equipment Code:	FDS
	Highest Fundamental Field Strength:	120.3 dBuV/m (10501MHz)- 113.8 dBuV/m (24000MHz)
	EUT Frequency Ranges:	10501-10549 and 24076-24174MHz
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:	Djed Mouada	
Report Date(s):	March 27, 2017	

Table 2. EUT Specifications

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

Table 3. References

C. Test Site

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

Radiated Emissions measurements were performed in a 3m 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.

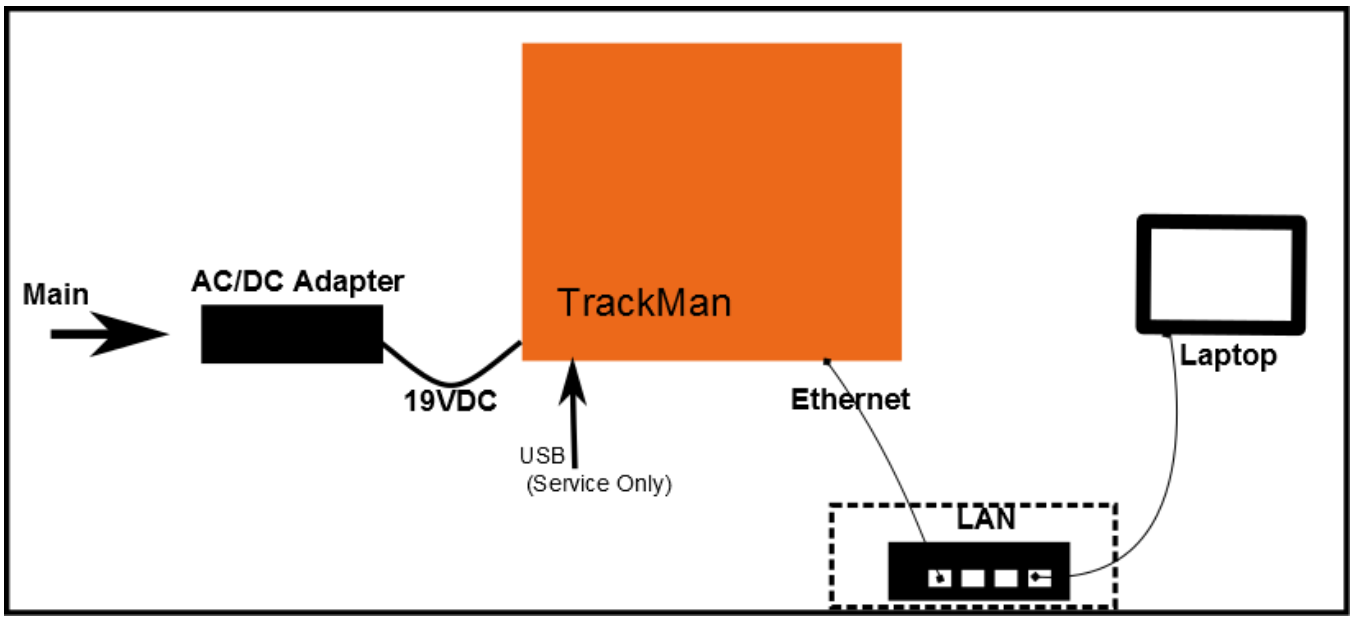
D. Description of Test Sample

The TrackMan A/S TMA4A, Equipment Under Test (EUT), is an all-in-one complete dual radar system intended to measure the path and trajectory of golf clubs and balls.

The only peripherals required in order to operate the TrackMan™, is a Smart Phone (iOS) with suitable app installed, a Tablet or a standard computer with wireless connectivity and a standard web-browser.

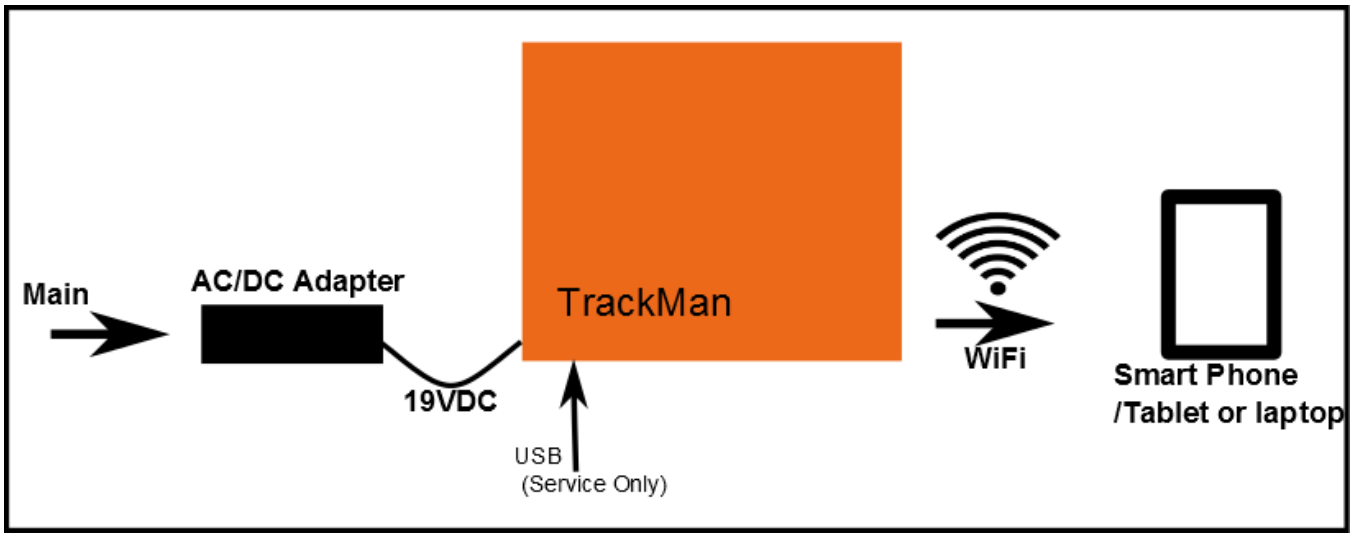
In order to provide auto alignment the radar is equipped with motorized legs. A 2-axis inclinometer provides angle data which are transmitted to an embedded microcontroller which in turn controls the motor driver circuit.

A software servo loop controls the motorized legs until perfect leveling is obtained. The servo loop is only active during TrackMan™ set-up and installation.



N.B. The LAN and Laptop is not part of the product. (LAN and Laptop is however supplied by TrackMan for the METlabs test.)

Figure 1. Block Diagram of EUT Configuration 1, Ethernet



N.B. The Laptop is not part of the product. (Laptop is however supplied by TrackMan for the METlabs test.)

Figure 2. Block Diagram of EUT Configuration 1, WiFi

E. Equipment Configuration

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
1	Trackman 4	TrackMan4	TMA4A			

Table 4. Equipment Configuration

F. Support Equipment

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
1	AC/DC adapter	FSP Group Inc.	FSP065-RECN2	100-240AC input 19VDC, 3.42A output

Table 5. Support Equipment

G. 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
1	USB	USB micro	1	1	3	Yes	PC USB port
2	Ethernet/LAN	Cat 5 LAN cable w. RJ45	1	5	100	Yes	Router
3	Power Plug in	DC	1	1	N/A	Yes	AC/DC adapter

Table 6. Ports and Cabling Information

H. Mode of Operation

The TMA4A comprises both a single frequency X-band radar (10GHz) and a dual frequency K-band radar (24GHz). The X-band Radar comprises 3 Receiver channels and the K-Band Radar comprises 5 receiver channels. The Radar transmitters continuously illuminates the "target, and "target" reflects the signal which is received by the receiving antennas. The received signals are down converted to base band in a mixer utilizing a LO signals which are coherent with the transmitted signals (Zero-IF principle).

Frequency stabilization is provided by means of PLL controlled microwave oscillators. The reference for the PLL (and thus for the microwave oscillators) is a high performance crystal controlled oscillator providing better than ±25ppm overall frequency stability during normal operating conditions.

The base band signals are amplified and synchronously digitized in a 16channel, 24bit analog-to-digital converter. The digitized signals are routed to the embedded PC board (SMARC Module from ADLink) piggybacked on the EU33 4002 where data are processed in real-time.

The analyzed data are then routed to the GUI device (Smart phone, Tablet or PC with WLAN of similar) over the WiFi connection. The GUI shows the relevant data and results for the user.

For normal operation the TrackMan™ is powered by an internal SMART battery Li-ION battery. During normal operation, no external power supply is required, but charging of the battery is provided by means of an external +19VDC supply.

The antennas used for transmitting and receiving are identical. The antenna pattern is shaped to maximize the overall loop gain of the TrackMan™ system for golf ball trajectories, where the golf ball is launched a couple of meters in front of the radar.

An embedded digital camera (Global Digital Star) is used to point out the horizontal reference line from a picture. The camera is only used during setup of the TrackMan™ Radar Unit.

During operation, video is streamed to the user through the WiFi channel.

The build-in GPS receiver and integrated antenna provides location coordinates for data processing and location tracking purpose.

I. Method of Monitoring EUT Operation

The normal mode of operation of the TrackMan™ system is the following:

- The TrackMan™ embedded application software establishes wireless communication with the configuration memory, camera, inclinometer sensor and RF- sampling circuit.
- The inclinometer servo loop is initialized and the motorized legs are activated until perfect leveling is obtained.
- The camera is activated to take a picture. From the picture a desired horizontal reference line is defined.
- The application software continuously analyses the received signal form a golf club movement. Once a club movement together with a ball movement from the same position takes place, the signal will be tracked until loss of signal. Immediately after the tracking is completed, key results will be calculated and transmitted to GUI device (PC and Smart Phone) and then the application software will start looking for another club movement.

1. A solid green LED on the front will indicate error-free boot and Radar ready to be operated
2. Any other LED status besides the solid green LED (i.e. red LED) will indicate an error-situation

J. 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.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to TrackMan A/S upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.203 Antenna Requirement

Test Requirement: 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.

Test Results: The EUT as tested is compliant with the criteria of §15.203. The EUT has integral antennas.

Test Engineer(s): Djed Mouada

Test Date(s): November 14, 2016

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.207 AC Power Line Conducted Emissions

Test Requirement(s): 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 7. 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 as tested is compliant with the criteria of §15.207. Measured emissions were within applicable limits.

