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Test of 2.4 GHz Odyssey Diode Laser

To FCC 47 CFR Part 15.249 & IC RSS-210

Test Report Serial No.:
TUVR68-A1 Rev B

MiCOM Labs
opening wireless markets

TEST REPORT

FROM

Test of 2.4 GHz Odyssey Diode Laser

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

Test Report Serial No.: TUVR68-A1 Rev B

This report supersedes TUVR68-A1 Rev A

Manufacturer: CAO Group, Inc
8683 South 700 West
Sandy, Utah 84070
USA

Product Function: 2.4 GHz Wireless Dental Laser and Foot Switch

Copy No: pdf **Issue Date:** 5th May '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

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ACCREDITATION & LISTINGS

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

United Kingdom Accreditation Service

ACCREDITATION CERTIFICATE

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 S 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

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DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	24th March 2005	
Rev A	30th March 2005	
Rev B	5th May 2005	Update to Section 5.1.3 Receiver Spurious Emissions

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1. TEST RESULT CERTIFICATE

Manufacturer:	CAO Group, Inc 8683 South 700 West Sandy, Utah 84070 USA		Tested:	MiCOM Labs, Inc. 3922 Valley Avenue 'B' Pleasanton California, 94566, USA
EUT:	Odyssey 2.4G Diode Laser & Wireless Foot Switch		Tel:	+1 925 462 0304
Model:	Diode Laser	Footswitch	Fax:	+1 925 462 0306
S/N(s):	PROT04	PROT04(01296)		
Test Date(s):	25th Feb - 10th Mar '05		Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part15.249 & 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.

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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	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(vi)	LAB34	Edition 1 August 2002	The expression of uncertainty in EMC Testing
(vii)	ETSI TR 100 028 V1.4.1	2001-12	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, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

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3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the 2.4 GHz Odyssey Diode Laser to FCC and Industry Canada regulations
Applicant:	TUV Rheinland of North America 1279 Quarry Lane, Suite 'A' Pleasanton, California 94566, USA
Manufacturer:	CAO Group, Inc 8683 South 700 West Sandy, Utah 84070 USA
Laboratory performing the tests:	MiCOM Labs, Inc. 3922 Valley Avenue, Suite "B" Pleasanton, California 94566 USA
Test report reference number:	TUVR68-A1 Rev B
Date EUT received:	24th February 2005
Standard(s) applied:	FCC 47 CFR Part15.249 & IC RSS-210
Dates of test (from - to):	25th February to 10th March 2005
No of Units Tested:	Odyssey 2.4GHz Diode Laser and Footswitch
Type of Equipment:	Medical Laser
Manufacturers Trade Name:	Odyssey 2.4 GHz Diode Laser
Model:	2.4G
Location for use:	Indoors – medical environment
EUT Modes of Operation:	DSSS (Direct Sequence Spread Spectrum)
Declared Frequency Range(s):	Diode Laser and Footswitch operation: 2,405MHz – 2,480MHz
Type of Modulation:	Direct Sequence Spread Spectrum (DSSS)
Declared Nominal Output Power:	+0 dBm
Transmit/Receive Operation:	Simplex (2,405 to 2,480 MHz)
Rated Input Voltage and Current:	Laser Diode Unit 100-240 Vac, 50-60 Hz, 1.5A Footswitch 9Vdc.
Operating Temperature Range:	+5ºC to +40ºC
ITU Emission Designator:	2M46W7D
Microprocessor(s) Model:	ZiLOG Z8F0822SJ
Clock/Oscillator(s):	11.0592 MHz, 16 MHz
Frequency Stability:	±20ppm
Equipment Dimensions:	Diode Laser 9" x 6" x 5" Foot Switch 9" x 8" x 1.75"
Weight:	Diode Laser approximately 6 lbs Foot Switch 1.5 lbs
Primary function of equipment:	Medical dental laser

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3.2. Scope of Test Program

The scope of the test program was to test the Odyssey 2.4G Diode Laser for compliance against appropriate FCC and Industry Canada regulatory requirements;

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

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

Description of EUT

The Odyssey 2.4G Diode Laser is a low power soft tissue medical laser system consisting of a Diode Laser unit and a wireless remote foot controller. The foot switch is synchronized to a specific Diode Laser unit and is capable of turning On or Off the Diode Laser working beam.

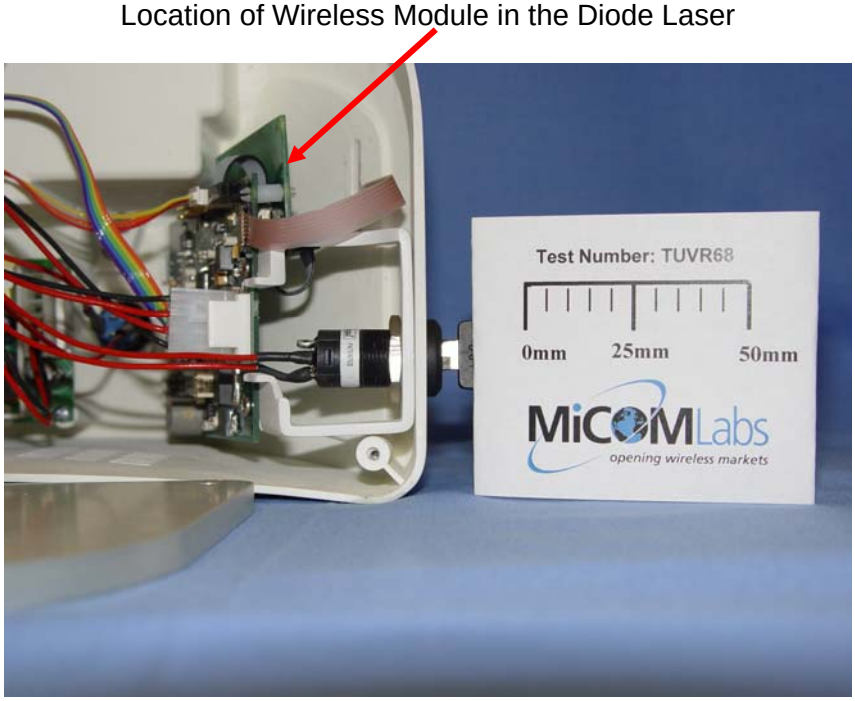
The Diode Laser operates from 90-240Vac 50/60 Hz mains. The footswitch powered via a 9Vdc alkaline battery.

Both the Diode Laser and the foot pedal utilize the same 2.4GHz wireless transceiver.

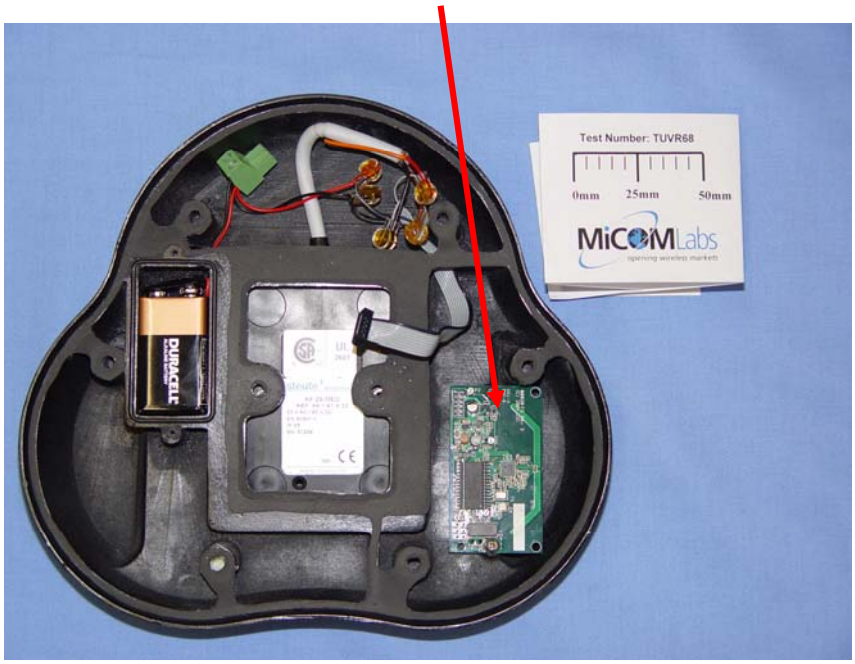
Odyssey 2.4G Diode Laser and Footswitch

Both the diode laser and footswitch utilize the same wireless module number

Location of Wireless Module in the Diode Laser



Location of the Wireless Module in the Foot Switch



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

Category	Name	Model No.	Serial No.
EUT	Odyssey 2.4G Diode Laser	n/a	PROT04
EUT	Footswitch	n/a	PROT04 (01296)

3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Diode Laser (integral)	0	Printed circuit trace	N/A	N/A
Footswitch (integral)	0	Printed circuit trace	N/A	N/A

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. AC power socket

3.6. Test Configurations

Matrix of test configurations

Operating Channel	Frequencies (MHz)
0	2,405
7	2,440
15	2,480

For transmitter spurious emission testing both the controller and footswitch were tested simultaneously. The units were configured to communicate on a fixed frequency channel via custom software.

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.

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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

Radiated emissions (30 MHz-1 GHz), see Section 5.1.2.3 were performed by;

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.

Sanmina SCI: FCC Registration Number: **90844**

IC Registration Number: **IC5541**

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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
5.9.1	99% BW	99% Operational bandwidth of the Equipment	Radiated	Complies	5.1.1
15.249 (a) (d) **6.2.2(m2)(1)**	Field Strength	Maximum field strength measurement	Radiated	Complies	5.1.2
15.209(a) **6.2.2(m2)(3)** **7.3**	Radiated Emissions	Tx Emissions >1 GHz (1-26 GHz)	Radiated	Complies	5.1.3.1
		Receiver Emissions >1 GHz (1-26 GHz)	Radiated	Complies	5.1.3.2
		Band Edge	Radiated	Complies	5.1.3.3
		Emissions <1 GHz (30M-1 GHz)	Radiated	Complies	5.1.3.4
15.207 **6.6, 7.4**	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies	5.1.4

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

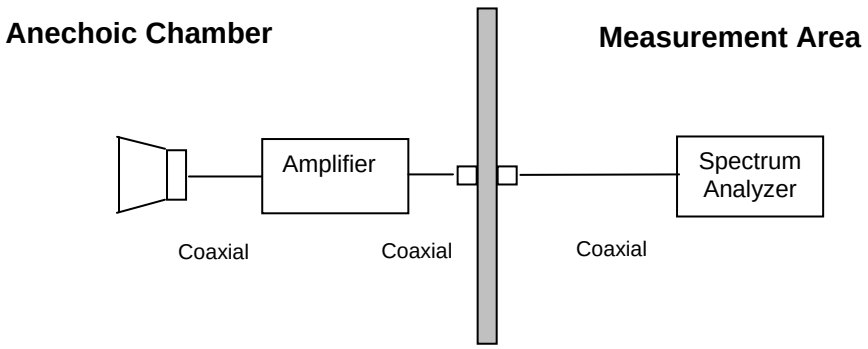
5.1. 2.4GHz Device Characteristics

5.1.1. 99 % Bandwidth

Industry Canada RSS-210 §5.9.1

Test Procedure
The 99 %bandwidth measurement was performed as a radiated test in a 3-meter semi-anechoic chamber in both horizontal and vertical polarities with the maximum value found reported. The footswitch and controller were both placed on a polystyrene table 0.8m above the ground-plane and the maximum emission found through rotation of the turntable, measurement distance 3m. System gain was included as an offset in the spectrum analyzer settings.

