Test of Actiontec R3000 Wireless Router

To: FCC CFR 47 Part 15C, 15.407

Test Report Serial No.: ATEC01-U19 Rev A

TEST REPORT

FROM

Test of Actiontec R3000 Wireless Router

to

To FCC CFR 47 Part 15C, 15.407

Test Report Serial No.: ATEC01-U19 Rev A

Note: this report contains data with regard to the 5150 – 5250 and 5725 - 5850 MHz bands for Actiontec Wireless Router. 2.4 GHz data is reported in MiCOM Labs report ATEC01- U18

This report supersedes: NONE

Applicant: Actiontec Electronics Inc.
760 N Mary Ave
Sunnyvale, California 94085
USA

Product Function: Wireless Router

Copy No: pdf Issue Date: 20th January 2015

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

TESTING CERT #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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ACCREDITATION, LISTINGS & RECOGNITION

TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

ilac-MRA

A2LA American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

MICOM LABS

Pleasanton, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 28th day of February 2014.

President & CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2015

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC 17065. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

USA Telecommunication Certification Body (TCB) - TCB Identifier – US0159

Industry Canada Certification Body - CAB Identifier – US0159

European Notified Body - Notified Body Identifier - 2280

Japan – Recognized Certification Body (RCB) - RCB Identifier - 210

DOCUMENT HISTORY

Document History		
Revision	**Date**	**Comments**
Draft		
Rev A	20th January 2015	Initial release

1. TEST RESULT CERTIFICATE

Applicant:	Actiontec Electronics Inc. 760 N Mary Ave Sunnyvale, California 94085 USA	Tested By:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California, 94566, USA
EUT:	Wireless Router	Tel:	+1 925 462 0304
Model:	R3000	Fax:	+1 925 462 0306
S/N:	SB234420100018		
Test Date(s):	1st - 18th December 2014	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.407 & IC RSS-210	EQUIPMENT COMPLIES
Non-DFS Bands only (5150-5250 and 5725-5850)	

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

TESTING CERT #2381.01

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 15.407	1st May 2014	Code of Federal Regulations
(ii)	FCC 06-96	June 2006	Memorandum Opinion and Order
(iii)	FCC OET KDB 662911	31st October 2013	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
(vii)	ANSI C63.4	2009	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(viii)	CISPR 22/ EN 55022	2010	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(ix)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(x)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(xi)	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(xii)	A2LA	July 2012	Reference to A2LA Accreditation Status – A2LA Advertising Policy
(xiii)	FCC Public Notice – DA 02-2138	2002	Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the Actiontec R3000 Wireless Router in the frequency range 5150 – 5250 and 5725-5850 MHz to FCC Part 15.407 regulations.
Applicant:	Actiontec Electronics Inc. 760 N Mary Ave Sunnyvale, California 94085, USA
Manufacturer:	As applicant
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court, Pleasanton, California 94566 USA
Test report reference number:	ATEC01-U19 Rev A
Date EUT received:	1st December 2014
Standard(s) applied:	FCC 47 CFR Part 15.407 & IC RSS-210
Dates of test (from - to):	1st - 18th December 2014
No of Units Tested:	One
Type of Equipment:	802.11a/b/g/n/ac Wireless Access Point 4x4 Spatial Multiplexing MIMO configuration
Applicants Trade Name:	Wireless Access Point
Model(s):	R3000
Location for use:	Indoor only
Declared Frequency Range(s):	5150 – 5250 and 5725 - 5850 MHz
Hardware Rev:	R3000-1B3
Firmware Rev	33.162L.05a
Type of Modulation:	OFDM
EUT Modes of Operation:	802.11a/n/ac
Declared Nominal Output Power: (Average Power)	802.11a/n/ac: +17 dBm
Transmit/Receive Operation:	Time Division Duplex
System Beam Forming:	R3000 has antenna beam forming capability, see Section 3.4 Antenna Details
Rated Input Voltage and Current:	12 Vdc 3 A
Operating Temperature Range:	Declared range 0º to +40º.
ITU Emission Designator:	802.11a 16M7D1D 802.11VHT-20 18M0D1D 802.11VHT-40 37M3D1D 802.11VHT-80 76M6D1D
Equipment Dimensions:	17.5x9.8x0.8mm
Weight:	0.5 grams
Primary function of equipment:	Wireless Router

3.2. Scope of Test Program

Actiontec R3000 Wireless Router

The scope of the test program was to test the Actiontec R300, 4x4 Spatial Multiplexing MIMO configuration in the frequency range 5150 – 5250 and 5725-5850 MHz for compliance against FCC CFR 47 Part 15C, 15.407 specifications.

FCC OET KDB Implementation

This test program implements the following FCC KDB – 662911 31st October 2013; ***Emissions Testing of Transmitters with Multiple Outputs in the Same Band***

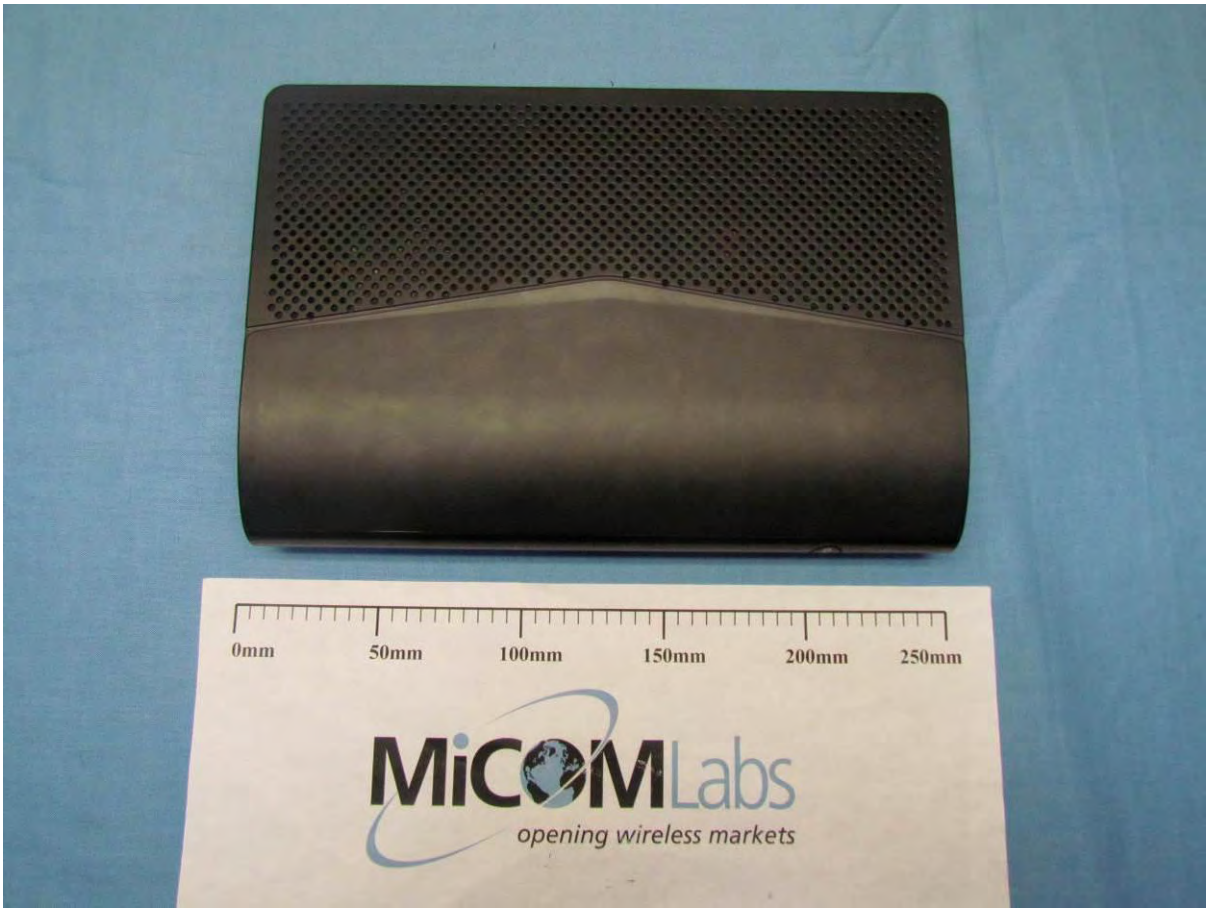
The KDB document provides guidance for measurements of conducted output emissions of devices that employ a single transmitter with multiple outputs in the same band, with the outputs occupying the same or overlapping frequency ranges. It applies to EMC compliance measurements on devices that transmit on multiple antennas simultaneously in the same or overlapping frequency ranges through a coordinated process. Examples include, but are not limited to, devices employing beam forming or multiple-input and multiple-output (MIMO.) This guidance applies to both licensed and unlicensed devices wherever the FCC rules call for conducted output measurements. Guidance is provided for in-band, out-of-band and spurious emission measurements.

This guidance does not apply to the multiple transmitters included in a composite device, such as a device that combines an 802.11 modem with a cell phone in one enclosure with each driving its own antenna.

Actiontec
802.11 a/b/g/n/ac Wireless Router

Actiontec
802.11 a/b/g/n/ac Wireless Router

Actiontec
802.11 a/b/g/n/ac Wireless Router



Actiontec
802.11 a/b/g/n/ac Wireless Router

3.3. Equipment Model(s) and Serial Number(s)

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	Wireless Router	Actiontec	R3000	SB234420100018
EUT	Power Adapter 120Vac 50/60Hz 0.8A 12 Vdc 3A	Actiontec	DS036-W120U	41600033
Support	Laptop PC	IBM	Thinkpad	None

3.4. Antenna Details

Integral Antenna

Model	Manufacturer	Type	Gain		Freq. Band
			dBi	Beam-Forming dB	MHz
N5X20B-TB-B65U	Airgain	Omni	4.0	4.3	5150 – 5250 5725 - 5850

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 4x10/100/1000 Ethernet (maximum cable length 100m) – RJ-45
2. 1x10/100/1000 Ethernet (maximum cable length 100m) – RJ-45
3. 2 x USB 2.0
4. 1 x dc Power Jack

3.6. Test Configurations

Testing was performed to determine the highest power level versus bit rate. The variant with the highest power was used to exercise the product.

Matrix of test configurations

Operational Mode(s) (802.11)	Variant	Data Rates with Highest Power	Frequencies (MHz)
5150-5250	Legacy	6 MBit/s	5180, 5200, 5240
	HT-20	6.5 MBit/s	
	HT-40	45 MBit/s	5190, 5230
	ac-80	29.3 MBit/s	5210

5725-5850	Legacy	6 MBit/s	5745, 5785, 5825
	HT-20	6.5 MBit/s	
	HT-40	45 MBit/s	5755, 5795
	ac-80	29.3 MBit/s	5775

Spurious Emission and Band-Edge Test Strategy, Bands 5,150 – 5250

Frequency Band	11a	11n HT-20	11n HT-40	11n ac-40	11n ac-80
5150-5250 MHz	SE 5180				
	SE 5200				
	SE 5240				
	BE 5150	BE 5150	BE 5150	BE 5150	BE 5150

5725-5850 MHz	SE 5745				
	SE 5785				
	SE 5825				
	BE 5460	BE 5460	BE 5460	BE 5460	BE 5460

KEY:-

SE – Spurious Emissions

BE – Band-Edge

3.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. NONE

3.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

3.9. Subcontracted Testing or Third Party Data

1. NONE

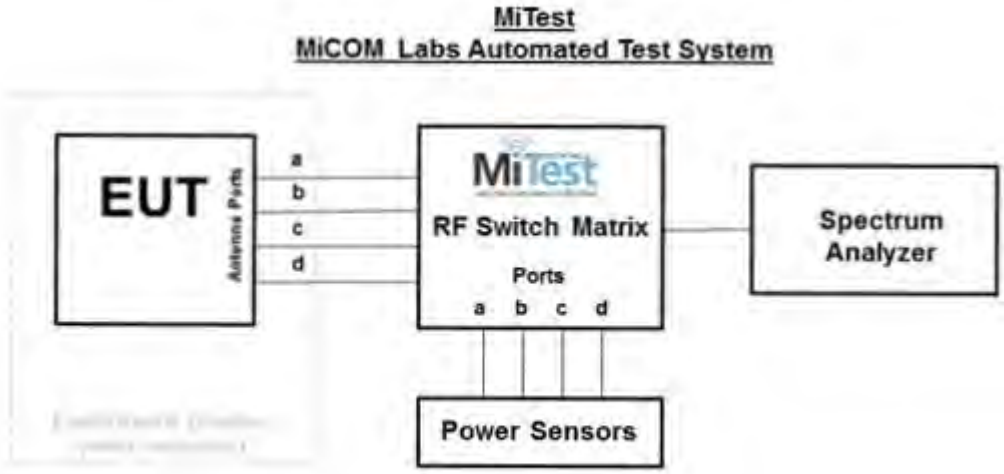
4. TESTING EQUIPMENT CONFIGURATION(S)

4.1. Conducted RF Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.1.1. 26 dB and 99% Bandwidth
2. Section 6.1.1.2. Maximum Conducted Output Power
3. Section 6.1.1.3. Peak Power Spectral Density

Conducted Test Set-Up Pictorial Representation



Conducted Test Measurement Setup

Traceability of Test Equipment Utilized for Conducted Testing

Asset#	Description	Manufacturer	Model #	Serial #	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	04 Dec 2015
193	Receiver 20 Hz to 7 GHz	Rhode & Schwarz	ESI 7	838496/007	14 Jan 2015
249	Resistance Thermometer	Thermotronics	GR2105-02	9340 #2	30 Oct 2015
287	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100201	31 Jul 2015
361	Desktop for RF#1, Labview Software installed	Dell	Vostro 220	WS RF#1	Not Required
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	17 Jul 2015
380	4x4 RF Switch Box	MiCOM Labs	MiTest RF Switch Box	MIC001	20 Jan 2015
390	USB Power Head 50MHz - 24GHz -60 to +20dBm	Agilent	U2002A	MY50000103	17 Oct 2015
398	Test Software	MiCOM	MiTest ATS	Version 1.9	Not Required
405	DC Power Supply 0-60V	Agilent	6654A	MY4001826	Cal when used
408	USB to GPIB interface	National Instruments	GPIB-USB HS	14C0DE9	Not Required
440	USB Wideband Power Sensor	Boonton	55006	9178	25 Sep 2015
441	USB Wideband Power Sensor	Boonton	55006	9179	25 Sep 2015
442	USB Wideband Power Sensor	Boonton	55006	9181	25 Sep 2015
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
75	Environmental Chamber	Thermatron	SE-300-2-2	27946	28 Nov 2015
RF#1 GPIB#1	GPIB cable to Power Supply	HP	GPIB	None	Not Required
RF#1 SMA#1	EUT to Mitest box port 1	Flexco	SMA Cable port1	None	20 Jan 2015
RF#1 SMA#2	EUT to Mitest box port 2	Flexco	SMA Cable port2	None	20 Jan 2015
RF#1 SMA#3	EUT to Mitest box port 3	Flexco	SMA Cable port3	None	20 Jan 2015
RF#1 SMA#4	EUT to Mitest box port 4	Flexco	SMA Cable port4	None	20 Jan 2015
RF#1 SMA#SA	Mitest box to SA	Flexco	SMA Cable SA	None	20 Jan 2015
RF#1 USB#1	USB Cable to Mitest Box	Dynex	USB Cable	None	Not Required

Measurement and Presentation of Test Data

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

Test and report automation was performed by MiTest. MiTest is an automated test system developed by MiCOM Labs. MiTest is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.

