eurofins | MET Labs

HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

January 16, 2020

Rajant Corporation
200 Chesterfield Parkway
Malvern, PA 19355

Dear Keith Sullivan,

Enclosed is the EMC Wireless test report for compliance testing of the Rajant Corporation, WLM200N5-26ESD as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.407, Subpart E (UNII 3).

Thank you for using the services of Eurofins MET Labs, 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,
EUROFINS MET LABS, INC.

Michelle Tawmging

Michelle Tawmging
Documentation Department

Reference: (\Rajant Corporation\ EMC106001-FCC407 UNII 3 Rev. 4)

Certificates and reports shall not be reproduced except in full, without the written permission of Eurofins MET Labs, Inc.

HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

Electromagnetic Compatibility Criteria
Test Report

for the

Rajant Corporation
Model WLM200N5-26ESD

Tested under
The FCC Certification Rules
contained in
Title 47 of the CFR
15.407 Subpart E

MET Report: EMC106001-FCC407 UNII 3 Rev. 4

January 16, 2020

Prepared For:

Rajant Corporation
200 Chesterfield Parkway
Malvern, PA 19355

Prepared By:
Eurofins MET Labs, Inc.
914 W. Patapsco Avenue
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

for the

Rajant Corporation
Model WLM200N5-26ESD

Tested under
The FCC Certification Rules
contained in
Title 47 of the CFR
15.407 Subpart E

Donald Salguero, Project Engineer
Wireless Laboratory

Michelle Tawmging
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 15.407 of the FCC Rules under normal use and maintenance.

Deepak Giri
Manager, Wireless Laboratory

© 2020, Eurofins MET Labs, Inc.

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 20, 2019	Initial Issue.
1	December 9, 2019	Implemented Customer-Requested Revisions
2	December 12, 2019	Implemented Customer-Requested Revisions
3	January 9, 2020	TCB Comments
4	January 16, 2020	TCB Comments

© 2020, Eurofins MET Labs, Inc.

Table of Contents

I. Executive Summary 1
A. Purpose of Test 2
B. Executive Summary 2
II. Equipment Configuration 3
A. Overview 4
B. References 5
C. Test Site 5
D. Description of Test Sample 5
E. Equipment Configuration 6
F. Support Equipment 6
G. Ports and Cabling Information 6
H. Mode of Operation 7
I. Method of Monitoring EUT Operation 7
J. Modifications 7
a) Modifications to EUT 7
b) Modifications to Test Standard 7
K. Disposition of EUT 7
III. Electromagnetic Compatibility Criteria for Intentional Radiators 8
§ 15.203 Antenna Requirement 9
§ 15.403(i) 26 dB Bandwidth 10
Duty Cycle 19
§ 15.407(a)(3) Maximum Conducted Output Power 21
§ 15.407(a)(3) Maximum Power Spectral Density 30
§ 15.407(b)(4) & (6 - 7) Undesirable Emissions 39
§ 15.407(b)(6) Conducted Emissions 61
§ 15.407(e) 6 dB Bandwidth 65
§ 15.247(i) Maximum Permissible Exposure 74
IV. Test Equipment 75
V. Certification & User's Manual Information 77
A. Certification Information 78
B. Label and User's Manual Information 82

© 2020, Eurofins MET Labs, Inc.

List of Figures

Figure 1: Executive Summary of EMC Part 15.407 ComplianceTesting 2
Figure 2: EUT Summary 4
Figure 3: References 5
Figure 4: Block Diagram of Test Configuration 5
Figure 5: Equipment Configuration 6
Figure 6: Support Equipment 6
Figure 7: Ports and Cabling Information 6
Figure 8: Antenna List 9
Figure 9: 26dB Bandwidth, Test Results 10
Figure 10: 26dB Bandwidth, 5745MHz, Chain 0 11
Figure 11: 26dB Bandwidth, 5745MHz, Chain 1 11
Figure 12: 26dB Bandwidth, 5785MHz, Chain 0 12
Figure 13: 26dB Bandwidth, 5785MHz, Chain 1 12
Figure 14: 26dB Bandwidth, 5825MHz, Chain 0 13
Figure 15: 26dB Bandwidth, 5825MHz, Chain 1 13
Figure 16: 26dB Bandwidth, n20, 5745MHz, Chain 0 14
Figure 17: 26dB Bandwidth, n20, 5745MHz, Chain 1 14
Figure 18: 26dB Bandwidth, n20, 5785MHz, Chain 0 15
Figure 19: 26dB Bandwidth, n20, 5785MHz, Chain 1 15
Figure 20: 26dB Bandwidth, n20, 5825MHz, Chain 0 16
Figure 21: 26dB Bandwidth, n20, 5825MHz, Chain 1 16
Figure 22: 26dB Bandwidth, n40, 5755MHz, Chain 0 17
Figure 23: 26dB Bandwidth, n40, 5755MHz, Chain 1 17
Figure 24: 26dB Bandwidth, n40, 5795MHz, Chain 0 18
Figure 25: 26dB Bandwidth, n40, 5795MHz, Chain 1 18
Figure 26: Duty Cycle, Test Results 19
Figure 27: Duty Cycle, 802.11n, 40MHz_5755MHz 19
Figure 28: Duty Cycle, 802.11a, 20MHz_5825MHz 20
Figure 29: Duty Cycle, 802.11n, 20MHz_5825MHz 20
Figure 30: Output Power, SISO Test Results 21
Figure 31: Output Power, MIMO Test Results 21
Figure 32: Output Power, 802.11a, 20MHz_5745MHz, Chain 0 22
Figure 33: Output Power, 802.11a, 20MHz_5745MHz, Chain 1 22
Figure 34: Output Power, 802.11a, 20MHz_5785MHz, Chain 0 23
Figure 35: Output Power, 802.11a, 20MHz_5785MHz, Chain 1 23
Figure 36: Output Power, 802.11a, 20MHz_5825MHz, Chain 0 24
Figure 37: Output Power, 802.11a, 20MHz_5825MHz, Chain 1 24
Figure 38: Output Power, 802.11n, 20MHz_5745MHz, Chain 0 25
Figure 39: Output Power, 802.11n, 20MHz_5745MHz, Chain 1 25
Figure 40: Output Power, 802.11n, 20MHz_5785MHz, Chain 0 26
Figure 41: Output Power, 802.11n, 20MHz_5785MHz, Chain 1 26
Figure 42: Output Power, 802.11n, 20MHz_5825MHz, Chain 0 27
Figure 43: Output Power, 802.11n, 20MHz_5825MHz, Chain 1 27
Figure 44: Output Power, 802.11n, 40MHz_5755MHz, Chain 0 28
Figure 45: Output Power, 802.11n, 40MHz_5755MHz, Chain 1 28
Figure 46: Output Power, 802.11n, 40MHz_5795MHz, Chain 0 29
Figure 47: Output Power, 802.11n, 40MHz_5795MHz, Chain 1 29
Figure 48: Power Spectral Density, SISO Test Results 30
Figure 49: Power Spectral Density, MIMO Test Results 30

© 2020, Eurofins MET Labs, Inc.

Figure 50: Power Spectral Density, 802.11a, 20MHz_5745MHz, Chain 0 31
Figure 51: Power Spectral Density, 802.11a, 20MHz_5745MHz, Chain 1 31
Figure 52: Power Spectral Density, 802.11a, 20MHz_5785MHz, Chain 0 32
Figure 53: Power Spectral Density, 802.11a, 20MHz_5785MHz, Chain 1 32
Figure 54: Power Spectral Density, 802.11a, 20MHz_5825MHz, Chain 0 33
Figure 55: Power Spectral Density, 802.11a, 20MHz_5825MHz, Chain 1 33
Figure 56: Power Spectral Density, 802.11n, 20MHz_5745MHz, Chain 0 34
Figure 57: Power Spectral Density, 802.11n, 20MHz_5745MHz, Chain 1 34
Figure 58: Power Spectral Density, 802.11n, 20MHz_5785MHz, Chain 0 35
Figure 59: Power Spectral Density, 802.11n, 20MHz_5785MHz, Chain 1 35
Figure 60: Power Spectral Density, 802.11n, 20MHz_5825MHz, Chain 0 36
Figure 61: Power Spectral Density, 802.11n, 20MHz_5825MHz, Chain 1 36
Figure 62: Power Spectral Density, 802.11n, 40MHz_5755MHz, Chain 0 37
Figure 63: Power Spectral Density, 802.11n, 40MHz_5755MHz, Chain 1 37
Figure 64: Power Spectral Density, 802.11n, 40MHz_5795MHz, Chain 0 38
Figure 65: Power Spectral Density, 802.11n, 40MHz_5795MHz, Chain 1 38
Figure 66: Radiated Emissions Test Setup 40
Figure 67: Undesirable Emissions, UNII3-Mask, 802.11a, 5745MHz..... 41
Figure 68: Undesirable Emissions, UNII3-Mask, 802.11a, 5785MHz_24..... 41
Figure 69: Undesirable Emissions, UNII3-Mask, 802.11a, 5825MHz_22..... 42
Figure 70: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5745MHz_25 42
Figure 71: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5785MHz_24 43
Figure 72: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5825MHz_23 43
Figure 73: Undesirable Emissions, UNII3-Mask, 802.11n, 40MHz_5755MHz_25 44
Figure 74: Undesirable Emissions, UNII3-Mask, 802.11n, 40MHz_5795MHz_23 44
Figure 75: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5745MHz_1-18GHz..... 45
Figure 76: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5785MHz_1-18GHz..... 45
Figure 77: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5825MHz_1-18GHz..... 46
Figure 78: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5745MHz_1-18GHz 46
Figure 79: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5785MHz_1-18GHz 47
Figure 80: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5825MHz_1-18GHz 47
Figure 81: Undesirable Emissions, Radiated Average, 802.11n, 40MHz_5755MHz_1-18GHz 48
Figure 82: Undesirable Emissions, Radiated Average, 802.11n, 40MHz_5795MHz_1-18GHz 48
Figure 83: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5745MHz_1-18GHz 49
Figure 84: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5785MHz_1-18GHz 49
Figure 85: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5825MHz_1-18GHz 50
Figure 86: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5745MHz_1-18GHz 50
Figure 87: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5785MHz_1-18GHz 51
Figure 88: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5825MHz_1-18GHz 51
Figure 89: Undesirable Emissions, Radiated Peak, 802.11n, 40MHz_5755MHz_1-18GHz 52
Figure 90: Undesirable Emissions, Radiated Peak, 802.11n, 40MHz_5795MHz_1-18GHz 52
Figure 91: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5745MHz_1-18GHz 53
Figure 92: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5785MHz_1-18GHz 53
Figure 93: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5825MHz_1-18GHz 54
Figure 94: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5745MHz_1-18GHz 54
Figure 95: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5785MHz_1-18GHz 55
Figure 96: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5825MHz_1-18GHz 55
Figure 97: Undesirable Emissions, EIRP Radiated, 802.11n, 40MHz_5755MHz_1-18GHz 56
Figure 98: Undesirable Emissions, EIRP Radiated, 802.11n, 40MHz_5795MHz_1-18GHz 56
Figure 99: Undesirable Emissions, Radiated Average, Worst Case_18-30GHz 57
Figure 100: Undesirable Emissions, Radiated Average, Worst Case _30-40GHz 57

© 2020, Eurofins MET Labs, Inc.

Figure 101: Undesirable Emissions, Radiated Peak, Worst Case _18-40GHz 58
Figure 102: Undesirable Emissions, EIRP Radiated -27dBm, Worst Case _18-40GHz 58
Figure 103: Radiated Spurious Emissions below 1GHz, Test Results 59
Figure 104: Radiated Spurious Emissions, 30MHz - 1GHz 59
Figure 105: Undesirable Emissions, Below 1 GHz, Test Setup 60
Figure 106: Undesirable Emissions, Above 1 GHz, Test Setup 60
Figure 107: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a) 61
Figure 108: Conducted Emissions Limits, Phase Line, Test Results 62
Figure 109: Conducted Emissions Limits, Phase Line, Prescan 62
Figure 110: Conducted Emissions Limits, Neutral Line, Test Results 63
Figure 111: Conducted Emissions Limits, Neutral Line, Prescan 63
Figure 112: Conducted Emissions Limits, Test Setup 64
Figure 113: 6dB Occupied Bandwidth, Test Results 65
Figure 114: 6dB Occupied Bandwidth, 5745MHz, Chain 0 66
Figure 115: 6dB Occupied Bandwidth, 5745MHz, Chain 1 66
Figure 116: 6dB Occupied Bandwidth, 5785MHz, Chain 0 67
Figure 117: 6dB Occupied Bandwidth, 5785MHz, Chain 1 67
Figure 118: 6dB Occupied Bandwidth, 5825MHz, Chain 0 68
Figure 119: 6dB Occupied Bandwidth, 5825MHz, Chain 1 68
Figure 120: 6dB Occupied Bandwidth, n20, 5745MHz, Chain 0 69
Figure 121: 6dB Occupied Bandwidth, n20, 5745MHz, Chain 1 69
Figure 122: 6dB Occupied Bandwidth, n20, 5785MHz, Chain 0 70
Figure 123: 6dB Occupied Bandwidth, n20, 5785MHz, Chain 1 70
Figure 124: 6dB Occupied Bandwidth, n20, 5825MHz, Chain 0 71
Figure 125: 6dB Occupied Bandwidth, n20, 5825MHz, Chain 1 71
Figure 126: 6dB Occupied Bandwidth, n40, 5755MHz, Chain 0 72
Figure 127: 6dB Occupied Bandwidth, n40, 5755MHz, Chain 1 72
Figure 128: 6dB Occupied Bandwidth, n40, 5795MHz, Chain 0 73
Figure 129: 6dB Occupied Bandwidth, n40, 5795MHz, Chain 1 73
Figure 130: Test Equipment List 76

© 2020, Eurofins MET Labs, Inc.

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**K**ilo**h**ert**z**
kPa	**K**ilo**pa**scal
kV	**K**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**Microh**enry
µ	**Microf**arad
µs	**Micros**econds
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

© 2020, Eurofins MET Labs, Inc.

I. Executive Summary

© 2020, Eurofins MET Labs, Inc.

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Rajant Corporation WLM200N5-26ESD, with the requirements of Part 15, §15.407. 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 WLM200N5-26ESD. Rajant Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the WLM200N5-26ESD, 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, §15.407, in accordance with Rajant Corporation, purchase order number 2018875. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference	Description	Results
§15.203	Antenna Requirement	Compliant
§15.403(i)	26dB Bandwidth	Compliant
§15.407 (a)(3,4)	Maximum Conducted Output Power	Compliant
§15.407 (a)(3)	Maximum Power Spectral Density	Compliant
§15.407 (b-4,5,6,7,8) Undesirable Emissions	Undesirable Emissions	Compliant
§15207	Conducted Emission Limits	Compliant
§15.407 ((a-5),f)	6 dB Bandwidth	Compliant
§15.407(f)	RF Exposure	Compliant

Figure 1: Executive Summary of EMC Part 15.407 ComplianceTesting

© 2020, Eurofins MET Labs, Inc.

II. Equipment Configuration

© 2020, Eurofins MET Labs, Inc.

A. Overview

Eurofins MET Labs, Inc. was contracted by Rajant Corporation to perform testing on the WLM200N5-26ESD, under Rajant Corporation's purchase order number 2018875.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Rajant Corporation WLM200N5-26ESD.

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

Model Tested:	WLM200N5-26ESD	
Model Covered:	WLM200N5-26ESD	
EUT Specifications:	Primary Power: 110 VAC, 60 Hz	
	FCC ID: VJA-WLM200N526ESD	
	Type of Modulations:	OFDM
	Equipment Code:	NII
	Max. RF Output Power:	22.36dBm
	EUT Frequency Ranges:	5745 – 5825MHz; 5755 – 5795 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Donald Salguero	
Report Date:	January 16, 2020	

Figure 2: EUT Summary

© 2020, Eurofins MET Labs, Inc.

B. References

CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
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 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 789033 D02 v02r01	General UNII Test Procedures New Rules

Figure 3: References

C. Test Site

All testing was performed at Eurofins MET Labs, Inc., 914 W. 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 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Eurofins MET Labs.

D. Description of Test Sample

The Rajant Corporation WLM200N5-26ESD Mini-PCI radio module, Equipment Under Test (EUT), is a high powered radio module operating on 5 GHz U-NII 1 and 3 bands. The radio features integrated Lightning & ESD* protection. The radio module is designed for reliable fixed, and portable wireless data networking applications.

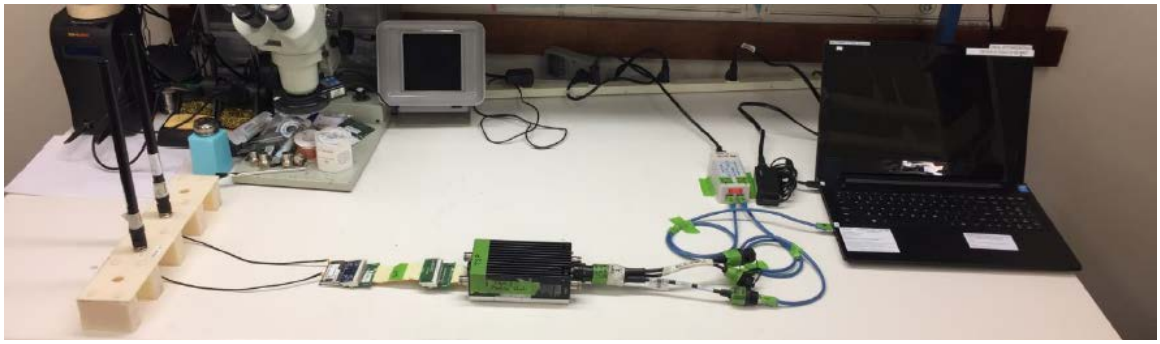


Figure 4: Block Diagram of Test Configuration

© 2020, Eurofins MET Labs, Inc.

E. Equipment Configuration

The EUT was set up as outlined in Figure 4. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	Qty	Rev. #
2	AC/DC POE	Tycon Power	TP-POE-HP-48G-RC	1	
3	Rajant Modular Host	Development	Development	1	
5	mini PCI Radio Card (EUT)	Compex Systems/Rajant	WLM200N526ESD	1	
7	Antenna 5800 MHz 6dBi Omni	PC TEL	KMA-5800-6-NM	2	

Figure 5: Equipment Configuration

F. 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	Qty	Rev. #
1	Test PC	Lenovo	T530	1	
4	Mini PCI Extender	Adex		1	
6	Antenna Fixture	Rajant	Development	1	
-	10m shielded Ethernet data cable			1	
-	IO Cable ASSY	Rajant	06-100055-603	1	
-	AC PWR Cord	For Item 2		1	
-	3m shielded Ethernet data cable			2	

Figure 6: 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
A	Laptop PWR In	PC Power Adapter to PC	1	3m		N	A
B	Laptop Ethernet	Connects Laptop Ethernet to AC/DC POE Input	1	1m		Y	Item 1B to Item 2C
C	POE Data Input	Connects Laptop Ethernet to AC/DC POE Data input	1	1m		Y	Item 1B to Item 2C
D	POE Data/Pwr Out	Data I/O, PWR Out of POE, connects to ETH0 of modular host	1	30m		Y	Item 2D to Item 3E
E	POE AC PWR input	Ac Power input Item 2	1	3m		N	
F	Modular Host Eth0	Data I/O, PWR input modular host, Port ETH0	1	30m		Y	Item 3E to Item 2D
G	Modular Host Multi IO	Multi IO connector	1	1m		Y	
J	Radio Chain 0	Radio Chain 0 to antenna	1	.3m		Y	Item 5F to Item 6H
K	Radio Chain 1	Radio Chain 1 to antenna	1	.3m		Y	Item 5G to Item 61
H	Chain 0 antenna	Antenna					Item 6H to Item7
I	Chain 1 antenna	Antenna					Item 6I to Item7

Figure 7: Ports and Cabling Information

© 2020, Eurofins MET Labs, Inc.

H. Mode of Operation

The following radio modes will be tested to certify U-NII-3 channels to current Part15E and RSS-247 requirements using 6dBi antennas.

• 802.11n 2x2:2 MIMO, 802.11n 1x1:1 MIMO HT40 and HT20 channel bandwidths
• 802.11a, 20MHz channel bandwidths

In each mode, a data pattern with high duty cycle will be used to produce a nearly continuous signal at the radio outputs.

I. Method of Monitoring EUT Operation

Direct observation of the output on each RF chain (conducted and radiated) is required to verify the operation of the radio in the intended mode.

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 Rajant Corporation upon completion of testing.

© 2020, Eurofins MET Labs, Inc.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

© 2020, Eurofins MET Labs, Inc.

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.

Test Results: The EUT as tested is **compliant** the criteria of §15.203. EUT is professionally installed.

Test Engineer: Donald Salguero

Test Date: November 14, 2019

Name / Description	Manufacturer	Model Number	Qty
Antenna 5800 MHz 6dBi Omni	PC TEL	KMA-5800-6-NM	2

Figure 8: Antenna List

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15. 403(i) 26 dB Bandwidth

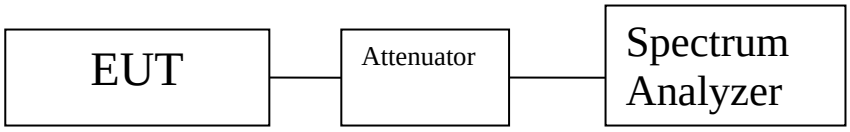
Test Requirements: **§ 15.403(i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

Test Procedure: The transmitter was set to low, mid, and high operating frequencies at the highest output power and connected to the spectrum analyzer through an attenuator. 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 26 dB Bandwidth was measured and recorded.

Test Results The 26 dB Bandwidth was compliant with the requirements of this section.

Test Engineer: Donald Salguero

Test Date: June 11, 2019



Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	26dB Bandwidth Chain 0 (MHz)	26dB Bandwidth Chain 1 (MHz)
802.11a	20	5745	25.115	24.302
		5785	24.614	24.28
		5825	24.784	24.001
802.11n	20	5745	24.512	24.447
		5785	24.278	24.42
		5825	24.55	24.308
	40	5755	49.229	47.532
		5795	48.256	48.407

Figure 9: 26dB Bandwidth, Test Results

© 2020, Eurofins MET Labs, Inc.