Test Measurement Set up



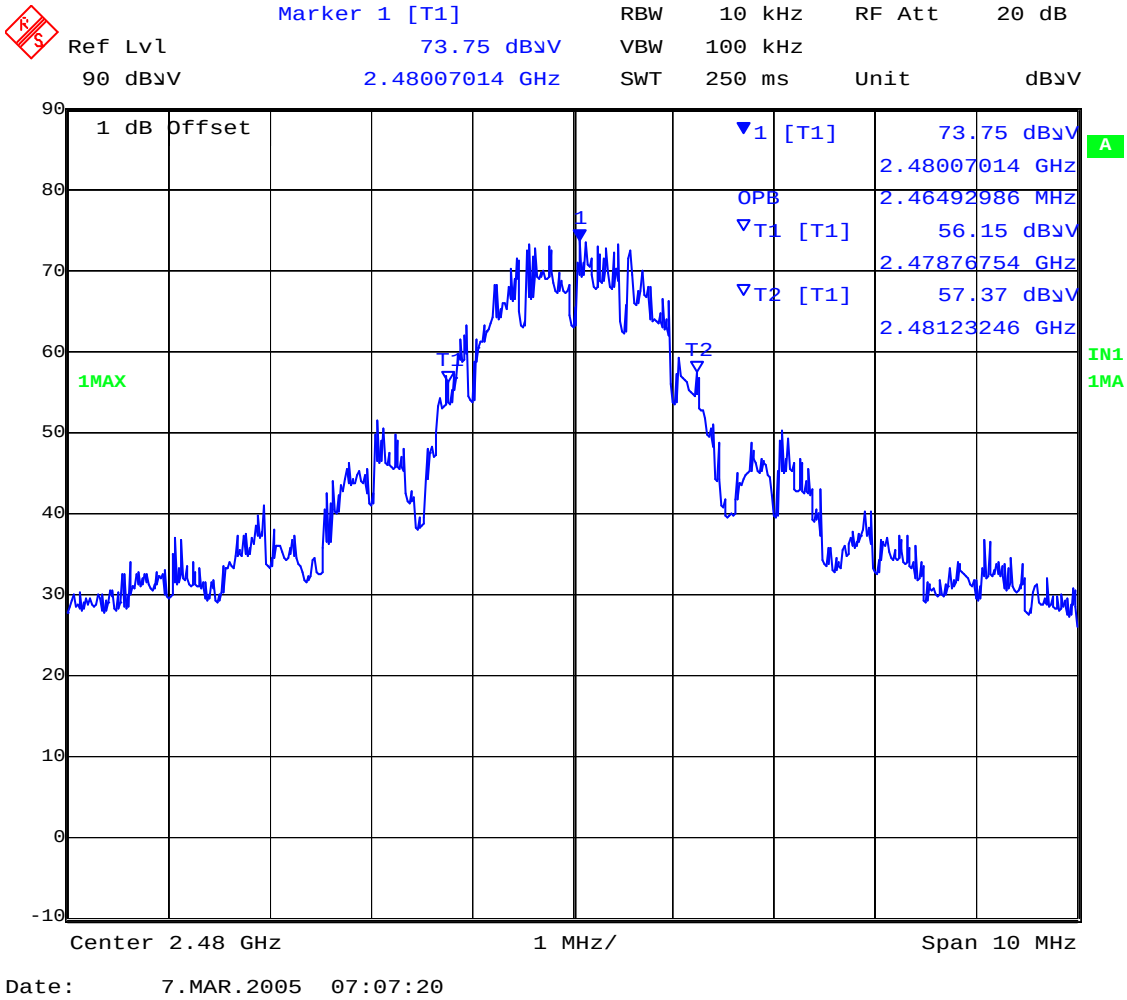
Test set up for 99 %bandwidth measurement

Measurement Results for 99 % Bandwidth(s)

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

TABLE OF RESULTS

Center Frequency (MHz)	FOOTSWITCH 99 % BW (MHz)	LASER 99 % BW (MHz)
2,405	2.424970	2.42485
2,440	2.444889	2.44489
2,480	2.464929	2.44489



FOOTSWITCH - WORST CASE 99% BANDWIDTH

LASER - WORST CASE 99% BANDWIDTH

SPECIFICATIONS

Limits

RSS-210 §**5.9.1** Where indicated, the 6dB (or 20 dB) bandwidth is measured at the points when the spectral density of the signal is 6dB (or 20dB) down from the in-band spectral density of the modulated signal, with the transmitter modulated by a representative signal. An alternative to the 20dB bandwidth is the 99% emission bandwidth.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0156, 0193, 0252, 0313, 0314.

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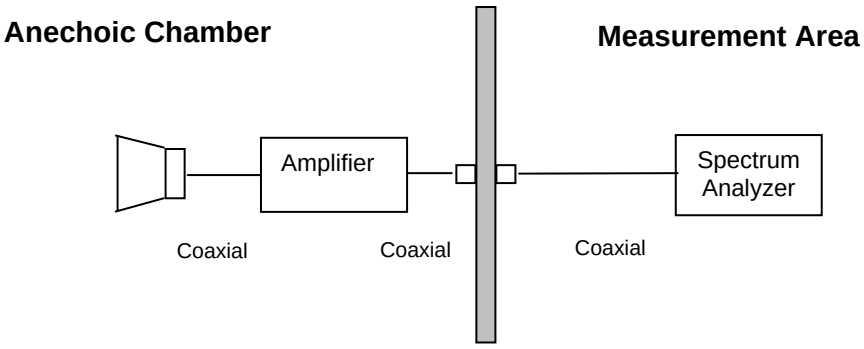
5.1.2. Field Strength

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 on the selected channel of interest.

Test Measurement Set up



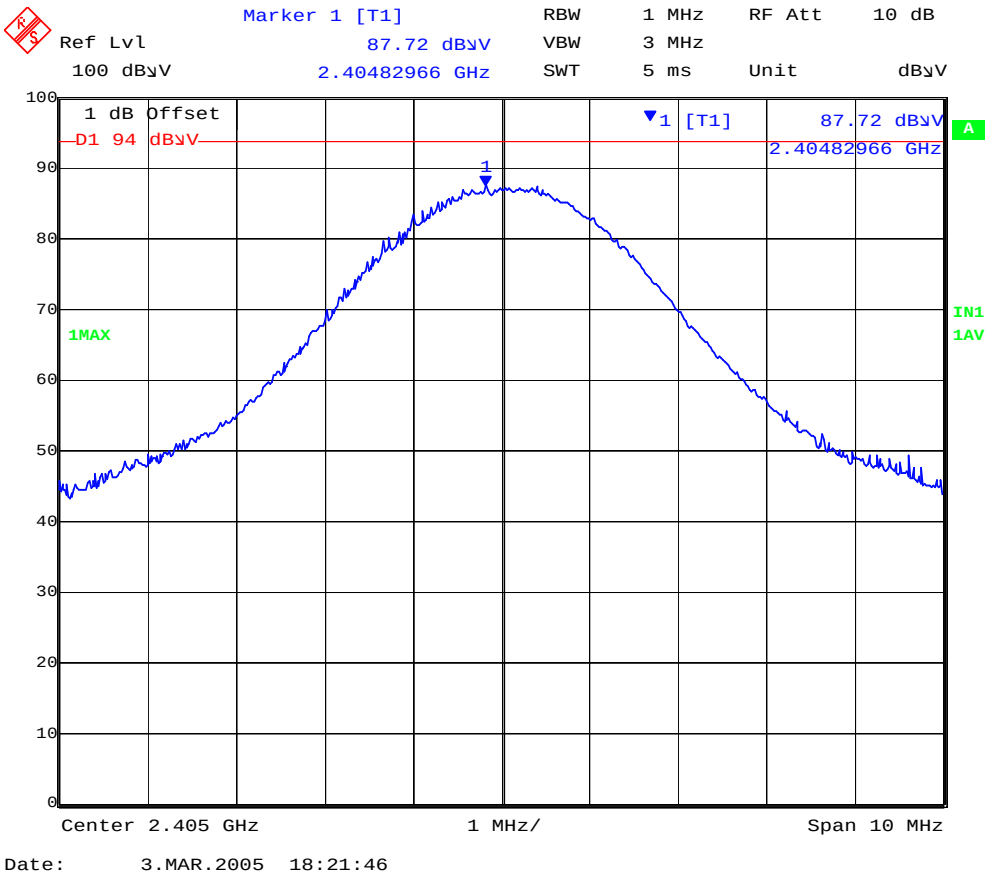
Test set up for field strength measurement

Measurement Results for Field Strength

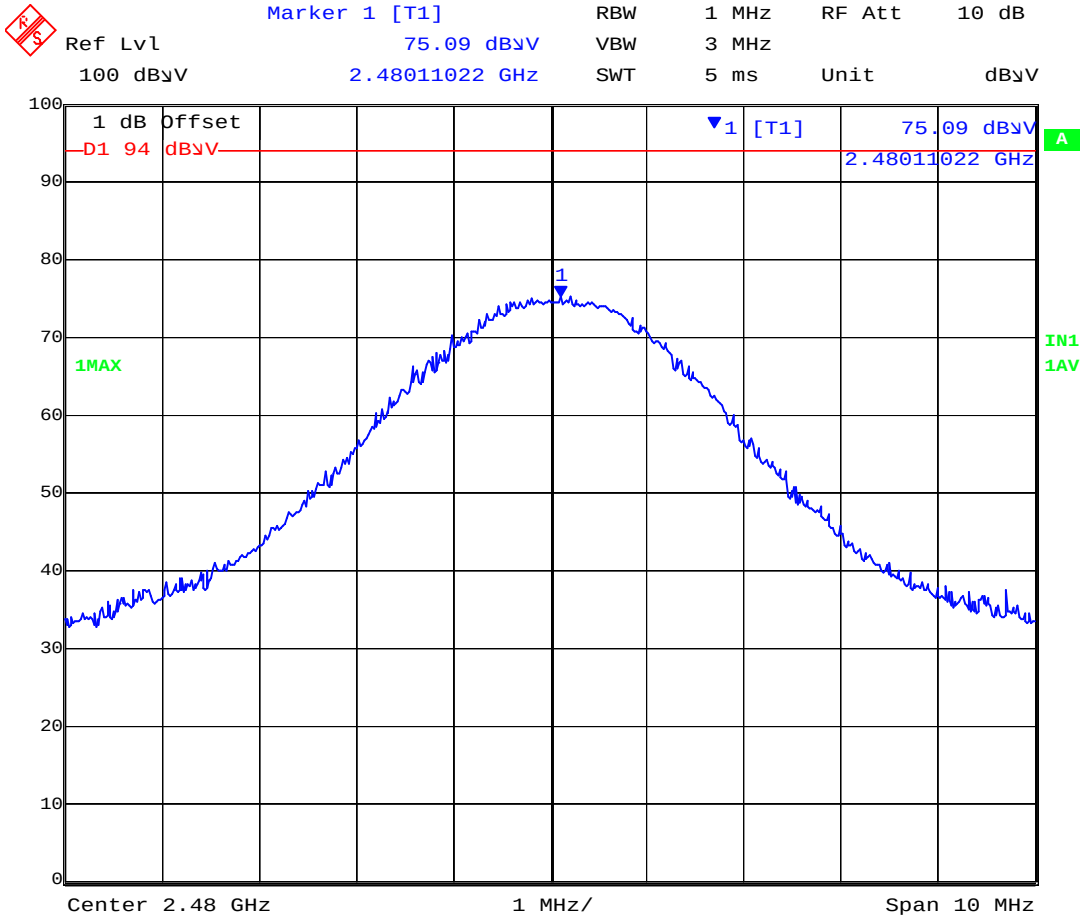
Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS FOR MEASUREMENT OF FIELD STRENGTH

Center Frequency (MHz)	Amplifier + Antenna Gain + Cable loss @ Fundamental Frequency (dB)	FOOTSWITCH Field Strength dBµV/m	LASER Field Strength dBµV/m
2,405	+1.0	87.72	73.97
2,440	+1.0	84.43	74.47
2,480	+1.0	81.88	75.09



FOOTSWITCH – FIELD STRENGTH



LASER – FIELD STRENGTH

SPECIFICATIONS

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, 0304, 0267, 0251, 0252.

