

# RADIO TEST REPORT

No. 506091R1

## EQUIPMENT UNDER TEST

Equipment: Tag  
Type / model: T201  
Manufacturer: Ekahau Inc.  
Tested by request of: Ekahau Inc.

## SUMMARY

The equipment complies with the requirements of the following standards:

FCC, Part 15, Subpart B (2004) and Subpart C (2004);  
RSS-210, Issue 5 (November 2001)

Industry Canada listed test facility No. IC 3481



Date of issue: May 9, 2005

Tested by:

*Bazhanov*

Vladimir Bazhanov

Approved by:

*Lars-Olov Johansson*

Lars-Olov Johansson

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**CONTENTS**

	<b>Page</b>
1. Client information.....	3
2. Equipment under test (EUT).....	3
2.1 Identification of the EUT according to the manufacturer/client declaration.....	3
2.2 Additional hardware information about the EUT.....	4
2.3 Additional software information about the EUT.....	4
2.4 Peripheral equipment.....	4
2.5 Modifications during the test.....	4
3. Test specifications.....	5
3.1 Standards.....	5
3.2 Additions, deviations and exclusions from standards.....	5
3.3 Test set-up.....	5
3.4 Operating environment.....	5
4. Test summary.....	6
5. Peak output power.....	7
5.1 Test protocol.....	7
6. 6 dB Bandwidth.....	8
6.1 Test protocol.....	8
7. Band edge compliance.....	9
7.1 Test set-up.....	9
7.2 Test protocol.....	9
8. Peak Power spectral density.....	11
8.1 Test protocol.....	11
9. Radiated spurious emissions.....	12
9.1 Operating environment.....	12
9.2 Measurement uncertainty.....	12
9.3 Test equipment.....	12
9.4 Measurement set-up.....	13
9.5 Test protocol.....	14
10. Conducted disturbance voltage in the frequency range 0,15 - 30 MHz.....	25
10.1 Operating environment.....	25
10.2 Measurement uncertainty.....	25
10.3 Test equipment.....	25
10.4 Measurement set-up.....	25
10.5 Test protocol.....	26
Appendix – Photos of the EUT.....	27



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**1. CLIENT INFORMATION**

The EUT has been tested by request of

Company: Ekahau Inc.  
Tammasaarenlaituri 3  
FI-00180 Helsinki  
Finland  
Name of contact: Mr. Arttu Huhtiniemi

**2. EQUIPMENT UNDER TEST (EUT)****2.1 Identification of the EUT according to the manufacturer/client declaration**

Equipment: Tag  
Type/Model: T201  
Brand name: -  
Serial number: -  
FCC ID Number: -  
Manufacturer: Ekahau Inc.  
Supplying voltage: 3,7 V DC from Li-ion battery  
Rating RF output power: 13,5 ± 1 dBm  
Antenna gain: 2,5 dBi max; -3 dBi average  
External antenna connector: NO  
Operating temperature range: 0 to 50 °C  
Frequency range: 2400 – 2483,5 MHz  
Number of channels: 13  
Modulation characteristics: DSSS  
Stand by mode supported: Yes



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**2.2 Additional hardware information about the EUT**

The EUT consists of the following units:

Unit	Type and version	Serial number
Tag	T201	-
AC/DC Adapter	FW7650/05 In: 100-240 V, 50-60 Hz, 150 mA Out: 5 V DC, 1000 mA	-

**2.3 Additional software information about the EUT**

During the tests the EUT supported the following software:

Software	Version	Comment
Test software	-	To control the transmission on specified channels

**2.4 Peripheral equipment**

Peripheral equipment is defined as equipment needed for correct operation of the EUT during the tests, but not included as a part of the testing and evaluation of the EUT.

Equipment	Manufacturer / Type	Serial number
Laptop PC	IBM ThinkPad / 2645450	55223TF

**2.5 Modifications during the test**

The following modifications have been made to the EUT to comply with radiated spurious emissions tests:

- Added 4pcs 4.7nF SMD bypass-capacitors to VDDCORE (1.8V) inputs to main processor (U20);
- Added 4pcs 4.7nF SMD bypass-capacitors to VDDIOM (3.3V for memory bus) inputs to main processor (U20);
- Added 2pcs 4.7nF SMD bypass-capacitors to VDDQ and VDD inputs to SDRAM (U40);
- Added SMD ferrite choke (BLM31, 600R/100MHz) in series to DC input from charging connector;
- Added 100nF SMD capacitor after the choke (nr 4.) from DC input to ground;
- Connected the antenna end of the internal RF cable shield to ground;
- Added a clamp ferrite filter (TDK ZCAT-series) to the charging cable, close to the Mini-USB connector.



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### 3. TEST SPECIFICATIONS

#### 3.1 Standards

FCC 47 CFR part 15 (2004) Subpart B – Unintentional radiators  
FCC 47 CFR part 15 (2004) Subpart C – Intentional Radiators: §15.247 Operation within the bands 902-928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz.

Measurements methods according to ANSI C63.4-2003

RSS-210, Issue 5 (November 2001): Low Power Licence-Exempt Radiocommunication Devices.

#### 3.2 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standards.

#### 3.3 Test set-up

Measurement set-ups for the test of conducted disturbance voltage in the frequency range 0,15-30 MHz and out-of-band spurious emissions test are described in corresponding sections. During other tests the EUT was connected to the spectrum analyzer by cable.

#### 3.4 Operating environment

If not additionally specified, the tests were performed under the following environmental conditions:

Air temperature: 21 - 24 °C  
Relative humidity: 17 - 22 %



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**4. TEST SUMMARY**

The results in this report apply only to the sample tested.

FCC reference	RSS-210 reference	Test	Result	Note
15.247(b)	6.2.2(o)(b)	Peak output power	Pass	
15.247(a)	6.2.2(o)Am(iv)	6 dB Bandwidth	Pass	
15.247(d)	6.2.2(o)	Band edge compliance	Pass	
15.247 (e)	6.2.2(o)(b)	Peak power spectral density	Pass	
15.247	6.2.2(o)(e1)	Out of band spurious emissions, radiated	Pass	
15B	6.2.2(o)(e1)	Out of band spurious emissions, radiated	Pass	
15B	6.2.2(o)	Conducted emission at AC port	Pass	



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**5. PEAK OUTPUT POWER**

**5.1 Test protocol**

Date of test: April 27, 2005

EUT mode of operation: TX on one channel.

Spectrum analyzer settings:

Span: 40 MHz  
 RBW: 3 MHz  
 VBW: 3 MHz  
 Sweep time: Auto  
 Detector: Peak  
 Trace: Max Hold

Channel (MHz)	Peak Output Power (dBm)	Limit value (dBm)
2412	13.8	< 30
2442	13.4	
2472	12.9	

Measurement results are corrected for attenuation in the set-up configuration and antenna gain declared by the manufacturer.

Example calculation:

Peak output power [dBm] = Analyser reading [dBm] + cable loss [dB] + EUT antenna gain [dBi]



**6. 6 dB BANDWIDTH****6.1 Test protocol**

Date of test: April 27, 2005

EUT mode of operation: TX on one channel.

Spectrum analyzer settings:

Span: 64 MHz  
RBW: 30 kHz  
VBW: 30 kHz  
Sweep time: 5 ms  
Detector: Peak  
Trace: Max Hold

Channel (MHz)	6 dB Bandwidth (MHz)	Limit value (MHz)
2412	12.2	> 0.5
2442	12.2	
2472	12.1	

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**7. BAND EDGE COMPLIANCE**

**7.1 Test set-up**

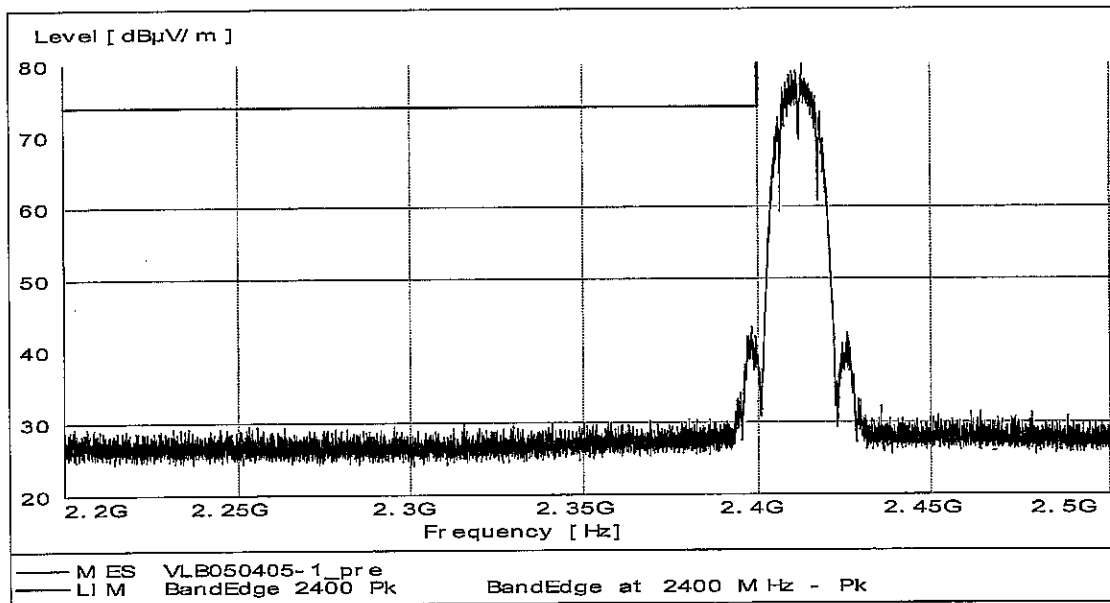
See Section 9.4.

**7.2 Test protocol**

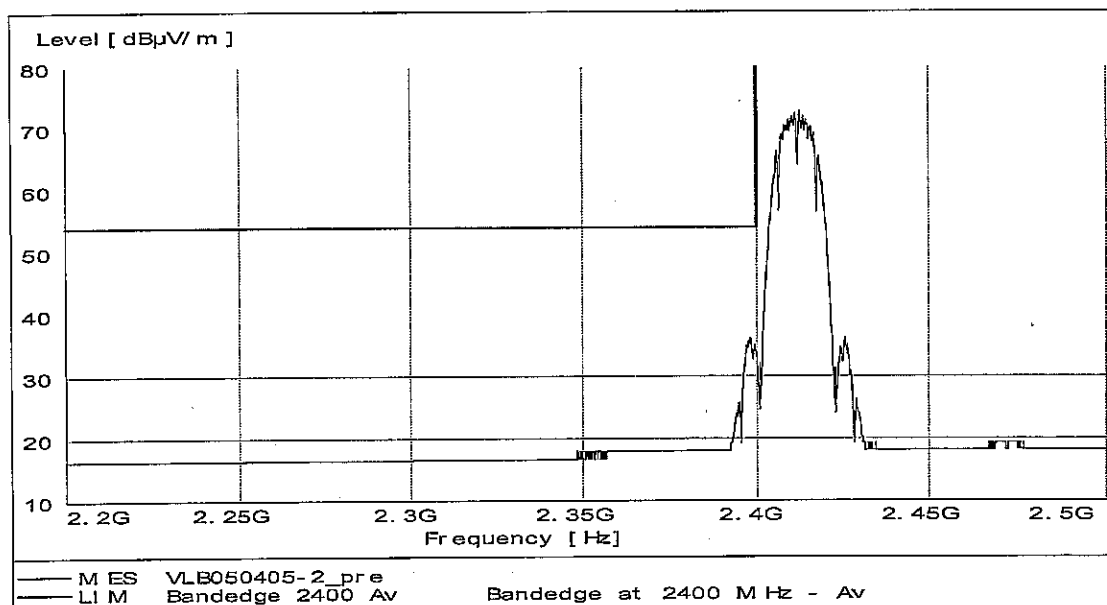
Date of test: April 4-5, 2005

Band edge compliance at 2400 MHz

Sweep with peak detector. Extra attenuation: 10 dB.



