Test of Aruba Networks AP60 802.11a/b/g
Access Point

To FCC 47 CFR Part 15.247, 15.407, IC RSS-210

Test Report Serial No.: TUVR24-A4 Rev E

TEST REPORT

FROM

MiCOM Labs

Test of Aruba Networks AP60 802.11a/b/g Access Point

To FCC 47 CFR Part 15.247,15.407,IC RSS-210

Test Report Serial No.: TUVR24-A4 REV E

This report supersedes TUVR24-A4 REV D

Remarks:

Equipment complied with the specification [X]

Equipment did not comply with the specification [ ]

This Test Report is issued Under the Authority of:

Gordon Hurst President & CEO

Copy No: pdf

Issue date: 3rd September 2004

Manufacturer: Aruba Networks
180 Great Oaks Boulevard, Suite B
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U.S.A.

UKAS TESTING

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CONTENTS

1 Executive Summary

The purpose of this test program was to demonstrate compliance of Aruba Networks AP60 802.11a/b/g Access Point operating in the 2.4GHz, 5.15-5.25GHz, 5.25-5.35GHz and 5.725-5.825GHz bands against the current USA and Canadian specifications for certification purposes. The equipment demonstrated compliance against FCC 47 CFR Subpart C Parts 15.247 and 15.407 and Industry Canada's RSS-210 Low Power License-Exempt Radio Communication Devices.

2 Technical Details

Purpose	To verify compliance of the Aruba Networks AP60 802.11a/b/g Access Point to FCC and Industry Canada specifications
Applicant / Client	TUV Rheinland 1279 Quarry Lane, Suite 'A' Pleasanton, CA 94566 U.S.A.
Manufacturer	Aruba Networks 180 Great Oaks Boulevard, Suite B San Jose, California 95119, U.S.A.
Laboratory performing the tests	MiCOM Labs, Inc. 3922 Valley Avenue, Suite "B" Pleasanton, California 94566 USA
Test report reference number	TUVR24-A4 REV E
Date EUT received	Initial test program: 18th March '04 Follow up test program: 29th June '04
Standard(s) applied	FCC 47 CFR Part 15.247,15.407,IC RSS-210
Dates of test (from - to)	Initial program: 18th March – 25th March '04 Follow up test program: 29th June '04
No of Units:	One
Equipment Category:	Access Point
Trade Name:	AP60 – external antenna option
Type of Equipment:	DSSS 802.11a/b/g access point
Location for use:	Indoor use only
Full Frequency Range(s):	2,400-2,4835MHz 5,150-5,250MHz (UNII Band) - Integral antenna only 5,250-5,350MHz (UNII Band) 5,725-5,825MHz (UNII Band)
Modulation:	Per 802.11a/b/g standard(s)
Client Declared Nominal Output Power:	2,400-2,4835MHz: +20dBm 5,150-5,250MHz (UNII Band): +6dBm 5,250-5,350MHz (UNII Band): +13dBm 5,725-5,825MHz (UNII Band): +20dBm
Transmit/Receive Operation:	Simplex
Rated Input Voltage:	120Vac, 60Hz and Power Over Ethernet (POE)
Temperature Range:	0°C – 50°C
Microprocessor(s):	Atheros AR2313
Clock/Oscillator(s):	25MHz and 40MHz
Frequency Stability:	2.4GHz - ±20ppm 5GHz – ±20ppm
Primary Function:	To initiate and receive Data Transmission, Telemetry, Telecommand, Voice

Antenna – AP60 (external antenna only)	
Antenna(s) tested:	2.4GHz – SmartAnt 2400-2500MHz/12dBi Gain - P/N – PCW24-08012-AFL 5GHz UNII Band Antenna Cushcraft P/N – S51514WP - *Gain 5.150-5.350 14dBi - Gain 5,470-5,875MHz 13.25dBi

*Note - only integral antennas are permitted in the frequency band 5,150-5,250MHz

2.1 Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Parts 15.247	2001	Code of Federal Regulations
(ii)	FCC 47 CFR Parts 15.407	2001	Code of Federal Regulations
(iii)	Industry Canada RSS-210	2001	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)
(iv)	ANSI C63.4	1992	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
(v)	CISPR 22 & EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(vi)	CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods
(vii)	M 3003 Addition 1	1997	Expression of Uncertainty and Confidence in Measurements
(viii)	LAB 34 Addition 1	2002	Expression of Uncertainty in EMC Testing
(ix)	FCC Public Notice – DA 02-2138	2002	Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices

2.2 Test and Uncertainty Procedures

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

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 and LAB 34, Normative Reference(s) **(vi)** and **(vii)**.

3 Test Summary

3.1 List of Measurements

3.1.1 2.4GHz – 802.11b/g

The following table(s) represent the list of measurements on the AP60, Direct Sequence devices under the **FCC, Part 15.247, 15.407** and **Industry Canada RSS-210**.

Section(s)	Test Items		Condition	Pass/Fail	Test Report Section
Transmit mode (TX):					
15.247(a)(2) **5.9.1**	6dB Bandwidth		Conducted	Complies	4.2.1.1
15.247(b) **6.2.2 (o) (b)**	Output Power	Shall not exceed 1.0 W	Conducted	Complies	4.2.1.2
15.247(b)(5) **14**	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Conducted	Complies	4.2.1.3
15.247(c) **5.9.1** **6.2.2 (o) (e1)**	Occupied BW/ Bandedge (20 dB below) Restricted Bands	The radiated emission in any 100kHz of out-band shall be at least 20dB below the highest in-band spectral density. Spurious emissions within restricted bands	Conducted Radiated	Complies	4.2.1.4
15.247(d) **6.2.2 (o) (b)**	Peak Power Spectral Density	Shall not be greater than 8 dBm in any 3kHz band	Conducted	Complies	4.2.1.5
15.247(e)	Processing Gain	N/A	N/A	N/A*	
15.205/ 209 **6.2.1 / 6.3**	Spurious Emissions above 1GHz	Spurious emissions above 1GHz (1-25GHz)	Radiated	Complies	4.2.1.6
Receive mode (RX):					
15.209 **7.3**	Spurious Emissions above 1GHz	Spurious emissions above 1GHz (1-25GHz)	Radiated	N/A	N/A

***** *The current specification does not require test of this parameter. The Processing Gain data is excluded from this application according to the FCC rule change on 16 May 2002*

3.1.2 5GHz 802.11a FCC 15.407 and RSS-210

The following table(s) represent the list of measurements on the AP60, Direct Sequence devices under the **FCC, Subpart E Part 15.407 (UNII)** and **Industry Canada RSS-210**.

Section(s)	Test Items	Description	Condition	Pass/Fail	Test Report Section
Transmit mode (TX):					
15.407(a)(2) **6.2.2 (q1)(ii)**	26dB Emission BW	Emission bandwidth measurement	Conducted	Complies	4.2.2.1
15.407(a)(2) **6.2.2 (q1)(ii)**	Output Power	250mW or 11dBm+26dB emission bandwidth	Conducted	Complies	4.2.2.2
15.407(a)(2) **6.2.2 (q1)(ii)**	Peak Power Spectral Density	Not to exceed +11dBm in any 1MHz band	Conducted	Complies	4.2.2.3
15.407(a)(6)	Peak Excursion Ratio	<13dB in any 1MHz bandwidth	Conducted	Complies	4.2.2.4
15.407(g) **15.31** **6.2.2 (q1)(iv)(e)**	Frequency Stability	Limits: contained within band of operation at all times. Supply voltage variation	Manufacturer declaration Conducted	Complies	4.2.2.5
15.407(f) **6.2.2 (q1)(iv)(g)**	RF Radiation Exposure	Exposure to radio frequency energy levels	Calculation	Complies	4.2.2.6
15.407(b)(1), (2),(3) **6.2.2 (q1) (ii)**	Spurious Emissions above 1GHz	Spurious emissions above 1GHz (1-40GHz)	Conducted	Complies	4.2.2.7
15.407(b)(1), (2),(3) **6.2.2 (q1) (ii)**	Conducted Spurious Emissions above 1GHz	Conducted spurious emissions above 1GHz (1-40GHz)	Conducted	Complies	4.2.2.8
15.407(c)	Discontinuation of Transmission	Discontinue transmission in case of either absence of information to transmit or operational failure	Conducted	Complies	
Receive mode (RX):					
15.407(b)(2) **6.2.2 (q1) (ii)**	Spurious Emissions above 1GHz	Spurious emissions above 1GHz (1-40GHz)	Radiated	N/A	N/A

3.1.3 General Common Test Requirements FCC 15.247, 15.407 and RSS-210

Section(s)	Test Items	Description	Condition	Pass/Fail	Test Report Section
Transmit mode (TX):					
15.207 **6.6**	AC Wireline Conducted Emissions 450kHz–30MHz	Class B	Conducted	Complies	4.3.1.1
15.205/ 209 **6.2.1 / 6.3**	Spurious Emissions below 1GHz	Shall not exceed the limits specified in FCC 15.209 or RSS-210 Table 3	Radiated (30MHz-1GHz)	Complies	4.3.1.2
Receive mode (RX):					
15.207 **7.4**	AC Wireline Conducted Emissions 450kHz–30MHz	Class B	Conducted	N/A	N/A
15.209 **7.3**	Spurious Emissions below 1GHz	Shall not exceed the limits specified in RSS-210.	Radiated (30MHz-1GHz)	N/A	N/A

Note 1: *Test results reported in this document relate only to the items tested*
Note 2: *No equipment modifications were required to achieve the results reported in this document*
Note 3: *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria.*

3.1.4 Test Configurations

Operational Modes of EUT

3.1.4.1 2.4GHz 802.11b/g Test Configurations

Operating Channel	Data Rates Tested (Mbit/s)	Operating Frequency (MHz) Power Level: +20dBm
1	1, 11, 54	2,412
6	1, 11, 54	2,437
11	1, 11, 54	2,462

3.1.4.2 5GHz 802.11a (UNII Band) Test Configurations

Operating Frequency (MHz)	Data Rate Tested (Mbit/s)	Operating Frequency (MHz)
5,150-5,350MHz	54	5,180
	54	5,260
	54	5,320
5,725-5,825MHz	54	5,745
	54	5,765
	54	5,805

* Operation within the 5.15-5.25GHz band shall use a transmitting antenna that is an integral part of the device.

Test Configuration

The test configuration was a standalone all indoor access point. In order to prove compliance with the relevant standards testing was performed on both the 2.4GHz (802.11b/g) and the 5GHz (802.11a) frequency bands. Conducted and radiated testing was performed as identified within this report.

The EUT operated in a continuous transmit mode on predefined data rates on either the 2.4GHz or 5GHz. The unit cannot operate with both transmitters switched-on simultaneously and therefore no testing was completed in this mode. The manufacturer declared that there was no receive or standby operational only modes available in the equipment. During testing the unit was powered simultaneously via two sources 115Vac 60Hz mains and Power Over Ethernet (POE).

Conducted Testing

The AP60 provided coaxial connections for external antenna connection to both 2.4GHz and 5GHz frequency bands. These ports (reverse SMA) permitted conducted testing to be performed.

3.1.5 Photographs AP60 - all indoor Access Point Complete with Antennas

Photo 1: Aruba AP-60 Access Point with dual antenna 5GHz and 2.4GHz Antenna

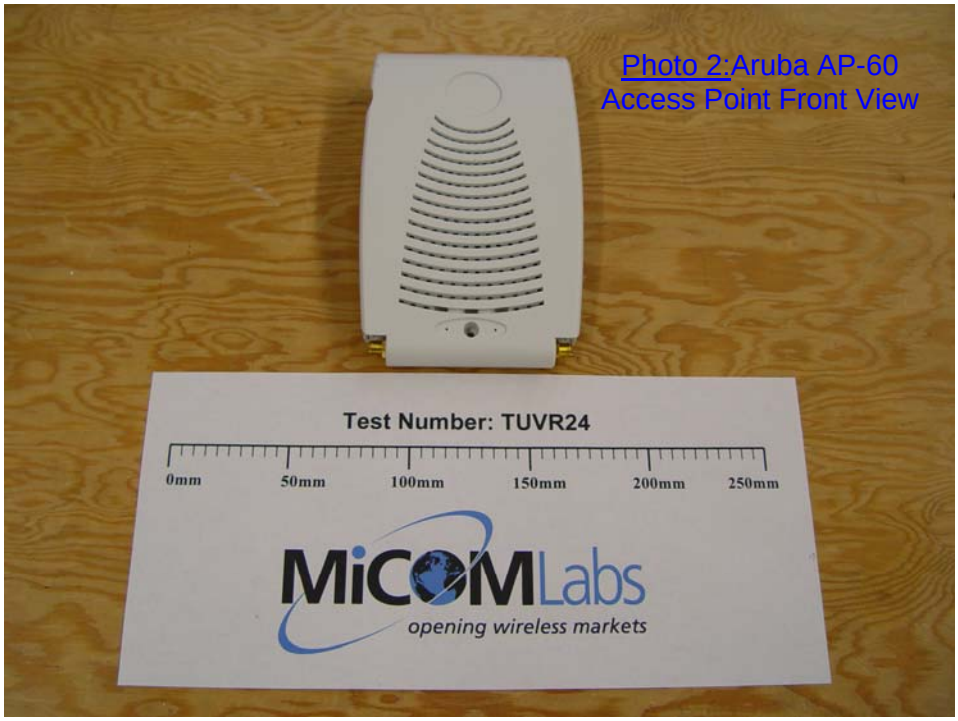


Photo 2:Aruba AP-60 Access Point Front View

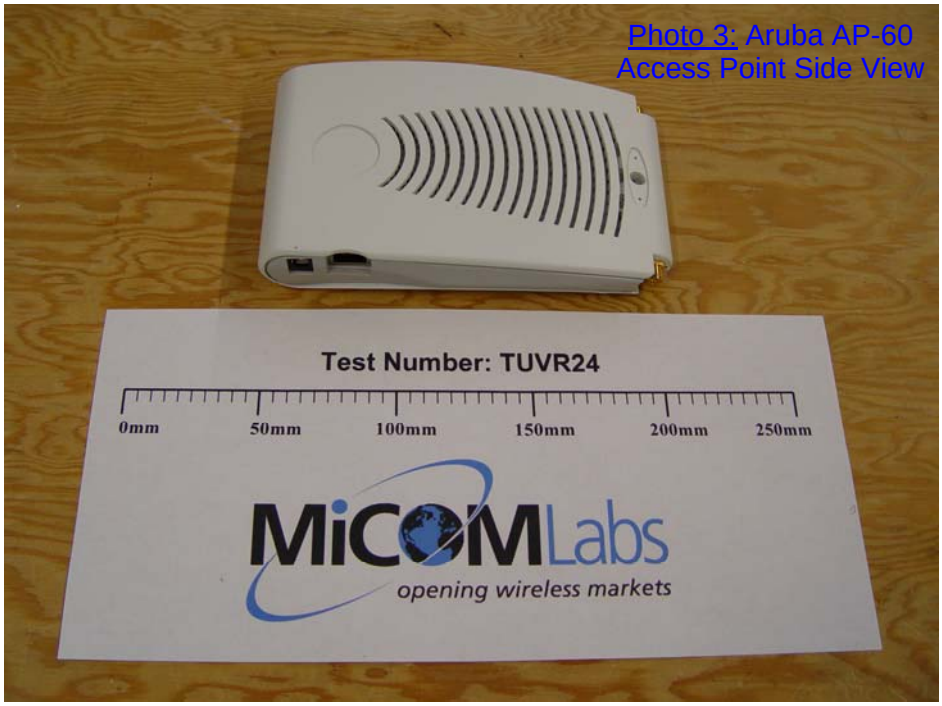


Photo 3: Aruba AP-60 Access Point Side View

4 Measurements, Examinations and Derived Results

4.1 General observations

Equipment model and serial number(s)

Module:	Model Number:	Serial Number:
Access Point	AP60	Not Available
Antenna SmartAnt; 2400-2500MHz	PCW24-08012-AFL	3A100453
Antenna 5.150-5.875GHz	S51514WP	Not Available
Aruaba 800 Switch	2000008B00/Rev 1.1	Not Available

*The AP60 Access Point submitted for testing was a pre-production model

Follow up test program 29th June '04

This test program introduced a different test methodology for measuring output power and peak power spectral density measurements. Section 2.1 Normative Reference(s) 'Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices' Method #2 was used for the measurement of Peak Power Spectral Density (PPSD). Power measurements and bandwidth's were also repeated as a result.

Module:	Model Number:	Serial Number:
Access Point	AP60	Not Available

*The AP60 Access Point submitted for testing was a full production model

This report provides summarised test results of each test performed. Detailed test results were recorded in Test Results Booklets and retained within the laboratory.

4.2 Test Results

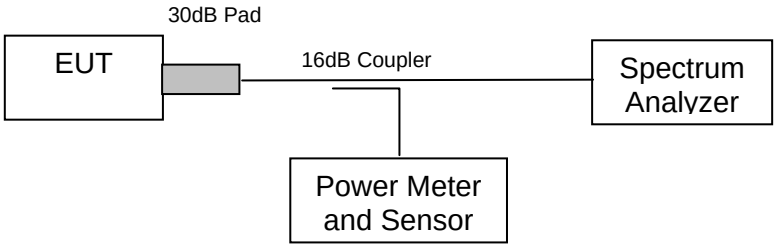
4.2.1 2.4GHz Device Characteristics

4.2.1.1 6dB Bandwidth

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

Test Procedure
The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyser connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate centre frequency. The spectrum analyzer was set to:
RBW=300kHz, VBW=200kHz, Span=50MHz, Sweep = 5mS

Test Measurement Set up



Measurement set up for 6dB Bandwidth test

Measurement Results

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

Radio parameters.
Data Rate(s): 1, 11, 54 Mbit/s

TABLE OF RESULTS – **1Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	6dB Bandwidth (MHz)
2,412	2,405.79	2,418.11	TUVR24/01	12.33
2,437	2,430.79	2,443.14	On file in lab	12.22
2,462	2,455.79	2,468.01	On file in lab	12.33

TABLE OF RESULTS – **11Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	6dB Bandwidth (MHz)
2,412	2,405.69	2,418.02	On file in lab	12.33
2,437	2,430.69	2,443.11	TUVR24/02	12.43
2,462	2,455.89	2,468.31	On file in lab	12.43

TABLE OF RESULTS – **54Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	6dB Bandwidth (MHz)
2,412	2,403.64	2,420.32	On file in lab	16.68
2,437	2,428.64	2,445.33	On file in lab	16.68
2,462	2,453.64	2,470.33	TUVR24/03	16.68

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	2.074KHz

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	Bar 1, RVA 01, K-CBL 8, K-CBL 10, S-Anlr 1

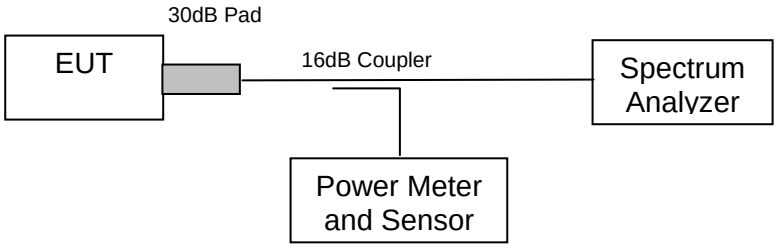
4.2.1.2 Output Power

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

Test Procedure

- The transmitter terminal of EUT was connected to the input of a RF power sensor via a coupler.
- Measurement is made while EUT is operating in continuous transmission mode at the appropriate centre frequency.

Test Measurement Set up



Measurement set up for Transmitter Output Power

Measurement Results for Transmitter Output Power

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

Radio parameters.
Data Rate(s): 1, 11, 54 Mbit/s

TABLE OF RESULTS – **1Mbit/s**

Centre Frequency (MHz)	Duty Cycle (%)	Measured O/P Power (dBm)	Path Loss (dB)	Conducted Power (dBm)
2,412	100	2.5	16.4	18.9
2,437	100	3.3	16.4	19.7
2,462	100	2.1	16.4	18.5

TABLE OF RESULTS – **11Mbit/s**

Centre Frequency (MHz)	Duty Cycle (%)	Measured O/P Power (dBm)	Path Loss (dB)	Conducted Power (dBm)
2,412	100	2.3	16.4	18.7
2,437	100	3.2	16.4	19.6
2,462	100	2.2	16.4	18.6

TABLE OF RESULTS – **54Mbit/s**

Centre Frequency (MHz)	Duty Cycle (%)	Measured O/P Power (dBm)	Path Loss (dB)	Conducted Power (dBm)
2,412	100	2.0	16.4	18.4
2,437	100	3.1	16.4	19.5
2,462	100	2.3	16.4	18.7

Antenna Gain - Maximum Permissible Power Level

For the antenna(s) tested the maximum permissible power level to be transmitted can be limited if transmitting antennas of directional gain greater than 6dBi are utilized the peak output power of the intentional radiator shall be reduced by the amount in dB that the directional gain exceeds 6dBi.

Antenna Type (2.4GHz)	Gain (dBi)	Amount Antenna Exceeds 6dBi (dB)	Highest Power Observed (dBm)	Maximum Permissible Power Level (dBm)
SmartAnt High Gain Directional Patch	12.0	6	+19.7	+13.7

Voltage Variation

The ac supply voltage was varied between 85% and 115% of nominal rated supply voltage. No changes in the measurements reported above were observed during the variation. The equipment complied with the specification.

Temperature Testing

The temperature was set at the extremes of equipment operation 0°C and +40°C. No change in output power was observed during this period. The equipment complied with the specification.

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 6 dBi 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. The maximum antenna gain (manufacturers declaration) is 0dBi, therefore the limit is +30dBm

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty (dB)	±1.33

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, RVA 01, K-CBL 8, K-CBL 10, S-Anlr 1, PMtr 1, PSnsr 1

4.2.1.3 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(mw) = P(watts) / 1000

d(cm) = d(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 centimetres^2

Substituting the logarithmic form of power and gain using:

P(mW) = 10 ^ (P(dBm)/10) and

G(numeric) = 10 ^ (G(dBi) /10)

Yields:

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

where

d = MPE distance in centimetres
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW / centimetres^2 (Limit S = 1mW / cm^2 from §1.310 Table 1)

Maximum output power observed from power measurements – +19.7dBm

Power Density Limit (mW / cm^2)	Maximum Measured Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
1	+19.7	12	38.5

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 / cm^2 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.

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, RVA 01, K-CBL 8, K-CBL 10, S-Anlr 1

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty (dB)	±1.33

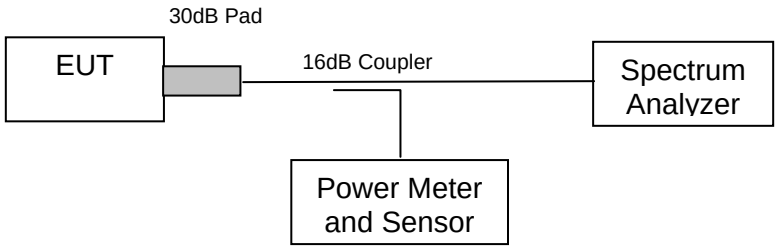
4.2.1.4 Band-Edge Measurement

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 if measured at 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate centre frequency.

The spectrum analyzer is set to:
RBW=300kHz, VBW=300kHz, Span=50MHz, Sweep = 5mS

Test Measurement Set up



Band-edge measurement test configuration

Measurement Results of Occupied Bandwidth

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

Radio parameters.
Data Rate(s): 1, 11, 54 Mbit/s

Results of Band-Edge Measurements

TABLE OF RESULTS – **1Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	Margin to Lower Limit (MHz)	Margin to Upper Limit (MHz)
2,412	2,402.9		On file in lab	2.9	
2,462		2,471.1	On file in lab		12.4

TABLE OF RESULTS – **11Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	Margin to Lower Limit (MHz)	Margin to Upper Limit (MHz)
2,412	2,402.9		On file in lab	2.9	
2,462		2,471.0	On file in lab		12.5

TABLE OF RESULTS – **54Mbit/s**

Centre Frequency (MHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Plot #	Margin to Lower Limit (MHz)	Margin to Upper Limit (MHz)
2,412	2,402.1		TUVR24/04	2.1	
2,462		2,471.9	TUVR24/05		11.57

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

Test Procedure
In order to comply with spurious emissions within restricted bands radiated plots are provided in order to prove compliance. Radiated plots were taken within an anechoic chamber. Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized within the chamber. For measurements > 1GHz except where otherwise specified an average detector was utilized with a 1MHz measurement bandwidth.

The following plots can be found in Section 7 Graphical Results
Channel 1 (2,412MHz) 11MBit/s – TUVR24/05a
Channel 11 (2,462MHz) 11MBit/s – TUVR24/05b

Specification

Limits Band-Edge

Lower Limit Band-edge	Upper Limit Band-edge	20dB down on maximum power
2,400MHz	2,483.5MHz	>= 20dB

Measurement Uncertainty Occupied Bandwidth / Band-edge

Measurement uncertainty	2.074KHz

Limits Restricted Bands

Frequency (MHz)	Field Strength (dBμV/m)	Measurement Distance
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Measurement Uncertainty Restricted Bands

Measurement uncertainty	+5.6dB/-4.5dB

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, RVA 01, K-CBL 8, K-CBL 10, S-Anlr 1

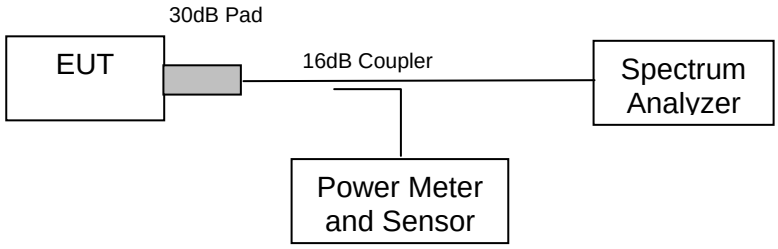
4.2.1.5 Peak Power Spectral Density

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

Test Procedure

The transmitter output is connected to a spectrum analyser, the maximum level in a 3KHz bandwidth is measured with the spectrum analyser using RBW = 3KHz and VBW ≥3KHz, sweep time = span / 3KHz with video averaging turned off. The Peak Power Spectral Density is the highest level found across the emission in any 3KHz band.

The spectrum analyzer was set as follows:
RBW= 3kHz, VBW=10kHz, Span=1MHz and Sweep time=350s



Test Measurement Set up

Measurement set up for Peak Power Spectral Density

Measurement Results for Peak Power Spectral Density

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

Radio parameters.
Data Rate(s): 1, 11, 54 Mbit/s

NOTE: Peak Power Spectral Density measurement was limited to channels exhibiting the maximum power value in Section 4.2.1.2 Transmitter Output Power

TABLE OF RESULTS – **1Mbit/s**

Centre Frequency (MHz)	Path Loss (dB)	Output Power (dBm)	Spectrum Analyzer Reading (dBm)	Plot #
2,412				
2,437	31.8	19.7	-4.22	TUVR24/06
2,462				

TABLE OF RESULTS – **11Mbit/s**

Centre Frequency (MHz)	Path Loss (dB)	Output Power (dBm)	Spectrum Analyzer Reading (dBm)	Plot #
2,412				
2,437	31.8	19.6	-2.29	TUVR24/07
2,462				

TABLE OF RESULTS – **54Mbit/s**

Centre Frequency (MHz)	Path Loss (dB)	Output Power (dBm)	Spectrum Analyzer Reading (dBm)	Plot #
2,412				
2,437	31.8	19.5	-5.46	TUVR24/08
2,462				

Antenna Gain - Maximum Permissible Peak Power Spectral Density

For the antenna(s) tested the maximum permissible power spectral density must be limited if transmitting antennas of directional gain greater than 6dBi are utilized the peak power spectral density of the intentional radiator shall be reduced by the amount in dB that the directional gain exceeds 6dBi.