5.1.3. Radiated Emissions

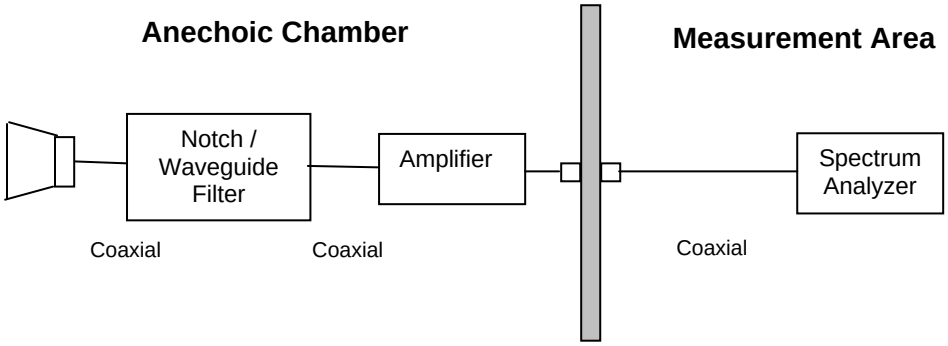
5.1.3.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

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 GHz 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

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Measurement Results Transmitter Radiated Spurious Emissions

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

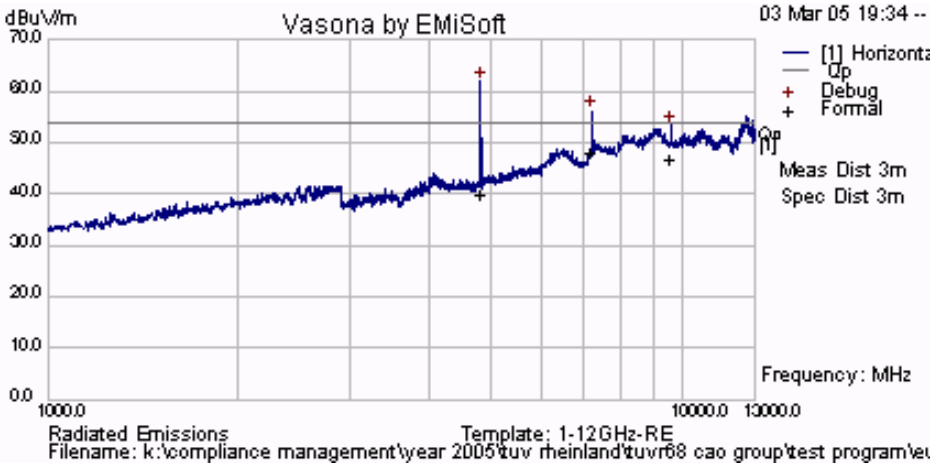
Radio parameters.
Channel 0 (2,405MHz) Results

TABLE OF RESULTS

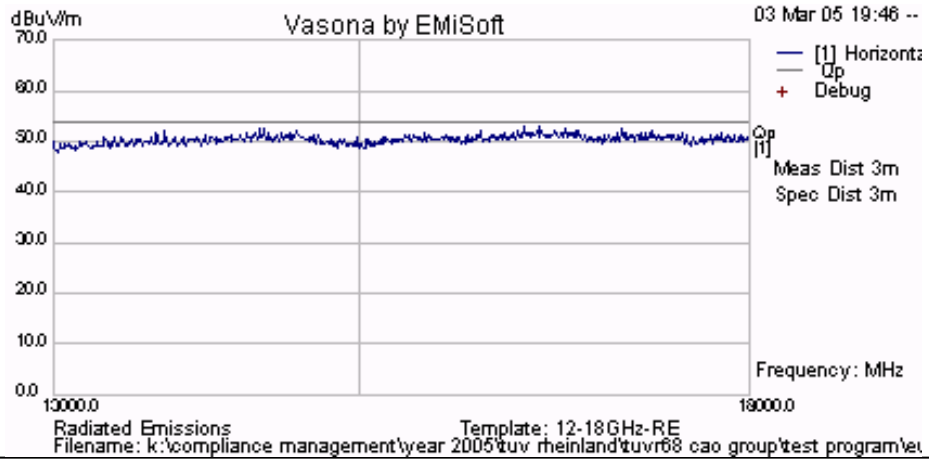
Freq. (MHz)	Polarity (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4808.99	H	30.32	7.35	37.67	54.00	-16.33
7216.49	H	35.66	10.24	45.90	54.00	-8.1
9621.76	H	31.34	13.36	44.70	54.00	-9.3
4808.98	V	30.36	7.35	37.71	54.00	-16.29
7213.61	V	35.29	10.23	45.52	54.00	-8.48

Note; Worst case results shown below. Results for Vertical polarization held on file.

Ch 0 Horizontal Results for 1 to 13 GHz



Ch 0 Horizontal Results for 13 to 18 GHz



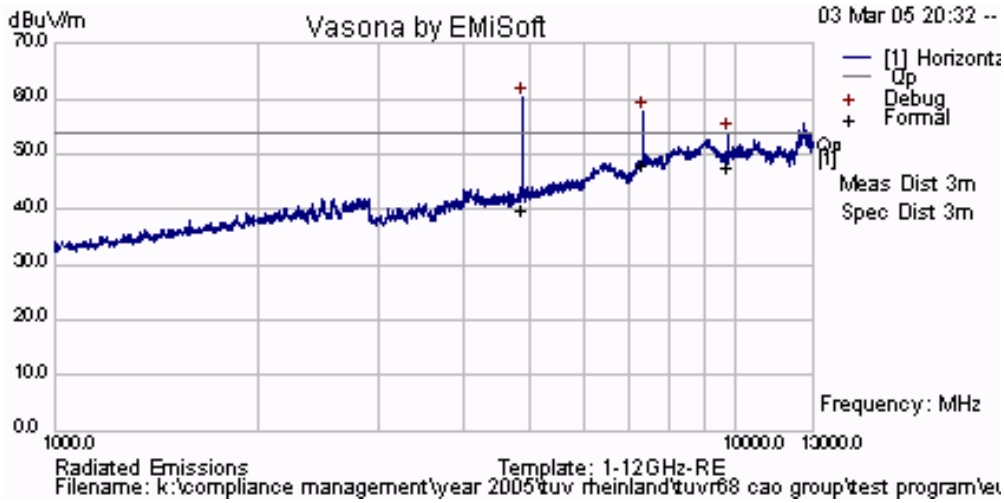
Channel 7 (2,440MHz) Results

TABLE OF RESULTS

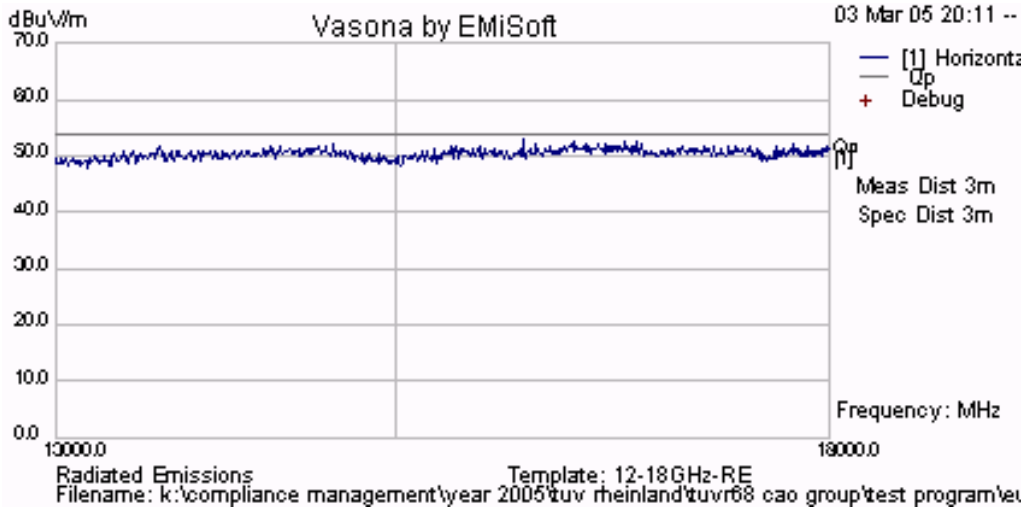
Freq. (MHz)	Polarity (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4879.12	H	30.38	7.44	37.82	54.00	-16.18
7318.09	H	35.43	10.54	45.97	54.00	-8.03
9768.20	H	32.40	13.06	45.46	54.00	-8.54
4881.03	V	30.38	7.44	37.82	54.00	-16.18
7318.61	V	35.65	10.54	46.19	54.00	-7.81

Note; Worst case results shown below. Results for Vertical polarization held on file.

