

**Test Report  
for  
DTL-1 and FLA-15**

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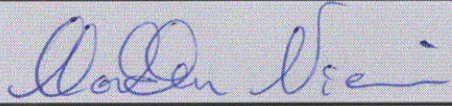
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## 1 CUSTOMER INFORMATION

|                         |                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Test laboratory:        | TAC Tampere<br>Nokia Mobile Phones Ltd.<br>Sinitaival 5<br>33720 TAMPERE<br>FINLAND<br><br>Tel. +358 10 505 6800<br>Fax. +358 10 505 6880 |
| FCC registration number | 94436 (July 09, 1999)                                                                                                                     |
| Customer:               | Nokia Mobile Phones Ltd.<br>Sinitaival 5<br>33720 TAMPERE<br>FINLAND<br><br>Tel. +358 10 505 6800<br>Fax. +358 10 505 6880                |
| Contact person:         | Pasi Vainio                                                                                                                               |
| Receipt of EUT:         | 11.9.2000                                                                                                                                 |
| Test plan reference:    | -                                                                                                                                         |
| Date of testing:        | 26.9. - 12.10.2000                                                                                                                        |
| Date of report:         | 17.10.2000                                                                                                                                |

The tests listed in this report have been done to demonstrate compliance to the CFR 47 Section 15.247.

Contents approved:

|                                                                                     |                                                                                      |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |
| Markku Niemi<br>Manager, TAC Tampere                                                | Tero Huhtala<br>EMC Test Engineer                                                    |

## 2 EUT AND ACCESSORY INFORMATION

### 2.1 EUT description

The EUT is a Connectivity Card (DTL-1) operating on the 2.4GHz – 2.4835GHz band using Bluetooth technology. It comes with a separate PC Card adapter (FLA-15) which allows inserting it to a computer with a PCMCIA slot. The EUT has an integral antenna and no external connections or controls. The EUT is in control of the software delivered with the EUT.

### 2.2 EUT and accessories

The table below lists all EUTs and accessories used in the tests. Later in this test report, only numbers in the last column are used to refer to the devices in each test.

### 2.3 Software

The computers were equipped with test software provided by the customer. The software was used to control the EUT in the tests.

|             | Name                     | Type                     | S/N                      | Number |
|-------------|--------------------------|--------------------------|--------------------------|--------|
| EUT         | Connectivity Card        | DTL-1                    |                          | 03011  |
|             | Connectivity Card        | DTL-1                    |                          | 03013  |
|             | Connectivity Card        | DTL-1                    |                          | 03025  |
|             | Connectivity Card        | DTL-1                    |                          | 03026  |
|             | PC Card Adapter          | FLA-15                   |                          | 03012  |
|             | PC Card Adapter          | FLA-15                   |                          | 03014  |
| Accessories | Laptop computer          | Dell Latitude Cpi D300XT | 0009321C-12800-924-1175  | 03015  |
|             | Charger                  | Dell AA 20031 (203cm)    | 16291-91V-0859           | 03016  |
|             | Charger AC cable         |                          |                          |        |
|             | Laptop computer          | Toshiba PA1270E YXCD     | 98037322                 | 03017  |
|             | Charger                  | Toshiba PA 2450U (199cm) | 9905C2264522             | 03018  |
|             | Charger AC cable         |                          |                          |        |
|             | Printer                  | Lexmark 4091-001         | 0049006, FCCID: IYL 2030 | 03033  |
|             | Power supply             | Lexmark AD-2030L         | 97010328647              | 03034  |
|             | Printer cable            | (179cm)                  |                          | 03035  |
|             | Digital camera           | Fuji DS-7                | 7102516                  | 03036  |
|             | Camera cable             | (209cm)                  |                          | 03037  |
|             | Nokia testingboard JTB-8 |                          |                          | 03022  |
|             | Nokia TDC-4 combox       |                          | 3916                     | 03019  |
| Software    | LinkMas.exe              |                          |                          |        |
|             | LinkSla.exe              |                          |                          |        |
|             | Lcitest5.exe             |                          |                          |        |

### 3 SUMMARY OF TEST RESULTS

| Section in CFR 47 |                                                | Result |
|-------------------|------------------------------------------------|--------|
| 15.207            | AC powerline conducted emissions               | PASS   |
| 15.247, a1        | Carrier frequency separation                   | PASS   |
| 15.247, a1ii      | Number of hopping frequencies                  | PASS   |
| 15.247, a1ii      | Time of occupancy                              | PASS   |
| 15.247, a         | 20dB bandwidth                                 | PASS   |
| 15.247, b1        | Peak output power                              | PASS   |
| 15.247, c         | Band-edge compliance of RF conducted emissions | PASS   |
| 15.247, c         | Spurious RF conducted emissions                | PASS   |
| 15.247, c         | Spurious radiated emissions                    | PASS   |

PASS      The EUT passed that particular test.

FAIL      The EUT failed that particular test.

## 4 STANDARDS AND MEASUREMENT METHODS

The tests were performed in guidance of CFR 47 section 15.247, FCC public notice DA 00-705 (March 30, 2000) and ANSI C63.4 (1992). Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method". For the test equipment, see device list in the end of this test report.

### 4.1 Selection of operation mode for tests

Before tests, several operation modes, TX slot lengths and modulation patterns were tried. The worst case was selected for each test and those results reported.

## 5 TEST SETUPS

To fulfill all requirements for the testing, total of three different test setups were used. Four EUTs were used, of which two were unmodified for radiated tests and another two were equipped with an external antenna connector for conductive measurements.

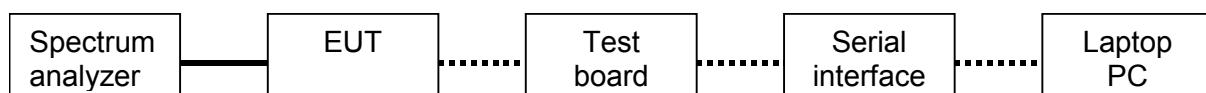
### 5.1 Setup A (conducted measurements, hopping disabled)

#### 5.1.1 Operational description

This setup was used in conducted measurements with hopping disabled. The EUT was inserted in a test board. The test board was connected to a computer using a test board/serial interface. The setup was capable of doing following:

- set the EUT channel (2 – 80)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- select between several different test modulation patterns

#### 5.1.2 Block diagram



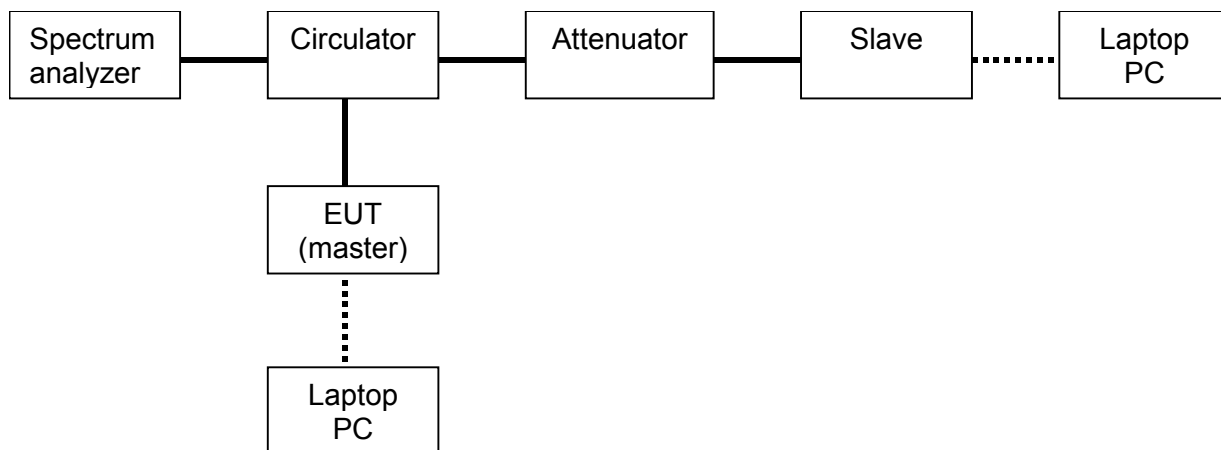
The solid lines are coaxial cables and the dashed lines are either EUT insertion to the test board or control cables between test setup devices. The measurement results were adjusted with the attenuation of the coaxial cable.

## 5.2 Setup B (conducted measurements, hopping enabled)

### 5.2.1 Operational description

This setup was used in conducted measurements with hopping enabled. The EUT (master) was inserted in a laptop PC equipped with a software, which can communicate with another device of same kind (slave).

### 5.2.2 Block diagram



The solid lines are coaxial cables and the dashed lines are either EUT insertion to the test board or control cables between test setup devices.

The circulator forwards the master's TX signal to the spectrum analyzer. The reverse direction of the circulator leaks some of the EUT power through the attenuator to the slave to allow communication. The slave's TX signal is forwarded through the attenuator and circulator to the master.

The reverse attenuation of the circulator was more than 20dB in the operation band of the EUT. The combined attenuation of reversed circulator and step attenuator (set to 40dB) is more than 60dB thus preventing the transmission of the slave from affecting the measurement results.

The attenuation of the coaxial cables, circulator and attenuator were used to adjust the measurement results.

## 5.3 Setup C (radiated measurements, hopping enabled)

### 5.3.1 Operational description

This setup was used in radiated measurements with hopping enabled. The master was inserted in a laptop PC equipped with a software, which could communicate with the slave.

### 5.3.2 Block diagram



The slave was placed far enough from the EUT not to disturb the measurements but still to allow communication with the master.