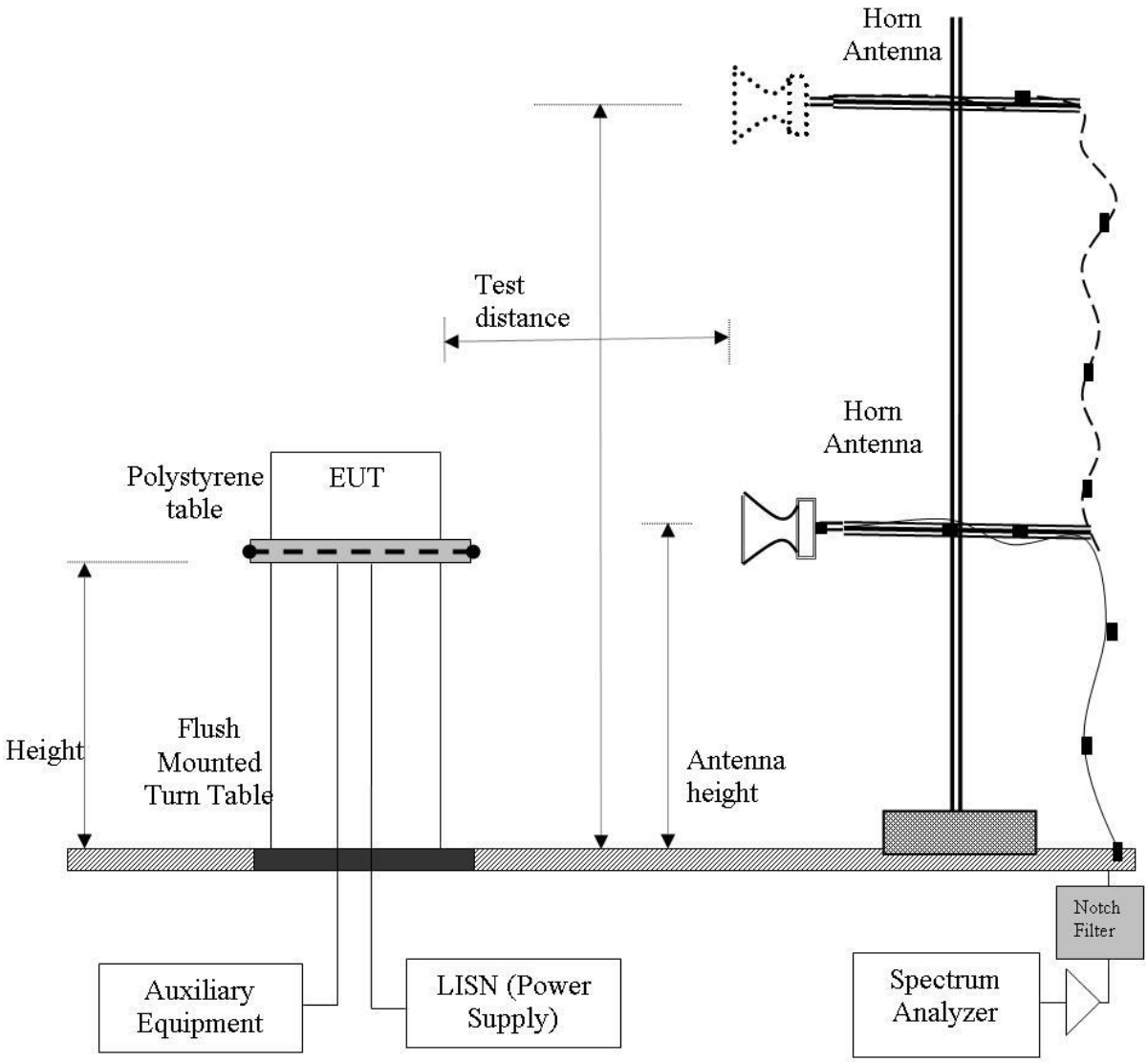
The MiCOM Labs "***MiTest***" Automated Test System" (Patent Pending)

4.2. Radiated Spurious Emission Test Set-up > 1 GHz

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.2.1

Radiated Emission Measurement Setup – Above 1 GHz

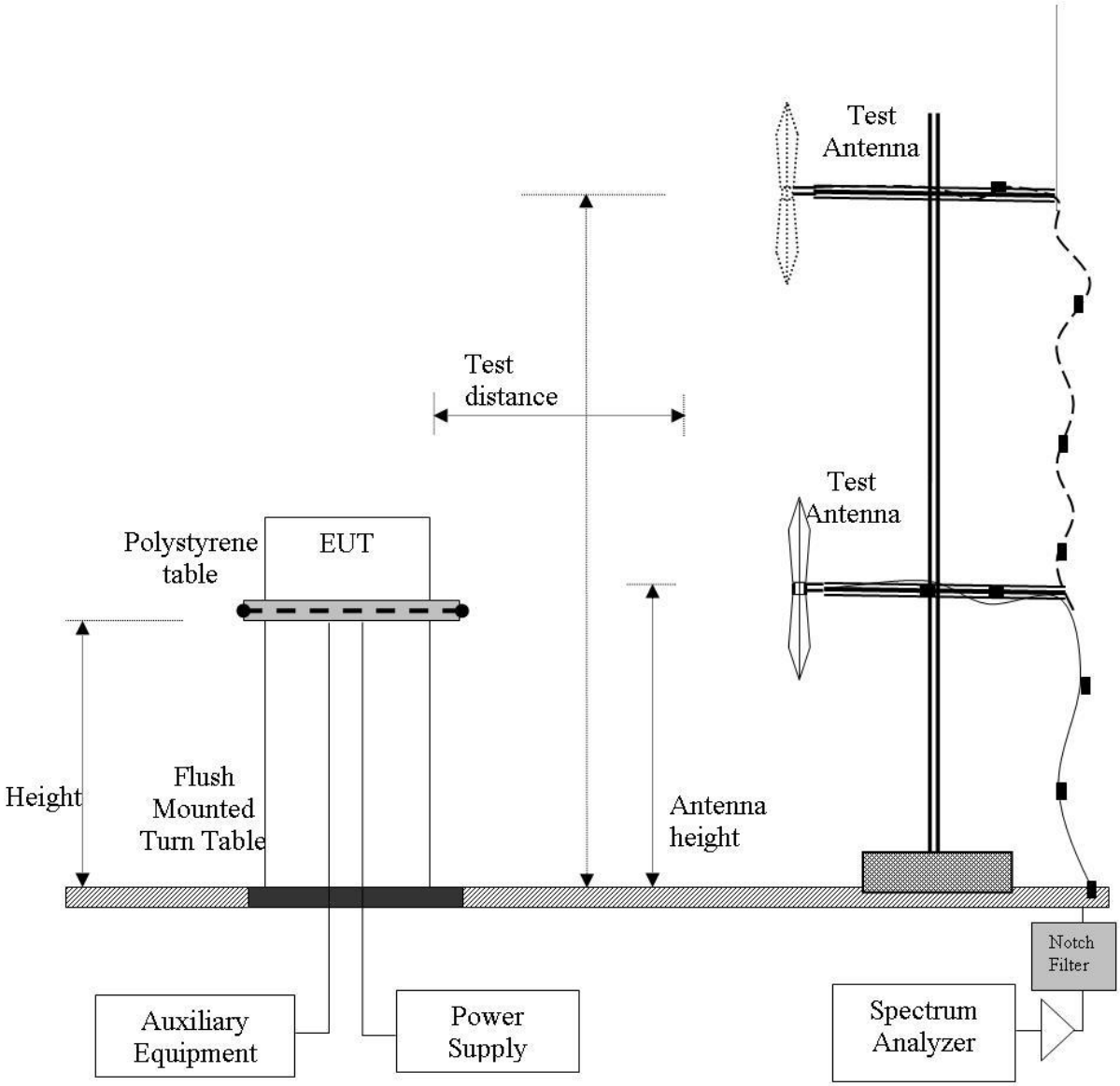


4.3. Digital Emissions Test Set-up (0.03 – 1 GHz)

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.2.2

Digital Emission Measurement Setup – Below 1 GHz



Traceability of Test Equipment Utilized for Radiated Emission Testing

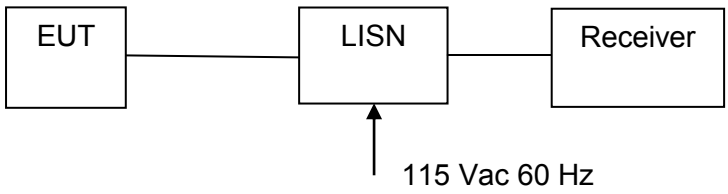
Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	04 Dec 2015
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CY101	04R08507	Not Required
287	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100201	31 Jul 2015
301	5470 to 5725 MHz Notch Filter	Microtronics	RBC50704	001	08 Oct 2015
302	5150 to 5350 MHz Notch Filter	Microtronics	BRC50703	002	08 Oct 2015
303	5725 to 5875 MHz Notch filter	Microtronics	BRC50705	003	08 Oct 2015
310	SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001	30 Oct 2015
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	14 Aug 2015
342	2.4 GHz Notch Filter	EWT	EWT-14-0203	H1	08 Oct 2015
343	5.15 GHz Notch Filter	EWT	EWT-14-0200	H1	08 Oct 2015
344	5.35 GHz Notch Filter	EWT	EWT-14-0201	H1	08 Oct 2015
345	5.46 GHz Notch Filter	EWT	EWT-14-0202	H1	08 Oct 2015
377	Band Rejection Filter 5150 to 5880MHz	Microtronics	BRM50716	034	08 Oct 2015
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	07 Oct 2015
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	23 Oct 2015
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	10 Oct 2015
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	30 May 2015
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
414	DC Power Supply 0-60V	HP	6274	1029A01285	Cal when used
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
416	Gigabit ethernet filter	ETS-Lingren	Gigafoil 260366	None	Not Required
502	Test Software for Radiated Emissions	EMISoft	Vasona	Version 5 Build 59	Not Required
87	Uninterruptible Power Supply	Falcon Electric	ED2000-1/2LC	F3471 02/01	Cal when used

4.4. ac Wireline Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.3 ac Wireline Conducted Emissions

Conducted Test Set-Up Pictorial Representation



Measurement set up for ac Wireline Conducted Emissions Test

Traceability of Test Equipment Utilized for ac Wireline Emission Testing

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	04 Dec 2015
184	Pulse Limiter	Rhode & Schwarz	ESH3Z2	357.8810.52	Cal when used
190	LISN (two-line V-network)	Rhode & Schwarz	ESH3Z5	836679/006	12 Sep 2015
193	Receiver 20 Hz to 7 GHz	Rhode & Schwarz	ESI 7	838496/007	14 Jan 2015
307	BNC-CABLE	Megaphase	1689 1GVT4	15F50B002	Cal when used
316	Dell desktop computer workstation with Vasona	Dell	Desktop	WS04	Not Required

5. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the FCC CFR47 Part 15.407

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(a)	26dB and 99% Emission BW	Emission bandwidth measurement	Conducted	Complies	6.1.1.1 A.1.1
15.407(a)	Maximum Conducted Output Power	Power Measurement	Conducted	Complies	6.1.1.2
15.407(a)	Peak Power Spectral Density	PPSD	Conducted	Complies	6.1.1.3 A.1.2
15.407(g) 15.31	Frequency Stability	Limits: contained within band of operation at all times.	Applicant declaration	Complies	6.1.1.5
15.407(f)	Radio Frequency Radiation Exposure	Exposure to radio frequency energy levels, Maximum Permissible Exposure (MPE)	Conducted	See included MPE exhibit	--

List of Measurements (continued)

The following table represents the list of measurements required under the FCC CFR47 Part 15.407

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(b)(2) 15.205(a) 15.209(a)	Radiated Emissions		Radiated		6.1.2
	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz		Complies	*6.1.2.1* *6.1.2.2* *6.1.2.3*
	Radiated Band Edge	Band edge results		Complies	*6.1.2.1* *6.1.2.2* *6.1.2.3*
15.407(b)(6) 15.205(a) 15.209(a)	Radiated Emissions	Emissions <1 GHz (30M-1 GHz)		Complies	*6.1.2.4*
15.407(b)(6) 15.207	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies	6.1.3

Note 1: Test results reported in this document relate only to the items tested

Note 2: The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria

Note 3: Section 3.7 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix

6. TEST RESULTS

6.1. Device Characteristics

6.1.1. Conducted Testing

6.1.1.1. 26 dB and 99 % Bandwidth

Conducted Test Conditions for 26 dB and 99% Bandwidth			
Standard:	FCC CFR 47:15.407	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	26 dB and 99 % Bandwidth	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.407 (a)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	KDB 789033 - D01 DTS General UNII Test Procedures v01		

Test Procedure for 26 dB and 99% Bandwidth Measurement

The bandwidth at 26 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. KDB 789033 Section 5.1 Emission Bandwidth was used in order to prove compliance. The Resolution Bandwidth was set to approximately 1% of the emission bandwidth.

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5180.0	24.248	25.752	21.944	24.449	25.752	21.944		
5200.0	23.848	24.950	21.643	24.048	24.950	21.643		
5240.0	24.048	24.850	21.643	24.950	24.950	21.643		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5180.0	16.733	16.934	16.733	16.834	16.934	16.733		
5200.0	16.733	16.934	16.733	16.834	16.934	16.733		
5240.0	16.733	16.934	16.733	16.834	16.934	16.733		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5210.0	121.443	119.840	103.808	119.840	121.443	103.808		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5210.0	76.553	76.553	76.152	76.553	76.553	76.152		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5180.0	23.547	25.050	23.347	24.850	25.050	23.347		
5200.0	24.148	24.749	23.347	25.050	25.050	23.347		
5240.0	23.447	23.347	23.246	23.146	23.447	23.146		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5180.0	18.036	18.236	18.036	18.136	18.236	18.036		
5200.0	18.136	18.136	18.036	18.136	18.136	18.036		
5240.0	18.036	18.036	18.036	18.036	18.036	18.036		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5190.0	60.922	67.134	46.293	61.924	67.134	46.293		
5230.0	53.707	57.315	46.293	57.114	57.315	46.293		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5190.0	37.275	37.275	36.874	37.275	37.275	36.874		
5230.0	37.074	37.074	36.874	36.874	37.074	36.874		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	4
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5745.0	22.144	23.046	22.044	23.146	23.146	22.044		
5785.0	22.244	22.846	22.244	23.447	23.447	22.244		
5825.0	22.345	22.745	22.144	22.745	22.745	22.144		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5745.0	16.733	16.834	16.733	16.834	16.834	16.733		
5785.0	16.733	16.934	16.733	16.834	16.934	16.733		
5825.0	16.733	16.834	16.733	16.733	16.834	16.733		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5775.0	82.565	82.966	82.966	82.164	82.966	82.164		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5775.0	75.752	75.752	75.752	75.752	75.752	75.752		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5745.0	23.747	23.848	23.647	24.048	24.048	23.647		
5785.0	23.747	23.848	23.647	23.848	23.848	23.647		
5825.0	24.048	23.447	23.246	23.547	24.048	23.246		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5745.0	18.036	18.136	18.136	18.136	18.136	18.036		
5785.0	18.036	18.136	18.036	18.136	18.136	18.036		
5825.0	18.036	18.136	18.136	18.036	18.136	18.036		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for 26 dB & 99% Occupied Bandwidth			
Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 26 dB Bandwidth (MHz) Port(s)				26 dB Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5755.0	43.086	42.685	43.086	42.886	43.086	42.685		
5795.0	43.086	42.886	42.886	42.886	43.086	42.886		

Test Frequency	Measured 99% Bandwidth (MHz) Port(s)				99% Bandwidth (MHz)			
MHz	**a**	**b**	**c**	**d**	**Highest**	**Lowest**		
5755.0	36.874	36.673	36.874	36.673	36.874	36.673		
5795.0	36.874	36.673	36.673	36.673	36.874	36.673		

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

6.1.1.2. Maximum Conducted Output Power

Conducted Test Conditions for Maximum Conducted Output Power			
Standard:	FCC CFR 47:15.407	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Maximum Conducted Output Power	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.407 (a)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	KDB 789033 - D01 DTS General UNII Test Procedures v01		

Test Procedure for Maximum Conducted Output Power Measurement

Method PM (Measurement using an RF average power meter). Section C) 4) of KDB 789033 defines a methodology using an average wideband power meter. Measurements were made while the EUT was operating in a continuous transmission mode (100% duty cycle) at the appropriate center frequency. All cable losses and offsets were taken into consideration in the measured result. All operational modes and frequency bands were measured independently and the resultant □ calculated. For multiple outputs, the measurements were made simultaneously on each output port and summed in a linear fashion. This technique was used in order to prove compliance.

