Test of Aruba AP-105 802.11a/b/g/n Wireless AP

To: FCC 47 CFR Part 15.407 & IC RSS-210

Test Report Serial No.: ARUB40-A4 Rev A

MiCOM Labs

opening wireless markets

TEST REPORT

FROM

Test of Aruba AP-105 802.11a/b/g/n Wireless AP
to
To: FCC 47 CFR Part 15.407 & IC RSS-210

Test Report Serial No.: ARUB40-A4 Rev A

Note: this report contains data with regard to the 5,150 to 5,250 MHz band for the Aruba Networks AP-105 Wireless Access Point. 2.4 and 5.8 GHz test data are reported in MiCOM Labs test report ARUB40-A2.

This report supersedes None

Applicant: Aruba Networks, Inc
1344 Crossman Avenue
Sunnyvale
CA 94089, USA

Product Function: Wireless Access Point

Copy No: pdf Issue Date: 10th September 2009

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
CERTIFICATE #2381.01

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ACCREDITATION, LISTINGS & RECOGNITION

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS 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

THE 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 18 June 2005*).

Presented this 26th day of February 2008.

President
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2009

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

LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

United States of America
Federal Communications Commission (FCC) Listing #: 102167

Canada

Industry Canada (IC) Listing #:4143A-2

Japan Registration

VCCI Membership Number: 2959

- Radiation 3 meter site; Registration No. R-2881
- Line Conducted, Registration Nos. C-3181 & T-1470
- Emissions; Registration Nos. C-3180 & T-1469

RECOGNITION

APEC MRA (Asia-Pacific Economic Community Mutual Recognition Agreement)

Conformity Assessment Body (CAB) – MiCOM Labs

Test data generated by MiCOM Labs is accepted in the following countries under the APEC MRA.

Country	Recognition Body	Phase	CAB Identification No.
Australia	Australian Communications and Media Authority (ACMA)	I	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	I	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	I	
Singapore	Infocomm Development Authority (IDA)	I	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	I I	

DOCUMENT HISTORY

Document History		
Revision	**Date**	**Comments**
Draft		
Rev A	10th September 2009	Initial release.

1. TEST RESULT CERTIFICATE

Applicant:	Aruba Networks, Inc 1344 Crossman Avenue Sunnyvale CA 94089, USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	802.11a/b/g/n Wireless Access Point	Tel:	+1 925 462 0304
Model:	AP-105	Fax:	+1 925 462 0306
S/N:	AL0000439 (Conducted Testing), AL0000437 (Radiated Testing)		
Test Date(s):	22nd June to 14th August 2009	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.407 & IC RSS-210	EQUIPMENT COMPLIES

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.

ACCREDITED

CERTIFICATE #2381.01

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

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2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 15.407	2007	Code of Federal Regulations
(ii)	FCC 06-96	June 2006	Memorandum Opinion and Order
(iii)	Industry Canada RSS-210	Issue 7 June 2007	Low Power License-Exempt Radiocommunication Devices (All Frequency Bands): Category 1 Equipment
(iv)	Industry Canada RSS-Gen	Issue 2 June 2007	General Requirements and Information for the Certification of Radiocommunication Equipment
(v)	ANSI C63.4	2003	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
(vi)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(vii)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(viii)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(ix)	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
(x)	A2LA	14th September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy
(xi)	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 Aruba AP-105 802.11a/b/g/n Wireless AP in the frequency ranges 5150 to 5250 MHz to FCC Part 15.407 and Industry Canada RSS-210 regulations.
Applicant:	Aruba Networks, Inc 1344 Crossman Avenue Sunnyvale CA 94089, USA
Manufacturer:	As applicant
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	ARUB40-A4 Rev A
Date EUT received:	22nd June 2009
Standard(s) applied:	FCC 47 CFR Part 15.407 & IC RSS-210
Dates of test (from - to):	22nd June to 19th August 2009
No of Units Tested:	Two (separate units for conducted and radiated)
Type of Equipment:	802.11a/b/g/n Wireless Access Point, 2x2 Spatial Multiplexing MIMO configuration
Applicants Trade Name:	Wireless Access Point
Model(s):	AP-105
Software Release	3.3.3.0, ART version is v0_9_b7_ar928xALL
Location for use:	Indoor
Declared Frequency Range(s):	5,150 to 5,250 MHz
Type of Modulation:	Per 802.11 –CCK, BPSK, QPSK, DSSS, OFDM
Declared Nominal Output Power: (Average Power)	802.11a: Legacy +19 dBm 802.11n: HT-20 +19 dBm 802.11n: HT-40 +19 dBm
EUT Modes of Operation:	Legacy 802.11a/b/g, 802.11n HT-20, HT-40
Transmit/Receive Operation:	Time Division Duplex
Rated Input Voltage and Current:	12Vdc 1.25A; POE 48 Vdc 350 mA
Operating Temperature Range:	Declared range 0 to +50ºC
ITU Emission Designator:	5150 – 5250 MHz 802.11a 17M1D1D 5150 – 5250 MHz 802.11n HT-20 18M2D1D 5150 – 5250 MHz 802.11n HT-40 38M1D1D
Frequency Stability:	±20 ppm max
Equipment Dimensions:	5½" x 5½" x 1¾"
Weight:	1 lb (454 grams)
Primary function of equipment:	Wireless Access Point for transmitting data and voice.

3.2. Scope of Test Program

RF Testing

The scope of the compliance program was to test the Aruba AP-105 wireless Access Point, 2x2 Spatial Multiplexing MIMO configurations in the frequency ranges 5150 - 5250 MHz for compliance against FCC 47 CFR Part 15.407 and Industry Canada RSS-210 specifications.

Aruba AP-105 Access Point
The AP-105 is a multi-band 802.11a/b/g/n dual-radio indoor wireless access point designed for dense enterprise deployments of 802.11n. The AP-105 delivers unprecedented value with the performance and reliability of 802.11n in a compact, streamlined 2x2 MIMO package. Capable of delivering wireless data rates of up to 300Mbps, the multifunction AP-105 provides wireless LAN access, air monitoring, and wireless intrusion detection and prevention over the 2.4GHz and 5GHz RF spectrum. The access point works in conjunction with Aruba's line of high-performance controllers to deliver high-speed, secure network services.

802.11n enables the use of wireless as a primary network connection with speed and reliability comparable to a wired LAN. 802.11n increases performance through techniques such as channel bonding, block acknowledgement, and Multiple In Multiple Out (MIMO). Advanced RF techniques such Cyclic Delay Diversity also increase range and reliability.

The AP-105 features a 100/1000Base-T Ethernet interface and operates from standard 802.3af Power over Ethernet (PoE) sources. Equipped with four internal omni-directional antennas, the AP-105 provides full RF diversity and 2x2 MIMO operation on both the 2.4GHz and 5GHz bands.

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

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	802.11a/b/g/n Wireless Access Point	Aruba Networks	AP-105	AL0000439 (Conducted Testing) AL0000437 (Radiated Testing)
Support	Laptop PC	IBM	Thinkpad	None

3.4. Antenna Details

1. Integral Antenna;-
    a. 4.9 – 5.875 GHz; Gain: 4.0 dBi

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 10/100/1000 Ethernet
2. Console - Serial maintenance terminal
3. 12 Vdc, 4mm supply connector

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)
a,n	Legacy	6 MBit/s	5,180 5,200 5,240
	HT-20	6.5 MCS	
	HT-40	13.5 MCS	5,190 5,230

Conducted Testing

Conducted test parameters were performed on a single antenna connector. The performance testing was carried out on the transmitter port exhibiting the highest output power. A table of output power V's antenna port for each operational mode is provided below. The power from each transmitter is provided together with the aggregate power for all two transmitters. Complete characterization for each chain has been provided only for the power settings utilized in the generation of this report. Aggregate power measurements are provided for all power settings.

Channel 5,180 MHz

a Mode Legacy, 6 Mbit/s

Configuration	ART Power Setting	Tx 1 Measured Pwr (dBm)	Tx 2 Measured Pwr (dBm)	Aggregate Measured Pwr (dBm)
a	2	-8.38	Note 1	-0.62
	3	-2.39	Note 1	+2.60
	4	+1.36	Note 1	+4.88
	5	+3.53	-0.40	+6.40
	6	+4.97	+2.64	+7.66
	7	+6.14	+4.57	+8.60
	8	+7.61	+5.91	+9.37
	9	+8.55	+7.38	+10.34
	10	+9.25	+8.61	+12.13
	11	+10.12	+9.61	+13.40
	12	+11.11	+10.68	+14.63
	13	+12.34	+11.73	+15.86
	14	+13.61	+12.74	+16.78
	15	+14.38	+13.49	+17.53
	15.5	+14.86	+14.19	+18.09
	16	+15.31	+14.87	+18.63
	17	+16.08	+16.15	+19.69
	17.5	+16.57	+16.65	+20.36
	18	+17.02	+17.13	+21.01
	19	+18.37	+17.96	+21.67
	20	+19.04	+18.81	+22.59

Note 1 – Power level is less than -20 dBm.

Channel 5,180 MHz
HT-20 'n' Mode, 6.5 MCS

Configuration	ART Power Setting	Tx 1 Measured Pwr (dBm)	Tx 2 Measured Pwr (dBm)	Aggregate Measured Pwr (dBm)
HT-20	2	-11.32	Note 1	-0.62
	3	-2.53	Note 1	+2.76
	4	+0.96	Note 1	+4.80
	5	+3.45	-0.50	+6.42
	6	+4.95	+2.39	+7.88
	7	+6.12	+4.47	+8.82
	8	+7.24	+5.93	+9.75
	9	+8.32	+7.12	+10.62
	10	+9.00	+8.35	+11.99
	11	+10.22	+9.59	+13.34
	12	+11.15	+10.80	+14.69
	13	+12.30	+11.72	+15.84
	14	+13.58	+12.59	+16.60
	15	+14.38	+13.43	+17.72
	16	+15.33	+14.79	+18.65
	17	+16.04	+15.86	+19.99
	17.5	+16.49	+16.43	+20.55
	18	+16.90	+16.97	+21.11
	19	+18.43	+17.86	+21.89
	20	+18.87	+18.67	+22.62

Note 1 – Power level is less than -20 dBm.

Channel 5,190 MHz
HT-40 'n' Mode, 13.5 MCS

Configuration	ART Power Setting	Tx 1 Measured Pwr (dBm)	Tx 2 Measured Pwr (dBm)	Aggregate Measured Pwr (dBm)
HT-40 (5,190 GHz)	2	-9.26	Note 1	-0.48
	3	-2.74	Note 1	+3.10
	4	+1.41	Note 1	+5.18
	5	+3.72	-0.30	+6.58
	6	+5.32	+2.43	+7.89
	7	+6.29	+4.56	+8.93
	8	+7.12	+6.13	+9.97
	9	+8.21	+7.27	+10.92
	10	+9.29	+8.44	+12.19
	11	+10.34	+9.69	+13.61
	12	+11.36	+10.90	+14.83
	13	+12.51	+11.85	+15.82
	13.5	+12.99	+12.31	+16.37
	14	+13.44	+12.74	+16.85
	15	+14.43	+13.33	+17.74
	16	+15.21	+14.67	+18.99
	17	+15.96	+16.01	+20.26
	17.5	+16.59	+16.56	+20.69
	18	+17.19	+17.07	+21.11
	19	+18.55	+17.65	+21.87
	20	+18.71	+18.56	+23.05

Note 1 – Power level is less than -20 dBm.

Antenna Test Configurations for Radiated Emissions

Spurious Emission and Band-Edge Test Strategy

11a	11n HT-20	11n HT-40
5180	5180	5190
5200	5200	
5240	5240	5230
BE 5150	BE 5150	BE 5150
Pk 5180	Pk 5180	Pk 5190
Pk 5200	Pk 5200	
Pk 5240	Pk 5240	Pk 5230

KEY;-

BE – Band-Edge

PK - Peak Emission

3.7. Equipment Modifications

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

EUT Software Power Settings - Conducted Testing

1. Reduction in output power to meet the Peak Power Spectral Density EIRP limits. The following matrix was generated identifying the reduction in power required bringing the EUT into compliance.

5150 – 5250 MHz

	Channel Freq (MHz)	Nominal ART Power	Passing ART Power	Tx 1 Measured Pwr (dBm)	Tx 2 Measured Pwr (dBm)	Aggregate Measured Pwr (dBm)
11a	5180	20	17.5	+16.57	+16.65	+20.36
	5200	20	17.5	+16.57	+16.65	+20.36
	5240	20	17	+16.08	+16.15	+19.69
HT-20	5180	20	18	+16.90	+16.97	+21.11
	5200	20	18	+16.90	+16.97	+21.11
	5240	20	17.5	+16.49	+16.43	+20.55
HT-40	5190	20	17.5	+16.59	+16.56	+20.69
	5230	20	18	+17.19	+17.07	+21.11

EUT Software Power Settings - Radiated Testing

2. Reduction in output power to meet band-edge and emission requirements was required in certain circumstances. The following matrix was generated identifying the reduction in power required bringing the EUT into compliance.

5150 – 5250 MHz

	Channel Freq (MHz)	Nominal ART Power	Passing ART Power	Tx 1 Measured Pwr (dBm)	Tx 2 Measured Pwr (dBm)	Aggregate Measured Pwr (dBm)
11a	5180	20	15.5	+14.86	+14.19	+18.09
	5200	20	15.5	+14.86	+14.19	+18.09
	5240	20	15.5	+14.86	+14.19	+18.09
HT-20	5180	20	15.0	+14.38	+13.43	+17.72
	5200	20	15.0	+14.38	+13.43	+17.72
	5240	20	15.0	+14.38	+13.43	+17.72
HT-40	5190	20	13.5	+12.99	+12.31	+16.37
	5230	20	13.5	+12.99	+12.31	+16.37

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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. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407** and **Industry Canada RSS-210**.and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(a) **A9.2(2)** **4.4**	26dB and 99% Emission BW	Emission bandwidth measurement	Conducted	Complies	5.1.1
15.407(a) **A9.2(2)** **4.6**	Transmit Output Power	Power Measurement	Conducted	Complies	5.1.2
15.407(a) **A9.2(2)**	Peak Power Spectral Density	PPSD	Conducted	Complies	5.1.3
15.407(a)(6)	Peak Excursion Ratio	<13dB in any 1MHz bandwidth	Conducted	Complies	5.1.4
15.407(g) **15.31** **2.1** **4.5**	Frequency Stability	Limits: contained within band of operation at all times.	Applicant declaration	Complies	5.1.5
15.407(f) **5.5**	Radio Frequency Radiation Exposure	Exposure to radio frequency energy levels, Maximum Permissible Exposure (MPE)	Conducted	Complies	5.1.6

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List of Measurements (continued)

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(b)(2) **15.205(a)** **15.209(a)** **2.2** **2.6** **A9.3(2)** **4.7**	Radiated Emissions		Radiated		5.1.7
	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz		Complies	*5.1.7.1*
	Radiated Band Edge	Band edge results		Complies	*5.1.7.1*
RSS-GEN **6**	Receiver Radiated Spurious Emissions	Emissions above 1 GHz		Complies	*5.1.7.2*
15.407(b)(6) **15.205(a)** **15.209(a)** **2.2**	Radiated Emissions	Emissions <1 GHz (30M-1 GHz)		Complies	*5.1.7.3*
15.407(b)(6) **15.207** **7.2.2**	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies	5.1.8

5. TEST RESULTS

5.1. Device Characteristics

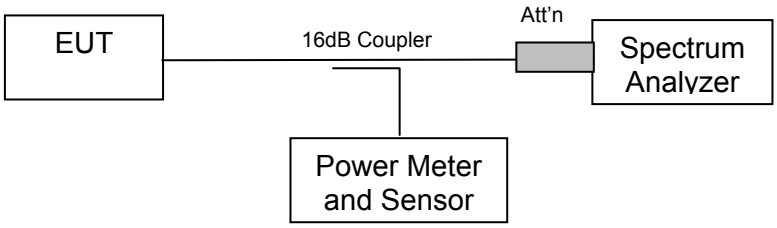
5.1.1. 26 dB and 99 % Bandwidth

FCC, Part 15 Subpart C §15.407(a)

FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 § A9.2(2)
Industry Canada RSS-Gen 4.4

Test Procedure
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.

Test Measurement Set up



Measurement set up for 26 dB and 99 % bandwidth test

Radio Parameters
Duty Cycle: 100%
Output: Modulated Carrier
Power: Maximum Default Power

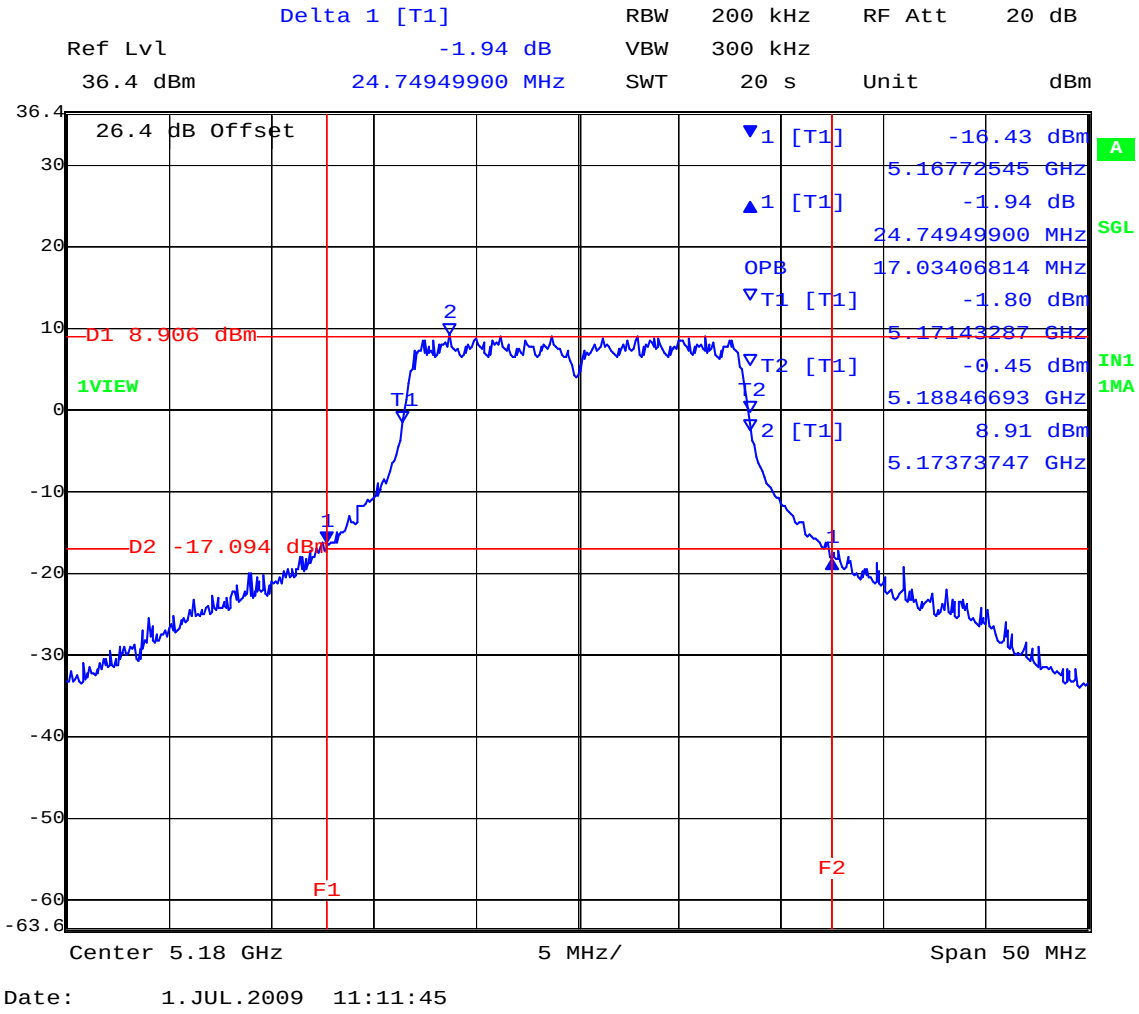
Measurement Results for 26 dB and 99 % Operational Bandwidth(s)

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

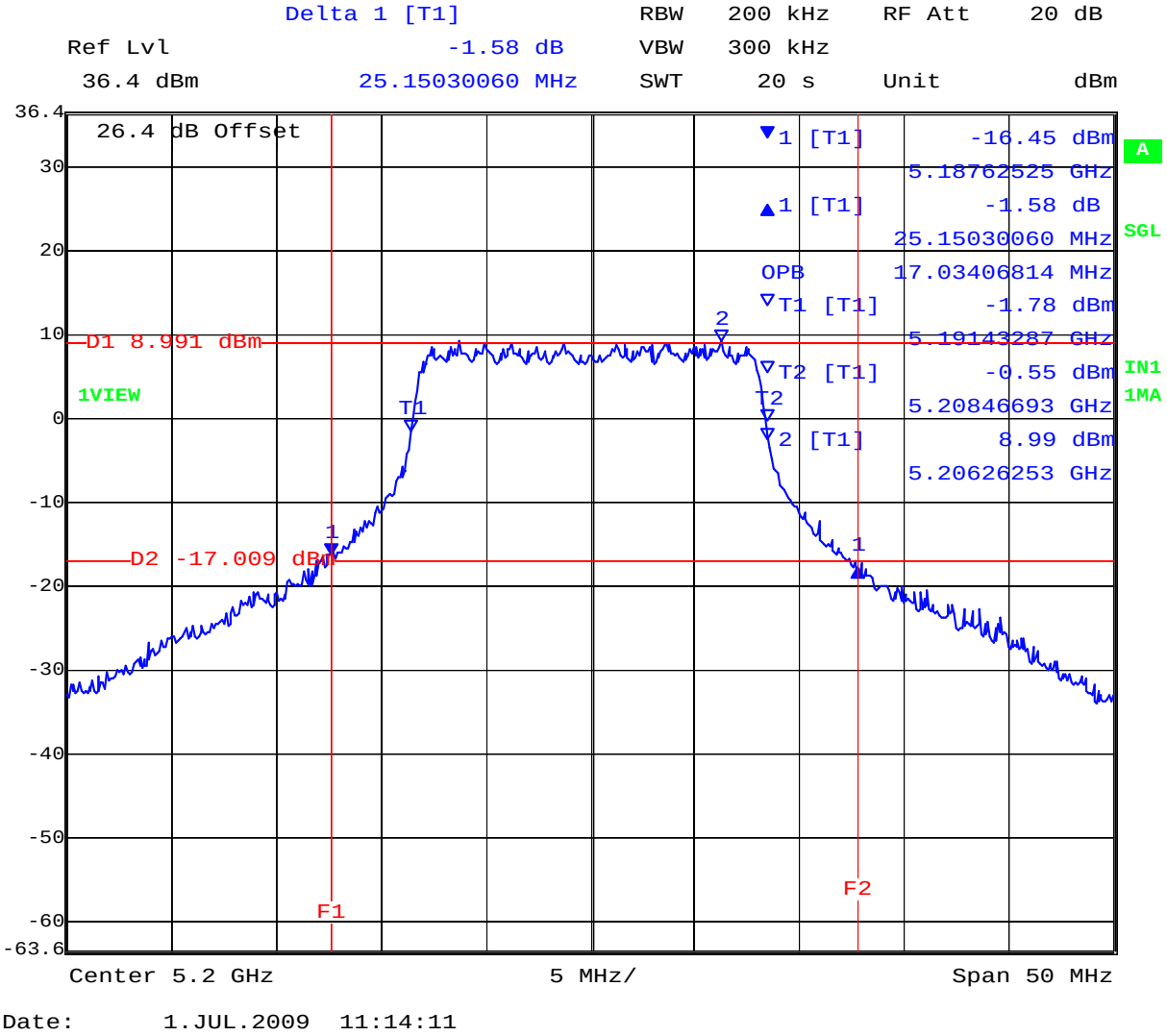
TABLE OF RESULTS – **802.11a Legacy**

Center Frequency (MHz)	26 dB Bandwidth (MHz)	99 % BW (MHz)
5,180	24.749	17.034
5,200	25.150	17.034
5,240	24.850	17.034

