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Test of iSWITCH-Wireless Universal Footswitch

To FCC 47 CFR Part15.249/209 & IC RSS-210

Test Report Serial No.: TUVR29-A1 REV D

TEST REPORT

FROM

Test of iSWITCH - Wireless Universal Footswitch

To FCC 47 CFR Part15.249/209 & IC RSS-210

Test Report Serial No.: TUVR29-A1 Rev D

This report supersedes TUVR29-A1 Rev C

Manufacturer: Stryker Endoscopy
5900 Optical Court
San Jose, California 95138, USA
USA

Product Function: Wireless Medical Remote Control System

Copy No: pdf **Issue Date:** 27th January '05

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
3922 Valley Avenue, Suite B
Pleasanton, California 94566, USA
Phone: 925.462.0304
Fax: 925.462.0306
www.micomlabs.com

UKAS TESTING
2106

MiCOM Labs is a UKAS (United Kingdom Accreditation Service) Testing Laboratory

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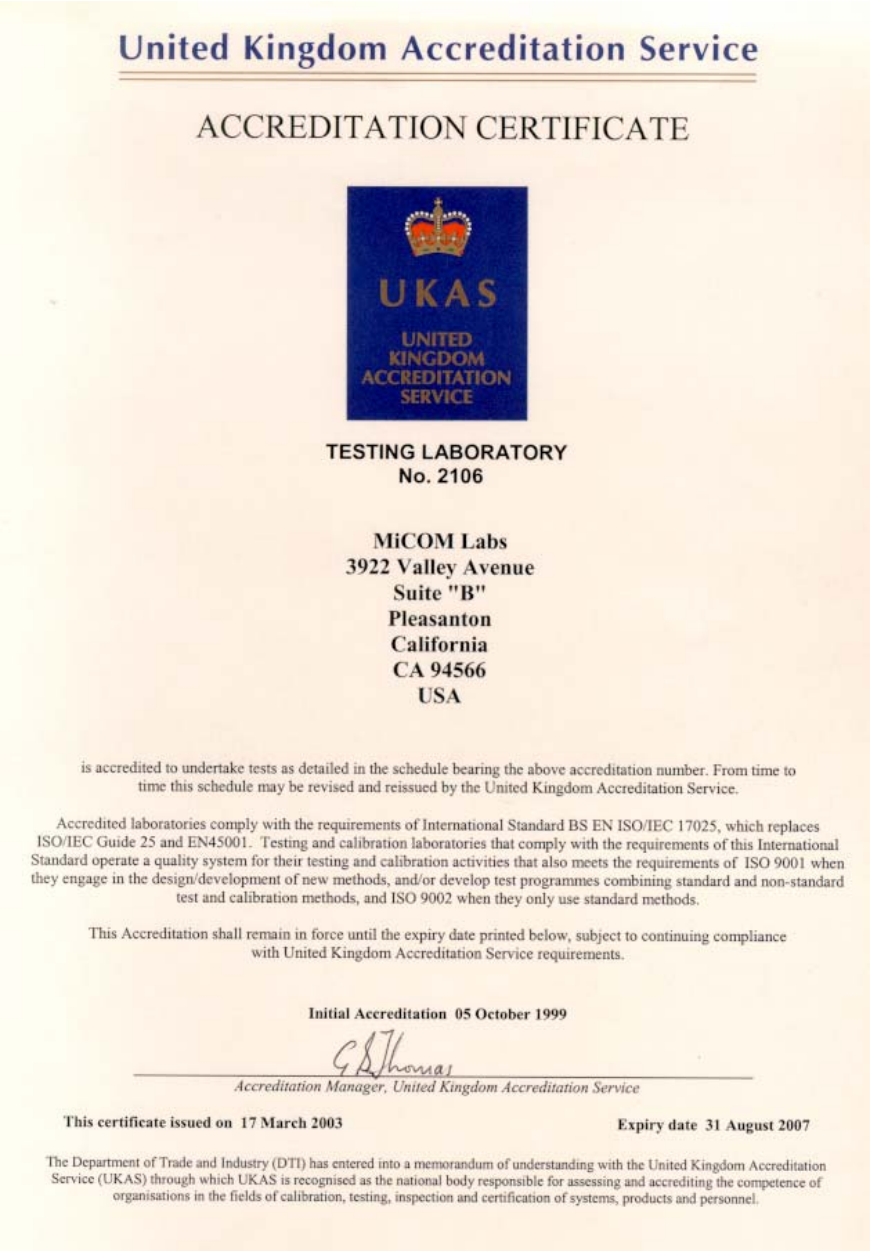
Note: As the result of the client request to include data from a third party MiCOM Labs accreditation does not cover testing reported in the following Sections;

5.1.2.3 Radiated Emissions less than 1GHz
5.1.3 AC Wireline Emissions (i.e. conducted emissions)
5.2.1 Field Strength (125 KHz intentional radiator)

ACCREDITATION & LISTINGS

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the United Kingdom Accreditation Service (UKAS) www.ukas.org test laboratory number 2106. MiCOM Labs test schedule is available at the following URL;
http://www.ukas.org/testing/lab_detail.asp?lab_id=875&location_id=&vMenuOption=3 .



United Kingdom Accreditation Service

ACCREDITATION CERTIFICATE

UKAS
UNITED KINGDOM ACCREDITATION SERVICE

TESTING LABORATORY
No. 2106

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

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

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

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

Initial Accreditation 05 October 1999

G B Thomas
Accreditation Manager, United Kingdom Accreditation Service

This certificate issued on 17 March 2003 Expiry date 31 August 2007

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

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

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	6th December '04	
Final Draft	10th December '04	
Rev A	13th December '04	
Rev B	20th December '04	Section 5.2.1 updated. Magnetic loop antenna used to measure frequency range 9 KHz – 30 MHz
Rev C	14th January '05	Section 5.1.2.2 updated. Revised band edge measurement results
Rev D	27th January '05	Section 5.1.2.3 Test procedure reference

1. TEST RESULT CERTIFICATE

Manufacturer:	Stryker Endoscopy 5900 Optical Court San Jose, California 95138, USA		Tested By:	MiCOM Labs, Inc. 3922 Valley Avenue 'B' Pleasanton California, 94566, USA
EUT:	iSwitch – Wireless Universal Footswitch		Tel:	+1 925 462 0304
Model:	Controller	Footswitch	Fax:	+1 925 462 0306
S/N(s):	#11	#7		
Date(s) Tested:	4th Nov. - 14th Jan. '05		Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part15.249/209 & IC RSS-210	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

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

Approved & Released for MiCOM Labs, Inc. by:

UKAS TESTING 2106

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 15.249	2001	Code of Federal Regulations
(ii)	Industry Canada RSS-210	Issue 5 Nov. 2001	Low Power License-Exempt Radiocommunication Devices (All Frequency Bands)
(iii)	ANSI C63.4	2003	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(iv)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(v)	M 3003 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 Organizations.

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).

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the iSWITCH - Wireless Universal Footswitch to FCC and Industry Canada regulations
Applicant:	TUV Rheinland of North America 1279 Quarry Lane, Suite 'A' Pleasanton, California 94566, USA State, Zip, USA
Manufacturer:	Stryker Endoscopy 5900 Optical Court San Jose, California 95138, USA
Laboratory performing the tests:	MiCOM Labs, Inc. 3922 Valley Avenue, Suite “B” Pleasanton, California 94566 USA
Test report reference number:	TUVR29-A1 Rev D
Date EUT received:	4th November '04
Standard(s) applied:	FCC 47 CFR Part15.249/209 & IC RSS-210
Dates of test (from - to):	4th Nov. - 14th Jan. '05
No of Units Tested:	One controller, one footswitch
Type of Equipment:	iSwitch – Wireless Universal Footswitch
Manufacturers Trade Name:	iSwitch
Model:	iSwitch
Location for use:	Health care facilities i.e. hospital operating theatre
EUT Modes of Operation:	Standby, activate
Declared Frequency Range(s):	Footswitch and Controller operation: 2,402MHz – 2,478MHz Controller RFID: 125KHz
Type of Modulation:	Frequency
Client Declared Nominal Output Power:	2.4GHz (conducted): +0 dBm (1mW) RFID: +0.01mW
Transmit/Receive Operation:	Simplex (2,402MHz - 2,478MHz)
Rated Input Voltage and Current:	100-240 Vac ~ 50/60 Hz, 0.6 A
Operating Temperature Range:	0 to 40ºC
ITU Emission Designator:	1M0F1D
Microprocessor(s) Model:	PIC18LF252, PIC18F6520, CYWUSB6934
Clock/Oscillator(s):	13MHz, 16MHz
Frequency Stability:	Controller and Footswitch - ±50ppm
Equipment Dimensions:	L = 16.5”, W = 12.5”, H = 3”
Weight:	Approximately 5 lbs
Primary function of equipment:	The iSwitch is a wireless remote-control system that centralizes control of the various footswitch-operated devices found in hospital operating theaters.

3.2. Scope of Test Program

The scope of the test program was to test the Stryker Endoscopy iSWITCH for compliance against appropriate FCC and Industry Canada technical standards;

FCC CFR 47 Part 15, subsection 15.249 frequency band 2,400 – 2,483.5MHz

FCC CFR 47 Part 15, subsection 15.209 frequency band 125KHz (RFID)

Industry Canada RSS-210 Section 6.2.2 (m2) 2,400-2,483.5MHz

Industry Canada RSS-210 Section 6.2.1 125KHz

iSwitch Wireless System

The iSwitch is a wireless remote-control system that centralizes control of the various footswitch-operated devices found in hospital operating rooms. It is intended for use in surgical procedures where the footswitch-operated devices, such as the Stryker TPS or SERFAS systems are normally used. The iSwitch consolidates the functions of these devices into one wireless footswitch, freeing the operating room from excessive cables and foot controls.

System Components

There are two separate devices that complete the iSwitch system;

i).. Controller

ii).. Footswitch

The 125 KHz RFID is used for the controller to identify which footswitch it should communicate with. The user aligns the footswitch RFID tag in close proximity (within 5 inches or less) of the RFID reader on the controller to synchronize the footswitch with the controller. Now, the controller and footswitch will only communicate with each other until the user chooses to disassociate the controller and footswitch by holding down a button on the controller. A single controller can be synchronized with up to two footswitches at any given time.

Once the footswitch is synchronized to the controller, the footswitch can now be used to control the connected surgical devices. This is achieved via 2.4GHz wireless communication between the footswitch and controller.

Controller and Footswitch Devices

Footswitch

Controller

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

Name	Model No.	Serial No.
Controller	277-200-100	11
Footswitch	277-100-100	7

3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Controller - 2.4GHz pcb antenna	Unknown	Stryker Endoscopy	105-201-978	None
Controller – 125KHz (447µH) antenna	Unknown	Stryker Endoscopy	105-202-764	None
Footswitch - 2.4GHz pcb antenna	Unknown	Stryker Endoscopy	105-201-940	None

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. Firewire ports x 3
2. Device ports x 4
3. USB port
4. AC power socket

3.6. Test Configurations

Matrix of test configurations

Operating Channel	Frequencies (MHz)	Peak Output Power
2	2,402	+0 dBm
40	2,440	+0 dBm
78	2,478	+0 dBm
--	0.125	63.5 dBµV/m

For emissions testing both the controller and footswitch were tested simultaneously. The units were configured to communicate on a forced frequency channel via custom software. As a result the emissions were worst case. Full transmit power was enabled during all testing. The client declared that Channel 1 would never be used in operational mode therefore Channel 2 was selected as the lowest channel of operation.

Only worst case plots are provided for each test parameter 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

3.9. Subcontracted Testing

The manufacturer requested that they would like to include measurements performed by a third party in this report. The results provided by the third form part of a separate test report 30460534.003. Although these results have been included MiCOM Labs takes no responsibility for their accuracy.

Third Party Compliance Test Laboratory	Test Description
TUV Rheinland of North America 1279 Quarry Lane, Suite 'A' Pleasanton, California 94566 USA Tel: +1 925 249 9123	Radiated Emissions Conducted Emissions

Radiated emissions (30 MHz-1 GHz), see Section 5.1.2.3 and conducted emissions, see Section 5.1.3 were performed by TUV Rheinland at 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 30 MHz-1 GHz.

Sanmina SCI: FCC Registration Number: 90844

125 KHz Field Strength Measurements

Field strength measurements for the 125KHz RFID transmitter was subcontracted to Sanmina-SCI at the above address. A magnetic loop antenna was used for the measurement 9 KHz – 30 MHz.

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.249** and **Industry Canada RSS-210** for devices operating at 2.4 GHz.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.249 (a) **15.249 (d)** **6.2.2(m2)(1)**	Field Strength	Maximum field strength measurement	Radiated	Complies	5.1.1
15.209(a) **6.2.2(m2)(3)**	Radiated Emissions	Emissions >1 GHz (1-26 GHz) Band Edge	Radiated Radiated	Complies Complies	5.1.2.1 5.1.2.2
		Emissions <1 GHz (30M-1 GHz)	Radiated	Complies Completed by 3rd Party, see Section 3.9	5.1.2.3
15.207 **6.6**	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies Completed by 3rd Party, see Section 3.9	5.1.3

The following table represents the list of measurements required under the **FCC CFR47 Part 15.209** and **Industry Canada RSS-210 Section 6.2.1** for devices operating at 125 KHz RFID.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.209 **6.2.1**	Field Strength	Maximum field strength measurement	Radiated	Complies Completed by 3rd Party, see Section 3.9	5.2.1

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. 2.4GHz Device Characteristics

5.1.1. Field Strength

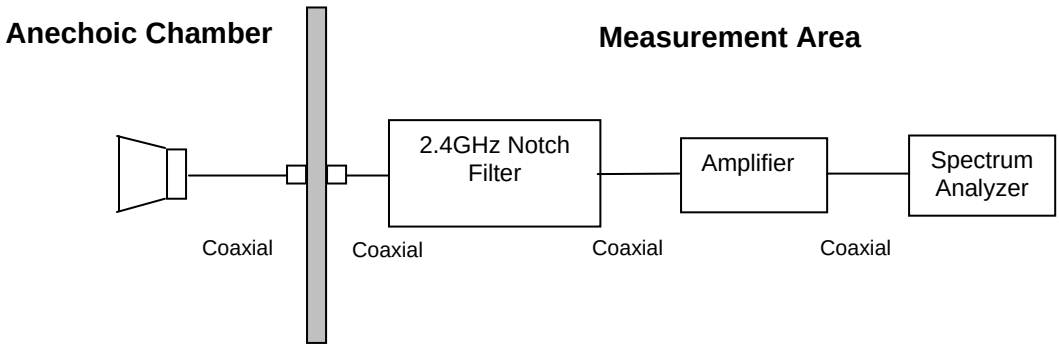
FCC, Part 15 Subpart C §15.249(a)
Industry Canada RSS-210 §6.2.2 (m2)(1)

Test Procedure
The field strength measurement was performed as a radiated test in a 3-meter semi-anechoic chamber in both horizontal and vertical polarities. The footswitch and controller were both placed on a polystyrene table 0.8m above the ground-plane and emissions maximized through 360ºC rotation of the turntable, measurement distance 3m. Both the controller and footswitch were communicating simultaneously at maximum power on the selected channel of interest. The system amplifier gain was included as an offset in the spectrum analyzer settings.