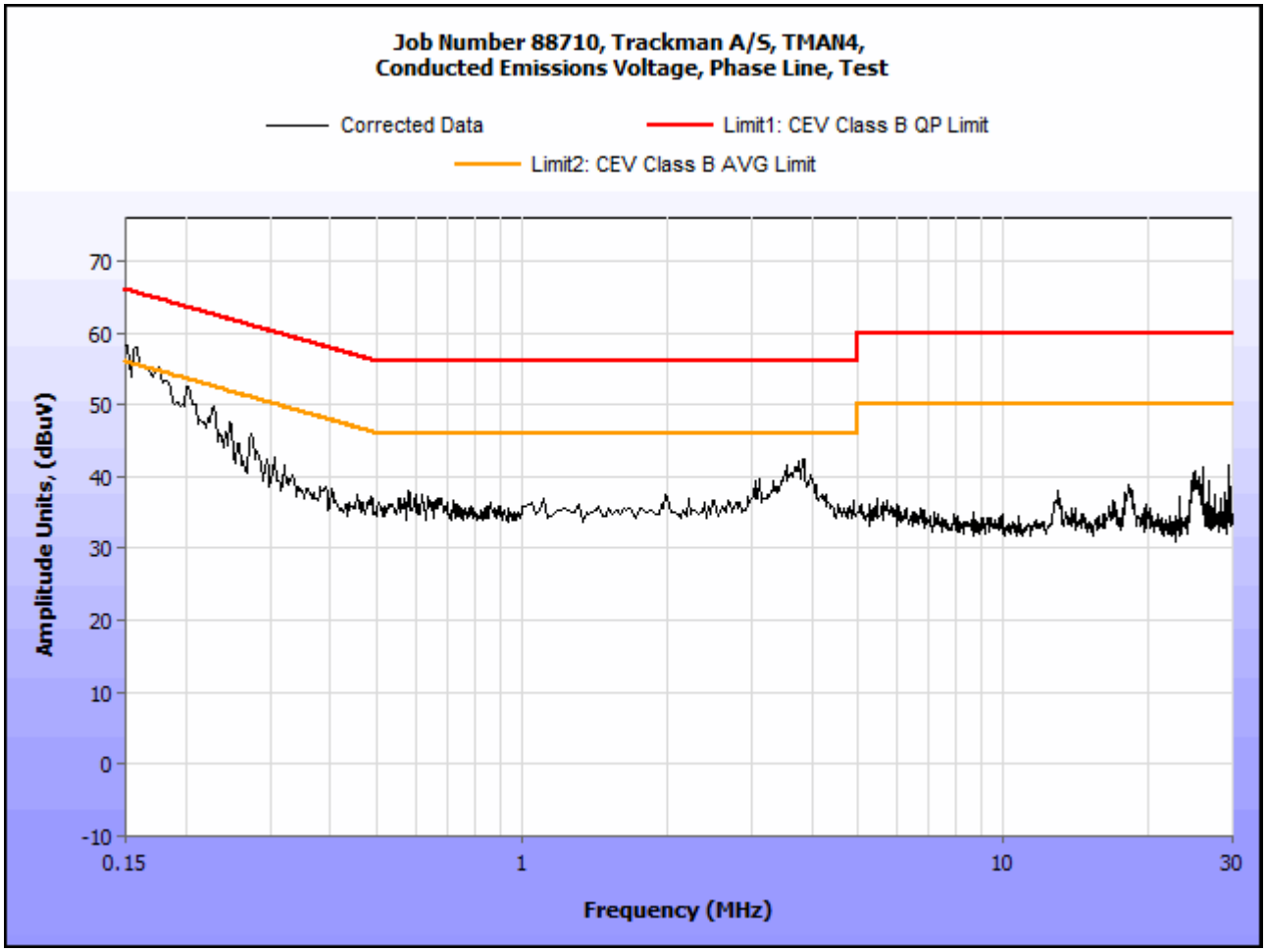
Test Engineer(s): Djed Mouada

Test Date(s): November 14, 2016

15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.157	37.96	0	37.96	79	-41.04	27.65	0	27.65	66	-38.35
0.365	35.15	0	35.15	79	-43.85	31.57	0	31.57	66	-34.43
7.324	34.16	0	34.16	73	-38.84	31.66	0	31.66	60	-28.34
2.668	22.82	0	22.82	73	-50.18	19.87	0	19.87	60	-40.13
14.39	36.35	0.12	36.47	73	-36.53	30.9	0.12	31.02	60	-28.98
20.2	32.75	0.16	32.91	73	-40.09	27.47	0.16	27.63	60	-32.37

Table 8. Conducted Emissions, 15.207(a), Phase Line, Test Results

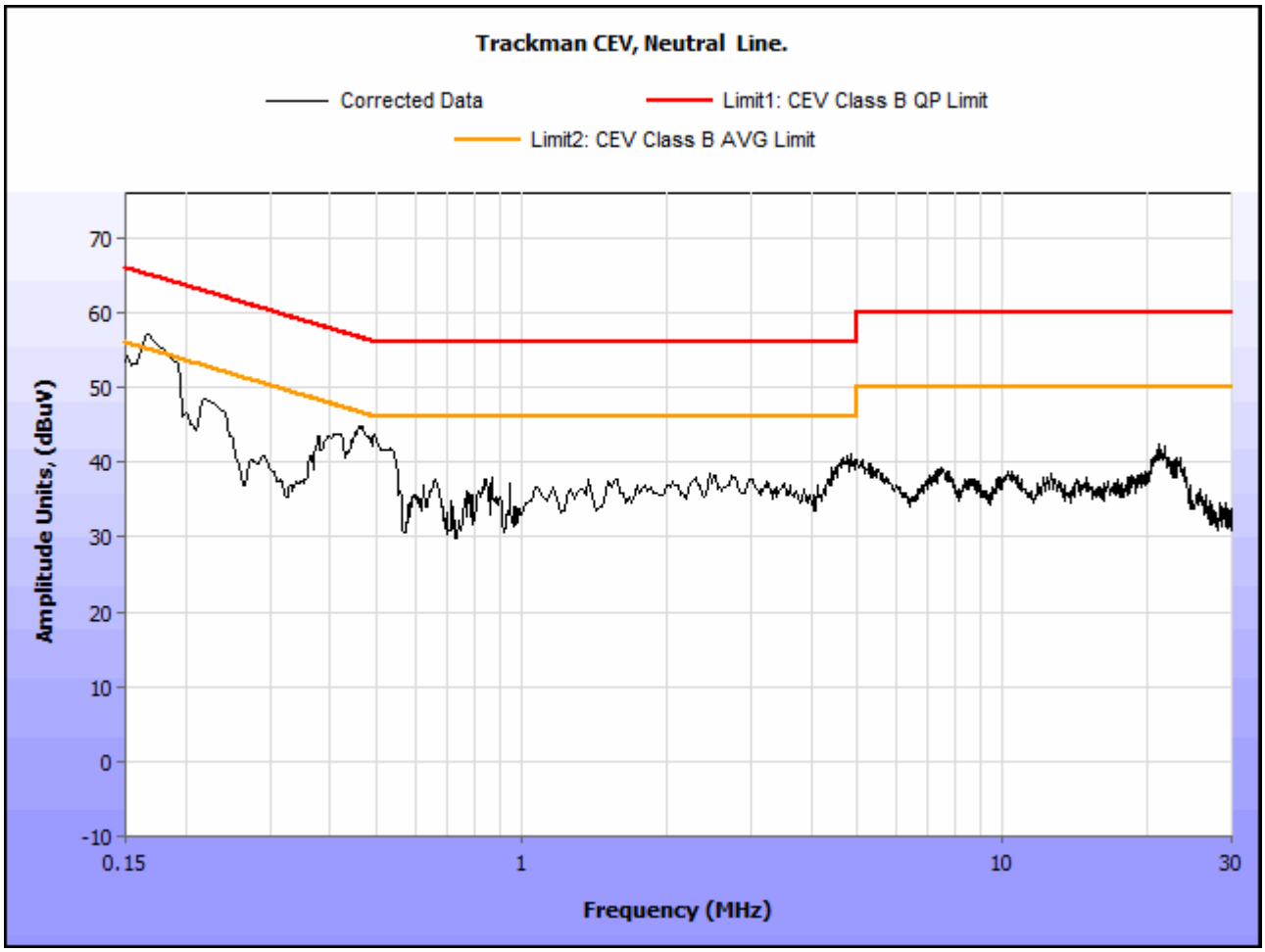


Plot 1. Conducted Emissions, 15.207(a), Phase Line

15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.26	43.22	0	43.22	61.43	-18.21	19.18	0	19.18	51.43	-32.25
0.574	42.17	0	42.17	56	-13.83	40.26	0	40.26	46	-5.74
1.287	29.4	0	29.4	56	-26.6	29.24	0	29.24	46	-16.76
13.2	29.17	0.11	29.28	60	-30.72	19.16	0.11	19.27	50	-30.73
15.97	32.15	0.12	32.27	60	-27.73	32.49	0.12	32.61	50	-17.39
20.322	32.95	0.17	33.12	60	-26.88	27.14	0.17	27.31	50	-22.69

Table 9. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 2. Conducted Emissions, 15.207(a), Neutral Line

15.207(a) Conducted Emissions Test Setup Photo

Photograph 1. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.245 (a) Operational requirements

Test Requirements: Operation under the provisions of this section is limited to intentional radiators used as field disturbance sensors, excluding perimeter protection systems.

Test Results: The intended operation of the EUT is that of a field disturbance sensor and not as perimeter protection systems. Therefore, the EUT meets the requirements of 15.245(a).

Test Engineer(s): Djed Mouada

Test Date(s): November 18, 2016

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.245 Radiated Field Strength of Fundamental

Test Requirements: **F**ield strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25
24075-24175	2500	25

Field strength limits are specified at a distance of 3 meters.

The emissions limits shown above are based on measurement instrumentation employing an average detector. The provisions of §15.35 for limiting peak emissions apply.

Test Procedure: Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast from 1 m to 4 m height to determine worst case orientation for maximum emissions. The antenna was placed 3m away from the EUT. The EUT was rotated about all three orthogonal axes.

For the purposes of demonstrating compliance, peak measurements were taken in lieu of average.

Test Results: The EUT as tested is compliant with the criteria of §15.245. No anomalies were detected.

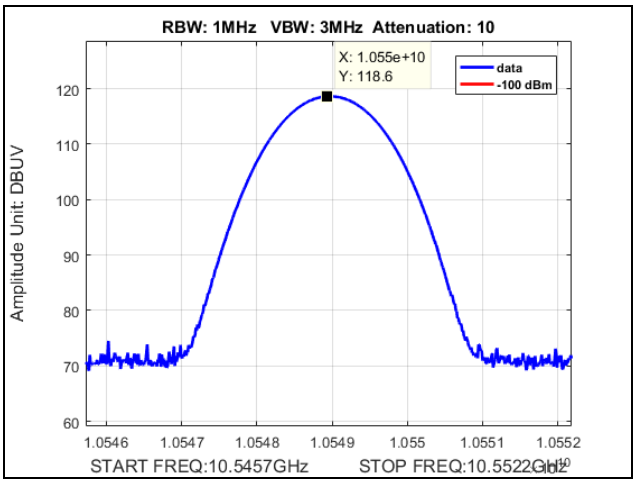
Test Engineer(s): Djed Mouada

Test Date(s): November 18, 2016

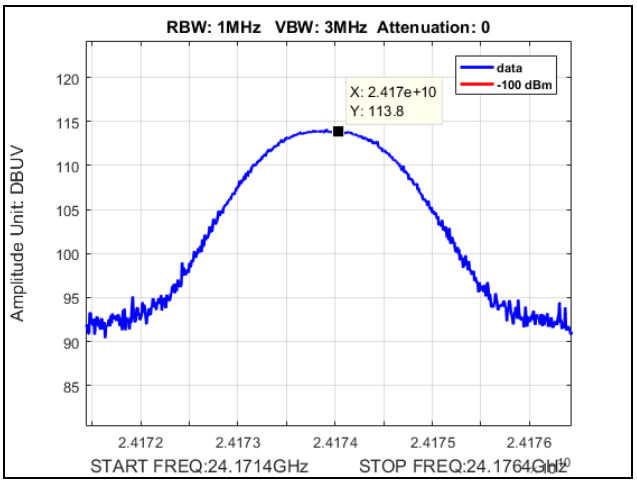
Field Strength of Fundamental

10GHz			
Channel	**measured Field Strength(dBuV/m)**	**Limit (dBuV/m)**	**Margin**
Low	120.3	127	-6.7
Mid	119	127	-8
High	118.6	127	-8.4

