

# ENGINEERING TEST REPORT



## 2.4 GHz Cordless Telephone MODEL: CLT-W10, CLT-W20, CLT-W25

FCC ID: MBH-CLTWXX

*Applicant:*

**SANYO Canada Inc.**  
1-300 Applewood Crescent  
Concord, Ontario  
Canada, L4K 5C7

*In Accordance With*

**Federal Communications Commission (FCC)**  
**Part 15, Subpart C, Section 15.247**  
**Frequency Hopping Spread Spectrum Transmitters**  
**Operating in the 2400 - 2483.5 MHz Band**

UltraTech's File No.: SAN-097F15C247

This Test report is Issued under the Authority of  
Tri M. Luu, Professional Engineer,  
Vice President of Engineering  
UltraTech Group of Labs

Date: June 24, 2004



Report Prepared by: Dan Huynh

Tested by: Mr. Hung Trinh, EMC/RFI Technician

Issued Date: June 24, 2004

Test Dates: March 30 – May 27, 2004

- The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
- This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.

## UltraTech

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## EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Description             | Description of Contents   | Quality Check (OK) |
|-----------|-------------------------|---|--------------------|
| --        | Test Report             | <ul style="list-style-type: none"><li>Exhibit 1: Submittal check lists</li><li>Exhibit 2: Introduction</li><li>Exhibit 3: Performance Assessment</li><li>Exhibit 4: EUT Operation and Configuration during Tests</li><li>Exhibit 5: Summary of test Results</li><li>Exhibit 6: Measurement Data</li><li>Exhibit 7: Measurement Uncertainty</li><li>Exhibit 8: Measurement Methods</li></ul> | OK                 |
| 1         | Test Setup Photos       | Radiated Emissions Setup Photos   | OK                 |
| 2         | External EUT Photos     | External EUT Photos   | OK                 |
| 3         | Internal EUT Photos     | Internal EUT Photos   | OK                 |
| 4         | Cover Letters           | <ul style="list-style-type: none"><li>Letter from Ultratech for Certification Request</li><li>Letter from the Applicant to appoint Ultratech to act as an agent</li><li>Letter from the Applicant to request for Confidentiality Filing</li></ul>   | OK                 |
| 5         | Attestation Statements  | Modification Required for Compliance  | OK                 |
| 6         | ID Label/Location Info  | <ul style="list-style-type: none"><li>ID Label</li><li>Location of ID Label</li></ul>   | OK                 |
| 7         | Block Diagrams          | Block diagram   | OK                 |
| 8         | Schematic Diagrams      | Schematics  | OK                 |
| 9         | Parts List/Tune Up Info | Parts List  | OK                 |
| 10        | Operational Description | Detailed Operational Description  | OK                 |
| 11        | RF Exposure Info        | See section 6.9 of this test report for details.  | OK                 |
| 12        | Users Manual            | Instruction Manual  | OK                 |

## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

|                                      |  |
|--------------------------------------|--|
| <b>Reference:</b>                    | FCC Part 15, Subpart C, Section 15.247:2003; FCC Public Notice DA 00-705   |
| <b>Title:</b>                        | Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15   |
| <b>Purpose of Test:</b>              | To gain FCC Certification Authorization for Frequency Hopping Spread Spectrum Transmitters Operating in the 2400 - 2483.5 MHz Band .   |
| <b>Test Procedures:</b>              | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| <b>Environmental Classification:</b> | <input checked="" type="checkbox"/> Commercial, industrial or business environment<br><input checked="" type="checkbox"/> Residential environment  |

### 2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

### 2.3. NORMATIVE REFERENCES

| Publication                 | Year         | Title   |
|-----------------------------|--------------|---|
| 47 CFR Parts 0-19           | 2003         | Code of Federal Regulations – Telecommunication   |
| ANSI C63.4                  | 2003         | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| CISPR 22 & EN 55022         | 2002<br>2003 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment   |
| CISPR 16-1                  | 1999         | Specification for Radio Disturbance and Immunity measuring apparatus and methods  |
| FCC Public Notice DA 00-705 | 2000         | Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems   |

## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

| APPLICANT              |  |
|------------------------|--|
| <b>Name:</b>           | SANYO Canada Inc.  |
| <b>Address:</b>        | 1-300 Applewood Crescent<br>Concord, Ontario<br>Canada L4K 5C7   |
| <b>Contact Person:</b> | Akio Ichimori<br>Phone #: 905-760-4051<br>Fax #: 905-760-9301<br>Email Address: <a href="mailto:aichimori@sanyo.com">aichimori@sanyo.com</a> |

| MANUFACTURER           |   |
|------------------------|---|
| <b>Name:</b>           | Integrated Display Telecommunications<br>(Shenzhen) Co., Ltd.   |
| <b>Address:</b>        | Block 21, Chentian Industrial Village<br>Xixian Town, Bao An District, Shenzhen City<br>China   |
| <b>Contact Person:</b> | S.D Park<br>Phone #: (0755)27936930<br>Fax #: (0755)27936020<br>Email Address: <a href="mailto:sdpark.td@idthk.com">sdpark.td@idthk.com</a> |

### 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

|                                       |  |
|---------------------------------------|--|
| <b>Brand Name:</b>                    | Sanyo  |
| <b>Product Name:</b>                  | 2.4GHz Cordless Telephone  |
| <b>Model Name or Number:</b>          | CLT-W10, CLT-W20, CLT-W25  |
| <b>Serial Number:</b>                 | Pre-Production   |
| <b>Type of Equipment:</b>             | Frequency Hopping Spread Spectrum Transmitters   |
| <b>Input Power Supply Type:</b>       | Base Station: 9V DC/AC via AC power adapter 120V 60Hz<br>Handset: 3.6V NiMH battery pack |
| <b>Primary User Functions of EUT:</b> | Cordless Telephone   |

### 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER                            |   |
|--|---|
| <b>Equipment Type:</b>                 | <input checked="" type="checkbox"/> Portable (Handset)<br><input checked="" type="checkbox"/> Mobile (Base Station)                               |
| <b>Intended Operating Environment:</b> | <input checked="" type="checkbox"/> Commercial, industrial or business environment<br><input checked="" type="checkbox"/> Residential environment |
| <b>Power Supply Requirement:</b>       | Base Station: 9V DC/AC via AC power adapter 120V 60Hz<br>Handset: 3.6V NiMH battery pack  |
| <b>RF Output Power Rating:</b>         | Base Station: 26.55 dBm (0.452 W) peak conducted power<br>Handset: 23.90 dBm (0.245 W) peak conducted power                                       |
| <b>Operating Frequency Range:</b>      | 2401.056 – 2482.272 MHz   |
| <b>RF Output Impedance:</b>            | 50 Ohm  |
| <b>Channel Spacing:</b>                | 850 kHz   |
| <b>20 dB Bandwidth:</b>                | Base Station: 653.30 kHz<br>Handset: 661.32 kHz   |
| <b>Modulation Type:</b>                | GFSK  |
| <b>Channel Occupancy:</b>              | 0.032 seconds within a 38 second period   |
| <b>Emission Designation:</b>           | Frequency Hopping Spread Spectrum   |
| <b>Antenna Connector Type:</b>         | Internal antenna located on the PCB   |

### 3.4. LIST OF EUT'S PORTS

| Port Number  | EUT's Port Description | Number of Identical Ports | Connector Type     | Cable Type (Shielded/Non-shielded) |
|--------------|------------------------|---------------------------|--------------------|------------------------------------|
| Base Station |                        |                           |                    |                                    |
| 1            | Telephone Line Jack    | 1                         | RJ11               | Non-Shielded                       |
| 2            | Power Jack             | 1                         | Power Plug-in Jack | Non-Shielded                       |
| Handset      |                        |                           |                    |                                    |
| 1            | Headset Jack           | 1                         | 2.5mm Mini Jack    | Non-Shielded                       |

### 3.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

| Ancillary Equipment # 1  |                           |
|--------------------------|---------------------------|
| Description:             | Headset                   |
| Brand:                   | Planet Wireless           |
| Model Name or Number:    | N/A                       |
| Serial Number:           | N/A                       |
| Connected to EUT's Port: | Headset Jack (on Handset) |

| Ancillary Equipment # 2  |                          |
|--------------------------|--------------------------|
| Description:             | Telephone Line Simulator |
| Brand:                   | Teltone                  |
| Model Name or Number:    | TLS-5Q-02                |
| Serial Number:           | 019047                   |
| Connected to EUT's Port: | Telephone Line           |

## EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

### 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

|                     |   |
|---------------------|---|
| Temperature:        | 21°C  |
| Humidity:           | 51%   |
| Pressure:           | 102 kPa   |
| Power Input Source: | Base Station: 9V DC/AC via AC power adapter 120V<br>60Hz<br>Handset: 3.6V NiMH battery pack |

### 4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

|                                  |  |
|----------------------------------|--|
| <b>Operating Modes:</b>          | <ul style="list-style-type: none"><li>Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements.</li><li>The EUT operates in normal Frequency Hopping mode for occupancy duration and frequency separation.</li></ul> |
| <b>Special Test Software:</b>    | None.  |
| <b>Special Hardware Used:</b>    | None.  |
| <b>Transmitter Test Antenna:</b> | The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.  |

| <b>Transmitter Test Signals</b>   |  |
|---|--|
| <b>Frequency Band(s):</b>   | 2401.056 – 2482.272 MHz  |
| <b>Frequency(ies) Tested:</b><br>(Near lowest, near middle & near highest frequencies in the frequency range of operation.) | <ul style="list-style-type: none"><li>2401.056 MHz</li><li>2441.664 MHz</li><li>2482.272 MHz</li></ul> |
| <b>RF Power Output:</b><br>(measured maximum output power)  | 26.55 dBm (0.452 W) Peak Conducted Power   |
| <b>Normal Test Modulation:</b>  | GFSK   |
| <b>Modulating Signal Source:</b>  | Internal   |

## EXHIBIT 5. SUMMARY OF TEST RESULTS

### 5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: February 17, 2004.

### 5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

| Reference   | Test Requirements   | Compliance (Yes/No) |
|---|---|---------------------|
| Public Notice DA 00-1407  | Part 15 Unlicensed Modular Transmitter Approval                                   | Not Applicable      |
| 15.107(a)   | AC Power Line Conducted Emissions Measurements                                    | Yes                 |
| 15.247(a)(1)  | Frequency Hopping Systems Characteristics   | Yes                 |
| 15.247(b)   | Peak Output Power   | Yes                 |
| 15.247(b)(5),<br>1.1307, 1.1310,<br>2.1091 & 2.1093   | RF Exposure Limit   | Yes                 |
| 15.247(c)   | Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal | Yes                 |
| 15.247(c), 15.209 & 15.205  | Transmitter Radiated Emissions  | Yes                 |
| The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report can be provided upon request. |   |                     |

### 5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

- Handset: C214 change from 470p to 1n
- Base Unit: C214 change from 1n to 1n8

## **EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS**

### **6.1. TEST PROCEDURES**

This section contains test results only. Details of test methods and procedures can be found in Exhibit 7 of this report, ANSI C63.4 and FCC Public Notice DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

### **6.2. MEASUREMENT UNCERTAINTIES**

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 6 for Measurement Uncertainties.