Antenna Type (2.4GHz)	Gain (dBi)	Amount greater than 6dBi (dB)	Highest PPSD Observed (dBm)	PPSD Limit (dBm)	Maximum Permissible PPSD (dBm)
SmartAnt High Gain Directional Patch	12.0	6	-2.29	+8	-8.29

Specification

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

Laboratory Measurement Uncertainty Spectral Density

Measurement uncertainty (dB)	±1.33

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, RVA 01, K-CBL 8, K-CBL 10, S-Anlr 1

4.2.1.6 Spurious emissions above 1GHz (1-25GHz)

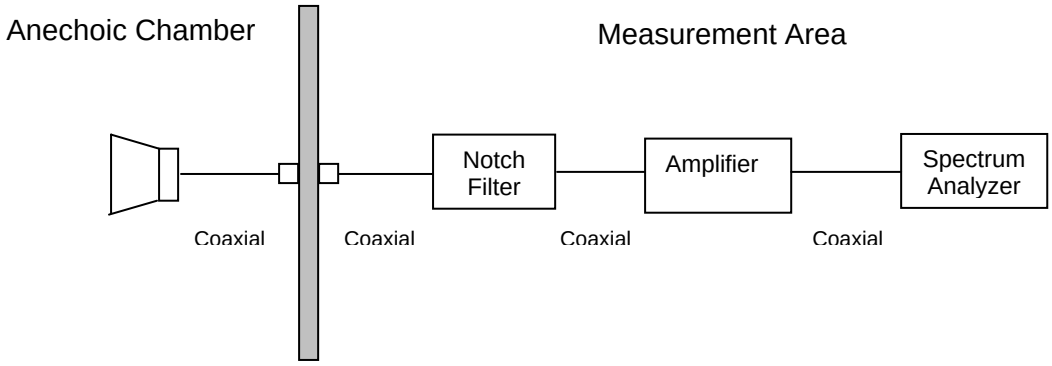
FCC, Part 15 Subpart C §15.247(c)
Industry Canada RSS-210 §6.2.2(q1)

Test Procedure

Preliminary radiated emissions 1GHz to 25GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. A notch filter is used to remove the fundamental frequency. The highest emissions relative to the limit are listed. Frequencies not covered by the 'Restricted Bands of Operation' are compared to the fundamental carrier per 47 CFR 15.247(c).

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

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

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

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

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

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

Measurement Results Spurious Emissions above 1GHz (1GHz - 25GHz)

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

TABLE OF RESULTS

Frequency (MHz)	Polarity (H/V)	Antenna Factor (dB)	Correction Factor (dB)	Corrected Field Strength Reading (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)	Margin (dB)	OB/RB /NRB
2,406	H	30.5	30.88	106.1	-	-	-	-	OB*
2,406	V	30.5	30.88	118.4	-	-	-	-	OB*
2,242	V	29.9	-2.80	47.53	54	237.96	500	-6.47	RB
2,279	H	30.3	-2.21	47.69	54	242.38	500	-6.31	RB
2,299	V	29.9	-2.60	47.23	54	229.88	500	-6.77	RB
2,690	H	31.3	-0.53	47.14	54	227.51	500	-6.86	RB
2,689	V	30.8	-1.03	50.64	54	340.41	500	-3.36	RB
4,828	V	34.2	+5.03	47.93	54	249.17	500	-6.07	RB

***Note:** OB implies Operational Band, in this case the limit was measured using the spectrum analyzer
RB implies "Restricted Band"
NRB implies "Non Restricted Bands of Operation"

Frequencies not covered by the Restricted Bands of Operation i.e. Non Restricted Bands are compared to the fundamental carrier per 47 CFR §15.247(c). 'OB' – Operational Band in the matrix identifies the fundamental carrier and should be a minimum of 20dB below the carrier.

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 (μV/m)	Measurement Distance (meters)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	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	Bar 1, Notch, ANT 1-18, K-Cbl 11, 5F50N001, ReCVR1

4.2.2 5GHz UNII Band Device Characteristics

4.2.2.1 26dB Emission Bandwidth and Power Limits

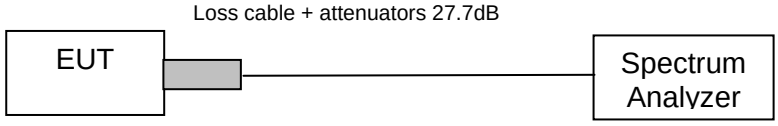
FCC, Part 15 Subpart C §15.407(a)(2) – 26dB Bandwidth
Industry Canada RSS-210 §6.2.2 (q1)(ii) – 99% Bandwidth

Test Procedure
The 26dB bandwidth is measured using a spectrum analyser connected to the antenna port. The measurement reference for the 26dB bandwidth is from the peak value measured within the in-band emission while the EUT is operating in transmission mode at the appropriate centre frequency. Plots of the highest bandwidths measured can be found in Section 7 Graphical Results. Spectrum analyzer settings:

26dB BW setting: RBW=1MHz, VBW=3MHz, Span=50MHz, Sweep = 5mS

Parameter re-tested in the follow up test program: 29th June '04

Measurement Results



Measurement set up for 26dB bandwidth test

Ambient conditions
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

NOMINAL OUTPUT POWER LEVEL SETTINGS – SEE SECTION 4.2.2.2

TABLE OF RESULTS

Centre Frequency (MHz)	Low Frequency (MHz)	High Frequency (MHz)	Plot #, (see Section 7)	26dB BW (MHz)
5,180	5,155.4	5,195.2	TUVR24/09	39.8
5,260	5,238.3	5,274.1	On file in lab	35.8
5,320	5,303.1	5,333.5	On file in lab	30.4

TABLE OF RESULTS

Centre Frequency (MHz)	Low Frequency (MHz)	High Frequency (MHz)	Plot #, (see Section 7)	26dB BW (MHz)
5,475	5,734.6	5,768.4	TUVR24/10	33.8
5,765	5,749.2	5,785.0	On file in lab	35.8
5,805	5,794.8	5,828.8	On file in lab	34.0

Power Limits

Maximum Power Calculation

FCC Power Limits

Frequency Band (MHz)	FCC Limit	Maximum Observed 26dB Bandwidth (MHz)	Power Limit
5,150-5,250	50mW (+17dBm) or 4dBm + $10Log_{10}$ B	39.8	50mW (+17dBm)
5,250-5,350	250mW (+24dBm) or 11dBm + $10Log_{10}$ B	35.8	250mW (+24dBm)
5,725-5,825	1W (+30dBm) or 17dBm + $10Log_{10}$ B	35.8	1W (+30dBm)

Industry Canada Power Limits

Frequency Band (MHz)	Industry Canada Limit	Maximum Observed 26dB* Bandwidth (MHz)	Power Limit
5,150-5,250	200mW (+23dBm) or 10dBm + $10Log_{10}$ B	39.8	200mW (+23dBm)
5,250-5,350	1W (+30dBm) or 17dBm + $10Log_{10}$ B	35.8	1W (+30dBm)
5,725-5,825	4W (+36dBm) or 23dBm + $10Log_{10}$ B	35.8	4W (+36dBm)

***Note: RSS-210 specifies that a 26dB bandwidth can be used to calculate power limits, see Section 6.2.2 (q1) (iv) (b)**

Specification

Limits

§15.407 (a) 1 -3 For the following frequency band the peak transmit power over the following range of operation shall not exceed the lesser of;

(1) 5,150-5,250MHz of 50mW (+17dBm) or 4dBm + 10Log10 B, where B is the 26dB BW in MHz
(2) 5,250-5,350GHz of 250mW (+24dBm) or 11dBm + 10Log10 B, where B is the 26dB BW in MHz
(3) 5,725-5,825MHz of 1W (+30dBm) or 17dBm + 10Log10 B, where B is the 26dB BW in MHz

RSS-210 §6.2.2 (q1)(i-iii)

(i) **5,150-5,250MHz (indoor use only) - The maximum equivalent isotropically radiated power (EIRP) shall not exceed 200mW or 10 + 10 Log10 B dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

(ii) **5,250-5,350MHz The maximum transmitter power shall not exceed 250mW or 11 + 10 Log10 B, dBm, whichever power is less. The maximum EIRP shall not exceed 1.0 watt or 17 + 10Log10 B dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

(iii) **5,725-5,825MHz The maximum transmitter power shall not exceed 1.0 watt or 17 + 10 Log10 B dBm, whichever power is less. The maximum EIRP shall not exceed 4.0 watts or 23 + 10 Log10 B, dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

*Note: Section 6.2.2 (q1) (iv) (b) permits the use of a 26dB bandwidth as alternative

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	± 2.81dB

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	Bar 1, 3F50N002, ReCVR 1, coupler

4.2.2.2 Output Power

FCC, Part 15 Subpart C §15.407(a)(2)
Industry Canada RSS-210 §6.2.2 (q1)(ii)

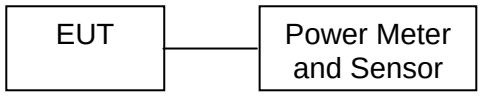
Test Procedure

- A transmitter antenna terminal of EUT was connected to the input of the RF power sensor.
- Measurement is made while EUT is operating in transmission mode at the appropriate centre frequency.

Parameter re-tested in the follow up test program: 29th June '04

Equipment s/w settings were as follows:
Data rate = 36MBit/s
Pattern = RANDOM

Test Measurement Set up



Measurement set up for Transmitter Output Power

Measurement Results for Output Power

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5,150-5,350MHz

Centre Frequency (MHz)	Duty Cycle (%)	Measured O/P Power (dBm)	Path Loss (dB)	Conducted Power (dBm)	Maximum Allowable Power (dBm) (see Section 4.2.2.1)
5,180	100	+16.12	0	+16.12	**+17.0 / 23.0**
5,260	100	+16.57	0	+16.57	**+24.0 / 30.0**
5,320	100	+16.91	0	+16.91	**+24.0 / 30.0**

TABLE OF RESULTS – 5,725-5,825MHz

Centre Frequency (MHz)	Duty Cycle (%)	Measured O/P Power (dBm)	Path Loss (dB)	Conducted Power (dBm)	Maximum Allowable Power (dBm) (see Section 4.2.2.1)
5,745	100	+15.97	0	+15.97	**+30.0 / 36.0**
5,765	100	+16.87	0	+16.87	**+30.0 / 36.0**
5,805	100	+16.66	0	+16.66	**+30.0 / 36.0**

Antenna Type - Maximum Permissible Power Level

For the antenna(s) tested the maximum permissible power level to be transmitted can be limited if transmitting antennas of directional gain greater than 6dBi are utilized the peak output power of the intentional radiator shall be reduced by the amount in dB that the directional gain exceeds 6dBi.

Antenna Type (2.4GHz)	Gain (dBi)	Amount Antenna Exceeds 6dBi (dB)	Highest Power Observed (dBm)	Maximum Permissible Power Level (dBm)
Cushcraft High Gain Directional Patch	14.0	8	+16.9	+8.9

Specification

Limits

§15.407 (a) 1 -3 For the following frequency band the peak transmit power over the following range of operation shall not exceed the lesser of;

(1) 5,150-5,250MHz of 50mW (+17dBm) or 4dBm + 10Log10 B, where B is the 26dB BW in MHz
(2) 5,250-5,350GHz of 250mW (+24dBm) or 11dBm + 10Log10 B, where B is the 26dB BW in MHz
(3) 5,725-5,825MHz of 1W (+30dBm) or 17dBm + 10Log10 B, where B is the 26dB BW in MHz

RSS-210 §6.2.2 (q1)(i-iii);

(i) **5,150-5,250MHz (indoor use only) - The maximum equivalent isotropically radiated power (EIRP) shall not exceed 200 mW or 10 + 10 Log10 B, dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

(ii) **The maximum transmitter power shall not exceed 250 mW or 11 + 10 Log10 B, dBm, whichever power is less. The maximum EIRP shall not exceed 1.0 watt or 17 + 10Log10 B dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

(iii) **The maximum transmitter power shall not exceed 1.0 watt or 17 + 10 Log10 B, dBm, whichever power is less. The maximum EIRP shall not exceed 4.0 watts or 23 + 10 Log10 B, dBm, whichever power is less. B is the 99%* power bandwidth in MHz.**

*Note: Section 6.2.2 (q1) (iv) (b) permits the use of a 26dB bandwidth as alternative

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty (dB)	±1.33

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, PMtr 1, PSnsr 1, coupler

4.2.2.3 Peak Power Spectral Density

FCC, Part 15 Subpart C §15.407(a)(5)
Industry Canada RSS-210 §6.2.2 (q1)(ii)

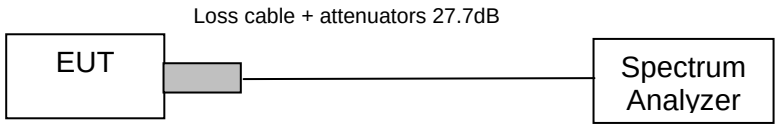
Test Procedure
This is an antenna conducted measurement using a spectrum analyzer. The transmitter output is connected to a spectrum analyser in sample detector mode. Method 2 in Reference (ix) was used in order to prove compliance. The Peak Power Spectral Density is the highest level found across the emission in any 1MHz reference bandwidth.

The spectrum analyzer settings were as follows:
RBW= 1MHz, VBW=3MHz, Span 50MHz and 5mS sweep time
Sample Detection, Power Average with 100 samples

Parameter re-tested in the follow up test program: 29th June '04

Equipment s/w settings were as follows:
Data rate = 36MBit/s
Output Power = see Section 4.2.2.2 Output Power
Pattern = RANDOM

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

Measurement Results for Peak Power Spectral Density

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5,150-5,350MHz

Centre Frequency (MHz)	Path Loss (dB)	Plot #, (see Section 7)	Corrected Peak Power Spectral Density (dBm)
5,180	27.7	On file in lab	+3.46
5,260	27.7	On file in lab	+3.50
5,320	27.7	TUVR24/11	+3.75

TABLE OF RESULTS – 5,725-5,825MHz

Centre Frequency (MHz)	Path Loss (dB)	Plot #, (see Section 7)	Corrected Peak Power Spectral Density (dBm)
5,745	27.7	On file in lab	+3.05
5,765	27.7	On file in lab	+3.11
5,805	27.7	TUVR24/12	+3.78

Antenna Gain - Maximum Permissible Peak Power Spectral Density

For the antenna(s) tested the maximum permissible power spectral density must be limited if transmitting antennas of directional gain greater than 6dBi are utilized the peak power spectral density of the intentional radiator shall be reduced by the amount in dB that the directional gain exceeds 6dBi.

Antenna Type (2.4GHz)	Freq. Band (MHz)	Gain (dBi)	Amount greater than 6dBi (dB)	Highest PPSD Observed (dBm)	PPSD Limit (dBm)	Maximum Permissible PPSD (dBm)
Cushcraft High Gain Directional Patch	5,150-5,250	14.0	6	+3.46	+4	-2.54
"	5,250-5,350	14.0	6	+3.75	+11	-2.25
"	5,725-5,825	14.0	6	+3.78	+17	-2.22

Specification

Limits

§15.407 (a)(1-3) For each of the following frequency bands the Peak Power Spectral Density shall not exceed;

(a) (1) 5,150-5,250MHz +4dBm in any 1MHz band
(a) (2) 5,250-5,350MHz +11dBm in any 1MHz band
(a) (3) 5,725-5,825MHz +17dBm in any 1MHz band

RSS-210 §6.2.2 (q1)(i-iii) **For each of the following frequency bands the Peak Power Spectral Density shall not exceed;**
(i) 5,150-5,250MHz +10dBm in any 1MHz band (EIRP).
(ii) 5,250-5,350MHz +11dBm in any 1MHz band.
(iii) 5,725-5,825MHz +17dBm in any 1MHz band.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	± 2.81dB

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	Bar 1, 3F50N002, ReCVR 1, coupler

4.2.2.4 Peak Excursion Ratio

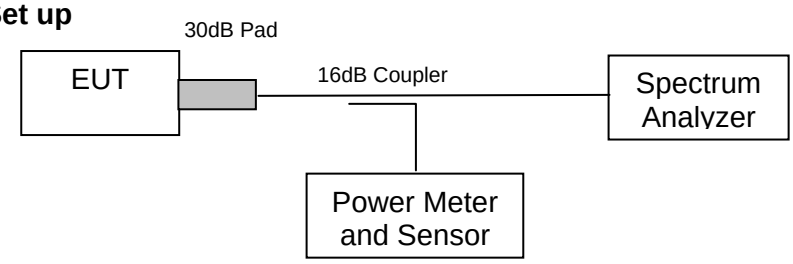
FCC, Part 15 Subpart C §15.407(a)(6)

Test Procedure

This is an antenna conducted measurement using a spectrum analyzer. The transmitter output is connected to a spectrum analyser in peak hold operational mode. Method 1 in Reference (viii) was used in order to prove compliance. The Peak Excursion Ratio is the difference in amplitude (dB) between the two traces.

The spectrum analyzer setting was as follows:
RBW= 1MHz, VBW=3MHz, Span 20MHz and 5mS sweep time

Test Measurement Set up



Measurement set up for Peak Excursion Ratio

Measurement Results for Peak Excursion Ratio

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5,150-5,350MHz

Centre Frequency (MHz)	Duty Cycle (%)	Plot #, see Section 7 (only worst case plot reported)	Measured Excursion Ratio (dB)
5,180	100	On file in lab	11.0
5,260	100	TUVR24/13	11.5
5,320	100	On file in lab	10.7

TABLE OF RESULTS – 5,725-5,825MHz

Centre Frequency (MHz)	Duty Cycle (%)	Plot #, see Section 7 (only worst case plot reported)	Measured Excursion Ratio (dB)
5,745	100	TUVR24/14	12.2
5,785	100	On file in lab	12.0
5,805	100	On file in lab	11.8

Specification

Limits

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

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	± 2.81dB

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	Bar 1, 3F50N002, ReCVR 1, coupler

4.2.2.5 Frequency Stability

FCC, Part 15 Subpart C §15.407(g)
Industry Canada RSS-210 §6.2.2 (q1)(iv)(e)

Test Procedure

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

Manufacturer Declaration

The frequency stability of the 40MHz reference oscillator sets the frequency stability of the RF transceiver signals. Therefore all of the RF signals should have ±20ppm stability.
This stability accounts for room temp tolerance of the crystal oscillator circuit, frequency variation across temperature, and crystal ageing.

Worst case:
2.4835GHz – 20ppm/49.67KHz
5.825GHz – 20ppm/116.5KHz

±20ppm at 5.825GHz translates to a maximum frequency shift of ±116KHz. As the edge of the channels are at least one MHz from either of the band edges, ±116.5KHz is more than sufficient to guarantee that the intentional emission will remain in the band over the entire operating range of the radio.

Voltage Variation

The ac supply voltage was varied between 85% and 115% of the nominal rated supply voltage. No change in fundamental frequency was observed during the variation. The equipment was found to be compliant.

Temperature Testing

The temperature was set at the extremes of equipment operation 0°C and +50°C. No change in fundamental frequency was observed during this period. The equipment complied with the specification.

4.2.2.6 RF Radiation Exposure

FCC, Part 15 Subpart C §15.247(f)
Industry Canada RSS-210 §6.2.2(q1)(iv)(g)

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(mw) = P(watts) / 1000

d(cm) = d(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 centimetres^2

Substituting the logarithmic form of power and gain using:

P(mW) = 10 ^ (P(dBm)/10) and

G(numeric) = 10 ^ (G(dBi) /10)

Yields:

d = 0.282 * 10 ^ ((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 / centimetres^2 (Limit S = 1mW / cm^2 from §1.310 Table 1)

Maximum output power observed from power measurements – **+16.91dBm**
Maximum antenna gain – **14dBi**

Power Density Limit (mW / cm^2)	Maximum Measured Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
1	16.91	14	9.9

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 / cm^2 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.

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	Bar 1, PMtr 1, PSnsr 1, coupler, 3dB & 30dB pads

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty (dB)	±1.33

4.2.2.7 Spurious emissions above 1GHz (1-40GHz)

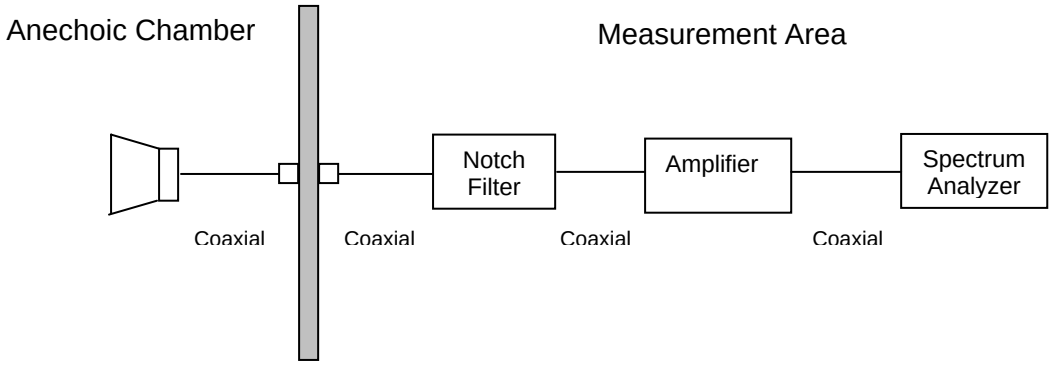
FCC, Part 15 Subpart C §15.247(b)(1),(2)
Industry Canada RSS-210 §6.2.2(q1)

Test Procedure

Preliminary radiated emissions 1 to 40GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. The highest emissions relative to the limit are listed. Frequencies not covered by the 'Restricted Bands of Operation' are compared to the fundamental carrier.

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

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

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

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

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

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

Measurement Results Spurious Emissions above 1GHz (1GHz - 40GHz)

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

TABLE OF RESULTS

Frequency (MHz)	Polarity (H/V)	Antenna Factor (dB)	Correction Factor (dB)	Corrected Field Strength Reading (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)	Margin (dB)	OB/RB /NRB
5,215	H	35.5	37.17	126.0	-	-	-	-	OB*
5,225	V	35.5	37.17	103.5	-	-	-	-	OB*
1,079	H	24.9	-11.3	32.7	54	43.2	500	-21.3	RB
1,079	V	25.0	-11.4	38.6	54	85.1	500	-15.4	RB
1,170	H	25.8	-10.0	29.2	54	28.8	500	-24.83	RB
1,261	V	25.9	-9.43	40.2	54	102.3	500	-65.83	OB
1,261	H	26.0	-9.33	33.7	54	48.4	500	-49.83	OB
1,441	H	26.6	-7.90	31.8	54	38.9	500	-22.2	RB

Apart from the emissions reported above no additional spurious were observed and system was found to be compliant with the requirements in the range 1-40GHz.

***Note:** OB implies Operational Band, in this case the limit was measured using the spectrum analyzer
RB implies “Restricted Band”
NRB implies “Non Restricted Bands of Operation”

Frequencies not covered by the Restricted Bands of Operation i.e. Non Restricted Bands are compared to the fundamental carrier per 47 CFR §15.247(c). ‘OB’ – Operational Band in the matrix identifies the fundamental carrier and should be a minimum of 20dB below the carrier.

Band-Edge Requirements

FCC, Part 15 Subpart C §15.407 (b)(1), (b)(2), (b)(3), (b)(4), (b)(7)

Specifically in-line with 15.407 (b) (1) and (b)(2). All emissions outside of the 5,150-5,350MHz band did not exceed an EIRP of -27dBm/MHz. No emissions were observed in the 5,150-5,250MHz and 5,250MHz-5,350MHz bands.

Specifically in-line with 15.407 (b) (3) for transmitters operating in the 5.725-5.825 GHz band; all emissions within the frequency range from the band edge to 10 MHz above or below the band edge do not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions do not exceed an EIRP of -27 dBm/MHz.

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. When measuring the emission limits, the nominal carrier frequency was adjusted as close to the upper and lower band edge as the equipment software permitted.

Data plots for band-edge requirements are available in Section 7 'Graphical Results', see plots TUVR24/30-33

Restricted Bands

FCC, Part 15 Subpart C §15.407(b)(7)
Industry Canada RSS-210 §5.9.1, §6.2.2 (o)(e1)

Test Procedure

In order to comply with spurious emissions within restricted bands radiated plots are provided in order to prove compliance. Radiated plots were taken within an anechoic chamber. Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized within the chamber. For measurements > 1GHz except where otherwise specified an average detector was utilized with a 1MHz resolution bandwidth.

The equipment complies with the restricted band and band-edge requirements for 5.15GHz, 5.35GHz, 5.46 per FCC Sections 15.205 and 15.209.

The following Restricted Band plots can be found in Section 7 'Graphical Results'
5,180MHz – TUVR24/34

5,320MHz – TUVR24/35
5,745MHz – TUVR24/36
5,805MHz – TUVR24/37

No spurious emissions were found within the restricted bands between the frequency band 1-40GHz. All emissions were below the limit specified below.

Specification

Limits

§15.247(b)/§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 (μV/m)	Measurement Distance (meters)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	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	Bar 1, Notch, ANT 1-18, K-Cbl 11, 5F50N001, ReCVR1

4.2.2.8 Conducted Spurious Emissions above 1GHz (1-40GHz)

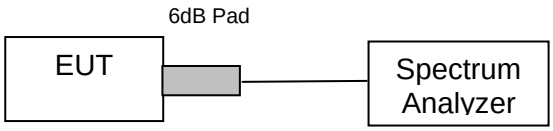
FCC, Part 15 Subpart C §15.247(b)(1),(2),(3)
Industry Canada RSS-210 §6.2.2(q1)

Test Procedure

Conducted spurious emissions 1 to 40GHz are measured via a spectrum analyzer. The emissions are recorded and maximized through peak hold detection. The results are compared to the limit specified.

The spectrum analyzer setting was as follows:
RBW= 1MHz, VBW=3MHz, Span various and automatic sweep time

Test Measurement Set up



Measurement set up for Radiated Emission Test

Measurement Results for Conducted Spurious Emissions

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

OUTPUT POWER - +20dBm

Plot Range Frequency (GHz)	**Plots provided in Section 7 'Graphical Results'**	
	Operating Frequency	
	5,180MHz	**5,805MHz**
	Peak Emission Level (dBm)	**Peak Emission Level (dBm)**
1 to 40	-35.17	-35.23
1 to 10	-39.67	-40.40
10 to 20	-38.17	-38.90
20 to 30	-38.00	-38.73
30 to 40	-35.00	-34.90
5.15 to 5.825	-37.50	-34.73

Specification

Limits

§15.407 (b)(1),(2),(3) Peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following;

(b)(1) 5.15-5.25G All emissions outside of this band shall not exceed an EIRP of –27dBm/MHz

(b)(2) 5.25-5.35G All emissions outside of this band shall not exceed an EIRP of –27dBm/MHz

(b)(3) 5.725-5.825G All emissions within the frequency range from the band edge to 10MHz above or below the band edge shall not exceed an EIRP of –17dBm/MHz; for frequencies 10MHz or greater above or below band edge, emissions shall not exceed an EIRP of –27dBm/MHz

Traceability

METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'.	Bar 1, K-CBL 11, S-Anlr 3, SSwpr 1

Measurement Uncertainty

Below 26.5GHz	Above 26.5GHz
±2.37dB	±4.6dB

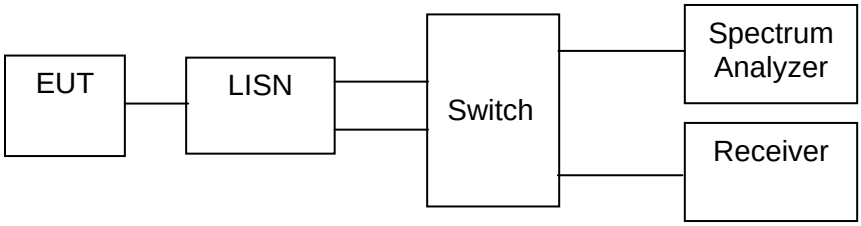
4.2.3 Common Device Characteristics for the 2.4GHz and 5GHz Bands

4.2.3.1 AC Wireline Conducted Emissions (150KHz – 30MHz)

FCC, Part 15 Subpart C §15.407(b)/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 emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Test Measurement Set up



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

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

The following matrix references the AC Wireline Conducted Emission plot s in Section 7, Graphical Results 'AC Wireline Emissions', plots 19-20.

