

InterLab®

# EMC Measurement/Technical Report on Bluetooth® Transceiver Bluetooth Carkit HF850

**Report Reference:** 4\_MOT\_1604\_TAS\_FCCd

## Test Laboratory (Headquarter):

7 Layers AG  
Borsigstr. 11  
40880 Ratingen  
Germany



TTI-P-G 178/99

### 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.

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## **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 EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.**

## 0.2 Measurement Summary

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

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#### Conducted Emissions

|                                            |         |            |              |
|--------------------------------------------|---------|------------|--------------|
| The measurement was performed according to |         | ANSI C63.4 | 1992         |
| OP-Mode                                    | Setup   | Port       | Final Result |
| op-mode 1                                  | setup 1 | DC port    | passed       |

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

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#### Spurious Radiated Emissions

|                                            |         |            |              |
|--------------------------------------------|---------|------------|--------------|
| The measurement was performed according to |         | ANSI C63.4 | 1992         |
| OP-Mode                                    | Setup   | Port       | Final Result |
| op-mode 1                                  | setup 1 | Enclosure  | passed       |

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

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

This test report replaces the report 4\_MOT\_1604\_TAS\_FCCb. This report is based on the results from ☐ the report 4\_MOT\_1604\_TAS\_FCCb.



## **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 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

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

### **1.2 Project Data**

Responsible for testing and report: Robert Machulec  
Receipt of EUT: 07.09.2004  
Date of Test(s): 24.09.2004 - 12.10.2004  
Date of Report: 14.12.2004

### **1.3 Applicant Data**

Company Name: Motorola ESG  
Address: 1700 Belle Meade Ct  
  
Lawrenceville GA 30043  
USA  
Contact Person: Michael Calendine

### **1.4 Manufacturer Data**

Company Name: please see Applicant data  
Address:

Contact Person:

## 2.0 Product Labeling

### 2.1 FCC ID Label:

FCC ID: 020BTHCK100



### 2.2 Location of Label on the EUT:

see above

### 3. Testobject Data

#### 3.1 General EUT Description

|                                       |                        |
|---------------------------------------|------------------------|
| <b>Equipment under Test:</b>          | Bluetooth® Transceiver |
| <b>Type Designation:</b>              | Bluetooth Carkit HF850 |
| <b>Kind of Device:<br/>(optional)</b> | Mobile phone accessory |
| <b>Voltage Type:</b>                  | DC                     |
| <b>Voltage level:</b>                 | 12 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

Temp. Ant. Conn.  
Enclosure  
DC port

**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<br>(AB040a00) | Bluetooth CarKit     | HF850            | test sample 1 | 8489426S01<br>T4 | V0.701    | 07.09.2004      |

EUT A is equipped with an integrated antenna.

**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 nevertheless Ancillary Equipment can influence the test results.

| Short Description  | Equipment under Test | Type Designation | HW Status                 | SW Status | Serial No.                        | FCC Id  |
|--------------------|----------------------|------------------|---------------------------|-----------|-----------------------------------|---------|
| AE 4               | GSM Mobile Phone     | Siemens S55      | Prod.-Date:<br>2002-10-23 | 06.2670   | IMEI: 35-<br>1083-51-<br>004316-0 | PWX-S55 |
| AE 3<br>(AB043a00) | Ext. Control Unit    | SYN1101A         | T4,<br>8489536s01         | -         | test sample 1                     | -       |
| AE 2<br>(AB042a00) | Ext. Speaker         | SSN4020A         | -                         | -         | test sample 1                     | -       |
| AE 1<br>(AB041a00) | Ext. Microphone      | SMN4095B         | -                         | -         | test sample 1                     | -       |

### 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 |             |

### 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 on 79 channels, charging | The EUT is set to transmit in hopping mode |