Specification Limits for Maximum Transmit (Conducted) Power

Operating Frequency Band 5150-5250 MHz

15. 407 (a)(1)
(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

Maximum Transmit (Conducted) Power Limits

Limit 5150 – 5250 MHz: +30 dBm (+36 dBm/EIRP, 6 dBi antenna)

EUT: Indoor wireless router
Antenna gain: 4.0 dBi
Beamforming Gain: 4.3 dB

Maximum conducted power = +30 – (4.0 + 4.3 – 6) = +27.7 dBm

Operating Frequency Band 5725 – 5850 MHz

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. 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. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

Maximum Transmit (Conducted) Power Limits

Limit non-Point to Point Operation: +30 dBm (+36 dBm/EIRP, 6 dBi antenna)

Limit Point to Point Operation: +30 dBm (unlimited EIRP)

EUT: Indoor wireless router
Antenna gain: 4.0 dBi
Beamforming Gain: 3.5 dB

Maximum conducted power = +30 – (4.0 + 3.5 – 6) = +28.5 dBm

Equipment Configuration for Peak Transmit Power			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5180.0	21.61	20.61	20.72	20.93	27.05	N/A	27.7	-0.65	22.00
5200.0	21.23	20.02	20.34	21.27	26.81	N/A	27.7	-0.89	21.00
5240.0	21.58	20.76	20.79	21.65	27.28	N/A	27.7	-0.42	20.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5210.0	21.85	21.2	21.36	22.02	27.68	N/A	27.7	-0.02	21.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power

Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5180.0	21.49	20.93	20.57	21.12	27.10	N/A	27.7	-0.60	22.00
5200.0	20.89	20.42	20.4	20.91	26.73	N/A	27.7	-0.97	21.00
5240.0	21.33	20.6	20.58	21.5	27.09	N/A	27.7	-0.61	20.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power

Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5190.0	21.44	20.26	20.97	21.38	27.10	N/A	27.7	-0.60	21.00
5230.0	22.04	19.93	21.03	22.00	27.40	N/A	27.7	-0.30	20.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	3.50
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5745.0	21.33	21.01	21.94	22.33	27.75	N/A	28.5	-0.75	15.00
5785.0	22.43	21.54	22.55	22.79	28.42	N/A	28.5	-0.08	15.00
5825.0	21.98	21.01	22.04	22.5	27.98	N/A	28.5	-0.52	14.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power			
Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	3.50
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5775.0	21.44	21.2	21.64	21.99	27.75	N/A	28.5	-0.75	14.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power			
Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	3.50
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5745.0	21.50	21.25	21.62	22.27	27.74	N/A	28.5	-0.76	15.00
5785.0	22.43	21.71	22.19	22.77	28.36	N/A	28.5	-0.14	15.00
5825.0	22.29	21.23	21.87	22.43	28.04	N/A	28.5	-0.46	14.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Transmit Power			
Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	3.50
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Conducted Output Power (dBm) Port(s)				Calculated Total Power	Minimum 26 dB Bandwidth	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s) dBm	MHz	dBm	dBm	
5755.0	22.09	21.45	22.2	22.49	28.20	N/A	28.5	-0.30	15.00
5795.0	21.7	21.1	21.72	22.1	27.80	N/A	28.5	-0.70	14.00

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

6.1.1.3. Peak Power Spectral Density

Conducted Test Conditions for Power Spectral Density			
Standard:	FCC CFR 47:15.407	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Power Spectral Density	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	KDB 789033 - D01 DTS General UNII Test Procedures v01		

Test Procedure for Power Spectral Density

The In-Band power spectral density was measured using the measure and sum approach per FCC KDB 662911 (D01 Multiple Transmitter Output v0.)

Measure and sum the spectra across the outputs. With this technique, spectra are measured at each antenna port of the device at the required resolution bandwidth. The individual spectra are then summed mathematically in linear power units. Unlike in-band power measurements, in which the sum involves a single measured value (output power) from each output, measurements for compliance with PSD limits involve summing entire spectra across corresponding frequency bins on the various outputs. Consistency is maintained for any device with N transmitter outputs to be certain the individual outputs are all aligned with the same span and same number of points. In this instance, the linear power spectrum value within the first spectral bin of output 0 is summed with that in the first spectral bin of output 1, and the first spectral bin of output 2, and so on up to the Nth output to obtain the true value for the first frequency bin of the summed spectrum. The summed spectrum value for each frequency bin is computed in this fashion. These summed spectral values were calculated within the MiTest System and a summed (∑) plot produced and included for review.

NOTE:

It may be observed that spectrum in some plots break the limit line however this in itself does NOT constitute a failure. In all cases the antenna port summation plot is provided in order to prove compliance. A summation plot adds each point for each individual output (all antenna chains assuming a MIMO device) and combines into a single graphical image. A failure occurs only after the summation of all spectrum plots have been summed and are found to be greater than the limit line.

Supporting Information

Calculated Power = A + 10 log (1/x) dBm

Where;

A = Total Power Spectral Density [10 Log10 (10(a/10) + 10(b/10) + 10(c/10) + 10(d/10)]

x = Duty Cycle

Limits

For the Power Spectral Density limits for each frequency band and different equipment technologies see Section 'Maximum Conducted Output Power'

As the antenna gain + beam-forming gain is greater than 6 dBi it can be observed in the Maximum Conducted Output Power limit is reduced therefore the Power Spectral Density follows and complies with the regulations.

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results							
Test Frequency	**Measured Power Spectral Density Port(s) (dBm/MHz)**				**Amplitude Summation + DCCF (+0.04 dB)**	**Limit**	**Margin**
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5180.0	9.901	9.340	9.229	9.324	14.432	14.7	-0.268
5200.0	10.604	9.445	9.934	10.649	14.623	14.7	-0.077
5240.0	11.205	10.205	10.448	11.037	14.468	14.7	-0.232

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results							
Test Frequency	**Measured Power Spectral Density Port(s) (dBm/MHz)**				**Amplitude Summation + DCCF (+0.13 dB)**	**Limit**	**Margin**
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5210.0	5.380	4.143	4.862	5.608	10.237	14.7	-4.5

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

DCCF - Duty Cycle Correction Factor

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.04 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5180.0	9.598	8.960	8.986	9.526	14.551	14.7	-0.1
5200.0	10.299	9.254	9.509	10.426	14.423	14.7	-0.3
5240.0	10.758	9.614	10.148	10.474	14.601	14.7	-0.1

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	4.30
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.09 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5190.0	7.612	6.101	6.666	7.948	12.694	14.7	-2.0
5230.0	8.638	6.630	8.105	9.060	13.787	14.7	-0.9

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

DCCF - Duty Cycle Correction Factor

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11a	**Duty Cycle (%):**	99.0
Data Rate:	6 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	3.50
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.04 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5745.0	10.318	9.680	10.703	11.133	15.322	15.5	-0.2
5785.0	10.586	9.240	10.352	10.544	15.235	15.5	-0.3
5825.0	9.757	8.262	9.511	9.688	15.128	15.5	-0.4

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11ac-80	**Duty Cycle (%):**	96.6
Data Rate:	29.3 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.13 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5775.0	4.443	3.870	3.071	3.928	9.672	15.5	-5.8

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

DCCF - Duty Cycle Correction Factor

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11n HT-20	**Duty Cycle (%):**	99.0
Data Rate:	6.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.04 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5745.0	9.622	9.337	9.980	10.384	15.445	15.5	-0.1
5785.0	9.897	9.298	9.424	9.950	15.490	15.5	-0.0
5825.0	9.545	8.246	9.089	9.698	14.945	15.5	-0.6

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Equipment Configuration for Peak Power Spectral Density			
Variant:	802.11n HT-40	**Duty Cycle (%):**	97.6
Data Rate:	13.5 MBit/s	**Antenna Gain (dBi):**	4.00
Modulation:	OFDM	**Beam Forming Gain (Y):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	GMH
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density Port(s) (dBm/MHz)				Amplitude Summation + DCCF (+0.09 dB)	Limit	Margin
MHz	**a**	**b**	**c**	**d**	**dBm/MHz**	**dBm/MHz**	**dB**
5755.0	6.618	5.500	6.057	6.775	11.890	15.5	-3.6
5795.0	5.870	5.261	5.796	6.162	11.667	15.5	-3.8

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

DCCF - Duty Cycle Correction Factor

Note: click the links in the above matrix to view the graphical image (plot).

6.1.1.4. Frequency Stability

FCC, Part 15 Subpart C §15.407(g)

Test Procedure

The manufacturer of the equipment is responsible for ensuring that the frequency stability is such that emissions are always maintained within the band of operation under all conditions.

Manufacturer Declaration

The frequency stability of the reference oscillator sets the frequency stability of the RF transceiver signals. Therefore all of the RF signals should have ±20ppm stability.
This stability accounts for room temp tolerance of the crystal oscillator circuit, frequency variation across temperature, and crystal ageing.

±20ppm at 5.250 GHz translates to a maximum frequency shift of ±105 KHz. As the edge of the channels is at least one MHz from either of the band edges, ±105 KHz is more than sufficient to guarantee that the intentional emission will remain in the band over the entire operating range of the EUT.

Specification

Limits

§15.407 (g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

6.1.2. Radiated Emission Testing

FCC, Part 15 Subpart C §15.407(b)(2), §15.205(a)/15.209(a)

Test Procedure
Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode. Depending on the frequency band spanned a notch filter and/or waveguide filter was used to remove the fundamental frequency.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Only the highest emissions relative to the limit are listed.

Specification

(b) *Undesirable emission limits.* Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(4) For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of −17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of −27 dBm/MHz.

(5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

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

(7) The provisions of §15.205 apply to intentional radiators operating under this section.

(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength (dBμV/m);

$$E = 1000000 \times \sqrt{30P} / 3 \text{ μV/m}$$

where P is the EIRP in Watts

Therefore: -27 dBm/MHz = 68.23 dBuV/m

Note: The data in this Section identifies that the EUT is in compliance with the -27dBm/MHz EIRP limit (68.23 dBμV/m) for out of band emissions. All out of band emissions are less than 68.23 dB μV/m.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR – FO

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

Field Strength Calculation Example:

Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

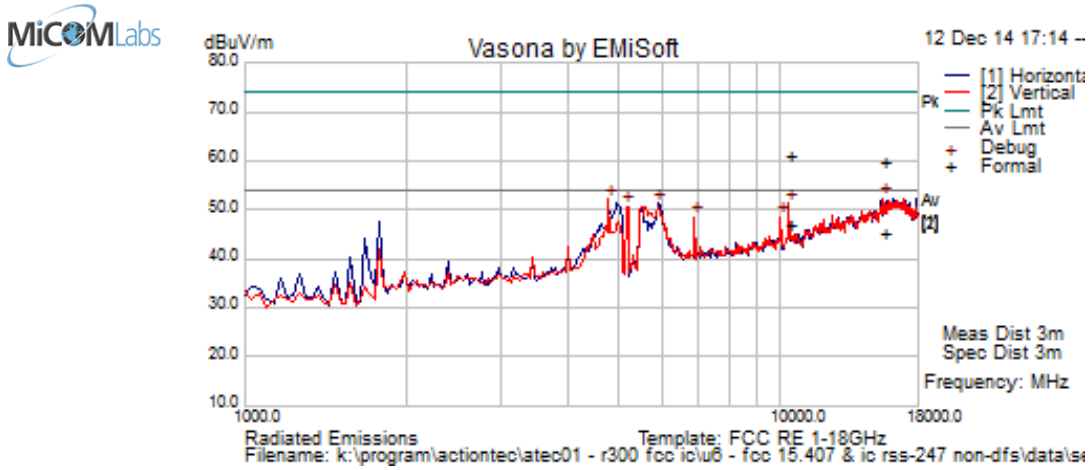
Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

6.1.2.1. Spurious Emissions

Test Freq.	5180 MHz	**Engineer**	GMH
Variant	802.11a; 6 Mbs	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	21	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			

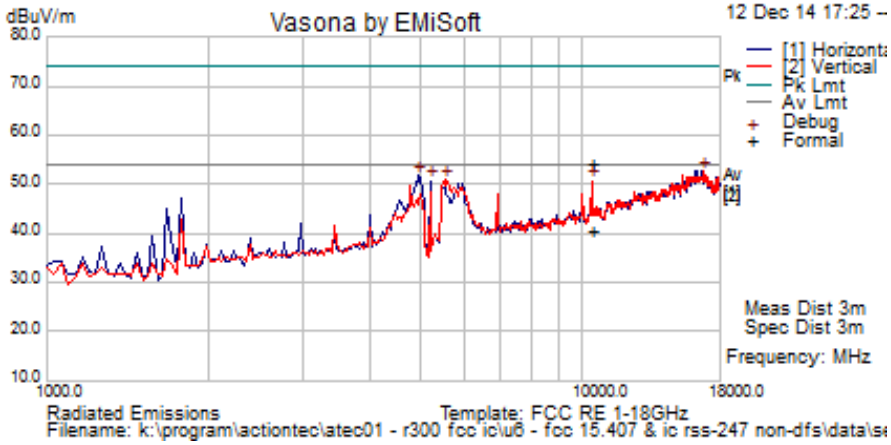


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail	Comments
15528.040	48.8	11.4	-0.6	59.6	Peak Max	V	128	111	74.0	-14.4	Pass	
10361.668	57.3	8.9	-5.3	60.9	Peak Max	V	123	8	74.0	-13.1	Pass	
15528.040	34.2	11.4	-0.6	45.0	Average Max	V	128	111	54	-9.0	Pass	
10361.668	43.1	8.9	-5.3	46.8	Average Max	V	123	8	54	-7.2	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	5200 MHz	**Engineer**	GMH
Variant	802.11a; 6 Mbs	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	21	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			