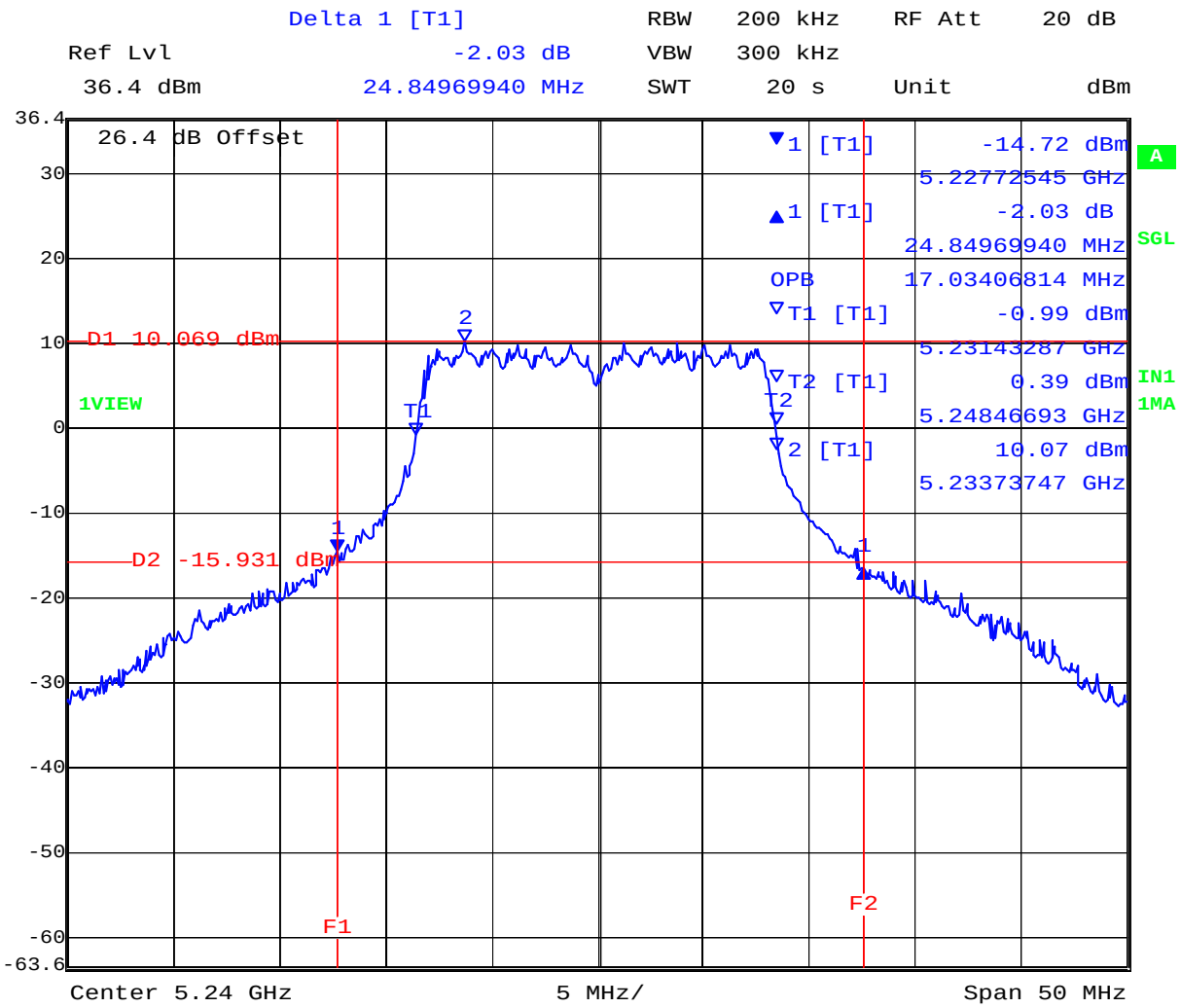
5,180 MHz 802.11a Legacy 26 dB and 99 % Bandwidth



5,200 MHz 802.11a Legacy 26 dB and 99 % Bandwidth



5,240 MHz 802.11a Legacy 26 dB and 99 % Bandwidth



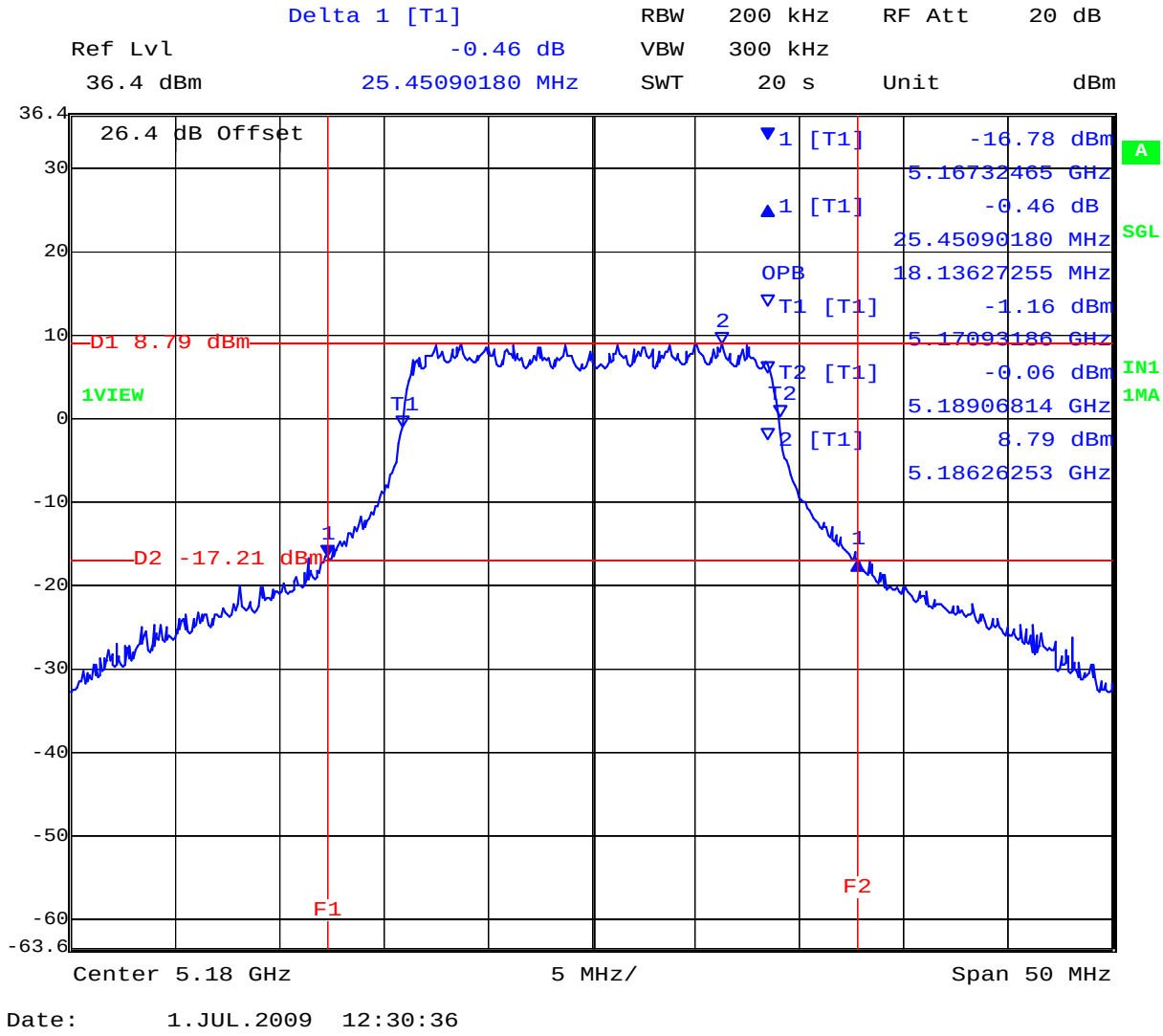
Date: 1.JUL.2009 11:16:38

Measurement Results for 26 dB and 99 % Operational Bandwidth(s) -Continue

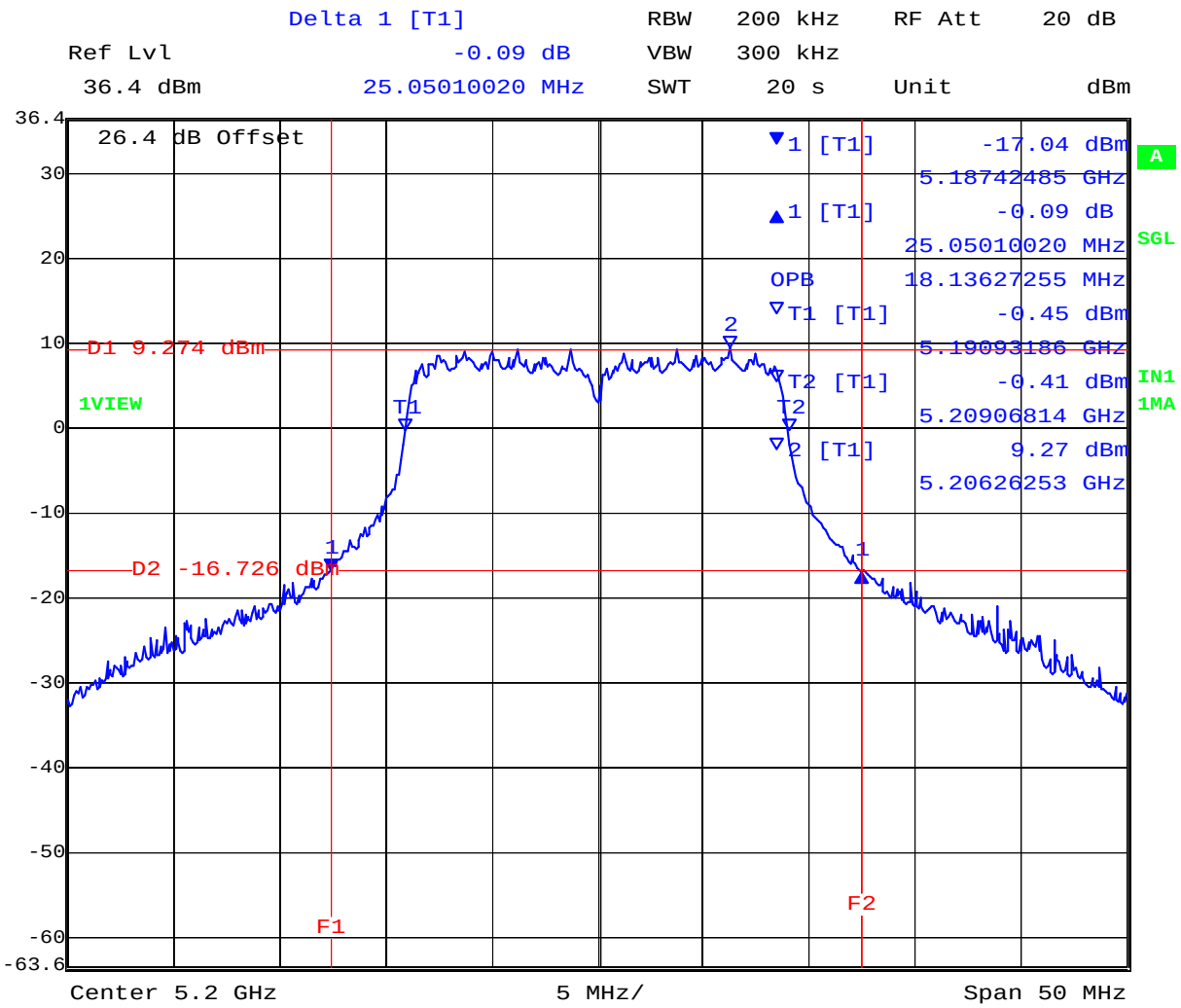
TABLE OF RESULTS – **802.11n HT20**

Center Frequency (MHz)	26 dB Bandwidth (MHz)	99 % BW (MHz)
5,180	25.451	18.136
5,200	25.050	18.136
5,240	25.551	18.136

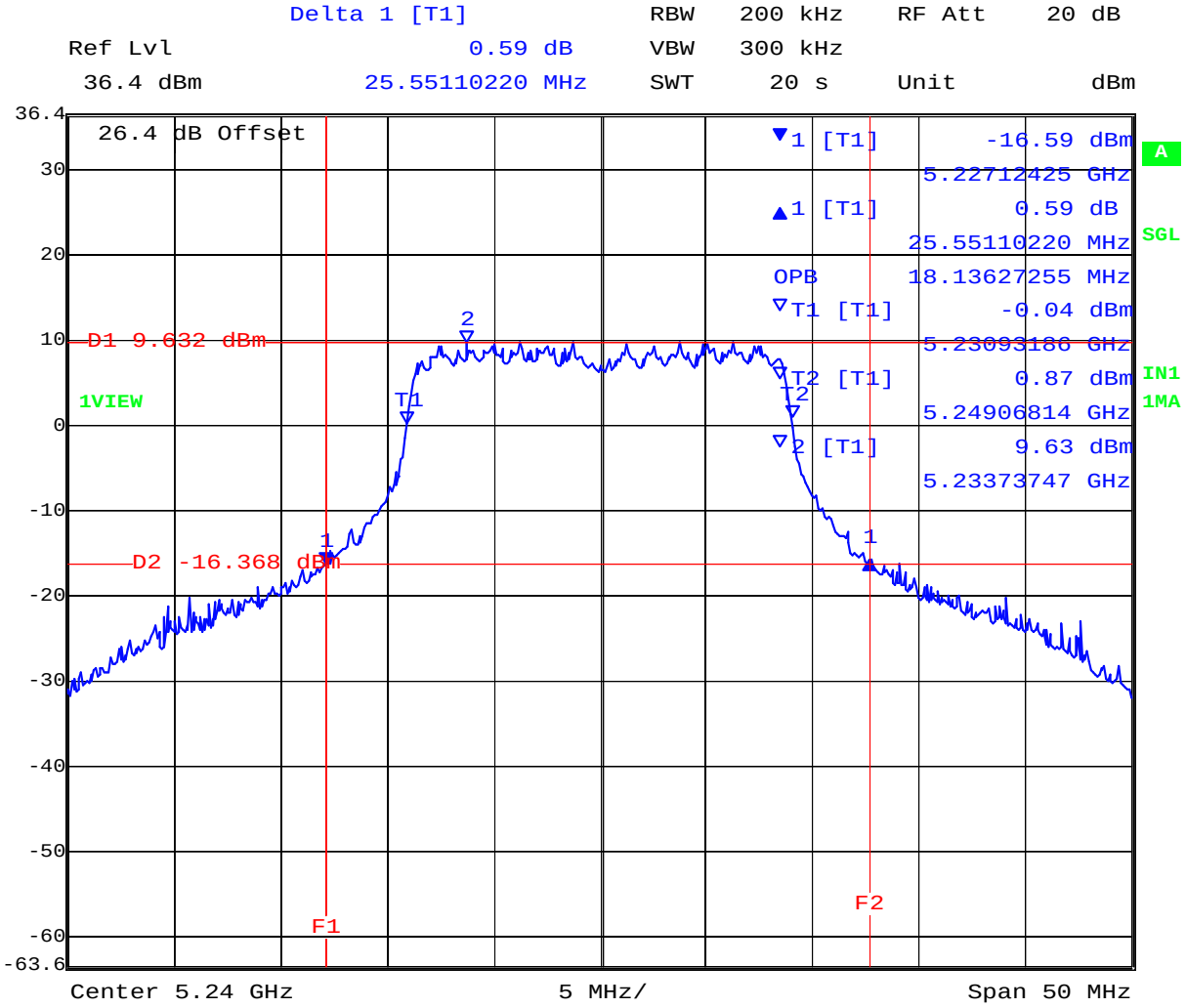
5,180 MHz 802.11n HT20 26 dB and 99 % Bandwidth