## 6 TEST RESULTS

### 6.1 AC powerline conducted emissions (§15.207)

|                              |                                                 |        |      |
|------------------------------|-------------------------------------------------|--------|------|
| EUT                          | 03012, 03025                                    |        |      |
| Accessories                  | 03017, 03018, 03033, 03034, 03035, 03036, 03037 |        |      |
| Test setup                   | C                                               |        |      |
| Temp, Humidity, Air Pressure | 18 °C                                           | 45 %RH | mbar |
| Date of measurement          | 4.10.2000                                       |        |      |
| Measured by                  | Asko Välimäki                                   |        |      |
| Result                       | PASS                                            |        |      |

#### 6.1.1 Limit

| Classs B limit       |                 |
|----------------------|-----------------|
| Frequency band (MHz) | Quasi-peak (µV) |
| 0.45 - 30            | 250             |

#### 6.1.2 EUT operation mode

|                       |                        |
|-----------------------|------------------------|
| EUT operation mode    | Data transmission, DM5 |
| EUT channel           | Hopping                |
| EUT TX power level    | Nominal                |
| EUT operation voltage | 110V/60Hz              |

#### 6.1.3 EUT test setup

The EUT was set according to ANSI C63.4-1992, figure 9a.



Picture 1. AC conducted emission measurement setup.

#### 6.1.4 Emission measurement data

The measurement results were adjusted with the attenuation of the cable between the LISN and receiver.

##### Line N

| Freq [MHz] | Pk [uV] | QP [uV] | Av [uV] |
|------------|---------|---------|---------|
| 2.758      | 85.7    | 52.6    | 27.0    |
| 3.01       | 67.4    | 54.8    | 27.4    |
| 1.082      | 56.4    | 52.6    | 38.7    |
| 1.478      | 63.2    | 56.7    | 51.8    |
| 2.462      | 62.2    | 55.1    | 39.7    |
| 2.166      | 65.2    | 56.3    | 47.3    |

##### LINE L

| Freq [MHz] | Pk [uV] | QP [uV] | Av [uV] |
|------------|---------|---------|---------|
| 2.462      | 62.2    | 54.1    | 38.3    |
| 2.266      | 60.3    | 49.4    | 39.6    |
| 2.858      | 52.8    | 51.1    | 43.2    |
| 2.562      | 61.2    | 52.5    | 47.8    |
| 1.478      | 64.2    | 57.4    | 51.3    |
| 3.154      | 51.9    | 44.3    | 32.5    |

## 6.2 Carrier frequency separation (§15.247a1)

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | B            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 26.9.2000    |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

### 6.2.1 EUT operation mode

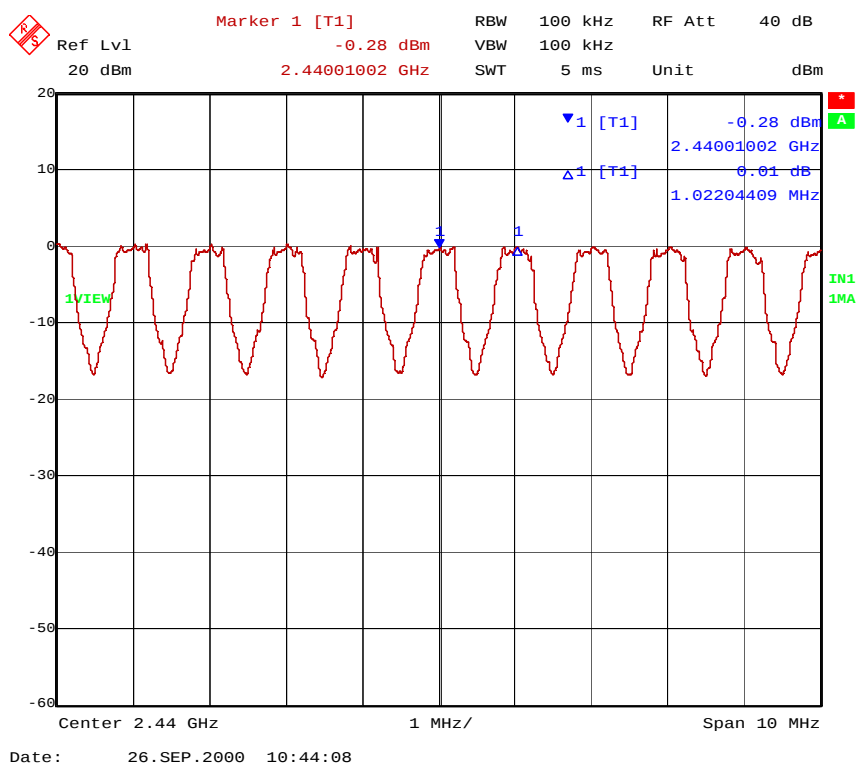
|                    |                        |
|--------------------|------------------------|
| EUT operation mode | Data transmission, DM5 |
| EUT channel        | Hopping                |
| EUT TX power level | Nominal                |

### 6.2.2 Limits and results

#### Carrier frequency separation

| Limit (MHz) | Result (MHz) |
|-------------|--------------|
| ≥ 0.1       | 1.022        |

### 6.2.3 Screen shot



Picture 2. Carrier frequency separation between channels 40 and 41

## 6.3 Number of hopping frequencies (§15.247a2)

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | B            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 26.9.2000    |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | PASS         |        |      |

### 6.3.1 EUT operation mode

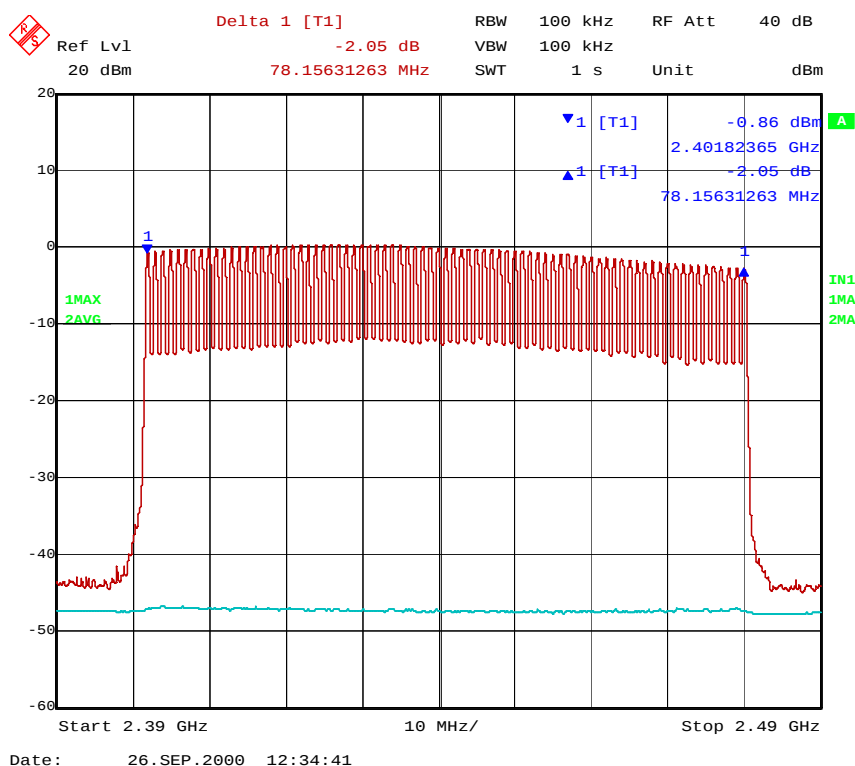
|                    |                        |
|--------------------|------------------------|
| EUT operation mode | Data transmission, DM5 |
| EUT channel        | Hopping                |
| EUT TX power level | Nominal                |

### 6.3.2 Limits and results

#### Number of hopping frequencies

| Number | Measured value |
|--------|----------------|
| ≥ 75   | 79             |

### 6.3.3 Screen shot



Picture 3. Number of hopping frequencies

**6.4 Time of occupancy (§15.247a3)**

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | B            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 26.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

**6.4.1 EUT operation mode**

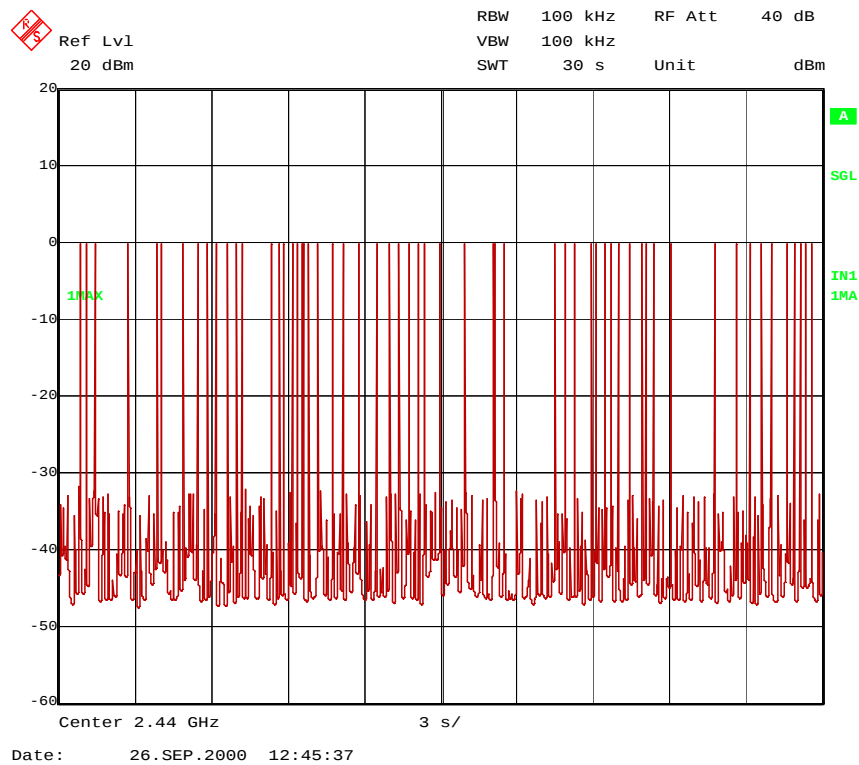
|                    |                        |
|--------------------|------------------------|
| EUT operation mode | Data transmission, DM5 |
| EUT channel        | Hopping                |
| EUT TX power level | Nominal                |

