

TEST OF Wireless Access Point AP60/61
802.11a/b/g

To FCC Part 15.247/407 & IC RSS-210

Test Report Serial No.:TUVR51-A1 REV A





Test of Wireless Access Point AP60/61 802.11a/b/g

To FCC 47 CFR Part 15.247/407 & IC RSS-210

Test Report Serial No.: TUVR51-A1 REV A

This report supersedes NONE

Manufacturer: Aruba Wireless Networks
180 Great Oaks Blvd
San Jose
California, 95119 USA

Copy No: pdf

Issue date: 26th October '04

**This Test Report is Issued Under the Authority
of
MiCOM Labs, Inc.**

UKAS (United Kingdom Accreditation Service) Testing Laboratory No. 2106



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ACCREDITATION & LISTINGS

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the United Kingdom Accreditation Service (UKAS) www.ukas.org test laboratory number 2106. MiCOM Labs test schedule is available at the following URL;

http://www.ukas.org/testing/lab_detail.asp?lab_id=875&location_id=&vMenuOption=3.

United Kingdom Accreditation Service

ACCREDITATION CERTIFICATE



**TESTING LABORATORY
No. 2106**

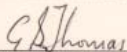
**MiCOM Labs
3922 Valley Avenue
Suite "B"
Pleasanton
California
CA 94566
USA**

is accredited to undertake tests as detailed in the schedule bearing the above accreditation number. From time to time this schedule may be revised and reissued by the United Kingdom Accreditation Service.

Accredited laboratories comply with the requirements of International Standard BS EN ISO/IEC 17025, which replaces ISO/IEC Guide 25 and EN45001. Testing and calibration laboratories that comply with the requirements of this International Standard operate a quality system for their testing and calibration activities that also meets the requirements of ISO 9001 when they engage in the design/development of new methods, and/or develop test programmes combining standard and non-standard test and calibration methods, and ISO 9002 when they only use standard methods.

This Accreditation shall remain in force until the expiry date printed below, subject to continuing compliance with United Kingdom Accreditation Service requirements.

Initial Accreditation 05 October 1999


Accreditation Manager, United Kingdom Accreditation Service

This certificate issued on 17 March 2003

Expiry date 31 August 2007

The Department of Trade and Industry (DTI) has entered into a memorandum of understanding with the United Kingdom Accreditation Service (UKAS) through which UKAS is recognised as the national body responsible for assessing and accrediting the competence of organisations in the fields of calibration, testing, inspection and certification of systems, products and personnel.

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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 #: 4143

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DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	26 th October 2004	Document release

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1. TEST RESULT CERTIFICATE

Manufacturer:	Aruba Wireless Networks	Tested By:	MiCOM Labs, Inc.
	180 Great Oaks Blvd		3922 Valley Avenue
	San Jose		Suite 'B'
	California, 95119 USA		Pleasanton
EUT Description:	Product Description		California 94566, USA
Model:	AP60 S/N: A30000911		Tel: (+1) 925 462 0304
	AP61 S/N: A30000641		Fax: (+1) 925 462 0306
	OR-AP S/N: N/A		
	OR-APWS S/N: N/A		
Date(s) Tested:	9th Sept - 16th Oct '04		

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.247/407 & 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.

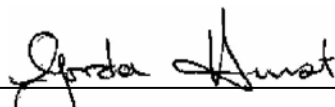
Notes:

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

Approved & Released for MiCOM Labs, Inc. by:



Graeme Grieve
Quality Manager MiCOM Labs, Inc.



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 Parts 15.247	2001	Code of Federal Regulations
(ii)	Industry Canada RSS-210	Issue 5 Nov. 2001	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)
(iii)	ANSI C63.4	2000	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9KHz to 40GHz
(iv)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(v)	M 3003 Addition 1	Edit 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(vi)	LAB34	August 2002	Edition 1. The expression of uncertainty in EMC Testing
(vii)	ETSI TR 100 028	ETSI TR 100 028	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(viii)	UKAS LAB 1	Edition 4 May 2004	Reference to Accreditation for Laboratories.
(ix)	DTI URN 98/997	1998	Conditions for the use of National Accreditation Marks by UKAS and UKAS Accredited Organisations.
(x)	FCC 47 CFR Part 15.407	2001	Code of Federal Regulations

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, Normative Reference (iii).

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, Normative Reference (v).

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3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Purpose:	Test of the Wireless Access Point AP60/61 802.11a/b/g to FCC and Industry Canada regulations
Applicant:	TUV Rheinland of North America 1279 Quarry Lane, Suite A Pleasanton California, 95566 USA
Manufacturer:	Aruba Wireless Networks 180 Great Oaks Blvd San Jose California, 95119 USA
Laboratory performing the tests:	MiCOM Labs, Inc. 3922 Valley Avenue, Suite "B" Pleasanton, California 94566 USA
Test report reference number:	TUVR51-A1 REV A
Date EUT received:	9th September '04
Dates of test (from - to):	9th Sept - 16th Oct '04
Standard(s) applied:	FCC 47 CFR Part 15.247/407 & IC RSS-210
No of Units Tested:	4 units AP60, AP61, OR-AP, OR-APWS
Equipment Category:	Wireless Access Point
Manufacturers Trade Name:	AP
Type of Equipment:	802.11a/b/g Wireless LAN
Location for use:	Internal use only
Full Frequency Range(s):	2.4-2.4835GHz, 5.725-5.850GHz 5.150-5.350GHz
Modulation:	Per 802.11 - DBPSK, DQPSK, CCK, OFDM
Client Declared Nominal Output Power:	802.11b: +20dBm (100mW) 802.11g: +17dBm (50mW) 802.11a: +16dBm (40mW)
Transmit/Receive Operation:	Simplex
Rated Input Voltage and Current:	AC/DC Converter 115VAC / 5VDC (DC current rating 2.5A) Option: POE (Power Over Ethernet)
Temperature Range:	0 - 40°C
ITU Emission Designator:	802.11b: 15M5D7D (11MBit/s) 802.11g: 18M0D7D (54MBit/s) 802.11a: 18M6D7D (54MBit/s)
Microprocessor(s):	IDT 79RC32H434
Clock/Oscillator(s):	33.33MHz, 25MHz, 24MHz
Frequency Stability:	±20ppm
Primary Function:	To initiate and receive Data Transmission, Telemetry, Telecommand, Voice

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3.2. Scope of Test Program

The scope of this test program had two separate purposes; and

1).. Extend Aruba Wireless Networks original FCC/IC filing for their AP60 product line to include an additional antenna for their AP60 in the 2.4GHz range only. The AP60 variant utilizes external antennas was previously tested and certified FCC Identifier QDARUBA60 and IC 4675A-AP6061, see MiCOM Labs test report TUVR24 REV E, issued 3rd September 2004 for the complete test suite.

2).. Increase the number of product variants to include three additional variants limited to operate with integral antennas only;

a).. AP 61

b).. OR-AP

c).. OR-APWS

These devices are limited to integral antenna operation only. All variants (AP60, AP61, OR-AP, OR-APWS) operate with the same pcb and wireless module. The only difference between the integral antenna variants is that the OR-AP and OR-APWS devices have a different case style to that of the AP61. All cases are made from non-conductive plastic produced by Chi-Mei Corp, PA-765 UL 94 V-O ABS.

The manufacturer claims the electronic circuitry (pcb and wireless module) employed in the AP61, OR-AP and OR-APWS integral antenna products are identical to that utilized in the AP60. It is for this reason that limited testing was completed on the AP61, OR-AP and OR-APWS variants. Section 4 Test Summary identifies the list of measurements performed.

The same printed circuit board was utilized to test all variants.

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3.2.1. Equipment Photographs

AP61



OR-AP



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OR-APWS



AP60 with External Antenna



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

NAME	DESCRIPTION	MODEL No.	SERIAL No.	TYPE
AP60	External Antennas	AP60	A30000911	Manufactured Product
AP61	Integral Antennas	AP61	A30000641	Manufactured Product
OR-AP	Integral Antennas	OR-AP	N/A	Development Product
OR-APWS	Integral Antennas	OR-APWS	N/A	Development Product
CUI (PSU)	Power Supply	A1-15S05	DTS050300U	Manufactured Product

Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Integral Antenna (2.4GHz)	4.2 (max)	TYCO	151351-1	N/A
Integral Antenna (5GHz)	7.7 (max)	TYCO	151351-1	N/A
Wide Angle 135° Directional Patch (2.4GHz)	5.0	Cushcraft	SR2405135D	N/A

3.4. Cabling and I/O Ports

Number and type of I/O ports

1. Ethernet 10/100Base T
2. DC Power
3. Antenna Port (AP60 only)

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3.5. Test Configurations

The following test configurations were tested for each variant identified in Section 3.2 Scope of Test Program i.e. AP60, AP61, OR-AP, OR-APWS.

Matrix of test configurations

Operational Mode (802.11)	Operating Channel	Frequencies (MHz)	Maximum Data Rates (MBit/s)	Data Rate(s) Selected for Test Purposes (Mbit/s)
a	149, 157, 161	5,745 5,785 5,825	54	54
a	36, 52, 64	5,180 5,260 5,320	54	54
b	1, 6, 11	2,412 2,437	11	11
g		2,462	54	54

Only worst case plots are reported for each test parameter. Plots not included are held on file by the test laboratory and available upon request with client permission.

3.6. Equipment Modifications

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

1. NONE

3.7. Deviations from the Test Standard

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

1. NONE

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3.8. Subcontracted Testing

Radiated emission testing 30MHz-1GHz (Section 5.1.3 within this report) was subcontracted to the following test facility;

Sanmina-SCI
Homologation Services
EMI Test Laboratory
2305 Mission College Blvd.
Santa Clara, California 95054
USA

Sanmina-SCI, NVLAP (National Voluntary Laboratory Accreditation Program) Lab Code 100411-0 are ISO/IEC 17025 accredited for emission testing 30MHz-1GHz.

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4. TEST SUMMARY

List of Measurements

The following table represent the list of measurements required under the **FCC CFR47 Part 15.247, 15.407** and **Industry Canada RSS-210**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
5.205(a) / 15.209(a) 6.3	Radiated Emissions				5.1
	Band Edge	Restricted Bands (AP61 only)	Radiated		5.1.1
	Radiated Emissions	Emissions <1GHz (30M-1GHz) Note: AP60, OR-AP, OR-APWS only	Radiated		5.1.2
	Transmitter Radiated Spurious Emissions	missions >1GHz (1-26GHz, 2.4GHz) (1-40GHz, 5GHz)	Radiated		5.1.3

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

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

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

Note:

Radiated Emissions (< 1GHz) was performed on the following variants only. This test was previously performed on the AP60, see Section 3.2 Scope of Test Program

- i).. AP61
- ii).. OR-AP
- iii).. OR-APWS

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5. TEST RESULTS

5.1. Device Characteristics

5.1.1. Band Edge

FCC, Part 15 Subpart C §15.247(c)

Industry Canada RSS-210 §6.3

Radiated Band-Edge Results – Restricted Bands

This was a radiated test performed in a 3-meter anechoic chamber. Equipment was operated at maximum power on the frequency channel closest to the restricted band in each case. Prior to testing the turntable was rotated until the maximum emission was obtained from the EUT.

Radio parameters for the AP61 Variant

Antenna Type: Integral

Test Configuration: Power over Ethernet. 12 ft Cat 5 UTP (unshielded) dropped to the floor. Laptop connected to Cat5 UTP. ART (Atheros s/w), continuous transmit with TX100 with maximum transmit power.

Variant: **AP61 (integral antennas)**

Variant Tested: AP61

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	Restricted Band Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Plot #
2,412	2,390	47.70	54.00	6.3	TUVR51-01
2,462	2,483.5	46.11	54.00	7.89	TUVR51-02

TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	Restricted Band Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Plot #
2,412	2,390	52.13	54.00	1.87	TUVR51-03
2,462	2,483.5	50.20	54.00	3.80	TUVR51-04

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TABLE OF RESULTS – 802.11a 54Mbit/s

Centre Frequency (MHz)	Restricted Band Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Plot #
5,180	5,150	53.90	54.00	0.10	TUVR51-05
5,320	5,350	51.40	54.00	3.60	TUVR51-06

Specification

Limits

§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.

Frequency(MHz) Restricted Band Edge	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
2,390	500	54	3
2,483.5	500	54	3
5,150	500	54	3
5,350	500	54	3

Measurement Uncertainty Radiated Emissions

Measurement uncertainty (dB)	+5.6/ -4.5
------------------------------	------------

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-07	0156, 0193, K-CBL 08, K-CBL 10, ANT1-18,

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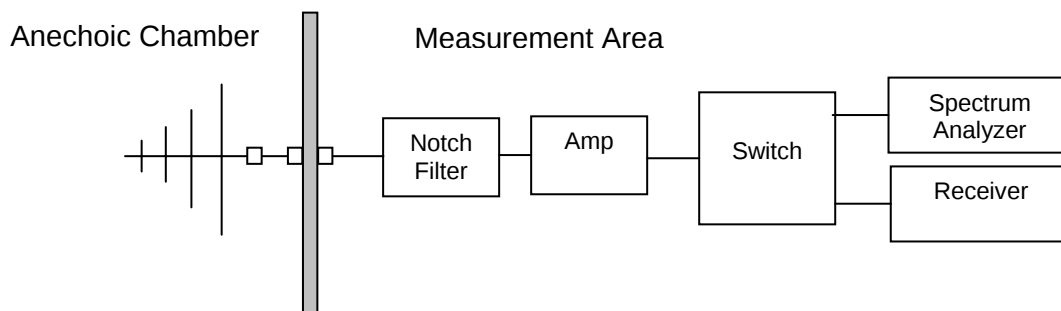
5.1.2. Radiated Spurious Emissions (30M-1GHz)

FCC, Part 15 Subpart C §15.247(c)/ §15.209
Industry Canada RSS-210 §6.2.2(q1)(ii)

Test Procedure

Testing 30M-1GHz was subcontracted to the company identified in Section 3.9 Subcontracted Testing. 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 120kHz. 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.