Using a 6 dB resolution bandwidth filter and positive peak detector with peak hold the spectrum analyzer was configured in the following manner;

RBW=1 MHz, VBW=3 MHz, Span=10 MHz, Sweep = 100 mS

Test Measurement Set up



Test set up for field strength measurement

Measurement Results for Field Strength Measurements

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

TABLE OF RESULTS

Center Frequency (MHz)	Amplifier Gain Fundamental Frequency (dB)	Field Strength dBµV/m		Plots
		Horizontal	Vertical	
2,402	29.7	67.01	64.87	TUVR29-A1/01
2,440	29.7	64.74	63.20	TUVR29-A1/02
2,478	29.7	65.30	63.38	TUVR29-A1/03

Only worst case horizontal plots are reported in Section 8 Graphical Results

Specification

Limits

§15.249 (a) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the matrix below.

§**6.2.2 (m2)(1)** The field strengths shall not exceed the following matrix.

Fundamental Frequency	Field Strength of fundamental		Field Strength Harmonics	
MHz	mV/m	dBµV/m	µV/m	dBµV/m
902-928	50	94	500	54
2,400-2,4835	50	94	500	54
5,725-5,875	50	94	500	54
24.0-24.25	250	108	2500	68

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	+5.92/-4.9dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0156, 0193, 0134, 2.4 Notch, 15F50N001, 10F50N002, SMA CBL01, SMA CBL04

5.1.2. Radiated Emissions

5.1.2.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

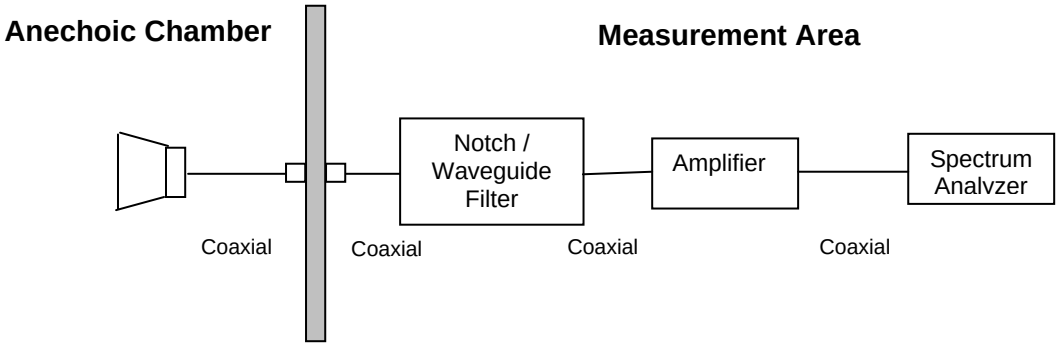
FCC, Part 15 Subpart C §15.249(d)
Industry Canada RSS-210 §6.2.2 (m2) (3)

Test Procedure

Preliminary radiated emissions above 1 GHz are measured in a semi-anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The footswitch and controller were both placed on a polystyrene table 0.8m above the ground-plane and emissions maximized through 360ºC rotation of the turntable, measurement distance 3m. Both the controller and footswitch were communicating simultaneously at maximum power on the selected channel of interest. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. The average value of the peak emission is measured and reported.

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

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where:

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

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

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

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

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

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

Measurement Results Transmitter Radiated Spurious Emissions 1 GHz - 26 GHz

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

Radio parameters.

Channel 2 (2,402MHz) Results

TABLE OF RESULTS

Freq. (MHz)	Polarity (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4808.038	H	33.48	7.06	40.55	54.00	-13.45
4808.420	V	34.09	7.06	41.16	54.00	-12.84
7194.98	H	34.28	9.54	43.82	54.00	-10.18
7206.986	V	35.66	9.55	45.21	54.00	-8.79

Channel 40 (2,440MHz) Results

TABLE OF RESULTS

Freq. (MHz)	Polarity (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4884.14	H	32.61	7.32	39.92	54.00	-14.08
4884.25	V	34.89	7.32	42.20	54.00	-11.80
7325.87	V	34.88	10.00	44.87	54.00	-9.13
7328.18	H	34.90	10.00	44.90	54.00	-9.10

Channel 78 (2,478MHz) Results

TABLE OF RESULTS

Freq. (MHz)	Polarity (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4963.59	H	27.98	7.45	35.43	54.00	-18.57
4965.41	V	28.05	7.44	35.49	54.00	-18.51
7438.60	H	34.46	10.15	44.61	54.00	-9.39
7441.80	V	34.41	10.14	44.56	54.00	-9.44

5.1.2.2. Radiated Band-Edge – Restricted Bands

In making band-edge measurements, there can be a problem obtaining meaningful data since a measurement instrument that is tuned to a band-edge frequency may also capture some in-band signals when using the resolution bandwidth (RBW) required by measurement procedure ANSI C63.4-1992 (hereafter C63.4). In an effort to compensate for this problem, the following technique sanctioned by the FCC for determining band-edge compliance has been developed.

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

STEP 1) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required by C63.4 and the Rules for the frequency being measured.

STEP 2) Encompass both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1 % of the total span, never using a RBW less than 30 kHz. Use a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission. Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement, it is only a relative measurement to determine how much the emission drops at the band-edge relative to the highest fundamental emission level.

STEP 3) Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by either 15.249(c) or 15.205.

STEP 4) You can use the above "delta" measurement technique for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two bandwidths must be measured in the conventional manner.

Corrected Reading

Corrected Peak Band Edge$_{PBE}$ = Peak Reading + Antenna Gain - Delta

Corrected Average Band Edge$_{ABE}$ = Average Reading + Antenna Gain - Delta

Antenna Gain @ 2.4 GHz = 30.7 dB/m

Note:

Amplifier gain and cable loss of -29.7 dB was included as a spectrum analyzer offset

TABLE OF RESULTS

Restricted Band @ 2,390 MHz - Conventional Measurement Method

Channel (MHz)	Peak/Ave.	Polarity	Measured (dBµV/m)	Antenna Gain (dB/m)	Corr'd Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Plot #
2,402	Peak	V	+30.8	30.7	61.5	74	-12.5	10
2,402	Ave.	V	-1.4	30.7	29.3	54	-24.7	11

TABLE OF RESULTS

Restricted Band @ 2,483.5 MHz

Center Frequency (MHz)	Restricted Band Frequency (MHz)	Limit (dBuV/m)	Measured (dBuV/m)	Delta (dB)	Corrected Reading (dBuV/m)	Plot #	Margin (dB)
$2{,}478_{PEAK}$	2,483.5	74.00	65.30	55.11	40.89	TUVR29/12	-33.11
$2{,}478_{AVE}$	2,483.5	54.00	29.41	55.11	5.00	TUVR29/13	-49.00

Polarity of maximum field strength - Vertical

Specification

Limits

§15.249 (d)
Emissions radiated outside of the specified frequency bands, except for harmonics shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

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

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§6.2.2 (m2) (3) Emissions radiated outside of the specified frequency bands, except for harmonics shall be attenuated by at least 50dB below the level of the fundamental or to the table below whichever is less stringent.

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/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	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0156, 0193, 0134, 2.4 Notch, 15F50N001, 10F50N002, SMA CBL01, SMA CBL04

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

FCC, Part 15 Subpart C §15.209
Industry Canada RSS-210 §6.3

Test Procedure
The manufacturer requested that they would like to include measurements performed by a third party. Test results for 30M-1 GHz Radiated Spurious Emissions were provided by the company identified in Section 3.9. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The 10m anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

EUT Operational Mode:	Receiving input from footswitches
Modifications:	
Test Procedure:	ANSI 63.4
Performance Criteria:	Class B Limit
Performance Verification:	Data Measured To Limit
Power:	230V 50Hz
Measure distance:	10m

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

TABLE OF RESULTS

Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Pol.	Total Corr'n Factor (dB)
133.2138	11.62	6.20	30.00	-23.80	294	104	Vert	-22.75
221.1858	29.11	28.04	30.00	-1.96	259	298	Horz	-18.36
225.9441	32.10	28.59	30.00	-1.41	279	100	Vert	-17.95
393.1992	39.34	34.59	37.00	-2.41	219	197	Horz	-11.97
491.5148	36.44	35.36	37.00	-1.64	272	294	Vert	-9.44
670.1767	20.94	14.37	37.00	-22.63	265	102	Horz	-5.43

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 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/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

Laboratory Uncertainty for Radiated Emissions

Measurement uncertainty	Not available

Traceability

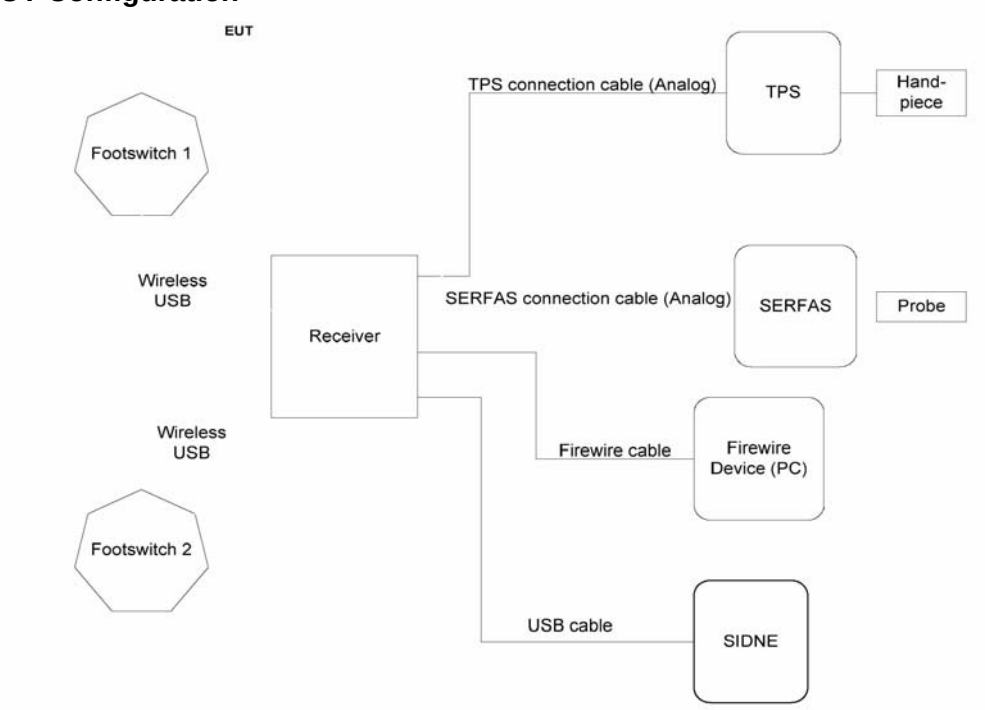
Method	Test Equipment Used
Measurements were made per TUV Rheinland work instructions	Not available

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

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

Test Procedure
The manufacturer requested that they would like to include measurements performed by a third party. Test results for AC Wireline Emissions was provided by the company identified in Section 3.9.

EUT Configuration



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

EUT Configuration:	See diagram below
EUT Operational Mode:	Receiving input from footswitches
Modifications:	None
Performance Verification:	Data Measured To Limit
Power:	110V 60Hz

TABLE OF RESULTS

LINE – LIVE

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
0.159961	58.04	49.35	65.51	-16.17	44.53	55.51	-10.98
0.175453	52.56	48.42	64.76	-16.33	31.43	54.76	-23.33
0.210228	49.15	41.94	63.26	-21.32	18.95	53.26	-34.31
0.248455	46.05	38.22	61.83	-23.61	12.73	51.83	-39.10
0.446717	41.55	33.90	57.00	-23.09	20.63	47.00	-26.36
0.447250	40.63	34.07	56.99	-22.92	20.95	46.99	-26.03

LINE - NEUTRAL

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
0.184394	52.21	45.60	64.32	-18.72	28.62	54.32	-25.70
0.227153	47.26	39.82	62.61	-22.79	9.83	52.61	-42.78
0.240210	46.22	38.47	62.11	-23.63	12.85	52.11	-39.25
0.270899	50.26	46.53	61.15	-14.62	43.43	51.15	-7.73
0.378115	44.90	40.22	58.35	-18.14	40.20	48.35	-8.16
0.444480	42.34	33.37	57.04	-23.66	14.60	47.04	-32.44

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 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

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 µV, 48 dBµV (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 µV (60 dBµV, 0.45 - 1.705 MHz) and 3000 µV (69.5 dBµV, 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 (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 Uncertainty for Conducted Emissions

Measurement uncertainty	Not available

Traceability

Method	Test Equipment Used
Measurements were made per TUV Rheinland work instructions	Not available

5.2. 125KHz Device Characteristics

5.2.1. Field Strength

FCC, Part 15 Subpart C §15.209
Industry Canada RSS-210 §6.2.1

Test Procedure
The field strength measurement was performed as a radiated test in a 10-meter anechoic chamber. The controller was placed on a table 0.8 m above the ground-plane and emissions maximized through 360ºC rotation of the turntable, measurement distance 3m. A magnetic loop antenna was placed 0.8 m above the ground plane for measurement purposes. The limits specified at 300 meters were extrapolated for the 3 m measurement distance.

Peak, average and quasi-peak detectors were used to report the results of the intentional radiator.

The RFID transmitter was transmitting continuously at maximum power on the single operating channel 125KHz.

Limit Calculation
125KHz limit extrapolated to a 3 meter measurement distance (40dB/decade)

Field strength in µV/m = 2,400/F (F in KHz) = 19.2 µV/m
2,400/125 = 19.2 µV/m
Conversion to dBµV/m = 25.66 dBµV/m

Limit = 25.66 dBµV/m + 80dB = 105.66dBµV/m

Measurement Results for Field Strength (9 kHz – 30 MHz)

Frequency (MHz)	Peak (dBuV/m)	QP (dBuV/m)	Ave (dBuV/m)	Ave Limit (dBuV/m)	Ave Margin (dB)
0.125782	63.47	61.47	58.63	105.66	-47.03

Spectrum plots of the fundamental frequency and spurious emissions are provided in Section 8 Graphical Results.