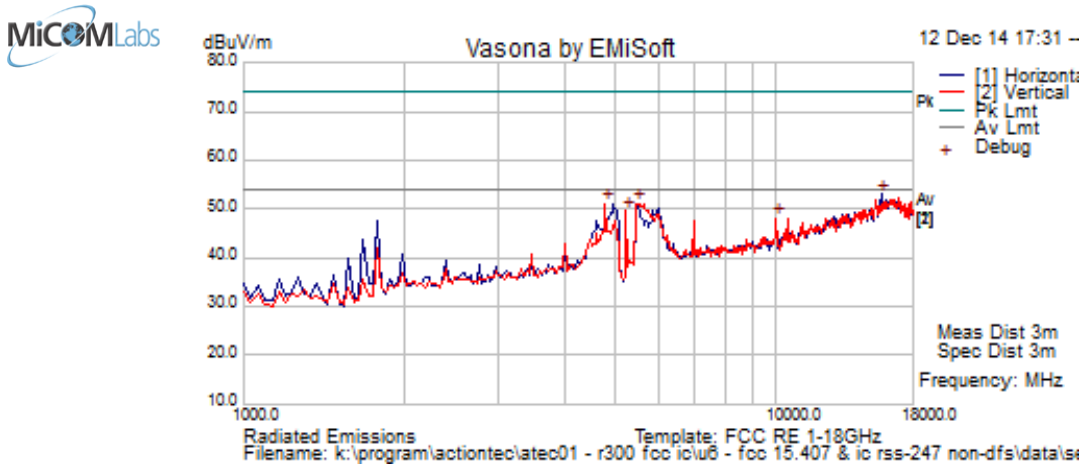


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail	Comments
10398.920	50.1	9.0	-5.0	54.0	Peak Max	V	99	240	74.0	-20.0	Pass	
10398.92	36.6	9.0	-5.0	40.5	Average Max	V	99	240	54.0	-13.5	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	5240 MHz	**Engineer**	GMH
Variant	802.11a; 6 Mbs	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	20	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			

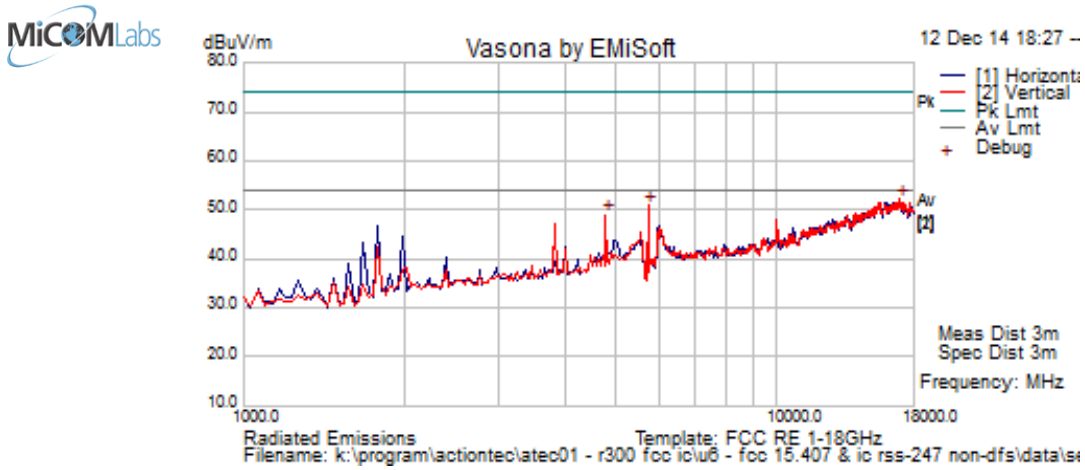


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail	Comments
15717.435	41.2	11.6	0.2	53.0	Peak [Scan]	H	150	0	54.0	-1.0	Pass	Noise
5496.99399	56.2	6.1	-11.2	51.2	Peak [Scan]	H	100	0	54.0	-2.8	Pass	
4781.563	56.6	5.6	-11.1	51.1	Peak [Scan]	V	100	0	54	-2.9	Pass	
5224.449	55.1	5.9	-11.4	49.6	Peak [Scan]	V	200	0	54	-4.4	Pass	
9993.988	44.7	8.7	-5.2	48.2	Peak [Scan]	V	100	0	54	-5.8	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	5745 MHz	**Engineer**	GMH
Variant	802.11a; 6 Mbs	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	17	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			

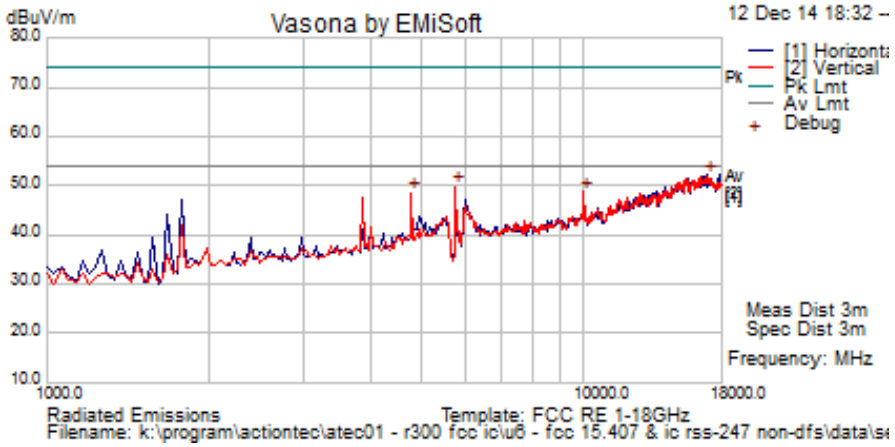


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail	Comments
17012.024	39.0	12.4	0.8	52.2	Peak [Scan]	V	100	0	54.0	-1.8	Pass	Noise
5735.47094	55.4	6.2	-10.7	51.0	Peak [Scan]	V	100	0	54.0	-3.0	Pass	FUND
4781.563	54.4	5.6	-11.1	48.9	Peak [Scan]	V	100	0	54	-5.1	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	5785 MHz	**Engineer**	GMH
Variant	802.11a; 6 Mbs	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	16	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			

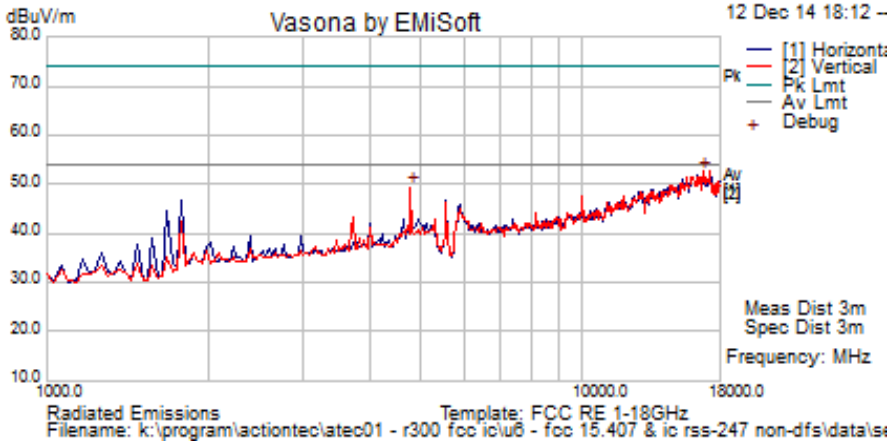


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17012.024	39.0	12.4	0.8	52.2	Peak [Scan]	H	150	0	54.0	-1.8	Pass	Noise
5769.53908	54.1	6.3	-10.5	49.8	Peak [Scan]	V	100	0	54.0	-4.2	Pass	Fund
9993.988	45.2	8.7	-5.2	48.7	Peak [Scan]	V	100	0	54	-5.3	Pass	
4781.563	54.1	5.6	-11.1	48.6	Peak [Scan]	V	100	0	54	-5.4	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	5825 MHz	**Engineer**	GMH
Variant	802.11a 6 Mbit/s	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	61
Power Setting	17	**Press. (mBars)**	1001
Antenna	Integral	**Duty Cycle (%)**	99
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
16739.479	39.0	12.1	1.5	52.7	Peak [Scan]	V	100	0	54.0	-1.3	Pass	Noise
4781.56313	54.9	5.6	-11.1	49.4	Peak [Scan]	V	100	0	54.0	-4.6	Pass	

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

6.1.2.2. Band-Edge Radiated Emissions

Peak Limit 74.0 dBµV/m, Average Limit 54.0 dBµV/m

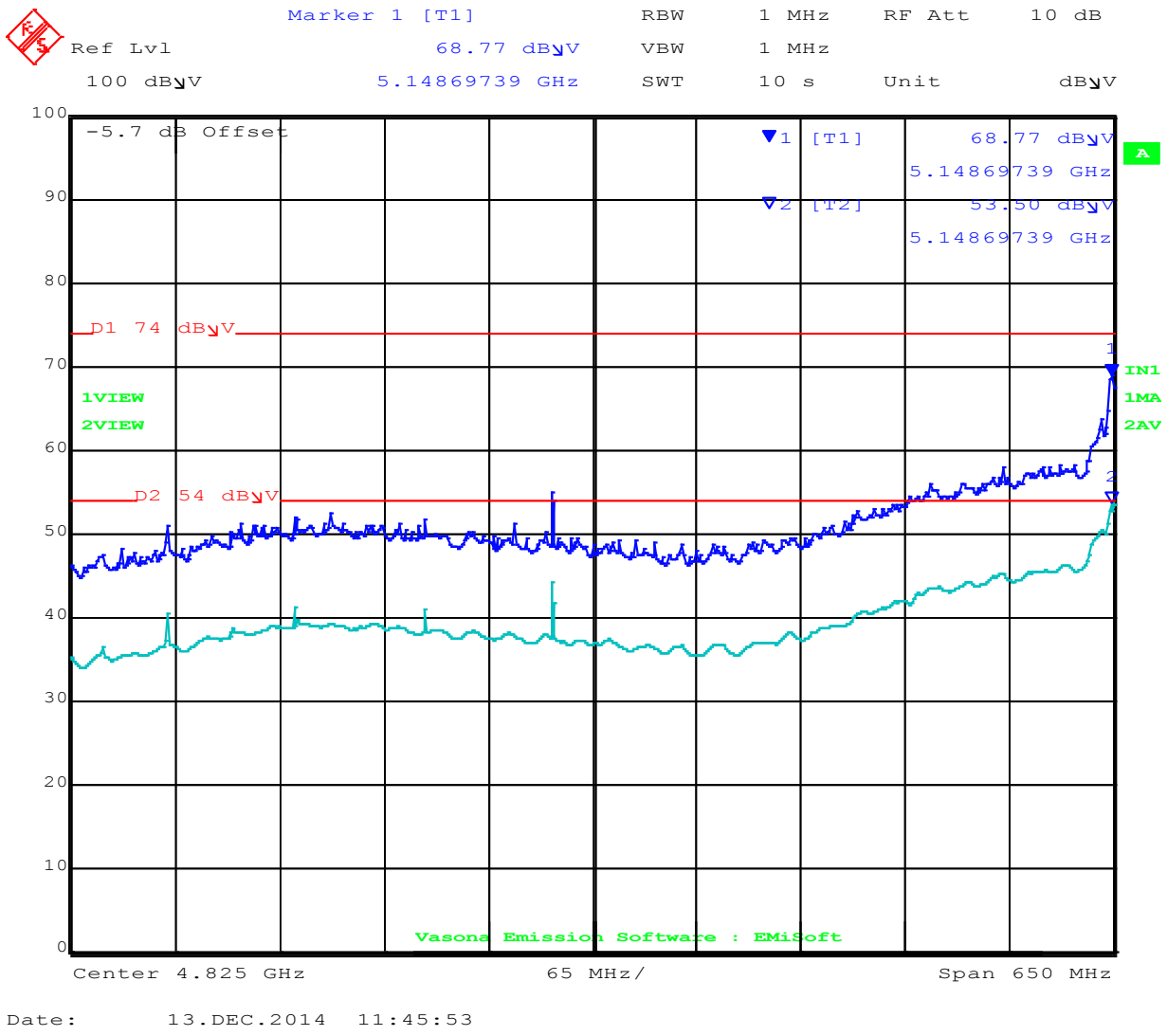
Frequency Band 5150 – 5350 MHz

	5150 MHz		
	dBµV/m		Power Setting
Operational Mode	Peak	Average	
a	68.77	53.50	20
n HT-20	67.71	53.53	20
n HT-40	67.73	52.63	18
ac-80	67.71	53.53	15

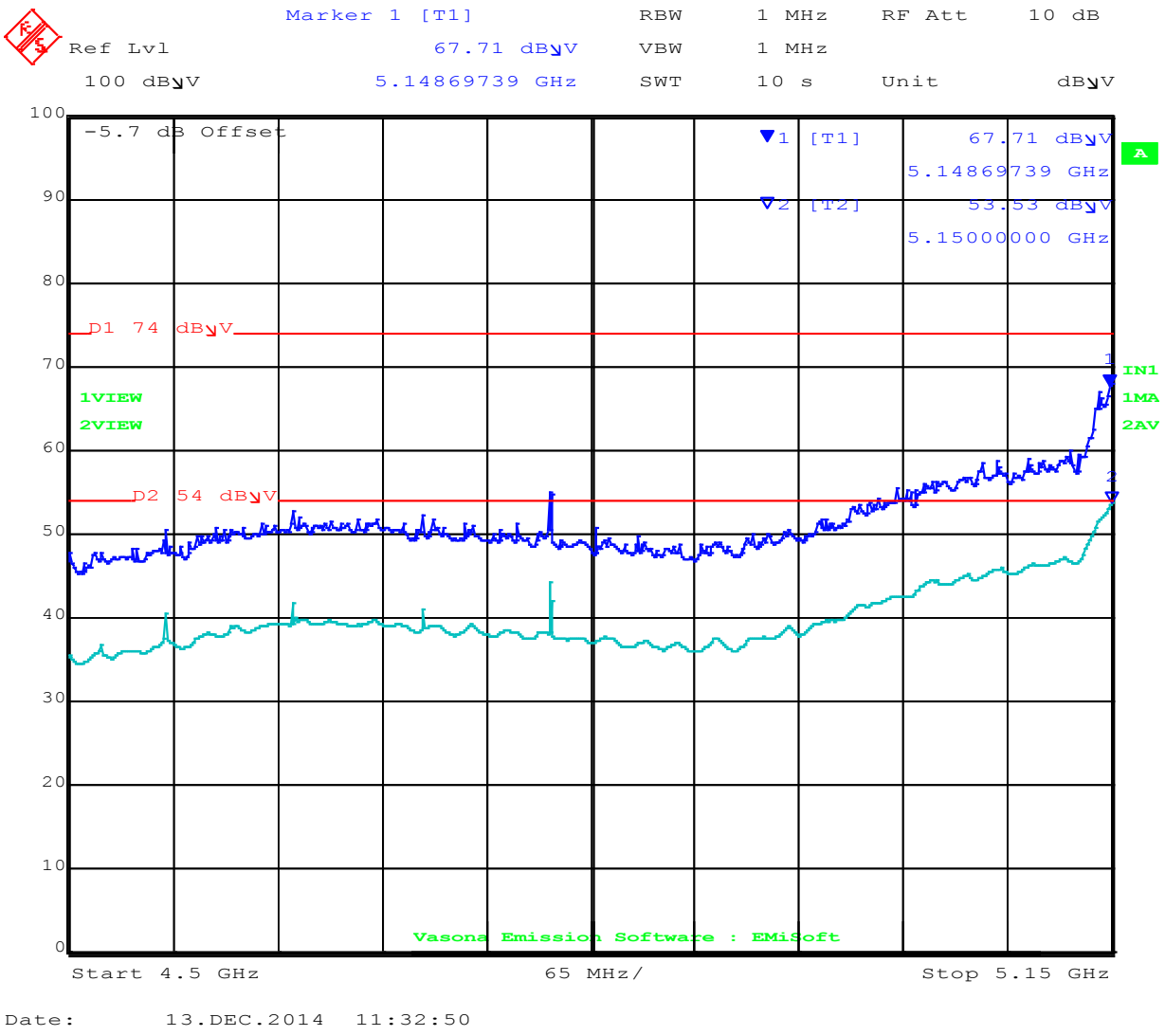
Frequency Band 5725 – 5850 MHz

	5725 MHz		5850 MHz	
Operational Mode	Limit -27 dBm\EIRP	Power Setting	Limit -27 dBm\EIRP	Power Setting
a	-36.53	17	-37.96	15
n HT-20	-36.16	17	-37.96	15
n HT-40	-36.53	15	-37.96	14
ac-80	-36.53	16	-37.96	16