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

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For example:

Given a Receiver input reading of 51.5dB μ V; 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:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3\text{dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (\mu V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100\mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250\mu\text{V/m}$$

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

Ambient conditions.

Temperature: 19 to 26 °C Relative humidity: 31 to 57% Pressure: 999 to 1009 mbar

Radio parameters for the AP61 Variant

Antenna Type: Integral

Test Configuration: Power over Ethernet. 12 ft Cat 5 UTP (unshielded) dropped to the floor. Laptop connected to floor jack in control room, Cat5 UTP through ferrite absorption clamp. ART (Atheros s/w), continuous transmit with TX100, 802-11a 5,220MHz, 54Mbps, Target power +16dBm

Variant: **AP61**

TABLE OF RESULTS

Freq. MHz	Peak dBuV/m	QP dBuV/m	QP Lmt dBuV/m	QP Margin dB	Angle deg	Hgt cm	Pol	Total Correction Factor
106.7055	30.40	27.56	40.00	-12.44	244	398	Horz	-23.15
185.9769	30.41	26.38	40.00	-13.62	173	102	Vert	-20.57
539.9952	46.68	46.24	47.00	-0.76	139	180	Horz	-8.78
629.9995	38.19	37.11	47.00	-9.89	172	194	Vert	-7.20
899.9951	41.88	41.14	47.00	-5.86	210	102	Horz	-3.56
989.9931	39.39	38.74	47.00	-8.26	1	101	Horz	-1.86

Plot included see Section 'Graphical Data', TUVR51/07

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Radio parameters for OR-AP Variant

Data Rate(s): 802.11a, 54MBit/s
Antenna Type: Integral

Test Set Up: Power over Ethernet. 12 ft Cat 5 UTP (unshielded) dropped to the floor.
Laptop connected to floor jack in control room, Cat5 UTP through ferrite absorption clamp.
ART, continuous transmit with TX100, 802-11a 5.220 GHz, 54Mbps, Target pwr +16dBm
Unit: **OR-AP**

TABLE OF RESULTS

Freq. MHz	Peak dBuV/m	QP dBuV/m	QP Lmt dBuV/m	QP Margin dB	Angle deg	Hgt cm	Pol	Total Correction Factor
47.80027	35.61	33.28	40.00	-6.72	197	102	Vert	-22.42
106.7063	32.41	29.45	40.00	-10.55	256	397	Horz	-23.15
539.9977	45.53	44.99	47.00	-2.01	57	194	Vert	-8.78
629.9941	39.78	39.05	47.00	-7.95	138	155	Vert	-7.20
899.9858	38.15	36.85	47.00	-10.15	1	102	Vert	-3.56
989.9871	40.09	39.01	47.00	-7.99	10	101	Vert	-1.85

Plot included see Section 'Graphical Data', TUVR51/08

Radio parameters for OR-APWS Variant

Data Rate(s): 802.11a, 54MBit/s
Antenna Type: Integral

Test Set Up: Power over Ethernet. 12 ft Cat 5 UTP (unshielded) dropped to the floor.
Laptop connected to floor jack in control room, Cat5 UTP through ferrite absorption clamp.
ART, continuous transmit with TX100, 802-11a 5.220 GHz, 54Mbps, Target pwr +16dBm
Unit: **OR-APWS**

TABLE OF RESULTS

Freq. MHz	Peak dBuV/m	QP dBuV/m	QP Lmt dBuV/m	QP Margin dB	Angle deg	Hgt cm	Pol	Total Correction Factor
47.04102	33.32	30.23	40.00	-9.77	272	194	Vert	-22.11
47.79971	36.69	34.52	40.00	-5.48	129	104	Vert	-22.42
184.2840	33.54	29.93	40.00	-10.07	174	104	Vert	-20.66
540.0022	41.49	40.82	47.00	-6.18	71	394	Vert	-8.78
720.0037	40.63	40.06	47.00	-6.94	166	102	Horz	-7.23
900.0022	41.49	40.51	47.00	-6.49	5	104	Vert	-3.56
989.9958	40.40	39.54	47.00	-7.46	174	284	Horz	-1.86

Plot included see Section 'Graphical Data', TUVR51/09

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Specification

Limits

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

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

Frequency(MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Measurement Uncertainty Radiated Emissions

Measurement uncertainty (dB)	+5.6/ -4.5
------------------------------	------------

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-07	HP 8546A E MI Receiver, HP8546A EMI Receiver (RF Filter Section), HP 9 KHz – 1 GHz Ant. Preamplifier, EMCO Biconilog (Imm/ Em),

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5.1.3. Transmitter Radiated Spurious Emissions (above 1GHz)

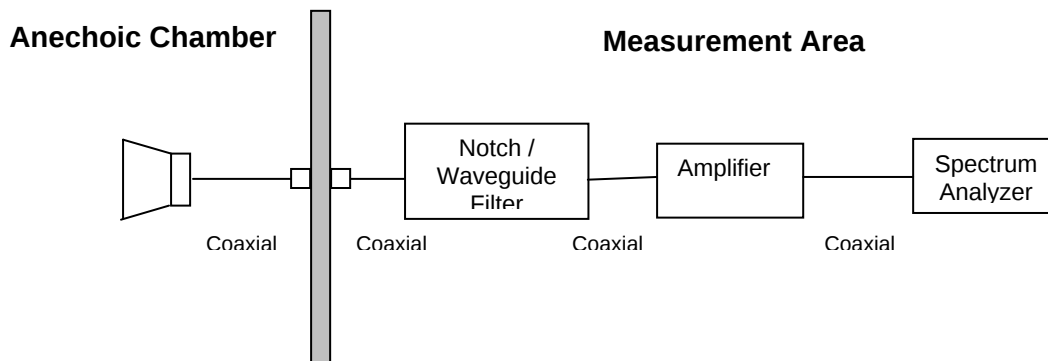
FCC, Part 15 Subpart C §15.247(c)
Industry Canada RSS-210 §6.3

Test Procedure

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

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

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For example:

Given receiver input reading of 51.5dB μ V; 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:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3\text{dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (}\mu\text{V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100\mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250\mu\text{V/m}$$

Measurement Results Transmitter Radiated Spurious Emissions 1GHz - 26GHz

Ambient conditions.

Temperature: 19 to 26 °C Relative humidity: 31 to 57% Pressure: 999 to 1009 mbar

Variant: **AP61**

Radio parameters.

Antenna Type: Integral

Test Configuration: Power over Ethernet. 12 ft Cat 5 UTP (unshielded) dropped under raised floor of the anechoic chamber to external laptop ART (Atheros s/w), continuous transmit TX100

802-11b 11MBit/s – Target power +20dBm

802-11g 54MBit/s – Target power +17dBm

802.11a 54MBit/s - Target power +16dBm

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AP61 802.11b Results

AP61: 802.11b Channel 1 (2,412MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11b Channel 6 (2,437MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11b Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
2015.993	V	53.17	-0.77	52.4	54.00	-1.6
2016.007	H	52.33	-0.77	51.56	54.00	-2.44
7384.894	H	35.61	10.72	46.33	54.00	-7.67
9847.66	H	33.26	16.23	49.49	54.00	-4.52

Plot included see Section 'Graphical Data', TUVR51/10 and TUVR51/11

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AP61 802.11g Results

AP61: 802.11g Channel 1 (2,412MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11g Channel 6 (2,437MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11g Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
7226.5	H	35.21	10.22	45.43	54.00	-8.57
7238.279	V	36.69	10.26	46.95	54.00	-7.05
12819.7	V	30.84	15.37	46.21	54.00	-7.79

Plot included see Section 'Graphical Data', TUVR51/12 and TUVR51/13

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AP61 802.11a Results

AP61: 802.11a Channel 36 (5,180MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11a Channel 52 (5,260MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11a Channel 64 (5,320MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
10645.2	V	33.63	16.4	50.03	54.00	-3.97
10647.09	H	34.46	16.4	50.86	54.00	-3.14
15957.65	V	32.83	18.2	51.03	54.00	-2.97

Plot included see Section 'Graphical Data', TUVR51/14 and TUVR51/15

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AP61 802.11a Results

AP61: 802.11a Channel 149 (5,745MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
10514.61	H	34.64	16.45	51.09	54.00	-2.91
10518.02	V	34.16	16.45	50.61	54.00	-3.39

Plot included see Section 'Graphical Data', TUVR51/16 and TUVR51/17

AP61: 802.11a Channel 157 (5,765MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP61: 802.11a Channel 161 (5,805MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

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AP60 802.11b Results – External Antenna

AP60 External Antenna: 802.11b Channel 1 (2,412MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
7244.067	V	36.04	10.28	46.32	54.00	-7.68
9648.013	H	38.08	14.6	52.68	54.00	-1.32

Plot included see Section 'Graphical Data', TUVR51/18 and TUVR51/19

AP60 External Antenna: 802.11b Channel 6 (2,437MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP60 External Antenna: 802.11b Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
7392.734	V	35.77	10.74	46.51	54.00	-7.49

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AP60 802.11g Results – External Antenna

AP60 External Antenna: 802.11g Channel 1 (2,412MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
7236.054	V	34.54	10.25	44.79	54.00	-9.21
7242.74	H	34.53	10.28	44.81	54.00	-9.19
15326.55	H	32.84	19.14	51.98	54.00	-2.02

Plot included see Section 'Graphical Data', TUVR51/20 and TUVR51/21

AP60 External Antenna: 802.11g Channel 6 (2,437MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
					54.00	
					54.00	
					54.00	
					54.00	
					54.00	

AP60 External Antenna: 802.11g Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Ave. Limit dB μ V/m	Margin dB
7384.274	H	34.27	10.72	44.99	54.00	-9.01
7388.626	V	35.94	10.73	46.67	54.00	-7.33
13356.29	V	33.34	15.09	48.43	54.00	-5.57
13366.05	H	33.34	15.09	48.43	54.00	-5.57

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OR-AP 802.11b Results

OR-AP: 802.11b Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dBμV/m	Correction Factor dB	Corrected Field Strength dBμV/m	Ave. Limit dBμV/m	Margin dB
2015.987	V	51.67	-0.77	50.9	54.00	-3.1
2242.221	V	45.89	0.12	46.01	54.00	-7.99
7389.847	V	35.62	10.73	46.35	54.00	-7.65
7390	H	36.94	10.73	47.67	54.00	-6.33

Plot included see Section 'Graphical Data', TUVR51/22 and TUVR51/23

OR-APWS 802.11b Results

OR-AP: 802.11b Channel 11 (2,462MHz)

TABLE OF RESULTS

Freq. MHz	Polarity H/V	Raw Reading dBμV/m	Correction Factor dB	Corrected Field Strength dBμV/m	Ave. Limit dBμV/m	Margin dB
2015.957	V	52.5	-0.77	51.73	54.00	-2.27
2279.452	V	48.07	0.26	48.33	54.00	-5.6

Plot included see Section 'Graphical Data', TUVR51/24 and TUVR51/25

There was no difference in the amplitude and frequency of spurious emissions found between the AP61, OR-AP and OR-APWS. The same pcb was utilized between all models. For this reason the above plots have been included in this report for comparison purposes only.

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To: FCC 47 CFR Part 15.247/407 & IC RSS-210
Serial #: TUVR51-A1 REV A
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Specification

Limits

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

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

Frequency(MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
Above 960	500	54	3

Measurement Uncertainty Radiated Emissions

Measurement uncertainty (dB)	+5.6/ -4.5
------------------------------	------------

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-07	0156, 0193, K-CBL 08, K-CBL 10, 0088, ANT1-18, ANT4, ANT5, Filter 2.4GHz Notch, Filter 5GHz Notch, W/Guide Filter 12.75-17GHz, W/Guide Filter 17-26.5GHz