### **6.3. MEASUREMENT EQUIPMENT USED**

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4, FCC 15.247 and CISPR 16-1.

### **6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER**

Cordless Telephone.

## 6.5. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

| FCC Section | FCC Rules  | Laboratory's Comments                        |
|-------------|--|--|
| 15.31       | The hoping function must be disabled for tests, which should be performed with the EUT transmitting on the number of frequencies specified in this Section. The measurements made at the upper and lower ends of the band of operation should be made with the EUT tuned to the highest and lowest available channels.   | Hopping function was disabled during testing |
| 15.203      | <p>Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.</p> <p>The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed:</p> <p>(a) The application (or intended use) of the EUT<br/>         (b) The installation requirements of the EUT<br/>         (c) The method by which the EUT will be marketed</p> | The antenna is an integral part of the PCB.  |
| 15.204      | Provided the information for every antenna proposed for use with the EUT:<br>(a) type (e.g. Yagi, patch, grid, dish, etc...),<br>(b) manufacturer and model number<br>(c) gain with reference to an isotropic radiator   | Refer antenna description for details.       |
| 15.247(a)   | Description of how the EUT meets the definition of a frequency hopping spread spectrum, found in Section 2.1. Based on the technical description.  | Refer to FHSS Description                    |
| 15.247(a)   | <u>Pseudo Frequency Hopping Sequence:</u><br>Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirements specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1   | Refer to FHSS Description                    |
| 15.247(a)   | <u>Equal Hopping Frequency Use:</u><br>Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g. that each new transmission event begins on the next channel in the hopping sequence after final channel used in the previous transmission events).  | Refer to FHSS Description                    |

| FCC Section             | FCC Rules   | Laboratory's Comments     |
|-------------------------|---|---------------------------|
| 15.247(g)               | Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system  | Refer to FHSS Description |
| 15.247(h)               | Describe how the EUT complies with the requirement that it not have the ability to coordinate with other FHSS is an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters | Refer to FHSS Description |
| Public Notice DA 00-705 | <u>System Receiver Input Bandwidth:</u><br>Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.              | Refer to FHSS Description |
| Public Notice DA 00-705 | <u>System Receiver Hopping Capability:</u><br>Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals  | Refer to FHSS Description |

## 6.6. AC POWER LINE CONDUCTED EMISSIONS [47 CFR §15.107(a)]

### 6.6.1. Limits

The equipment shall meet the limits of the following table:

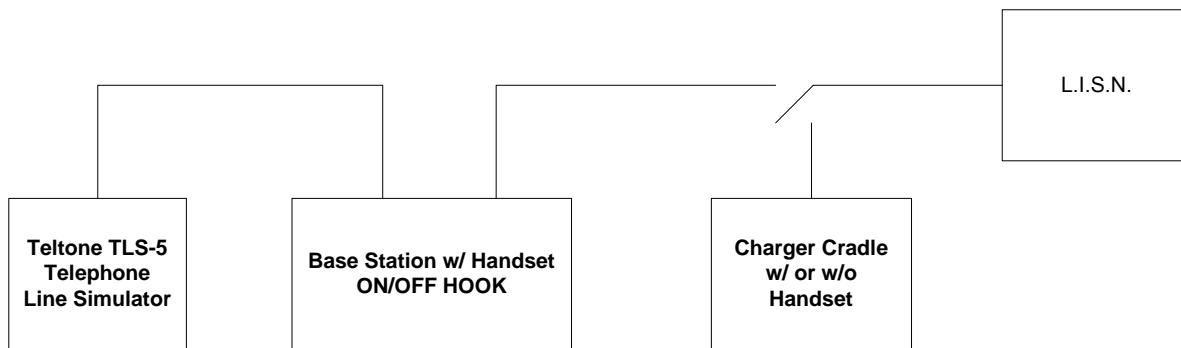
| Frequency of emission (MHz) | Class B Conducted Limits (dB $\mu$ V) |           | Measuring Bandwidth     |
|-----------------------------|---------------------------------------|-----------|-------------------------|
|                             | Quasi-peak                            | Average   |                         |
| 0.15–0.5 .....              | 66 to 56*                             | 56 to 46* | RBW = 9 kHz             |
| 0.5–5 .....                 | 56 .....                              | 46 .....  | VBW $\geq$ 9 kHz for QP |
| 5–30 .....                  | 60 .....                              | 50 .....  | VBW = 1 Hz for Average  |

\* Decreases linearly with logarithm of the frequency

### 6.6.2. Method of Measurements

Refer to Section 8.2 of this test report & ANSI C63.4.

### 6.6.3. Test Arrangement



### 6.6.4. Test Equipment List

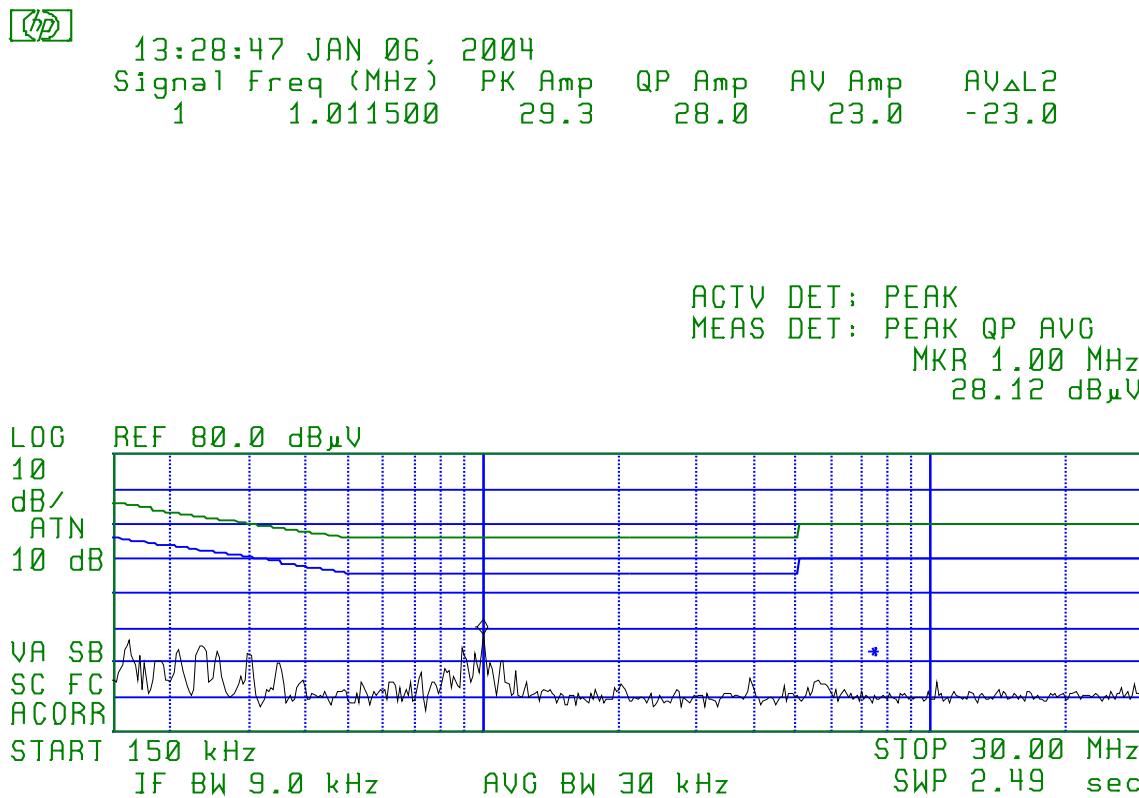
| Test Instruments                               | Manufacturer     | Model No. | Serial No. | Frequency Range                         |
|--|------------------|-----------|------------|---|
| Spectrum Analyzer/EMI Receiver                 | Hewlett Packard  | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz                        |
| Transient Limiter                              | Hewlett Packard  | 11947A    | 310701998  | 9 kHz – 200 MHz<br>10 dB attenuation    |
| L.I.S.N.                                       | EMCO             | 3825/2    | 89071531   | 9 kHz – 200 MHz<br>50 Ohms / 50 $\mu$ H |
| 24'(L) x 16'(W) x 8'(H)<br>RF Shielded Chamber | Braden Shielding | ...       | ...        | ...                                     |