**6.4.2 Limits and results****Time of occupancy**

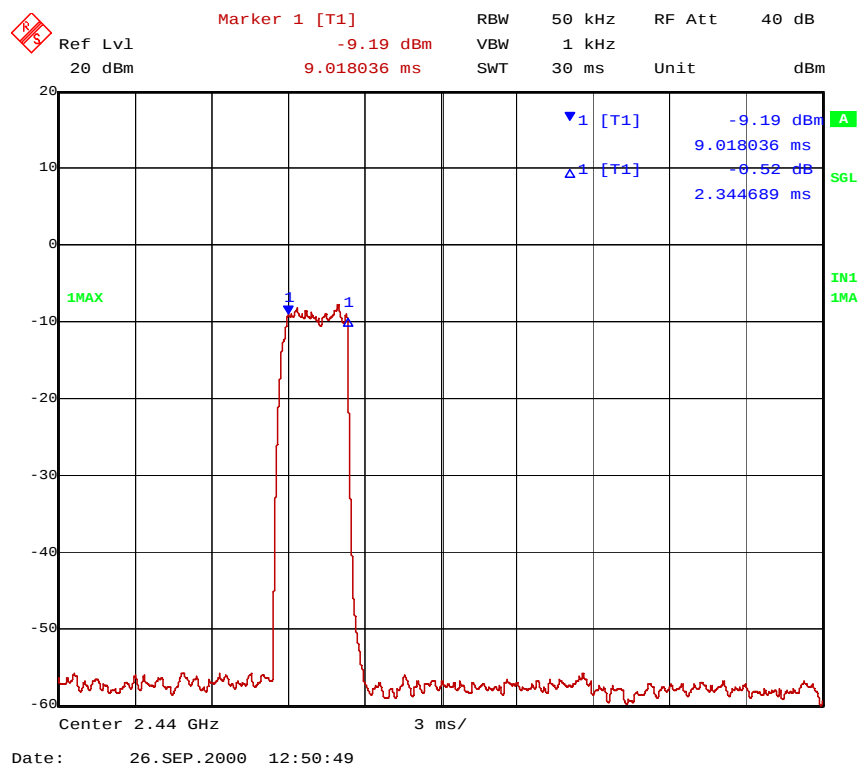
| Limit (s) | Measured value (s) |
|-----------|--------------------|
| ≤ 0.4     | 0.1336             |

In measurement time of 30s, total of 57 transmissions occurred. The duration of one transmission was 2.344689ms.  $57 * 2.344689 = 133.6\text{ms}$ .

### 6.4.3 Screen shots



Picture 4. Number of transmissions on channel 40



Picture 5. Duration of one transmission on channel 40

**6.5 20dB bandwidth (§15.247a1)**

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | A            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 27.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

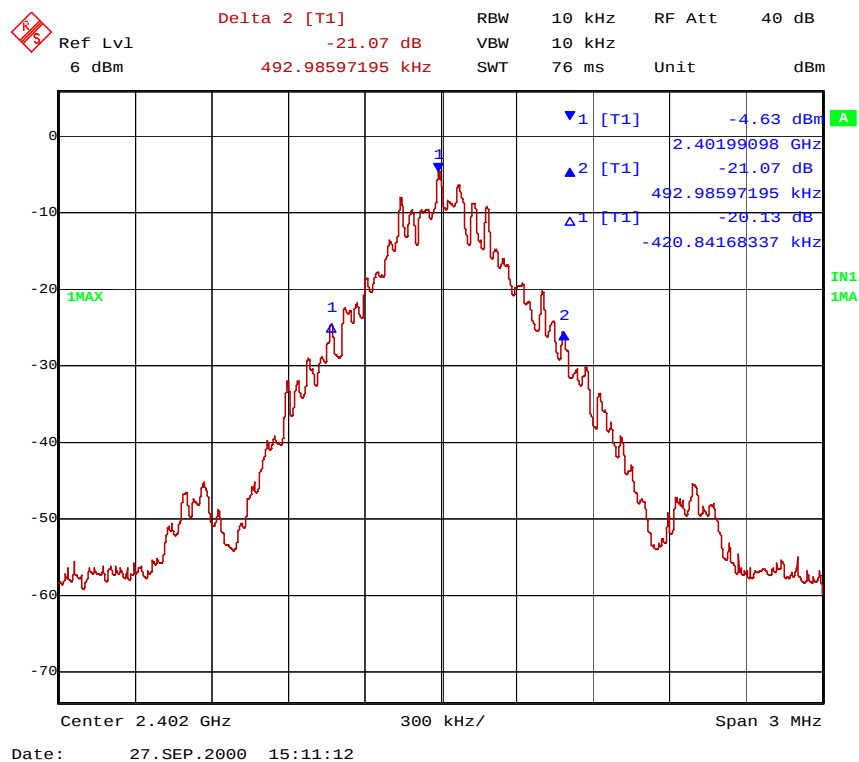
**6.5.1 EUT operation mode**

|                    |                                                                                          |
|--------------------|------------------------------------------------------------------------------------------|
| EUT operation mode | Hopping disabled, alternation of TX and RX. TX using 5 time slots with PRBS9 modulation. |
| EUT channel        | 2, 40, 80                                                                                |
| EUT TX power level | Nominal (0dBm)                                                                           |
| Operation voltage  | Nominal                                                                                  |

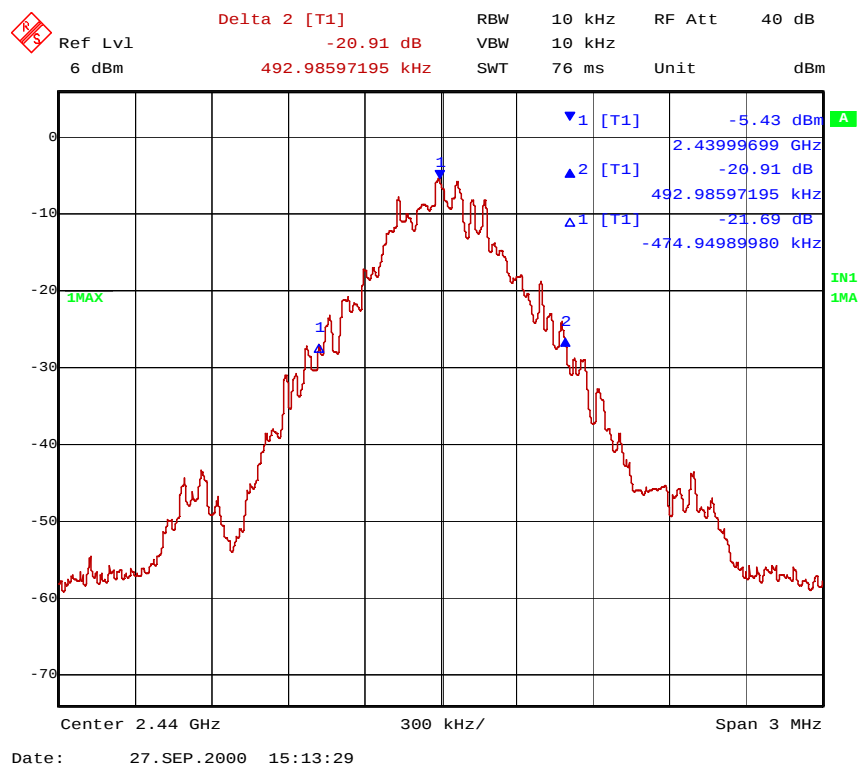
**6.5.2 Limits and results**

| 20dB bandwidth |             |                      |
|----------------|-------------|----------------------|
| EUT Channel    | Limit (MHz) | Measured value (MHz) |
| 2              | ≤1.0        | 0.9138               |
| 40             |             | 0.9679               |
| 80             |             | 0.9438               |