Specification

Limits

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

6.2.1 Table 7 lists the permissible levels of unwanted emissions of transmitters and receivers as specified below.

Frequency(MHz)	Field Strength (μV/m)	Measurement Distance (meters)
0.009-0.490	2400/F (F in KHz)	300
0.490-1.705	24000/F (F in KHz)	30
1.705-30.0	30	30

Laboratory Uncertainty for Radiated Emissions

Measurement uncertainty	Not available

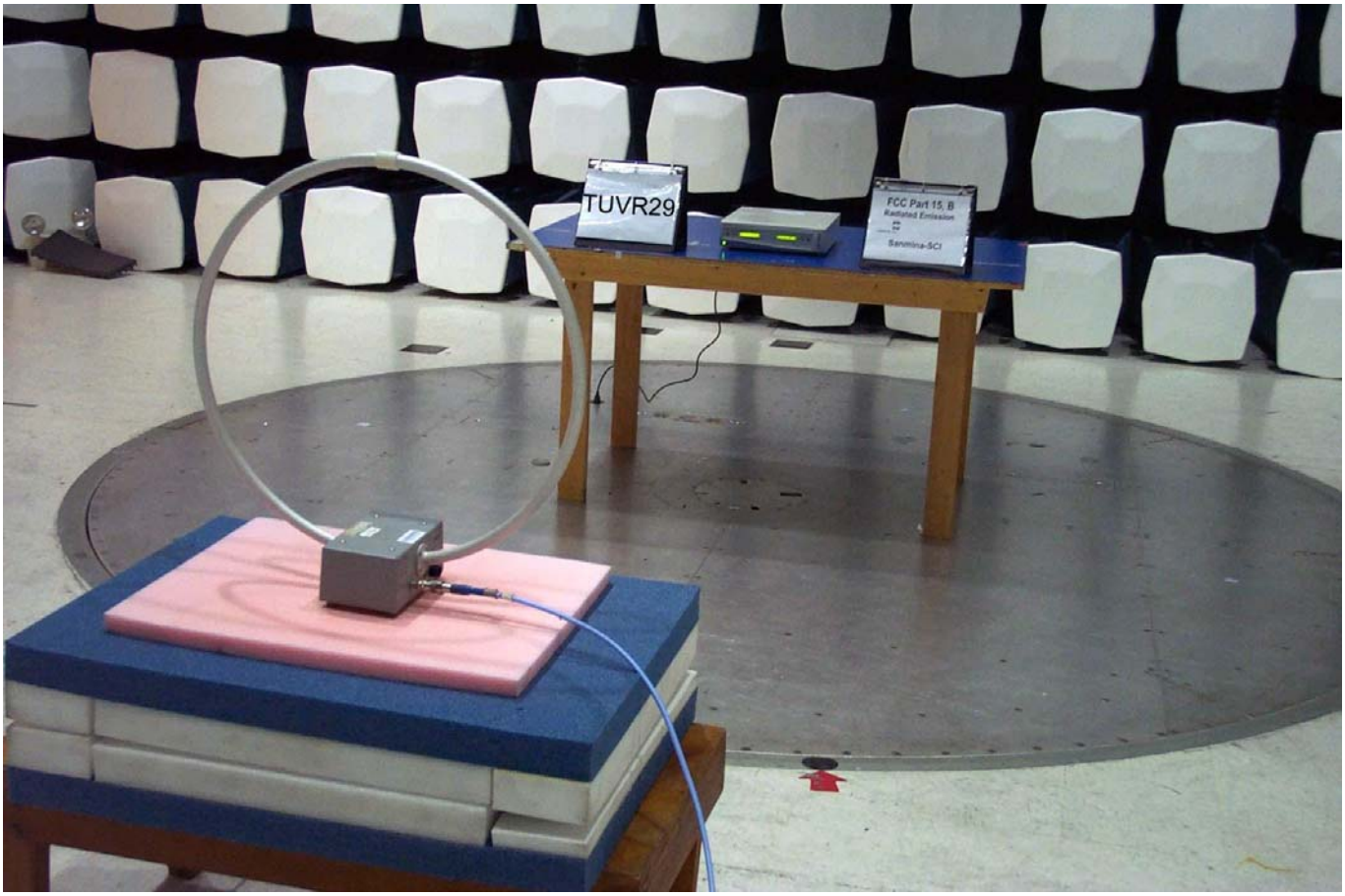
Traceability

Method	Test Equipment Used
Measurements were made per Sanmia-SCI work instructions	Not available

6. PHOTOGRAPHS

6.1. Radiated Emissions (30 MHz-1 GHz)

6.2. Field Strength Measurement 125KHz RFID



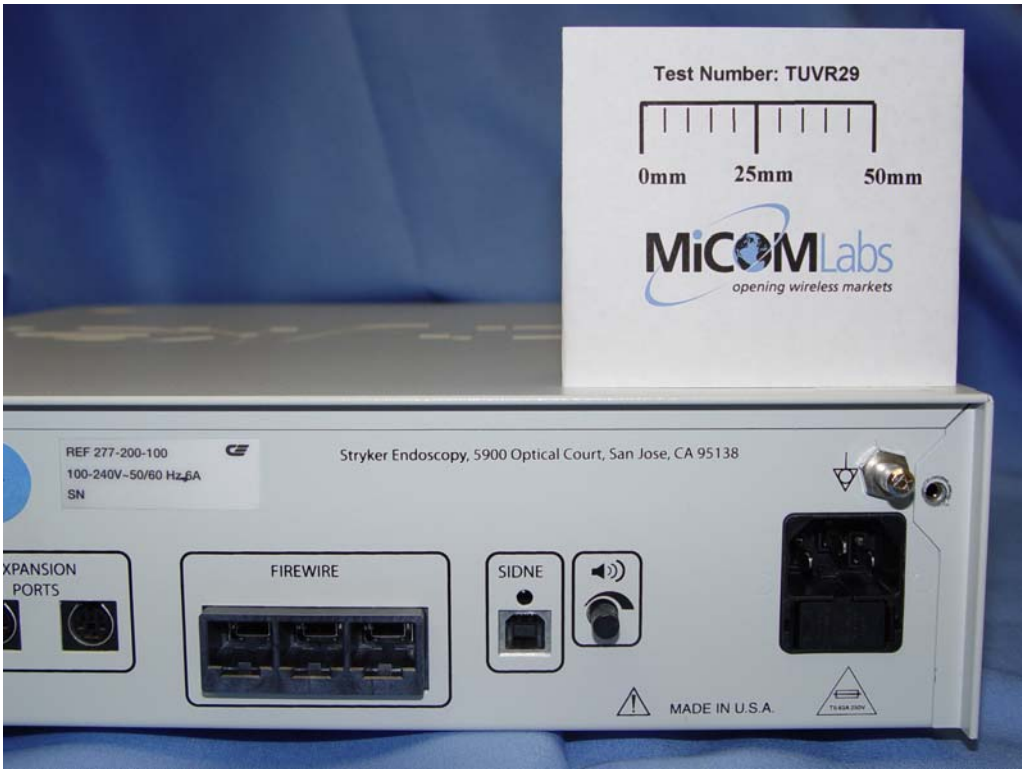
6.3. Spurious Emissions >1 GHz

6.4. Conducted Emissions (150 kHz - 30 MHz)

6.5. Photograph of Controller Front Panel

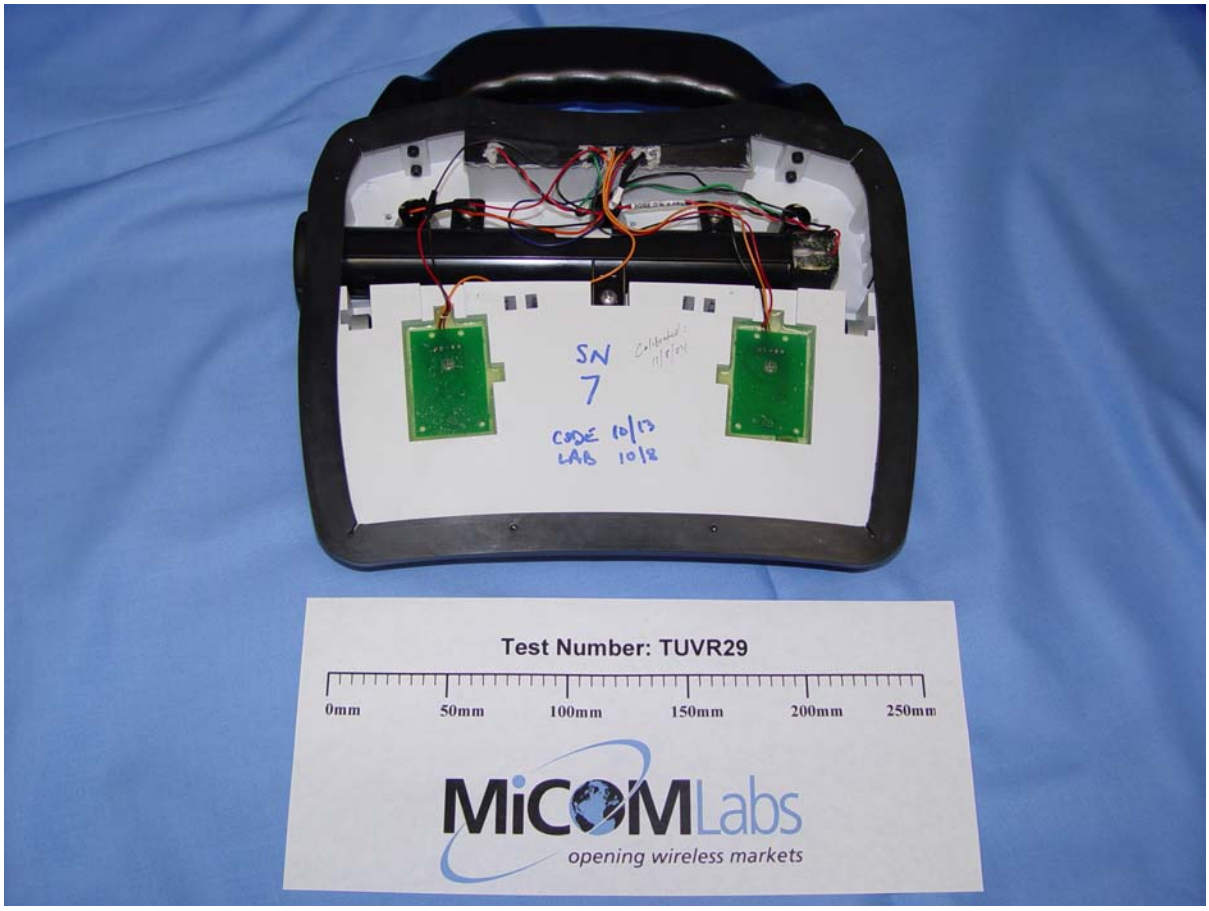
RFID Transmitter Location

6.6. Photograph of Controller Interface Ports



6.7. Internal Photograph of Controller Unit

6.8. Internal Photograph of Footswitch



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-2 GHz)	Schaffner and Chase	CBLG140A	Not Applicable	1195
ANT1-18	Horn Antenna	The Electro-Mechanics Company	3115	12 Aug '05	9205-3882
0088	Spectrum Analyzer	Hewlett Packard	8564E	15 May '05	3410A00141
0134	Amplifier	Com Power	PA 122	1st Sept '05	181910
0213	20-300 MHz Antenna	Schwarzbeck	VHBB 9124	6 Apr '05	9124/0257
0250	230 MHz-1 GHz Antenna	Schwarzbeck	VUSLP9111	6 Apr '05	186
ANT4	18 GHz-26.5 GHz	Millimeter Products	261K	30 Apr '05	595
ANT5	26.5 GHz-40 GHz	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
3 dB Att'n	3 dB N-Type Attenuator	ARRA	N9444-30	N/A	--
30 dB Att'n	30 dB N-Type Attenuator	NARDA	32319	N/A	--
Filter	2.4 GHz Notch	Micro-Tronics	--	N/A	--
W/guide Filter #1	12.75-17 GHz	CMT	--	--	--
W/guide Filter #2	17-26.5 GHz	HP	--	--	--

SANMINA - LIST OF TEST EQUIPMENT

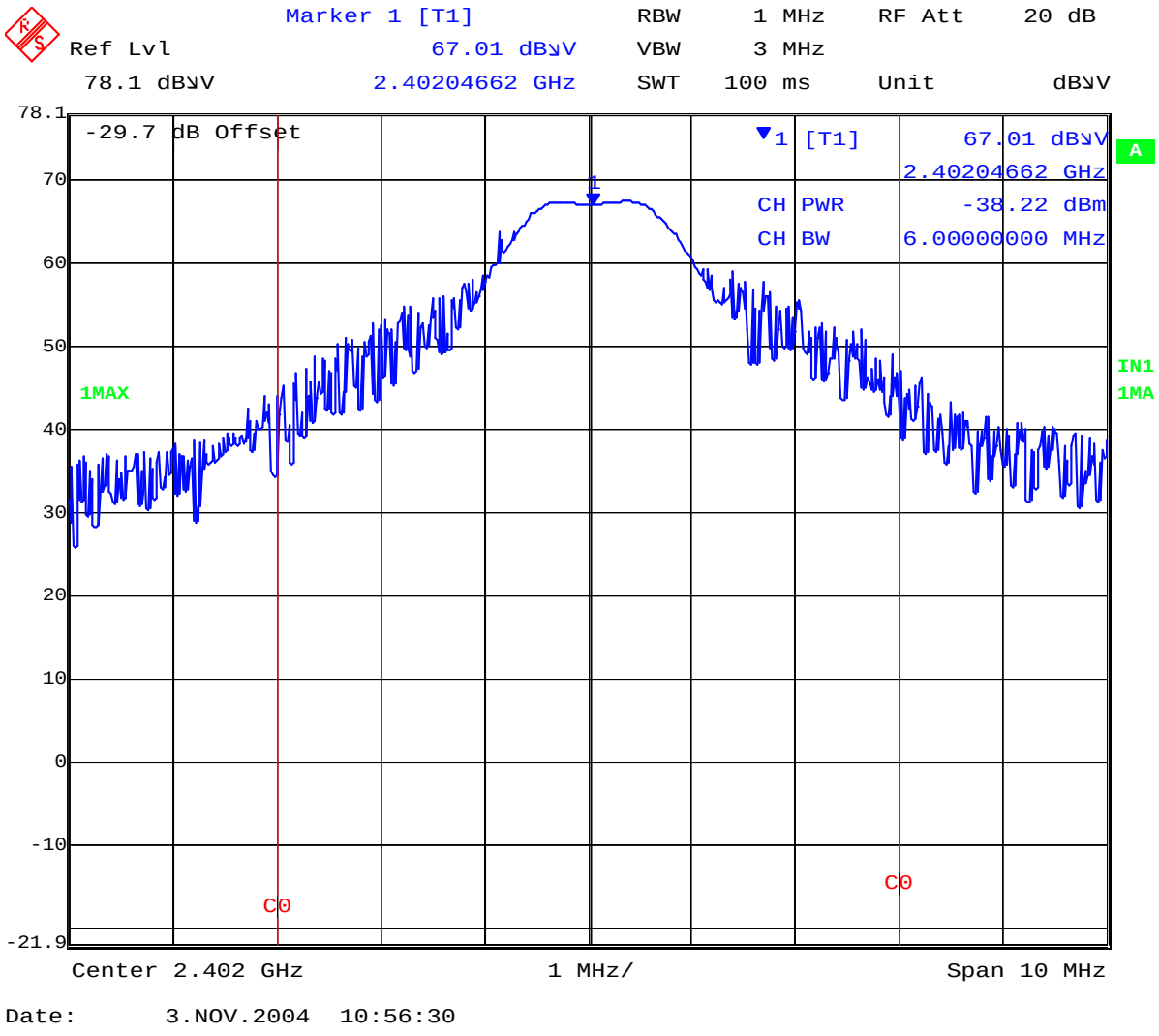
DESCRIPTION	MODEL	SERIAL NUMBER	LAST CAL DATE	CAL DUE DATE
HP 8546A EMI Receiver (Receiver Section) 9Khz – 6.5Ghz	85462A	3325A00166	03/06/2004	03/06/2005
HP8546A EMI Receiver (RF Filter Section)	85460A	3330A00162	03/06/2004	03/06/2005
EMCO Active Loop (Emissions)	6502	9110-2683	3/31/2004	3/31/2005

