Test of AP-175P / MSR2K23N0-XX
802.11a/b/g/n AP

To: FCC 47 CFR Part 90 & IC RSS 111

Test Report Serial No.: ARUB61-U4 Rev A

MiCOM Labs

opening wireless markets

TEST REPORT

FROM

Test of Aruba Networks, Inc AP-175P / MSR2K23N0-XX 802.11a/b/g/n AP

To FCC 47 CFR Part 90 & IC RSS 111

Test Report Serial No.: ARUB61-U4 Rev A

This report supersedes NONE

Manufacturer: Aruba Networks, Inc
1344 Crossman Avenue
Sunnyvale
California 94089, USA

Product Function: Wireless Access Point Operating at 4.9 GHz

Copy No: pdf **Issue Date:** 1st November 2010

This Test Report is Issued Under the Authority of;

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ACCREDITED

TESTING CERTIFICATE #2381.01

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ACCREDITATION, LISTINGS & RECOGNITION

1.1. ACCREDITATION

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

ilac-MRA

A2LA The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Laboratory

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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*).

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION CORPORATE SEAL 1978 DISTRICT OF COLUMBIA A2LA

Presented this 14th day of April 2010.

President & CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2011

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

1.2. 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

1.3. 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	
Vietnam	Ministry of Information and Communications	I	

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	1st November 2010	Initial Release

2. TEST RESULT CERTIFICATE

Manufacturer:	Aruba Networks, Inc 1344 Crossman Avenue, Sunnyvale California 94089, USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200, Pleasanton California, 94566, USA
EUT:	Wireless Access Point Operating at 4.9 GHz	Telephone:	+1 925 462 0304
Model(s):	AP-175P / MSR2K23N0-XX	Fax:	+1 925 462 0306
S/N:	25A02102800027		
Test Date(s):	18th - 26th August 2010	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 90 & IC RSS 111 (4.9 GHz Operation)	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.

Approved & Released for MiCOM Labs, Inc. by:

ACCREDITED

TESTING CERTIFICATE #2381.01

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

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3. REFERENCES AND MEASUREMENT UNCERTAINTY

3.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 90	2007	Code of Federal Regulations
(ii)	RSS-111	2009 Issue 3	Broadband Public Safety Equipment Operating in the Band 4940- 4990 MHz
(iii)	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
(iv)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(v)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(vi)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(vii)	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
(viii)	A2LA	14th September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy

3.2. 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.

4. PRODUCT DETAILS AND TEST CONFIGURATIONS

4.1. Technical Details

Details	Description
Purpose:	Test of the AP-175P / MSR2K23N0-XX 802.11a/b/g/n AP to FCC 47 CFR Part 90 Subpart Y and Industry Canada RSS-111 regulations.
Applicant:	As Manufacturer
Manufacturer:	Aruba Networks, Inc 1344 Crossman Avenue Sunnyvale California 94089, USA
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	ARUB61-U4 Rev A
Date EUT received:	18TH August 2010
Standard(s) applied:	FCC 47 CFR Part 90 & IC RSS 111 (Public Safety Band)
Dates of test (from - to):	18th - 26th August 2010
No of Units Tested:	1
Type of Equipment:	Wireless Access Point
Manufacturers Trade Name:	Wireless Access Point
Model(s):	AP-175P / MSR2K23N0-XX
Location for use:	Outdoor
Software Release	Build# 75568 Version: 5.0.7.1
Declared Frequency Range(s):	4940 - 4990 MHz
Declared Nominal Output Power:	+18 dBm (average)
Type of Modulation:	OFDM
EUT Modes of Operation:	Per 802.11 – DBPSK, DQPSK, CCK, OFDM
Transmit/Receive Operation:	Duplex; Legacy 802.11a; 802.11n HT-20.
Rated Input Voltage and Current:	Power Over Ethernet (POE) 48 Vdc @ 1.25 A
Operating Temperature Range:	Declared range 0 to +40ºC
ITU Emission Designator:	4.9 GHz - 16M1W7D
Clock/Oscillator(s):	25 MHz, 40 MHz.
Frequency Stability:	±20 ppm
Equipment Dimensions:	10.2“ x 10.2” x 4.0” (25.9cm x 25.9cm x 10.2cm)
Weight:	7ibs (3.25 kgs)
Primary function of equipment:	Wireless Access Point for transmitting data and voice

4.2. Scope of Test Program

The scope of the test program was to test AP-175P / MSR2K23N0-XX 802.11a/b/g/n AP to;-

FCC 47 CFR Part 90, Subpart Y regulatory requirements;-

Industry Canada RSS-111.

The AP-175 is a Wireless Access Point operating in the 4.9 GHz Public Safety Band Radio employing OFDM modulation at 20 MHz bandwidths in the frequency range 4940 to 4990 MHz.

The device will operate using 802.11a and 802.11n HT-20 bandwidths. Results for both operational modes are presented in this document.

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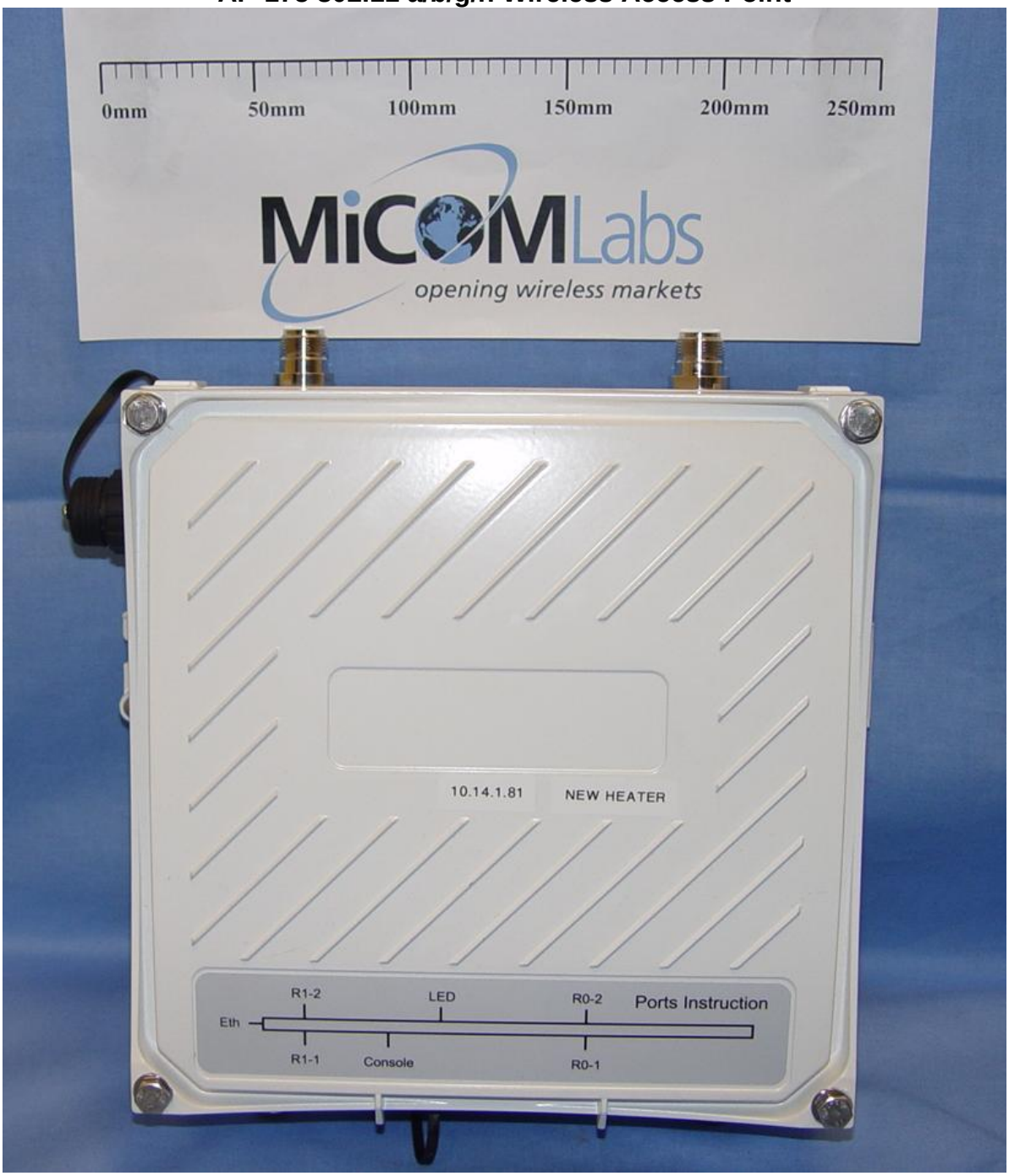
AP-175 802.11 a/b/g/n Wireless Access Point



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

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	802.11 a/b/g/n Wireless Access Point	Aruba Networks Inc	AP-175P	25A02102800027
Support	Power Over EtherNet (POE) 48Vdc supply	PowerDsine	7100G	74000000004
Support	Laptop PC – ThinkPad	IBM	T60	-
Support	Laptop PC – ThinkPad	IBM	T30	-
Support	Switch Controller	Aruba Networks Inc	620	AE0000949

4.4. Antenna Details

The following is a description of the EUT antennas.

Antenna Type:	Manufacturer	Model	Gain (dBi)	Frequency Range (MHz)
Dipole	Aruba	AP-ANT-86	9	4900 – 5000 MHz
Directional	Aruba	AP-ANT-5714	14	4900 – 5000 MHz

No antennas were tested as part of this program.

4.5. Cabling and I/O Ports

Number and type of I/O ports

1. 1000/100/10 Ethernet with POE x 1.
2. USB Local maintenance terminal (LMT) x 1.

4.6. Test Configurations

Matrix of test configurations

Parameter	Operational Mode	Test Conditions	Bandwidths (MHz)
Occupied BW & Emission Mask	Modulated	Ambient	20
Peak Output power	Modulated	Ambient	20
Peak Power Spectral Density	Modulated	Ambient	20
Frequency Stability	CW	Temperature Variations and Voltage Variations	--
Conducted Spurious	Modulated	Ambient	20
Radiated Emissions	Modulated	Ambient	20

4.7. Equipment Modifications

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

1. NONE

4.8. Deviations from the Test Standard

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

1. NONE

5. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 90**, **Subpart Y, Industry Canada RSS-111,** and **Industry Canada RSS-Gen.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
2.1049; 90.210(m) 4.4	26 dB / 99% Occupied BW & Emission Mask	Emission mask and bandwidth measurement(s)	Conducted	Complies	6.1.1
2.1046; 90.1215 (a) 4.3	Peak and Average Output Power	Modulated Output Power	Conducted	Complies	6.1.2
2.1046; 90.1215 (a) 4.3	Peak Power Spectral Density	Maximum Spectral Density	Conducted	Complies	6.1.3
Subpart C 90.1217	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Radiated	Complies	6.1.4
2.1055(a)(1); 90.213 4.2	Frequency Stability	Includes temperature and voltage variations	Conducted	Complies	6.1.5
2.1051; 90.210(m) 4.4/4.5 6	Conducted Spurious Emissions at Antenna Port	Emissions from the antenna port 30 MHz – 40 GHz	Conducted	Complies	6.1.6
2.1053; 90.210(m) ANSI/TIA-603 4.4	Radiated Spurious Emissions	Spurious emissions 30 MHz – 40 GHz	Radiated	Complies	6.1.7
Industry Canada only **RSS-Gen §4.8, §6**	Receiver Radiated Spurious Emissions	Emissions below and above 1 GHz	Radiated	Complies	*6.1.8*

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*

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6. TEST RESULTS

6.1. Device Characteristics

6.1.1. Occupied Bandwidth and Emission Mask

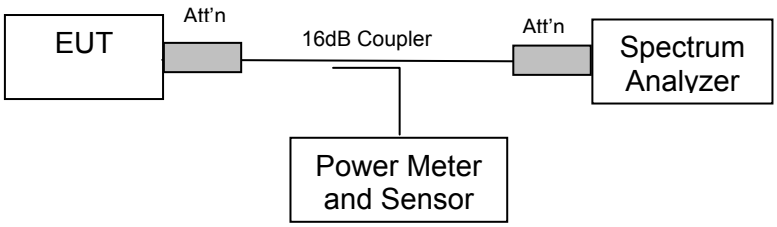
FCC 47 CFR Part 90, Subpart Y; 2.1049; §90.210(m)
IC Section 4.4

Test Procedure
The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure the 26 dB occupied bandwidth and emission mask for the radio. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

For emission masks the zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

The EUT is not equipped with an audio low-pass filter.