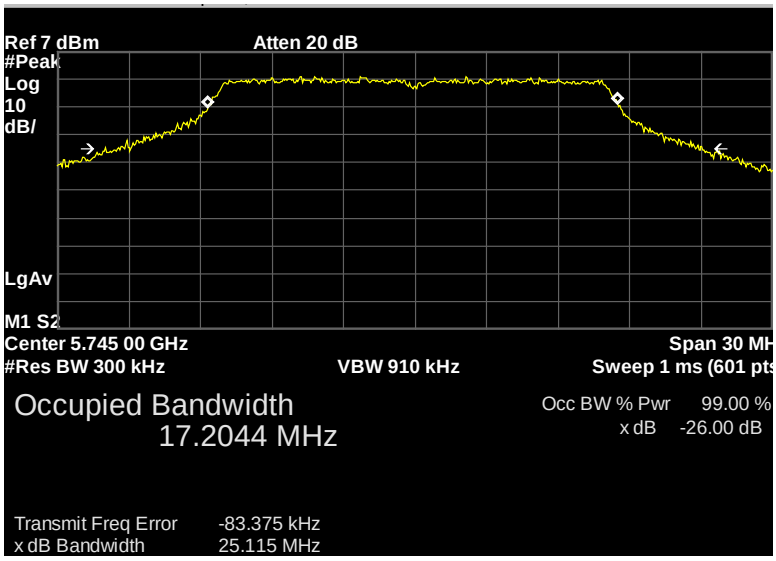


Figure 10: 26dB Bandwidth, 5745MHz, Chain 0

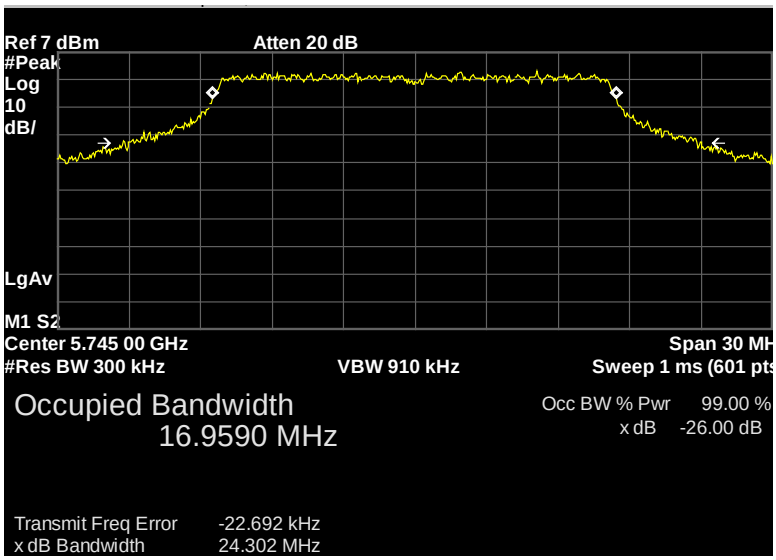


Figure 11: 26dB Bandwidth, 5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

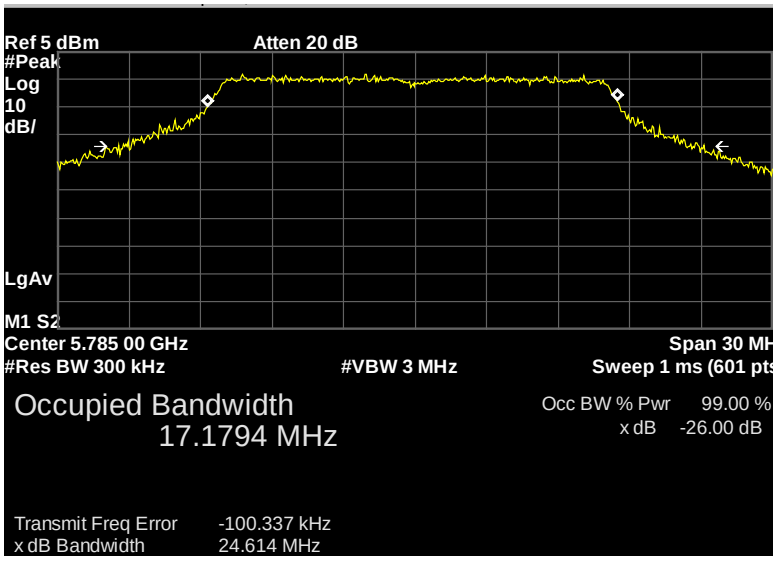


Figure 12: 26dB Bandwidth, 5785MHz, Chain 0

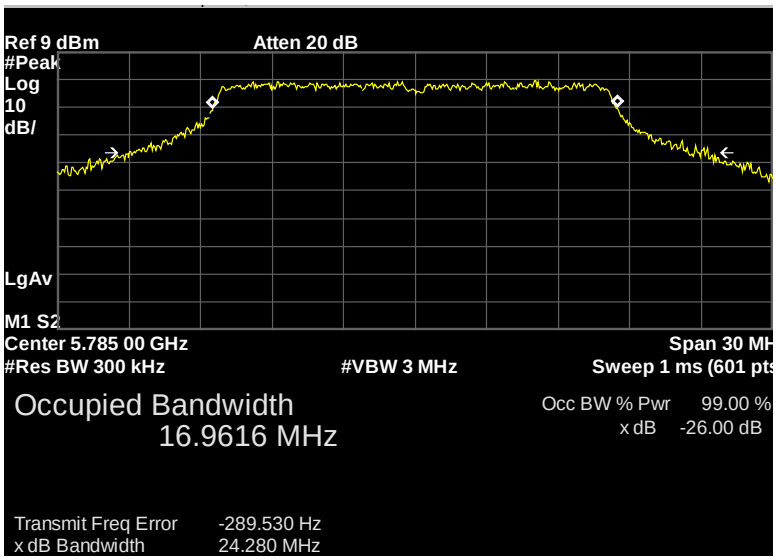


Figure 13: 26dB Bandwidth, 5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

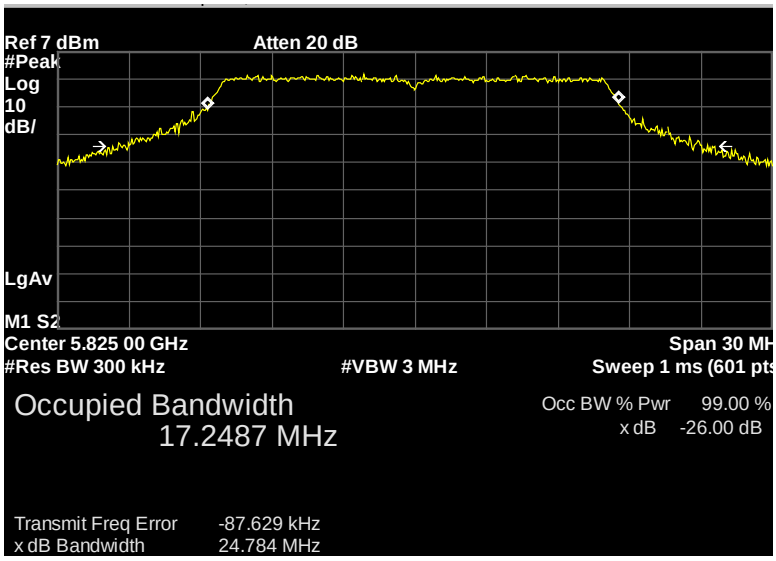


Figure 14: 26dB Bandwidth, 5825MHz, Chain 0

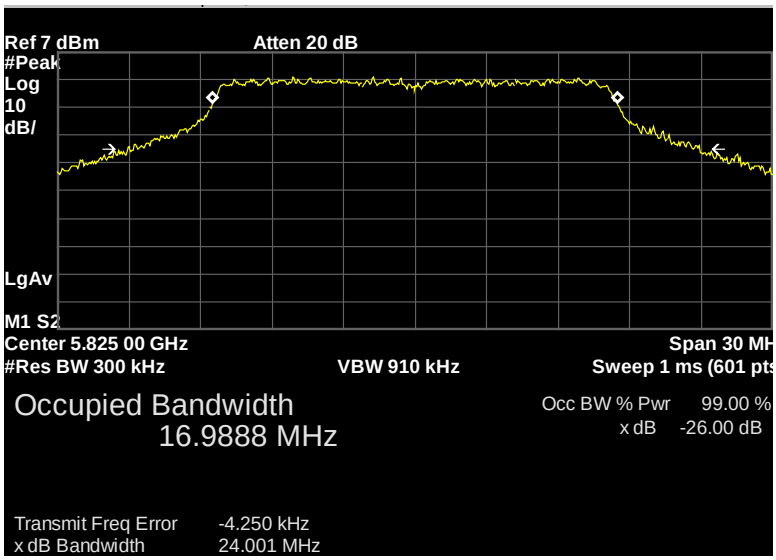


Figure 15: 26dB Bandwidth, 5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

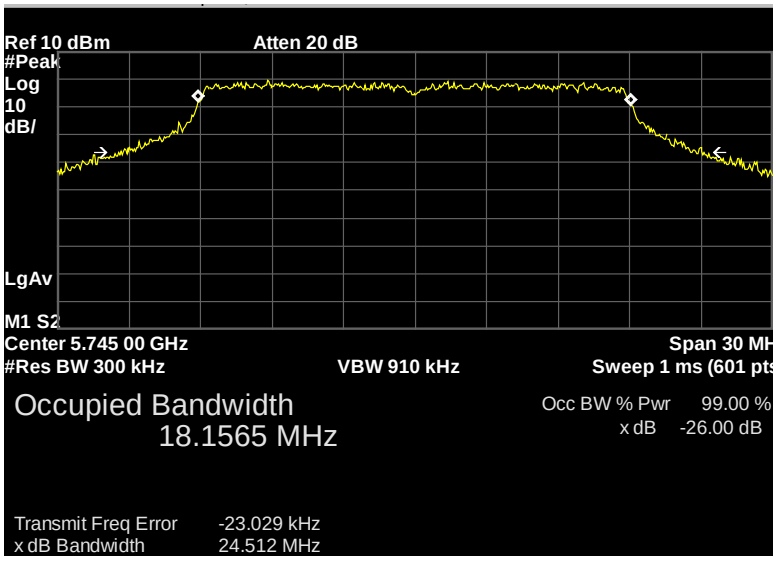


Figure 16: 26dB Bandwidth, n20, 5745MHz, Chain 0

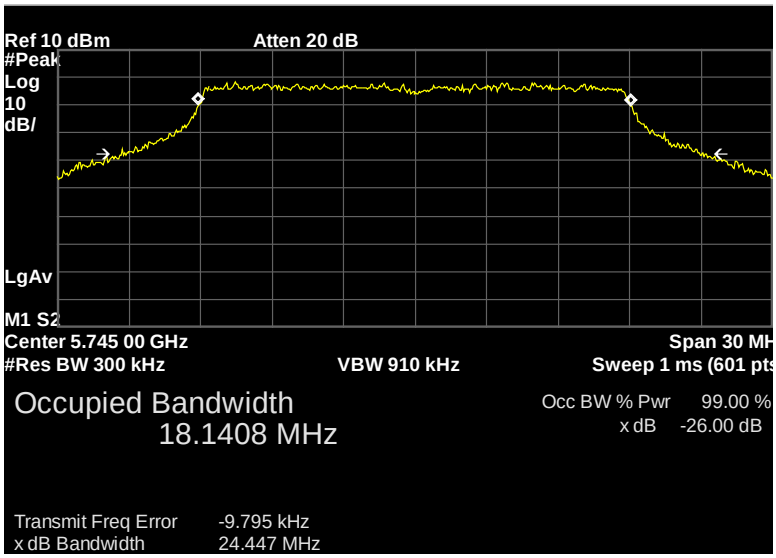


Figure 17: 26dB Bandwidth, n20, 5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

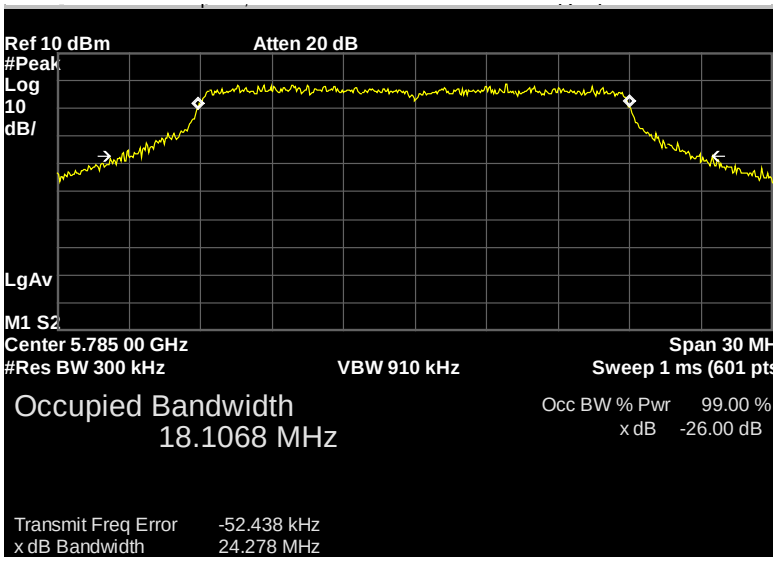


Figure 18: 26dB Bandwidth, n20, 5785MHz, Chain 0

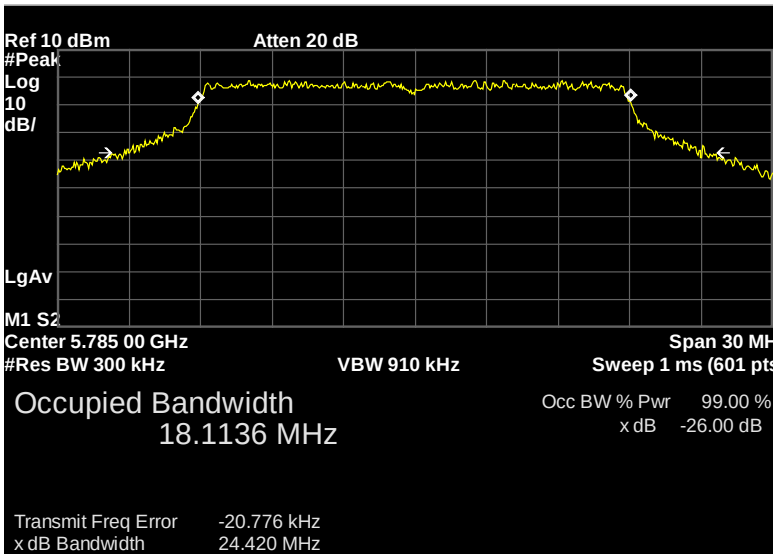


Figure 19: 26dB Bandwidth, n20, 5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

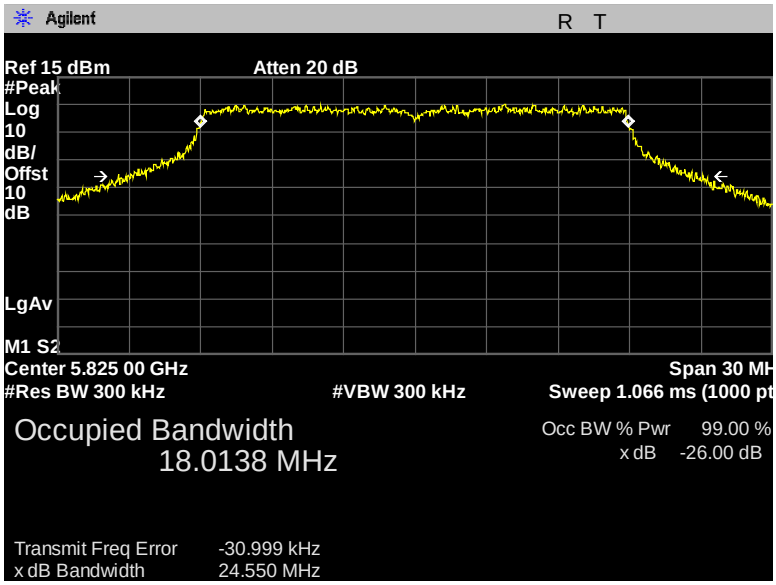


Figure 20: 26dB Bandwidth, n20, 5825MHz, Chain 0

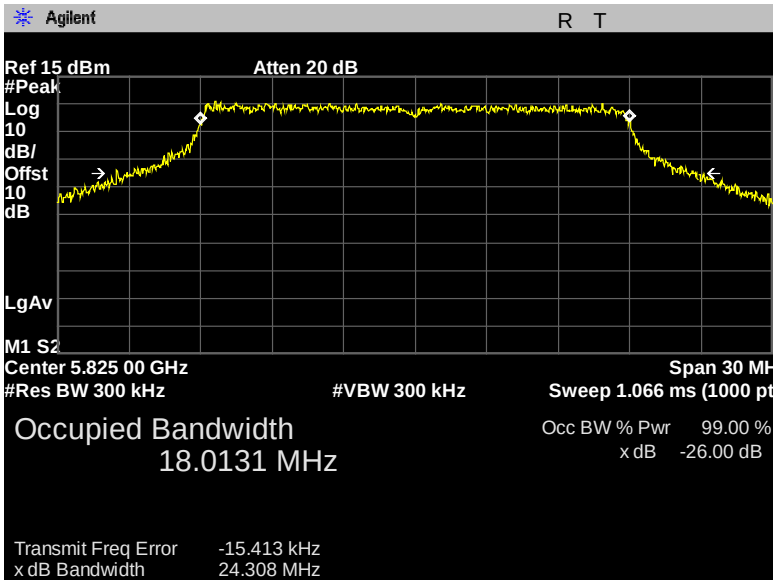


Figure 21: 26dB Bandwidth, n20, 5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

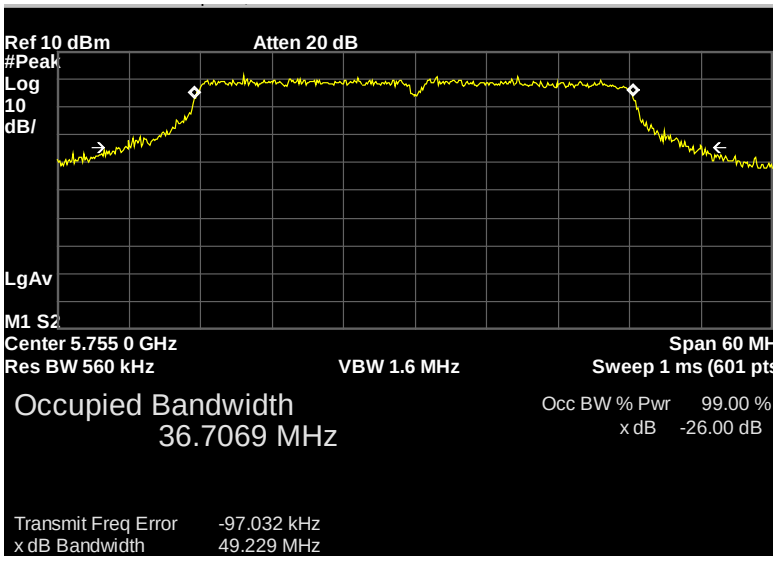


Figure 22: 26dB Bandwidth, n40, 5755MHz, Chain 0

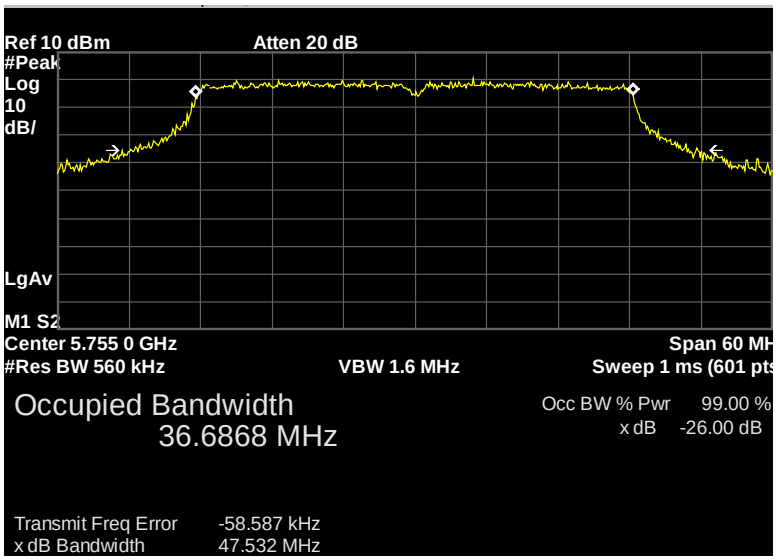


Figure 23: 26dB Bandwidth, n40, 5755MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

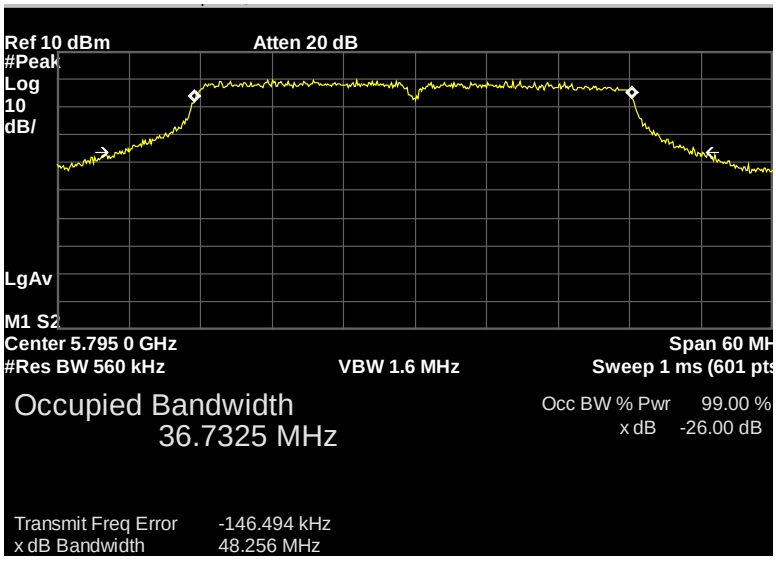


Figure 24: 26dB Bandwidth, n40, 5795MHz, Chain 0

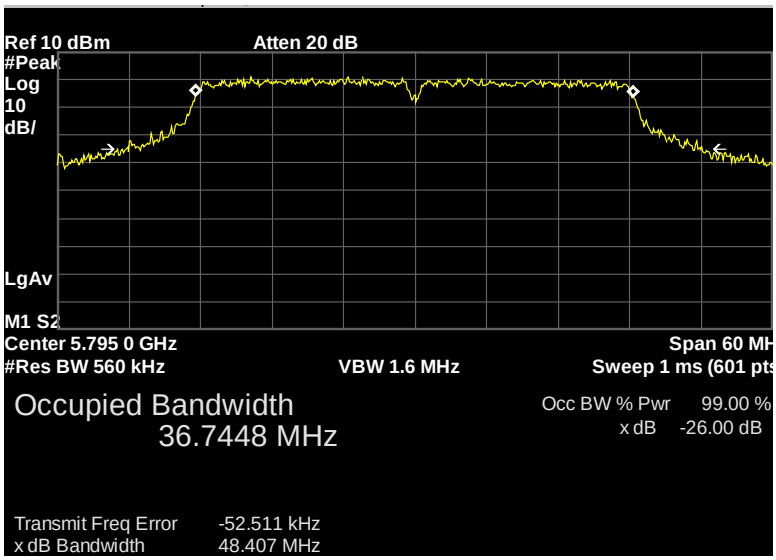


Figure 25: 26dB Bandwidth, n40, 5795MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
Duty Cycle

Test Procedure: The EUT was connected to a spectrum analyzer and was ran at maximum achievable duty cycle for all modes. The duty cycle was measured in accordance with section 12.2 of ANSI C63.10-2013.

Test Engineer: Donald Salguero

Test Date: November 8, 2019

Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	DCCF (dB)	1/T Minimum VBW (Hz)
802.11a	NA	NA	100	0	10
802.11n HT20	NA	NA	100	0	10
802.11n HT40	NA	NA	100	0	10

Figure 26: Duty Cycle, Test Results

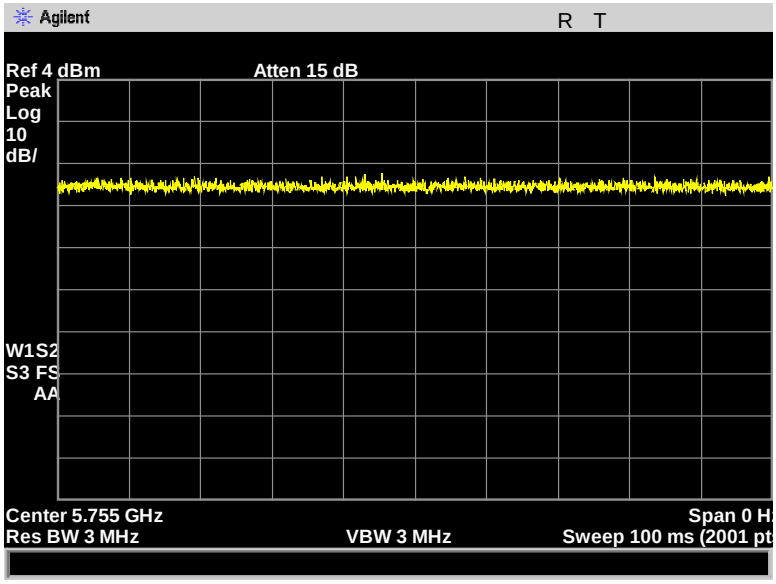


Figure 27: Duty Cycle, 802.11n, 40MHz_5755MHz

© 2020, Eurofins MET Labs, Inc.

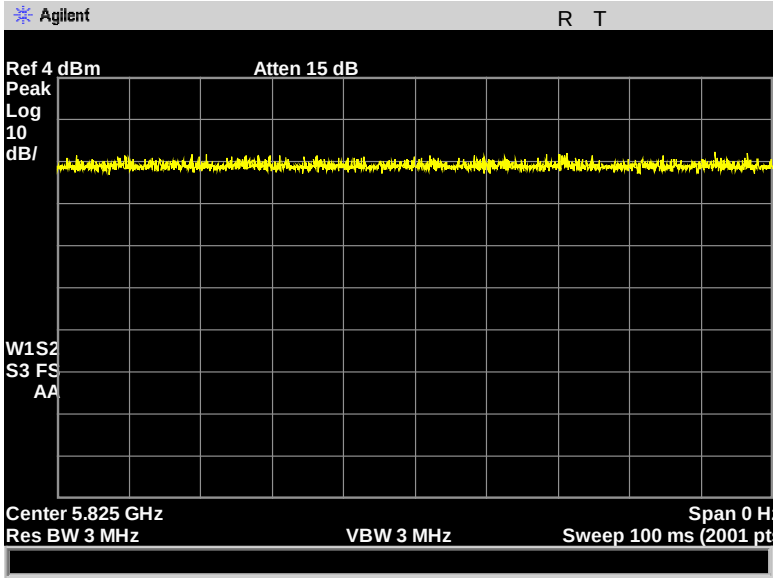


Figure 28: Duty Cycle, 802.11a, 20MHz_5825MHz

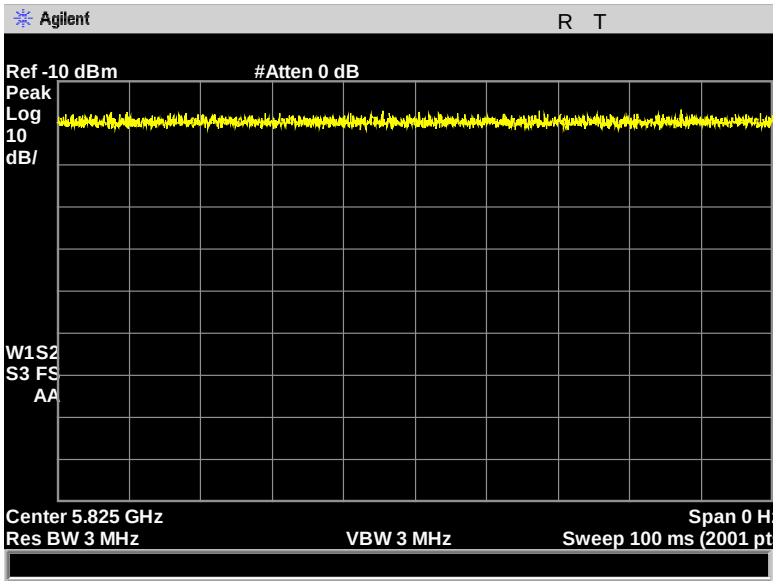


Figure 29: Duty Cycle, 802.11n, 20MHz_5825MHz

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§15. 407(a)(3) Maximum Conducted Output Power

Test Requirements: **§15.407(a)(3):** For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

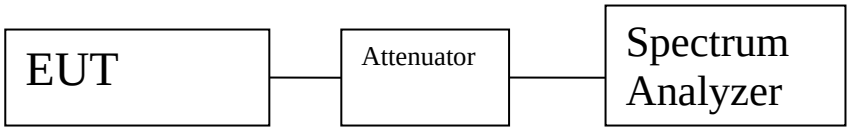
If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable and attenuator. Measurements were taken with the EUT set to transmit continuously at max power on its low, mid, and high channels. Its power was measured according to measurement method SA-1, as described in 789033 D02 General UNII Test Procedures v02r01.