#### 6.6.5. Test Data

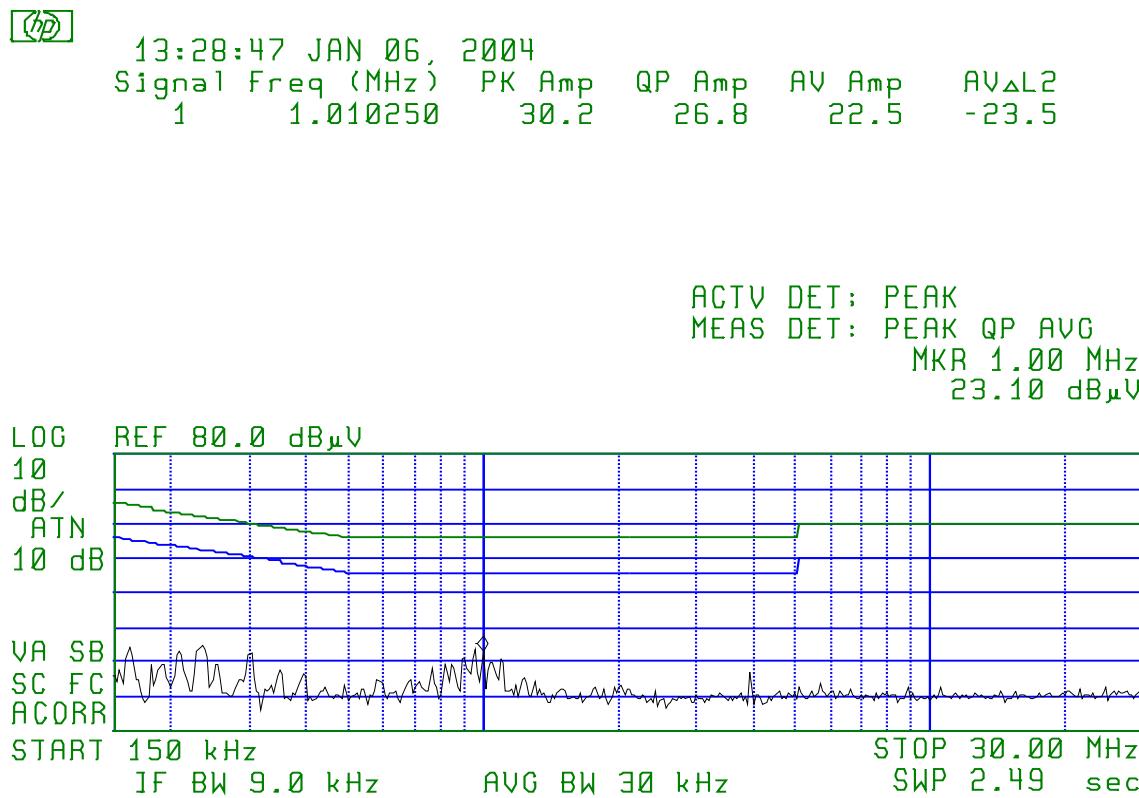
| Frequency (MHz)  | RF Level (dB $\mu$ V) | Receiver Detector (P/QP/AVG) | QP Limit (dB $\mu$ V) | AVG Limit (dB $\mu$ V) | Margin (dB) | Pass/ Fail | Line Tested (L1/L2) |
|--|-----------------------|------------------------------|-----------------------|------------------------|-------------|------------|---------------------|
| <b>Base Station with Sanyo Canada Inc. AC Adapter (Model: PI-41-735US)</b> |                       |                              |                       |                        |             |            |                     |
| 1.011500   | 28.0                  | QP                           | 56.0                  | 46.0                   | -28.0       | Pass       | L1                  |
| 1.011500   | 23.0                  | AVG                          | 56.0                  | 46.0                   | -23.0       | Pass       | L1                  |
| <b>Charger with SINO American AC Adapter (Model: A10920)</b>               |                       |                              |                       |                        |             |            |                     |
| 1.010750   | 27.5                  | QP                           | 56.0                  | 46.0                   | -28.5       | Pass       | L1                  |
| 1.010750   | 23.5                  | AVG                          | 56.0                  | 46.0                   | -22.5       | Pass       | L1                  |
| 1.010950   | 28.6                  | QP                           | 56.0                  | 46.0                   | -27.4       | Pass       | L2                  |
| 1.010950   | 23.3                  | AVG                          | 56.0                  | 46.0                   | -22.7       | Pass       | L2                  |

Note: See the following test data plots (1 – 4) for detailed measurements

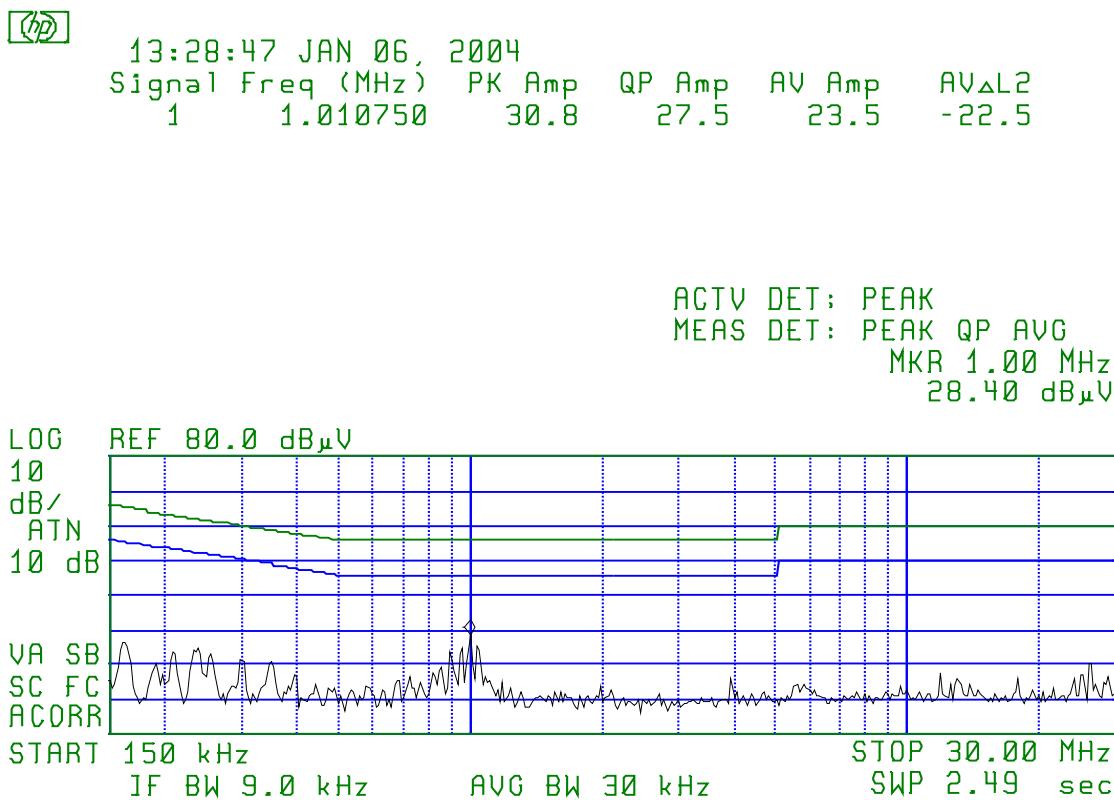
Plot 1:  
AC Power Line Conducted Emissions  
Base Station with Sanyo Canada Inc. AC Adapter (Model: PI-41-735US)  
Line Voltage: 120 Vac 60 Hz  
Line Tested: L1



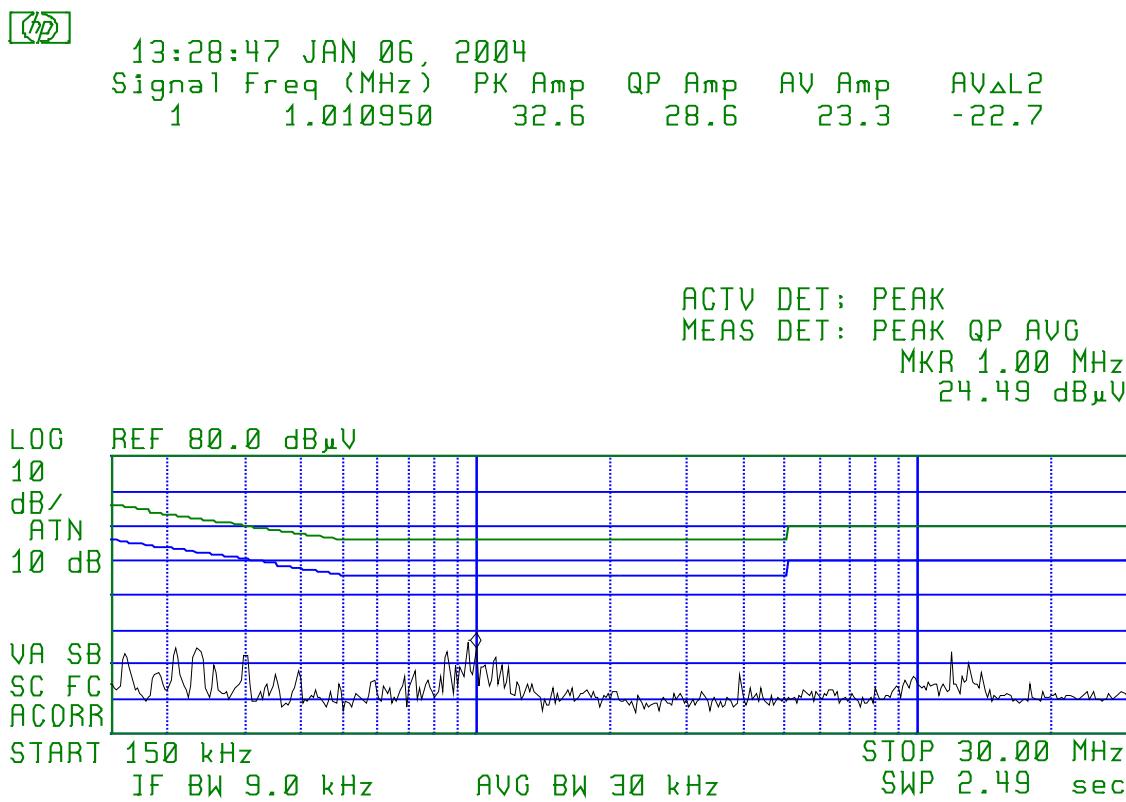
Plot 2:  
AC Power Line Conducted Emissions  
Base Station with Sanyo Canada Inc. AC Adapter (Model: PI-41-735US)  
Line Voltage: 120 Vac 60 Hz  
Line Tested: L2



Plot 3:  
AC Power Line Conducted Emissions  
Charger with SINO American AC Adapter (Model: A10920)  
Line Voltage: 120 Vac 60 Hz  
Line Tested: L1



Plot 4:  
AC Power Line Conducted Emissions  
Charger with SINO American AC Adapter (Model: A10920)  
Line Voltage: 120 Vac 60 Hz  
Line Tested: L2



## 6.7. HOPPING CHANNEL CARRIER FREQUENCY CHARACTERISTICS [47 CFR §§ 15.247(a)(1) & (a)(1)(iii)]

### 6.7.1. Limits

- **§ 15.247(a)(1):** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system-hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
- **§ 15.247(a)(1)(iii):** Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

### 6.7.2. Method of Measurements

ANSI C63.4 and Public Notice DA 00-705

#### Carrier Frequency Separation:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = wide enough to capture the peaks of two adjacent channels
- RBW = 1% of the span
- VBW  $\geq$  RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

#### Number of hopping frequency:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = the frequency band of operation
- RBW = 1% of the span
- VBW  $\geq$  RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

#### **Time of Occupancy (Dwell Time):**

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW  $\geq$  RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

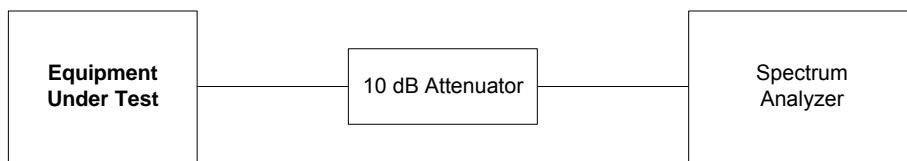
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. date rate modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

#### **20 dB Bandwidth:**

Use the spectrum analyzer setting as follows:

- Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20 dB bandwidth
- VBW  $\geq$  RBW
- Sweep = auto
- Detector = peak
- Trace = max hold
- The transmitter shall be transmitting at its maximum data rate.
- Allow the trace to stabilize.
- Use the marker-to-peak function to set the marker to the peak of the emission.
- Use the marker-delta function to measure 20 dB down on both sides of the emission.
- The 20 dB BW is the delta reading in frequency between two markers.