Test Measurement Set up



Test set up for Occupied Bandwidth and Emission Mask measurement

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

TABLE OF RESULTS – 802.11a

Center Frequency (MHz)	99% Bandwidth (MHz)
4,950.0	16.633

Emission Mask & 99% Bandwidth for 20 MHz BW Channel Freq 4950 MHz

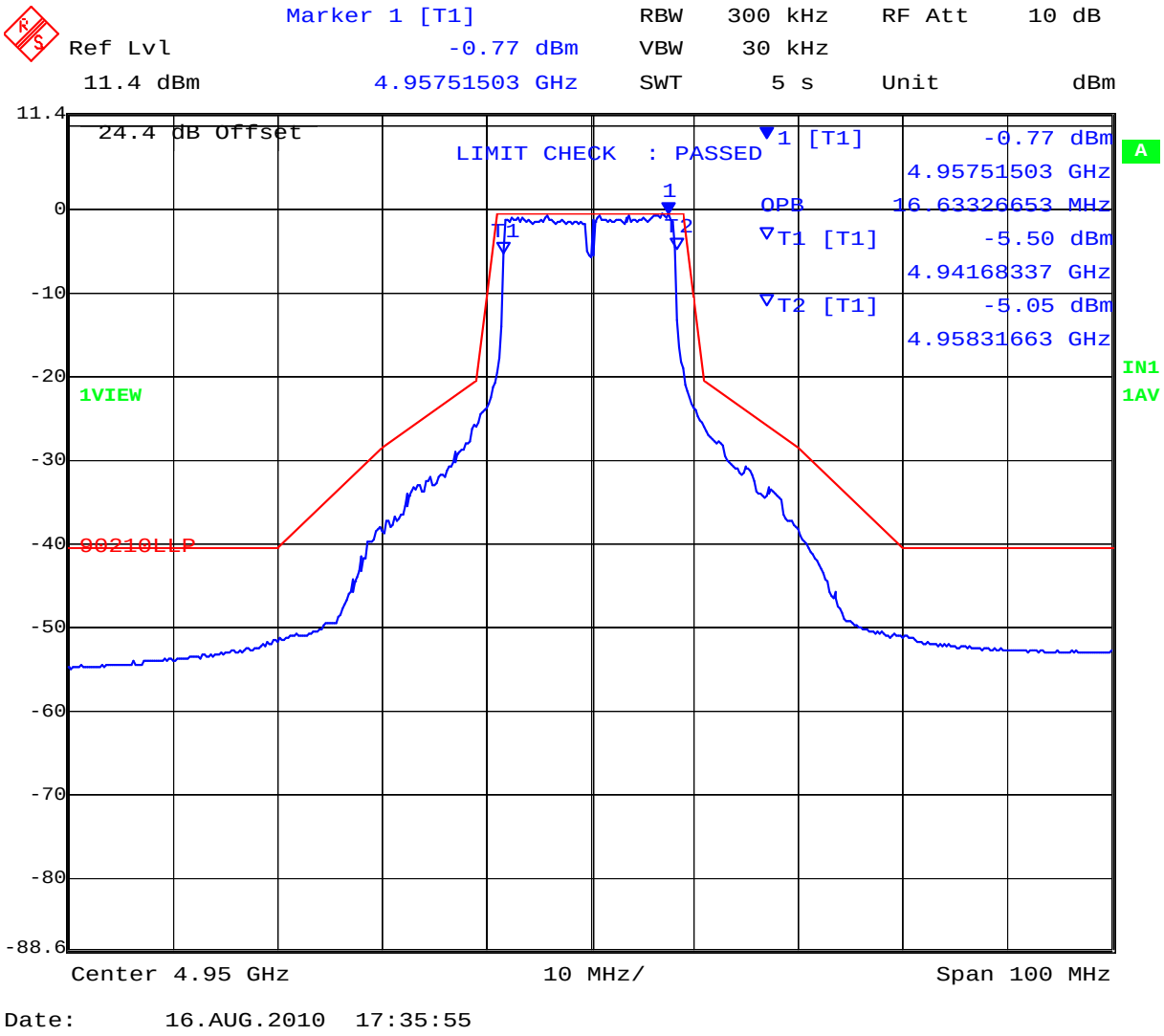


TABLE OF RESULTS – 802.11a

Center Frequency (MHz)	99% Bandwidth (MHz)
4,980.0	15.633

Emission Mask & 99% Bandwidth for 20 MHz BW Channel Freq 4980 MHz

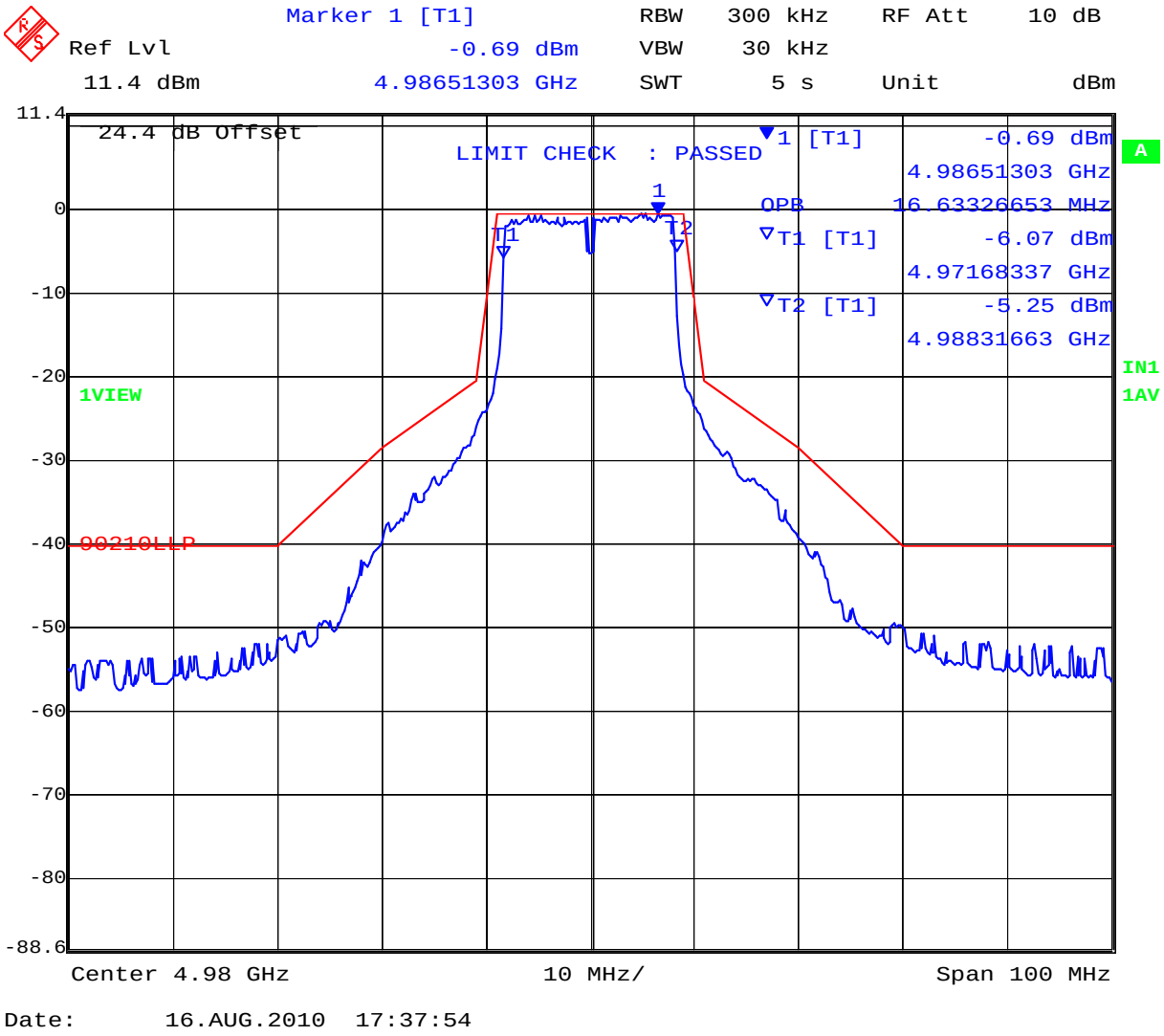
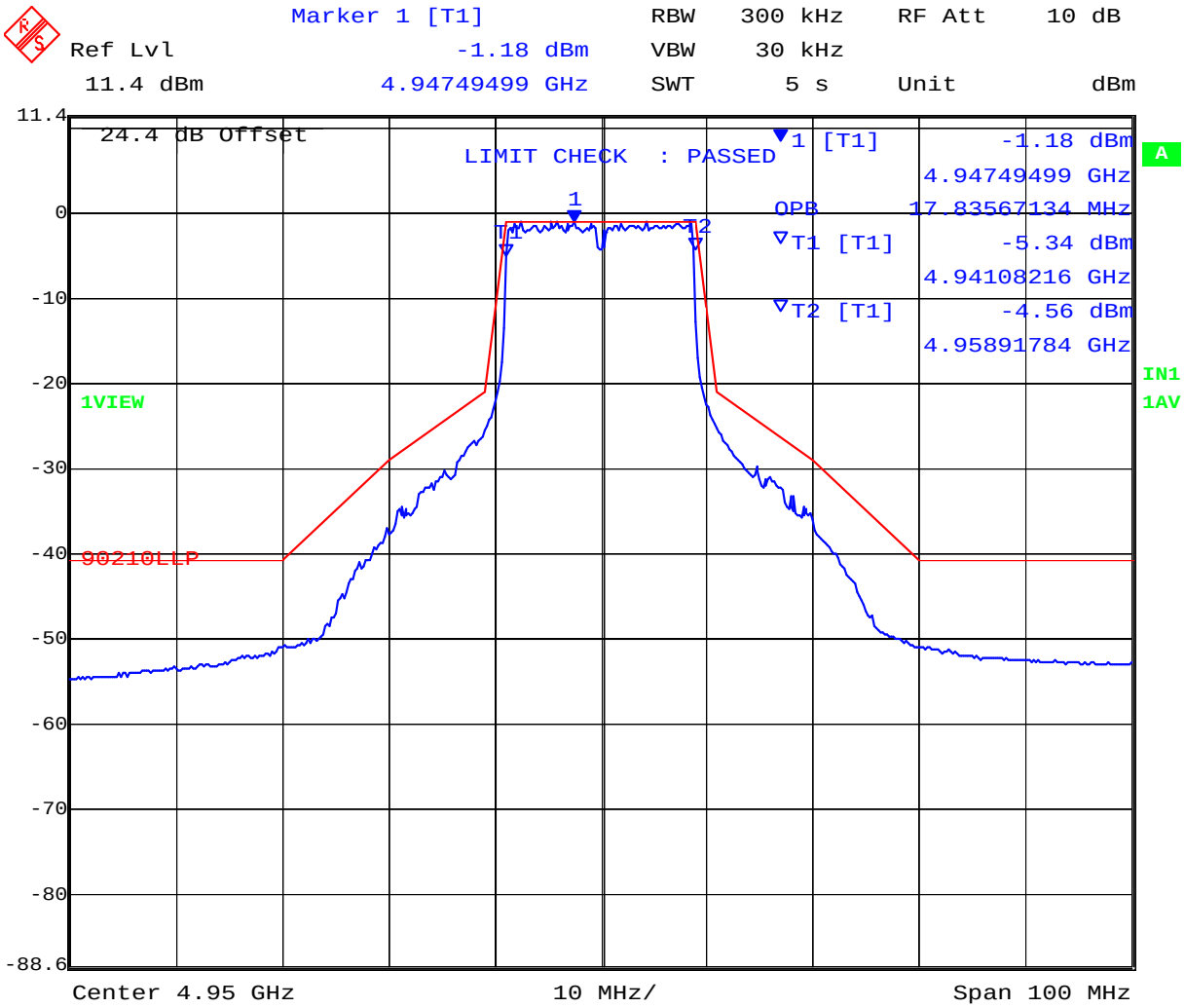


TABLE OF RESULTS – 802.11 HT-20

Center Frequency (MHz)	99% Bandwidth (MHz)
4,950.0	17.836

Emission Mask & 99% Bandwidth for 20 MHz BW Channel Freq 4950 MHz

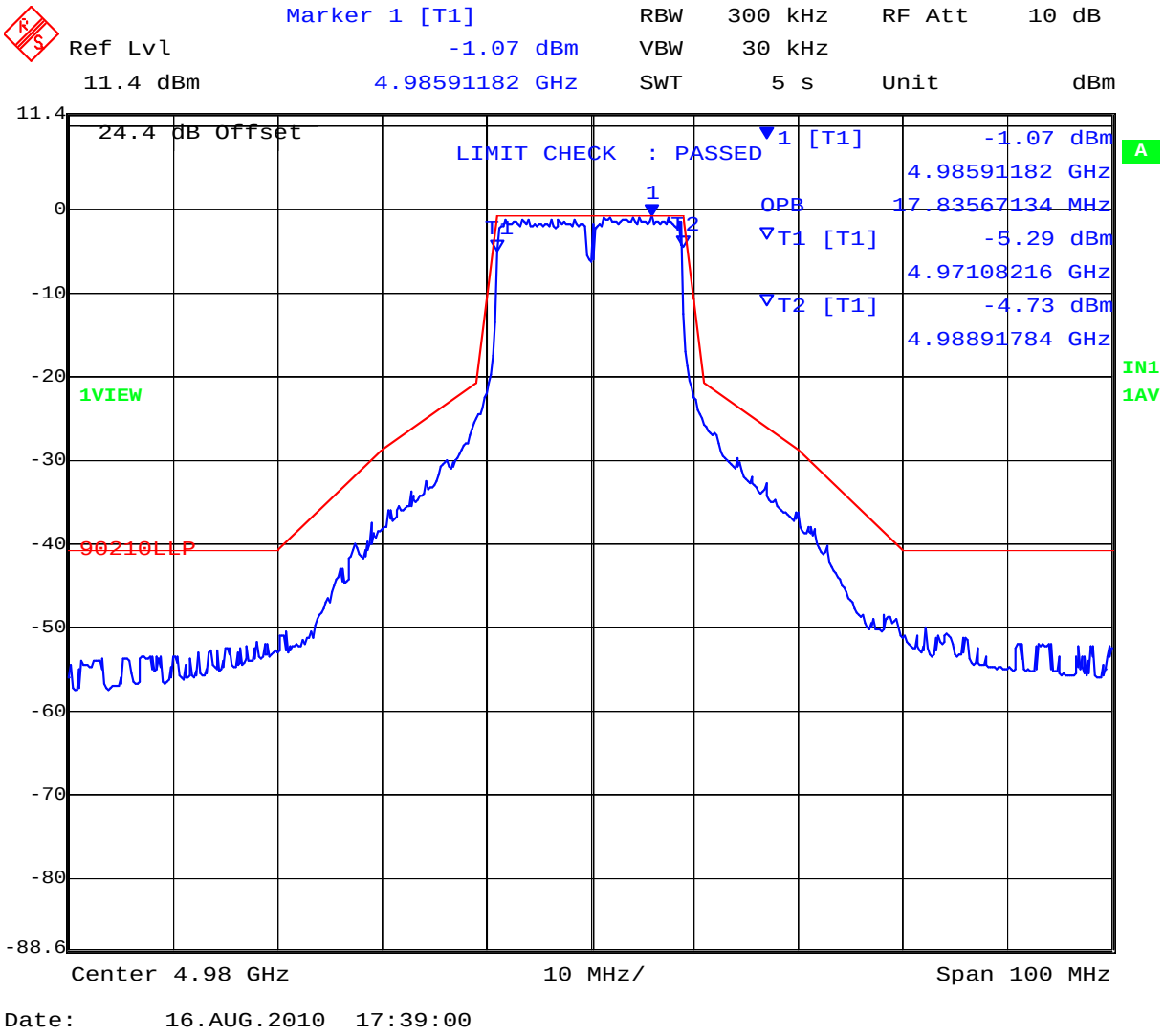


Date: 16.AUG.2010 17:34:06

TABLE OF RESULTS – 802.11 HT-20

Center Frequency (MHz)	99% Bandwidth (MHz)
4,980.0	17.836

Emission Mask 99% Bandwidth for 20 MHz BW Channel Freq 4980 MHz



Specification Limits
FCC Part §90.210

Limits for Authorized Bandwidth

Frequency Band (MHz) and Related Documents	Spectrum Masks with Audio Filter	Without Audio Filter
4950 – 4990 MHz	L or M	L or M

Reference to the emission masks are provided below

Limits Emission Masks
90.210(L), Emission Mask L. For low power transmitters (20 dBm of less) operating in the 4940 – 4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0 – 45% of the authorized bandwidth (BW) : 0dB.

(2) On any frequency removed from the assigned frequency between 45 – 50 % of the authorized bandwidth: 219 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50 – 55 % of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55 – 100 % of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100 – 150 % of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency above 150 % of the authorized bandwidth: 50 dB.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

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Limits Emission Masks (continued)

90.210(m), Emission Mask M. For high power transmitters (greater than 20 dBm) operating in the 4940 – 4900 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0 – 45% of the authorized bandwidth (BW) : 0dB.

(2) On any frequency removed from the assigned frequency between 45 – 50 % of the authorized bandwidth: 568 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50 – 55 % of the authorized bandwidth: 26 + 145 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55 – 100 % of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100 – 150 % of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Note to paragraph m: Low power devices may as an option, comply with paragraph (m).

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

6.1.2. Peak Output Power

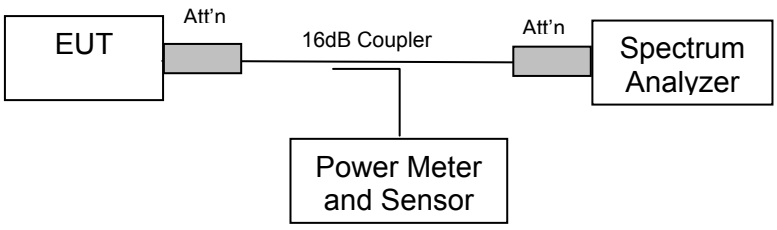
FCC 47 CFR Part 90, Subpart Y; 2.1046; §90.1215

IC Section 4.3

Test Procedure

Average power measurements were measured with the use of an average power head. Peak power measurements were recorded via the spectrum analyzer. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

Test Measurement Set up



Test set up for modulated output power measurement

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

TABLE OF RESULTS – 20 MHz Bandwidth Modulated Carrier

Center Frequency (MHz)	Operational Mode	Average Power (dBm)
4950.0	802.11a	+18.14
	HT-20	+18.20
4980.0	802.11a	+18.09
	HT-20	+18.00

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Specification Limits

FCC Part §90.1215(a)

Power limits.

The transmitting power of stations operating in the 4940-4990 MHz band must not exceed the maximum limits in this section.

(a) The peak transmit power should not exceed:

Channel Bandwidth (MHz)	Low power peak transmitter power (dBm)	High power peak transmitter power (dBm)
1	7	20
5	14	27
10	17	30
15	18.8	31.8
20	20	33

High power devices are also limited to a peak power spectral density of 21 dBm per one MHz. High power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 21 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi. However, high power point-to-point or point-to-multipoint operation (both fixed and temporary-fixed rapid deployment) may employ transmitting antennas with directional gain up to 26 dBi without any corresponding reduction in the transmitter power or spectral density. Corresponding reduction in the peak transmit power and peak power spectral density should be the amount in decibels that the directional gain of the antenna exceeds 26 dBi.

(b) Low power devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

(c) The peak transmit power is measured as a conducted emission over any interval of continuous transmission calibrated in terms of an RMS-equivalent voltage. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement conforming to the definitions in this paragraph for the emission in question.

(d) The peak power spectral density is measured as conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected

directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of one MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

6.1.3. Peak Power Spectral Density (PPSD)

FCC 47 CFR Part 90, Subpart Y; 2.1046; §90.1215

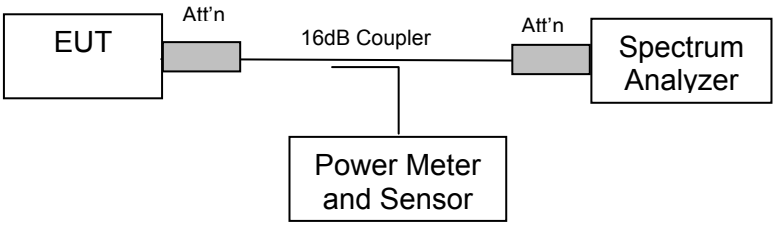
IC Section 4.3

Test Procedure

The test methodology used for this measurement was determined to provide the highest possible PPSD readings.

Peak power spectral density measurements were performed via the spectrum analyzer and plots were recorded. Modulation was ON and the system duty cycle was set for 100% i.e. continuous operation at all times. The system highest power setting was selected.

Test Measurement Set up

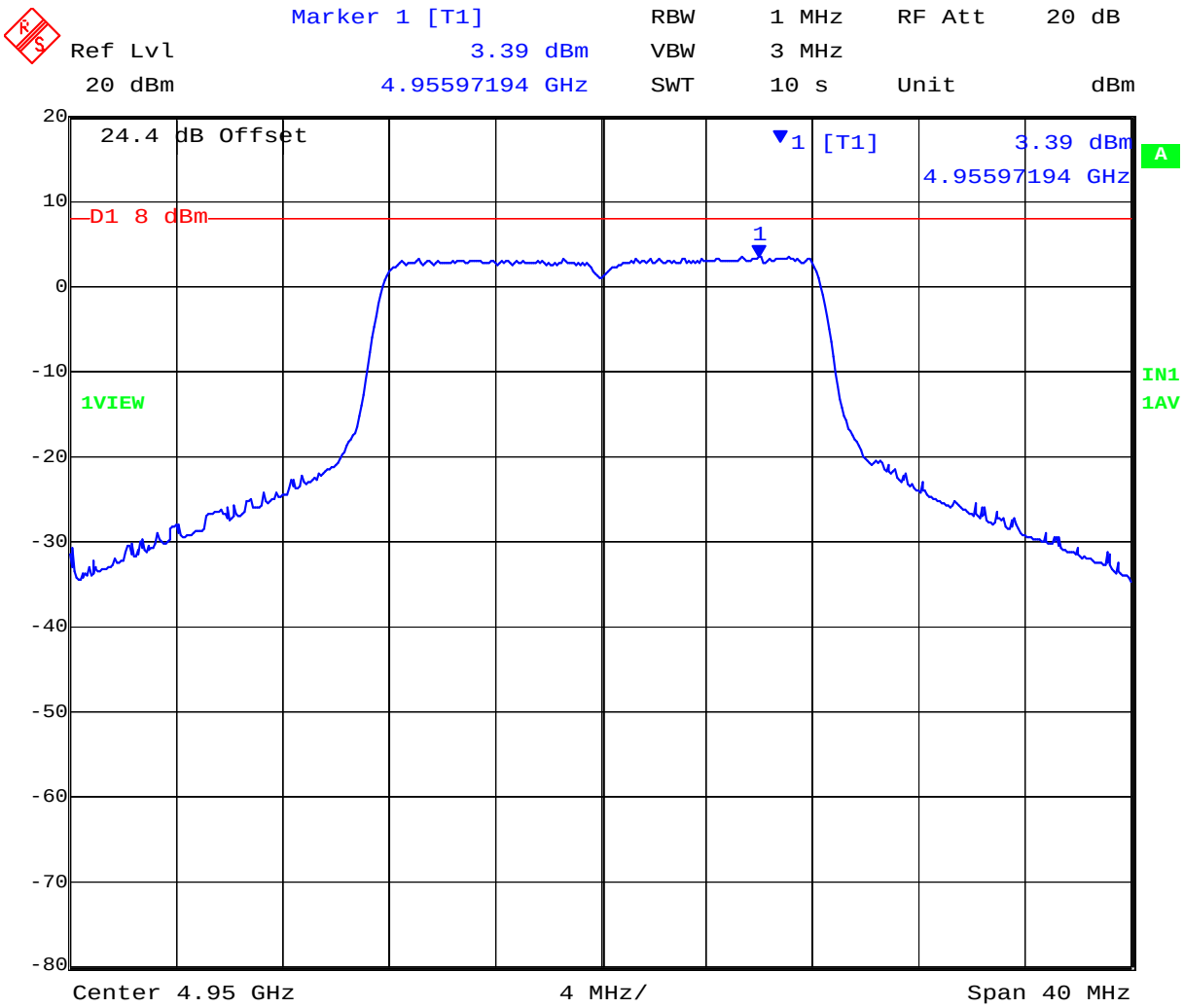


Test set up for Peak Power Spectral Density measurement(s)