Test Results: The EUT was **compliant** with this requirement. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: November 8, 2019



Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	Chain0 (dBm)	Chain1 (dBm)	Antenna Gain (dBi	Limit (dBm)	Margin0 (dB)	Margin1 (dB)
802.11a	20	5745	19.03	19.65	6.00	30.00	-10.97	-10.35
		5785	17.77	18.15	6.00	30.00	-12.23	-11.85
		5825	17.04	17.23	6.00	30.00	-12.96	-12.77

Figure 30: Output Power, SISO Test Results

Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	Chain0 (dBm)	Chain1 (dBm)	Sum (dBm)	Antenna Gain (dBi)	Limit (dBm)	Margin (dB)
802.11n	20	5745	18.53	18.62	21.59	9.01	26.99	-5.4
		5785	17.89	17.63	20.77	9.01	26.99	-6.22
		5825	17.11	17.12	20.13	9.01	26.99	-6.86
802.11n	40	5755	18.54	18.28	21.42	9.01	26.99	-5.57
		5795	17.72	17.77	20.76	9.01	26.99	-6.23

Figure 31: Output Power, MIMO Test Results

© 2020, Eurofins MET Labs, Inc.

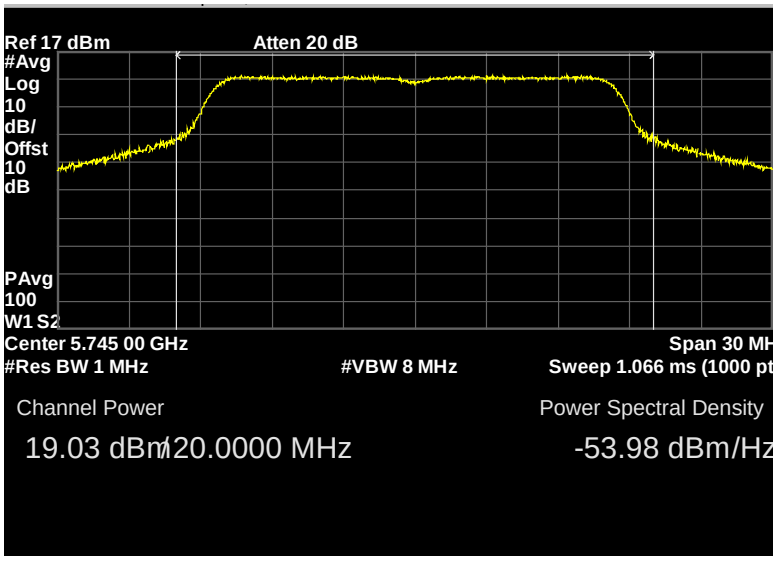


Figure 32: Output Power, 802.11a, 20MHz_5745MHz, Chain 0

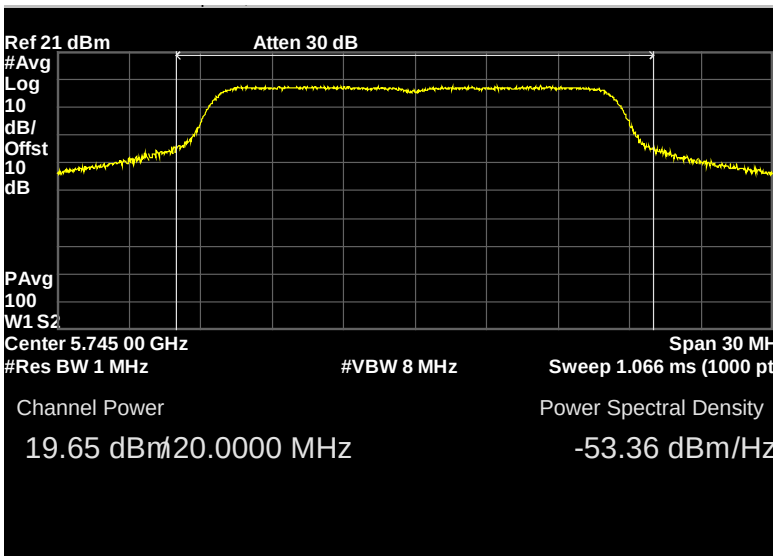


Figure 33: Output Power, 802.11a, 20MHz_5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

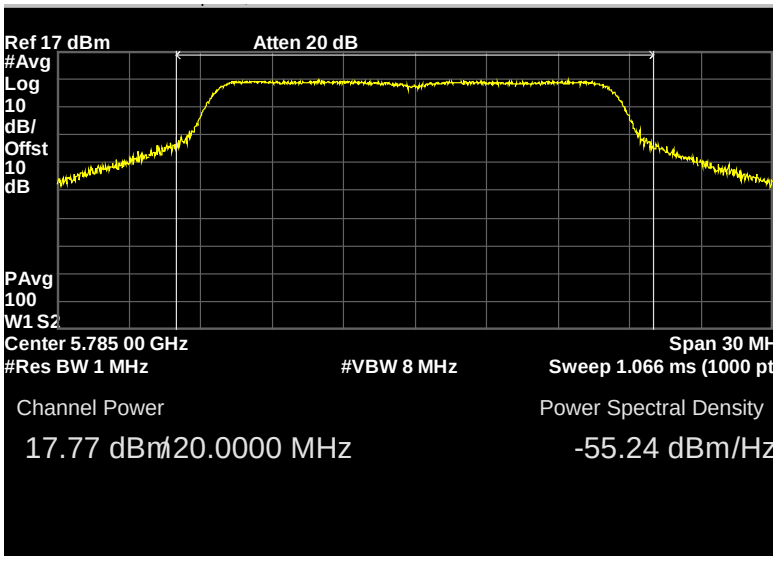


Figure 34: Output Power, 802.11a, 20MHz_5785MHz, Chain 0

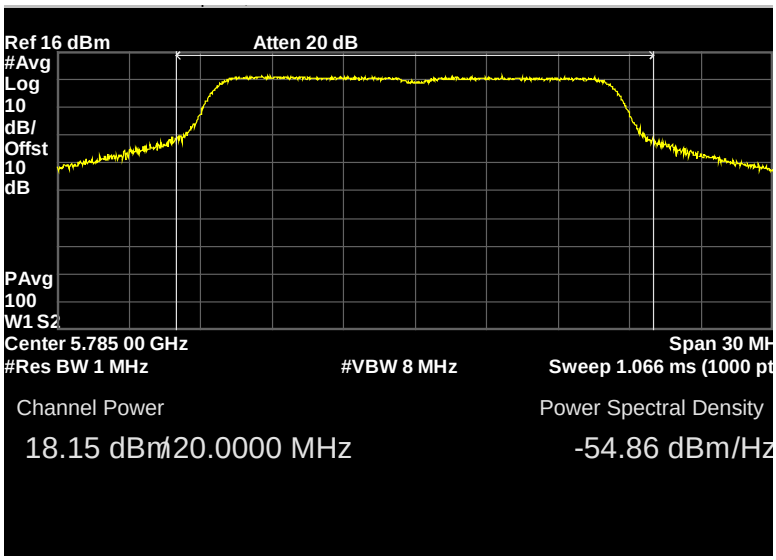


Figure 35: Output Power, 802.11a, 20MHz_5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

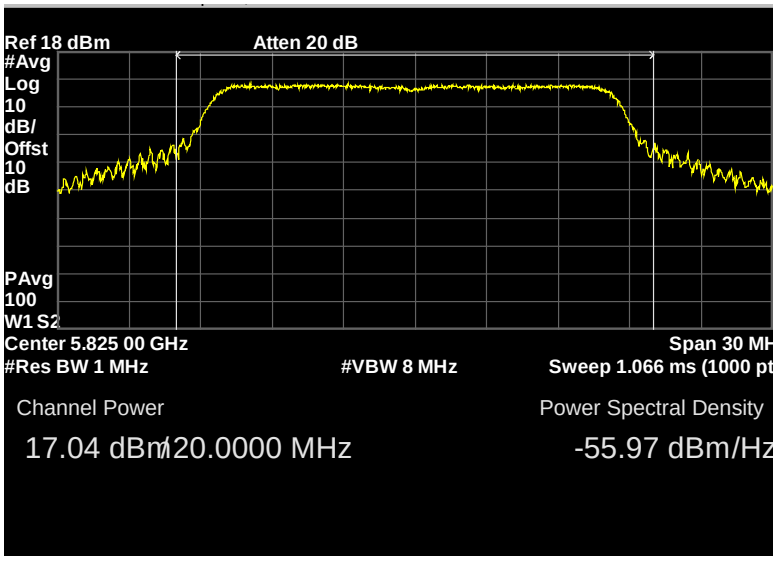


Figure 36: Output Power, 802.11a, 20MHz_5825MHz, Chain 0

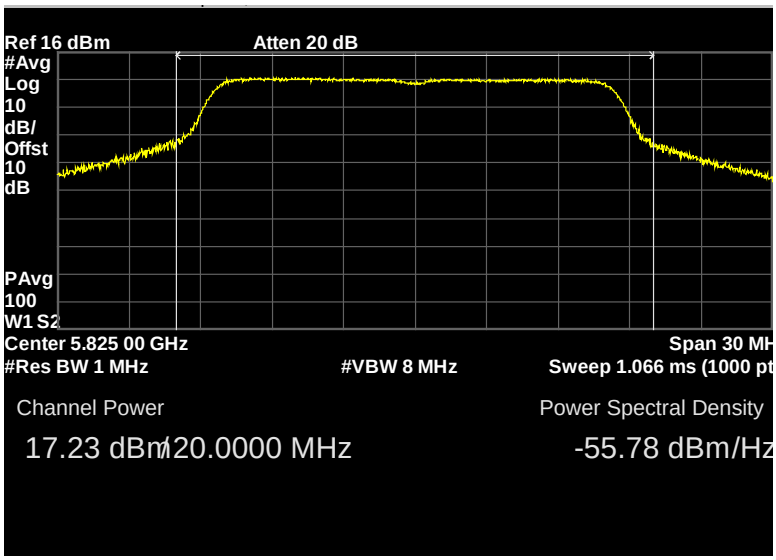


Figure 37: Output Power, 802.11a, 20MHz_5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

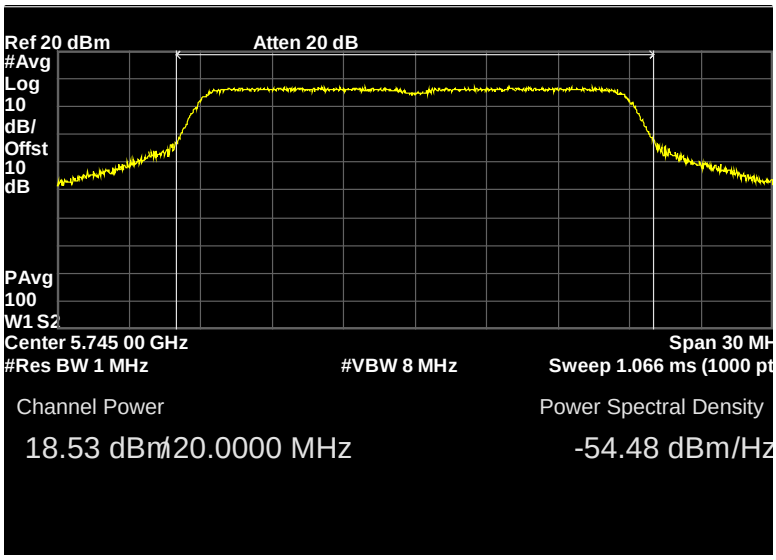


Figure 38: Output Power, 802.11n, 20MHz_5745MHz, Chain 0

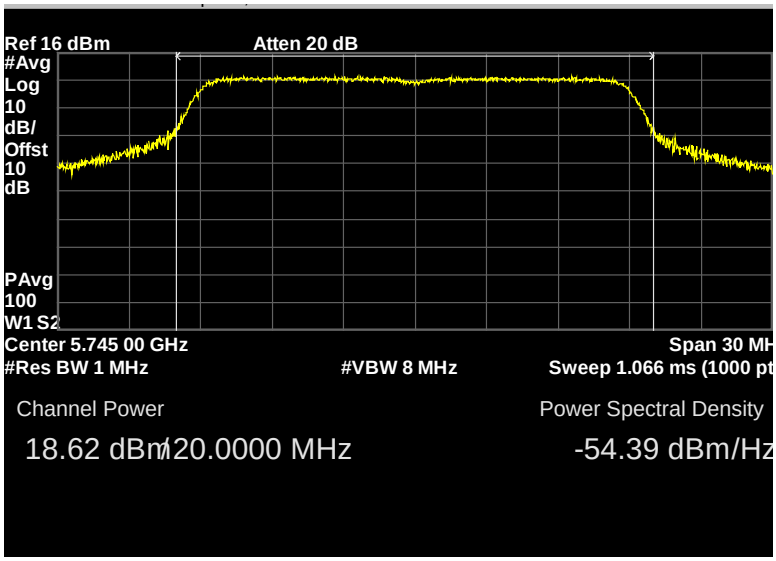


Figure 39: Output Power, 802.11n, 20MHz_5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

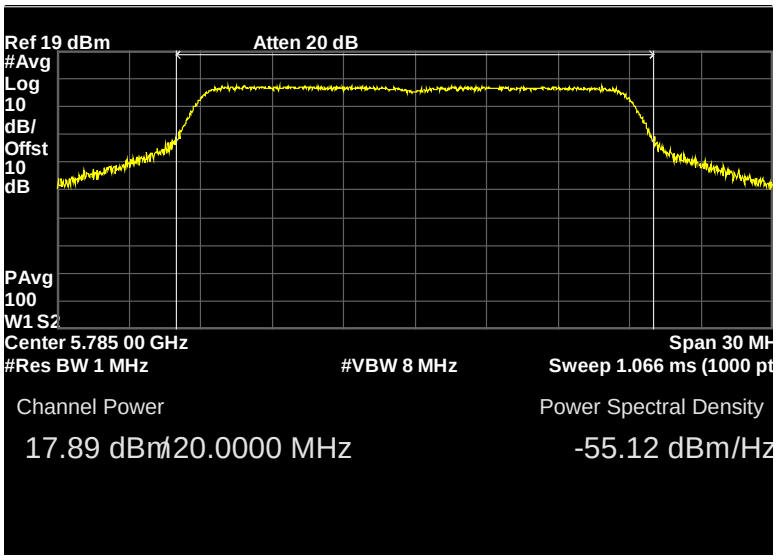


Figure 40: Output Power, 802.11n, 20MHz_5785MHz, Chain 0

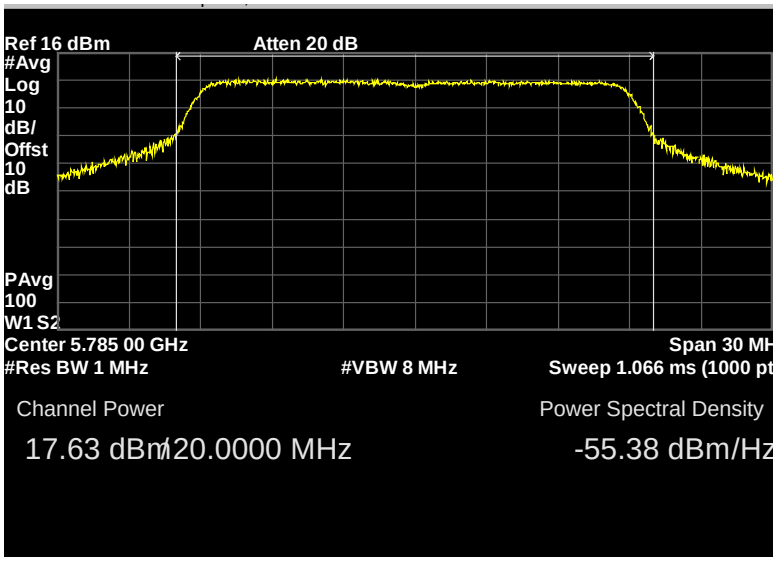


Figure 41: Output Power, 802.11n, 20MHz_5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

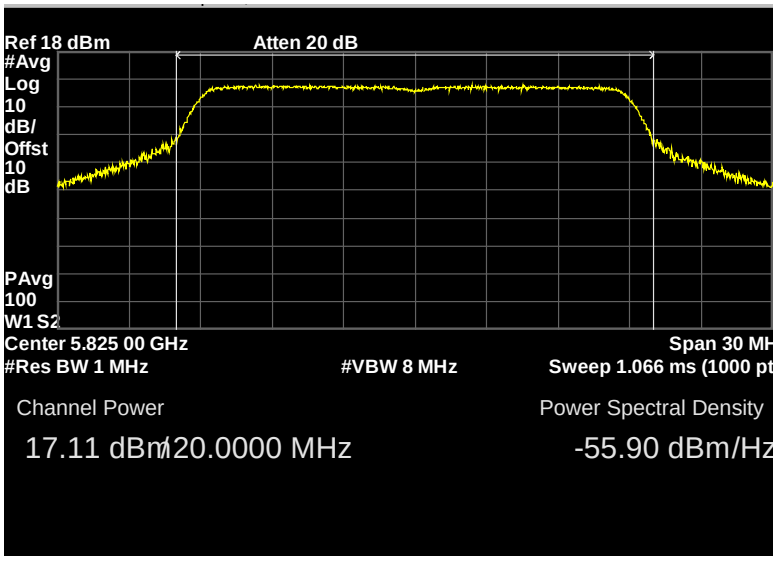


Figure 42: Output Power, 802.11n, 20MHz_5825MHz, Chain 0

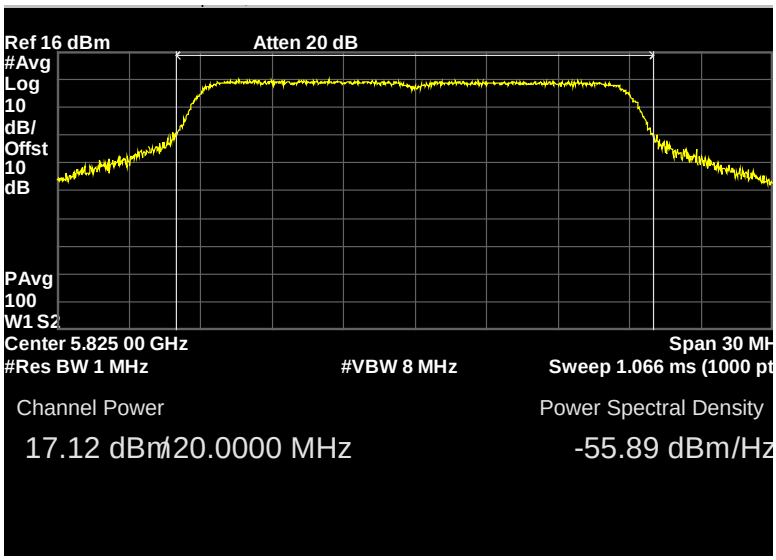


Figure 43: Output Power, 802.11n, 20MHz_5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

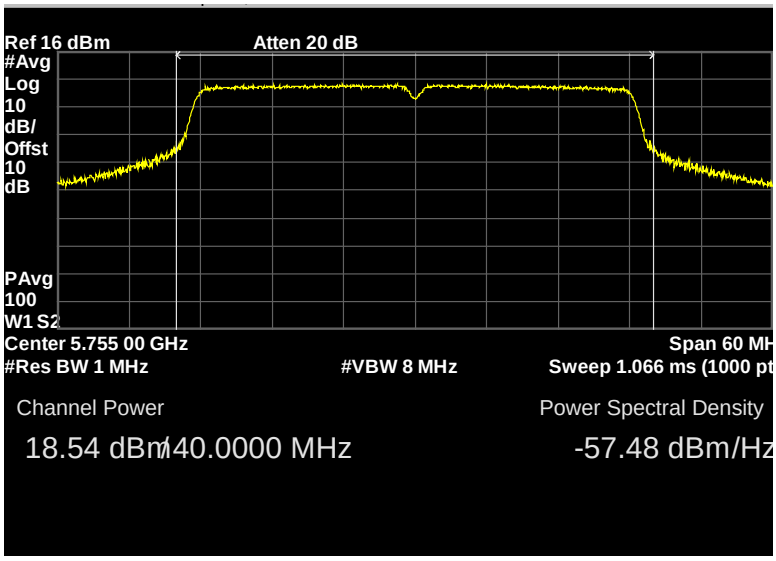


Figure 44: Output Power, 802.11n, 40MHz_5755MHz, Chain 0

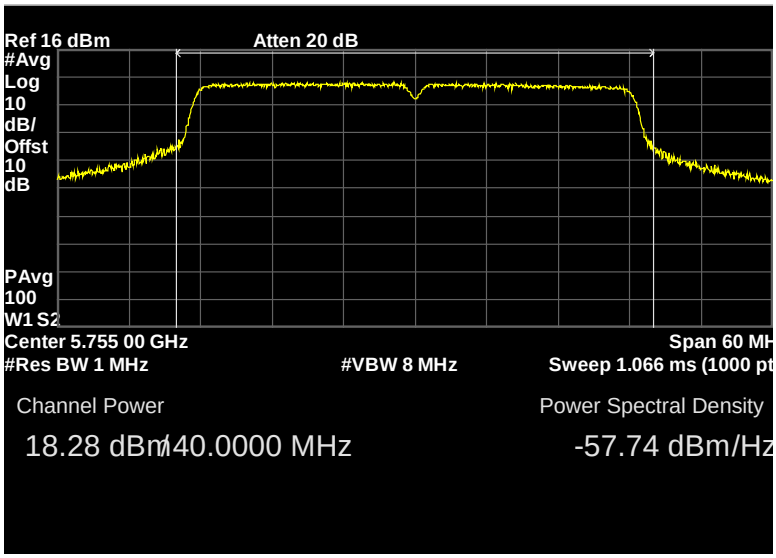


Figure 45: Output Power, 802.11n, 40MHz_5755MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

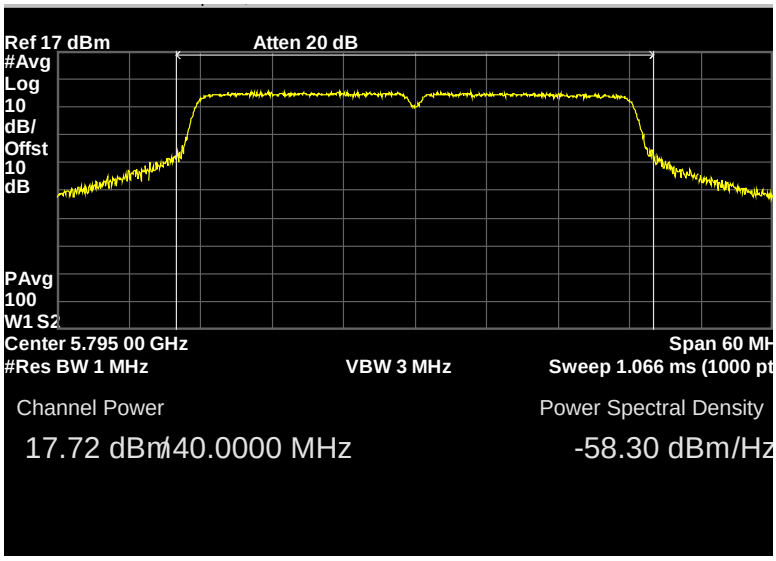


Figure 46: Output Power, 802.11n, 40MHz_5795MHz, Chain 0

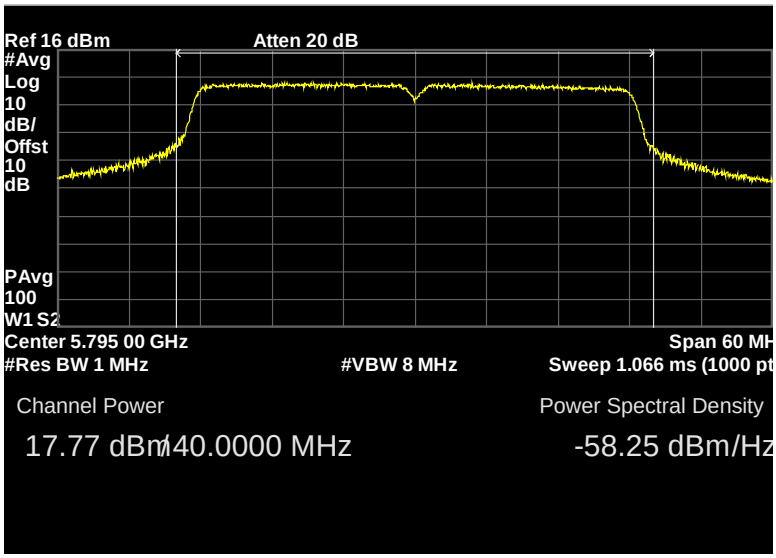


Figure 47: Output Power, 802.11n, 40MHz_5795MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(a)(3) Maximum Power Spectral Density

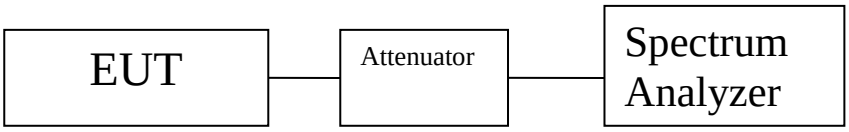
Test Requirements: **§15.407(a)(3):** In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.
If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable and attenuator. Measurements were taken with the EUT set to transmit continuously at max power on its low, mid, and high channels. Its power was measured according KDB 789033 D02 General UNII Test Procedures v02r01. A 510 kHz RBW was used during testing.