## 4. Test Results

### 4.1 Conducted Emissions

**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: 150 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): | QP Limit (dBμV) |
|------------------------|-----------------|
| 0.15 – 0.5             | 66 to 56        |
| 0.5 – 5                | 56              |
| 5 – 30                 | 60              |

| Frequency Range (MHz): | AV Limit (dBμV) |
|------------------------|-----------------|
| 0.15 – 0.5             | 56 to 46        |
| 0.5 – 5                | 46              |
| 5 – 30                 | 50              |

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

#### 4.1.3 Test Protocol

Temperature: 25 °C  
Air Pressure: 1010 hPa  
Humidity: 50 %

| Op. Mode  | Setup         | Port                | Test Parameter      |                  |
|-----------|---------------|---------------------|---------------------|------------------|
| op-mode 1 | setup 1       | DC port             |                     |                  |
| Powerline | Frequency MHz | Measured Value dBμV | Delta to Limit dBμV | Remarks          |
| +         | 1,10          | 46,50               | 9,50                | quasi peak value |
| -         | 1,08          | 42,30               | 3,70                | average value    |

Remark: No (further) spurious emissions were found in the range 20 dB below the limit.

#### 4.1.3 Test result: Conducted Emissions

| FCC Part 15, Subpart B | Op. Mode  | Setup   | Port    | Result        |
|------------------------|-----------|---------|---------|---------------|
|                        | op-mode 1 | setup 1 | DC port | <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 were 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: 28 °C  
Air Pressure: 1009 hPa  
Humidity: 41 %

| Op. Mode     | Setup         | Port                   | Test Parameter |    |                      |                   |                             |                        |
|--------------|---------------|------------------------|----------------|----|----------------------|-------------------|-----------------------------|------------------------|
| op-mode 1    | setup 1       | 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 |                      |                   |                             |                        |
| -            |               |                        |                |    |                      |                   |                             |                        |

Remark: No (further) spurious emissions were found in the range 20 dB below the limit.

#### 4.2.3 Test result: Spurious Radiated Emissions

| FCC Part 15, Subpart B | Op. Mode  | Setup   | Port      | Result |
|------------------------|-----------|---------|-----------|--------|
|                        | op-mode 1 | setup 1 | Enclosure | passed |

## 5. Testequipment

### *EUT Digital Signalling System*

| Equipment                                        | Type    | Serial No. | Manufacturer    |
|--------------------------------------------------|---------|------------|-----------------|
| Digital Radio Communication Tester               | CMD 55  | 831050/020 | Rohde & Schwarz |
| Signalling Unit for Bluetooth Spurious Emissions | PTW60   | 100004     | Rohde & Schwarz |
| Universal Radio Communication Tester             | CMU 200 | 102366     | 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 18MHz-26GHz | JS4-18002600-32-5P   | 849785          | Miteq             |
| Broadband Amplifier 30MHz-18GHz | JS4-00101800-35-5P   | 896037          | Miteq             |
| 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                | 5HC3500/12750-1.2-KK | 200035008       | Trilithic         |
| High Pass Filter                | 5HC2700/12750-1.5-KK | 9942012         | Trilithic         |
| High Pass Filter                | 4HC1600/12750-1.5-KK | 9942011         | 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 | 828304/029    | Rohde & Schwarz |
| Two-Line V-Network  | ESH 3-Z5 | 829996/002    | 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      |
| Spectrum Analyzer 9KHz To 3GHz      | FSP3              | 838164/004     | Rohde & Schwarz |
| Temperature Chamber                 | VT 4002           | 58566002150010 | Vötsch          |
| Temperature Chamber                 | KWP 120/70        | 59226012190010 | Weiss           |
| ThermoHygro_01                      | 430202            |                | Fischer         |

## Anechoic Chamber

| Equipment                         | Type           | Serial No. | Manufacturer       |
|-----------------------------------|----------------|------------|--------------------|
| 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 |