5,200 MHz 802.11n HT20 26 dB and 99 % Bandwidth



5,240 MHz 802.11n HT20 26 dB and 99 % Bandwidth



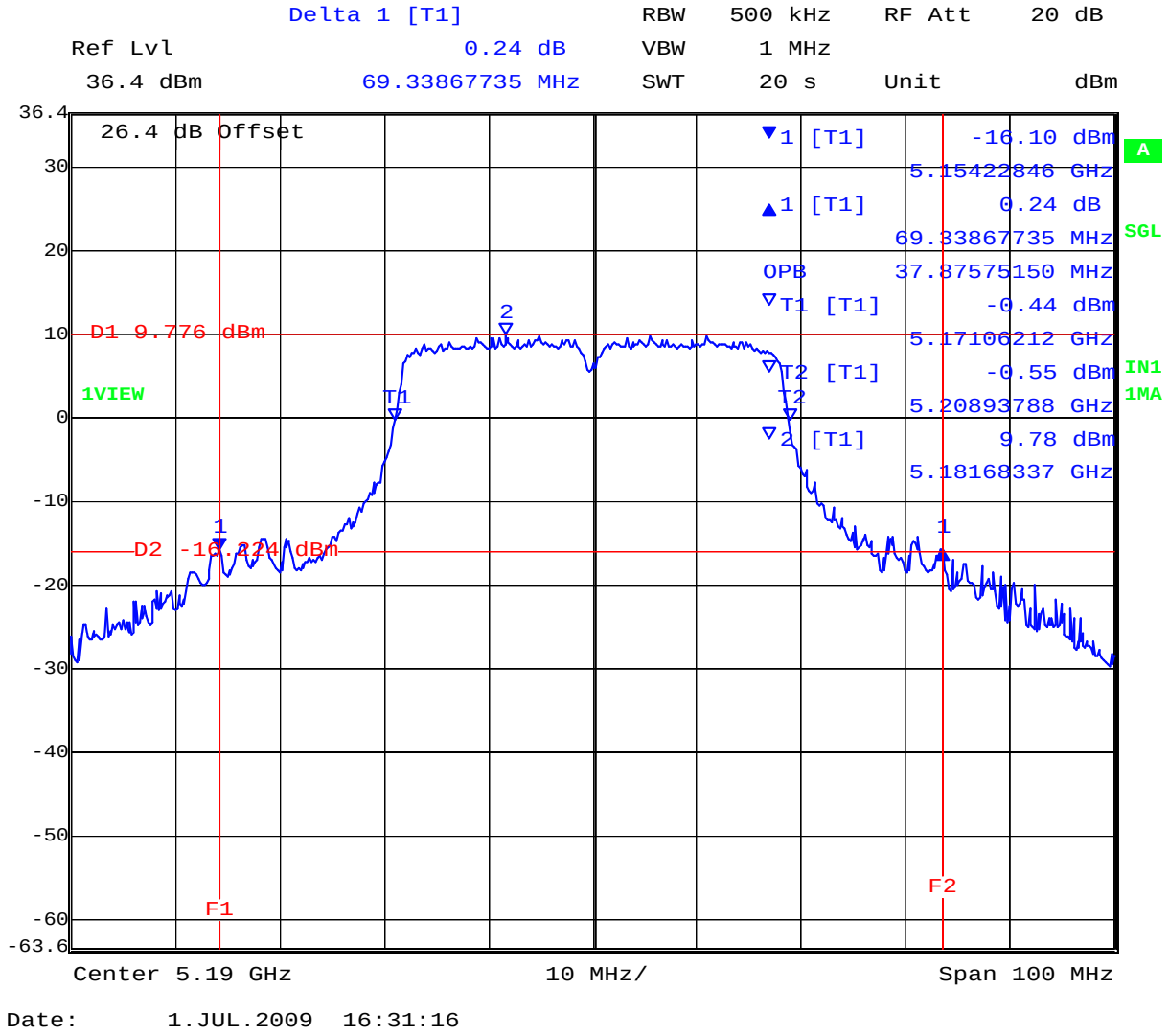
Date: 1.JUL.2009 12:14:08

Measurement Results for 26 dB and 99 % Operational Bandwidth(s) -Continued

TABLE OF RESULTS – **802.11n HT40**

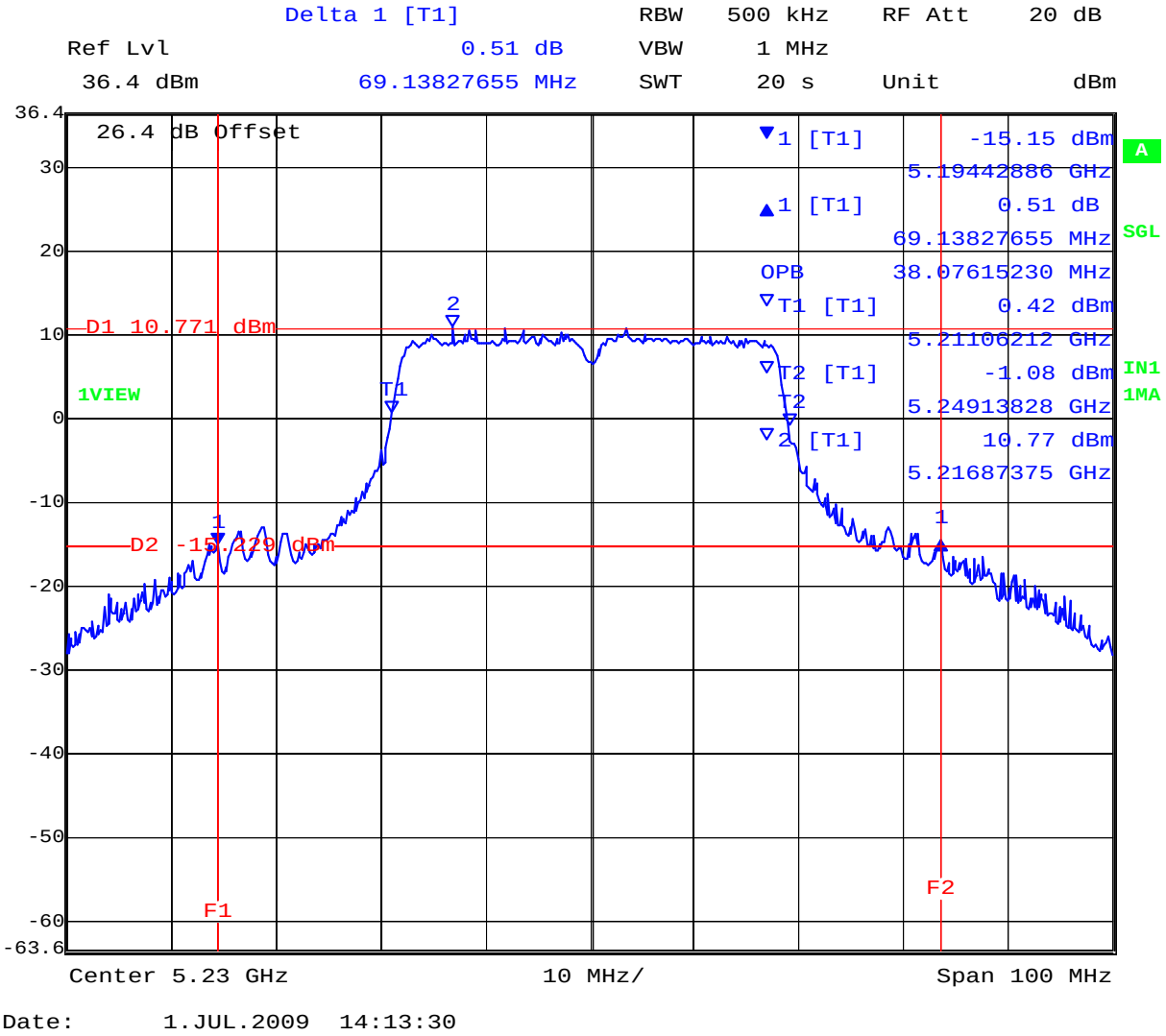
Center Frequency (MHz)	26 dB Bandwidth (MHz)	99 % BW (MHz)
5,190	69.339	37.876
5,230	69.138	38.076

5,190 MHz 802.11n HT40 26 dB and 99 % Bandwidth



Date: 1.JUL.2009 16:31:16

5,230 MHz 802.11n HT40 26 dB and 99 % Bandwidth



Specification

Limits

FCC, Part 15 §15.407 (a)(1), (a)(2) and Industry Canada RSS-210 § A9.2(2)

(a)(1) For the band 5.15-5.25 GHz the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or +4 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed +4 dBm in any 1 megahertz band.

(a)(2) For the 5.25-5.35 GHz band the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or +11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed +11 dBm in any 1 megahertz band.

Industry Canada RSS-Gen 4.4

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

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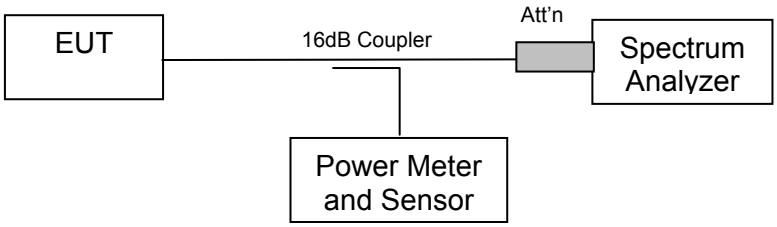
5.1.2. Transmit Output Power

FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 §9.9(2)
Industry Canada RSS-Gen 4.6

Test Procedure

The transmitter terminal of EUT was connected to the input of an average power meter. Measurements were made while EUT was operating in a continuous transmission mode i.e. 100 % duty cycle at the appropriate center frequency. All cable losses and offsets were taken into consideration in the measured result.

Test Measurement Set up



Measurement set up for Transmitter Output Power

Maximum Transmit Power, FCC Limits

Limit 5150 – 5250 MHz: Lesser of 50 mW (+17dBm) or 4 + 10 Log (B) dBm

Frequency Range (MHz)	Maximum 26 dB Bandwidth (MHz)	4 + 10 Log (B) (dBm)	Limit (dBm)
5150 – 5250	69.339	22.41	17.00

Maximum Conducted Power Industry Canada Limits

Limit 5150 – 5250 MHz: Lesser of 200 mW (+23 dBm) or 10 + 10 Log (B) dBm

Frequency Range (MHz)	Maximum 99% Bandwidth (MHz)	10 + 10 Log (B) (dBm)	Limit (dBm)
5150 – 5250	38.076	25.81	23.00

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Measurement Results for Transmit Output Power
Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

EUT parameters.
Power Level: Maximum
Duty Cycle: 100%

TABLE OF RESULTS – **802.11a Legacy**

Center Frequency (MHz)	Maximum Conducted Power (dBm)
5,180	+16.09
5,200	+16.11
5,240	+16.21

TABLE OF RESULTS – **802.11n HT20**

Center Frequency (MHz)	Maximum Conducted Power (dBm)
5,180	+16.52
5,200	+16.71
5,240	+16.67

TABLE OF RESULTS – **802.11n HT40**

Center Frequency (MHz)	Maximum Conducted Power (dBm)
5,190	+16.60
5,230	+16.76

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Specification

Limits

FCC, Part 15 §15.407 (a)(1), (a)(2) and Industry Canada RSS-210 § A9.2(2)

(a)(1) For the band 5.15-5.25 GHz the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or +4 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed +4 dBm in any 1 megahertz band.

(a)(2) For the 5.25-5.35 GHz band the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or +11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed +11 dBm in any 1 megahertz band.

Industry Canada RSS-210 §A9.2(2)

For the band 5150-5250 MHz, the maximum equivalent isotropically radiated power (e.i.r.p.) shall not exceed 200 mW or 10 + 10 log10 B, dBm, whichever power is less. B is the 99% emission bandwidth in MHz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

For the band 5250-5350 MHz and 5470-5725 MHz, the maximum conducted output power shall not exceed 250 mW or 11 + 10 log10 B, dBm, whichever power is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band. The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10 B, dBm, whichever power is less. B is the 99% emission bandwidth in MHz.

Industry Canada RSS-Gen 4.4

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

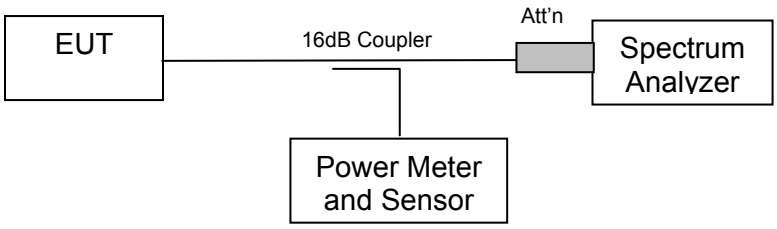
Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

5.1.3. Peak Power Spectral Density

FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 § A9.2(2)

Test Procedure
The transmitter output was connected to a spectrum analyzer and the peak power spectral density measured. Method 2 Sample Detection and power averaging, specified in FCC document DA 02-2138 (Normative Reference (ix) Section 2.1 "Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices") was used to determine the peak power spectral density of the emission. The Peak Power Spectral Density is the highest level found across the emission in a 1 MHz resolution bandwidth.

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

Measurement Results for Peak Power Spectral Density

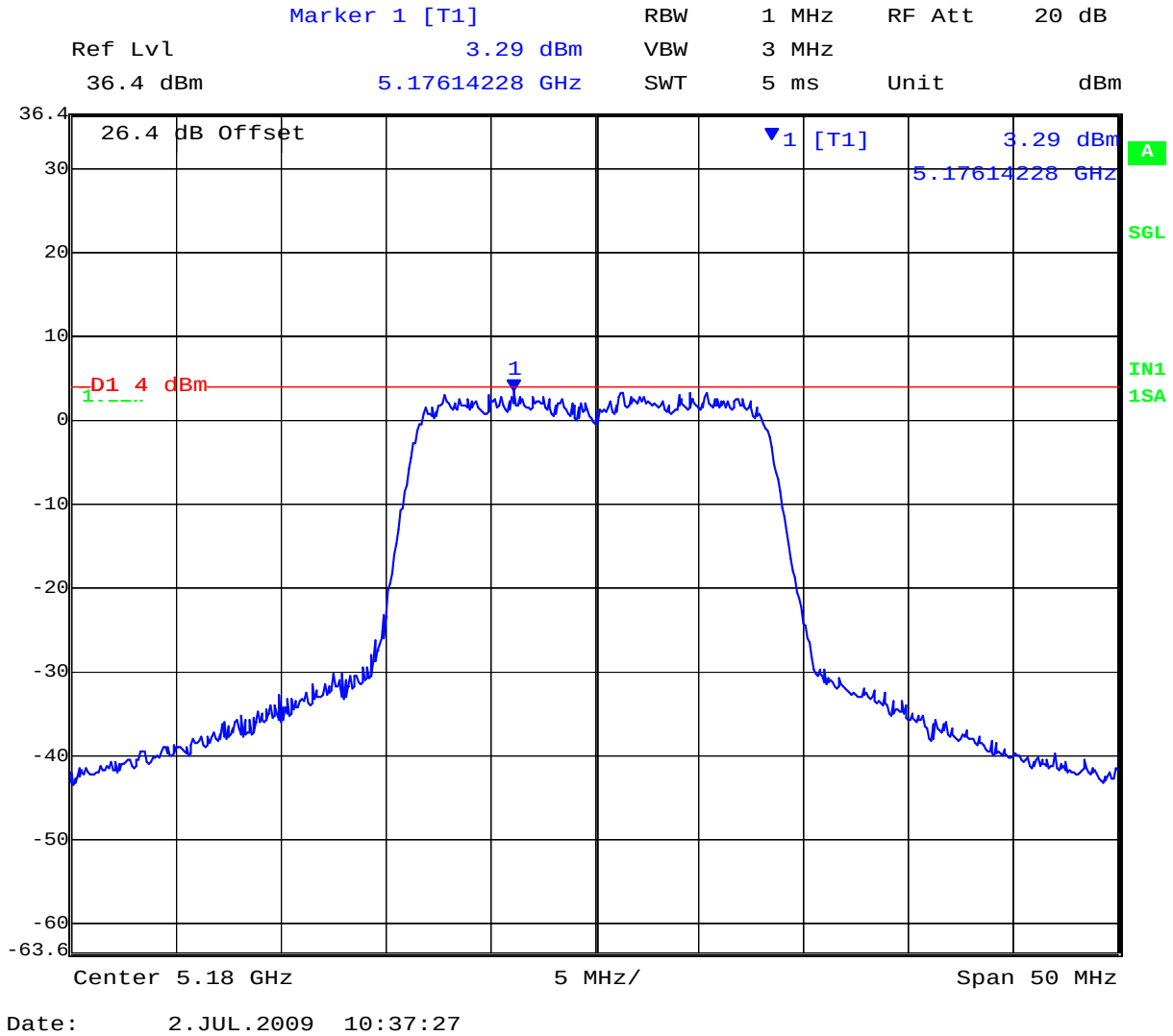
Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Radio Parameters
Duty Cycle: 100%
Output: Modulated Carrier
Power: Maximum Default Power

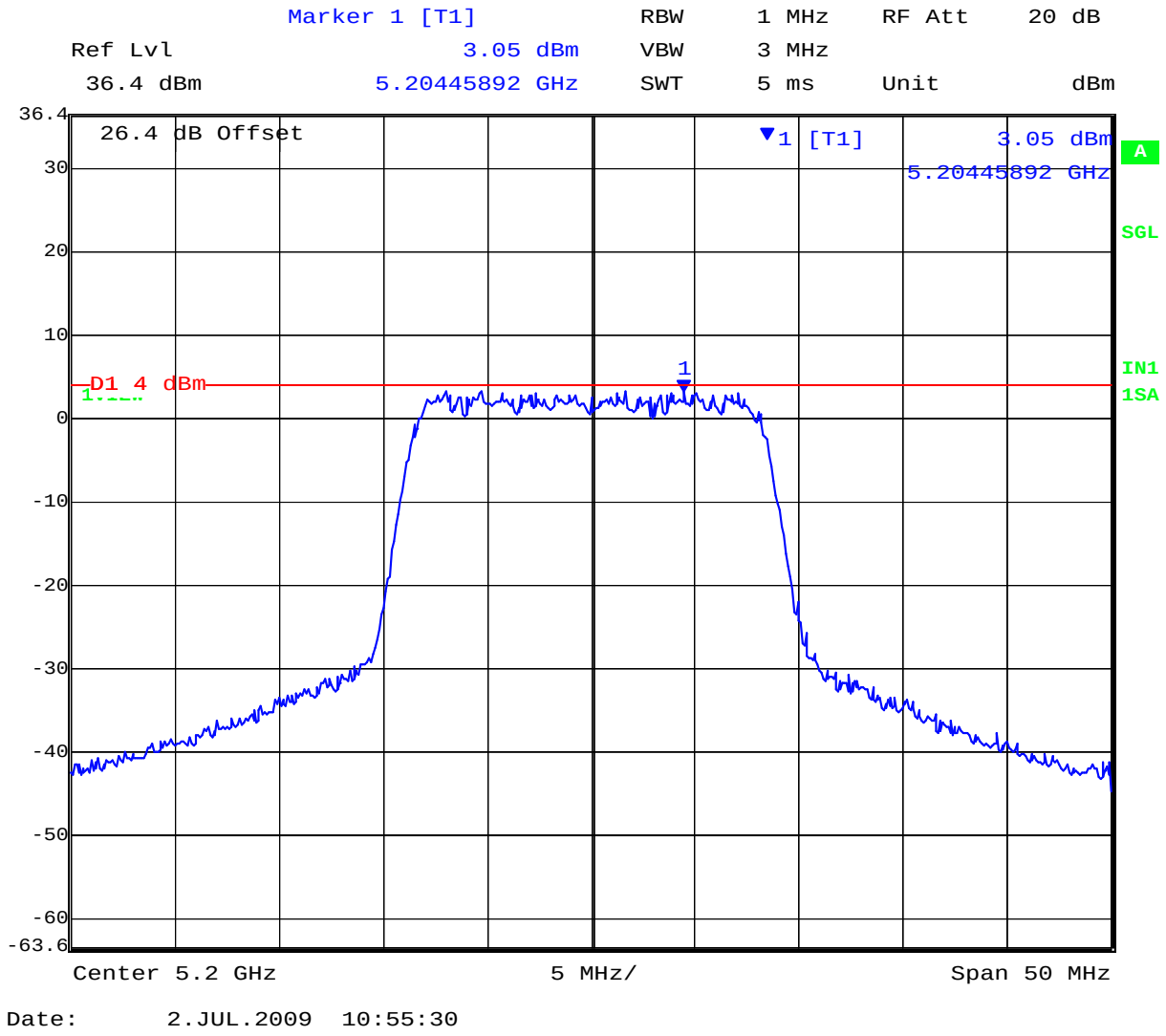
TABLE OF RESULTS – **802.11a Legacy**

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)
5,180	5176.14228	+3.39
5,200	5204.45892	+3.05
5,240	5233.03607	+3.53

5,180 MHz 802.11a Legacy Peak Power Spectral Density



5,200 MHz 802.11a Legacy Peak Power Spectral Density



5,240 MHz 802.11a Legacy Peak Power Spectral Density

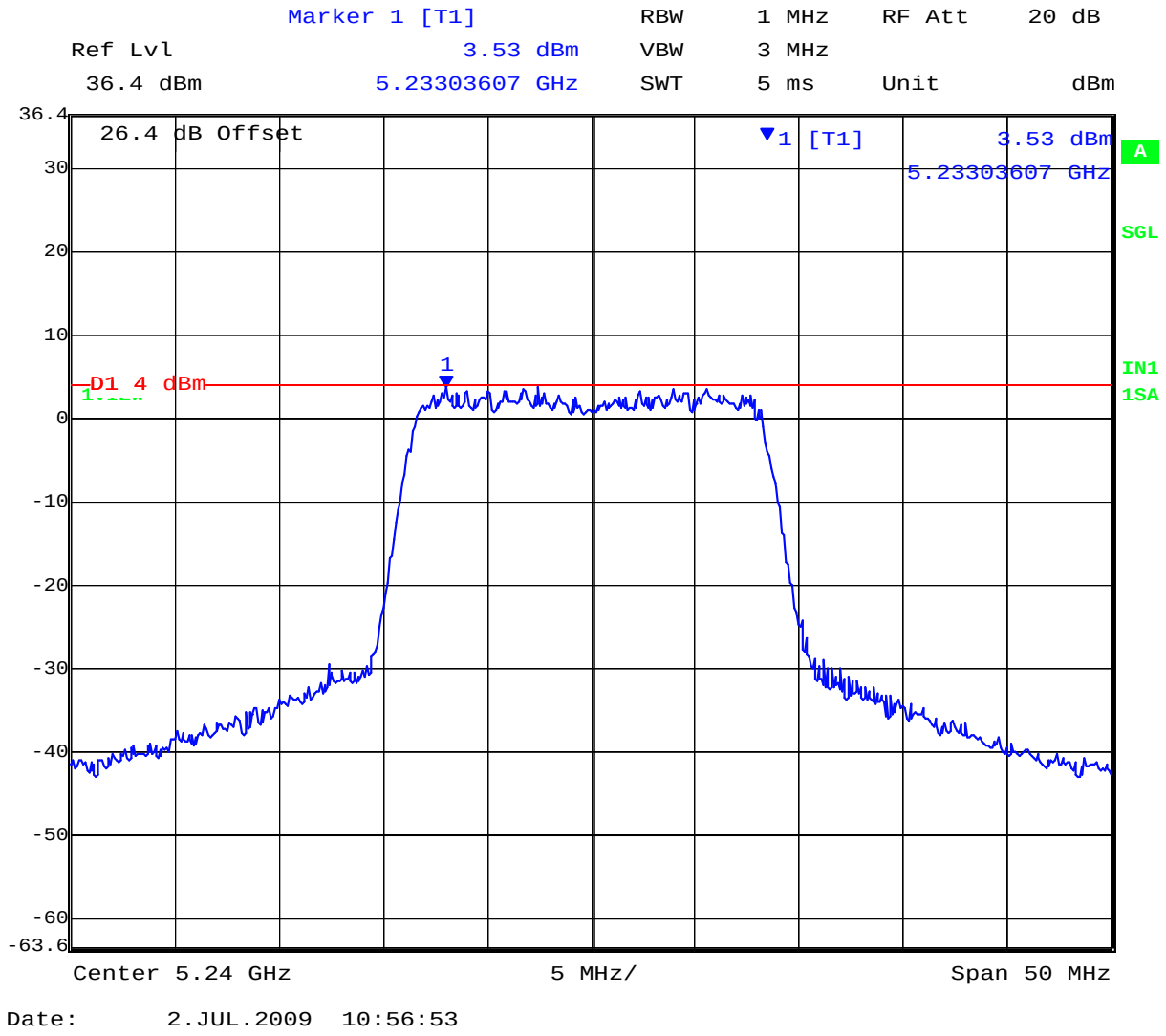
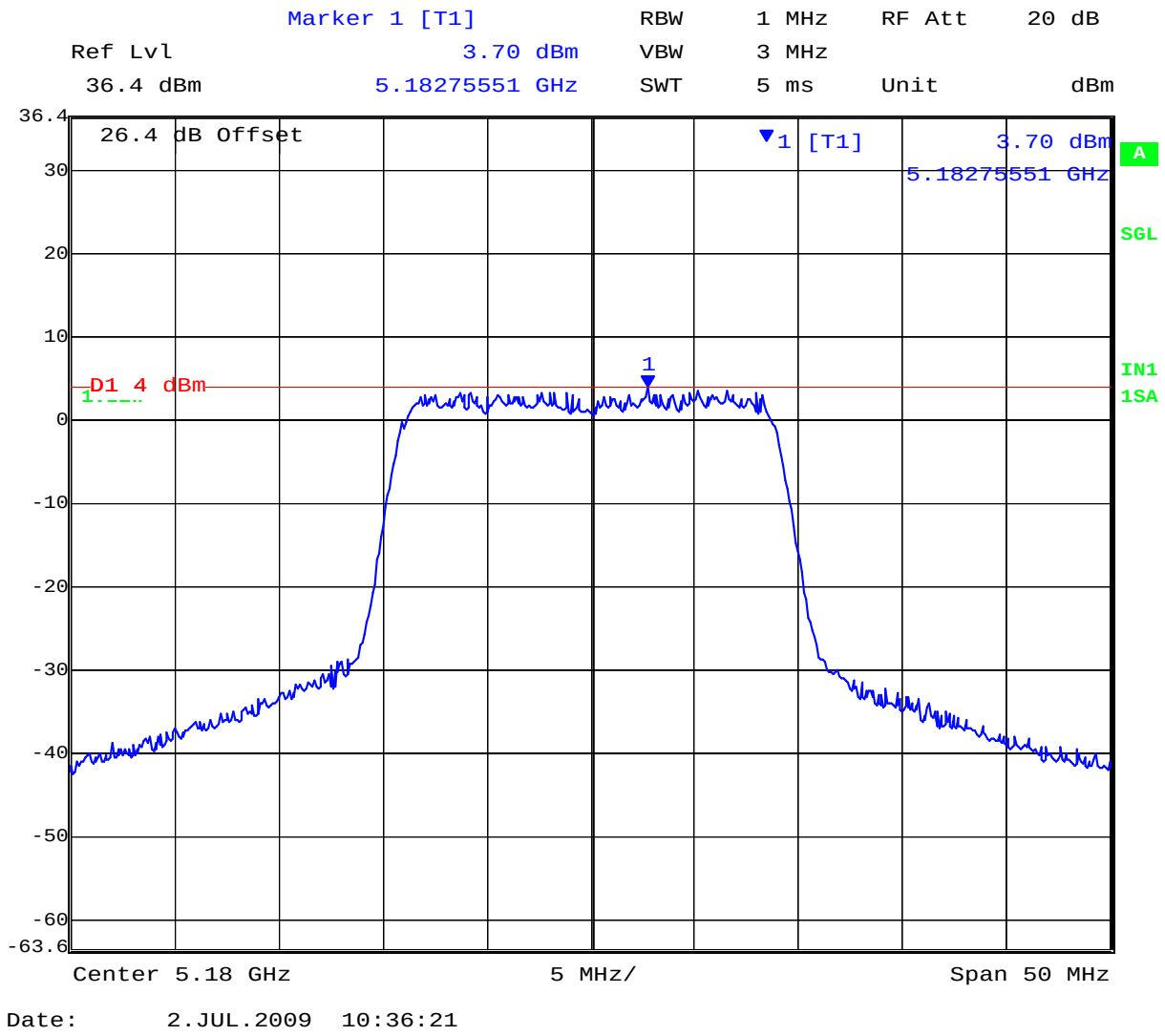