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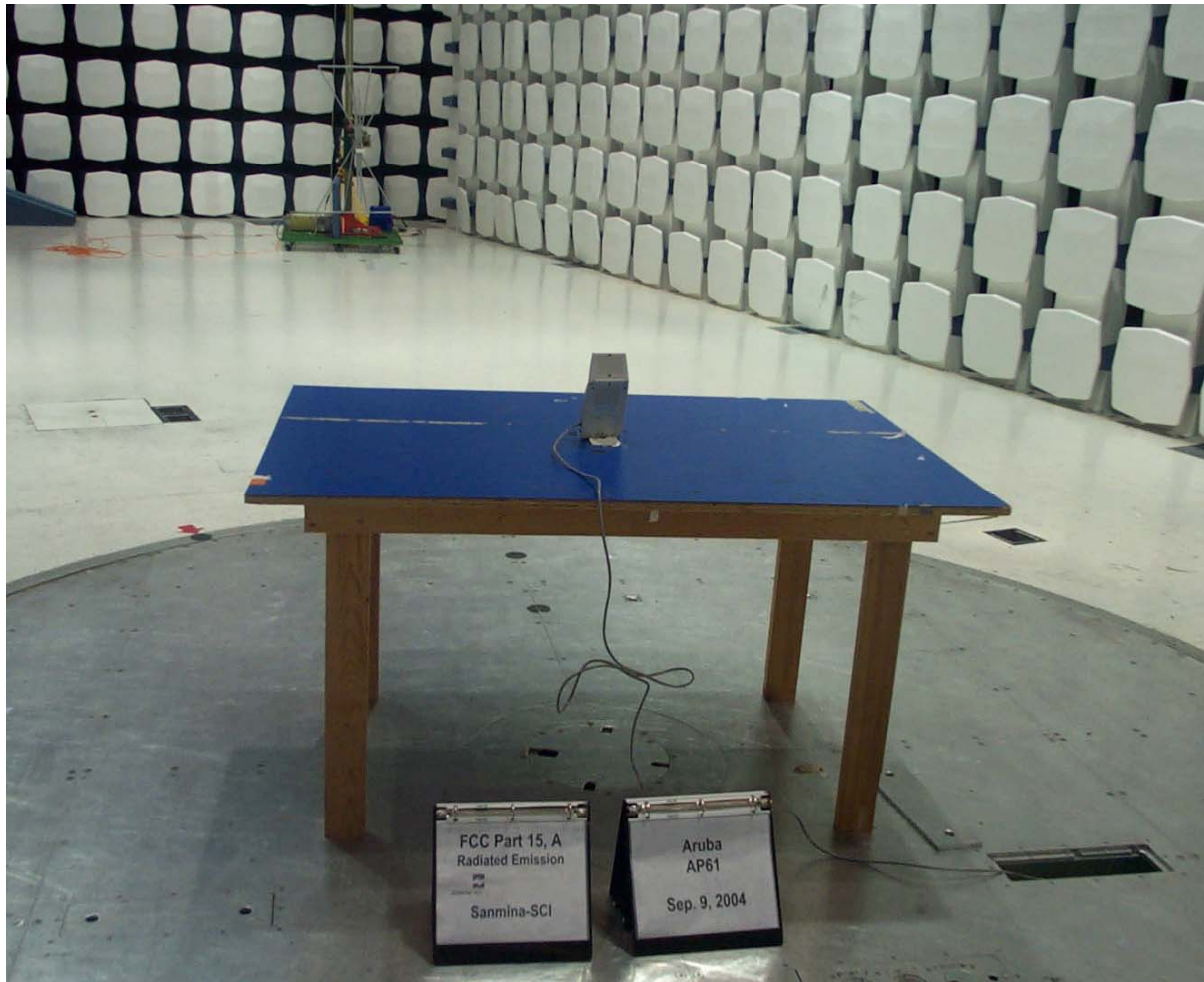
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6. TEST SET-UP PHOTOGRAPHS

6.1. Radiated Emissions (30MHz-1GHz)

Variant AP61 – Integral Antennas



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6.2. Restricted Bands and Spurious Emissions >1GHz

AP60 with external antenna



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7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Calibration Due Date	Serial #
0156	Barometer /Thermometer	Control Co.	4196	12 Aug '05	E2844
K-CBL 08	SMA Cable	Megaphase	Sucoflex 104	18 Jun '05	Unknown
K-CBL 10	SMA Cable	Megaphase	Sucoflex 104	18 Jun '05	Unknown
K-CBL 11	SMA Cable	Megaphase	Sucoflex 104	18 Jun '05	Unknown
K-CBL 12	SMA Cable	Megaphase	Sucoflex 104	18 Jun '05	Unknown
15F50B001	BNC Cable	Megaphase	Unknown	18 Jun '05	Unknown
15F50B002	BNC Cable	Megaphase	Unknown	18 Jun '05	Unknown
10F50B003	BNC Cable	Megaphase	Unknown	18 Jun '05	Unknown
15F50N001	N-Type Cable	Megaphase	Unknown	18 Jun '05	Unknown
5F50N001	N-Type Cable	Megaphase	Unknown	18 Jun '05	Unknown
3F50N002	N-Type Cable	Megaphase	Unknown	18 Jun '05	Unknown
ANT 1	Antenna (30M-2GHz)	Schaffner and Chase	CBLG140A	Not Applicable	1195
ANT1-18	Horn Antenna	The Electro-Mechanics Company	3115	12 Aug '05	9205-3882
0213	20-300MHz Antenna	Schwarzbeck	VHBB 9124	6 Apr '05	9124/0257
0250	230MHz-1GHz Antenna	Schwarzbeck	VUSLP9111	6 Apr '05	186
ANT4	18GHz-26.5GHz	Millimeter Products	261K	30 Apr '05	595
ANT5	26.5GHz-40GHz	Millimeter Products	261A	30 Apr '05	599
0193	EMI Receiver	Rhode & Schwartz	ESI 7	16 Mar '05	838496/007
0088	Spectrum Analyzer	Hewlett Packard	8564E	15 May '05	
0190	LISN	Rhode & Schwartz	ESH3Z5	3 Apr '05	836679/006
0070	Power Meter	Hewlett Packard	437B	13 May '05	3125U13554
0116	Power Sensor	Hewlett Packard	R8485A	16 Mar '05	3318A19694
Coupler	Coupler	Hewlett Packard	86205A	N/A	1623
3dB Att'n	3dB N-Type Attenuator	ARRA	N9444-30	N/A	--
30dB Att'n	30dB N-Type Attenuator	NARDA	32319	N/A	--
Filter	2.4GHz Notch	Micro-Tronics	--	N/A	--
W/guide Filter	12.75-17GHz	CMT	--	--	--
W/guide Filter	17-26.5GHz	HP	--	--	--

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To: FCC 47 CFR Part 15.247/407 & IC RSS-210
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Subcontracted Test Equipment

DESCRIPTION	MODEL	SERIAL NUMBER	LAST CAL DATE	CAL DUE DATE
RECEIVERS				
HP 8546A EMI Receiver (Receiver Section) 9Khz – 6.5Ghz	85462A	3325A00168	11/17/2003	11/17/2004
HP8546A EMI Receiver (RF Filter Section)	85460A	3330A00174	11/17/2003	11/17/2004
HP 9 KHz – 1 GHz Ant. Preamplifier	310N	185516	9/11/2003	9/11/2004
ANTENNAS				
EMCO Biconilog (Imm/ Em))	3142	1117	03/25/2004	03/25/2005

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8. GRAPHICAL RESULTS

This report contains the following plots as referenced in the test results, Section 5 of this report.

802.11a/b/g Graphical Plots		
Parameter		Plot No.
Section 5.1.1 Band Edge (Radiated) AP61		
Band Edge 2,390MHz - 802.11b Tx Ch 2,412MHz		TUVR51/01
Band Edge 2,483.5MHz - 802.11b Tx Ch 2,462MHz		TUVR51/02
Band Edge 2,390MHz - 802.11g Tx Ch 2,412MHz		TUVR51/03
Band Edge 2,483.5MHz - 802.11g Tx Ch 2,462MHz		TUVR51/04
Band Edge 5,150MHz - 802.11a Tx Ch 5,180MHz		TUVR51/05
Band Edge 5,350MHz - 802.11a Tx Ch 5,320MHz		TUVR51/06
Section 5.1.2 Radiated Emissions 30MHz – 1GHz		
	AP61	TUVR51/07
	OR-AP	TUVR51/08
	OR-APWS	TUVR51/09
Section 5.1.3 Radiated Spurious Emissions >1GHz		
AP61 802.11b		
	Ch 11 Horizontal	TUVR51/10
	Ch 11 Vertical	TUVR51/11
AP61 802.11g		
	Ch 11 Horizontal	TUVR51/12
	Ch 11 Vertical	TUVR51/13
AP61 802.11a Low 5GHz Band		
	Ch 36 Horizontal	TUVR51/14
	Ch 36 Vertical	TUVR51/15
AP61 802.11a High 5GHz Band		
	Ch 149 Horizontal	TUVR51/16
	Ch 149 Vertical	TUVR51/17
AP60 + External Antenna #6 802.11b		
	Ch 1 Horizontal	TUVR51/18
	Ch 1 Vertical	TUVR51/19
AP60 + ANT #6 802.11g		
	Ch 1 Horizontal	TUVR51/20
	Ch 1 Vertical	TUVR51/21
OR-AP 802.11b		
	Ch 11 Horizontal	TUVR51/22
	Ch 11 Vertical	TUVR51/23
OR-APWS 802.11b		
	Ch 11 Horizontal	TUVR51/24
	Ch 11 Vertical	TUVR51/25

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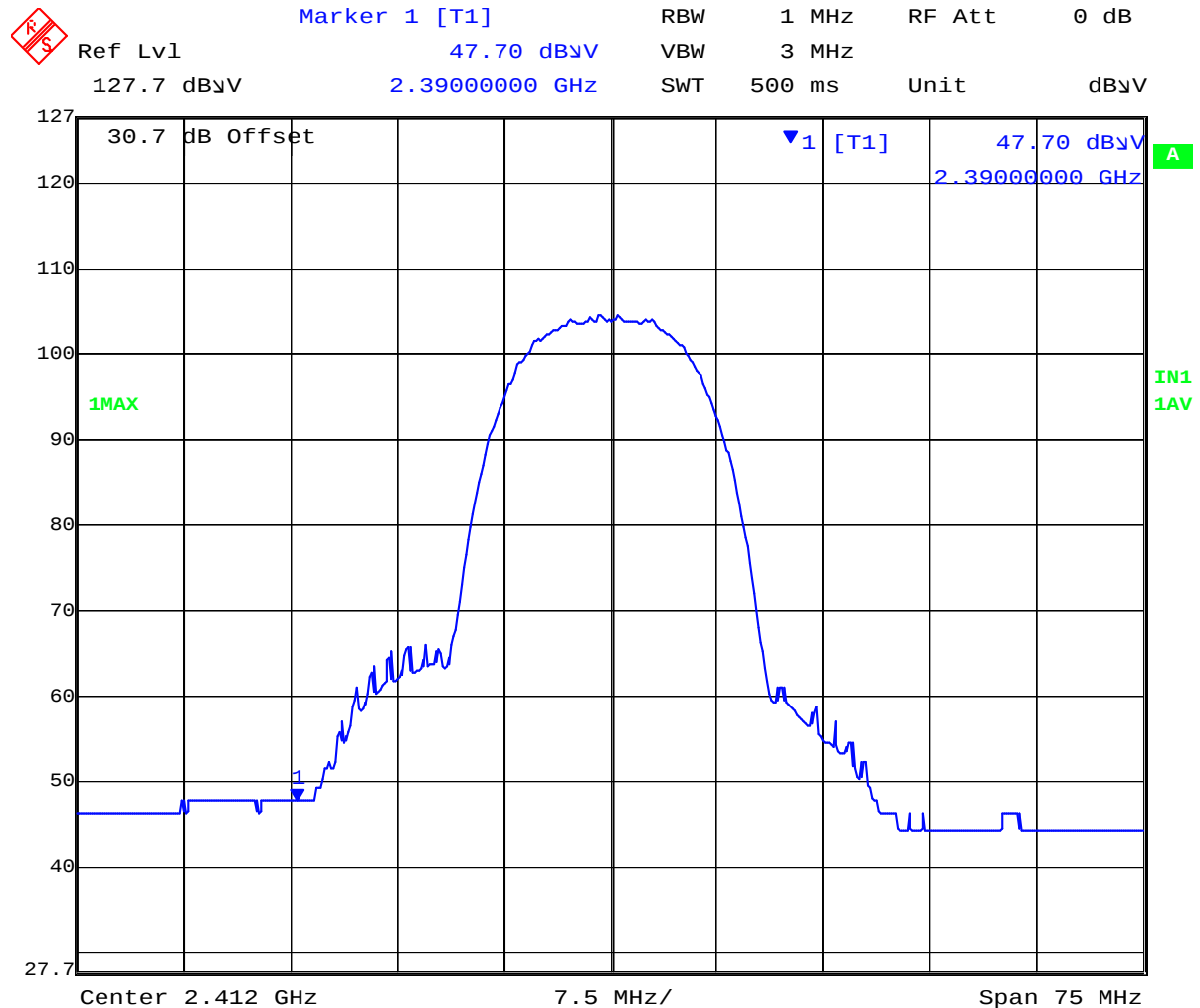
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Band Edge 802.11b 2,390MHz Channel 2,412MHz - TUVR51/01



