

# EMC Measurement/Technical Report

on

## Bluetooth PC card II from IBM



**TTI-P-G 178/99**

Report Reference: 4\_TDK\_0300\_BT\_FCCd

7 Layers AG  
Borsigstr. 11  
40880 Ratingen  
Germany

**Note:**

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the testing laboratory.

---

Registergericht - registered in:  
Ratingen, HRB 3264  
Aufsichtsratsvorsitzende -  
Chairman of the Supervisory Board:  
Dr. Sabine Grobecker

Vorstand - Board of Directors:  
Dr. Wolfgang Dahm  
Dr. Hans-Jürgen Meckelburg

7 layers AG, Borsigstrasse 11  
40880 Ratingen, Germany  
Phone: +49 (0) 2102 749 0  
Fax: +49 (0) 2102 749 350  
<http://www.7Layers.com>

---



## Table of Contents

<b>0. Summary</b>	<b>3</b>
0.1 Technical Report Summary	3
0.2 Measurement Summary	4
<b>1. Administrative Data</b>	<b>5</b>
1.1 Testing Laboratory	5
1.2 Project Data	5
1.3 Applicant Data	5
1.4 Manufacturer Data	5
<b>2. Product Labeling</b>	<b>6</b>
2.1 FCC ID Label	6
2.2 Location of Label on the EUT	6
<b>3. Testobject Data</b>	<b>7</b>
3.1 General EUT Description	7
3.2 EUT Main Components	8
3.3 Ancillary Equipment	8
3.4 EUT Setups	8
3.5 Operating Modes	9
<b>4. Measurement Results</b>	<b>10</b>
4.1 Conducted Emissions	10
Occupied Bandwidth	
Peak Power Output	
Spurious RF Conducted Emissions	
4.5 Spurious RF Radiated Emissions	12
Dwell Time	
Power Density	
Channel Separation	
Processing Gain	
<b>5. Testequipment</b>	<b>15</b>
<b>6. Foto Report</b>	<b>18</b>
<b>7. Setup Drawings</b>	<b>21</b>



## **0 Summary**

### **0.1 Technical Report Summary**

**Type of Authorization:**

Certification for an Unintentional Radiator (Class B digital device)

**Applicable FCC Rules:**

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 19 (10-1-98 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification Sections

Part 15, Subpart B - Unintentional Radiators

§ 15.101 Equipment authorization requirement

§ 15.107 Conducted limits

§ 15.109 Radiated emission limits

**Summary Test Results:**

**The Equipment under test fulfilled the requirements of the applied FCC rules.**

## 0.2 Measurement Summary

### **FCC Part 15, Subpart B §15.107**

#### **Conducted Emissions (AC Power Line)**

The measurement was performed according to ANSI C63.4 1992

<b>OP-Mode</b>	<b>Setup</b>	<b>Port</b>	<b>Final Result</b>
op-mode 2	setup 1	AC line of the laptop	passed

### **FCC Part 15, Subpart B §15.31, §15.109**

#### **Spurious Radiated Emissions**

The measurement was performed according to ANSI C63.4 1992

<b>OP-Mode</b>	<b>Setup</b>	<b>Port</b>	<b>Final Result</b>
op-mode 2	setup 1/2	enclosure	passed

Responsible for  
Accreditation Scope: \_\_\_\_\_

Responsible  
for Test Report: \_\_\_\_\_

## **1. Administrative Data**

### **1.1 Testing Laboratory**

Company Name: 7 Layers AG  
Address: Borsigstr. 11  
40880 Ratingen  
Germany

This facility has been fully described in a report submitted to the FCC and accepted in a letter dated February 07, 2000 under the registration number 96716.

The test facility is also accredited by the following accreditation organisation:

- Deutscher Akkreditierungs Rat DAR-Registration no. TTI-P-G 178/99
- Regulierungsbehörde für Telekommunikation und Post (Reg TP)

Responsible for Accreditation Scope: Dipl.-Ing Bernhard Retka  
Dipl.-Ing Arndt Stöcker

### **1.2 Project Data**

Responsible for testing and report: Dipl.- Ing. Thomas Hoell  
Receipt of EUT: 07.08.01  
Date of Test(s): 20.08. - 28.09.01  
Date of Report: 04.10.01

### **1.3 Applicant Data**

Company Name: TDK Systems Europe UK  
Address: 126 Colindale Avenue  
  
Colindale, London NW9 5HD  
UK  
Contact Person: Peter de Wit

### **1.4 Manufacturer Data**

Company Name: see applicant  
Address:

Contact Person:



## **2.0 Product Labeling**

### **2.1 FCC ID Label:**

At the time of the test report there was no FCC label available.