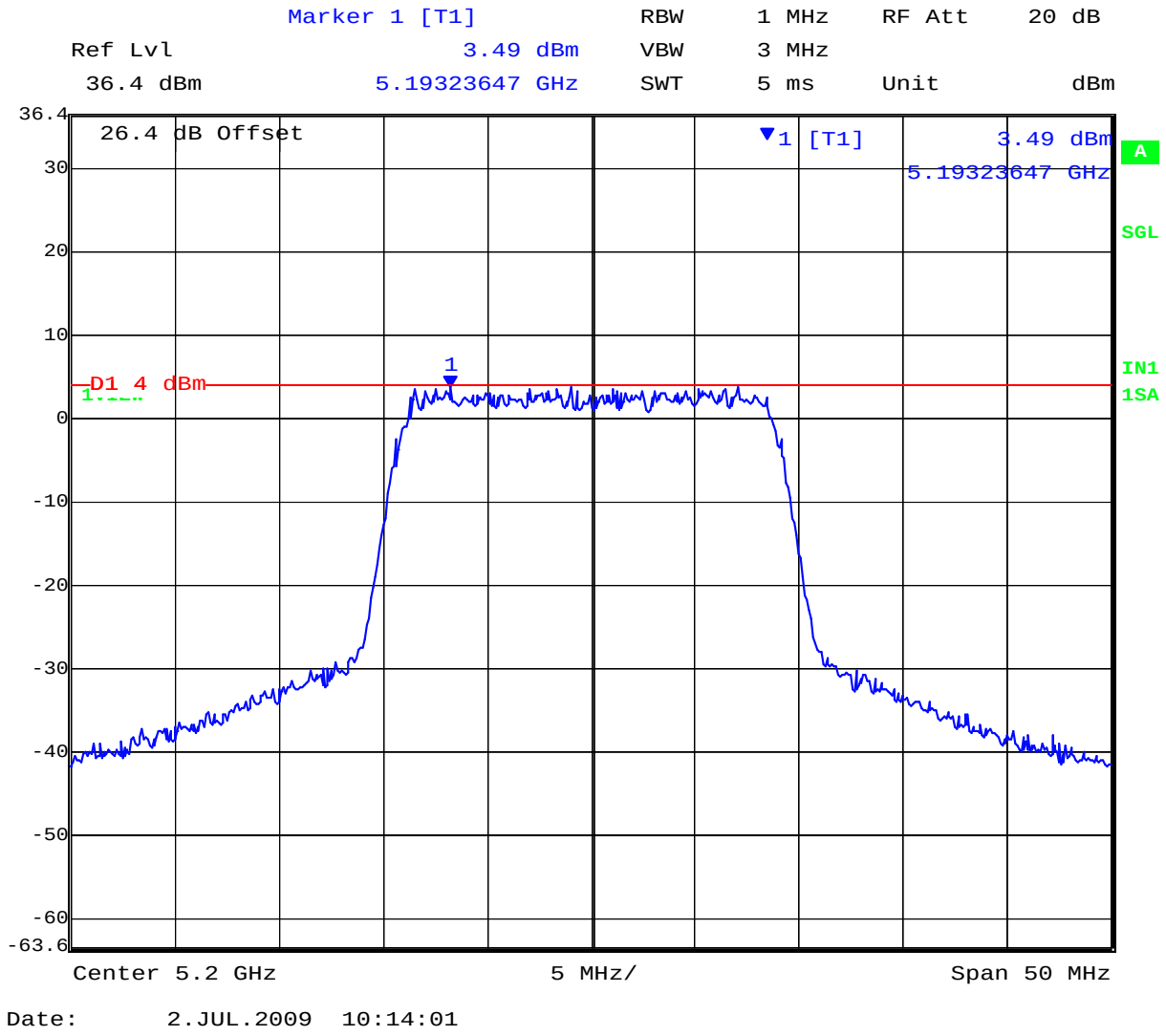
TABLE OF RESULTS – **802.11n HT20**

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)
5,180	5182.75551	+3.70
5,200	5193.23647	+3.49
5,240	5244.15832	+3.95

5,180 MHz 802.11n HT20 Peak Power Spectral Density



5,200 MHz 802.11n HT20 Peak Power Spectral Density



5,240 MHz 802.11n HT20 Peak Power Spectral Density

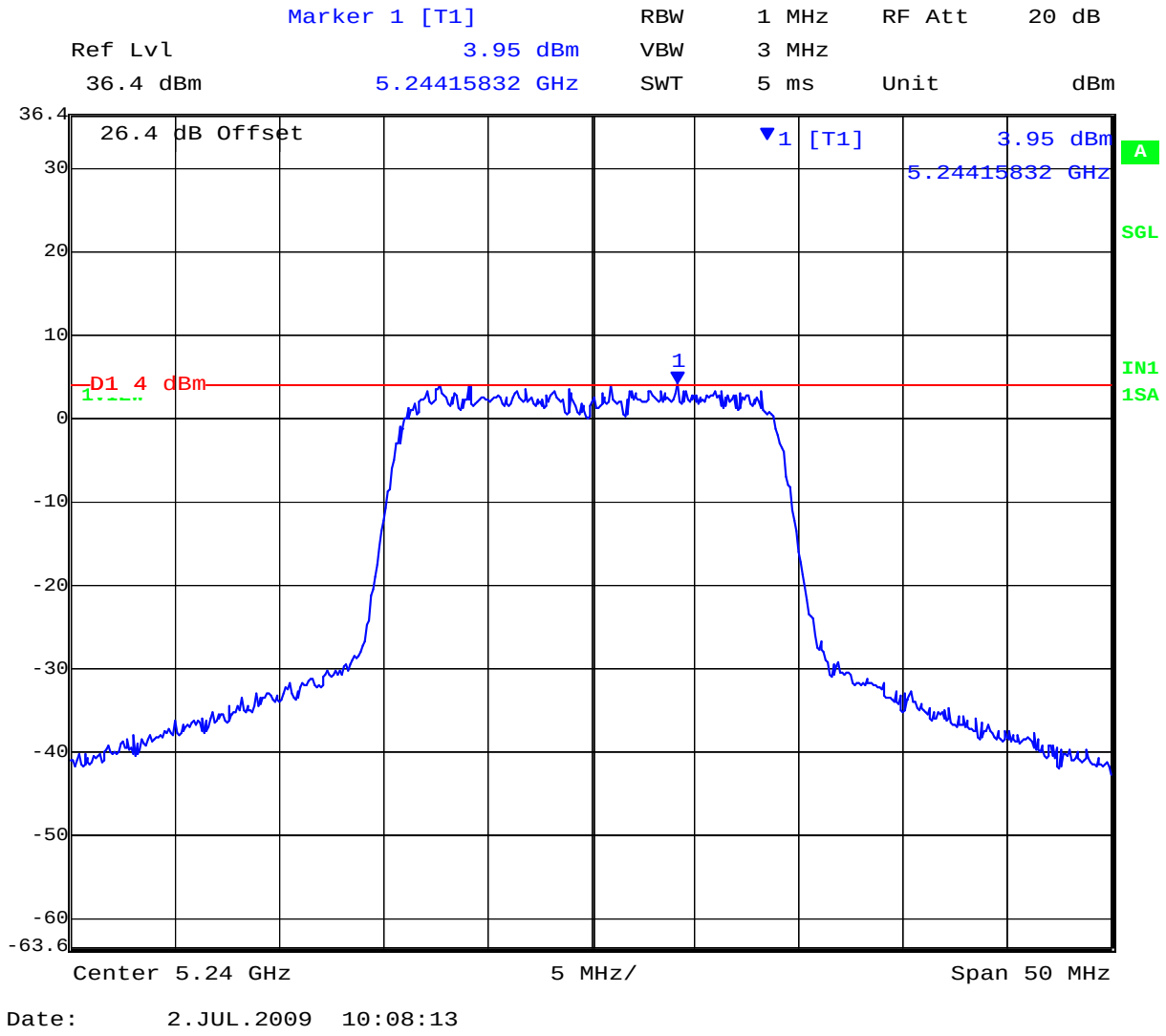
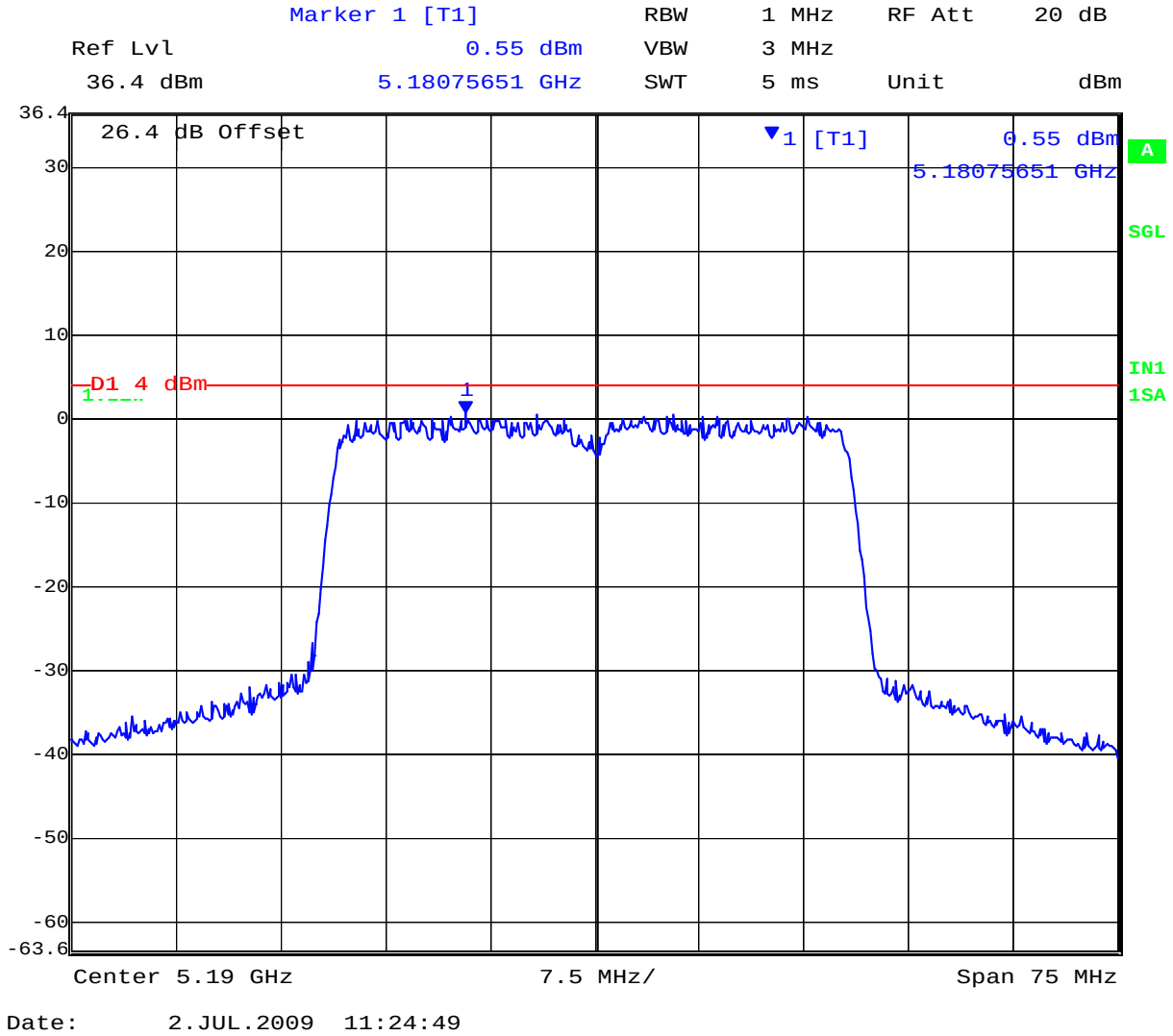


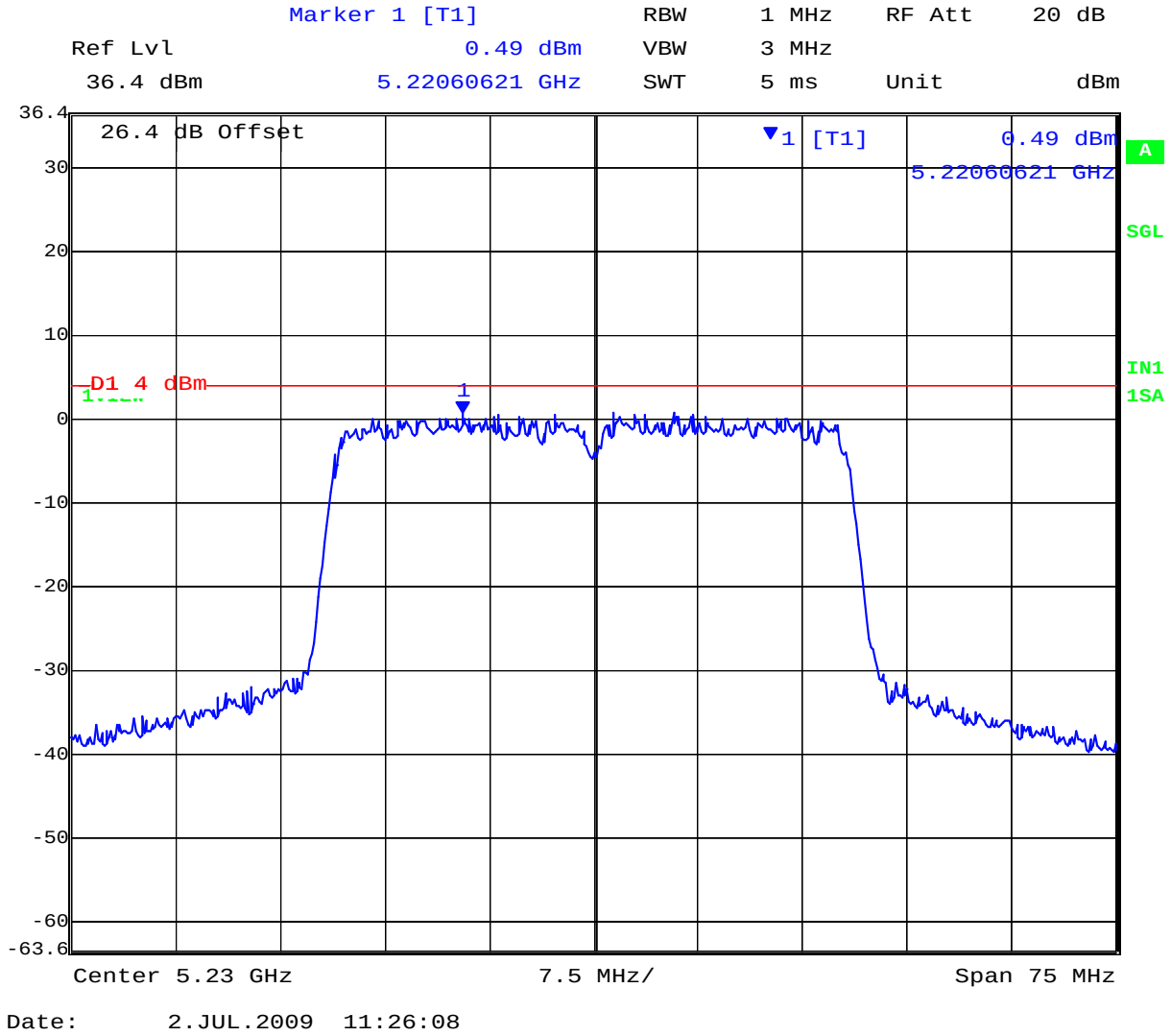
TABLE OF RESULTS – **802.11n HT40**

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)
5,190	5180.75651	+0.55
5,230	5220.60621	+0.49

5,190 MHz 802.11n HT40 Peak Power Spectral Density



5,230 MHz 802.11n HT40 Peak Power Spectral Density



Specification

FCC, Part 15 §15.407 (a)(1), (a)(2)
5150 – 5250 MHz
(a)(1) The peak power spectral density shall not exceed +4 dBm in any 1 megahertz band.

5250 – 5350 MHz & 5470 – 5725 MHz
(a)(2) The peak power spectral density shall not exceed +11 dBm in any 1 megahertz band.

Industry Canada RSS-210 § **A9.2(1), A9.2(2)**
5150 – 5250 MHz
§ **A9.2(1)** The eirp spectral density shall not exceed +10 dBm in any 1 MHz band

5250 – 5350 MHz & 5470 – 5725 MHz
§ **A9.2(2)** The power spectral density shall not exceed +11 dBm in any 1 MHz band

Laboratory Measurement Uncertainty for Spectral Density

Measurement uncertainty	±1.33 dB

Traceability

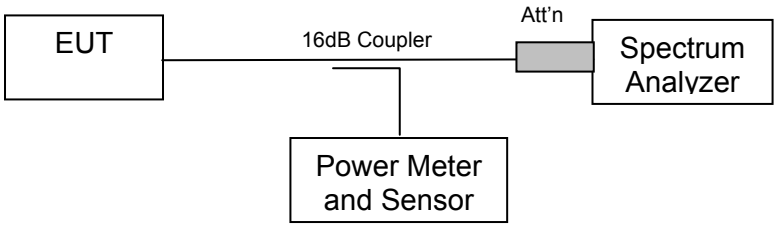
Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

5.1.4. Peak Excursion Ratio

FCC, Part 15 Subpart C §15.407(a)(6)

Test Procedure
Normative Reference (xi) Section 2.1 Measurement Procedure DA 02-2138 "Measurement Procedure Updated for Peak Transmit Power in the UNII Bands" was implemented to determine the Peak Excursion Ratio. This is a conducted measurement using a spectrum analyzer. The Peak Excursion Ratio is the difference in amplitude (dB) between the two traces.