Date: 5.JAN.1997 20:53:35

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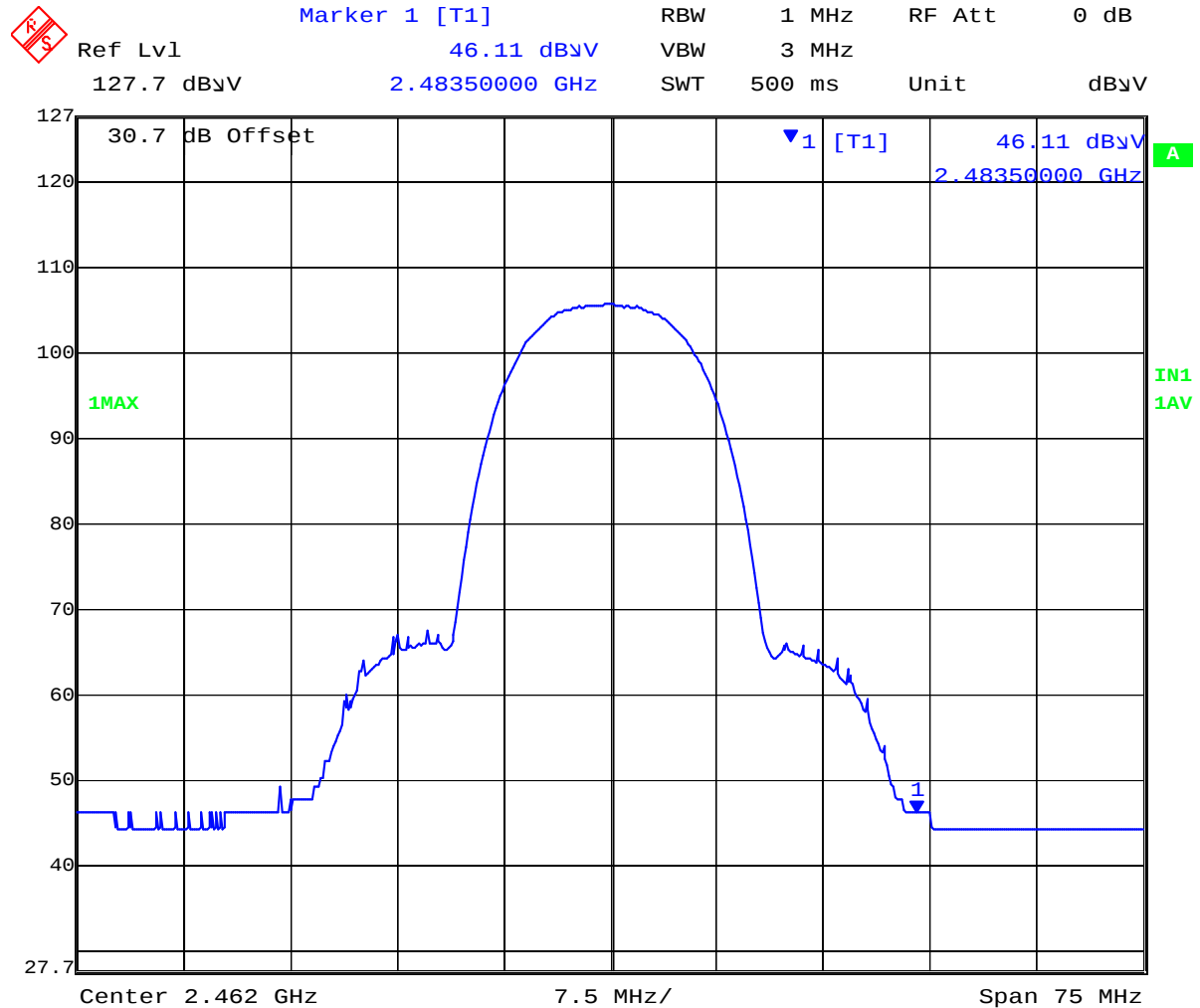
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Band Edge 802.11b 2,483.5MHz Channel 2,462MHz - TUVR51/02



Date: 5.JAN.1997 20:51:57

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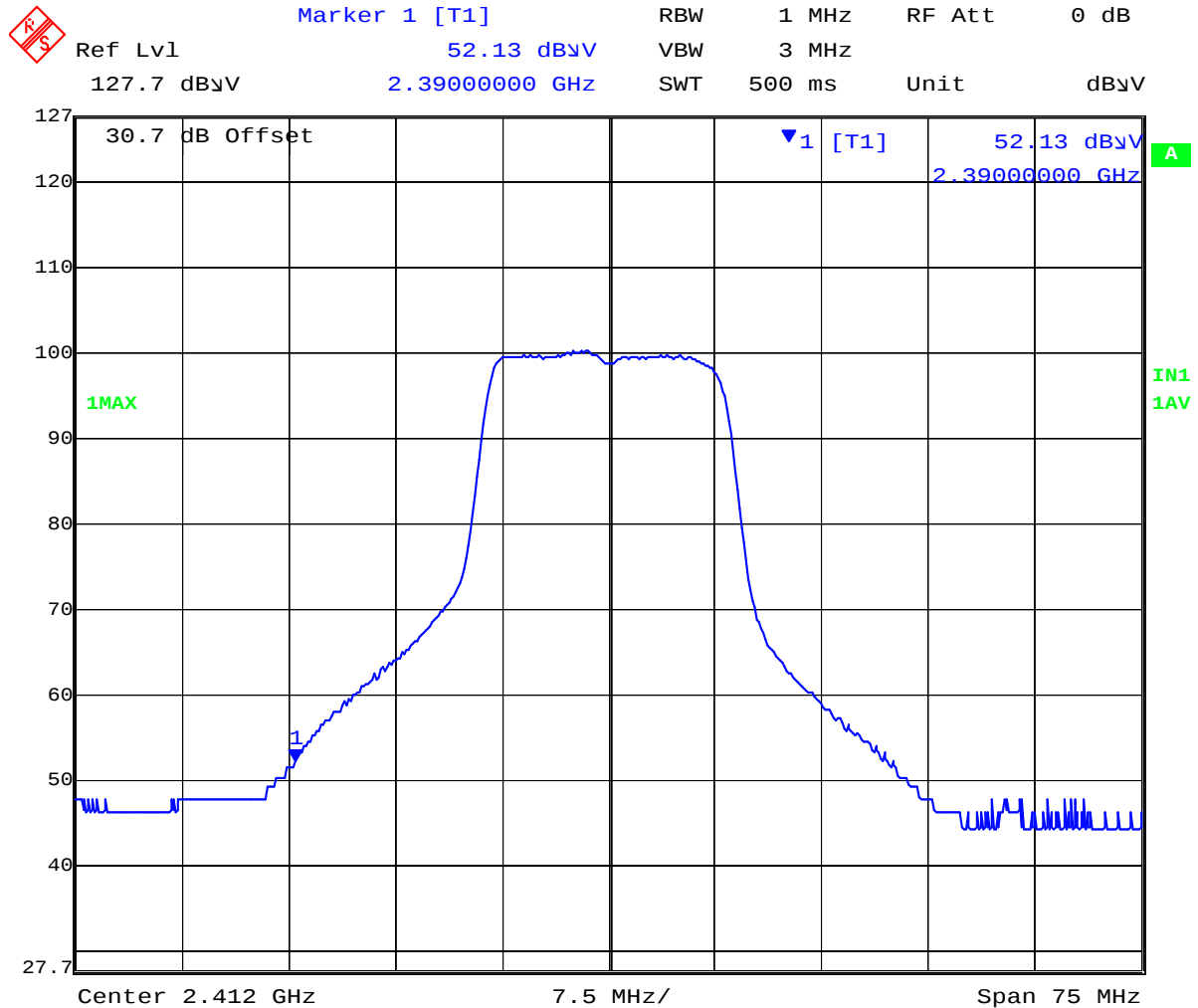
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Band Edge 802.11g 2,390MHz Channel 2,412MHz - TUVR51/03



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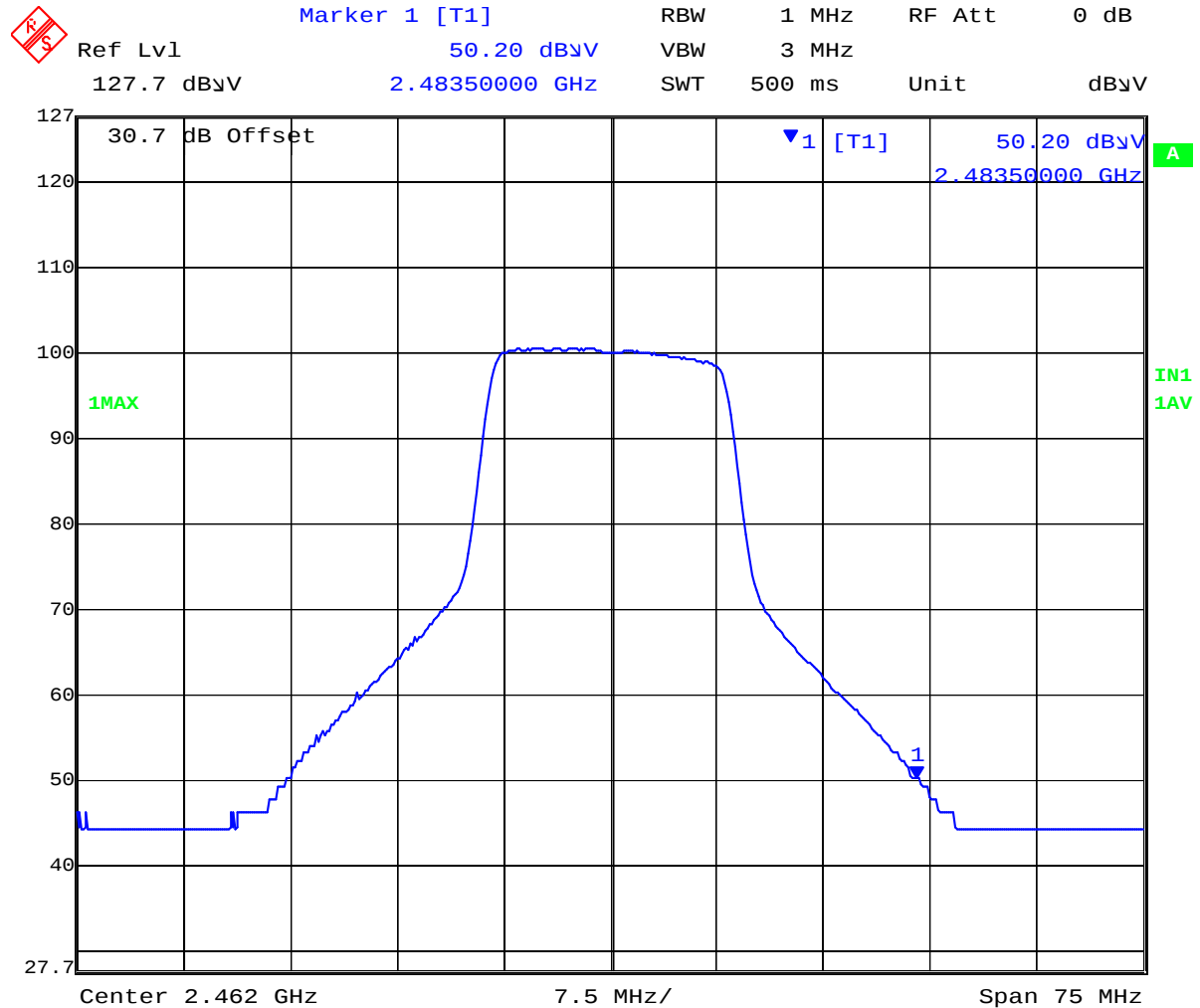
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Band Edge 802.11g 2.4835MHz Channel 2,462MHz - TUVR51/04



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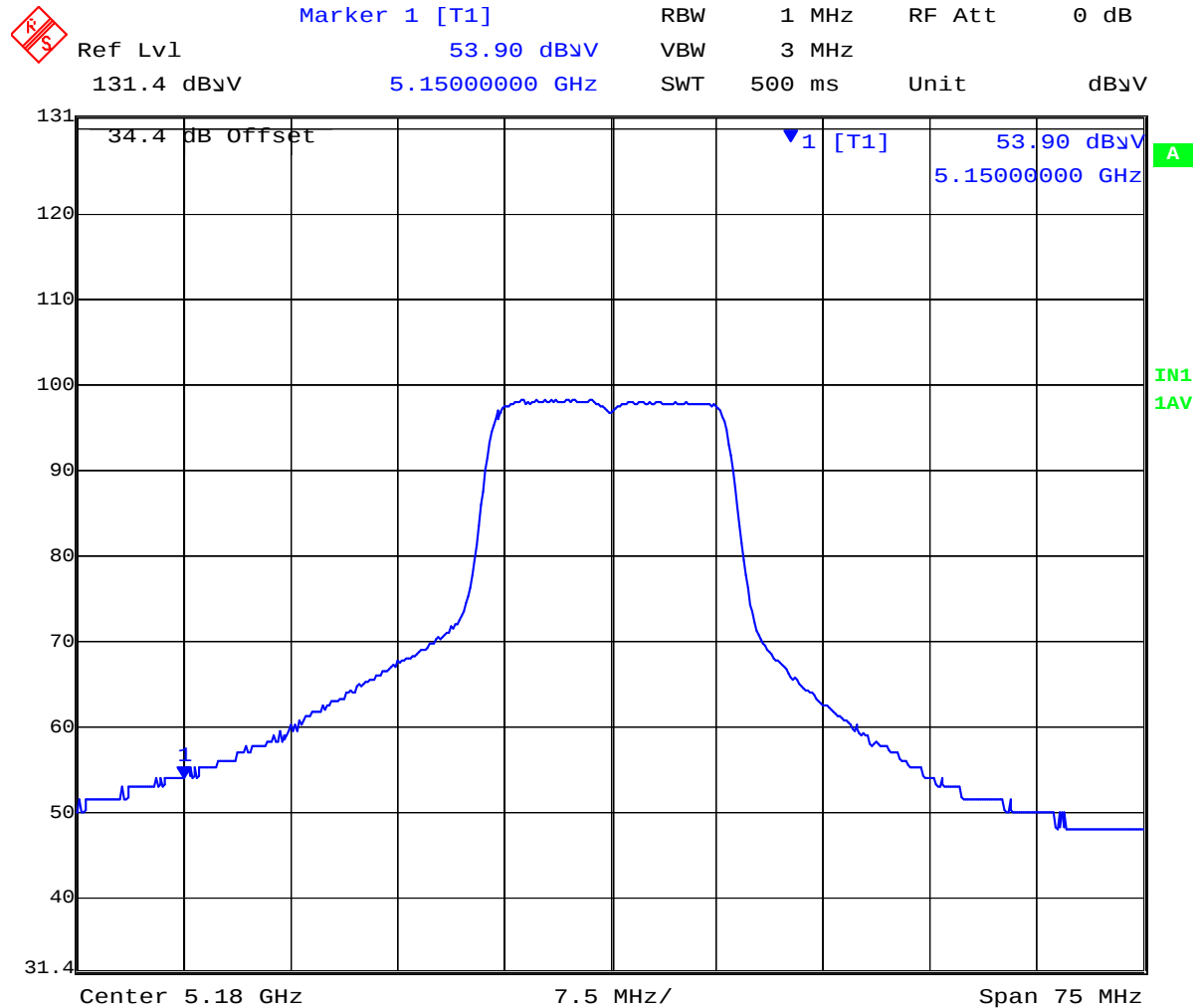
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Band Edge 802.11a 5,150MHz Channel 5,180MHz - TUVR51/05