Ch 7 Horizontal Results for 1 to 13 GHz



Ch 7 Horizontal Results for 13 to 18 GHz



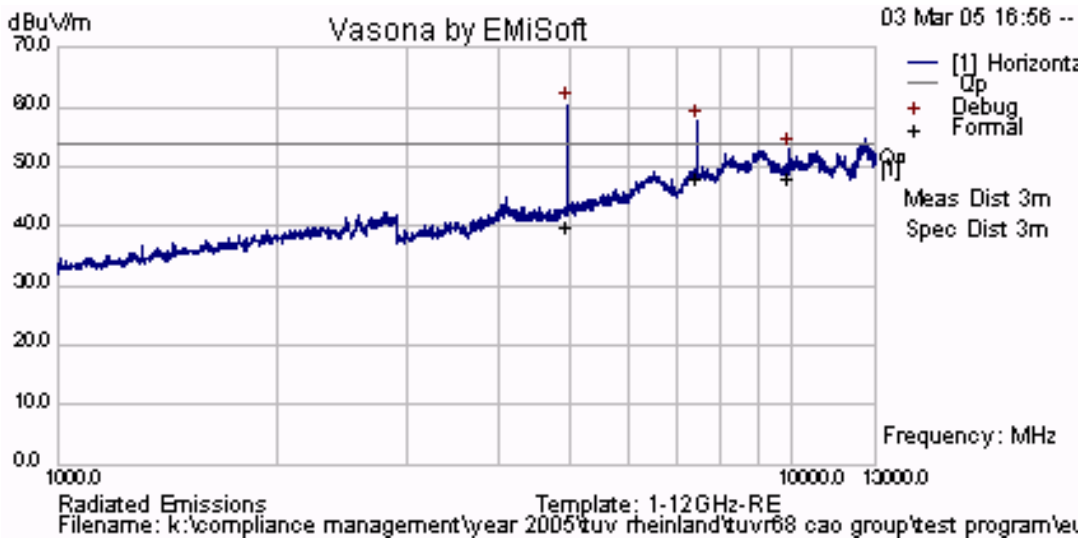
Channel 15 (2,480MHz) Results

TABLE OF RESULTS

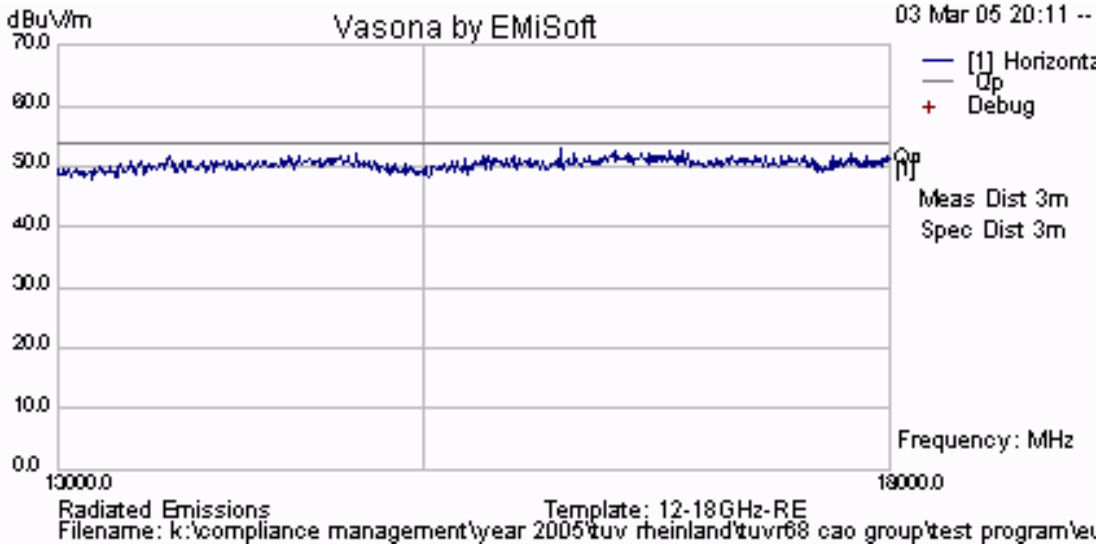
Freq. (MHz)	Polarity (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4958.83	H	30.26	7.58	37.84	54.00	-16.16
7438.55	H	34.9	10.92	45.82	54.00	-8.18
9919.36	V	32.83	12.96	45.79	54.00	-8.21
4959.13	V	29.6	7.58	37.18	54.00	-16.82
7438.35	V	35.24	10.91	46.15	54.00	-7.85

Note; Worst case results shown below. Results for Vertical polarization held on file.

Ch 15 Horizontal Results for 1 to 13 GHz



Ch 15 Horizontal Results for 13 to 18 GHz



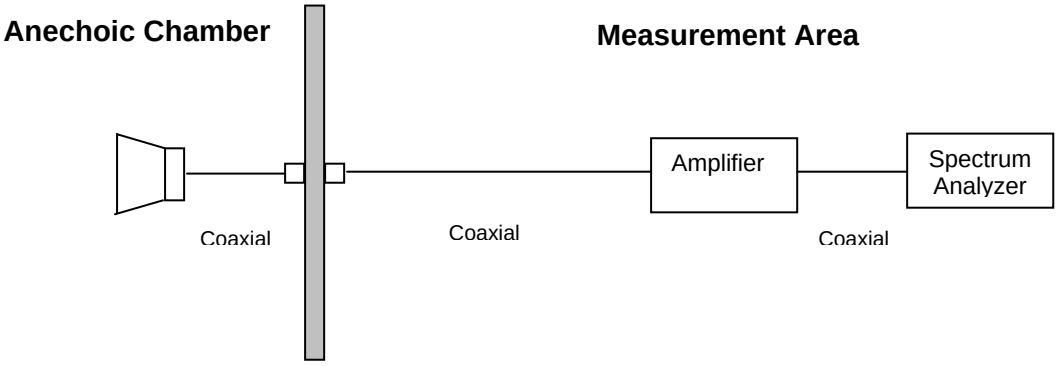
5.1.3.2. Receiver Spurious Emissions

FCC, Part 15 Subpart C §15.247(c)
Industry Canada RSS-210 §7.3

Test Procedure
Preliminary radiated emissions above 1GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. The highest emissions relative to the limit are listed for each frequency spanned.

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

Test Measurement Set up

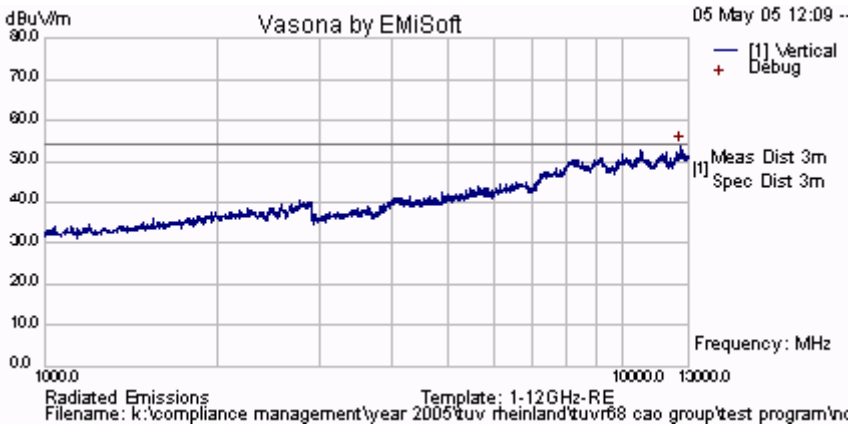


Measurement set up for Receiver Radiated Emission Test

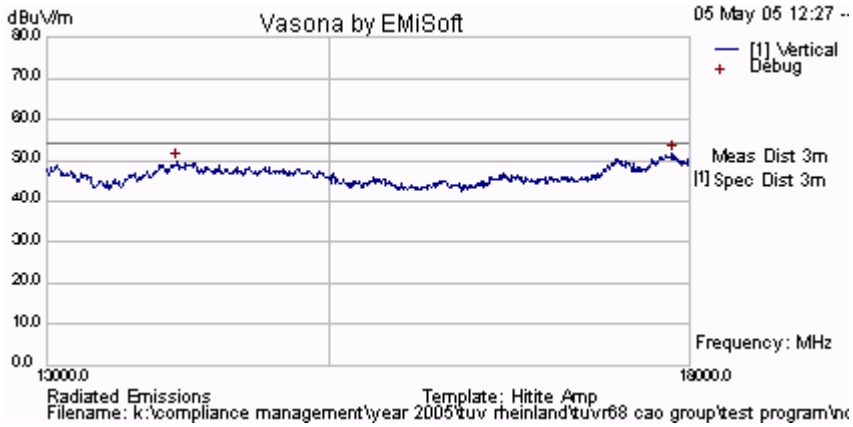
Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57% Pressure: 999 to 1009 mbar

CH.	Freq. (MHz)	Pol. (H/V)	Peak Reading (dBμV/m)	Ave Reading (dBμV/m)	Corr'n Factor (dB)	Corr'd Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
							54.00	

No emissions were observed



Ch 40: 1-13GHz



Ch 40: 13-18GHz

5.1.3.3. 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.

<u>Corrected Reading</u>

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

Amplifier gain and cable loss of -29.7 dB

System Gain = Amplifier gain + cable loss + antenna gain = +1dB

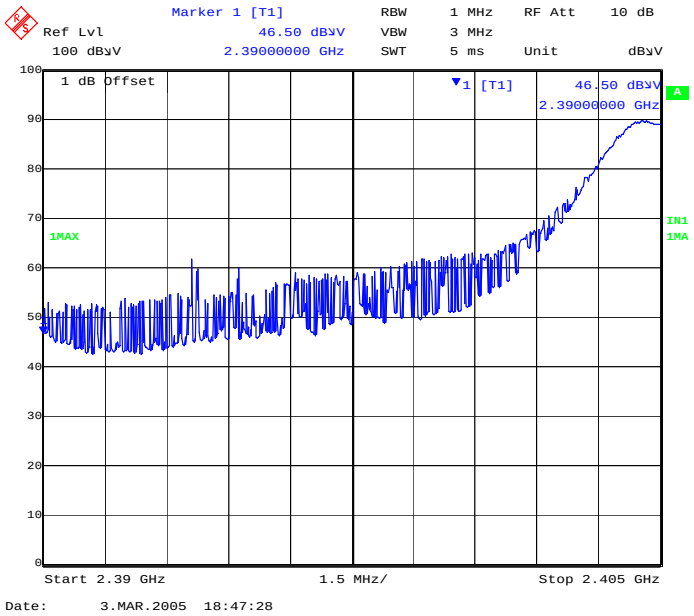
FOOTSWITCH BANDEDGE MEASUREMENT RESULTS

Radiated Band Edge (continued) TABLE OF RESULTS

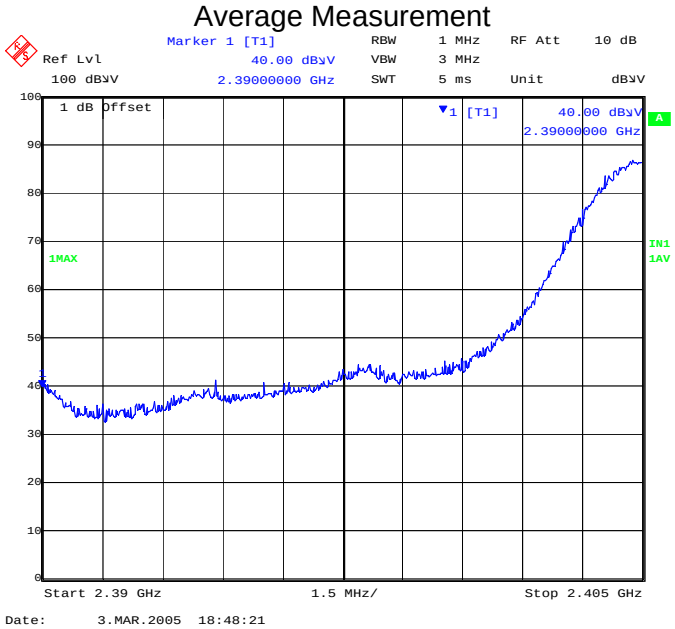
Restricted Band @ 2,390 MHz - Conventional Measurement Method

Channel (MHz)	Peak/Ave.	Polarity	Measured (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2,405	Peak	V	46.50	74.00	-27.5
2,405	Ave.	V	40.00	54.00	-14.0