### **2.2 Location of Label on the EUT:**

see above

### 3. Testobject Data

#### 3.1 General EUT Description

<b>Equipment under Test:</b>	Bluetooth PC card II from IBM
<b>Type Designation:</b>	
<b>Kind of Device:</b> <b>(optional)</b>	Bluetooth transceiver PCMCIA card
<b>Voltage Type:</b>	DC
<b>Voltage level:</b>	3.3 V

#### General product description:

Bluetooth is a short-range radio link intended to be a cable replacement between portable and/or fixed electronic devices.

Bluetooth operates in the unlicensed ISM Band at 2.4 GHz. In the US a band of 83.5 MHz width is available. In this band, 79 RF channels spaced 1MHz apart are defined. The channel is represented by a pseudo-random hopping sequence through the 79 channels. The channel is divided into time slots, with a nominal slot length of 625µs, where each slot corresponds to different RF hop frequencies. The nominal hop rate is 1600 hops/s. All frequencies are equally used. The average time of occupancy is 0.3797 s within a 30 second period. The symbol rate on the channel is 1 Ms/s.

#### The EUT provides the following ports:

##### Ports

AC line of the laptop  
temporary antenna connector  
Enclosure

**The main components of EUT are listed and described in Chapter 3.2**

### 3.2 EUT Main components:

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A	Bluetooth PC card II from IBM	-	04026b980080	Rev. 6	Beta 11	07.08.01

**NOTE:** The short description is used to simplify the identification of the EUT in this test report

### 3.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But never the less Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial No.	FCC Id
AE 5	PC Mouse	Logitech M-MD15L	-	-	-	DZLMMD15L
AE 4	Printer	HP DJ 895 cxi	-	-	SG97E1V0Y5	-
AE 3	Keyboard	Compaq	-	-	123755-002	AQ6-23K15
AE 2	Monitor	Samsung Sync Master 700p	-	-	SE 17H3MK3052 56N	CSE 7839
AE 1	Laptop	IBM Thinkpad	-	-	ZZ-00013	-

### 3.4 EUT Setups

This chapter describes the combination of EUT's and ancillary equipment used for testing.

Setup No.	Combination of EUTs	Description
setup 1	EUT A + AE 1 + AE 2 + AE 3 + AE 4 + AE 5	
setup 2	EUT A + AE 1	



### 3.5 Operating Modes

This chapter describes the operating modes of the EUT's used for testing.

Op. Mode	Description of Operating Modes	Remarks
op-mode 1	TX mode, the EUT transmits continuously on 2402 MHz	
op-mode 2	TX mode, the EUT transmits continuously on 2441 MHz	
op-mode 3	TX mode, the EUT transmits continuously on 2480 MHz	
op-mode 4	inquiry mode	
op-mode 5	paging mode	

## 4. Test Results

### 4. 1 Conducted Emissions (AC Power Line)

**Standard** FCC Part 15, 10-1-98  
Subpart B

**The test was performed according to:** ANSI C63.4 1992

#### 4. 1 .1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4-1992.

The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 $\mu$ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into EMI test software ES-K1 from R&S.

##### Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

EMI receiver settings:

- Detector: Peak - Maxhold
- Frequency range: 450 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF-Bandwidth: 10 kHz
- Measuring time / Frequency step: 1 ms
- Measurement on phase + neutral lines of the power cords

Intention of this step is, to determine the conducted EMI-profile of the EUT. With this data, the test system performs ( to reduce the number of final measurements) a data reduction with the following parameters:

- Offset for acceptance analysis: Limit line – 6 dB
- Maximum number of final measurements: 6

##### Step 2: Final measurement

With the frequencies determined in step 1, the final measurement will be performed.

EMI receiver settings:

- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1s / frequency

At the final test the cable were and moved within the range of positions likely to find their maximum emission.

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

.

#### 4. 1 .2 Test Limits

FCC Part 15, Subpart B, §15.107

Frequency Range (MHz):                      Class B Limit (dBμV)  
0.45 – 30    48

Used conversion factor: Limit (dBμV) = 20 log (Limit (μV)/1μV)

#### 4. 1 .3 Test Protocol

Temperature: 22 °C

Air Pressure: 1015 hPa

Humidity: 42 %

Op. Mode	Setup	Port	Test Parameter
op-mode 2	setup 1	AC line of the laptop	

Powerline	Frequency MHz	Measured Value dBμV	Delta to Limit dBμV	Remarks

Remark: No peaks closer than 15 dB to the limit found.