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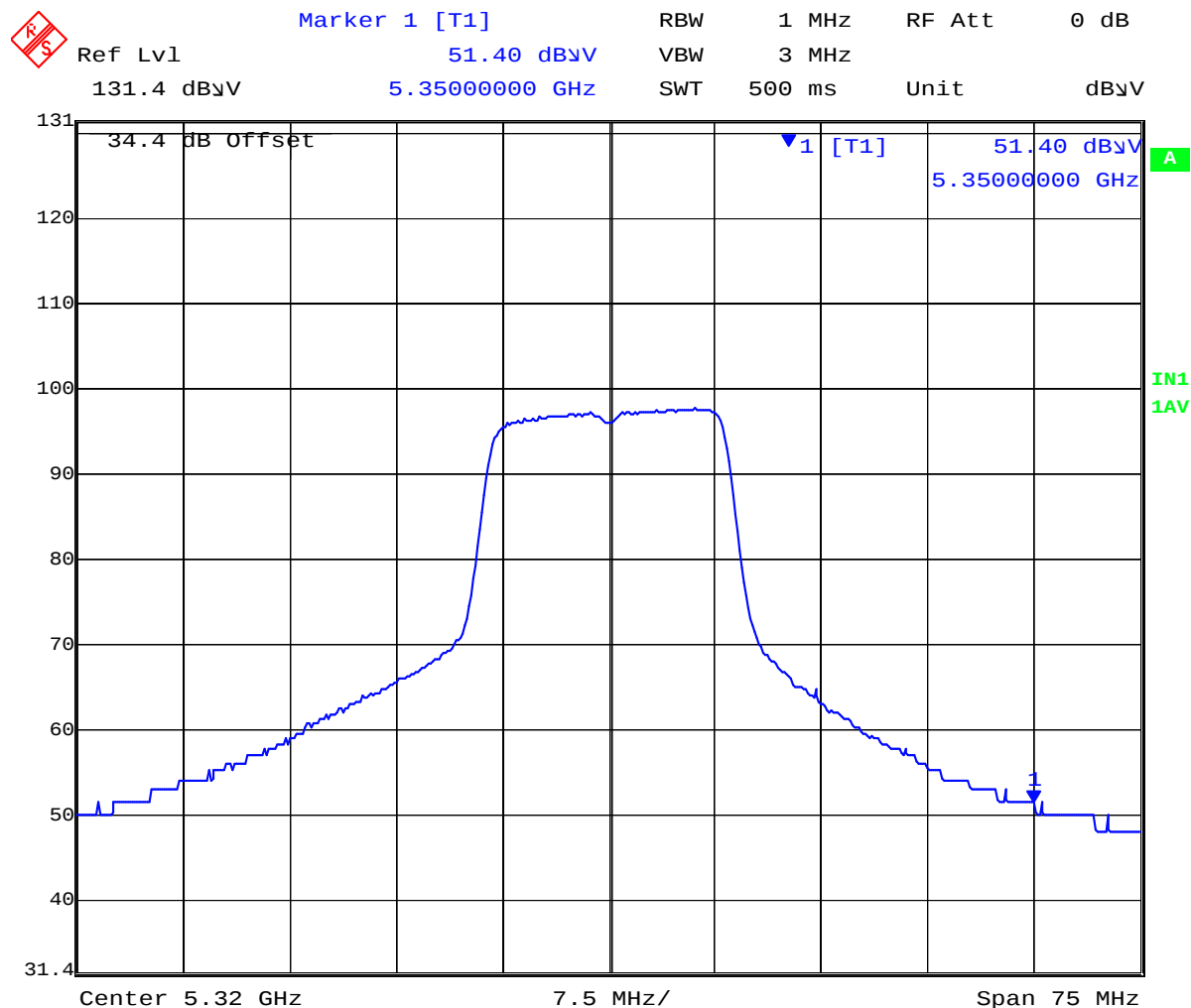
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Band Edge 802.11a 5,350MHz Channel 5,320MHz - TUVR51/06



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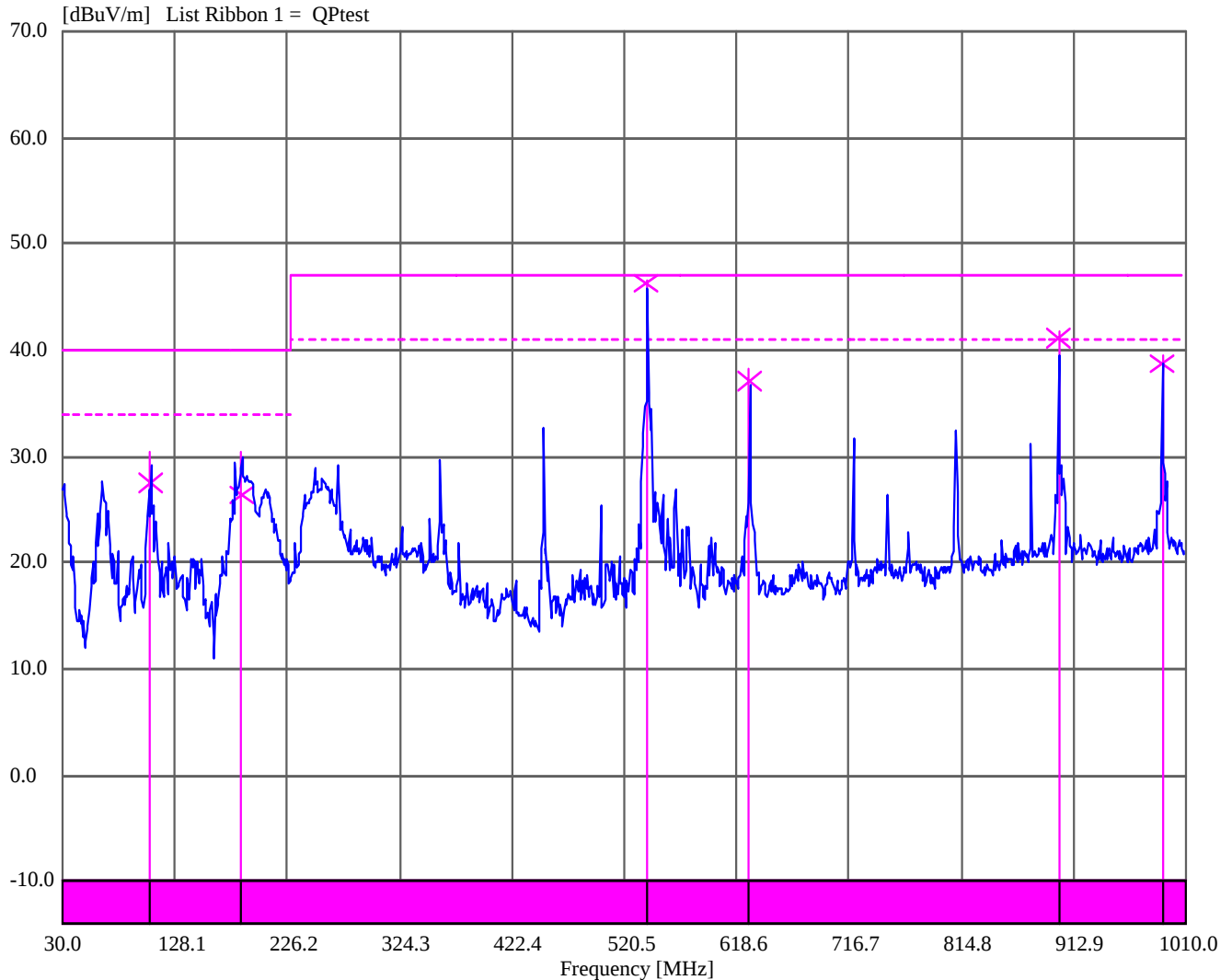
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Radiated Emissions AP61, 30MHz-1GHz - TUVR51/07

9/9/04 10:09:30



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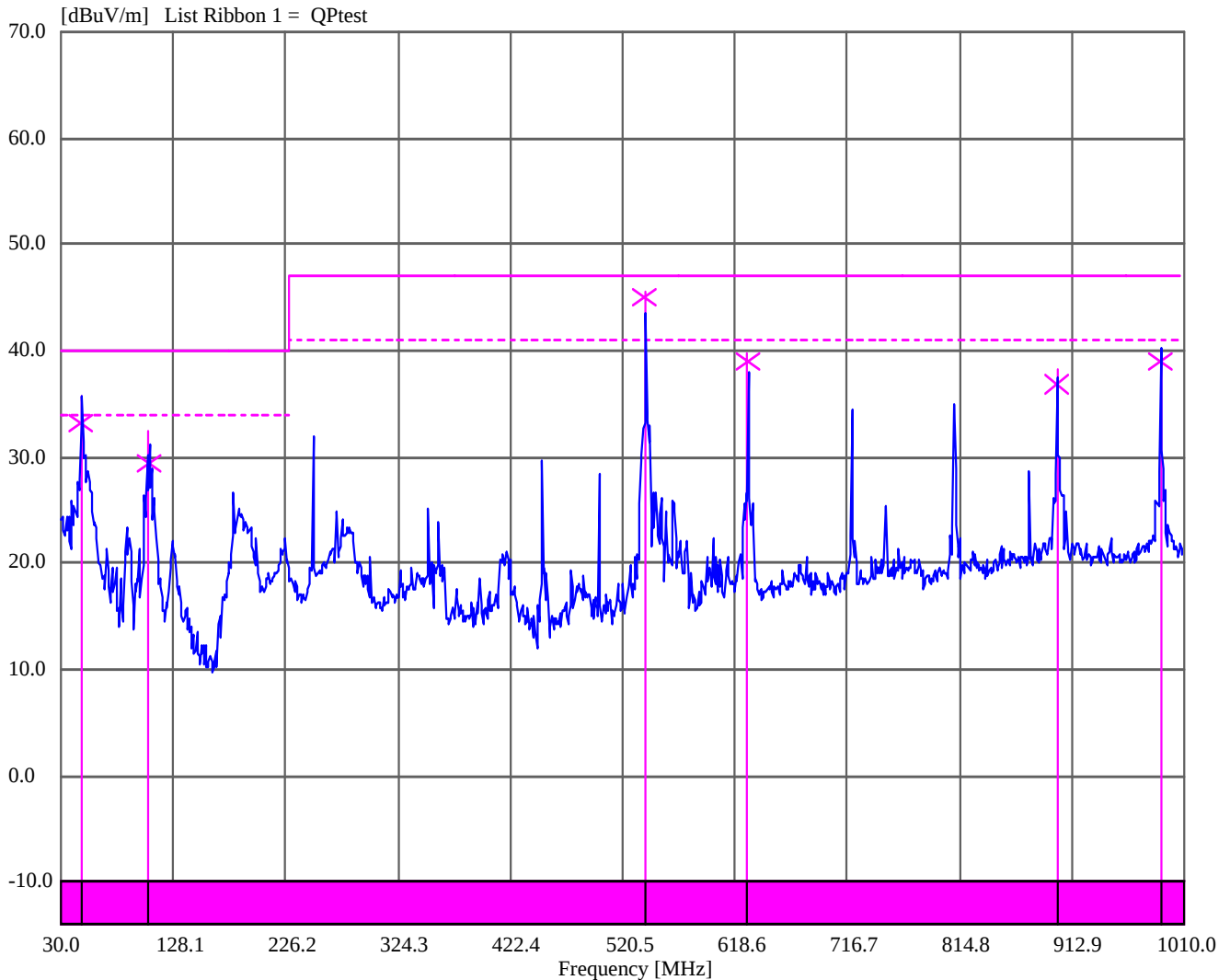
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Radiated Emissions OR-AP, 30M-1GHz - TUVR51/08