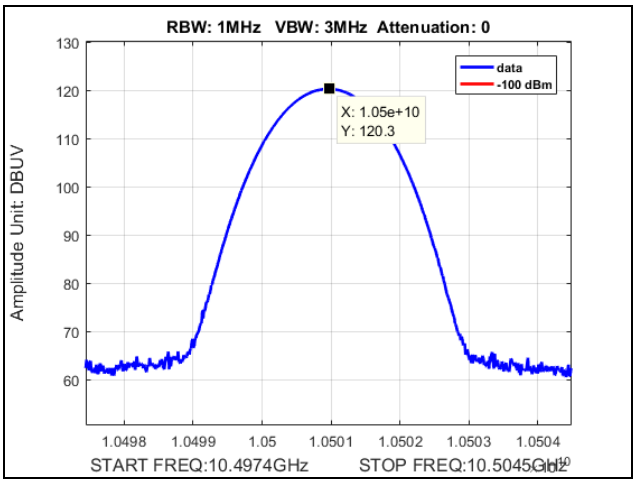
24GHz			
Channel	**measured Field Strength(dBuV/m)**	**Limit (dBuV/m)**	**Margin**
Low	113.1	127	-13.9
Mid	112	127	-15
High	113.8	127	-13.2



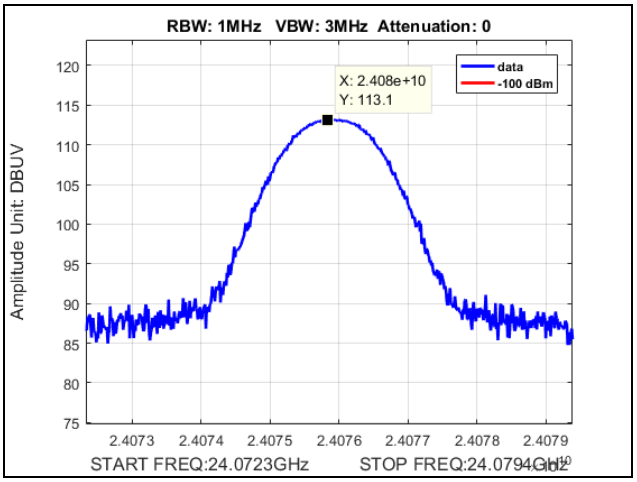
Plot 3. Field Strength of Fundamental, High Channel, 10GHz, radar



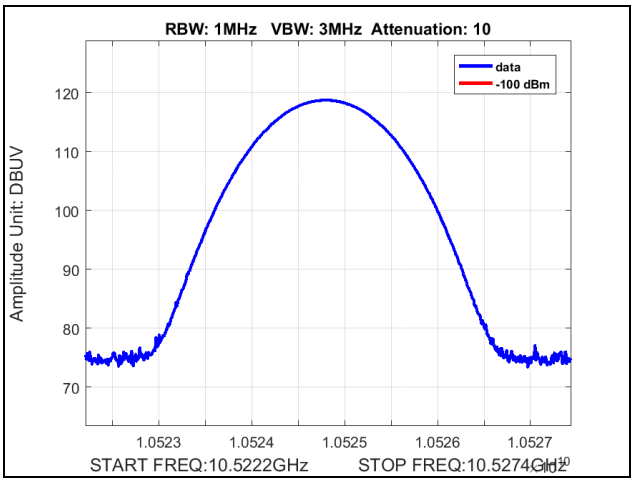
Plot 4. Field Strength of Fundamental, High Channel, 24GHz, radar



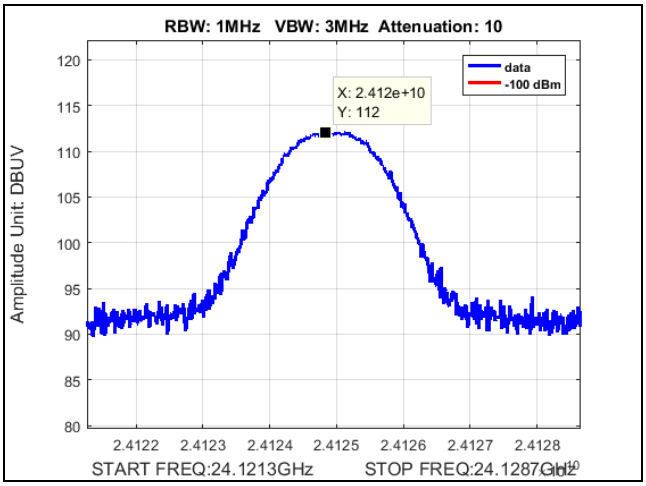
Plot 5. Field Strength of Fundamental, Low Channel, 10GHz, radar



Plot 6. Field Strength of Fundamental, Low Channel, 24GHz, radar



Plot 7. Field Strength of Fundamental, Mid Channel, 10GHz, radar



Plot 8. Field Strength of Fundamental, Mid Chanel, 24GHz, radar

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.245 (b)(3) Spurious Emissions

Test Requirements:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

For all other field disturbance sensors, 7.5 mV/m.

Field strength limits are specified at a distance of 3 meters.

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions of §15.35 for limiting peak emissions apply.

Test Procedure: The EUT was placed on a non-conducting stand on a turntable in a chamber. To find the maximum emission the EUT was set to transmit on low, mid, and high channels. Additionally, the turntable was rotated 360 degrees, the EUT was oriented through its three orthogonal axes, and the receive antenna height was varied in order to maximize emissions.

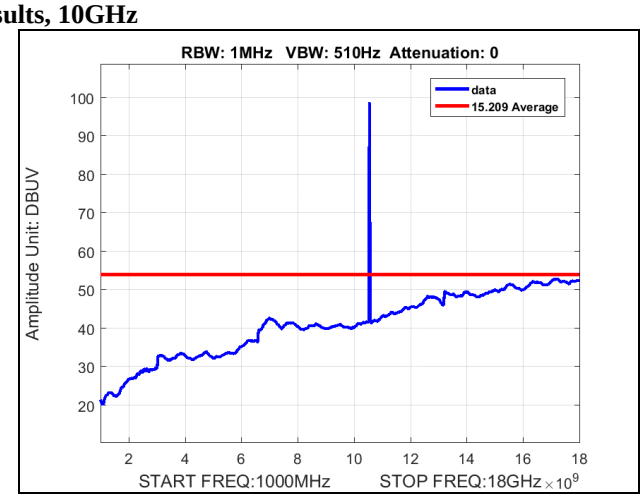
For emissions above 1 GHz and in restricted bands, measurements of the field strength were made with a peak detector and an average detector and compared with the limits of 15.209.
For Measurements above 1 GHz, measurement distance closer than 3m were used. This is in accordance with 15.31(f)(1).
Note that the dBuV/m and the distances of measurements were 1m, 75 cm and 25 cm and the correction factors were -954dB. -12.04 dB and -21.5dB respectively. Antennas and cables factors were added to the spectrum analyzer.

Test Results: The EUT as tested was compliant with the requirements of 15.245. No anomalies detected.

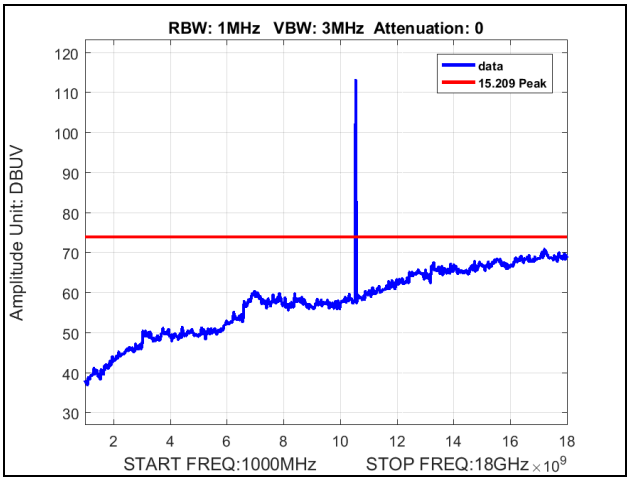
Test Engineer(s): Djed Mouada

Test Date(s): November 18, 2016

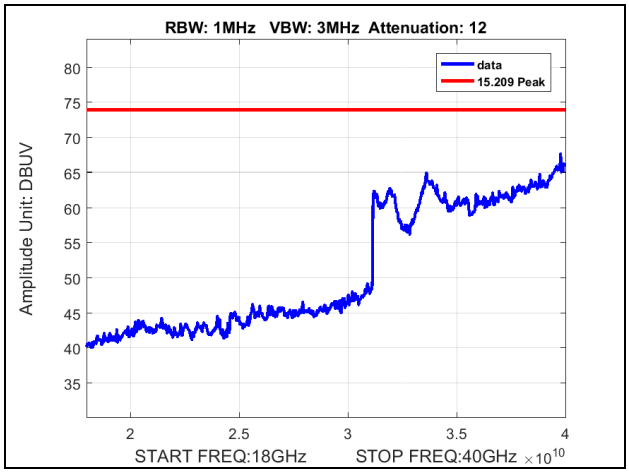
Spurious Emissions, Test Results, 10GHz



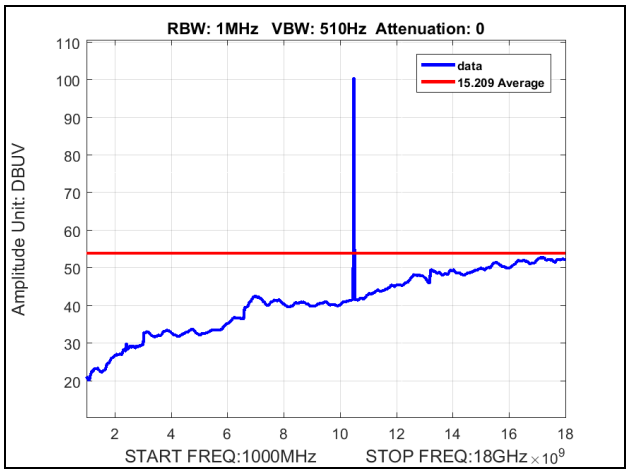
Plot 9. Spurious Emissions, High Channel, 1-18GHz, AVG



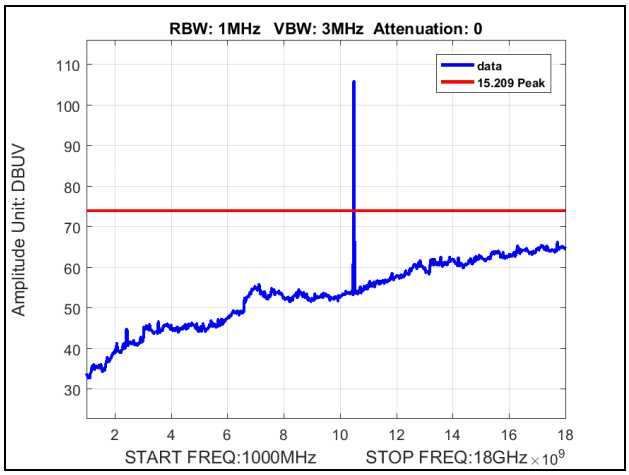
Plot 10. Spurious Emissions, High Channel, 1-18GHz, Peak