Test Results: The EUT was **compliant** with this requirement. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: November 8, 2019



Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	Chain0 (dBm)	Chain1 (dBm)	Antenna Gain (dBi)	Limit (dBm)	Margin0 (dB)	Margin1 (dB)
802.11a	20	5745	4.777	5.223	8.016	6.00	-25.223	-24.777
		5785	3.036	4.122	6.623	6.00	-26.964	-25.878
		5825	3.354	3.471	6.423	6.00	-26.646	-26.529

Figure 48: Power Spectral Density, SISO Test Results

Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	Chain0 (dBm)	Chain1 (dBm)	Sum (dBm)	Antenna Gain (dBi)	Limit (dBm)	Margin (dB)
802.11n	20	5745	4.351	4.043	7.210	9.01	26.99	-19.780
		5785	3.285	3.454	6.381	9.01	26.99	-20.609
		5825	2.339	2.426	5.393	9.01	26.99	-21.597
802.11n	40	5755	1.137	1.133	4.145	9.01	26.99	-22.845
		5795	-0.538	0.476	3.009	9.01	26.99	-23.981

Figure 49: Power Spectral Density, MIMO Test Results

© 2020, Eurofins MET Labs, Inc.

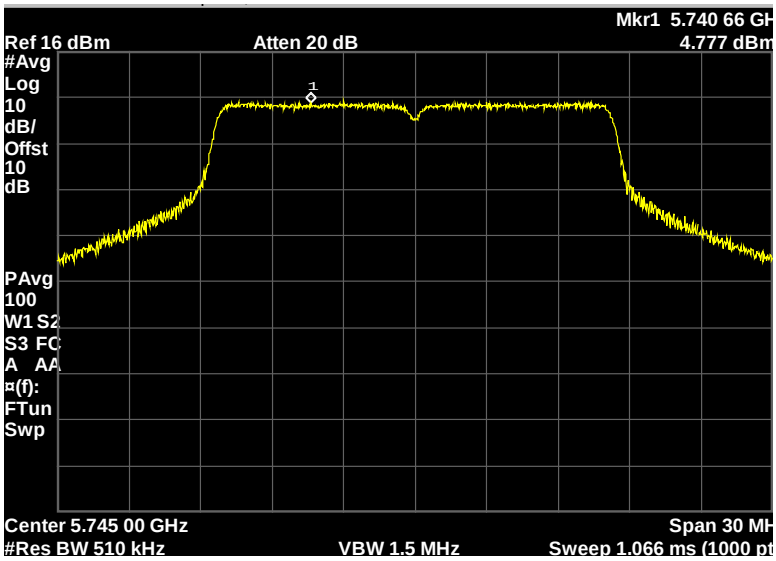


Figure 50: Power Spectral Density, 802.11a, 20MHz_5745MHz, Chain 0

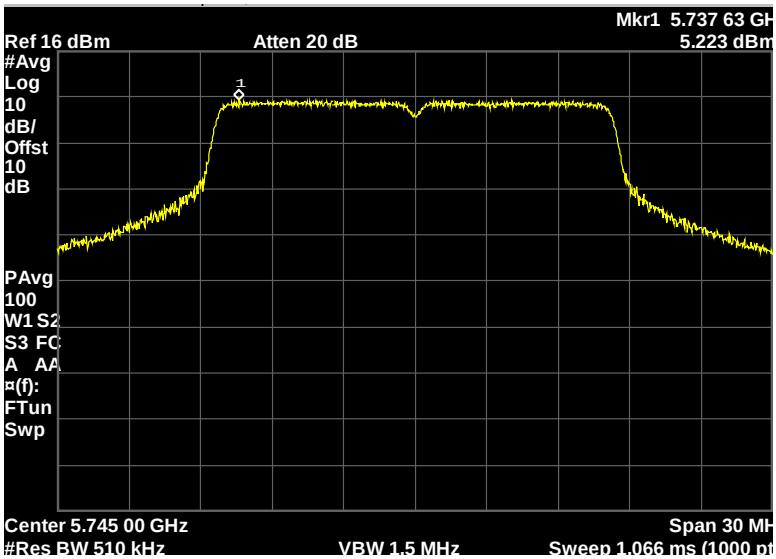


Figure 51: Power Spectral Density, 802.11a, 20MHz_5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

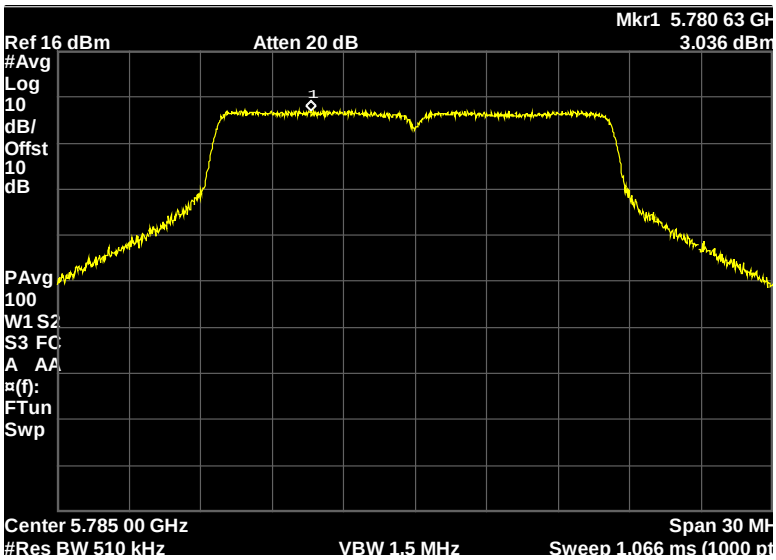


Figure 52: Power Spectral Density, 802.11a, 20MHz_5785MHz, Chain 0

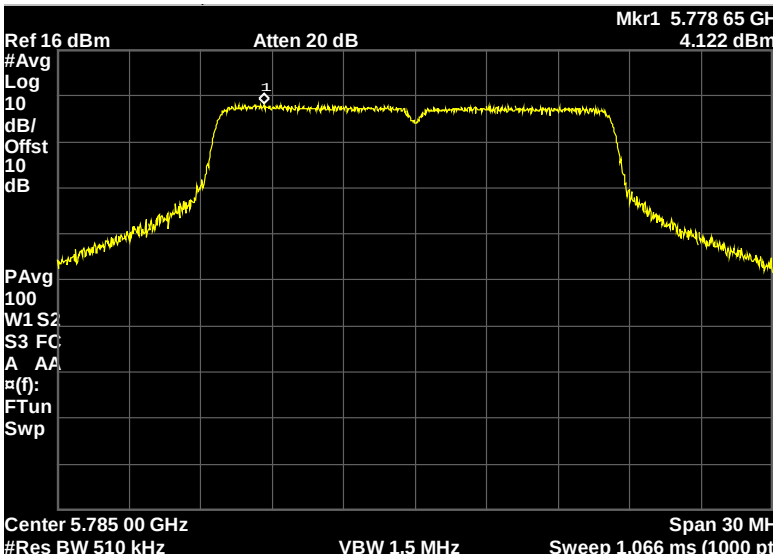


Figure 53: Power Spectral Density, 802.11a, 20MHz_5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

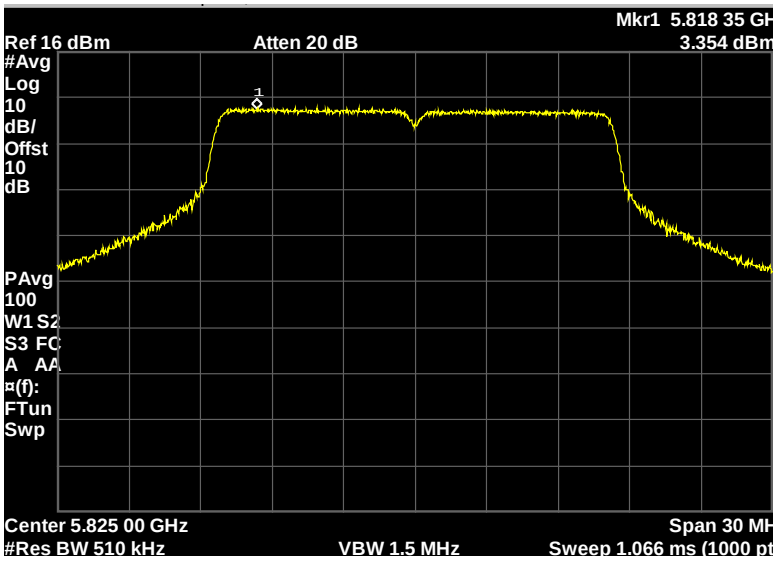


Figure 54: Power Spectral Density, 802.11a, 20MHz_5825MHz, Chain 0

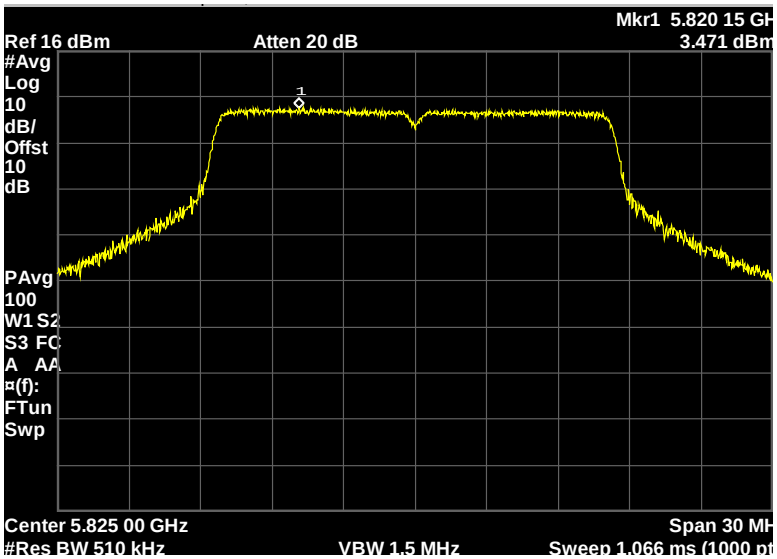


Figure 55: Power Spectral Density, 802.11a, 20MHz_5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

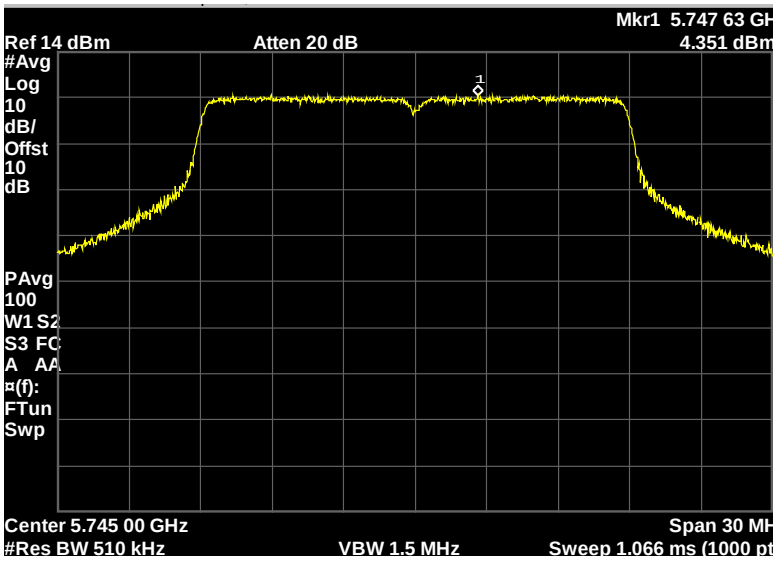


Figure 56: Power Spectral Density, 802.11n, 20MHz_5745MHz, Chain 0

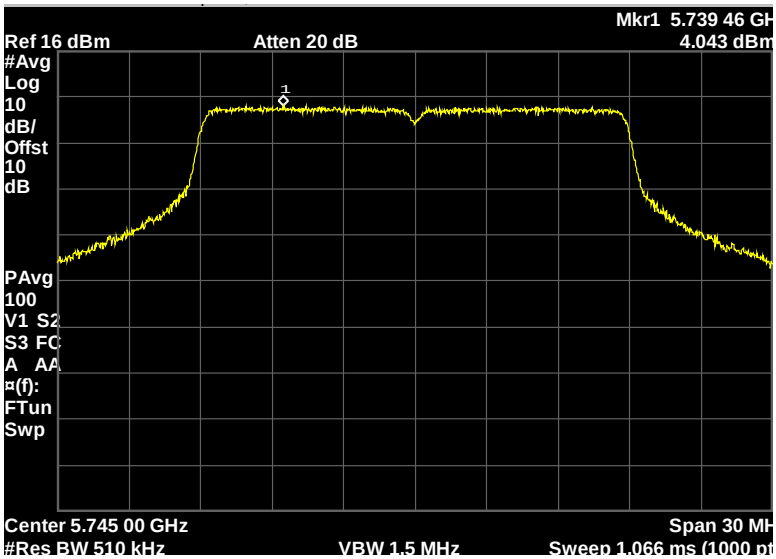


Figure 57: Power Spectral Density, 802.11n, 20MHz_5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

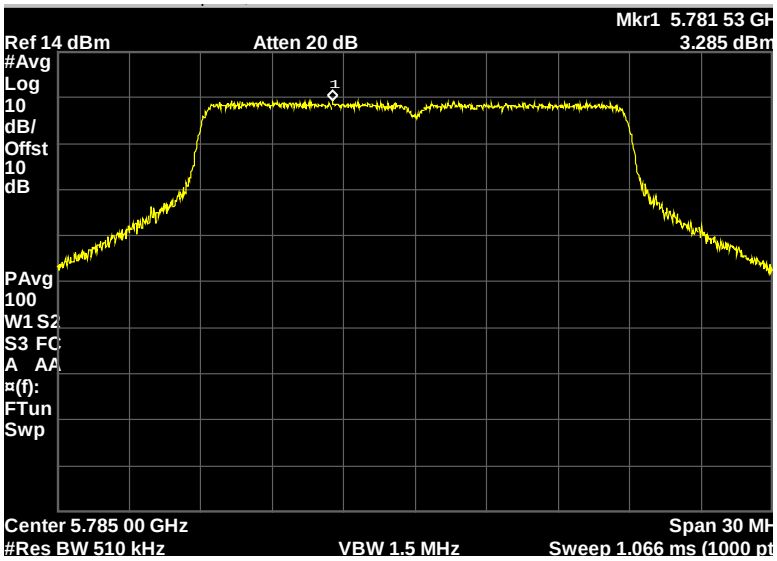


Figure 58: Power Spectral Density, 802.11n, 20MHz_5785MHz, Chain 0

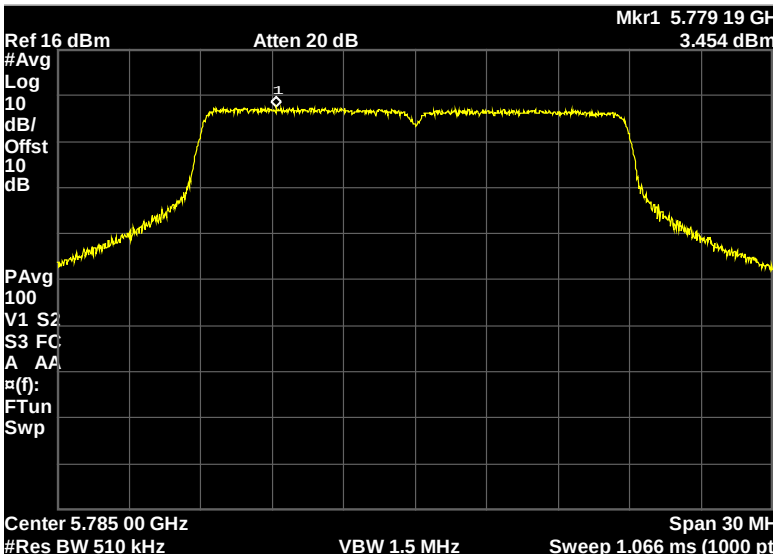


Figure 59: Power Spectral Density, 802.11n, 20MHz_5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

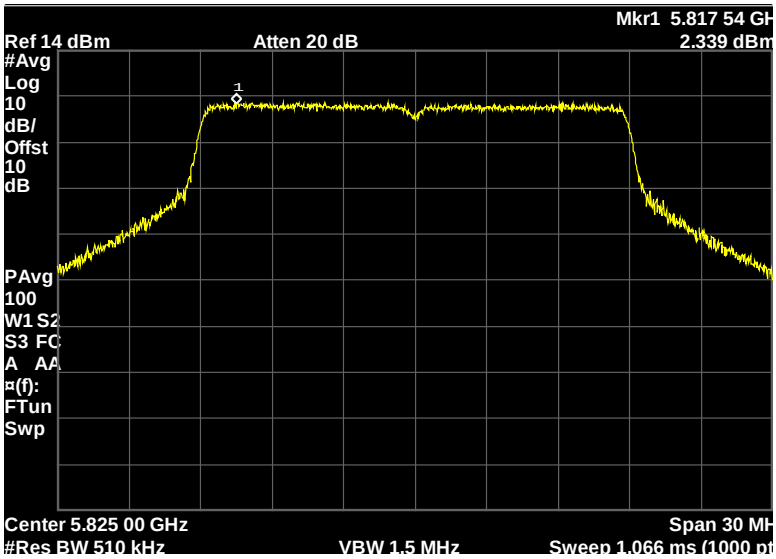


Figure 60: Power Spectral Density, 802.11n, 20MHz_5825MHz, Chain 0

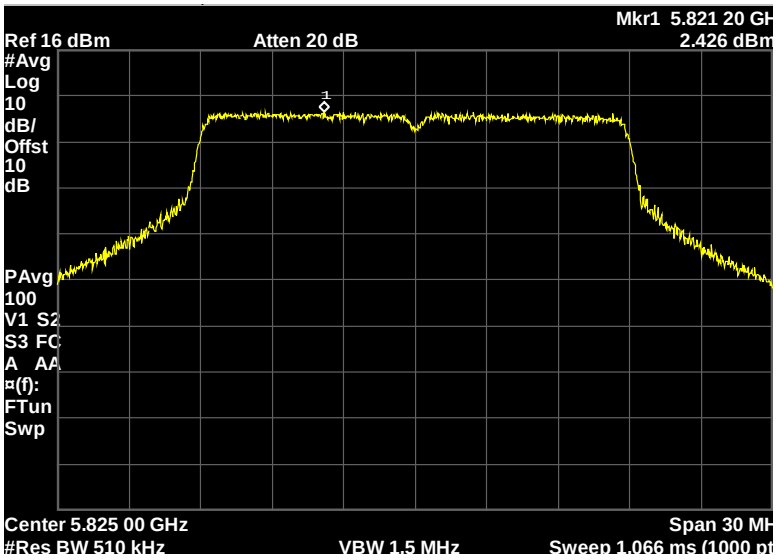


Figure 61: Power Spectral Density, 802.11n, 20MHz_5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

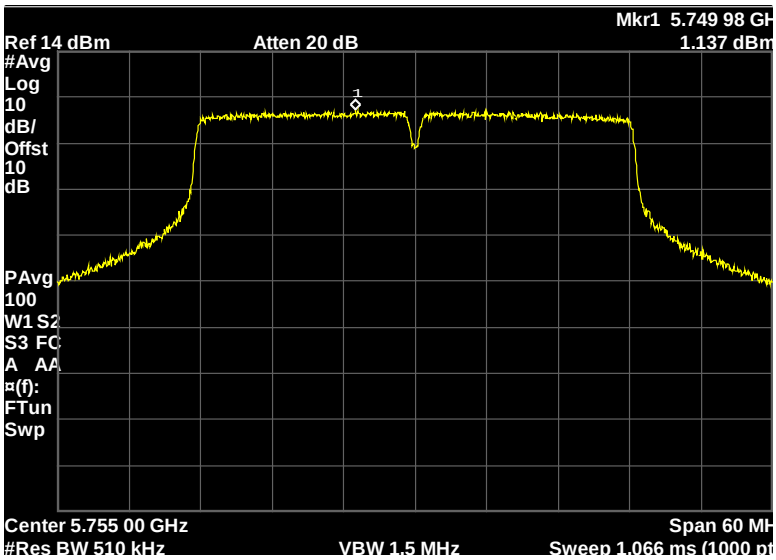


Figure 62: Power Spectral Density, 802.11n, 40MHz_5755MHz, Chain 0

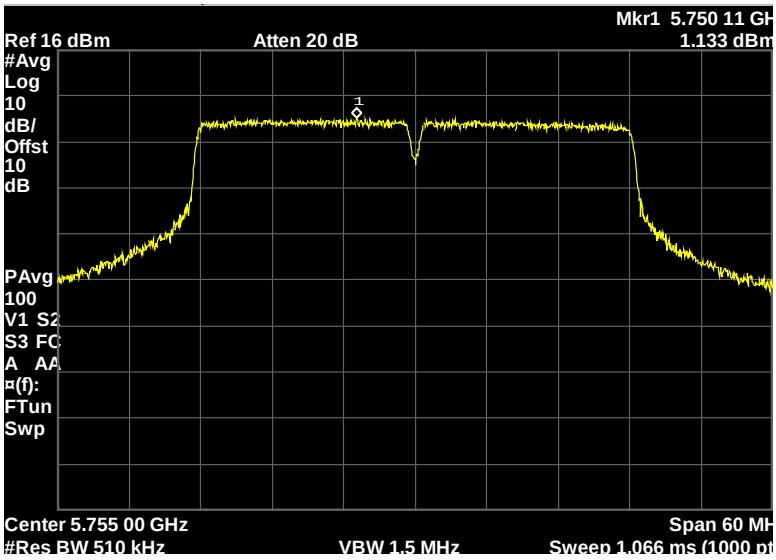


Figure 63: Power Spectral Density, 802.11n, 40MHz_5755MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

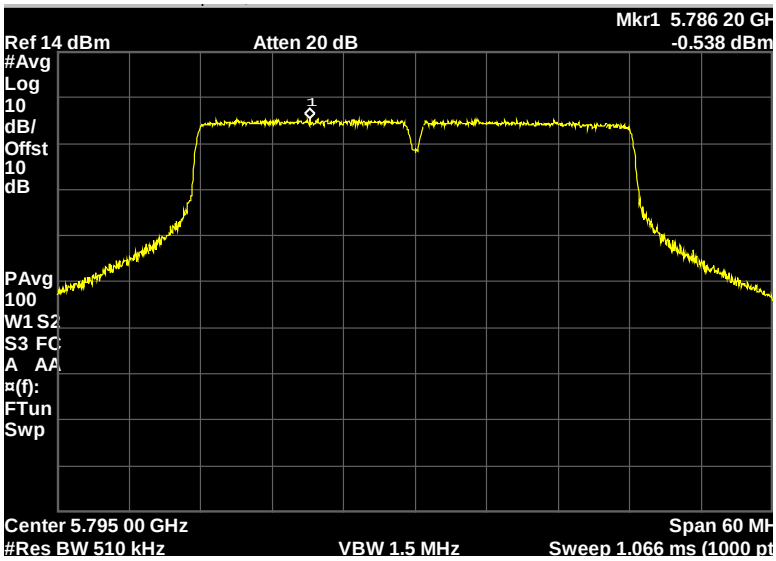


Figure 64: Power Spectral Density, 802.11n, 40MHz_5795MHz, Chain 0

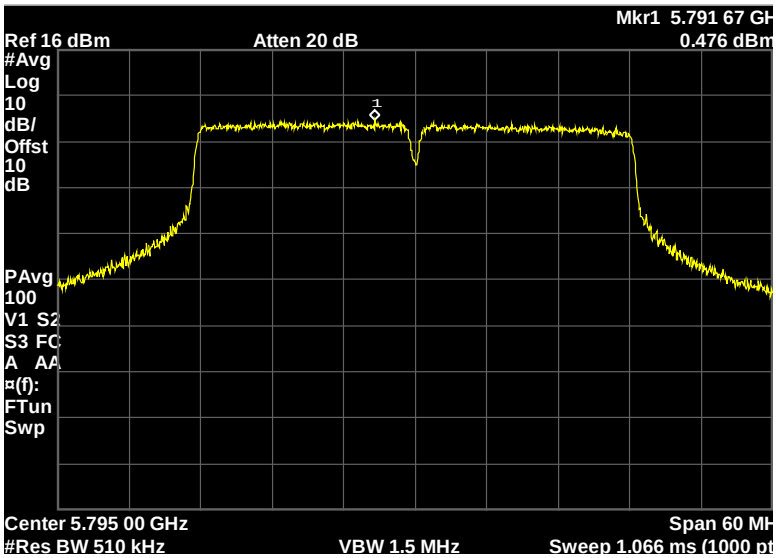


Figure 65: Power Spectral Density, 802.11n, 40MHz_5795MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§15.407(b)(4) & (6 – 7) Undesirable Emissions

Test Requirements:

§ 15.407(b)(4): For transmitters operating in the 5.725-5.85 GHz band:
(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

§ 15.407(b)(6): Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

§ 15.407(b)(7): The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

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 frequencies from 30 MHz to 1 GHz, measurements were first made using a peak detector with a 100 kHz resolution bandwidth. Emissions which exceeded the limits were re-measured using a quasi-peak detector with a 120 kHz resolution bandwidth.