Test Measurement Set up



Measurement set up for Peak Excursion Ratio

Measurement Results for Peak Excursion Ratio

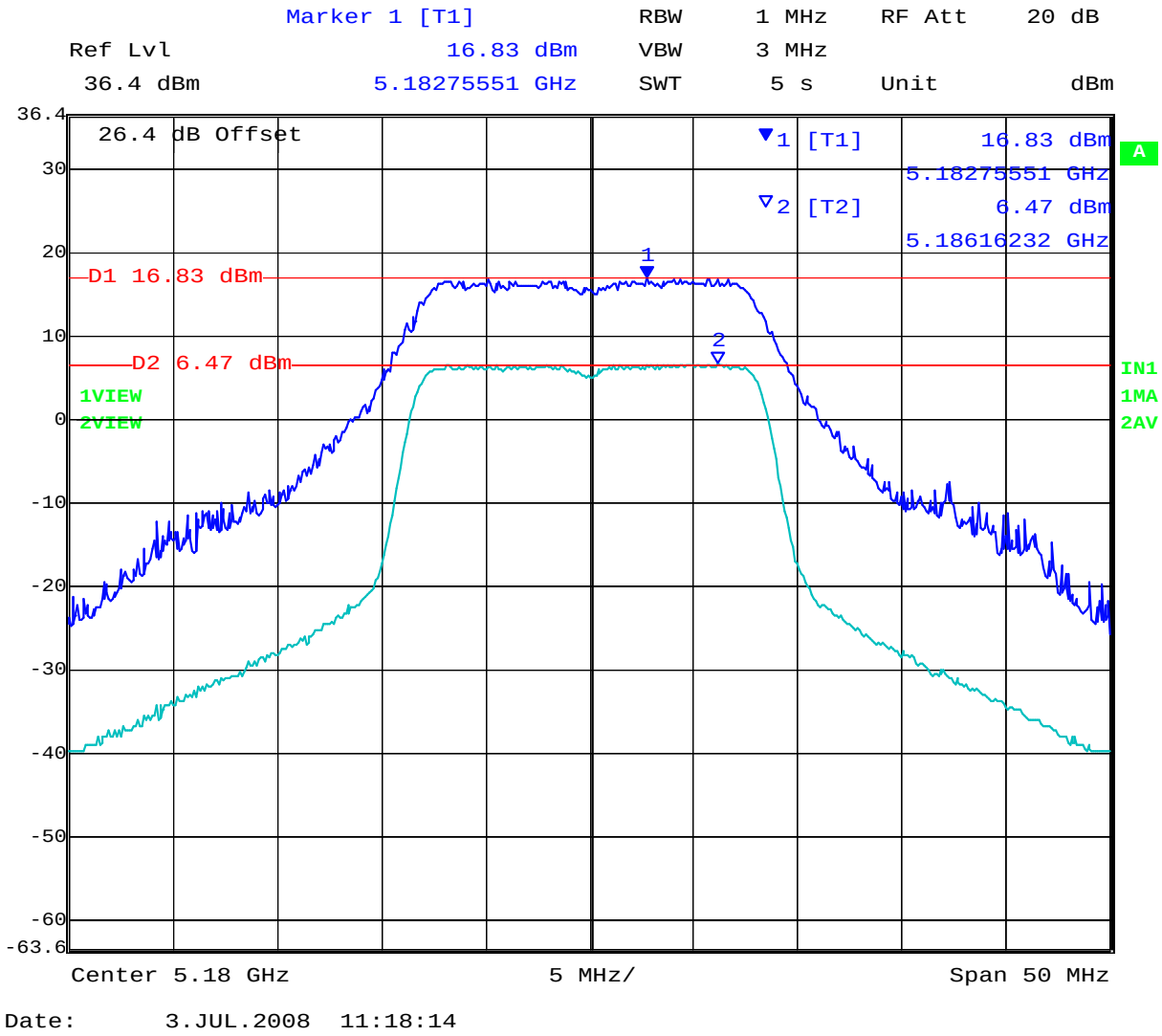
Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57% Pressure: 999 to 1012 mbar

Radio Parameters
Duty Cycle: 100%
Output: Modulated Carrier
Power: Maximum Default Power

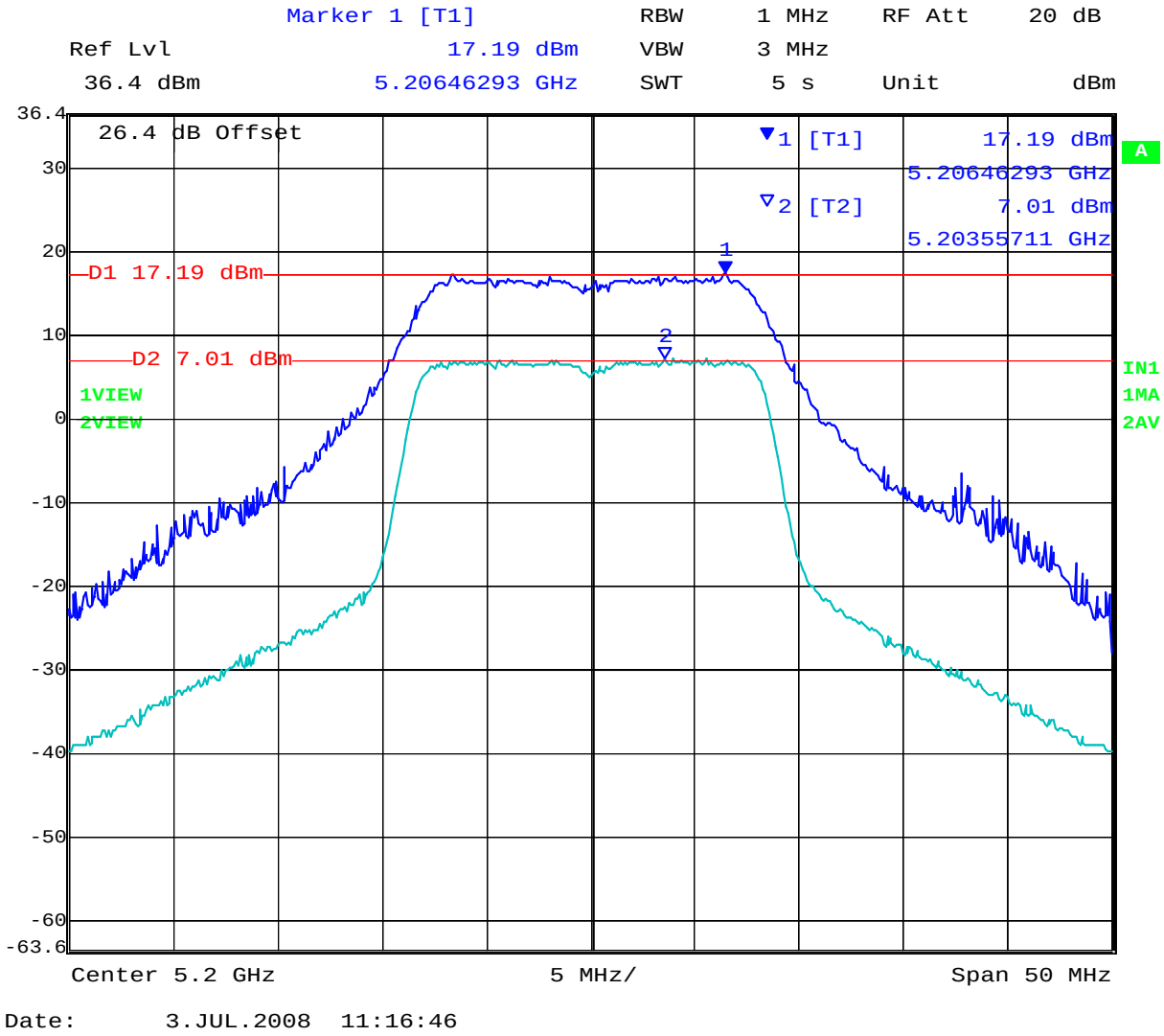
TABLE OF RESULTS – **802.11a Legacy**

Centre Frequency (MHz)	Peak Excursion Ratio (dB)
5,180	10.36
5,200	10.18
5,240	9.80

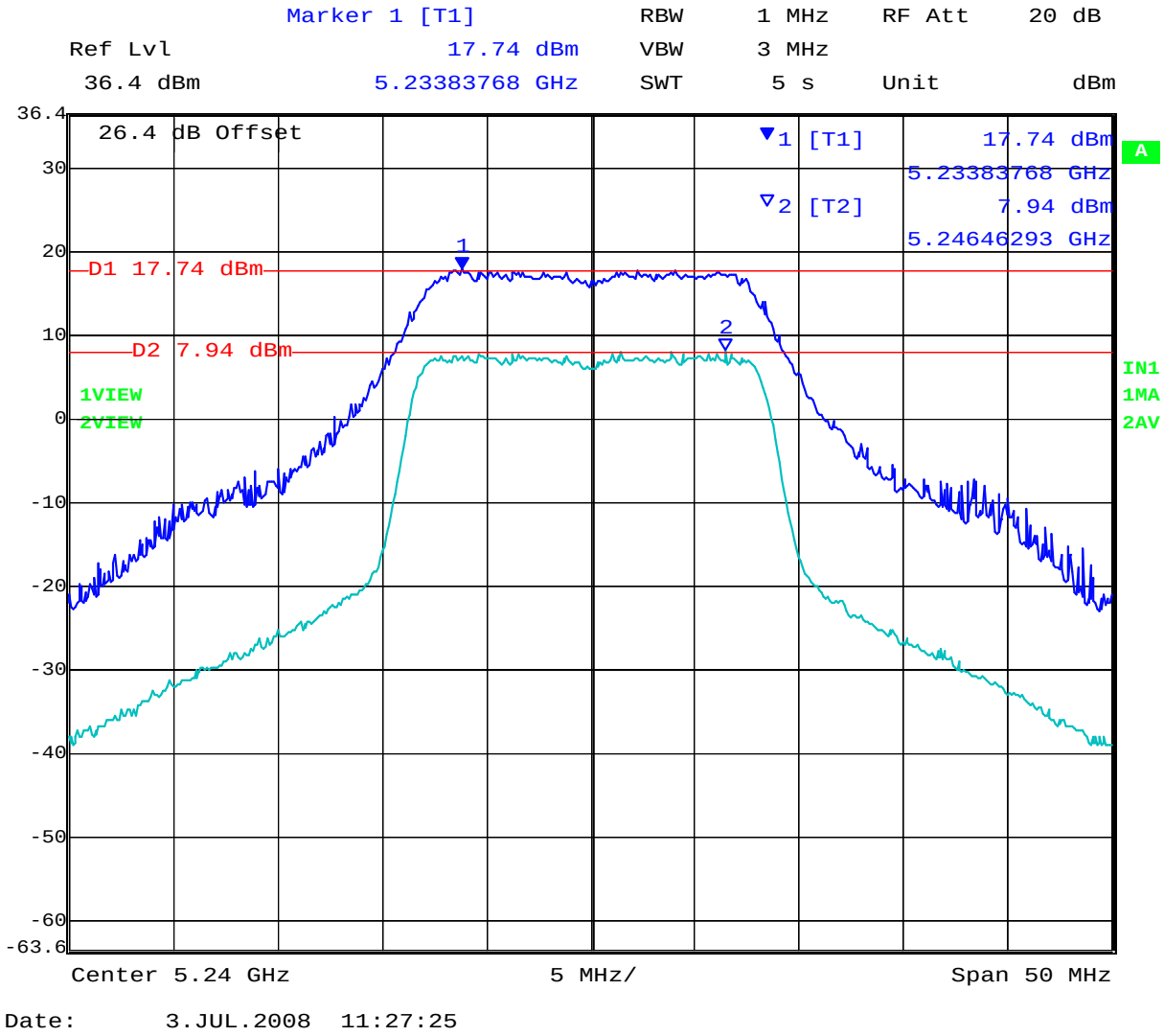
5,180 MHz 802.11a Legacy - Peak Excursion Ratio



5,200 MHz 802.11a Legacy - Peak Excursion Ratio



5,240 MHz 802.11a Legacy - Peak Excursion Ratio

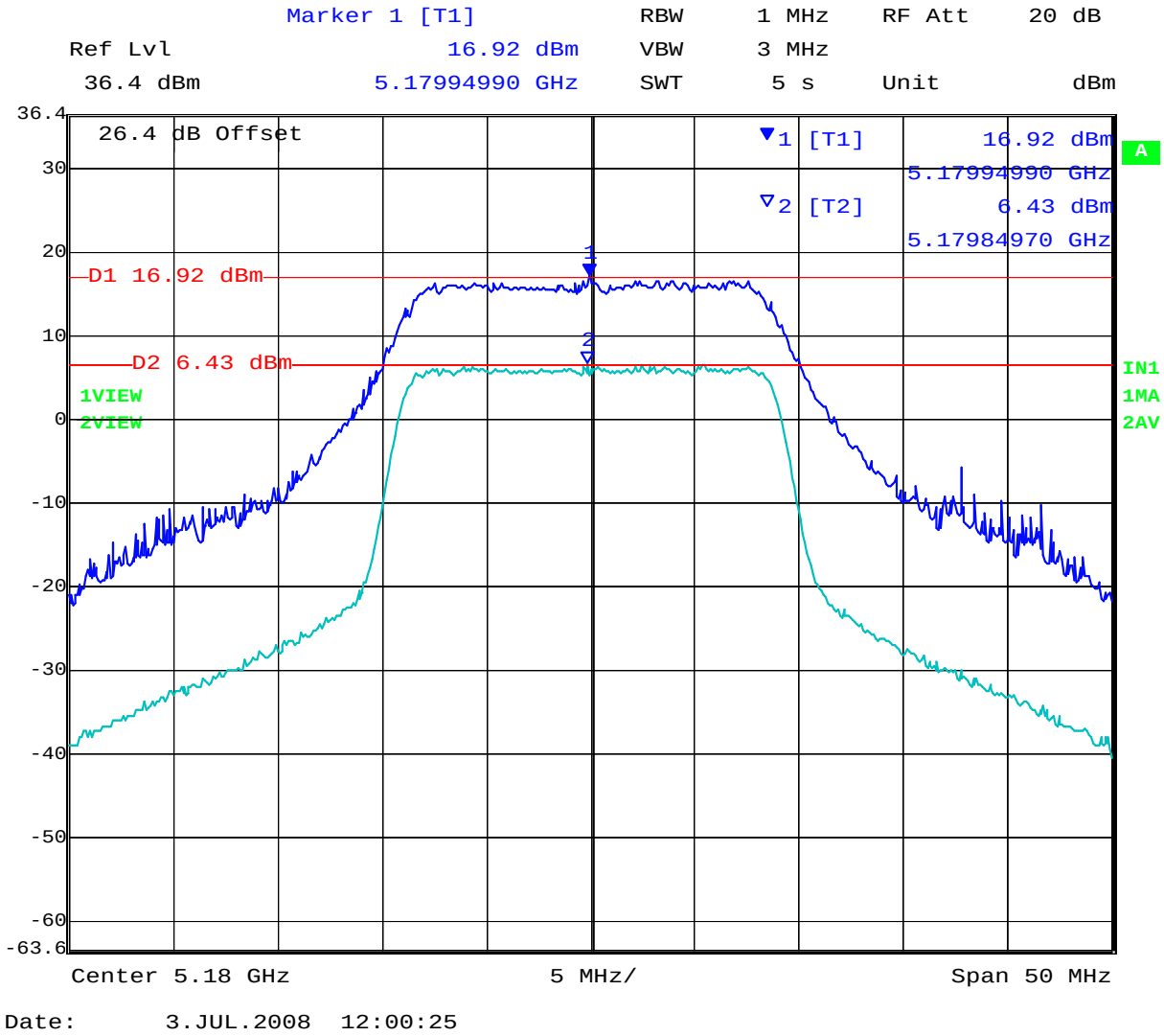


Date: 3.JUL.2008 11:27:25

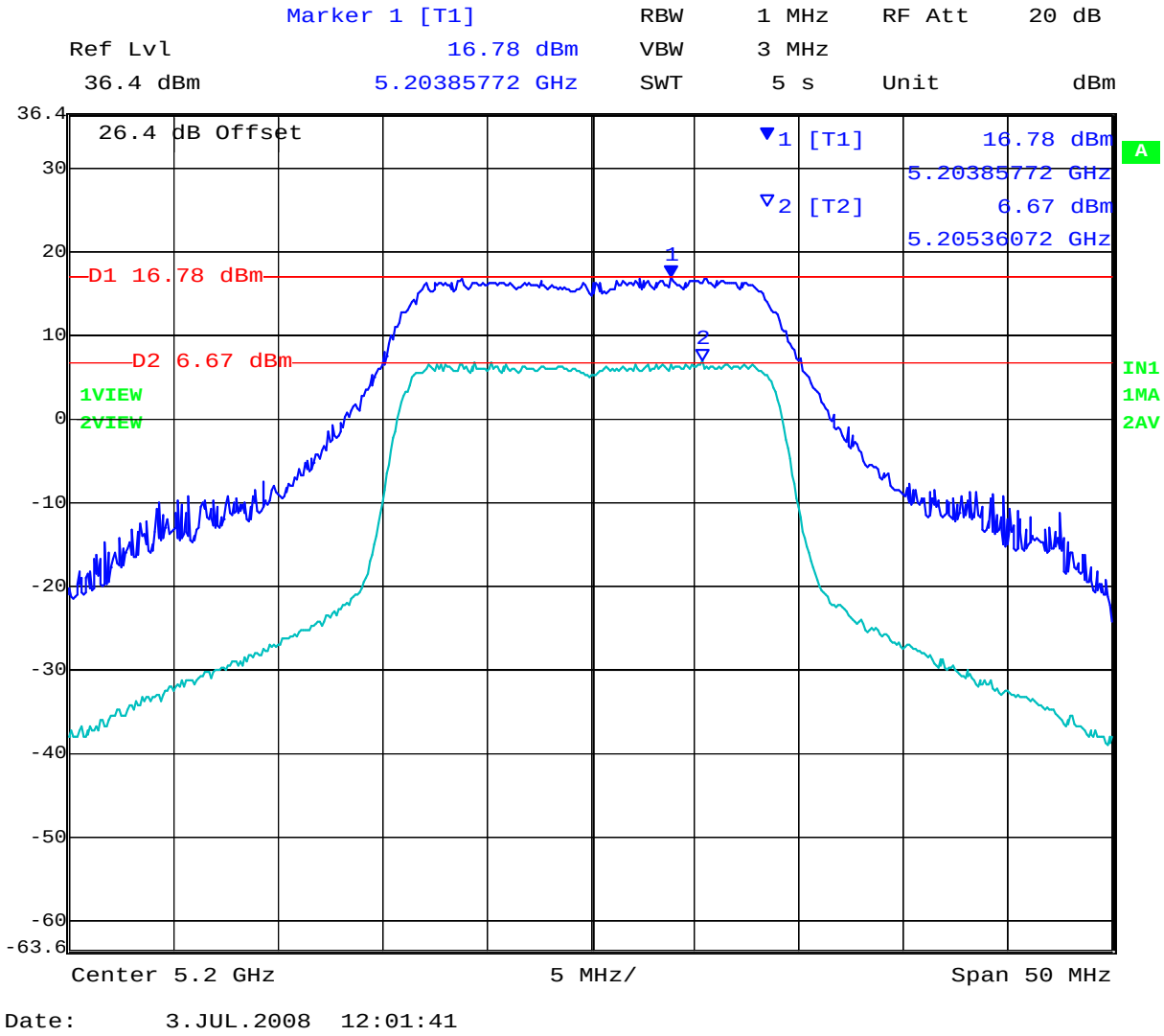
TABLE OF RESULTS – **802.11n HT20**

Centre Frequency (MHz)	Peak Excursion Ratio (dB)
5,180	10.49
5,200	10.11
5,240	9.82

5,180 MHz 802.11n HT20 - Peak Excursion Ratio



5,200 MHz 802.11n HT20 - Peak Excursion Ratio



5,240 MHz 802.11n HT20 - Peak Excursion Ratio

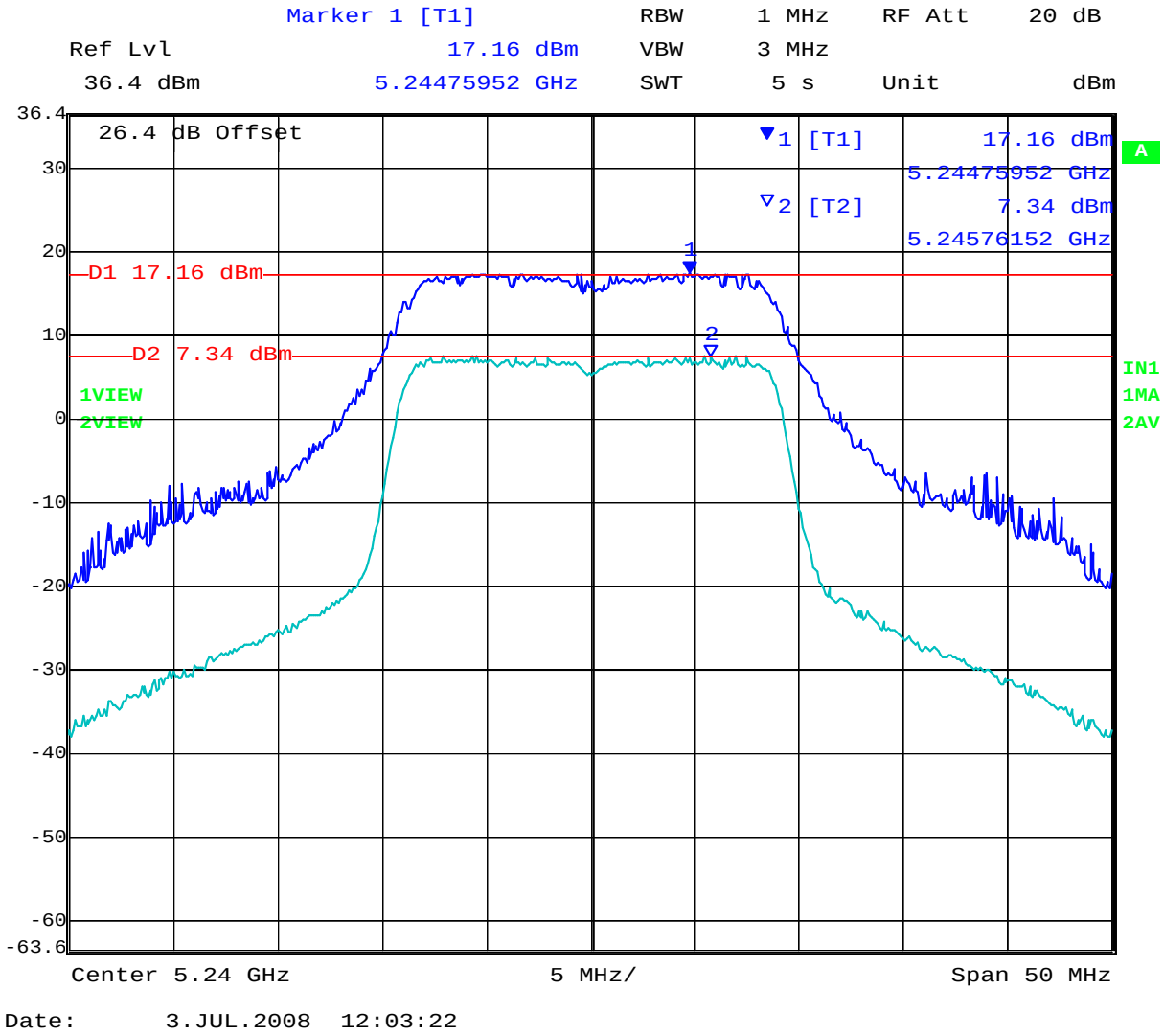
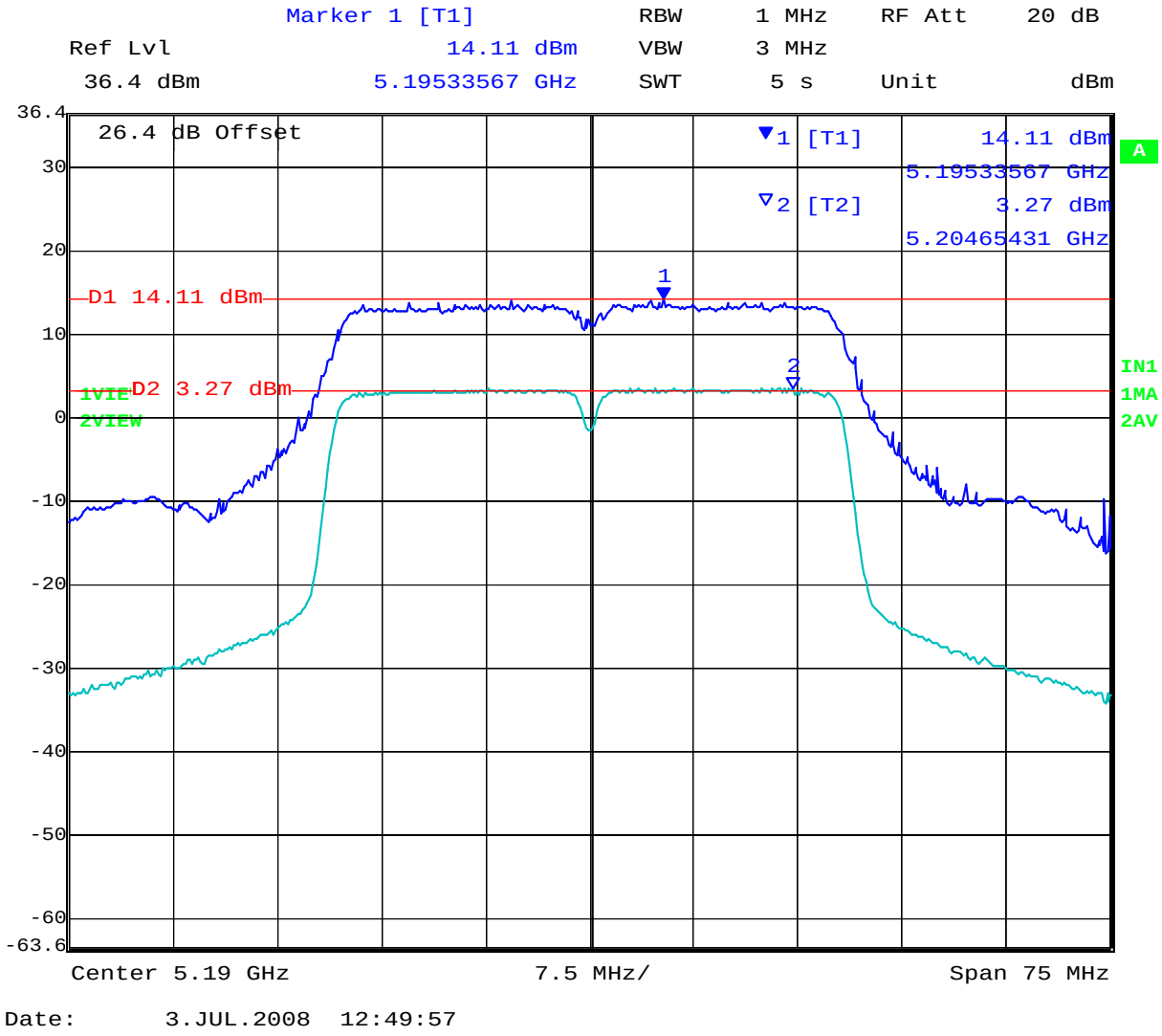