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

TABLE OF RESULTS – 802.11a PPSD 20 MHz Bandwidth 4950 MHz

Center Frequency (MHz)	Peak Power Spectral Density (dBm/ MHz)
4950.0	+3.39

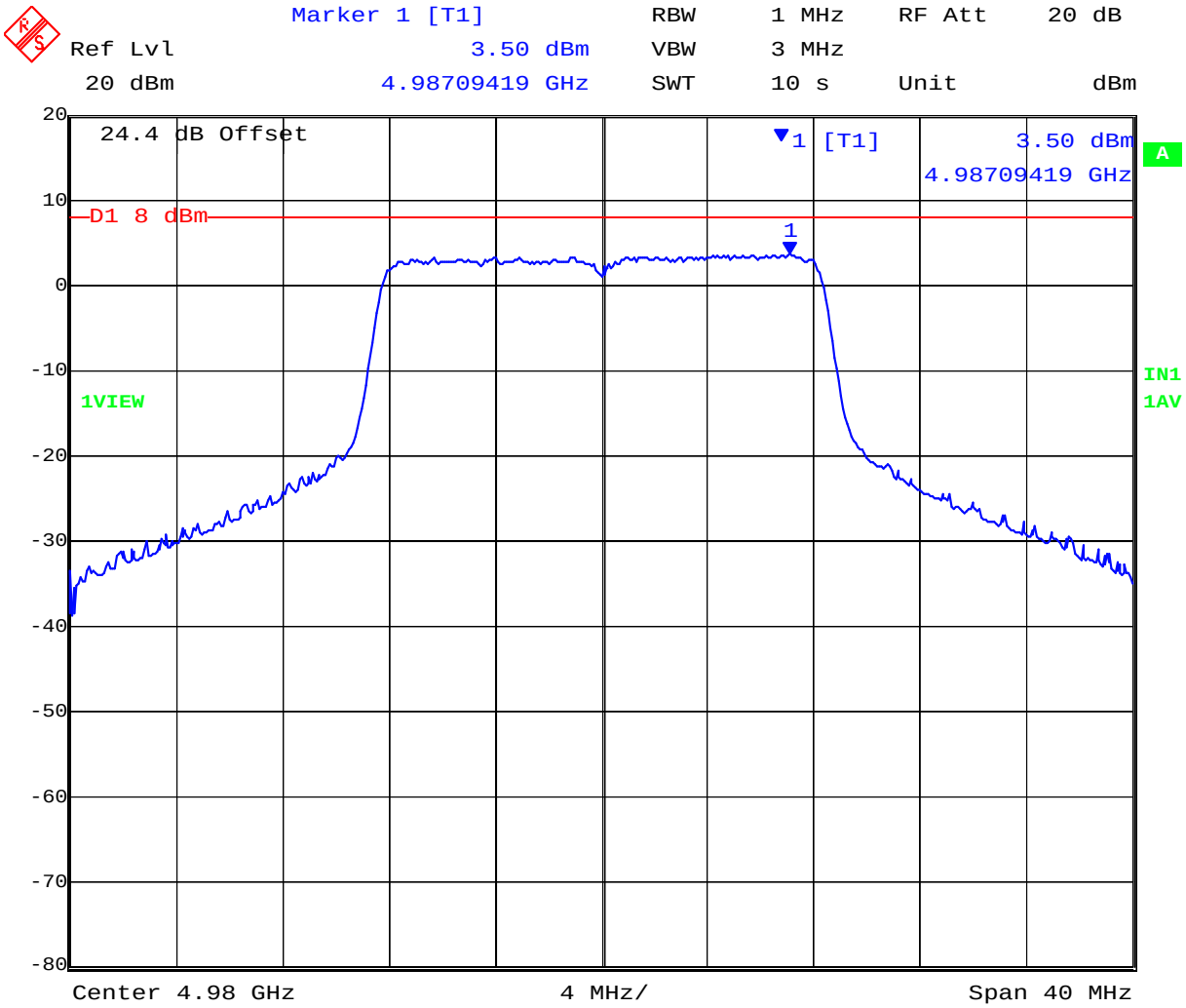


Date: 16.AUG.2010 18:36:18

Peak Power Spectral Density 20 MHz BW Channel Freq 4950 MHz

TABLE OF RESULTS – 802.11a PPSD 20 MHz Bandwidth 4980 MHz

Center Frequency (MHz)	Peak Power Spectral Density (dBm/MHz)
4980.0	+3.50

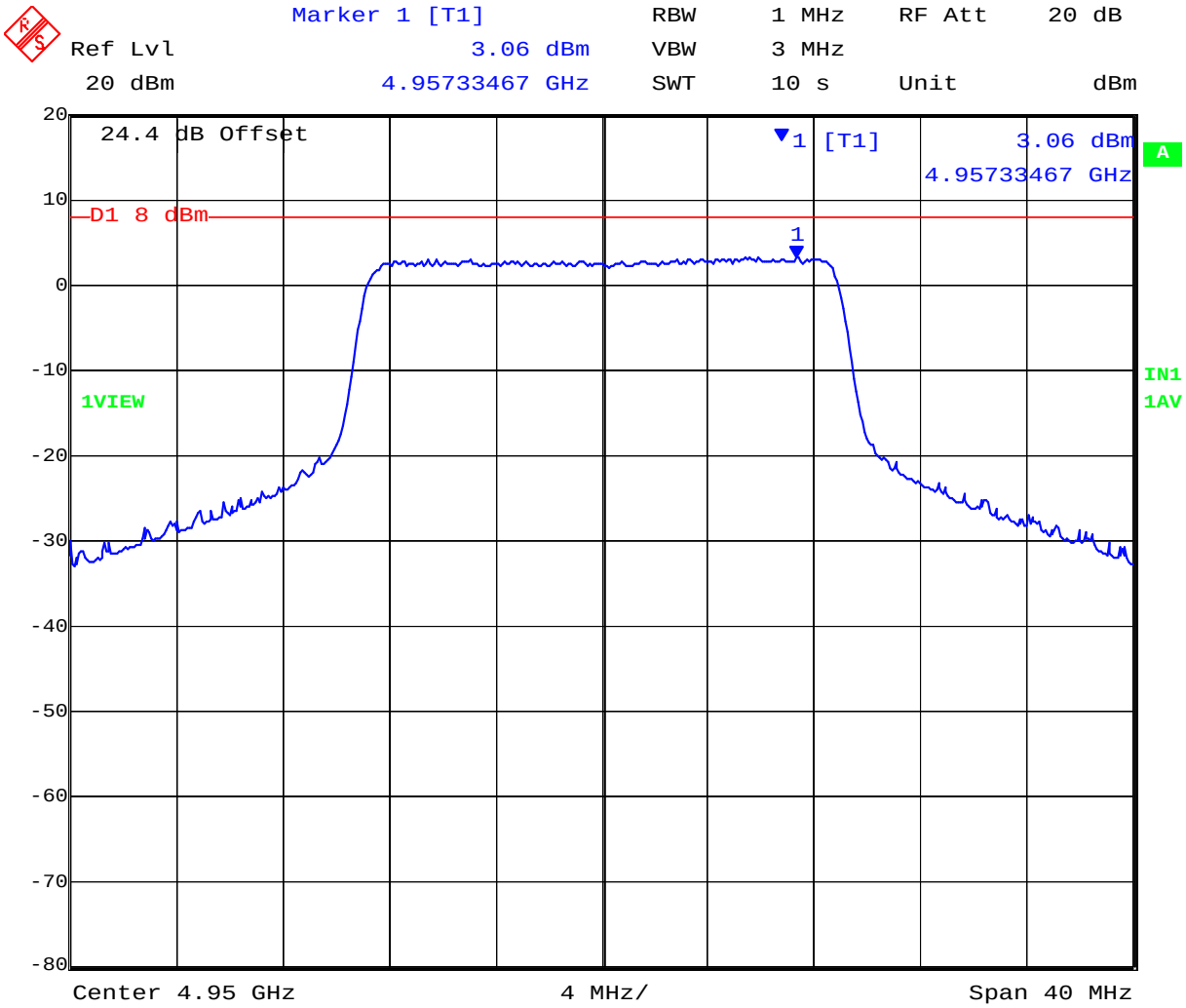


Date: 16.AUG.2010 18:32:17

Peak Power Spectral Density 20 MHz BW Channel Freq 4980 MHz

TABLE OF RESULTS – 802.11 HT-20 PPSD 20 MHz Bandwidth 4950 MHz

Center Frequency (MHz)	Peak Power Spectral Density (dBm/ MHz)
4950.0	+3.06

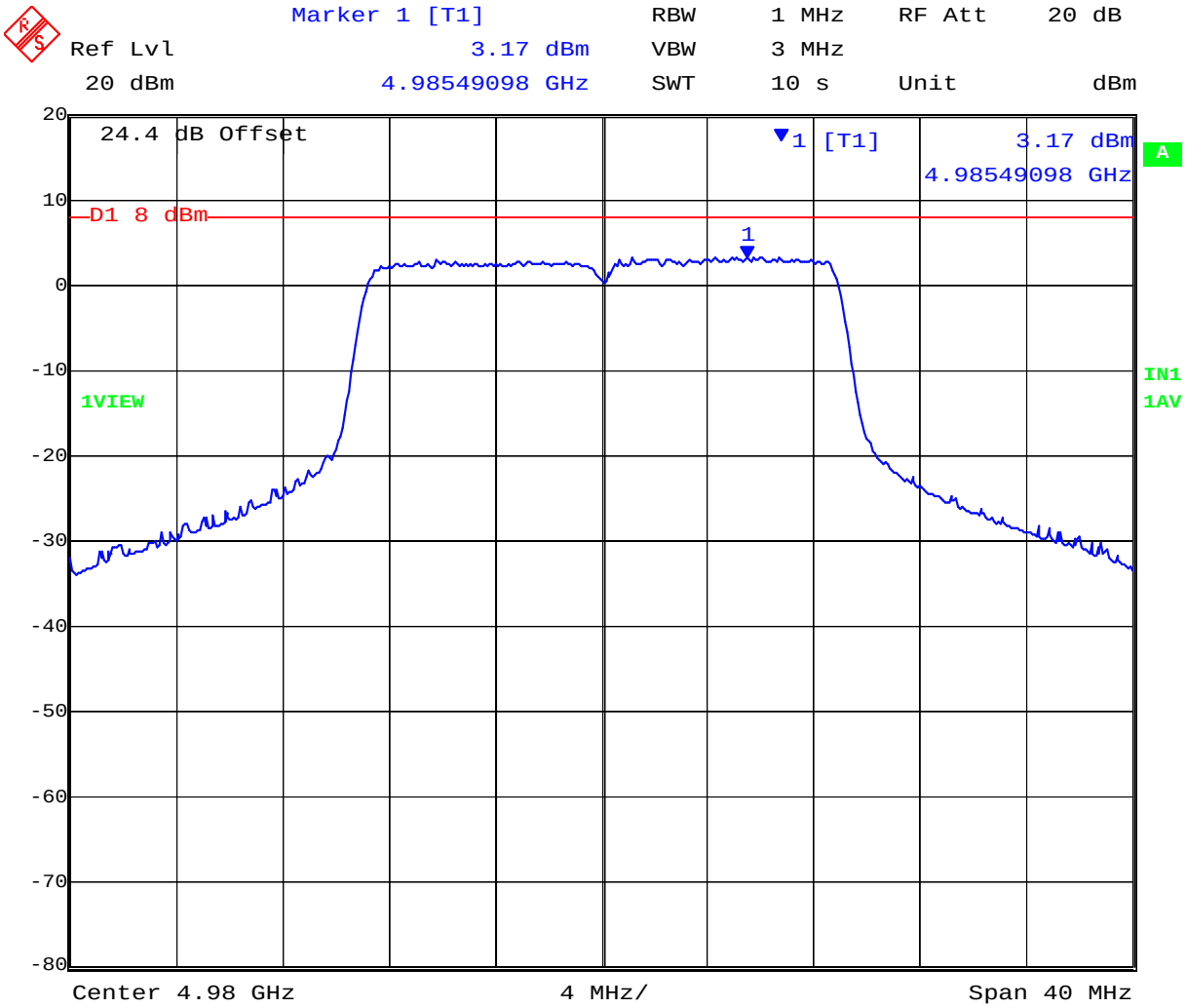


Date: 16.AUG.2010 18:35:19

Peak Power Spectral Density 20 MHz BW Channel Freq 4950 MHz

TABLE OF RESULTS – 802.11 HT-20 PPSD 20 MHz Bandwidth 4980 MHz

Center Frequency (MHz)	Peak Power Spectral Density (dBm/MHz)
4980.0	+3.17



Date: 16.AUG.2010 18:33:57

Peak Power Spectral Density 20 MHz BW Channel Freq 4980 MHz

Specification Limits
FCC Part §90.1215

Refer to the Power Limits Specification in Section 5.1.2 of this report.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

6.1.4. Maximum Permissible Exposure
FCC, Part 90 Subpart C §90.1217

Calculations for Maximum Permissible Exposure Levels

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

EIRP = P * G

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

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

4 9 GHz 20 MHz Channel = Max. Peak Output Power +18.20 dBm, 66.1 mW

Max. Antenna Gain = 14 dBi, **25.12 numeric**

The EUT belongs to the Occupational/Controlled Exposure class of devices; power density limit is 5.0mW/cm^2

Maximum Gain Antennas – Calculated Safe Distance @ 1 mW/cm^2

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)
14.0	25.12	+18.20	66.1	11.5	35.0

Note: for 4.9 GHz mobile or fixed location transmitters the minimum separation distance is 35 cm, even if calculations indicate the MPE distance to be less.

Specification
Maximum Permissible Exposure Limits

§90.1217 Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency levels in excess of the Commission's guidelines. See §1.1307 (b)(1) of this chapter. Limit S = 1mW / cm^2 from 1.310 Table 1

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33dB

6.1.5. Frequency Stability; Temperature Variations, and Voltage Variations

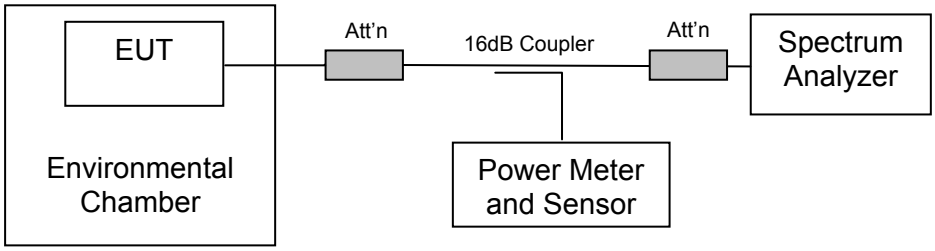
FCC 47 CFR Part 90, Subpart Y; 2.1055(a)(1); §90.213

IC Section 4.2

Test Procedure

The transmitter output was connected to a spectrum analyzer and the frequency stability was measured in an un-modulated state. Frequency stability was measured through the extremes of temperature on the mid channel only. Before measurements were taken at each temperature the equipment waited until thermal balance was obtained.

Test Measurement Set up



Measurement set up for Frequency Stability

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

TABLE OF RESULTS Frequency Stability;-

Temperature Variations

Voltage (Vdc)	Temperature(°C)	FREQUENCY Channel 4975 MHz	
		Measured Value (MHz)	ppm
+48.0	-25	4950.02114	4.27
	-15	4950.02154	4.35
	-10	4950.0212	4.28
	-5	4950.01525	3.08
	+15	4950.01252	2.53
	+20	4949.99456	-1.10
+40.8	+20	4949.99504	-1.00
+55.2	+20	4949.99548	-0.91
+43.2	+25	4949.99052	-1.92
	+35	4949.98075	-3.89
	+45	4949.97671	-4.71
	+55	4949.98234	-3.57
Maximum Frequency Drift		+21.54 kHz / +4.35 ppm	
Minimum Frequency Drift		-23.29 kHz / -4.71 ppm	