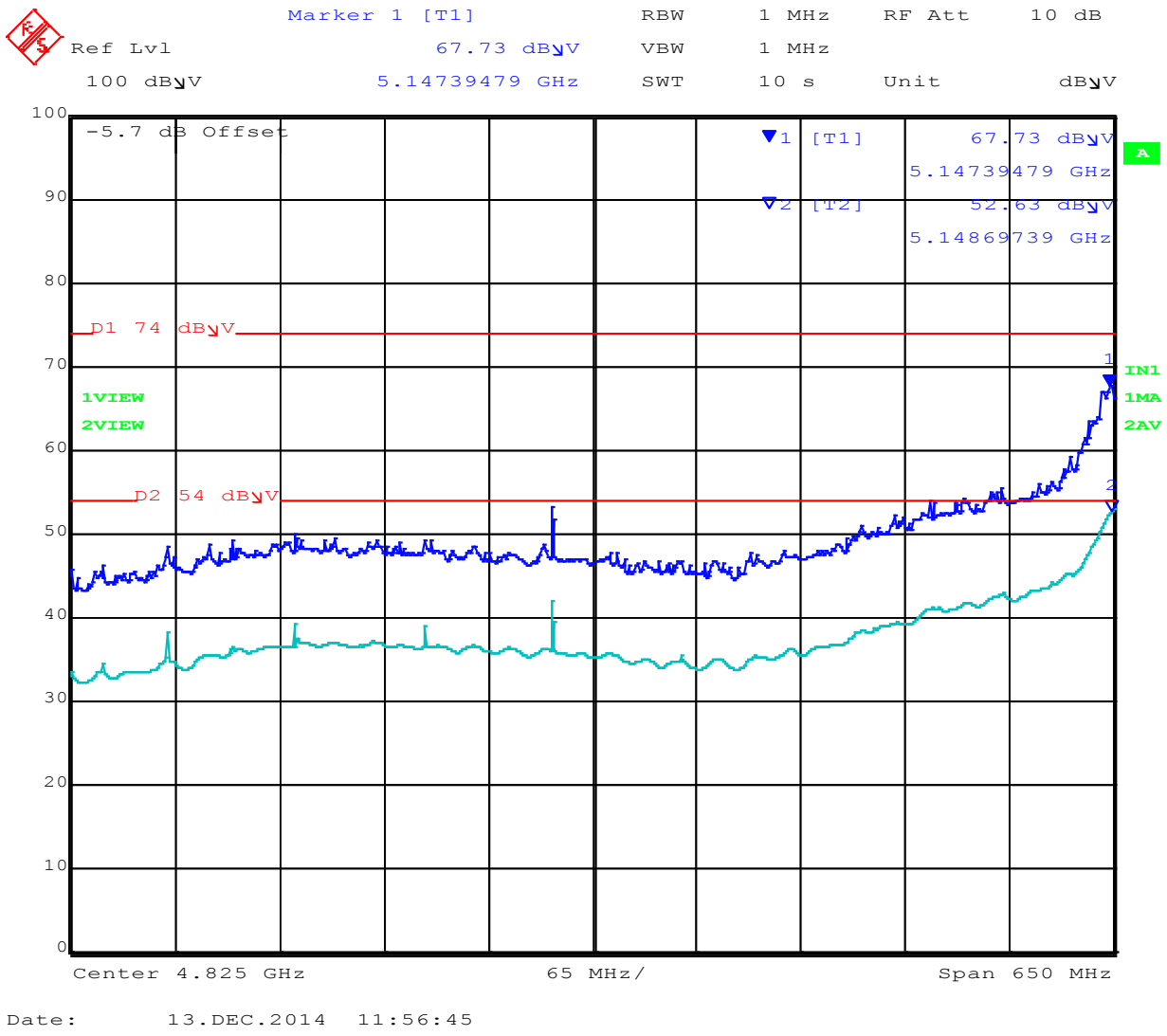
5150 – 5250 MHz 802.11a - 5150 MHz Band-Edge Emissions



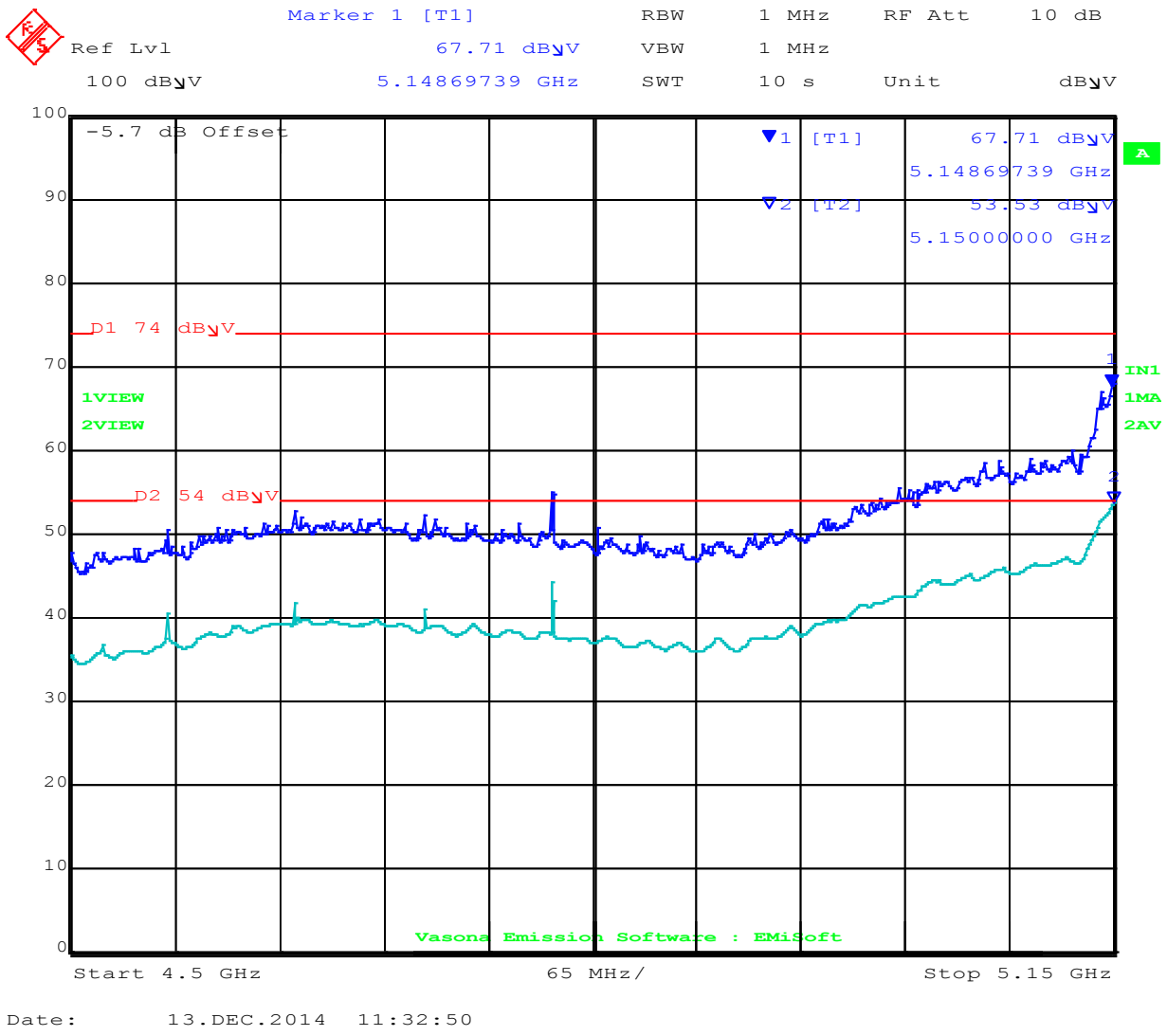
5150 – 5250 MHz 802.11n HT-20 - 5150 MHz Band-Edge Emissions



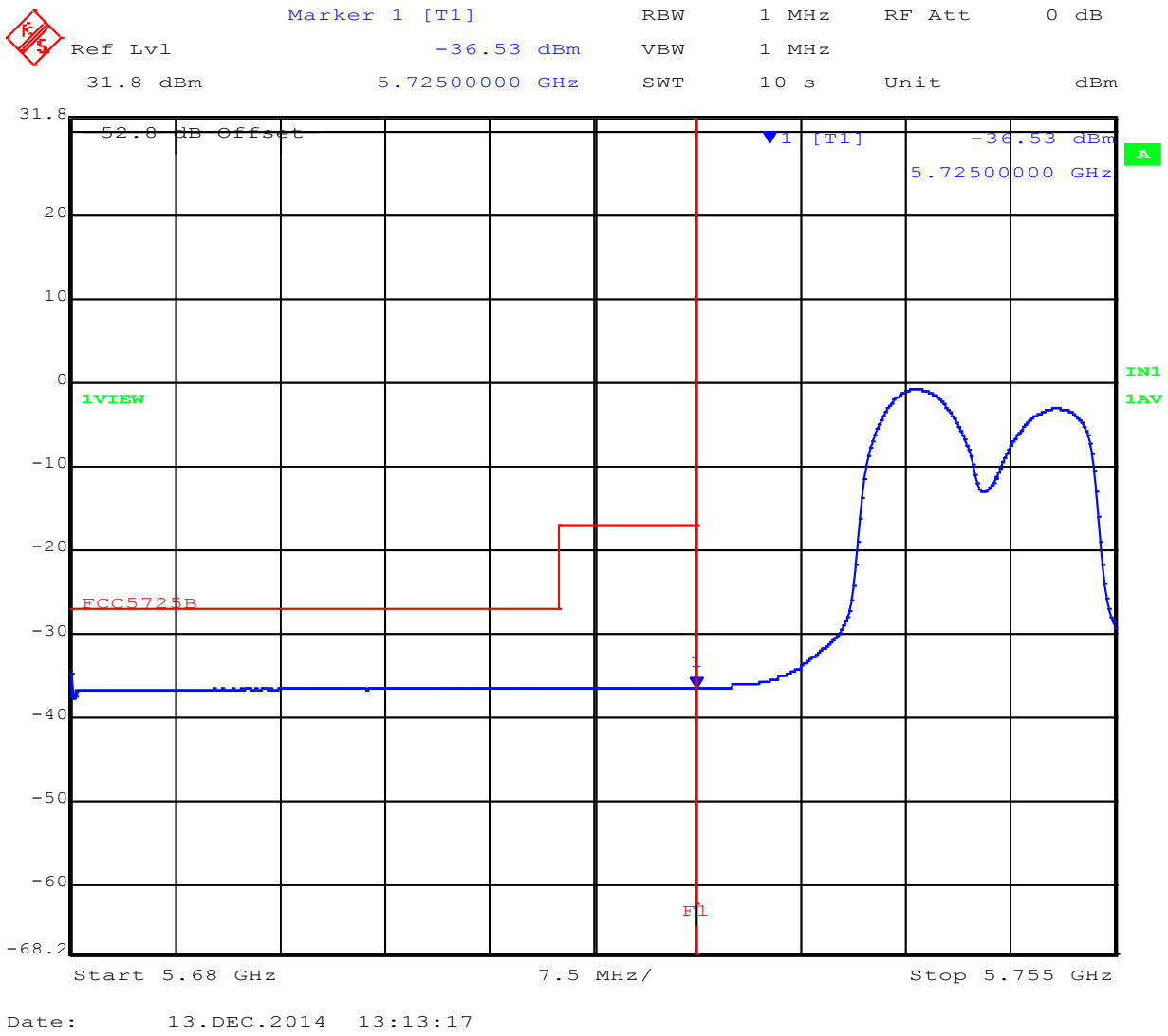
5150 – 5250 MHz 802.11n HT-40 - 5150 MHz Band-Edge Emissions



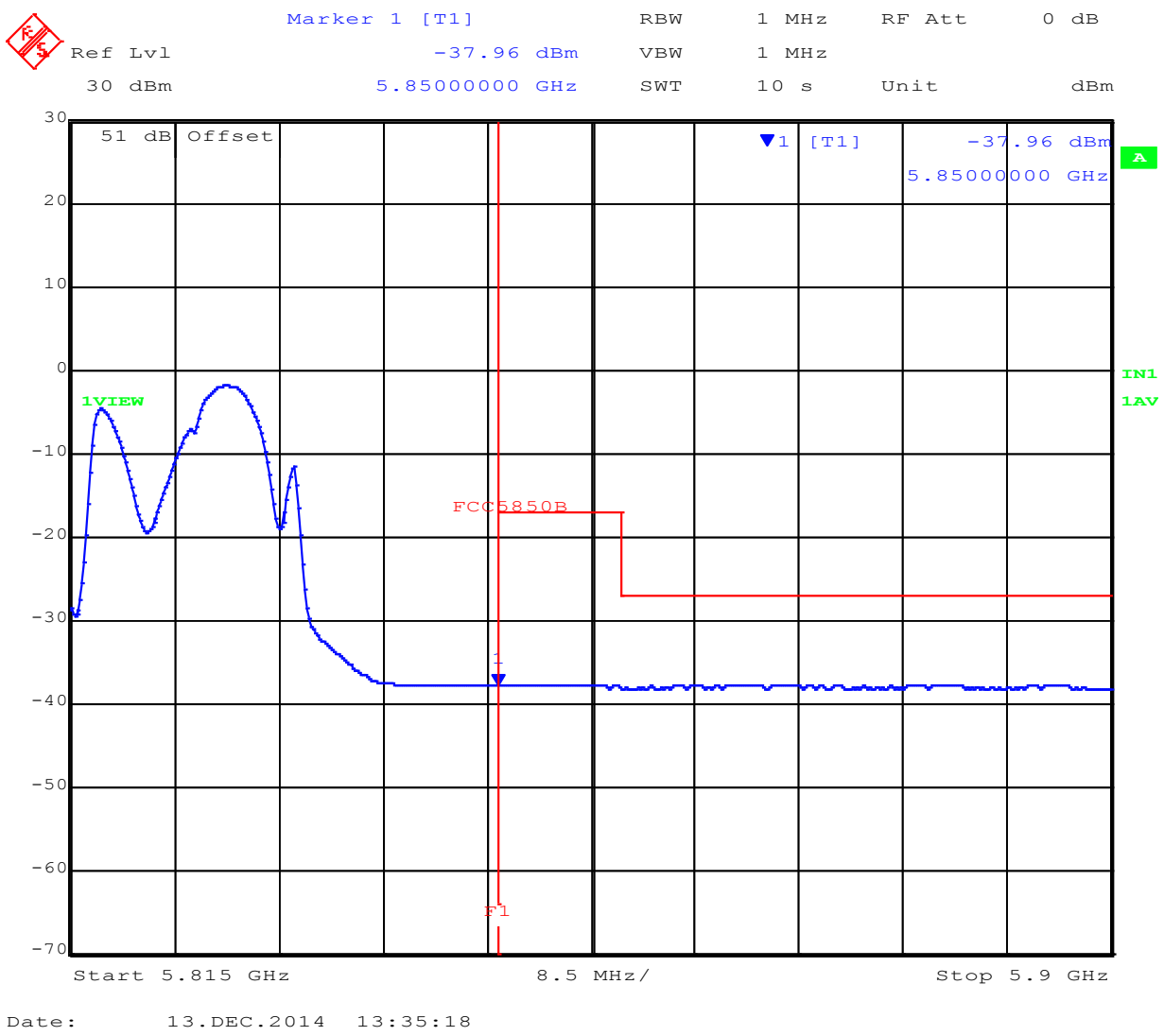
5150 – 5250 MHz 802.11ac-80 - 5150 MHz Band-Edge Emissions