#### **6.7.3. Test Arrangement**



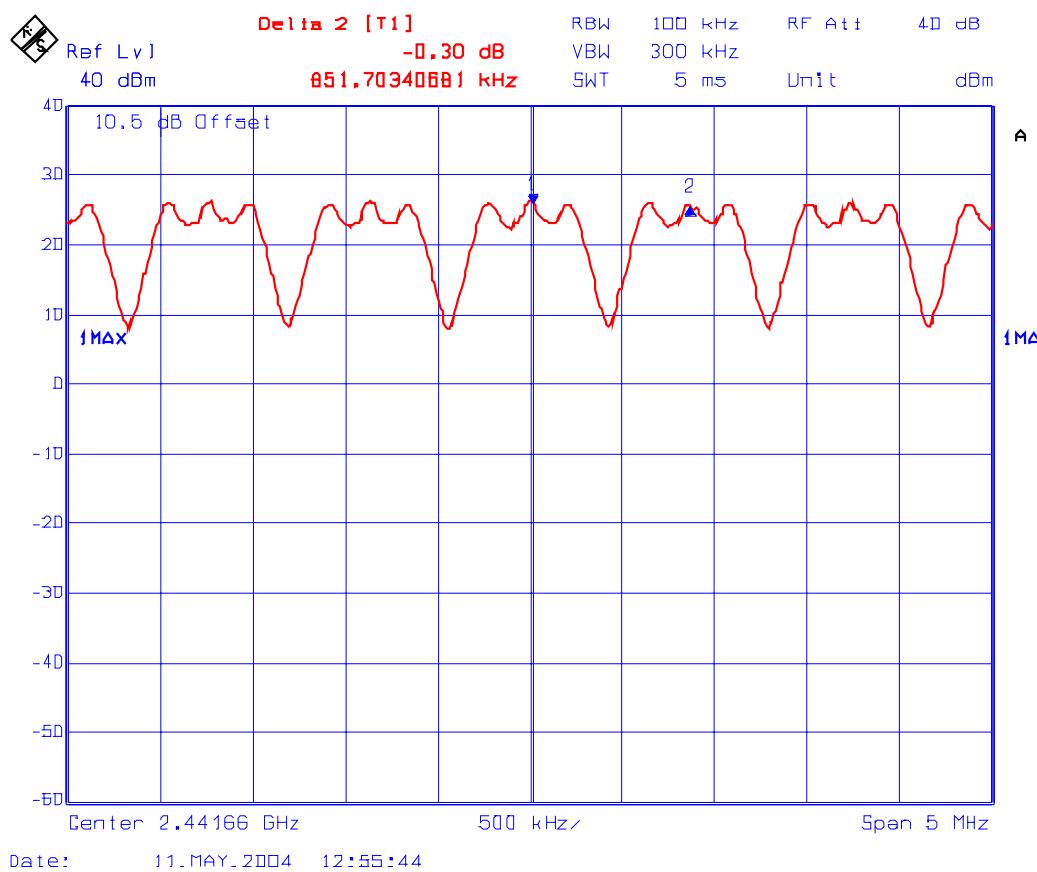
#### **6.7.4. Test Equipment List**

| Test Instruments  | Manufacturer          | Model or P/N  | Serial No. | Frequency Range |
|-------------------|-----------------------|---------------|------------|-----------------|
| Spectrum Analyzer | Rohde & Schwarz       | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz  |
| Attenuator        | Weinschel Corporation | 41-10-12      | 46231      | DC – 18 GHz     |

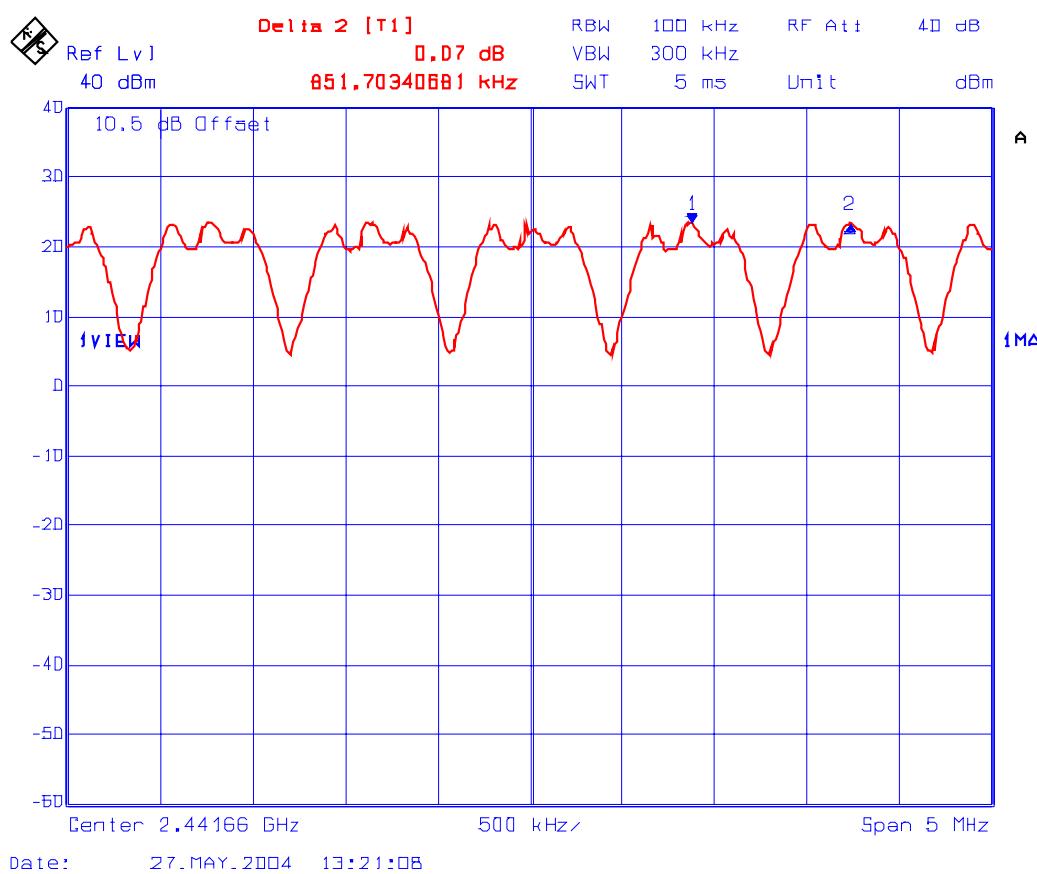
### 6.7.5. Test data

| Test Description               | FCC Specifications   | Measured Values   | Comments  |
|--------------------------------|--|---|---|
| Carrier Frequency Separation   | Minimum of 25 kHz or 20dB BW whichever is greater.   | Base Station 20dB BW: 851.70 kHz<br>Handset 20dB BW: 851.70 kHz | Complies, see plots 5 to 6 for detailed measurements.   |
| 20 dB Bandwidth                | --   | Base Station: 653.30 kHz<br>Handset: 661.32 kHz                 | Complies, see plots 7 to 12 for detailed measurements.  |
| Number of Hopping Frequencies  | At least 15 non-overlapping channels.  | 95 hopping frequencies  | Complies, see plots 13 to 17 for detailed measurements. |
| Time of Occupancy (Dwell Time) | The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. | 0.032 seconds within a 38 second period                         | Complies, see plots 18 to 23 for detailed measurements. |

Plot 5:  
Carrier Frequency Separation  
Base Station



Plot 6:  
Carrier Frequency Separation  
Handset



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File #: SAN-097F15C247

June 24, 2004

**All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)**

Plot 7:  
20 dB Bandwidth (Base Station)  
Test Frequency: 2401.056 MHz (CH 00)



Plot 8:  
20 dB Bandwidth (Base Station)  
Test Frequency: 2441.664 MHz (CH 47)



Plot 9:  
20 dB Bandwidth (Base Station)  
Test Frequency: 2482.272 MHz (CH 94)



Plot 10:  
20 dB Bandwidth (Handset)  
Test Frequency: 2401.056 MHz (CH 00)