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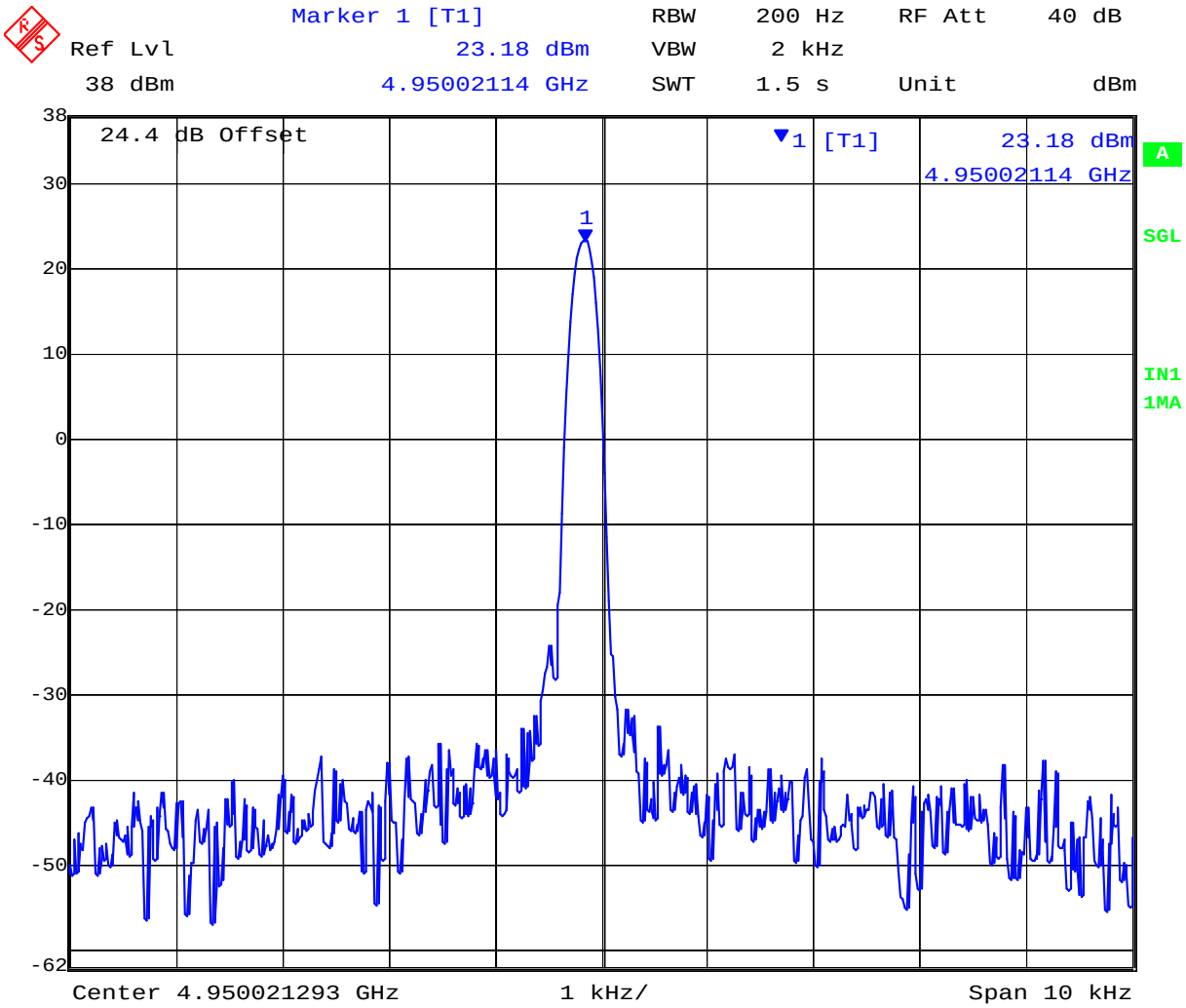
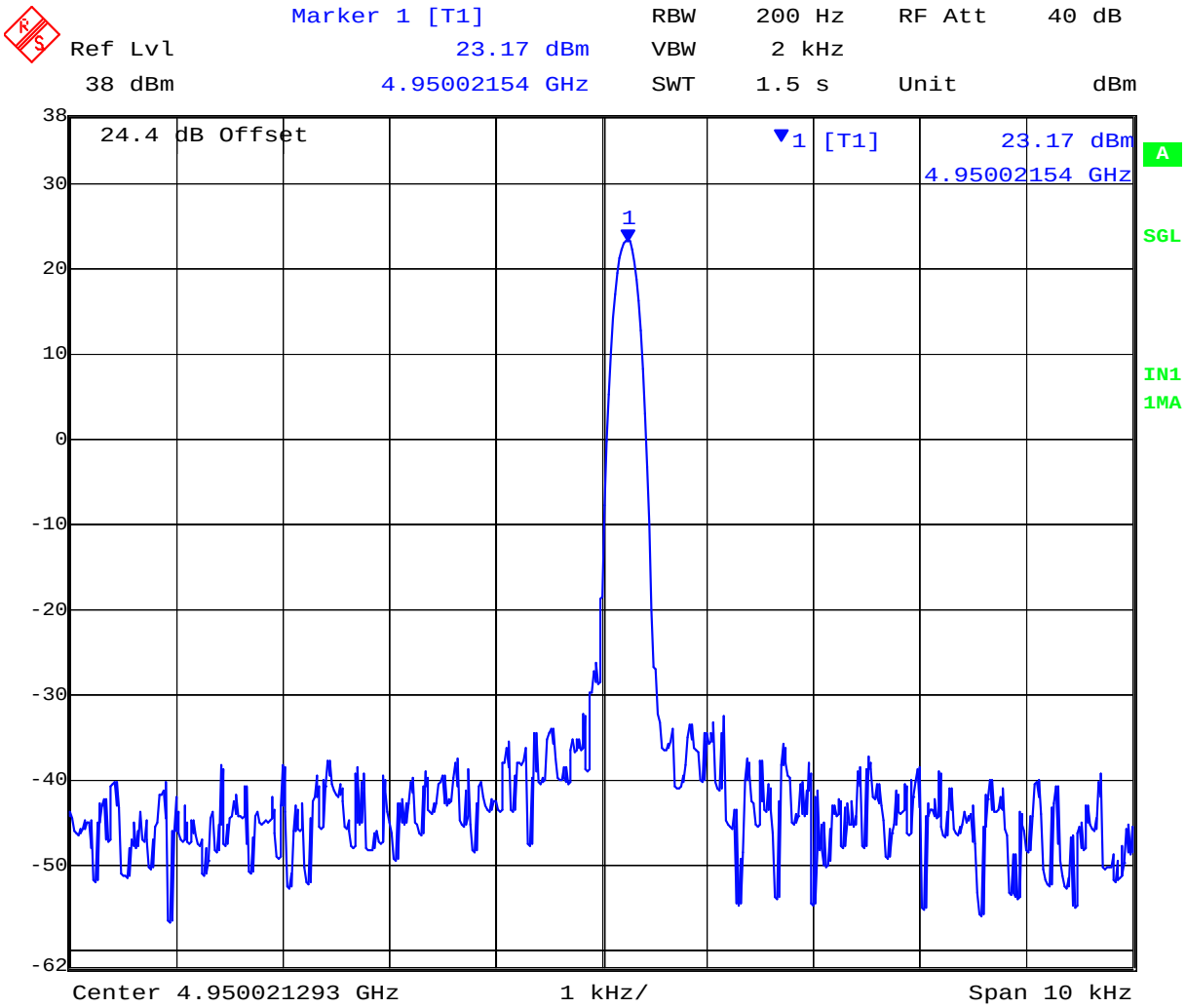