Sweep with average detector. Extra attenuation: 10 dB.

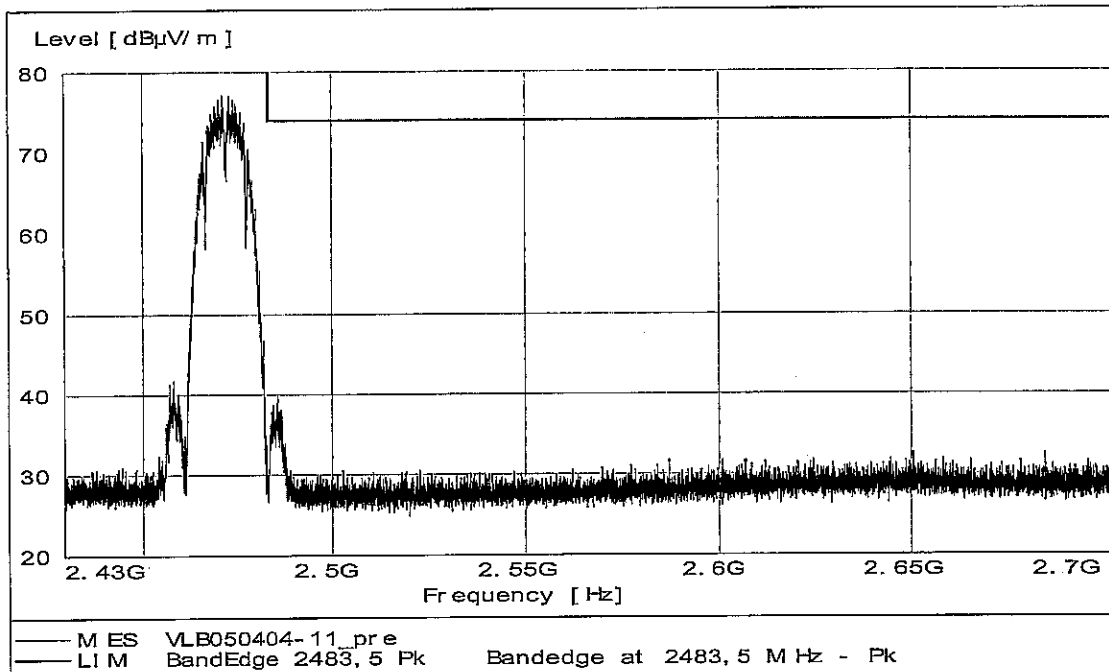


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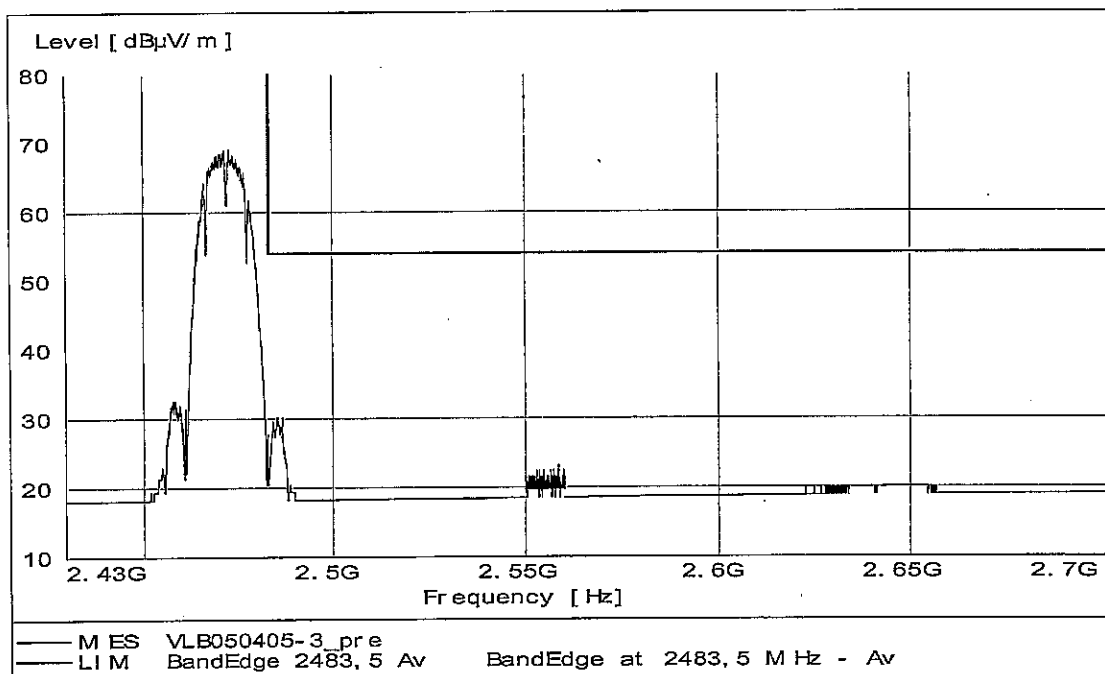
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Band edge compliance at 2483,5 MHz

Sweep with peak detector. Extra attenuation: 10 dB.



Sweep with average detector. Extra attenuation: 10 dB.



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**8. PEAK POWER SPECTRAL DENSITY**

**8.1 Test protocol**

Date of test: April 27, 2005

EUT mode of operation: TX and maximum data rate.

Spectrum analyzer settings:

Span: 64 MHz  
 RBW: 3 kHz  
 VBW: 10 kHz  
 Sweep time: Auto  
 Detector: Peak  
 Trace: Max Hold

Channel (MHz)	Peak Power Spectral Density (dBm)	Limit value (dBm)
2412	0.3	< 8
2442	0.9	
2472	0.4	

Measurement results are corrected for attenuation in the set-up configuration.

Example calculation:

Peak power spectral density [dBm] = Analyser reading [dBm] + cable loss [dB]



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**9. RADIATED SPURIOUS EMISSIONS**

**9.1 Operating environment**

Temperature: 21 – 22 °C (10 – 40 °C)  
 Relative Humidity: 20 – 22 % (10 – 90 %)

**9.2 Measurement uncertainty**

Radiated disturbance electric field intensity, 30 – 1000 MHz: ± 4,6 dB  
 Radiated disturbance electric field intensity, 1000 – 18000 MHz: ± 6,0 dB

The measurement uncertainty describes the overall uncertainty of the given measured value during operation of the EUT.

Measurement uncertainty is calculated in accordance with EA-4/02-1997.  
 The measurement uncertainty is given with a confidence of 95%.

**9.3 Test equipment**

Equipment	Manufacturer	Type	SEMKO No.
<i>Test site: Semi-anechoic shielded chamber, 10 x 20 x 8,5 m (W x L x H)</i>			30300
Software:	Rohde & Schwarz	ES-K1, V1.60	
Measurement receiver:	Rohde & Schwarz	ESAI	2973/2974
Antenna amplifier:	SEMKO		7992/7993
Antenna, bilog:	Chase	CBL6111A	8578
<i>Test site: Bluetooth anechoic shielded chamber, 3,7 x 7,0 x 2,4 m (W x L x H)</i>			12285
Software:	Rohde & Schwarz	ES-K1, V1.70	
Signal analyser:	Rohde & Schwarz	FSIQ 40	40023
Preamplifier:	MITEQ	AFS6/AFS44	12335
<b>Antennas:</b>			
Double Ridge Guide Horn:	EMCO	3115	4936
Horn antenna:	EMCO	3160-08	30099
Horn antenna:	EMCO	3160-09	30101
High pass filter	K&L	4410-X4500/18000-0	5133
Band rejection filter	K&L	6N45-2450/T 100-0/0	12389
Attenuator 20 dB	Hewlett Packard	8491A	30090



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#### 9.4 Measurement set-up

##### Test site: Semi-anechoic shielded chamber (30 – 1000 MHz)

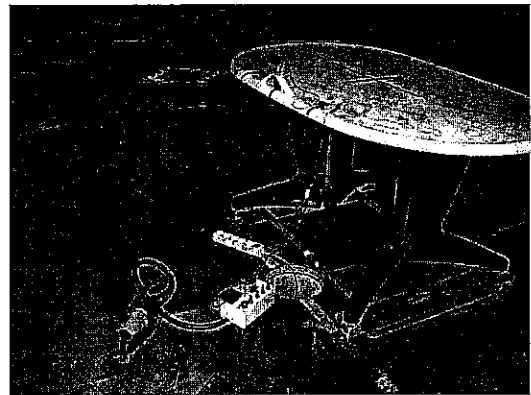
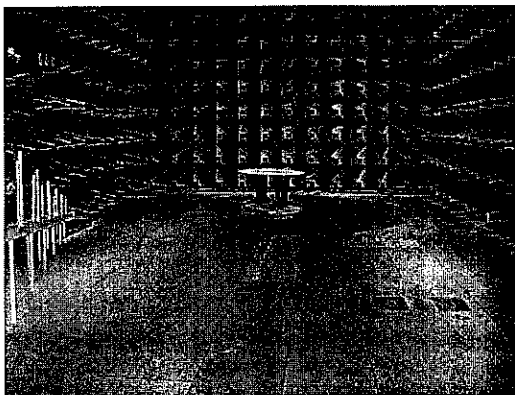
The radiated disturbance electric field intensity was measured in a semi-anechoic chamber at a distance of 10 m and the EUT was placed on a non-metallic table, 0,8 m above the reference ground plane. The specified test mode was enabled. Test set-up photos are given below.

An overview sweep with peak detection of the electric field intensity was performed with the measurement receiver in max-hold and with the antenna placed 1,5 m, 2,5 m and 3,5 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps.

At the frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration new measurements with quasi-peak detector were carried out.

The EUT was supplied with 120 V, 60 Hz during the test.