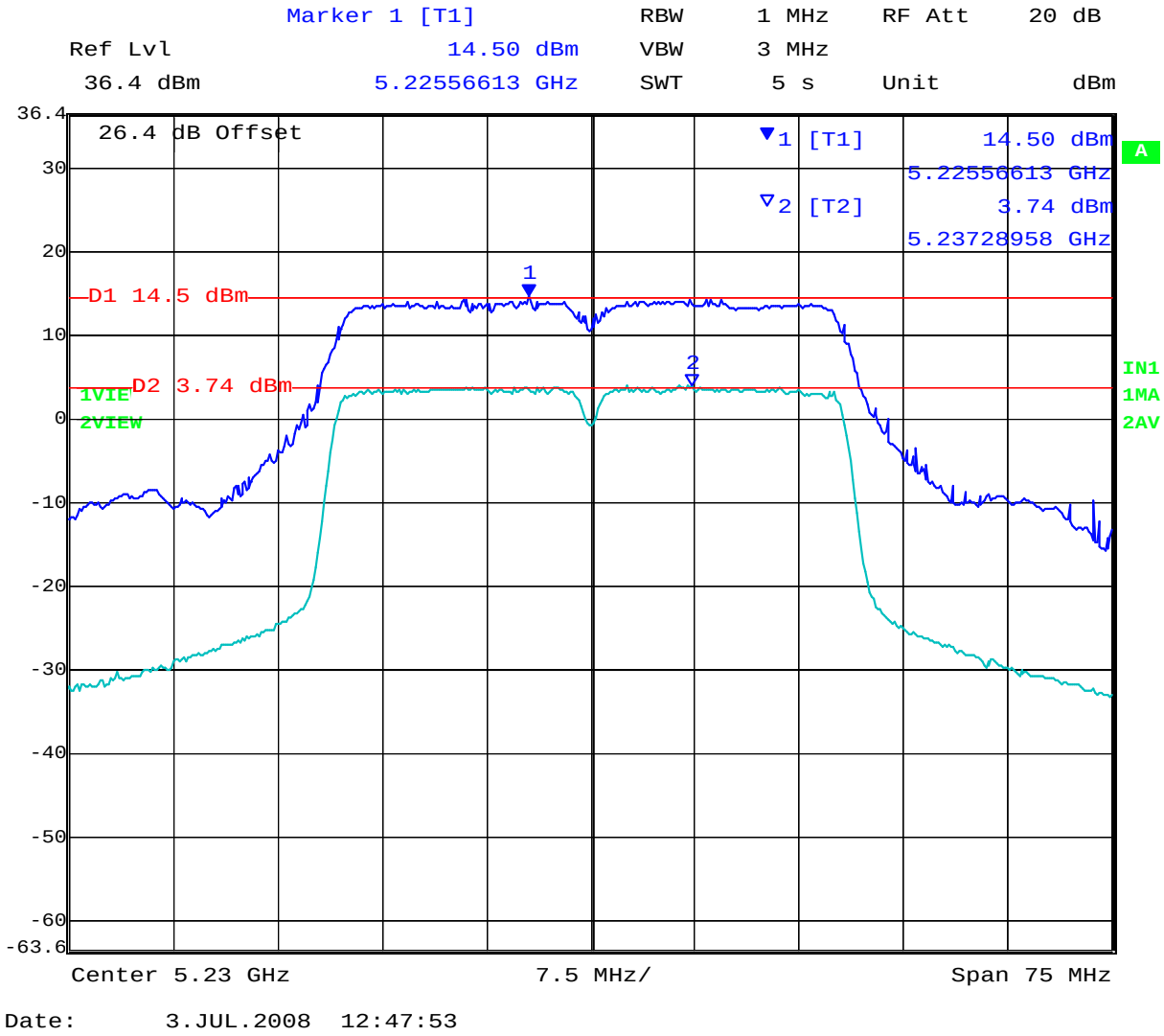
TABLE OF RESULTS – **802.11n HT40**

Centre Frequency (MHz)	Peak Excursion Ratio (dB)
5,190	10.84
5,230	10.76

5,190 MHz 802.11n HT40 - Peak Excursion Ratio



5,230 MHz 802.11n HT40 - Peak Excursion Ratio



Date: 3.JUL.2008 12:47:53

Specification

Limits

§15.407 (a)(6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified in this paragraph) shall not exceed 13dB across any 1MHz bandwidth or the emission bandwidth whichever is less

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	± 2.81dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

5.1.5. Frequency Stability

FCC, Part 15 Subpart C §15.407(g)
Industry Canada RSS-210 §2.1

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.

5.1.6. Maximum Permissible Exposure

FCC, Part 15 Subpart C §15.407(f)
Industry Canada RSS-Gen §5.5

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm^2) = EIRP/(4πd^2)

EIRP = P * G * 3

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

Numeric Gain = 10 ^ (G (dBi)/10)

The Aruba AP-105 has two transmitters. The peak power in the table below is calculated by assuming a worst case scenario where the two transmitters are operating simultaneously in the same band. The Peak Power in mW is calculated by taking the maximum conducted power measured in each band and multiplying by 2.

Because the EUT belongs to the General Population/Uncontrolled Exposure the limit of power density is 1.0 mW/cm^2

Freq. Band (MHz)	Antenna Gain (dBi)	Numeric Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Calculated Safe Distance @ 1mW/cm^2 Limit(cm)	Minimum Separation Distance (cm)
5150 - 5250	4.0	2.51	+16.76	95.0	4.3	20

Note: for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

Specification
Maximum Permissible Exposure Limits

FCC §1.1310 Limit = 1mW / cm^2 from 1.310 Table 1

RSS-Gen §5.5 Before equipment certification is granted, the application requirements of RSS-102 shall be met.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

5.1.7. Radiated Emissions

5.1.7.1. Transmitter Radiated Spurious Emissions (above 1 GHz); Peak Field Strength Measurements; and Radiated Band Edge Measurements – Restricted Bands

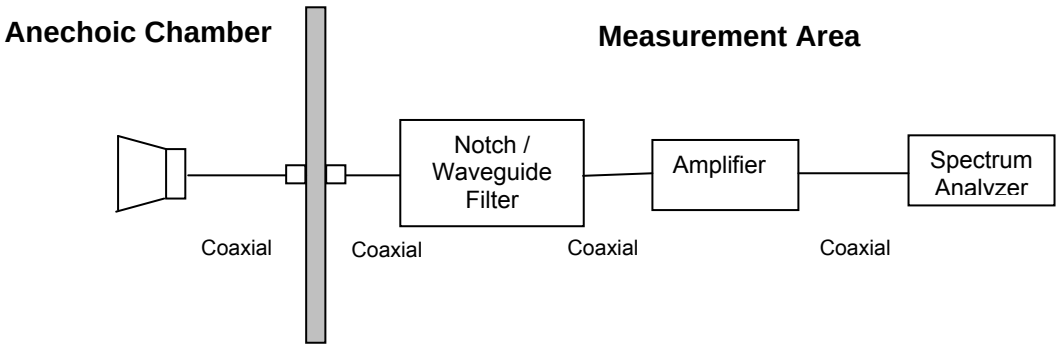
FCC, Part 15 Subpart C §15.407(b)(2), §15.205(a)/15.209(a)
Industry Canada RSS-210 §A9.3(2); §2.2; §2.6; RSS-Gen §4.7

Test Procedure

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

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

where: 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

For 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

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

$$E = 1000000 \times \sqrt{30P} / 3 \ \mu V/m$$

where P is the EIRP in Watts

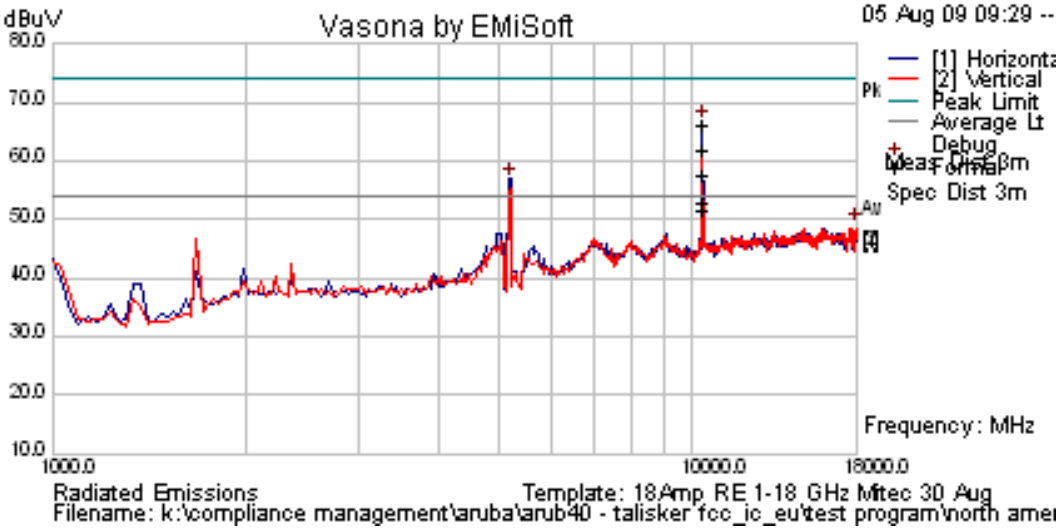
Therefore: -27 dBm/MHz = 68.23 dBuV/m

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 peak emissions are less than 68.23 dB μV/m.

Measurement Results Transmitter Radiated Spurious Emissions above 1 GHz

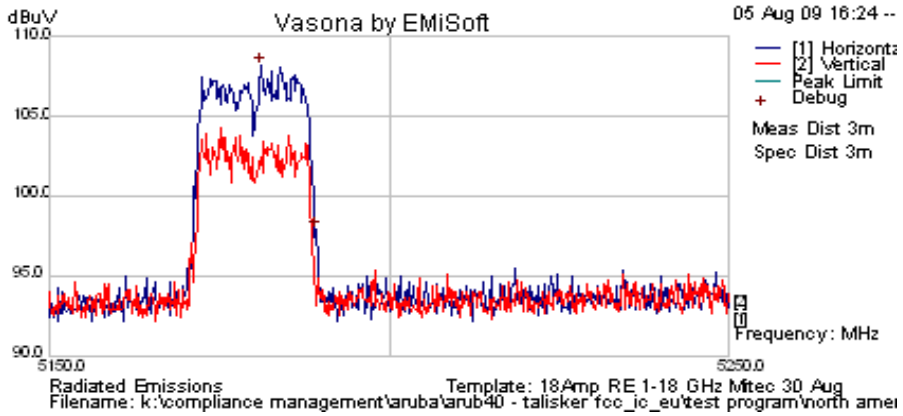
Ambient conditions.
Temperature: 17 to 23°C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5180 MHz
Antenna Model	Integral
Power setting	15.5 in ART test utility
Test Conditions	802.11a; 6 Mbps 120V AC Mains - Ethernet cable attached for ART control

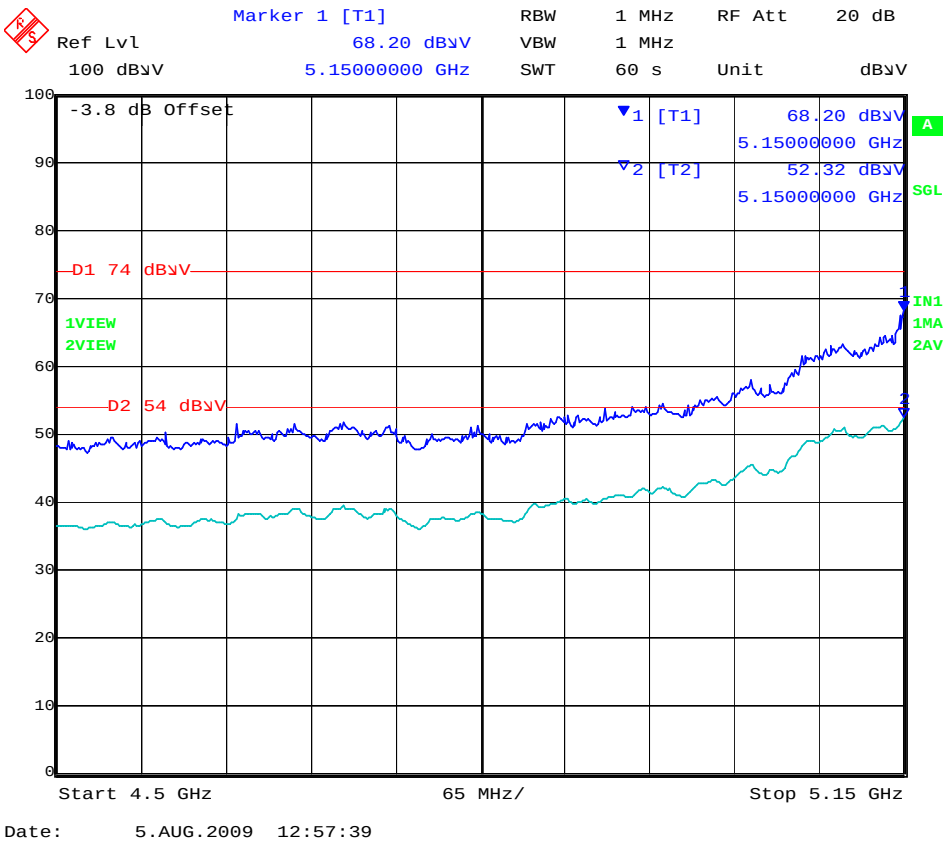


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5150.00	ART Power = 15.5			68.20	Peak				74	-5.8	Pass	BE
5150.00				52.32	Average				54	-1.68	Pass	BE
5181.06	58.88	14.62	34.65	108.1	Peak	H						FUND
10360.10	68.78	6.69	-0.24	75.24	Peak	V	122	313	68.23	-7.01	Pass	NRB
15533.95	48.43	8.27	-0.75	55.94	Peak	H	98	311	74	-18.06	Pass	RB
15533.95	34.19	8.27	-0.75	41.71	Average	H	98	311	54	-12.29	Pass	RB

Peak Emission Scan

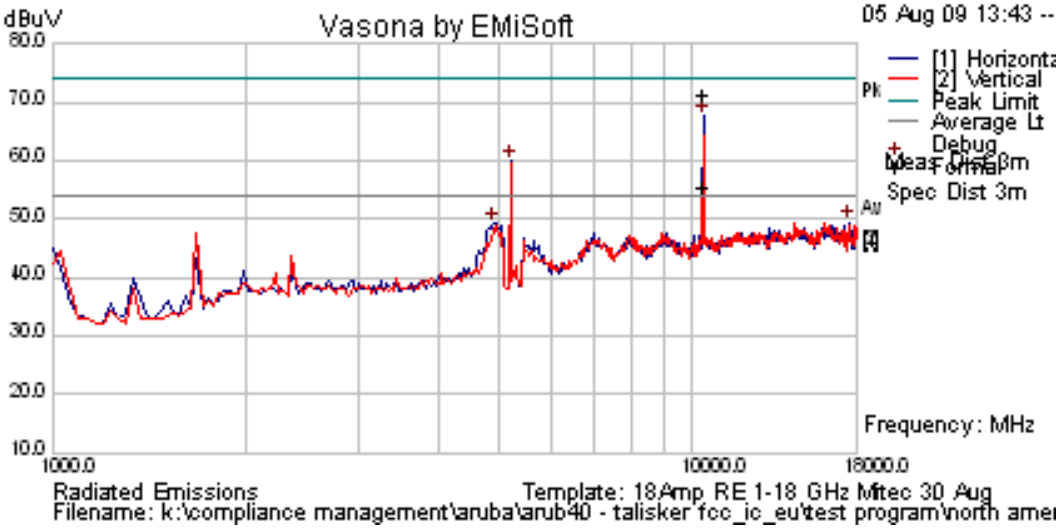


Band-Edge Emission Scan - 802.11a 4500 to 5150 MHz



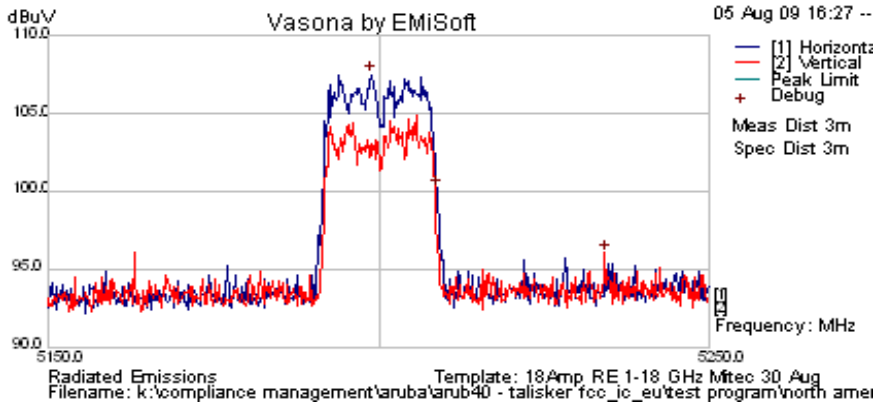
Date: 5.AUG.2009 12:57:39

Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5200 MHz
Antenna Model	Integral
Power setting	15.5 in ART test utility
Test Conditions	802.11a; 6 Mbps 120V AC Mains - Ethernet cable attached for ART control

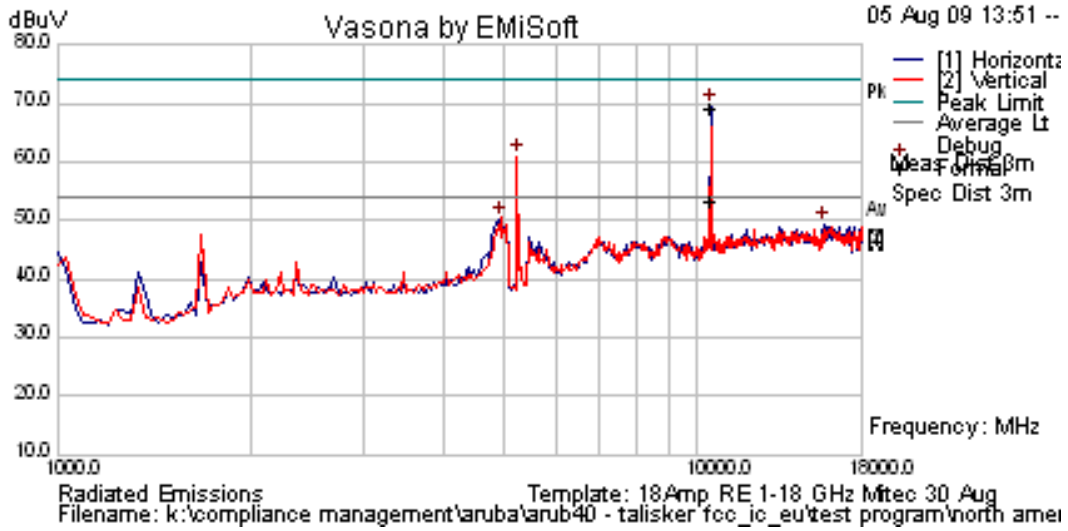


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5198.697	58.25	14.62	34.66	107.5	Peak	H						FUND
10400.78	68.65	6.72	-0.29	75.08	Peak	V	98	315	68.23	-6.85	Pass	NRB