Above 1 GHz, measurements were made pursuant the method described in FCC KDB 789033 D02 General UNII Test Procedure New Rules v02r01. The equation, **EIRP= E + 20 log D – 104.8** was used to convert field strength to EIRP (**E** = field strength (dBµV/m) and **D** = Reference measurement distance**).**

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.

Test Results:

The EUT was **compliant** with this requirement. All emission plots are cumulative.

See following pages for detailed test results. Only noise floor was observed above 18GHz, the noise floor was below 6dB applicable limits. No anomalies noted.

For emissions below 1GHz, apparent spurious emissions above the limit, specifically 249.984MHz one, remain even when radio transmitter is powered off; therefore, spurious emissions are subject to Class A digital emissions limits.

Test Engineer: Donald Salguero

Test Date: November 5 – November 6, 2019

© 2020, Eurofins MET Labs, Inc.

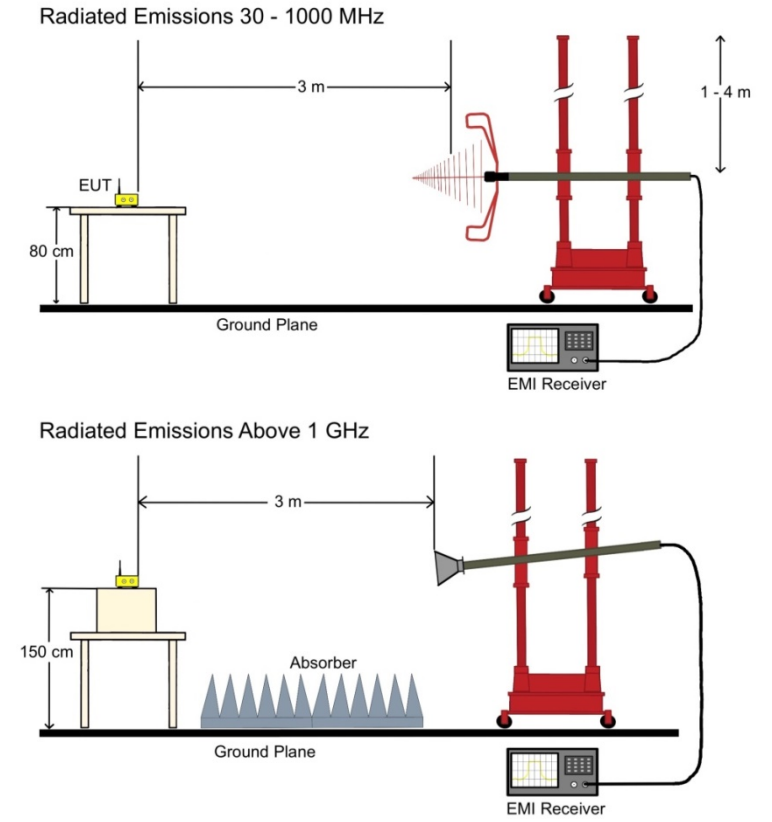


Figure 66: Radiated Emissions Test Setup

© 2020, Eurofins MET Labs, Inc.

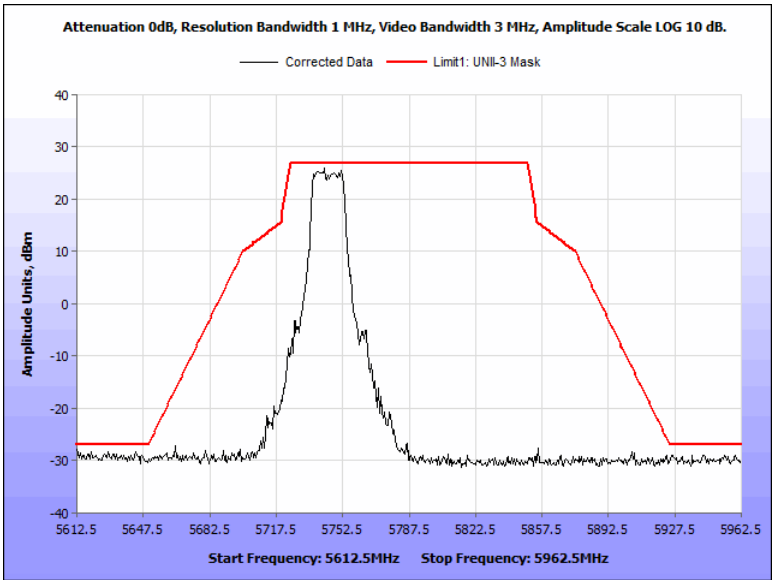


Figure 67: Undesirable Emissions, UNII3-Mask, 802.11a, 5745MHz

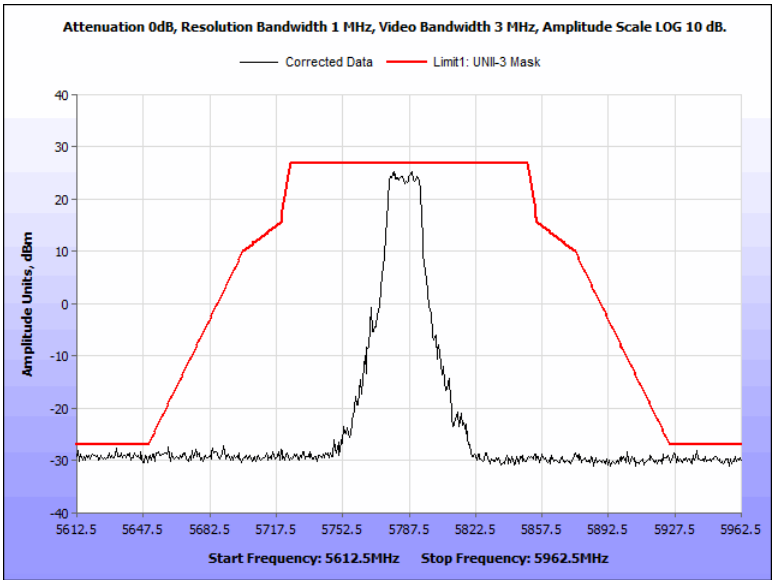


Figure 68: Undesirable Emissions, UNII3-Mask, 802.11a, 5785MHz_24

© 2020, Eurofins MET Labs, Inc.

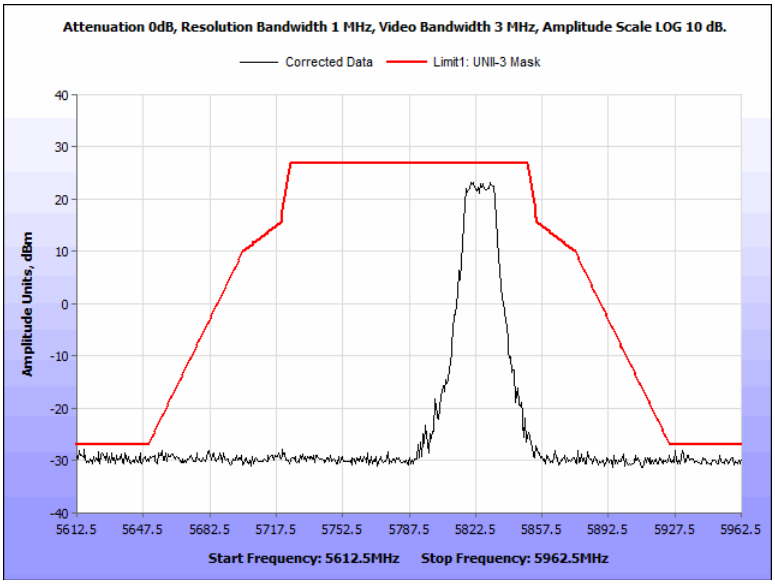


Figure 69: Undesirable Emissions, UNII3-Mask, 802.11a, 5825MHz_22

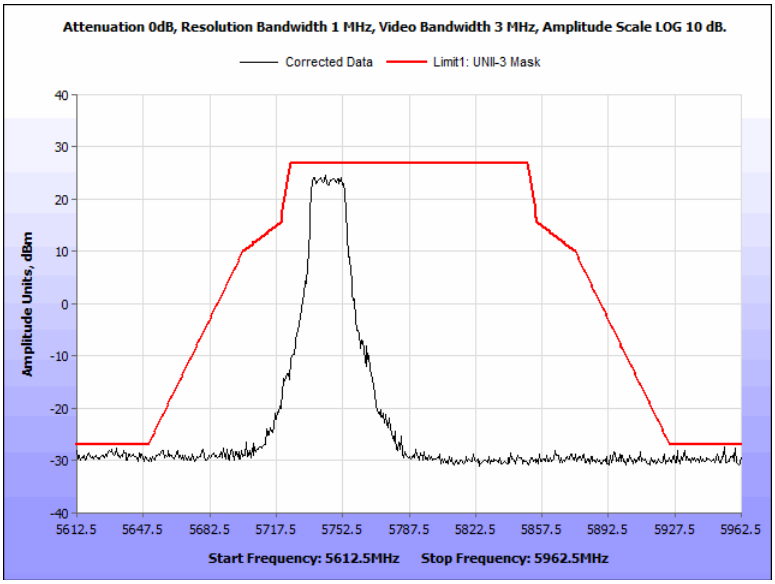


Figure 70: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5745MHz_25

© 2020, Eurofins MET Labs, Inc.

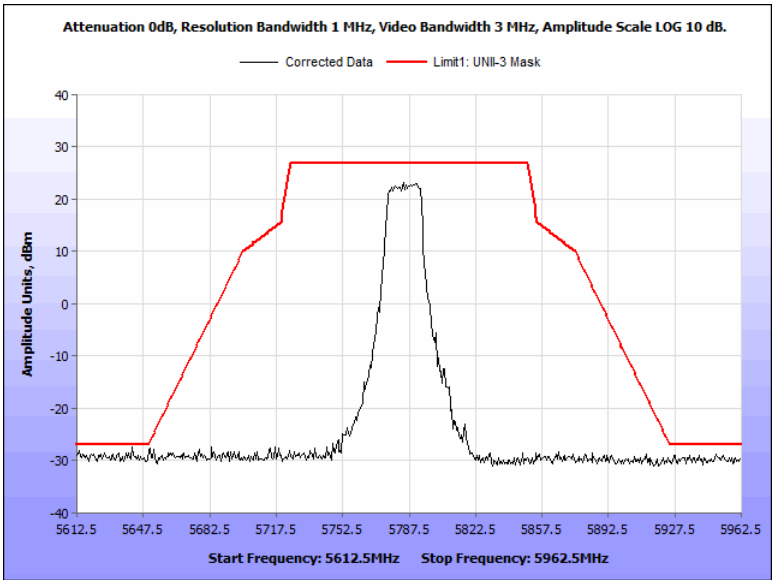


Figure 71: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5785MHz_24

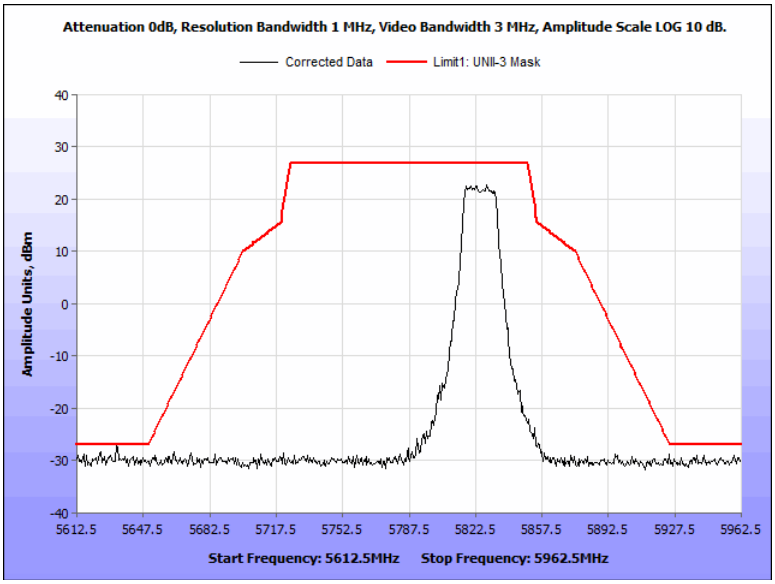


Figure 72: Undesirable Emissions, UNII3-Mask, 802.11n, 20MHz_5825MHz_23

© 2020, Eurofins MET Labs, Inc.

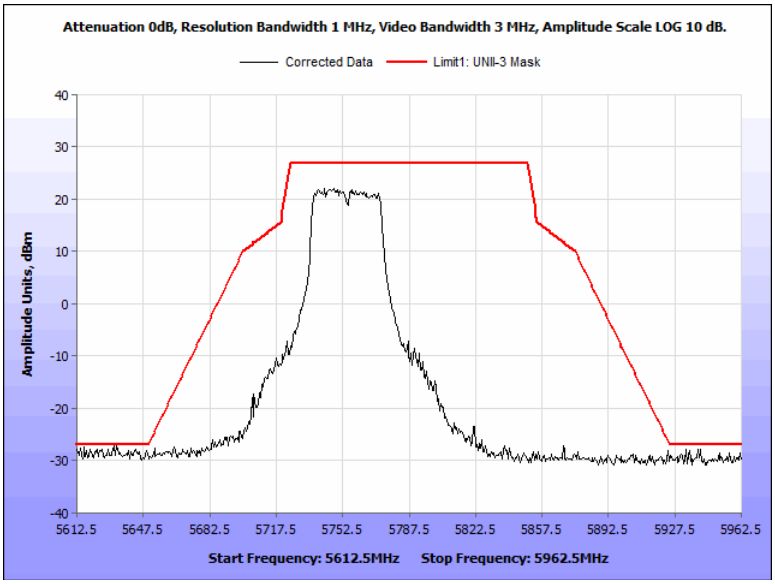


Figure 73: Undesirable Emissions, UNII3-Mask, 802.11n, 40MHz_5755MHz_25

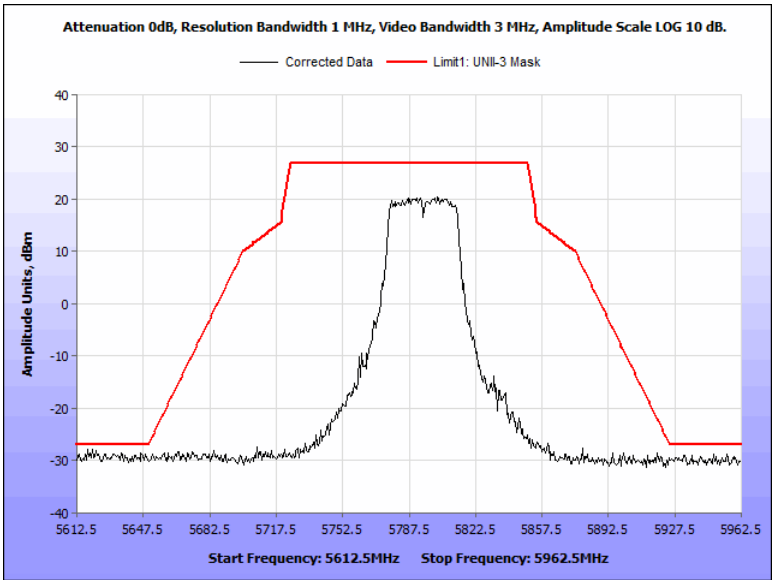


Figure 74: Undesirable Emissions, UNII3-Mask, 802.11n, 40MHz_5795MHz_23

© 2020, Eurofins MET Labs, Inc.

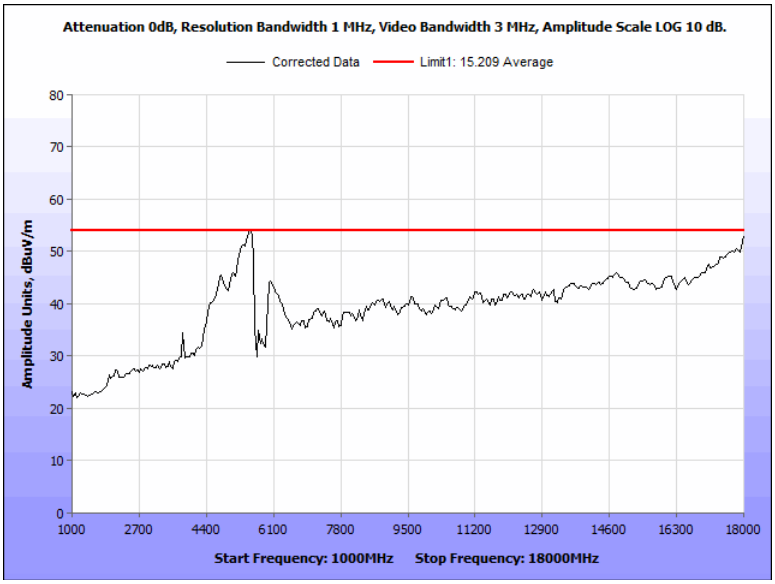


Figure 75: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5745MHz_1-18GHz

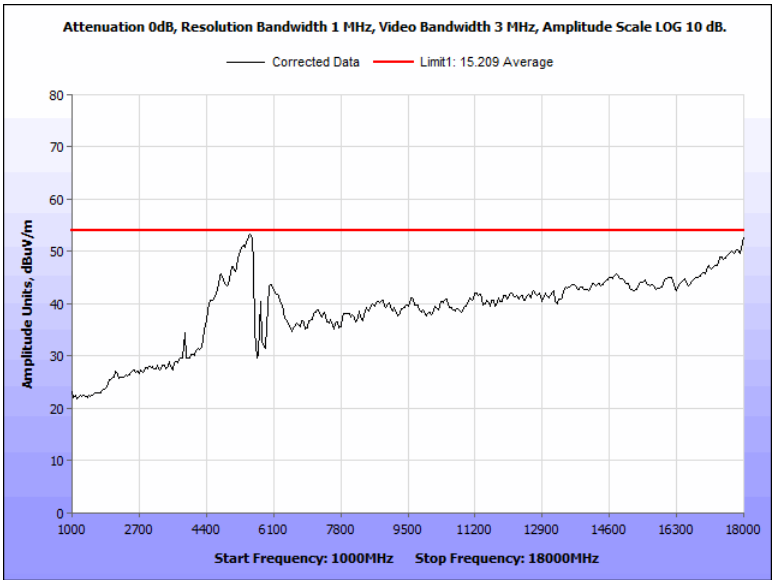


Figure 76: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5785MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

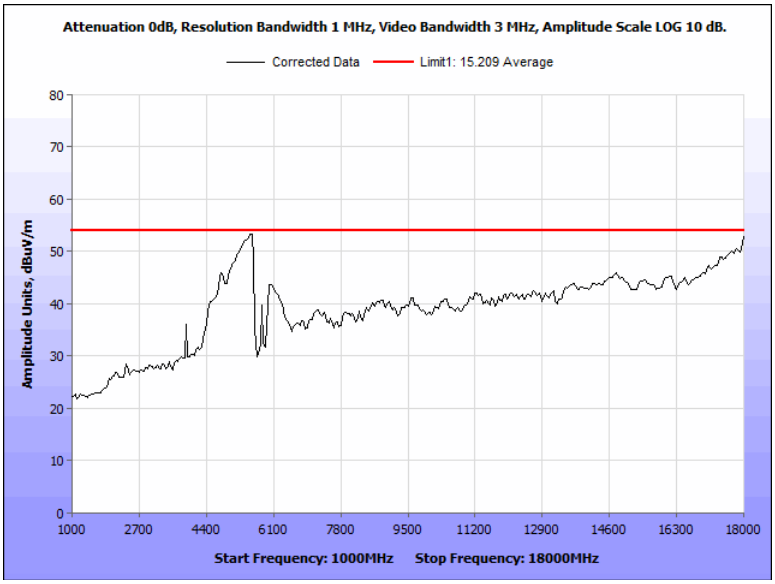


Figure 77: Undesirable Emissions, Radiated Average, 802.11a, 20MHz_5825MHz_1-18GHz

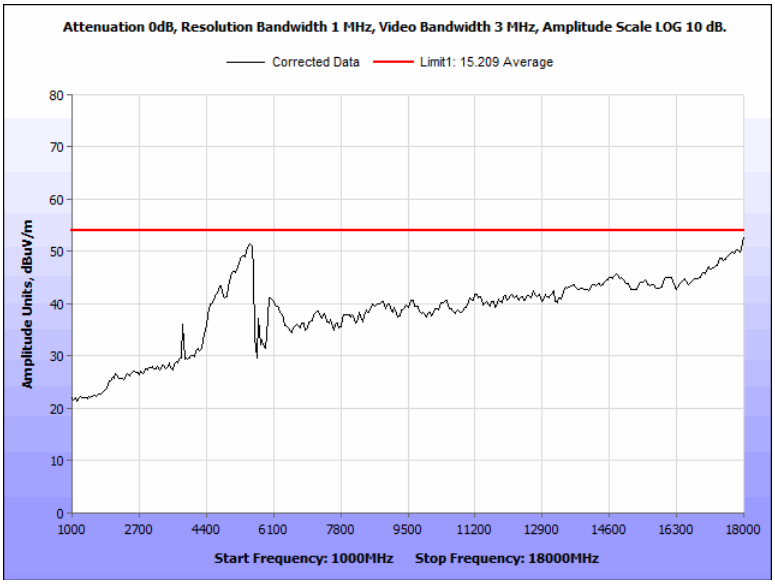


Figure 78: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5745MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