120Vac 60Hz and Power over Ethernet simultaneous applied to the Access Point

TABLE OF RESULTS – 120VAC 60Hz + POWER OVER ETHERNET

Frequency (MHz)	Peak Voltage (dBµV)	QP Limit (dBµV)	QP Voltage (dBµV)	Margin (dB)	Phase
1.075350	49.05	56.00	--.--	-6.95	L
1.075350	48.77	56.00	--.--	-7.23	N
2.935005	51.20	56.00	--.--	-4.30	L
2.937990	52.50	56.00	--.--	-3.50	N
3.469320	49.44	56.00	--.--	-6.56	L
3.475290	49.97	56.00	--.--	-6.03	N

L – Live

N – Neutral

120Vac only – External hub between switch and AP60 effectively disconnecting POE

TABLE OF RESULTS – 120VAC 60Hz (Power over Ethernet (POE) disconnected)

Frequency (MHz)	Peak Voltage (dBμV)	QP Limit (dBμV)	QP Voltage (dBμV)	Margin (dB)	Phase
0.266415	49.76	61.22	--.--	-11.46	L
0.603720	55.46	56.00	--.--	-0.54	N
0.606705	55.69	56.00	--.--	-0.31	L
0.687300	51.07	56.00	--.--	-4.93	L
2.905155	51.02	56.00	--.--	-4.98	N
2.920080	50.95	56.00	--.--	-5.05	L

L – Live

N – Neutral

Note: In both cases the measured Peak Voltage was less than the Quasi-Peak limit, therefore no Quasi-Peak or Average evaluations were required.

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 50μΩ 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) 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 μV (60dBμV, 0.45 - 1.705 MHz) and 3000 μV (69.5dBμV, 1.705 - 30 MHz).

§15.207 (a) Limit Matrix

The lower limit applies at the boundary between the frequency ranges.

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

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty (dB)	±2.64

Traceability

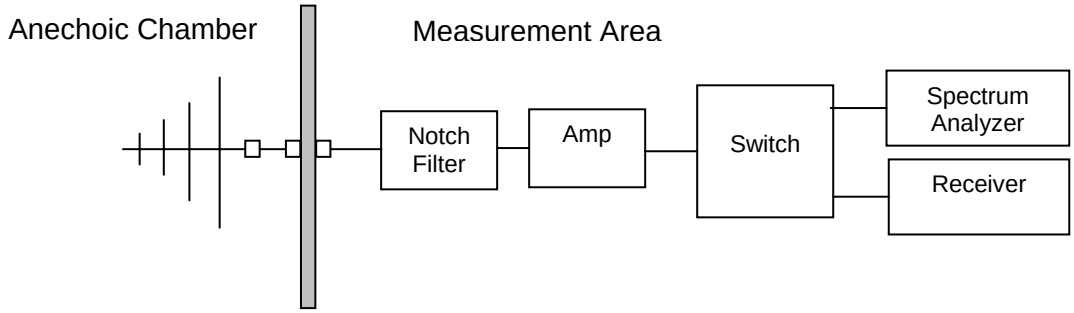
METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	Bar 1, ReCVR 1, LISN 1

4.2.3.2 Spurious Emissions (30MHz – 1GHz)

FCC, Part 15 Subpart C §15.407(b)(5)/ §15.209
Industry Canada RSS-210 §6.2.2(q1)(ii)

Test Procedure
Preliminary radiated emissions are measured in the anechoic chamber at a 3-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 on the Open Area Test Site (OATS). The highest emissions relative to the limit are listed. The OATS test set up is identified in the photograph in Section 5.

Test Measurement Set up



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

$$FS = R + AF + CORR$$

where:

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

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

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

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

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

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

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

Ambient conditions.
Temperature: 16 to 21 °C Relative humidity: 34 to 55% Pressure: 999 to 1012 mbar

Two system power-up configurations were measured and the worst case reported;
1).. 120Vac 60Hz with Power Over Ethernet
2).. 120Vac 60Hz (Power Over Ethernet disconnected)

Worst case #2 120Vac 60Hz with the Power Over Ethernet disconnected. Results for case #1 are held on file in the laboratory.

TABLE OF RESULTS – 120Vac 60Hz

Frequency (MHz)	Polarity (H/V)	Field Strength Reading Peak (dBμV/m)	Field Strength Reading QPeak (dBμV/m)	Limit (dBμV/m) **(QP)**	Margin (dB)
98.46	V	35.54	32.75	43.5	-10.75
257.85	V	39.78	--.--	46.0	-6.22
640.05	V	42.99	--.--	46.0	-3.01
760.10	H	43.21	--.--	46.0	-2.79
885.05	H	44.06	--.--	46.0	-1.94
909.55	V	34.38	--.--	46.0	-11.62

Reference pre-scan data is available in Section 7 Graphical Results '**Pre-scan (30-1GHz)'** TUVR24/21.

Specification

Limits

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

Laboratory Measurement Uncertainty for Radiated Emissions

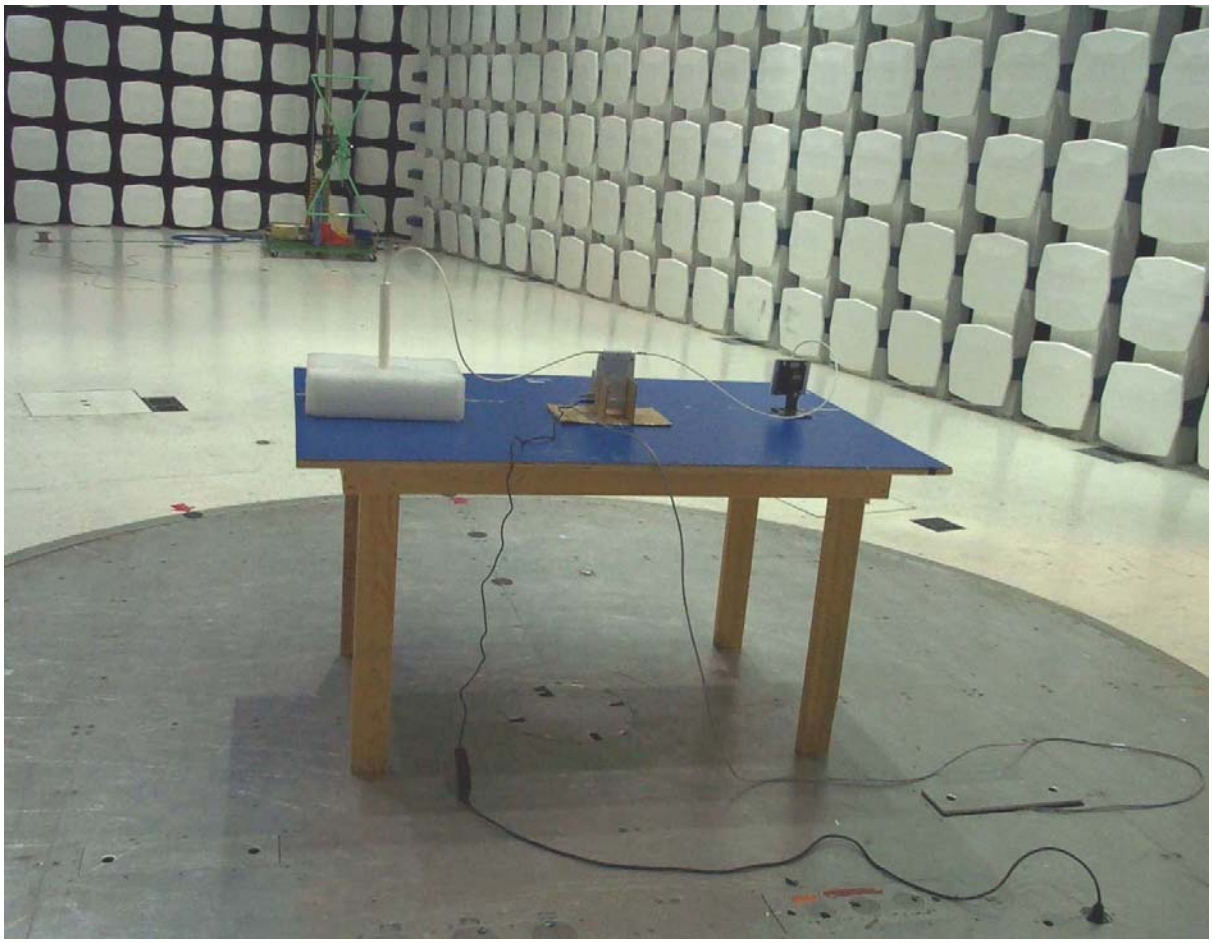
Measurement uncertainty (dB)	+5.6 / -4.5

Traceability

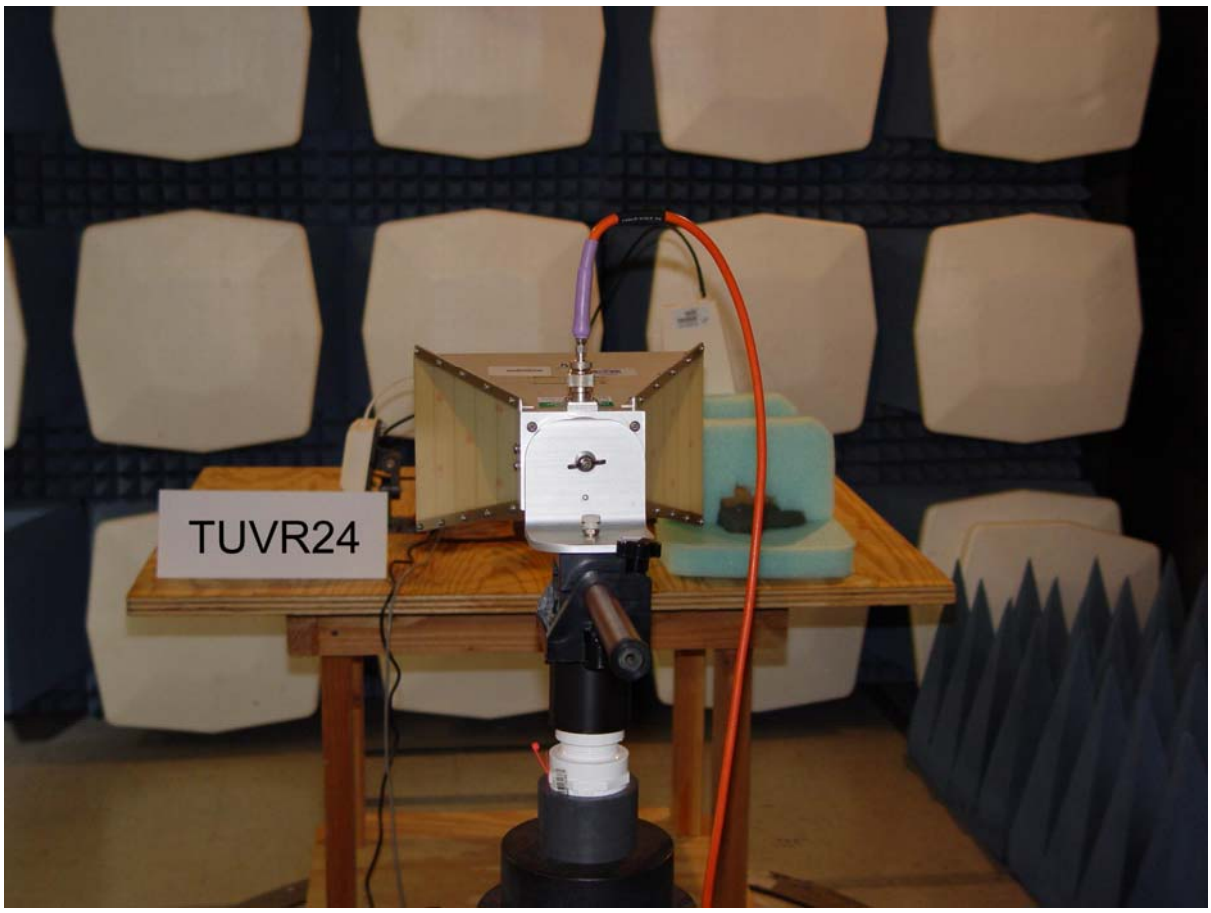
METHOD	TEST EQUIPMENT USED
Measurements were made per work instruction WI-EMC-07 ‘Radiated Emissions’	Bar 1, Notch, AMP 3, ANT 1, K-Cbl 11, 10F50N003, 15F50N001, 5F50N001, ReCVR1

5 Photographs

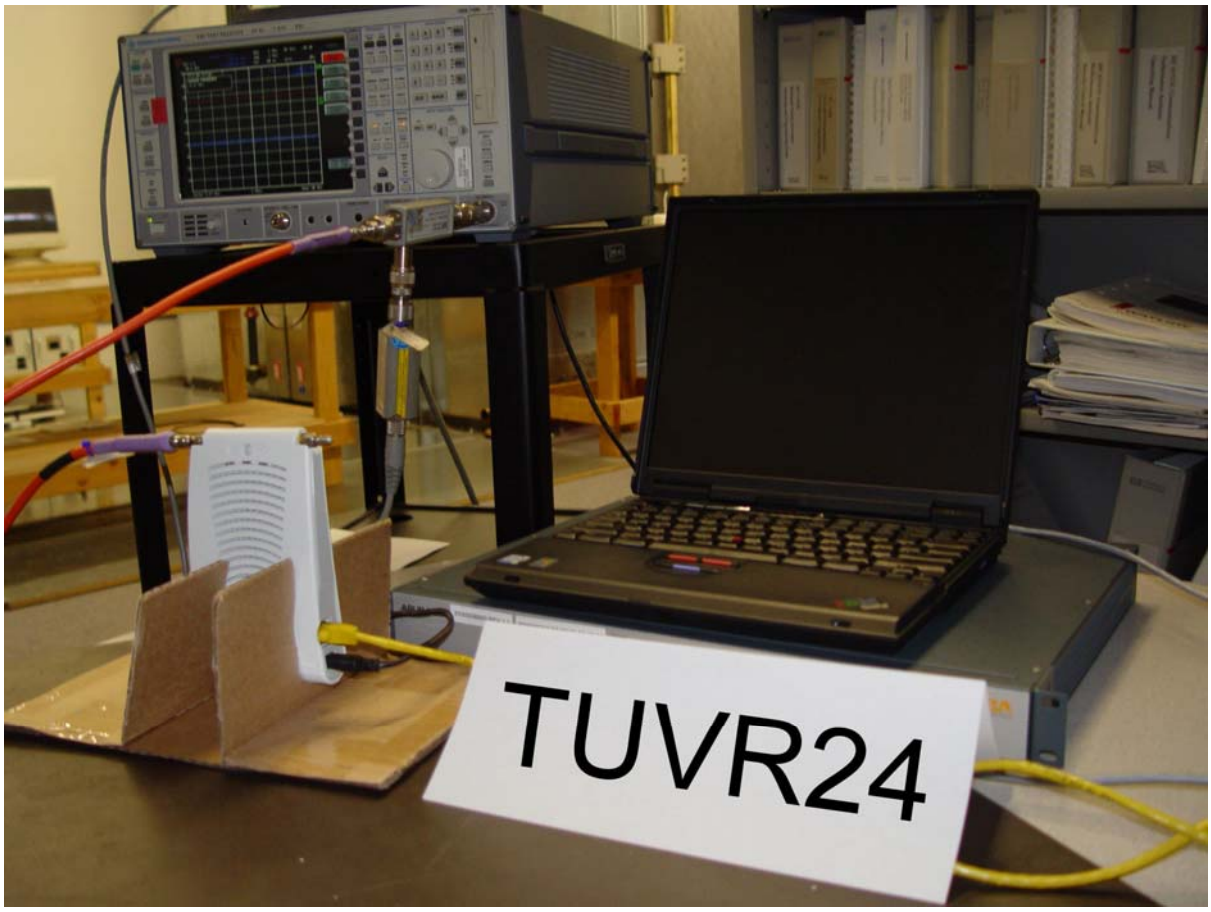
5.1 Radiated Emissions Test Set Up (30MHz-1GHz)



5.2 Spurious Emissions Test Set Up Above 1GHz



5.3 General Measurement Test Set Up



6 Test Equipment Details

Asset Abbrev. #	Instrument	Manufacturer	Part #	Calibration Due Date	Serial #
Bar 1	Barometer/Thermometer	Control Co.	4196	10 Jun '05	E2844
RVA 01	Variable Coaxial Attenuator	Weinschel	940-60-33	22 Jun '04	A6595
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	21 Oct '04	9205-3882
ANT2	20-300MHz Antenna	Schwarzbeck	VHBB 9124	30 Apr '04	9124/0257
ANT3	230MHz-1GHz Antenna	Schwarzbeck	VUSLP9111	30 Apr '04	186
ANT4	18GHz-26.5GHz	Millimeter Products	261K	30 Apr '04	595
ANT5	26.5GHz-40GHz	Millimeter Products	261A	30 Apr '04	599
AMP 3	Amplifier (0.5-22GHz)	Com-Power	PA-122	Not Applicable	181910
ReCVR 1	EMI Receiver	Rhode & Schwartz	ESI 7	16 Mar '05	838496/007
S-Anlr 3	Spectrum Analyzer	Hewlett Packard	8564E	15 May '05	
LISN 1	LISN	Rhode & Schwartz	ESH3Z5	25 Oct '04	836679/006
PMtr 1	Power Meter	Hewlett Packard	437B	15 Oct '04	3125U13554
PSnsr 1	Power Sensor	Hewlett Packard	R8485A	22 Jun '04	3318A19694
PSnsr 3	Power Sensor	Hewlett Packard	8487D	18 Oct '04	3318A00371
S-Anlr 1	Spectrum Analyser	Hewlett Packard	8565E	20 July '04	3425A00181
SSwpr 4	Synthesized Sweeper	Hewlett Packard	83640A	23 Jun '04	2927A00105
Coupler	Coupler	Hewlett Packard	86205A	N/A	1623
	3dB N-Type Attenuator	ARRA	N9444-30	N/A	
	30dB N-Type Attenuator	NARDA	32319	N/A	

7 Graphical Results

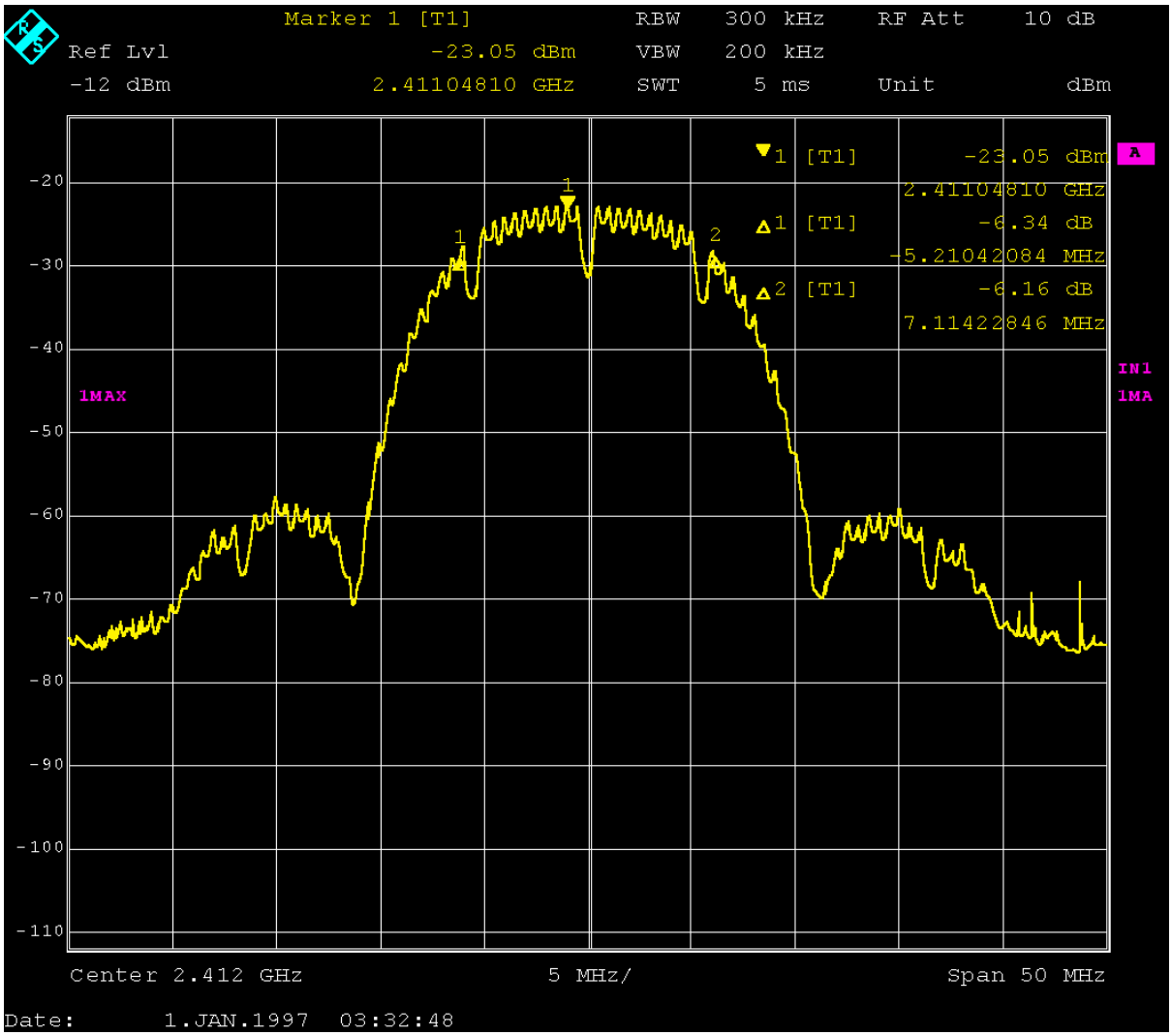
This report contains the following plots as referenced in the test results section

Note only the worst case results are reported. Additional data and results are kept on file in the laboratory.

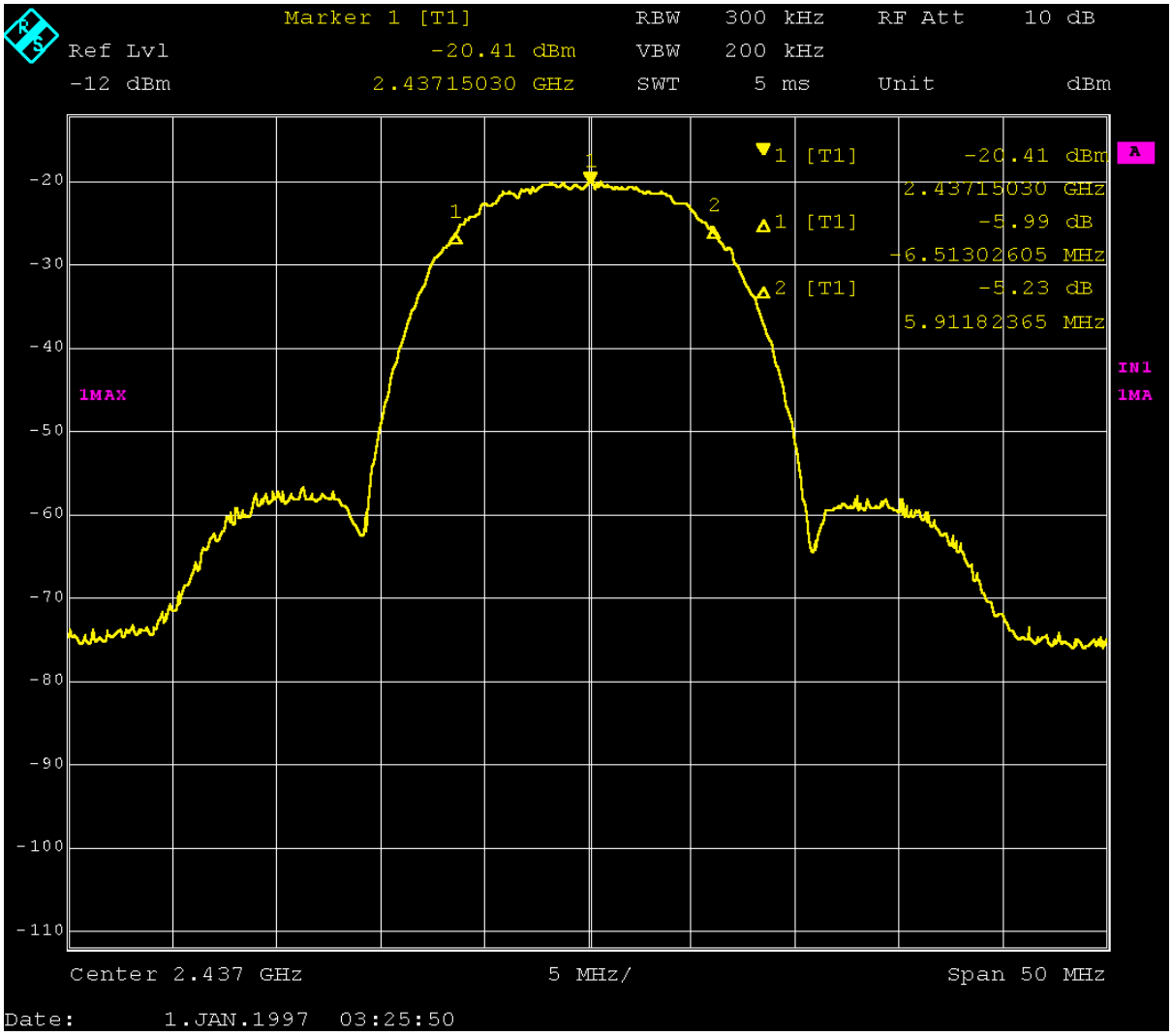
2.4GHz 802.11b/g		5GHz 802.11a	
Sect.4.2.1.1 6dB Bandwidth	TUVR24/01	**Sect.4.2.2.1** 26dB Bandwidth	TUVR24/09
	TUVR24/02		TUVR24/10
	TUVR24/03	**Sect.4.2.2.3** Peak Power Spectral Density	TUVR24/11
Sect.4.2.1.4 Band-edge	TUVR24/04		TUVR24/12
	TUVR24/05	**Sect.4.2.2.4** Peak Excursion	TUVR24/13
Sect. 4.2.1.4 Restricted Bands	TUVR24/05a		TUVR24/14
	TUVR24/05b	**Sect.4.2.2.8** Conducted Spurious Emissions	TUVR24/15
			TUVR24/16
			TUVR24/17
Sect.4.2.1.5 Peak Power Spectral Density	TUVR24/06		TUVR24/18
	TUVR24/07		TUVR24/19
	TUVR24/08		TUVR24/20
			TUVR24/21
			TUVR24/22
			TUVR24/23
			TUVR24/24
			TUVR24/25
			TUVR24/26
		Sect. 4.2.2.7 Band-edge	TUVR24/30
			TUVR24/31
			TUVR24/32
			TUVR24/33
		Sect. 4.2.2.7 Restricted Bands	TUVR24/34
			TUVR24/35
			TUVR24/36
			TUVR24/37
Common Device Characteristics			
Sect.4.3.1.1 AC Wireline Emissions	TUVR24/27		
	TUVR24/28		
Sect.4.3.1.2 Radiated Emissions <1GHz	TUVR24/29		