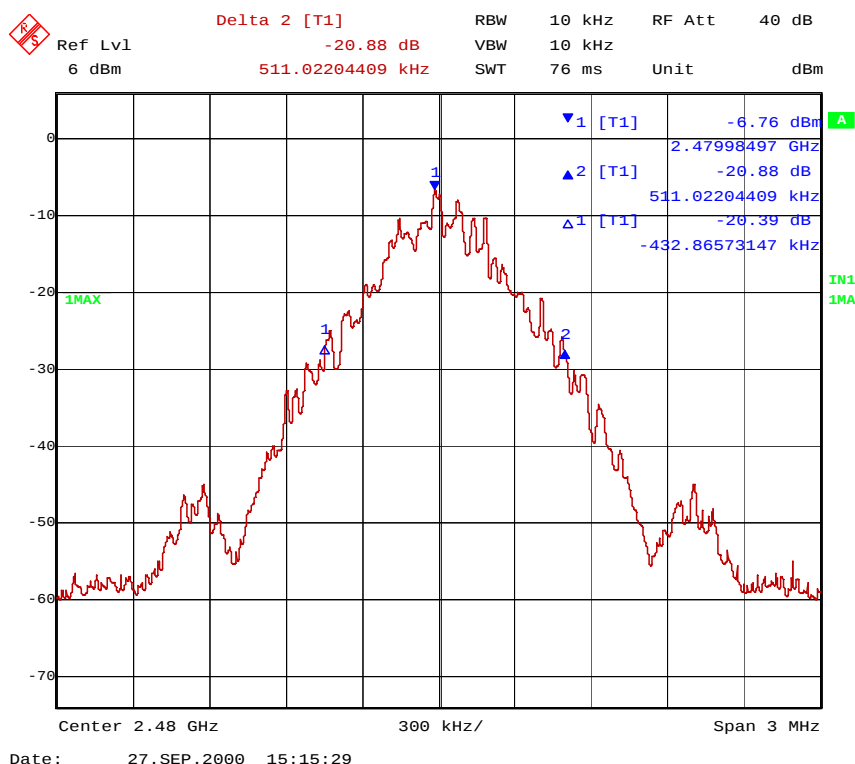
### 6.5.3 Screen shots



Picture 6. 20dB bandwidth, channel 2



Picture 7. 20dB bandwidth, channel 40



Picture 8. 20dB bandwidth, channel 80

6.6 Peak output power (§15.247b1)

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | A            |        |      |
| Temp, Humidity, Air Pressure | 18 °C        | 42 %RH | mbar |
| Date of measurement          | 28.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | PASS         |        |      |

6.6.1 EUT operation mode

|                    |                                                                                          |
|--------------------|------------------------------------------------------------------------------------------|
| EUT operation mode | Hopping disabled, alternation of TX and RX. TX using 5 time slots with PRBS9 modulation. |
| EUT channel        | 2, 40, 80                                                                                |
| EUT TX power level | Nominal (0dBm)                                                                           |
| Operation voltage  | Nominal                                                                                  |

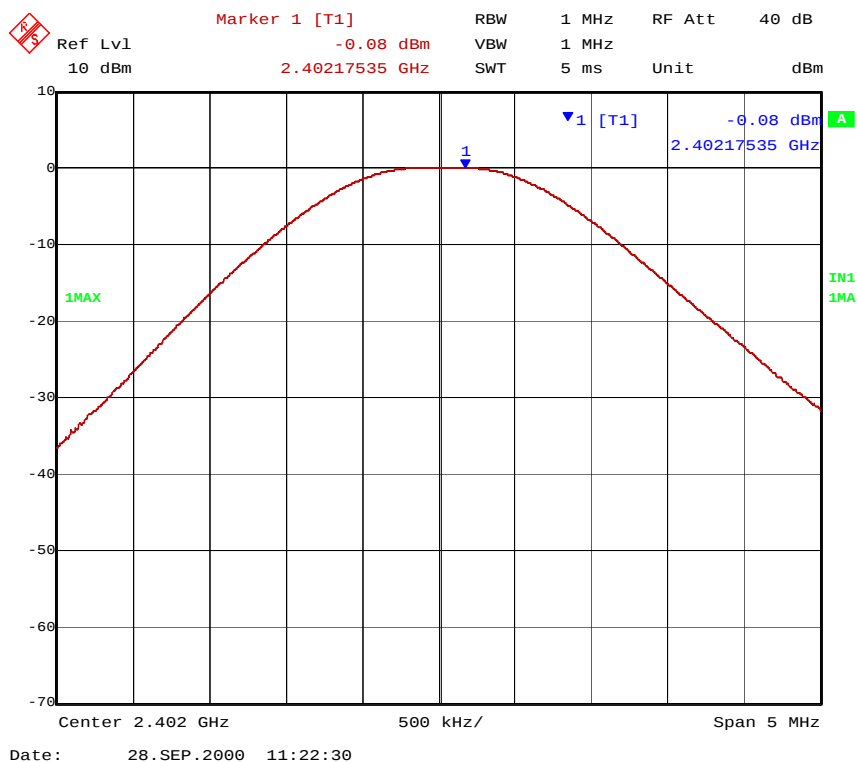
## 6.6.2 Limits and results

### Peak output power

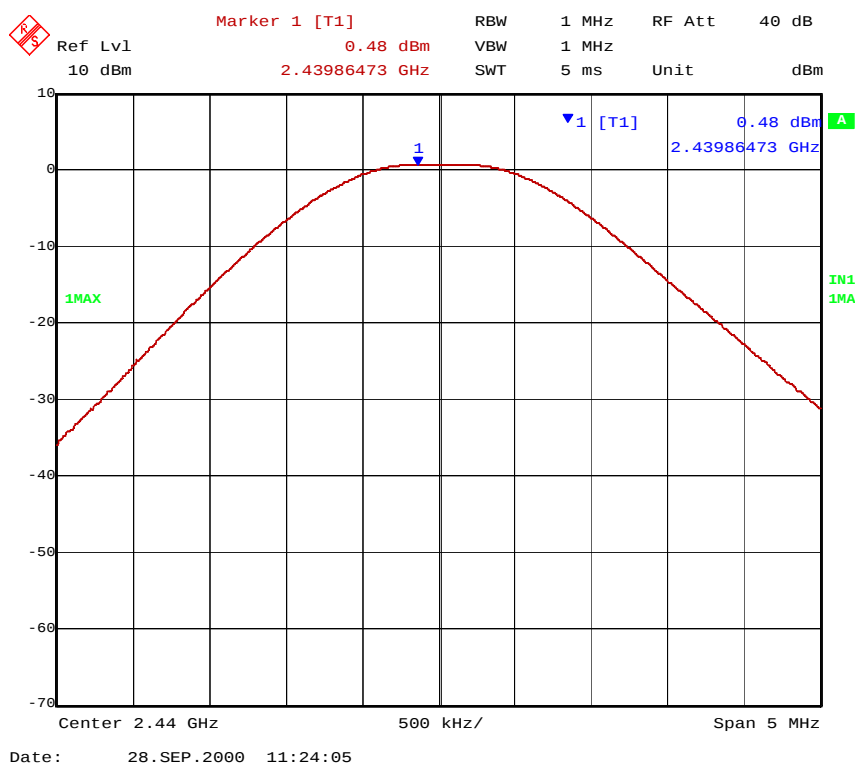
| EUT Channel | Limit (W) | Test result (W) |
|-------------|-----------|-----------------|
| 2           | $\leq 1$  | 0.00124         |
| 40          |           | 0.00141         |
| 80          |           | 0.00088         |

| EUT channel | Measured value [dBm] | Cable attenuation [dB] | Power output [dBm] | Power output [W] |
|-------------|----------------------|------------------------|--------------------|------------------|
| 2           | -0.08                | 0.2                    | 0.12               | 0.00103          |
| 40          | 0.42                 | 0.2                    | 0.62               | 0.00115          |
| 80          | -1.57                | 0.2                    | -1.37              | 0.00073          |

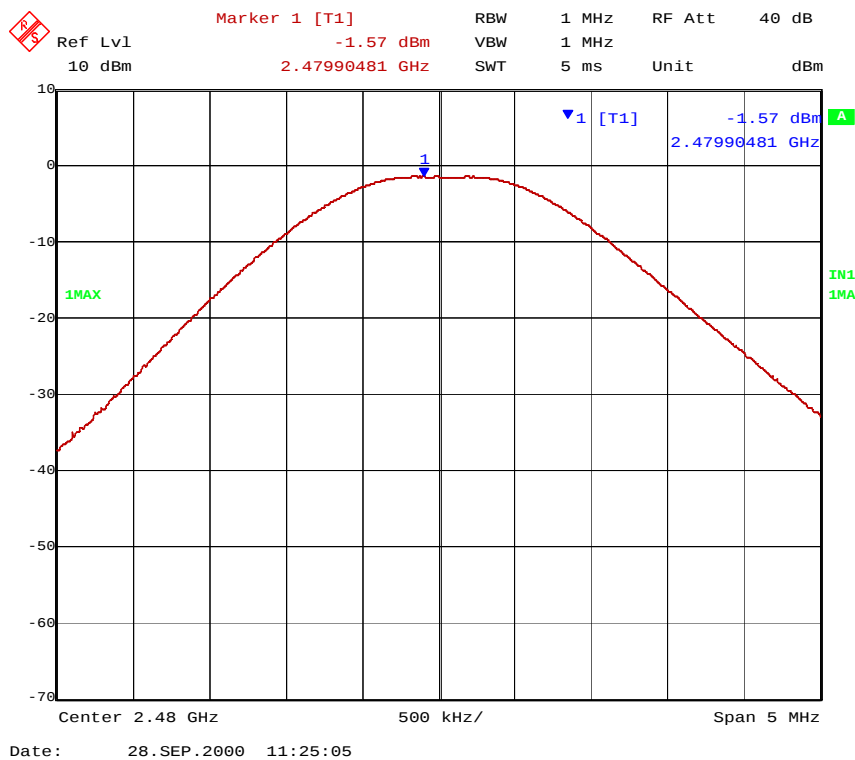
## 6.6.3 Screen shots



Picture 9. Peak output power on channel 2



Picture 10. Peak output power on channel 40



Picture 11. Peak output power on channel 80

## 6.7 Band-edge compliance of RF conducted emissions (§15.247c1)

### 6.7.1 Hopping enabled

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | B            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 26.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