9/9/04 11:58:19



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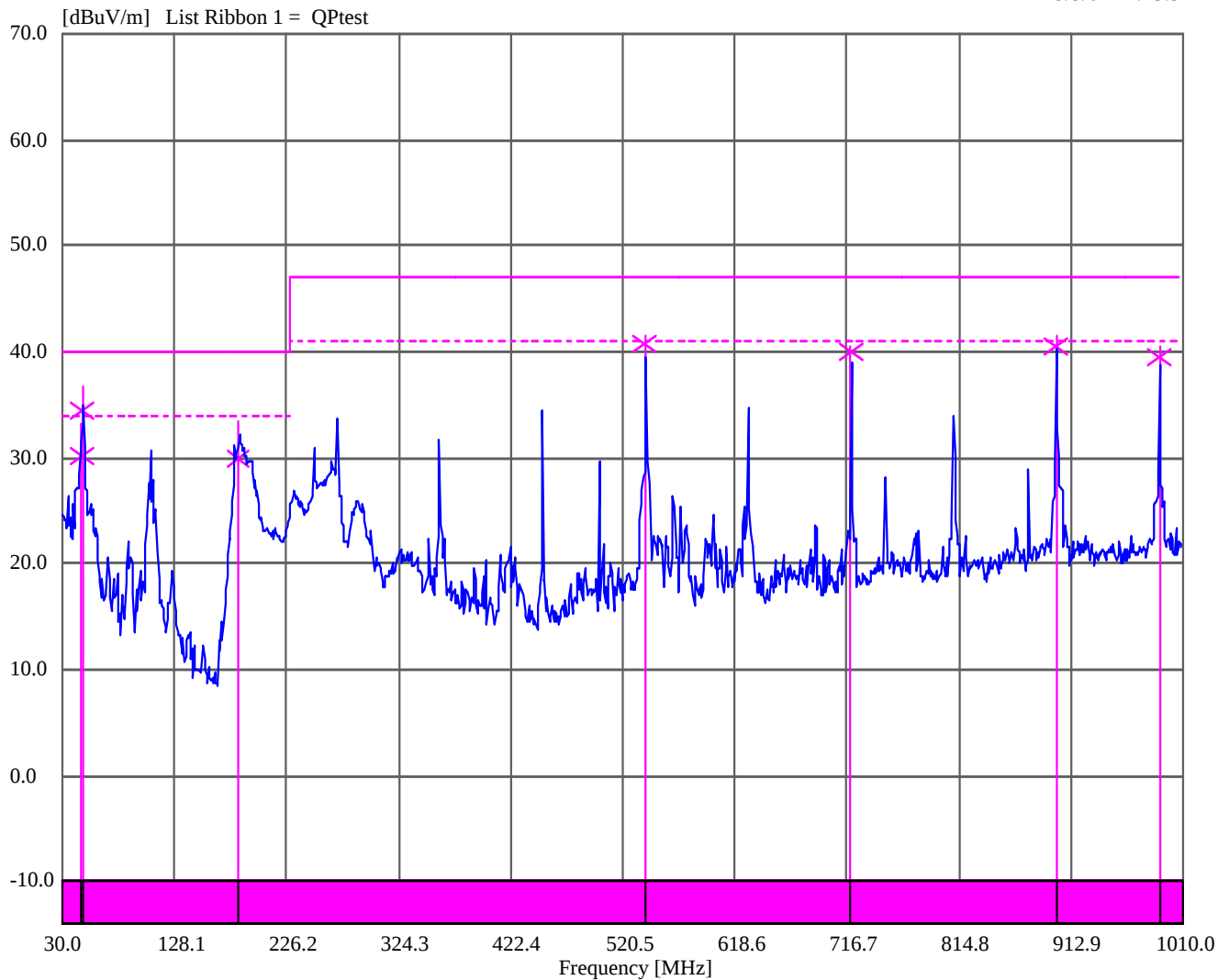
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Radiated Emissions, OR-APWS 30M-1GHz - TUVR51/09

9/9/04 14:25:32



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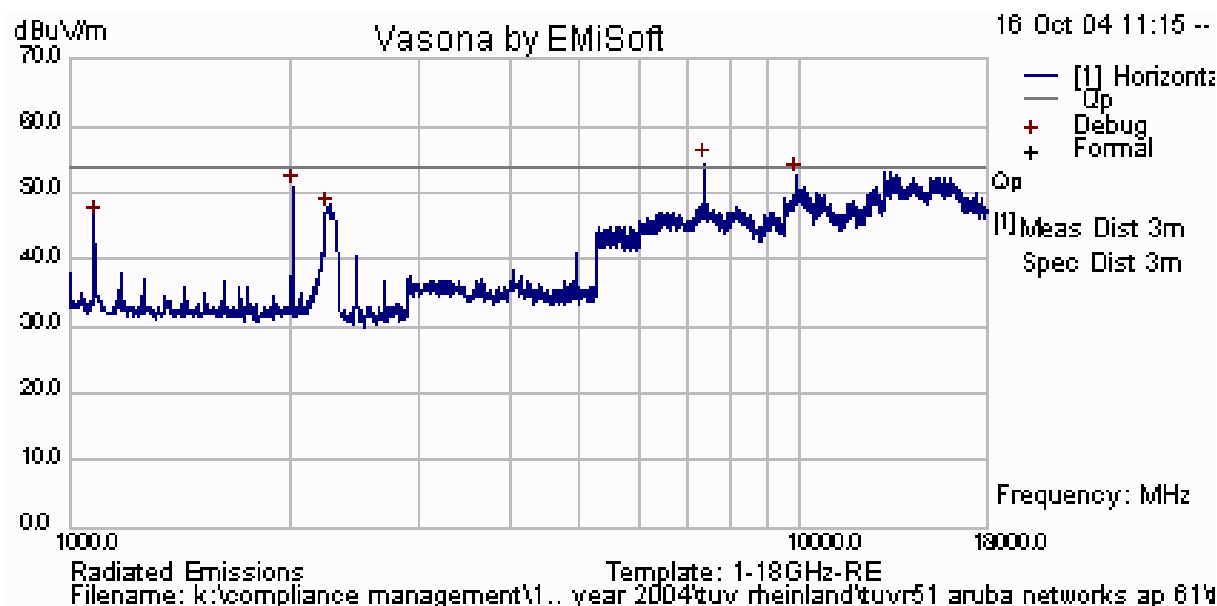
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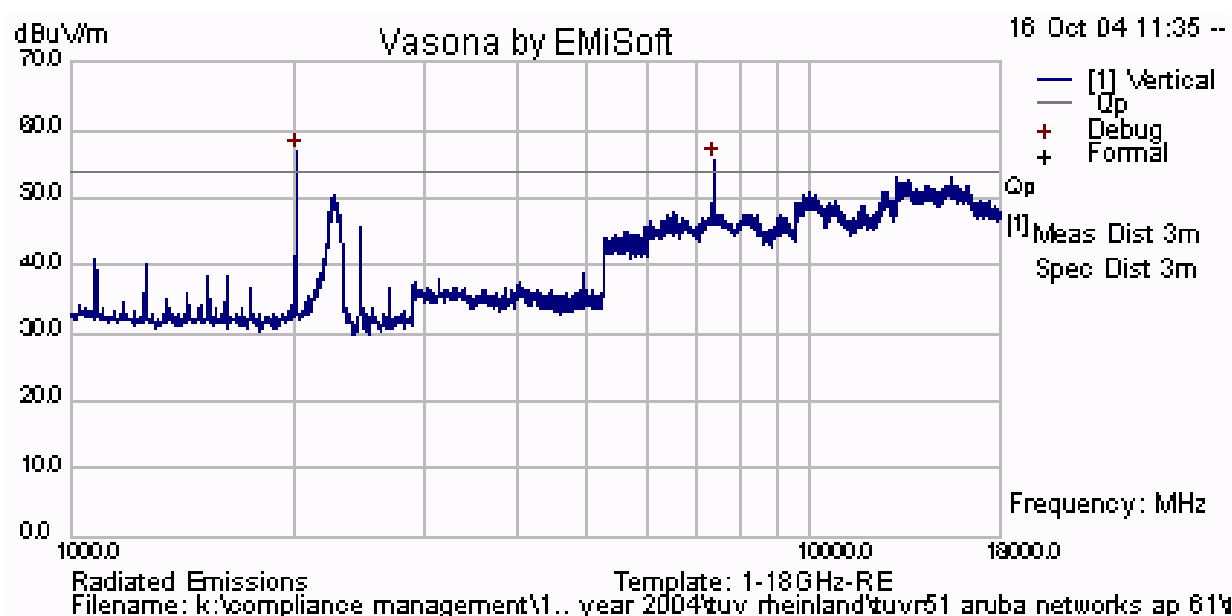
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Radiated Spurious Emissions >1GHz

TUVR51/10 – AP61 802.11b Channel 11 Horizontal



TUVR51/11 – AP61 802.11b Channel 11 Vertical



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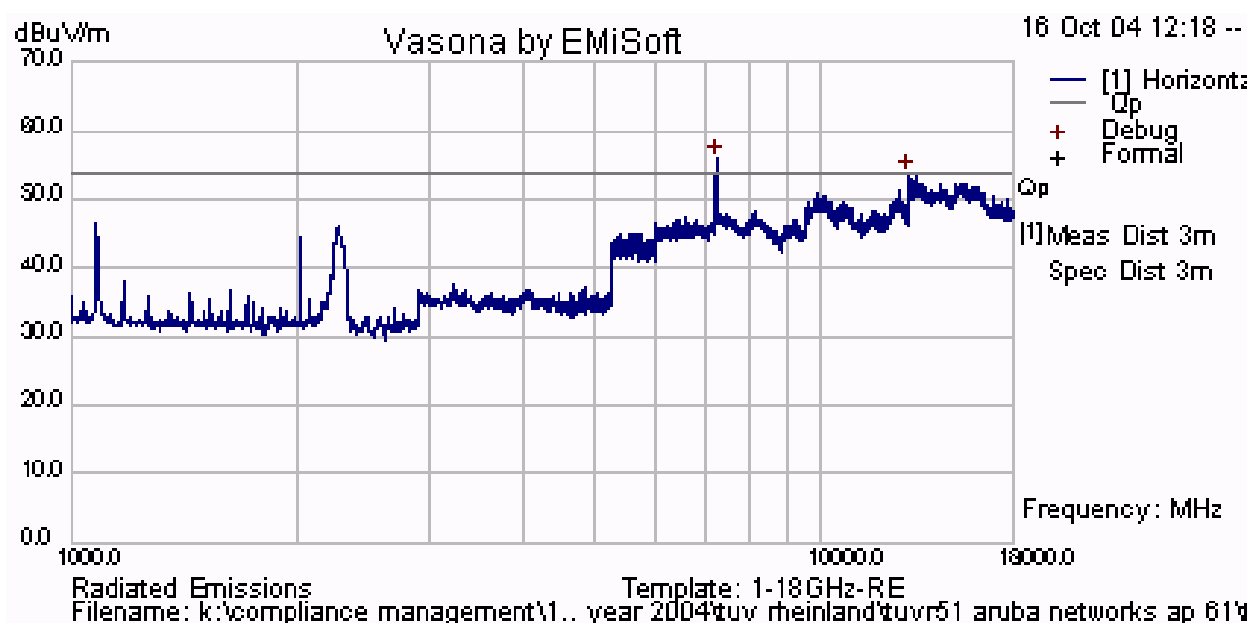
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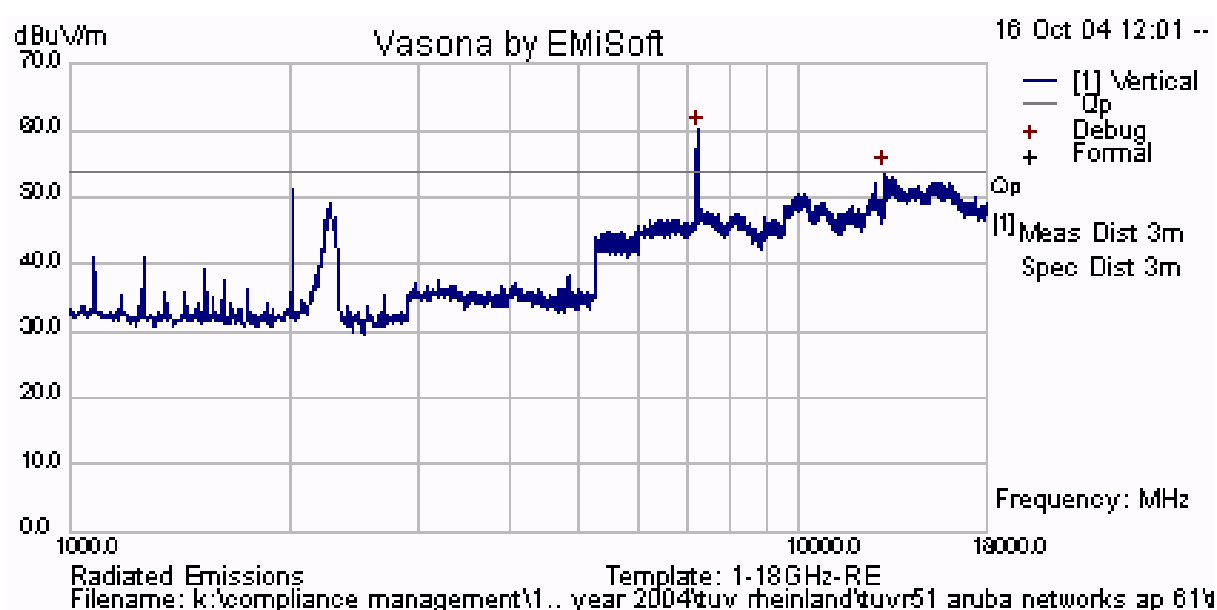
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TUVR51/12 – AP61 802.11g Channel 11 Horizontal



