

Test of Wireless Access Point
802.11a/b/g Wireless LAN

To FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: TUV32-A2 REV A





Test of Wireless Access Point AP70 802.11a/b/g

To FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: TUV32-A2 REV A

This report supersedes NONE

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

Copy No: pdf

Issue date: 1st October '04

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

UKAS (United Kingdom Accreditation Service) Testing Laboratory No. 2016



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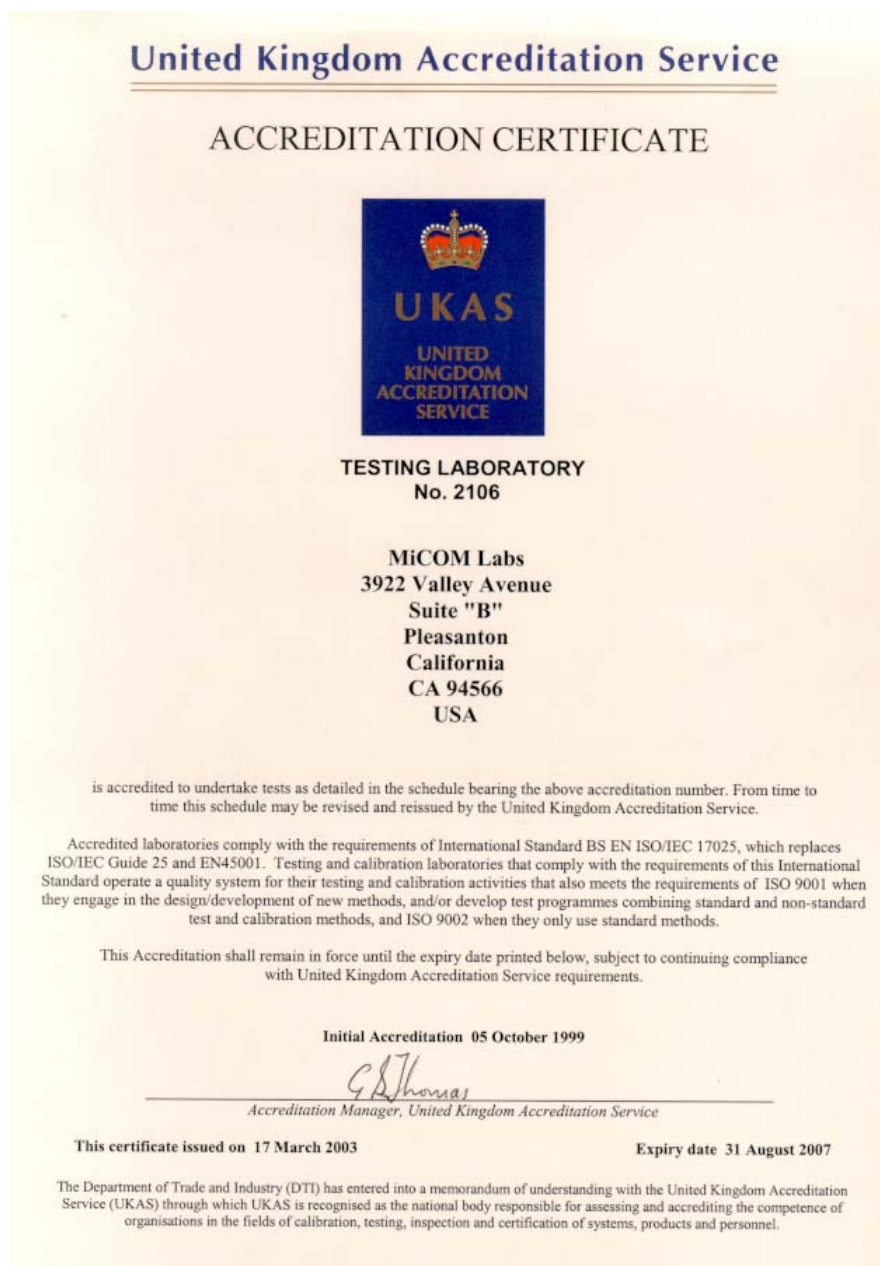
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ACCREDITATION & LISTINGS

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 .





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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
Initial Draft	21 st September '04	
Final Draft	26 th September '04	
Rev A	1 st October '04	



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1. TEST RESULT CERTIFICATE

Company Name:	Aruba Wireless Networks 180 Great Oaks Blvd San Jose, California, 95119 USA	Tested By:	MiCOM Labs, Inc. 3922 Valley Avenue Suite 'B' Pleasanton California 94566, USA Tel: (+1) 925 462 0304
EUT Description:	Product Description		
Model:	AP70 S/N: 3732		
Date(s) Tested:	22nd Aug.-19th Sept. '04		

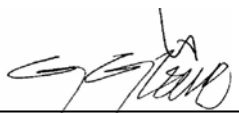
STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.247 & IC RSS-210	EQUIPMENT COMPLIES

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.

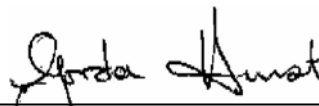
Notes:

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.



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.

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:	To test the Wireless Access Point AP70 802.11a/b/g to FCC and Industry Canada regulations
Applicant / Client:	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:	TUVR32-A2 REV A
Date EUT received:	21st August '04
Dates of test (from - to):	22nd Aug.-19th Sept. '04
Standard(s) applied:	FCC 47 CFR Part 15.247 & IC RSS-210
No of Units Tested:	One
Equipment Category:	Wireless Access Point
Type of Equipment:	802.11a/b/g Wireless LAN
Location for use:	Internal use only
Number of Independent Transmitters:	2
Full Frequency Range(s):	2.4-2.4835GHz, 5.725-5.850GHz
Modulation:	Per 802.11 - DBPSK, DQPSK, CCK, OFDM
Client Declared Nominal Output Power:	802.11b/g: +20dBm (100mW) 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

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

NAME	MODEL No.	SERIAL No.	TYPE	TEST PROGRAM
AP70	AP70	3732	Manufactured	Emissions (radiated and conducted) and RF Testing
CUI (PSU)	A1-15S05	DTS050300U	Manufactured	Emissions (radiated and conducted) and RF Testing

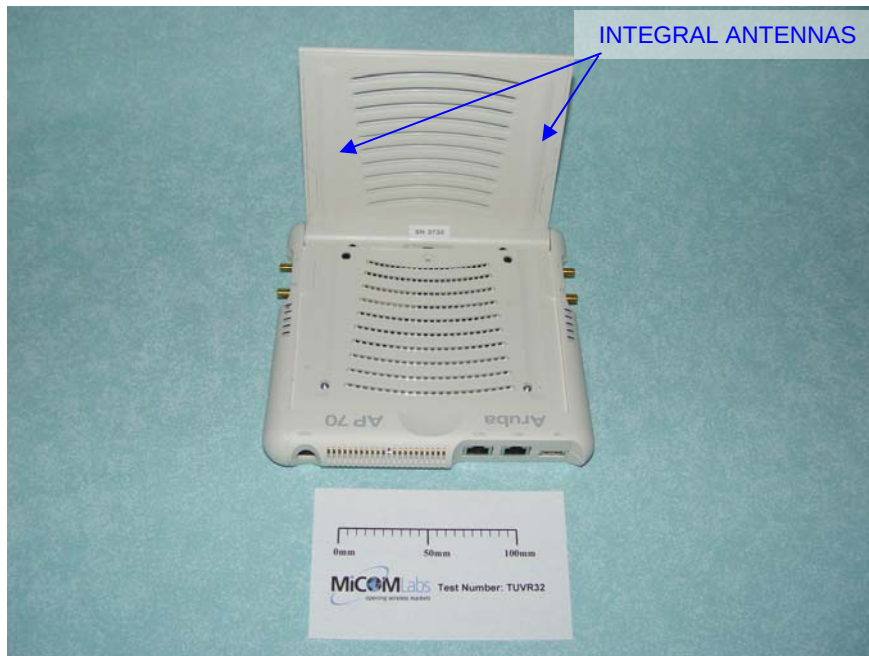
3.3. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Integral Antenna (2.4GHz)	4.2 (max)	TYCO	151351-1	N/A
Omni-Directional Dipole (2.4GHz)	6.0	Centurian	IG2450-RPSMA	040209
Wide Angle Directional (2.4GHz)	12.0	SmartAnt	PCW24-08012-AFL	3A100452
Integral Antenna (5GHz)	7.7 (max)	TYCO	151351-1	N/A
Omni-Directional Dipole (5GHz)	5.5	Cushcraft	S5153WBPX	N/A
Directional Patch (5GHz)	14	Cushcraft	S51514WP	N/A

3.4. Wireless Access Point AP70 802.11a/b/g



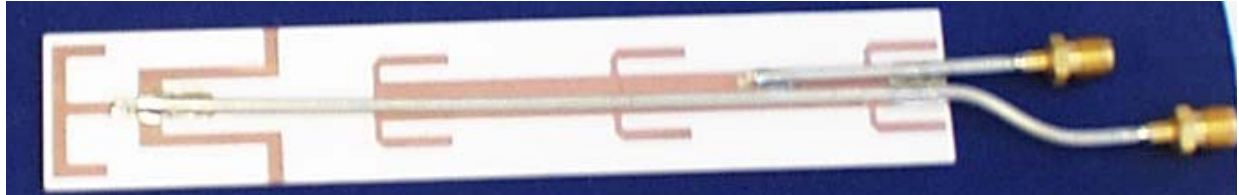
AP70 Access Point



AP70 Access Point – Open Top Identifying Integral Antennas



- | | |
|-----------------------------|------------------------------------|
| 1).. 5GHz Omni-Directional | 3).. 2.4GHz Omni-Directional |
| 2).. 5GHz Directional Patch | 4).. 2.4GHz Wide Angle Directional |



2.4 and 5GHz Integral Antenna Structure

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. Ethernet 10/100BT unscreened
2. Ethernet 10/100BT unscreened
3. USB (Universal Serial Bus)
4. DC power
5. 2 x 2.4GHz RPSMA Connector
6. 2 x 5GHz RPSMA Connector



3.6. Test Configurations

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)	
				Conducted	Radiated
a	149, 157, 165	5,745 5,785 5,825	54	54	54
b	1, 6, 11	2,412 2,437	11	11	11
g		2,462	54	54	54

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

3.7. Equipment Modifications

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

1. NONE

3.8. Deviations from the Test Standard

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

1. NONE



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3.9. Subcontracted Testing

Radiated emission testing 30MHz-1GHz (Section 5.1.6.2 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

4. TEST SUMMARY

List of Measurements

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

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(2) 5.9.1	6dB and 99% Bandwidth	>=500KHz	Conducted	Complies	5.1.1
15.247(b) 15.31(e) 6.2.2 (o) (b)	Peak Output Power Voltage Variation	Shall not exceed 1W Variation of supply voltage 85% -115%	Conducted	Complies	5.1.2
15.247(d) 6.2.2 (o) (b)	Peak Power Spectral Density	Shall not be greater than +8dBm in any 3kHz band	Conducted	Complies	5.1.3
15.247(b)(5) 14	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Conducted	Complies	5.1.4
EMISSIONS					
15.247c 15.205(a) / 15.209(a) 6.2.2 (o) (e1)	Conducted Spurious Emissions (1-26GHz)	The radiated emission in any 100kHz of out-band shall be at least 20dB below the highest in-band spectral density	Conducted	Complies	5.1.5



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5.205(a) / 15.209(a) 6.3	Radiated Emissions	Restricted Bands	Radiated	Complies	5.1.6
	Transmitter Radiated Spurious Emissions	Emissions above 1GHz			5.1.6.1
	Radiated Emissions	Emissions <1GHz (30M-1GHz)	(includes collocation of transmitters)		5.1.6.2
15.207 6.6	AC Wireline Conducted Emissions 150kHz–30MHz	Conducted Emissions	Conducted	Complies	5.1.7

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

5. TEST RESULTS

5.1. Device Characteristics

5.1.1. 6dB and 99% Bandwidth

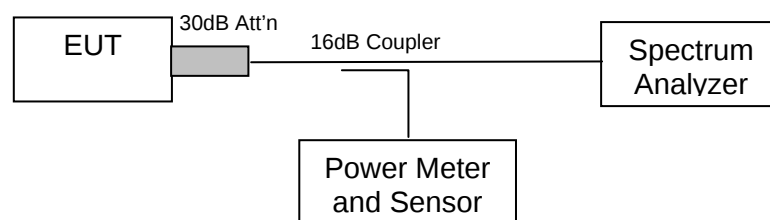
FCC, Part 15 Subpart C §15.247(a)(2)
Industry Canada RSS-210 §5.9.1

Test Procedure

The bandwidth at 6dB and 99% is measured with a spectrum analyser connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate centre frequency. Using a 6dB resolution bandwidth filter setting the spectrum analyzer was set to the following for both 6dB BW and 99% BW measurements;

RBW=1MHz, VBW=2 MHz, Span=50MHz, Sweep = 200mS

Test Measurement Set up



Measurement set up for 6dB Bandwidth test

Measurement Results for 6dB and 99% Operational Bandwidth(s)

Ambient conditions.

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

Power Setting – Maximum Level 4 (set through Aruba system interface)

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	6dB Bandwidth (MHz)	6dB Plot #	99% BW (MHz)	99% BW Plots
2,412	12.6252	TUVR32-01	15.5310	TUVR32-02
2,437	12.3246	On File	15.5310	On File
2,462	12.4240	On File	15.5310	On File

TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	6dB Bandwidth (MHz)	6dB Plot #	99% BW (MHz)	99% BW Plots
2,412	17.1342	TUVR32-03	18.0360	TUVR32-04
2,437	16.9839	On File	17.7354	On File
2,462	16.9839	On File	18.0360	On File

TABLE OF RESULTS – 802.11a 54Mbit/s

Centre Frequency (MHz)	6dB Bandwidth (MHz)	6dB Plot #	99% BW (MHz)	99% BW Plots
5,745	16.8336	On File	18.6372	On File
5,785	16.9138	TUVR32-05	18.6376	TUVR32-06
5,825	16.7134	On File	18.6372	On File

Specification

Limits

§15.247 (a)(2) For direct sequence systems the minimum 6dB bandwidth shall be at least 500KHz

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81dB
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Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0156, 0193, K-CBL 08, Coupler, 0070, 0116

5.1.2. Peak Output Power

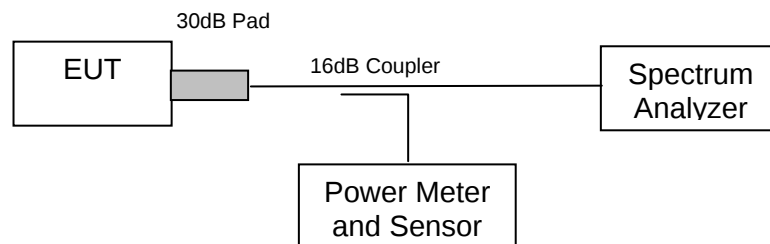
FCC, Part 15 Subpart C §15.247(b), §15.31(e)
Industry Canada RSS-210 §6.2.2(o)(b)

Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure peak power. The resolution filter bandwidth was set to 6dB, peak detector selected and the analyzer built-in power function was used to measure peak power over the 99% emission bandwidth. Average power was also measured utilizing the analyzers average power detector.

Spectrum analyzer settings: RBW=1MHz, VBW=2MHz, Span=50MHz, Sweep = 200mS

Test Measurement Set up



Measurement set up for Transmitter Peak Output Power

Measurement Results for Peak Output Power

Ambient conditions.

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

Power Setting – Maximum Level 4 (set through Aruba system interface)

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	99% Bandwidth (MHz)	Peak Power (dBm)	Ave. Power (dBm)	Peak Power Plot #
2,412	15.5310	+19.85	+12.49	On File
2,437	15.5310	+20.34	+13.24	TUVR32-07
2,462	15.5310	+20.34	+12.86	On File



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TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	99% Bandwidth (MHz)	Peak Power (dBm)	Ave. Power (dBm)	Peak Power Plot #
2,412	18.0360	+18.61	+8.62	On File
2,437	17.7354	+18.74	+9.10	TUVR32-08
2,462	18.0360	+18.41	+8.76	On File

TABLE OF RESULTS – 802.11a 54Mbit/s

Centre Frequency (MHz)	99% Bandwidth (MHz)	Peak Power (dBm)	Ave. Power (dBm)	Peak Power Plot #
5,745	18.6372	+15.19	+5.92	TUVR32-09
5,785	18.8376	+14.67	+5.46	On File
5,825	18.6372	+14.54	+5.32	On File

Supply Voltage Variation

The supply voltage was varied between 97.75VAC and 132.25VAC. The system operated as intended at either extreme with no change in the above measurement bandwidths.

Antenna Gain - Maximum Permissible Power Level

If transmitting antennas of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the stated values by the amount in dB that the directional gain of the antenna exceeds 6dBi.



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Antenna Type	Gain (dBi)	Antenna Gain >6dBi (dB)	Max. Allowable Peak Power (dBm)
Internal (2.4GHz)	4.2	0.0	+30.0
Omni-Directional (2.4GHz)	6.0	0.0	+30.0
Wide Angle Directional (2.4GHz)	12.0	6.0	+24.0
Internal (5GHz)	7.7	1.7	+28.3
Omni-Directional (5GHz)	5.5	0.0	+30.0
Directional Patch (5GHz)	14	8.0	+22.0

Specification

Limits

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (3) For systems using digital modulation in the 902-928MHz, 2400-2483.5MHz and 5725-5850MHz bands: 1watt

§15.247 (b) (4) Except as shown in paragraphs (b)(3)(i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b) (1) or (b)(2) of this section, as appropriate by the amount in dB that the directional gain of the antenna exceeds 6dBi.

§6.2.2(o)(b) For the band 2400-2483.5 MHz, the transmitter output power shall not exceed 1.0 watt

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33dB
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Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0156, 0193, K-CBL 08, Coupler, 0070, 0116

5.1.3. Peak Power Spectral Density

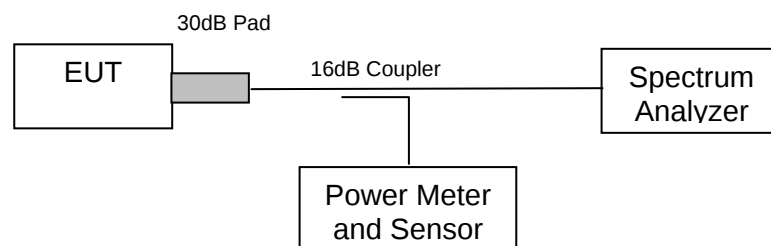
FCC, Part 15 Subpart C §15.247(d)
Industry Canada RSS-210 §6.2.2(o)(b)

Test Procedure

The transmitter output was connected to a spectrum analyser and the maximum level in a 3KHz bandwidth was measured. A peak value was found over the full emission bandwidth and the frequency span reduced to obtain enhanced resolution. Sweep time => span / 3KHz with video averaging turned off. The Peak Power Spectral Density is the highest level found across the emission in a 3KHz resolution bandwidth. Spectrum analyzer settings:

RBW= 3kHz, VBW=10kHz, Span=390KHz, Sweep time=500s, RBW Filter=3dB

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

Measurement Results for Peak Power Spectral Density

Ambient conditions.

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

Power Setting – Maximum Level 4 (set through Aruba system interface)

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
2,412	2,413.26	-8.24	On File
2,437	2,436.45	-7.33	TUV32-10
2,462	2,460.98	-8.60	On File



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TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
2,412	2,413.55	-12.44	On File
2,437	2,439.47	-12.10	TUV32-11
2,462	2,456.98	-12.79	On File

TABLE OF RESULTS – 802.11a 54Mbit/s

Centre Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,745	5,746.27	-14.88	TUV32-12
5,785	5,788.73	-15.44	On File
5,825	5,819.39	-15.39	On File

Antenna Gain - Maximum Permissible Peak Power Spectral Density

If transmitting antennas of directional gain greater than 6dBi are used the Peak Power Spectral Density of the intentional radiator shall be reduced below the stated values by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Antenna Type	Gain (dBi)	Antenna Gain >6dBi (dB)	Max. PSD (dBm)
Internal (2.4GHz)	4.2	0	+8.0
Omni-Directional (2.4GHz)	6.0	0.0	+8.0
Wide Angle Directional (2.4GHz)	12.0	6.0	+2.0
Internal (5GHz)	7.7	1.7	+6.3
Omni-Directional (5GHz)	5.5	0	+8.0
Directional Patch (5GHz)	14	8.0	+0.0



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Peak Power Spectral Density Limits

§15.247 (d) For direct sequence systems the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than +8dBm in any 3KHz band during any time interval of continuous transmission

RSS-210 §6.2.2(o)(b) The transmitter power spectral density (into the antenna) shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0 second duration.

Laboratory Measurement Uncertainty Spectral Density

Measurement uncertainty	$\pm 1.33\text{dB}$
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Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0156, 0193, K-CBL 08, Coupler, 0070, 0116

5.1.4. Maximum Permissible Exposure

FCC, Part 15 Subpart C §15.247(b)(5)
Industry Canada RSS-210 §14

Calculations for Maximum Permissible Exposure Levels

Given

$$E = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = field strength in volts/meter

P = power in watts

G = numeric antenna gain

d = distance in meters

S = power density in milliwatts / square centimeter

Combining and rearranging the terms to express the distance as a function of the variables, yields:

$$d = \sqrt{(30 * P * G) / (3770 * S)}$$

Rearrange to milliwatts and centimeters

$$P(\text{mw}) = P(\text{watts}) / 1000$$

$$d(\text{cm}) = d(\text{m}) * 100$$

yields

$$d = 100 * \sqrt{(30 * (P / 1000) * G) / (3770 * S)}$$

$$d = 0.282 * \sqrt{(P * G / S)}$$

where

d = distance in centimetres

P = Power in mW

G = Numeric Antenna Gain

S = Power Density in centimetres²

Substituting the logarithmic form of power and gain using:

$$P(\text{mW}) = 10 ^ { (P(\text{dBm})/10) } \text{ and}$$

$$G(\text{numeric}) = 10 ^ { (G(\text{dBi}) / 10) }$$

Yields:

$$d = 0.282 * 10^{\sqrt{(P + G / 20)}} / S$$

where

d = MPE distance in centimetres

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW / centimetres² (Limit S = 1mW / cm² from §1.310 Table 1)

Maximum peak output power observed from power measurements: **+20.34dBm**

Maximum Declared Antenna Gain: **14.0dBi**

Power Density Limit (mW / cm ²)	Maximum Measured Peak Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
1	+20.34	14.0	15.0

Specification

Maximum Permissible Exposure Limits

§15.247 (b)(5) 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 / cm² from 1.310 Table 1

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

RSS-210 §14 Before equipment certification is granted, the procedures of RSS-102 must be followed concerning exposure of humans to RF fields.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33dB
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5.1.5. Conducted Spurious Emissions

FCC, Part 15 Subpart C §15.247(c)
Industry Canada RSS-210 §5.9.1, §6.2.2 (o)(e1)

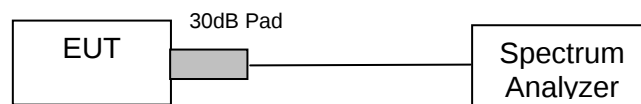
Test Procedure

The band-edge is measured at 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Measurements were made while EUT was operating in a continuous transmission mode i.e. 100% duty cycle at the appropriate centre frequency.