Test set-up photos:



##### Test site: Bluetooth anechoic shielded chamber (1 – 26 GHz)

In the Bluetooth anechoic chamber the EUT was placed on a non-metallic table, 1,4 m above the floor. The radiated disturbance electric field intensity was measured at a distance of 3 m. The specified test mode was enabled.

An overview sweep with peak detection of the electric field intensity was performed with the spectrum analyser in max-hold and with the antenna placed 1,4 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps. At the frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration new measurements with peak and average detectors were carried out. Test set-up photo is shown below.

The EUT was supplied with 120 V, 60 Hz during the test.



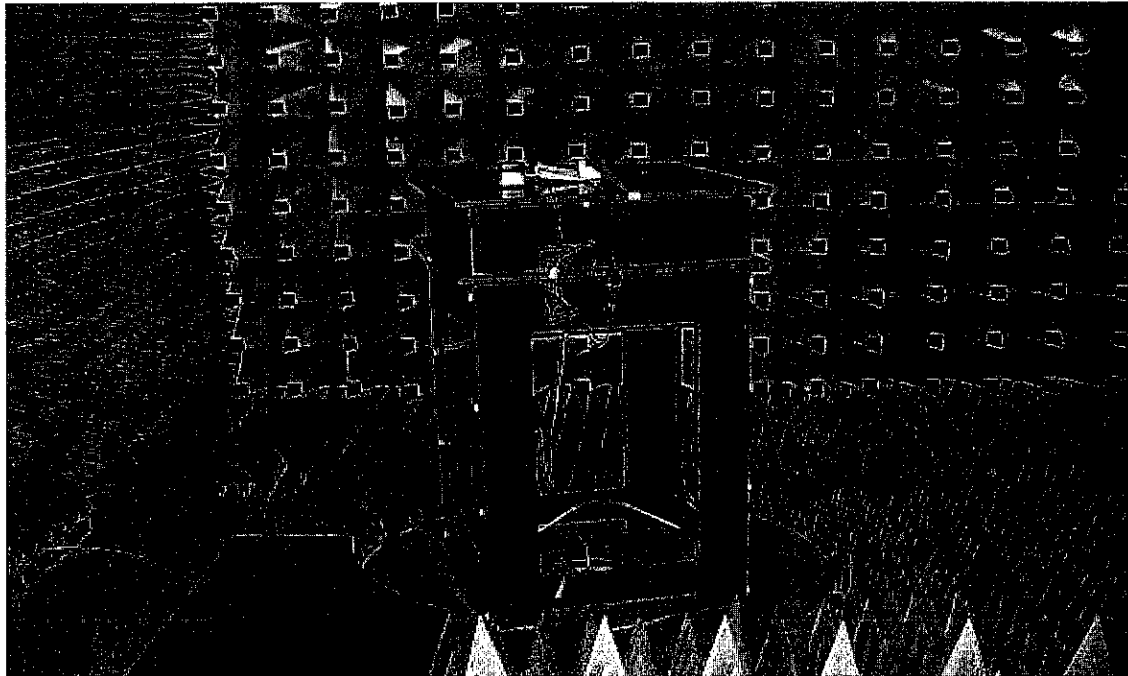
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Test set-up photo:

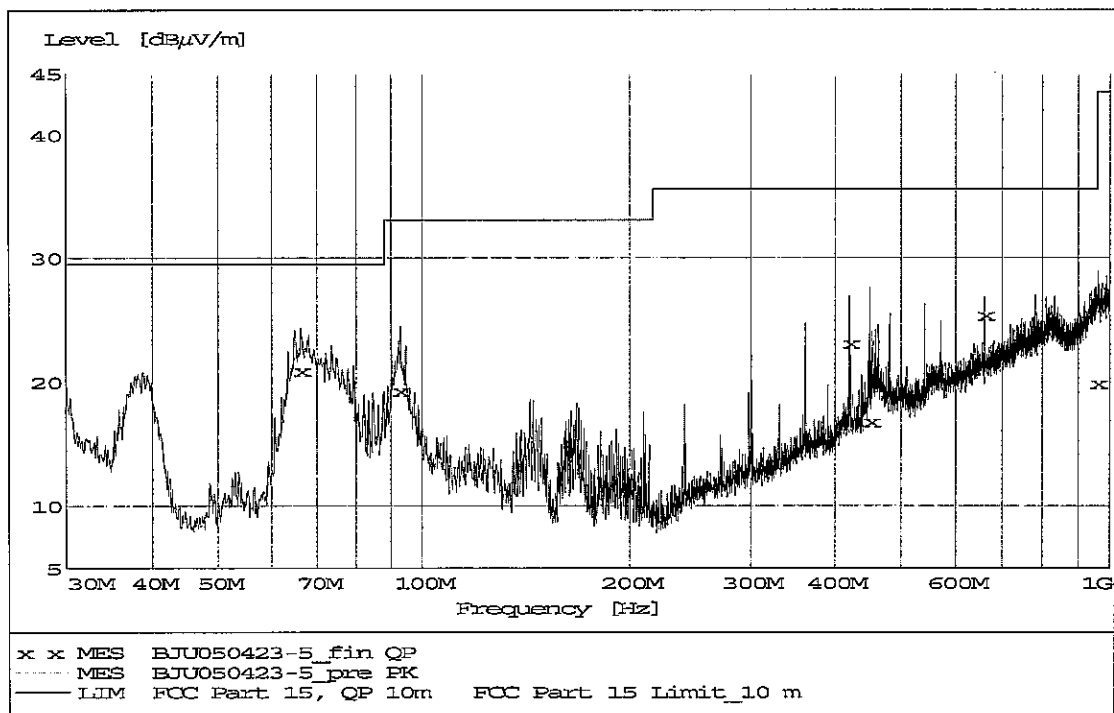


**9.5 Test protocol**

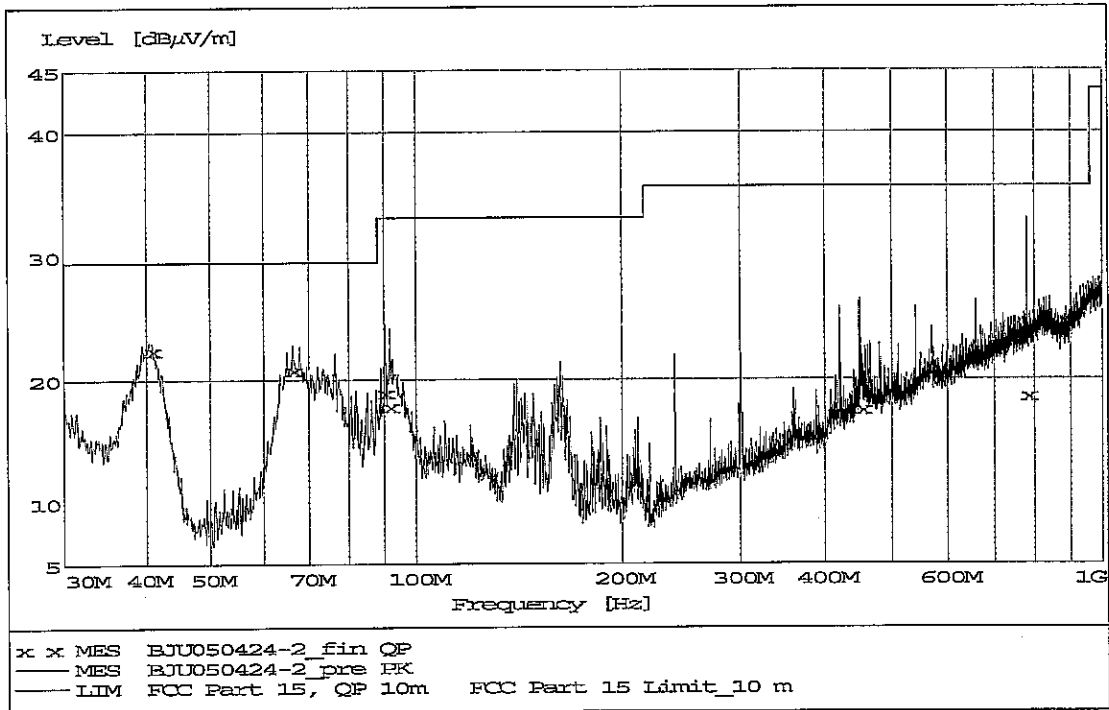
Semi-anechoic shielded chamber

Date of test: April 23-24, 2005

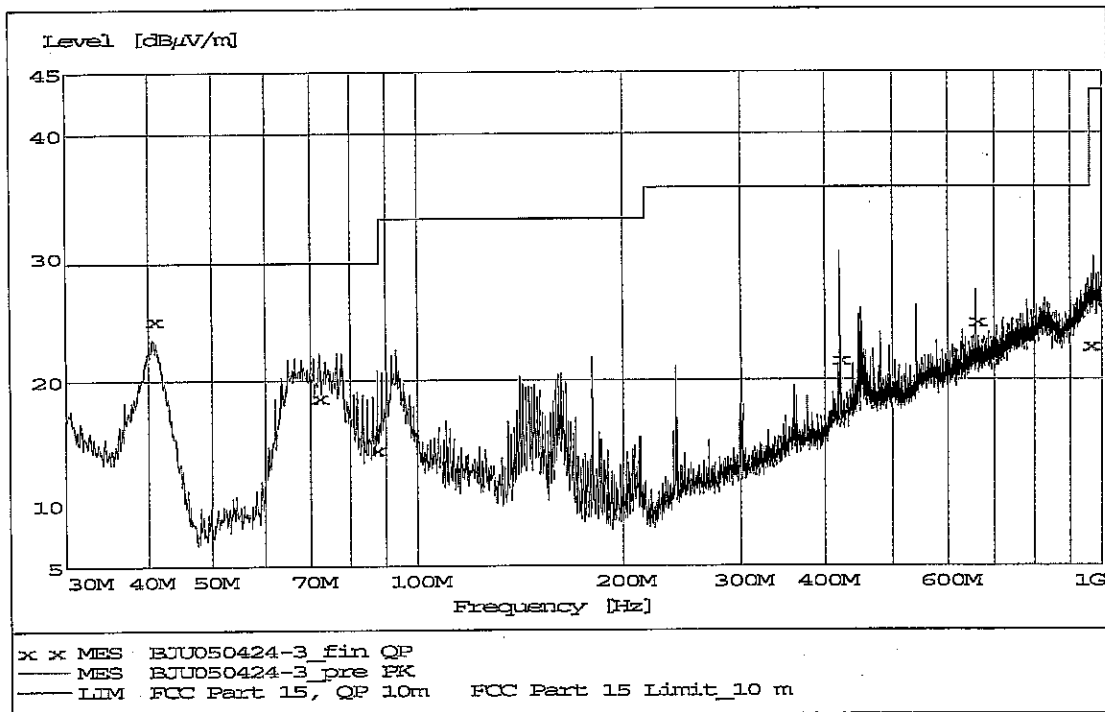
30 – 1000 MHz, max peak at a distance of 10 m on the lower TX channel