#### 4. 1 .4 Test result: Conducted Emissions (AC Power Line)

FCC Part 15, Subpart B	Op. Mode	Setup	Port	Result
	op-mode 2	setup 1	AC line of the laptop	<b>passed</b>

## 4. 2 Spurious Radiated Emissions

**Standard** FCC Part 15, 10-1-98  
Subpart B

**The test was performed according to:** ANSI C63.4 1992

### 4. 2 .1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4-1992.

The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The test was performed at an EUT to receiving antenna distance of 3m.

The radiated emissions measurements was made in a typical installation configuration.

The measurement procedure consists of four steps. It is implemented into EMI test software ES-K1 from R&S.

Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100  $\mu$ s
- Turntable angle range: -180 to 180 °
- Turntable stepsize: 90°
- Height variation range: 1 – 3m
- Height variation stepsize: 2m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. With this data, the test system performs ( to reduce the number of final measurements) a data reduction with the following parameters:

- Offset for acceptance analysis: Limit line – 10 dB
- Maximum number of final measurements: 12

Step 2:

With the frequencies determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

Settings for step 2:

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100ms
- Turntable angle range: -180 to 180 °
- Turntable stepsize: 45°
- Height variation range: 1 – 4m
- Height variation stepsize: 0,5m

- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0,5m

#### Step 3:

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency the turntable azimuth and antenna height, which was determined in step 3, will be adjusted.

The turntable azimuth will be slowly varied by +/- 22,5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by +/- 25 cm around the antenna height determined in step 3. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

#### Settings for step 3:

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100ms
- Turntable angle range: -22,5° to + 22,5 ° around the value determined in step 2
- Height variation range: -0,25m to + 0,25m around the value determined in step 2

#### Step 4:

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

- Detector: Quasi-Peak(< 1GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1s

The following modifications apply to the measurement procedure for the frequency range

above 1 GHz:

The measurement distance was reduced to 1m. The results were extrapolated by the extrapolation factor of 20 dB/decade (invers linear-distance for field strength measurements, invers linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 Ghz) and a horn antenna (18-25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.

Detector: Peak, Average

RBW = VBW = 1 MHz, above 7 GHz 100 kHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

#### 4. 2 .2 Test Limits

FCC Part 15, Subpart B, §15.109, Radiated Emission Limits

Frequency Range (MHz):	Class B Limit (dBµV/m)
30 – 88	40,0
88 – 216	43,5
216 – 960	46,0
above 960	54,0

§15.35(b)

..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit...

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

#### 4. 2 .3 Test Protocol

Temperature: 29 °C

Air Pressure: 1020 hPa

Humidity: 34 %

Op. Mode	Setup	Port	Test Parameter					
op-mode 2	setup 1/2	enclosure						
Polarisation	Frequency MHz	Corrected Value dBµV/m			Limit QP/AV dBµV/m	Limit Peak dBµV/m	Delta to AV/QP Limit/dB	Delta to Peak Limit dB
		QP	Peak	AV				
Vertical	4882,00		33,40	24,53	54,00	74,00	29,47	40,60

Remark: No spurious emission in the range 20 dB below the limit found.

Setup 1 was used for the measurement up to 1 GHz and setup 2 was used for the measurement above 1 GHz.

#### 4. 2 .4 Test result: Spurious Radiated Emissions

FCC Part 15, Subpart B		Op. Mode	Setup	Port	Result
		op-mode 2	setup 1/2	enclosure	passed

## 5. Testequipment

### *Rohde & Schwarz TS8960*

### *Bluetooth RF Conformance Test System*

Equipment	Type	Serial No.	Manufacturer
Laserprinter	Laserjet 2100	FRFJ023447	HP
Monitor 19"	Flexscan T68	50565029 -ED	EIZO
Power Meter	NRVD	832025/059	Rohde & Schwarz
Power Sensor	NRV-Z1	832279/015	Rohde & Schwarz
Power Sensor	NRV-Z1	832279/013	Rohde & Schwarz
Power Supply	PS-2403D	-	Conrad
RF Step Attenuator	RSP	833695/001	Rohde & Schwarz
Rubidium Frequency Normal	MFS	002	Efratom
Signal Analyser	FSP30	100051	Rohde & Schwarz
Signal Analyser	FSIQ26	832695/007	Rohde & Schwarz
Signal Generator	SMP 03	833680/003	Rohde & Schwarz
Signal Generator	SMIQ03B	834344/002	Rohde & Schwarz
Signal Generator	SMIQ03B	832870/017	Rohde & Schwarz
Signal Switching and Conditioning Unit	SSCU	338826/005	Rohde & Schwarz
Signalling Unit	PTW60 for TS8960	838312/014	Rohde & Schwarz
System Controller	PSM12	829323/008	Rohde & Schwarz