The spectrum analyzer is set to:

RBW=100kHz, VBW=300kHz, Span=110MHz, Sweep = 200mS

Test Measurement Set up



Band-edge measurement test configuration

Measurement Results of Conducted Spurious Emissions

Ambient conditions.

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

Power Setting – Maximum Level 4 (set through Aruba system interface)

Band-Edge Results

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	Band edge Frequency (MHz)	Limit @ 20dB below peak	Amplitude @ Band edge (dBm)	Plot #	Margin (dB)
2,412	2,400	-15.6	-37.08	TUVR32-13	-21.48
2,437	Reference	-45.24		On File	
2,462	2,483.5	-15.53	-45.07	TUVR32-14	-29.54



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TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	Band edge Frequency (MHz)	Limit @ 20dB below peak	Amplitude @ Band edge (dBm)	Plot #	Margin (dB)
2,412	2,400	-19.00	-28.65	TUV32-14	-9.65
2,437	Reference	-17.95		On File	
2,462	2,483.5	-17.87	-42.41	TUV32-15	-24.54

TABLE OF RESULTS – 802.11a 54Mbit/s

Centre Frequency (MHz)	Band edge Frequency (MHz)	Limit @ 20dB below peak	Amplitude @ Band edge (dBm)	Plot #	Margin (dB)
5,745	5,725	-21.30	-33.61	TUV32-16	-12.31
5,785	Reference	-21.87		On File	
5,825	5,850	-21.81	-42.40	TUV32-17	-20.59



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Conducted Spurious Emissions (above 1GHz)

Conducted spurious emissions (above 1GHz) are provided indicated by the following matrix. Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized during measurement. Limits which were derived from the band-edge measurements provided below are drawn on each plot.

802.11b

Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
802.11b – Channel 1 (2,412MHz), 11MBit/s					
30	2,400	-36.40	-15.6	ON FILE	-20.80
2,484	6,000	-43.65	-15.6	ON FILE	-28.05
6,000	13,000	-39.23	-15.6	ON FILE	-23.63
13,000	19,500	-33.40	-15.6	ON FILE	-17.80
19,500	26,000	-26.73	-15.6	ON FILE	-11.13
802.11b – Channel 6 (2,437MHz), 11MBit/s					
30	2,400	-45.77	-15.02	ON FILE	-30.75
2,484	6,000	-52.33	-15.02	ON FILE	-37.31
6,000	13,000	-39.73	-15.02	ON FILE	-24.71
13,000	19,500	-33.23	-15.02	ON FILE	-18.21
19,500	26,000	-27.54	-15.02	ON FILE	-12.52
802.11b – Channel 11 (2,462MHz), 11MBit/s					
30	2,400	-44.92	-15.53	ON FILE	-29.39
2,484	6,000	-48.03	-15.53	ON FILE	-32.50
6,000	13,000	-39.73	-15.53	ON FILE	-24.20
13,000	19,500	-33.06	-15.53	ON FILE	-17.53
19,500	26,000	-27.40	-15.53	ON FILE	-11.87



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802.11g

Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
802.11g – Channel 1 (2,412MHz), 54MBit/s					
30	2,400	-30.63	-19.0	TUVR32-16	-11.63
2,484	6,000	-42.75	-19.0	TUVR32-17	-23.75
6,000	13,000	-39.40	-19.0	TUVR32-18	-20.40
13,000	19,500	-34.06	-19.0	TUVR32-19	-15.06
19,500	26,000	-27.06	-19.0	TUVR32-20	-8.06
802.11g – Channel 6 (2,437MHz) 54MBit/s					
30	2,400	-45.67	-17.95	ON FILE	-27.72
2,484	6,000	-45.29	-17.95	ON FILE	-27.34
6,000	13,000	-39.90	-17.95	ON FILE	-21.95
13,000	19,500	-34.06	-17.95	ON FILE	-16.11
19,500	26,000	-27.23	-17.95	ON FILE	-9.28
802.11g – Channel 11 (2,462MHz) 54MBit/s					
30	2,400	-45.03	-17.87	ON FILE	-27.16
2,484	6,000	-43.85	-17.87	ON FILE	-25.98
6,000	13,000	-39.73	-17.87	ON FILE	-21.86
13,000	19,500	-33.40	-17.87	ON FILE	-15.53
19,500	26,000	-27.90	-17.87	ON FILE	-10.03



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802.11a

Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Plot #	Margin (dB)
802.11a – Channel 149 (5,745MHz), 54MBit/s					
30	4,000	-43.13	-21.3	ON FILE	-21.83
4,000	5,725	-35.51	-21.3	ON FILE	-14.21
5,850	7,000	-56.06	-21.3	ON FILE	-34.76
7,000	13,200	-54.90	-21.3	ON FILE	-33.60
13,200	27,000	-53.06	-21.3	ON FILE	-31.76
27,000	31,000	-57.23	-21.3	ON FILE	-35.93
31,000	40,000	-46.06	-21.3	ON FILE	-24.76
802.11a – Channel 157 (5,785MHz), 54MBit/s					
30	4,000	-42.98	-21.87	ON FILE	-21.11
4,000	5,725	-42.93	-21.87	ON FILE	-21.06
5,850	7,000	-56.40	-21.87	ON FILE	-34.53
7,000	13,200	-54.73	-21.87	ON FILE	-32.86
13,200	27,000	-53.40	-21.87	ON FILE	-31.53
27,000	31,000	-56.40	-21.87	ON FILE	-34.53
31,000	40,000	-45.90	-21.87	ON FILE	-24.03
802.11a – Channel 165 (5,825MHz), 54MBit/s					
30	4,000	-43.18	-21.81	ON FILE	-21.37
4,000	5,725	-43.04	-21.81	ON FILE	-21.23
5,850	7,000	-38.06	-21.81	ON FILE	-16.25
7,000	13,200	-54.56	-21.81	ON FILE	-33.05
13,200	27,000	-53.06	-21.81	ON FILE	-31.25
27,000	31,000	-56.90	-21.81	ON FILE	-35.09
31,000	40,000	-45.90	-21.81	ON FILE	-24.09



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Specification

Limits Band-Edge

Lower Limit Band-edge	Upper Limit Band-edge	Limit below highest level of desired power
2,400MHz	2,483.5MHz	>= 20dB

§15.247(c) In any 100KHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required.

§6.2.2 (o)(e1) In any 100 kHz bandwidth outside the operating frequency bands, between 30 MHz and 5 times the carrier frequency, the unwanted emission spectral density shall be either at least 20 dB below the in-band spectral density, or shall not exceed the levels specified in Table 3, whichever is less stringent.

Measurement Uncertainty Conducted Spurious Emissions

Measurement uncertainty	±2.37dB
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Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0156, 0193, K-CBL 08, Coupler, 0070, 0116, 0088

5.1.6. Radiated Emissions

5.1.6.1. Transmitter Radiated Spurious Emissions (above 1GHz)

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

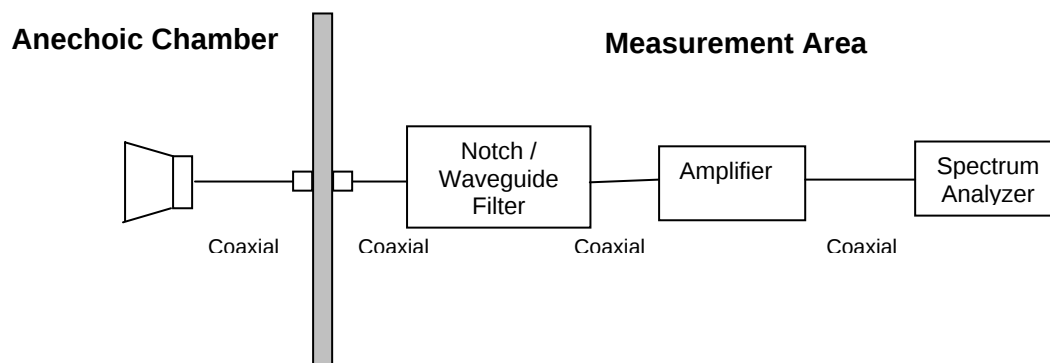
Test Procedure

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. 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. All measurements above 1GHz were performed using a minimum resolution bandwidth of 1MHz.

Spurious emission testing was performed with two active antennas connected. This ensures each antenna is compliant while simultaneously performing co-located transmitter testing. Results identify antenna pairs and frequency bands exercised simultaneously.

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 51.5dB 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

Radio parameters

Both transmitters 2.4GHz and 5GHz were operated simultaneously

Transmission: Maximum Power

Results

Power Setting – Maximum Level 4 (set through Aruba system interface), all test cases

Antenna Types: 2.4GHz and 5GHz **INTEGRAL ANTENNAS** (4.2dBi & 7.7dBi)

TABLE OF RESULTS – 802.11a + 802.11b/g (worst case for 802.11b or 802.11g reported)

Low Band 5GHz (5,150MHz-5,350MHz)

CHANNELS 1 & 36

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
4823.6	V	44.69	1.86	46.55	54.00	-7.45
10358.	H	42.12	10.06	52.18	54.00	-1.82
10359.	H	38.20	10.06	48.26	54.00	-5.74
10364.	V	38.00	10.26	48.26	54.00	-5.74
12969.	V	38.01	9.61	47.62	54.00	-6.38
15856.	H	39.10	9.61	48.71	54.00	-5.29



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CHANNELS 6 & 52

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
4871.74	V	44.58	1.86	46.44	54.00	-7.56
4871.74	H	47.14	2.06	49.20	54.00	-4.60
7460.00	H	40.20	6.36	46.56	54.00	-7.44
10521.7	V	39.80	11.43	51.23	54.00	-2.77
10527.0	V	40.30	11.43	51.73	54.00	-2.27
15690.0	H	38.40	10.01	48.41	54.00	-5.59

CHANNELS 11 & 64

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
4919.83	V	45.92	1.86	47.78	54.00	-6.22
4919.83	H	37.88	2.06	39.94	54.00	-14.06
10630.9	V	39.60	11.43	51.03	54.00	-2.97
10651.0	V	42.02	11.43	53.45	54.00	-0.55



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Results

Antenna Types: 2.4GHz and 5GHz **HIGH GAIN DIRECTIONAL PATCH** (11.5dBi & 14.0dBi)

TABLE OF RESULTS – 802.11a + 802.11b/g (worst case for 802.11b or 802.11g reported)

Low Band 5GHz (5,150MHz-5,350MHz)

CHANNELS 1 & 36

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1036.07	H	44.88	-10.36	34.52	54.00	-19.48
1192.38	V	42.06	-10.46	31.60	54.00	-22.40
1877.75	H	46.24	-4.02	42.22	54.00	-11.78
1877.75	V	44.30	-4.02	40.08	54.00	-13.92
10364.00	V	42.10	10.26	52.36	54.00	-1.64
13485.00	H	29.00	9.41	38.41	54.00	-15.59

(-ve correction factor indicates gain)

CHANNELS 6 & 52

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1192.38	V	42.56	-10.46	32.10	54.00	-21.90
2298.38	H	42.80	-2.42	40.38	54.00	-13.62
1877.75	V	45.06	-4.22	40.84	54.00	-13.16
1889.77	H	41.26	-4.02	37.24	54.00	-16.76
10143.00	H	39.12	11.86	50.98	54.00	-3.02
10527.00	V	41.32	11.43	52.75	54.00	-1.25
10536.00	V	42.02	11.43	53.45	54.00	-0.55

(-ve correction factor indicates gain)

CHANNELS 11 & 64

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1877.75	H	48.34	-4.02	44.32	54.00	-9.68
1877.75	V	43.03	-4.22	38.81	54.00	-15.19
2298.59	H	46.85	-2.42	44.43	54.00	-9.57
5004.00	V	40.68	1.86	42.54	54.00	-11.46
10642.0	V	41.01	11.43	52.44	54.00	-1.56
15401.0	V	34.00	11.25	45.25	54.00	-8.75

(-ve correction factor indicates gain)



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Results

Antenna Types: 2.4GHz and 5GHz **OMNI DIRECTIONAL DIPOLE** (6.0dBi & 5.5dBi)

TABLE OF RESULTS – 802.11a + 802.11b/g (worst case for 802.11b or 802.11g reported)

Low Band 5GHz (5,150MHz-5,350MHz)

CHANNELS 1 & 36

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1192.38	V	41.80	-10.46	31.34	54.00	-22.66
1384.76	H	38.28	-8.46	29.82	54.00	-24.18
1589.17	H	39.04	-6.22	32.82	54.00	-21.18
2286.57	V	41.54	-2.42	39.12	54.00	-14.88
10364.00	V	41.03	10.26	51.29	54.00	-2.71
10373.00	V	41.08	10.26	51.34	54.00	-2.66

(-ve correction factor indicates gain)

CHANNELS 6 & 52

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1192.38	H	40.06	-10.36	29.70	54.00	-24.30
1276.55	H	38.28	-8.46	29.82	54.00	-24.18
2298.59	V	40.38	-2.42	37.96	54.00	-16.04
10527.00	V	41.05	11.43	52.48	54.00	-1.52

(-ve correction factor indicates gain)

CHANNELS 11 & 64

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1192.38	H	40.38	-10.36	30.02	54.00	-23.98
2298.59	V	44.50	-2.42	42.08	54.00	-11.92
8179.00	H	38.15	5.92	44.07	54.00	-9.93
10785.00	V	41.10	10.23	51.33	54.00	-2.67

(-ve correction factor indicates gain)



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Results

Antenna Types: 5GHz **INTEGRAL ANTENNA** (7.7dBi)

TABLE OF RESULTS – 802.11a

High Band 5GHz (5,725MHz-5,850MHz)

CHANNEL 149

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1811.00	V	46.33	-4.22	42.11	54.00	-11.89
2591.00	H	45.33	-2.42	42.91	54.00	-11.09
11490.00	V	44.83	7.61	52.44	54.00	-1.56
11490.00	H	44.50	7.61	52.11	54.00	-1.89

(-ve correction factor indicates gain)

CHANNEL 157

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1811.00	V	46.33	-4.22	42.11	54.00	-11.89
2591.00	H	45.33	-2.42	42.91	54.00	-11.09
11570.00	V	44.50	7.61	52.11	54.00	-1.89
11570.00	H	43.20	7.61	50.81	54.00	-3.19
16215.00	H	37.90	9.61	47.51	54.00	-6.49

(-ve correction factor indicates gain)

CHANNEL 165

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2591.00	H	45.83	-2.42	43.41	54.00	-10.59
2764.00	V	46.33	-2.42	43.91	54.00	-10.09
11650.00	H	45.00	7.61	52.61	54.00	-1.39
11650.00	V	44.87	7.61	52.48	54.00	-1.52

(-ve correction factor indicates gain)



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Results

Antenna Types: 5GHz **HIGH GAIN DIRECTIONAL PATCH ANTENNA** (14.0dBi)

TABLE OF RESULTS – 802.11a

High Band 5GHz (5,725MHz-5,850MHz)

CHANNEL 149

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2756.00	V	45.83	-2.42	43.41	54.00	-10.59
2764.00	H	45.83	-2.42	43.41	54.00	-10.59
11490.00	V	45.00	7.61	52.61	54.00	-1.39
11490.00	H	45.00	7.61	52.61	54.00	-1.39

(-ve correction factor indicates gain)

CHANNEL 157

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
1699.00	V	45.83	-4.22	41.61	54.00	-12.39
2599.00	H	46.17	-2.42	43.75	54.00	-10.25
11570.00	V	44.67	7.61	52.28	54.00	-1.72
11570.00	H	44.50	7.61	52.11	54.00	-1.89
15419.00	H	36.00	9.61	45.61	54.00	-8.39

(-ve correction factor indicates gain)

CHANNEL 165

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2559.00	H	46.67	-2.42	44.25	54.00	-9.75
2559.00	V	46.33	-2.42	43.91	54.00	-10.09
11650.00	H	45.50	7.61	53.11	54.00	-0.89
11650.00	V	45.00	7.61	52.61	54.00	-1.39
12794.00	V	39.20	8.21	47.41	54.00	-6.59
15550.00	H	38.10	9.61	47.71	54.00	-6.29

(-ve correction factor indicates gain)



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Results

Antenna Types: 5GHz **OMNI DIRECTIONAL DIPOLE** (5.5dBi)

TABLE OF RESULTS – 802.11a

High Band 5GHz (5,725MHz-5,850MHz)

CHANNEL 149

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2425.00	H	46.00	-2.42	43.58	54.00	-10.42
2536.00	V	46.17	-2.42	43.75	54.00	-10.25
11490.00	H	44.83	7.61	52.44	54.00	-1.56
11490.00	V	44.33	7.61	51.94	54.00	-2.06
14150.00	H	38.90	9.61	48.51	54.00	-5.49

(-ve correction factor indicates gain)

CHANNEL 157

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2520.00	V	46.00	-2.42	43.58	54.00	-10.42
2693.00	H	45.67	-2.42	43.25	54.00	-10.75
11570.00	H	45.33	7.61	52.94	54.00	-1.06
11570.00	V	45.33	7.61	52.94	54.00	-1.06

(-ve correction factor indicates gain)

CHANNEL 165

Freq. MHz	Polarity H/V	Raw Reading dB μ V/m	Correction Factor dB	Corrected Field Strength dB μ V/m	Limit dB μ V/m	Margin dB
2457.00	V	46.00	-2.42	43.58	54.00	-10.42
2591.00	H	46.17	-2.42	43.75	54.00	-10.25
11650.00	V	44.83	7.61	52.44	54.00	-1.56
11650.00	H	45.33	7.61	52.94	54.00	-1.06
16154.00	V	39.10	9.61	48.71	54.00	-5.29

(-ve correction factor indicates gain)

Radiated Band-Edge Results – Restricted Bands

Equipment was operated on the frequency channel closest to the restricted band in each case.

TABLE OF RESULTS – 802.11b 11Mbit/s

Centre Frequency (MHz)	Restricted Band Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2,412	2,390	47.2	54.00	-6.8
2,462	2,483.5	42.1	54.00	-11.9

TABLE OF RESULTS – 802.11g 54Mbit/s

Centre Frequency (MHz)	Restricted Band Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2,412	2,390	49.6	54.00	-4.4
2,462	2,483.5	42.5	54.00	-11.5

Specification

Limits

§15.247 (c) Radiated emissions which fall in the restricted bands, as defined in §15.205 (a), must also comply with the radiated emission limits specified in §15.209 (a)

§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 of the regulation, 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:



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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 "Measurement of Radiated Emissions"	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

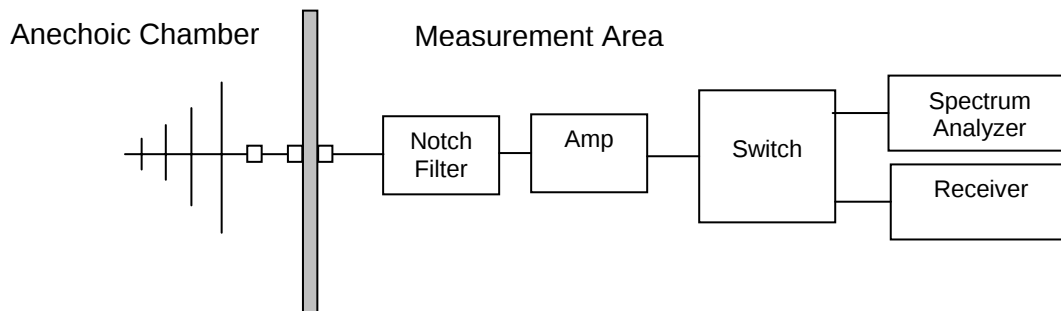
5.1.6.2. Radiated Emissions (30M-1GHz)

FCC, Part 15 Subpart C §15.205)/ §15.209
Industry Canada RSS-210 §6.2.2(q1)

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:

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

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

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

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

Ambient conditions.

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

Radio parameters.

Both transmitters 2.4GHz and 5GHz were operational

Antenna Types: 2.4GHz and 5GHz Omni directional antennas connected

Power Setting – Maximum Level 4 (set through Aruba system interface)

LAN and WAN data cables both carried traffic

RJ11 connected and generating noise

TABLE OF RESULTS - POWER OVER ETHERNET

Freq. MHz	Peak dBuV/m	QP dBuV/m	QP Lmt dBuV/m	QP Margin dB	Angle deg	Hgt cm	Pol	Total Correction Factor
30.94207	21.60	17.39	30.00	-12.61	354	101	Vert	-14.57
32.05312	27.47	23.91	30.00	-6.09	270	104	Vert	-15.35
250.0291	38.55	35.81	37.00	-1.19	250	397	Horz	-17.99
266.2992	31.61	25.94	37.00	-11.06	345	102	Vert	-17.19
500.0520	39.27	36.54	37.00	-0.46	136	203	Horz	-11.49
750.0877	32.98	31.01	37.00	-5.99	137	102	Horz	-5.78



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TABLE OF RESULTS - AC/DC POWER CONVERTER

Freq. MHz	Peak dBuV/m	QP dBuV/m	QP Lmt dBuV/m	QP Margin dB	Angle deg	Hgt cm	Pol	Total Correction Factor
78.36462	20.38	14.59	30.00	-15.41	48	281	Vert	-25.09
79.98328	21.32	16.36	30.00	-13.64	62	219	Vert	-25.07
250.0278	32.54	31.50	37.00	-5.50	243	103	Vert	-17.99
266.6428	32.45	27.23	37.00	-9.77	346	101	Vert	-17.11
500.0593	35.71	35.09	37.00	-1.91	134	200	Horz	-11.49
668.3296	30.29	23.88	37.00	-13.12	4	394	Vert	-7.09

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 'Measurement of Radiated Emissions'	HP 8546A E MI Receiver, HP8546A EMI Receiver (RF Filter Section), HP 9 KHz – 1 GHz Ant. Preamplifier, EMCO Biconilog (Imm/ Em),

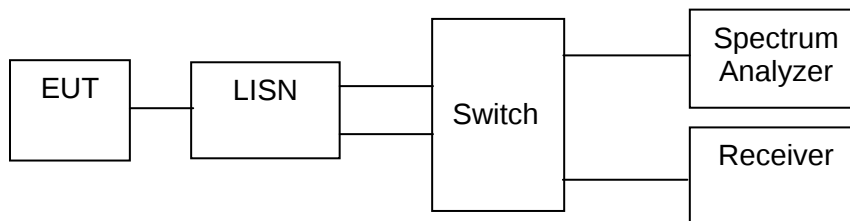
5.1.7. AC Wireline Conducted Emissions (150KHz – 30MHz)

FCC, Part 15 Subpart C §15.207
Industry Canada RSS-210 §6.6(b), §7.4

Test Procedure

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

Test Measurement Set up



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

Ambient conditions.