8. GRAPHICAL RESULTS

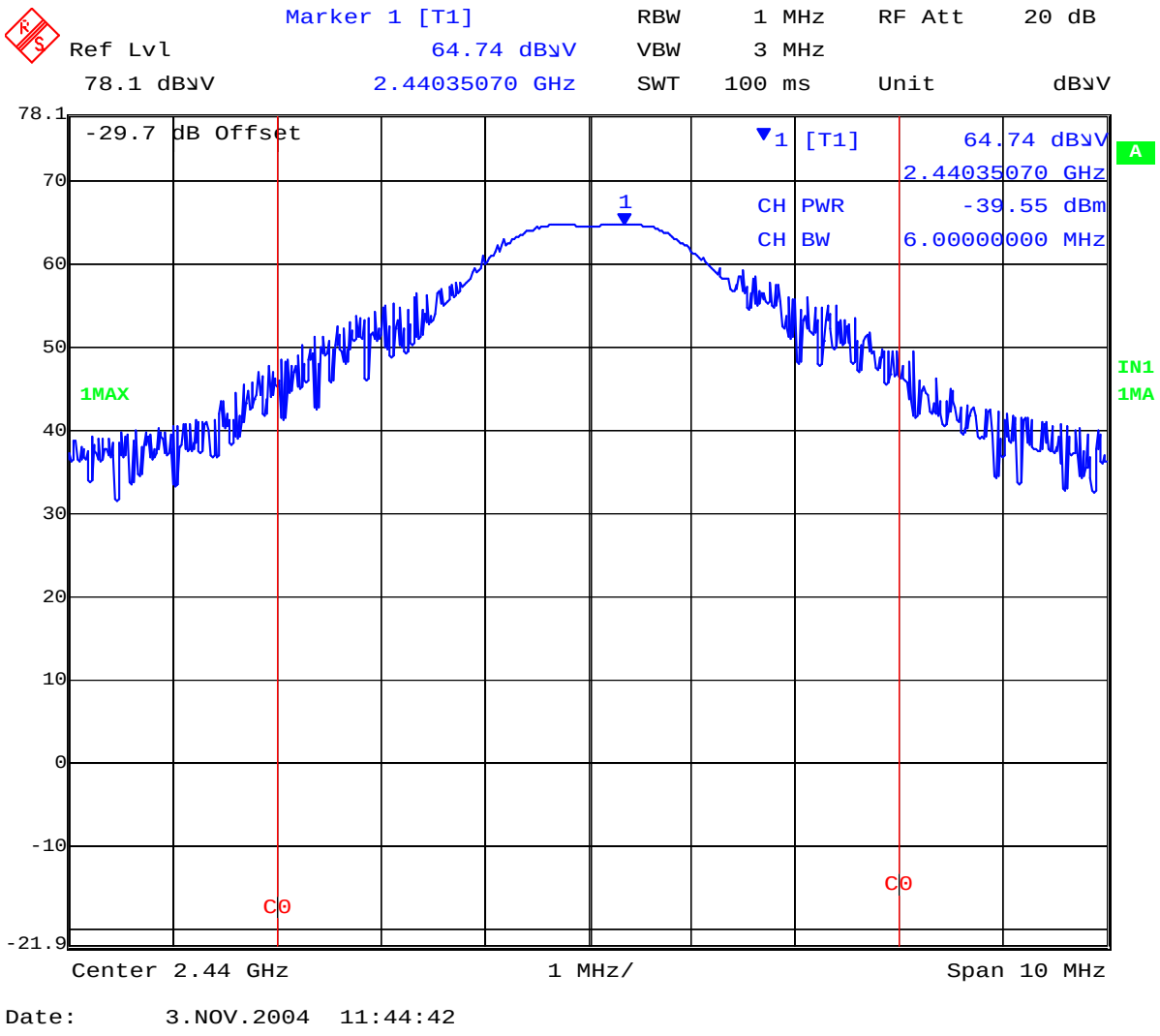
This report contains the following plots as referenced in the test results, Section 5 of this report. Only worst case plots are reported. All additional plots are held on file in the laboratory.

Parameter	Plot No.
Section 5.1.1 Field Strength (2.4GHz Fundamental Frequency)	
Channel 2 (2,402MHz) Horizontal	TUVR29-A1/01
Channel 40 (2,440MHz) Horizontal	TUVR29-A1/02
Channel 78 (2,478MHz) Horizontal	TUVR29-A1/03
Section 5.1.2.1 Radiated Emissions	
Channel 2 (2,402MHz) Horizontal	TUVR29-A1/04
Channel 2 (2,402MHz) Vertical	TUVR29-A1/05
Channel 40 (2,440MHz) Horizontal	TUVR29-A1/06
Channel 40 (2,440MHz) Vertical	TUVR29-A1/07
Channel 78 (2,478MHz) Horizontal	TUVR29-A1/08
Channel 78 (2,478MHz) Vertical	TUVR29-A1/09
Section 5.1.2.2 Radiated Band Edge	
Channel 2 (2,402MHz) Peak - Band Edge 2,390 MHz	TUVR29-A1/10
Channel 2 (2,402MHz) Ave. - Band Edge 2,390 MHz	TUVR29-A1/11
Channel 78 (2,478MHz) Peak - Band Edge 2,483.5 MHz	TUVR29-A1/12
Channel 78 (2,478MHz) Ave - Band Edge 2,483.5 MHz	TUVR29-A1/13
Channel 78 (2,478MHz) Delta - Band Edge 2,483.5 MHz	TUVR29-A1/14
Section 5.1.6 Radiated Emissions 30 MHz – 1 GHz Hor. & Vert.	TUVR29-A1/15
Section 5.1.7 AC Wireline Conducted Emissions Live & Neutral	TUVR29-A1/16
Section 5.2.1 Field Strength and Spurious Emissions (125 KHz Fundamental Frequency)	
9 KHz – 30 MHz	TUVR29-A1/17

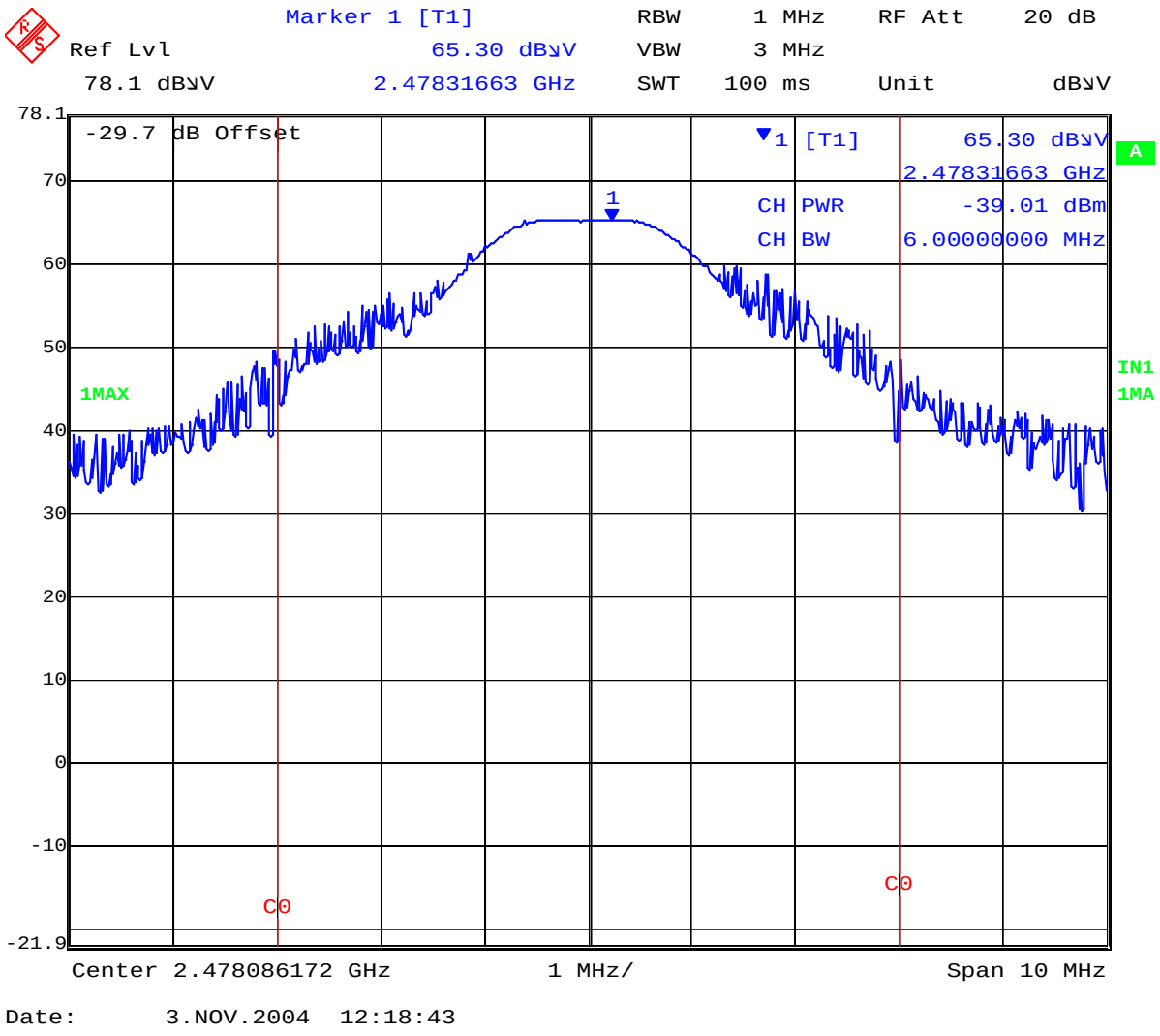
TUVR29-A1/01 - Field Strength Horizontal (2,402 MHz)



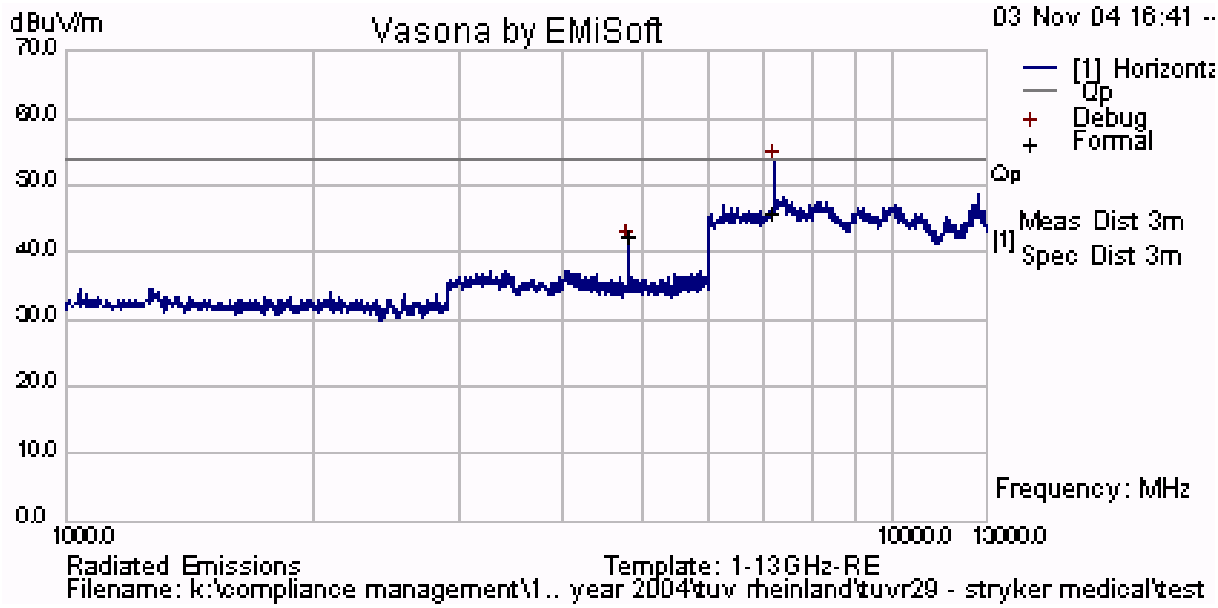
TUVR29-A1/02 - Field Strength Horizontal (2,440 MHz)