## 7 layers Bluetooth™ Full RF Test Solution

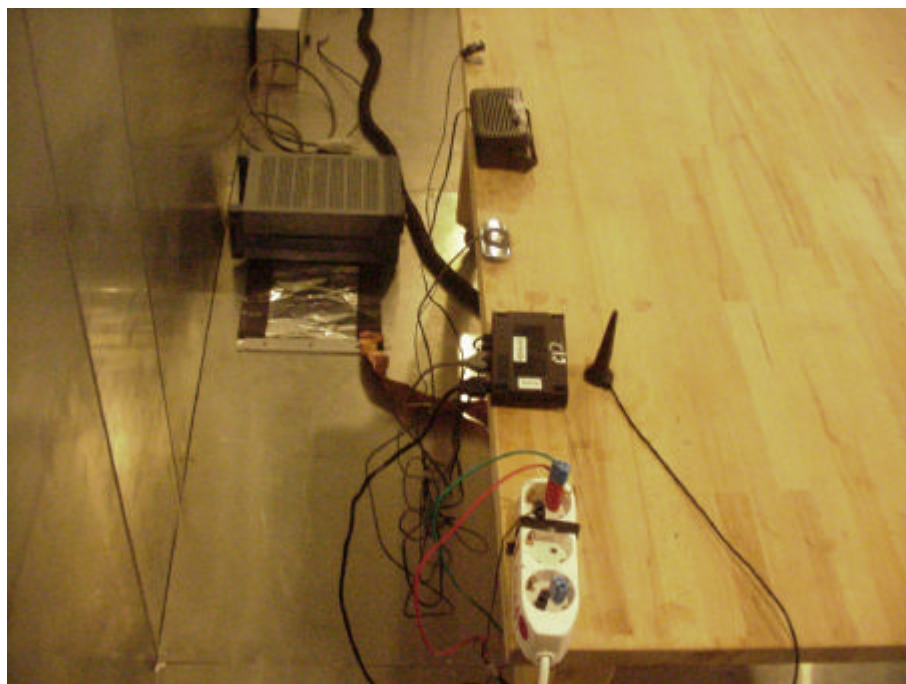
## Bluetooth RF Conformance Test System TS8960

| Equipment                                 | Type             | Serial No. | Manufacturer    |
|-------------------------------------------|------------------|------------|-----------------|
| 10MHz Reference                           | MFS              | 5489/001   | Efratom         |
| Power Meter<br>832025/059                 | NRVD             | 832025/059 | Rohde & Schwarz |
| Power Sensor A<br>832279/013              | NRV-Z1           | 832279/013 | Rohde & Schwarz |
| Power Sensor B<br>832279/015              | NRV-Z1           | 832279/015 | Rohde & Schwarz |
| Power Supply                              | E3632A           | MY40003776 | Agilent         |
| Power Supply                              | PS-2403D         | -          | Conrad          |
| RF Step Attenuator<br>833695/001          | RSP              | 833695/001 | Rohde & Schwarz |
| Rubidium Frequency Normal                 | MFS              | 002        | Efratom         |
| Signal Analyser FSIQ26<br>832695/007      | FSIQ26           | 832695/007 | Rohde & Schwarz |
| Signal Analyser FSP30<br>100051           | FSP30            | 100051     | Rohde & Schwarz |
| Signal Generator<br>101175                | SMIQ03B          | 101175     | Rohde & Schwarz |
| Signal Generator<br>833680/003            | SMP 03           | 833680/003 | Rohde & Schwarz |
| Signal Generator A<br>834344/002          | SMIQ03B          | 834344/002 | Rohde & Schwarz |
| Signal Generator B<br>832870/017          | SMIQ03B          | 832870/017 | Rohde & Schwarz |
| Signal Switching and<br>Conditioning Unit | SSCU             | 338826/005 | Rohde & Schwarz |
| Signalling Unit PTW60<br>838312/014       | PTW60 for TS8960 | 838312/014 | Rohde & Schwarz |
| System Controller<br>829323/008           | PSM12            | 829323/008 | Rohde & Schwarz |