Peak Emission Scan



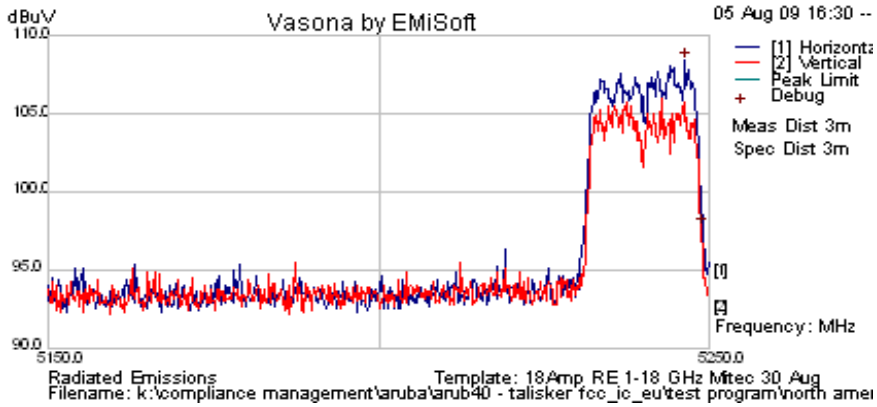
Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5240 MHz
Antenna Model	Integral
Power setting	15.5 in ART test utility
Test Conditions	802.11a; 6 Mbps 120V AC Mains - Ethernet cable attached for ART control



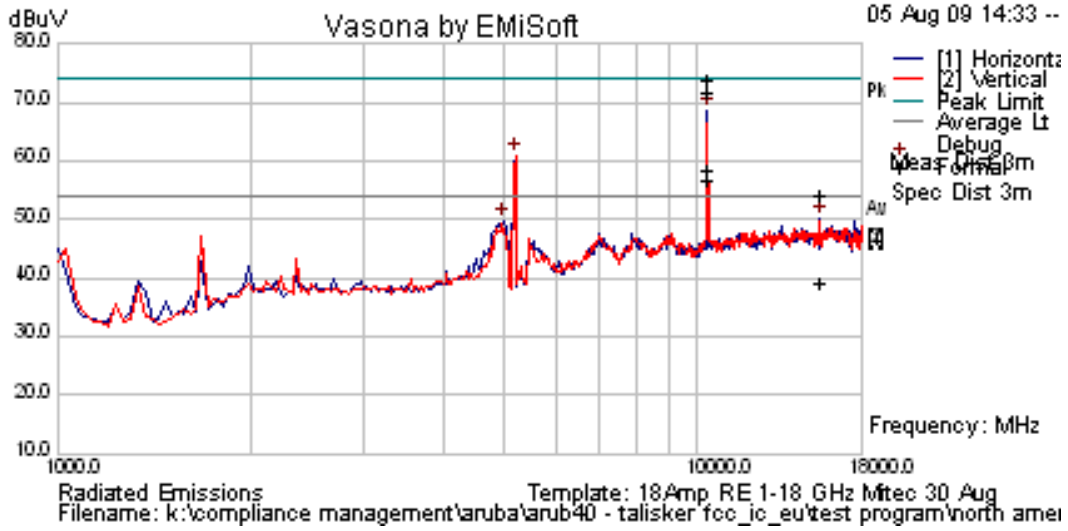
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5246.393	59.1	14.62	34.7	108.4	Peak	H						FUND
10480.1	66.71	6.77	-0.52	72.96	Peak	V	98	315	68.23	-4.73	Pass	NRB

This test report may be reproduced in full only. The document may only be updated by MiCOM Labs personnel. Any changes will be noted in the Document History section of the report.

Peak Emission Scan

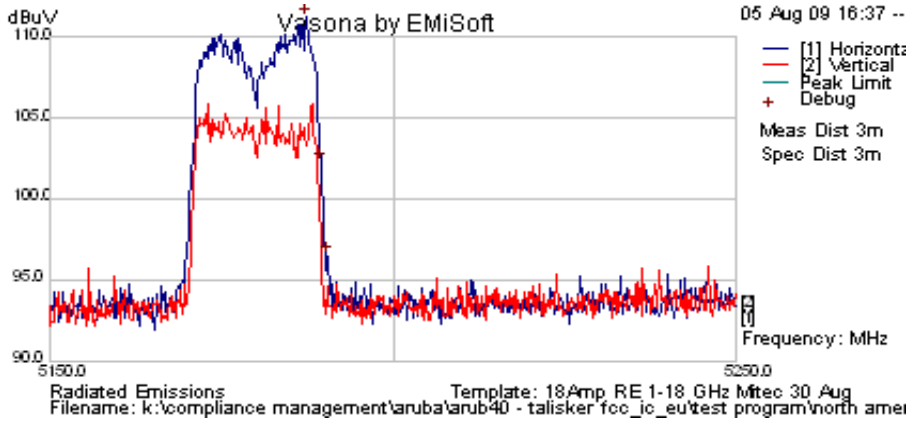


Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5180 MHz
Antenna Model	Integral
Power setting	15 in ART test utility
Test Conditions	802.11n HT-20; 6.5 MCS 120V AC Mains - Ethernet cable attached for ART control

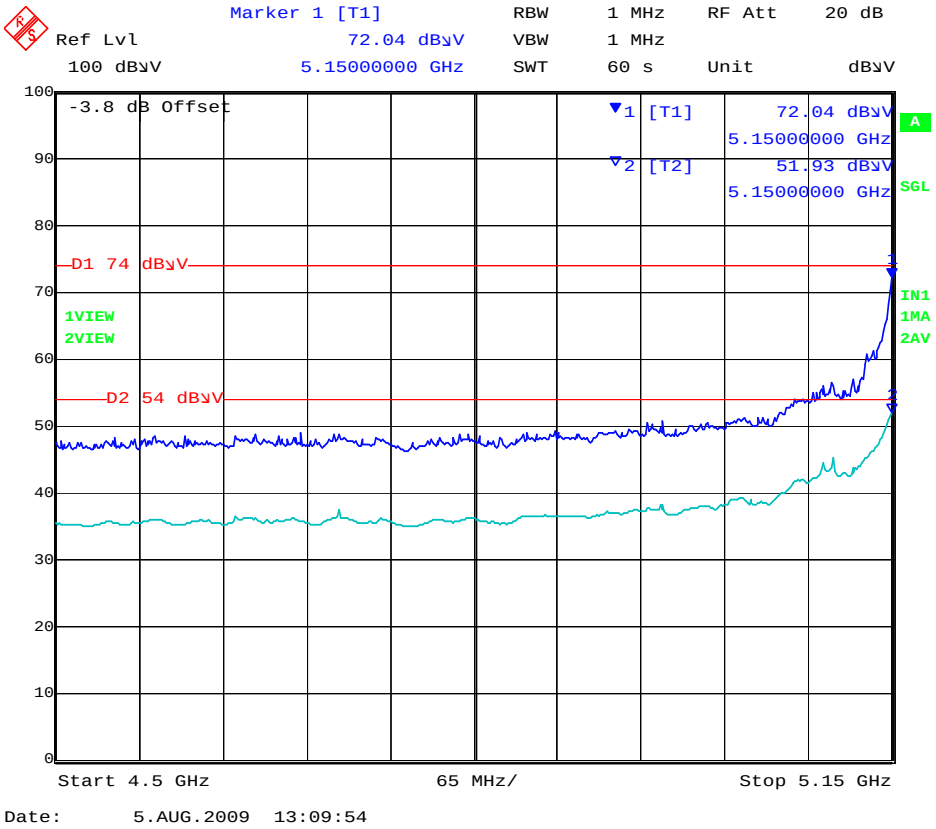


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5150	ART Power = 15.0			72.04	Peak				74	-1.96	Pass	BE
5150				51.93	Average				54	-2.07	Pass	BE
5187.275	61.97	14.62	34.65	111.3	Peak	H						FUND
10360.86	63.43	6.7	-0.23	69.89	Peak	V	100	315	68.23	-1.66	Pass	NRB
15534.94	48.05	8.27	-0.75	55.56	Peak	H	101	25	74	-18.44	Pass	RB
15534.94	32.76	8.27	-0.75	40.27	Average	H	101	25	54	-13.73	Pass	RB

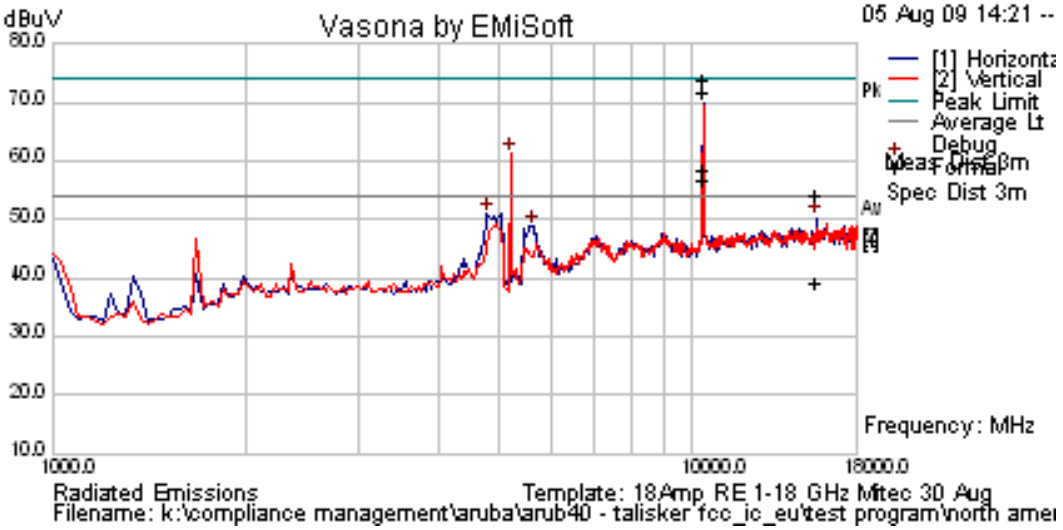
Peak Emission Scan



Band-Edge Emission Scan - 802.11 HT-20 4500 to 5150 MHz

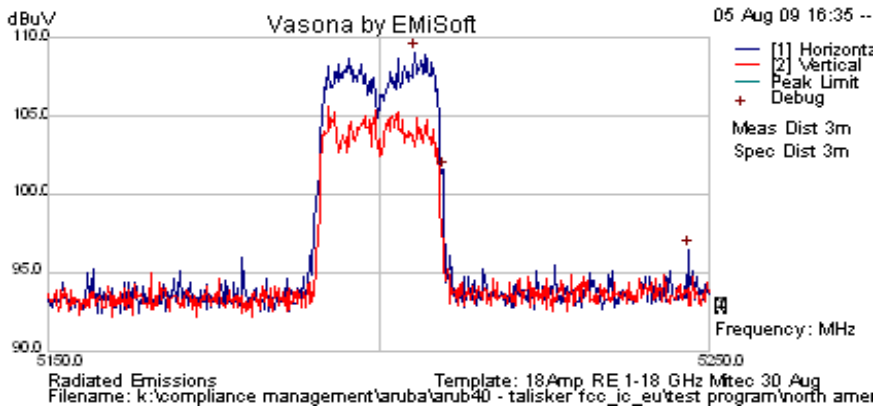


Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5200 MHz
Antenna Model	Integral
Power setting	15 in ART test utility
Test Conditions	802.11n HT-20; 6.5 MCS 120V AC Mains - Ethernet cable attached for ART control

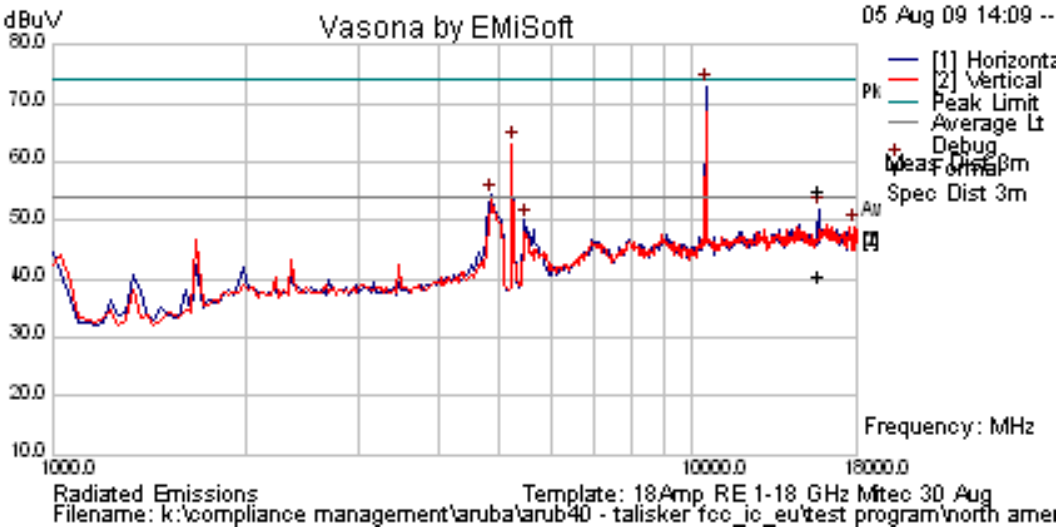


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5205.311	59.82	14.62	34.67	109.1	Peak	H						FUND
10400.48	67.28	6.72	-0.28	73.72	Peak	V	98	315	68.23	-5.49	Pass	NRB
15605.04	46.64	8.38	-0.75	54.27	Peak	H	110	0	74	-19.73	Pass	RB
15605.04	31.43	8.38	-0.75	39.06	Average	H	110	0	54	-14.94	Pass	RB

Peak Emission Scan

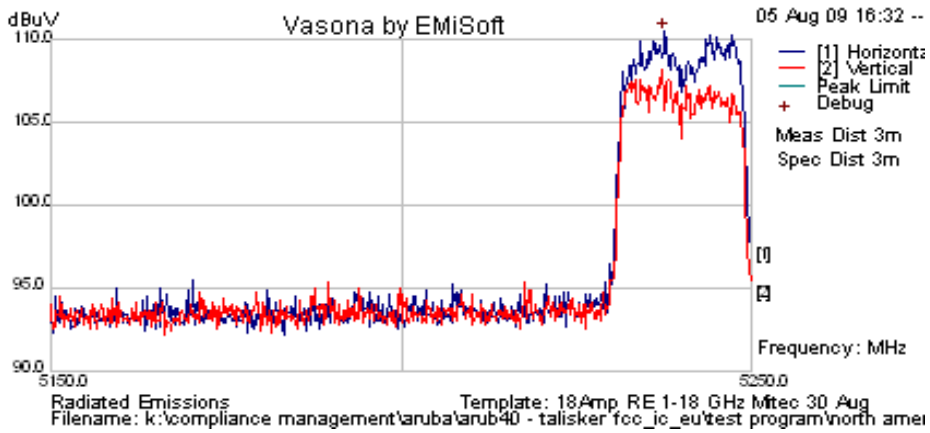


Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5240 MHz
Antenna Model	Integral
Power setting	15 in ART test utility
Test Conditions	802.11n HT-20; 6.5 MCS 120V AC Mains - Ethernet cable attached for ART control

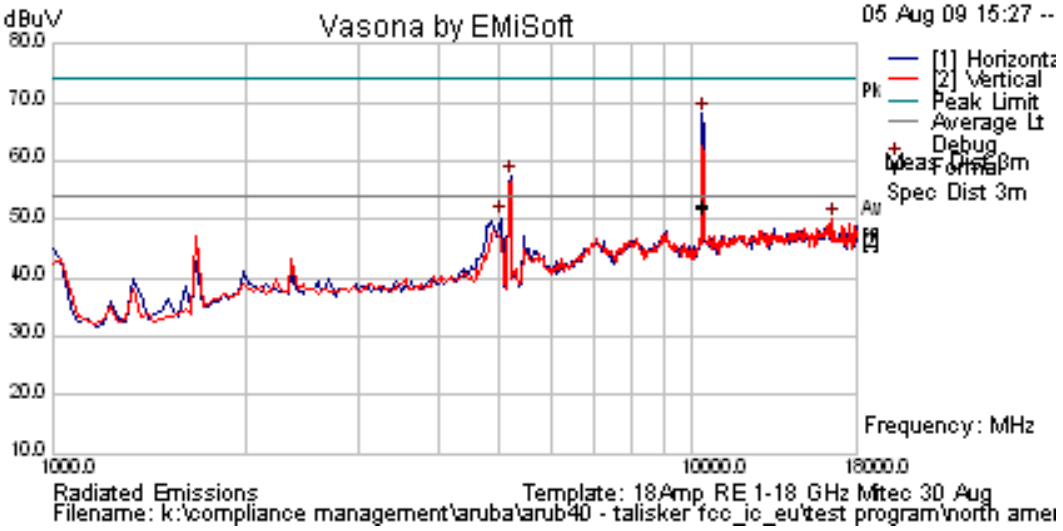


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5237.575	61.17	14.62	34.69	110.5	Peak	H						FUND
10478.81	65.24	6.77	-0.52	71.49	Peak	V	98	315	68.23	-3.26	Pass	NRB
15728.58	47.28	8.58	-0.62	55.24	Peak	H	98	355	74	-18.76	Pass	RB
15728.58	32.37	8.58	-0.62	40.34	Average	H	98	355	54	-13.66	Pass	RB

Peak Emission Scan

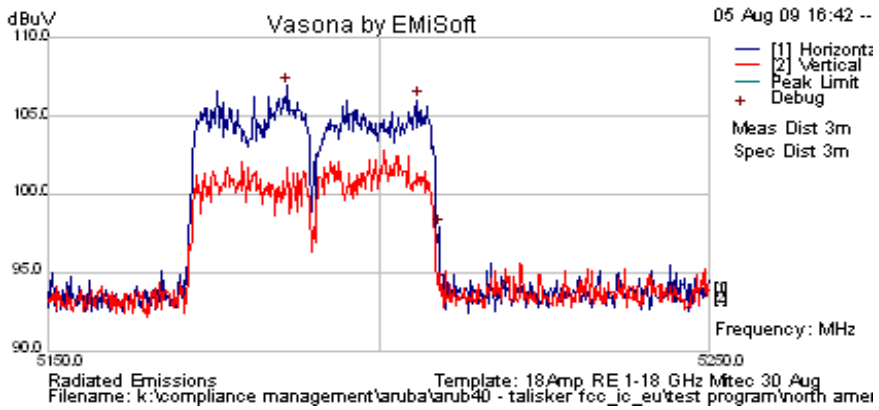


Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5190 MHz
Antenna Model	Integral
Power setting	13.5 in ART test utility
Test Conditions	802.11n HT-40; 13.5 MCS 120V AC Mains - Ethernet cable attached for ART control

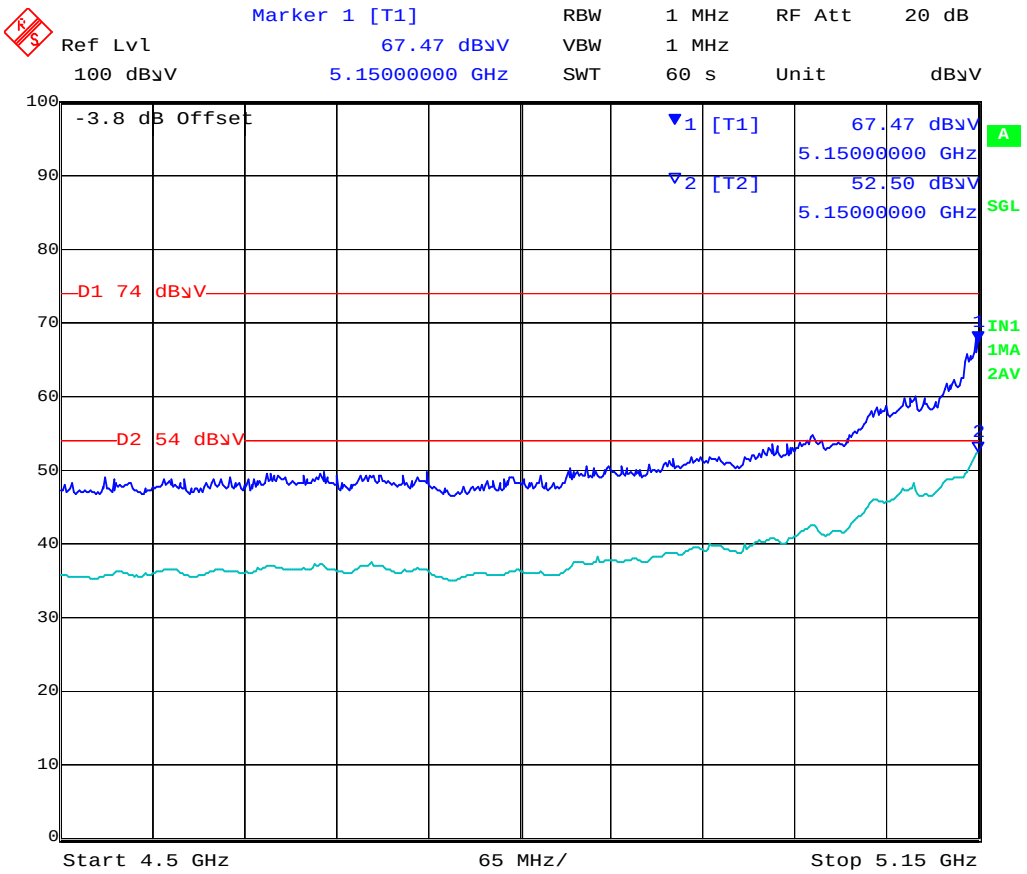


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5150	ART Power = 13.5			67.47	Peak				74	-6.53	Pass	BE
5150				52.5	Average				54	-1.5	Pass	BE
5186.072	57.66	14.62	34.65	106.9	Peak	H						FUND
10380.88	62.4	6.71	-0.23	68.88	Peak	V	108	315	68.23	-0.65	Pass	NRB