6dB Bandwidth (TUVR24/01-03)

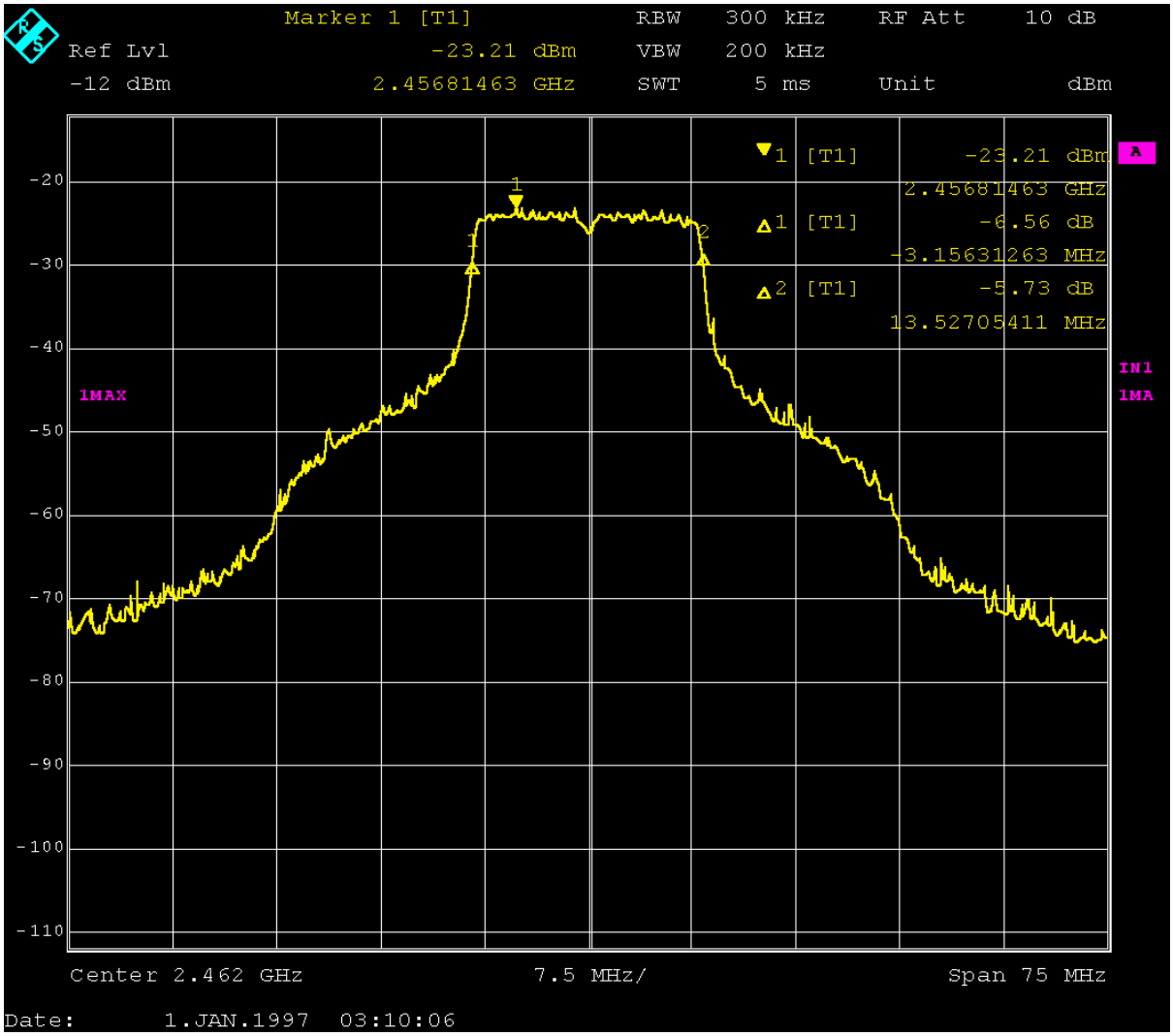
6dB BW 2,412MHz 1MB TUVR24/01



6dB BW 2,437MHz 11MB TUVR24/02

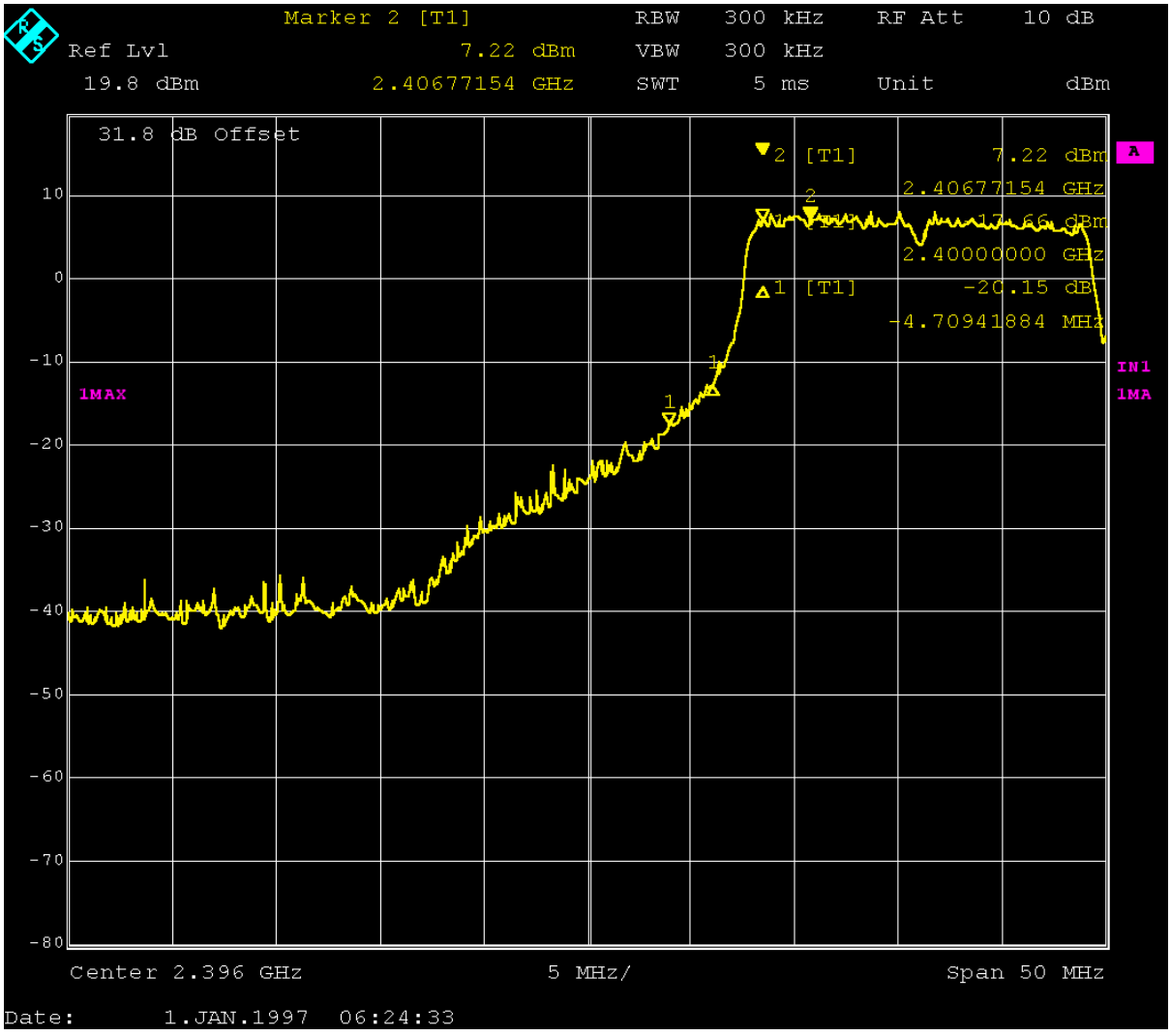


6dB BW 2,462MHz 54MB TUVR24/03

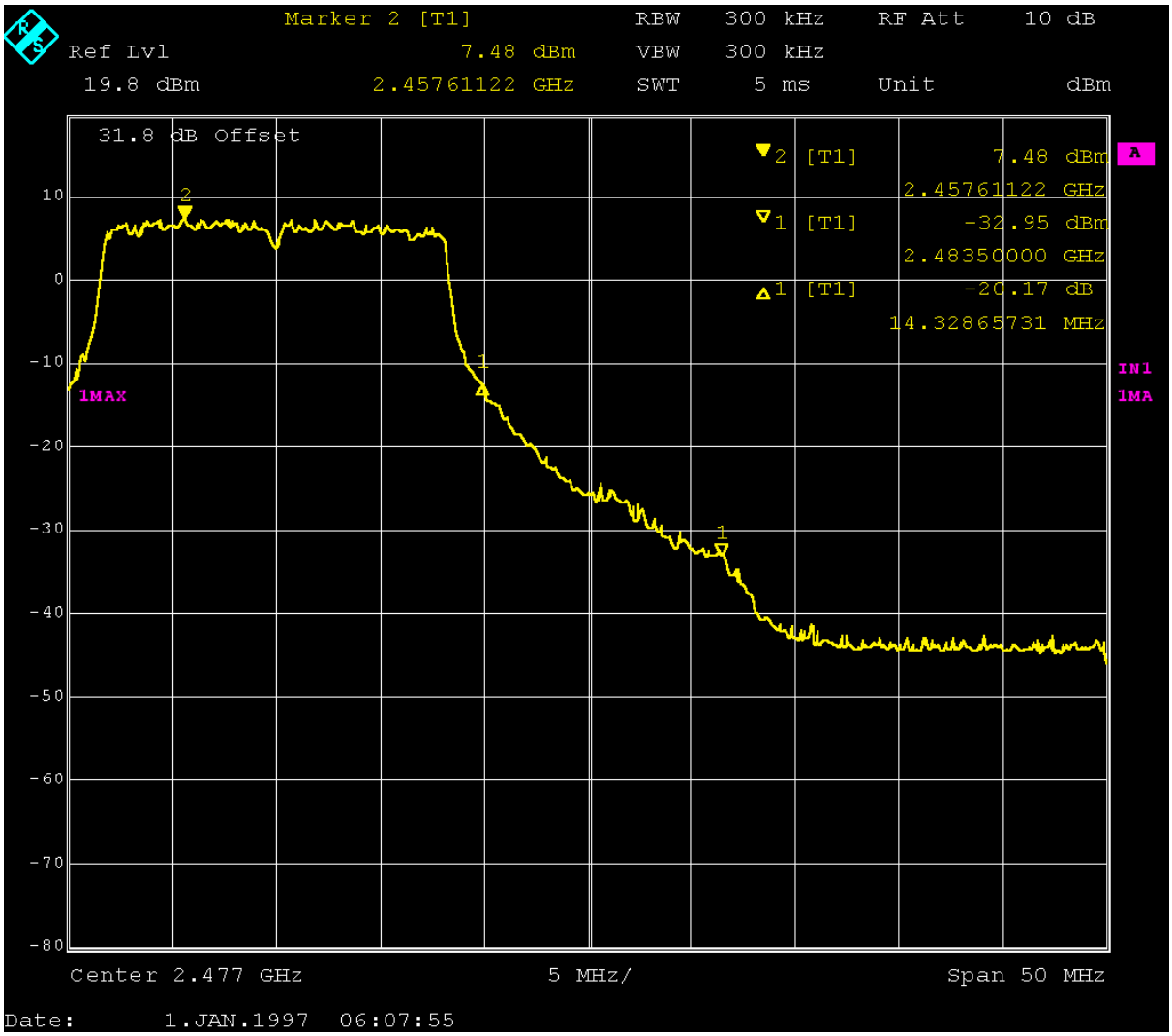


Band-edge (TUVR24/04-05)

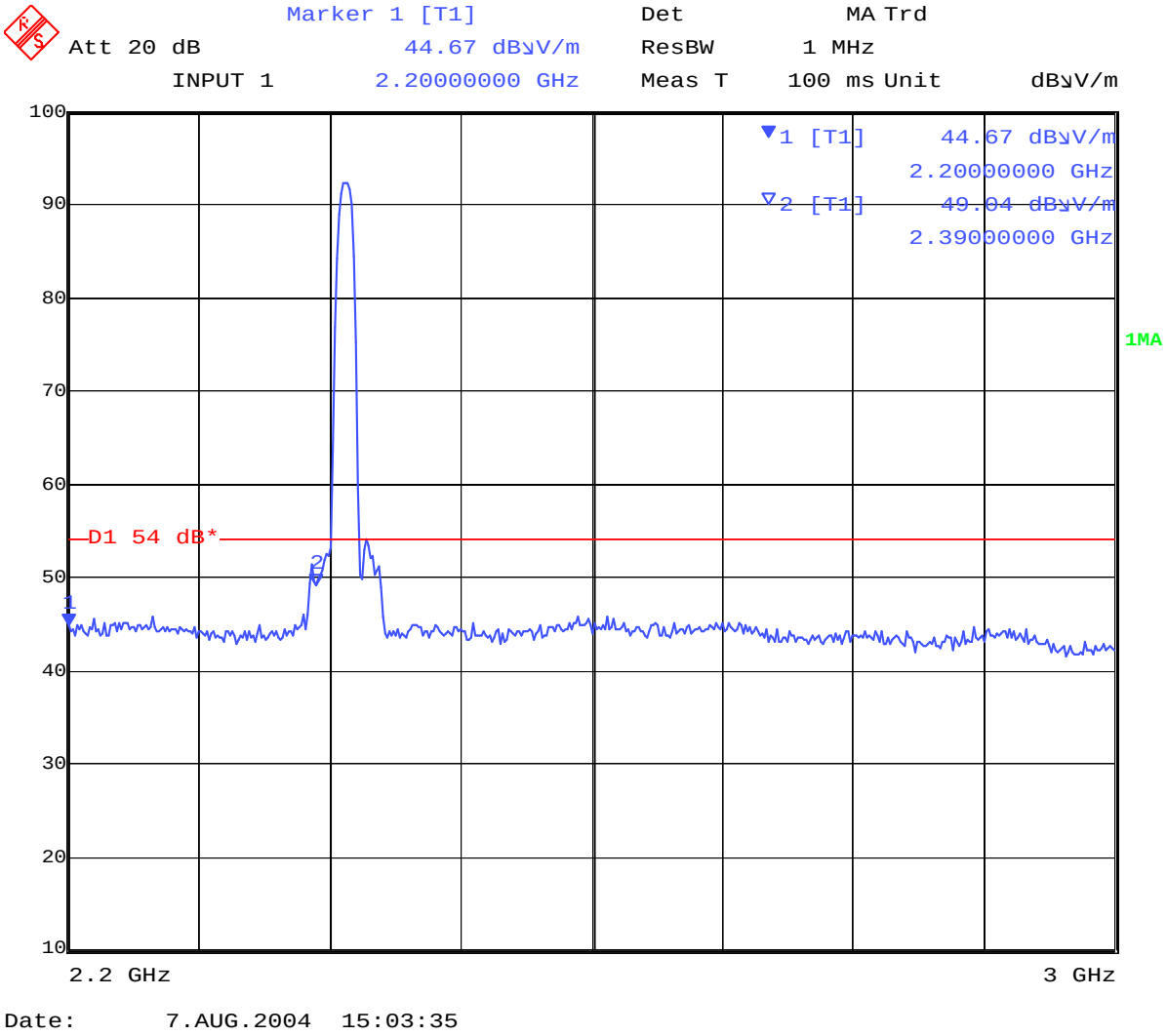
Band-edge 2,412MHz 54MB TUVR24/04



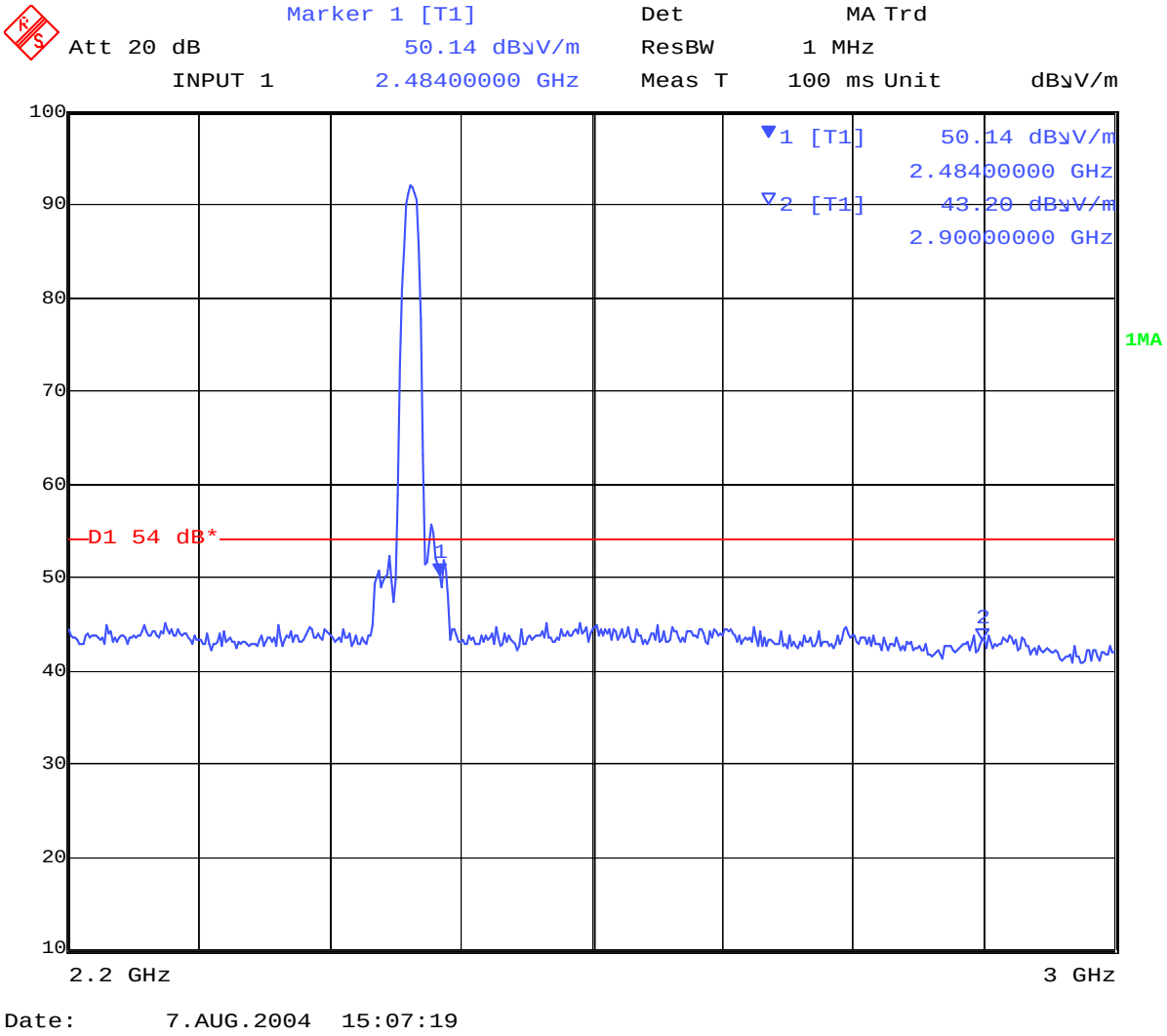
Band-edge 2,412MHz 54MB TUVR24/05



Restricted Bands 2,412MHz 11MB TUVR24/05a



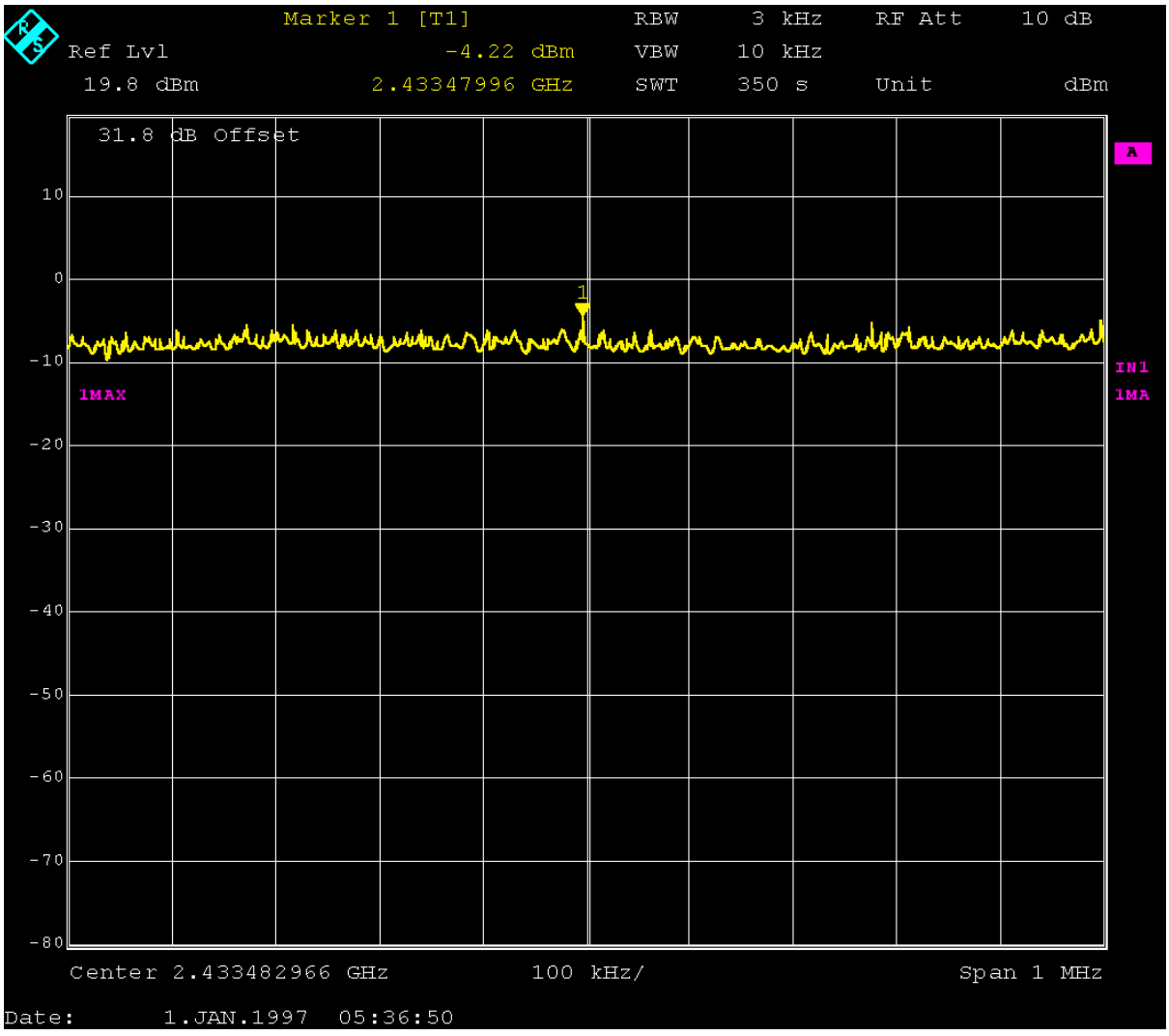
Restricted Bands 2,462MHz 11MB TUVR24/05b



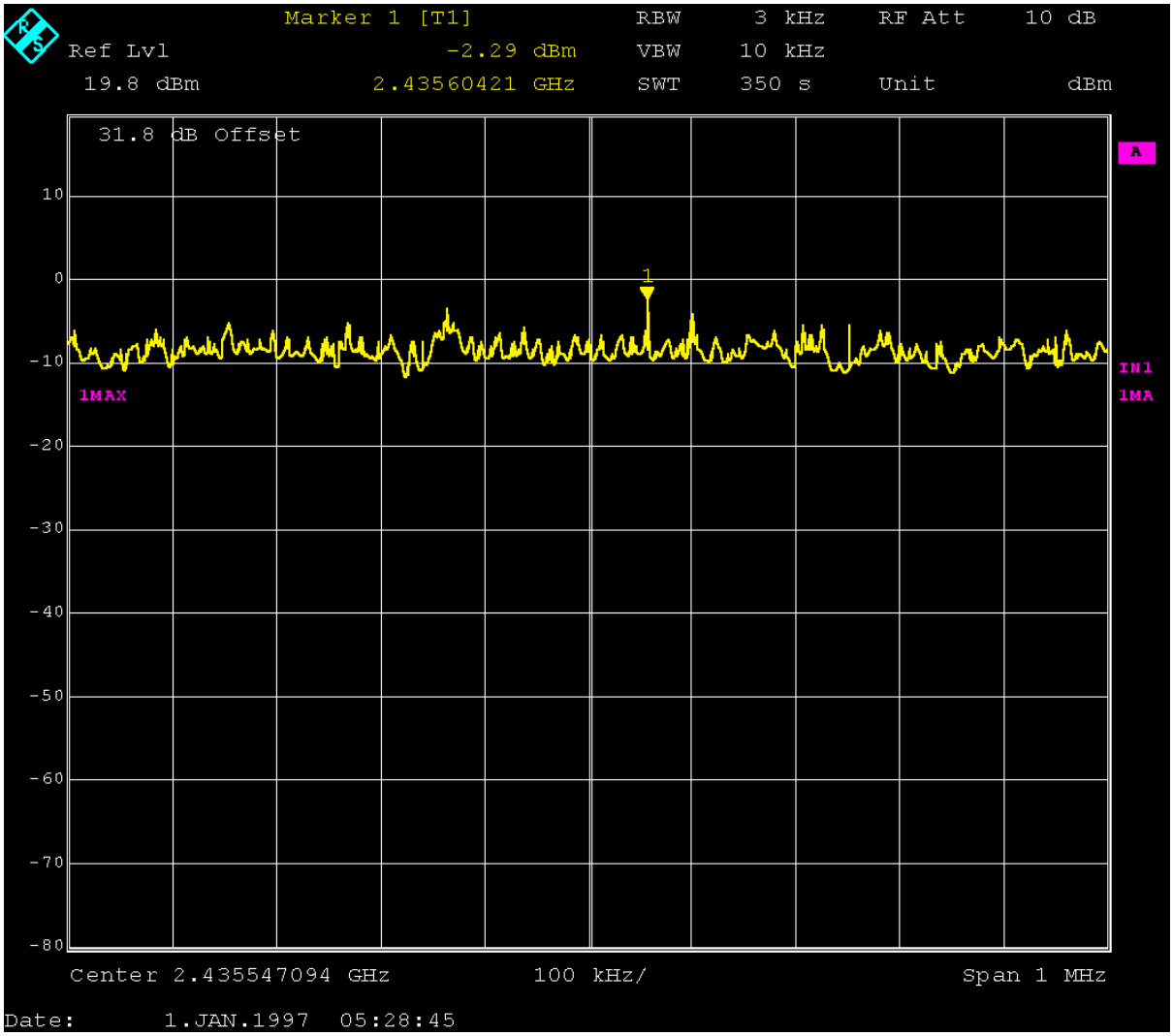
Date: 7.AUG.2004 15:07:19

Peak Power Spectral Density (TUVR24/06-08)