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

Power Setting – Maximum Level 4 (set through Aruba system interface)

TABLE OF RESULTS – AC/DC CONVERTER

Frequency (MHz)	Average (dB μ V)	Average Limit (dB μ V)	QP Voltage (dB μ V)	Margin (dB)	Phase
0.24600	40.551	51.89	--	-11.34	L
12.7460	35.417	50.00	--	-14.58	N
12.7940	36.935	50.00	--	-13.07	N
13.2820	35.561	50.00	--	-14.44	N
13.8260	37.011	50.00	--	-12.99	N
14.0740	35.582	50.00	--	-14.42	N

Emission plots are provided in Section 8, Graphical Results

Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150KHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 $\mu\Omega$ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

6.6(b) On any frequency or frequencies within the band of 0.15-30 MHz, the measured RF voltage (CISPR meter) shall not exceed 250 μ V, 48dB μ V (across 50 ohms)

Transmitters marketed for use only in a commercial, industrial or business environment and not intended for use in homes are permitted a limit of 1000 μ V (60dB μ V, 0.45 - 1.705 MHz) and 3000 μ V (69.5dB μ V, 1.705 - 30 MHz).

§15.207 (a) Limit Matrix

The lower limit applies at the boundary between frequency ranges

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

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	± 2.64 dB
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Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0156, 0193, 0190, 15F50B001, 15F0B002

6. TEST SET-UP PHOTOGRAPHS

6.1. Radiated Emissions (30MHz-1GHz)



Power Over Ethernet (POE)

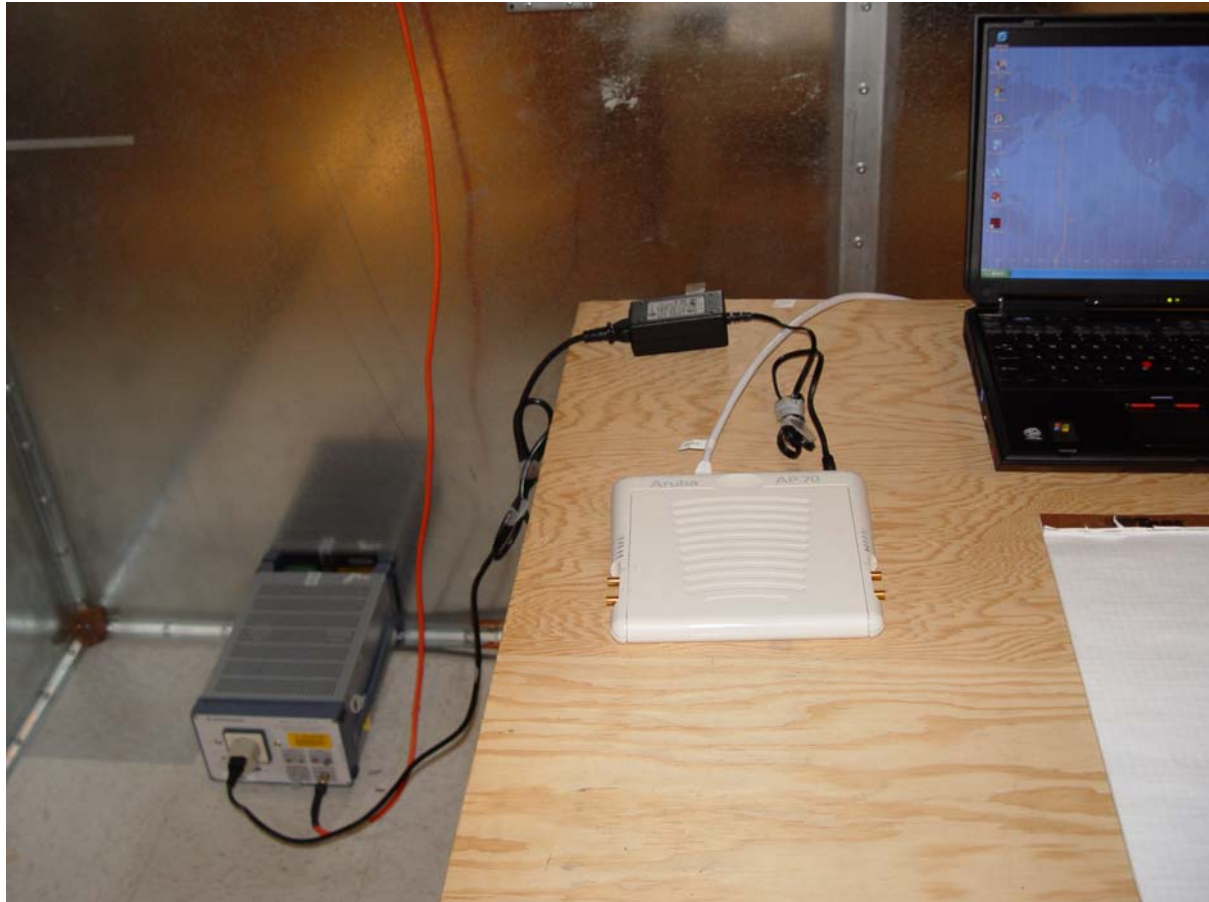


AC/DC Converter

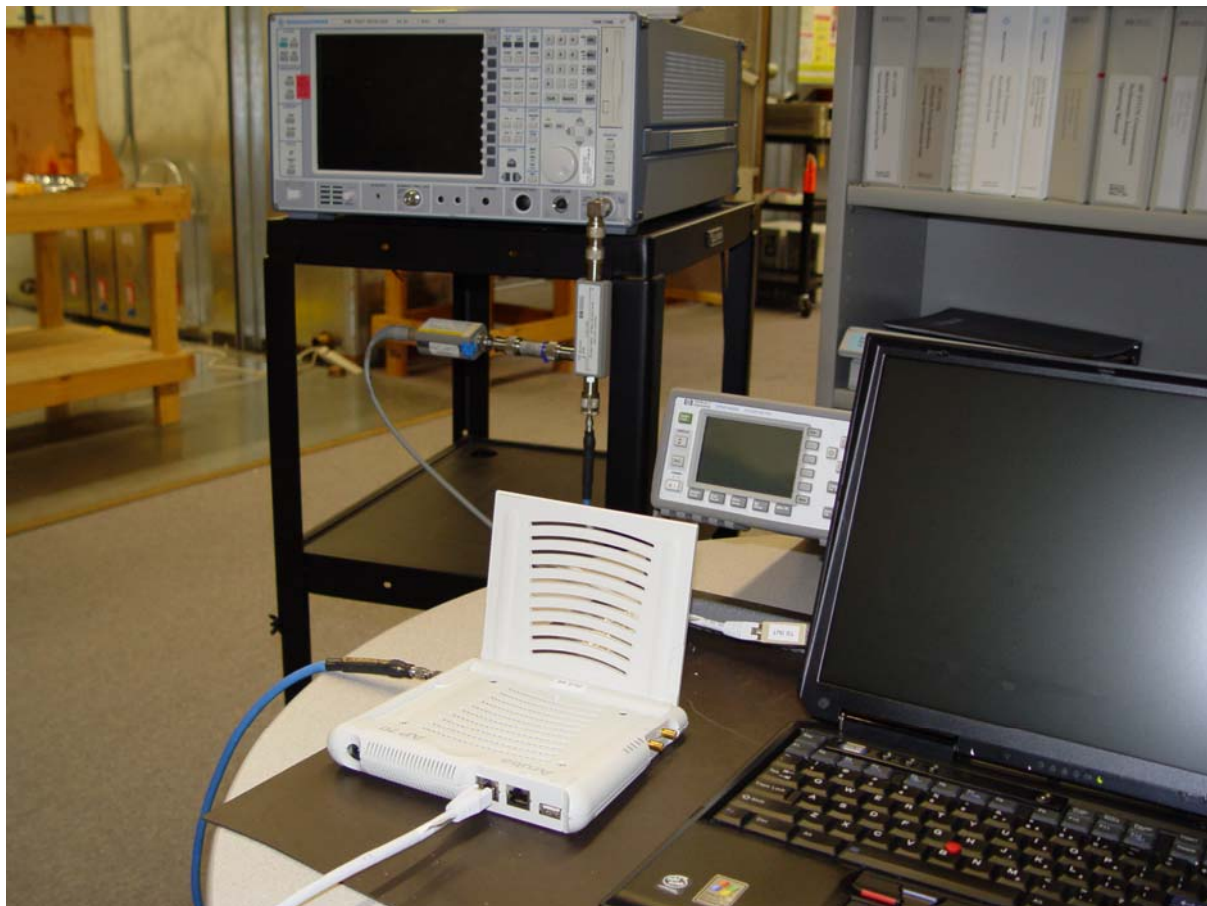
6.2. Spurious Emissions >1GHz



6.3. Conducted Emissions (150KHz - 30MHz)



6.4. General Measurement Test Set-Up



6.5. AP70 Internal PCB's





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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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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
EMCO Biconilog (Immunity)	3143	1122	N/A	N/A



8. GRAPHICAL RESULTS

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

2.4GHz 802.11a/b/g		
Parameter	Plot No.	Plot No.
Section 5.1.1 6dB and 99% BW	6dB BW	99% BW
- 802.11b CH1 2,412MHz	TUVR32-01	TUVR32-02
- 802.11g CH1 2,412MHz	TUVR32-03	TUVR32-04
- 802.11a CH157 5,785MHz	TUVR32-05	TUVR32-06
Section 5.1.2 Peak Output Power		
- 802.11b CH6 2,437MHz	TUVR32-07	
- 802.11g CH6 2,437MHz	TUVR32-08	
- 802.11a CH149 5,745MHz	TUVR32-09	
Section 5.1.3 Peak Power Spectral Density		
- 802.11b CH6 2,437MHz	TUVR32-10	
- 802.11g CH6 2,437MHz	TUVR32-11	
- 802.11a CH149 5,745MHz	TUVR32-12	
Section 5.1.5 Conducted Spurious Emissions		
LBE - lower band edge,UBE - upper band edge	Lower Band Edge	Upper Band edge
802.11b - LBE 2,400MHz / UBE 2,483.5MHz	TUVR32-13	TUVR32-14
802.11g - LBE 2,400MHz / UBE 2,483.5MHz	TUVR32-15	TUVR32-16
802.11a - LBE 5,725MHz / UBE 5,850MHz	TUVR32-17	TUVR32-18
802.11g conducted emissions 30M-2.4GHz	TUVR32-19	INTERNAL ANTENNA
2.4835 - 6GHz	TUVR32-20	INTERNAL ANTENNA
6GHz – 13GHz	TUVR32-21	INTERNAL ANTENNA
13GHz – 19.5GHz	TUVR32-22	INTERNAL ANTENNA
19.5GHz – 26GHz	TUVR32-23	INTERNAL ANTENNA



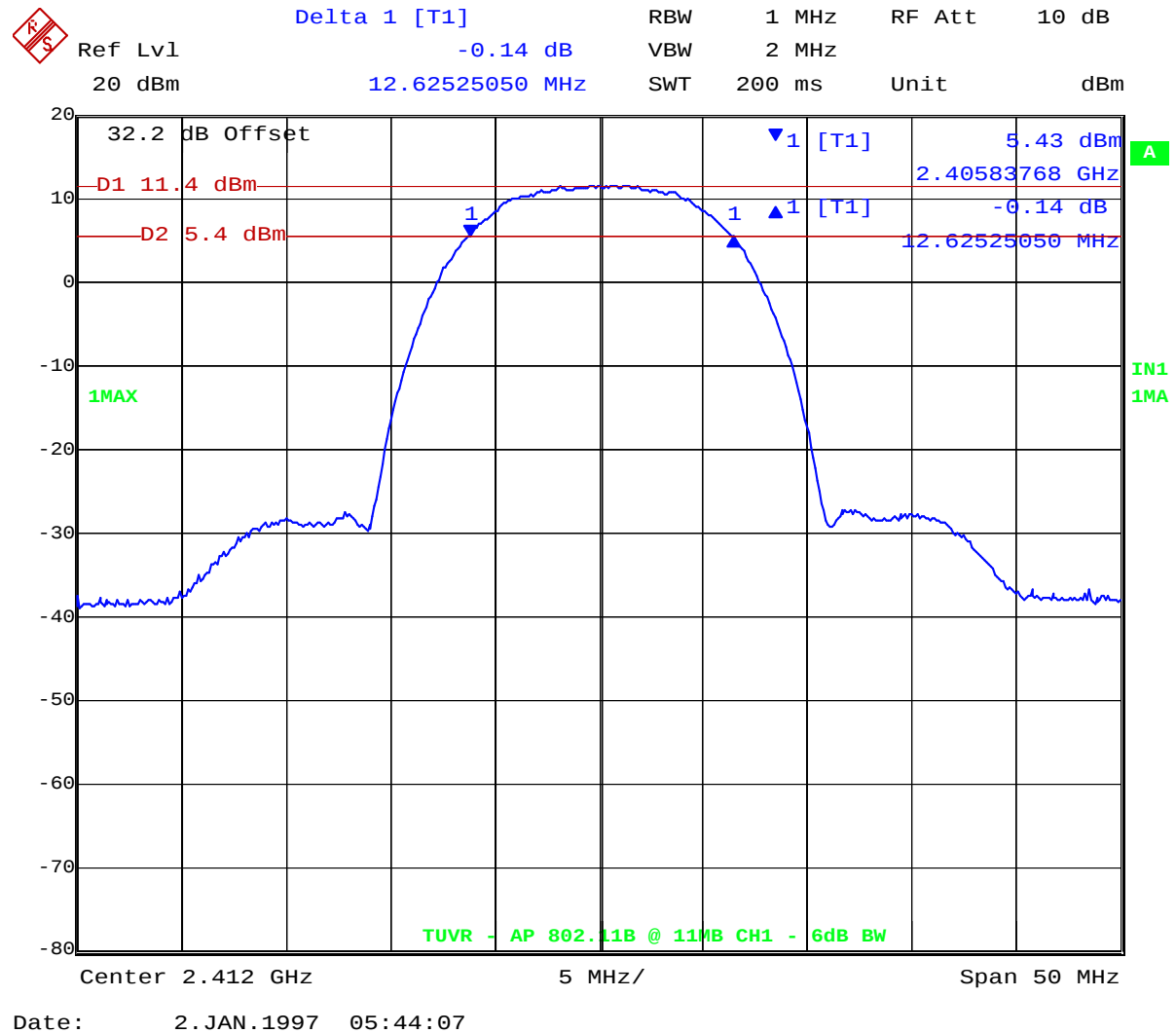
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Section 5.1.6 Radiated Emissions	From	To
Tx Radiated Spurious Emissions 1-26GHz	TUVR32-24	TUVR32-30
	POE	AC/DC Converter
Radiated Emissions 30M-1GHz	TUVR32-31	TUVR32-32
Section 5.1.7 AC Wireline Conducted Emissions		
- LINE 1	TUVR32-33	
- LINE 2	TUVR32-34	



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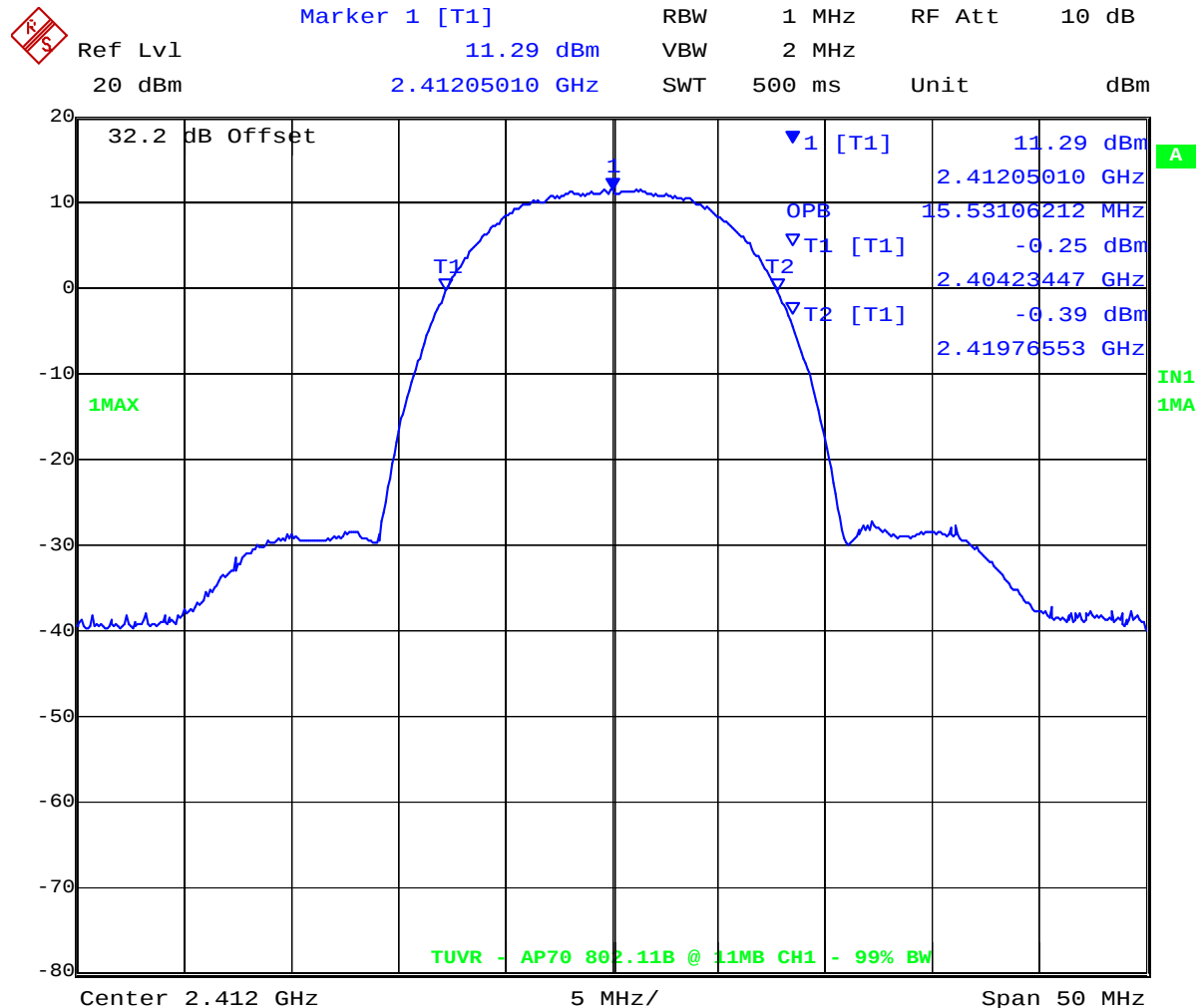
802.11b 6dB Bandwidth (2,412MHz) - TUVR32-01





Title: Wireless Access Point AP70 802.11a/b/g
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802.11b 99% Bandwidth (2,412MHz) - TUVR32-02

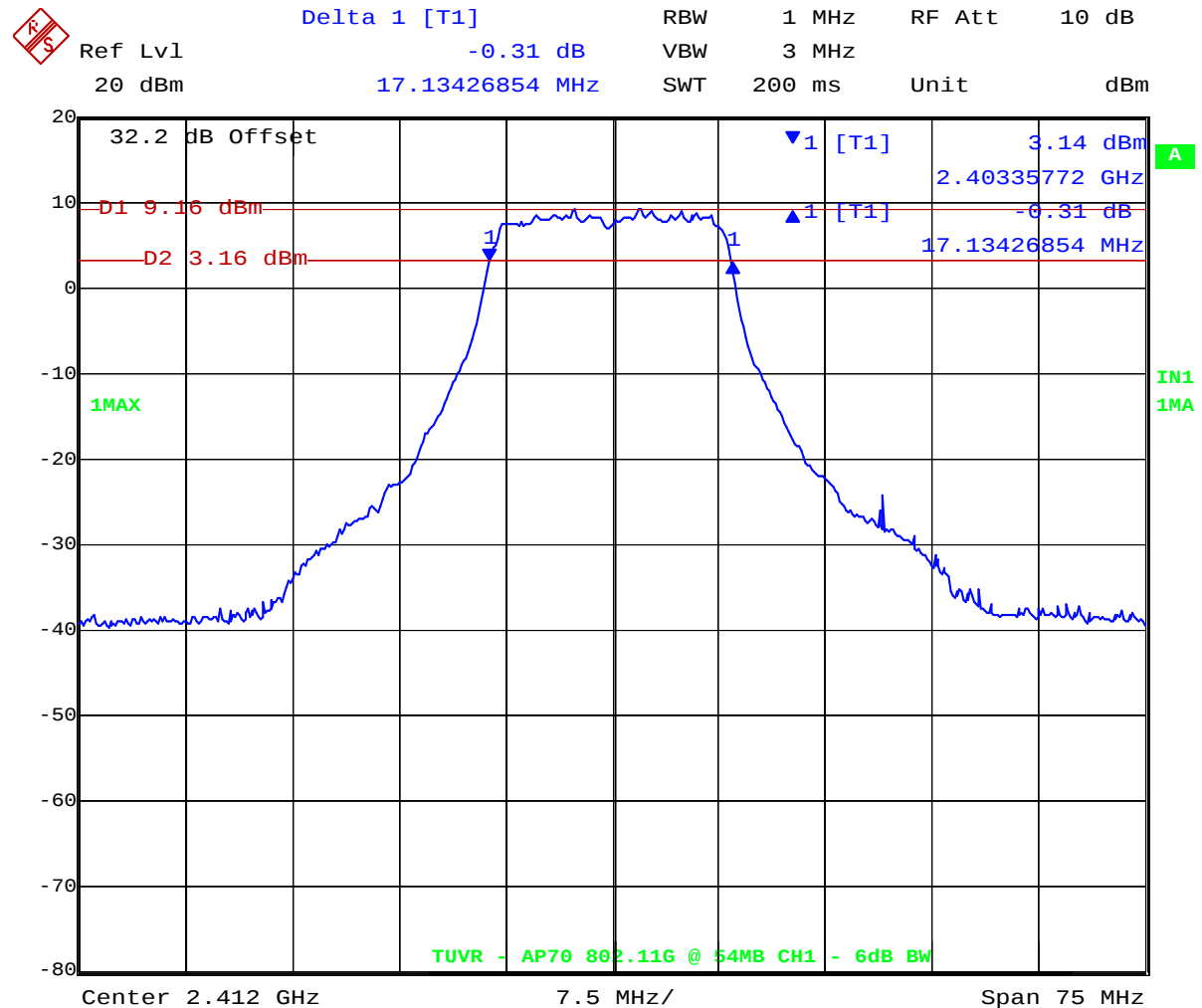


Date: 2.JAN.1997 05:53:16



Title: Wireless Access Point AP70 802.11a/b/g
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802.11g 6dB Bandwidth (2,412MHz) - TUVR32-03