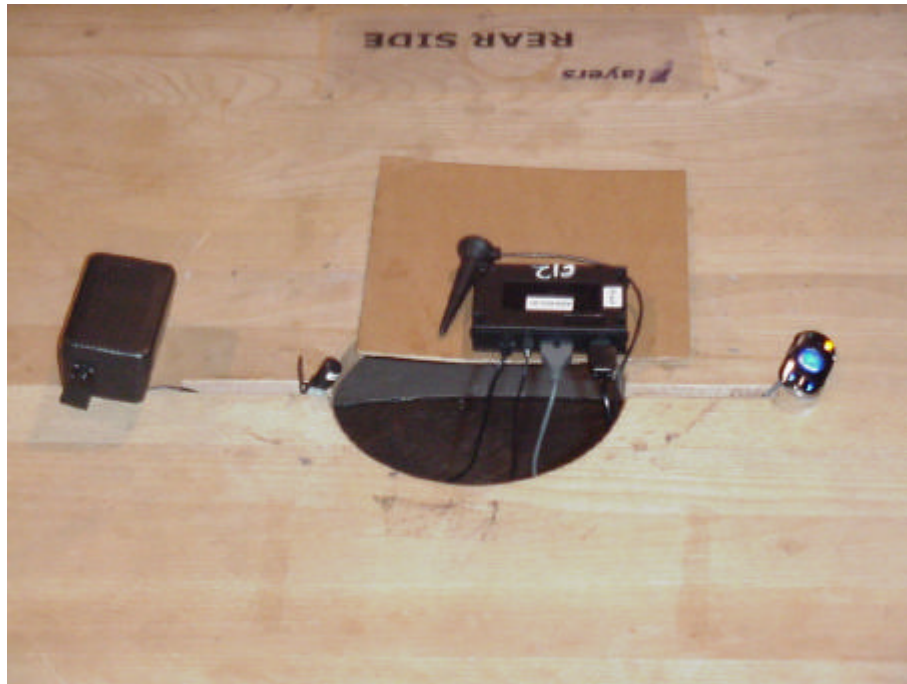
## 6. Foto Report



Picture 1 : EUT (view to the enclosure)

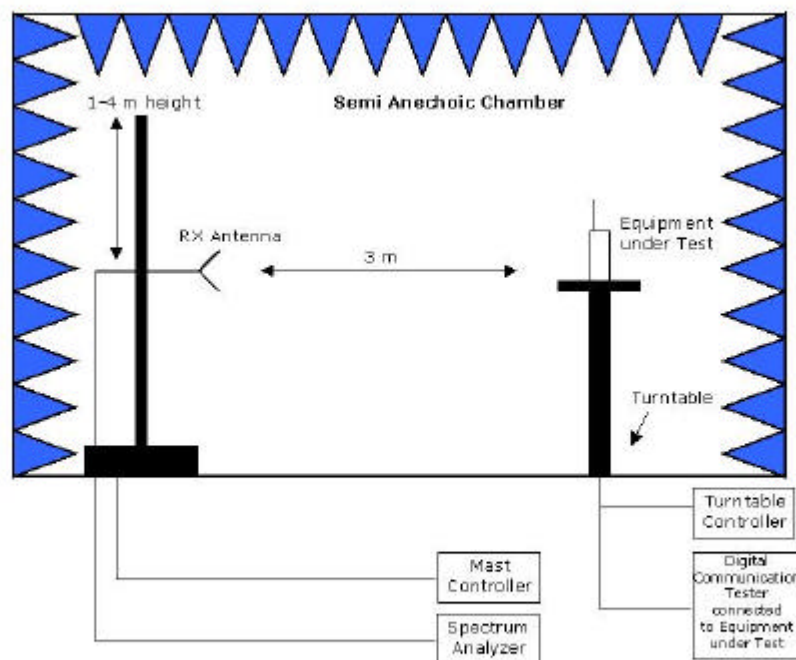


Picture 2 : Setup for conducted emissions tests



**Picture 3** : Setup for radiated emissions tests

## 7. Setup Drawings



**Drawing 1 : setup for radiated tests (in principle)**