#### 6.7.1.1 EUT operation mode

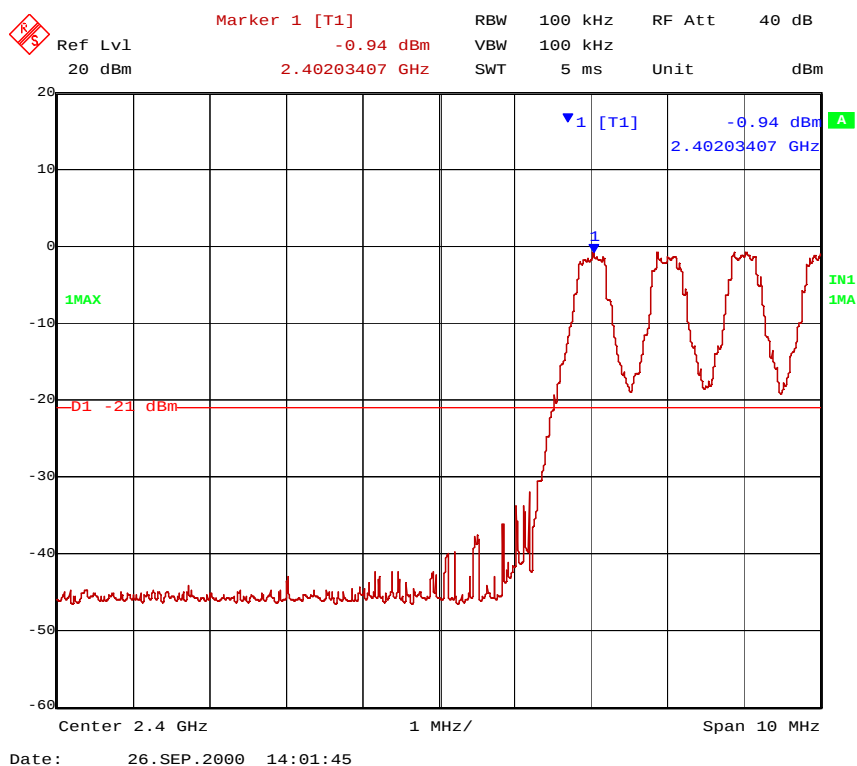
|                    |                        |
|--------------------|------------------------|
| EUT operation mode | Data transmission, DM5 |
| EUT channel        | Hopping                |
| EUT TX power level | Nominal                |

#### 6.7.1.2 Limits and results

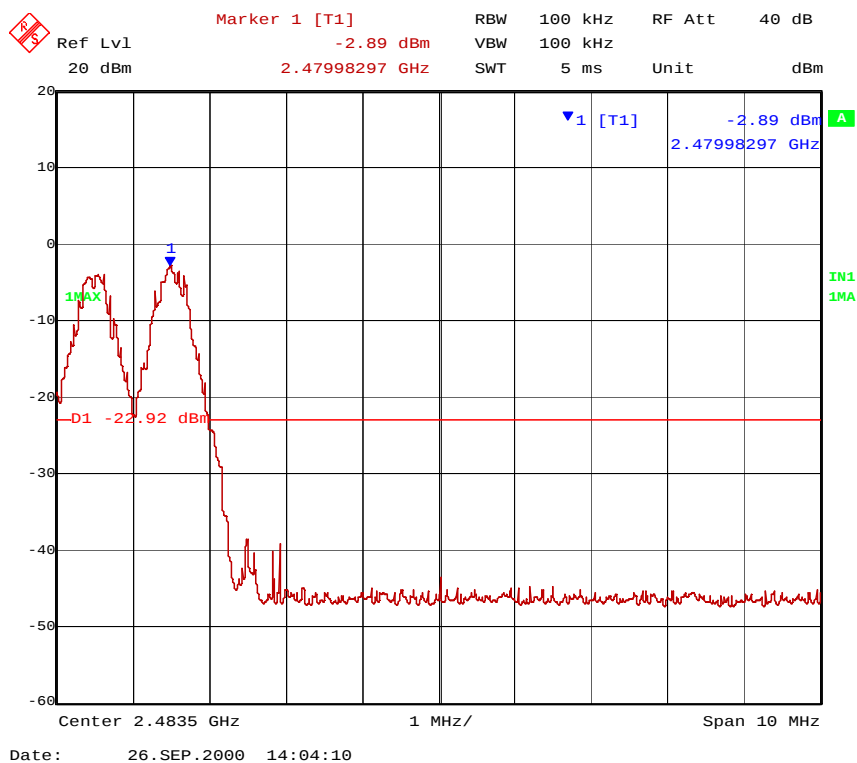
##### Bandedge compliance

| Channel | Limit (dBc) | Result (dBc) |
|---------|-------------|--------------|
| 2       | ≤ -20       | < -40        |
| 80      |             | < -40        |

### 6.7.1.3 Screen shots



Picture 12. Bandedge compliance, channel 2



Picture 13. Bandedge compliance, channel 80

## 6.7.2 Hopping disabled

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | A            |        |      |
| Temp, Humidity, Air Pressure | 19 °C        | 42 %RH | mbar |
| Date of measurement          | 27.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

### 6.7.2.1 Test method

The test is made according to ANSI C63.4 (1992).

### 6.7.2.2 EUT operation mode

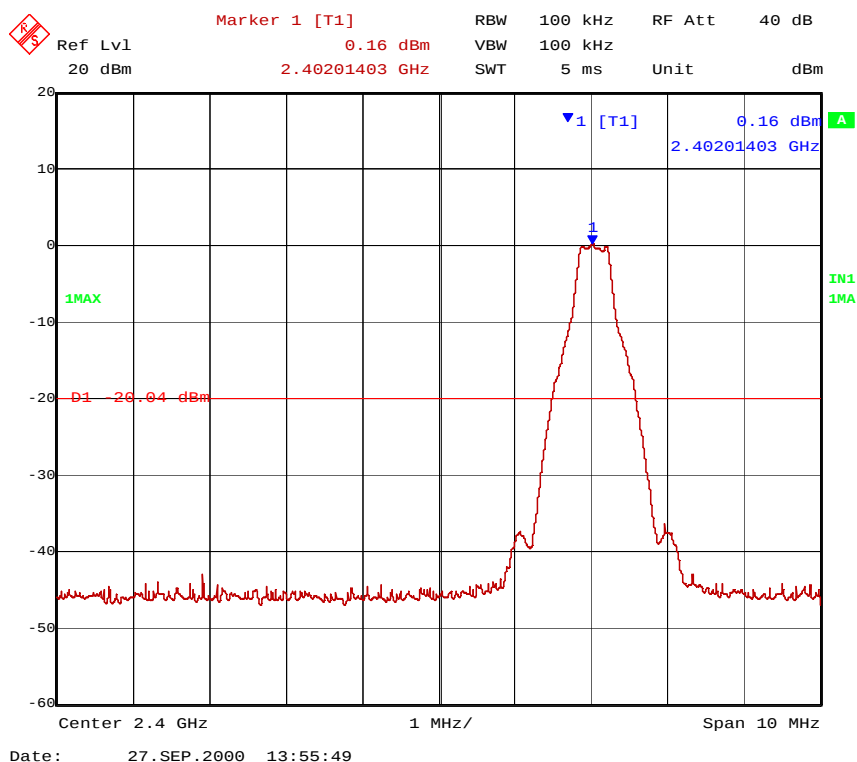
|                    |                                                                                          |
|--------------------|------------------------------------------------------------------------------------------|
| EUT operation mode | Hopping disabled, alternation of TX and RX. TX using 5 time slots with PRBS9 modulation. |
| EUT channel        | 2, 80                                                                                    |
| EUT TX power level | Nominal                                                                                  |

### 6.7.2.3 Limits and results

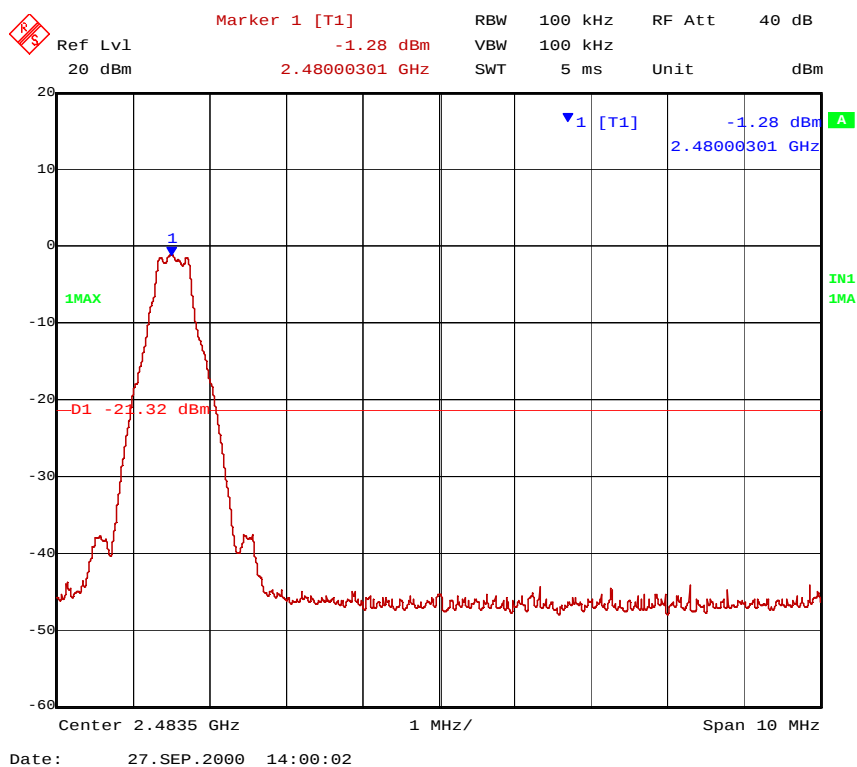
#### Bandedge compliance

| Channel | Limit (dBc) | Result (dBc) |
|---------|-------------|--------------|
| 2       | ≤ -20       | < -40        |
| 80      |             | < -40        |