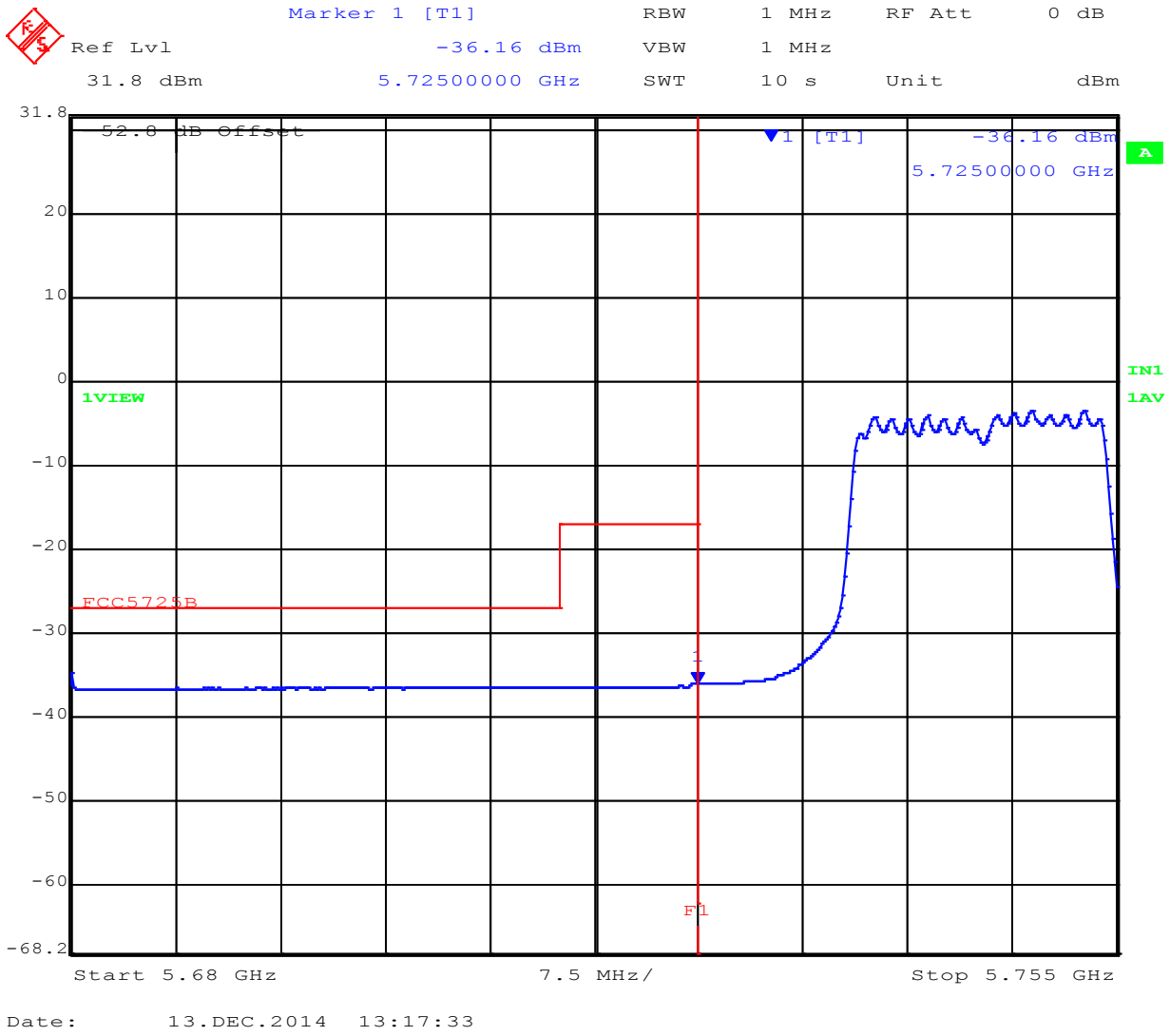
5725 – 5850 MHz 802.11a - 5725 MHz Band-Edge Emissions



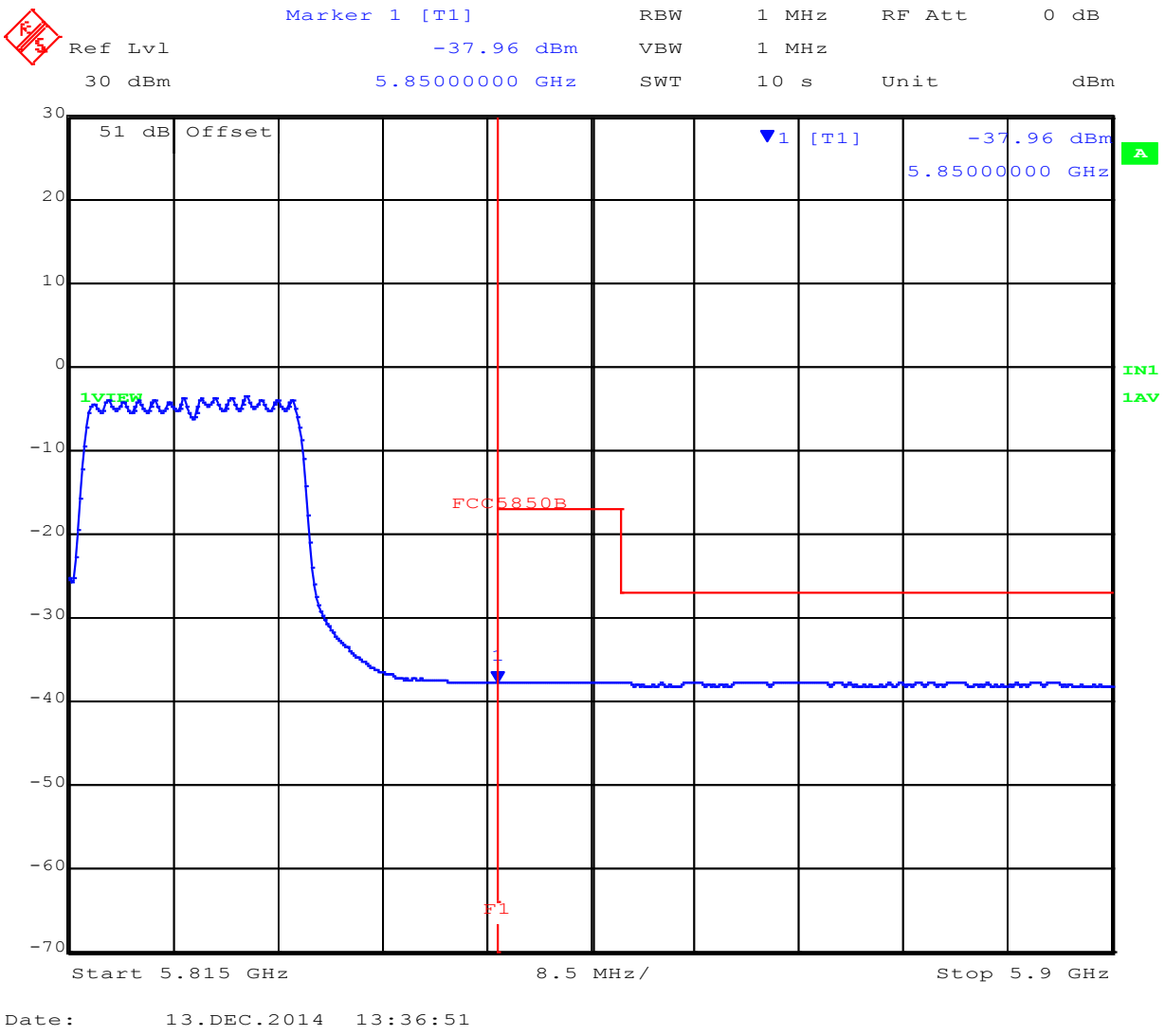
5725 – 5850 MHz 802.11a - 5850 MHz Band-Edge Emissions



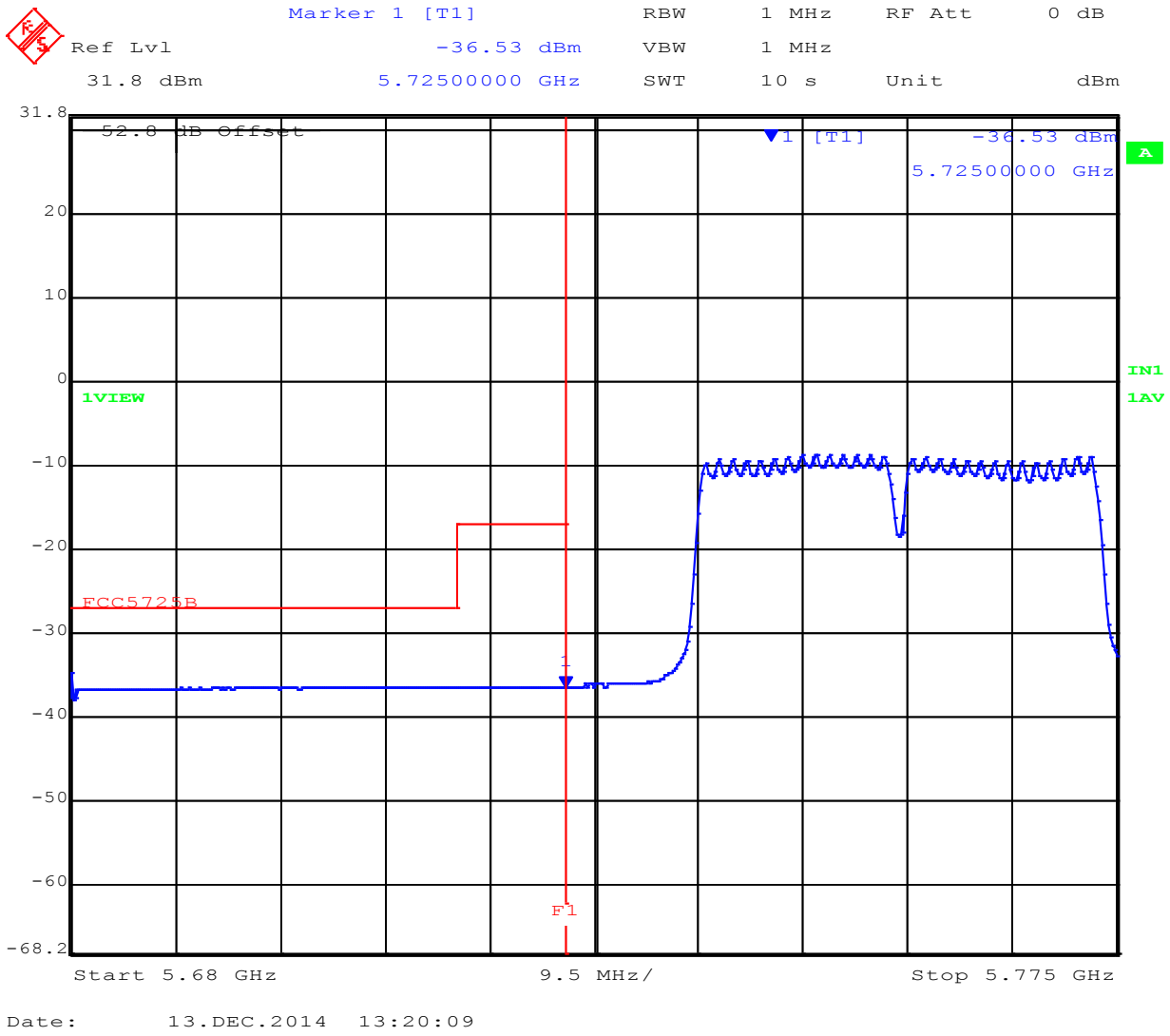
5725 – 5850 MHz 802.11n HT-20 - 5725 MHz Band-Edge Emissions



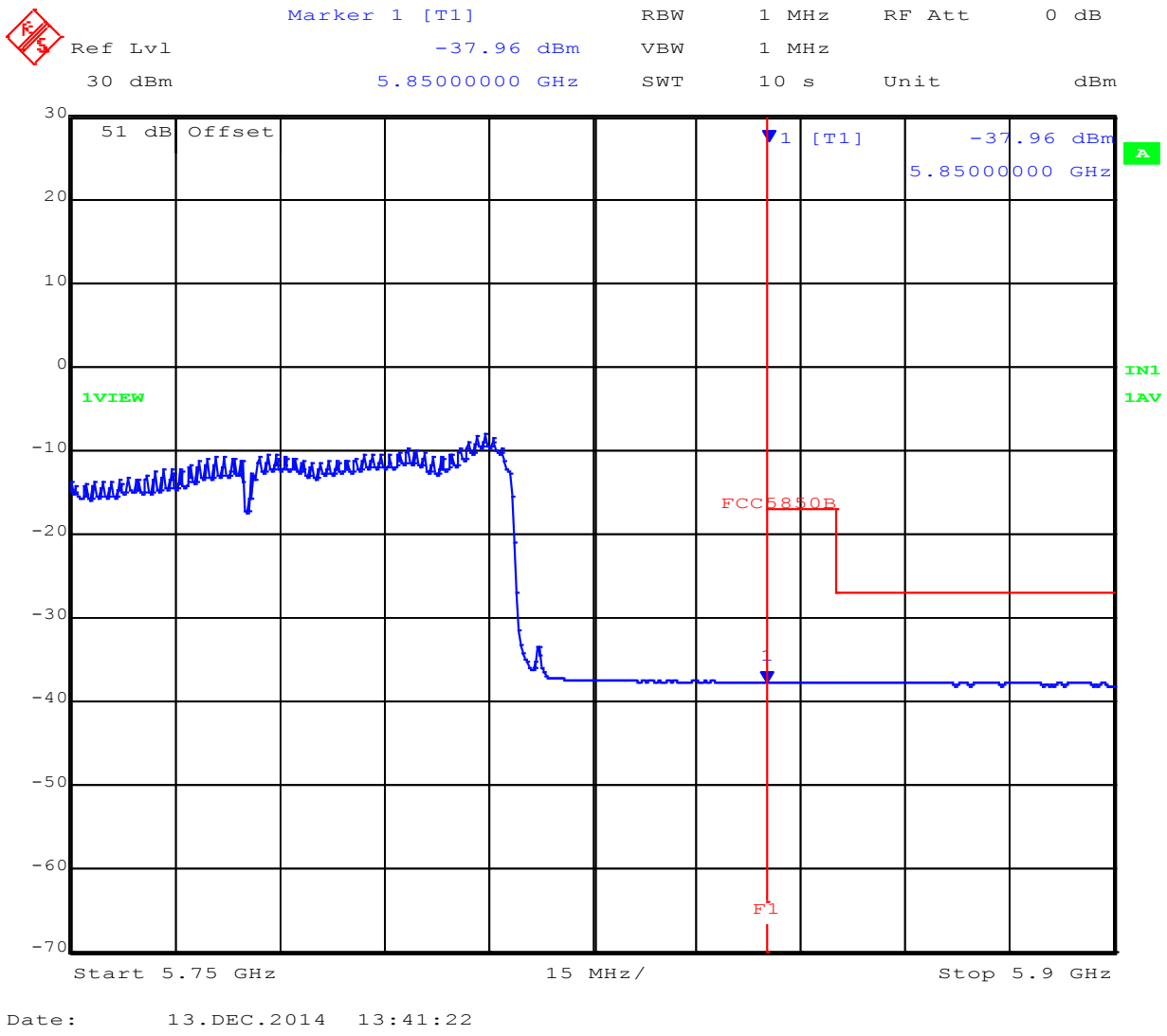
5725 – 5850 MHz 802.11n HT-20 - 5850 MHz Band-Edge Emissions