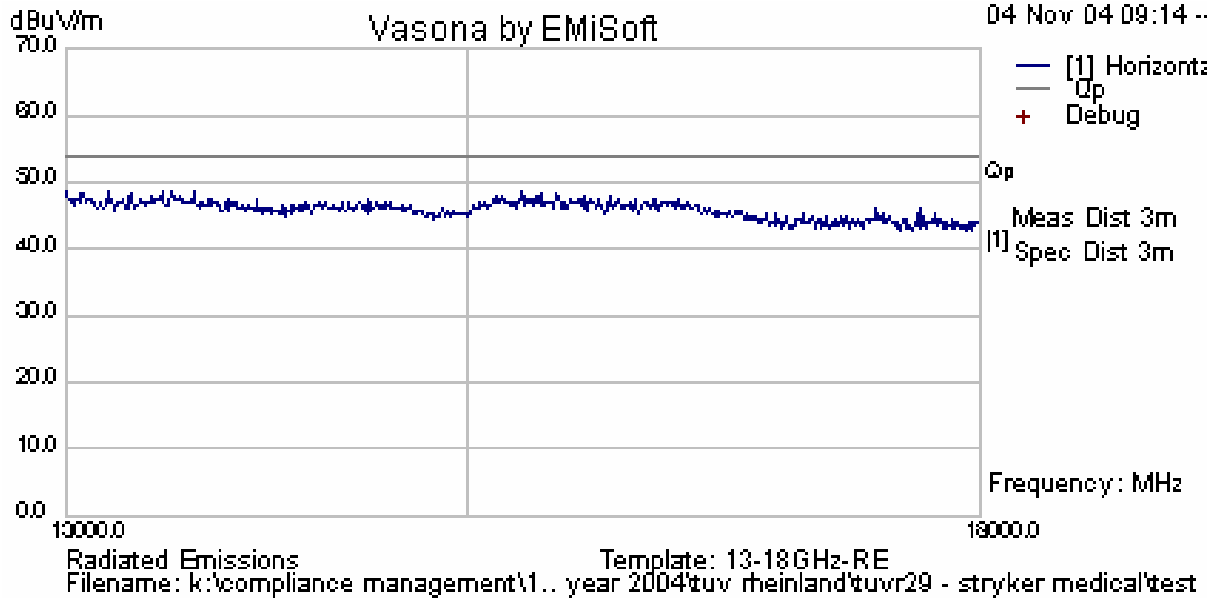


TUVR29-A1/03 - Field Strength Horizontal (2,478 MHz)

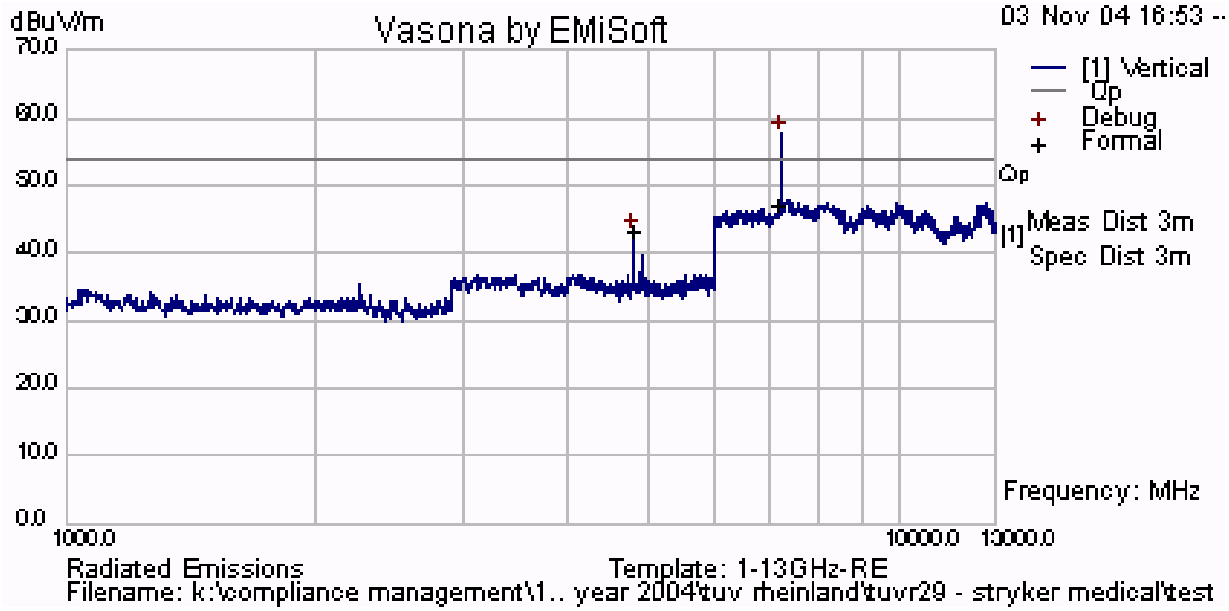


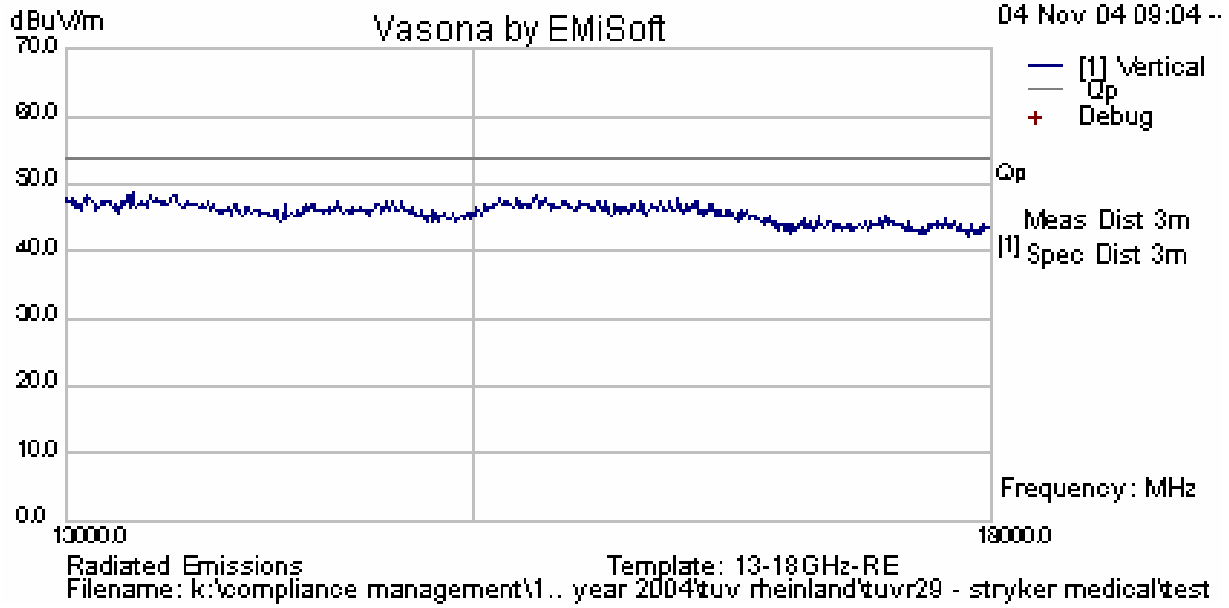
TUVR29-A1/04 – Transmitter Radiated Emissions 2,402MHz Horizontal



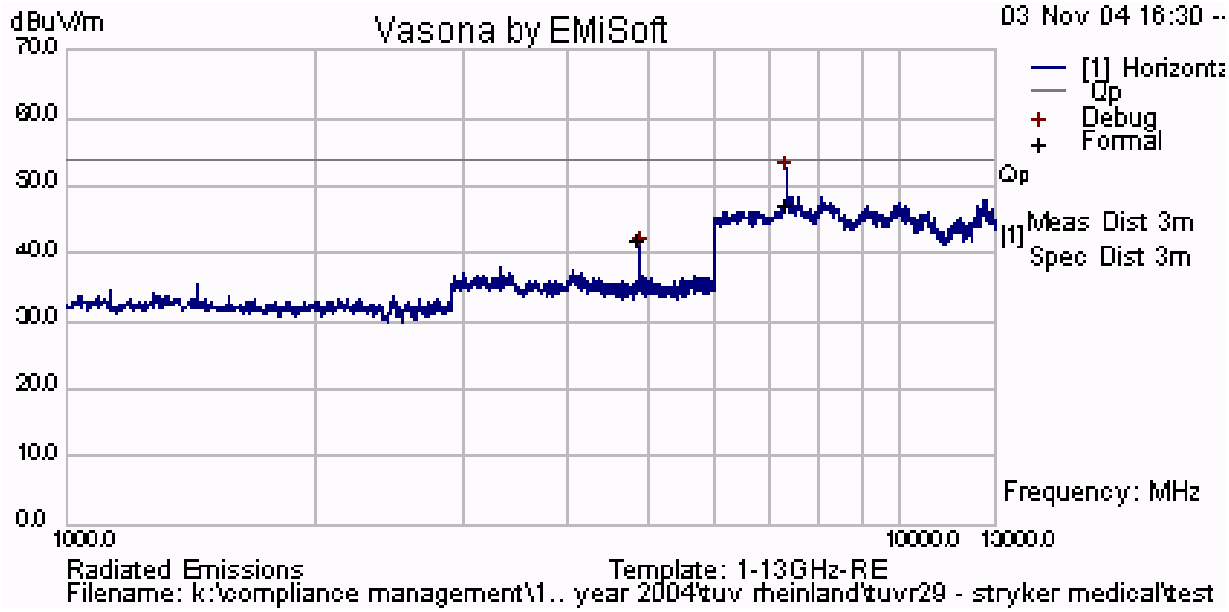


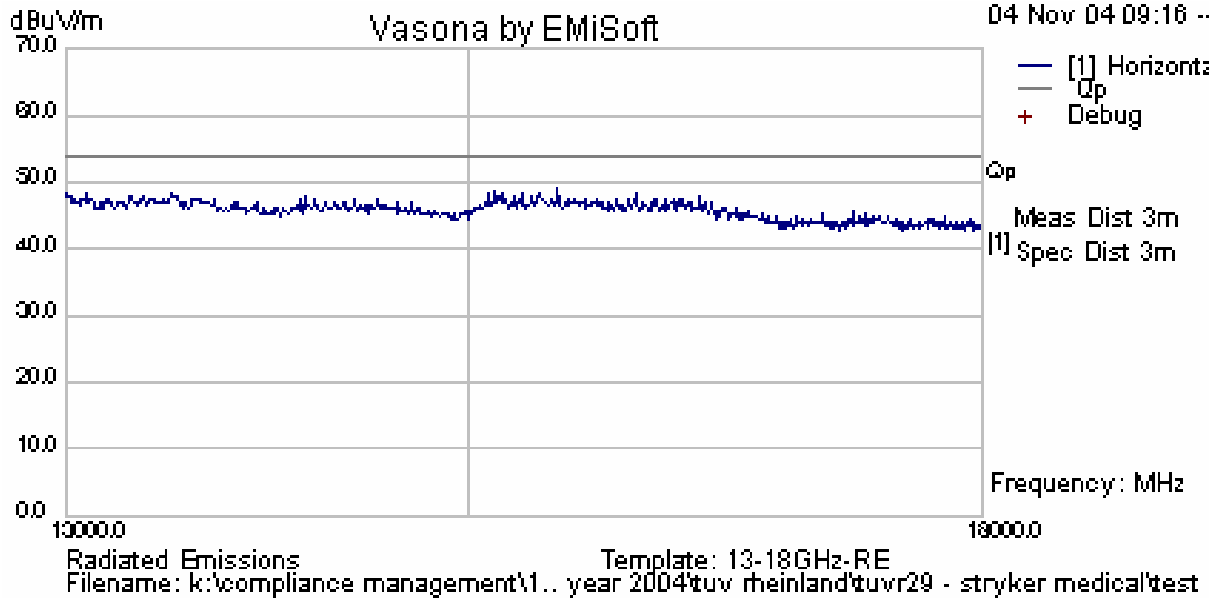
TUVR29-A1/05 – Transmitter Radiated Emissions 2,402MHz Vertical



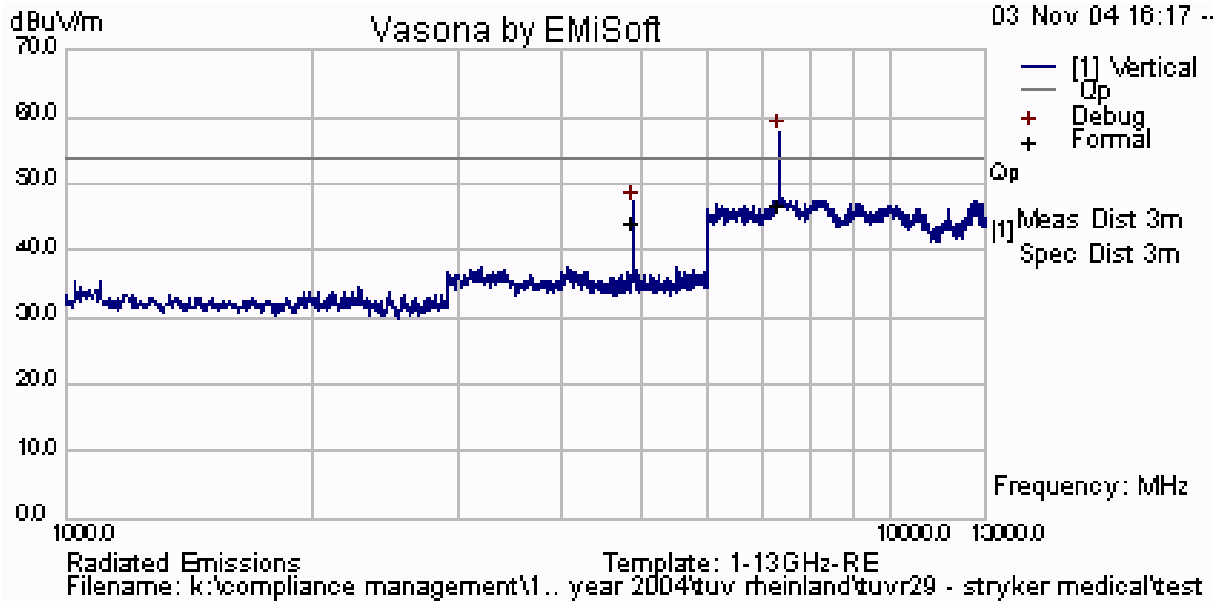


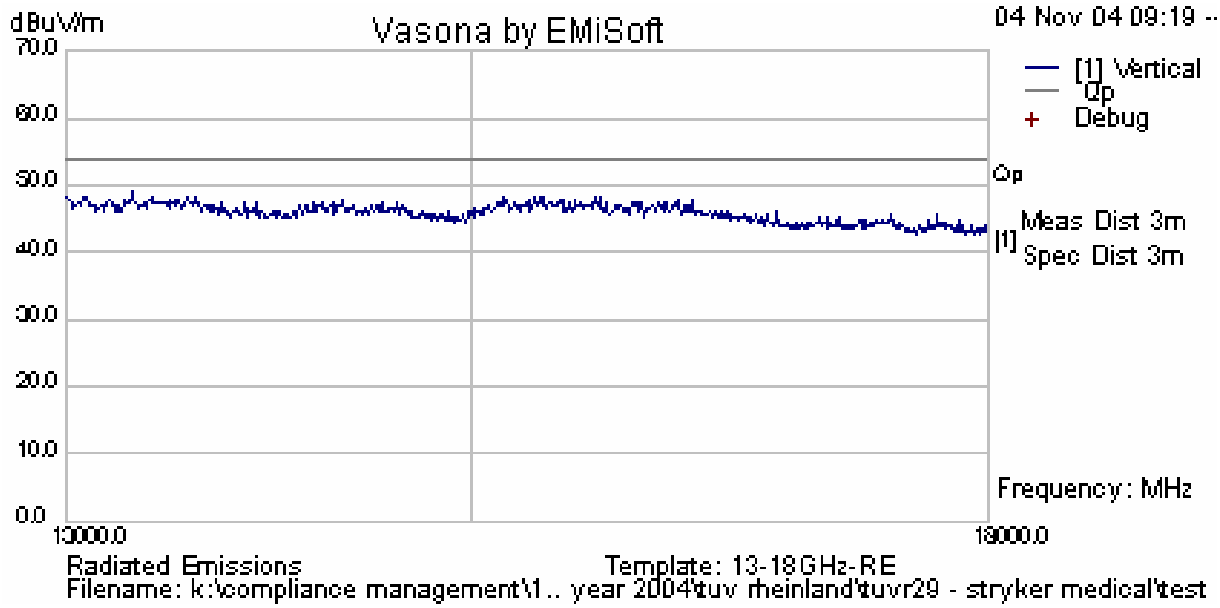
TUVR29-A1/06 - Transmitter Radiated Emissions 2,440MHz Horizontal