Peak Measurement



Average Measurement

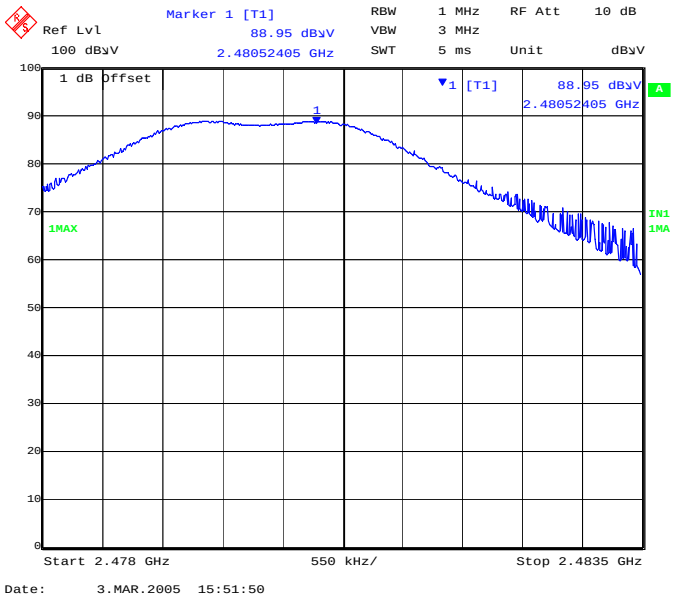


Radiated Band Edge (Footswitch continued) TABLE OF RESULTS

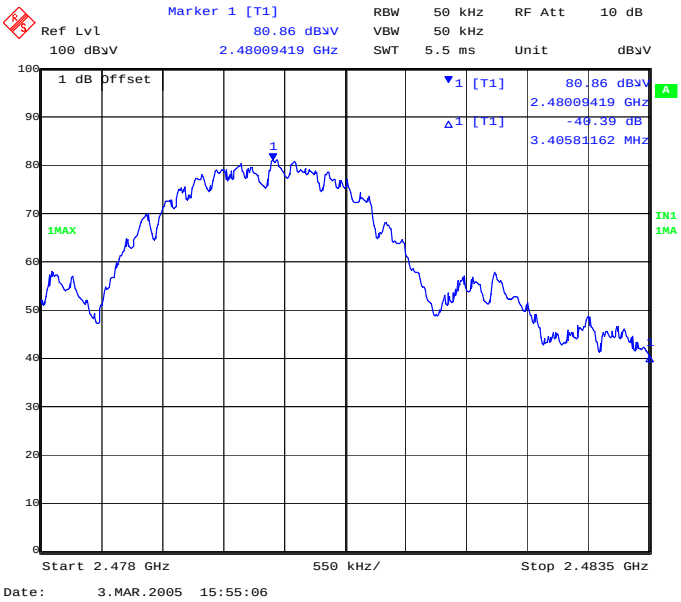
Restricted Band @ 2,483.5 MHz – Indirect Test Methodology

Center Frequency (MHz)	Peak/Ave	Polarity	Limit (dBuV/m)	Measured Peak (dBuV/m)	Delta (dBuV/m)	Corrected Reading (dBuV/m)	Margin (dB)
2,480	Peak	V	74.00	88.95	40.39	48.56	-25.44
2,480	Ave	V	54.00	63.35	40.39	22.96	-31.04

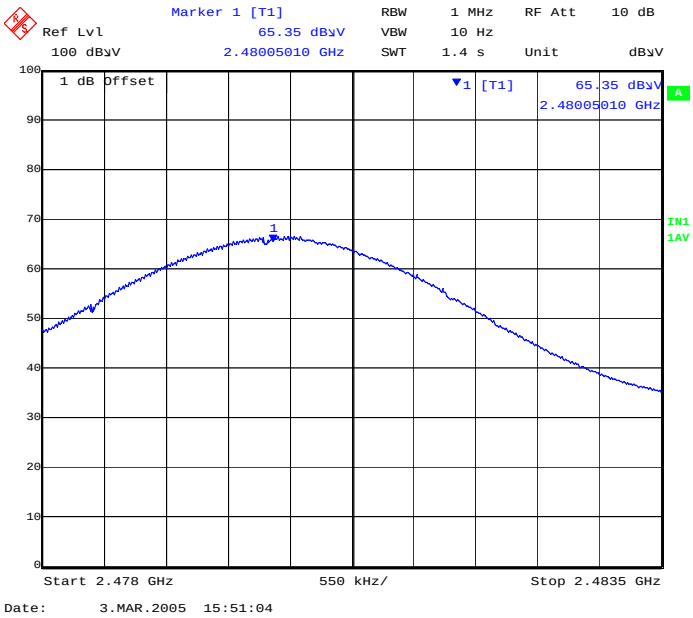
Peak Measurement



Delta Measurement



Average Measurement



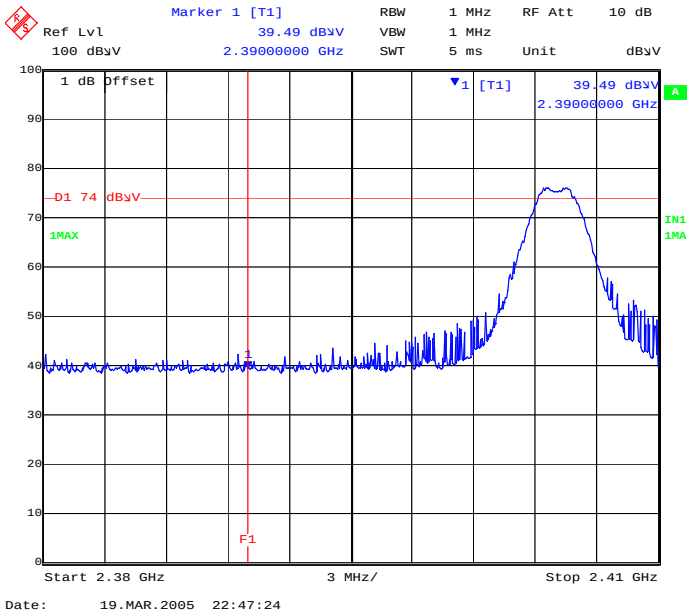
LASER BAND EDGE MEASUREMENT RESULTS

Radiated Band Edge (continued) TABLE OF RESULTS

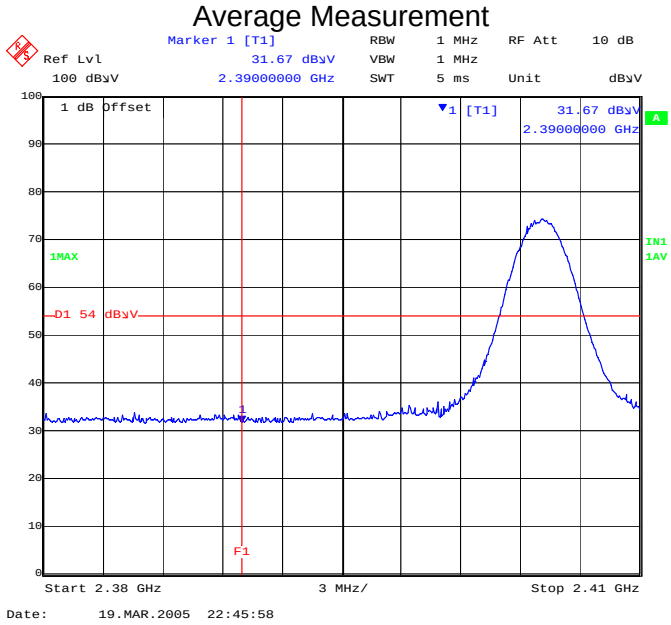
Restricted Band @ 2,390 MHz - Conventional Measurement Method

Channel (MHz)	Peak/Ave.	Polarity	Measured (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2,405	Peak	V	39.49	74.00	-34.51
2,405	Ave.	V	31.67	54.00	-23.00

Peak Measurement



Average Measurement

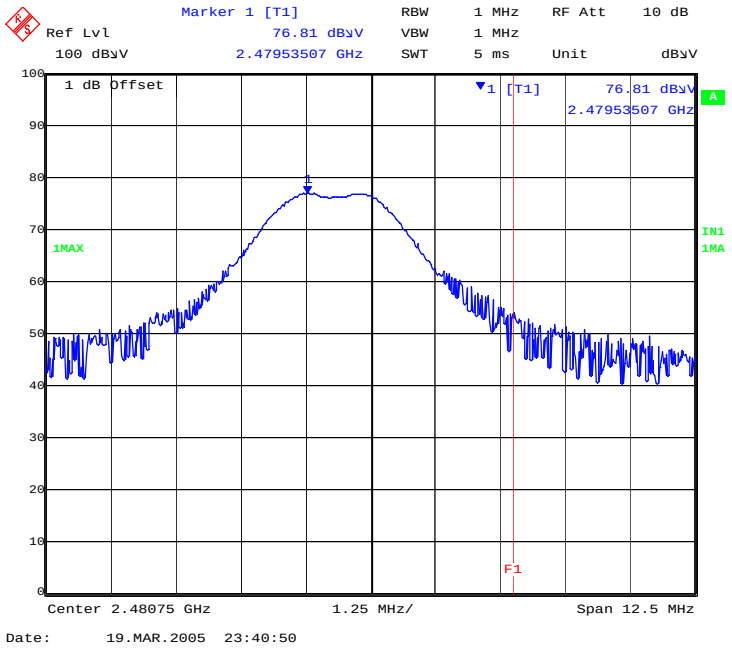


Radiated Band Edge (Laser continued) TABLE OF RESULTS

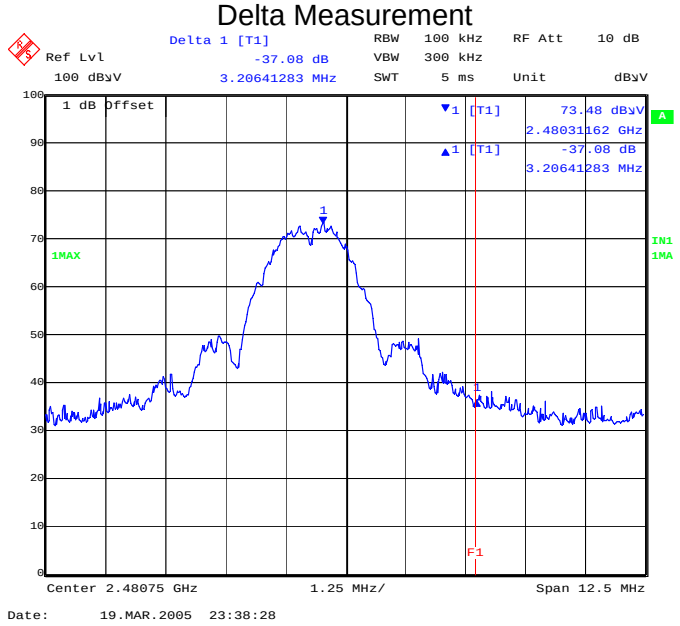
Restricted Band @ 2,483.5 MHz – Indirect Test Methodology

Center Frequency (MHz)	Peak/Ave	Polarity	Limit (dBuV/m)	Measured Peak (dBuV/m)	Delta (dBuV/m)	Corrected Reading (dBuV/m)	Margin (dB)
2,480	Peak	V	74.00	76.81	37.08	39.73	-34.27
2,480	Ave	V	54.00	54.00	37.08	16.92	-37.84