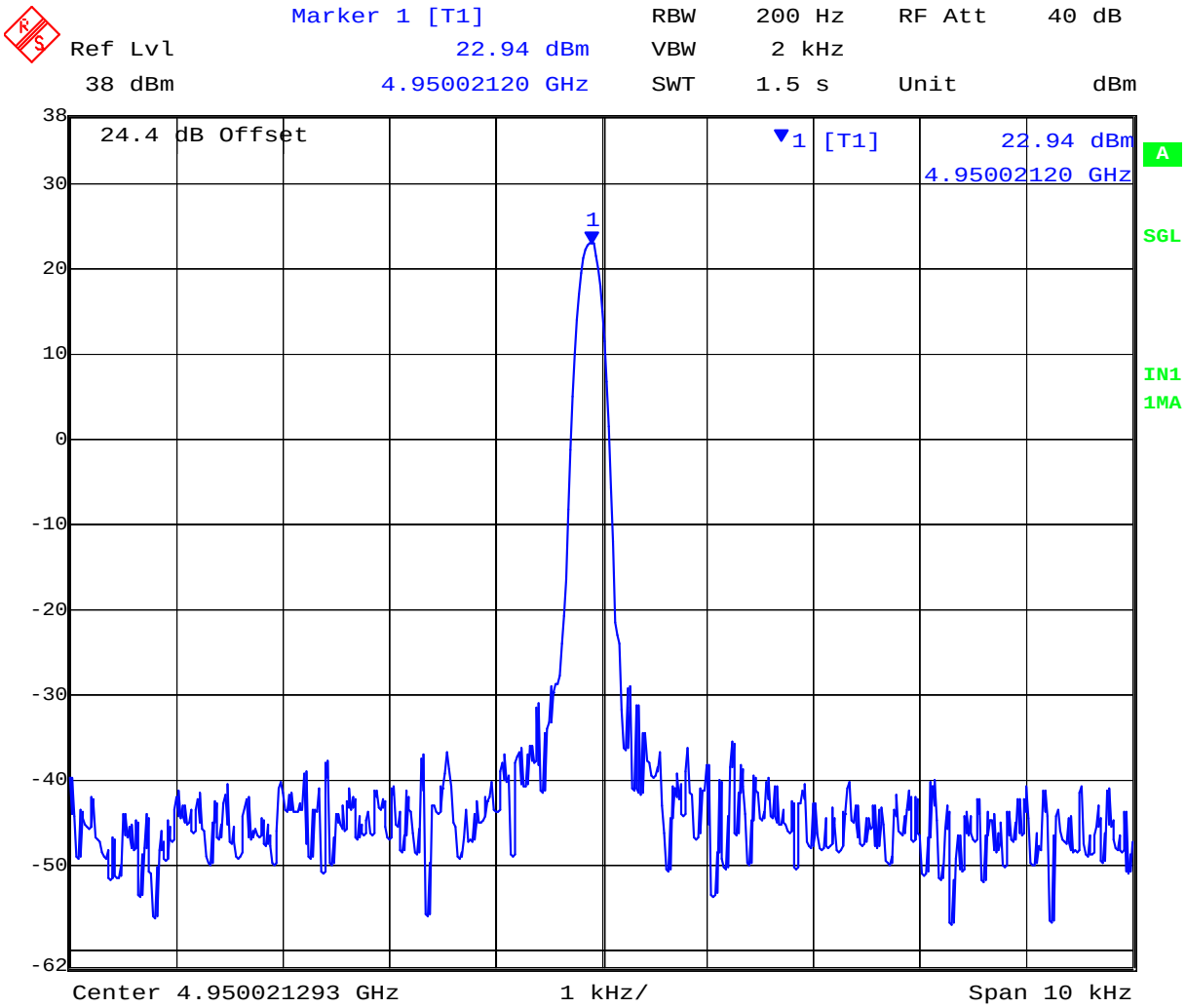
Date: 1.JAN.1997 03:42:28

Frequency Stability @ -25°C, +48 Vdc



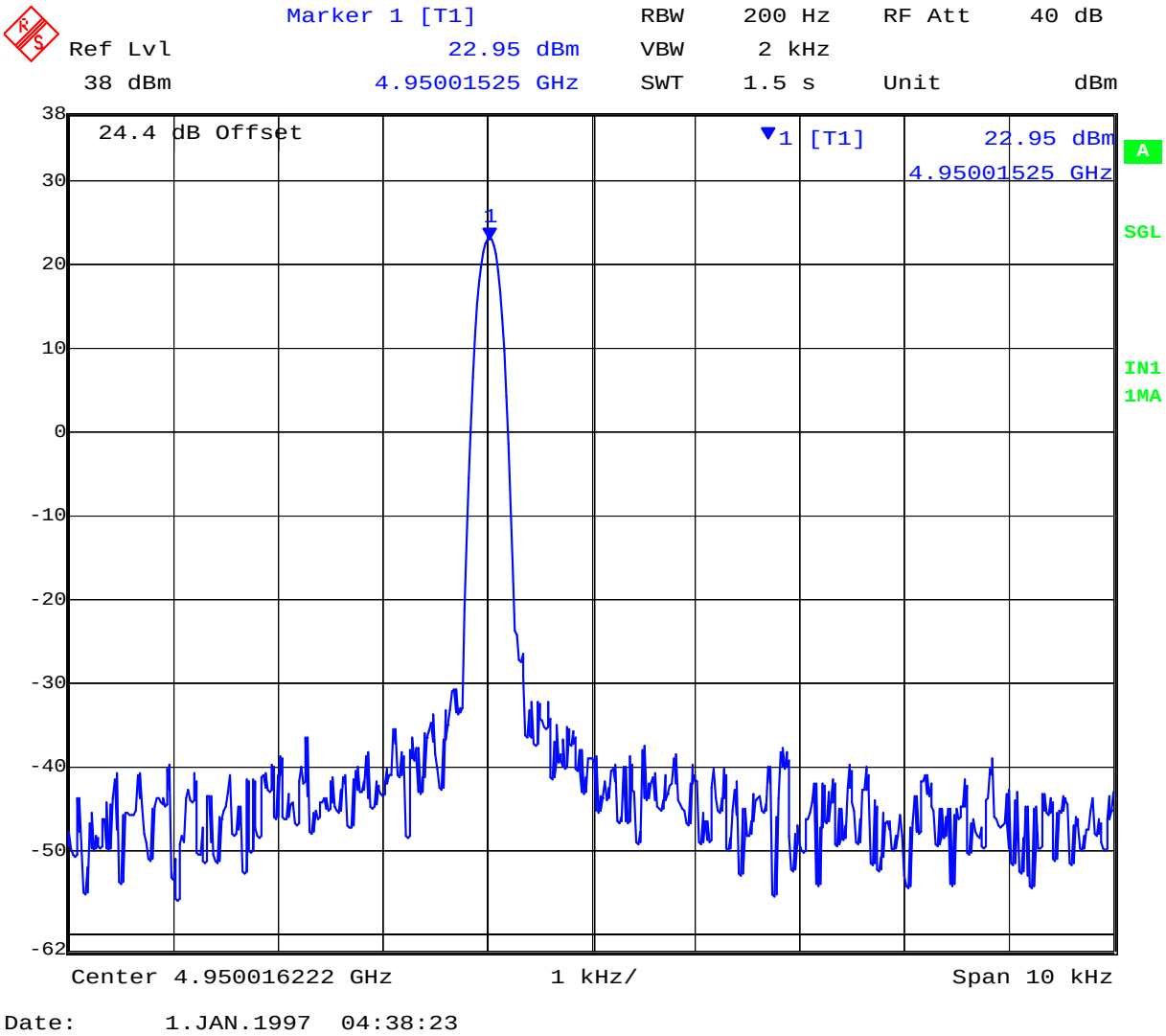
Date: 1.JAN.1997 03:54:42

Frequency Stability @ -15°C, +48 Vdc



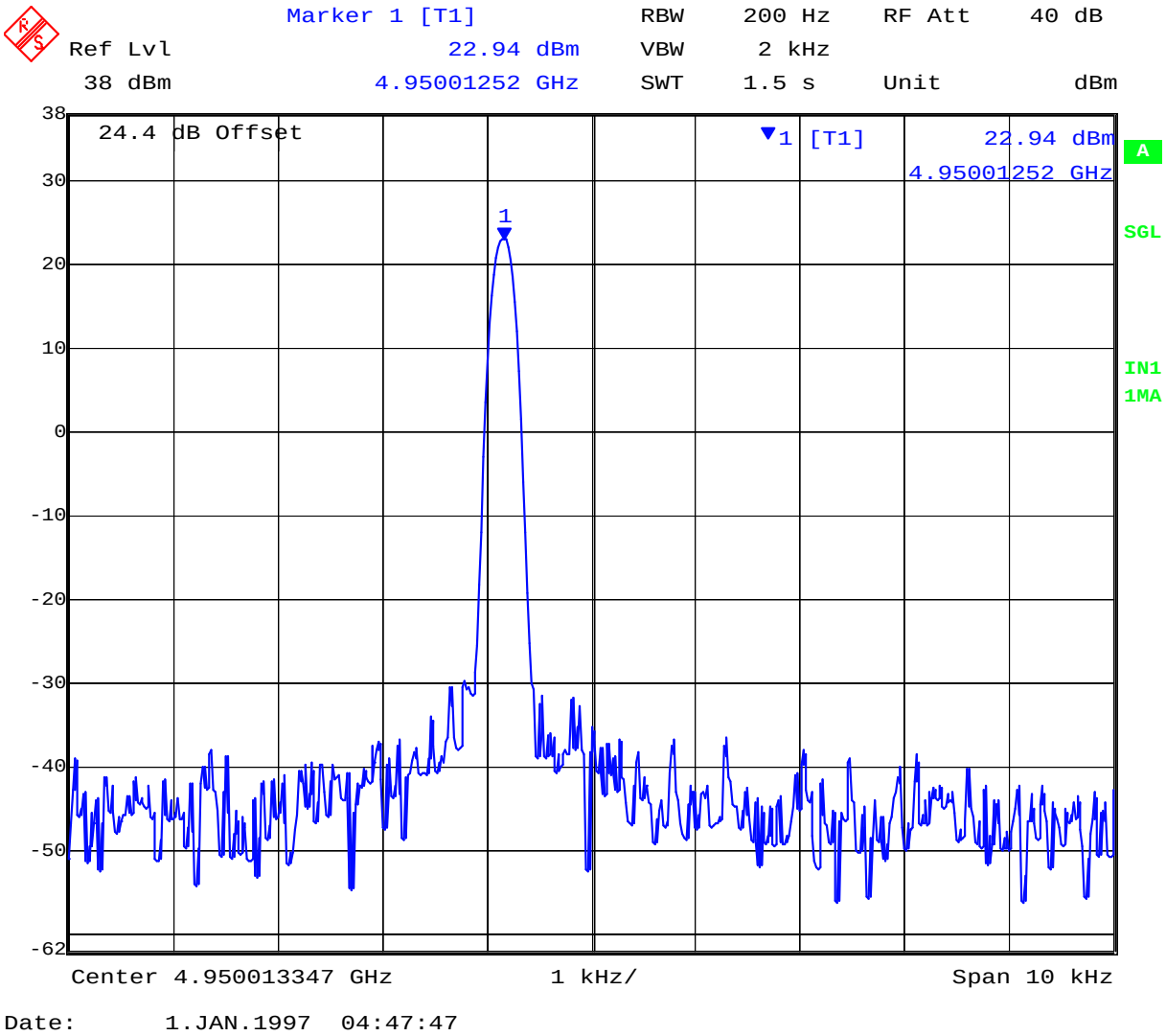
Date: 1.JAN.1997 04:09:29

Frequency Stability @ -5°C, +48 Vdc



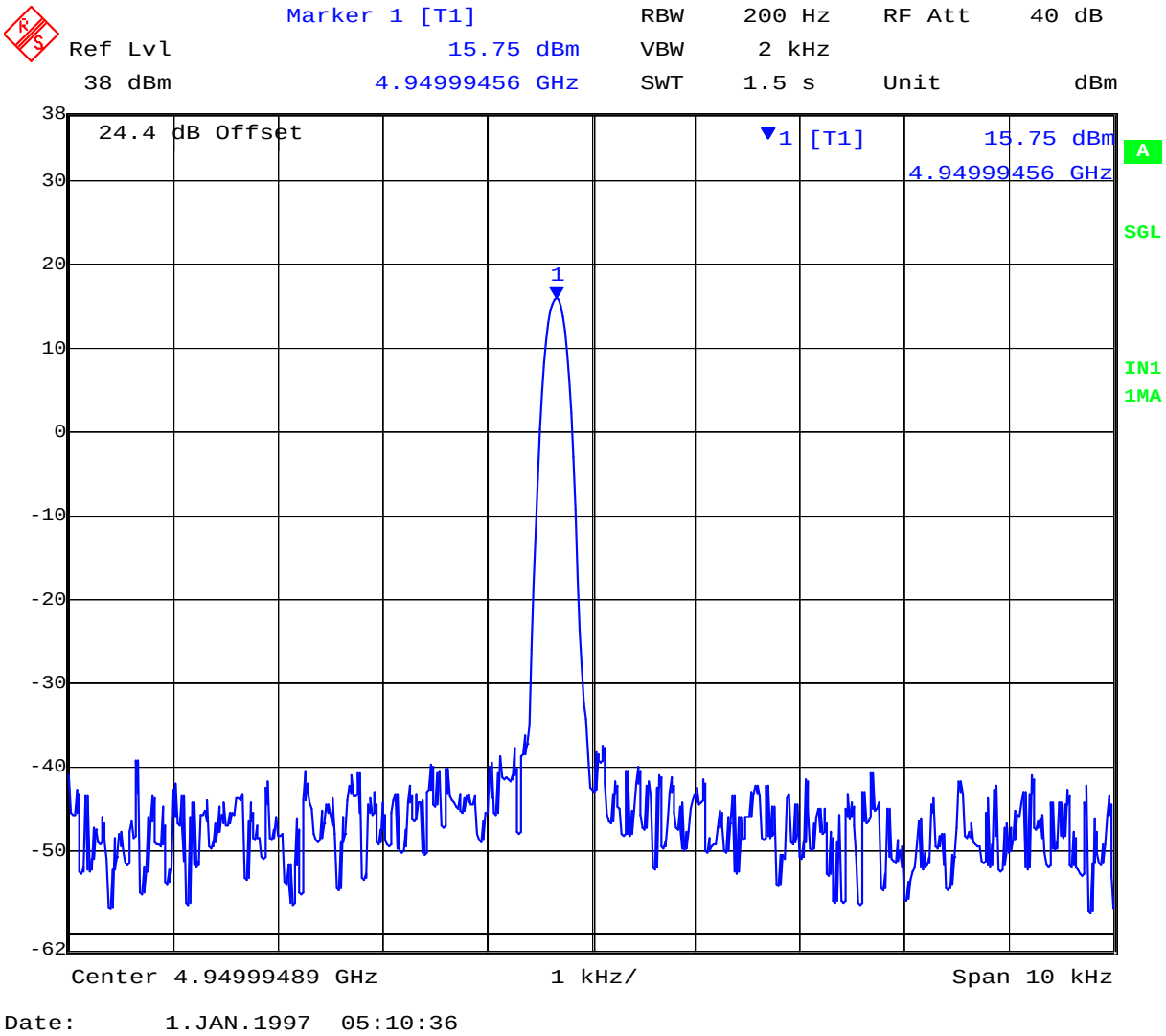
Date: 1.JAN.1997 04:38:23

Frequency Stability @ +5°C, +48 Vdc



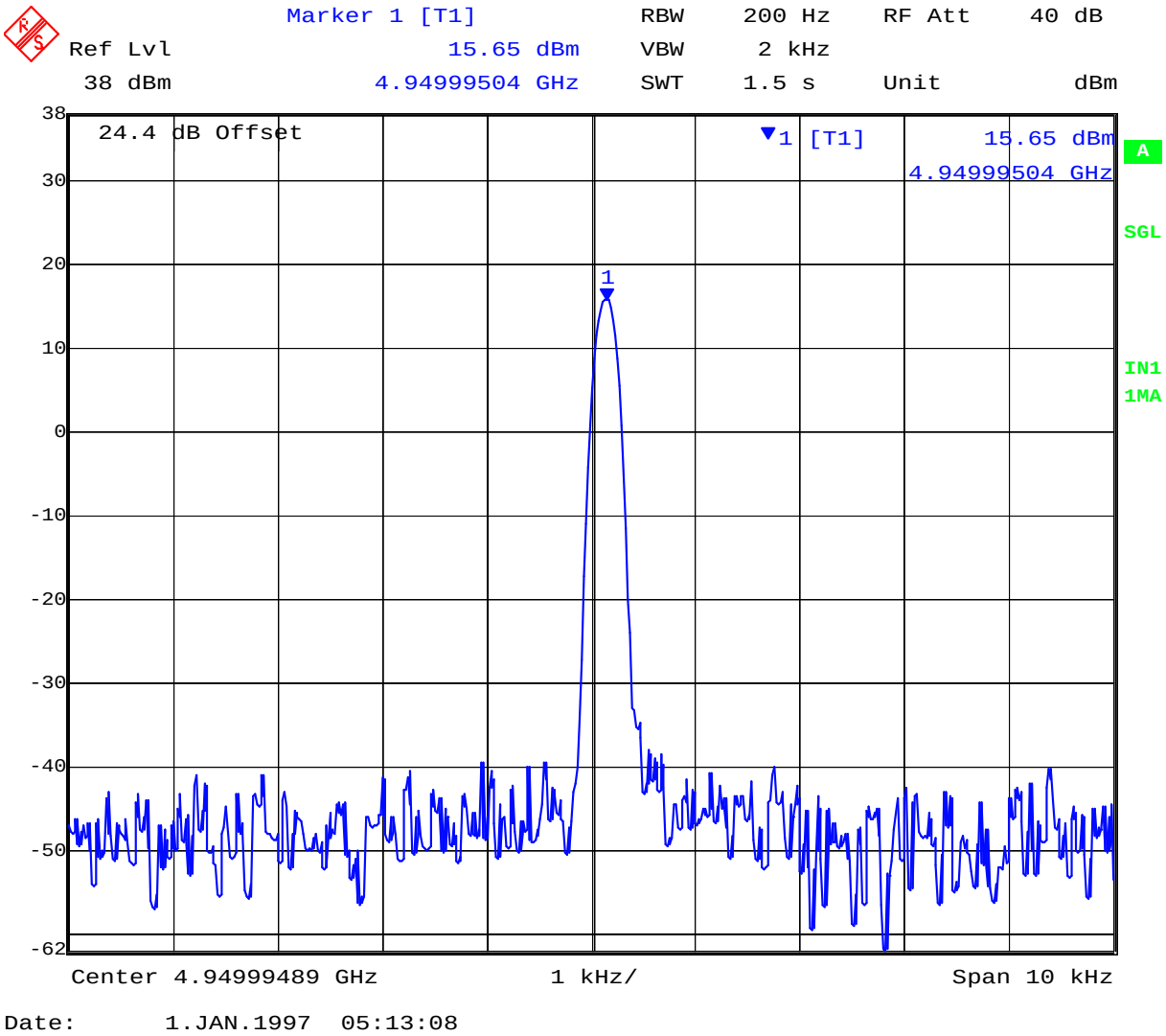
Date: 1.JAN.1997 04:47:47

Frequency Stability @ +15°C, +48 Vdc



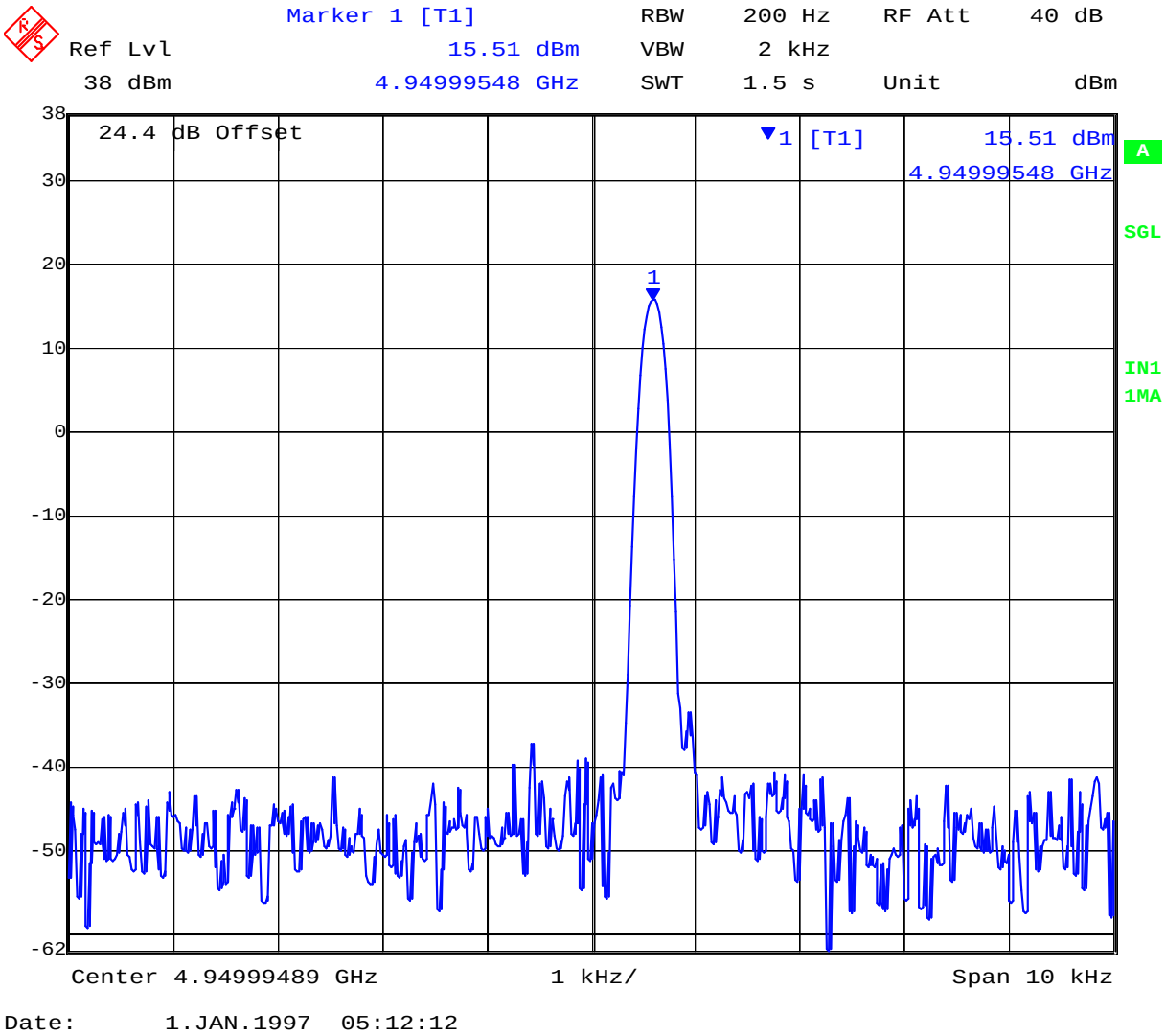
Date: 1.JAN.1997 05:10:36

Frequency Stability @ +20°C, +48 Vdc



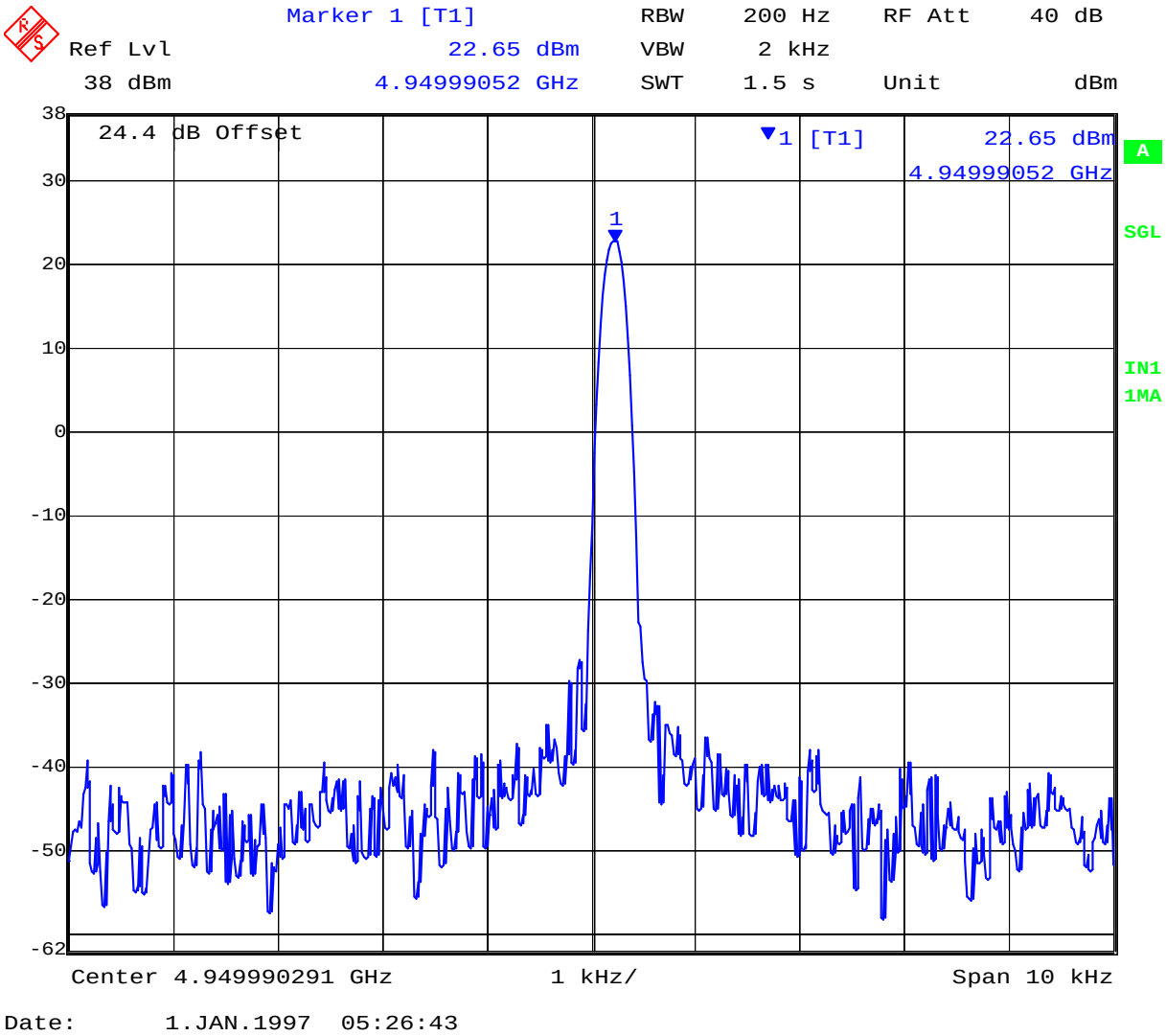
Date: 1.JAN.1997 05:13:08

Frequency Stability @ +20°C, +40.8 Vdc



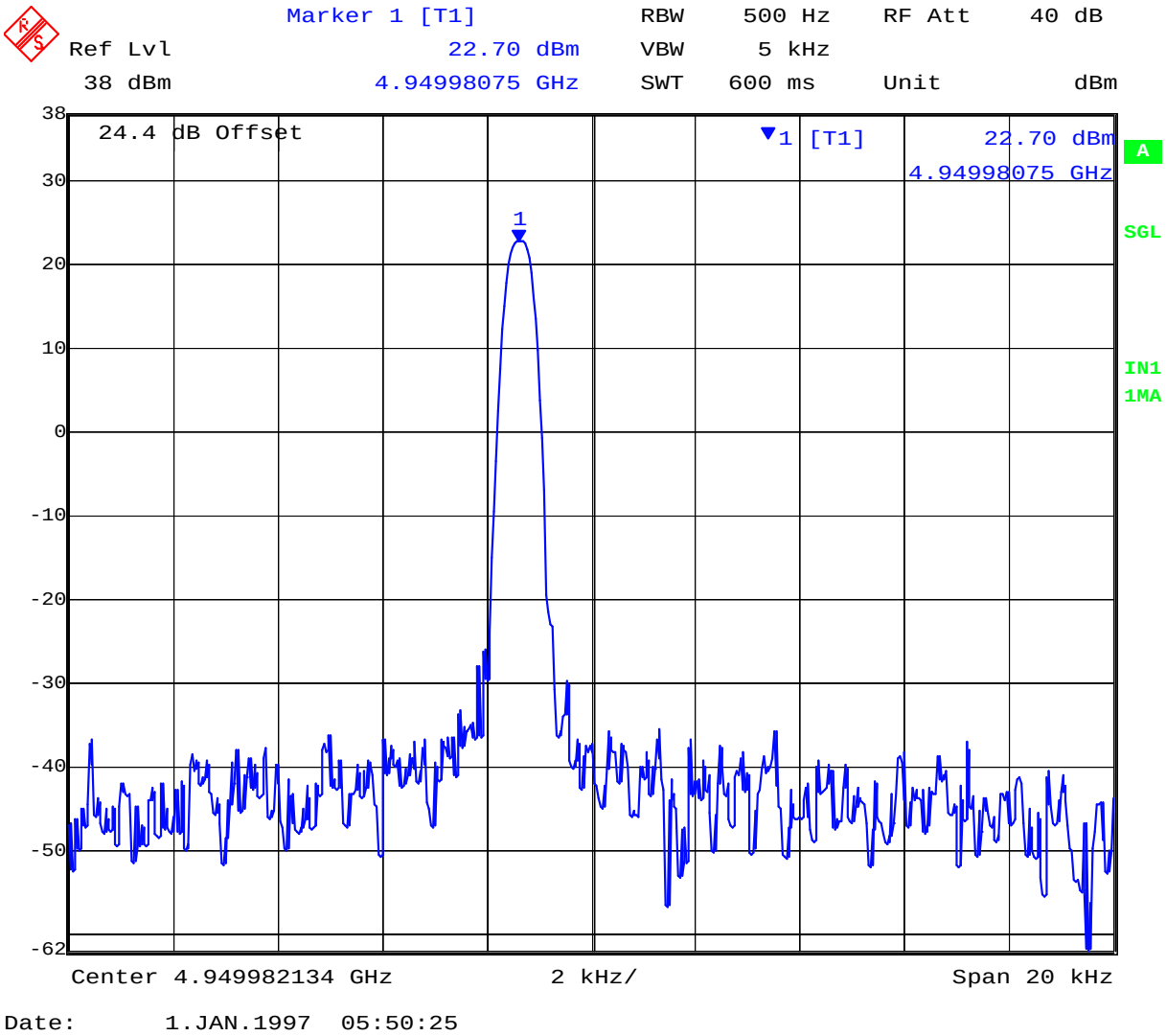
Date: 1.JAN.1997 05:12:12

Frequency Stability @ +20°C, +55.2 Vdc



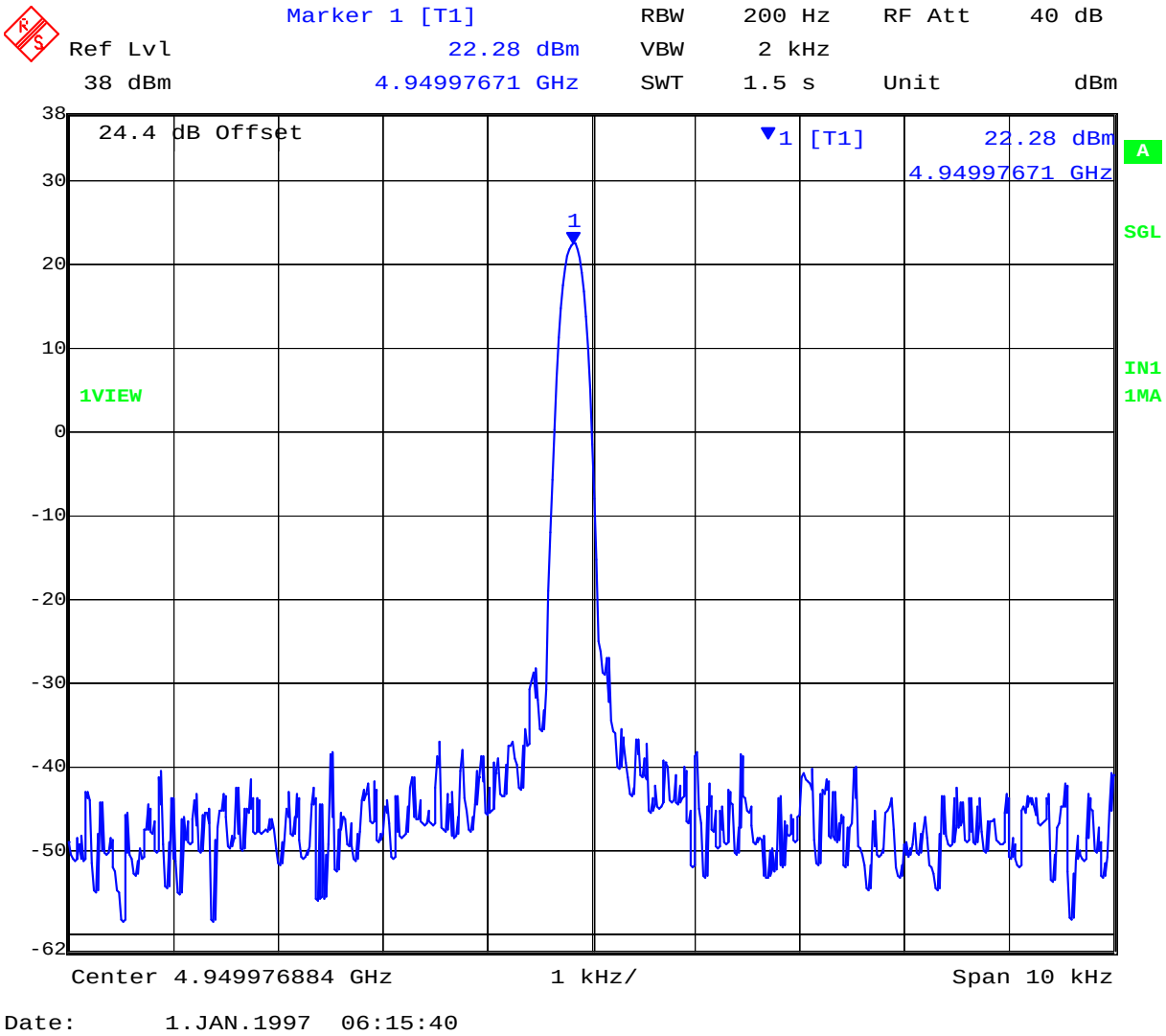
Date: 1.JAN.1997 05:26:43

Frequency Stability @ +25°C



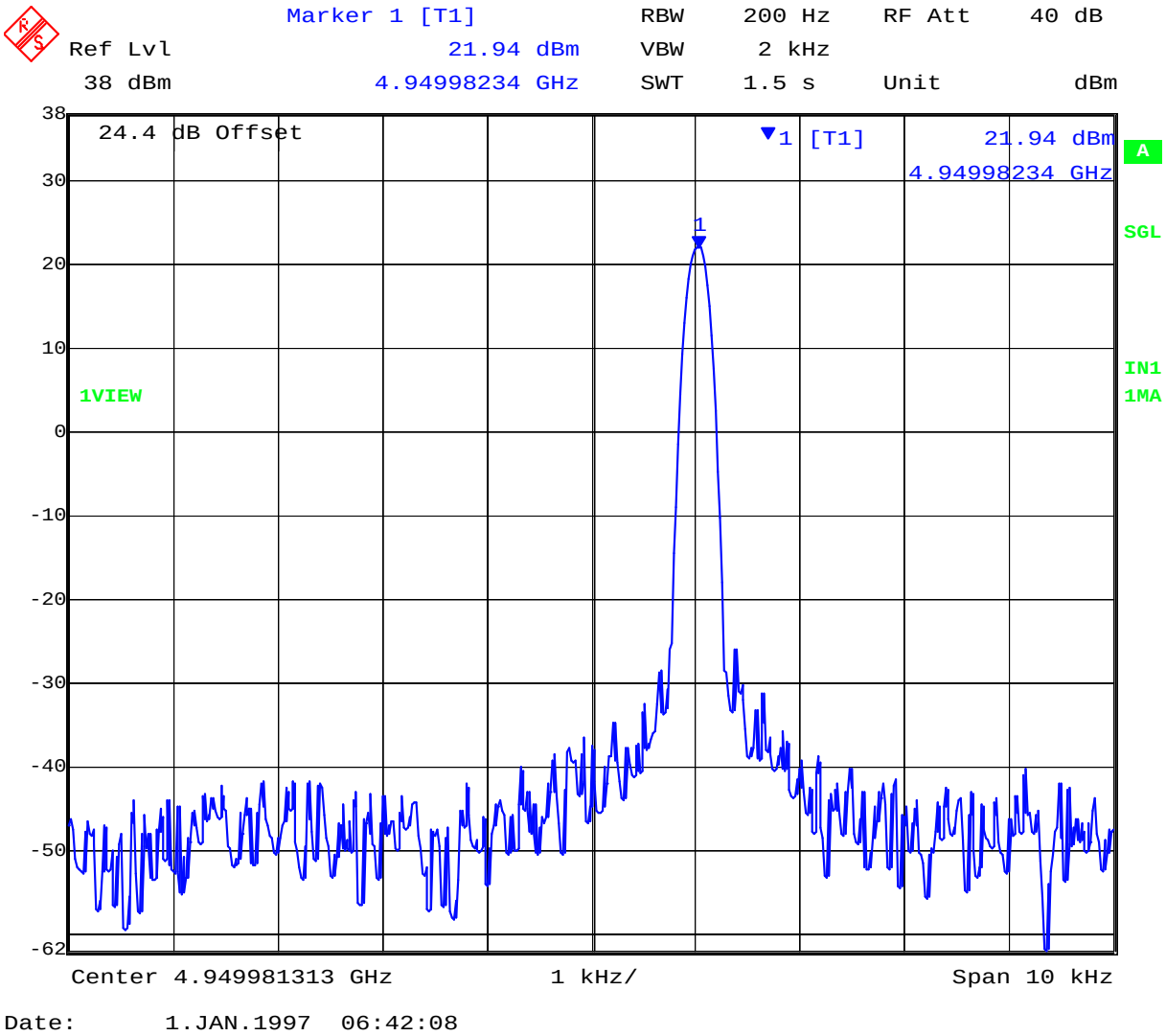
Date: 1.JAN.1997 05:50:25

Frequency Stability @ +35°C



Date: 1.JAN.1997 06:15:40

Frequency Stability @ +45°C



Date: 1.JAN.1997 06:42:08

Frequency Stability @ +55°C

Laboratory Measurement Uncertainty for Frequency Stability

Measurement uncertainty	±0.866 ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

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6.1.6. Spurious Emissions at Antenna Terminals - Transmitter

FCC 47 CFR Part 90, Subpart Y; 2.1051; §90.210(m)

IC Section 4.4/4.5
Industry Canada RSS-Gen 6

Test Procedure