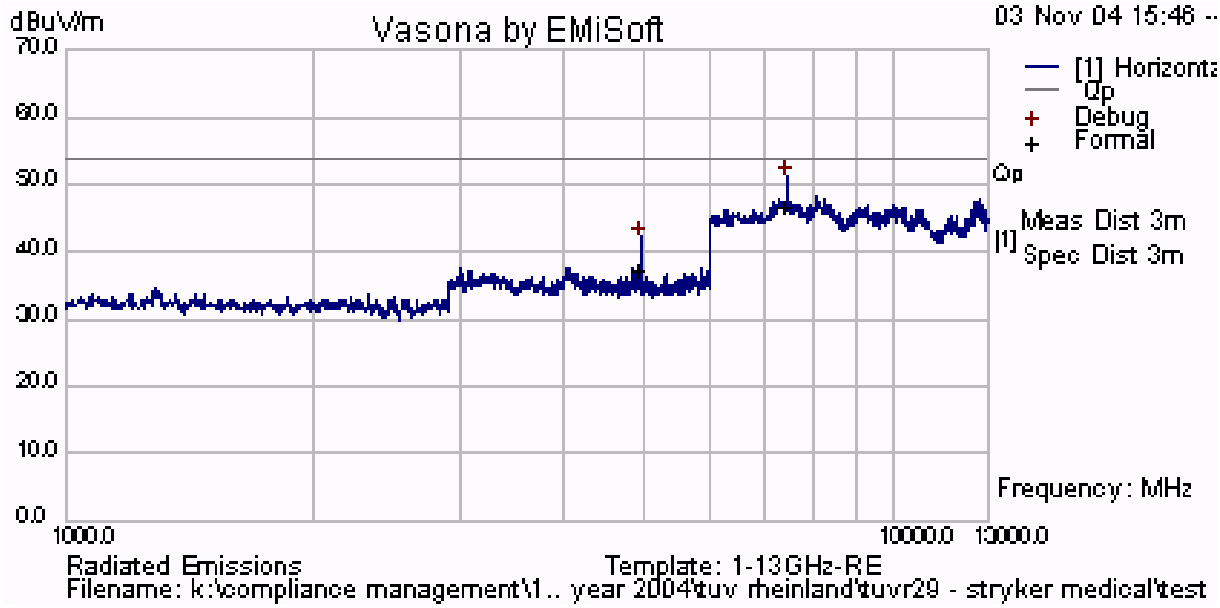


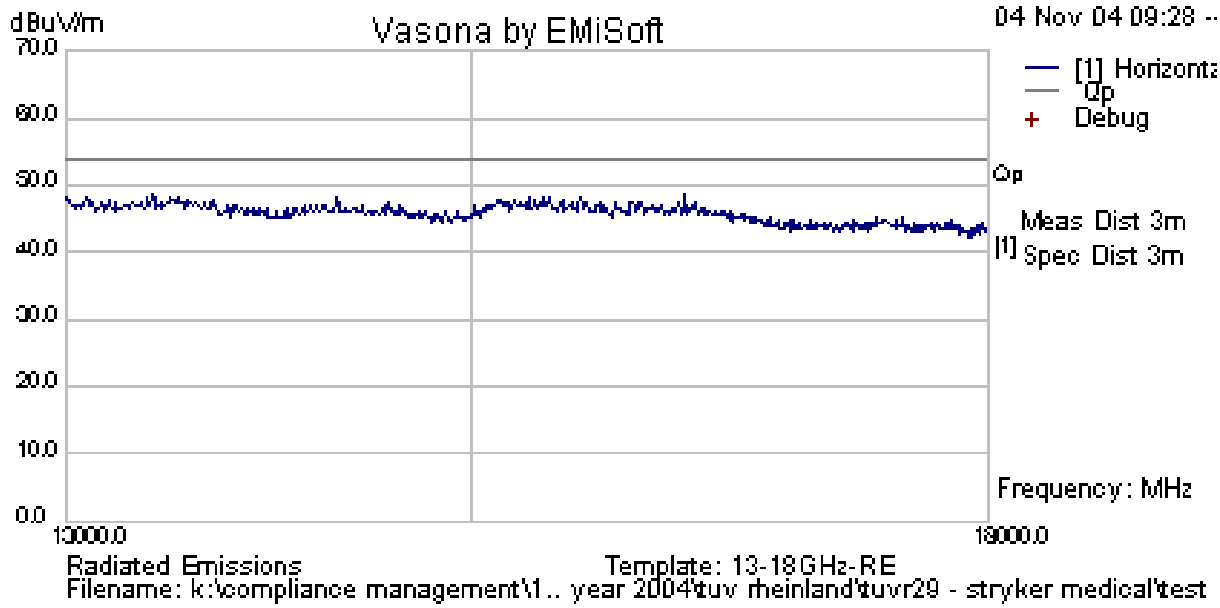
TUVR29-A1/07 - Transmitter Radiated Emissions 2,440MHz Vertical



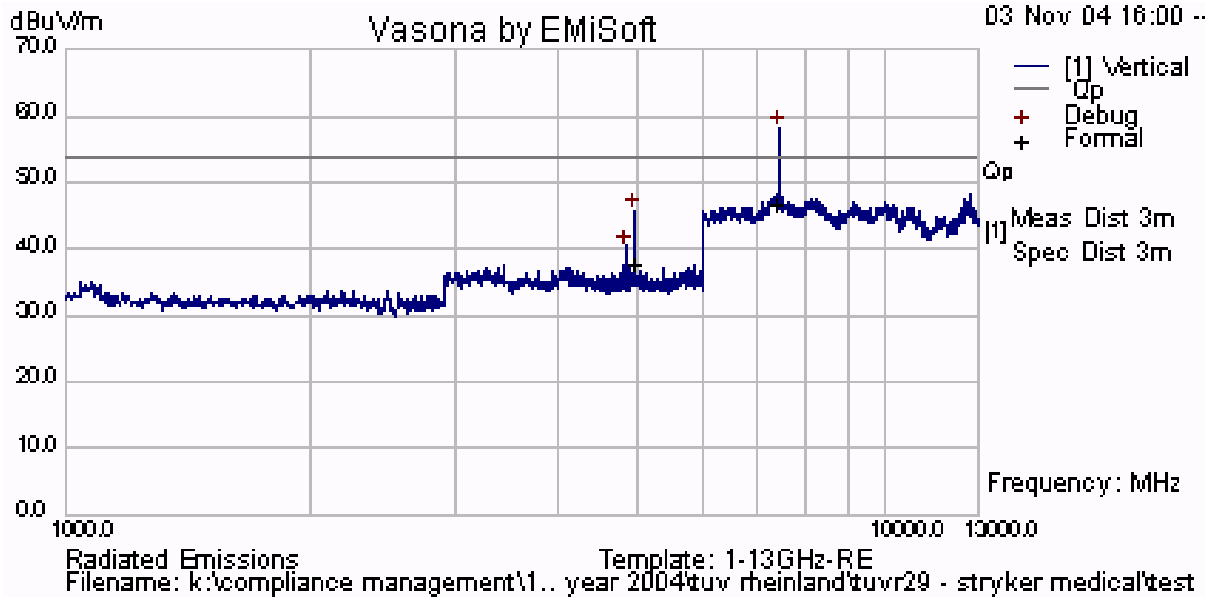


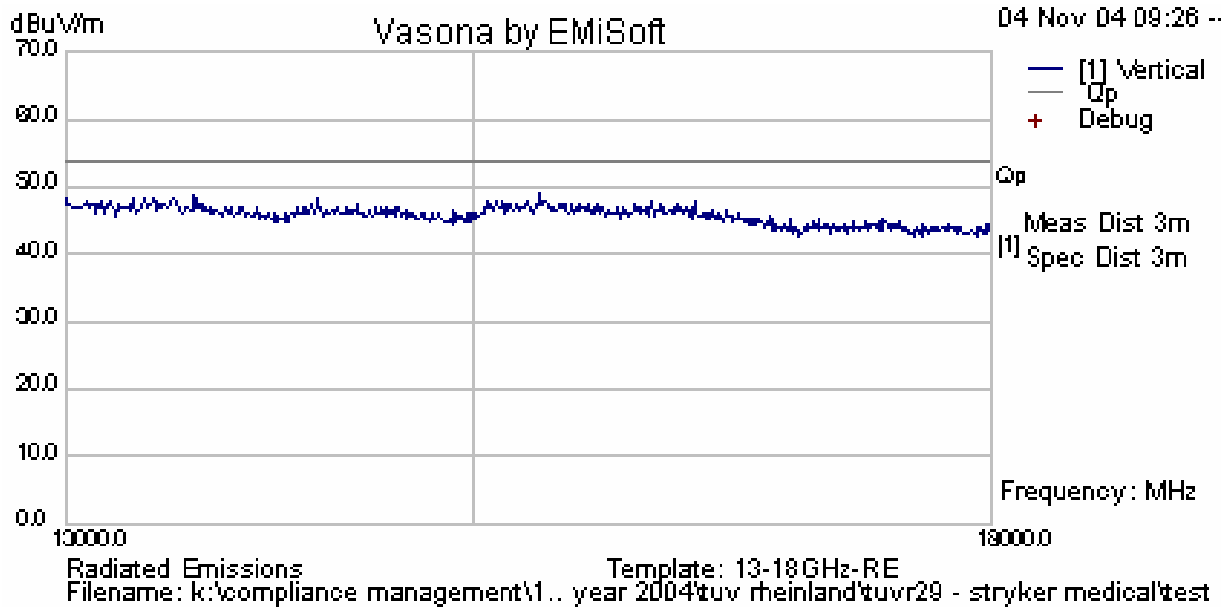
TUVR29-A1/08 - Transmitter Radiated Emissions 2,478MHz Horizontal