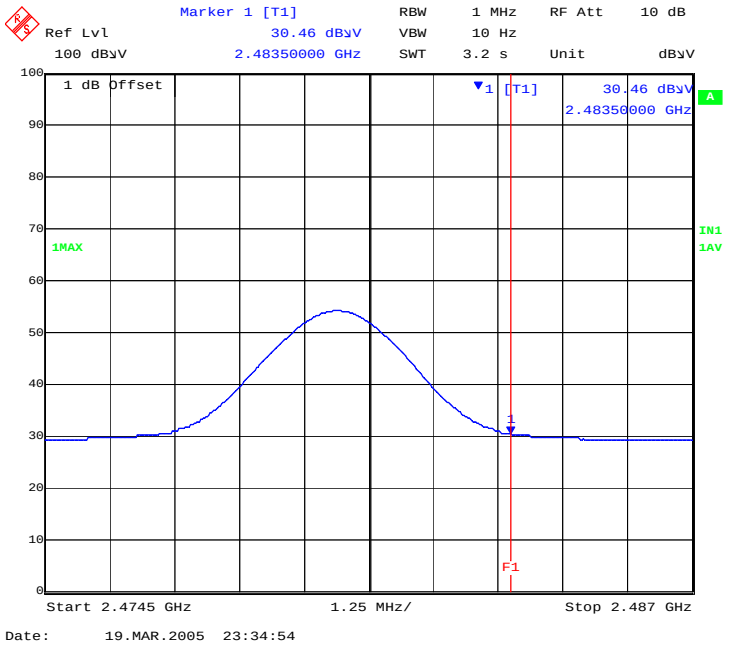
Peak Measurement



Delta Measurement



Average Measurement



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, 0304, 0293, 0307, 0256, 0253.

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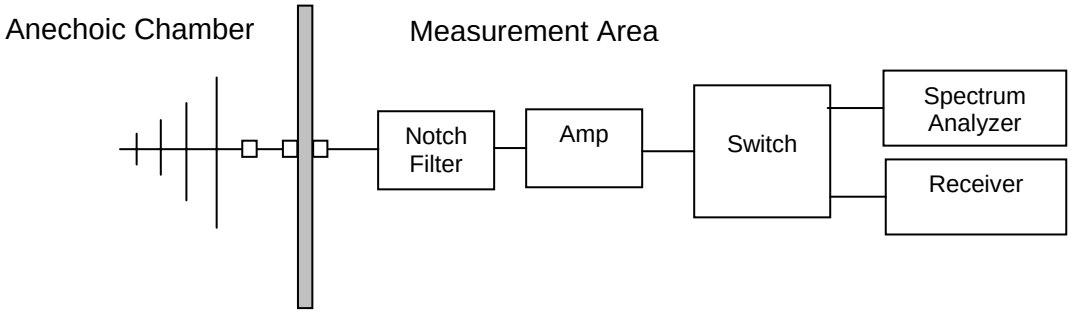
5.1.3.4. Radiated Spurious Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.209
Industry Canada RSS-210 §6.2.2(m2) (3)

Test Procedure
Testing 30M-1 GHz was subcontracted to the company identified in Section 3.9 Subcontracted Testing. Preliminary radiated emissions are measured in the anechoic chamber at a 10-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded with a spectrum analyzer in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

Test Measurement Set up



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

$$FS = R + AF + CORR$$

where:

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

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For example:
Given a Receiver input reading of 51.5dBμV; 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

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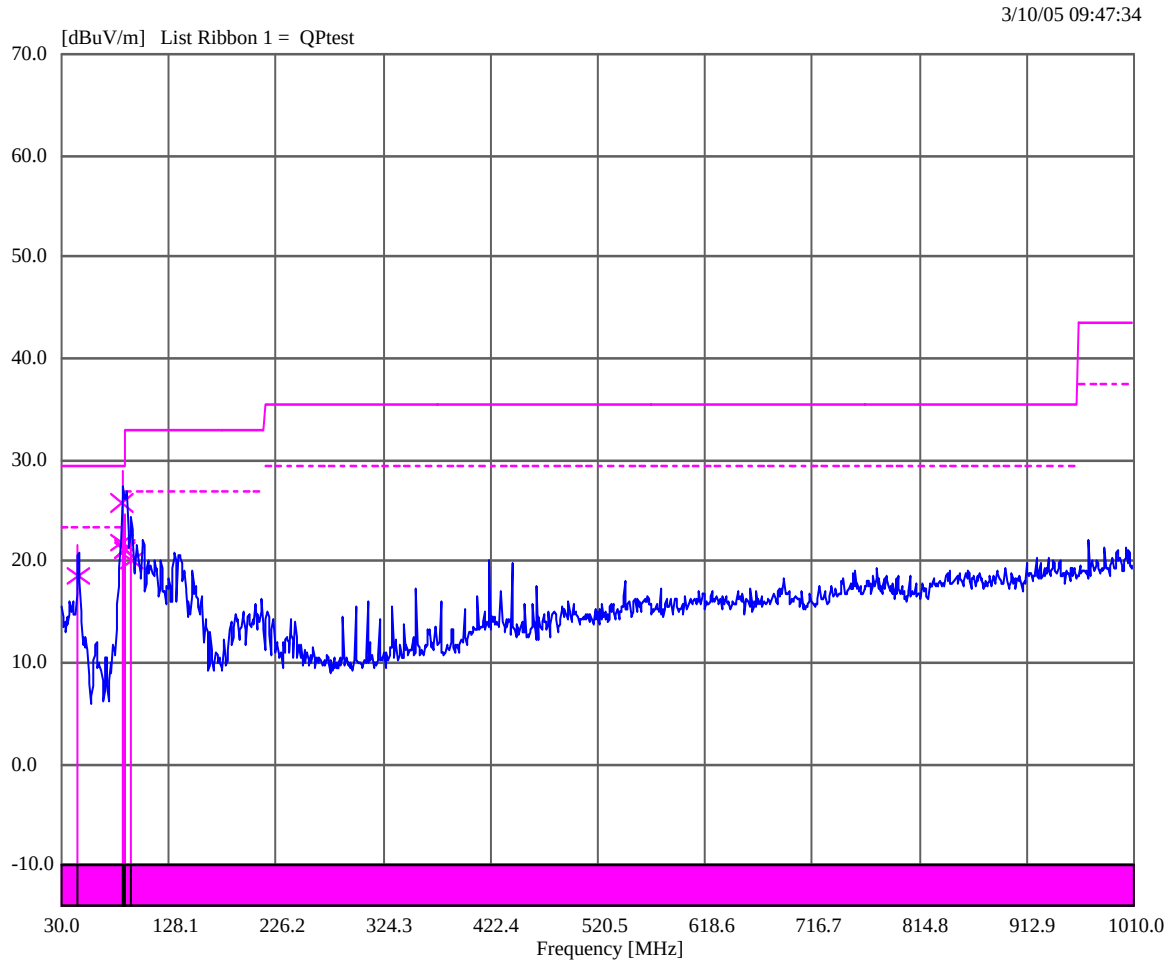
Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

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

Radio parameters.
Operational system laser and footswitch

TABLE OF RESULTS

Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Pol-arity	Total Correc-tion Factor
45.120236	21.60	18.58	29.50	-10.92	186	102	Vert	-19.35
86.215421	28.89	25.79	29.50	-3.71	339	104	Vert	-21.78
86.315392	25.05	21.87	29.50	-7.63	159	103	Vert	-21.76
87.583393	24.45	21.17	29.50	-8.33	152	155	Vert	-21.50
88.066371	24.69	21.27	33.00	-11.73	339	102	Vert	-21.40
93.385796	23.42	20.15	33.00	-12.85	318	103	Vert	-20.21



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.

§6.2.2(m2) (3) Limits per the Table 3, see below

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	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per Sanmina work instruction	8546A HP Receiver and RF Filter, HP Pre-amp, Antenna EMCO Biconilog

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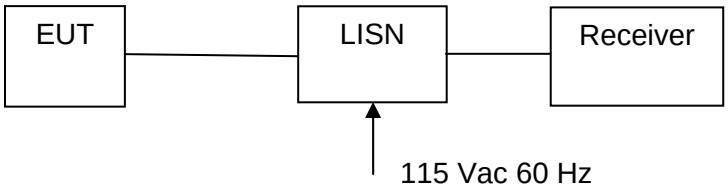
5.1.4. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.207
Industry Canada RSS-210 §6.6, §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 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

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

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

Radio parameters.

Operational system consisting of laser and wireless footswitch operating on Channel 7.

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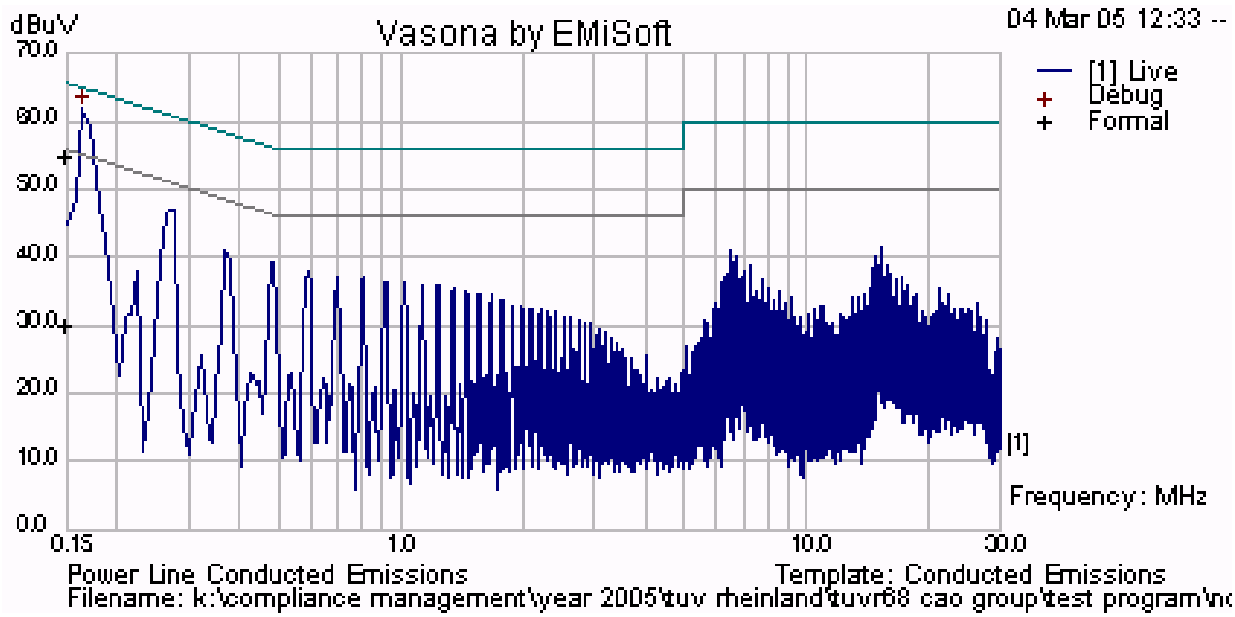
TABLE OF RESULTS