Transmitter conducted spurious emissions were measured for each bandwidth. Measurement were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Conducted spurious emissions were measured to 40 GHz.

Limit calculation depended on average transmit power level(s). See test report Section 5.1.2 for maximum power level measurements.

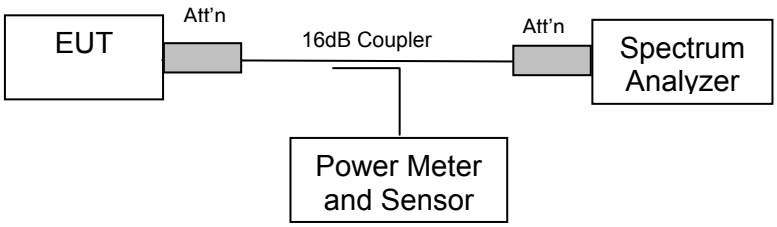
Worst case power measurement: +18.20 dBm (0.066W)

From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Attenuation
55 + 10 log (P) dB for 20 MHz bandwidth = 43.2 dB attenuation where P is Watts

Limit: +18.20 – 43.2 = -25.0 dBm

Test Measurement Set up



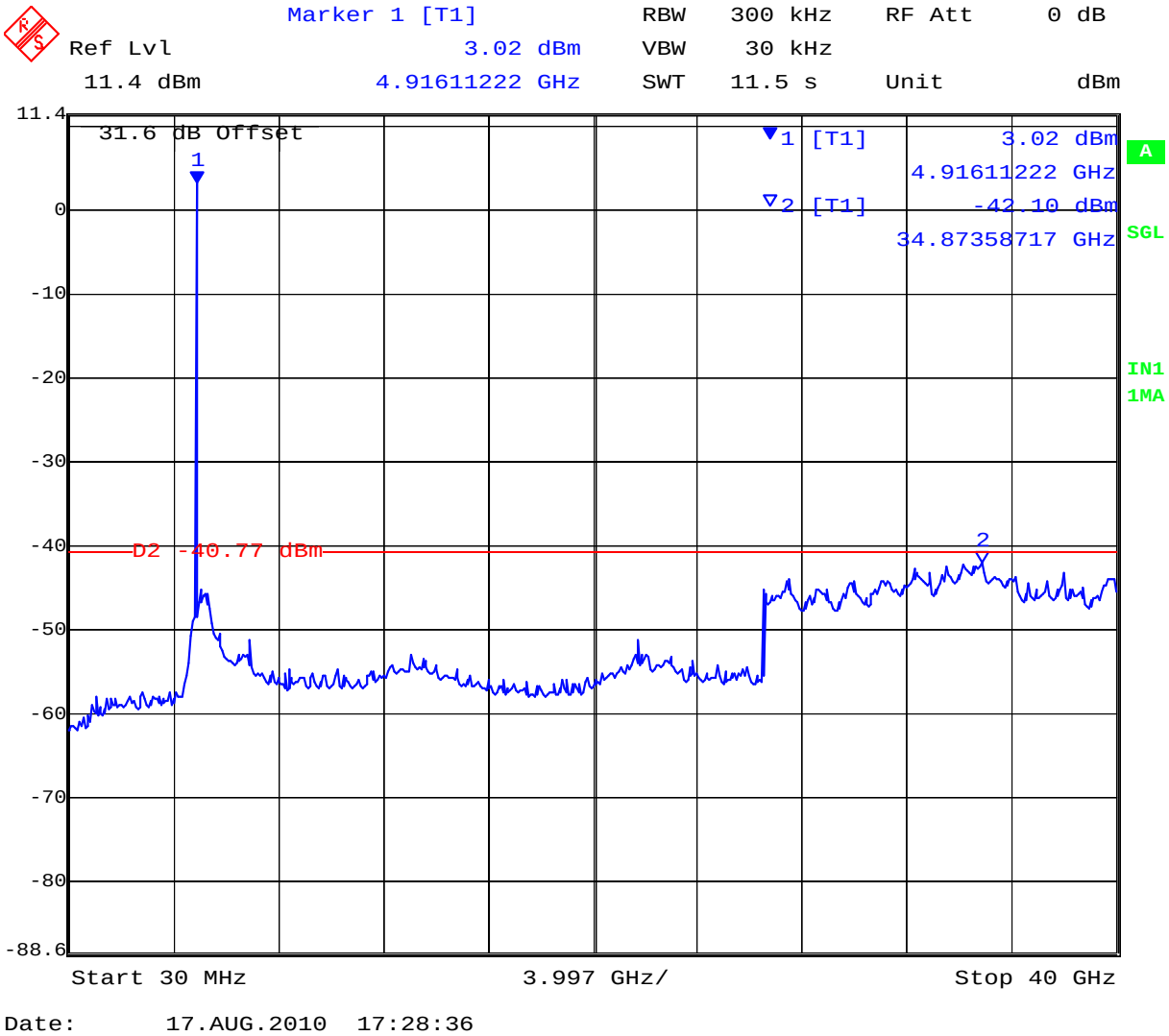
Conducted spurious emission test configuration

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

TABLE OF RESULTS

TABLE OF RESULTS – 802.11a 20 MHz Bandwidth 4950 MHz

Frequency (MHz)				
Start (MHz)	Stop (MHz)	Freq of Maximum Emission (MHz)	Emission Amplitude (dBm)	Margin (dB)
30	40,000	34,87358717	-42.10	-17.1

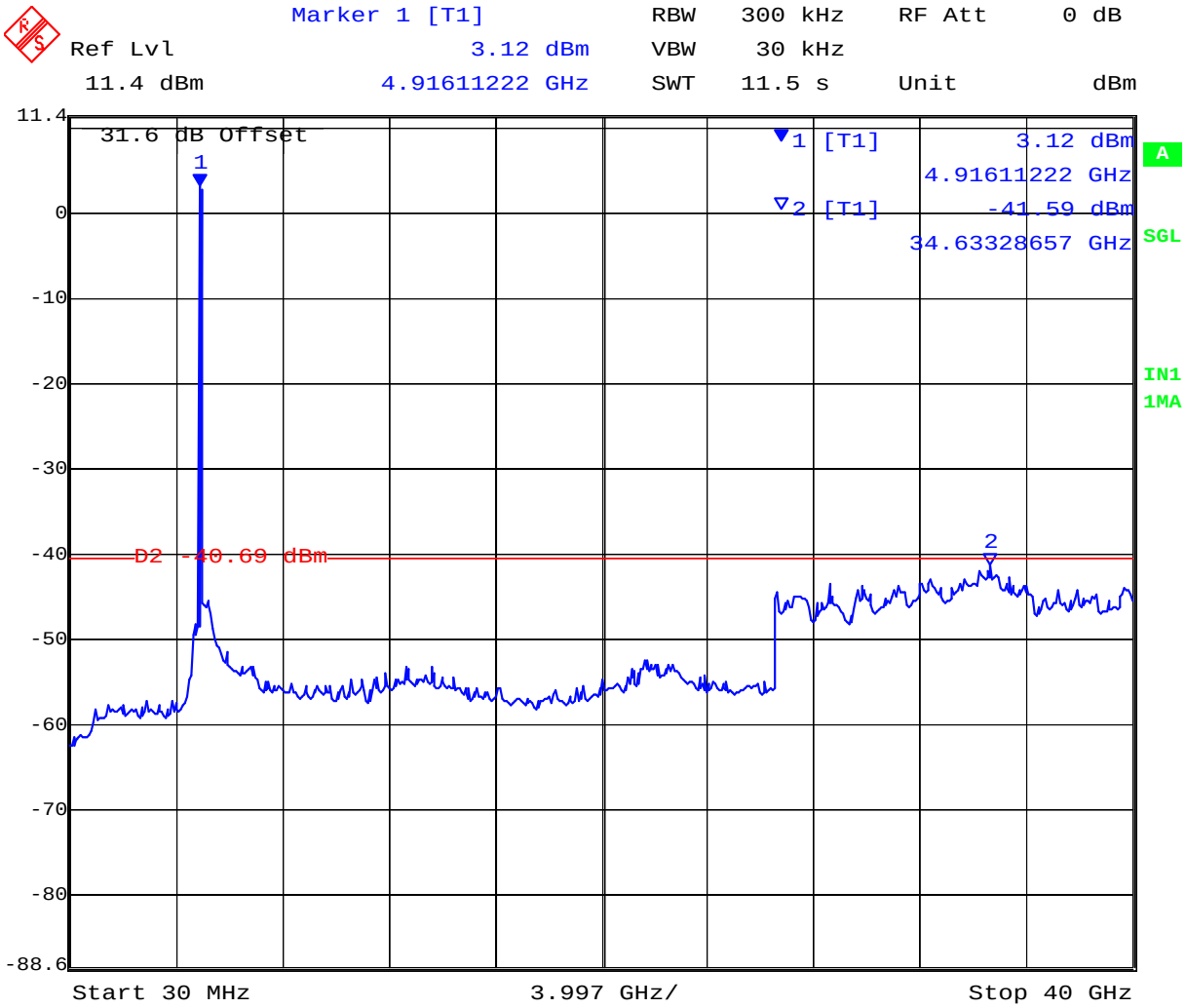


Date: 17.AUG.2010 17:28:36

Transmitter Channel 4950 MHz, 20 MHz Channel Spacing, 30 – 40,000 MHz

TABLE OF RESULTS – 802.11a 20 MHz Bandwidth 4980 MHz

Frequency (MHz)				
Start (MHz)	Stop (MHz)	Freq of Maximum Emission (MHz)	Emission Amplitude (dBm)	Margin (dB)
30	40,000	34,633.28657	-41.59	-16.59

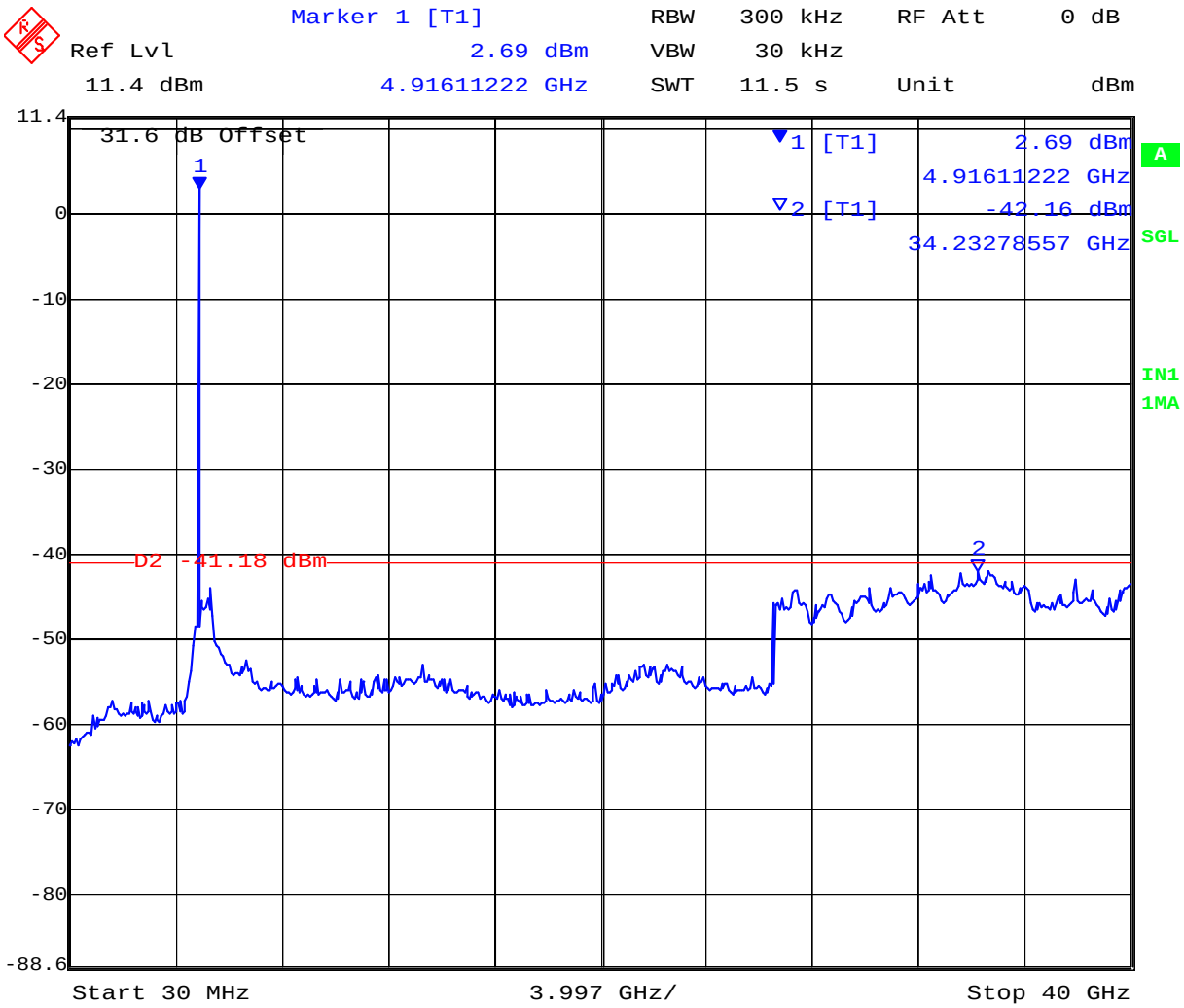


Date: 17.AUG.2010 17:34:42

Transmitter Channel 4980 MHz 20 MHz Spacing, 30 – 40,000 MHz

TABLE OF RESULTS – 802.11 HT-20, 20 MHz Bandwidth 4950 MHz

Frequency (MHz)				
Start (MHz)	Stop (MHz)	Freq of Maximum Emission (MHz)	Emission Amplitude (dBm)	Margin (dB)
30	40,000	34,232.78557	-42.16	-17.16