## 6.7.2.4 Screen shots



Picture 14. Bandedge compliance, channel 2



Picture 15. Bandedge compliance, channel 80

## 6.8 Spurious RF conducted emissions (§15.247c2)

|                              |              |        |      |
|------------------------------|--------------|--------|------|
| EUT                          | 03011, 03012 |        |      |
| Test setup                   | A            |        |      |
| Temp, Humidity, Air Pressure | 18 °C        | 42 %RH | mbar |
| Date of measurement          | 28.09.2000   |        |      |
| Measured by                  | Tero Huhtala |        |      |
| Result                       | <b>PASS</b>  |        |      |

### 6.8.1 EUT operation mode

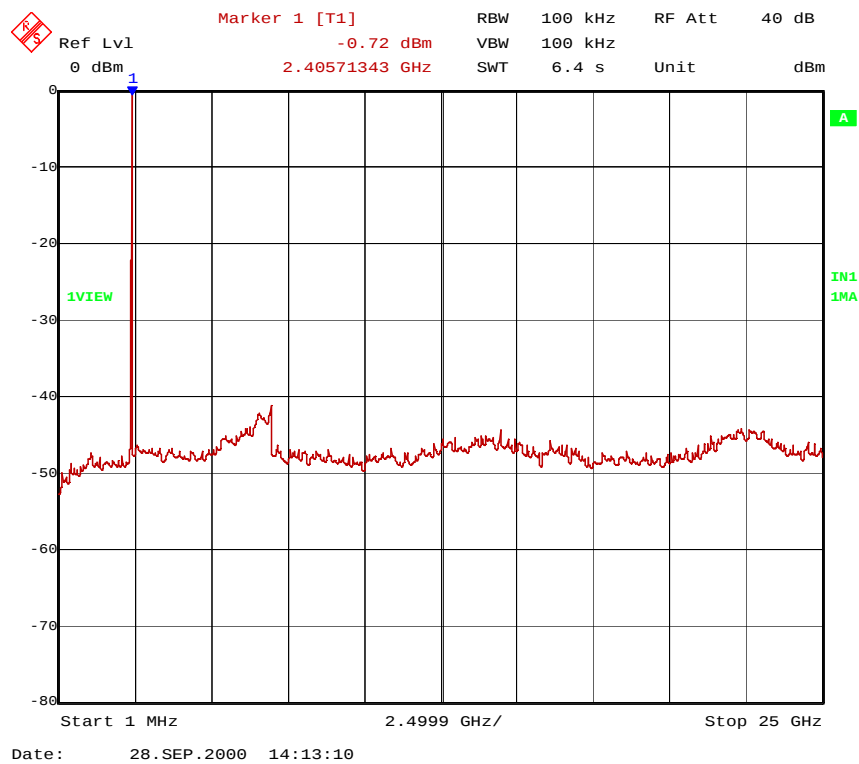
|                    |                                                                                          |
|--------------------|------------------------------------------------------------------------------------------|
| EUT operation mode | Hopping disabled, alternation of TX and RX. TX using 5 time slots with PRBS9 modulation. |
| EUT channel        | 2, 40, 80                                                                                |
| EUT TX power level | Nominal                                                                                  |

### 6.8.2 Limits and results

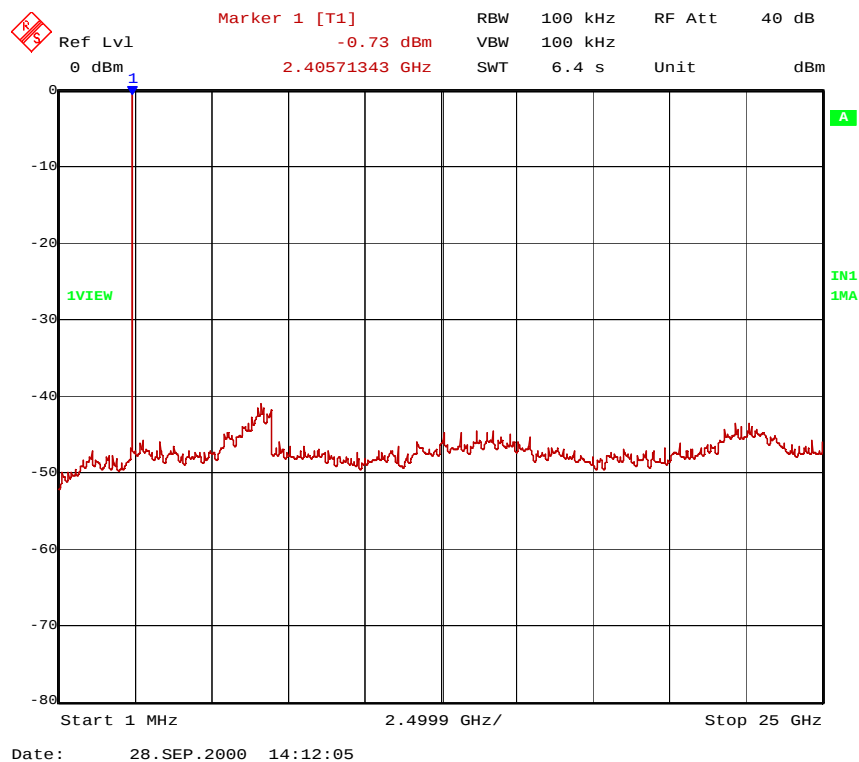
#### Spurious RF conducted emissions

| EUT Channel | Limit (dBc) | Result (dBc) |
|-------------|-------------|--------------|
| 2           | ≤ -20       | ≤ -40        |
| 40          |             | ≤ -40        |
| 80          |             | ≤ -40        |

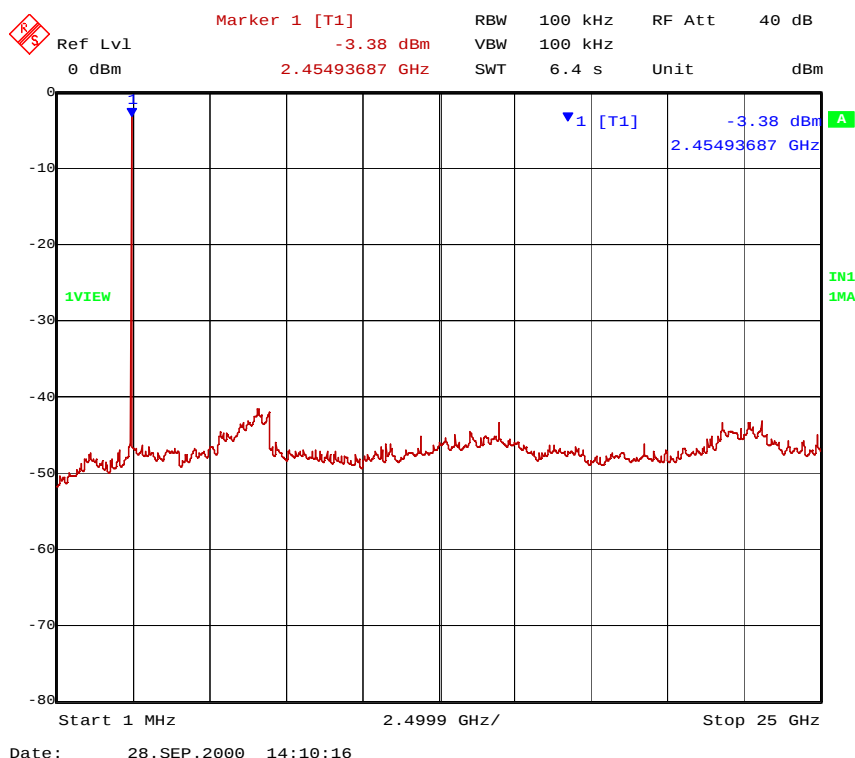
### 6.8.3 Screen shots



Picture 16. Spurious RF conducted emissions, TX on channel 2



Picture 17. Spurious RF conducted emissions, TX on channel 40



Picture 18. Spurious RF conducted emissions, TX on channel 80

## 6.9 Spurious radiated emissions (§15.247c1)

|                              |                    |
|------------------------------|--------------------|
| EUT                          | 03012, 03025       |
| Accessories                  | 03015, 03016       |
| Test setup                   | C                  |
| Temp, Humidity, Air Pressure | 22 °C 42 %RH mbar  |
| Date of measurement          | 11. - 12.10.2000   |
| Measured by                  | Asko Välimäki      |
| Result                       | <b>PASS (Note)</b> |

Note: At 422.76MHz there is a spike exceeding the limit line by 0.85dB. The measurement was repeated with another computer hosting the EUT. In that comparison measurement the spike had disappeared. It is obvious, that the emission came from the computer, not the EUT itself. For that reason the EUT passes the test.

### 6.9.1 Test method and level, 30MHz - 1GHz

The test was made according to ANSI C63.4 (1992) with following exceptions and additions:

- 1) The measurement was made in semi-anechoic chamber at measurement distance of 3m. The chamber had ferrite and absorber lining in all walls and ceiling, the floor was metal covered.
- 2) The measurement was divided in two parts; prescan and final measurement.