30 – 1000 MHz, max peak at a distance of 10 m on the middle TX channel



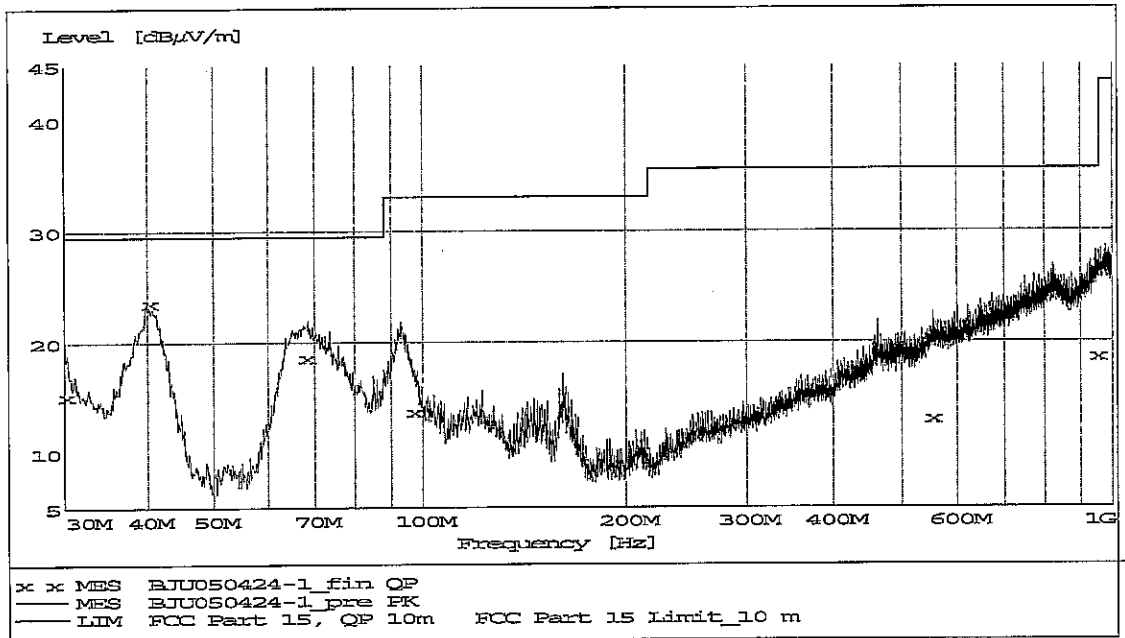
30 – 1000 MHz, max peak at a distance of 10 m on the upper TX channel



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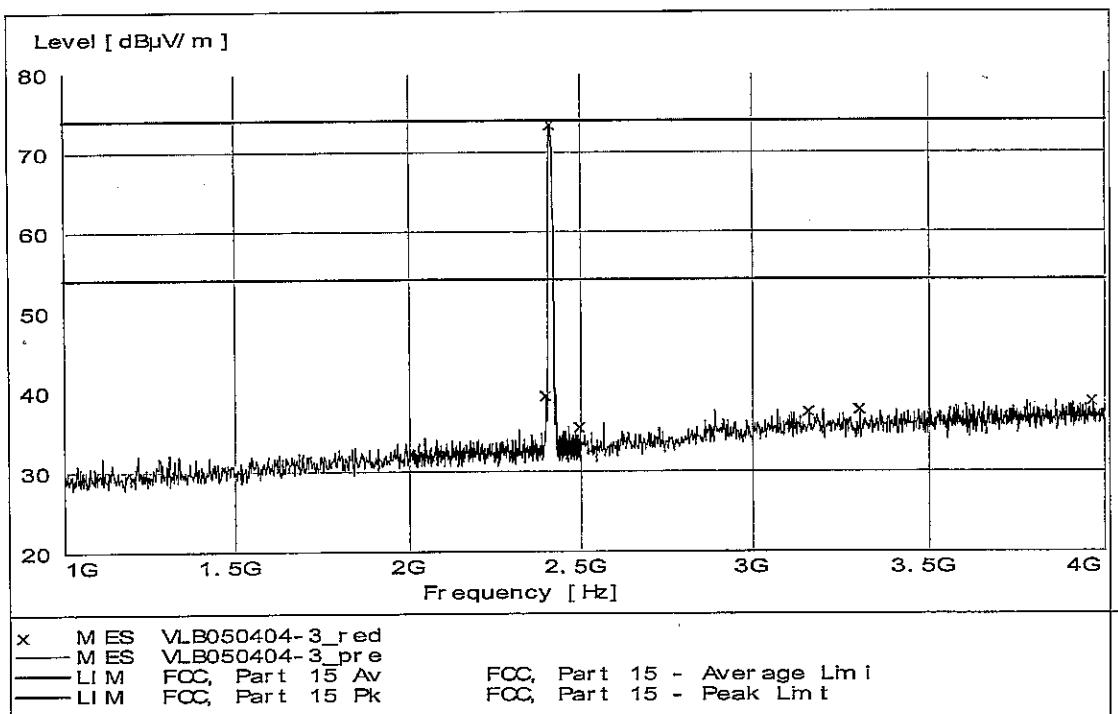
30 – 1000 MHz, max peak at a distance of 10 m in the standby mode



Bluetooth anechoic shielded chamber

Date of test: April 4-5, 2005

1000 – 4000 MHz, max peak at a distance of 3 m on the lower TX channel.  
The signal is attenuated by 20 dB.

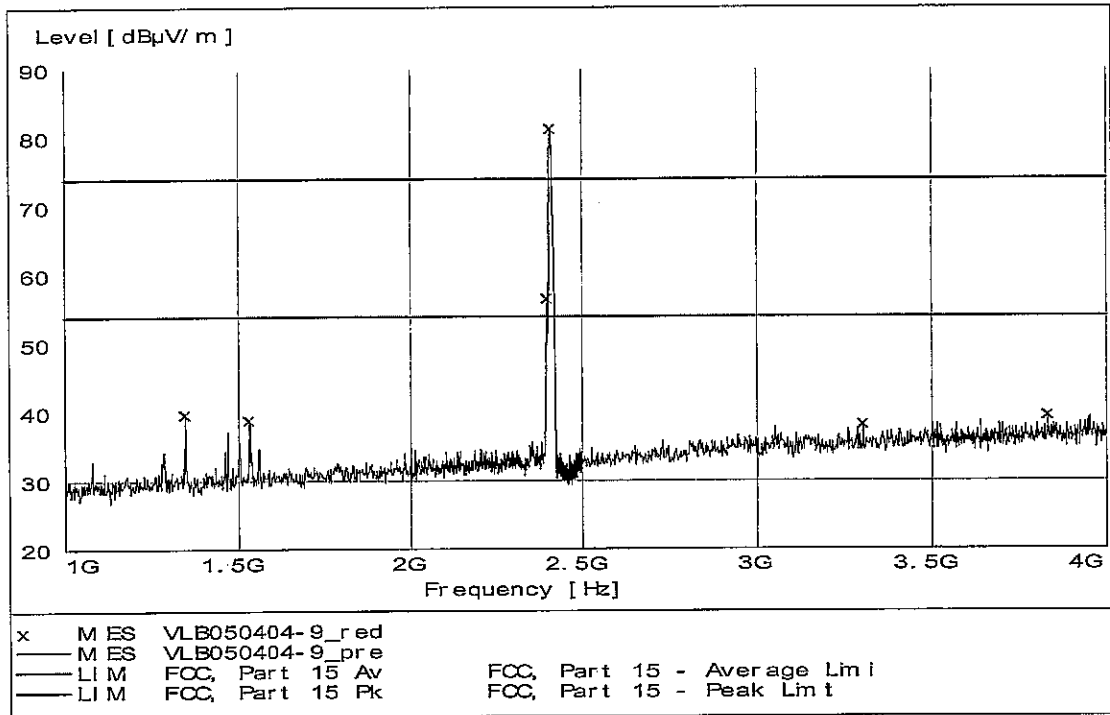


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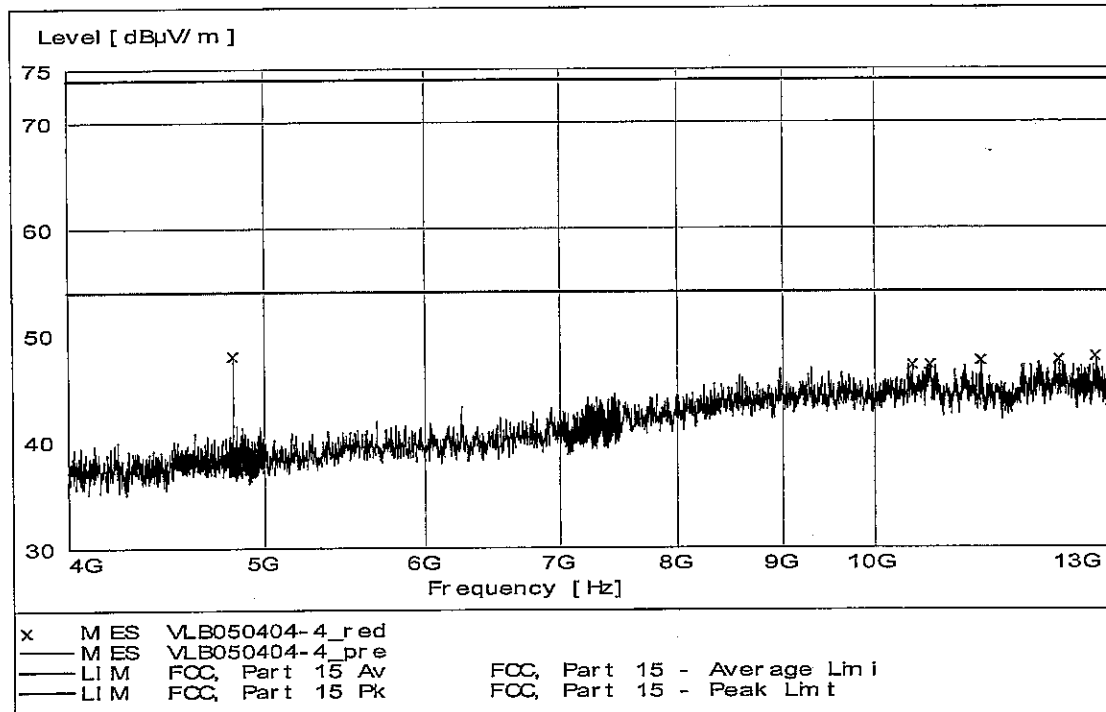
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1000 – 4000 MHz, max peak at a distance of 3 m on the lower TX channel.  
 The carrier is attenuated by band rejection filter K&L 6N45-2450/T100-0/0