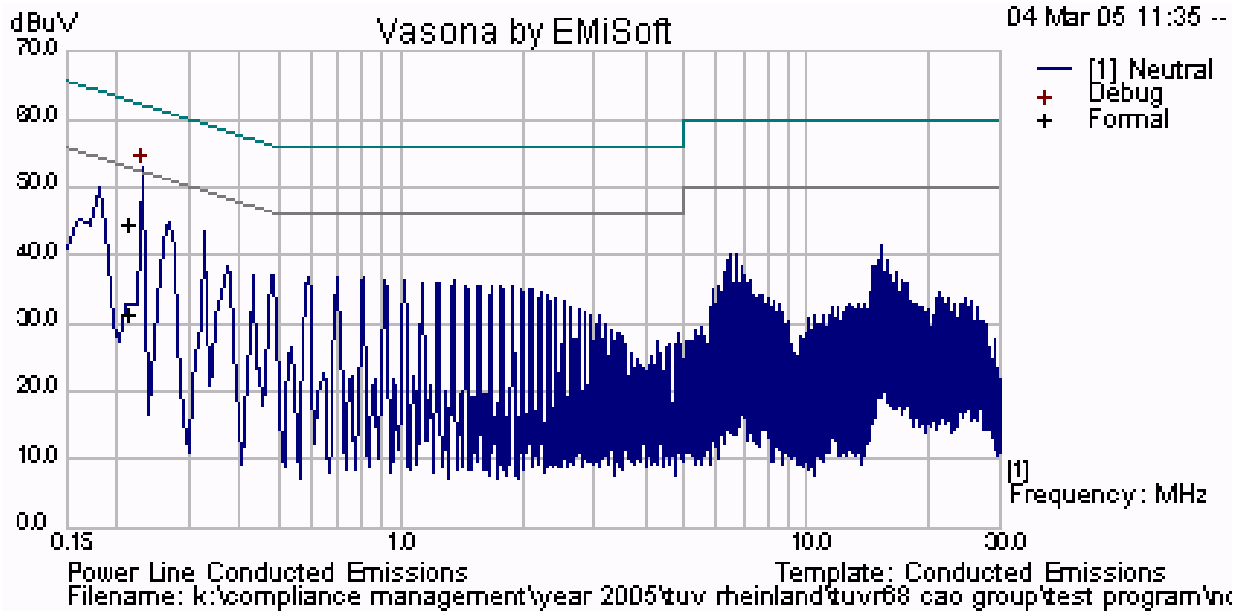
LINE - LIVE

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
0.15	61.8	52.78	66	-13.22	28.02	56	-27.98



LINE - Neutral

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
0.216	52.82	42.69	62.97	-20.28	29.23	52.97	-23.74



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 Measurement Uncertainty for Conducted Emissions

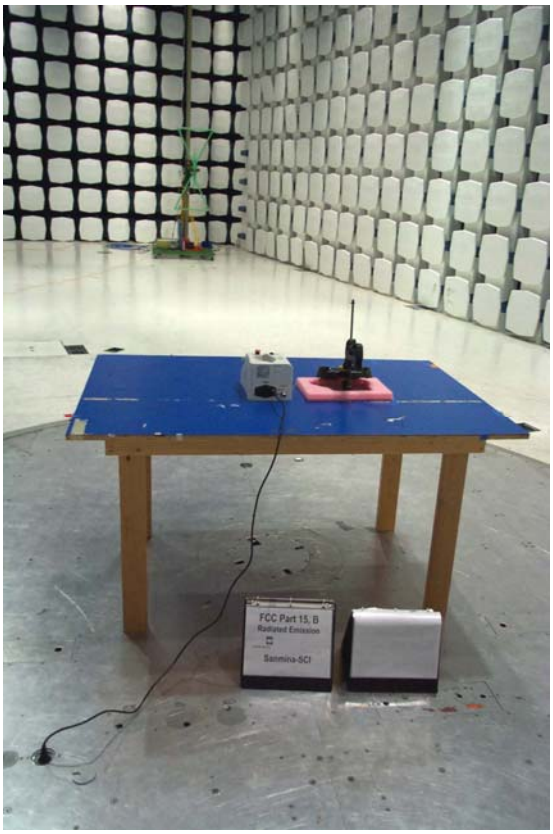
Measurement uncertainty	±2.64 dB

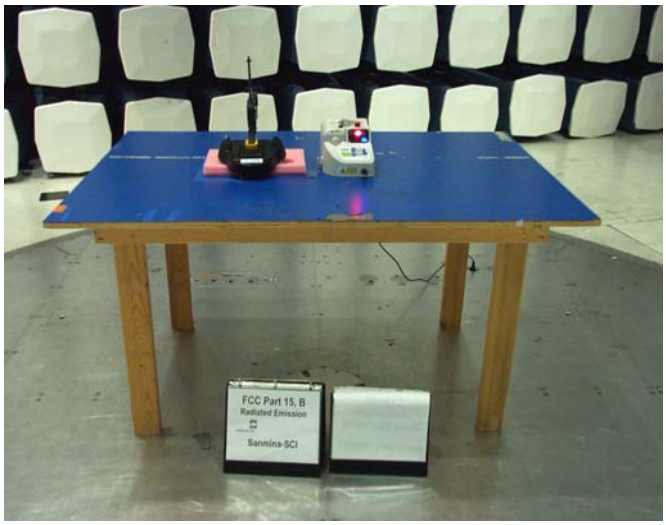
Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0156, 0184, 0193, 0190, 0293, 0307

6. PHOTOGRAPHS

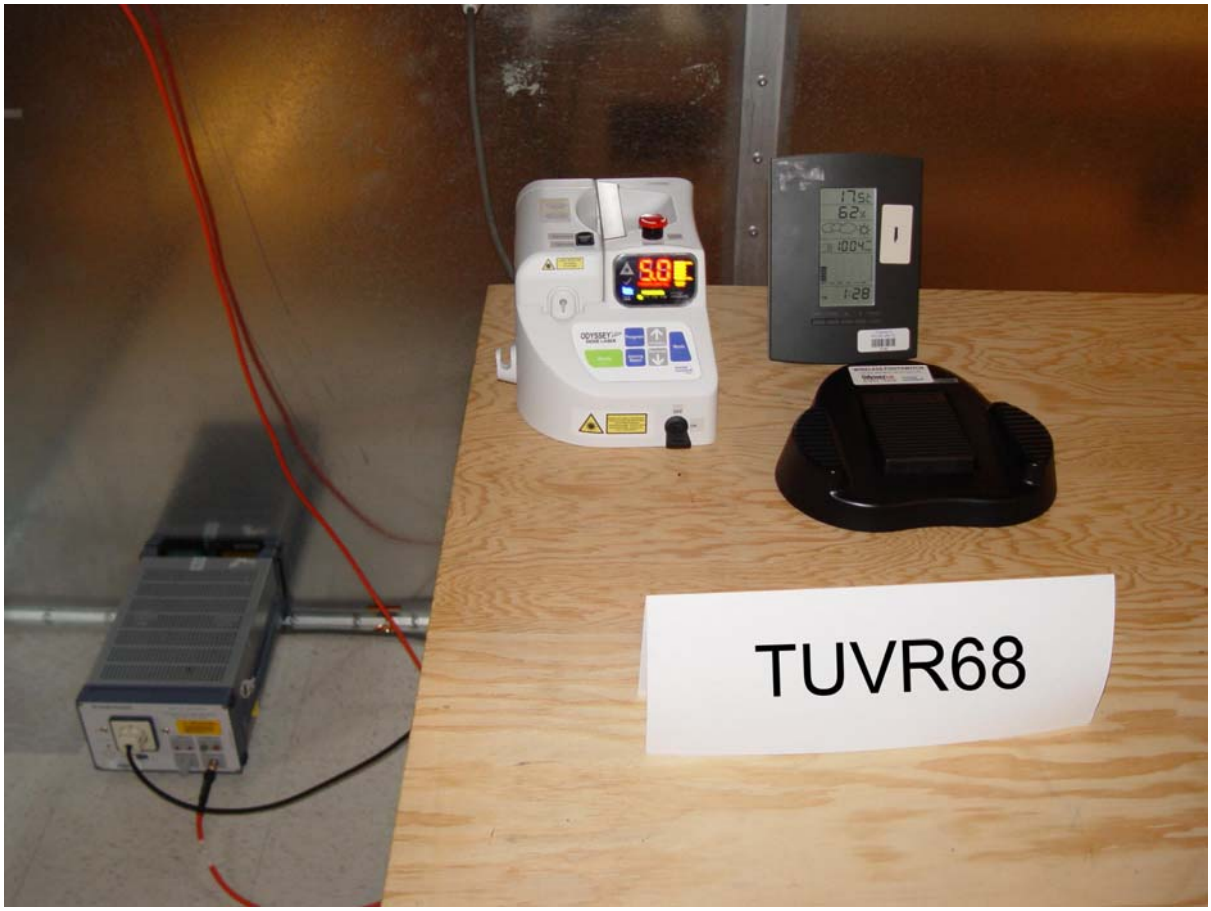
6.1. Radiated Emissions (30 MHz-1 GHz)





6.2. Radiated Emissions above 1GHz

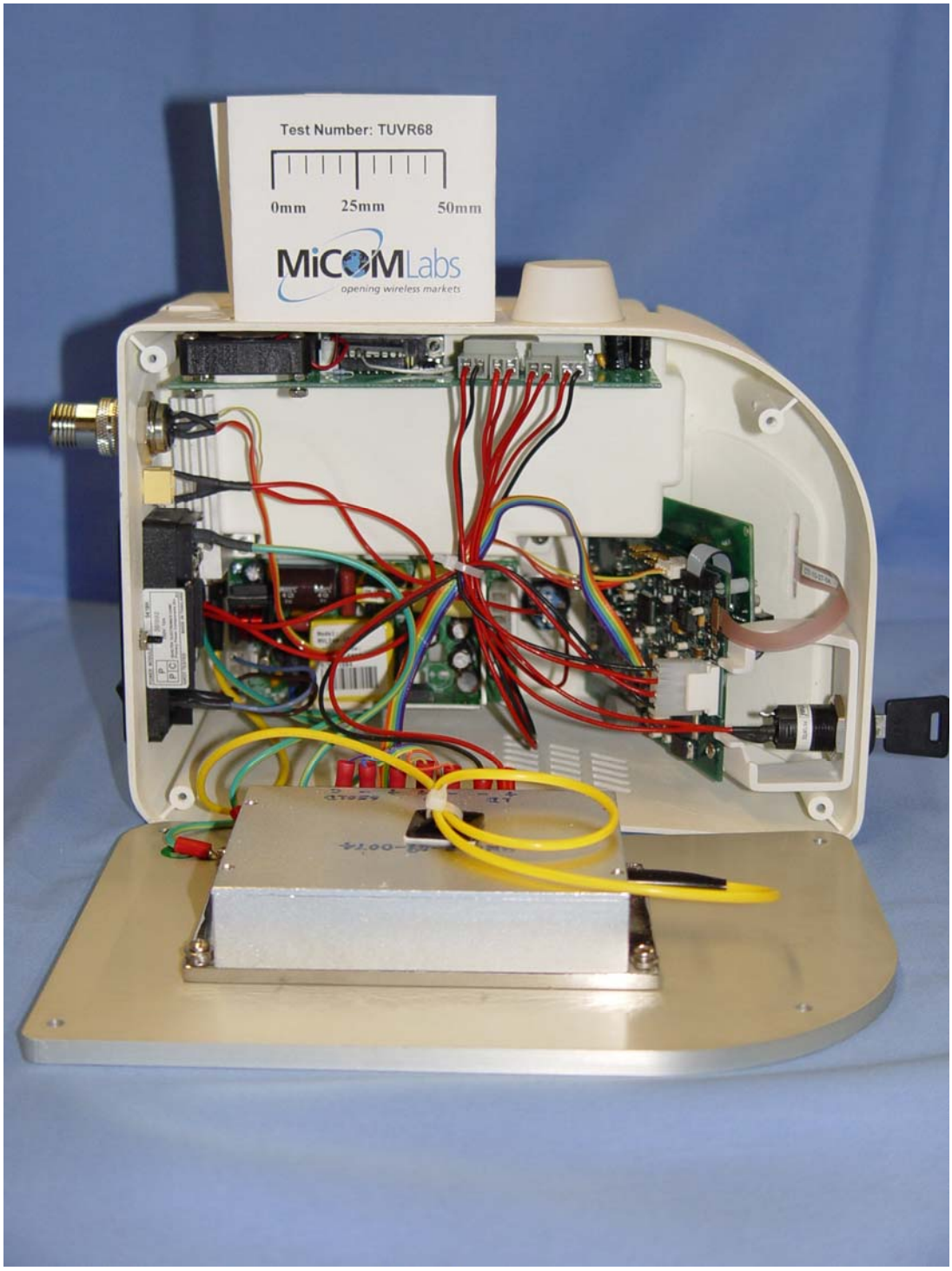
6.3. Conducted Emissions (150 kHz - 30 MHz)