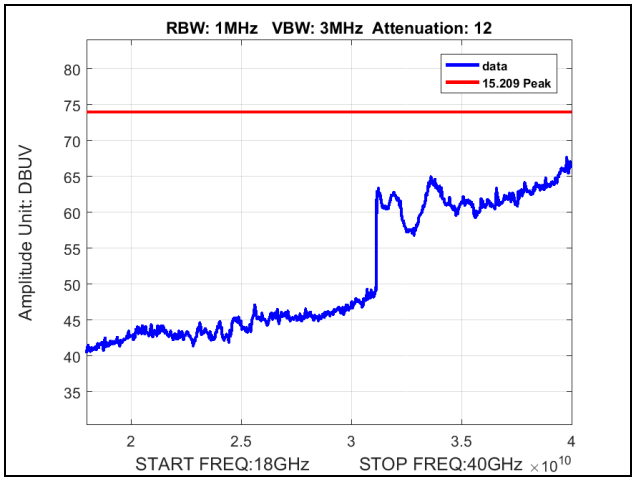
Plot 11. Spurious Emissions, High Channel, 18-40GHz, Peak



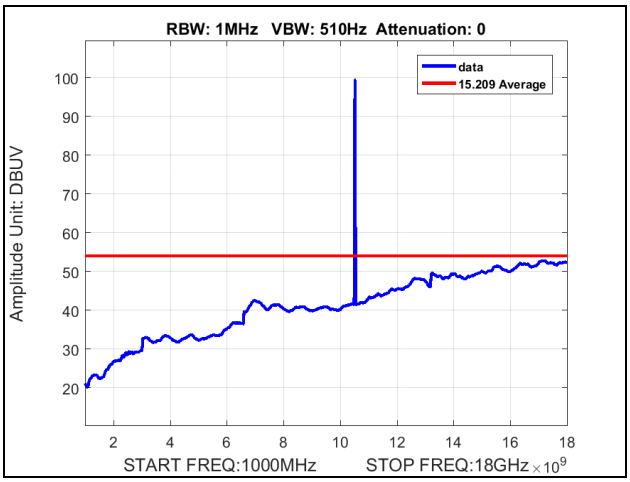
Plot 12. Spurious Emissions, Low Channel, 1-18GHz, AVG



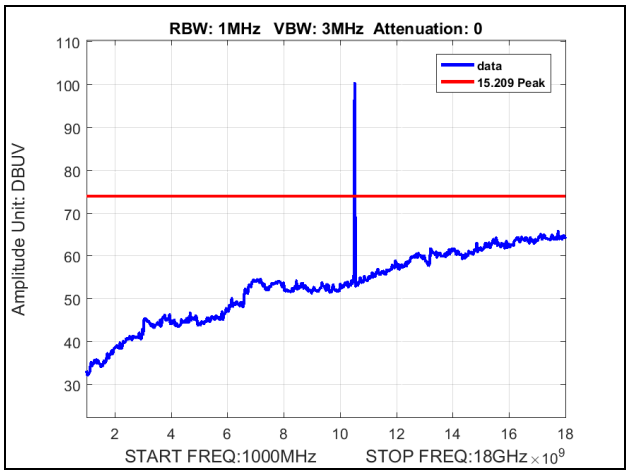
Plot 13. Spurious Emissions, Low Channel, 1-18GHz, Peak



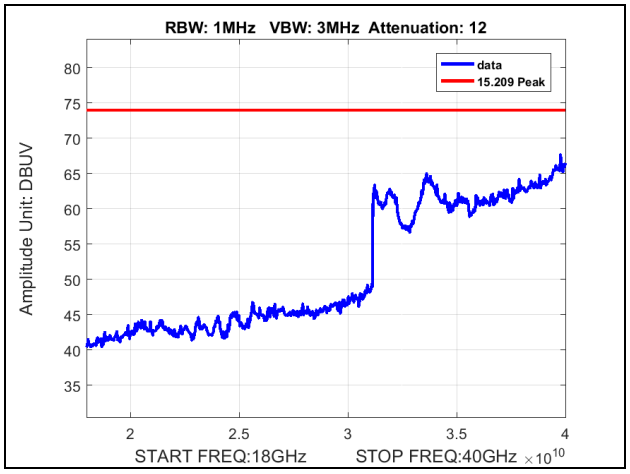
Plot 14. Spurious Emissions, Low Channel, 18-40GHz, Peak



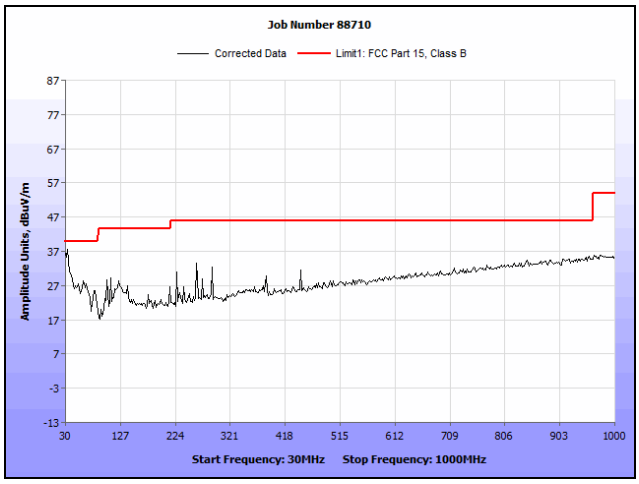
Plot 15. Spurious Emissions, Mid Channel, 1-18GHz, AVG



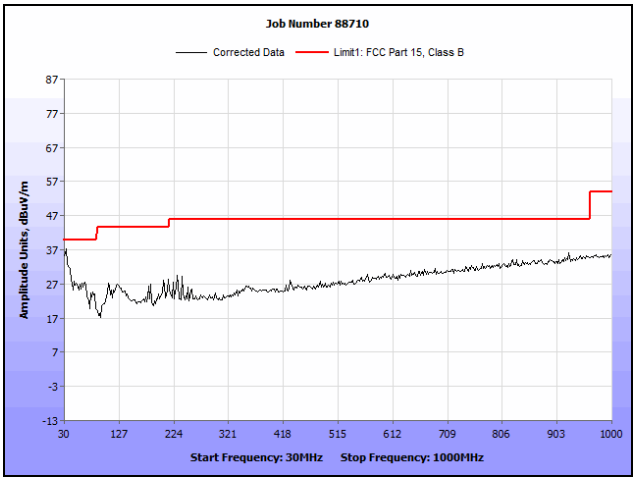
Plot 16. Spurious Emissions, Mid Channel, 1-18GHz, Peak



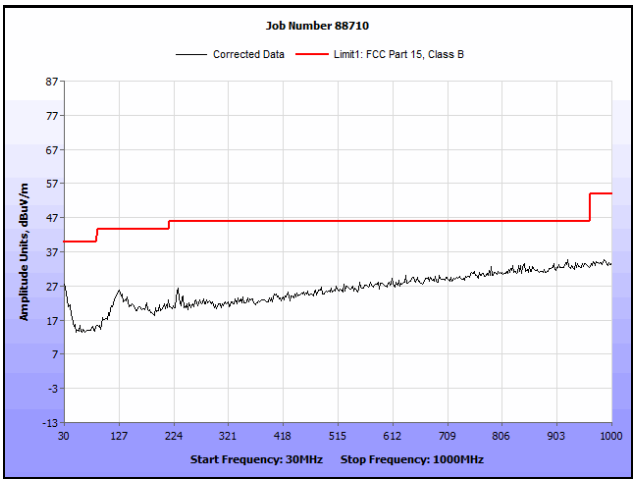
Plot 17. Spurious Emissions, Mid Channel, 18-40GHz, Peak



Plot 18. Spurious Emissions, High channel, 30MHz-1GHz, 10GHz, Radar

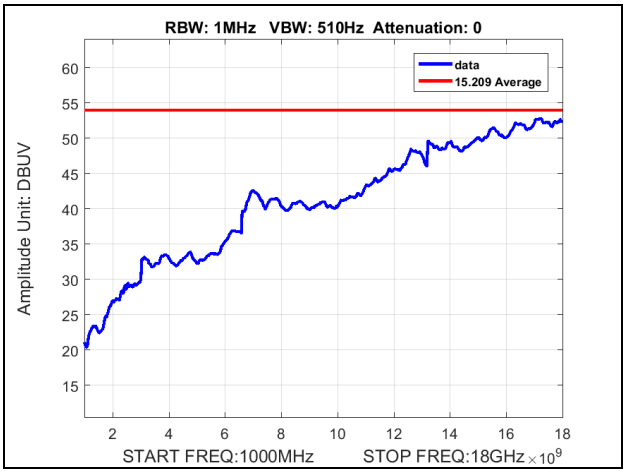


Plot 19. Spurious Emissions, Low Channel, 30MHz-1GHz, 10GHz, Radar

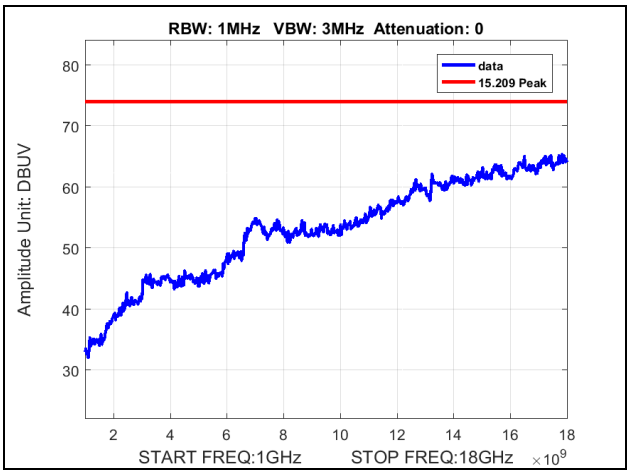


Plot 20. Spurious Emissions, Mid Channel, 30MHz-1GHz, 10GHz, Radar

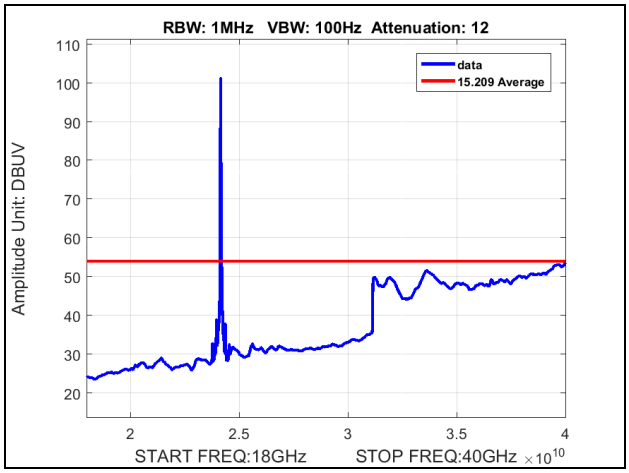
24GHz



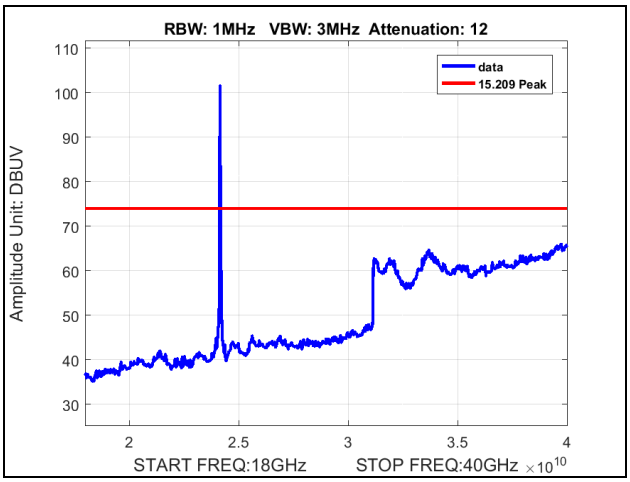
Plot 21. Spurious Emissions, High Channel, 1-18GHz, 24GHz, AVG