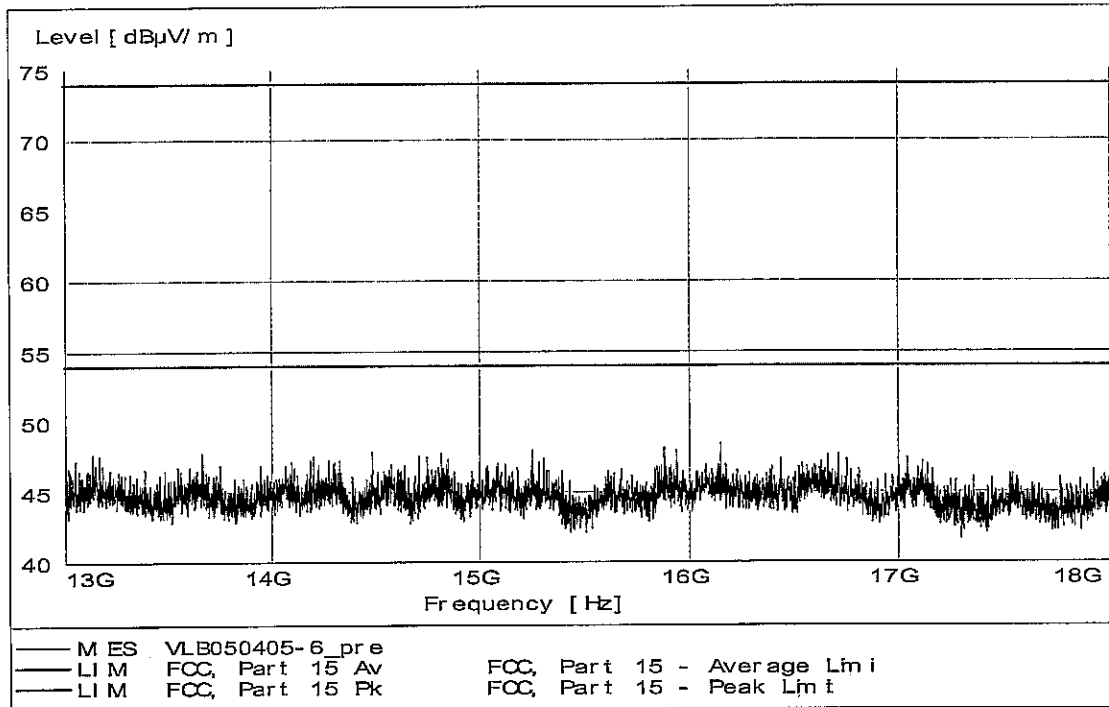
4000 – 13000 MHz, max peak at a distance of 3 m on the lower TX channel.  
 Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



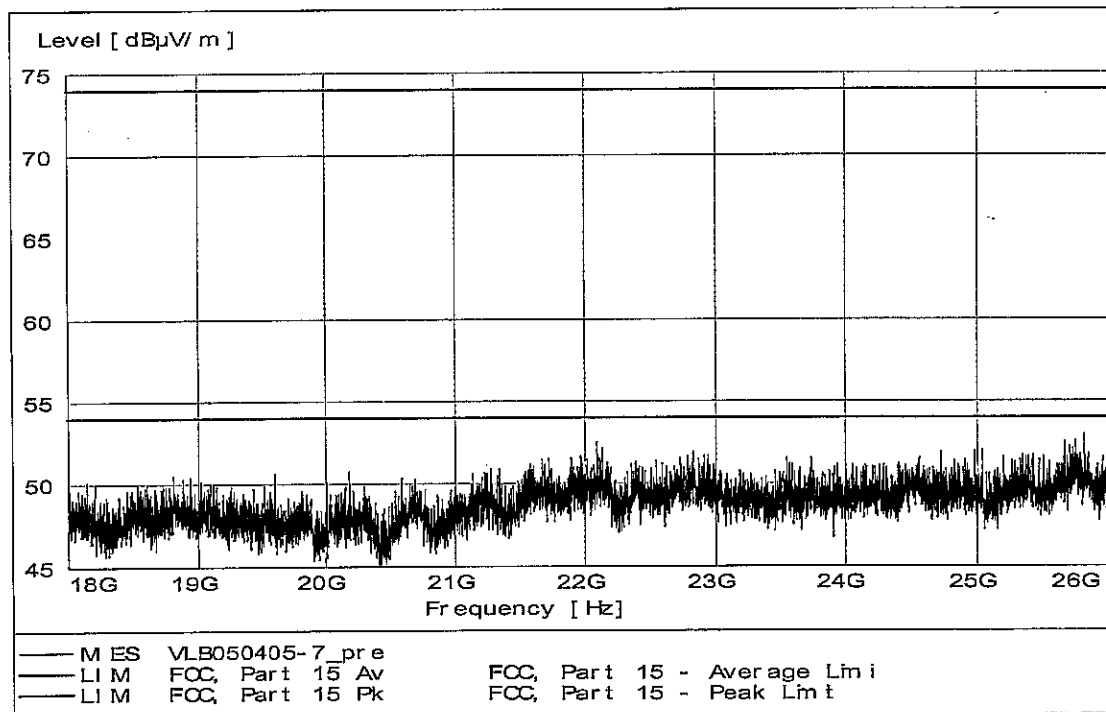
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13000 – 18000 MHz, max peak at a distance of 3 m on the lower TX channel



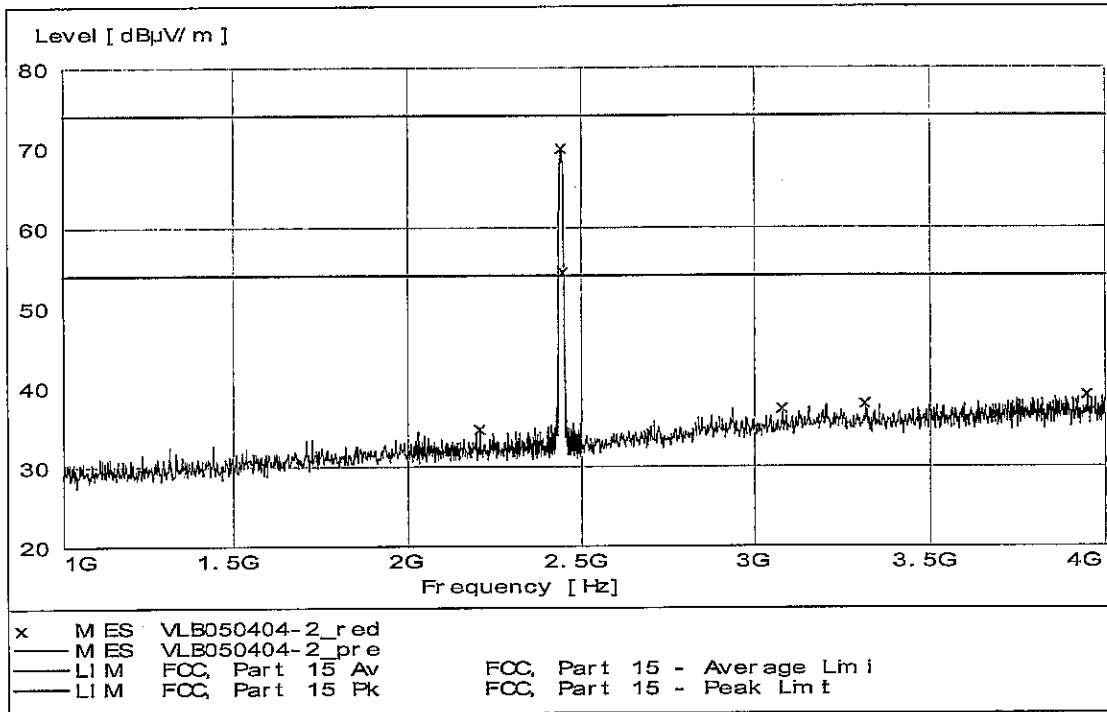
18000 – 26000 MHz, max peak at a distance of 3 m on the lower TX channel



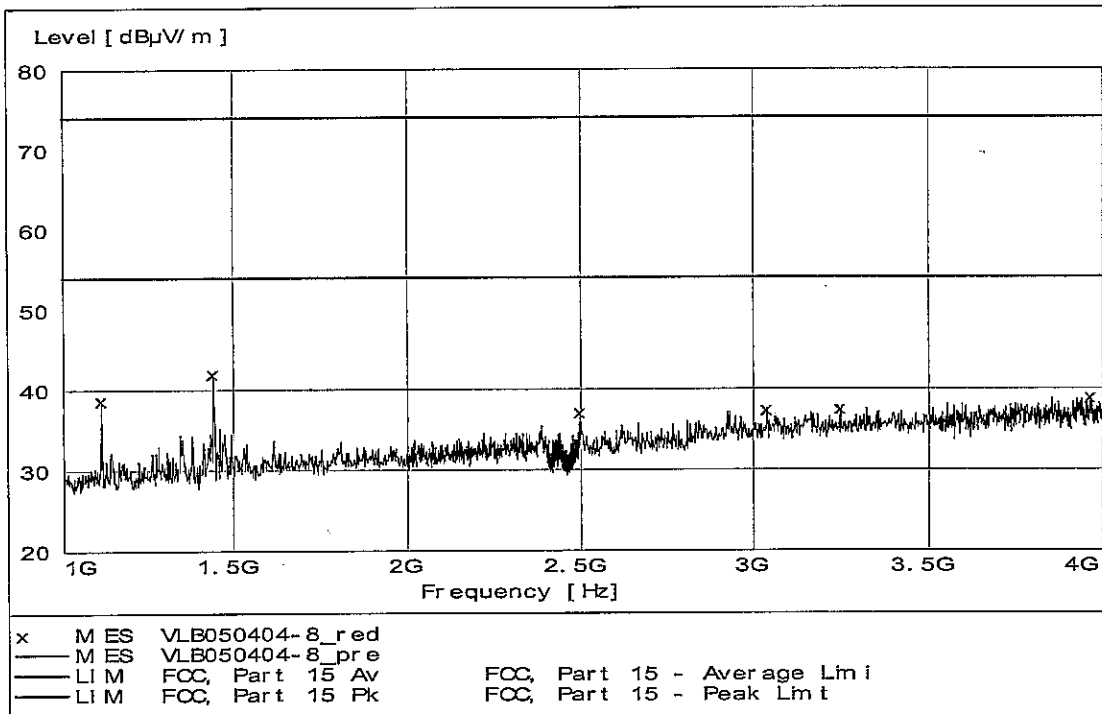
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1000 – 4000 MHz, max peak at a distance of 3 m on the middle TX channel.  
The signal is attenuated by 20 dB.