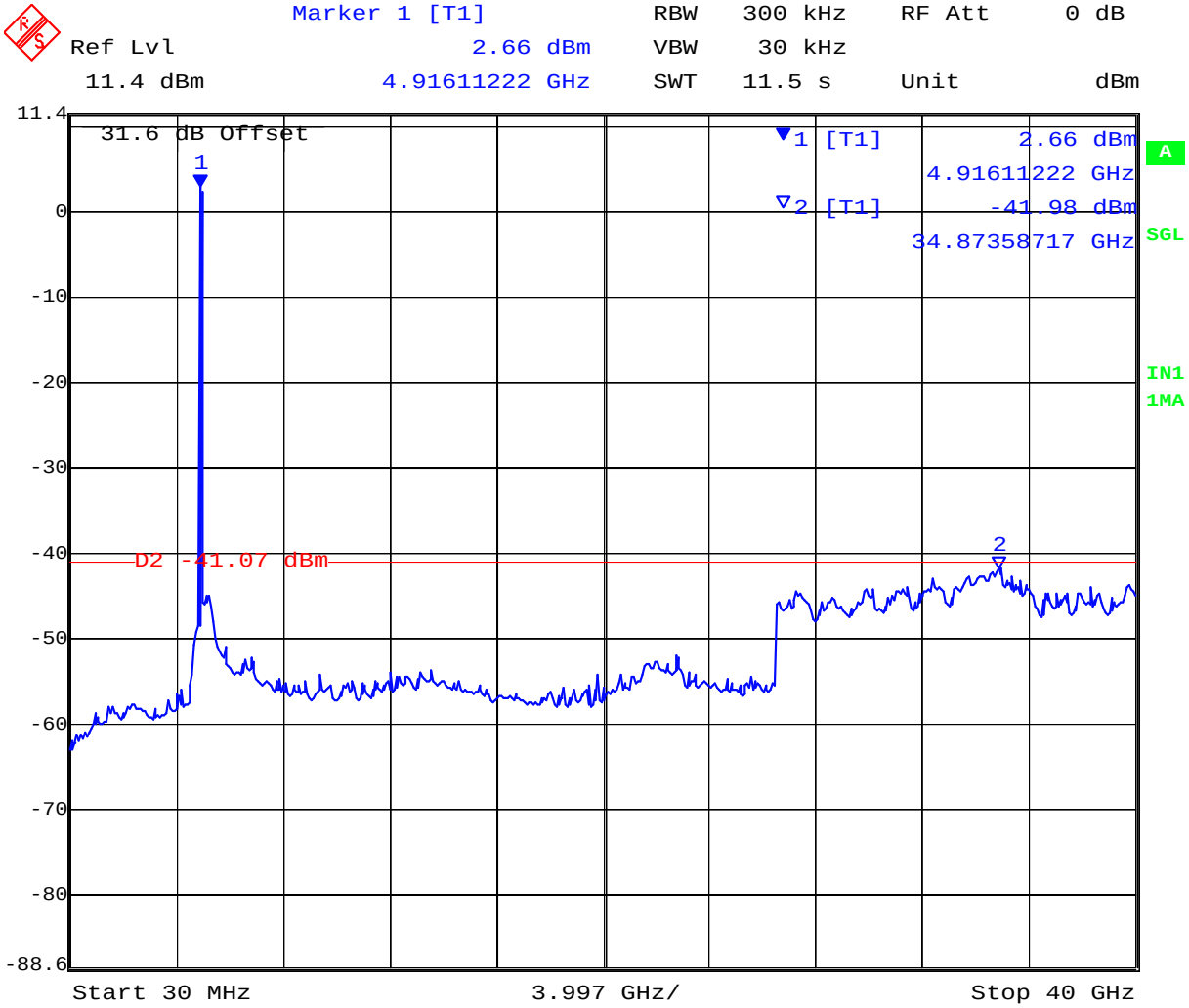


Date: 17.AUG.2010 17:31:34

Transmitter Channel 4950 MHz, 20 MHz Channel Spacing, 30 – 40,000 MHz

TABLE OF RESULTS – 802.11 HT-20, 20 MHz Bandwidth 4980 MHz

Frequency (MHz)				
Start (MHz)	Stop (MHz)	Freq of Maximum Emission (MHz)	Emission Amplitude (dBm)	Margin (dB)
30	40,000	34,873.58717	-41.98	-16.98



Date: 17.AUG.2010 17:33:18

Transmitter Channel 4980 MHz, 20 MHz Spacing, 30 – 40,000 MHz

Specification Limits

Conducted Spurious Emission at Antenna Terminals – Transmitter Limits FCC Part §90.210

Emission Mask (m)
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10log(P) dB, whichever is the lesser attenuation.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0070, 0116, 0158, 0088, 0252, 0313, 0314

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6.1.7. Radiated Spurious Emissions

FCC 47 CFR Part 90, Subpart Y; 2.1053; §90.210(m)

IC Section 4.4

Test Procedure
Measurements were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Substitution was performed on any emissions observed within 6 dB of the limit line. The antenna port was attenuated with a 50 Ω termination.

The measurement equipment was set to measure in peak hold mode. The emissions were 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.

The highest emissions relative to the limit are listed for each frequency spanned.

Measurements below 1 GHz utilized 100 KHz RBW, measurements above 1 GHz were performed using a minimum RBW of 1 MHz.

Limit calculation depended on average transmit power level(s). See test report Section 5.1.2 for maximum power level measurements.

Worst case power measurement: +18.20 dBm

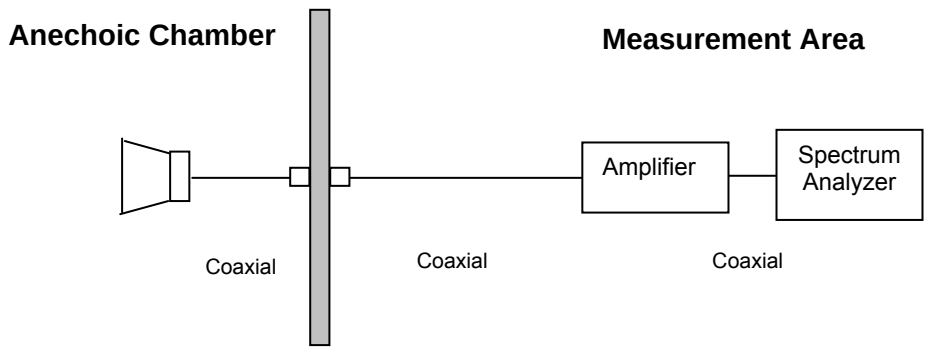
From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Attenuation
55 + 10 log (P) dB for 20 MHz bandwidth = 47.80 dB attenuation where P is Watts

Limit: +18.20 – 43.20 = -25.0 dBm

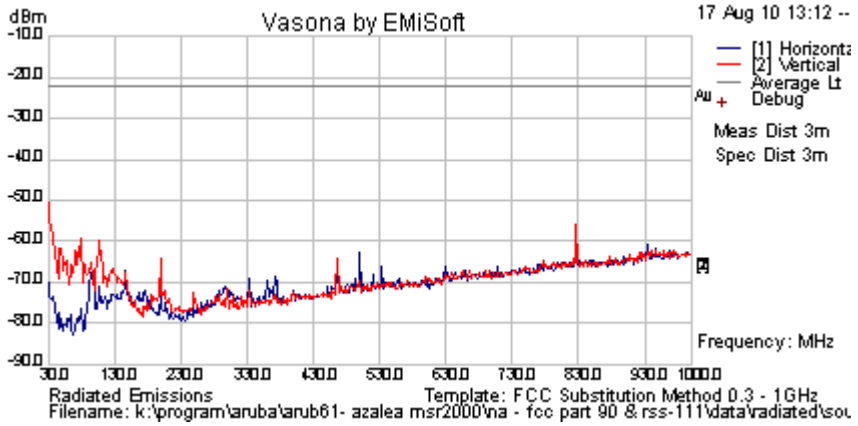
The -25 dBm limit was verified using a substitution method.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Test Freq.	4950 MHz	**Engineer**	CSB
Variant	802.11a; 6 Mbps	**Temp (ºC)**	25.5
Freq. Range	30 - 1000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

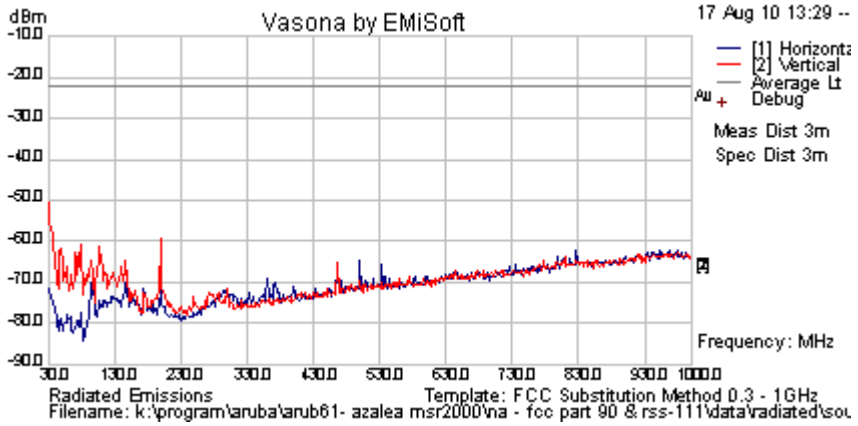


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
No Redio emissions within 6dB of limits.												

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.	4980 MHz	**Engineer**	CSB
Variant	802.11a; 6 Mbps	**Temp (ºC)**	25.5
Freq. Range	30 - 1000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

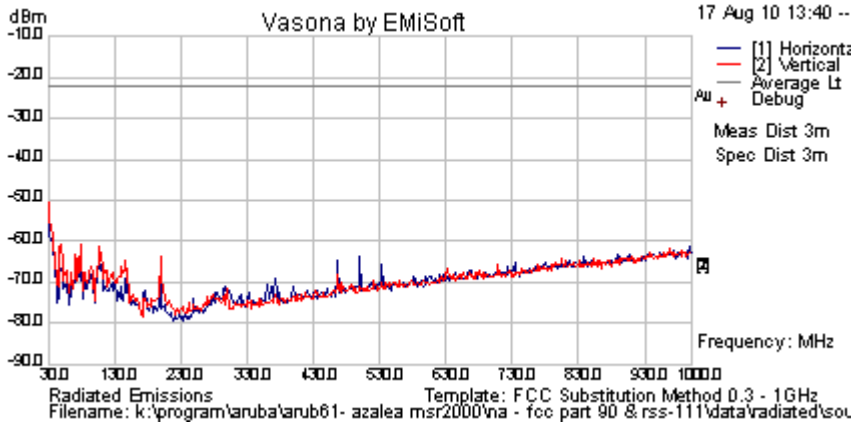


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
No Redio emissions within 6dB of limits.												

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.	4950 MHz	**Engineer**	CSB
Variant	802.11n HT-20; 6.5 MCS	**Temp (ºC)**	25.5
Freq. Range	30 - 1000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

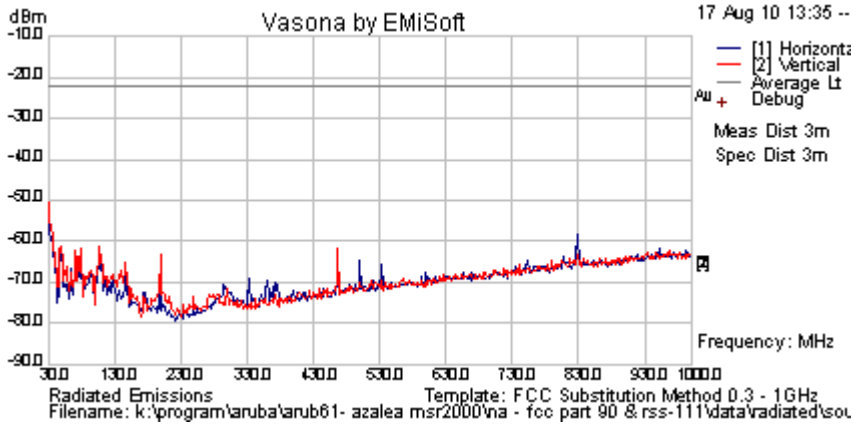


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
No Redio emissions within 6dB of limits.												

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.	4980 MHz	**Engineer**	CSB
Variant	802.11n HT-20; 6.5 MCS	**Temp (ºC)**	25.5
Freq. Range	30 - 1000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

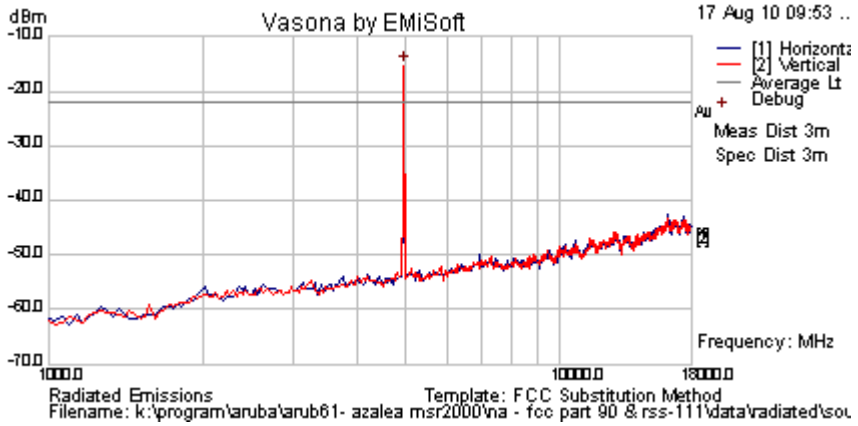


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
No Redio emissions within 6dB of limits.												

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.	4950 MHz	**Engineer**	CSB
Variant	802.11a; 6 Mbps	**Temp (ºC)**	25.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4950.020	-23.6	4.6	3.8	-15.3	Peak [Scan]	V	150	0	-22.2	--	--	FUND

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

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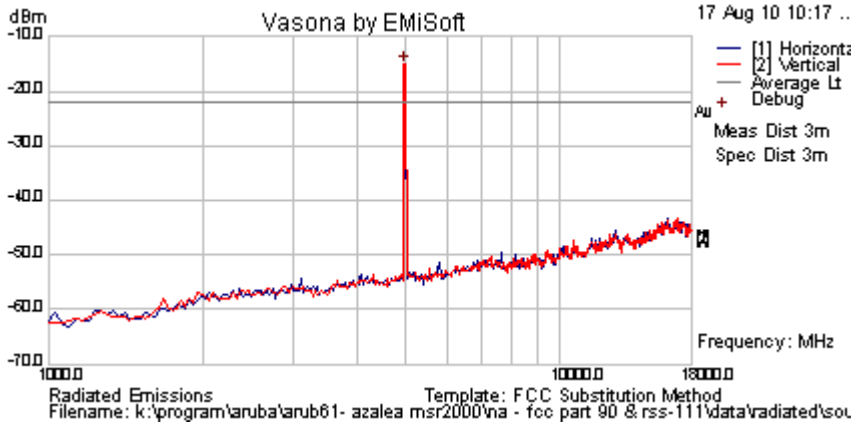
Test Freq.	4980 MHz	**Engineer**	CSB
Variant	802.11a; 6 Mbps	**Temp (ºC)**	25.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

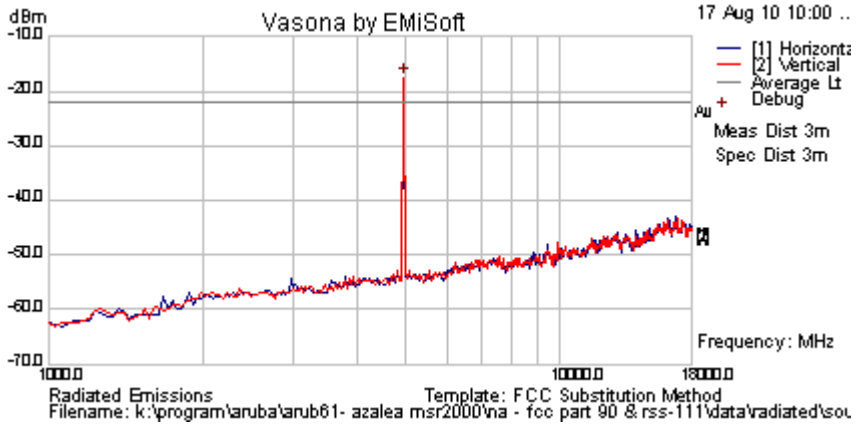


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4979.760	-23.5	4.6	3.8	-15.1	Peak [Scan]	V	150	0	-22.2	--	--	FUND

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.	4950 MHz	**Engineer**	CSB
Variant	802.11n HT-20; 6.5 MCS	**Temp (ºC)**	25.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			

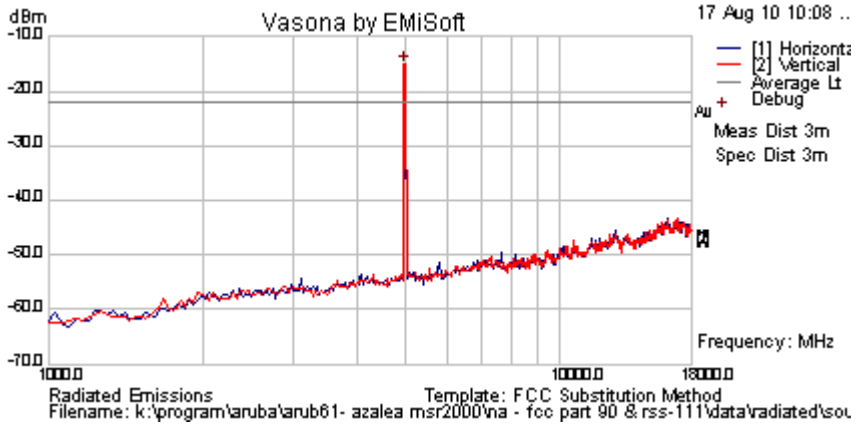


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4950.001	-25.8	4.6	3.8	-17.4	Peak [Scan]	V	150	0	-22.2	--	--	FUND

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.	4980 MHz	**Engineer**	CSB
Variant	802.11n HT-20; 6.5 MCS	**Temp (ºC)**	25.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	20 in ART test utility	**Press. (mBars)**	997
Antenna	50 Ohm terminations	**Duty Cycle (%)**	100
Test Notes 1	Limits was set at: 17.84 (lowest conducted output power) - 40dB = -22.16		
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
4979.760	-23.5	4.6	3.8	-15.1	Peak [Scan]	V	150	0	-22.2	--	--	FUND

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

Transmitter Limits

Limits FCC Part §90.210 (m)

Emission Mask M
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

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, 0104, 0158, 0134, 0310, 0312, Dipole.