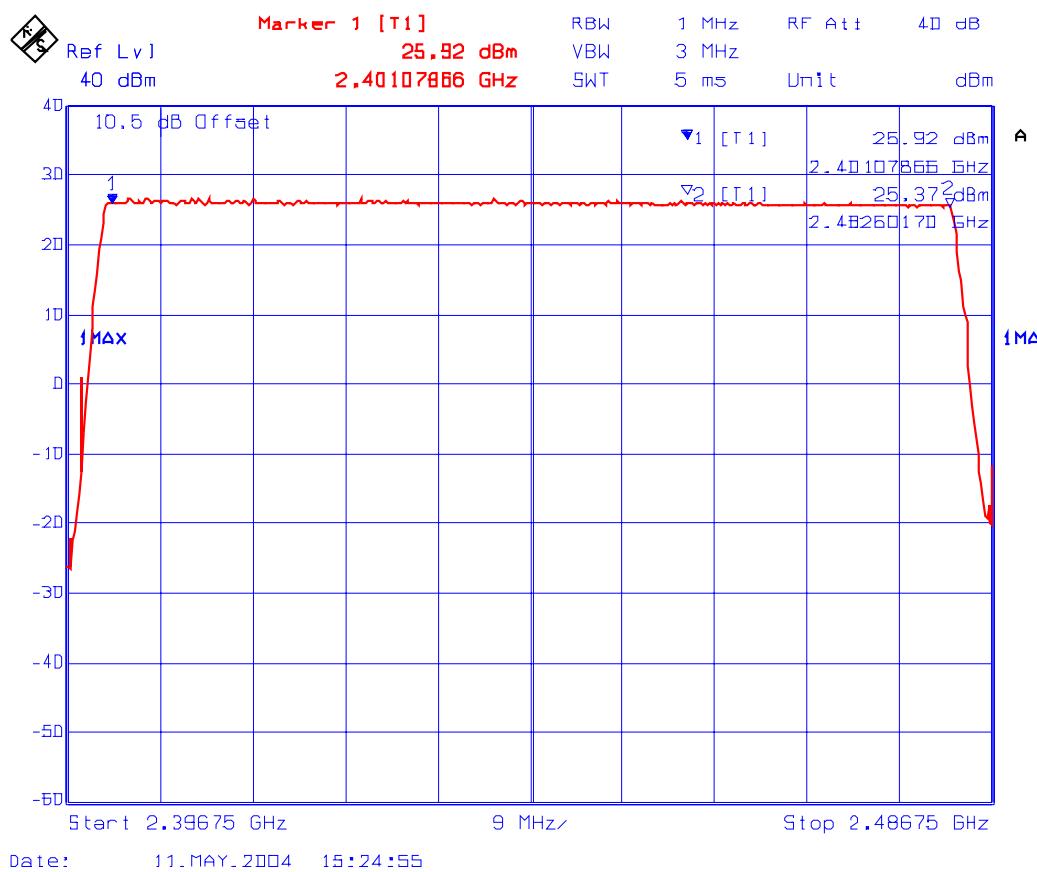
Plot 11:  
20 dB Bandwidth (Handset)  
Test Frequency: 2441.664 MHz (CH 47)



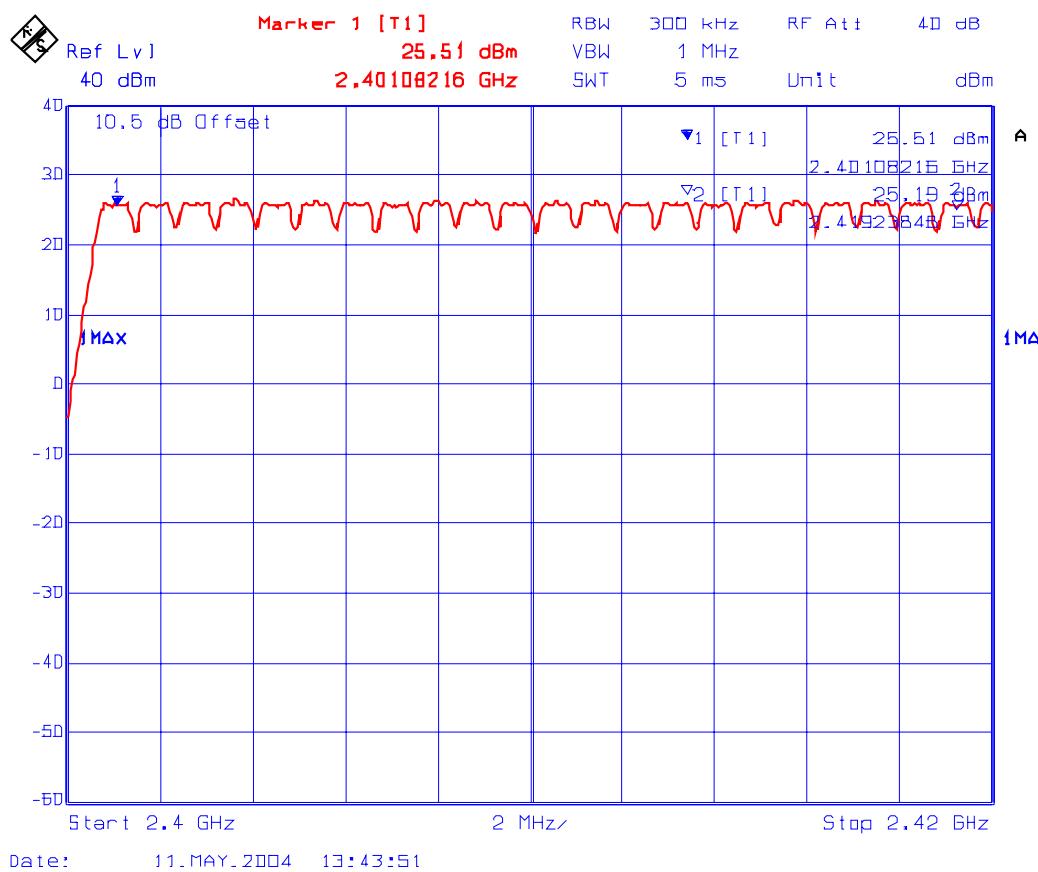
Plot 12:  
20 dB Bandwidth (Handset)  
Test Frequency: 2482.272 MHz (CH 94)



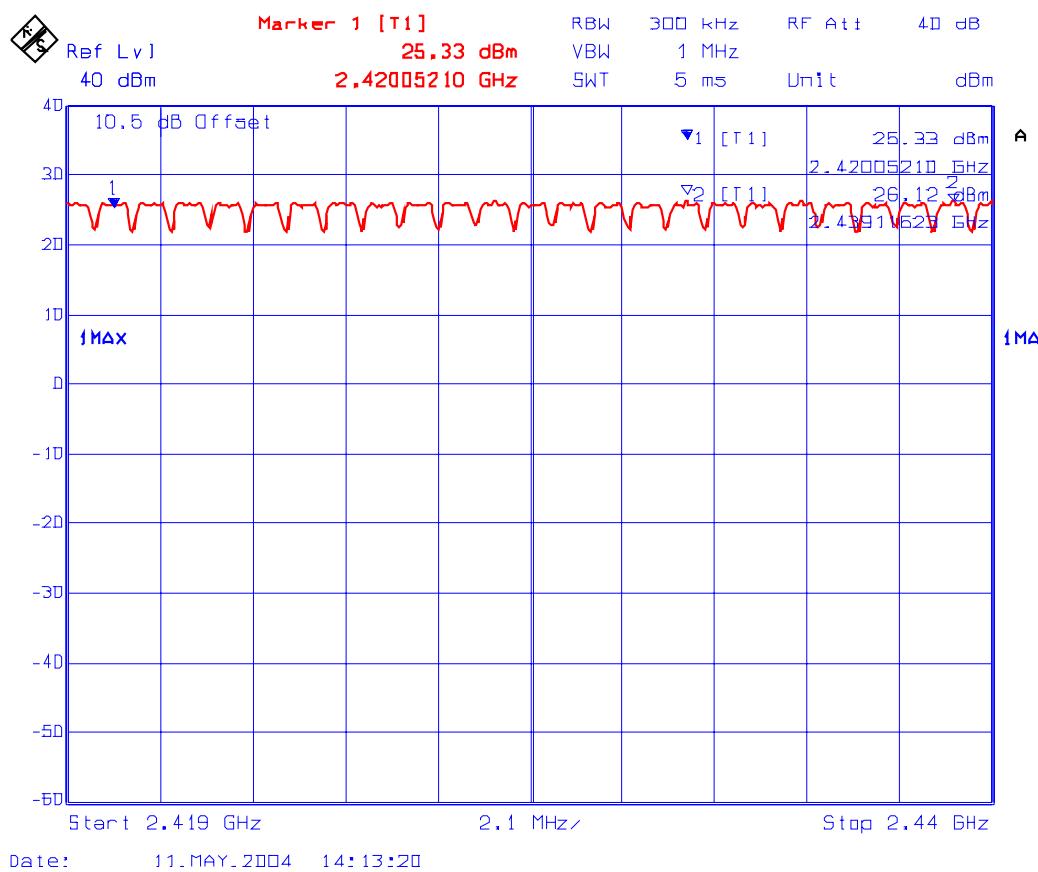
Plot 13:  
Number of Hopping Frequencies  
95 Hopping Frequencies (from 2401.056 – 2482.272 MHz)



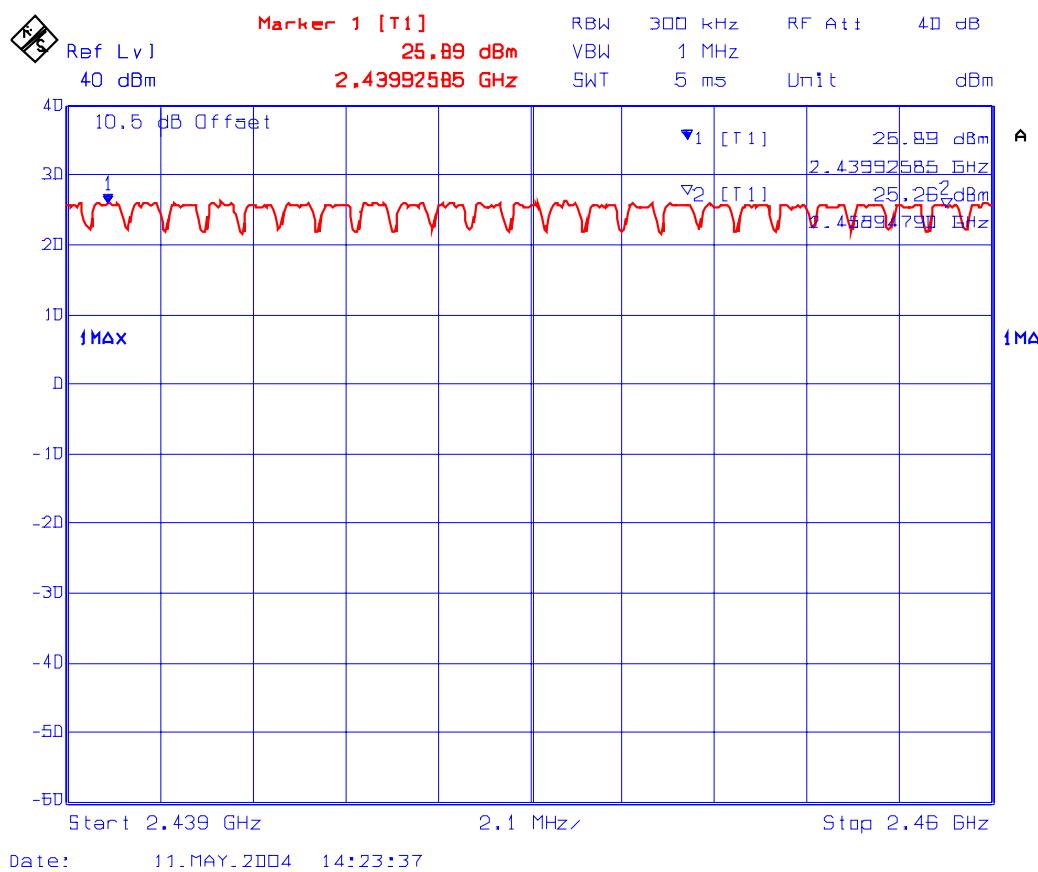
Plot 14:  
Number of Hopping Frequencies  
22 hopping frequencies (from 2401.056 - 2420 MHz)