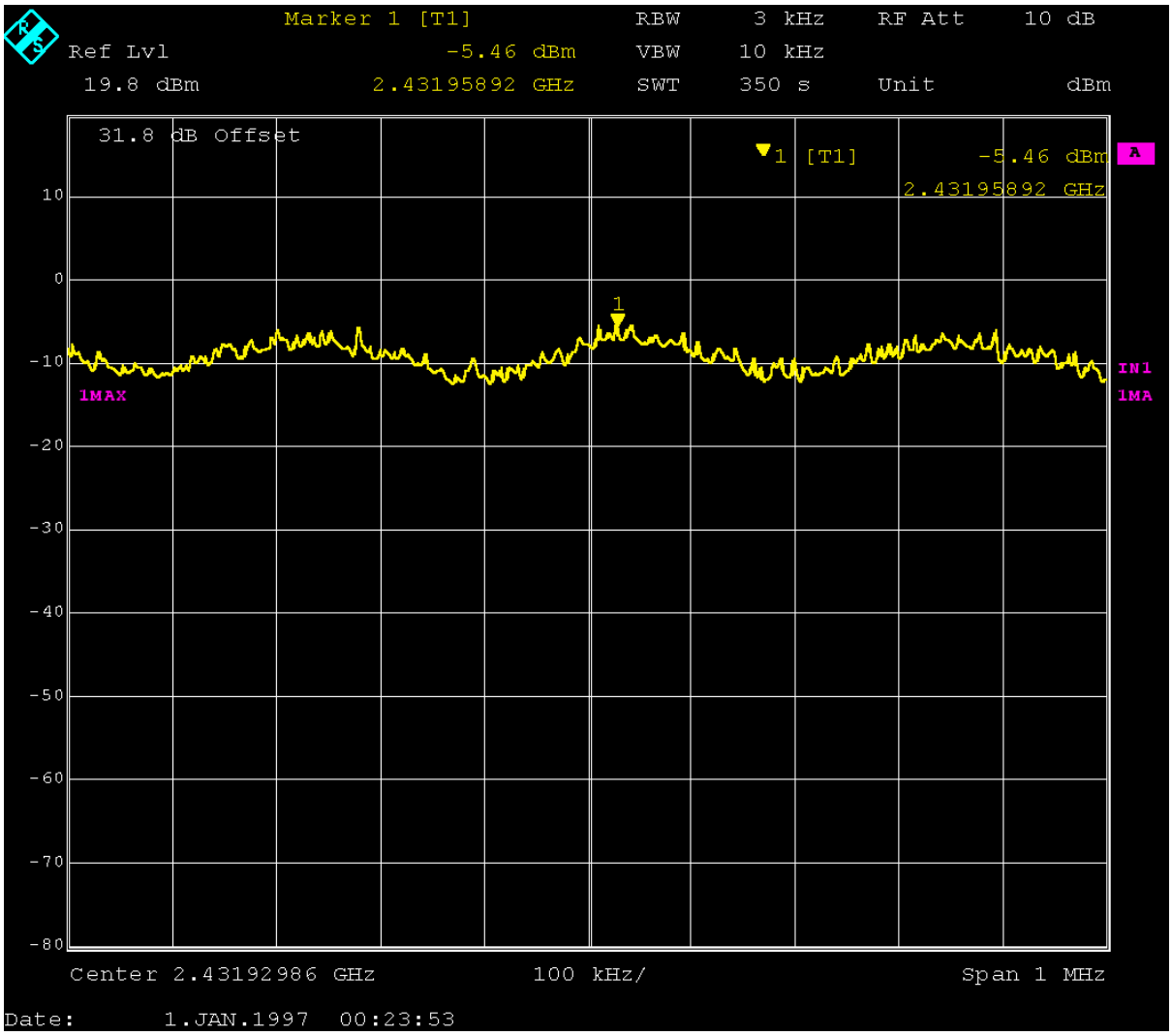
PPSD 2,437MHz 1MB TUVR24/06



PPSD 2,437MHz 11MB TUVR24/07

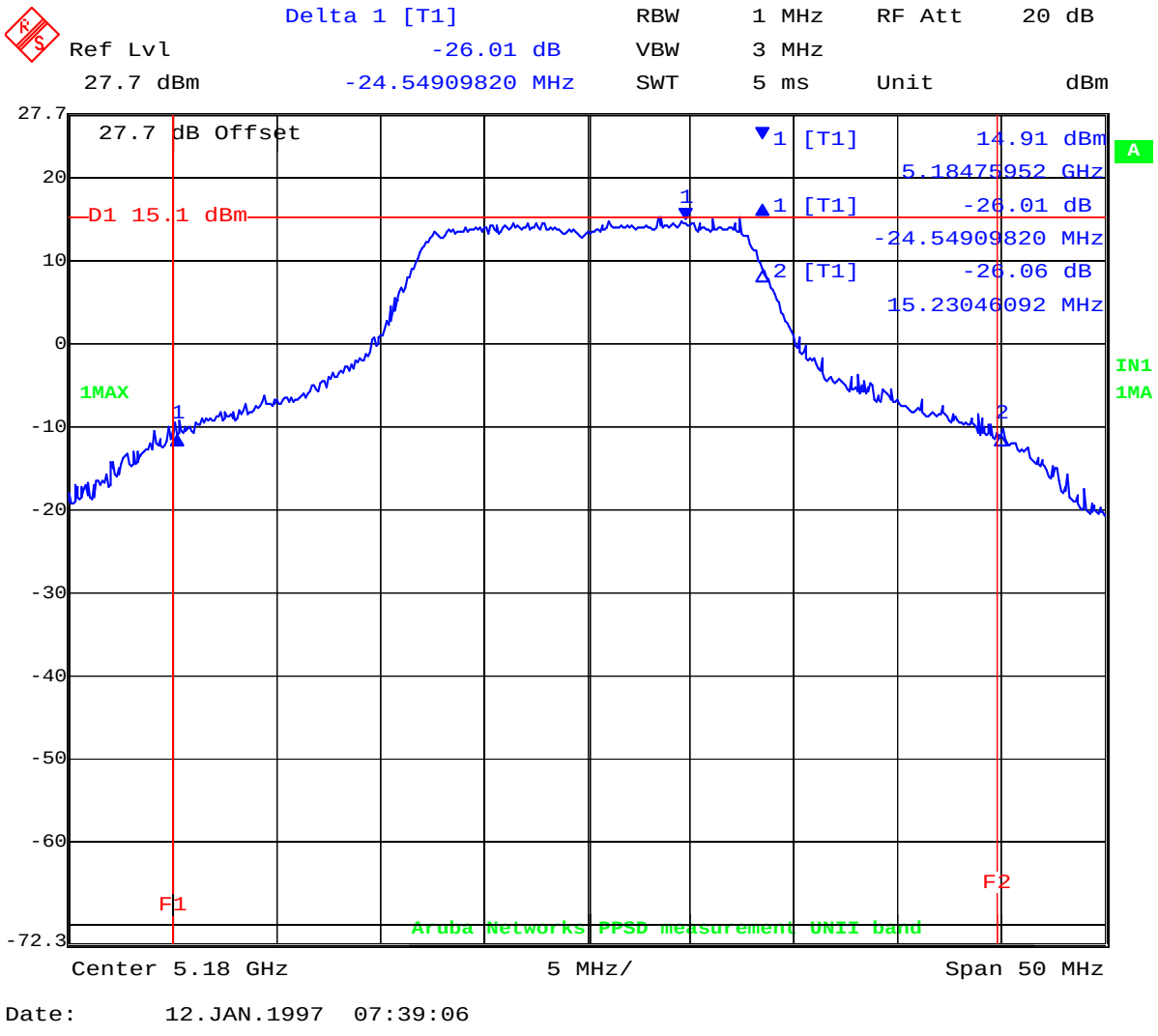


PPSD 2,437MHz 54MB TUVR24/08

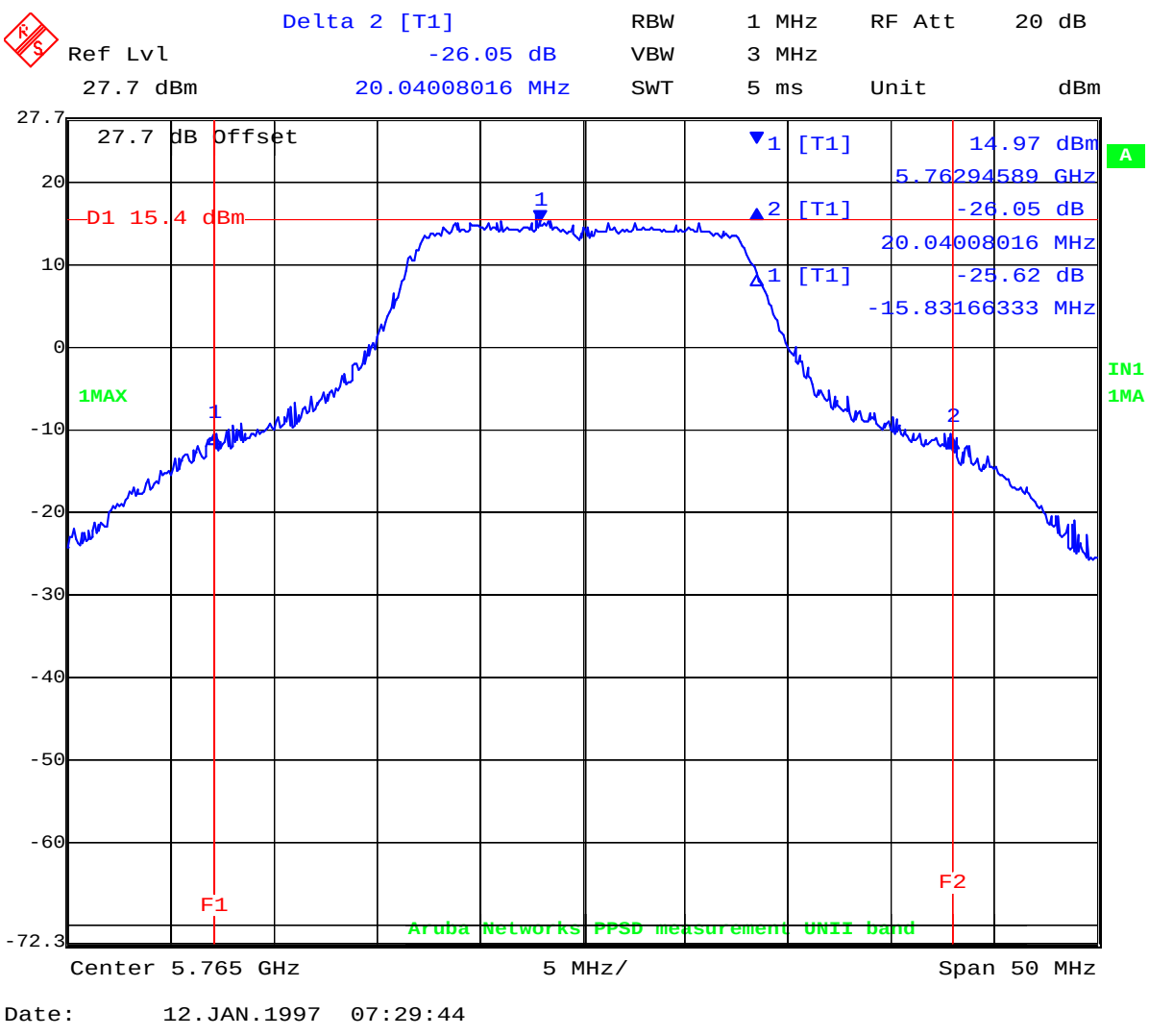


26dB Bandwidth (TUVR24/09-10)

26dB Bandwidth 5,180MHz 54MB TUVR24/09

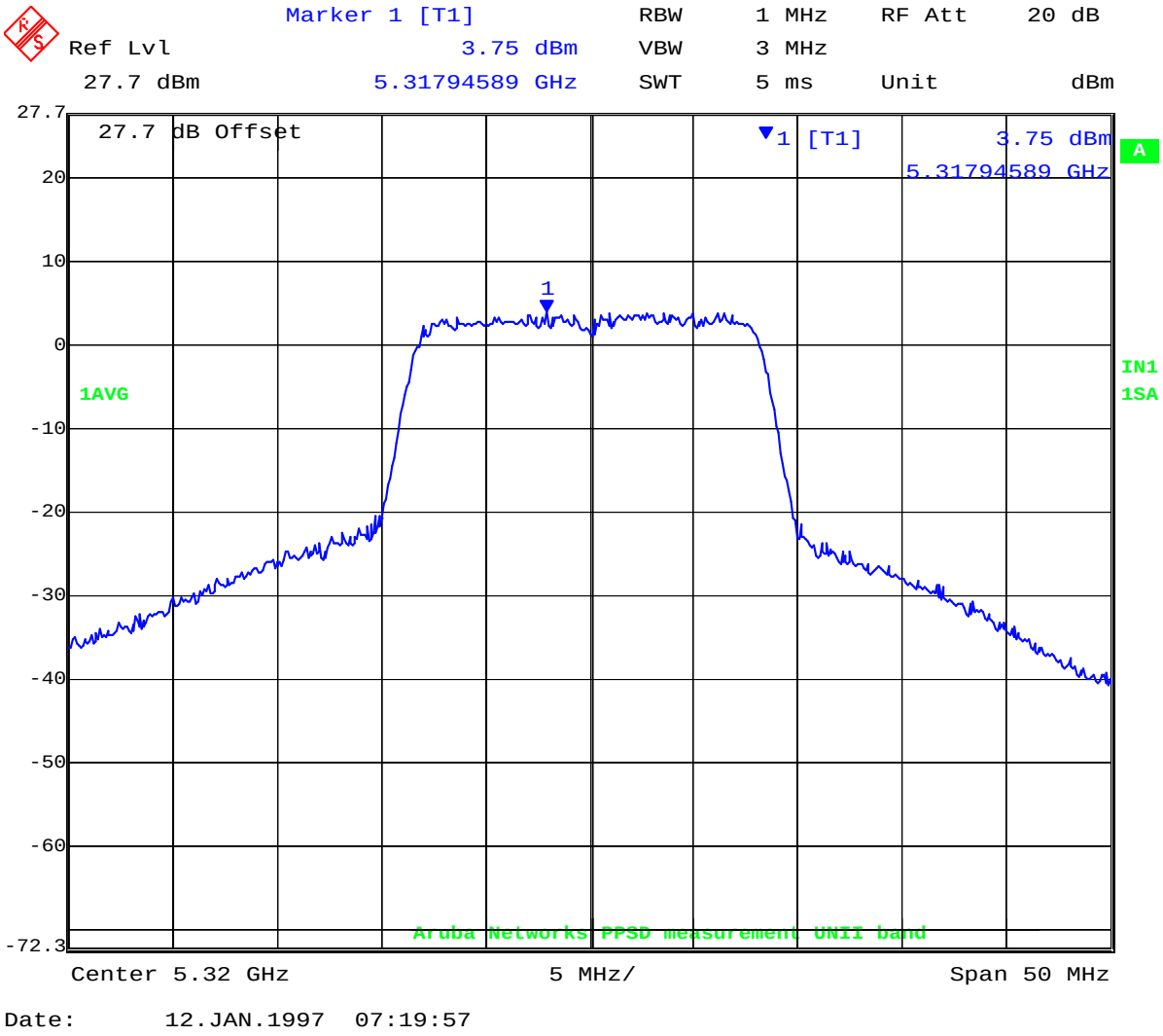


26dB Bandwidth 5,765MHz 54MB TUVR24/10

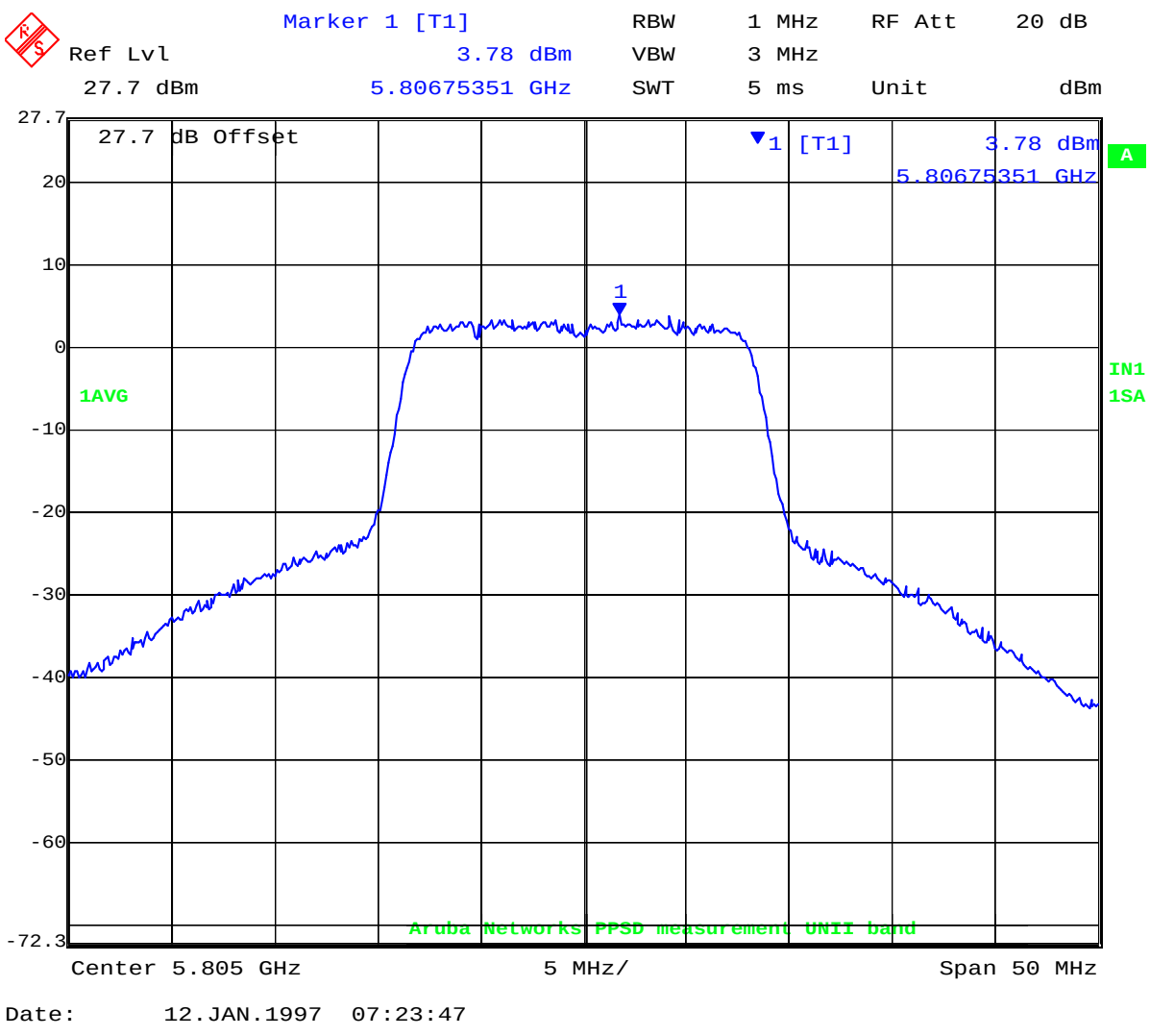


Peak Power Spectral Density (TUVR24/11-12)

PPSD 5,320MHz 36MB TUVR24/11

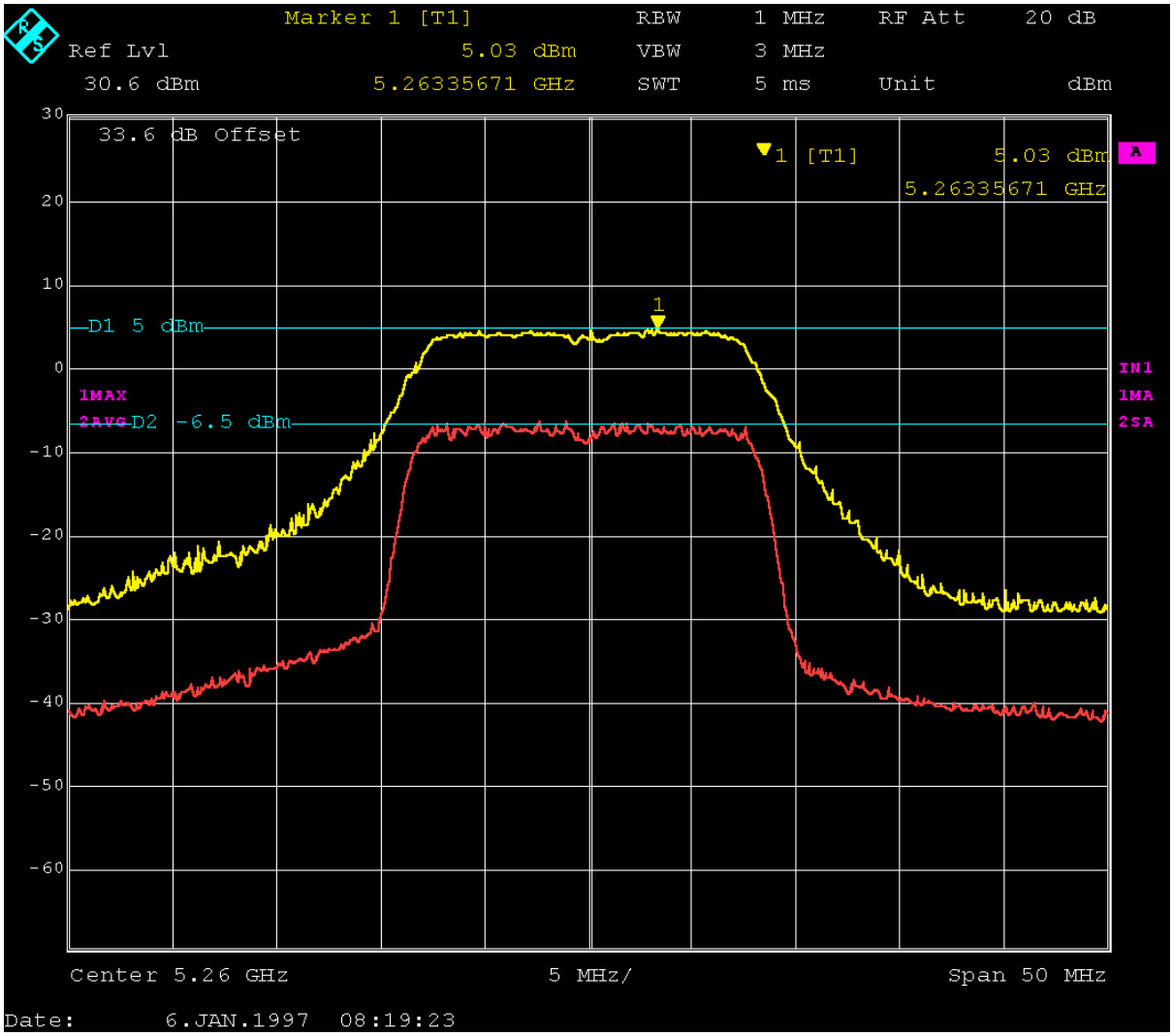


PPSD 5,805MHz 36MB TUVR24/12

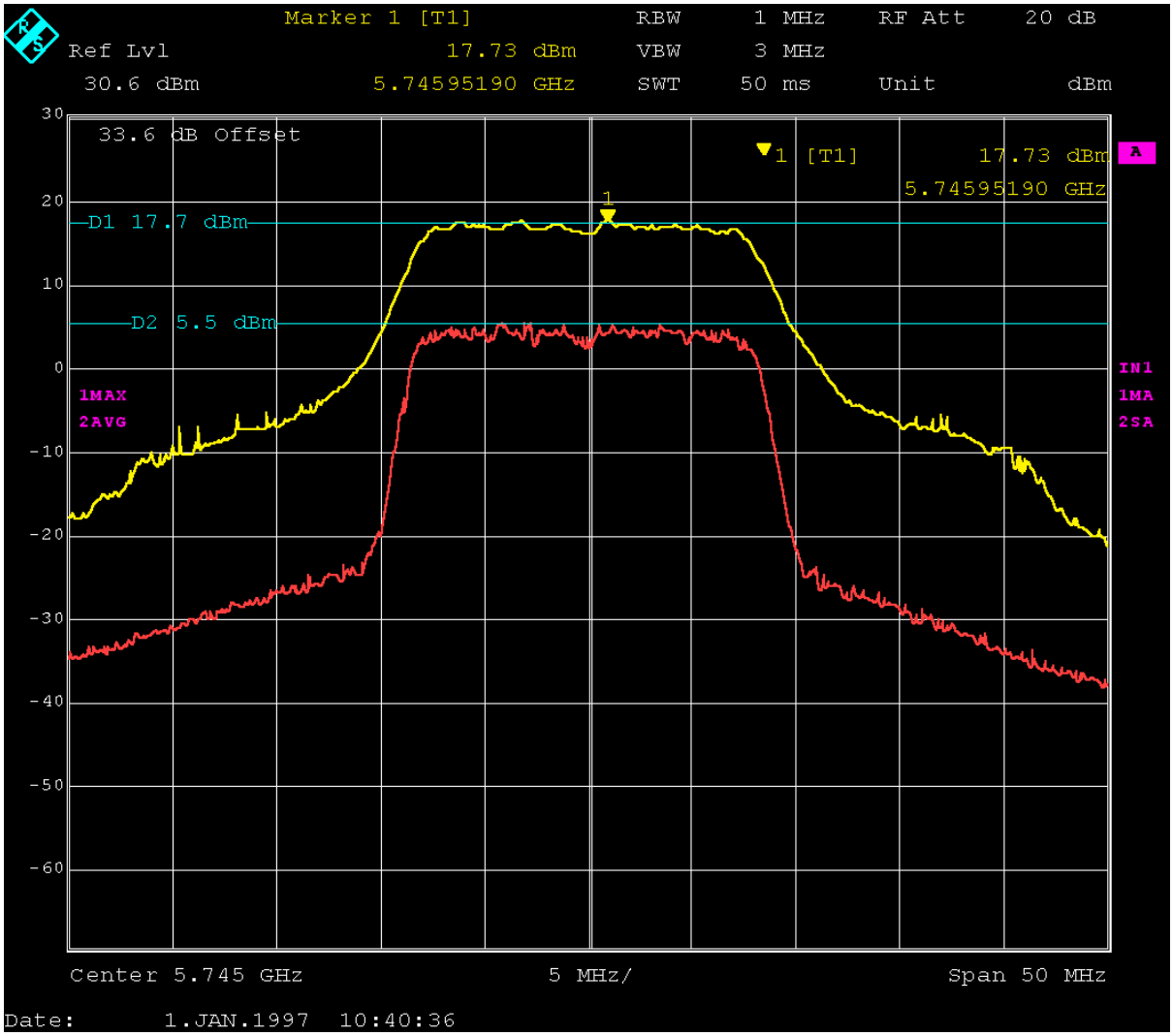


Peak Excursion Ratio (TUVR24/13-14)