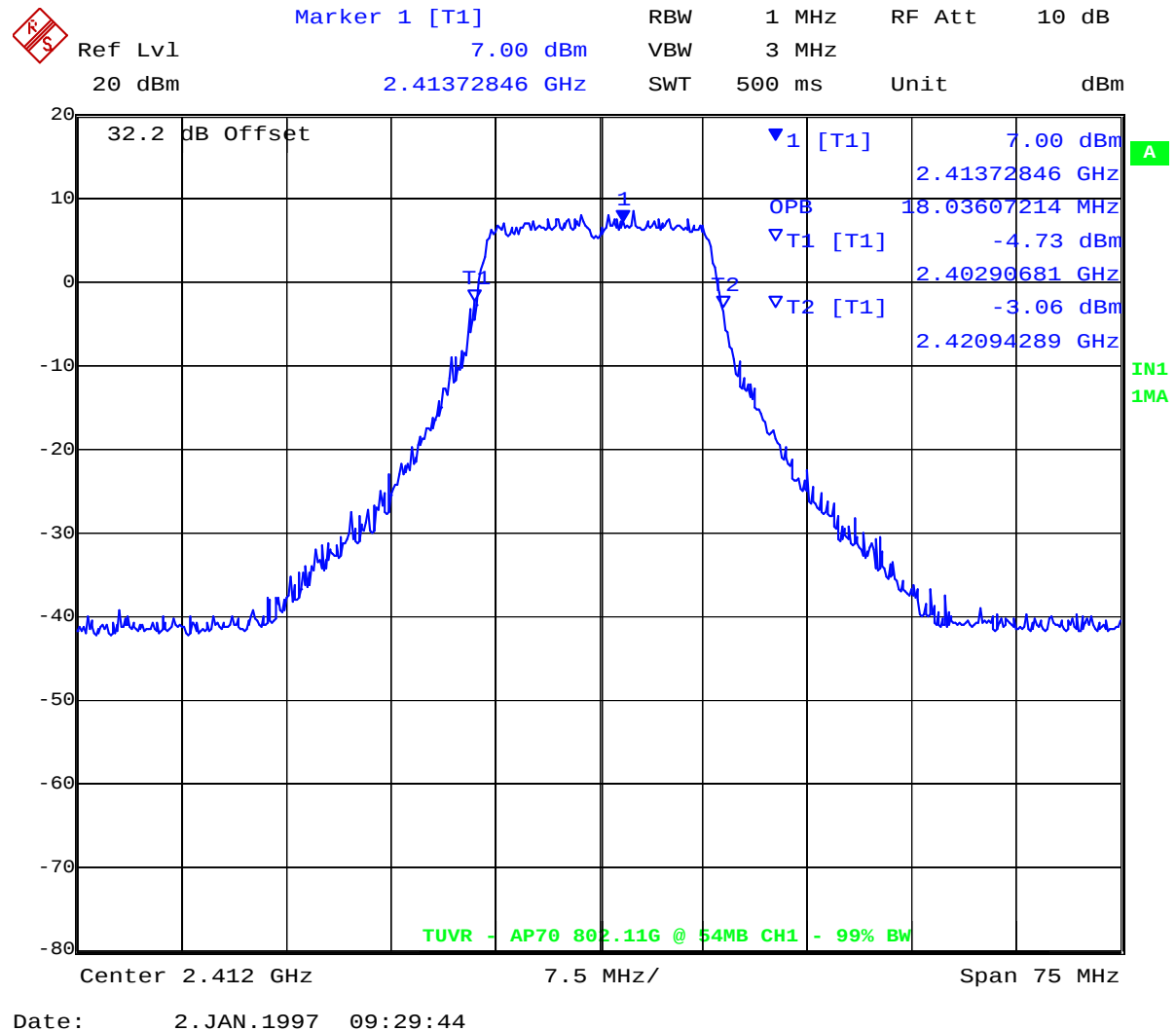


Date: 2.JAN.1997 09:13:25



Title: Wireless Access Point AP70 802.11a/b/g
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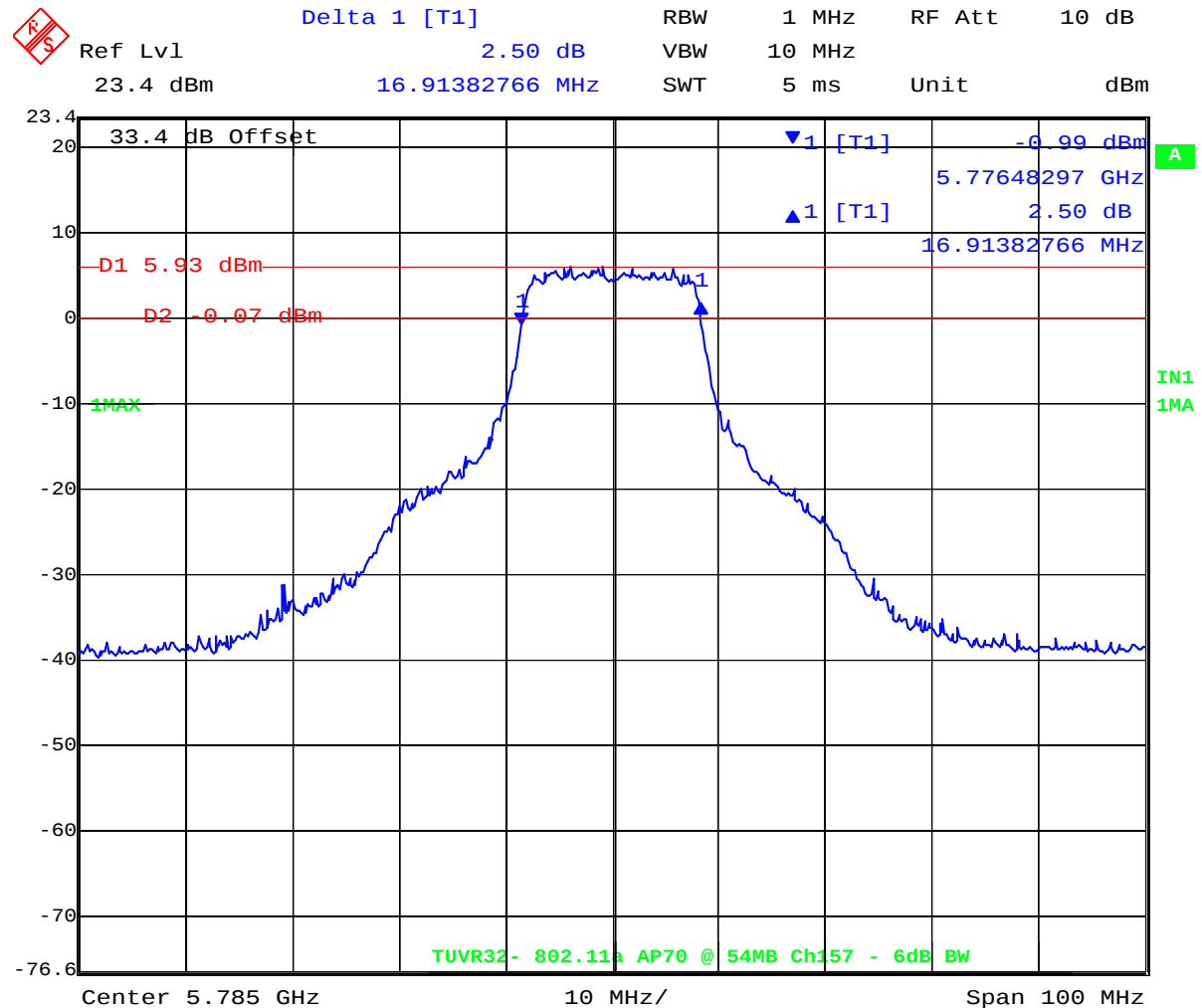
802.11g 99% Bandwidth (2,412MHz) - TUVR32-04





Title: Wireless Access Point AP70 802.11a/b/g
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802.11a 6dB Bandwidth (5,785MHz) - TUVR32-05

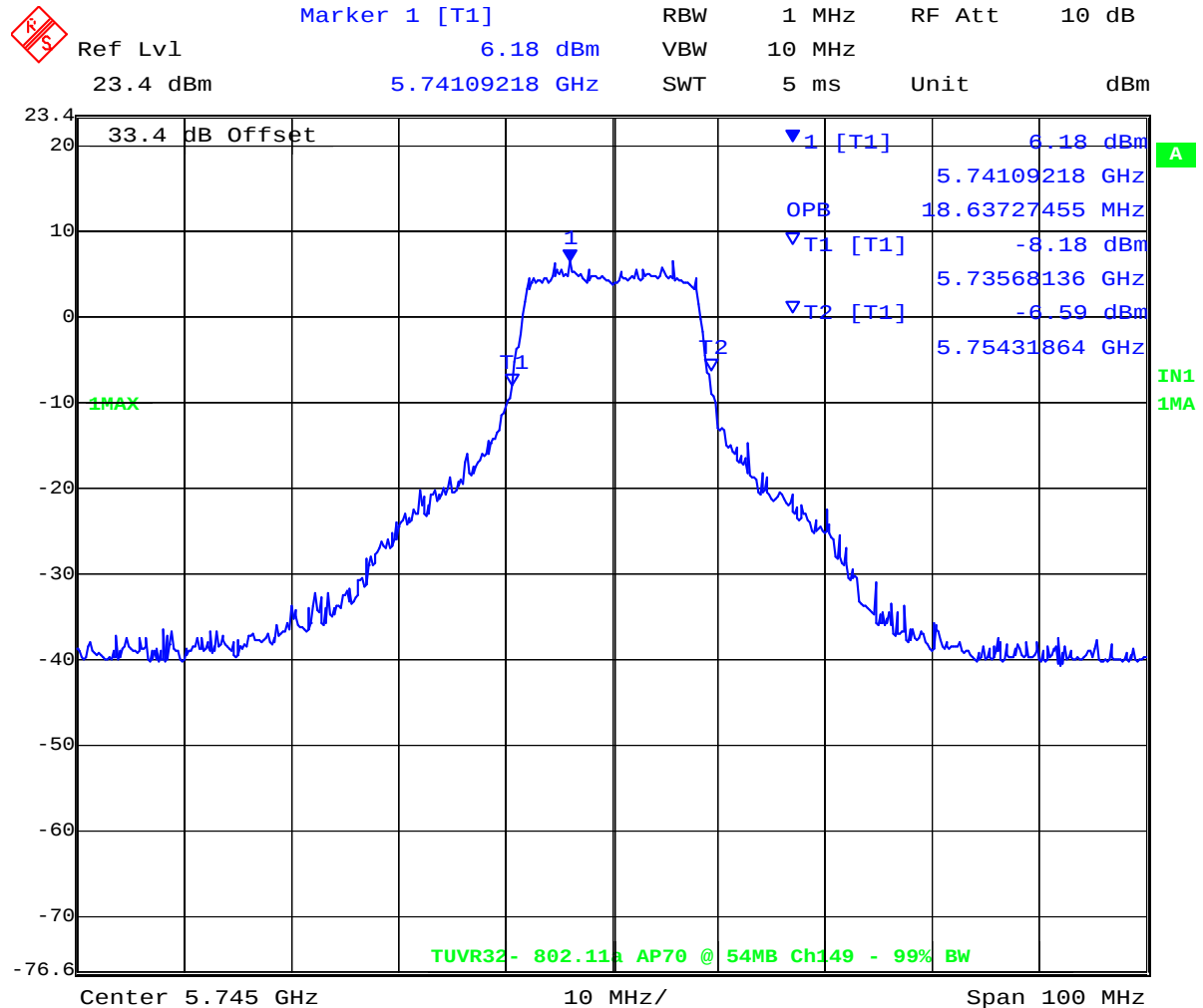


Date: 1.JAN.1997 08:34:11



Title: Wireless Access Point AP70 802.11a/b/g
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802.11a 99% Bandwidth (5,745MHz) - TUVR32-06

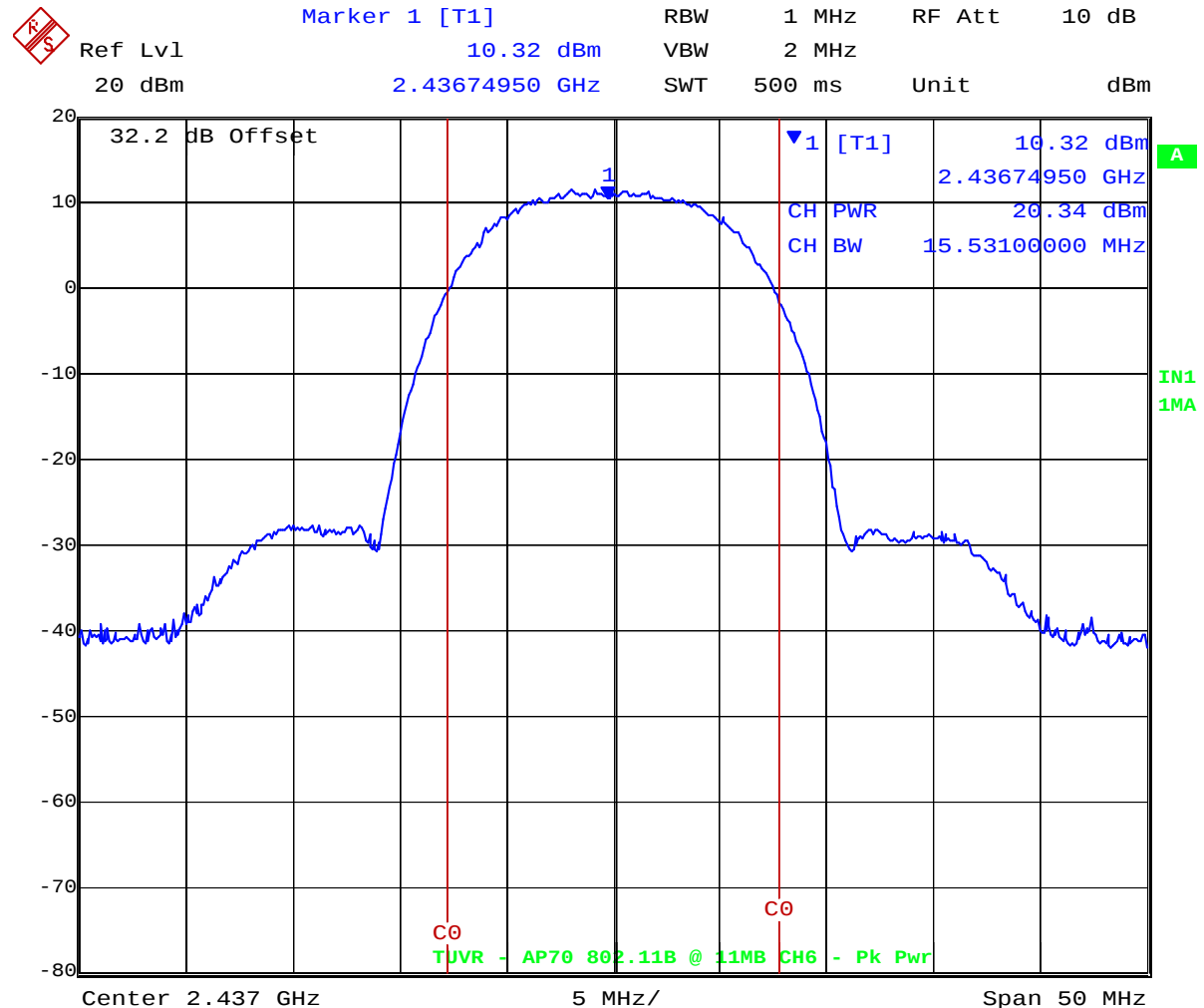


Date: 1.JAN.1997 08:42:55



Title: Wireless Access Point AP70 802.11a/b/g
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802.11b Peak Output Power (2,437MHz) - TUVR32-07

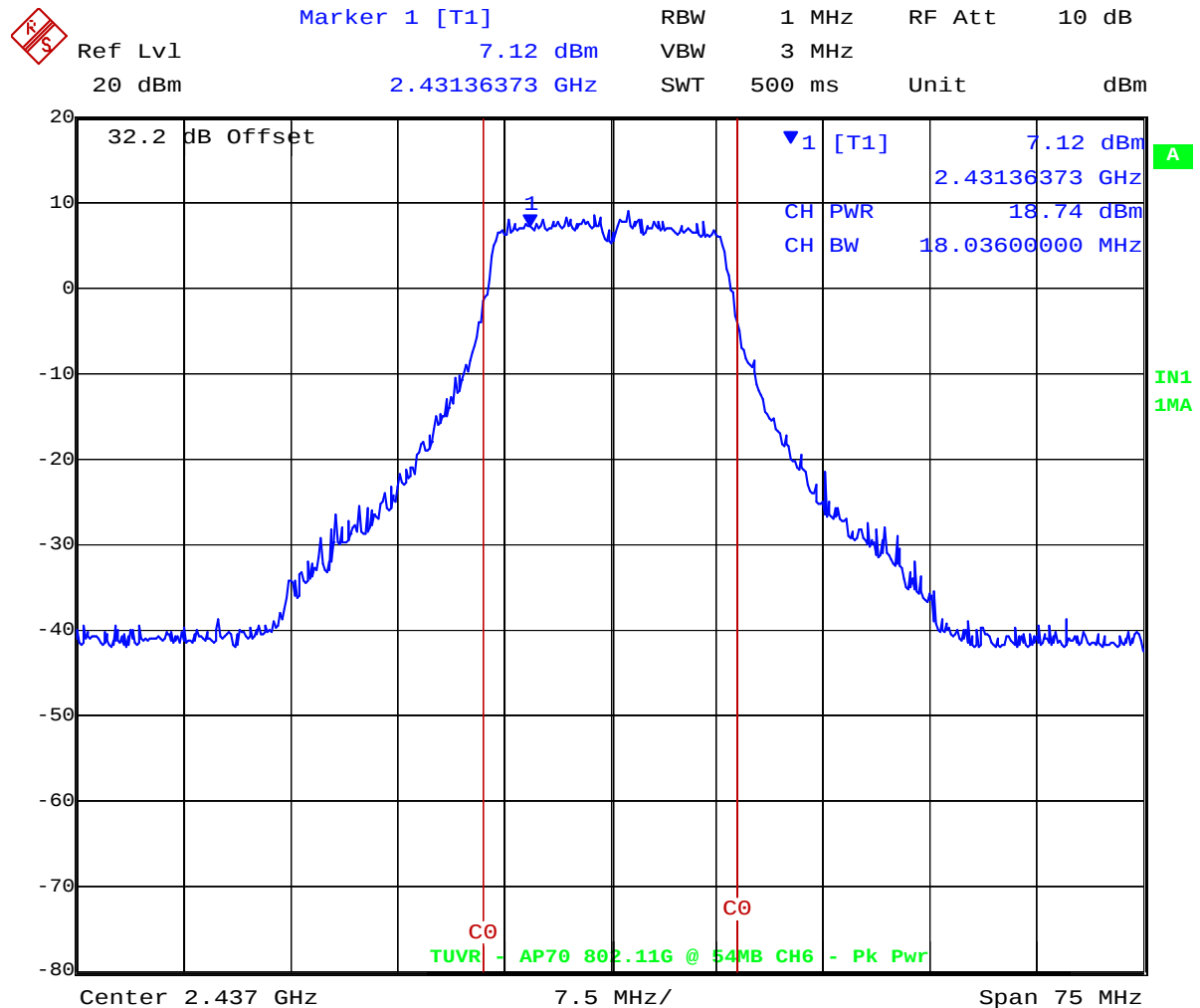


Date: 2.JAN.1997 07:09:45

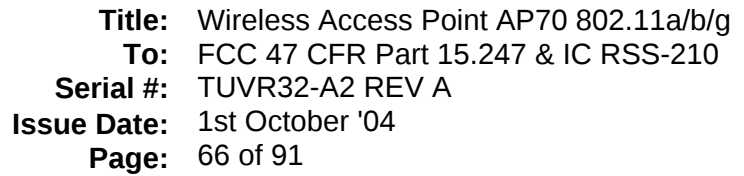


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802.11g Peak Output Power (2,437MHz) - TUVR32-08