TUVR51/13 – AP61 802.11g Channel 11 Vertical



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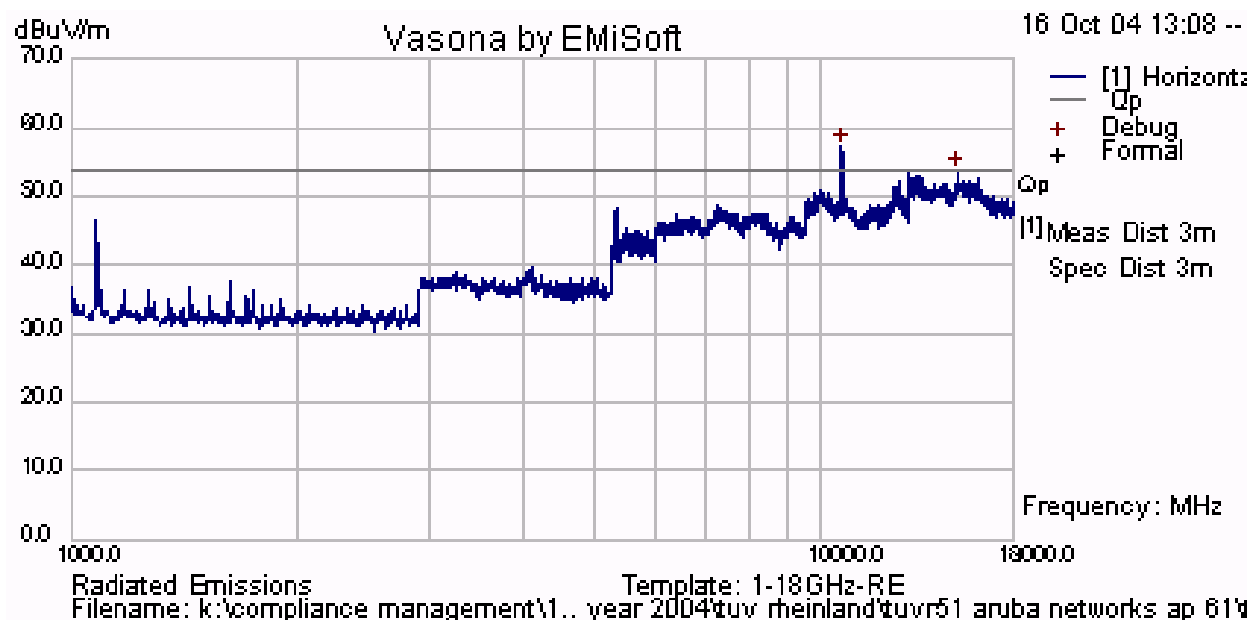
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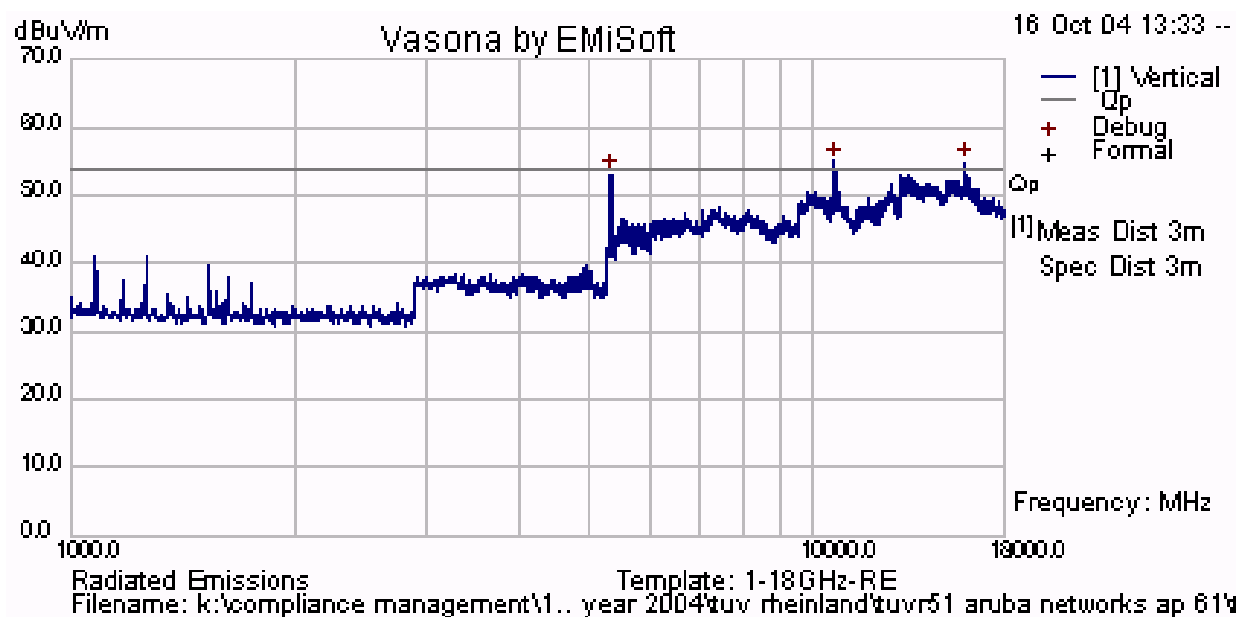
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TUVR51/14 – AP61 802.11a Channel 36 Horizontal



TUVR51/15 – AP61 802.11a Channel 36 Vertical



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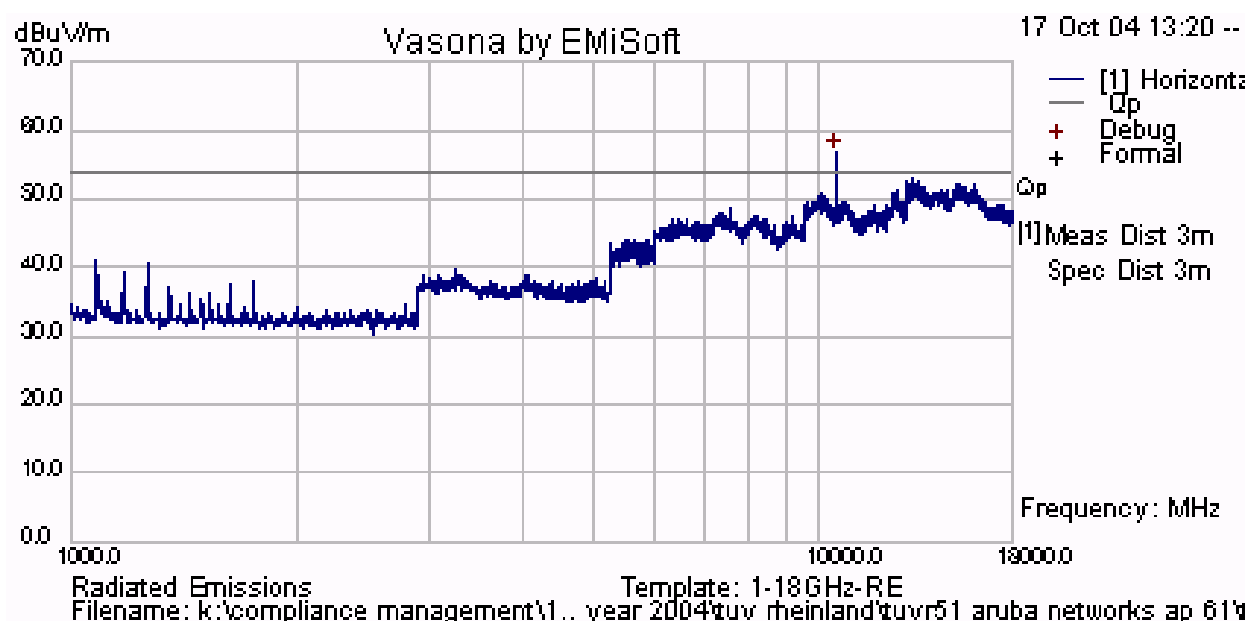
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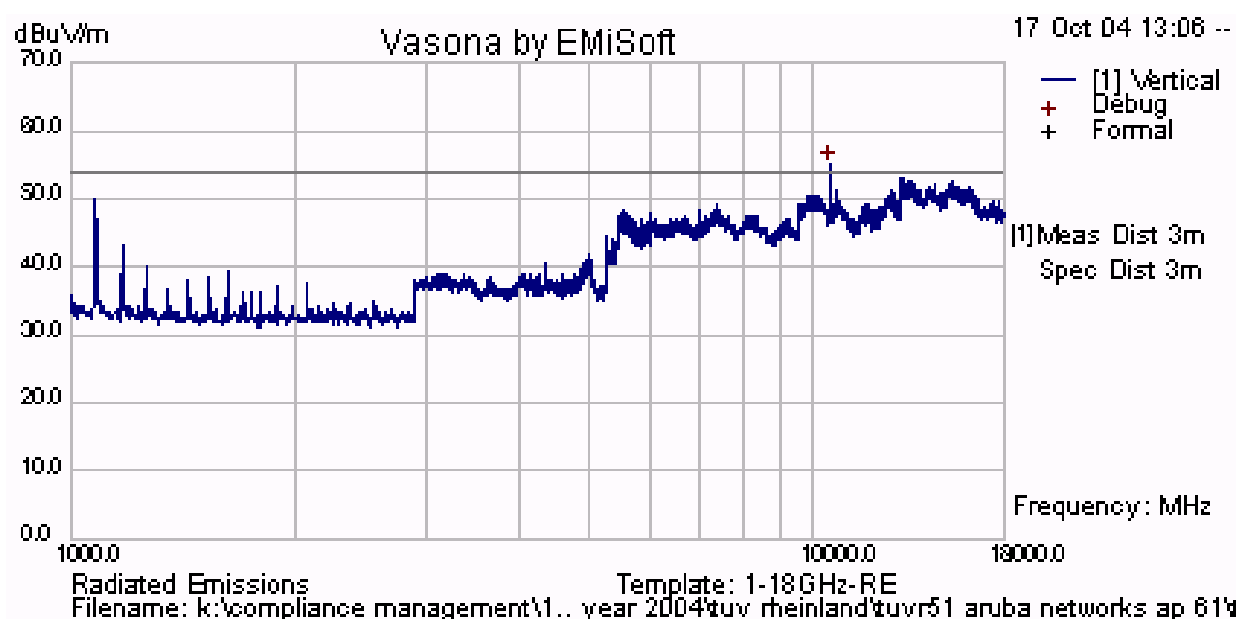
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TUVR51/16 – AP61 802.11a High Band Channel 149 Horizontal



TUVR51/17 – AP61 802.11a High Band Channel 149 Vertical



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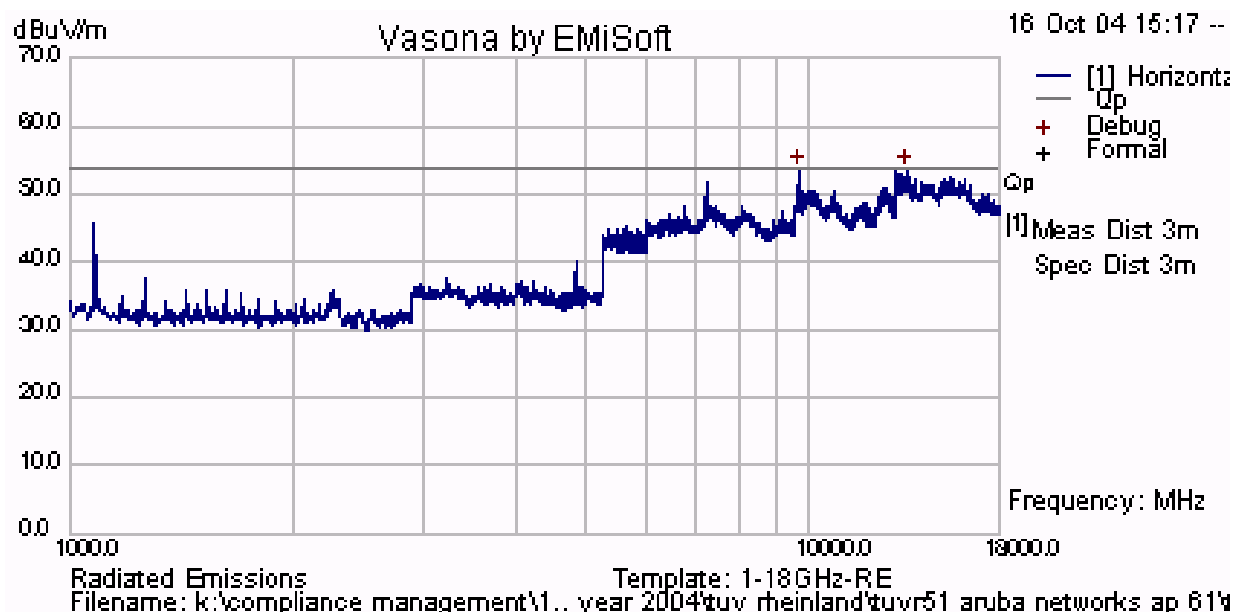
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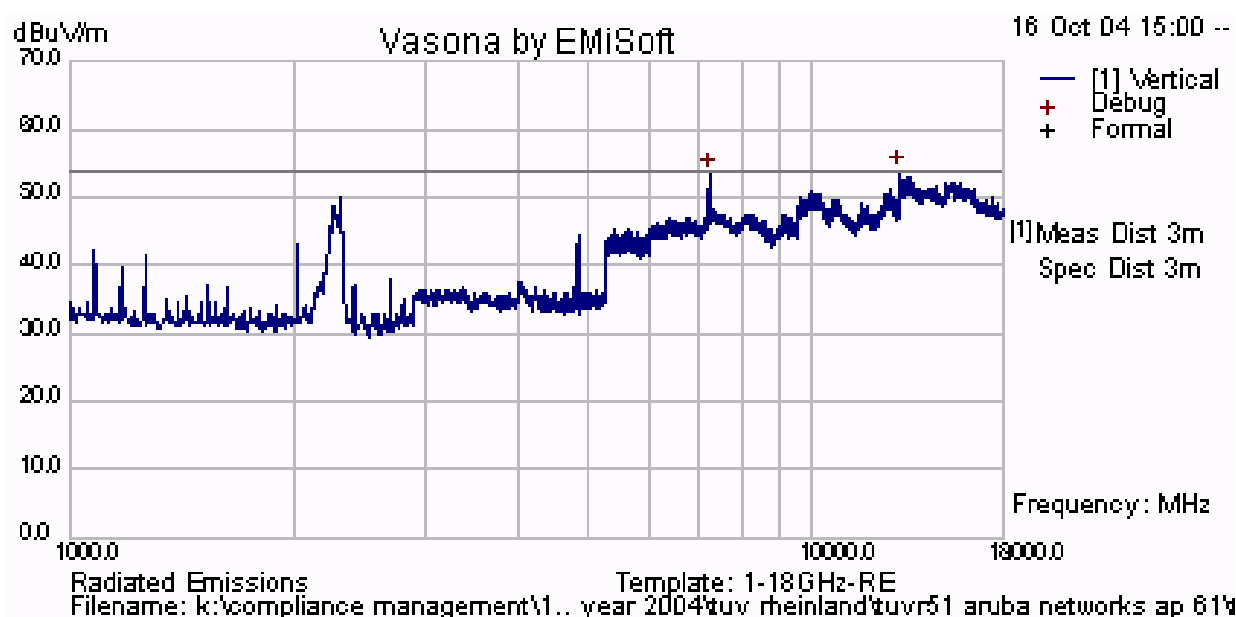
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TUVR51/18 – AP60 + External Antenna 802.11b Channel 1 Horizontal