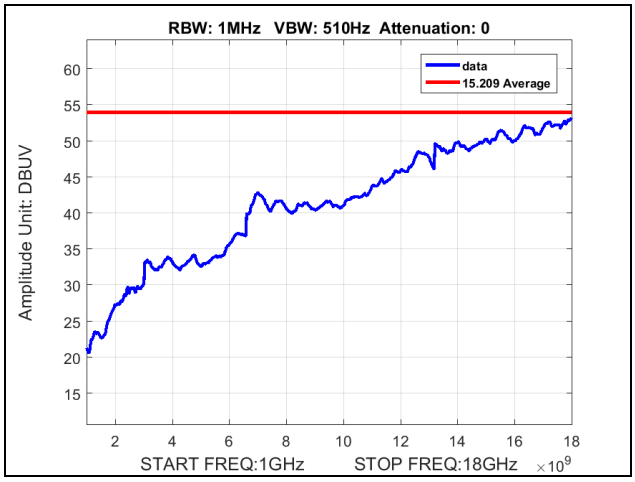
Plot 22. Spurious Emissions, High Channel, 1-18GHz, 24GHz, Peak



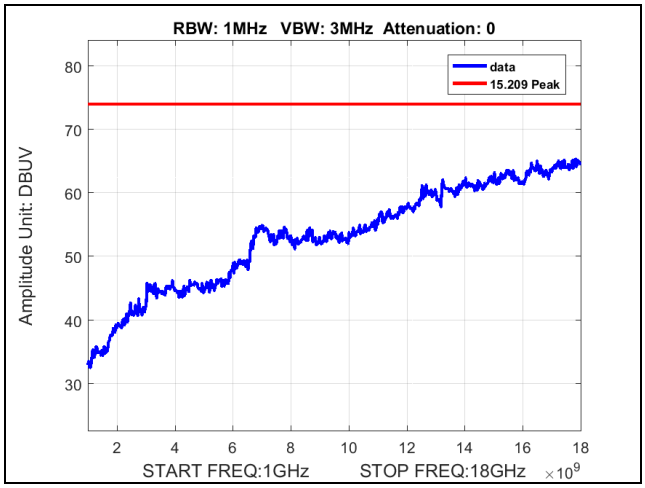
Plot 23. Spurious Emissions, High Channel, 18-40GHz, 24GHz, AVG



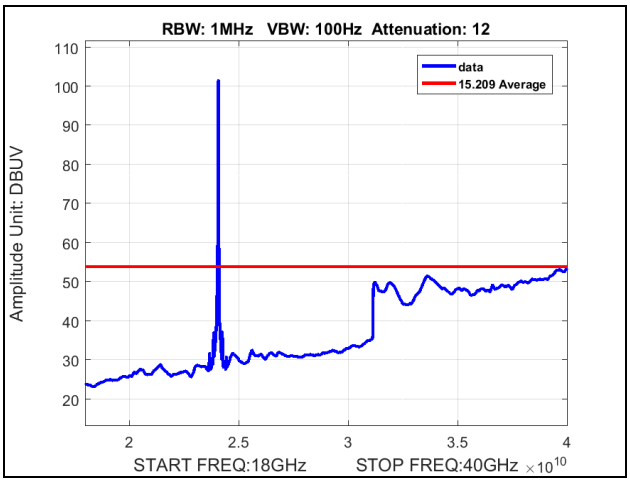
Plot 24. Spurious Emissions, High Channel, 18-40GHz, 24GHz, Peak



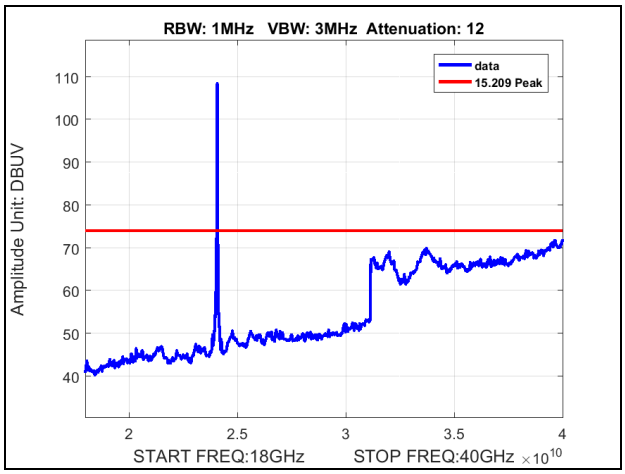
Plot 25. Spurious Emissions, Low Channel, 1-18GHz, 24GHz, AVG



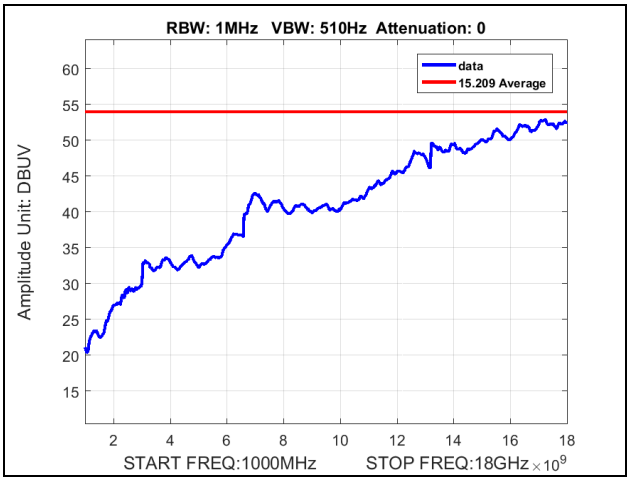
Plot 26. Spurious Emissions, Low Channel, 1-18GHz, 24GHz, Peak



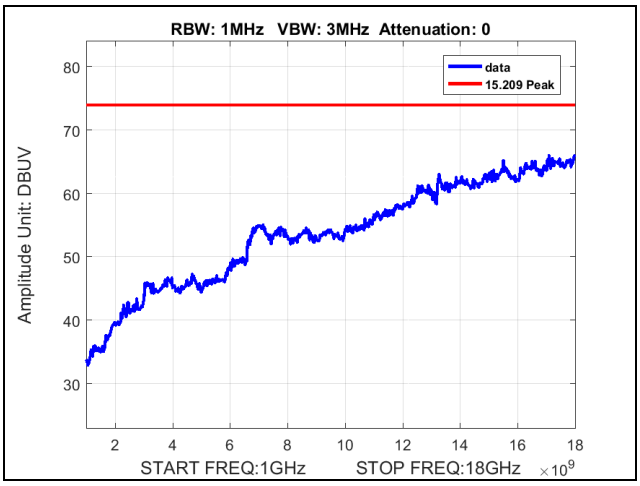
Plot 27. Spurious Emissions, Low Channel, 18-40GHz, 24GHz, AVG



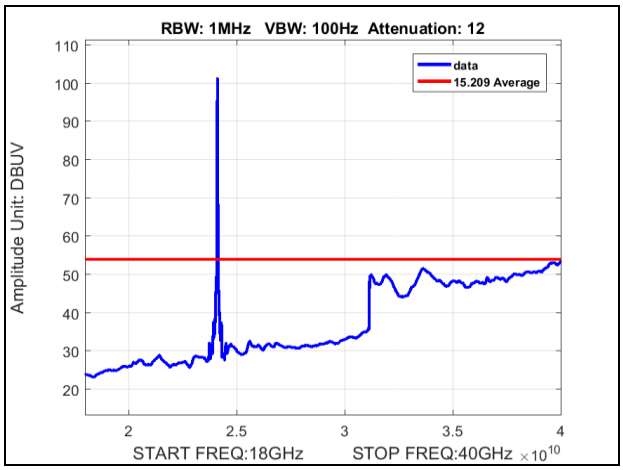
Plot 28. Spurious Emissions, Low Channel, 18-40GHz, 24GHz, Peak



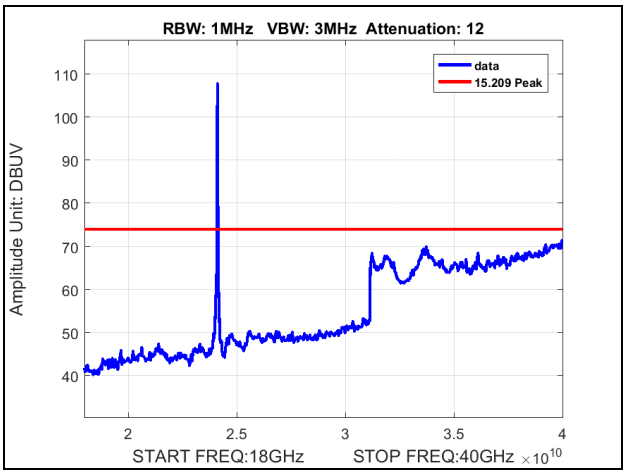
Plot 29. Spurious Emissions, Mid Channel, 1-18GHz, 24GHz, AVG



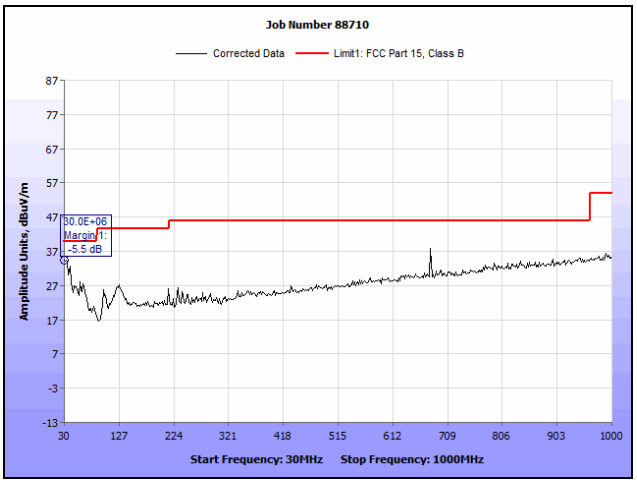
Plot 30. Spurious Emissions, Mid Channel, 1-18GHz, 24GHz, Peak



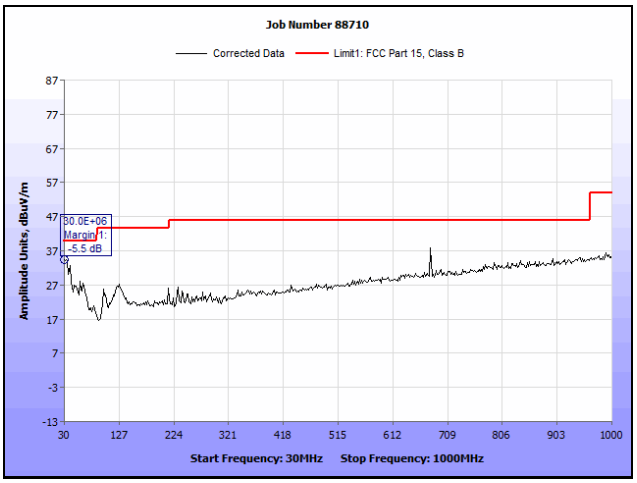
Plot 31. Spurious Emissions, Mid Channel, 18-40GHz, 24Ghz, AVG



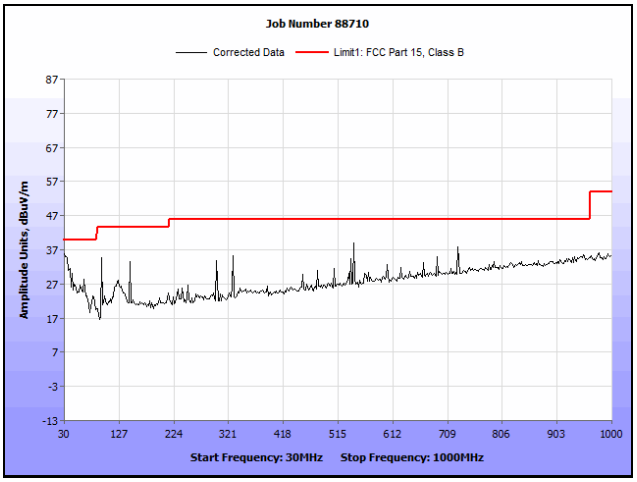
Plot 32. Spurious Emissions, Mid Channel, 18-40GHz, 24GHz, Peak