**6.9.1.1 Prescan**

- a) The EUT was set on the turntable and measuring antenna in horizontal polarization at 1m.
- b) The turntable was set to 0 degrees.
- c) The receiver was set to record the maximum level using peak detector.
- d) The antenna was raised from 1m to 4m in 1 meter steps.
- e) For each antenna height the table was rotated full turn in 45 degree steps.
- f) Antenna polarization was changed to vertical and phases b - e repeated.
- g) All suspect frequencies were recorded in a file.
- h) At every suspect frequency the turntable was rotated around, antenna scanned and the polarization changed to find the maximum levels.
- i) If there were any emissions closer than 10dB to the limit line, the final measurement was done.

**6.9.1.2 Final measurement**

- a) The final measurement was run at suspect frequencies only using quasi-peak detector.
- b) The turntable was rotated full turn to find out the worst azimuth.
- c) On those azimuths obtained in b, the antenna was scanned from 1m to 4m to find out the worst elevation.
- d) Phases b and c were repeated with another antenna polarization.
- e) Obtained quasi-peak values were reported

**6.9.2 Test method and level, 1GHz - 18GHz**

The test was made according to ANSI C63.4 (1992) with following exceptions and additions:

- 3) The measurement was made in semi-anechoic chamber at measurement distance of 1m. The chamber had ferrite and absorber lining in all walls and ceiling, the floor was metal covered.
- 4) The measurement was divided in two parts; prescan and final measurement.

**6.9.2.1 Prescan**

- j) The EUT was set on the turntable and measuring antenna in horizontal polarization at 1m.
- k) The turntable was set to 0 degrees.
- l) The receiver was set to record the maximum level using peak detector.
- m) The table was rotated full turn.
- n) Antenna polarization was changed to vertical and phases k - m repeated.
- o) All suspect frequencies were recorded in a file.

**6.9.2.2 Final measurement**

- f) The final measurement was run at suspect frequencies only with antenna in horizontal polarization.
- p) The receiver was set to record the maximum level using peak detector.
- g) At every suspect frequency (or frequency band), the turntable was rotated full turn to find out the worst azimuth.
- h) Phase g was repeated with vertical antenna polarization.
- i) Obtained values were recorded.

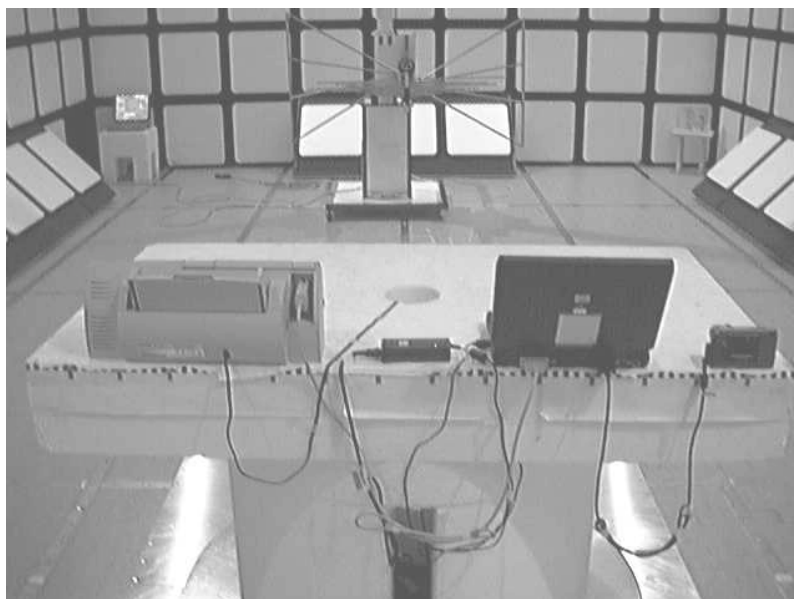
**Class B limit (3m measuring distance)**

| Frequency band (MHz) | Limit (µV/m) | Detector |
|----------------------|--------------|----------|
| 30 – 88              | 100          | QP       |
| 88-216               | 150          | QP       |
| 230-960              | 200          | QP       |
| 960-1000             | 500          | QP       |
| 1000-18000           | 500          | Av       |

### 6.9.3 EUT operation mode

|                       |                        |
|-----------------------|------------------------|
| EUT operation mode    | Data transmission, DM5 |
| EUT channel           | Hopping                |
| EUT TX power level    | Nominal                |
| EUT operation voltage | 110V/60Hz              |

### 6.9.4 EUT test setup



Picture 19. Radiated emission measurement setup

Note: The setup in picture 19 was used in radiated emission measurement between 30MHz and 1GHz. For measurements above 1GHz all accessories were removed, only the PC and EUT were left on the table. The charger was placed at the floor level on the turntable. That was to allow the EUT to radiate it's maximum power without being attenuated or blocked by the surrounding accessories.

### 6.9.5 Emission measurement data, 30MHz - 1GHz

The measurement results were obtained as described below.