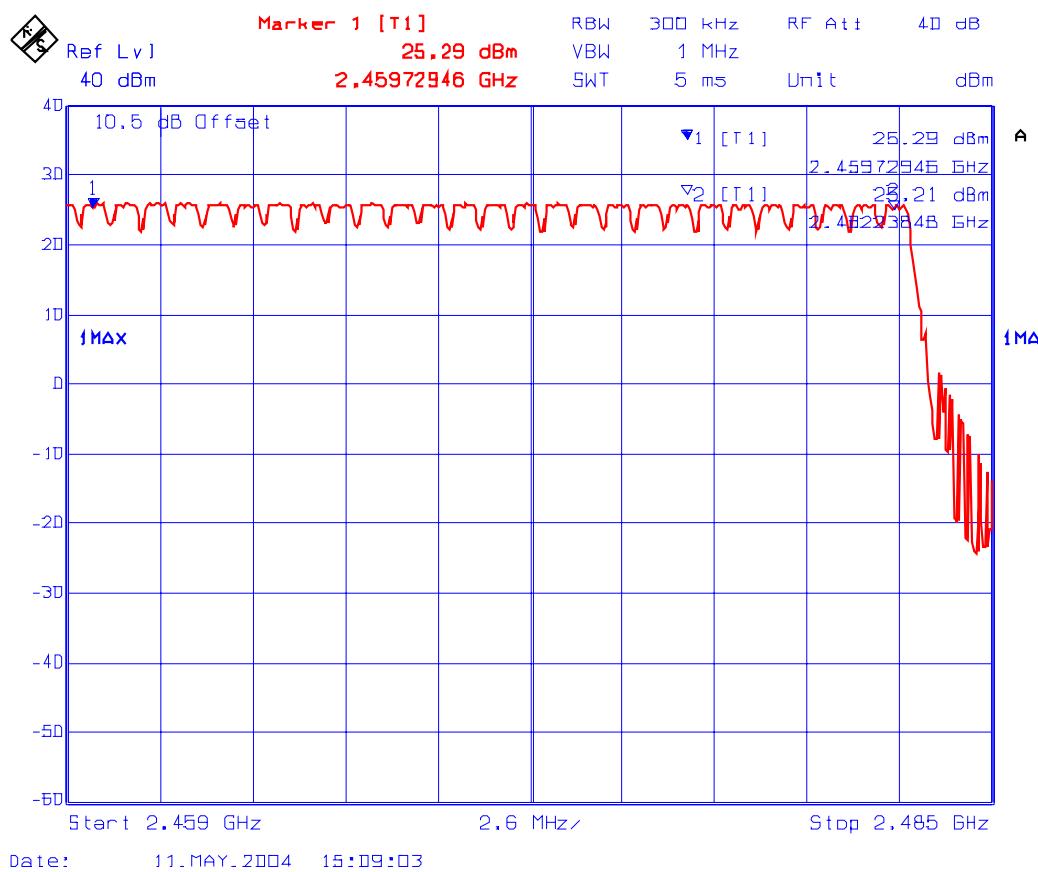
Plot 15:  
Number of Hopping Frequencies  
23 hopping frequencies (from 2419 - 2440 MHz)



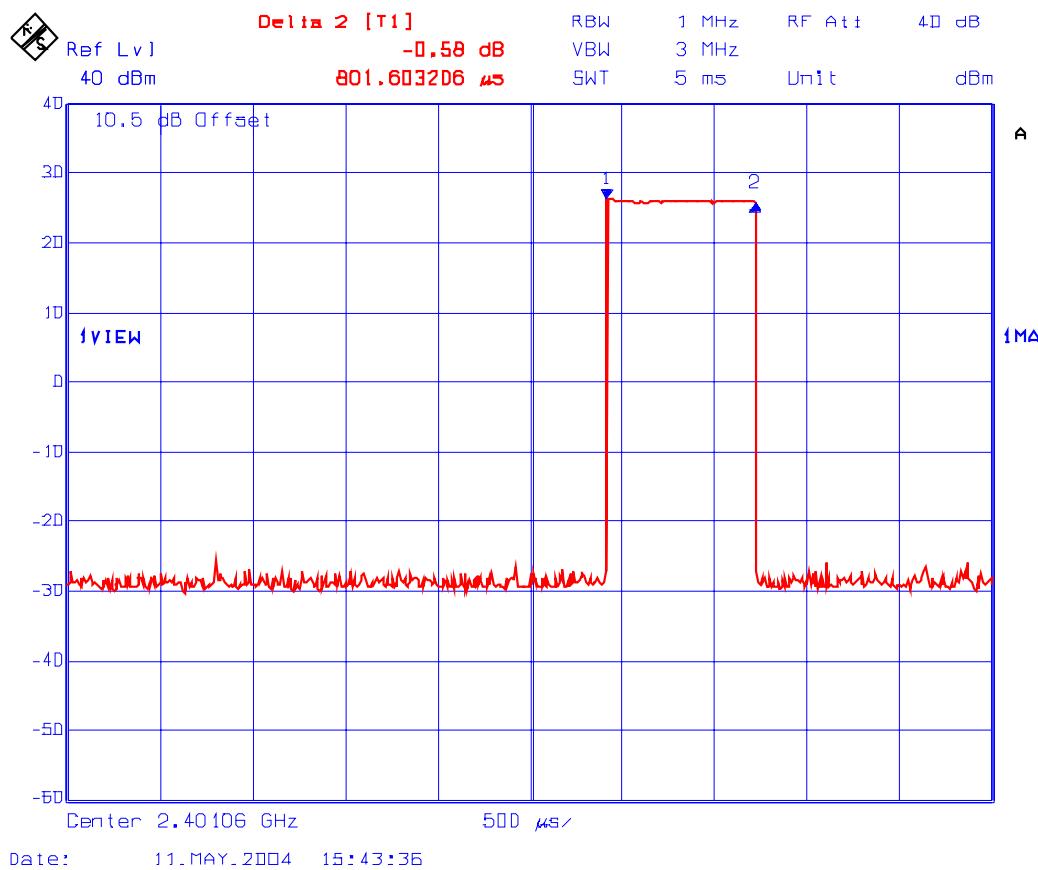
Plot 16:  
Number of Hopping Frequencies  
23 hopping frequencies (from 2439 - 2460 MHz)



Plot 17:  
Number of Hopping Frequencies  
27 Hopping Frequencies (from 2459 – 2482.272 MHz)

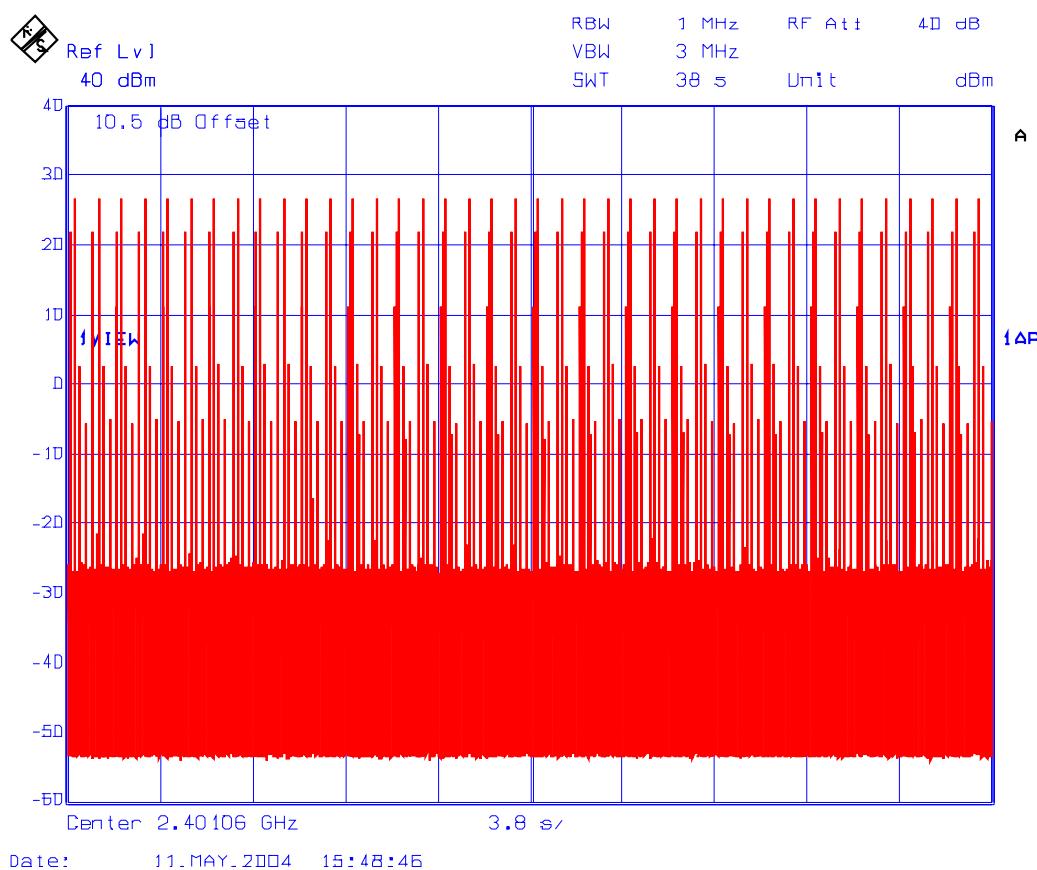


Plot 18:  
Time of Occupancy  
Test Frequency: 2401.056 MHz (CH 00)