TUVR51/19 - AP60 + External Antenna 802.11b Channel 1 Vertical



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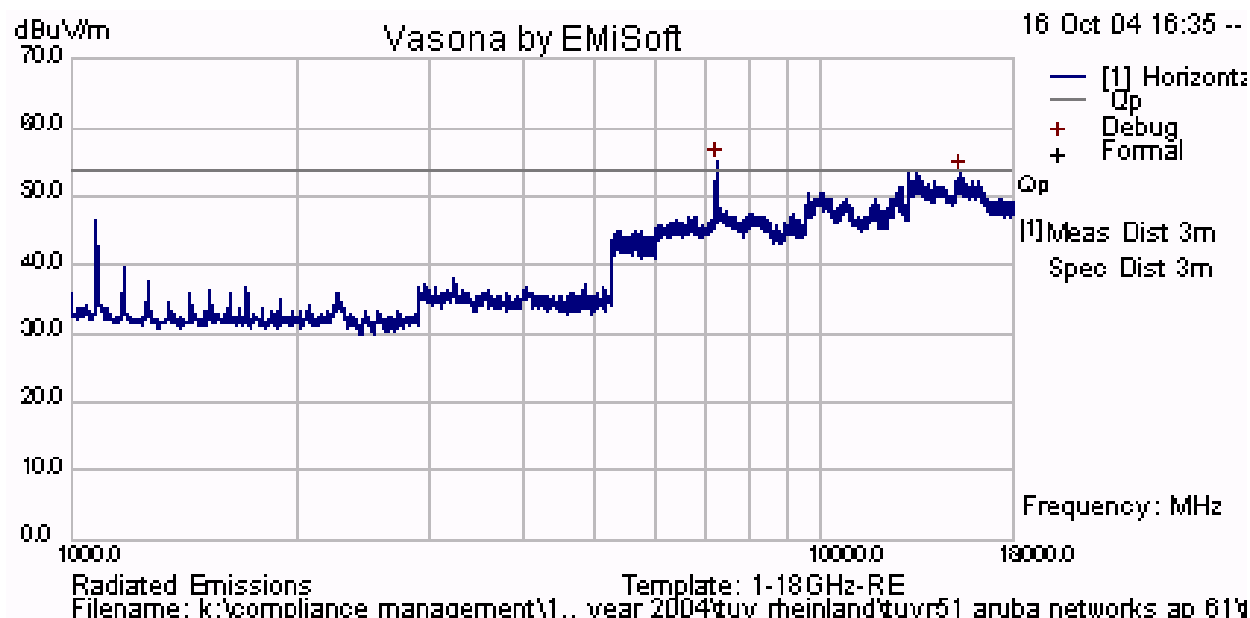
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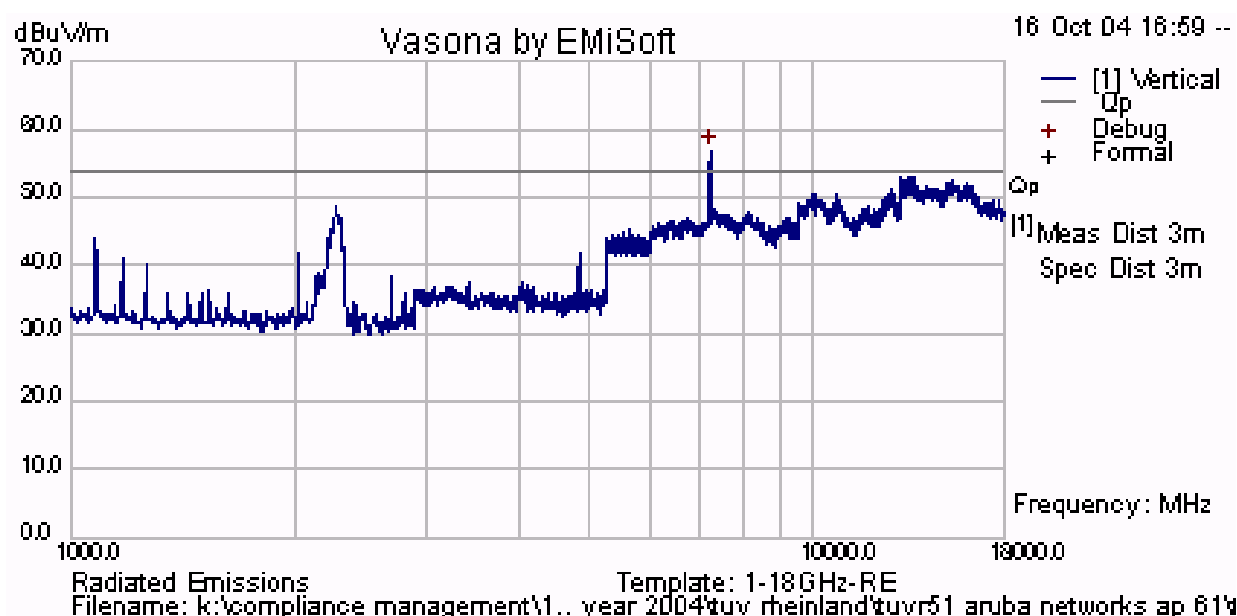
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TUVR51/20 – AP60 + External Antenna 802.11g Channel 1 Horizontal



TUVR51/21 - AP60 + External Antenna 802.11g Channel 1 Vertical



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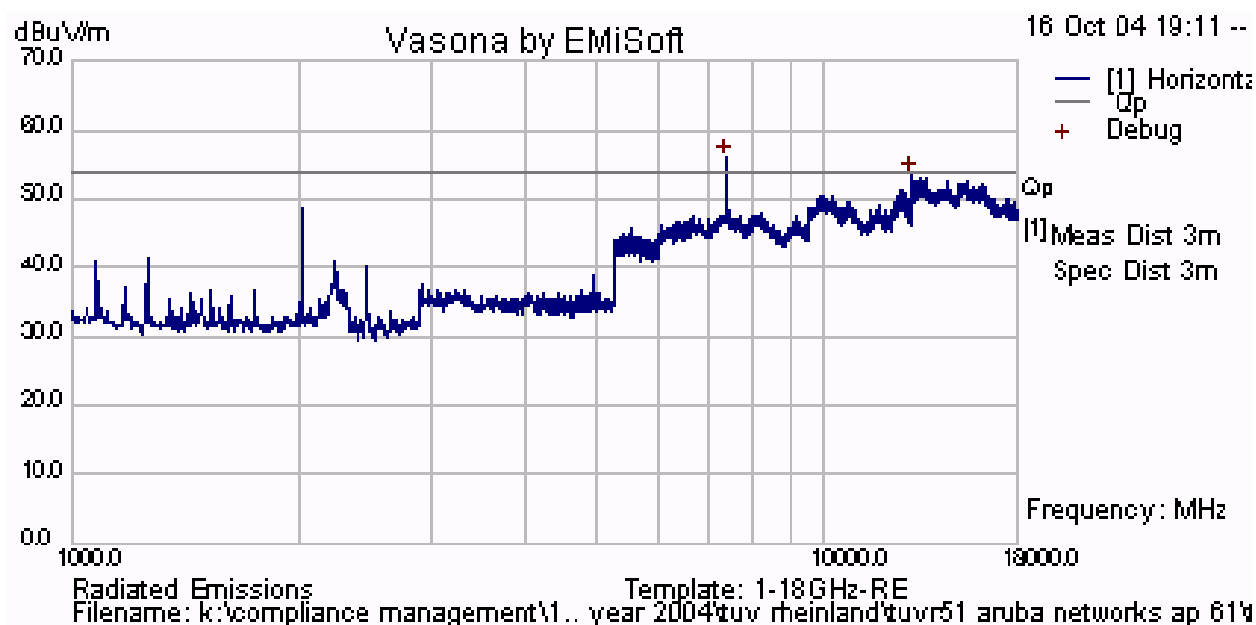
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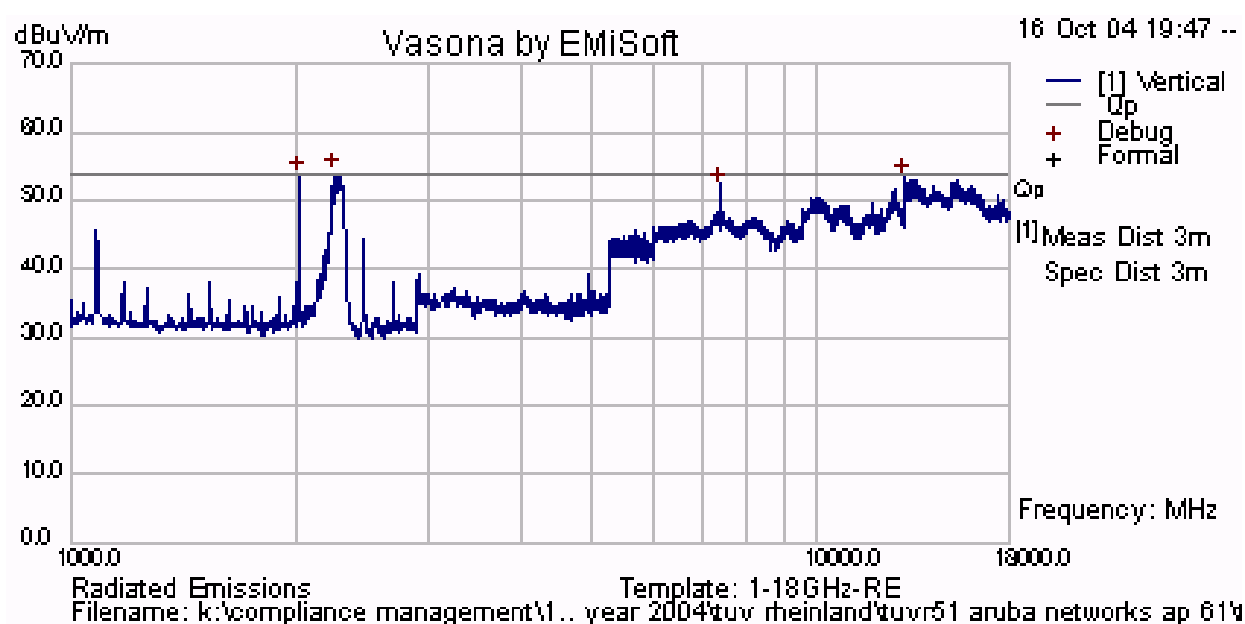
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TUVR51/22 – OR-AP 802.11b Channel 11 Horizontal



TUVR51/23 – OR-AP 802.11b Channel 11 Vertical



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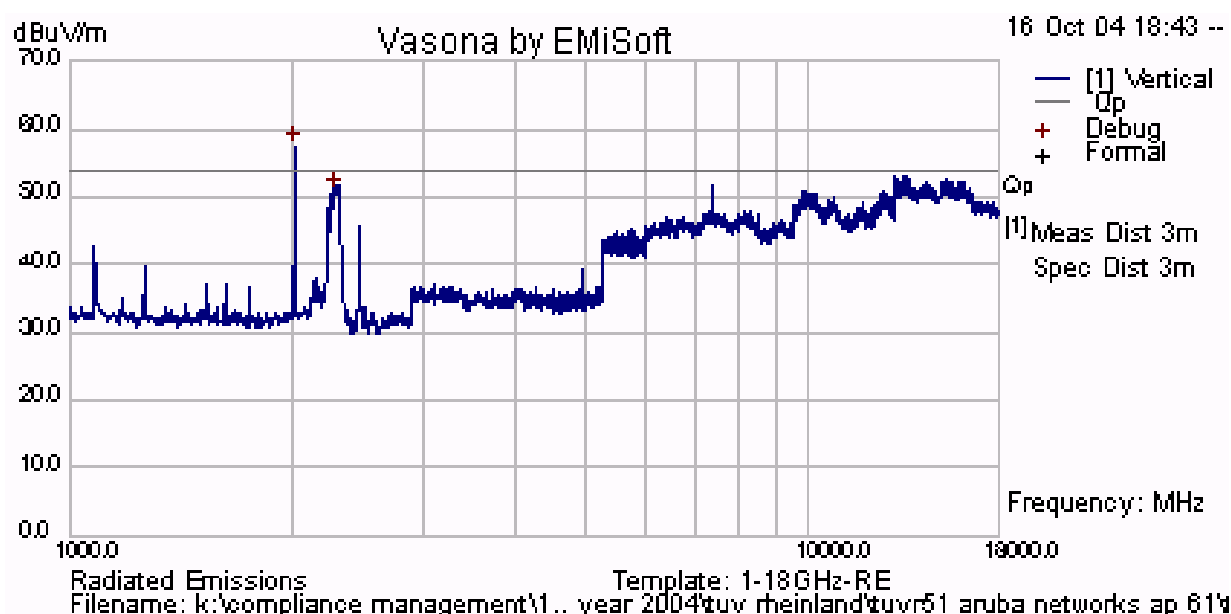
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TUVR51/24 – OR-APWS 802.11b Channel 11 Horizontal



TUVR51/25 – OR-APWS 802.11b Channel 11 Vertical



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