$$E[uV/m] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

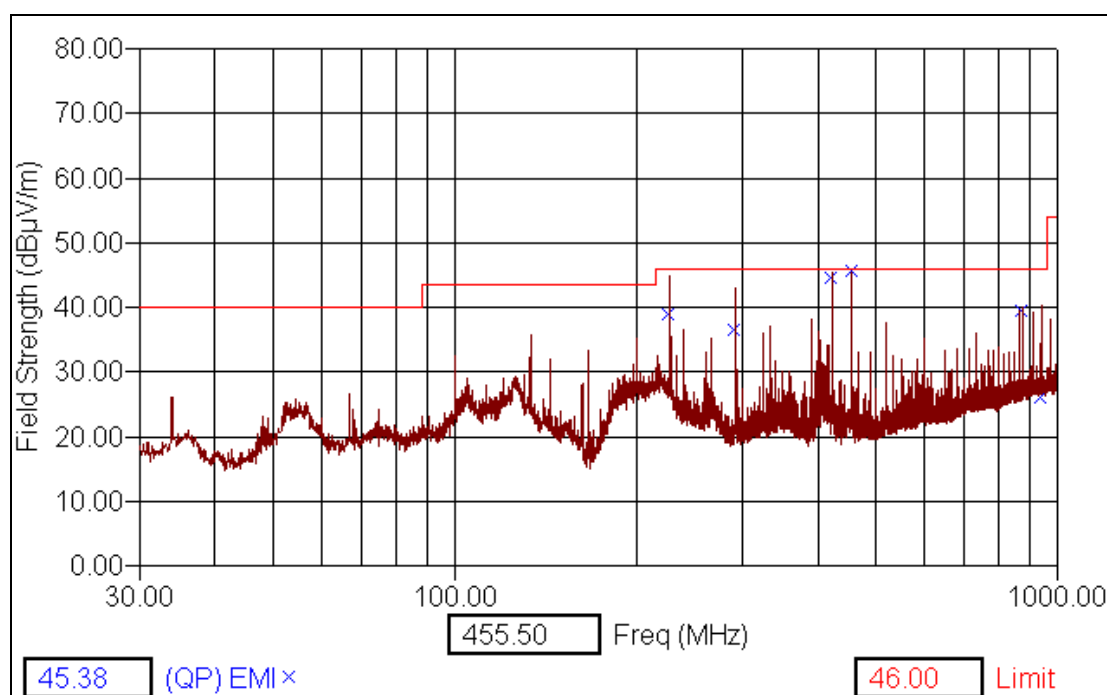
Where

$U_{RX}$  receiver reading

$A_{CABLE}$  Attenuation of the cable

$AF$  Antenna factor

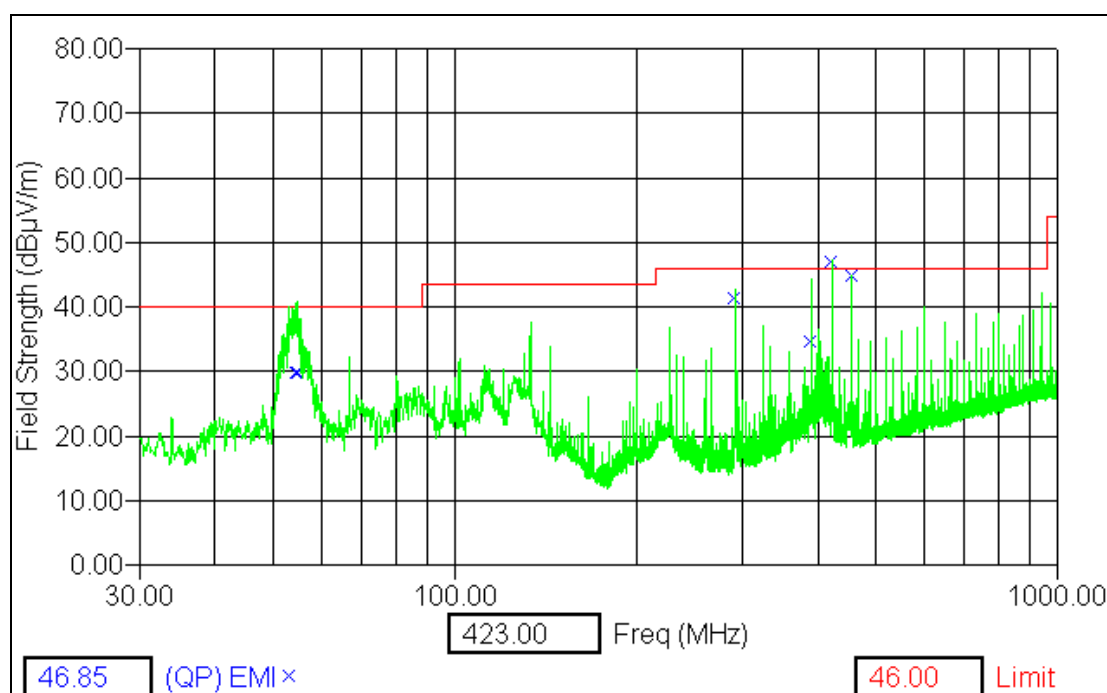
$G_{PREAMP}$  Gain of the preamplifier



Picture 20. Radiated emissions, horizontal polarization

| Freq (Max)<br>(MHz) | [QP] EMI<br>(dBμV/m) | Limit<br>(dBμV/m) | [QP] Marg<br>(dB) | Ttbl Agl<br>(deg) | Twr Ht<br>(cm) | Pol. |
|---------------------|----------------------|-------------------|-------------------|-------------------|----------------|------|
| 227.65              | 38.67                | 46.00             | -7.33             | 98.00             | 135.00         | H    |
| 292.70              | 36.34                | 46.00             | -9.66             | 297.00            | 101.00         | H    |
| 422.79              | 44.40                | 46.00             | -1.60             | 285.00            | 185.00         | H    |
| 455.30              | 45.38                | 46.00             | -0.62             | 154.00            | 185.00         | H    |
| 878.10              | 39.45                | 46.00             | -6.55             | 276.00            | 175.00         | H    |
| 943.43              | 25.70                | 46.00             | -20.30            | 183.00            | 115.00         | H    |

Table 1. Highest emissions, horizontal polarization



Picture 21. Radiated emissions, vertical polarization

| Freq (Max)<br>(MHz) | (QP) EMI<br>(dBµV/m) | Limit<br>(dBµV/m) | (QP) Margin<br>(dB) | Ttbl Agl<br>(deg) | Twr Ht<br>(cm) |
|---------------------|----------------------|-------------------|---------------------|-------------------|----------------|
| 54.47               | 29.77                | 40.00             | -10.23              | 1.00              | 163.00         |
| 55.23               | 29.73                | 40.00             | -10.27              | 9.00              | 152.00         |
| 292.71              | 40.97                | 46.00             | -5.03               | 314.00            | 171.00         |
| 390.26              | 34.59                | 46.00             | -11.41              | 101.00            | 145.00         |
| 422.76              | 46.85                | 46.00             | 0.85                | 197.00            | 143.00         |
| 455.30              | 44.56                | 46.00             | -1.44               | 190.00            | 200.00         |

Table 2. Highest emissions, vertical polarization

### 6.9.6 Emission measurement data, 1GHz - 18GHz

The measurement results were obtained as described below.

$$E[uV / m] = U_{RX} + A_{CABLE} + AF - G_{PREAMP} - C_{DISTANCE}$$

Where

$U_{RX}$  receiver reading

$A_{CABLE}$  Attenuation of the cable

$AF$  Antenna factor

$G_{PREAMP}$  Gain of the preamplifier

$C_{DISTANCE}$  Conversion factor from 3m to 1m measurement distance

| Freq [GHz]       | U <sub>RX</sub> [dBuV] | A <sub>CABLE</sub> [dB] | AF [1/m] | G <sub>PREAMP</sub> [dB] | C <sub>DISTANCE</sub> [dB] | E [dBuV] | E [uV/m] | Limit [uV/m] |
|------------------|------------------------|-------------------------|----------|--------------------------|----------------------------|----------|----------|--------------|
| Restricted bands |                        |                         |          |                          |                            |          |          |              |
| 17.776500        | 21.99                  | 5.88                    | 44.60    | 31.60                    | 9.54                       | 31.33    | 36.86    | 500          |
| 1.681000         | 44.43                  | 0.56                    | 26.10    | 37.10                    | 9.54                       | 24.45    | 16.69    | 500          |
| 1.645533         | 44.88                  | 0.56                    | 25.60    | 37.10                    | 9.54                       | 24.40    | 16.60    | 500          |
| Harmonics        |                        |                         |          |                          |                            |          |          |              |
| 4.852400         | 54.71                  | 1.44                    | 33.20    | 34.10                    | 9.54                       | 45.71    | 192.97   | 500          |
| 4.848400         | 54.10                  | 1.44                    | 33.20    | 34.10                    | 9.54                       | 45.10    | 179.89   | 500          |
| 4.844600         | 53.82                  | 1.44                    | 33.20    | 34.10                    | 9.54                       | 44.82    | 174.18   | 500          |
| Band edge        |                        |                         |          |                          |                            |          |          |              |
| 2.389300         | 63.17                  | 1.10                    | 28.30    | 35.30                    | 9.54                       | 47.73    | 243.50   | 500          |
| 2.485530         | 66.76                  | 1.10                    | 28.30    | 35.30                    | 9.54                       | 51.32    | 368.13   | 500          |
| Fundamental      |                        |                         |          |                          |                            |          |          |              |
| 2.402000         | 110.56                 | 1.10                    | 28.30    | 35.30                    | 9.54                       | 95.12    | 57016.43 |              |
| 2.440000         | 110.41                 | 1.10                    | 28.30    | 35.30                    | 9.54                       | 94.97    | 56040.24 |              |
| 2.480000         | 108.54                 | 1.10                    | 28.30    | 35.30                    | 9.54                       | 93.10    | 45185.59 |              |

Notes: For the measurements above 1GHz, following arrangements were done:

- 1) Only peak detector was used
- 2) The measurement bandwidth was decreased to 3kHz to make it possible to find the emissions.
- 3) All spikes visibly out of the noise floor were recorded and later maximized by the procedure described in 6.9.2.
- 4) The highest fundamentals, harmonics, restricted band emissions and spurious emissions were reported.

## 7 TEST EQUIPMENT

15.247, a (20dB bandwidth), 15.247, b1 (Peak output power), 15.247, c (Band-edge compliance of RF conducted emissions), 15.247, c (Spurious RF conducted emissions)

| Equipment     | Type            | Manufacturer  | Device number |
|---------------|-----------------|---------------|---------------|
| EMI receiver  | ESI 40          | Rohde&Schwarz | 38845         |
| Circulator    | 4923            | Narda         | 39283         |
| Coaxial cable | SMA male/N male | Own           | C             |

15.247, a1 (Carrier frequency separation), 15.247, a1ii (Number of hopping frequencies), 15.247, a1ii (Time of occupancy), 15.247, c (Band-edge compliance of RF conducted emissions)

| Equipment    | Type   | Manufacturer  | Device number |
|--------------|--------|---------------|---------------|
| EMI receiver | ESI 40 | Rohde&Schwarz | 38845         |
| Circulator   | 4923   | Narda         | 39283         |

|               |                   |                 |       |
|---------------|-------------------|-----------------|-------|
| Attenuator    | 8496A             | Hewlett-Packard | 22901 |
| Coaxial cable | SMA male/SMA male | Own             | A     |
| Coaxial cable | SMA male/N male   | Own             | C     |

## 15.247, c (Spurious radiated emissions)

| Equipment                                                                                                      | Type                                    | Manufacturer            | Device number |
|----------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------------------|---------------|
| 3m semi-anechoic Chamber                                                                                       |                                         | TDK                     | 30599         |
| EMI Receiver                                                                                                   | 8546A                                   | HP                      | 26518         |
| RF Filter Section                                                                                              | 85460A                                  | HP                      | 26517         |
| Biconilog antenna                                                                                              | 3142                                    | EMCO                    | 26502         |
| Preamplifier                                                                                                   | 8447F                                   | HP                      | 26503         |
| Computer, equipped with:<br>- Standard emission software<br>- GPIB interface card                              | ErgoPro<br>STD_EMI v6.20<br>NI_TNT_GPIB | Fujitsu-ICL<br>EA<br>NI | 25610         |
| System Interface, including:<br>- Remote switch interface<br>- Remote switch module<br>- RF coaxial switch set | SI200<br>P196X2-SW<br>RSM-01<br>ISM-01  | EA<br>EA<br>EA<br>EA    | 26506         |
| Mast/turntable controller                                                                                      | HD-100                                  | Deisel                  | 30642         |
| Antenna Mast                                                                                                   | MA240                                   | Deisel                  | 26501         |
| Turndisk                                                                                                       | DS412                                   | Deisel                  | 26500         |

## 15.247, c (Spurious radiated emissions)

| Equipment                 | Type            | Manufacturer | Device number |
|---------------------------|-----------------|--------------|---------------|
| 3m semi-anechoic Chamber  |                 | TDK          | 30599         |
| Spectrum analyzer         | 8593EM          | HP           | 24778         |
| Horn antenna              | 3115            | EMCO         | 26497         |
| Preamplifier              | 8449B           | HP           | 26504         |
| Mast/turntable controller | HD-100          | Deisel       | 30642         |
| Turndisk                  | DS412           | Deisel       | 26500         |
| Coaxial cable             | SMA male/N male | Own          | C             |
| Coaxial cable             | SMA male/N male | Own          | B             |

## 15.207 (AC powerline conducted emissions)

| Equipment     | Type          | Manufacturer  | Device number |
|---------------|---------------|---------------|---------------|
| EMI receiver  | ESI 40        | Rohde&Schwarz | 38845         |
| LISN          | L2-16         | PMM           | 30636         |
| LISN          | L2-16         | PMM           | 30637         |
| Coaxial cable | N male/N male | Own           | FCC LISN      |