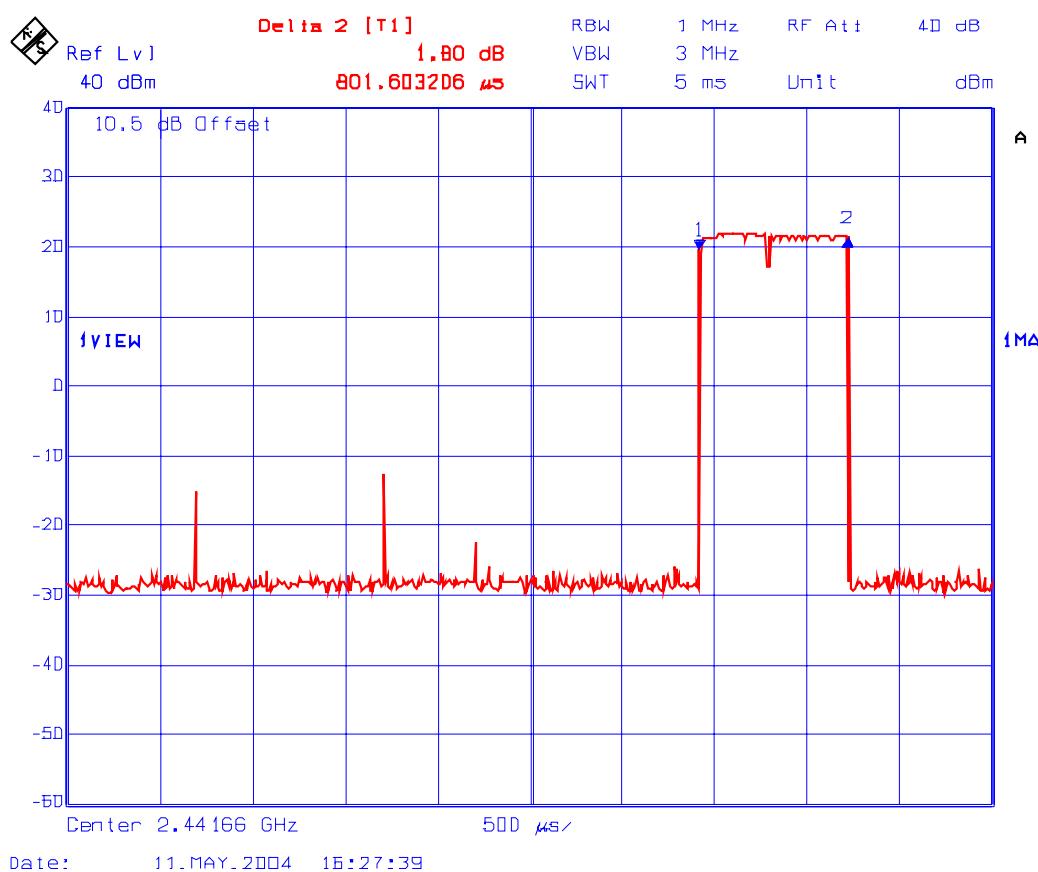
Dwell Time @ 2401.056 MHz = 801.60 μsec

Plot 19:  
Time of Occupancy  
Test Frequency: 2401.056 MHz (CH 00)



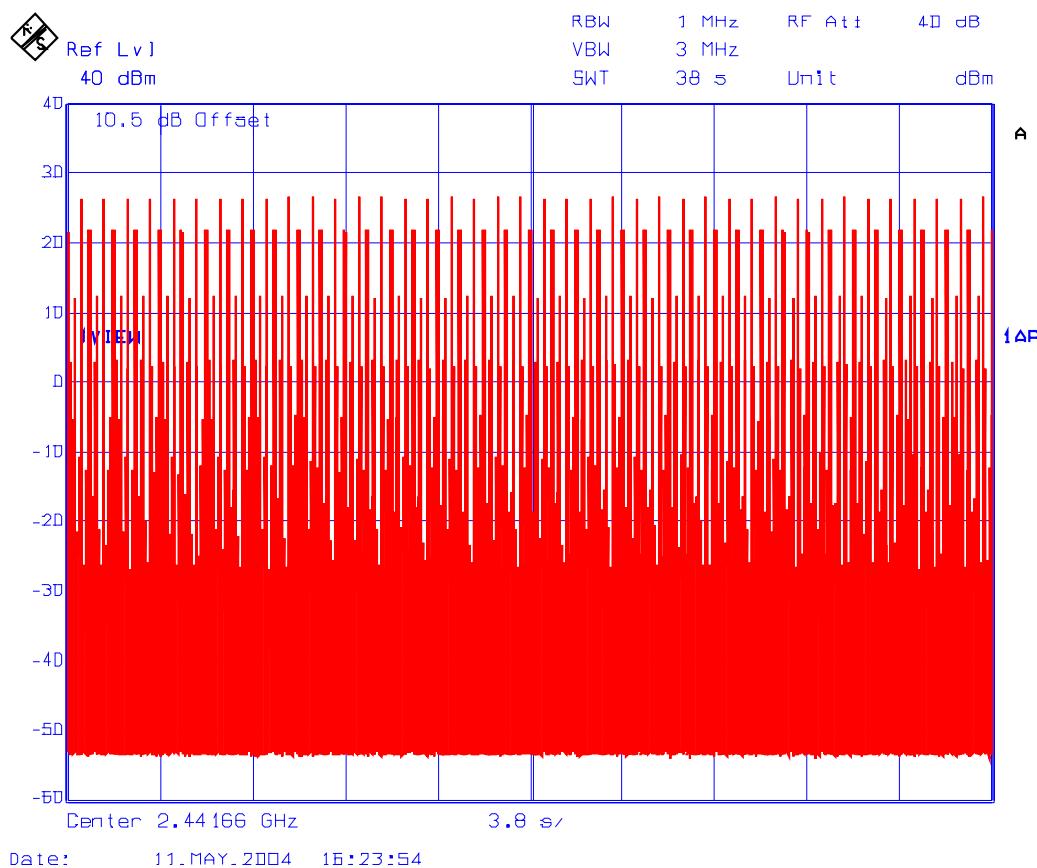
Average time of occupancy in 38 s = (Dwell Time @ 2401.056 MHz) x (number of hops in 38 s)  
= 801.60  $\mu$ sec x 40  
= 0.032 s

Plot 20:  
Time of Occupancy  
Test Frequency: 2441.664 MHz (CH 47)



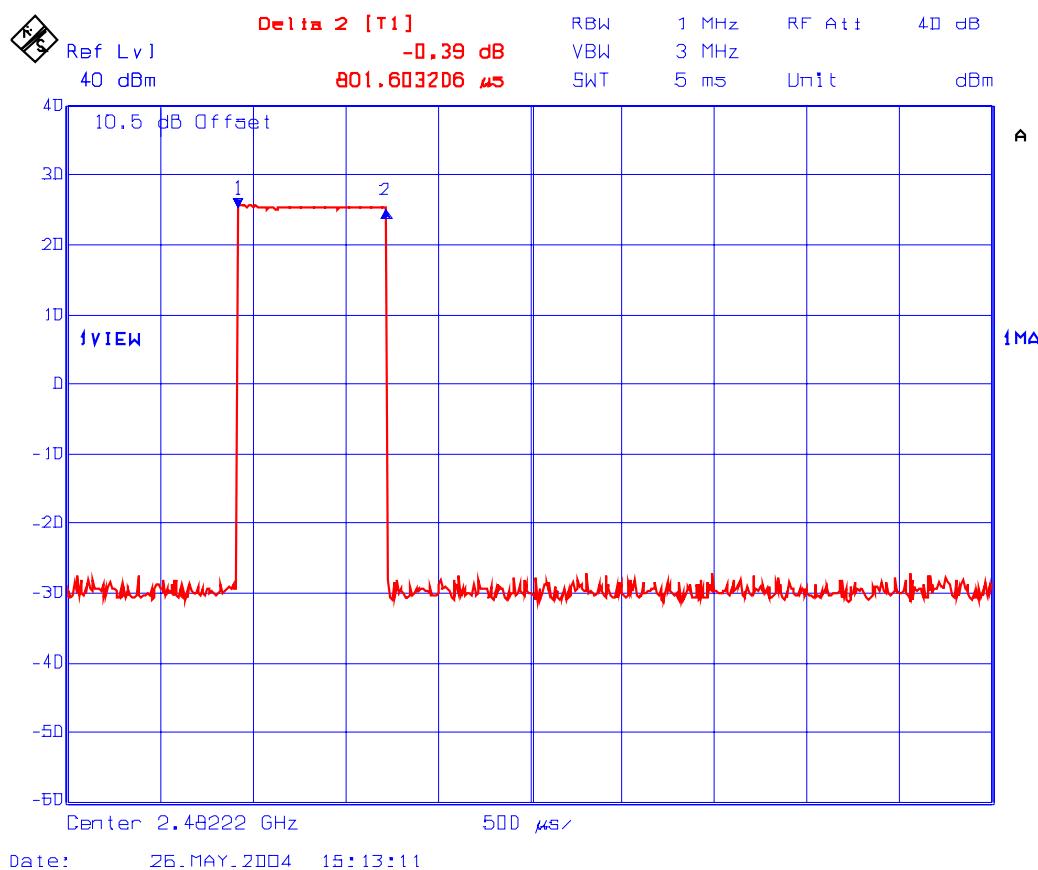
Dwell Time @ 2441.664 MHz = 801.60  $\mu$ sec

Plot 21:  
Time of Occupancy  
Test Frequency: 2441.664 MHz (CH 47)