Pk Excursion 5,260MHz 54MB TUVR24/13

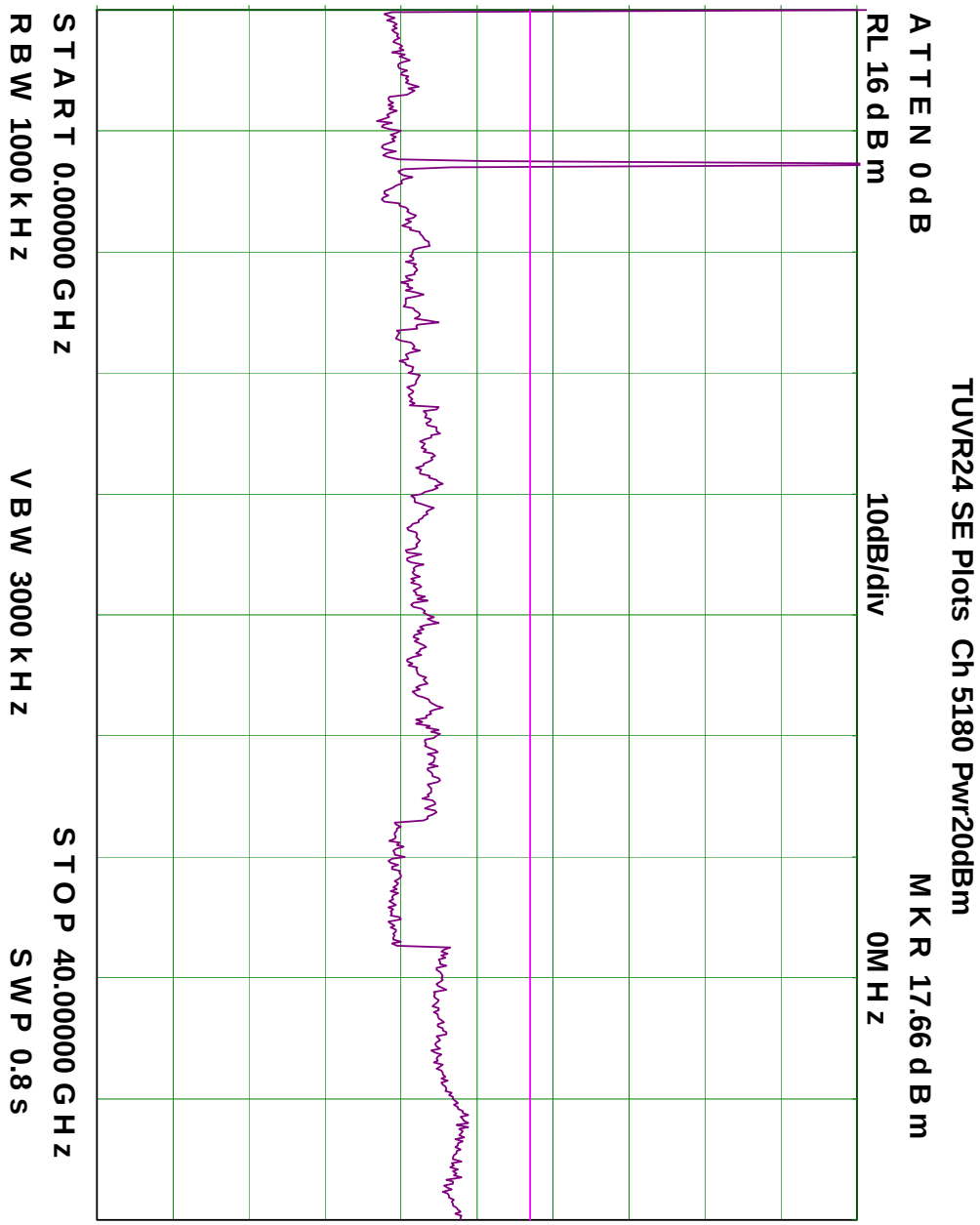


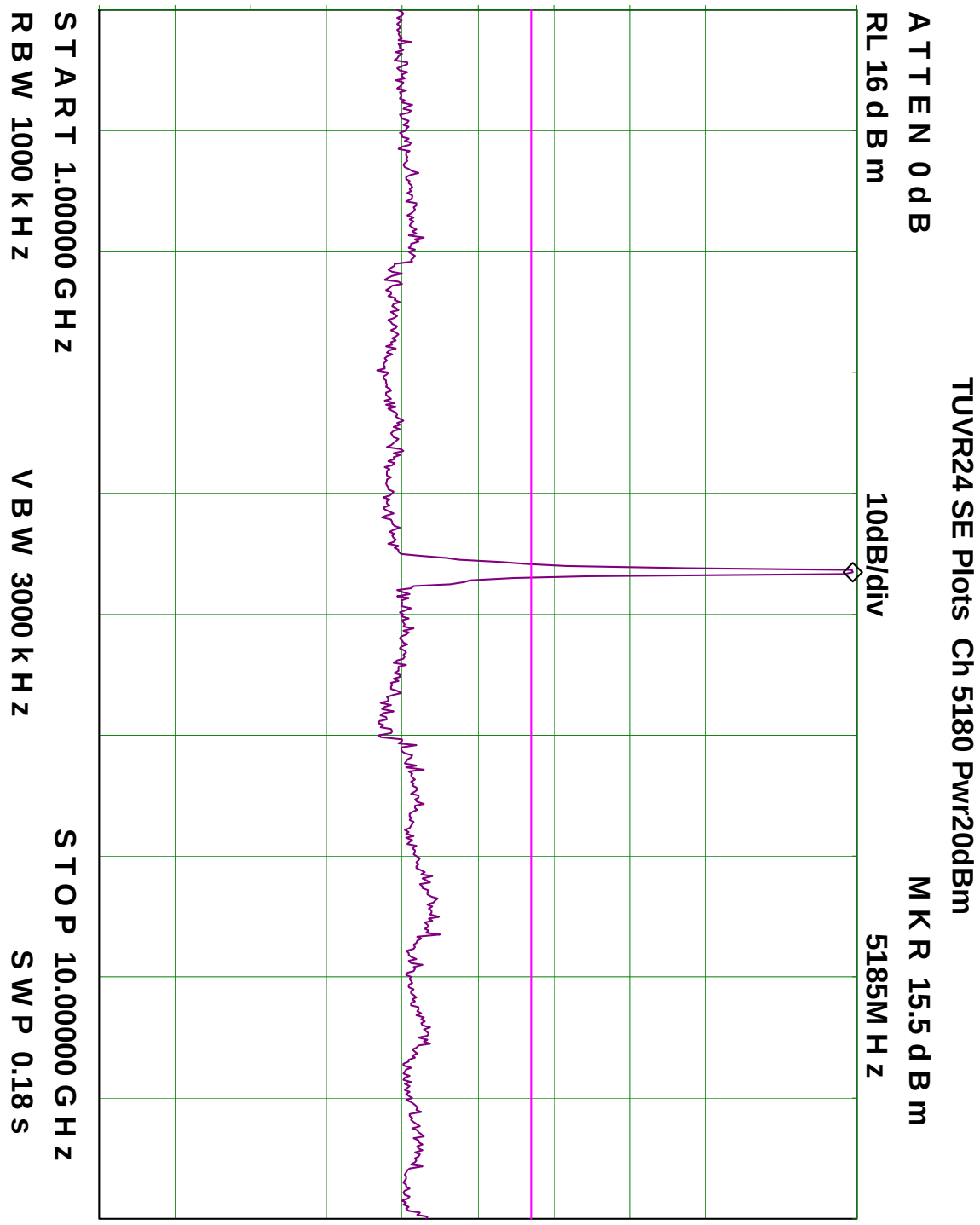
Pk Excursion 5,745MHz 54MB TUVR24/14

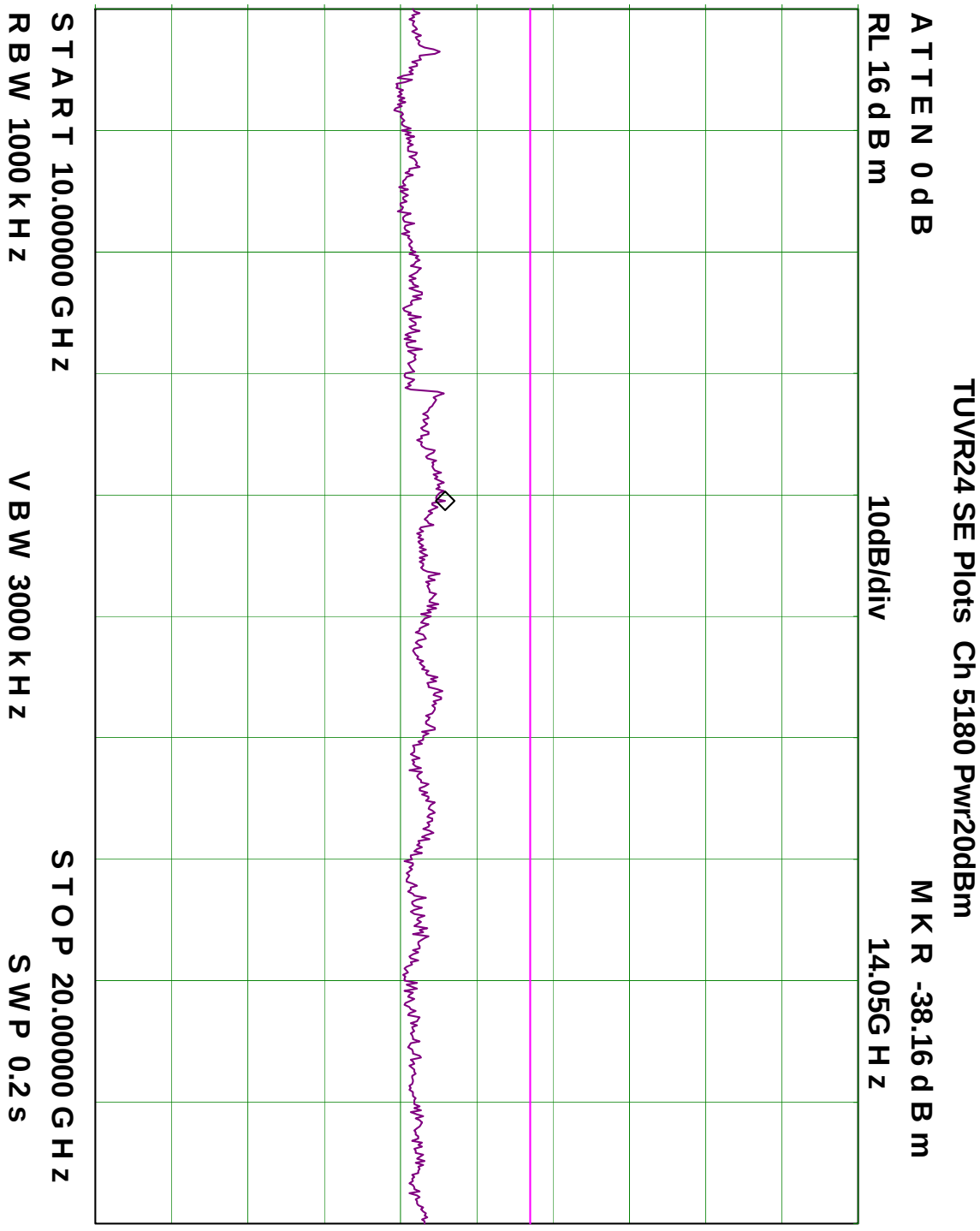


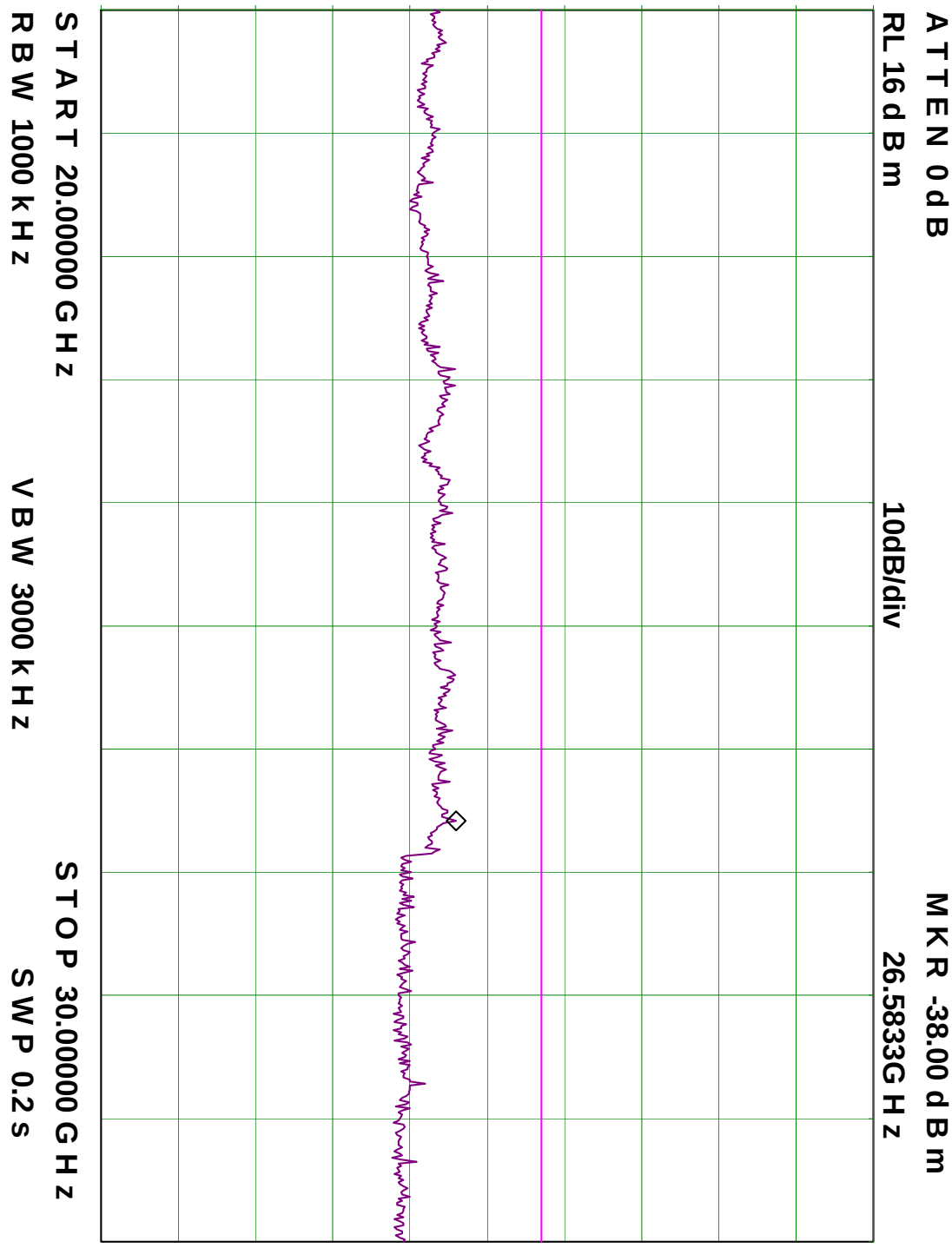
Conducted Spurious Emissions (TUVR24/15-26)

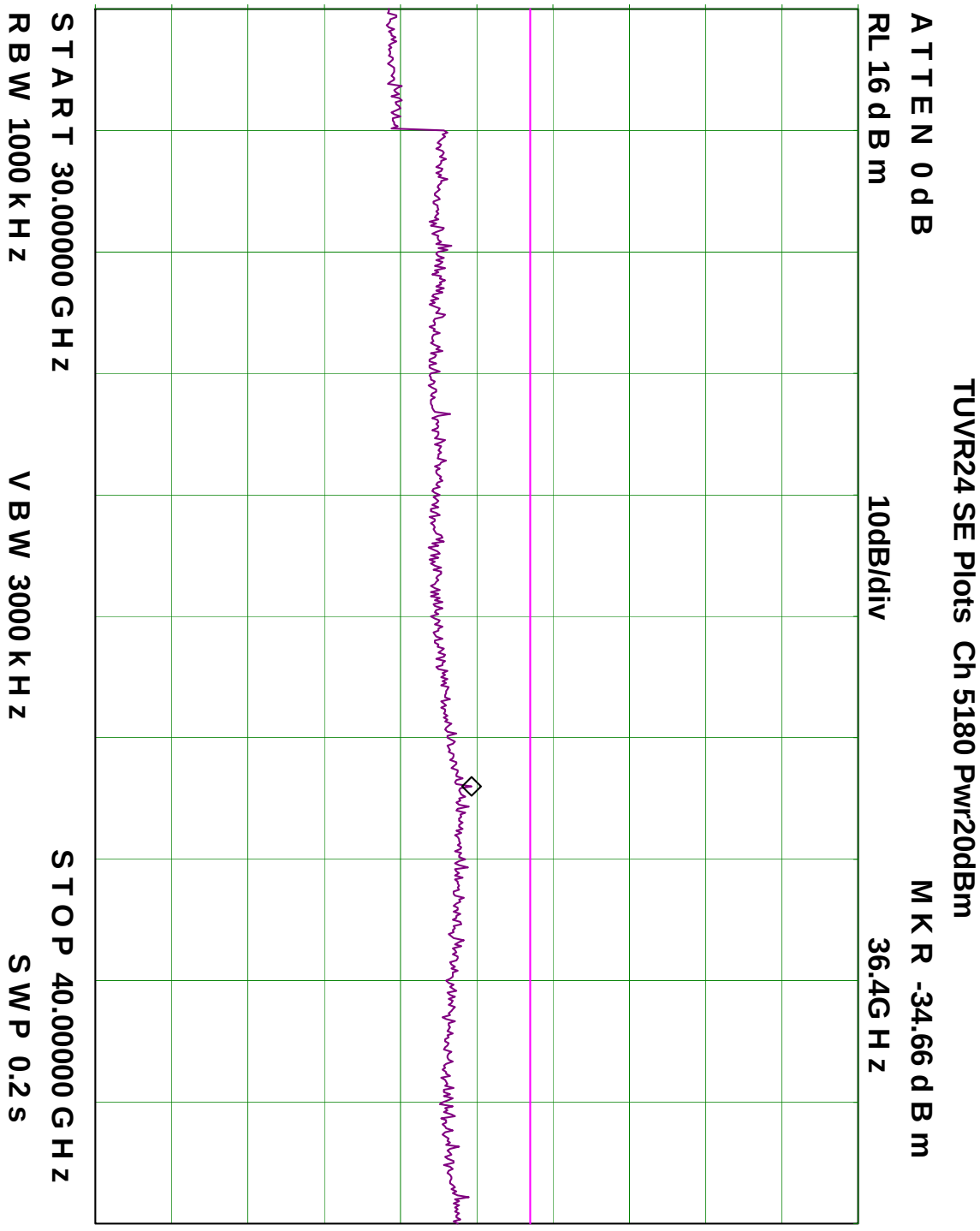
Conducted Spurious Emissions 5,180MHz 54MB TUVR24/15-20

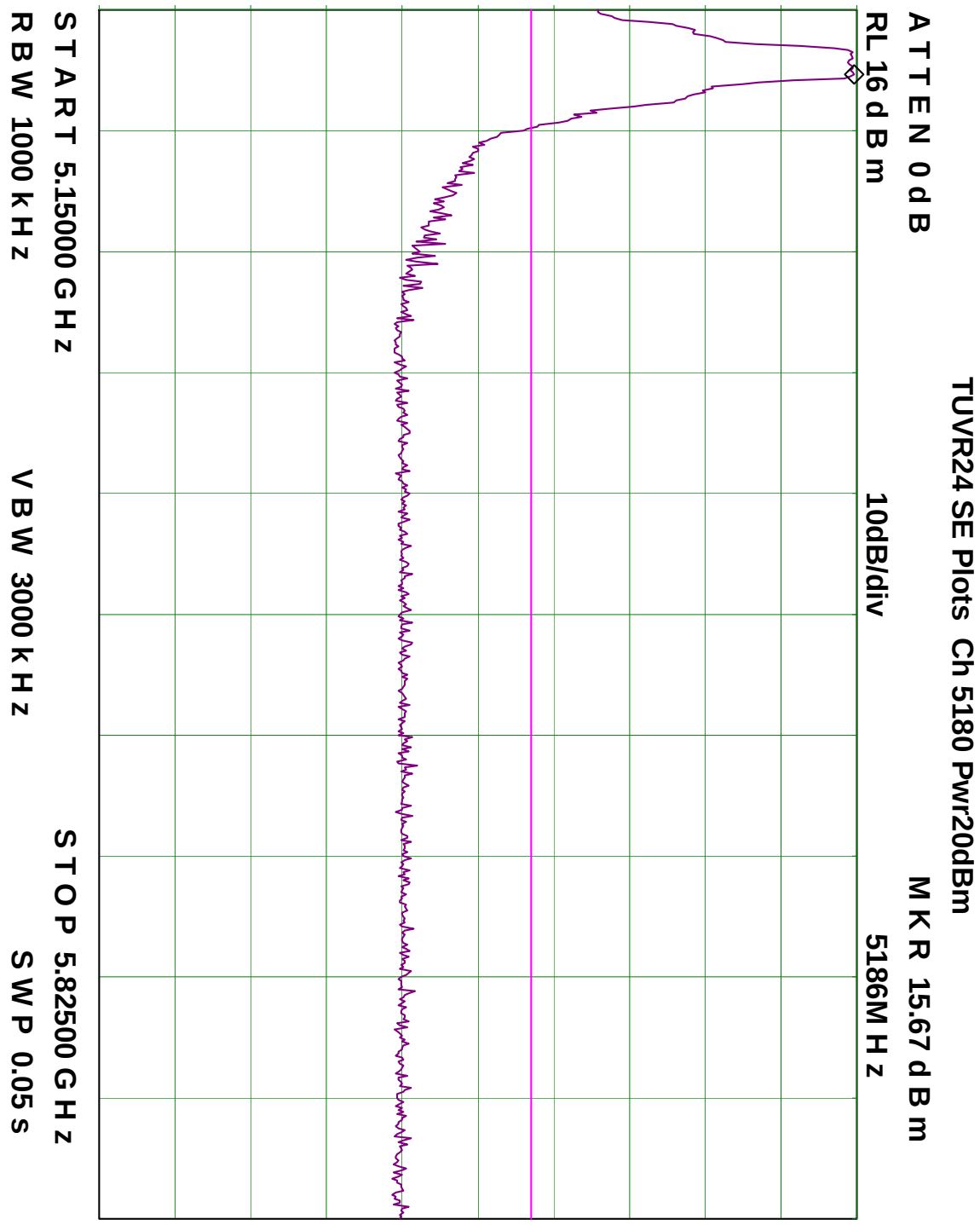



TUVR24 SE Plots Ch 5180 Pwr20dBm
ATTEN 0dB
RL 16 dBm
10dB/div
MKR 15.5 dBm
5185MHz
START 1.00000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 10.00000 GHz
SWP 0.18 s

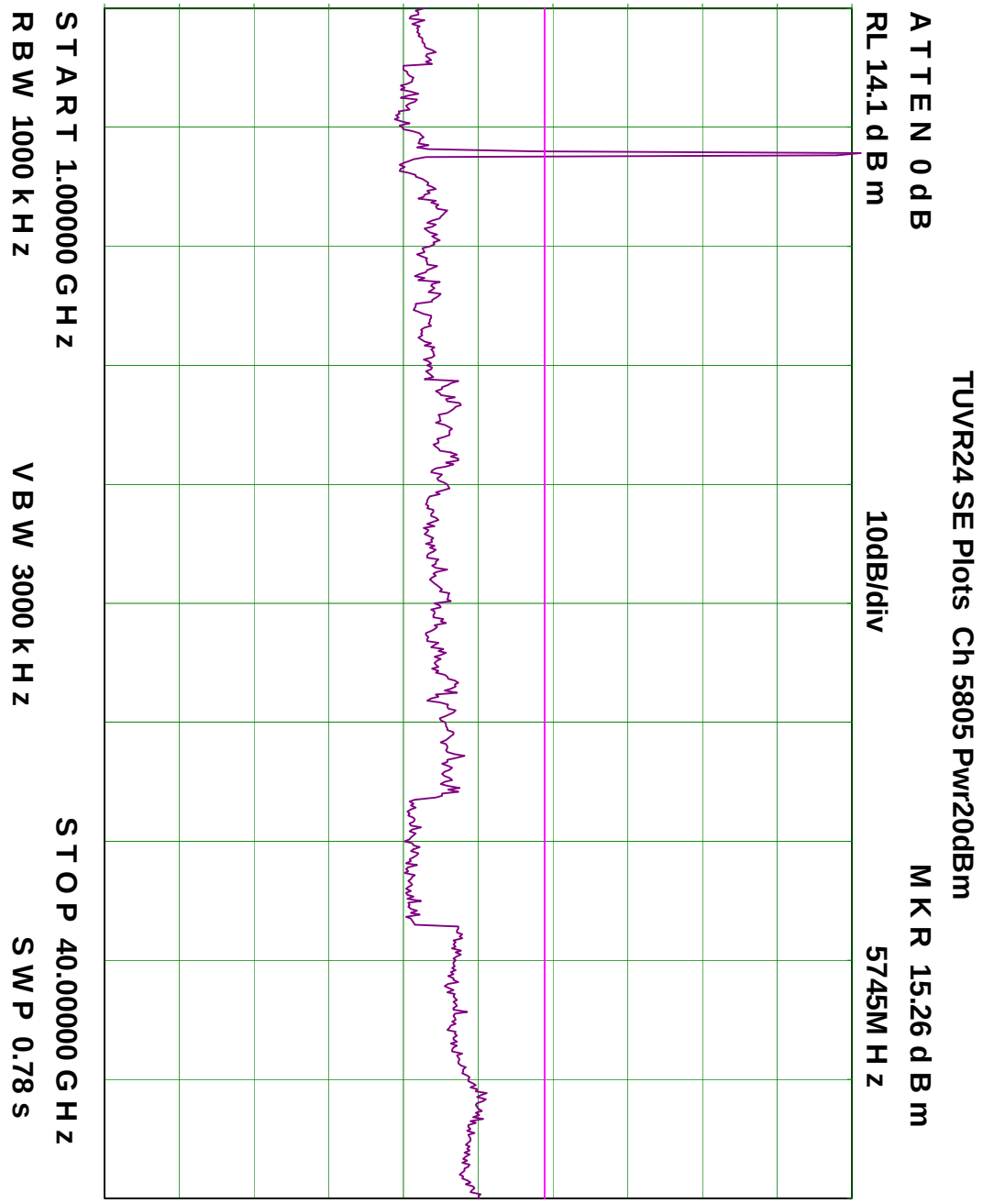

TUVR24 SE Plots Ch 5180 Pwr20dBm
ATTEN 0 dB
RL 16 dBm
10dB/div
MKR -38.16 dBm
14.05GHz
START 10.0000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 20.0000 GHz
SWP 0.2s

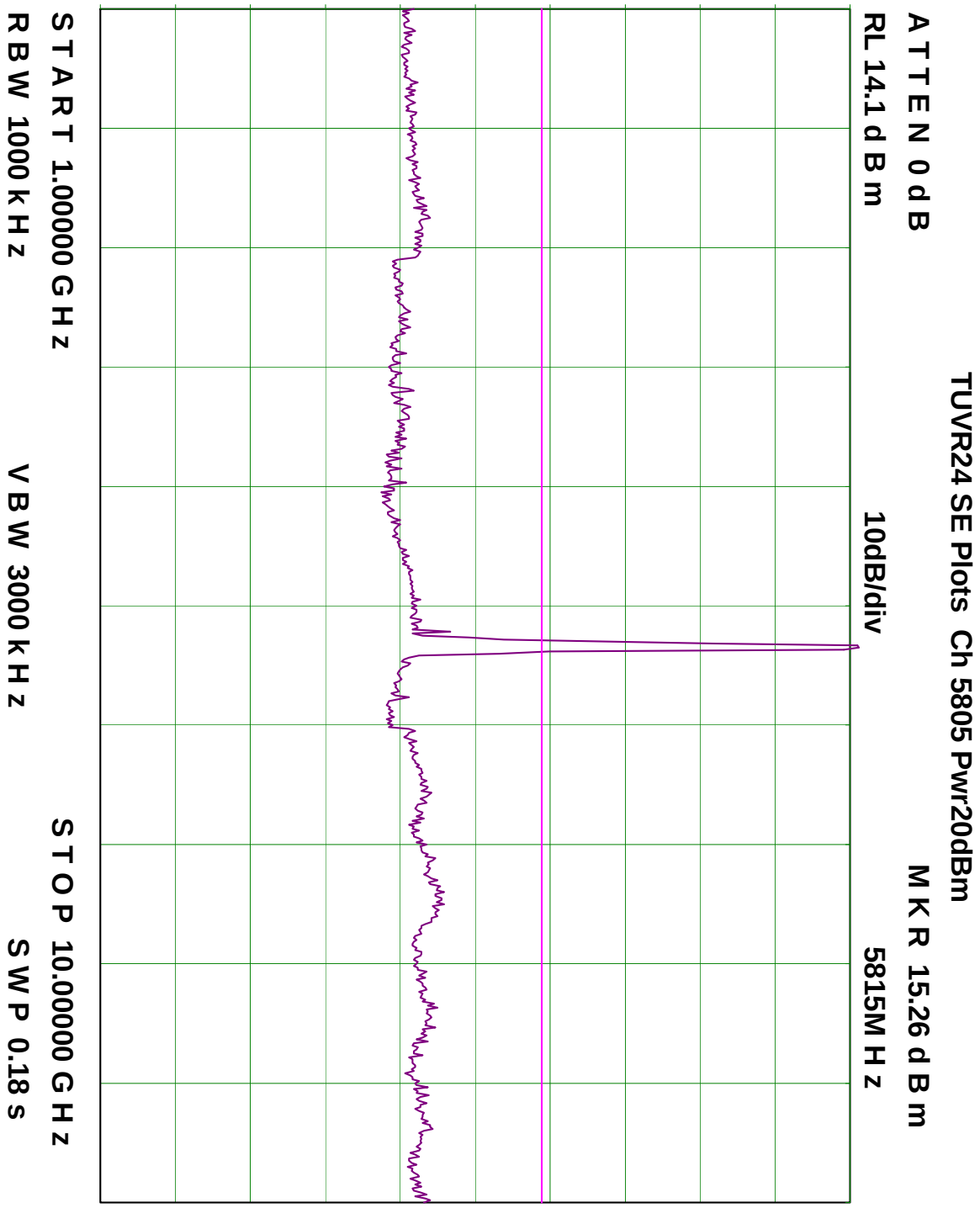

TUVR24 SE Plots Ch 5180 Pwr20dBm
ATTEN 0 dB
RL 16 dBm
10dB/div
MKR -38.00 dBm
26.5833GHz
START 20.00000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 30.00000 GHz
SWP 0.2s