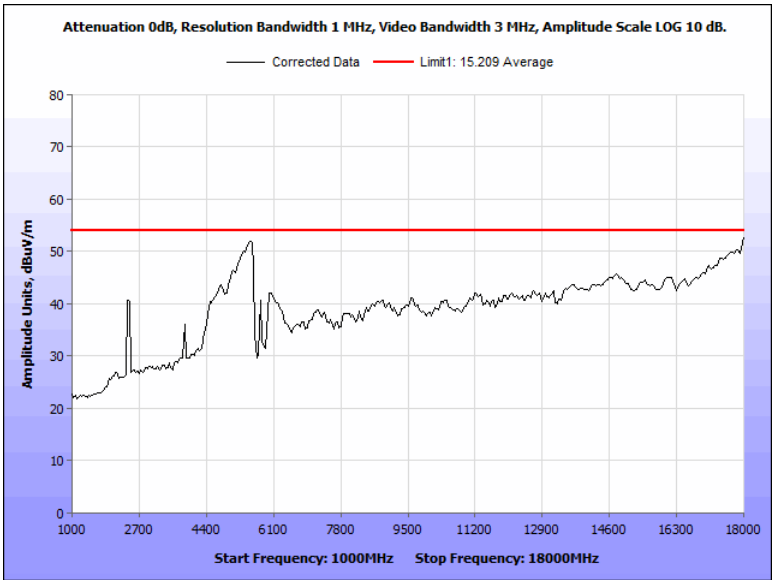


Figure 79: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5785MHz_1-18GHz

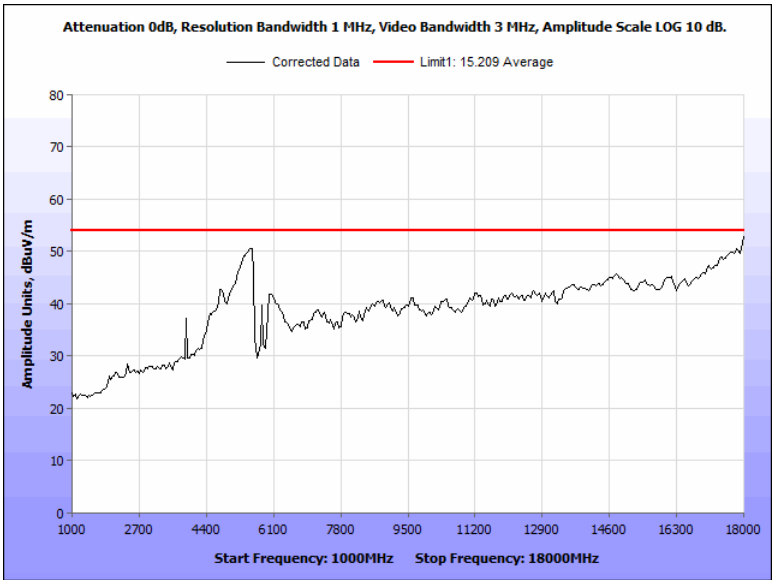


Figure 80: Undesirable Emissions, Radiated Average, 802.11n, 20MHz_5825MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

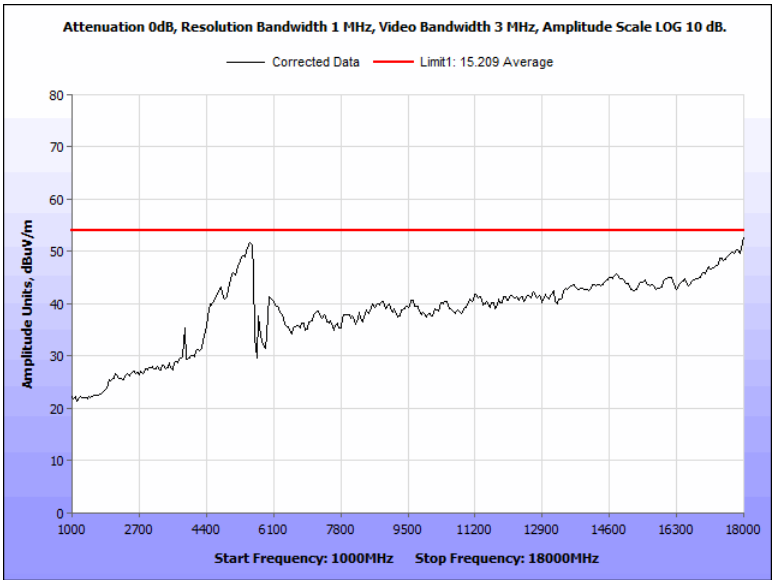


Figure 81: Undesirable Emissions, Radiated Average, 802.11n, 40MHz_5755MHz_1-18GHz

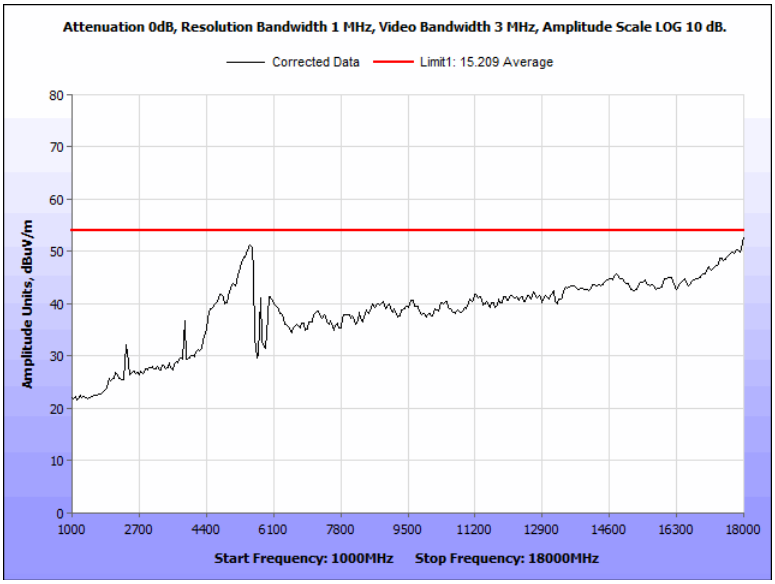


Figure 82: Undesirable Emissions, Radiated Average, 802.11n, 40MHz_5795MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

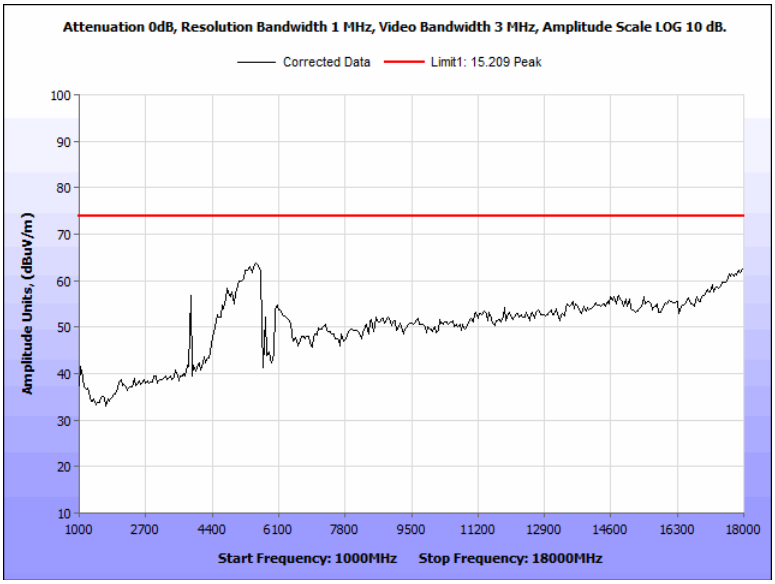


Figure 83: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5745MHz_1-18GHz

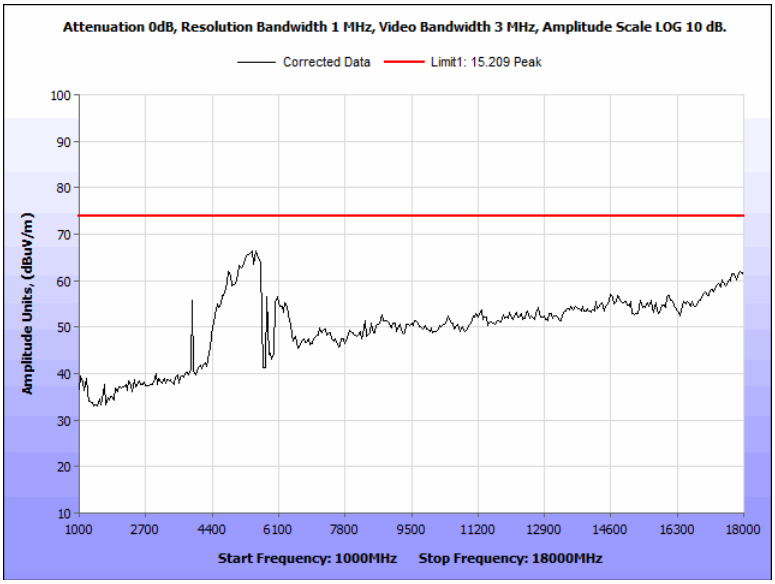


Figure 84: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5785MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

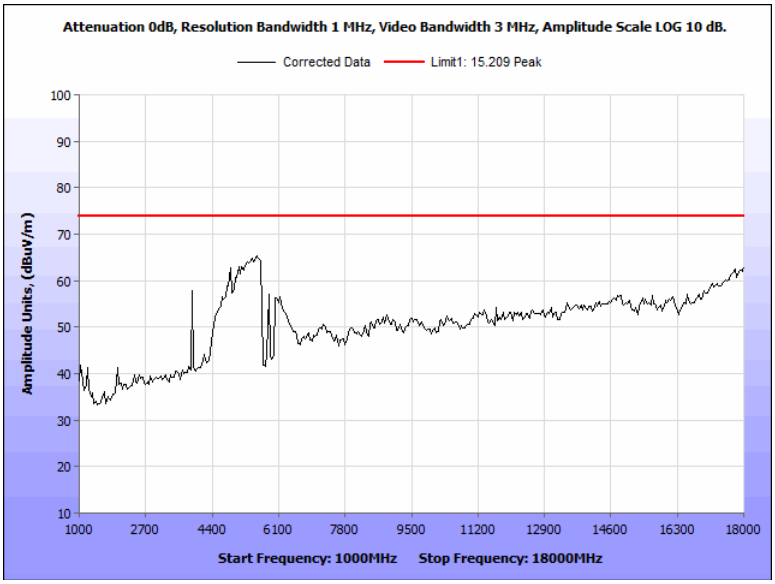


Figure 85: Undesirable Emissions, Radiated Peak, 802.11a, 20MHz_5825MHz_1-18GHz

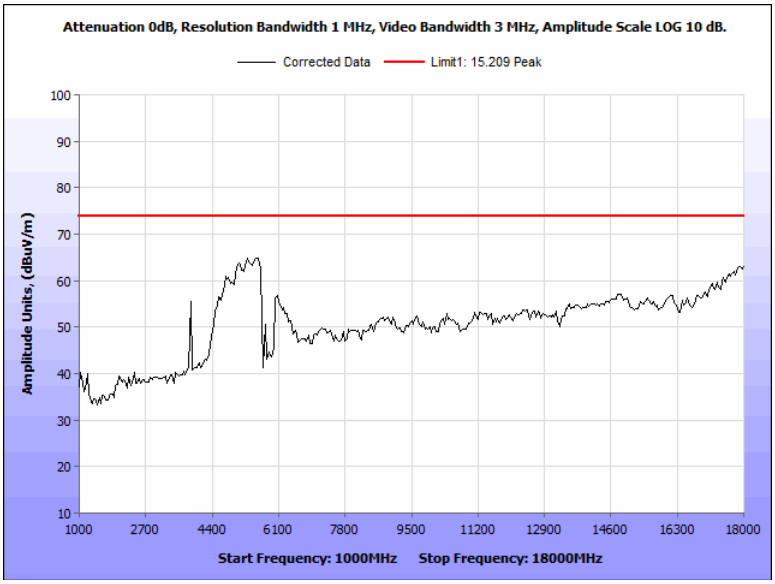


Figure 86: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5745MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

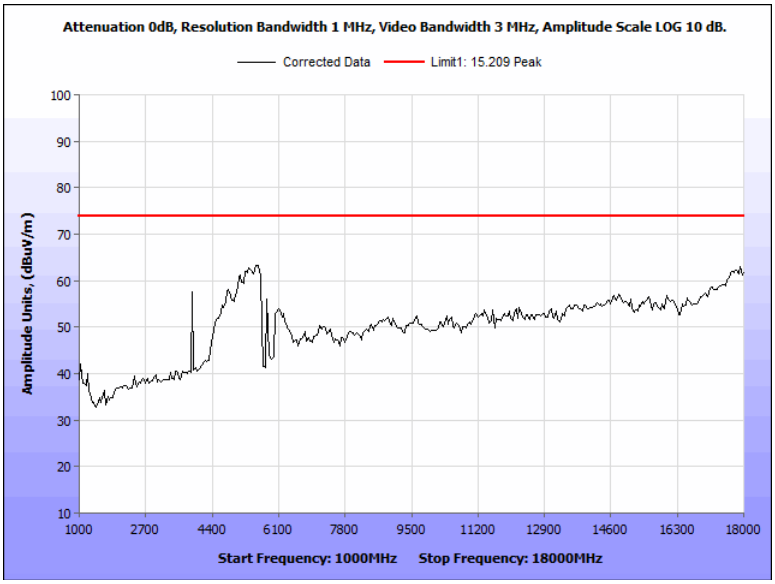


Figure 87: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5785MHz_1-18GHz

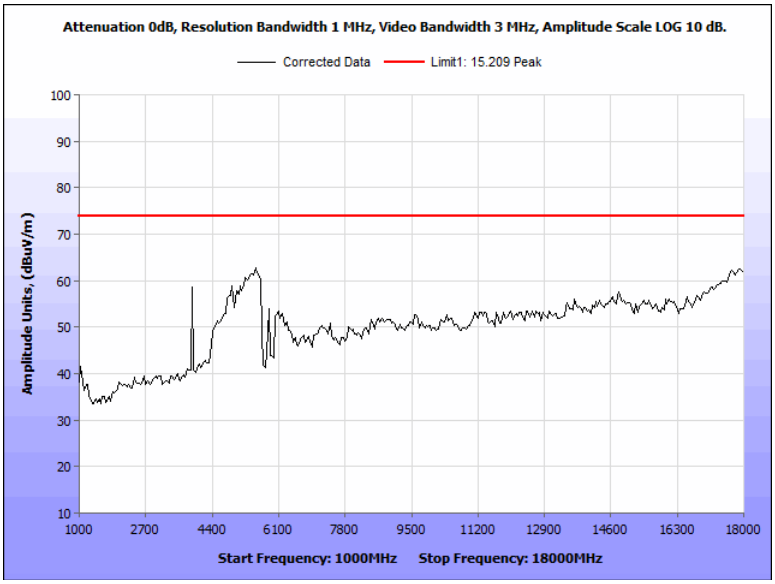


Figure 88: Undesirable Emissions, Radiated Peak, 802.11n, 20MHz_5825MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

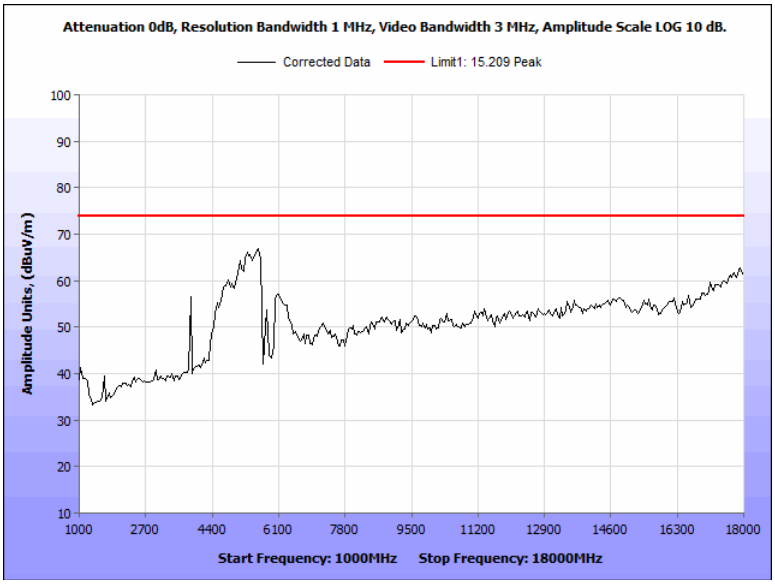


Figure 89: Undesirable Emissions, Radiated Peak, 802.11n, 40MHz_5755MHz_1-18GHz

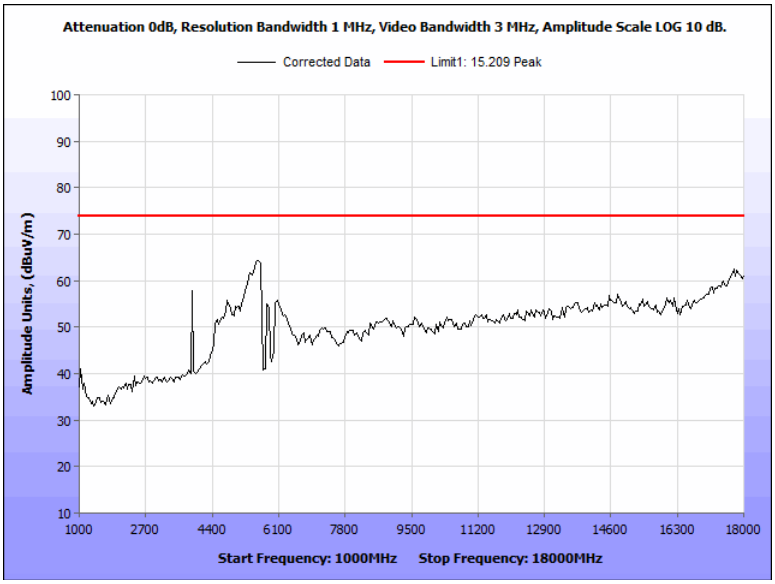


Figure 90: Undesirable Emissions, Radiated Peak, 802.11n, 40MHz_5795MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

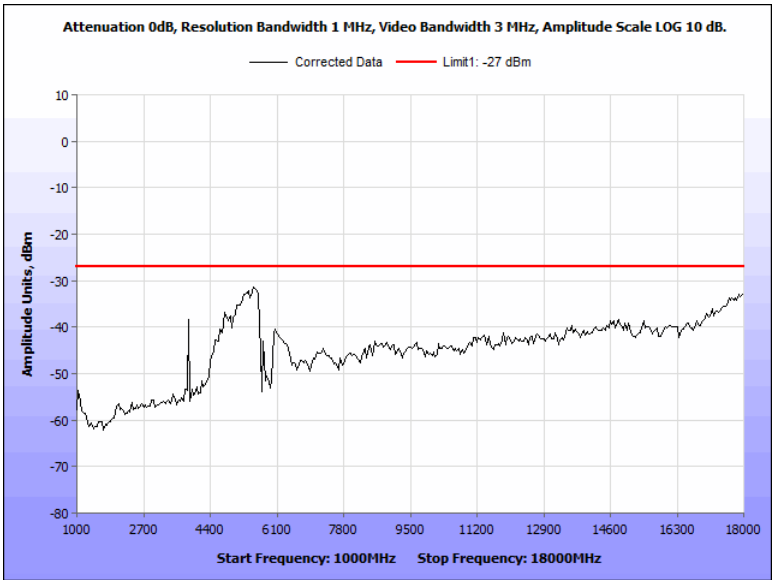


Figure 91: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5745MHz_1-18GHz

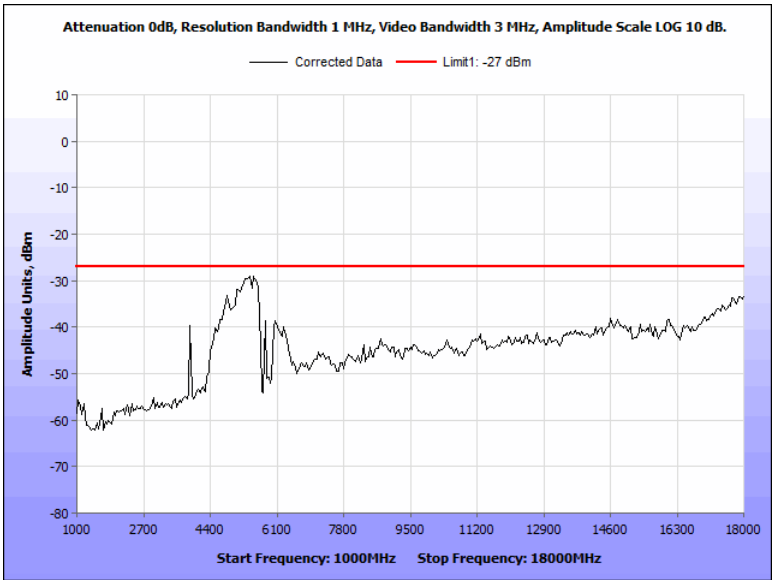


Figure 92: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5785MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

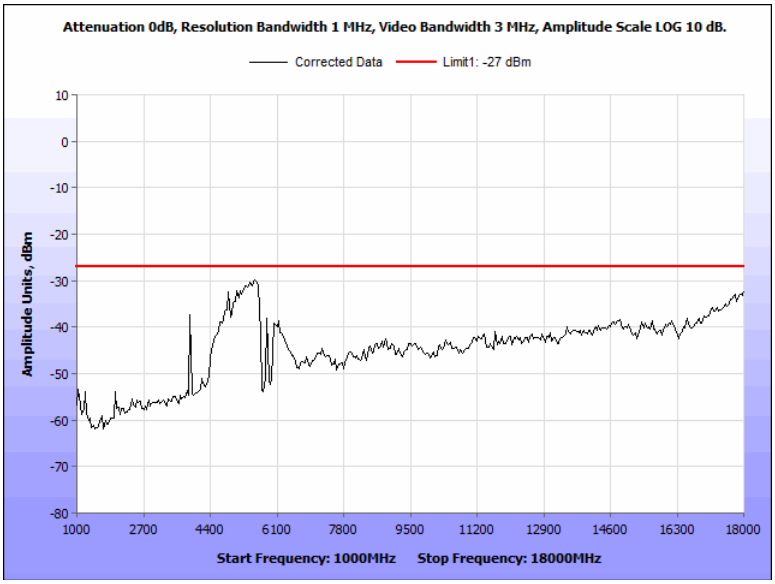


Figure 93: Undesirable Emissions, EIRP Radiated, 802.11a, 20MHz_5825MHz_1-18GHz

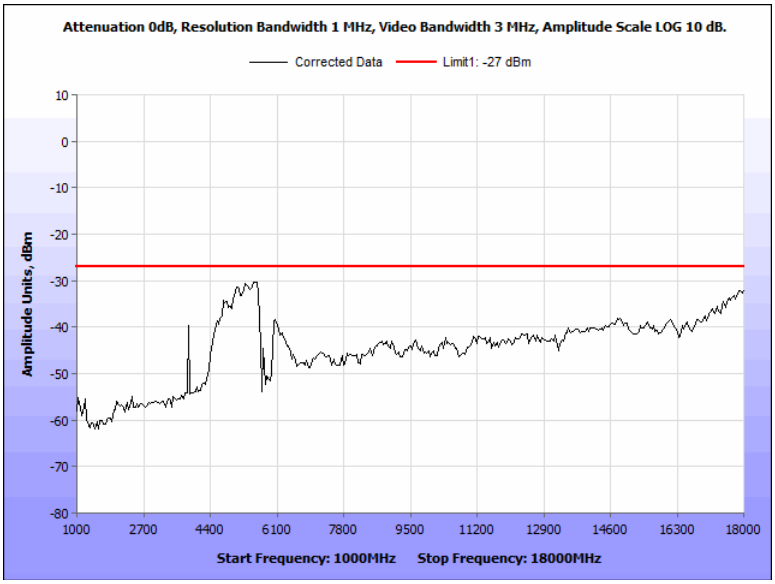


Figure 94: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5745MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

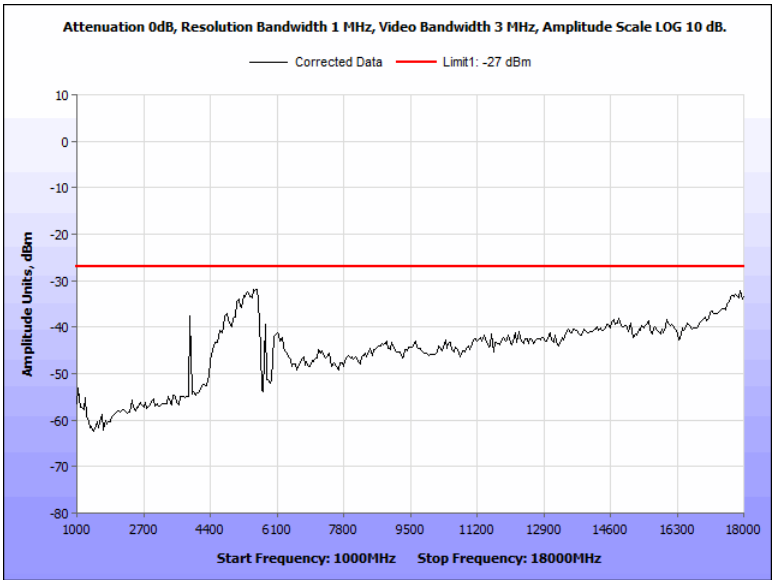


Figure 95: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5785MHz_1-18GHz

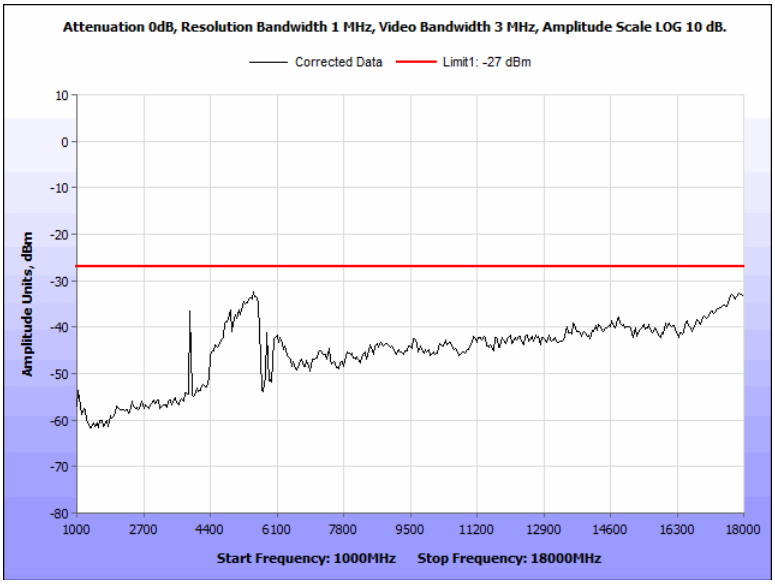


Figure 96: Undesirable Emissions, EIRP Radiated, 802.11n, 20MHz_5825MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