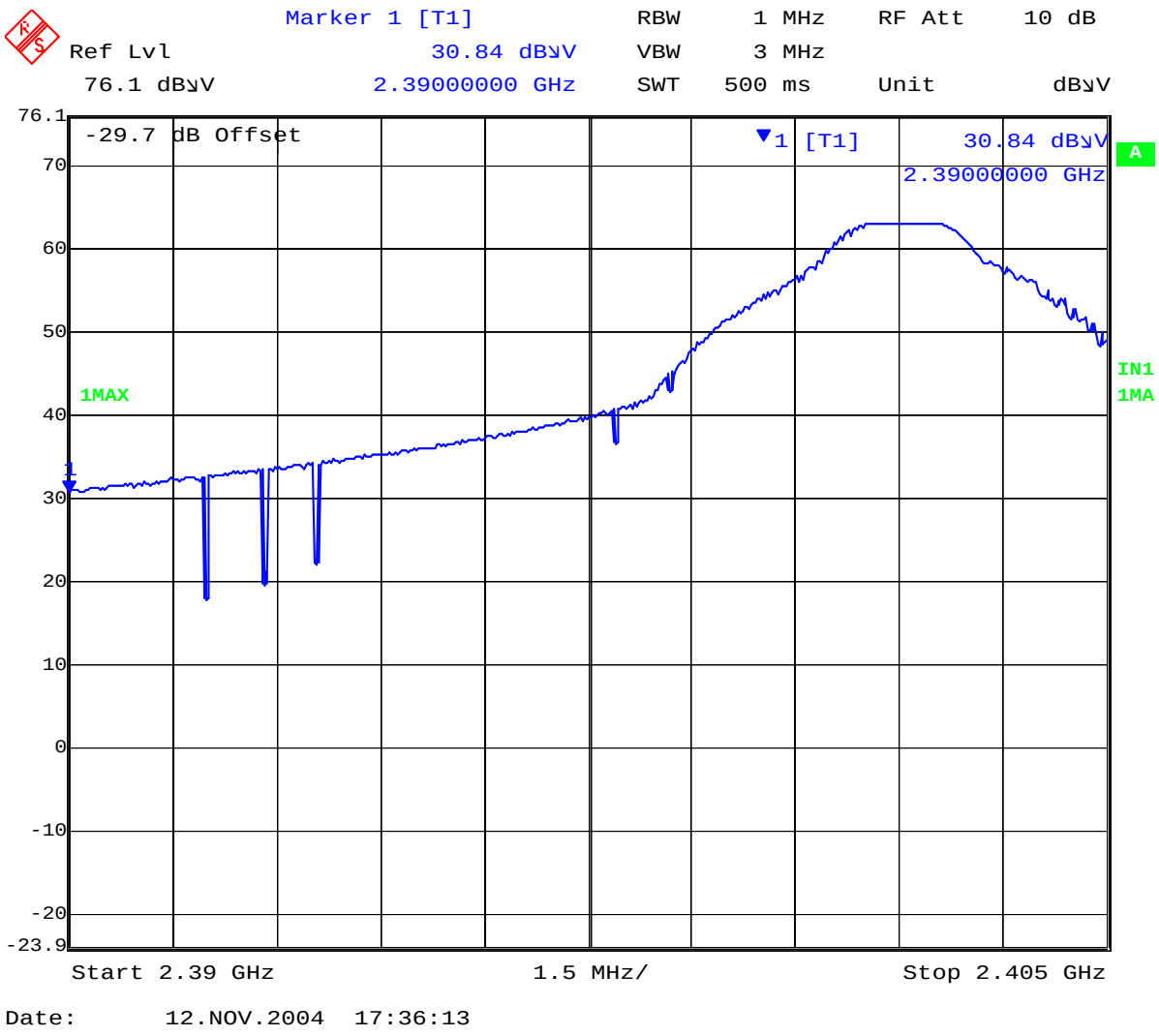


TUVR29-A1/09 - Transmitter Radiated Emissions 2,478MHz Vertical

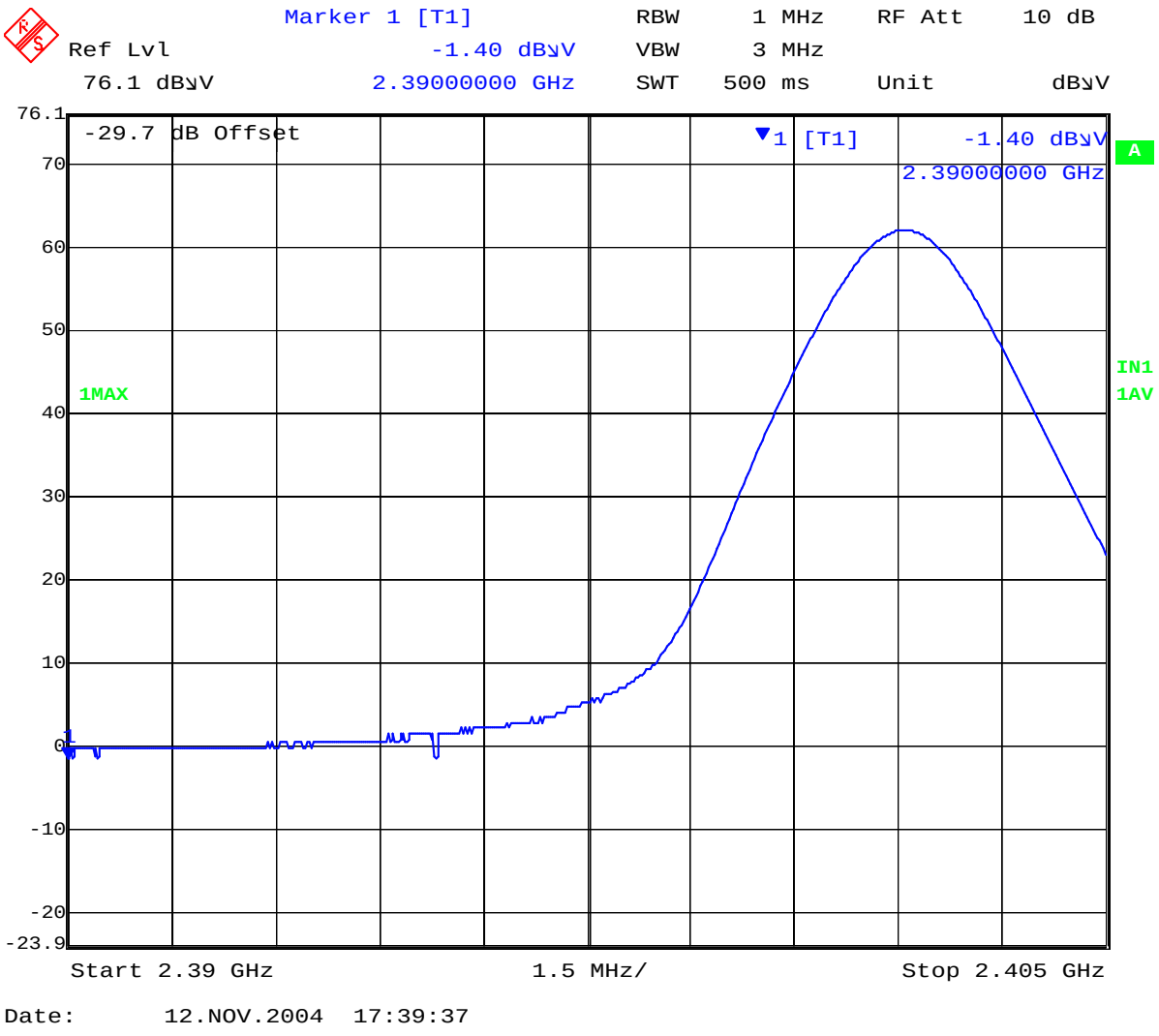




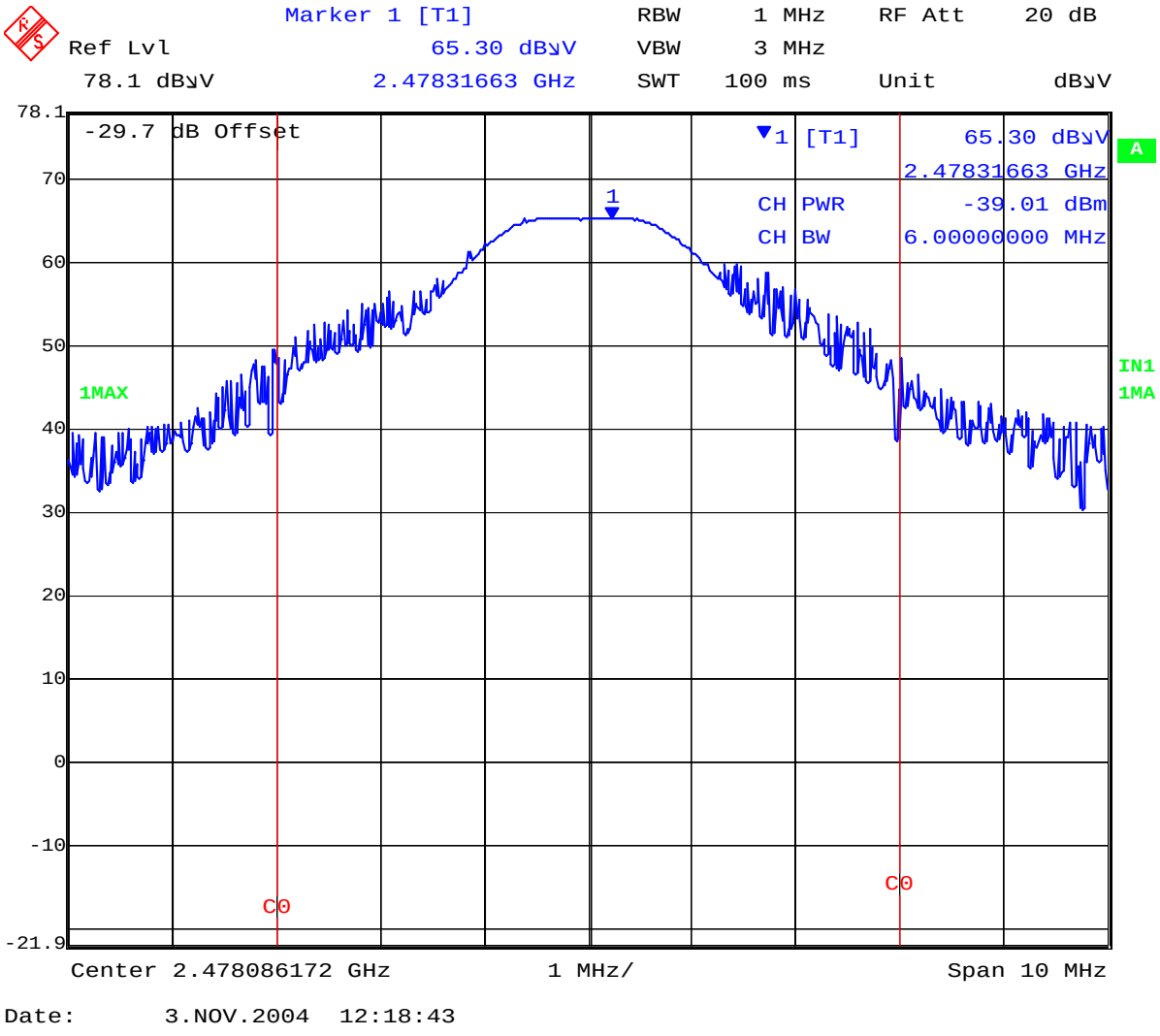
TUVR29-A1/10 – 2,390 MHz Radiated Band Edge Peak



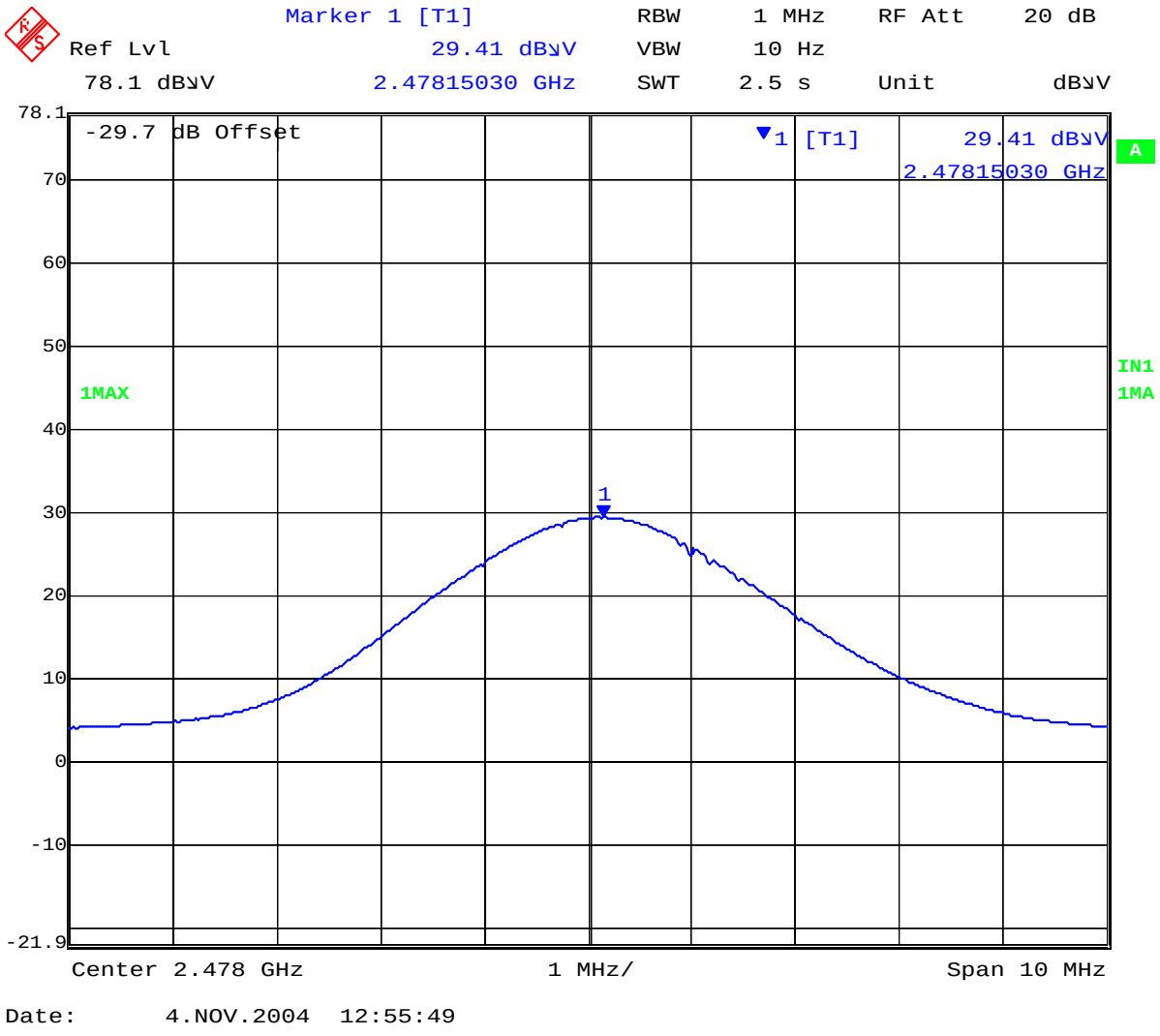
TUVR29-A1/11 – 2,390 MHz Radiated Band Edge Ave.



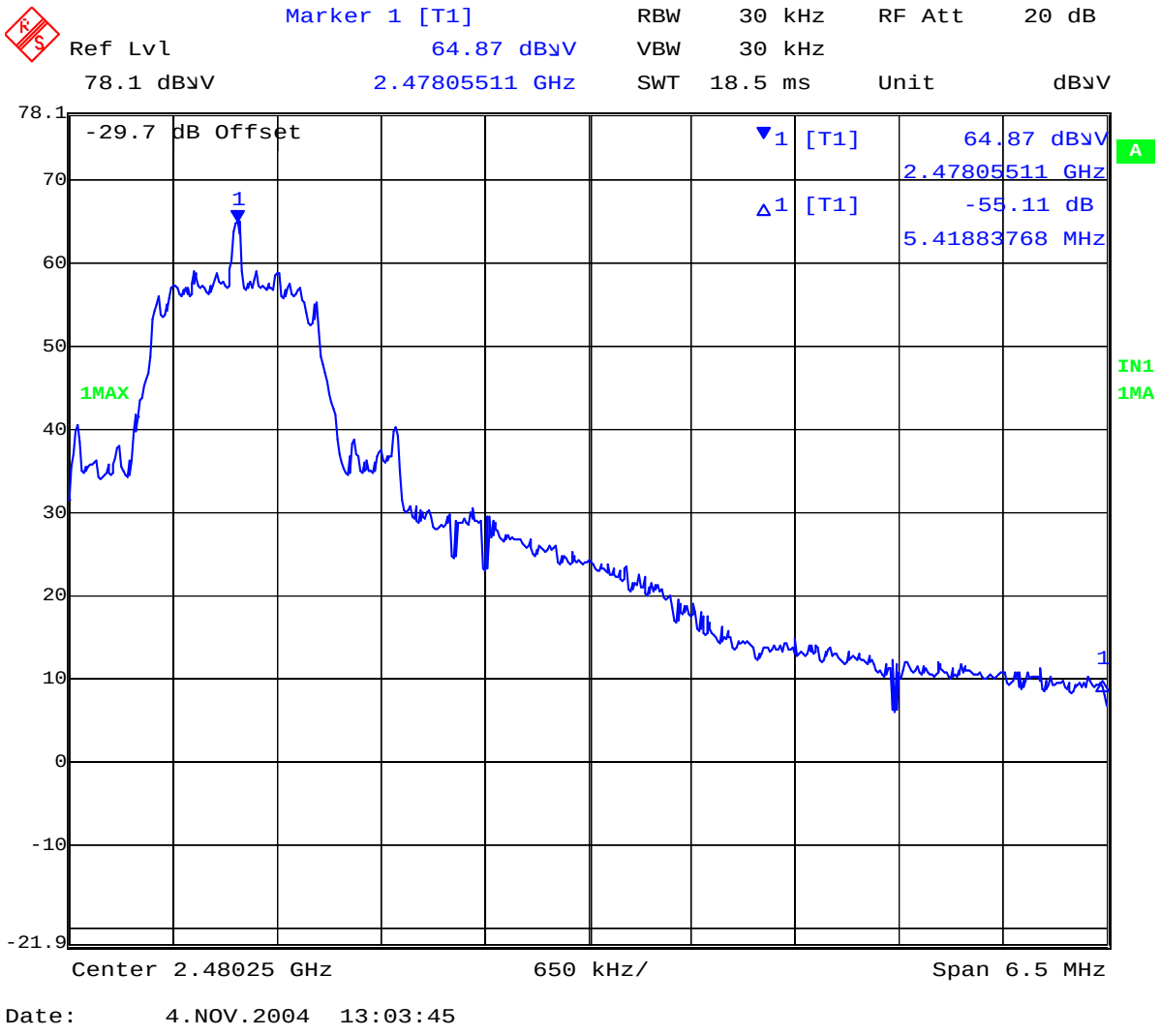
TUVR29-A1/12 - 2,483.5 MHz Radiated Band Edge Peak