Date: 2.JAN.1997 09:34:20



Ref Lvl 23.4 dBm

Marker 1 [T1] 3.83 dBm

5.74149299 GHz

CH PWR 15.19 dBm

CH BW 18.83760000 MHz

33.4 dB Offset

1

IN1 1MA

TUVR32- 802.11a AP70 @ 54MB Ch149 - Pk Pwr

Center 5.745 GHz

10 MHz/

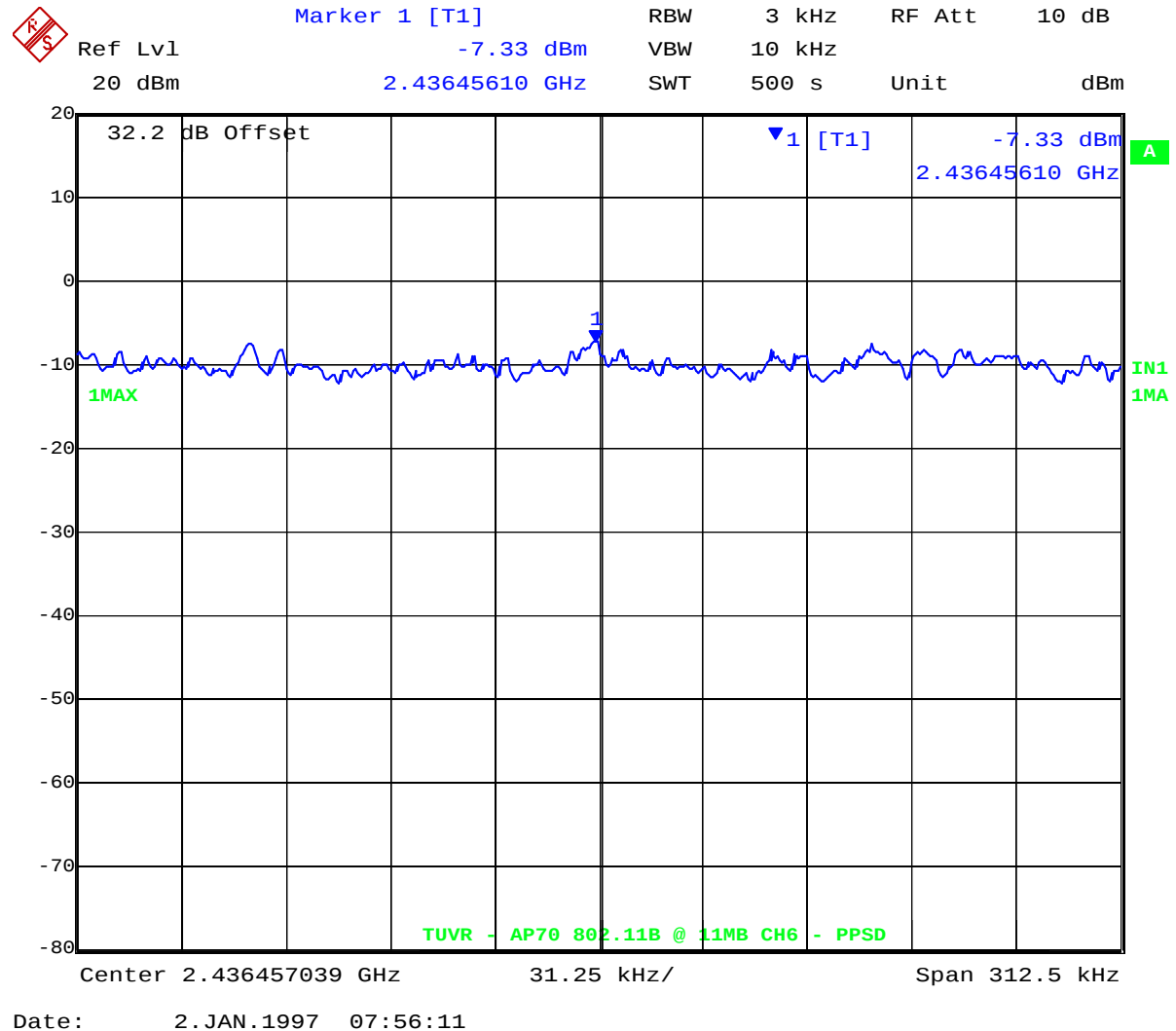
Span 100 MHz

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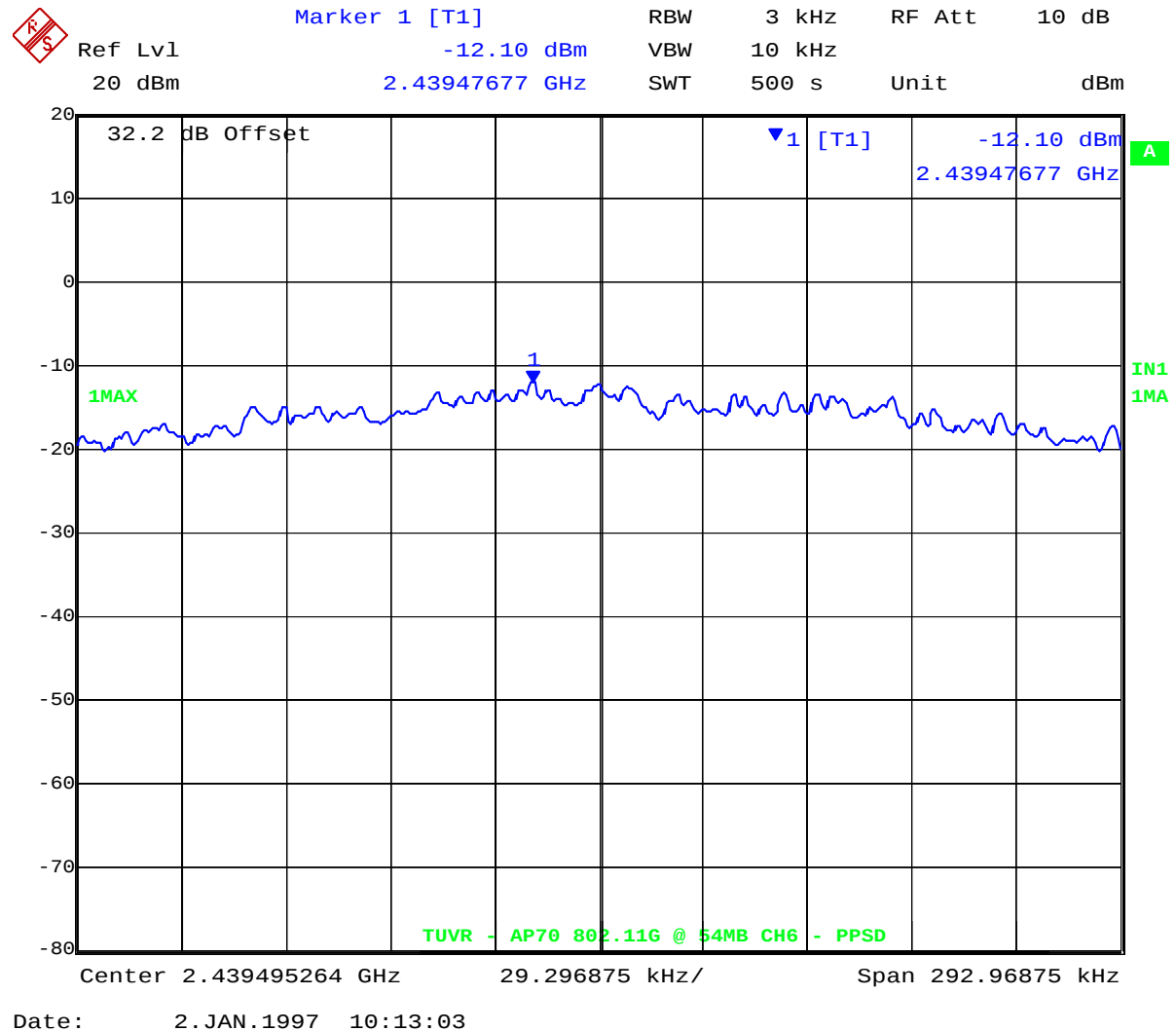
802.11b Peak Power Spectral Density (2,437MHz) - TUVR32-10





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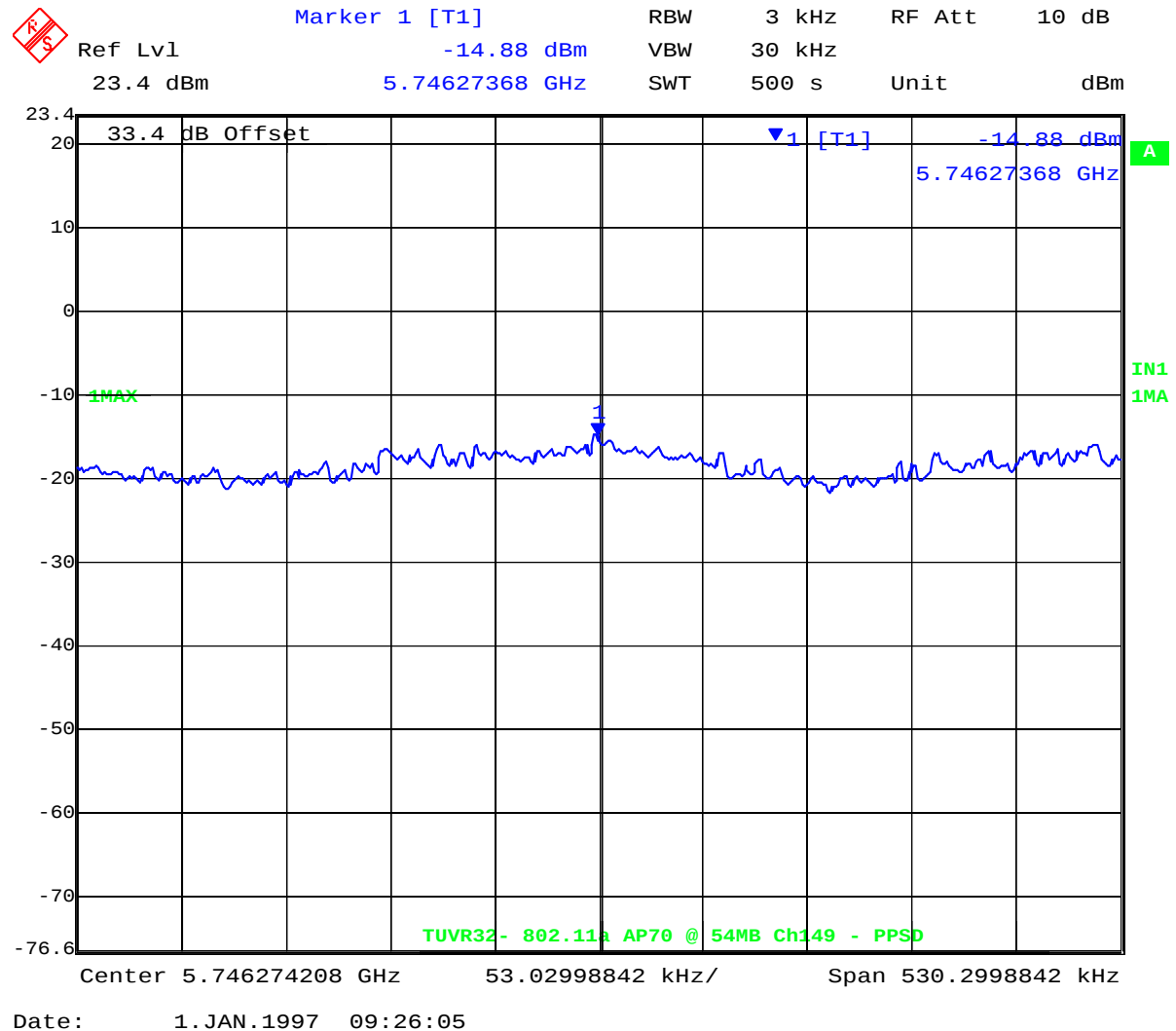
802.11g Peak Power Spectral Density (2,437MHz) - TUVR32-11



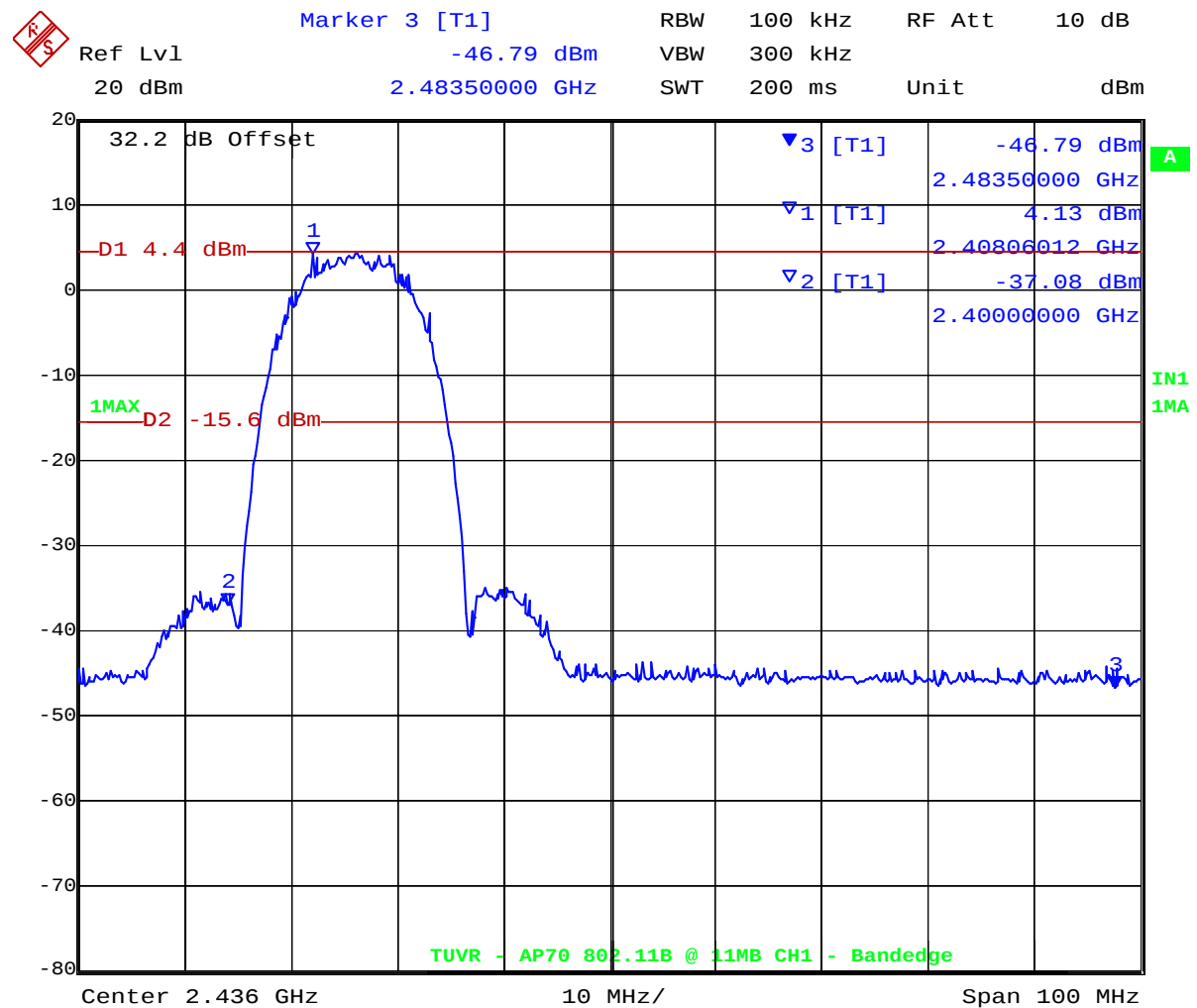


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802.11a Peak Power Spectral Density (5,745MHz) - TUVR32-12



802.11b Conducted Spurious Emissions, Lower Band Edge 2,400MHz - TUVR32-13

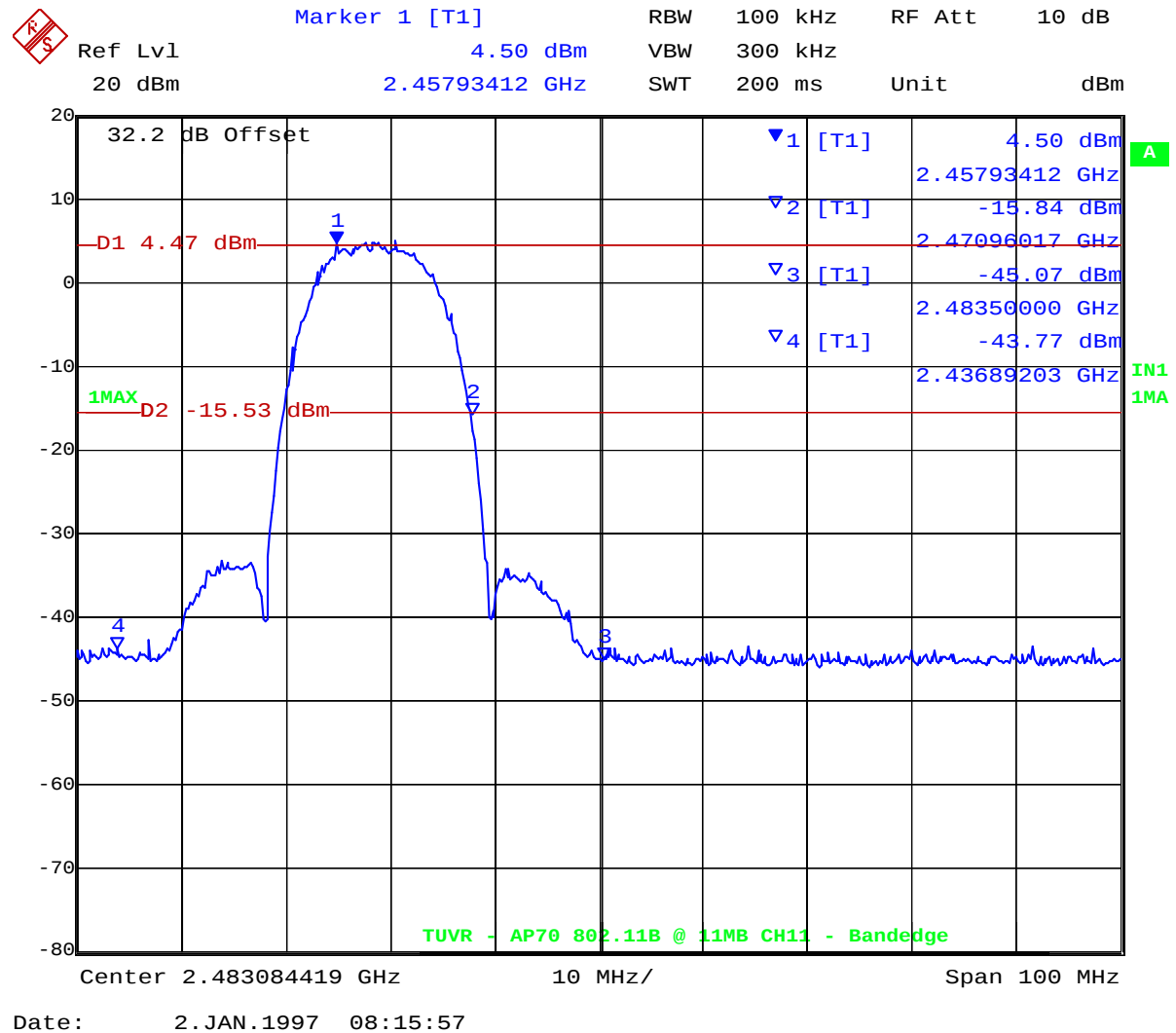


Date: 2.JAN.1997 08:29:01



Title: Wireless Access Point AP70 802.11a/b/g
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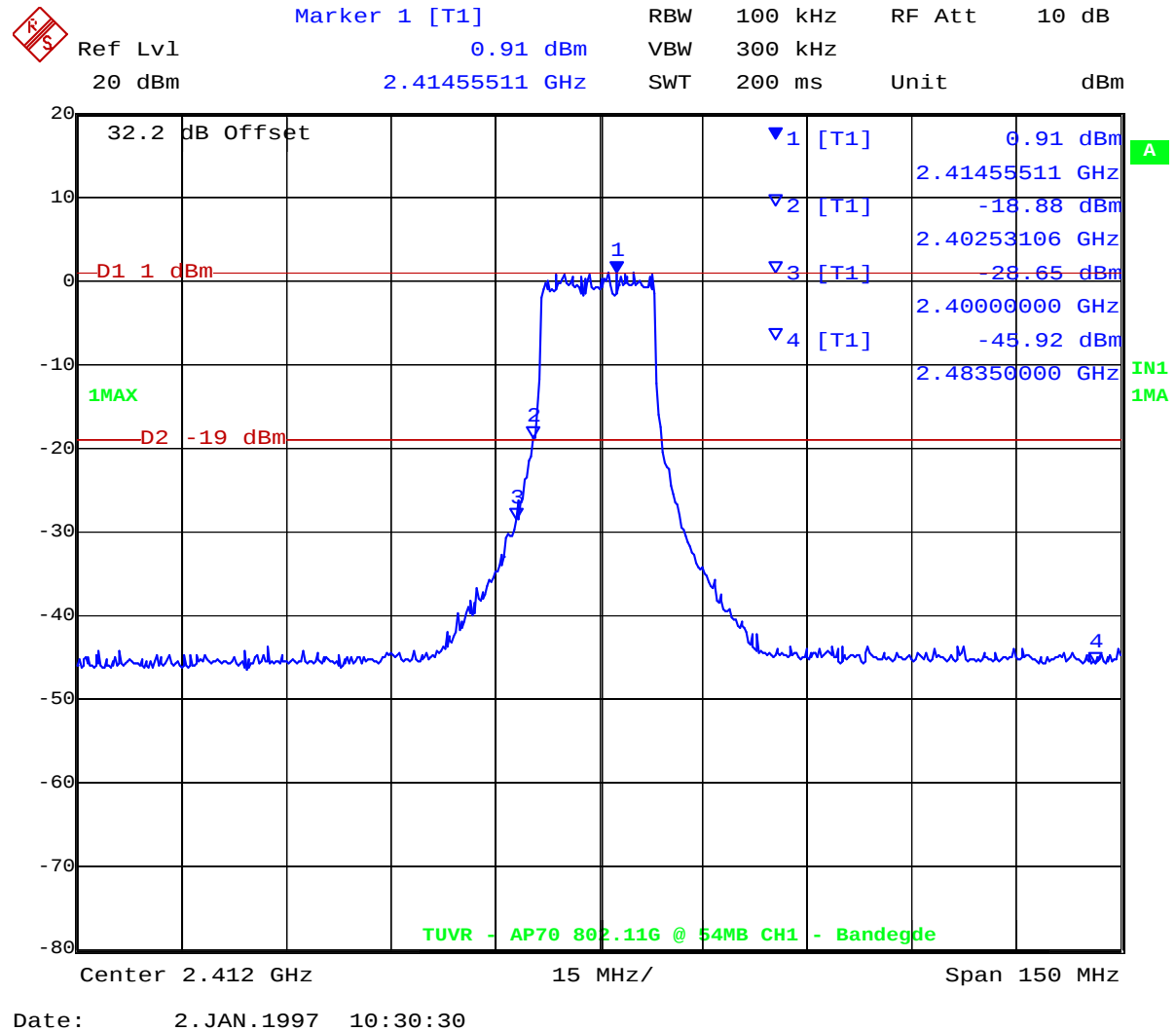
802.11b Conducted Spurious Emissions, Upper Band Edge 2,483.5MHz - TUVR32-14





Title: Wireless Access Point AP70 802.11a/b/g
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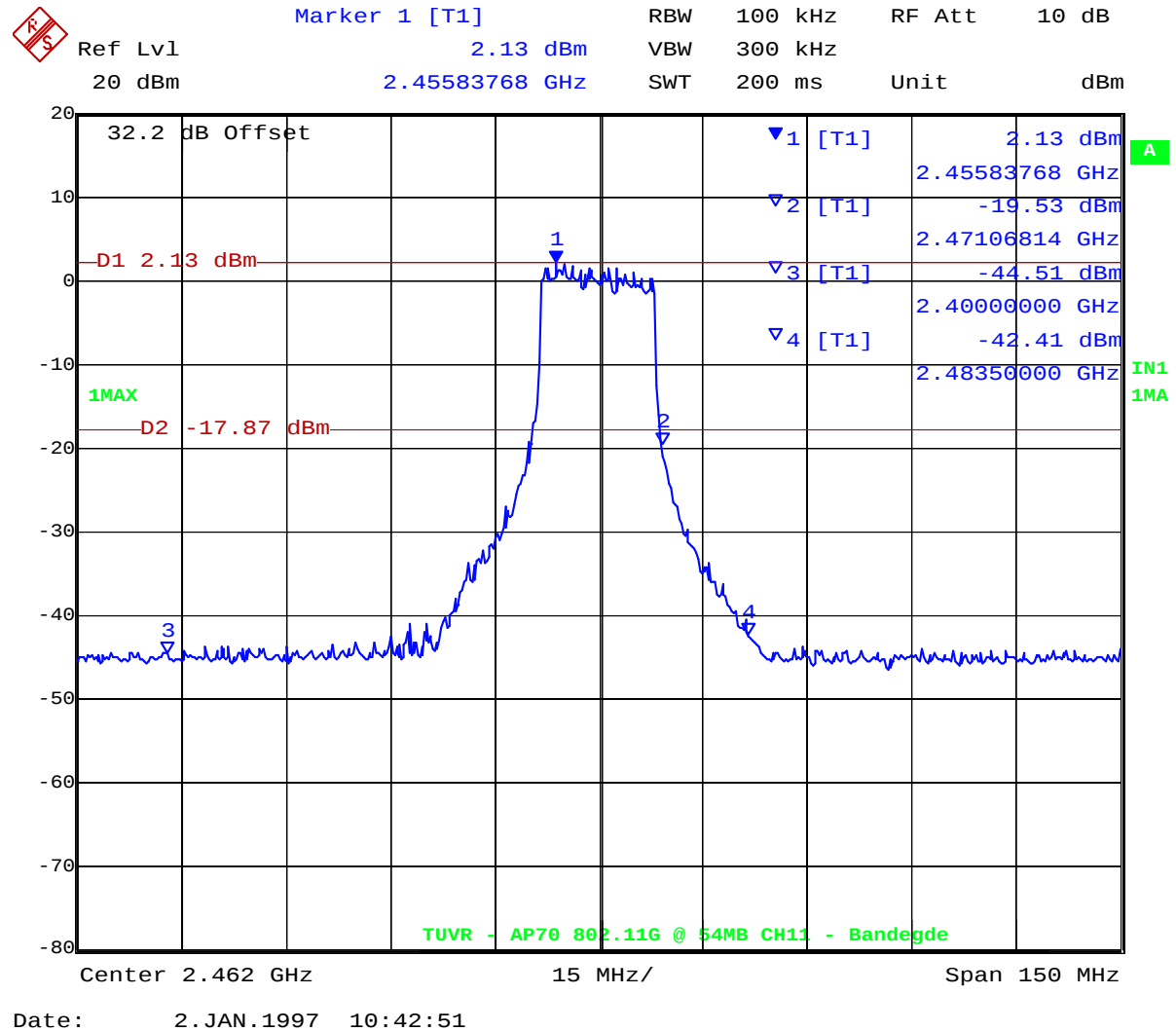
802.11g Conducted Spurious Emissions, Lower Band Edge 2,400MHz - TUVR32-15