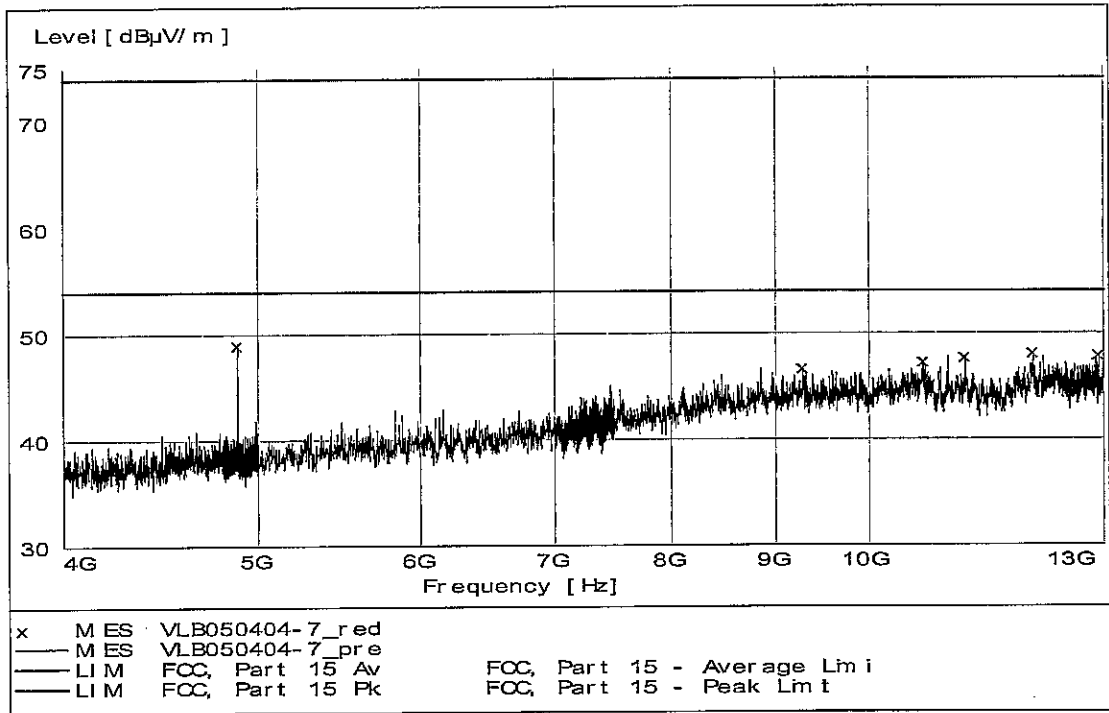
1000 – 4000 MHz, max peak at a distance of 3 m on the middle TX channel.  
The carrier is attenuated by band rejection filter K&L 6N45-2450/T100-0/0.



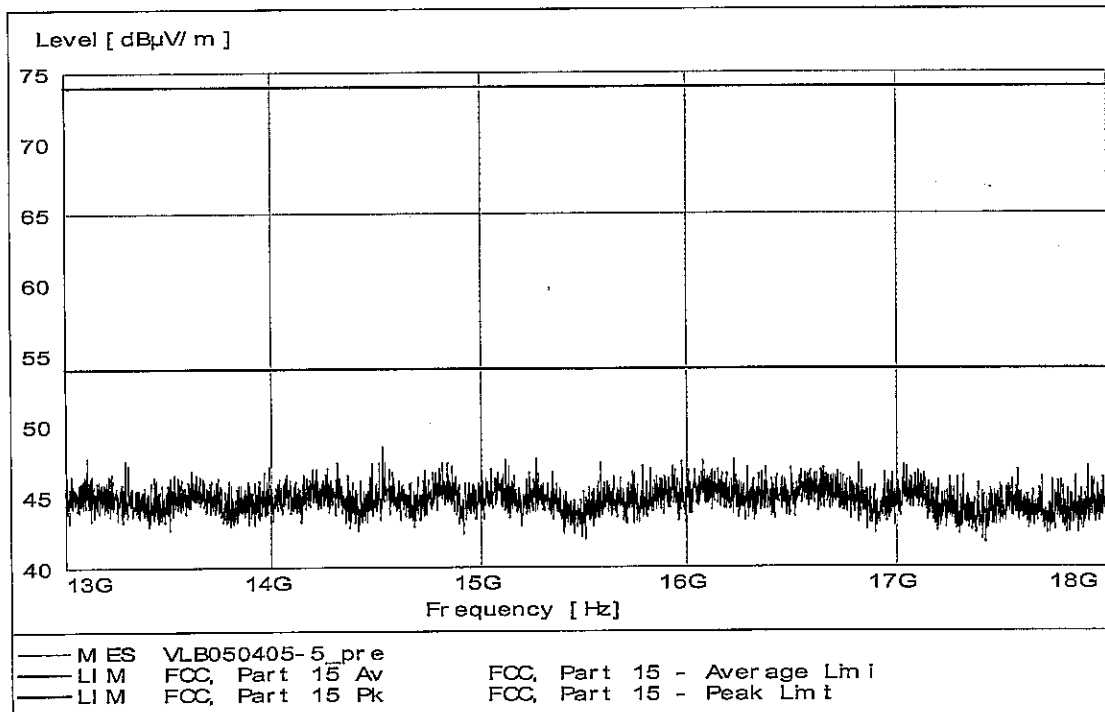
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4000 – 13000 MHz, max peak at a distance of 3 m on the middle TX channel.  
Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



13000 – 18000 MHz, max peak at a distance of 3 m on the middle TX channel



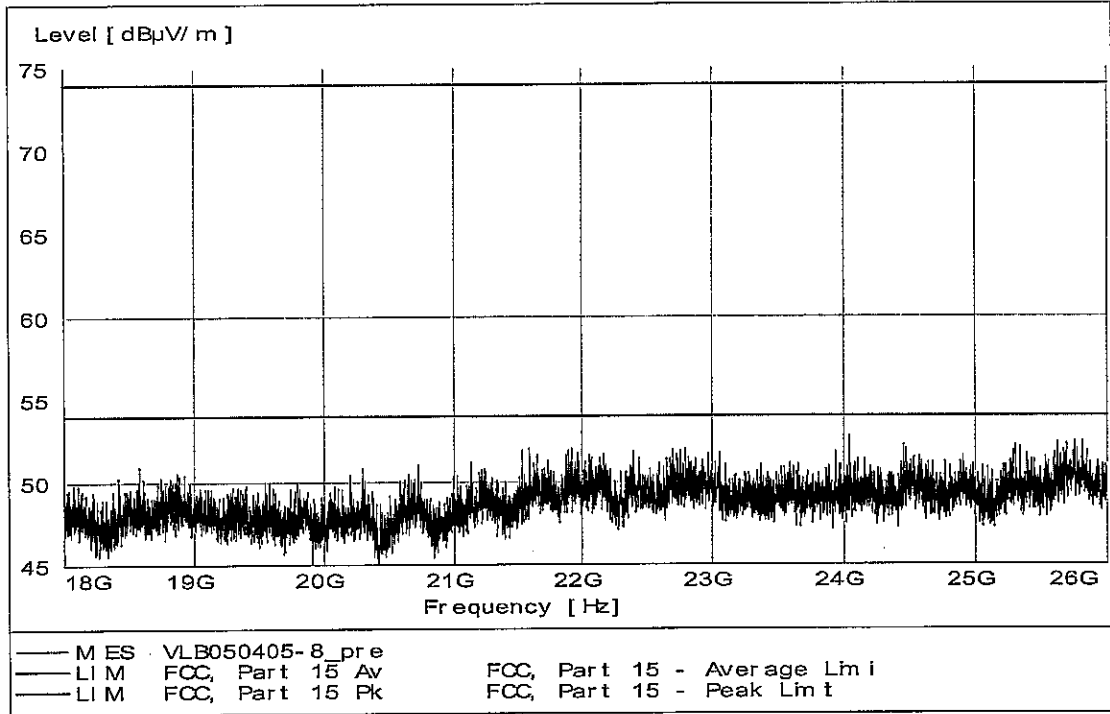
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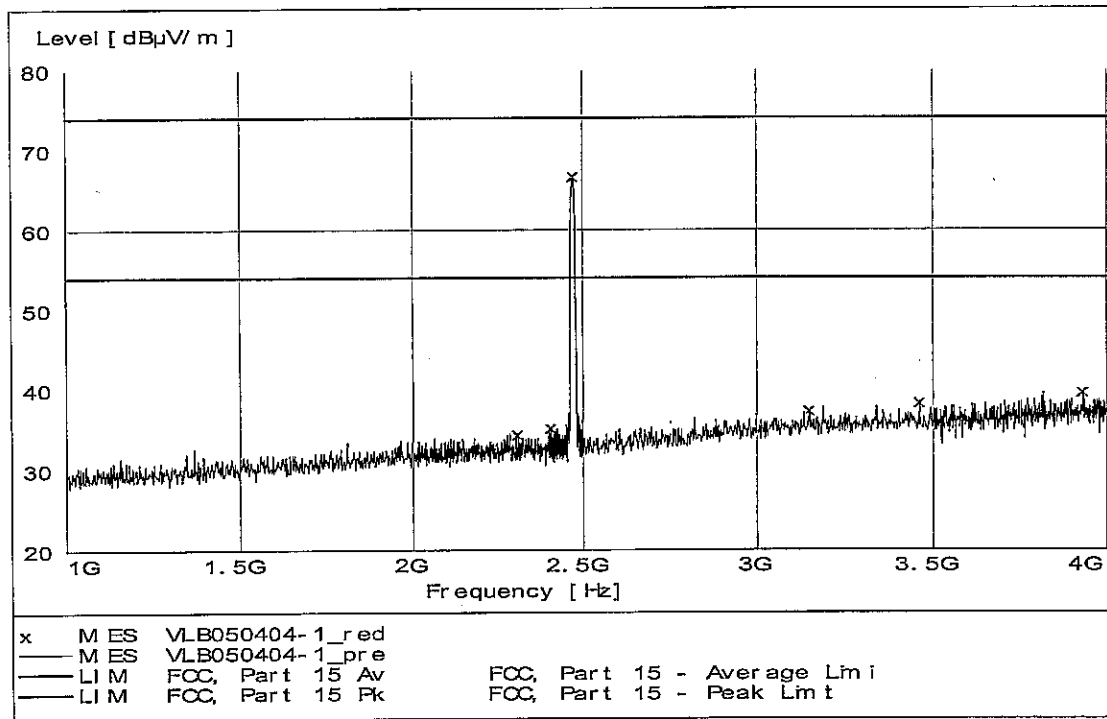
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18000 – 26000 MHz, max peak at a distance of 3 m on the middle TX channel