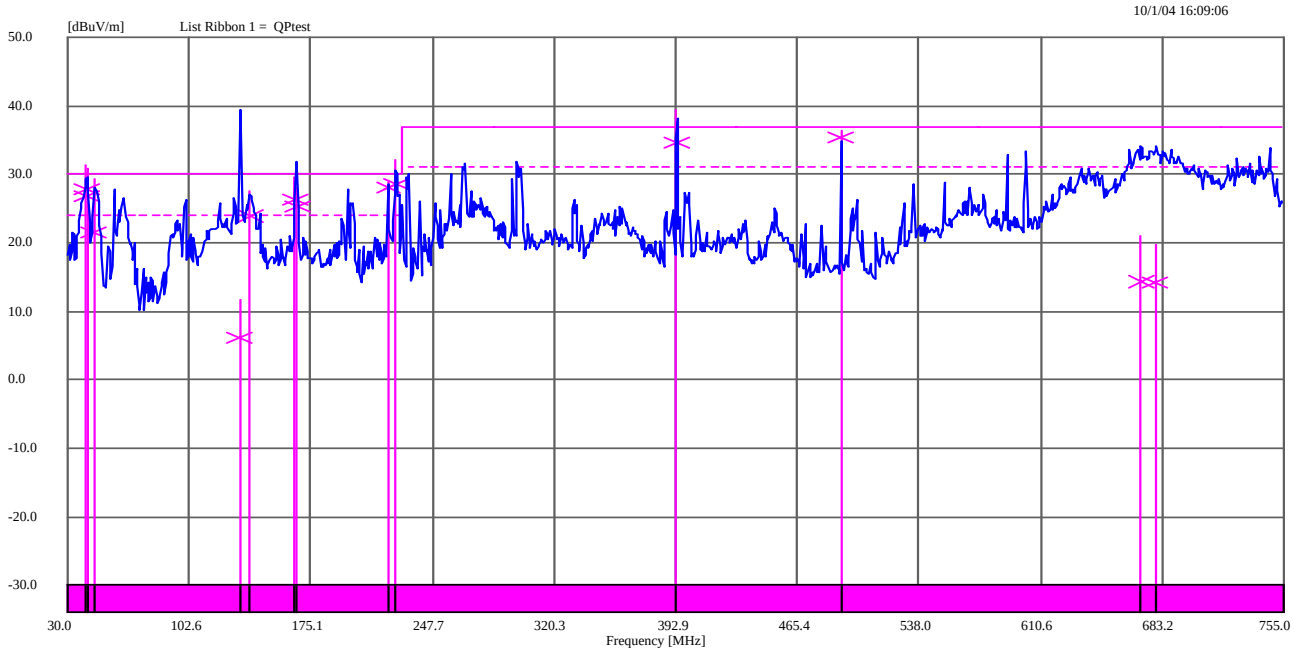
TUVR29-A1/13 - 2,483.5 MHz Radiated Band Edge Average



TUVR29-A1/14 - 2,483.5 MHz Radiated Band Edge Delta

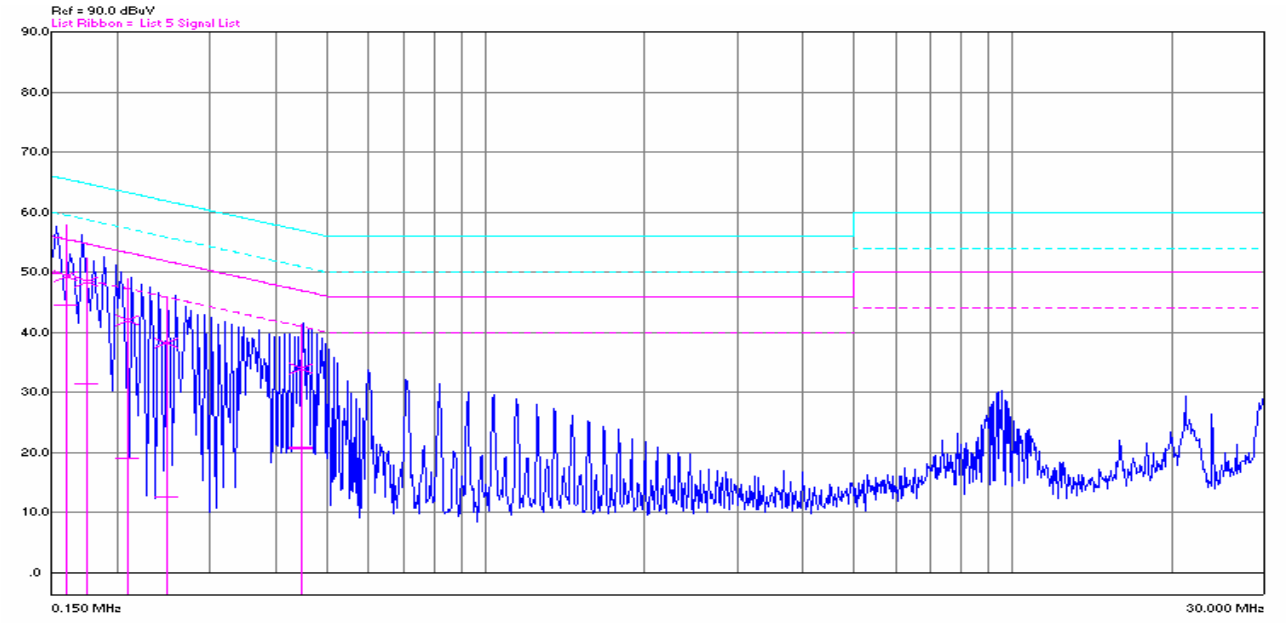


TUVR29-A1/15 – Radiated Emissions 30M-1GHz (H & V)

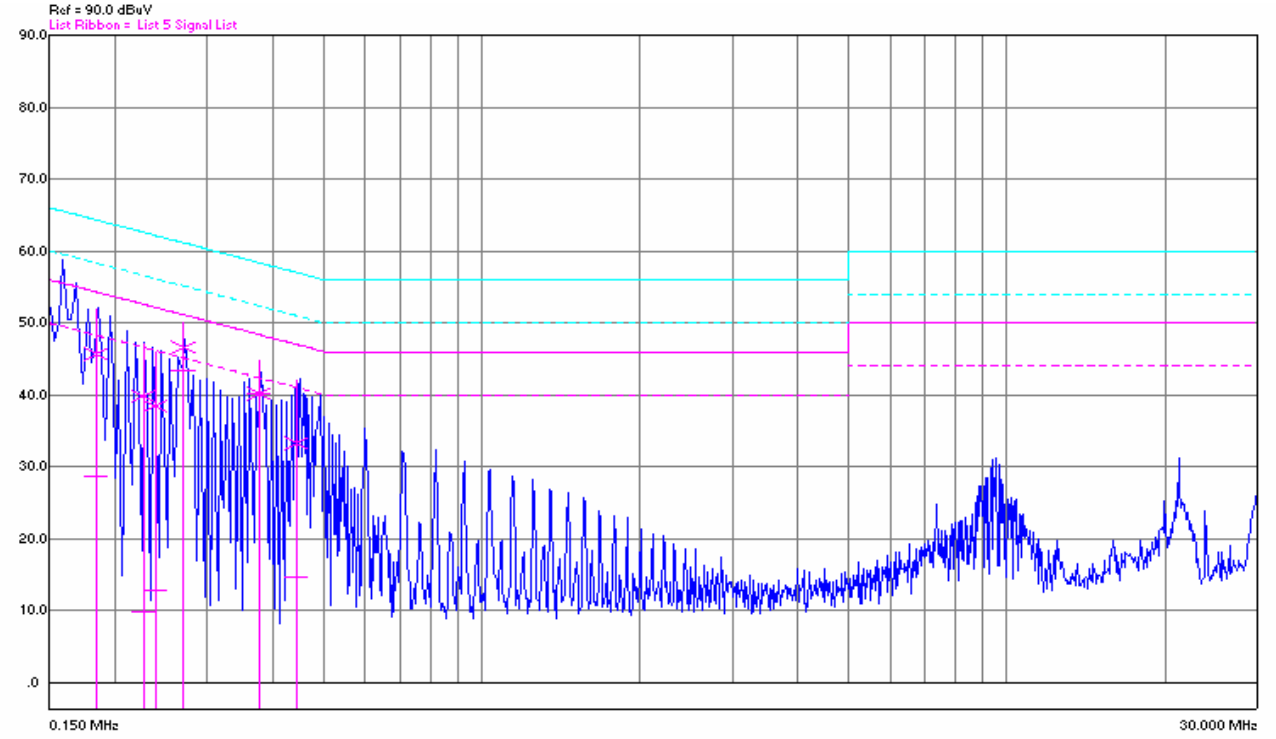


TUVR29-A1/16 - AC Wireline Conducted Emissions (Live and Neutral)

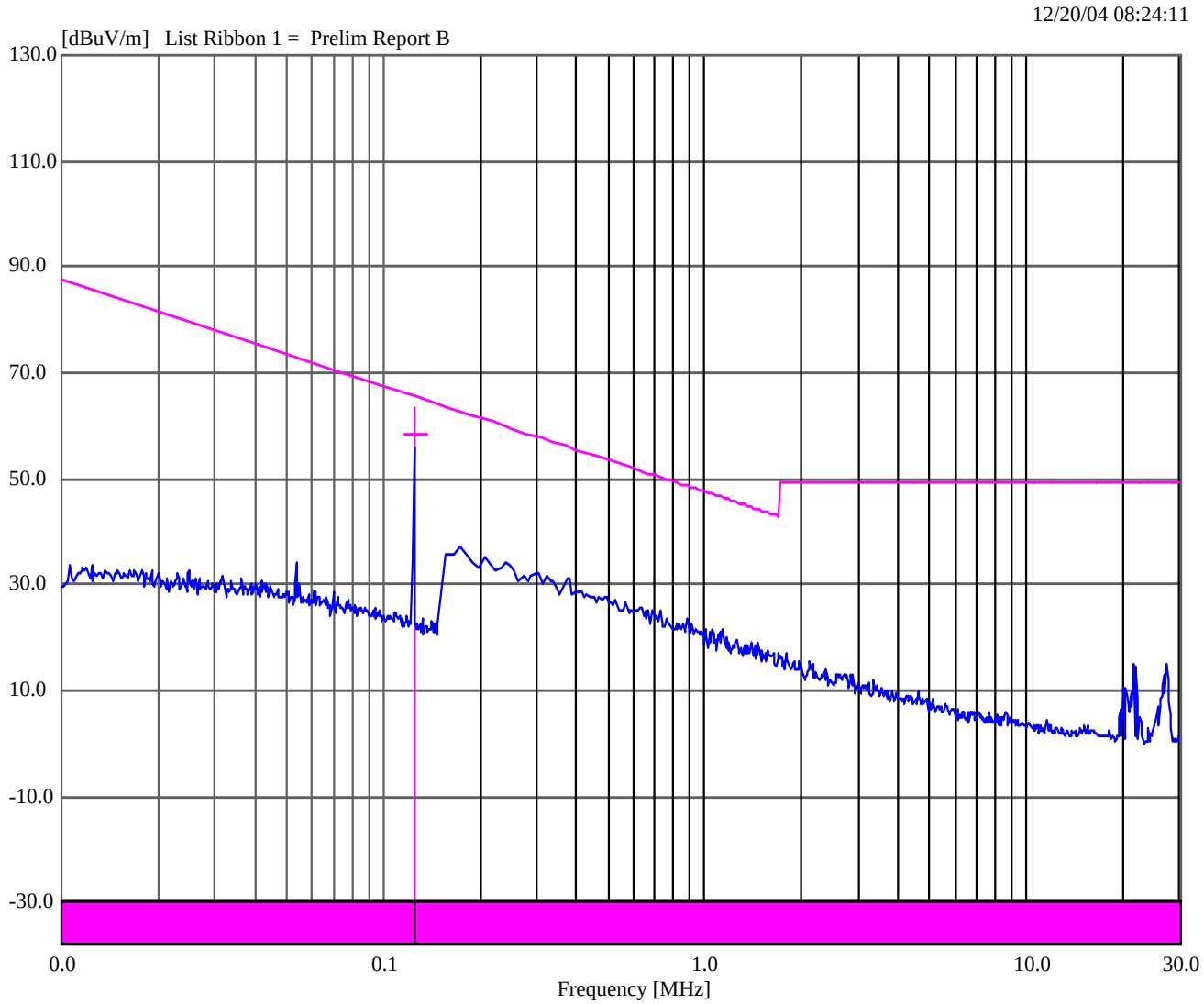
Line: Live



Line: Neutral



TUVR29-A1/17–125KHz Field Strength & Spurious Emission Plot 9KHz–30MHz



Limit line on the above plot is incorrect. Limit at 125 KHz should be 105.66dBµV/m

3922 Valley Avenue, Suite “B”
Pleasanton, CA 94566, USA
Tel: 1.925.462.0304
Fax: 1.925.462.0306
www.micomlabs.com