### *EMI Test System*

Equipment	Type	Serial No.	Manufacturer
Comparison Noise Emitter	CNE III	99/016	York
EMI Analyzer	ESI 26	830482/004	Rohde & Schwarz
Signal Generator	SMR 20	846834/008	Rohde & Schwarz

## EMI Radiated Auxiliary Equipment

Equipment	Type	Serial No.	Manufacturer
Antenna mast 4m	MA 240	240/492	HD GmbH H. Deisel
Biconical dipole	VUBA 9117	9117108	Schwarzbeck
Broadband Amplifier 45MHz-27GHz	JS4-00102600-42-5A	619368	Miteq
Cable "ESI to EMI Antenna"	RTK081+Aircell7	W18.01+W38.01a	Huber+Suhner
Cable "ESI to Horn Antenna"	RTK 081	W18.04+3599/001	Rosenberger
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic
KUEP pre amplifier	Kuep 00304000	001	7layers
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz
Pyramidal Horn Antenna 26,5 GHz	Model 3160-09	9910-1184	EMCO

## EMI Conducted Auxiliary Equipment

Equipment	Type	Serial No.	Manufacturer
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber+Suhner
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz

## Auxiliary Test Equipment

Equipment	Type	Serial No.	Manufacturer
Broadband Resist. Power Divider N	1506A / 93459	LM390	Weinschel
Broadband Resist. Power Divider SMA	1515 / 93459	LN673	Weinschel
Digital Multimeter 01	Voltcraft M-3860M	IJ096055	Conrad
Digital Multimeter 02	Voltcraft M-3860M	IJ095955	Conrad
Digital Oscilloscope	TDS 784C	B021311	Tektronix
Fibre optic link Satellite	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver	FO RS232 Link	182-018	Pontis
I/Q Modulation Generator	AMIQ-B1	832085/018	Rohde & Schwarz
Notch Filter ultra stable	WRCA800/960-6EEK	24	Wainwright
Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz
Temperature Chamber	KWP 120/70	59226012190010	Weiss
Temperature Chamber	VT 4002	58566002150010	Vötsch
ThermoHygro_01	430202		Fischer



## *Anechoic Chamber*

<b>Equipment</b>	<b>Type</b>	<b>Serial No.</b>	<b>Manufacturer</b>
Air Compressor (pneumatic)			Atlas Copco
Controller	HD 100	100/603	HD GmbH H. Deisel
EMC Camera	CE-CAM/1		CE-SYS
EMC Camera for observation of EUT	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter telephone systems / modem	B84312-C40-B1		Siemens&Matsushita
Filter Universal 1A	B84312-C30-H3		Siemens&Matsushita
Fully/Semi AE Chamber	10.58x6.38x6		Frankonia
Turntable	DS 420S	420/573/99	HD GmbH, H. Deisel
Valve Control Unit (pneum.)	VE 615P	615/348/99	HD GmbH, H. Deisel