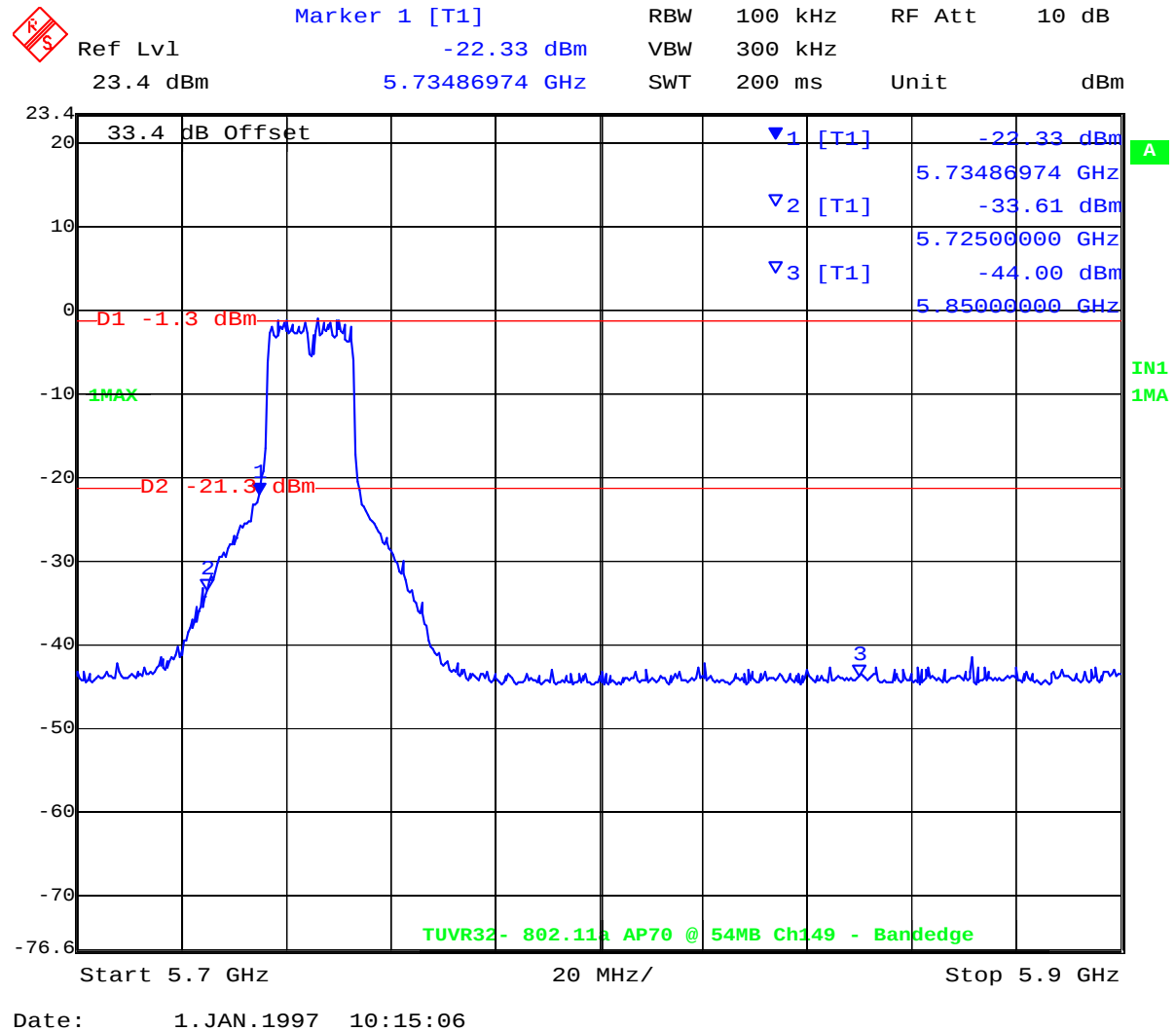


Title: Wireless Access Point AP70 802.11a/b/g
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802.11g Conducted Spurious Emissions, Upper Band Edge 2,483.5MHz - TUVR32-16



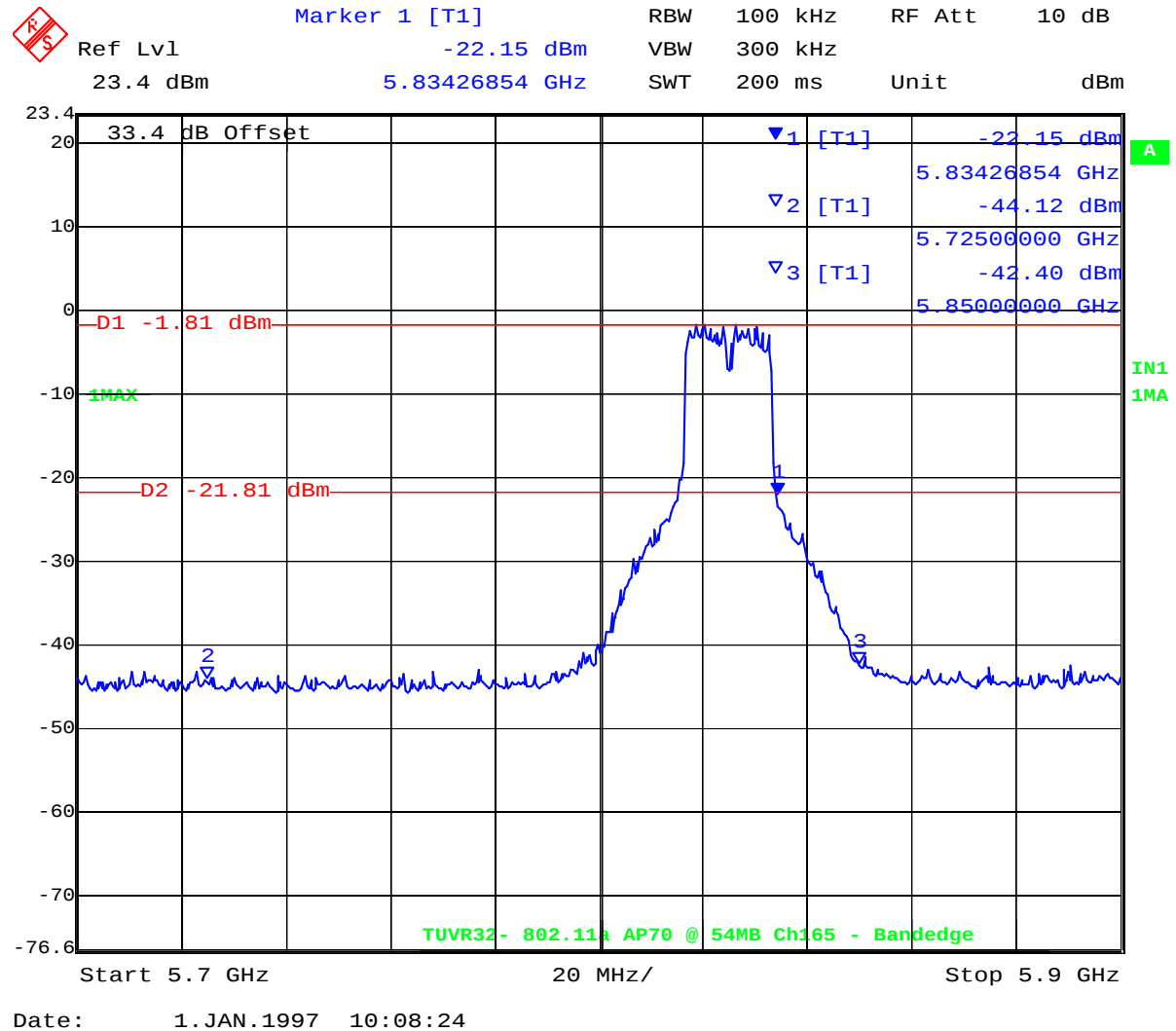
802.11a Conducted Spurious Emissions, Lower Band Edge 5,725MHz - TUVR32-17





Title: Wireless Access Point AP70 802.11a/b/g
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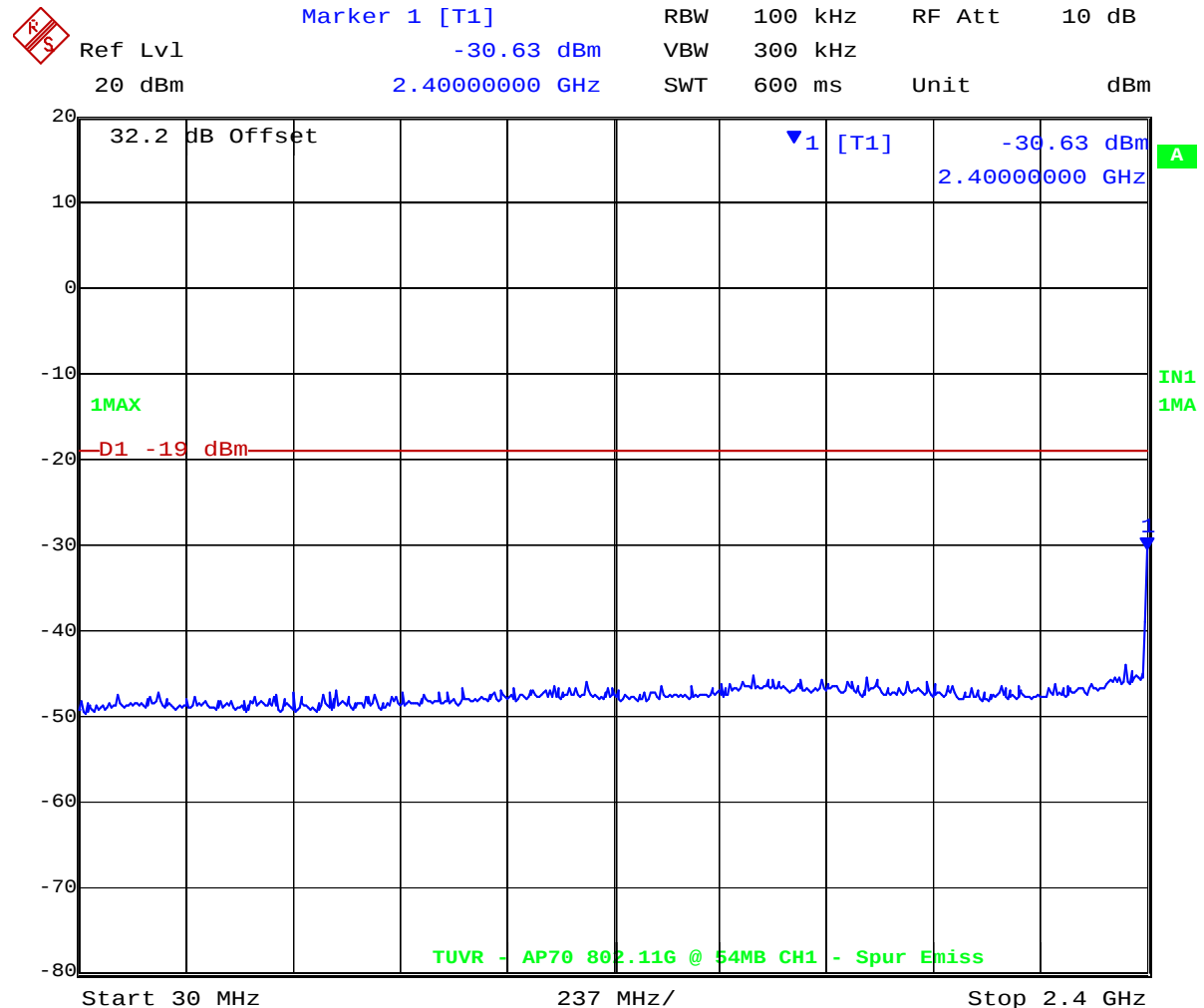
802.11a Conducted Spurious Emissions, Upper Band Edge 5,850MHz - TUV32-18





Title: Wireless Access Point AP70 802.11a/b/g
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802.11g CH1 Conducted Spurious Emissions, (30MHz-2.4GHz) - TUVR32-19

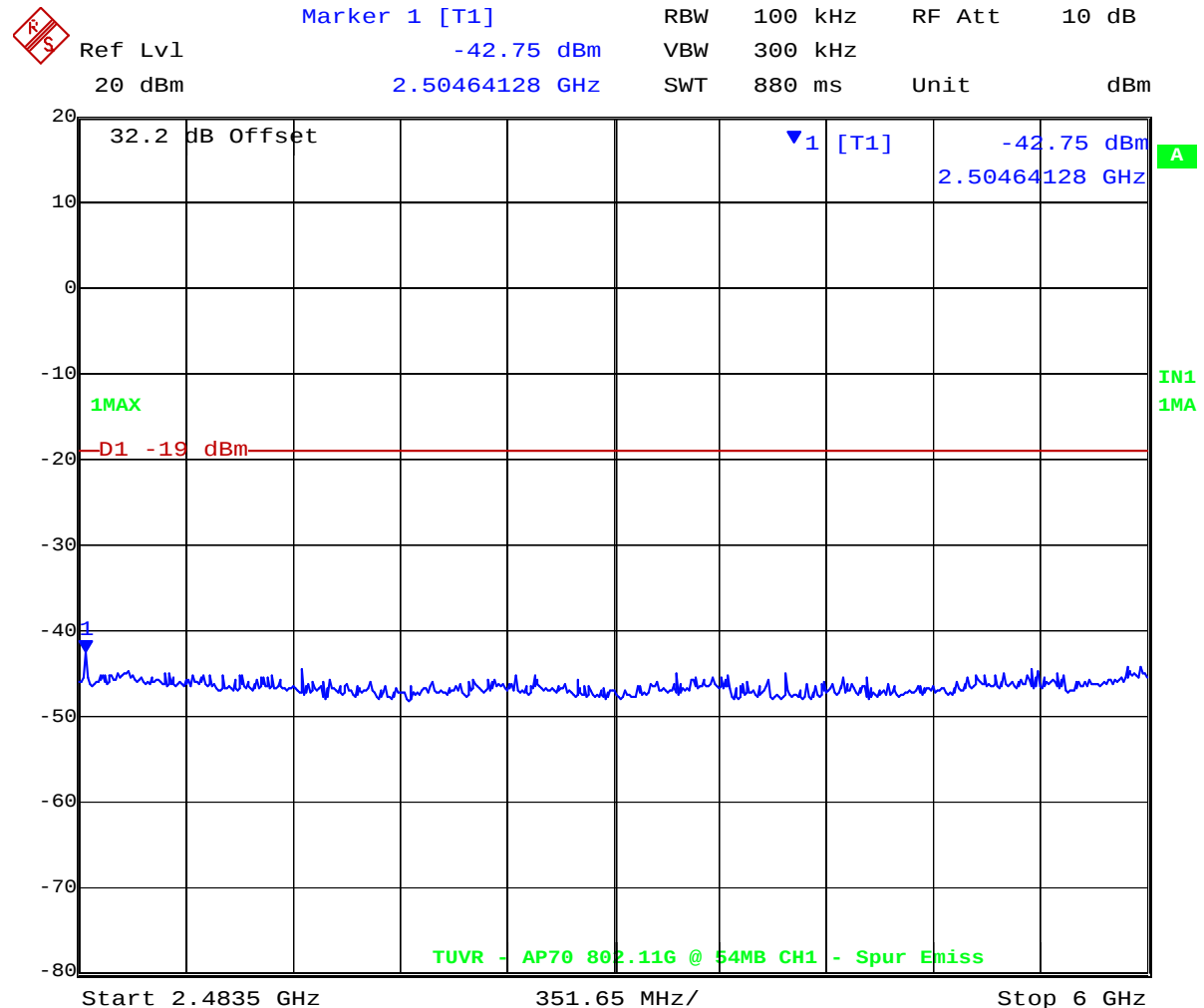


Date: 2.JAN.1997 11:08:29



Title: Wireless Access Point AP70 802.11a/b/g
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802.11g CH1 Conducted Spurious Emissions, (2.4835-6GHz) - TUVR32-20

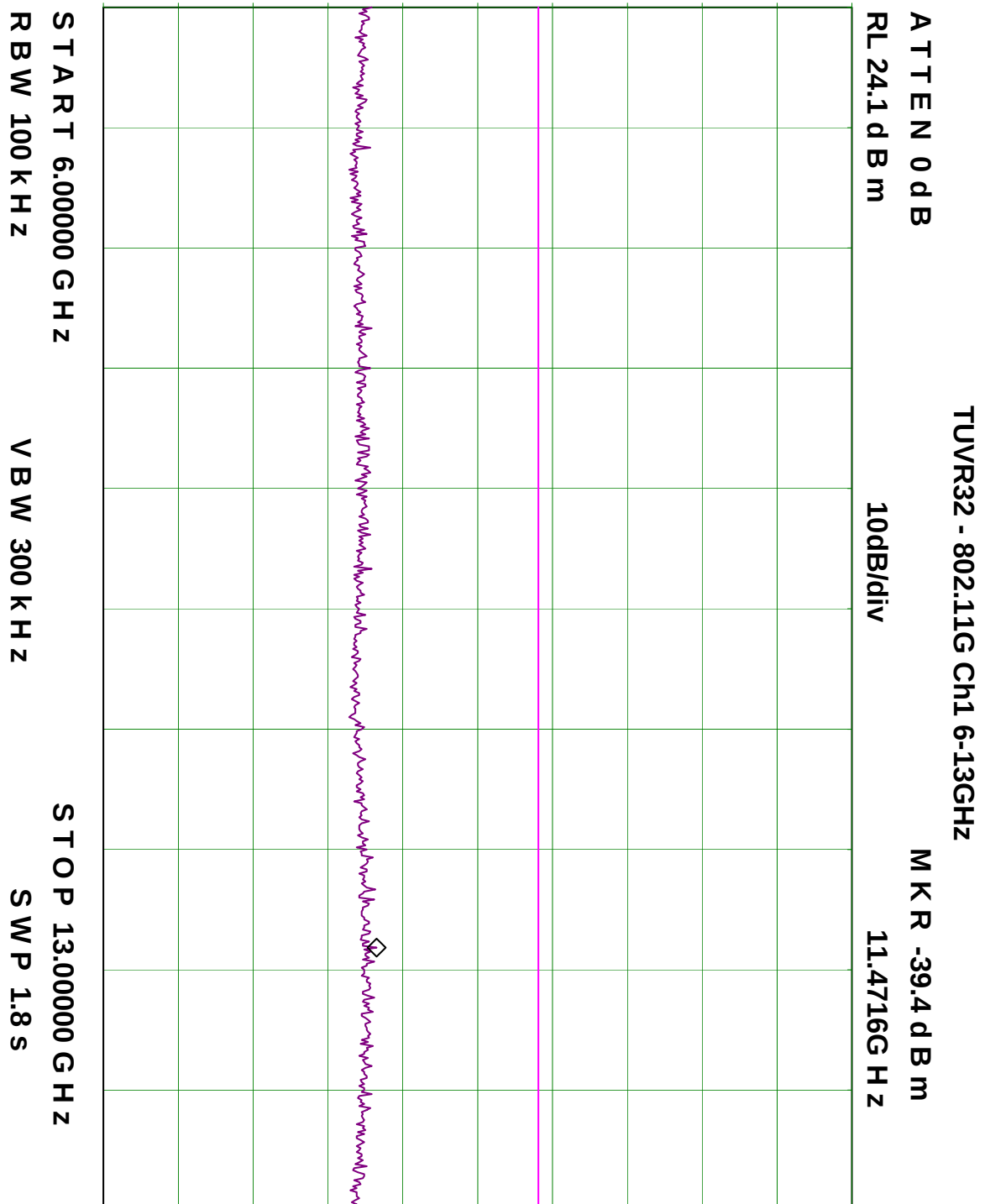


Date: 2.JAN.1997 11:21:59



Title: Wireless Access Point AP70 802.11a/b/g
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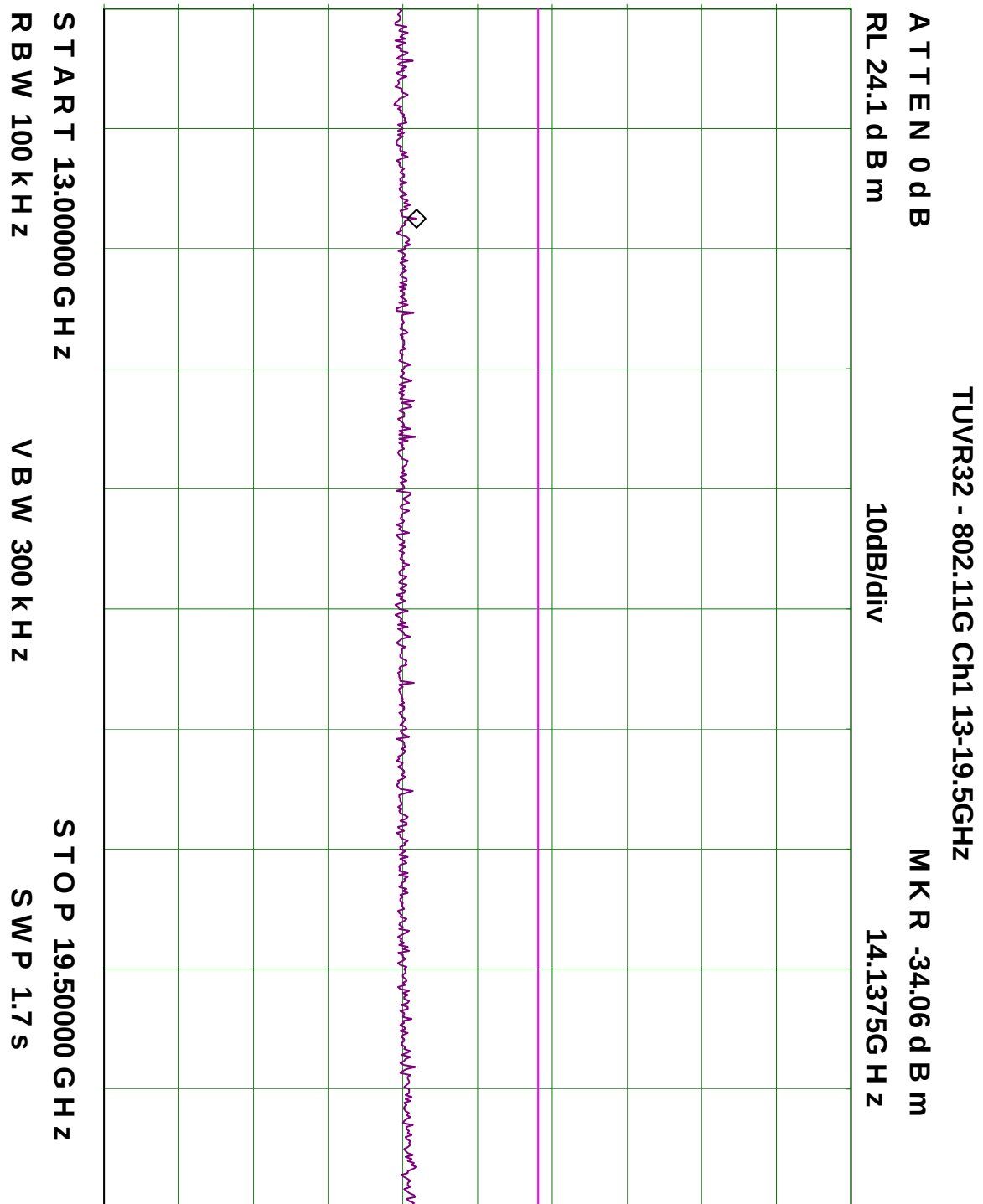
802.11g CH1 Conducted Spurious Emissions, (6-13GHz) - TUV32-21