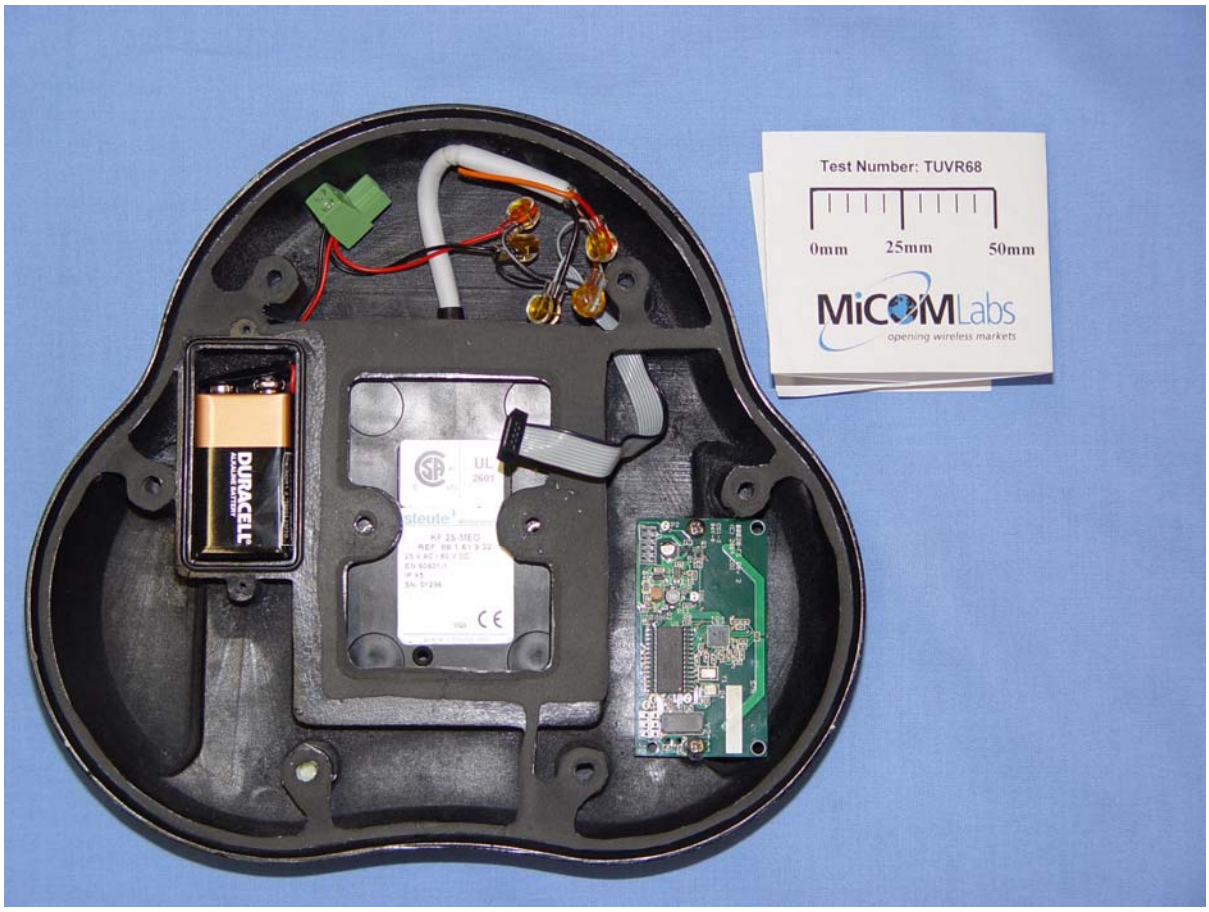
6.4. Photograph of Odyssey 2.4G Diode Laser Front Panel

6.5. Photograph of Odyssey 2.4G Diode Laser Interface Ports

6.6. Internal Photograph of Odyssey 2.4G Diode Laser

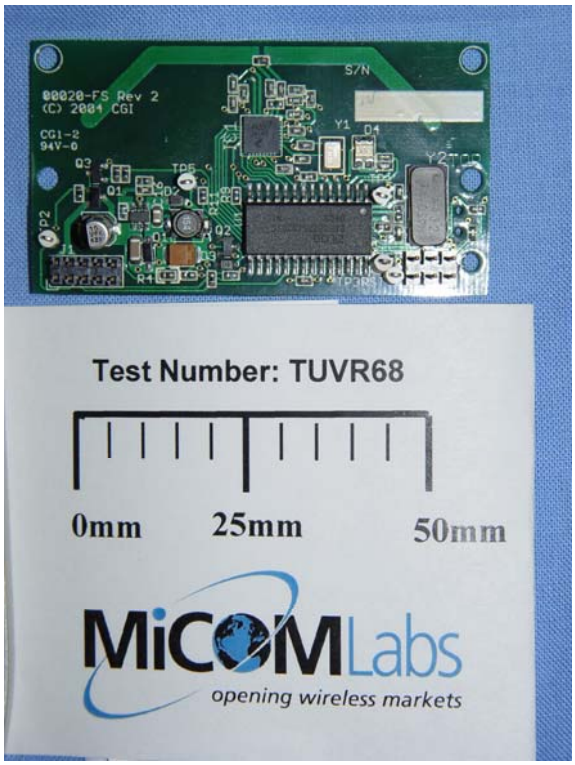


6.7. Internal Photograph of Footswitch

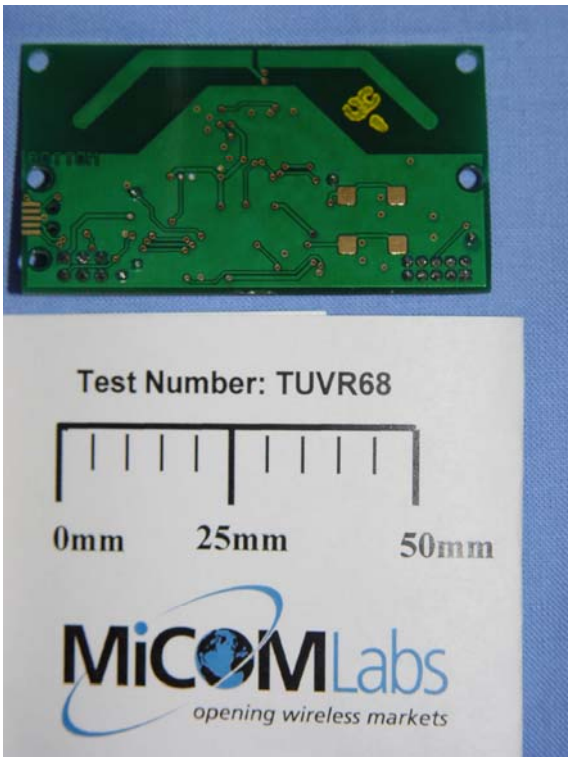


6.8. Photo of Wireless Module used in Odyssey 2.4G Diode Laser & Footswitch

Top



Bottom



7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Calibration Due Date	Serial #
156	Barometer /Thermometer	Control Co.	4196	12 Aug '05	E2844
251	K-Type Cable	Megaphase	TM40 K1K2 36	18 Jun '05	K-CBL 08
252	K-Type Cable	Megaphase	TM40 K1K2 36	18 Jun '05	K-CBL 10
256	K-Type Cable	Megaphase	TM40 K1K2 36	18 Jun '05	K-CBL 11
253	K-Type Cable	Megaphase	TM40 K1K2 36	18 Jun '05	K-CBL 12
293	BNC Cable	Megaphase	Unknown	18 Jun '05	15F50B001
307	BNC Cable	Megaphase	Unknown	18 Jun '05	15F50B002
267	N-Type Cable	Megaphase	Unknown	18 Jun '05	15F50N001
271	N-Type Cable	Megaphase	Unknown	18 Jun '05	5F50N001
269	N-Type Cable	Megaphase	Unknown	18 Jun '05	3F50N002
078	Antenna (30M-2 GHz)	Schaffner and Chase	CBL6140A	Not Applicable	1195
104	Horn Antenna	The Electro-Mechanics Company	3115	12 Aug '05	9205-3882
088	Spectrum Analyzer	Hewlett Packard	8564E	15 May '05	3410A00141
134	Amplifier	Com Power	PA 122	1st Sept '05	181910
213	20-300 MHz Antenna	Schwarzbeck	VHBB 9124	6 Apr '05	9124/0257
250	230 MHz-1 GHz Antenna	Schwarzbeck	VUSLP9111	6 Apr '05	186
145	18 GHz-26.5 GHz	Millimeter Products	261K	30 Apr '05	595
107	26.5 GHz-40 GHz	NortheastMicrowave	261A	30 Apr '05	599
193	EMI Receiver	Rhode & Schwartz	ESI 7	16 Mar '05	838496/007
088	Spectrum Analyzer	Hewlett Packard	8564E	15 May '05	
190	LISN	Rhode & Schwartz	ESH3Z5	3 Apr '05	836679/006
070	Power Meter	Hewlett Packard	437B	13 May '05	3125U13554
116	Power Sensor	Hewlett Packard	R8485A	16 Mar '05	3318A19694
313	Directional Coupler	Hewlett Packard	HP 86205A	N/A	3140A01285
314	30 dB N-Type Attenuator	ARRA	N9444-30	N/A	--
304	2.4 GHz Notch	Micro-Tronics	BRM50701	01 Dec 05	001
311	Band Pass 12-18 GHz	CMT	--	03 Nov 05	--
315	Band Pass17-26.5 GHz	HP	--	21 Aug 05	--

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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

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