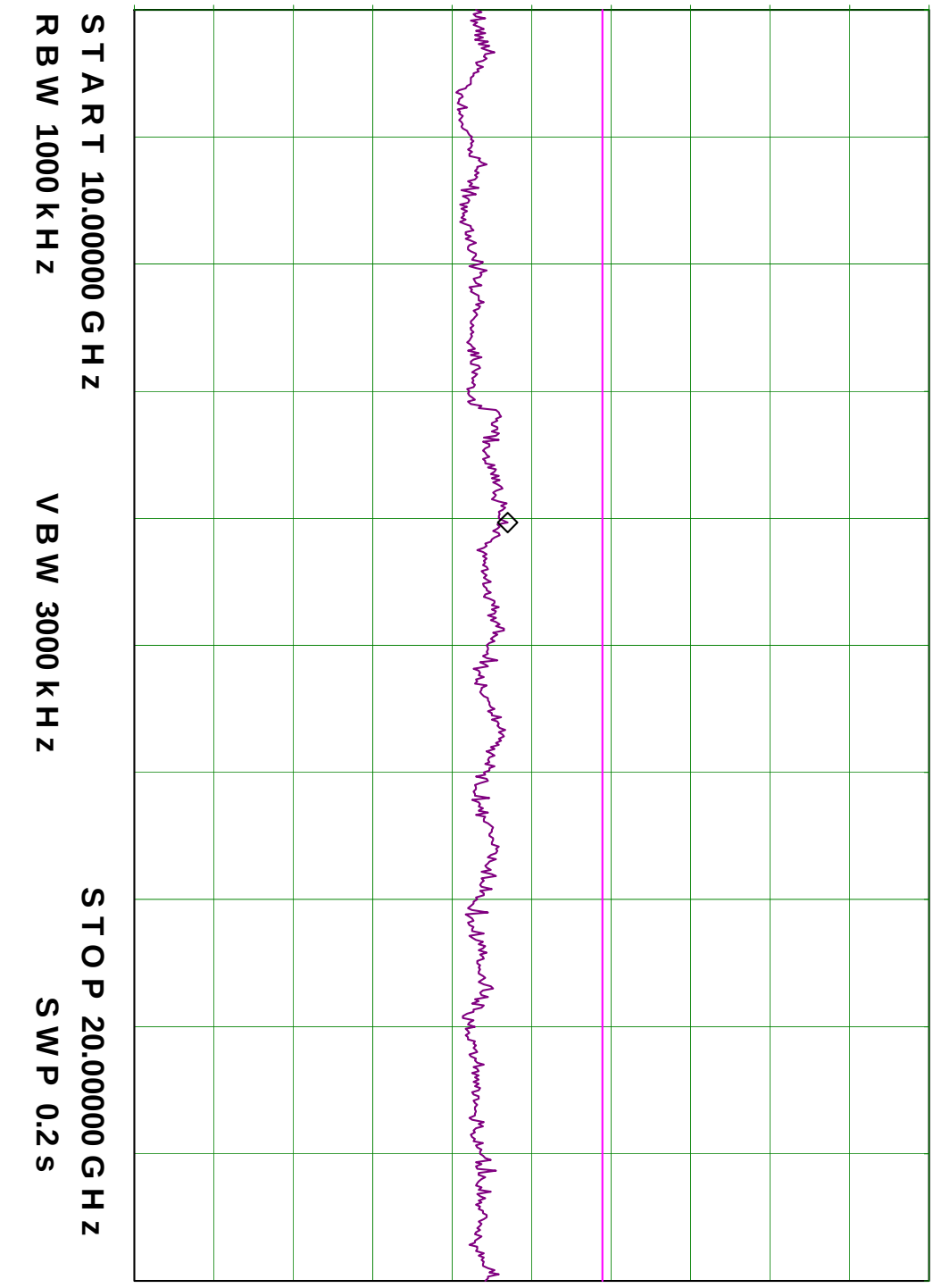

TUVR24 SE Plots Ch 5180 Pwr20dBm
ATTEN 0 dB
RL 16 dBm
10dB/div
MKR -34.66 dBm
36.4GHz
START 30.0000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 40.0000 GHz
SWP 0.2s

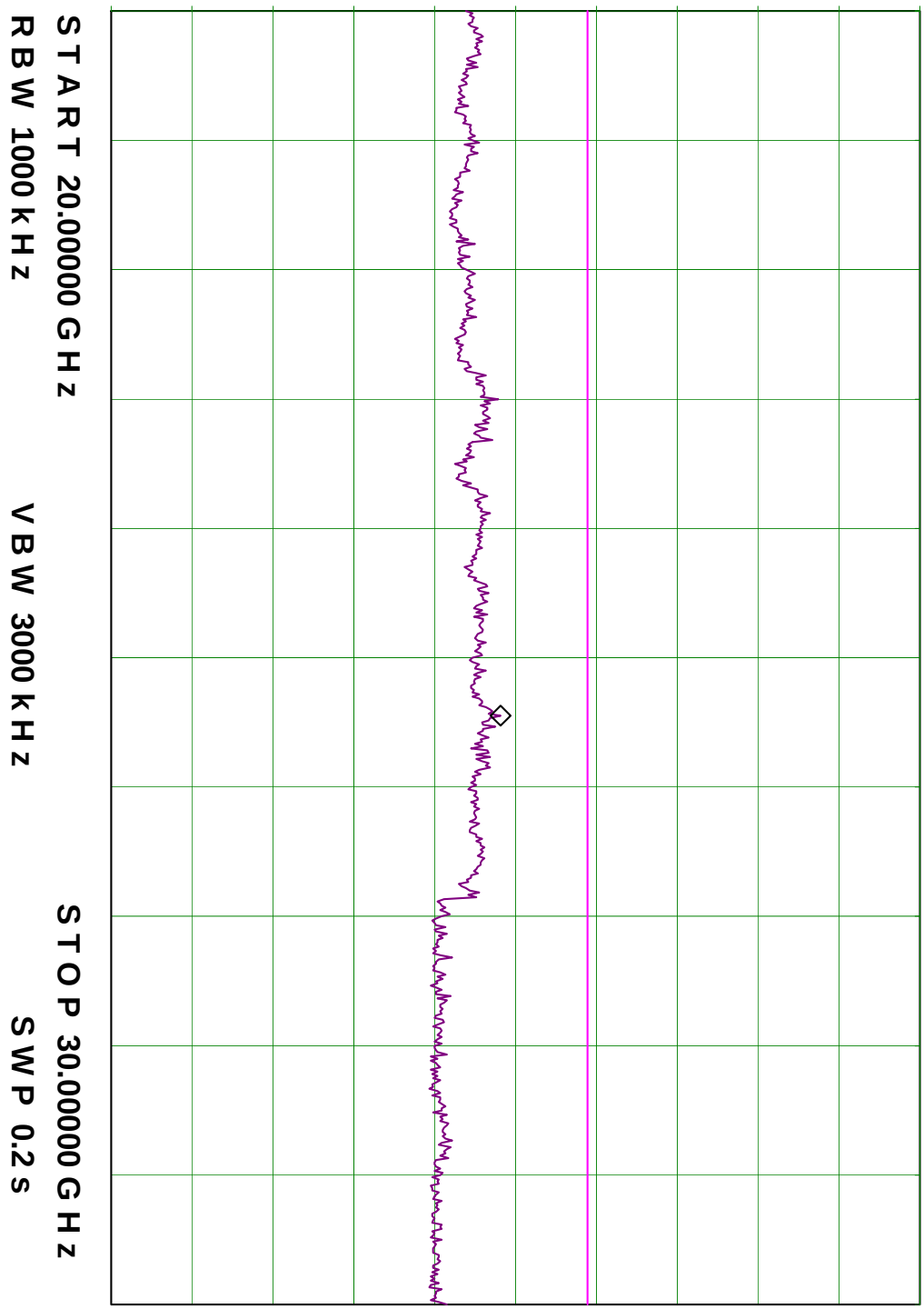

TUVR24 SE Plots Ch 5180 Pwr20dBm
ATTEN 0 dB
RL 16 dB m
10dB/div
MKR 15.67 dB m
5186M Hz
START 5.15000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 5.82500 GHz
SWP 0.05 s

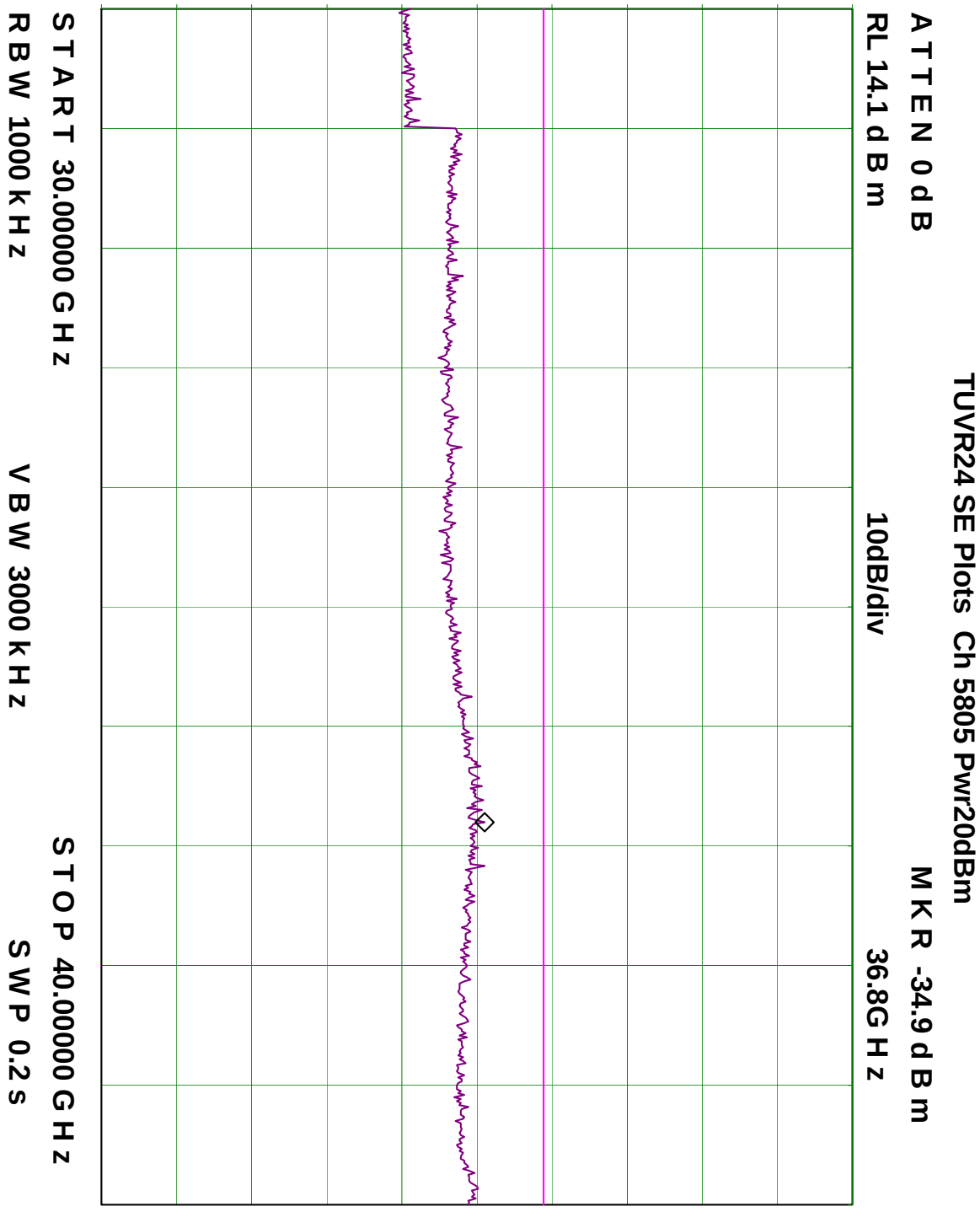
Conducted Spurious Emissions 5,805MHz 54MB TUVR24/21-26

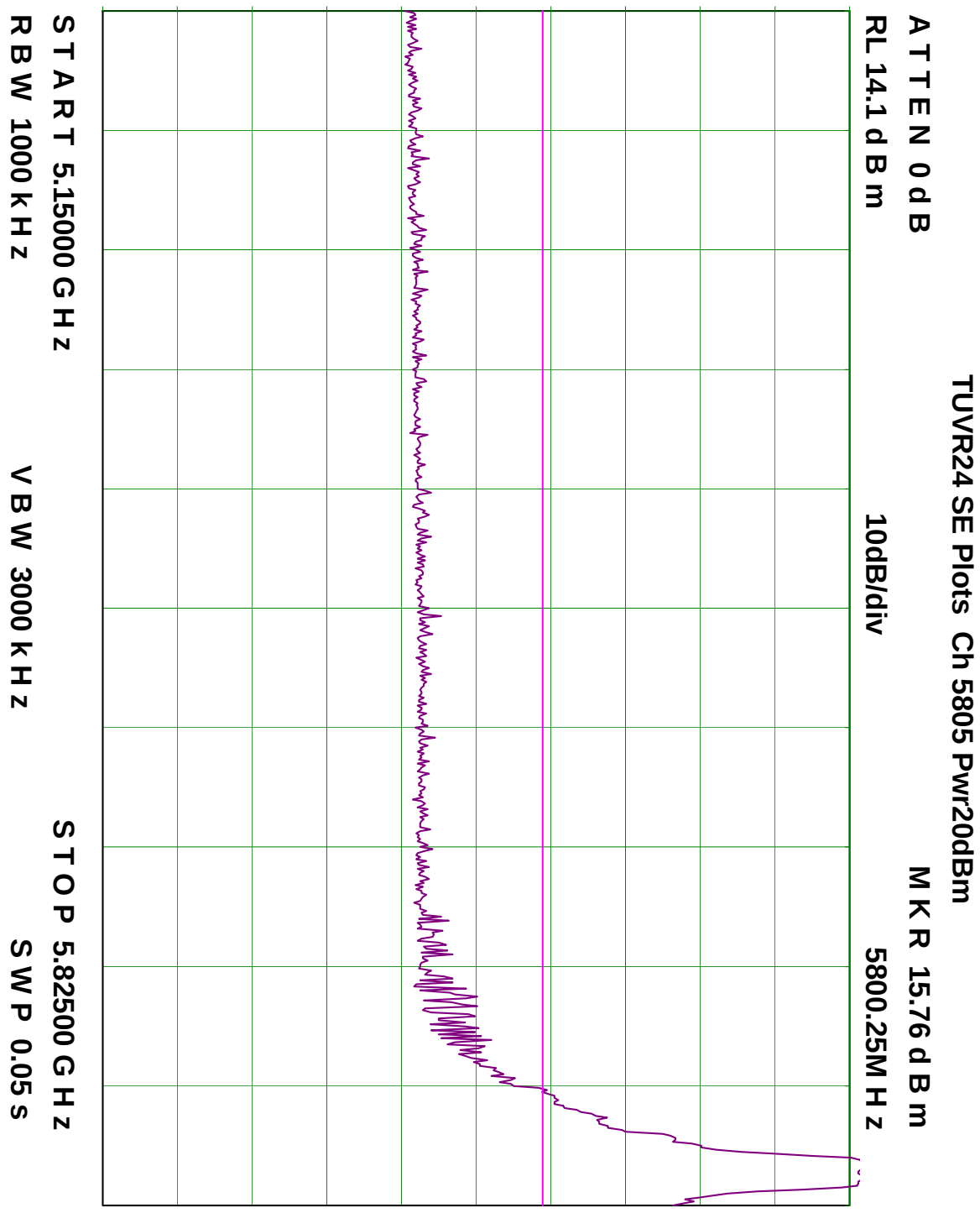



TUVR24 SE Plots Ch 5805 Pwr20dBm
ATTEN 0 dB
RL 14.1 dBm
10dB/div
MKR 15.26 dBm
5815MHz
START 1.00000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 10.00000 GHz
SWP 0.18 s


TUVR24 SE Plots Ch 5805 Pwr20dBm
ATTEN 0dB
RL 14.1dBm
10dB/div
MKR -38.9dBm
14.033GHz
START 10.00000GHz
RBW 1000kHz
VBW 3000kHz
STOP 20.00000GHz
SWP 0.2s

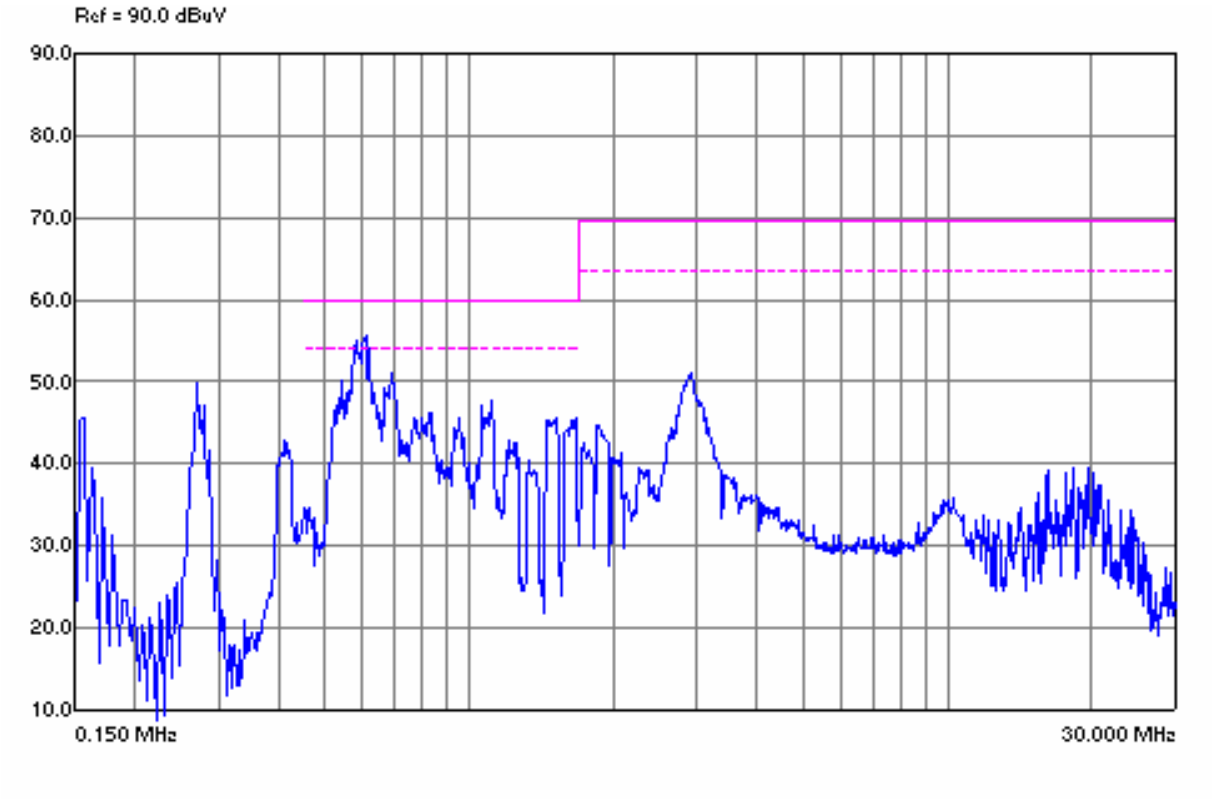

TUVR24 SE Plots Ch 5805 Pwr20dBm
ATTEN 0 dB
RL 14.1 dBm
10dB/div
MKR -37.73 dBm
25.45GHz
START 20.00000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 30.00000 GHz
SWP 0.2 s


TUVR24 SE Plots Ch 5805 Pwr20dBm
ATTEN 0 dB
RL 14.1 dBm
10dB/div
MKR -34.9 dBm
36.8GHz
START 30.00000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 40.00000 GHz
SWP 0.2 s

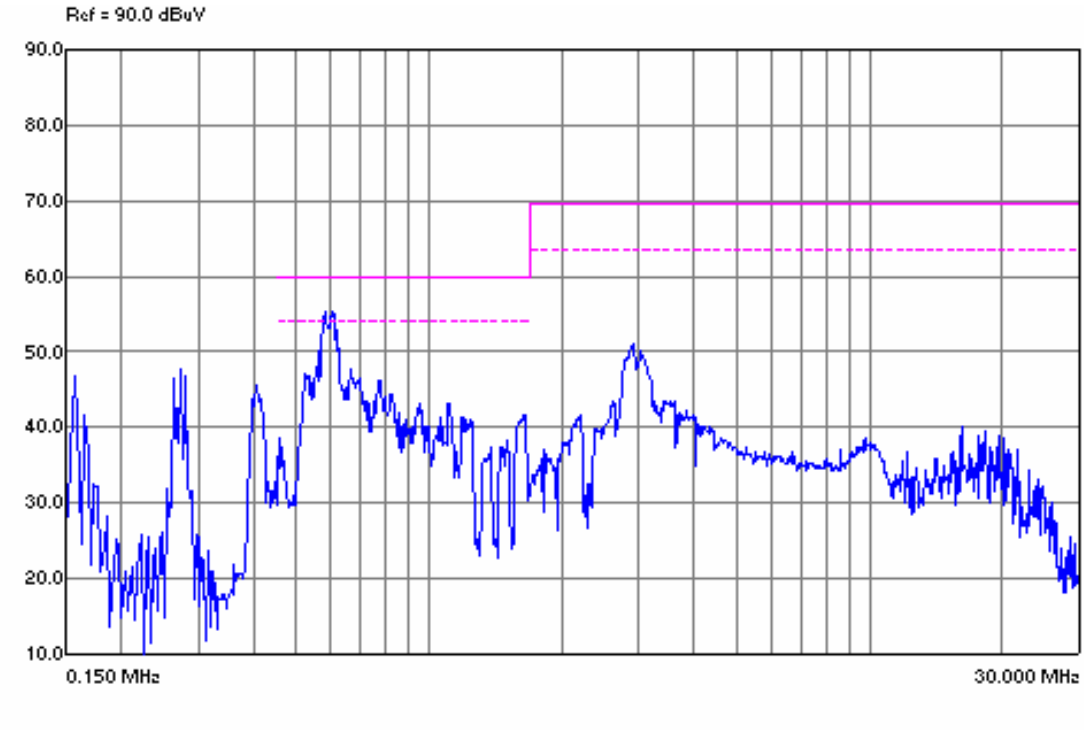

TUVR24 SE Plots Ch 5805 Pwr20dBm
ATTEN 0 dB
RL 14.1 dBm
10dB/div
MKR 15.76 dBm
5800.25MHz
START 5.15000 GHz
RBW 1000 kHz
VBW 3000 kHz
STOP 5.82500 GHz
SWP 0.05 s

AC Wireline Emissions (TUVR24/27-28)