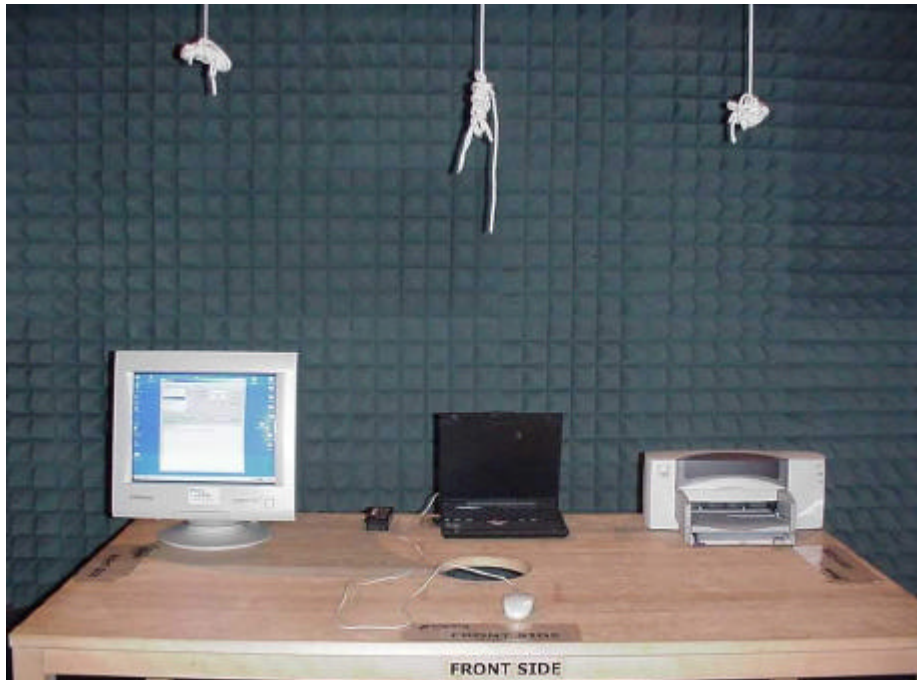
## 6. Foto Report



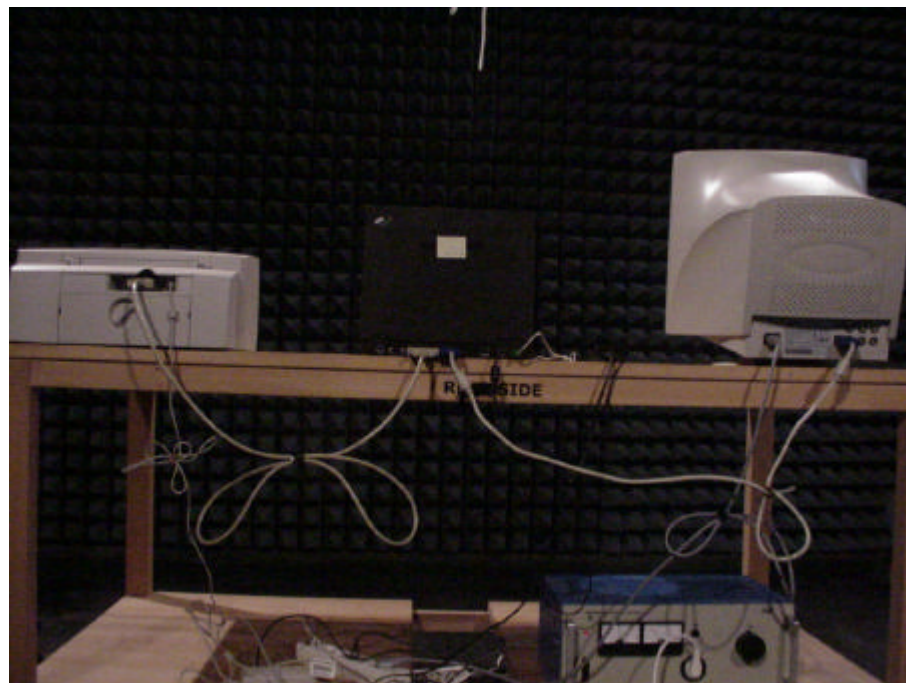
Picture 1 : EUT plugged into the PCMCIA slot of the laptop



Picture 2 : Setup for radiated emission tests above 1 GHz



Picture 3 : Setup for radiated emission tests below 1 GHz



Picture 4 : Setup for radiated emission tests below 1 GHz (rear view)



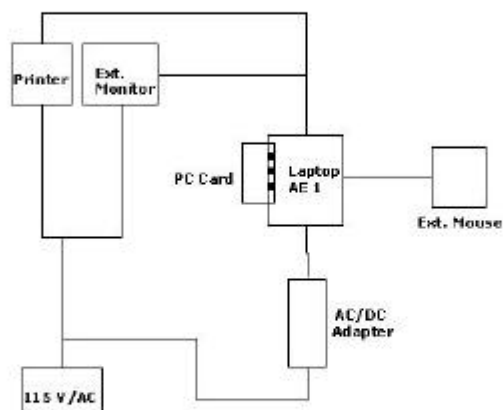


Picture 5 : Setup for AC mains test



Picture 6 : Setup for AC mains test, rear view

## 7. Setup Drawings



Drawing 1 : Test setup