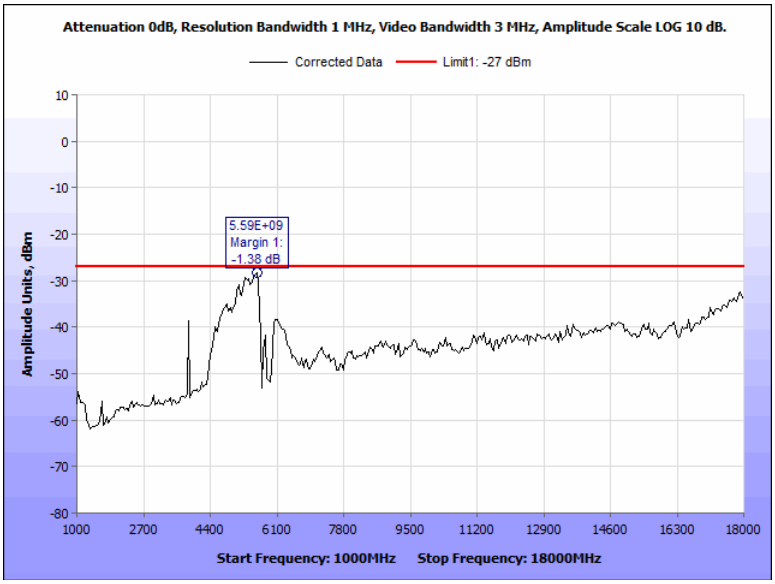


Figure 97: Undesirable Emissions, EIRP Radiated, 802.11n, 40MHz_5755MHz_1-18GHz

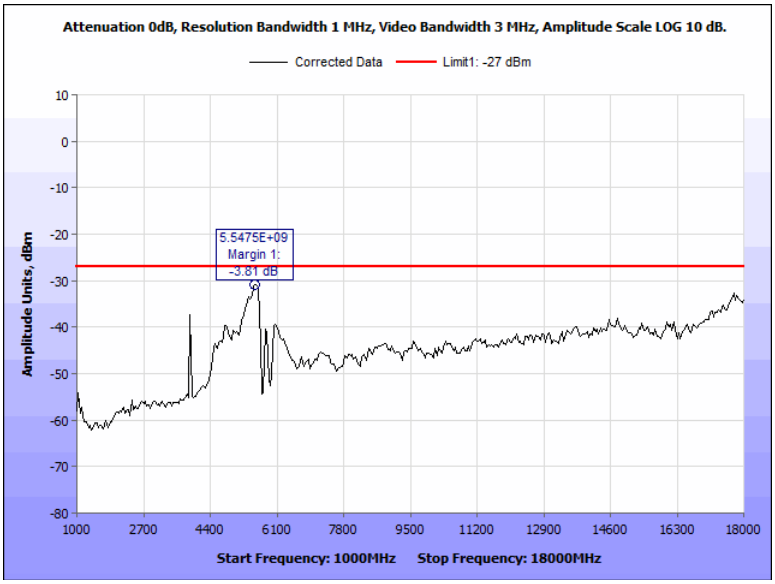


Figure 98: Undesirable Emissions, EIRP Radiated, 802.11n, 40MHz_5795MHz_1-18GHz

© 2020, Eurofins MET Labs, Inc.

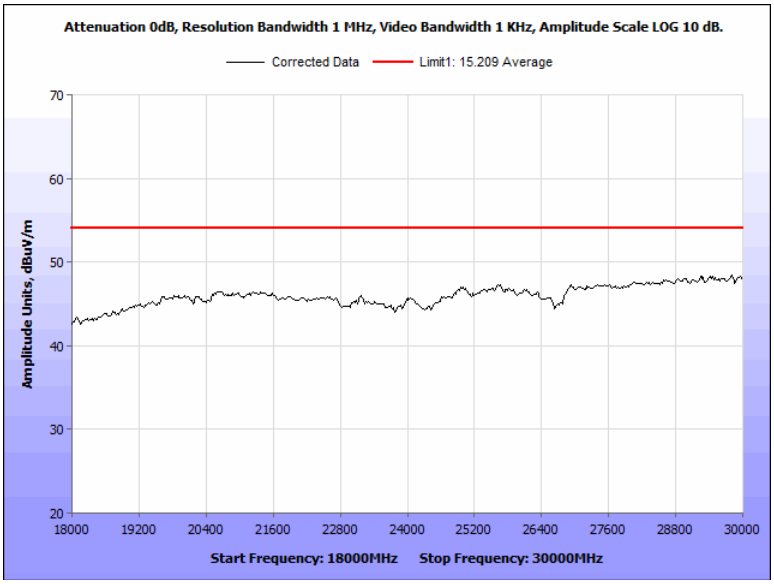


Figure 99: Undesirable Emissions, Radiated Average, Worst Case_18-30GHz

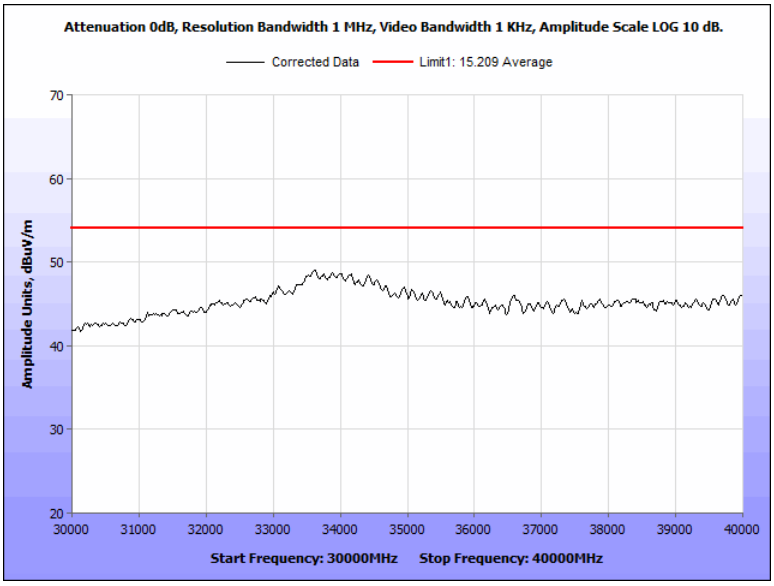


Figure 100: Undesirable Emissions, Radiated Average, Worst Case _30-40GHz

© 2020, Eurofins MET Labs, Inc.

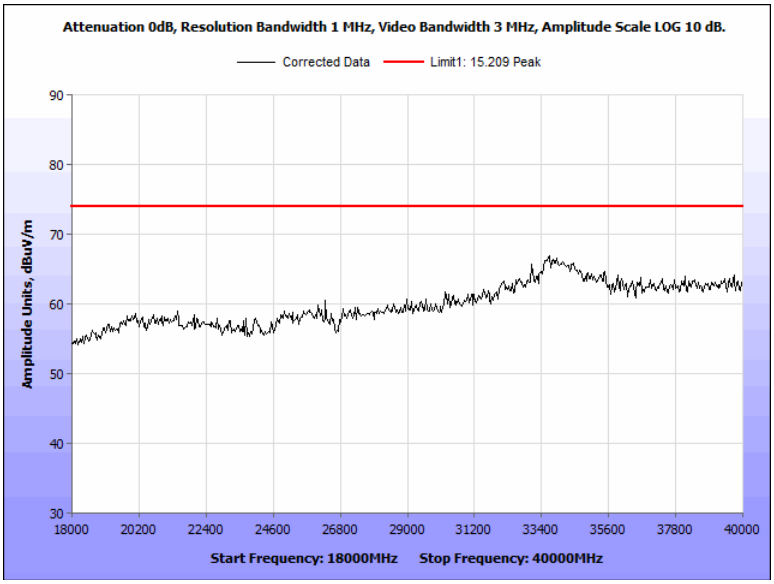


Figure 101: Undesirable Emissions, Radiated Peak, Worst Case _18-40GHz

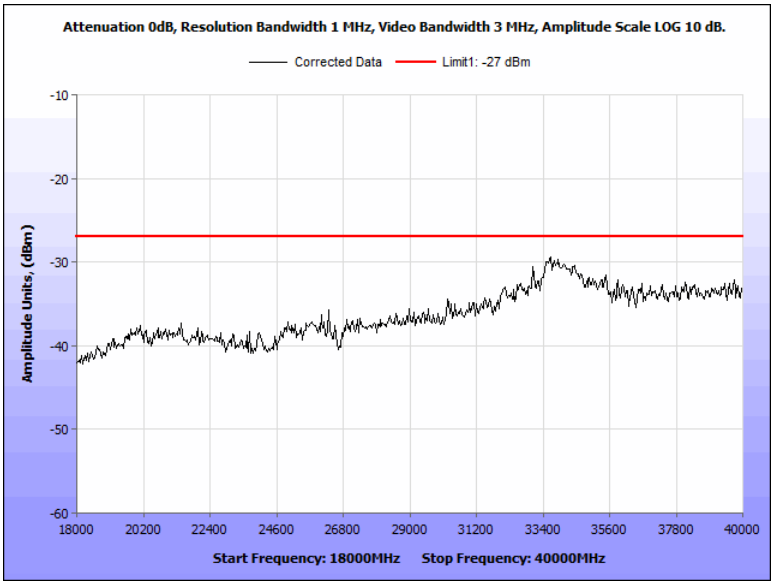


Figure 102: Undesirable Emissions, EIRP Radiated -27dBm, Worst Case _18-40GHz

© 2020, Eurofins MET Labs, Inc.

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna Height (m)	Uncorrected Amplitude (dBµV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
*249.984	92.1	H	1.3256	38.02	16.30	2.34	10.46	46.20	46.4	-0.20
249.984	179.5	V	1.0013	34.39	16.30	2.34	10.46	42.57	46.4	-3.83
299.992	292.4	H	1.6386	22.01	18.30	2.52	10.46	32.37	46.4	-14.03
299.992	76.3	V	1.0091	27.13	18.30	2.52	10.46	37.49	46.4	-8.91
366.681	297	H	1.0026	20.49	19.67	2.85	10.46	32.55	46.4	-13.85
366.681	358.6	V	1.3882	25.18	19.67	2.85	10.46	37.24	46.4	-9.16
*114.078	98.6	H	1.9774	33.75	16.73	1.84	10.46	41.86	43.5	-1.64
114.078	180.4	V	2.1473	31.34	16.73	1.84	10.46	39.45	43.5	-4.05
433.352	299	H	2.3013	13.02	21.04	3.16	10.46	26.76	46.4	-19.64
433.352	166.3	V	1.4165	22.64	21.04	3.16	10.46	36.38	46.4	-10.02
800.02	242.5	H	1.0791	14.15	26.10	4.36	10.46	34.15	46.4	-12.25
800.02	264.2	V	1.0095	13.58	26.10	4.36	10.46	33.58	46.4	-12.82

Figure 103: Radiated Spurious Emissions below 1GHz, Test Results

Note: * - At this frequency, the measured electric-field strength exhibits a margin of compliance that is less than 3 dB below the specification limit. We recommend that every emission measured, have at least a 3 dB margin to allow for deviations in the emission characteristics that may occur during the production process.

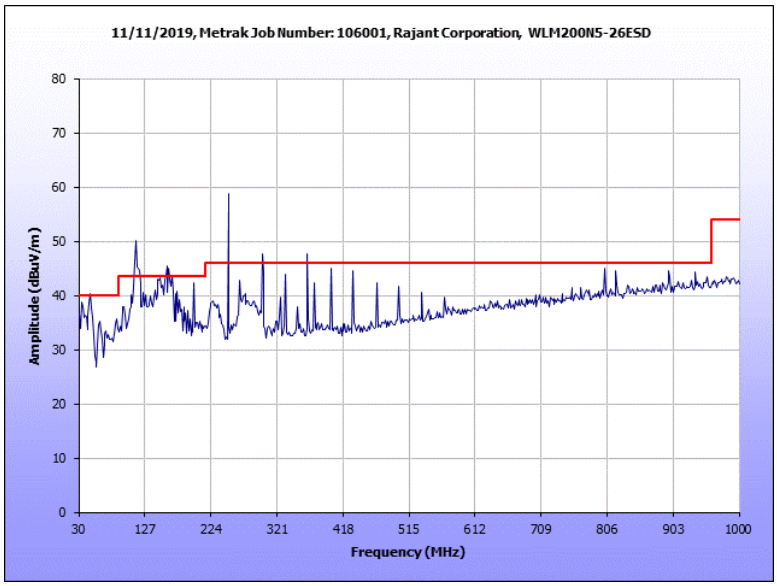


Figure 104: Radiated Spurious Emissions, 30MHz - 1GHz

© 2020, Eurofins MET Labs, Inc.

Figure 105: Undesirable Emissions, Below 1 GHz, Test Setup

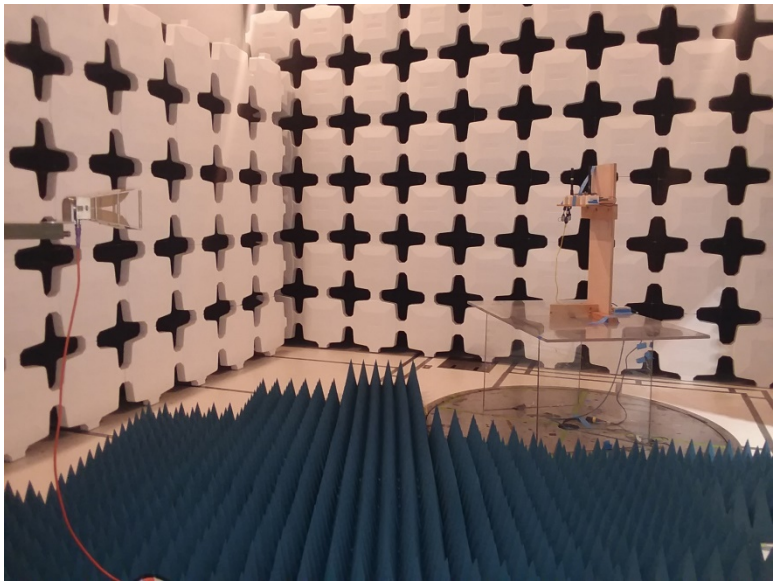


Figure 106: Undesirable Emissions, Above 1 GHz, Test Setup

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.407(b)(6) Conducted Emissions

Test Requirement(s): **§ 15.407 (b)(6):** Any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

§ 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

Figure 107: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a non-metallic 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 C63.10-2013*. Scans were performed with the transmitter on.

Test Results: The EUT was **compliant** with this requirement. Measured emissions were below applicable limits.

Test Engineer: Donald Salguero

Test Date: November 14, 2019

© 2020, Eurofins MET Labs, Inc.

Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) Avg.	Limit (dBµV) Avg.	Pass/ Fail Avg.	Margin (dB) Avg.
0.2832	35.05	0	45.05	60.72	PASS	-15.67	26.73	0	36.73	50.72	PASS	-13.99
0.3346	35.93	0	45.93	59.34	PASS	-13.41	30.01	0	40.01	49.34	PASS	-9.33
0.5028	31.83	0	41.83	56	PASS	-14.17	26.38	0	36.38	46	PASS	-9.62
29.75	36.75	0.12	46.87	60	PASS	-13.13	32.37	0.12	42.49	50	PASS	-7.51
29.465	36.71	0.12	46.83	60	PASS	-13.17	32.01	0.12	42.13	50	PASS	-7.87
29.18	36.02	0.12	46.14	60	PASS	-13.86	31.33	0.12	41.45	50	PASS	-8.55

Figure 108: Conducted Emissions Limits, Phase Line, Test Results

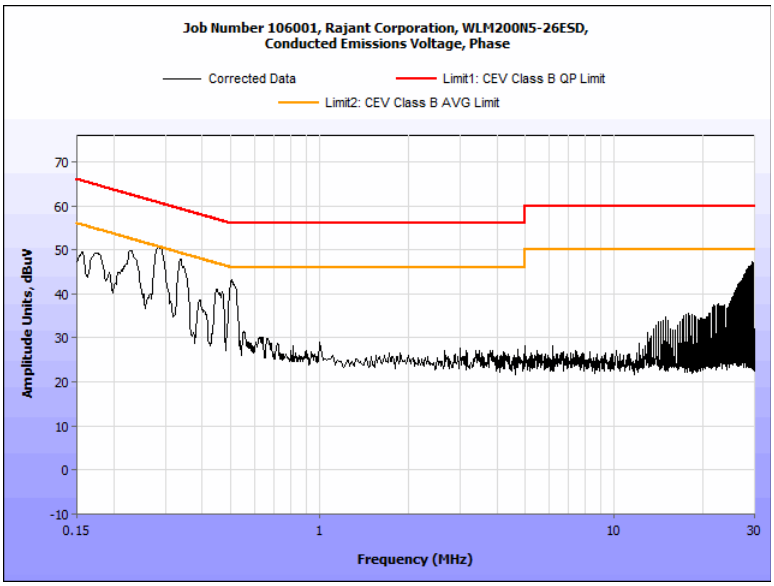


Figure 109: Conducted Emissions Limits, Phase Line, Prescan

© 2020, Eurofins MET Labs, Inc.

Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) Avg.	Limit (dBµV) Avg.	Pass/ Fail Avg.	Margin (dB) Avg.
0.27532	41.63	0	51.63	60.96	PASS	-9.33	36.54	0	46.54	50.96	PASS	-4.42
0.15	34.72	0	44.72	66	PASS	-21.28	13.74	0	23.74	56	PASS	-32.26
0.331467	39.07	0	49.07	59.41	PASS	-10.34	32.46	0	42.46	49.41	PASS	-6.95
29.758	36.81	0.12	46.93	60	PASS	-13.07	35.11	0.12	45.23	50	PASS	-4.77
29.466	36.43	0.12	46.55	60	PASS	-13.45	34.05	0.12	44.17	50	PASS	-5.83
29.138	35.63	0.12	45.75	60	PASS	-14.25	34.13	0.12	44.25	50	PASS	-5.75

Figure 110: Conducted Emissions Limits, Neutral Line, Test Results

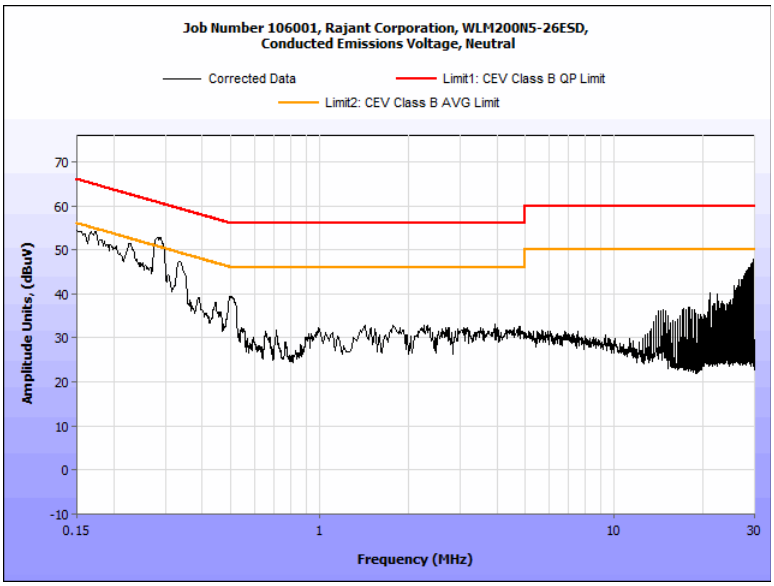


Figure 111: Conducted Emissions Limits, Neutral Line, Prescan

© 2020, Eurofins MET Labs, Inc.

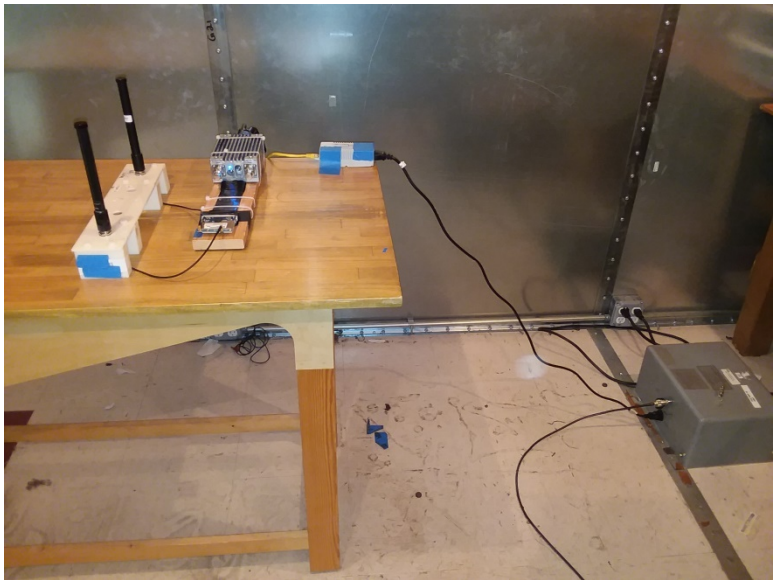


Figure 112: Conducted Emissions Limits, Test Setup

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15. 407(e) 6 dB Bandwidth

Test Requirements: **§ 15.407(e):** Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

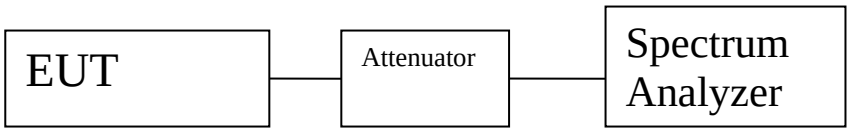
Test Procedure: The transmitter was set to low, mid, and high operating frequencies at the highest output power and connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW = 100 kHz, VBW= 3xRBW. The 6 dB Bandwidth was measured and recorded.

Test Results: The EUT was **compliant** with this requirement.

The 6dB Bandwidth was determined from the plots on the following pages. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: November 4, 2019



Mode	Nominal Bandwidth (MHz)	Center Frequency (MHz)	6dB Bandwidth Chain 0 (MHz)	6dB Bandwidth Chain 1 (MHz)
802.11a	20	5745	16.631	16.584
		5785	16.61	16.592
		5825	16.625	16.593
802.11n	20	5745	17.849	17.836
		5785	17.806	17.85
		5825	17.833	17.831
	40	5755	36.463	36.499
		5795	36.518	36.42

Figure 113: 6dB Occupied Bandwidth, Test Results

© 2020, Eurofins MET Labs, Inc.