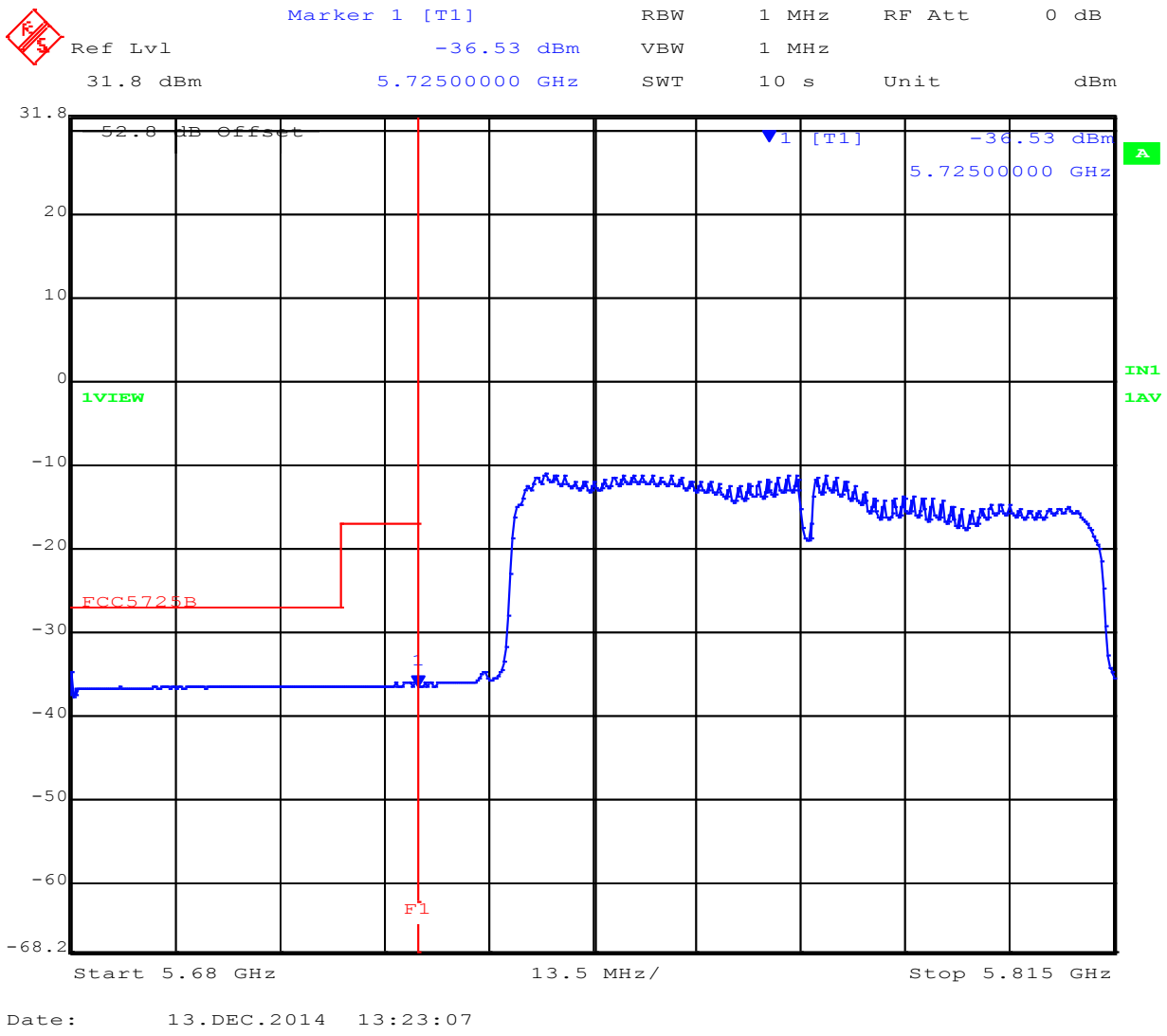
5725 – 5850 MHz 802.11n HT-40 - 5725 MHz Band-Edge Emissions



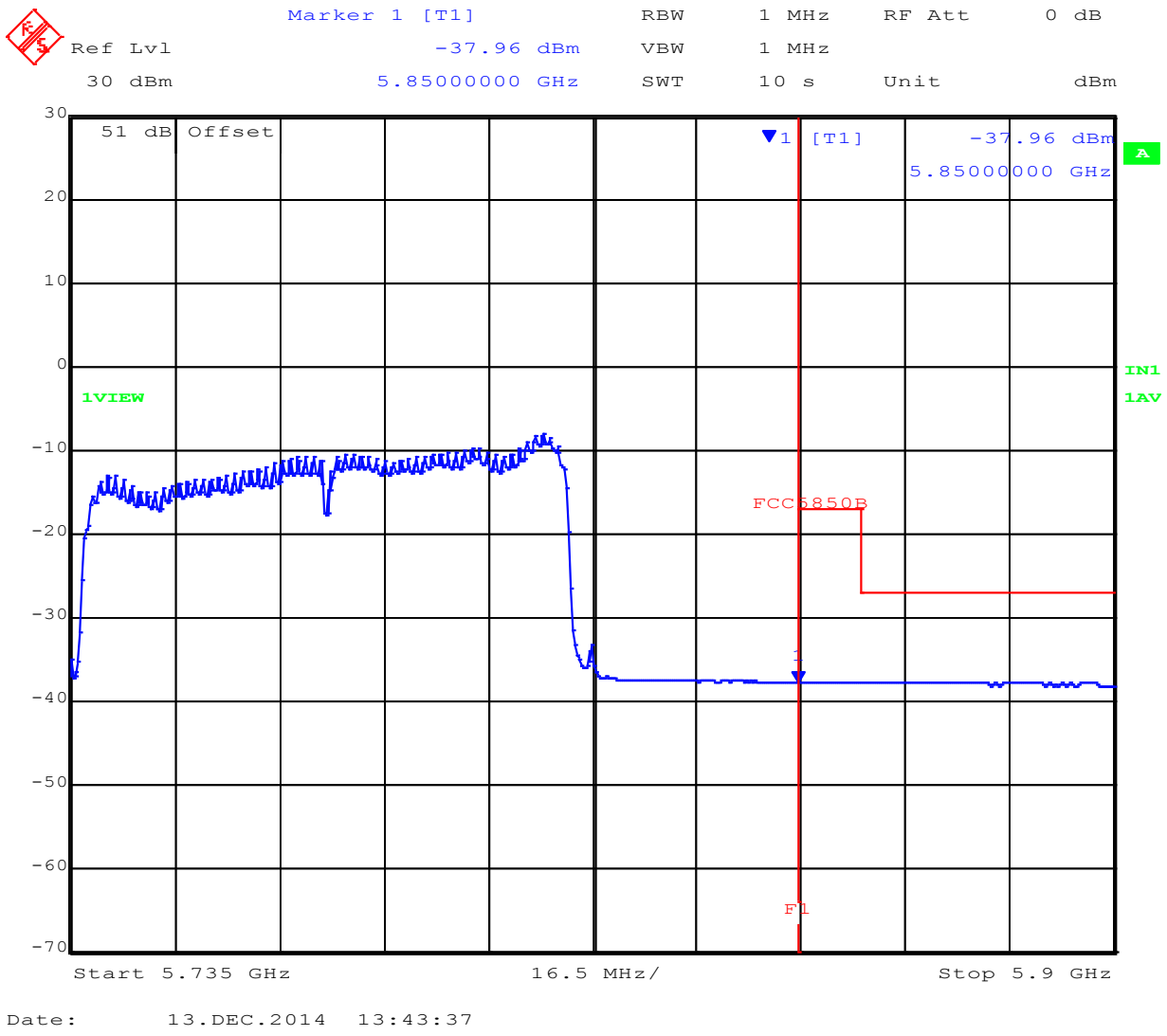
5725 – 5850 MHz 802.11n HT-40 - 5850 MHz Band-Edge Emissions



5725 – 5850 MHz 802.11ac-80 - 5725 MHz Band-Edge Emissions



5725 – 5850 MHz 802.11ac-80 - 5850 MHz Band-Edge Emissions



6.1.2.3. Digital Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209

Test Procedure

Testing 30M-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

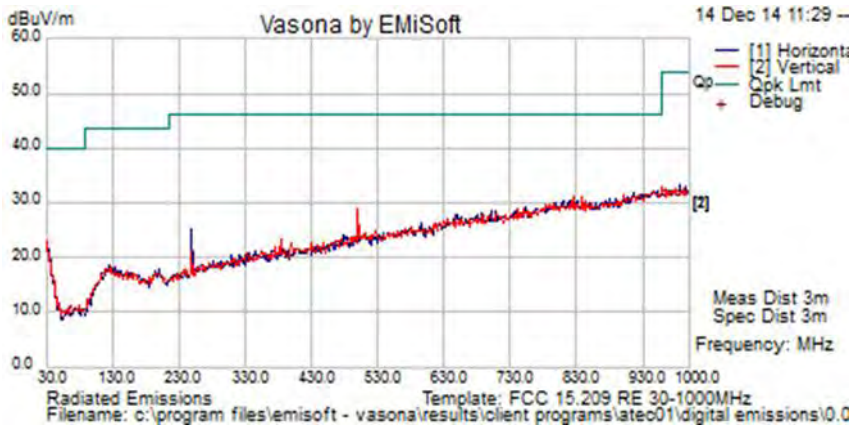
FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100μV/m
48 dBμV/m = 250μV/m

Test Freq.	5500 MHz	**Engineer**	GMH
Variant	802.11n HT-20 6.5MBit/s Digital Emissions	**Temp (ºC)**	17
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum.(%)**	55
Power Setting	N/A	**Press. (mBars)**	1007
Antenna	Integral		
Test Notes 1	ac/dc convertor 115 Vac 60Hz		
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
No emissions found within 6 dB of the limit												

Legend:	DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency
	NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band

Specification

Limits

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

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§15.209 (a) Limit Matrix

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

6.1.3. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

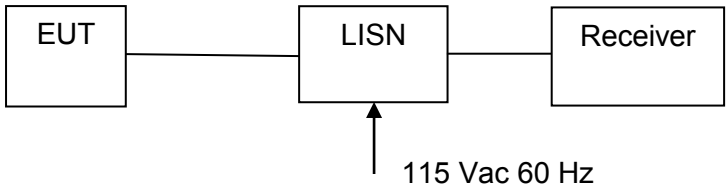
FCC, Part 15 Subpart C §15.207

Test Procedure
The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Test Measurement Set up



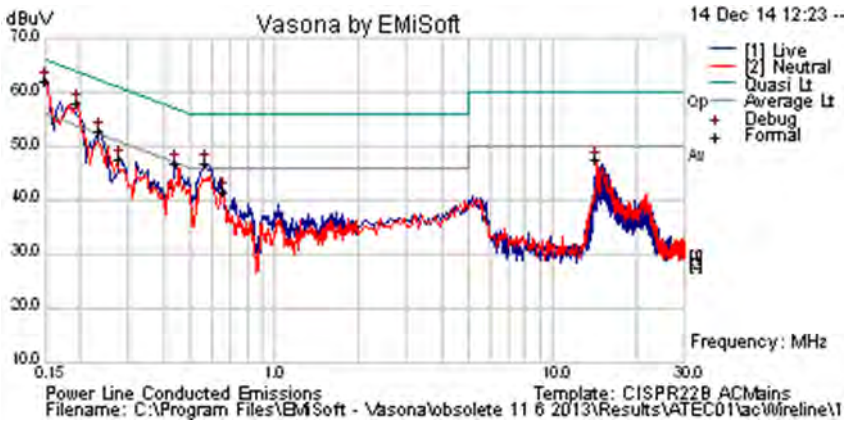
Measurement set up for AC Wireline Conducted Emissions Test

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

ac Wireline Emissions

Test Freq.	5500	**Engineer**	GMH
Variant	802.11n HT-20 6.5 Mbit/s	**Temp (ºC)**	20
Freq. Range	0.150 MHz - 30 MHz	**Rel. Hum.(%)**	75
Power Setting	N/A	**Press. (mBars)**	999
Antenna	Integral		
Test Notes 1	ac/dc 120Vac 60 Hz 0.8A Output: 12 Vdc 3A		
Test Notes 2	Actiontec Power AdaptorModel: CDS036-W120U		



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.150	48.4	9.9	0.1	58.3	Quasi Peak	Live	66	-7.7	Pass	
0.443	32.9	9.9	0.1	42.9	Quasi Peak	Live	57	-14.1	Pass	
0.280	31.5	9.9	0.1	41.5	Quasi Peak	Live	60.83	-19.3	Pass	
0.565	34.4	9.9	0.1	44.4	Quasi Peak	Live	56	-11.6	Pass	
0.235	24.5	9.9	0.1	34.5	Quasi Peak	Live	62.26	-27.8	Pass	
0.661	25.2	10.0	0.1	35.3	Quasi Peak	Neutral	56.0	-20.7	Pass	
14.451	29.3	10.4	0.6	40.3	Quasi Peak	Neutral	60.0	-19.7	Pass	
0.195	43.6	9.9	0.1	53.5	Quasi Peak	Neutral	63.8	-10.3	Pass	
0.150	37.0	9.9	0.1	47.0	Average	Live	56	-9.0	Pass	
0.443	23.9	9.9	0.1	33.8	Average	Live	47	-13.2	Pass	
0.280	20.7	9.9	0.1	30.7	Average	Live	50.83	-20.2	Pass	
0.565	24.5	9.9	0.1	34.5	Average	Live	46	-11.5	Pass	
0.235	24.5	9.9	0.1	34.5	Average	Live	52.26	-17.8	Pass	
0.661	15.3	10.0	0.1	25.4	Average	Neutral	46.0	-20.6	Pass	
14.451	20.0	10.4	0.6	30.9	Average	Neutral	50.0	-19.1	Pass	
0.195	34.8	9.9	0.1	44.8	Average	Neutral	53.8	-9.0	Pass	

Legend:	DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency
	NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band

Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, 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 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. 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.