6.1.8. Receiver Radiated Spurious Emissions

Industry Canada RSS-Gen §4.8, §6

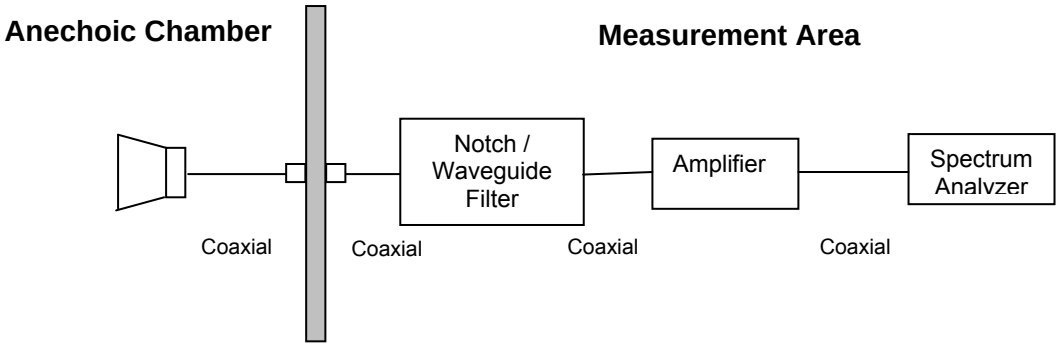
Test Procedure

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

Receiver Spurious Emissions

Industry Canada RSS-Gen §4.10,
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.

Table 1: FCC 15.209 Spurious Emissions Limits

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 Spectrum Measurement

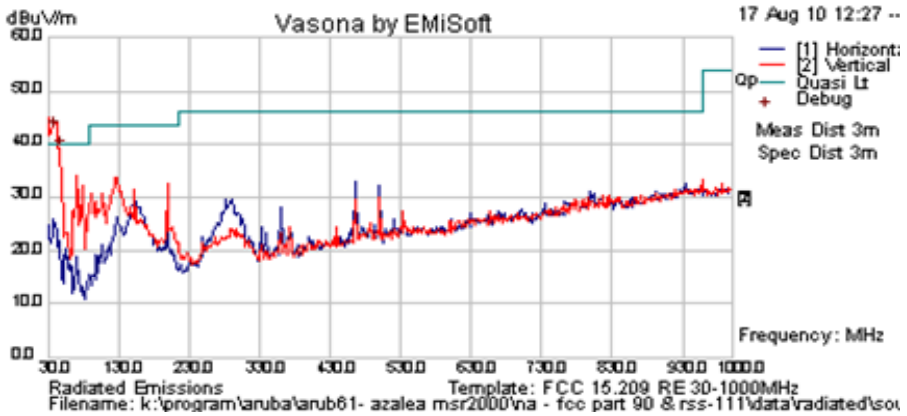
Measurement Uncertainty	+5.6/ -4.5 dB

Traceability:

Method	Test Equipment Used
Work instruction WI-03	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

Measurement Results for Receiver Emissions

Test Freq.	4965 MHz	**Engineer**	CSB
Variant	802.11a/n; Receive Mode	**Temp (ºC)**	26.5
Freq. Range	30 - 1000 MHz	**Rel. Hum.(%)**	33
Power Setting	N/A	**Press. (mBars)**	998
Antenna	50 Ohm Terminations	**Duty Cycle (%)**	100
Test Notes 1	EUT in Receive Mode		
Test Notes 2			

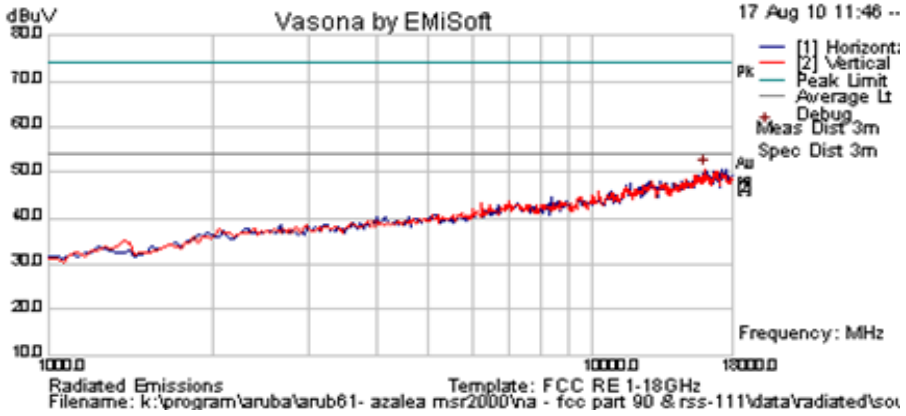


Formally measured emission peaks

Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Pass /Fail	Comments
No Redio emissions within 6dB of limits.												

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.	4965 MHz	**Engineer**	CSB
Variant	802.11a/n; Receive Mode	**Temp (ºC)**	26.5
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	33
Power Setting	N/A	**Press. (mBars)**	998
Antenna	50 Ohm Terminations	**Duty Cycle (%)**	100
Test Notes 1	EUT in Receive Mode		
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 Redio emissions within 6dB of limits.												

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

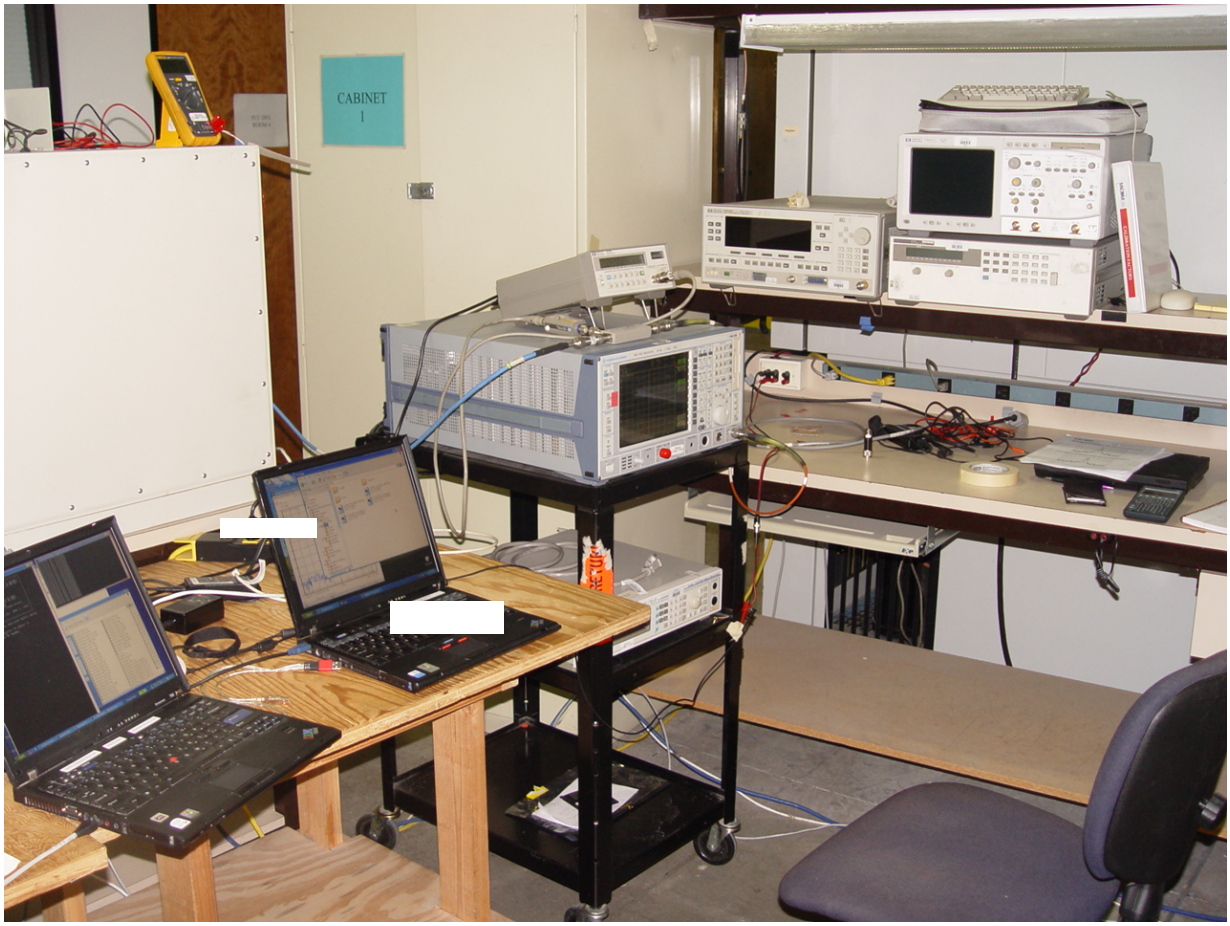
6.1.9. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.207
Industry Canada RSS-Gen §4.8, §6

Refer to the results for AC Power line testing in Sportan International Inc test report No. FR9N1919-01AB (Section 4.1)

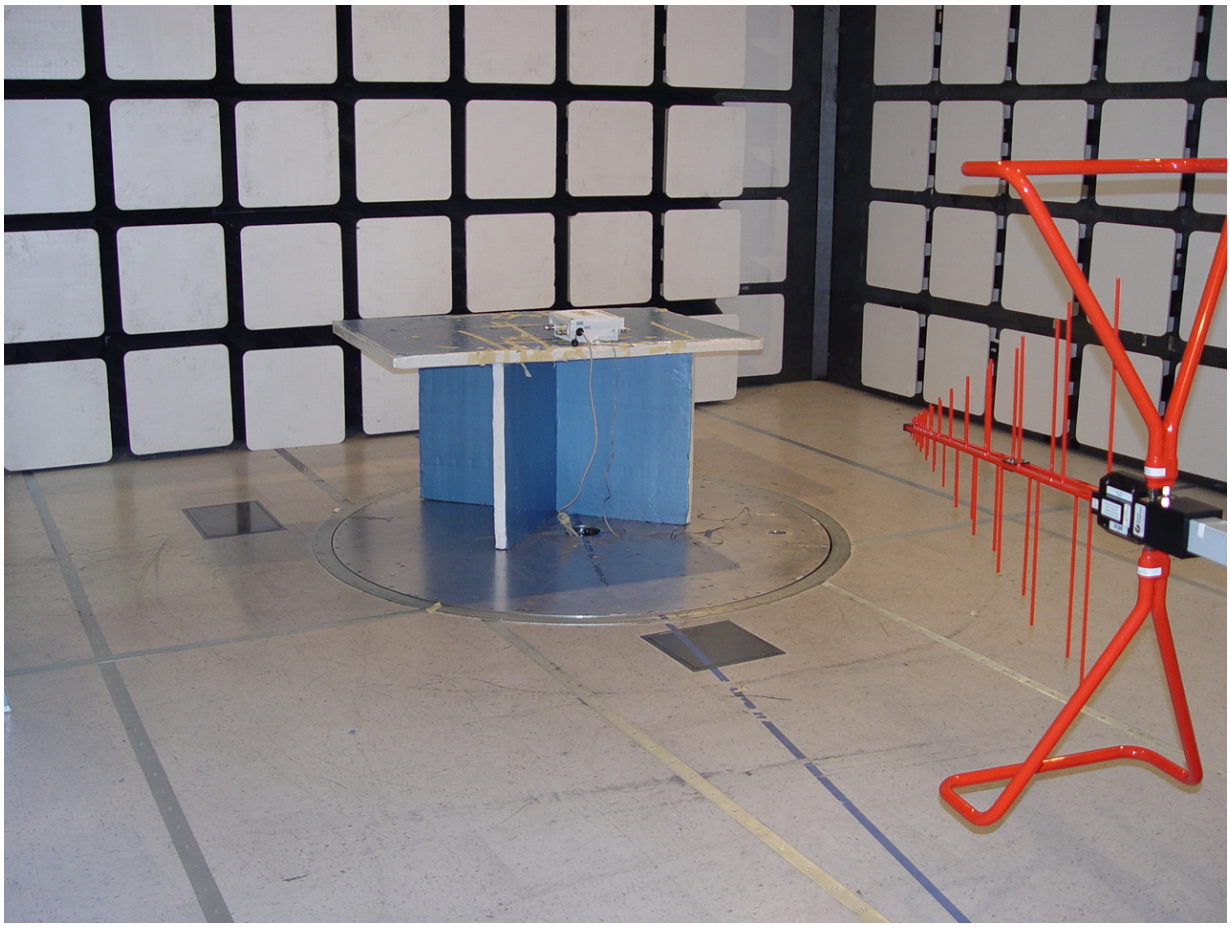
7. TEST SET-UP PHOTOGRAPHS

7.1. General Measurement Test Set-Up

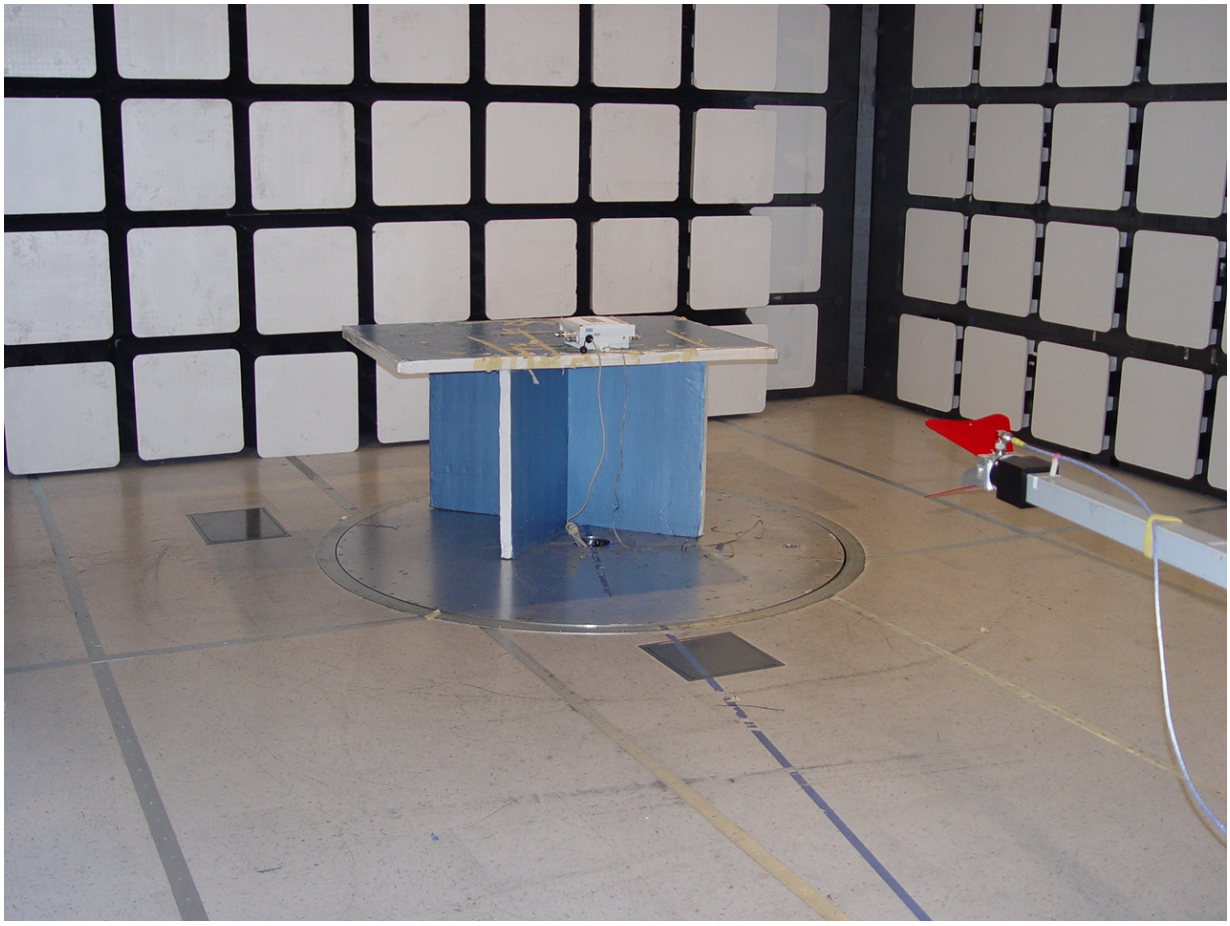


7.2. Environmental Chamber

7.3. Radiated Emissions < 1 GHz



7.4. Spurious Emissions > 1 GHz



8. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
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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