Peak Emission Scan



Band-Edge Emission Scan - 802.11 HT-40 4500 to 5150 MHz



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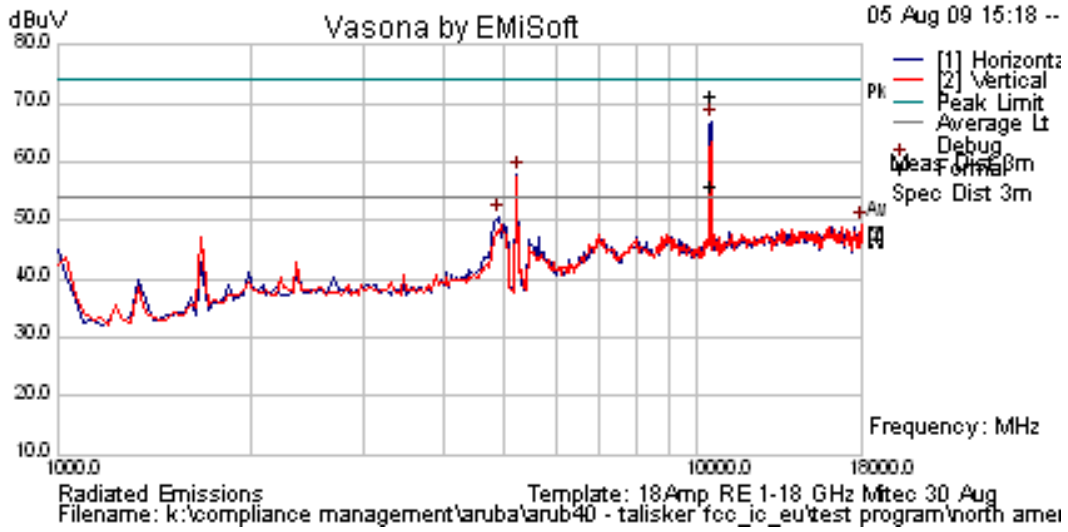
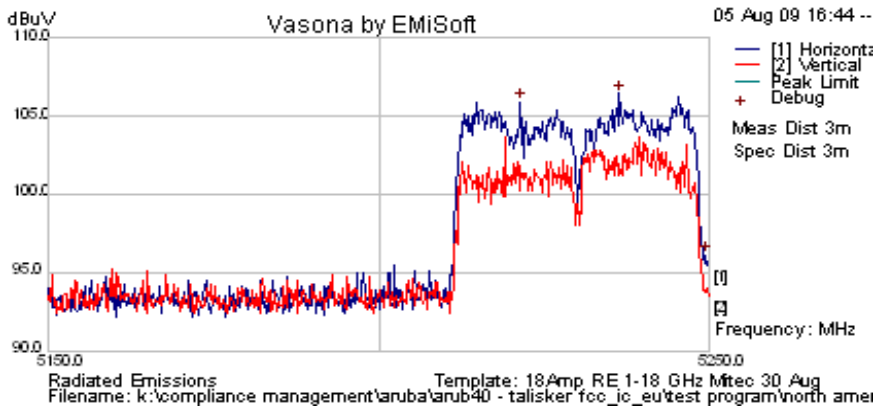
Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Frequency	5230 MHz
Antenna Model	Integral
Power setting	13.5 in ART test utility
Test Conditions	802.11n HT-40; 13.5 MCS 120V AC Mains - Ethernet cable attached for ART control



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
5236.373	57.14	14.62	34.69	106.5	Peak	H						FUND
10460.02	65.11	6.76	-0.46	71.4	Peak	V	109	315	68.23	-3.17	Pass	NRB

Peak Emission Scan



Specification

Limits

15.407 (b)(2). All emissions outside of the 5,150-5,350MHz band shall not exceed an EIRP of -27dBm/MHz.

§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.

RSS-210 §A9.3(2) For transmitters operating in the 5250-5350 MHz band, all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz e.i.r.p. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band shall not exceed out of band emission limit of 27 dBm/MHz e.i.r.p. in the 5150-5250 MHz band in order to operate indoor/outdoor, or alternatively shall comply with the spectral power density for operation within the 5150-5250 MHz band and shall be labeled "for indoor use only".

RSS-Gen §4.7 The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

RSS-Gen §6 Receiver Spurious Emission Standard
If a radiated measurement is made, all spurious emissions shall comply with the limits of the following Table. The resolution bandwidth of the spectrum analyzer shall be 100 kHz for spurious emission measurements below 1.0 GHz and 1.0 MHz for measurements above 1.0 GHz

§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

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

5.1.7.2. Receiver Radiated Spurious Emissions (above 1 GHz)

Industry Canada RSS-Gen §4.8, §6

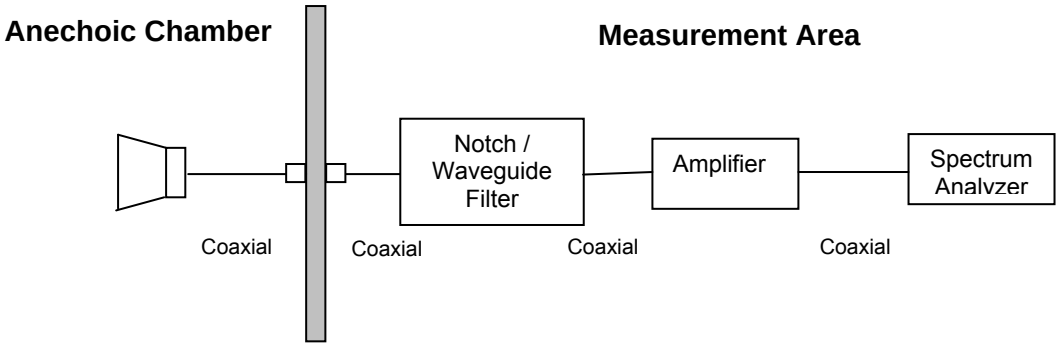
Test Procedure

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

All Sectors of the EUT were tested simulatneously

Test Measurement Set up



Measurement set up for Radiated Emission Test

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

where: 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

For 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:

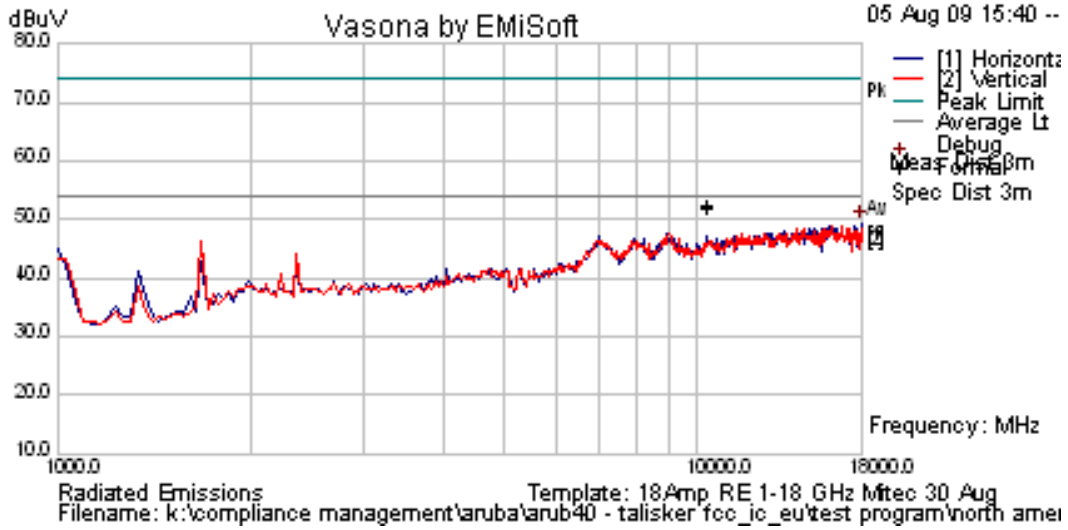
Level (dBμV/m) = 20 * Log (level (μV/m))

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

Section 5.1.6.1 Transmitter Spurious above 1 GHz identifies that emissions peaking above 54 dBμV/m emanate from the EUT and not transmitted through the antenna port. These (1 – 3.5 GHz) emissions were formally measured and characterized and are not considered when examining Receiver Radiated Spurious above 1 GHz.

Receiver Radiated Spurious Emissions above 1 GHz

Date	5th August, 2009
Engineer	CSB
Test Case	ARUB40
Antenna Model	Integral
Power setting	Receive in ART test Utility
Test Conditions	802.11a/n 120V AC Mains - Ethernet cable attached for ART control



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments

No receiver emissions were observed.

Specification

Receiver Radiated Spurious Emissions

Industry Canada RSS-Gen §4.8,
The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

RSS-Gen §6
The following receiver spurious emission limits shall be complied with;
(a) If a radiated measurement is made, all spurious emissions hall comply with the limits of Table 1.

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

Traceability

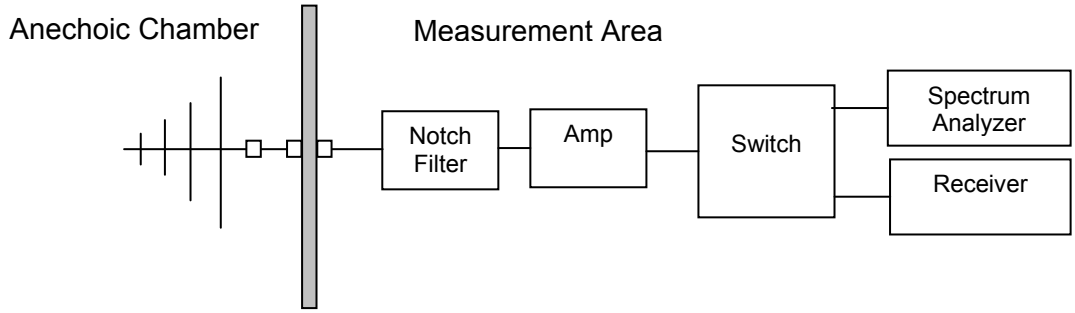
Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

5.1.7.3. Radiated Spurious Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.407(b)(6); §15.205(a); §15.209(a)
Industry Canada RSS-210 §2.2

Test Procedure
Preliminary radiated emissions are measured in the anechoic chamber at a 10-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded with a spectrum analyzer 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.

The EUT had two methods of powering on ac/dc converter and Power over Ethernet, Both modes were tested.



Test Measurement Set up

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

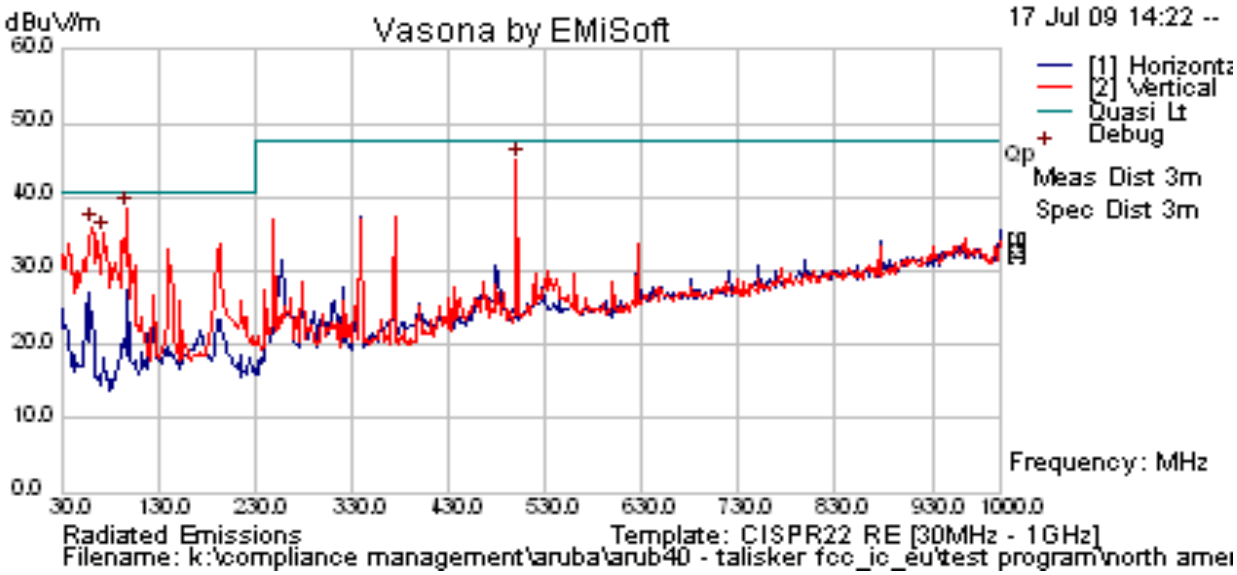
Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

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

For emissions below 1 GHz the AP-105 Wireless Access Point ports were fully loaded and exercised;

TABLE OF RESULTS – AC Power Supply

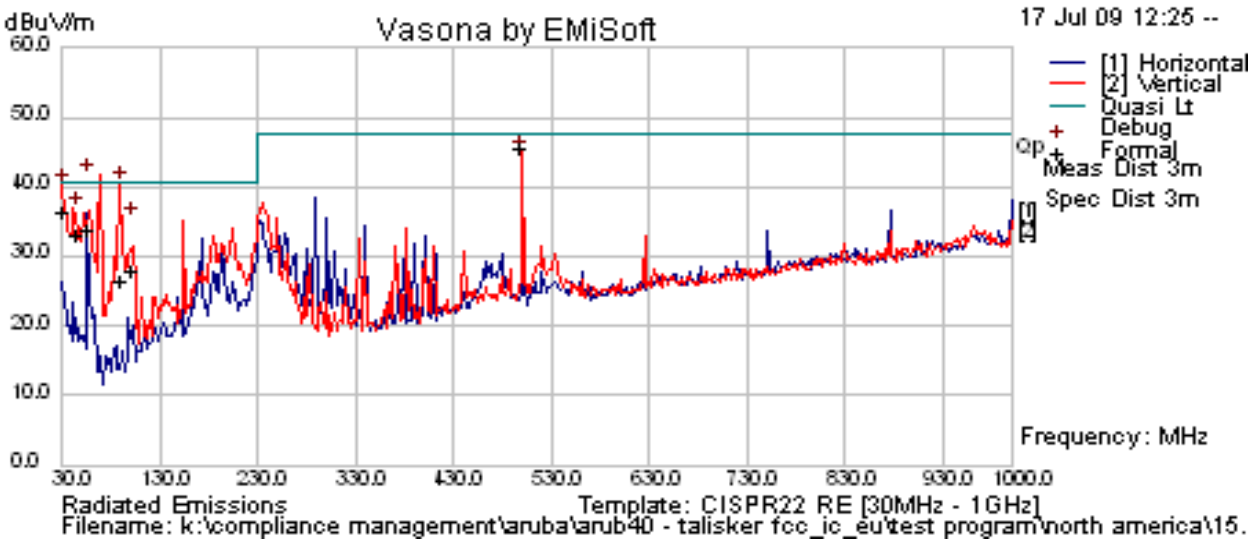
Date	17th July 2009
Engineer	CSB
Test Case	ARUB40
Antenna Model	Integral
Power setting	20 - Art Max
Test Conditions	Ethernet cable connected to PC for ART control AC Power Supply 120 VAC



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
98.059	54.32	4.14	-21.53	36.93	Quasi Max	V	103	200	40.5	-3.57	Pass	
499.992	47.2	6	-12.62	40.58	Quasi Max	V	259	217	47.5	-6.92	Pass	
62.529	53.1	3.84	-23.56	33.38	Quasi Max	V	98	88	40.5	-7.12	Pass	
75.523	49.84	3.94	-23.16	30.62	Quasi Max	V	163	258	40.5	-9.88	Pass	
249.997	45.58	4.99	-18.92	31.65	Quasi Max	V	203	141	47.5	-15.85	Pass	
874.986	29.18	7.24	-7.72	28.7	Quasi Max	V	98	365	47.5	-18.8	Pass	

TABLE OF RESULTS – POE Power Supply

Date	17th July 2009
Engineer	CSB
Test Case	ARUB40
Antenna Model	Integral
Power setting	20 - Art Max
Test Conditions	Ethernet cable connected to PC for ART control POE Power Supply



Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
500.0004	50.1	6.0	-12.62	43.49	Quasi Max	V	104	0	47.5	-4.01	Pass	
31.608	43.84	3.41	-10.95	36.3	Quasi Max	V	113	187	40.5	-4.2	Pass	
57.864	53.76	3.80	-23.82	33.74	Quasi Max	V	103	342	40.5	-6.76	Pass	
45.042	50.15	3.63	-20.67	33.11	Quasi Max	V	107	246	40.5	-7.39	Pass	
102.289	44.09	4.18	-20.29	27.98	Quasi Max	V	109	322	40.5	-12.52	Pass	
92.094	45.33	4.09	-23.11	26.31	Quasi Max	V	145	206	40.5	-14.19	Pass	

Specification

Limits

§15.407(b)(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209.

§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.

RSS-210 §2.2 refers to Section 2.7 Table 2 below;-

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

Traceability

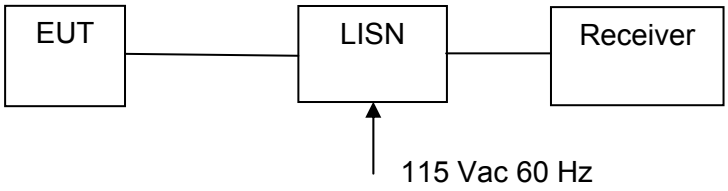
Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

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

FCC, Part 15 Subpart C §15.407(b)(6)/15.207
Industry Canada RSS-Gen §7.2.2

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.

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

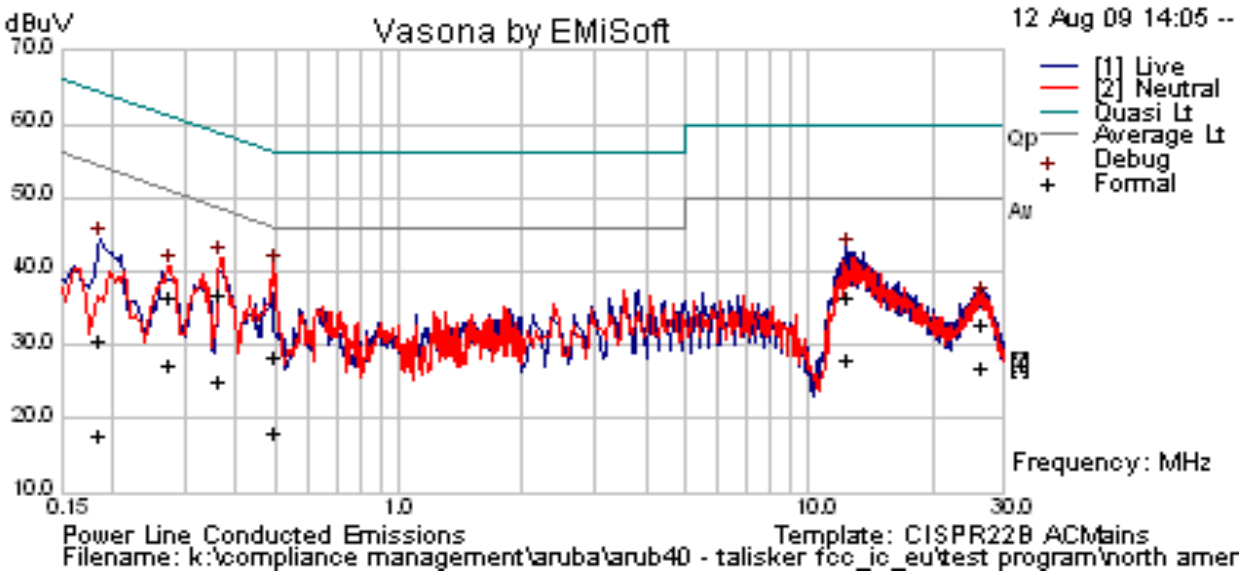
AC Wireline Emissions 115Vac 60Hz
Transmitter Power Level: Maximum

Date	August 12th 2009
Engineer	CSB
Test Case	ARUB40
Antenna Model	Integral Antenna
Power setting	20 - Art Max
Test Conditions	Ethernet cable connected to PC for ART control 120 V AC Mains

TABLE OF RESULTS

Freq (MHz)	Line	Peak (dBμV)	QP (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Ave. (dBμV)	Ave. Limit (dBμV)	Ave. Margin (dB)
0.186	Neutral	44.83	30.54	64.21	-33.67	17.69	54.21	-36.53
0.275	Live	40.65	36.35	60.97	-24.61	27.34	50.97	-23.62
0.366	Live	41.17	36.89	58.59	-21.70	24.91	48.59	-23.68
0.496	Live	41.05	28.25	56.07	-27.82	18.07	46.07	-28.00
12.408	Neutral	43.47	36.48	60.00	-23.52	28.18	50.00	-21.82
26.504	Live	38.16	32.83	60.00	-27.17	27.01	50.00	-22.99

AC Wireline Conducted Emissions 0.15 – 30 MHz, 115 Vac 60 Hz



Specification

Limit

§15.407 (b)(6); Any U-NII devices using an AC power line are required to comply also with the limits set forth in Section 15.207.

§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.

RSS-Gen §7.2.2
The radio frequency voltage that is conducted back into the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The tighter limit applies at the frequency range boundaries.

§15.207 (a) and **RSS-Gen §7.2.2** 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

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0158, 0184, 0287, 0190, 0293, 0307

6. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0088	Spectrum Analyzer	Hewlett Packard	8564E	3410A00141
0134	Amplifier	Com Power	PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0287	EMI Receiver	Rhode & Schwartz	ESIB 40	100201
0252	SMA Cable	Megaphase	Sucoflex 104	None
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001
0313	Coupler	Hewlett Packard	86205A	3140A01285
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623
0070	Power Meter	Hewlett Packard	437B	3125U11552
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001
0301	5.6 GHz Notch Filter	Micro-Tronics	RBC50704	001
0302	5.25 GHz Notch Filter	Micro-Tronics	BRC50703	002
0303	5.8 GHz Notch Filter	Micro-Tronics	BRC50705	003
0304	2.4GHzHz Notch Filter	Micro-Tronics	--	001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002
0335	1-18GHz Horn Antenna	ETS- Lindgren	3117	00066580
0337	Amplifier	MiCOM Labs	--	--
0338	Antenna	Sunol Sciences	JB-3	A052907

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440 Boulder Court, Suite 200
Pleasanton, CA 94566, USA
Tel: 1.925.462.0304
Fax: 1.925.462.0306
www.micomlabs.com