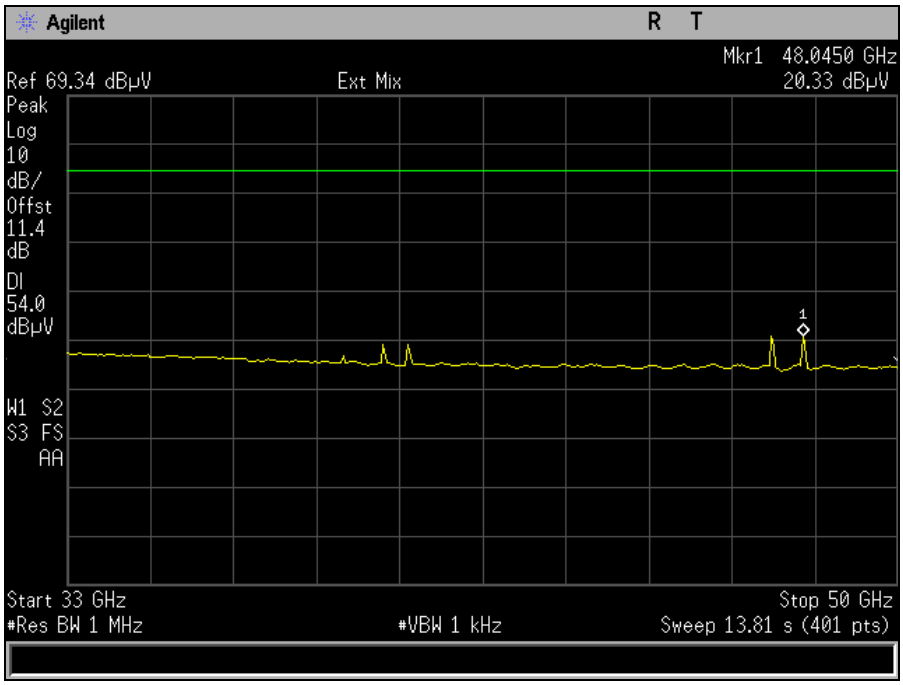
Plot 33. Spurious Emissions, High Channel, 30MHz-1GHz, 24GHz, Radar



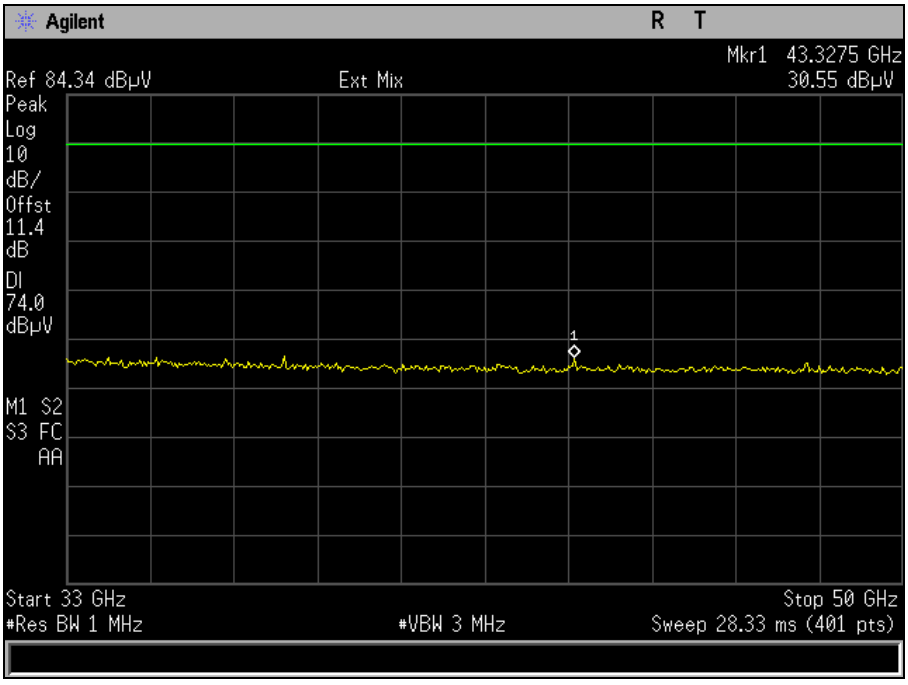
Plot 34. Spurious Emissions, Low Channel, 30MHz-1GHz, 24GHz, Radar



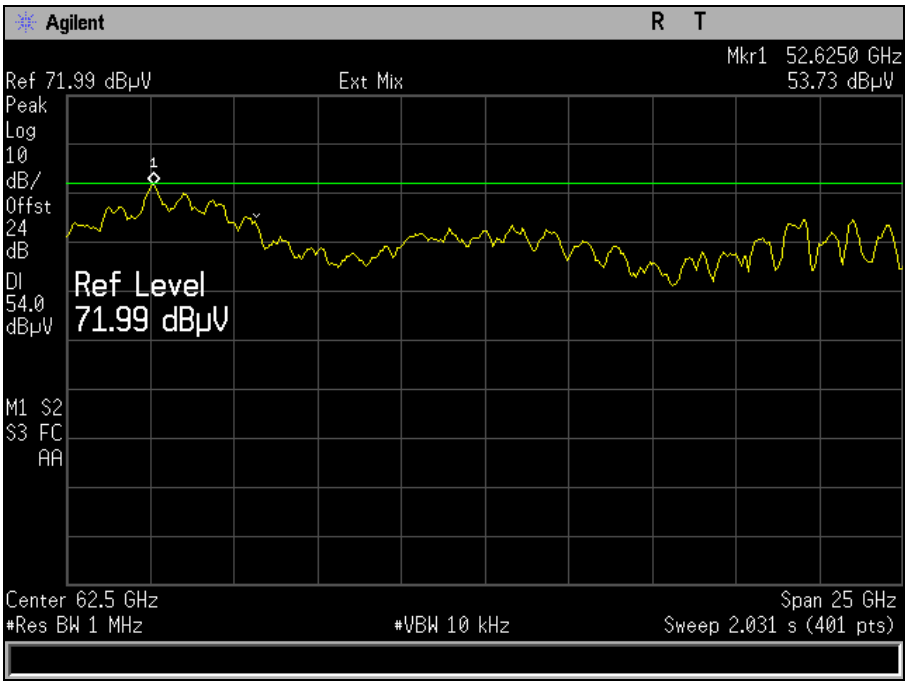
Plot 35. Spurious Emissions, Mid Channel, 30MHz-1GHz, 24GHz, Radar



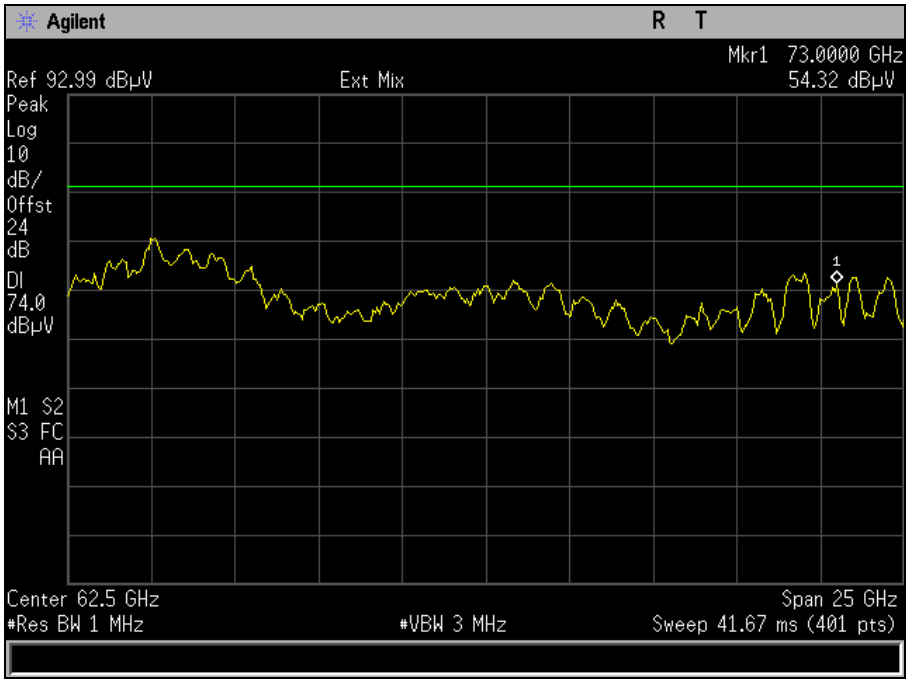
Plot 36. Spurious Emissions, 33-50 GHz, Worst case, all radios on, Average (75cm)



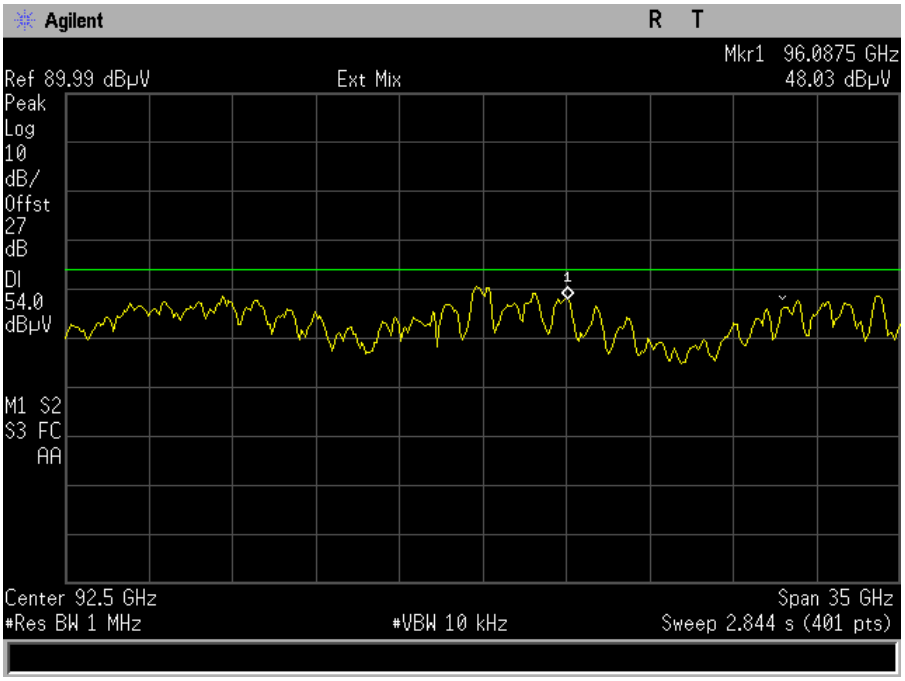
Plot 37. Spurious Emissions, 33-50 GHz, Worst case, all radios on, Peak (75cm)