§15.207 (a) Limit Matrix
The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

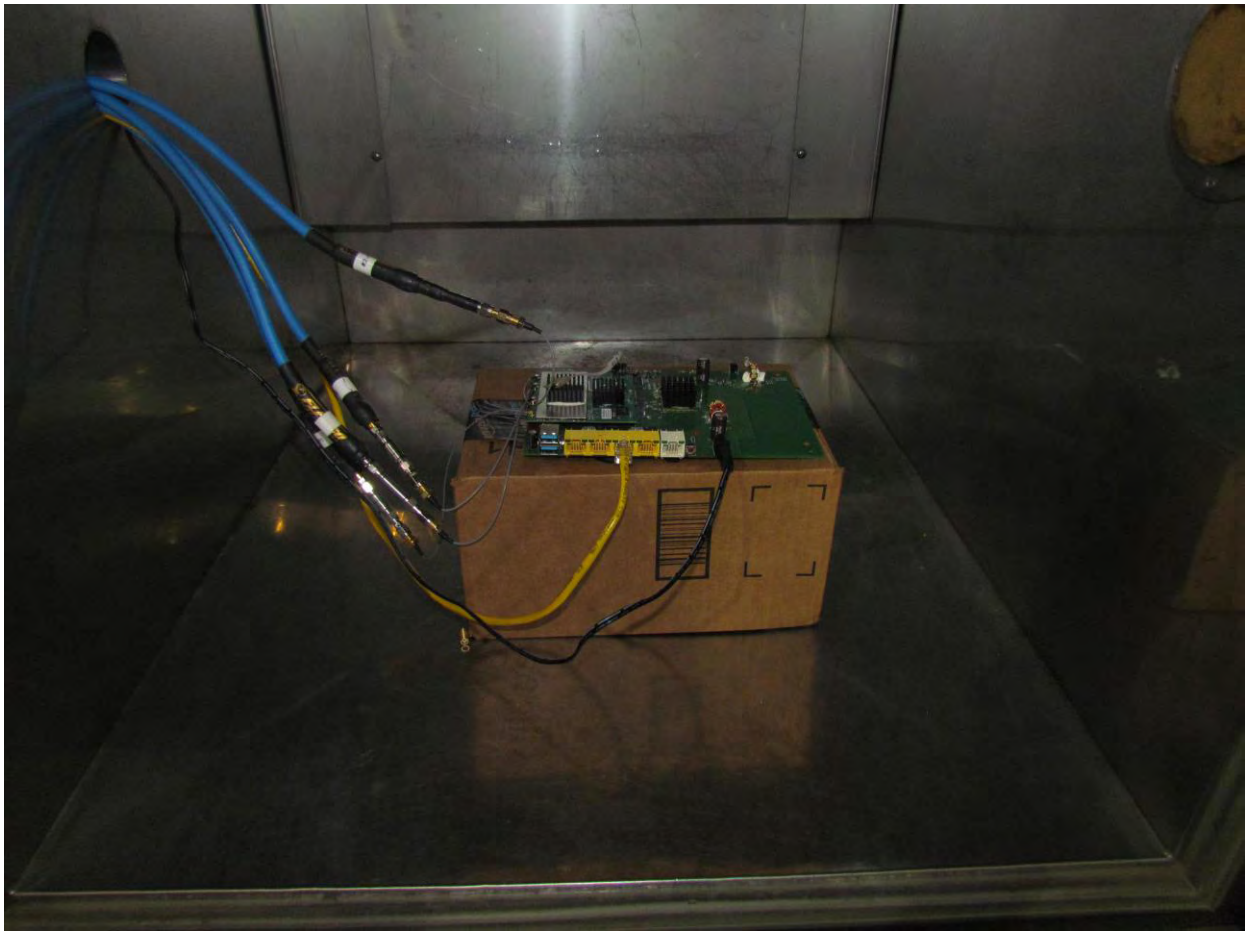
* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

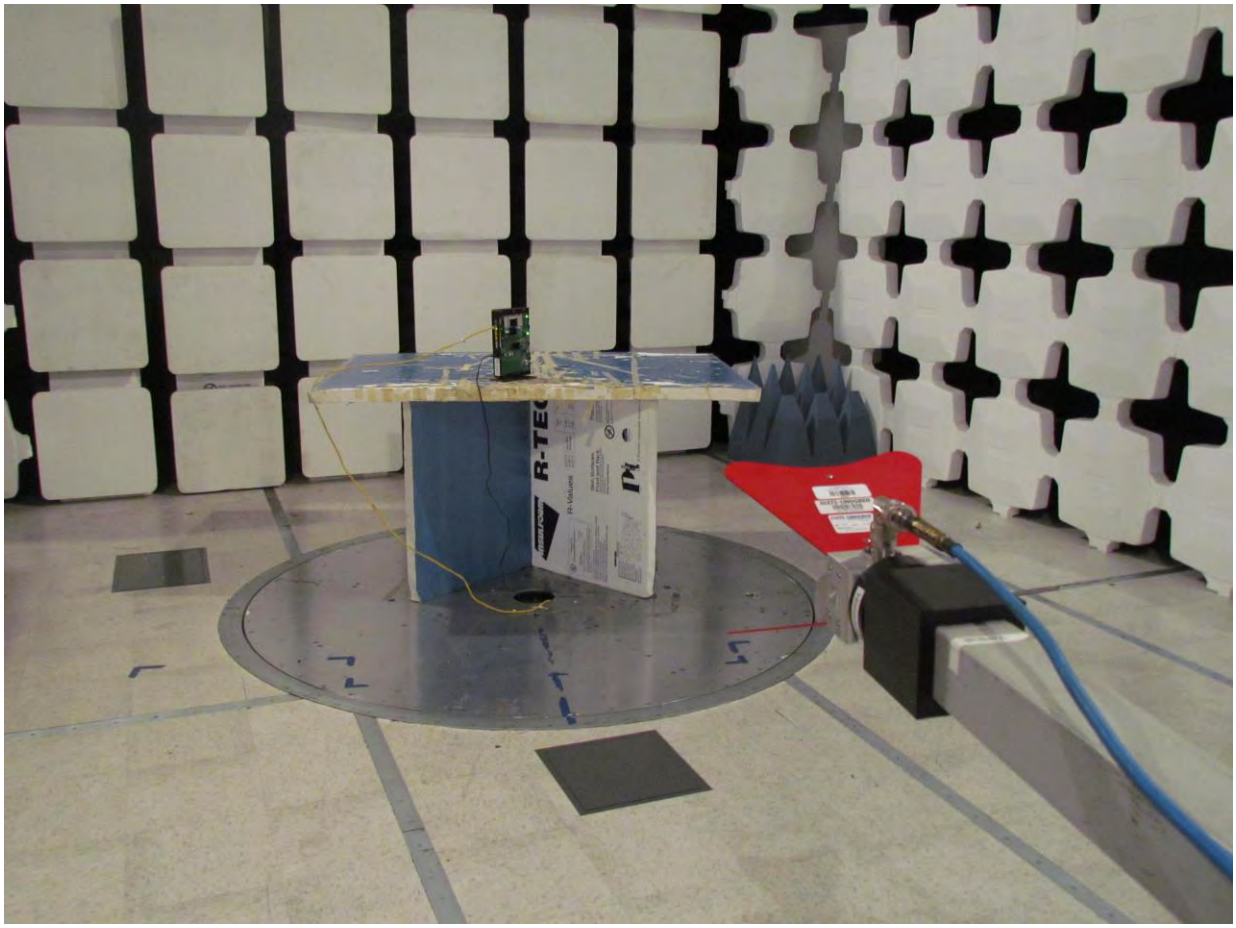
Measurement uncertainty	±2.64 dB

7. PHOTOGRAPHS

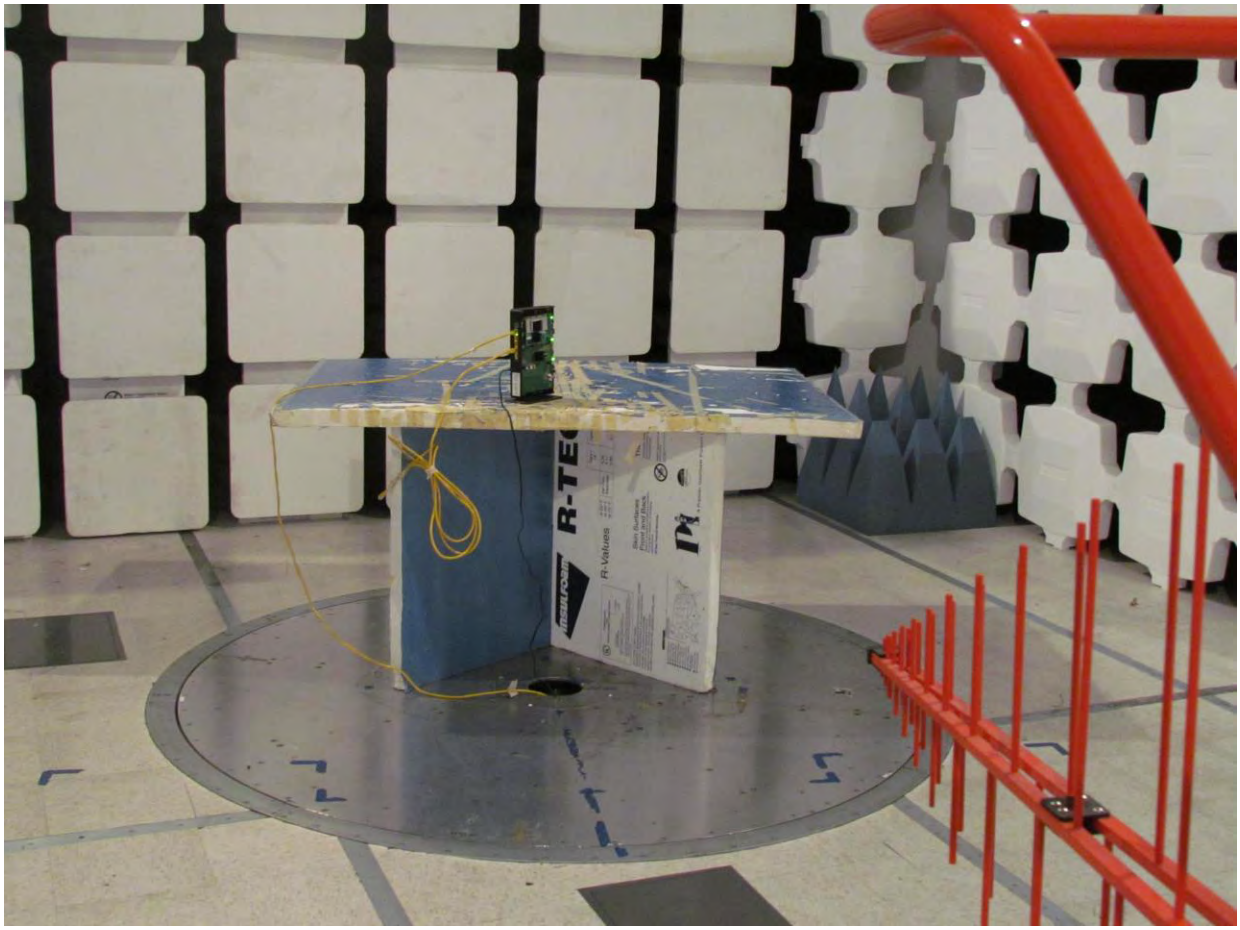
7.1. Conducted Test Setup

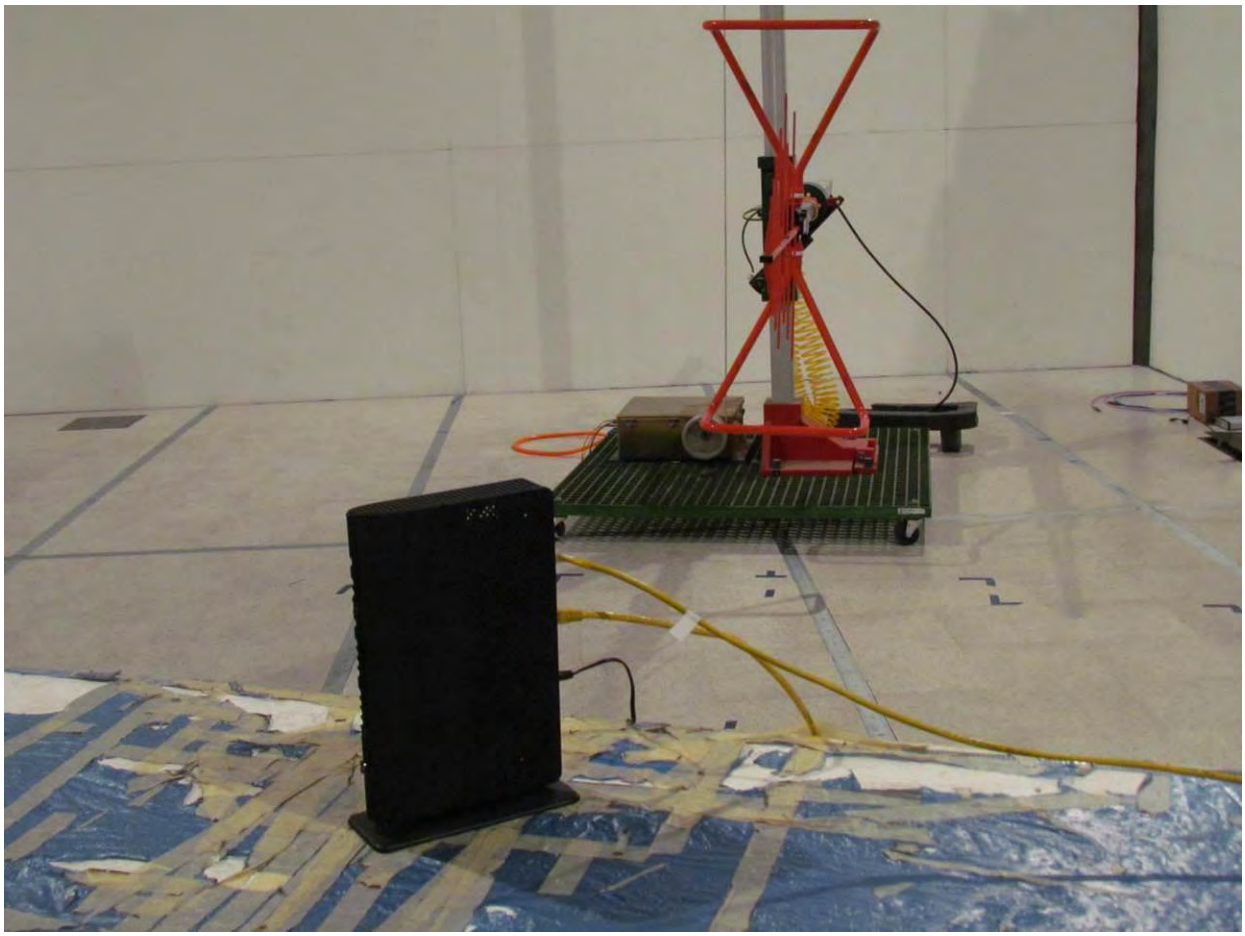


7.2. Test Setup - Digital Emissions > 1 GHz



7.3. Digital Emissions Test Setup (<1 GHz)





7.4. ac Wireline Test Setup