Title: Wireless Access Point AP70 802.11a/b/g
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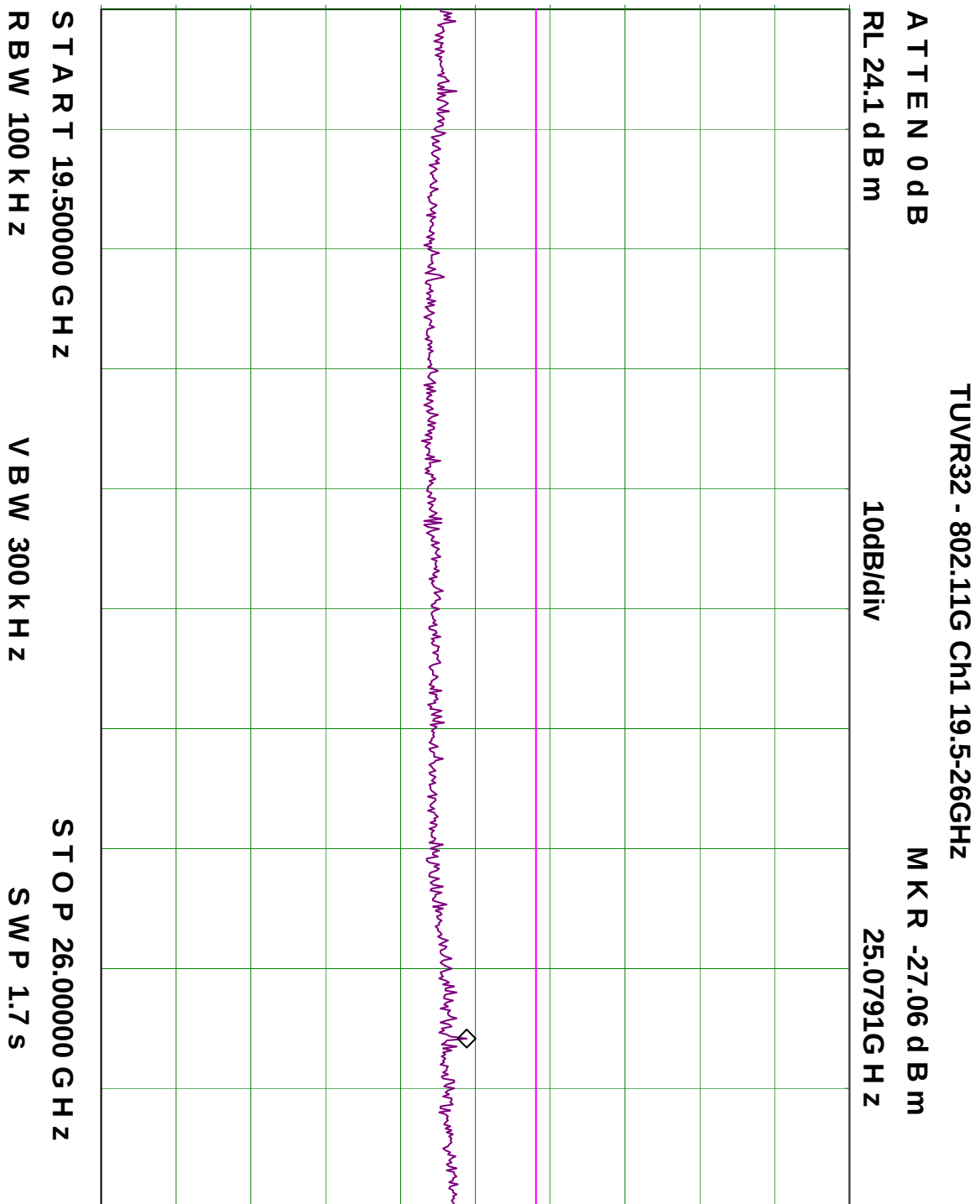
802.11g CH1 Conducted Spurious Emissions, (13-19.5GHz) - TUVR32-22





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802.11g CH1 Conducted Spurious Emissions, (13-19.5GHz) - TUV32-23





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**Internal Antenna - 802.11a/g CH1&36 HORIZONTAL (1-7GHz) Transmitter
Radiated Spurious Emissions - TUVR32-24**

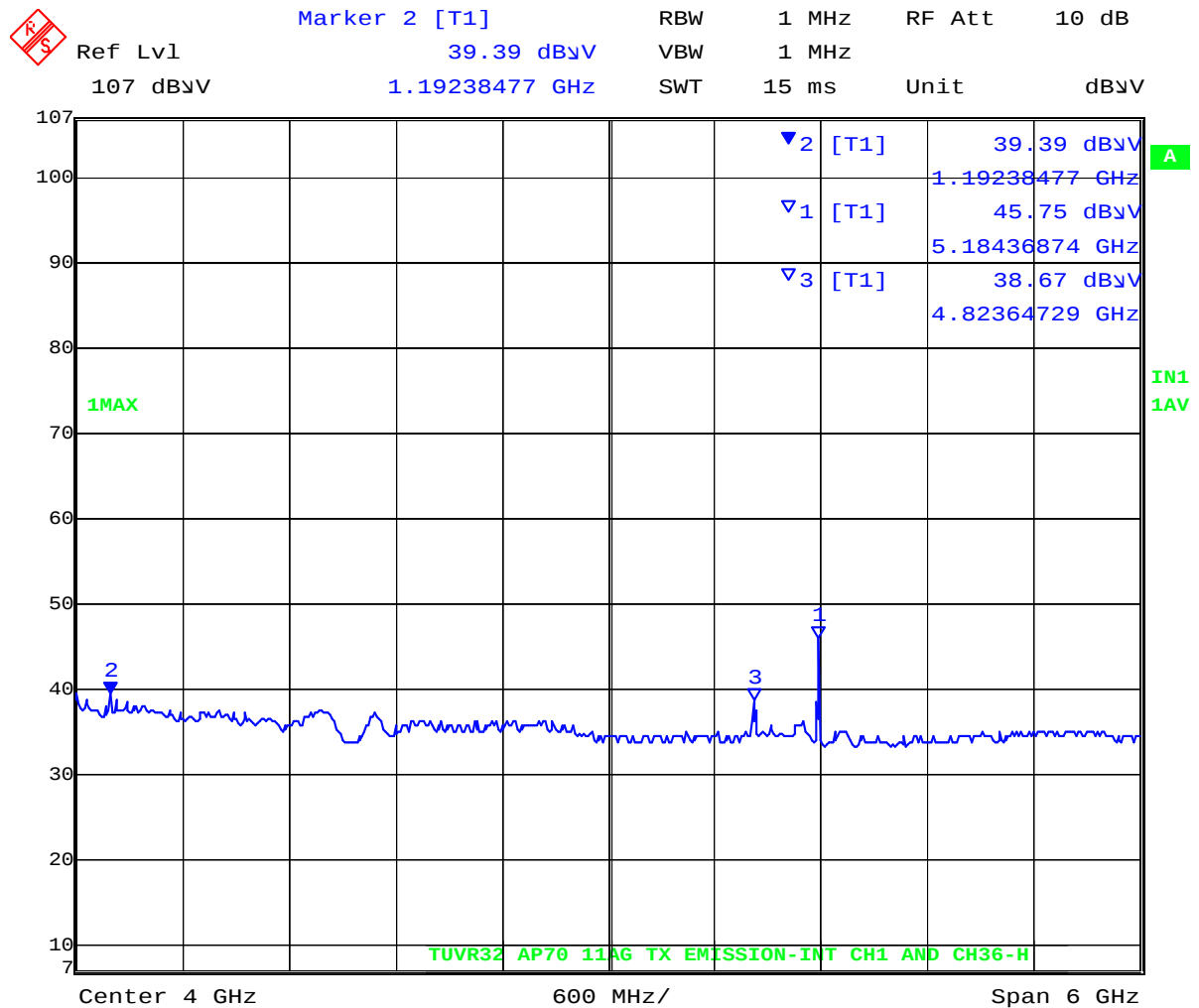


Date: 1.JAN.1997 05:25:29



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Internal Antenna - 802.11a/g CH1&36 VERTICAL (1-7GHz) Transmitter Radiated Spurious Emissions - TUVR32-25

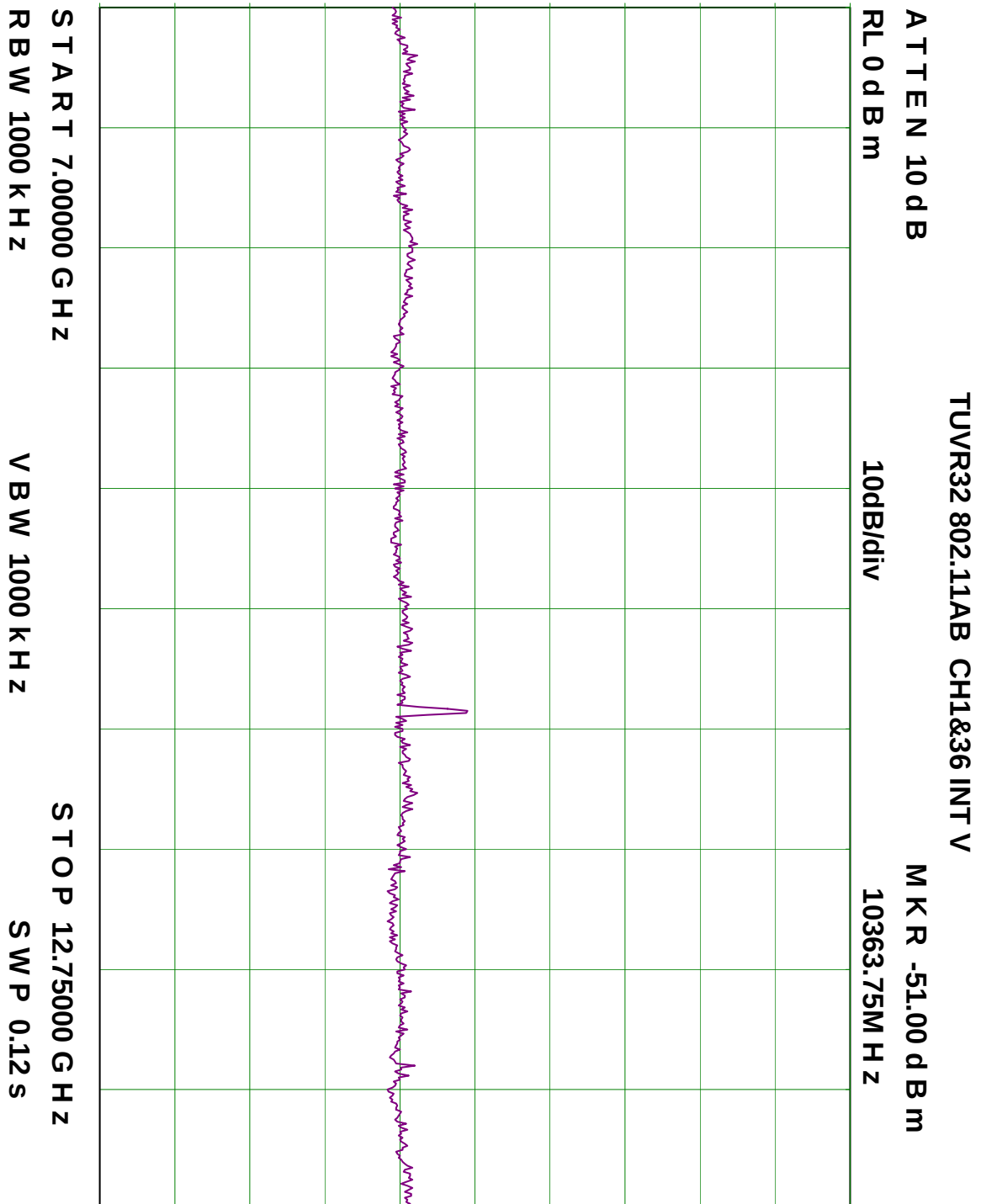


Date: 1. JAN. 1997 05:28:27



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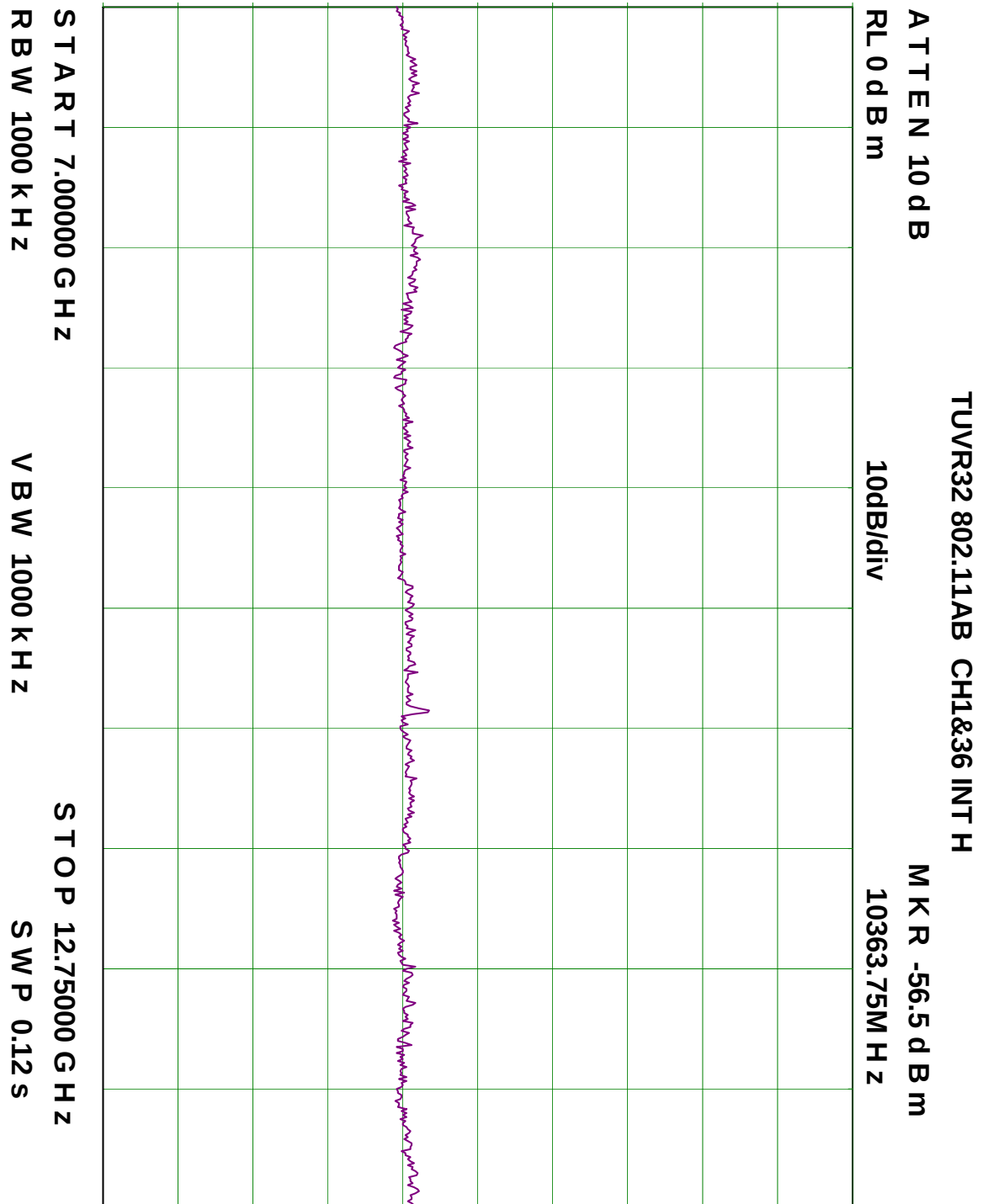
**Internal Antenna - 802.11a/b VERTICAL (7-12.75GHz) Transmitter Radiated
Spurious Emissions - TUVR32-26**





Title: Wireless Access Point AP70 802.11a/b/g
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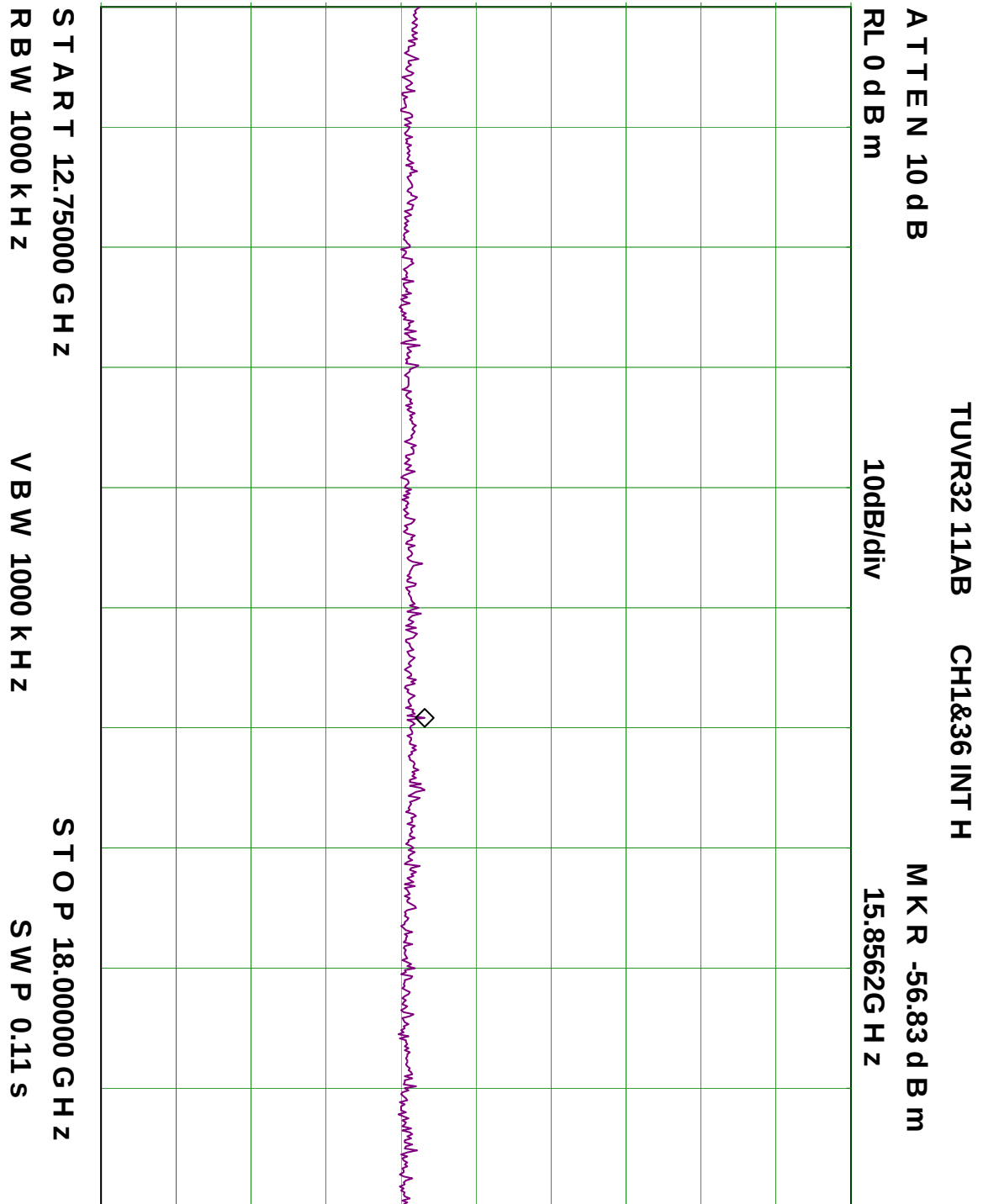
Internal Antenna - 802.11a/b HORIZONTAL (7-12.75GHz) Transmitter Radiated Spurious Emissions - TUVR32-27