AC Wireline Emissions L (Live) TUVR24/27

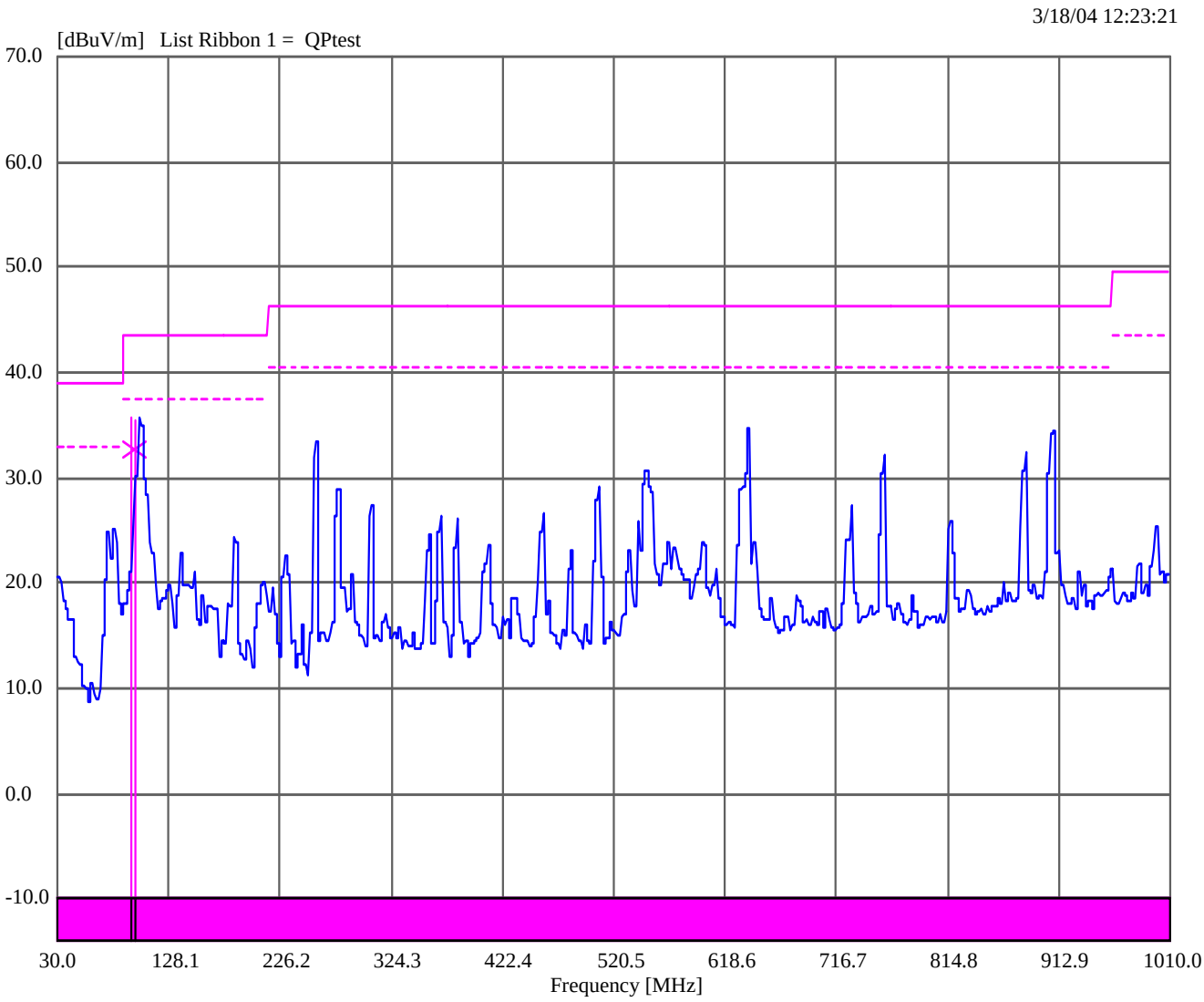


AC Wireline Emissions N (Neutral) TUVR24/28

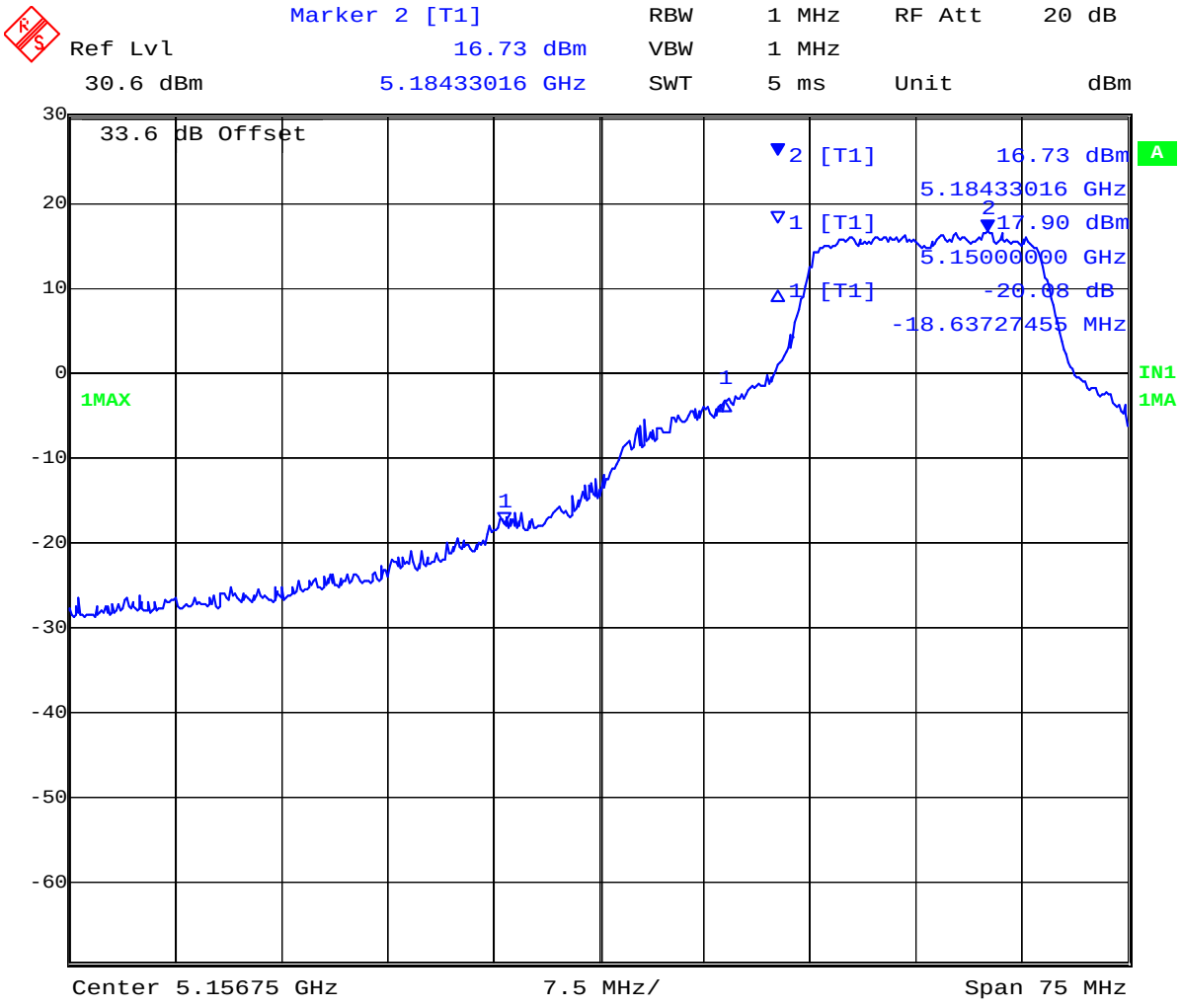


Spurious Emissions <1GHz Plots (30-1GHz) (TUVR24/29)

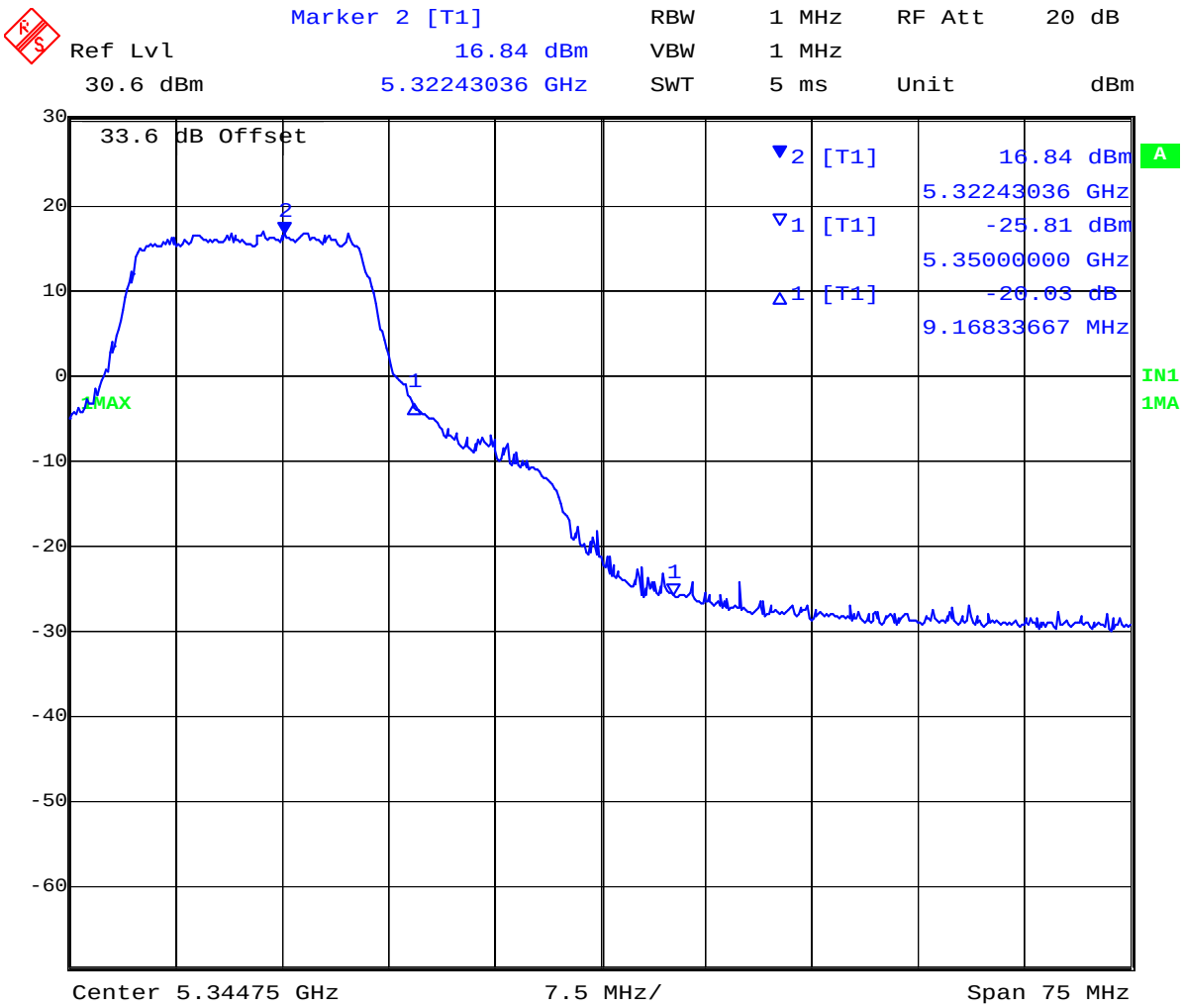
SE <1GHz TUVR24/29



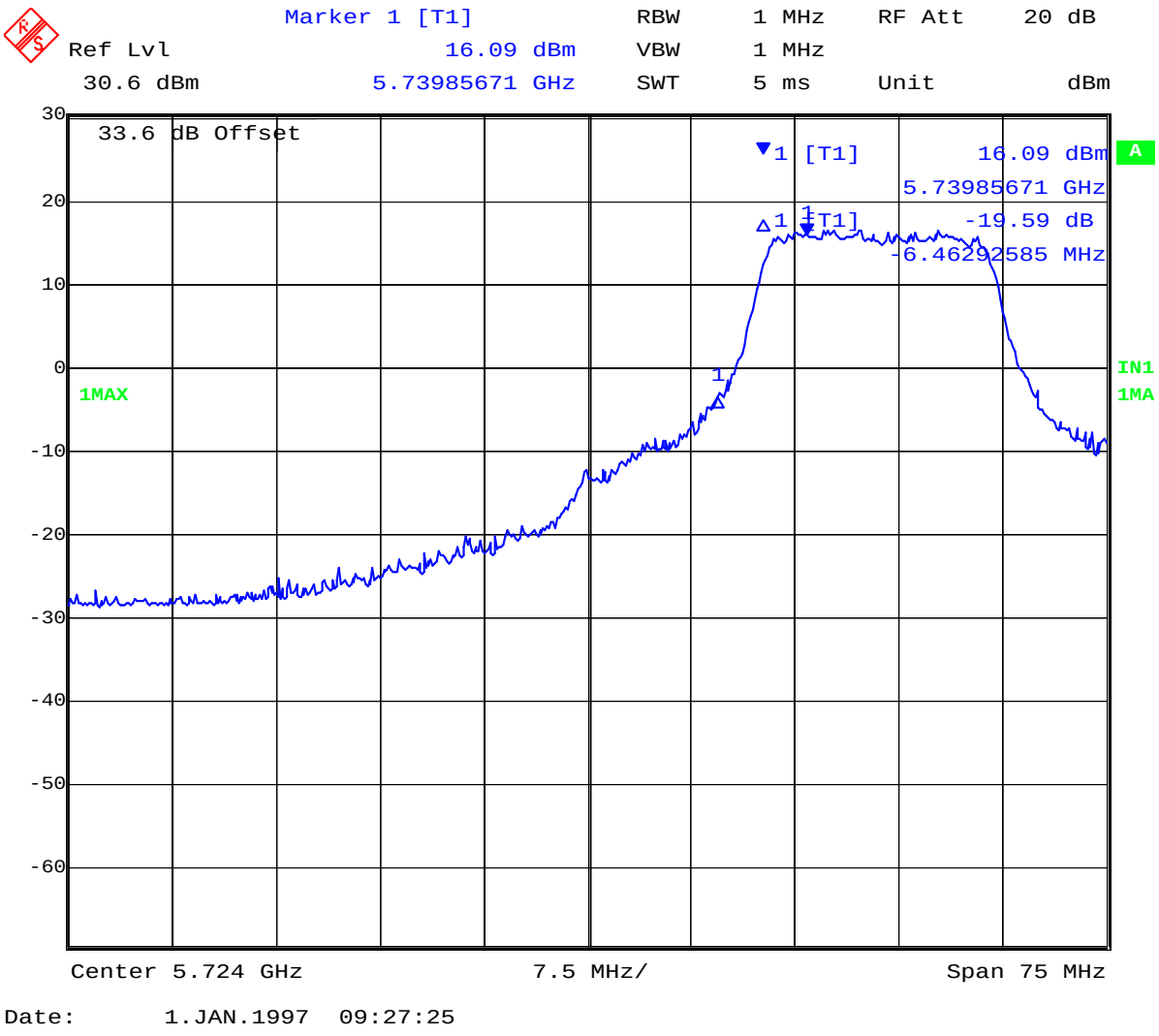
Spurious Emissions >1GHz Plots (Band-edge 5,150MHz) (TUVR24/30)



Spurious Emissions >1GHz Plots (Band-edge 5,350MHz) (TUVR24/31)

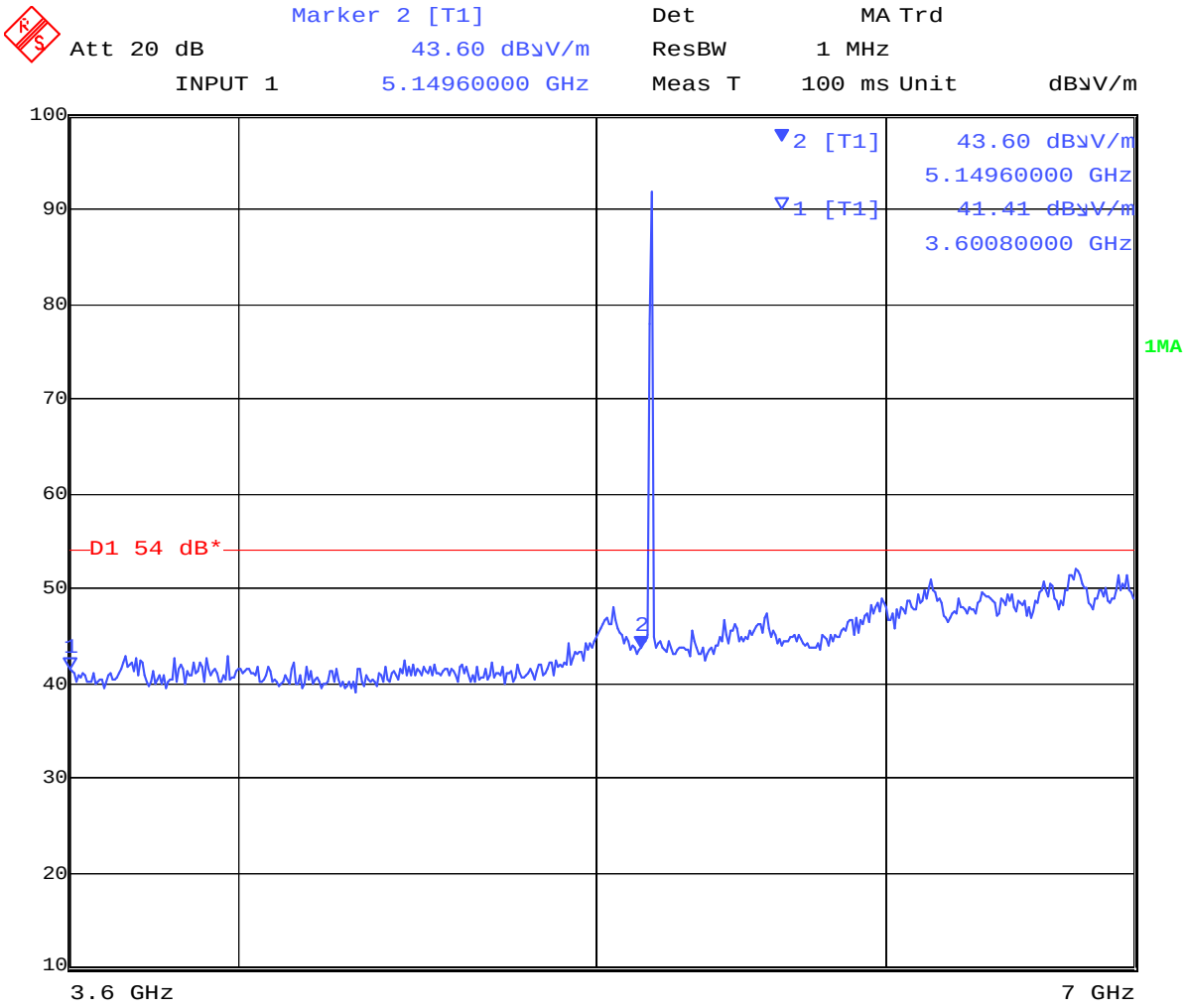


Spurious Emissions >1GHz Plots (Band-edge 5,725MHz) (TUVR24/32)

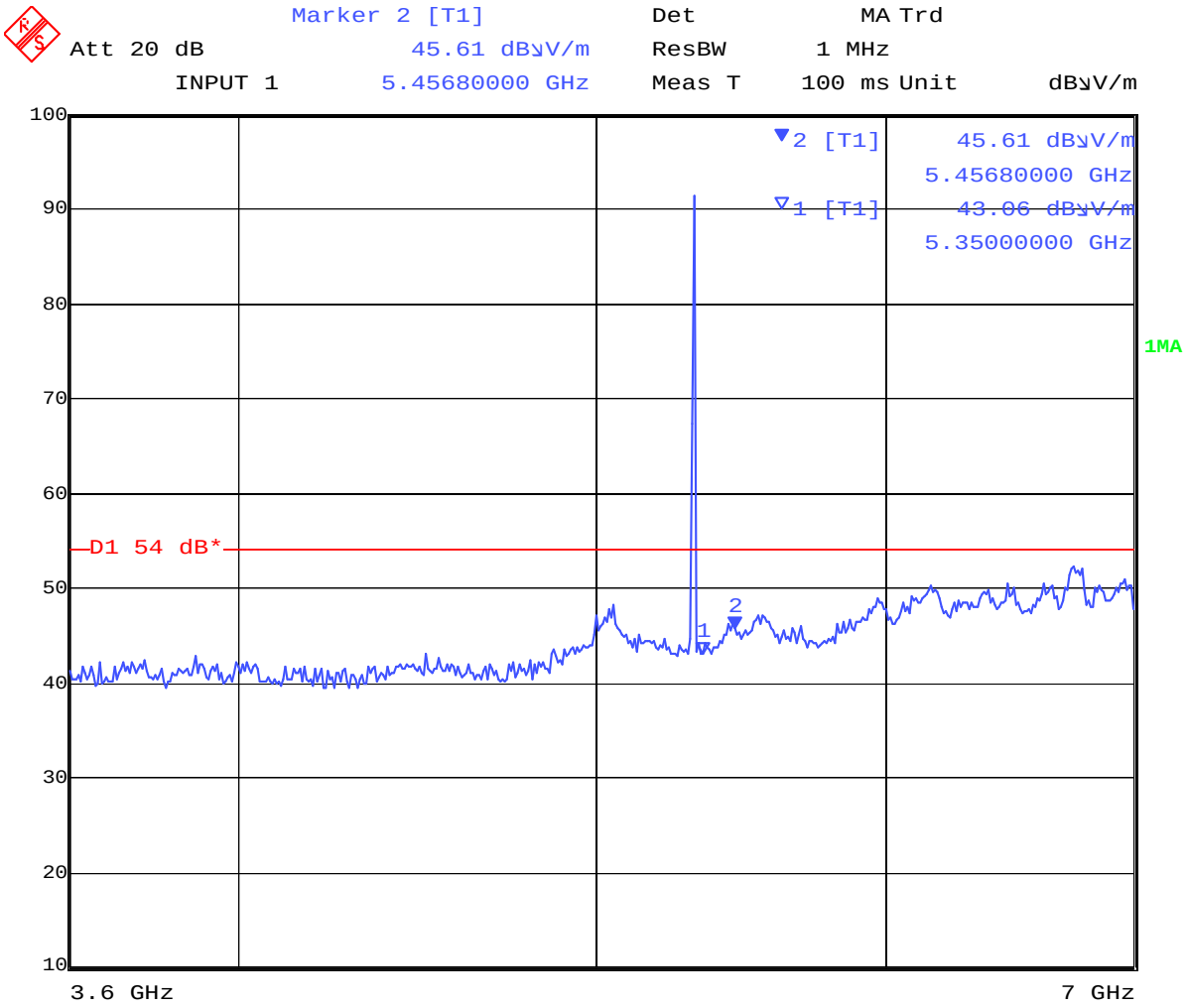


Spurious Emissions >1GHz Plots (Band-edge 5,825MHz) (TUVR24/33)

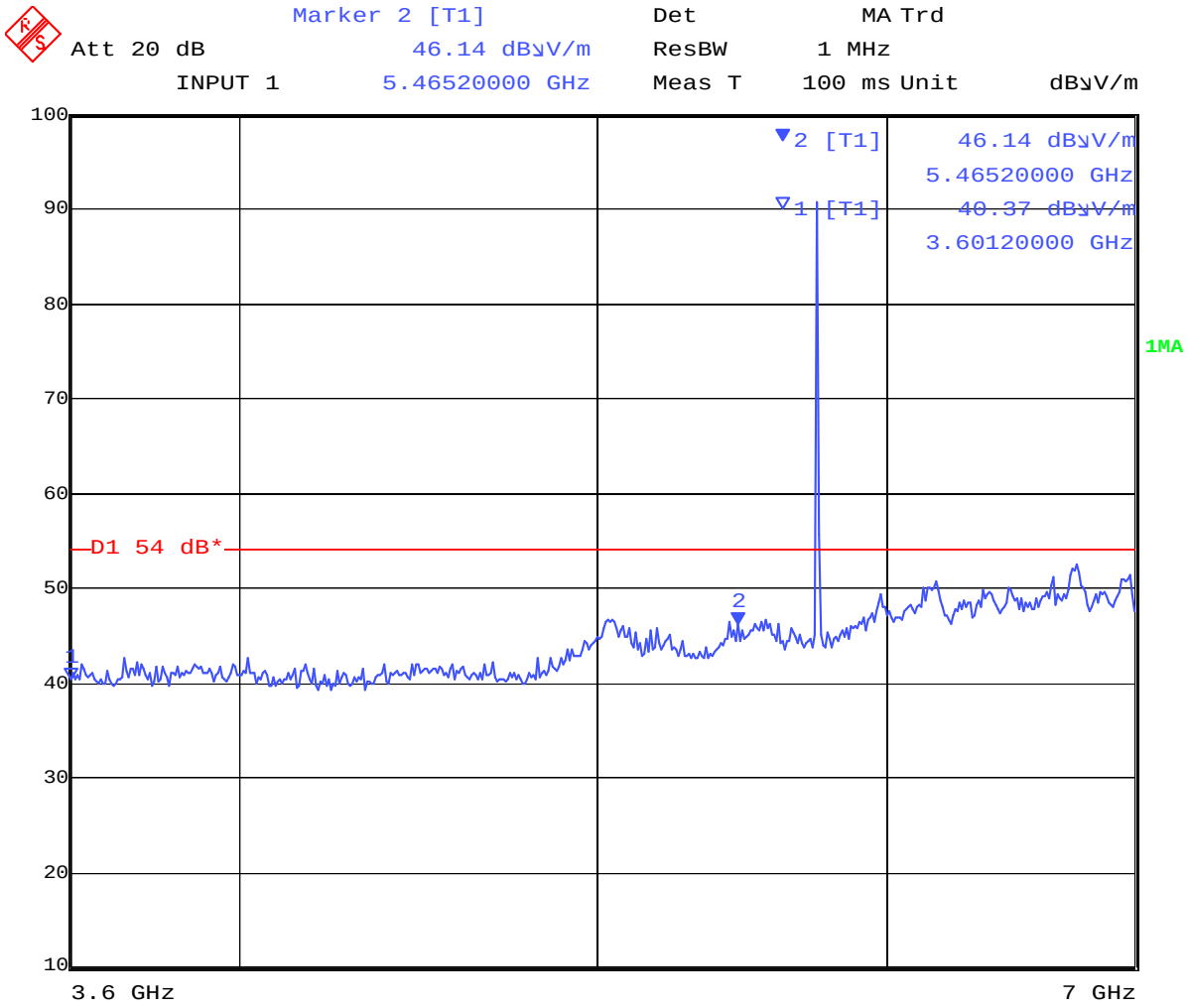
Spurious Emissions >1GHz Plots Restricted Bands 5,150MHz (TUVR24/34)



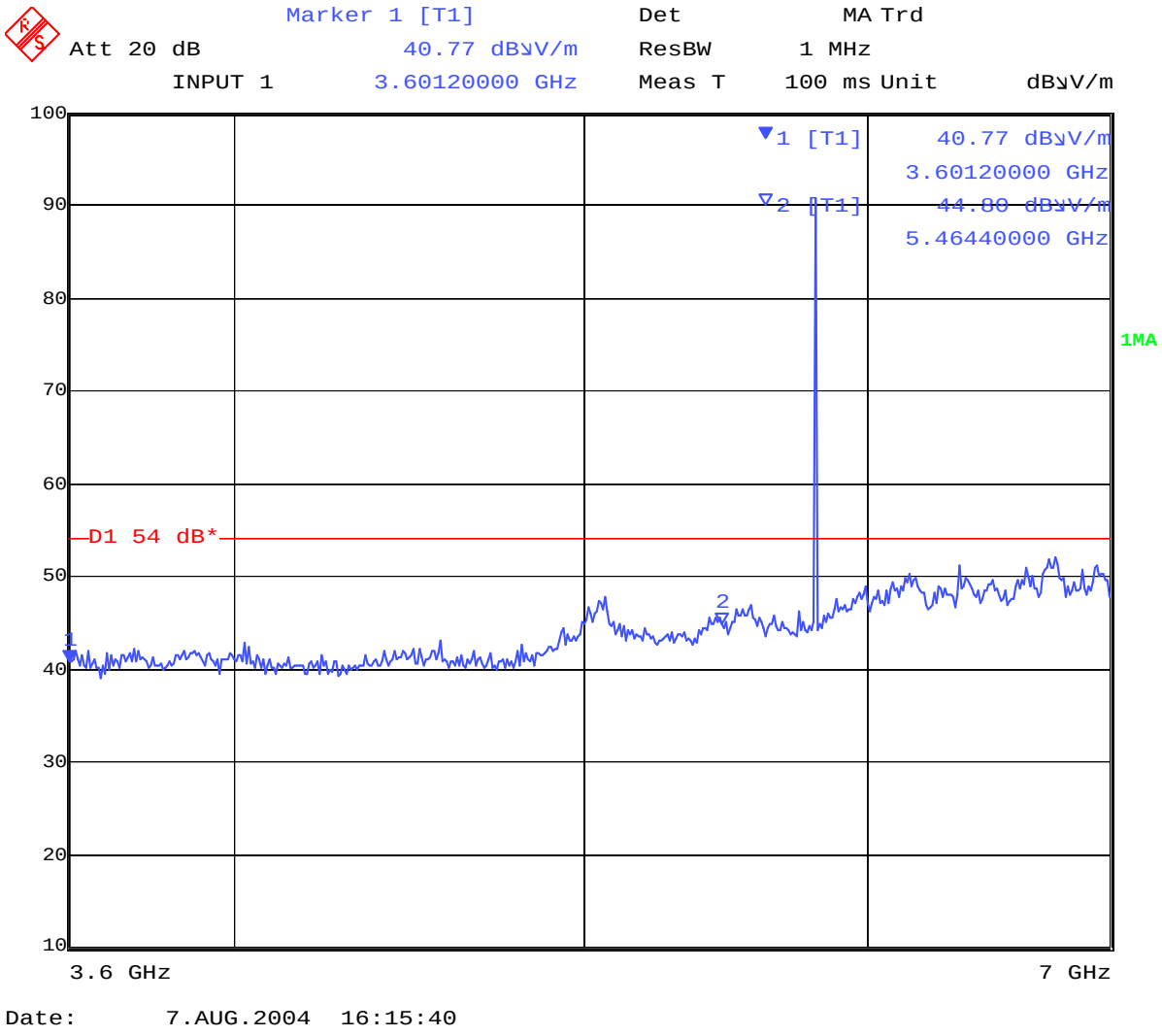
Spurious Emissions >1GHz Plots Restricted Bands 5,320MHz (TUVR24/35)



Spurious Emissions >1GHz Plots Restricted Bands 5,475MHz (TUVR24/35)



Spurious Emissions >1GHz Plots Restricted Bands 5,805MHz (TUVR24/35)



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