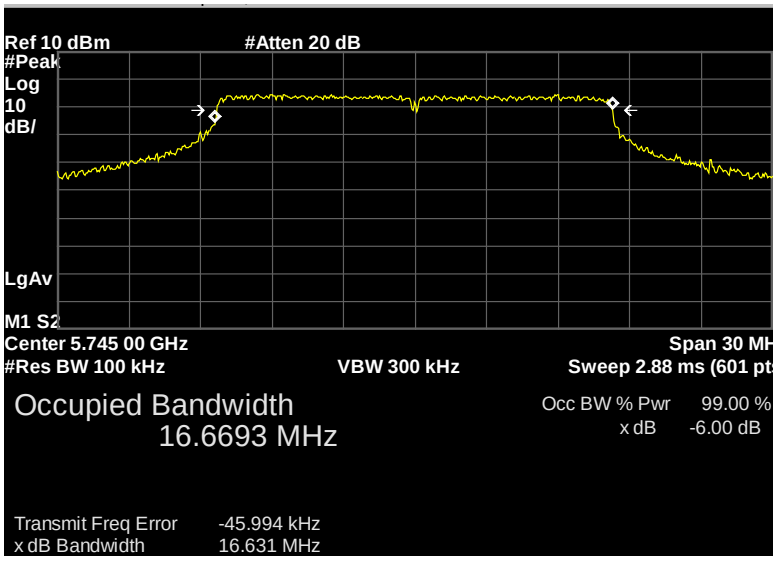


Figure 114: 6dB Occupied Bandwidth, 5745MHz, Chain 0

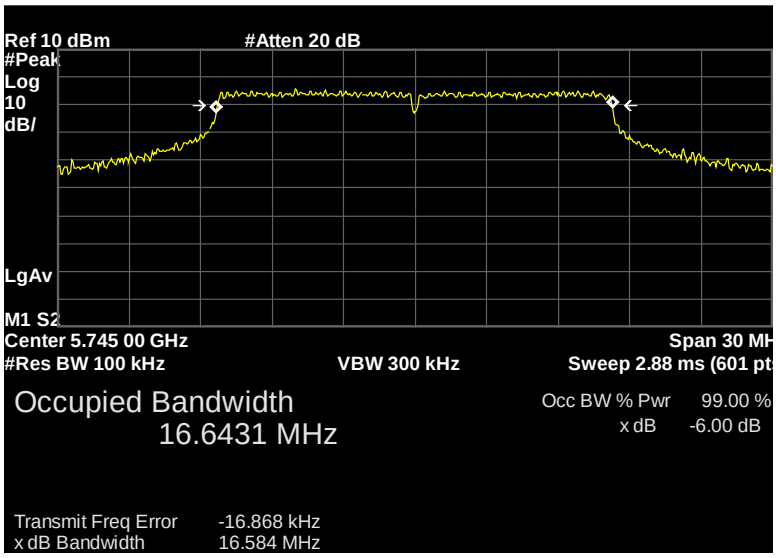


Figure 115: 6dB Occupied Bandwidth, 5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

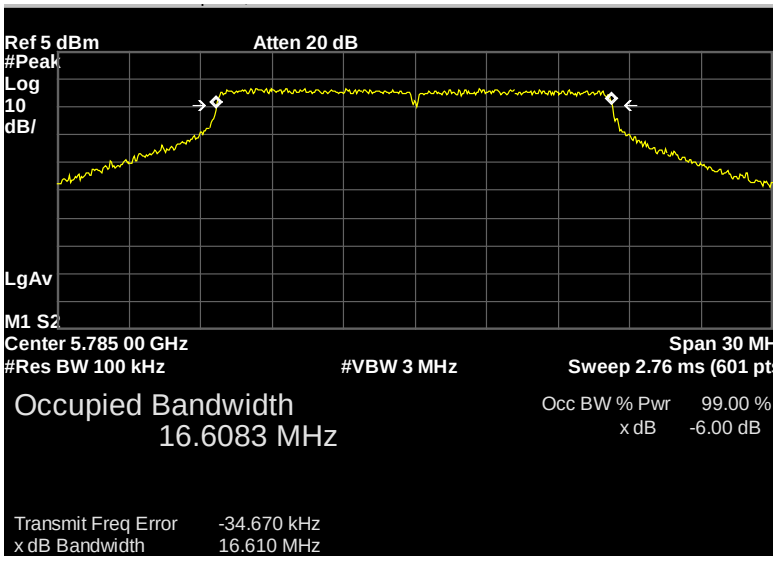


Figure 116: 6dB Occupied Bandwidth, 5785MHz, Chain 0

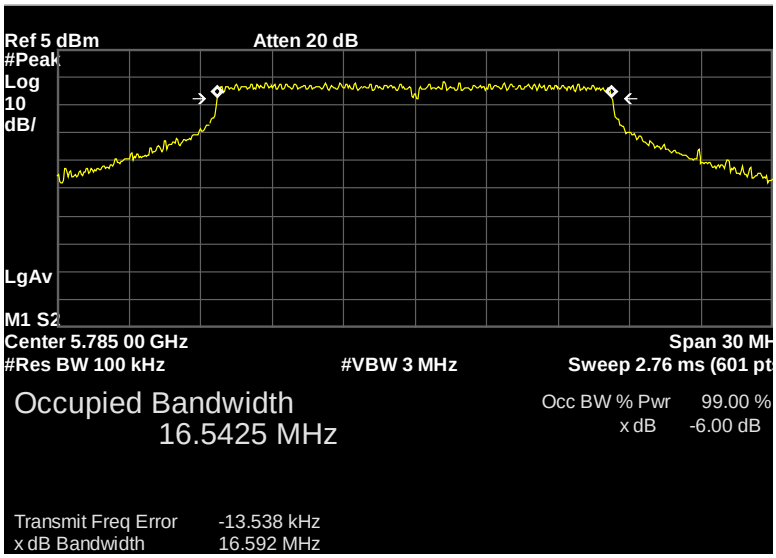


Figure 117: 6dB Occupied Bandwidth, 5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

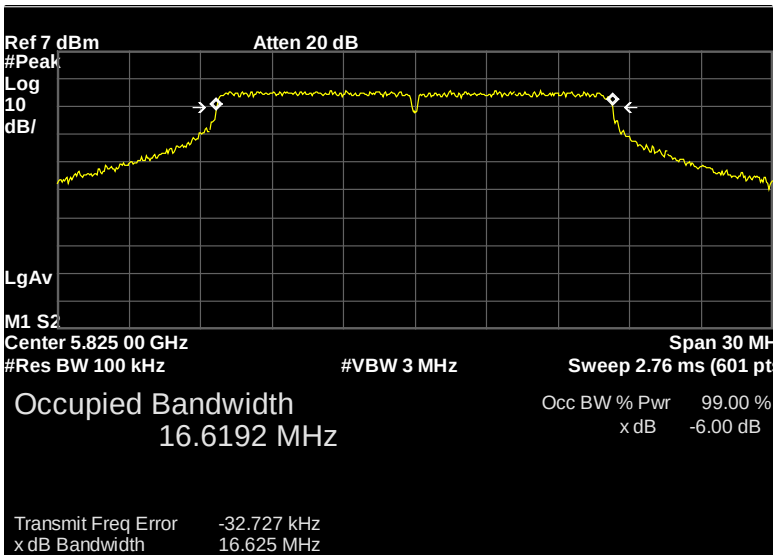


Figure 118: 6dB Occupied Bandwidth, 5825MHz, Chain 0

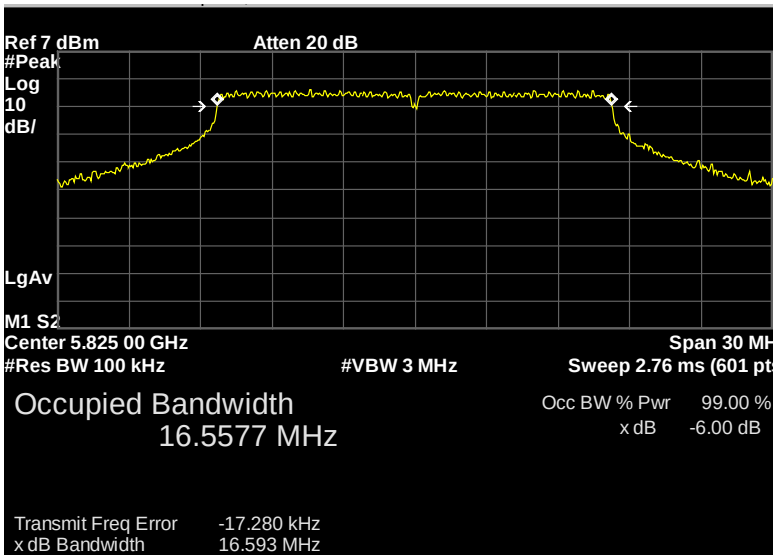


Figure 119: 6dB Occupied Bandwidth, 5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

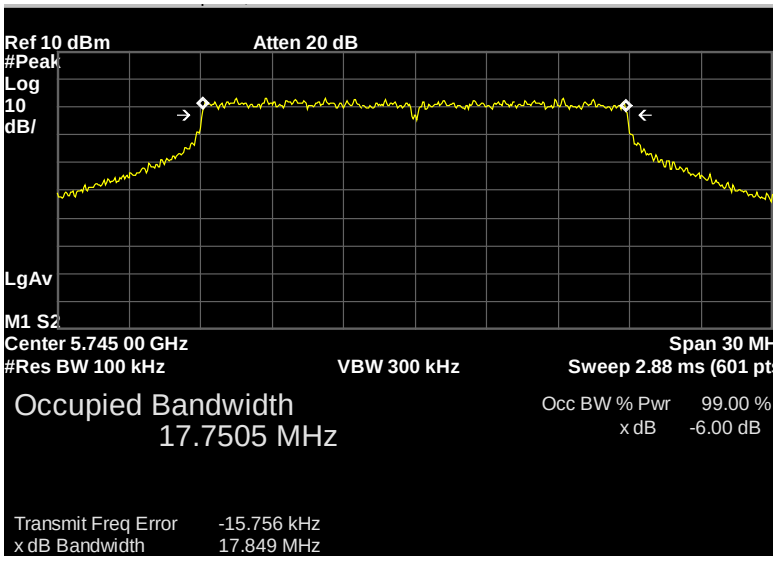


Figure 120: 6dB Occupied Bandwidth, n20, 5745MHz, Chain 0

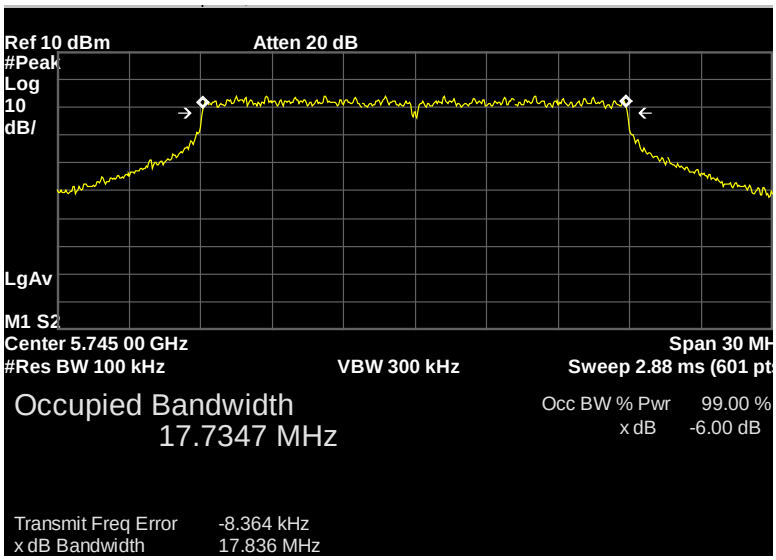


Figure 121: 6dB Occupied Bandwidth, n20, 5745MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

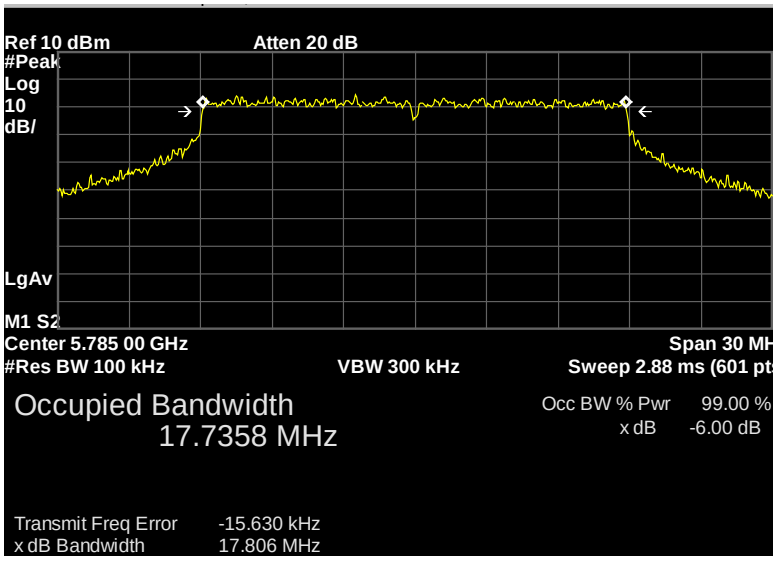


Figure 122: 6dB Occupied Bandwidth, n20, 5785MHz, Chain 0

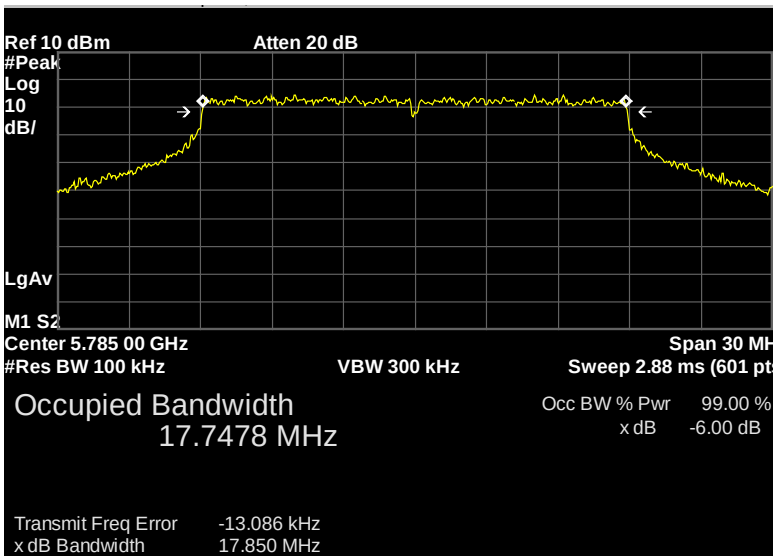


Figure 123: 6dB Occupied Bandwidth, n20, 5785MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

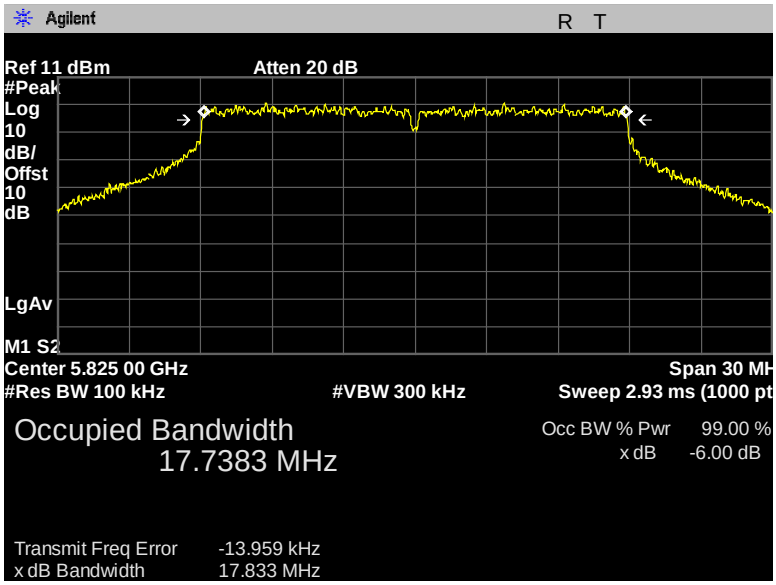


Figure 124: 6dB Occupied Bandwidth, n20, 5825MHz, Chain 0

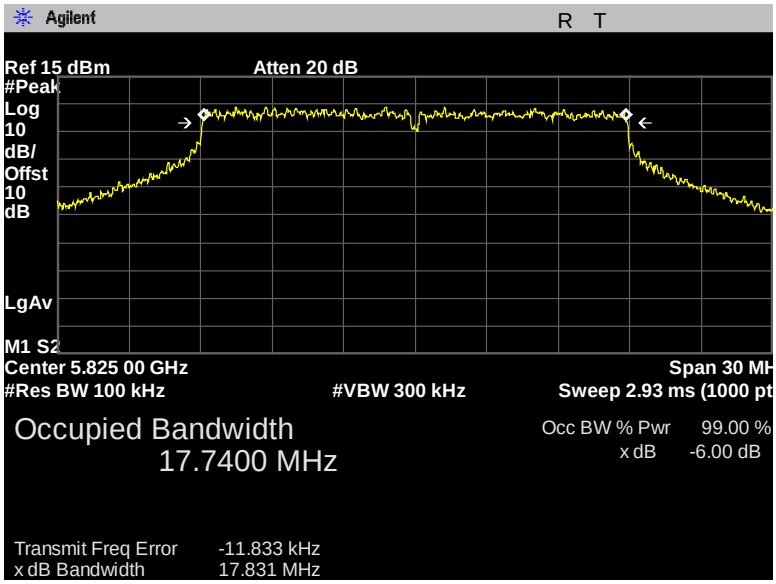


Figure 125: 6dB Occupied Bandwidth, n20, 5825MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

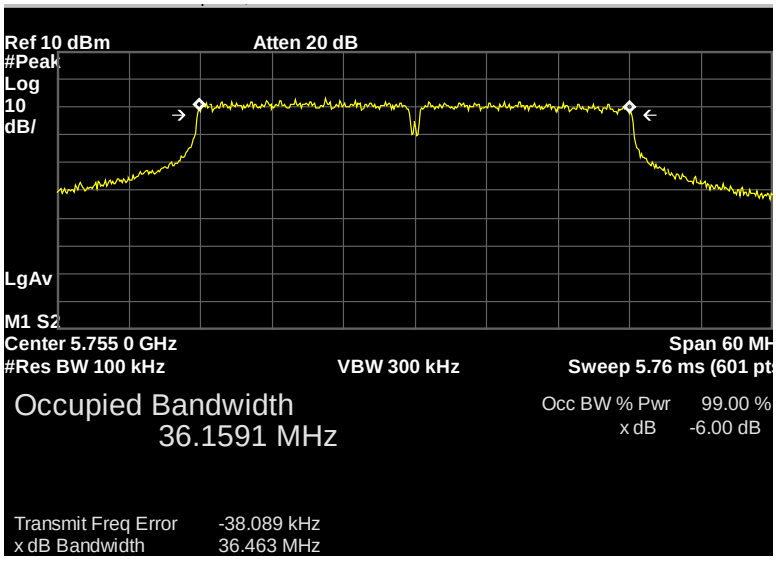


Figure 126: 6dB Occupied Bandwidth, n40, 5755MHz, Chain 0

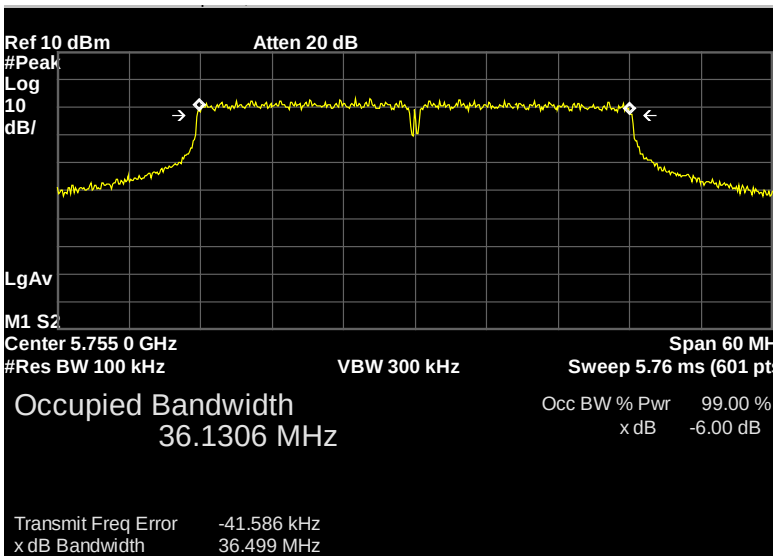


Figure 127: 6dB Occupied Bandwidth, n40, 5755MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

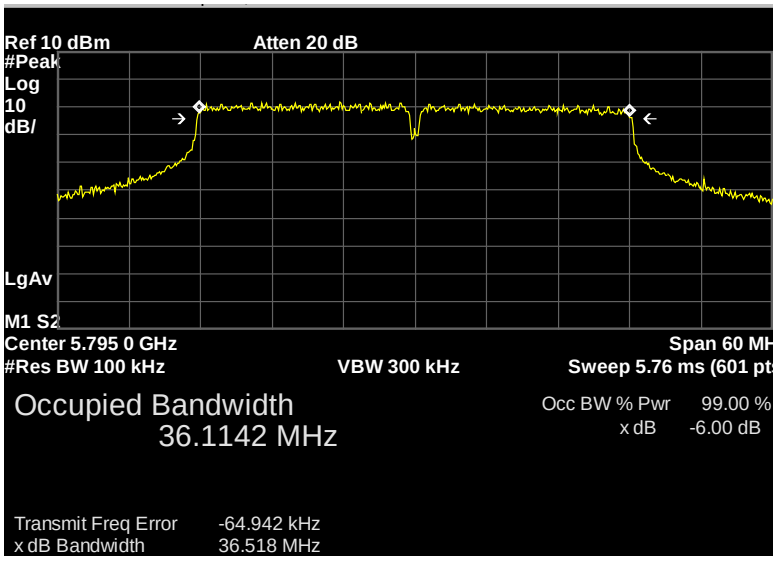


Figure 128: 6dB Occupied Bandwidth, n40, 5795MHz, Chain 0

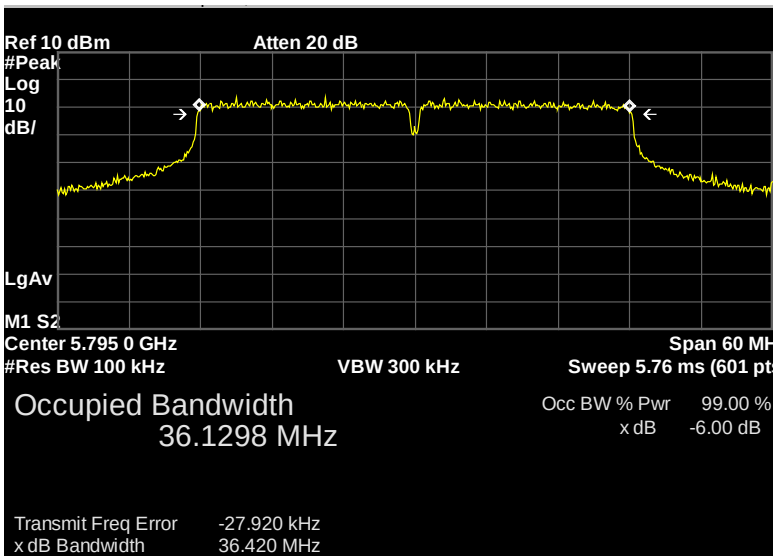


Figure 129: 6dB Occupied Bandwidth, n40, 5795MHz, Chain 1

© 2020, Eurofins MET Labs, Inc.

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.407(f) Maximum Permissible Exposure

Test Requirement(s): **§15.407(f):** U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307(b), §2.1091 and §2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment.

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit: EUT's operating frequencies @ 5725 - 5850 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

Test Results:

FCC									
Frequency (MHz)	**Con. Pwr. (dBm)**	**Con. Pwr. (mW)**	**Ant. Gain (dBi)**	**Ant. Gain numeric**	**Pwr. Density (mW/cm^2)**	**Limit (mW/cm^2)**	**Margin**	**Distance (cm)**	**Result**
5745	22.59	181.552	9.01	7.962	0.28756	1	0.71244	20	Pass

*Conducted Power includes 1dB of tune up tolerance

The safe distance where Power Density is less than the MPE Limit listed above was found to be 20 cm.

© 2020, Eurofins MET Labs, Inc.

IV. Test Equipment

© 2020, Eurofins MET Labs, Inc.

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

MET ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL	CAL DUE
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	1/4/2019	1/4/2021
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	8/30/2018	2/29/2020
1T4300B	SEMI-ANECHOIC 3M CHAMBER SVSWR	EMC TEST SYSTEMS	NONE	6/30/2019	12/30/2020
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	6/30/2019	6/30/2020
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	5/16/2018	11/16/2019
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	5/15/2018	11/15/2019
1T4504	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	NOT REQUIRED	
1T4565	LISN (24 AMP)	SOLAR ELECTRONICS COMPANY	9252-50-R-24-BNC	4/3/2019	10/3/2020
1T7450	TRANSIENT LIMITER	COM-POWER	LIT-153A	NOT REQUIRED	
1T4905	HORN ANTENNA	COM-POWER	AH-118	5/7/2019	11/7/2020
1T8743	PREAMPLIFIER	A.H. SYSTEMS, INC.	PAM-0118P	SEE NOTE	

Figure 130: Test Equipment List

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

© 2020, Eurofins MET Labs, Inc.

V. Certification & User's Manual Information

© 2020, Eurofins MET Labs, Inc.

Certification & User's Manual Information

L. 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.

© 2020, Eurofins MET Labs, Inc.

(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.

© 2020, Eurofins MET Labs, Inc.

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.

© 2020, Eurofins MET Labs, Inc.

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.

© 2020, Eurofins MET Labs, Inc.

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 user's 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.

© 2020, Eurofins MET Labs, Inc.

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.

© 2020, Eurofins MET Labs, Inc.

End of Report

© 2020, Eurofins MET Labs, Inc.