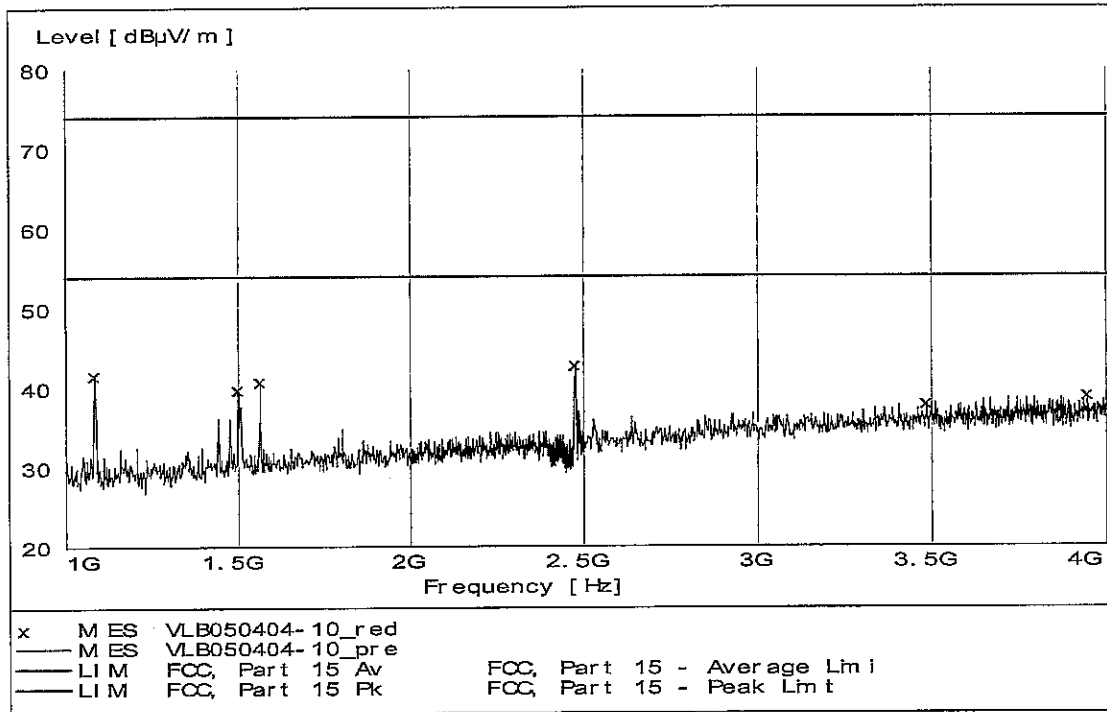
1000 – 4000 MHz, max peak at a distance of 3 m on the upper TX channel  
The signal is attenuated by 20 dB.



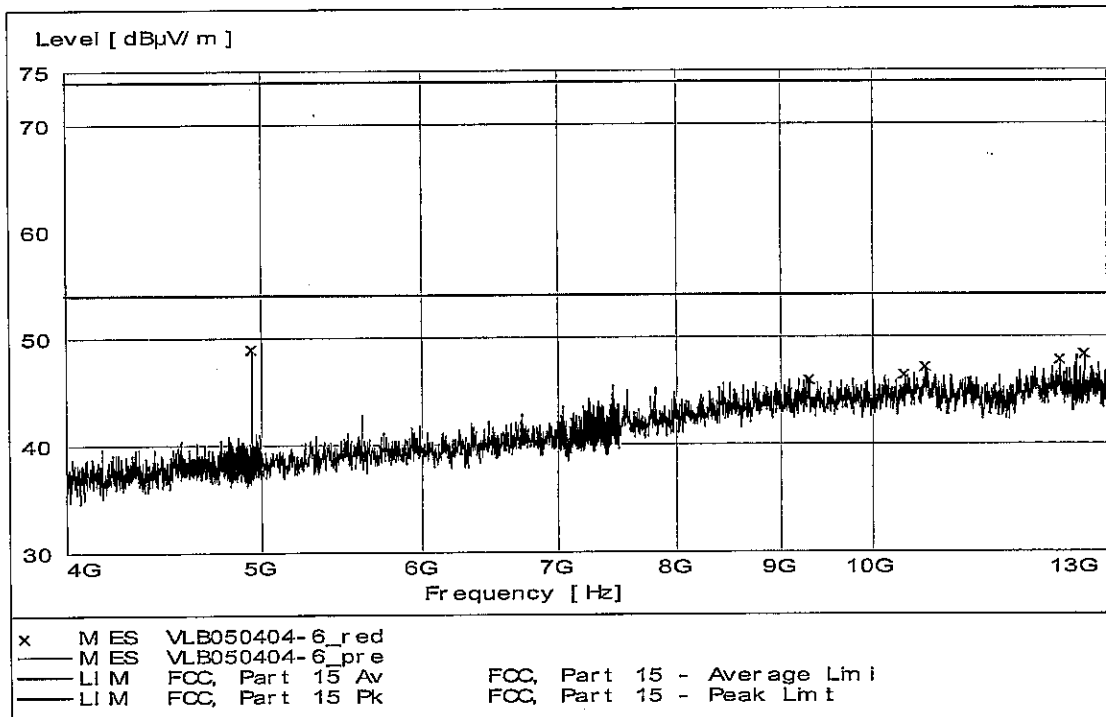
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1000 – 4000 MHz, max peak at a distance of 3 m on the upper TX channel.  
The carrier is attenuated by band rejection filter K&L 6N45-2450/T100-0/0.



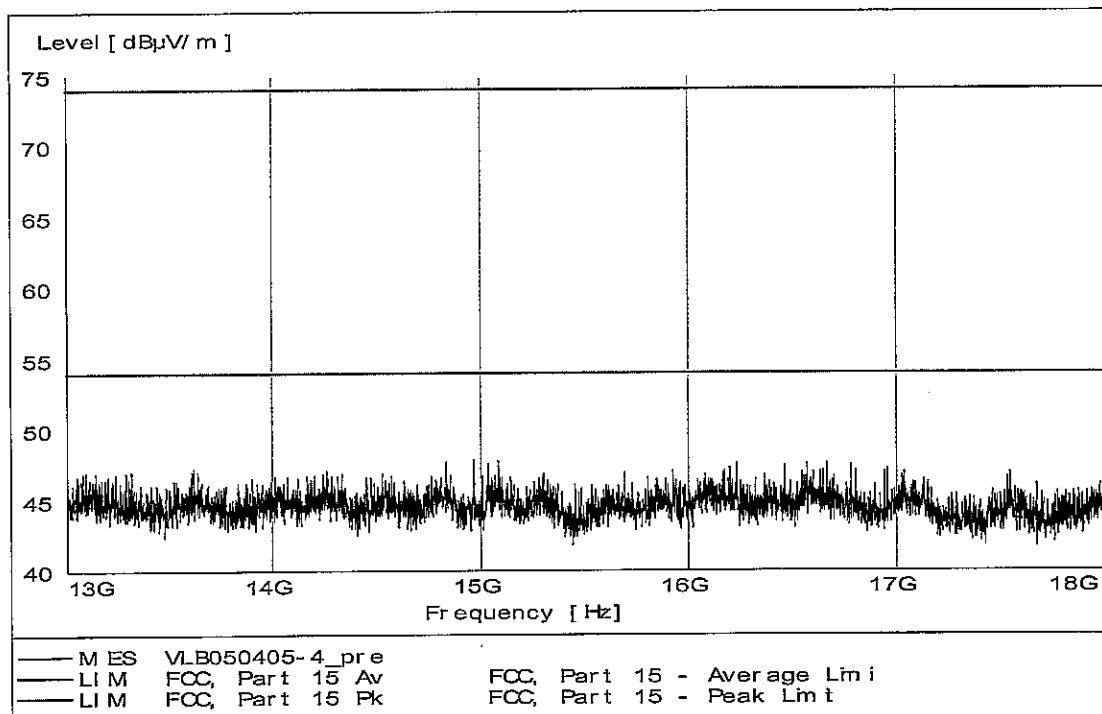
4000 – 13000 MHz, max peak at a distance of 3 m on the upper TX channel.  
Emissions below 4000 MHz are attenuated by high-pass filter K&L 4410-X4500/18000-0.



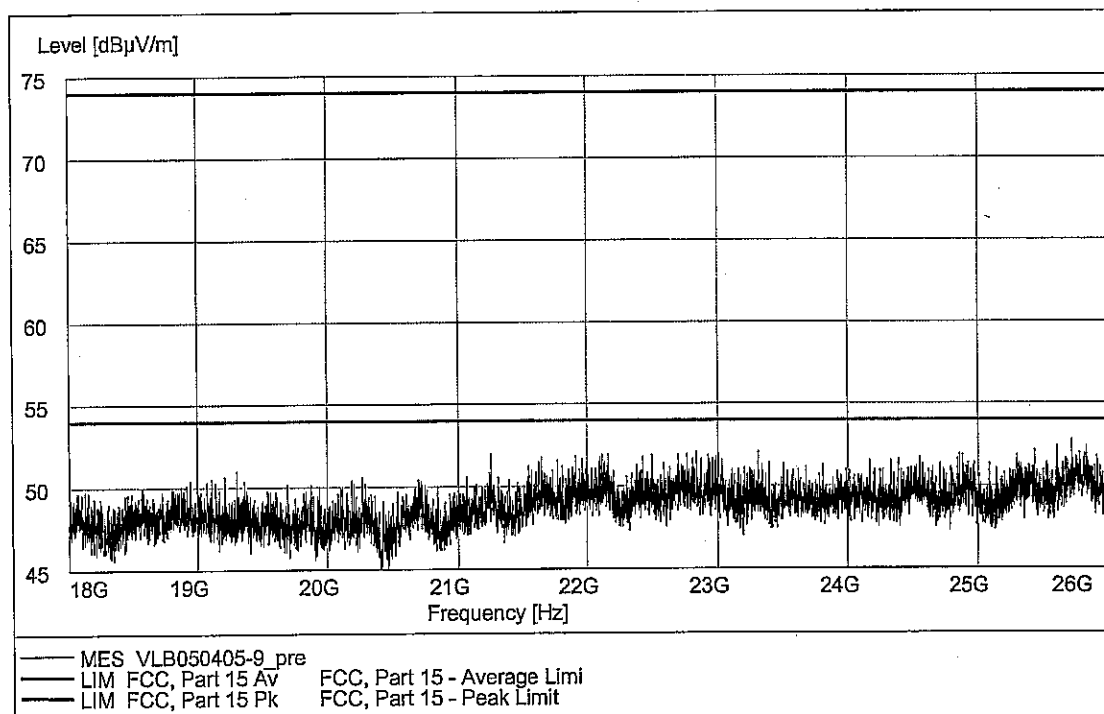
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13000 – 18000 MHz, max peak at a distance of 3 m on the upper TX channel