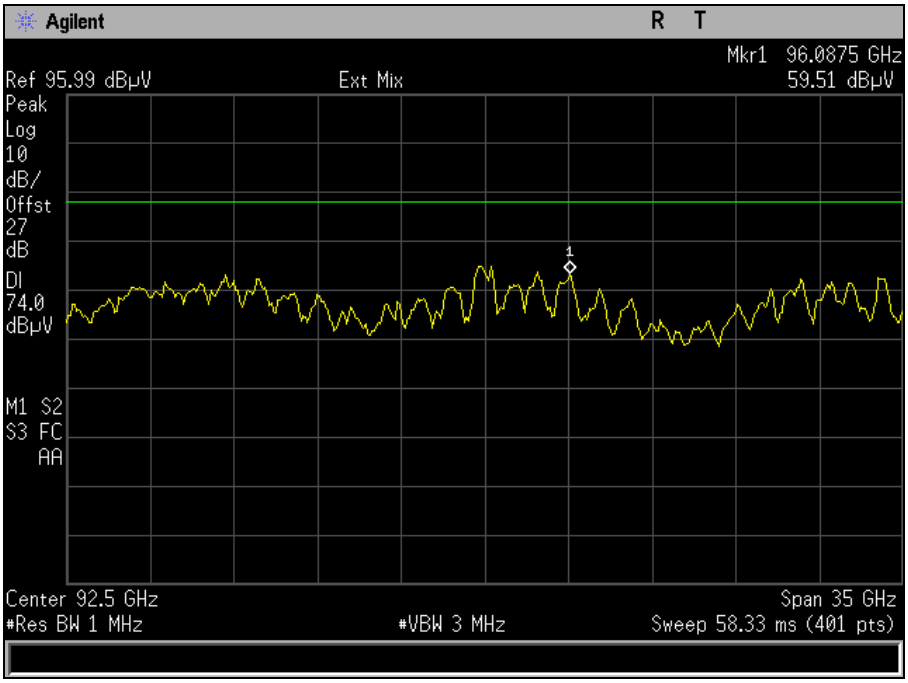
Plot 38. Spurious Emissions, 50-75 GHz, Worst case, all radios on, Average (25cm)



Plot 39. Spurious Emissions, 50-75 GHz, Worst case, all radios on, Peak (25cm)

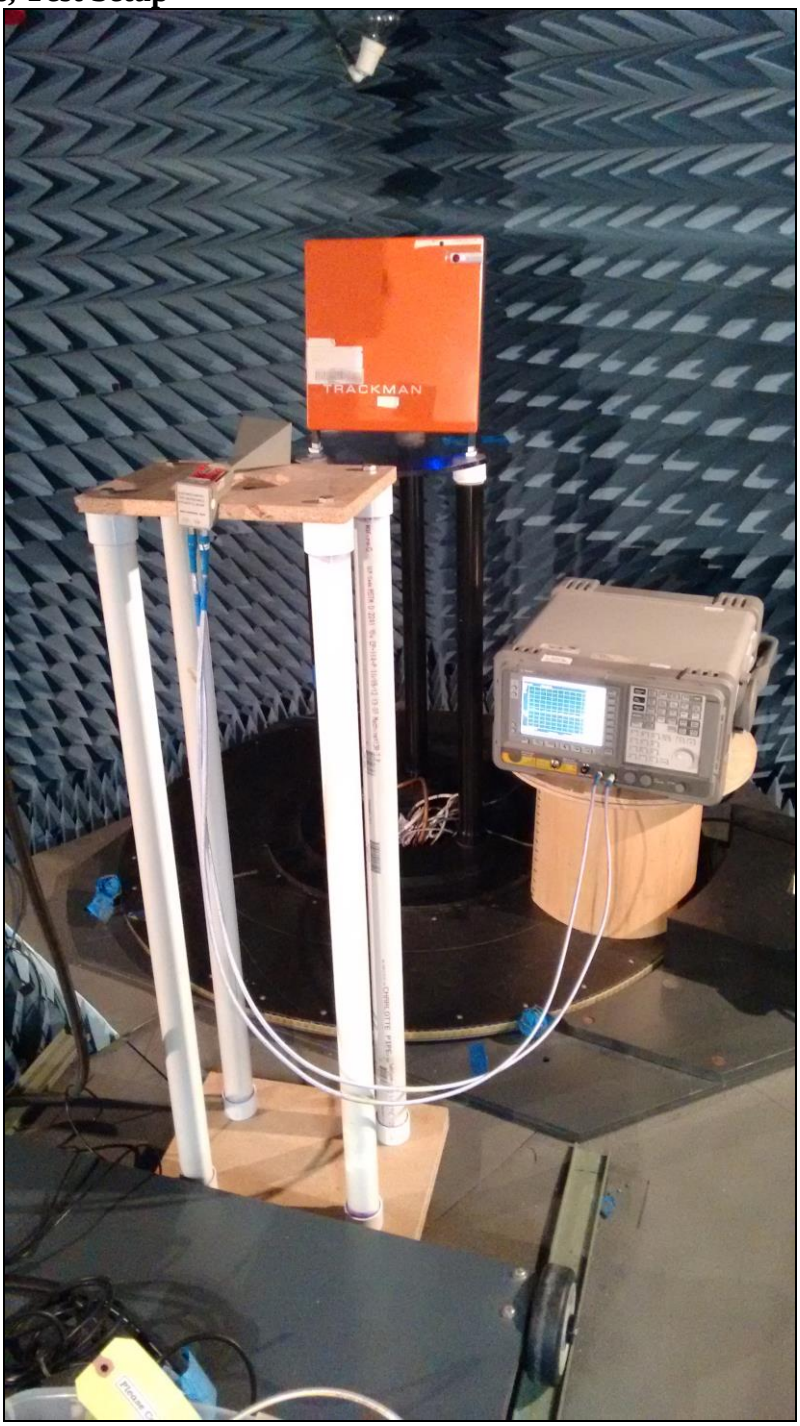


Plot 40. Spurious Emissions, 75-110 GHz, Worst case, all radios on, Average (25cm)

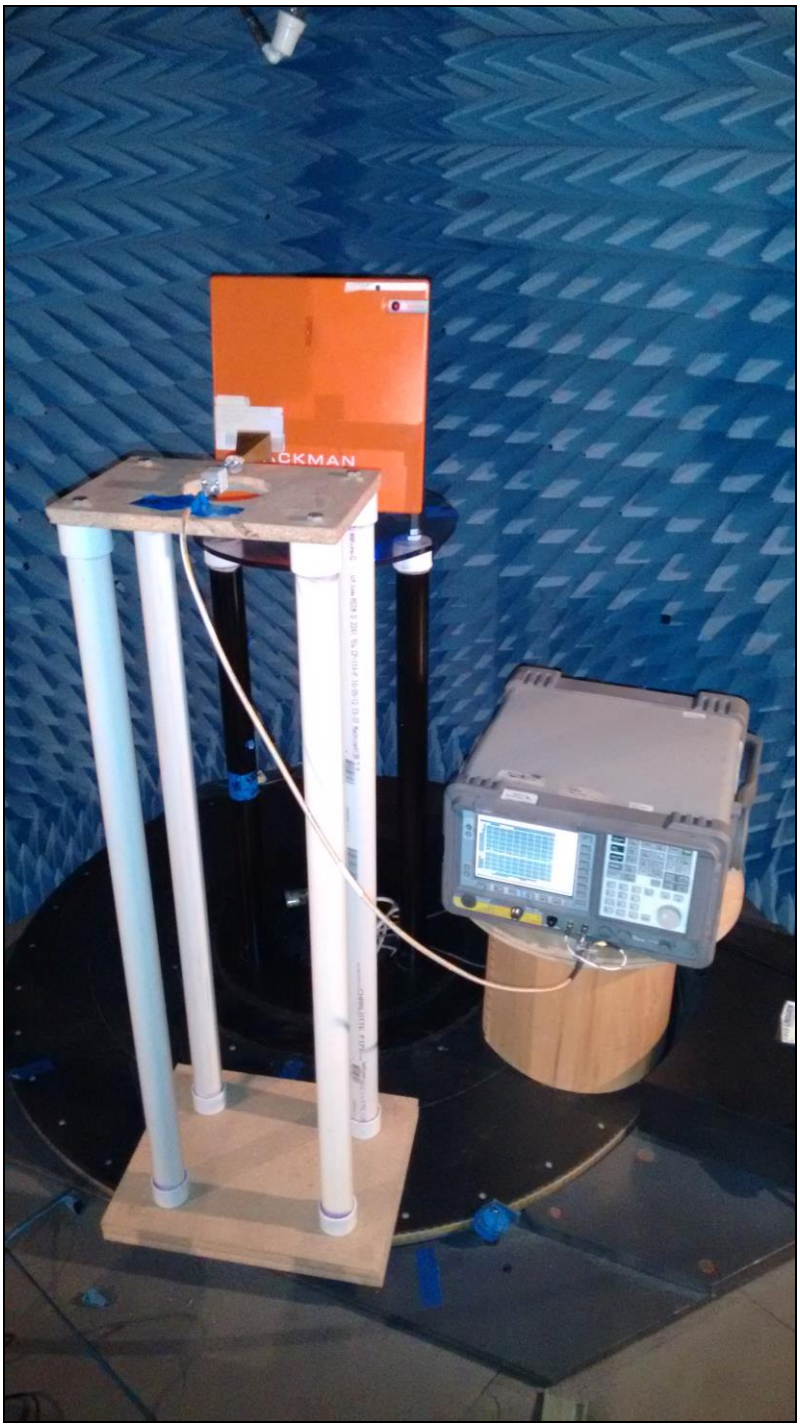


Plot 41. Spurious Emissions, 75-110 GHz, Worst case, all radios on, Peak (25cm)