Title: Wireless Access Point AP70 802.11a/b/g
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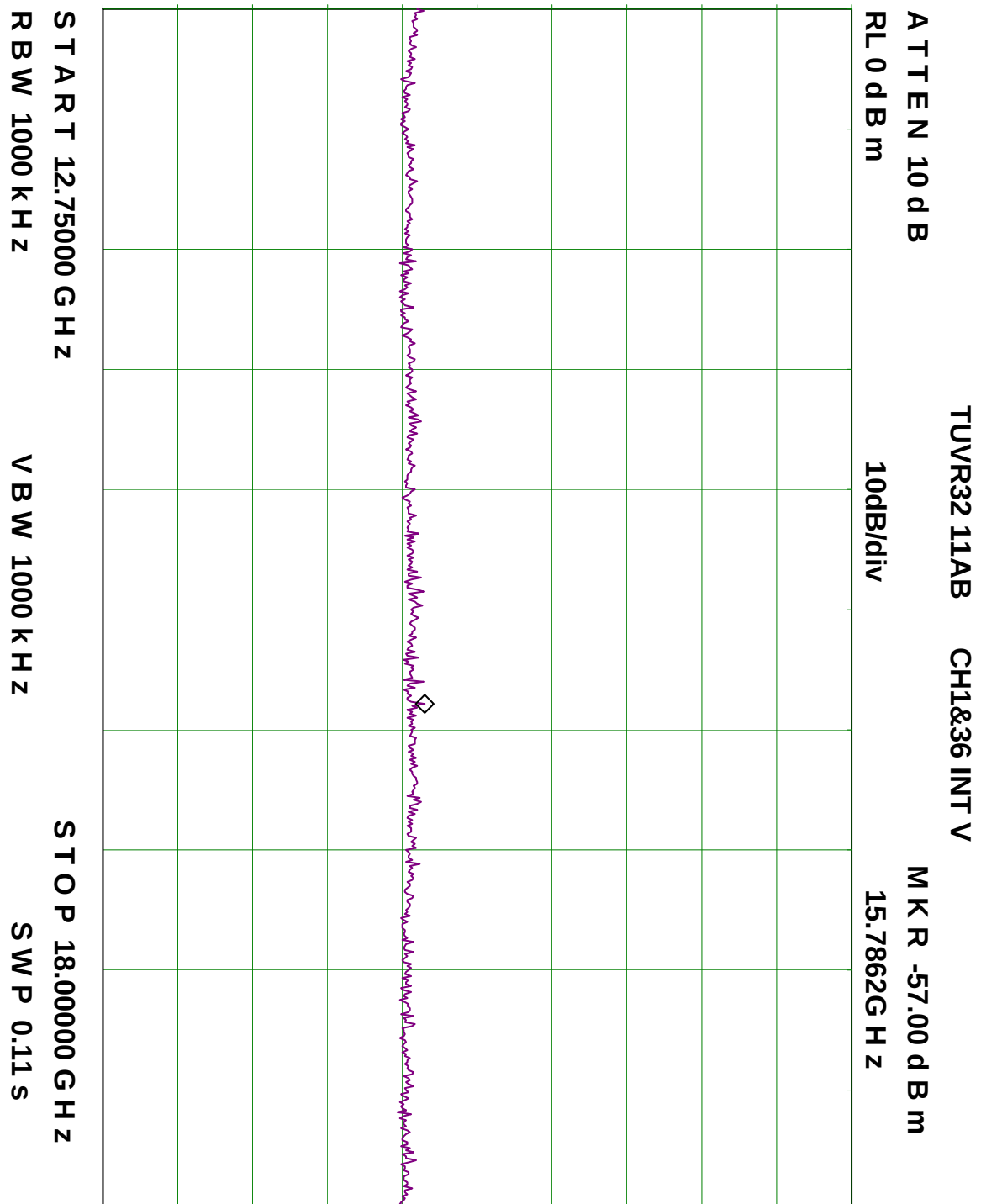
Internal Antenna - 802.11a/b HORIZONTAL (12.75-18GHz) Transmitter Radiated Spurious Emissions - TUVR32-28





Title: Wireless Access Point AP70 802.11a/b/g
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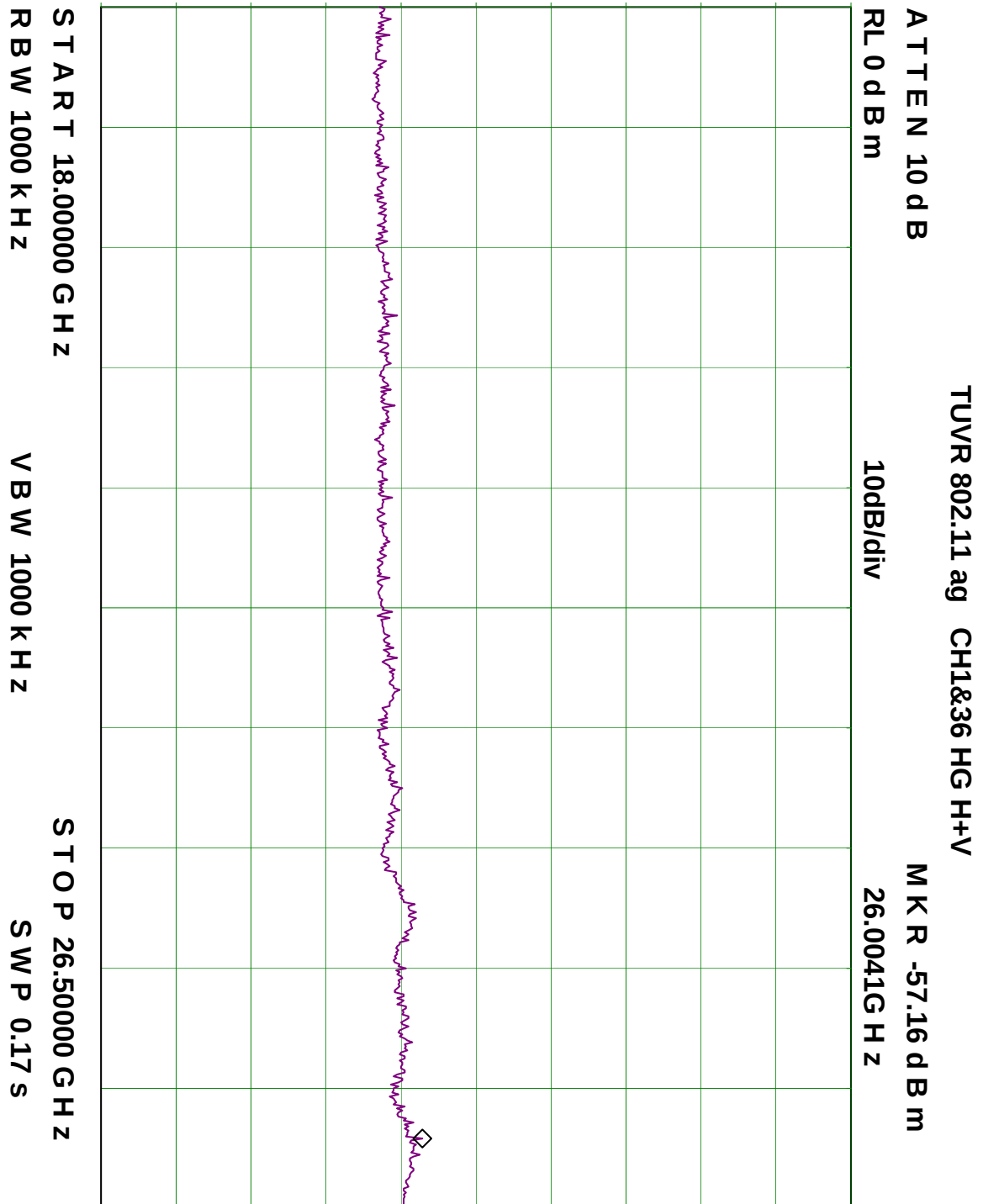
**Internal Antenna - 802.11a/b VERTICAL (12.75-18GHz) Transmitter Radiated
Spurious Emissions - TUV32-29**





Title: Wireless Access Point AP70 802.11a/b/g
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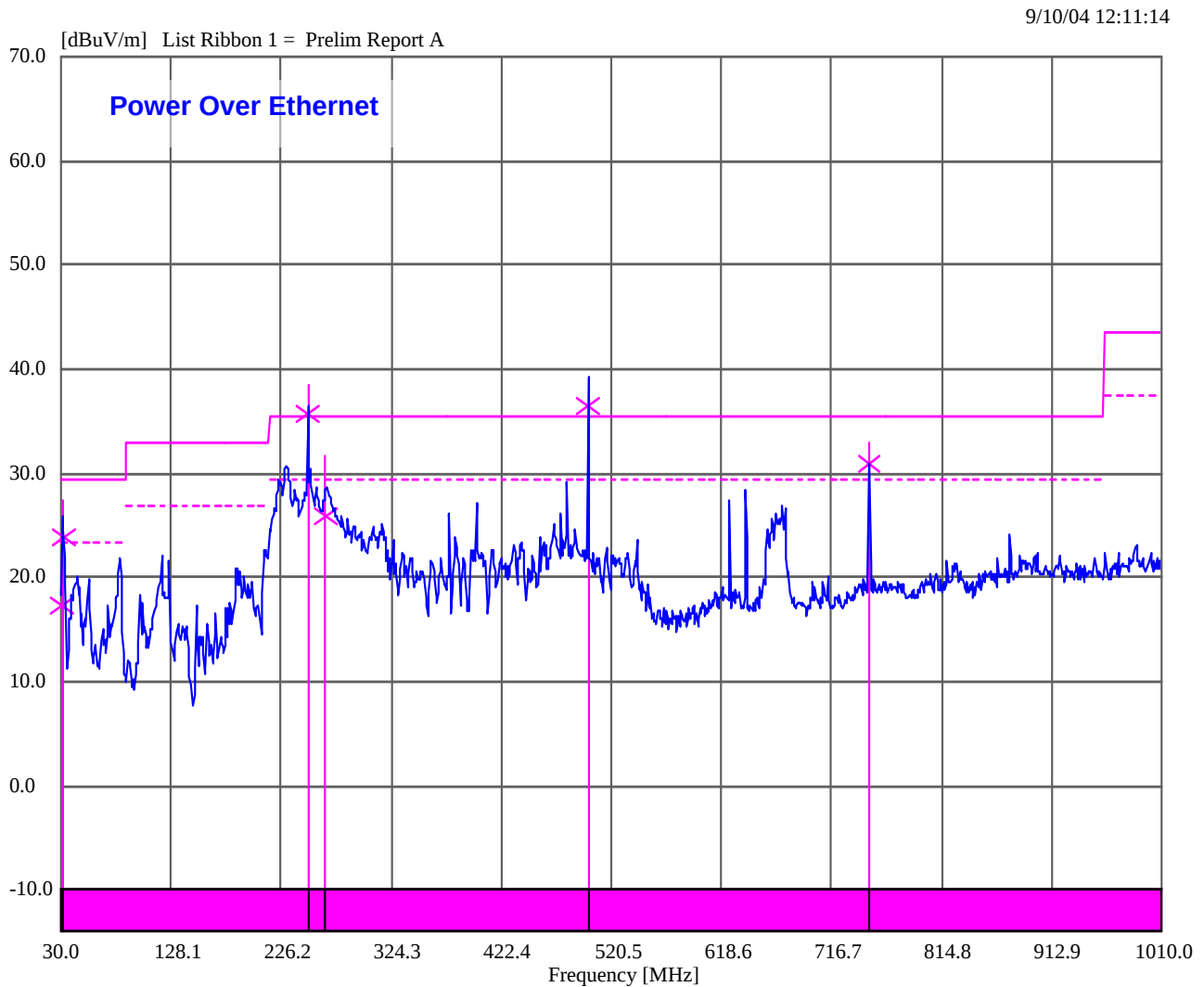
Internal Antenna - 802.11a/g HORIZONTAL + VERTICAL (18-26.5GHz)
Transmitter Radiated Spurious Emissions - TUVR32-30





Title: Wireless Access Point AP70 802.11a/b/g
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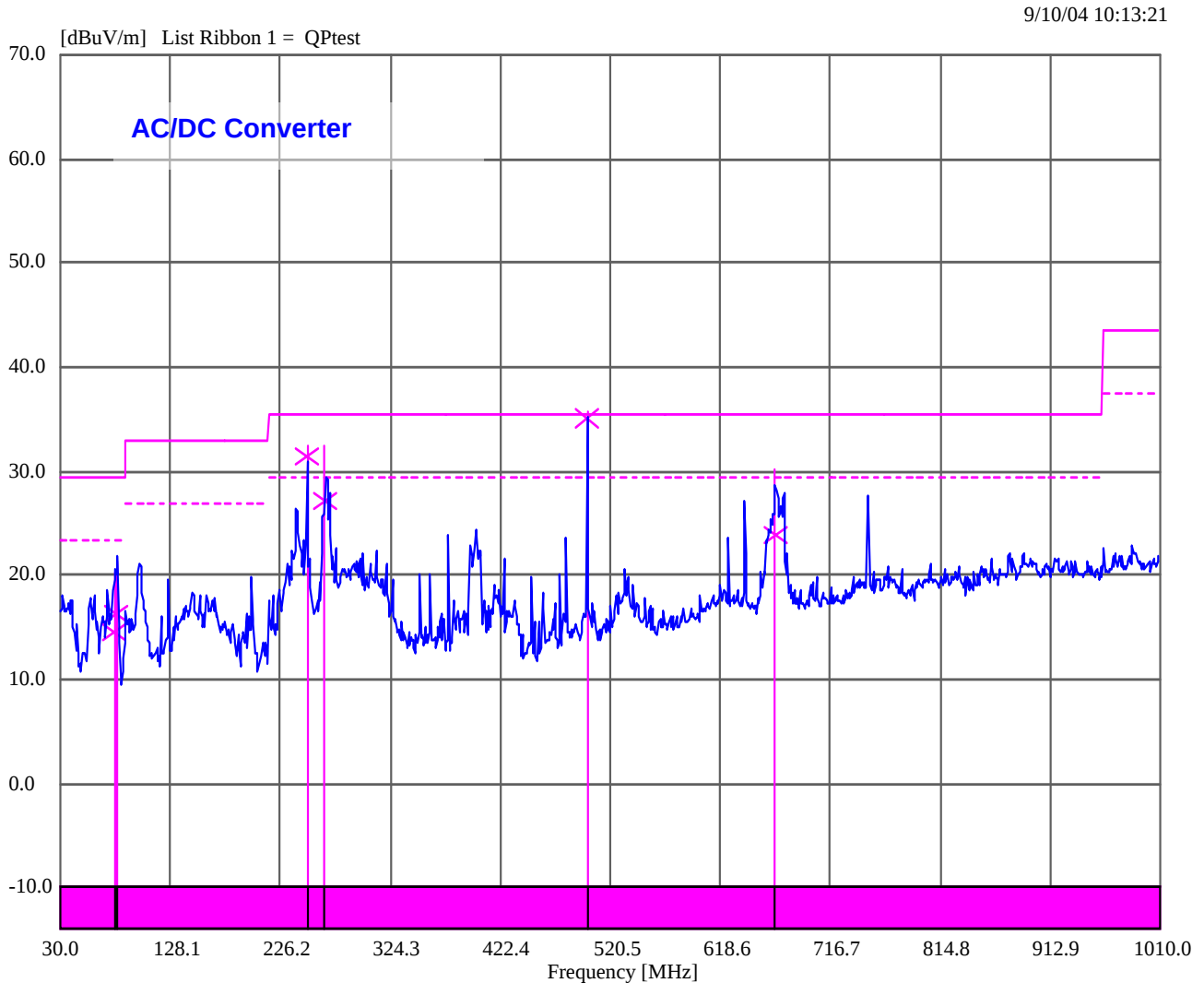
Radiated Spurious Emissions 30M-1GHz Power Over Ethernet - TUV32-31





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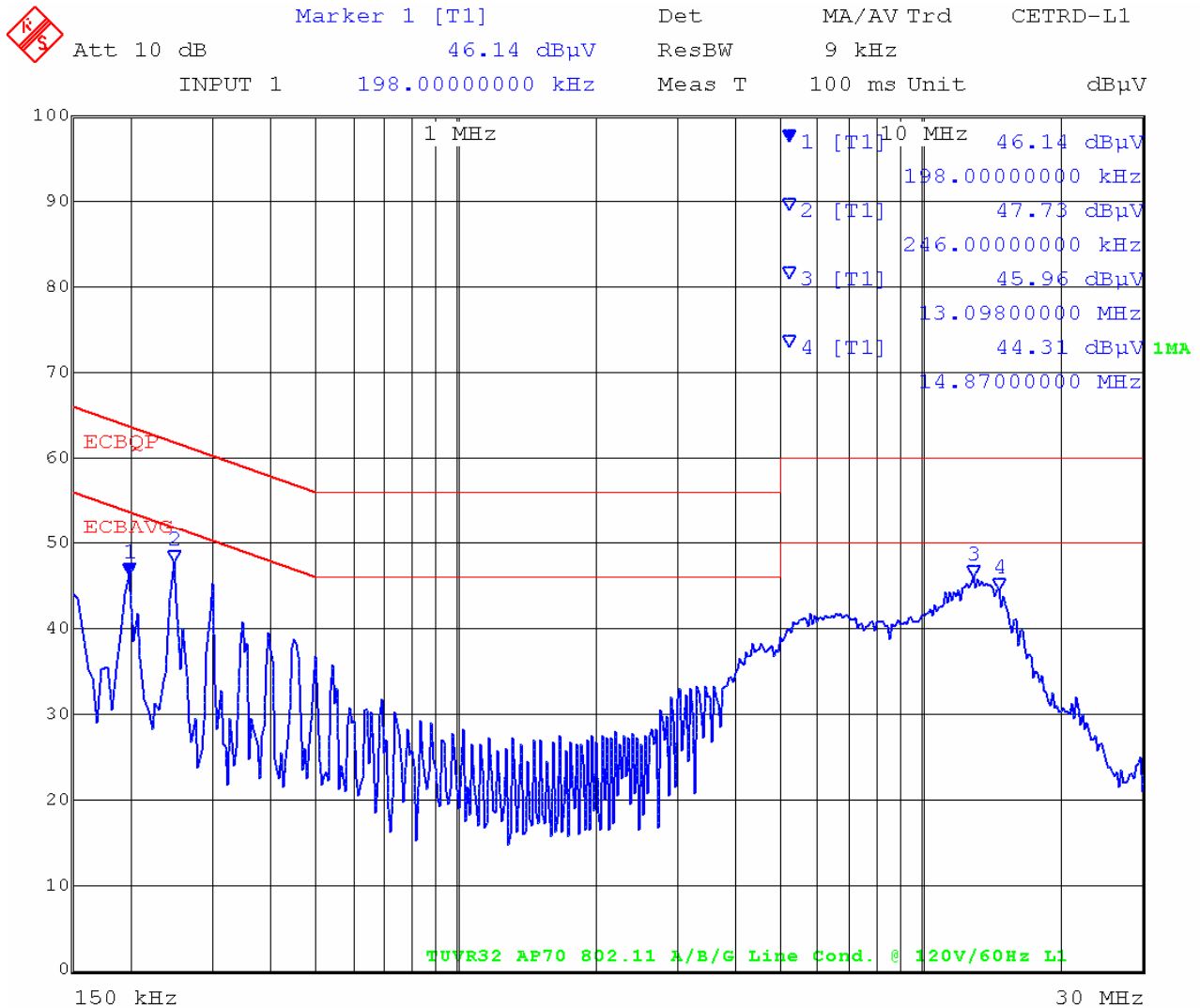
Radiated Spurious Emissions 30M-1GHz AC/DC Converter - TUV32-32





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AC Wireline Conducted Emissions (Live Line) - TUVR32-33

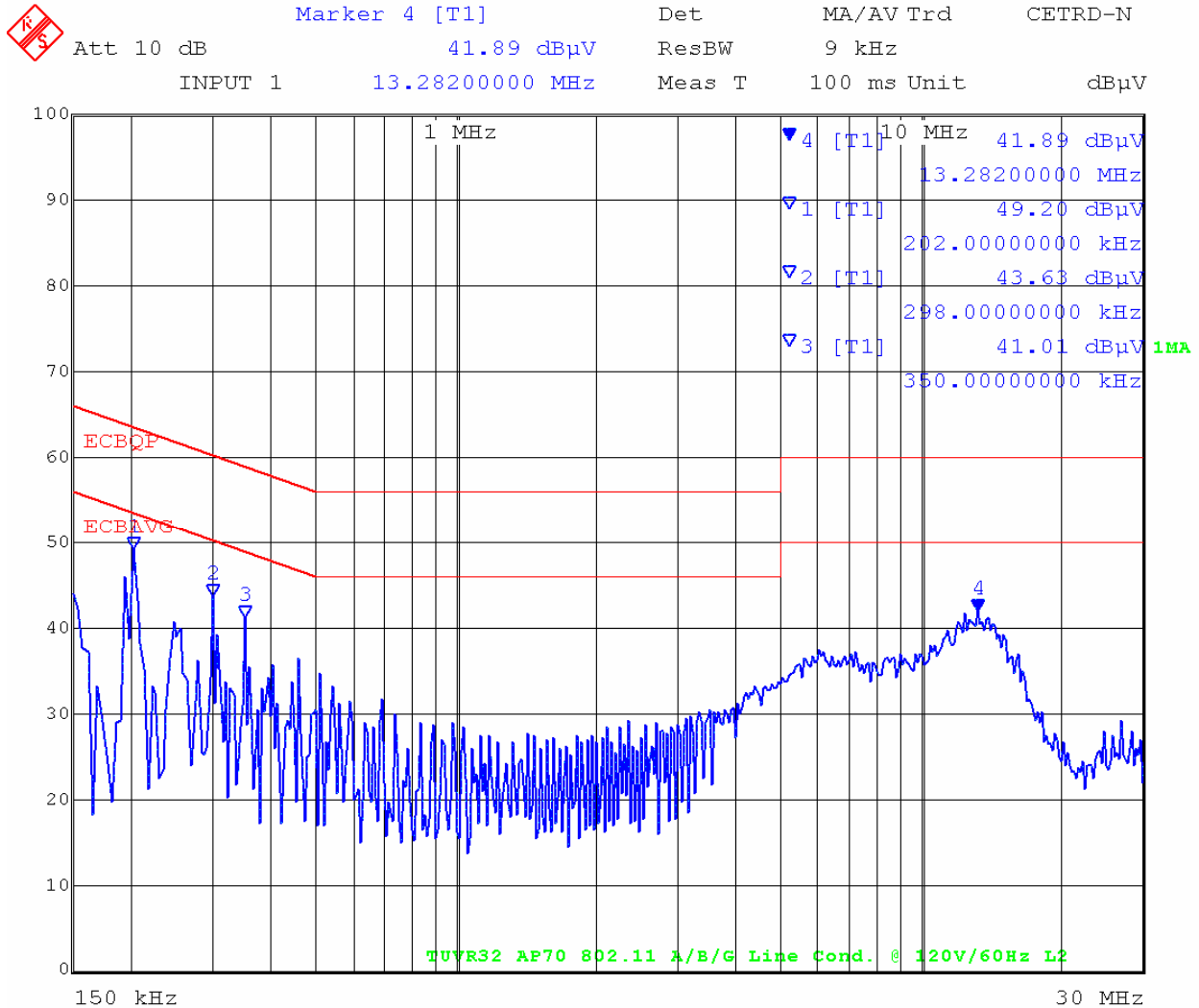


Date: 1.JAN.1997 00:43:42



Title: Wireless Access Point AP70 802.11a/b/g
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AC Wireline Conducted Emissions (Neutral Line) - TUVR32-34



Date: 1.JAN.1997 00:51:43



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