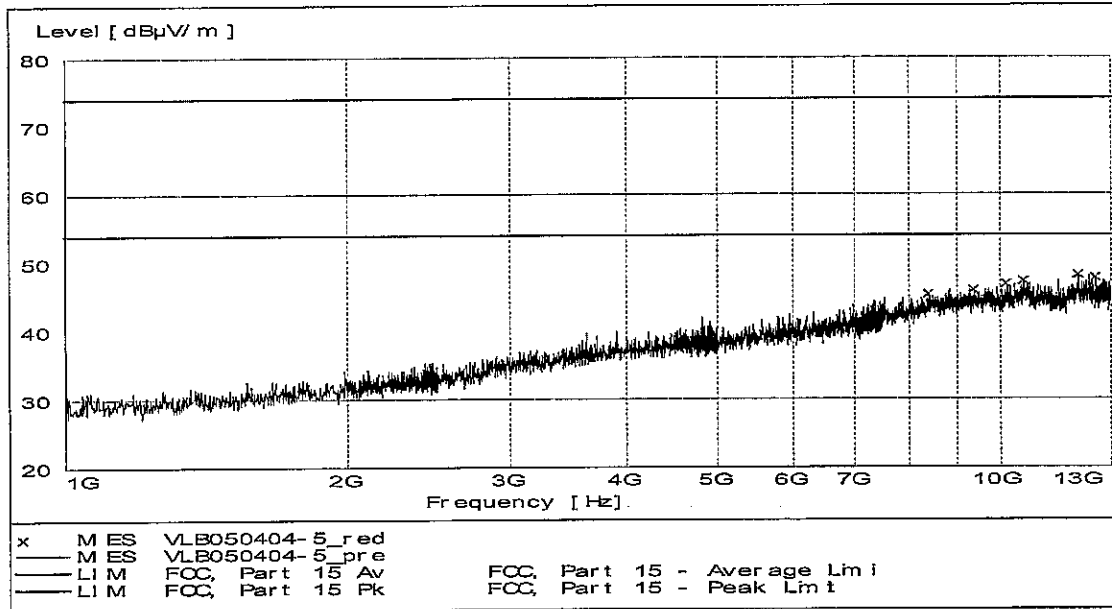
18000 – 26000 MHz, max peak at a distance of 3 m on the upper TX channel



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1000 – 13000 MHz, max peak at a distance of 3 m in the standby mode



Data summary

Field strength of spurious emissions						
Frequency [MHz]	RBW [kHz]	Measured level		Limit		Note
		Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	Peak [dB(µV/m)]	QP/AV [dB(µV/m)]	
40,7	120	-	25	-	29,5	10 m distance
66,1	120	-	21	-	29,5	"
91,4	120	-	23	-	33	"
420,0	120	-	23	-	35,6	"
659,9	120	-	25	-	35,6	"
780,1	120	-	25	-	35,6	"
960 – 1000	120	< 30	-	-	43,5	Background noise level
1083	1000	46	-	74	54	3 m distance
1112	1000	44	-	74	54	"
1349	1000	45	-	74	54	"
1441	1000	47	-	74	54	"
1499	1000	45	-	74	54	"
1531	1000	45	-	74	54	"
1565	1000	44	-	74	54	"
4824	1000	54	51	74	54	"
4884	1000	55	51	74	54	"
4944	1000	54	51	74	54	"
13000 – 18000	1000	< 48	-	74	54	Background noise level
18000 – 26000	1000	< 53	-	74	54	Background noise level

The limit at 10 m test distance was calculated using an inverse linear extrapolation factor 20 dB/decade.

Example calculation:

$$\text{Measured level [dB}\mu\text{V/m]} = \text{Analyser reading [dB}\mu\text{V]} + \text{cable loss [dB]} - \text{preamplifier gain [dB]} + \text{antenna factor [1/m]}$$

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**10. CONDUCTED DISTURBANCE VOLTAGE IN THE FREQUENCY RANGE 0,15 - 30 MHZ**

**10.1 Operating environment**

Temperature: 23 °C (10 – 40 °C)  
 Relative Humidity: 21 % (10 - 90 %)

**10.2 Measurement uncertainty**

Conducted disturbance voltage, quasi-peak detection: ±2,0 dB

The measurement uncertainty describes the overall uncertainty of the given measured value during operation of the EUT.

Measurement uncertainty is calculated in accordance with EA-4/02-1997.  
 The measurement uncertainty is given with a confidence of 95%.

**10.3 Test equipment**

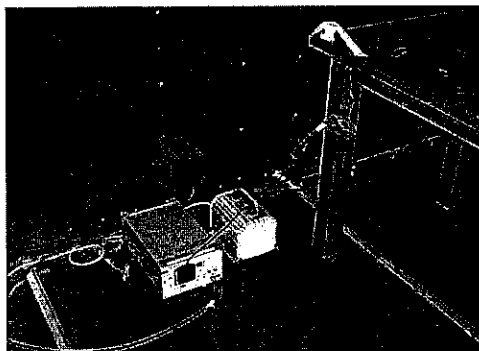
Test site:	FCC		
Equipment	Manufacturer	Type	SEMKO No.
Software:	Rohde & Schwarz	ES-K1 V1.60	
Measurement receiver:	Rohde & Schwarz	ESHS 30	4946
Artificial mains network:	Rohde & Schwarz	ESH3-Z5	2727
Transformer:	TUFVASSONS	AFM-1500	375

**10.4 Measurement set-up**

The mains terminal disturbance voltage was measured with the EUT located 0,8 m above the ground plane and 0,4 m from the vertical ground plane. The EUT was connected to an artificial mains network (AMN). The AMN was placed on the ground plane. Amplitude measurements were performed with a quasi-peak detector.

The EUT was supplied with 120 V, 60 Hz during the test.

Test set-up photo:



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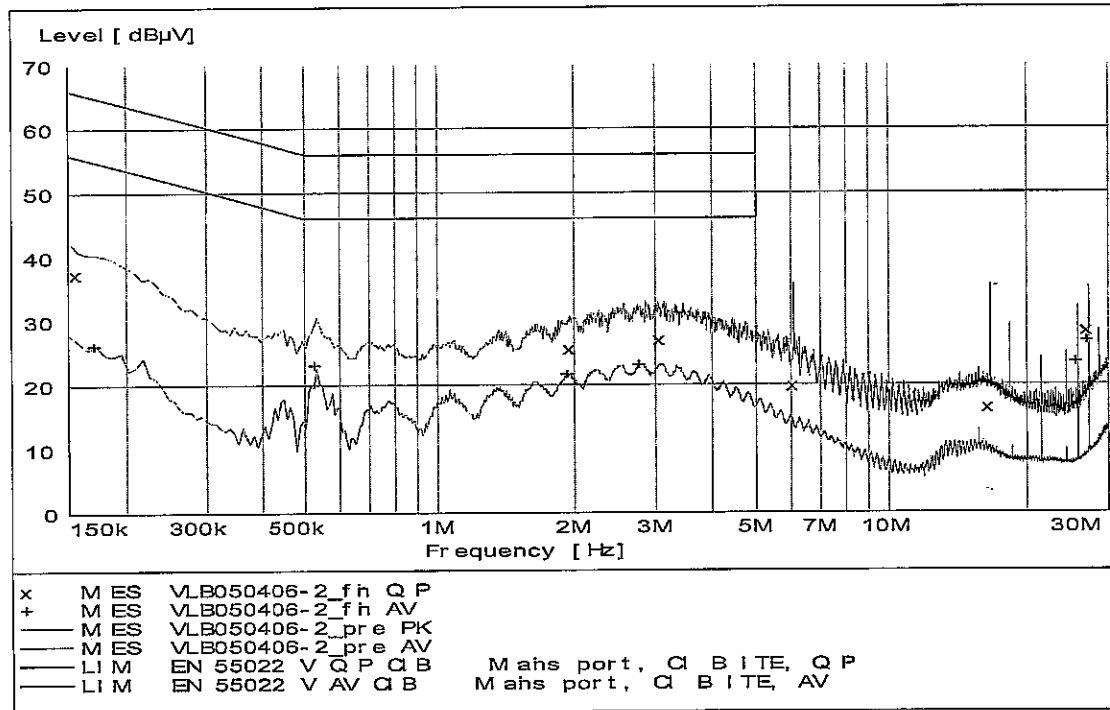
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**10.5 Test protocol**

Date of test: April 6, 2005

Frequency /MHz	Quasi-Peak	
	Disturbance Level /dB(μV)	Permitted limit /dB(μV)
0,158	38	66
1,980	26	56
3,098	27	56
6,128	20	60
16,710	17	60
27,233	29	60

Overview sweeps performed with peak and average detectors are shown below.



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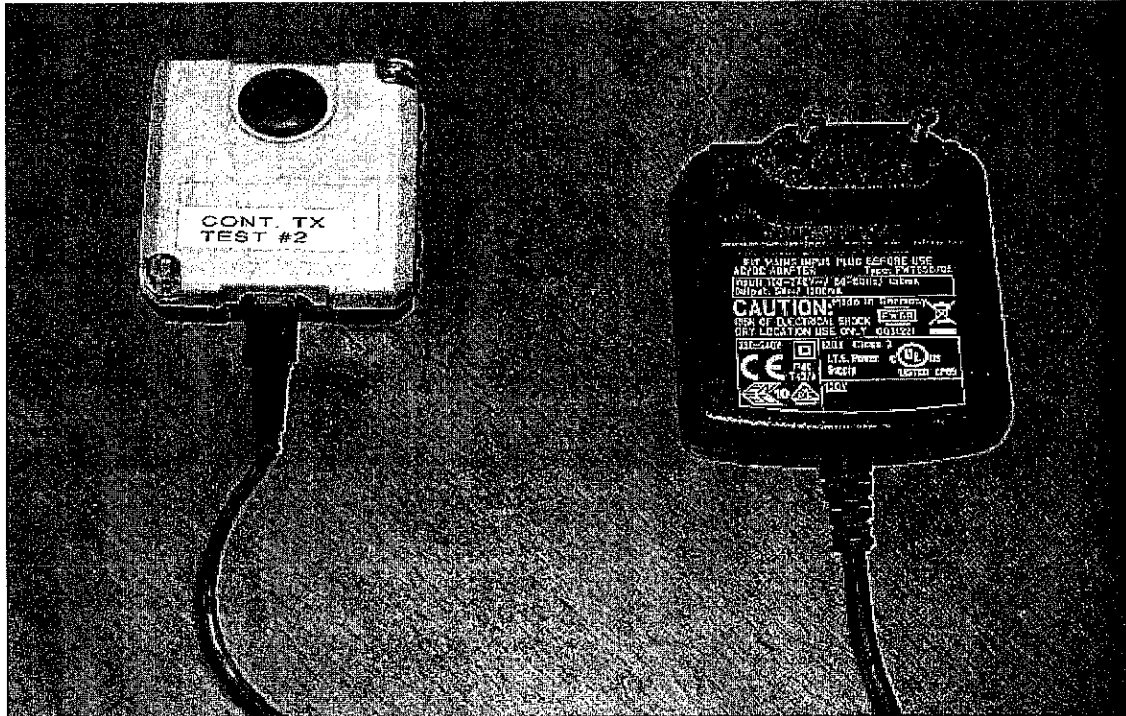
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**APPENDIX – PHOTOS OF THE EUT**

General view



AC/DC Adapter (identification photo)



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