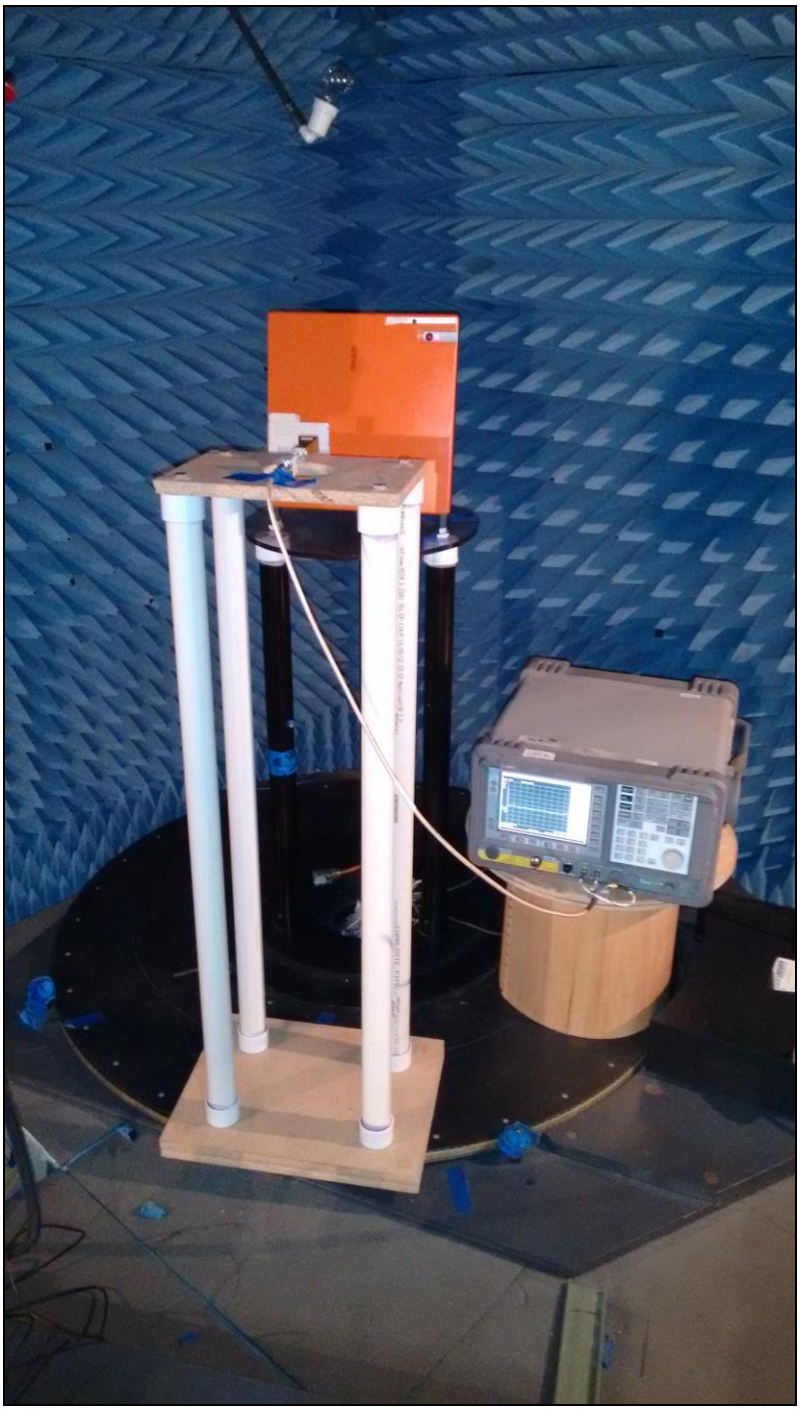
Spurious Emissions, Test Setup



Photograph 2. Spurious Emissions, Test Setup, 33 – 50 GHz



Photograph 3. Spurious Emissions, Test Setup, 50 GHz - 75 GHz



Photograph 4. Spurious Emissions, Test Setup, 75 GHz - 110 GHz

§ 15.245 20dB Bandwidth

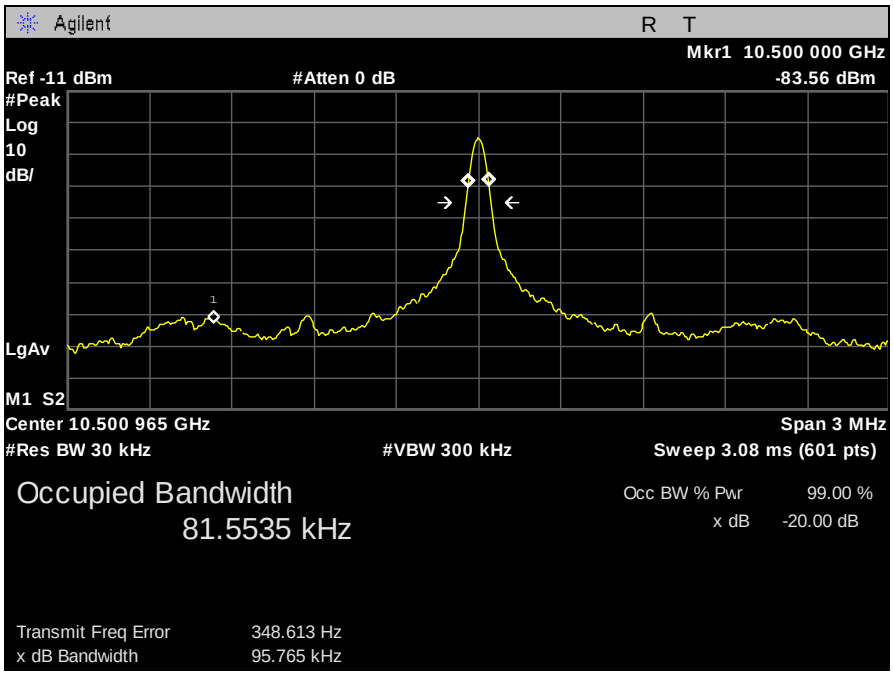
Test Requirements: **§ 15.215**
c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §15.217 through §15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

Test Procedure: The transmitter was set to low, mid, and high operating frequencies at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth, VBW > RBW. The 20 dB Bandwidth was measured and recorded.

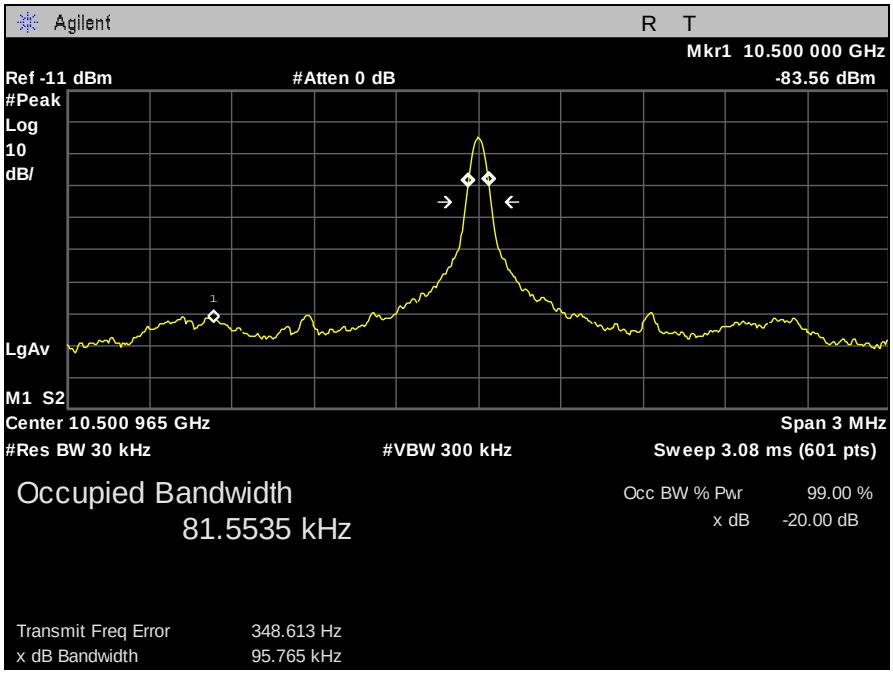
Test Results The 20 dB Bandwidth was compliant with the requirements of this section. No anomalies detected.

Test Engineer(s): Djed Mouada.

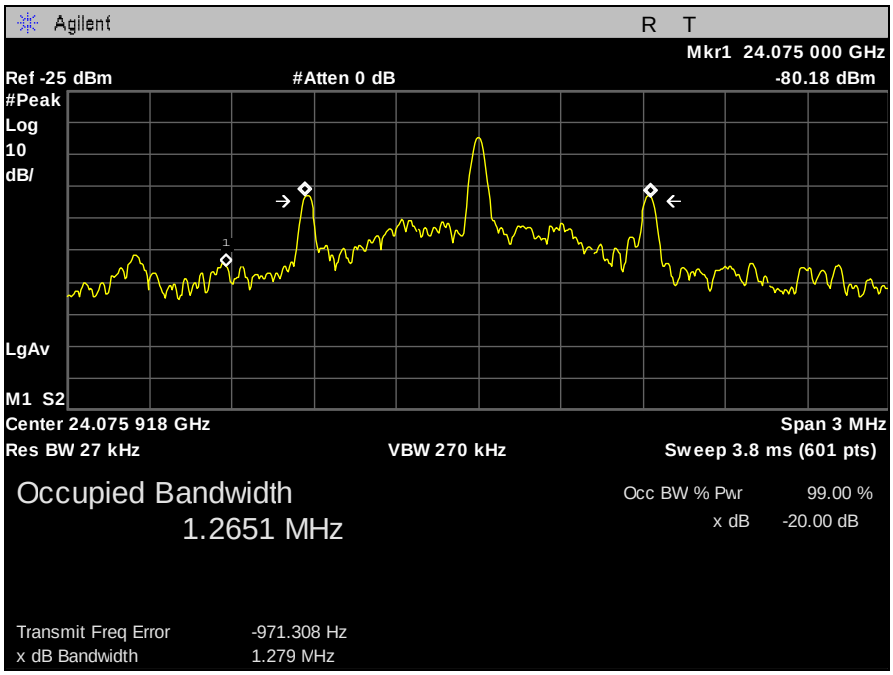
Test Date(s): November 7, 2016



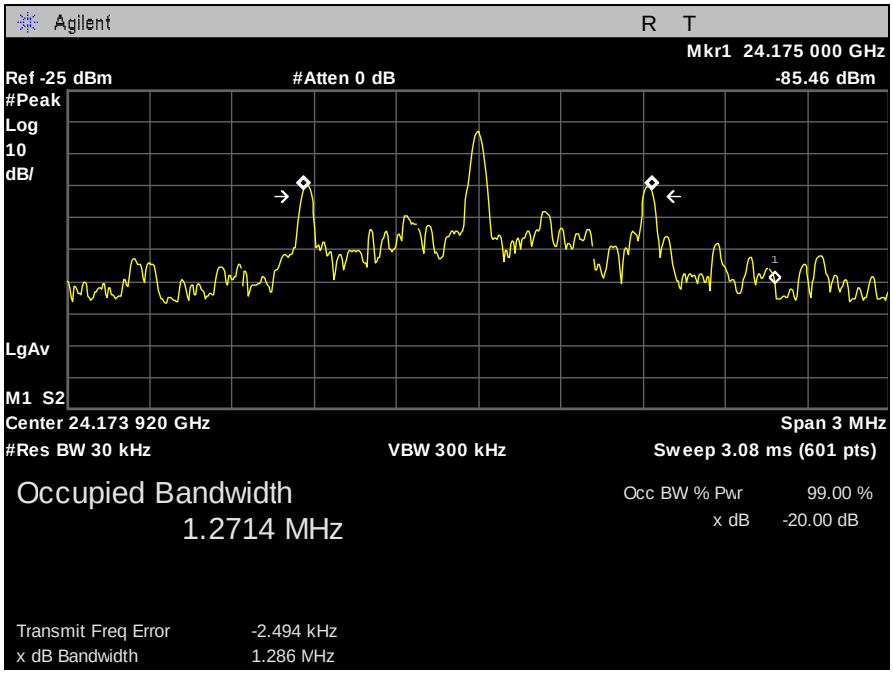
Plot 42. Occupied Bandwidth, 10 GHz, Low Channel



Plot 43. Occupied Bandwidth, 10 GHz, High Channel



Plot 44. Occupied Bandwidth, 24 GHz, Low Channel



Plot 45. Occupied Bandwidth, 24 GHz, 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 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T6658	SPECTRUM ANALYZER	AGILENT	E4407B	12/09/2015	10/22/2017
1T4497	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4432B	4/22/2016	10/22/2017
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	10/08/2015	04/08/2017
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	8/10/2016	2/10/2018
1T4300B	SEMI-ANECHOIC 3M CHAMBER # 1 D (2043A-1) (IC)	EMC TEST SYSTEMS	NONE	01/11/2015	01/11/2018
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	12/7/2016	12/7/2018
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	2/26/2016	8/26/2017
1T4666	HARMONIC MIXER	HP	11970Q	11/3/2016	5/3/2018
1T4745	ANTENNA, HORN	ETS-LINDGREN	3116	1/21/2017	7/21/2018
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	SEE NOTE	
1T4855	WR-06 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M06HWD	SEE NOTE	
1T4853	WR-15 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M15HWA	SEE NOTE	
1T4854	WR-10 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M10HWA	SEE NOTE	
1T4857	DIPLEXER	OML, INC.	DPL26 DIPLEXER	SEE NOTE	
1T4666	HARMONIC MIXER	HP	11970Q	11/3/2016	5/3/2018
331T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	

Table 10. Test Equipment

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

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