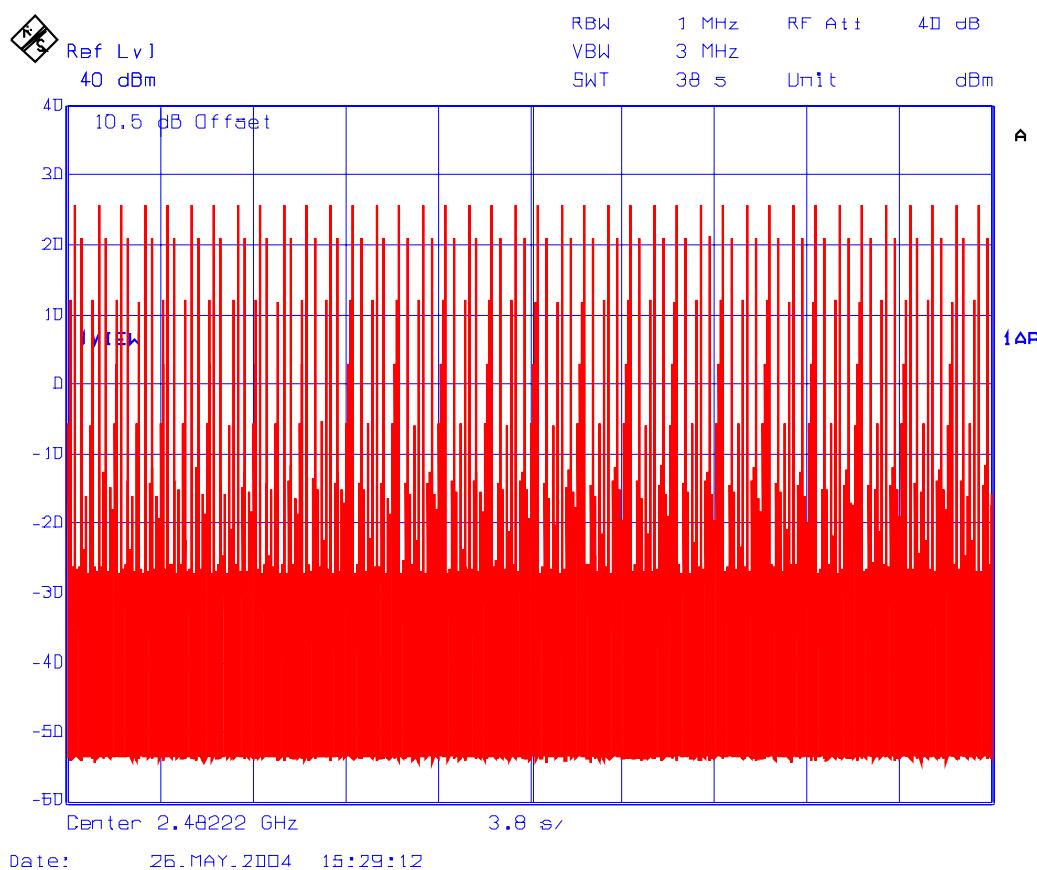
Average time of occupancy in 38 s = (Dwell Time @ 2441.664 MHz) x (number of hops in 38 s)  
= 801.60  $\mu$ sec x 40  
= 0.032 s

Plot 22:  
Time of Occupancy  
Test Frequency: 2482.272 MHz (CH 94)



Dwell Time @ 2482.272 MHz = 801.60  $\mu$ sec

Plot 23:  
Time of Occupancy  
Test Frequency: 2482.272 MHz (CH 94)



Average time of occupancy in 38 s = (Dwell Time @ 2482.272 MHz) x (number of hops in 38 s)  
= 801.60  $\mu$ sec x 40  
= 0.032 s

| FCC Specification   | Manufacturer's Explanation |
|---|----------------------------|
| <b>FCC Requirement @ Section 15.247(a)(1):</b><br>The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals | Refer to FHSS Descriptions |
| <b>FCC Requirement @ Section 15.247(g):</b><br>Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system   | Refer to FHSS Descriptions |
| <b>FCC Requirement @ Section 15.247(h):</b><br>Describe how the EUT complies with the requirement that it does not have the ability to coordinate with other FHSS in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters   | Refer to FHSS Descriptions |

## 6.8. PEAK OUTPUT POWER & EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) [47 CFR § 15.247(b)]

### 6.8.1. Limits

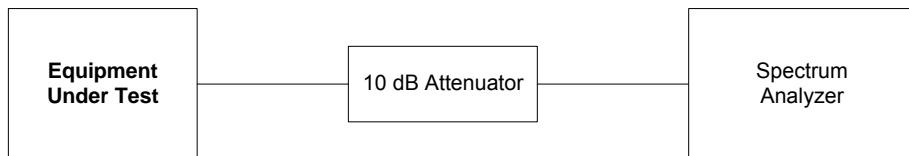
The maximum peak output power of the intentional radiator shall not exceed the following:

- § 15.247(b)(1): For frequency hopping systems in the 2400–2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400–2483.5 band: 0.125 Watt.
- § 15.247(b)(4): If the antennas of directional gain greater than 6 dBi are used, the peak power from the intentional radiator shall be reduced below, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 6.8.2. Method of Measurements

Refer to Section 8.3 of this test report and ANSI C63.4

### 6.8.3. Test Arrangement



### 6.8.4. Test Equipment List

| Test Instruments  | Manufacturer          | Model No.     | Serial No. | Frequency Range |
|-------------------|-----------------------|---------------|------------|-----------------|
| Spectrum Analyzer | Rohde & Schwarz       | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz  |
| Attenuator        | Weinschel Corporation | 41-10-12      | 46231      | DC – 18 GHz     |

### 6.8.5. Test Data

| Transmitter Channel | Frequency (MHz) | Peak Power at Antenna Terminal (dBm) | *Calculated EIRP (dBm) | Conducted Power Limit (dBm) | EIRP Limit (dBm) |
|---------------------|-----------------|--------------------------------------|------------------------|-----------------------------|------------------|
| <b>Base Station</b> |                 |                                      |                        |                             |                  |
| 00                  | 2401.056        | 26.55                                | 28.05                  | 30.0                        | 36.0             |
| 47                  | 2441.664        | 26.47                                | 27.97                  | 30.0                        | 36.0             |
| 94                  | 2482.272        | 26.00                                | 27.50                  | 30.0                        | 36.0             |
| <b>Handset</b>      |                 |                                      |                        |                             |                  |
| 00                  | 2401.056        | 23.90                                | 25.40                  | 30.0                        | 36.0             |
| 47                  | 2441.664        | 23.35                                | 24.85                  | 30.0                        | 36.0             |
| 94                  | 2482.272        | 22.89                                | 24.39                  | 30.0                        | 36.0             |

\* EIRP = Peak power at antenna terminal in dBm + EUT Antenna gain in dBi.

## 6.9. RF EXPOSURE REQUIREMENTS [47 CFR §§ 15.247(b)(5) & 1.1310]

### 6.9.1. Limits

- FCC 15.247(b)(5):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1).
- FCC 1.1310:-** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency range (MHz)  | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm <sup>2</sup> ) | Averaging time (minutes) |
|--|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| <b>(A) Limits for Occupational/Controlled Exposures</b>        |                               |                               |                                     |                          |
| 0.3–3.0 .....  | 614                           | 1.63                          | *(100)                              | 6                        |
| 3.0–30 .....   | 1842/f                        | 4.89/f                        | *(900/f <sup>2</sup> )              | 6                        |
| 30–300 .....   | 61.4                          | 0.163                         | 1.0                                 | 6                        |
| 300–1500 .....   | .....                         | .....                         | f/300                               | 6                        |
| 1500–100,000 .....   | .....                         | .....                         | 5                                   | 6                        |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                          |
| 0.3–1.34 .....   | 614                           | 1.63                          | *(100)                              | 30                       |
| 1.34–30 .....  | 824/f                         | 2.19/f                        | *(180/f <sup>2</sup> )              | 30                       |
| 30–300 .....   | 27.5                          | 0.073                         | 0.2                                 | 30                       |
| 300–1500 .....   | .....                         | .....                         | f/1500                              | 30                       |
| 1500–100,000 .....   | .....                         | .....                         | 1.0                                 | 30                       |

f = frequency in MHz

\* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

### 6.9.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091

- Spread spectrum transmitters operating under section 15.247 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:
  - (1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
  - (2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
  - (3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
  - (4) Any other RF exposure related issues that may affect MPE compliance

**Calculation Method of RF Safety Distance:**

$$S = PG/4\pi r^2 = EIRP/4\pi r^2$$

Where:

P: power input to the antenna in mW

EIRP: Equivalent (effective) isotropic radiated power

S: power density mW/cm<sup>2</sup>

G: numeric gain of antenna relative to isotropic radiator

r: distance to centre of radiation in cm

$$r = \sqrt{PG/4\pi S}$$

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones., an SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d)

### 6.9.3. MPE Evaluation

| Evaluation of RF Exposure Compliance Requirements  |   |
|--|---|
| RF Exposure Requirements   | Compliance with FCC Rules   |
| Minimum calculated separation distance between antenna and persons required: <b>*7.1 cm</b>  | Manufacturer' instruction for separation distance between antenna and persons required: <b>20 cm.</b> |
| Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement | None, antenna is permanently attached.  |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits  | Please refer to User's Manual for RF Exposure Information.  |
| Any other RF exposure related issues that may affect MPE compliance  | None.   |

\* The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

RF EXPOSURE DISTANCE LIMITS:  $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$

$S = 1.0 \text{ mW/cm}^2$

$EIRP = 28.05 \text{ dBm} = 638.26 \text{ mW (Max. EIRP)}$

$$r = (EIRP/4\pi S)^{1/2} = (638.26 /4\pi(1.0))^{1/2} = 7.1 \text{ cm}$$

## 6.10. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [47 CFR § 15.247(c)]

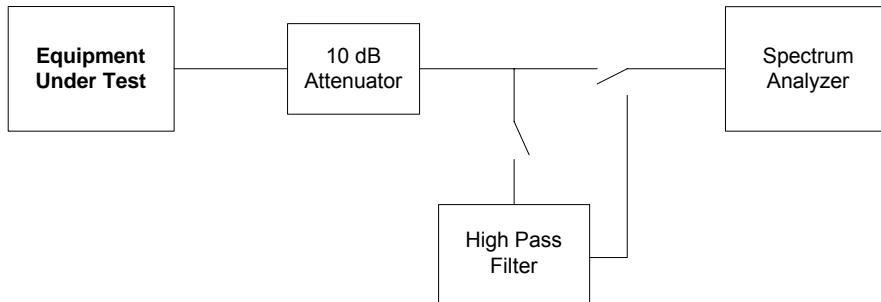
### 6.10.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### 6.10.2. Method of Measurements

Refer to Section 8.4 of this test report and ANSI C63.4

### 6.10.3. Test Arrangement



### 6.10.4. Test Equipment List

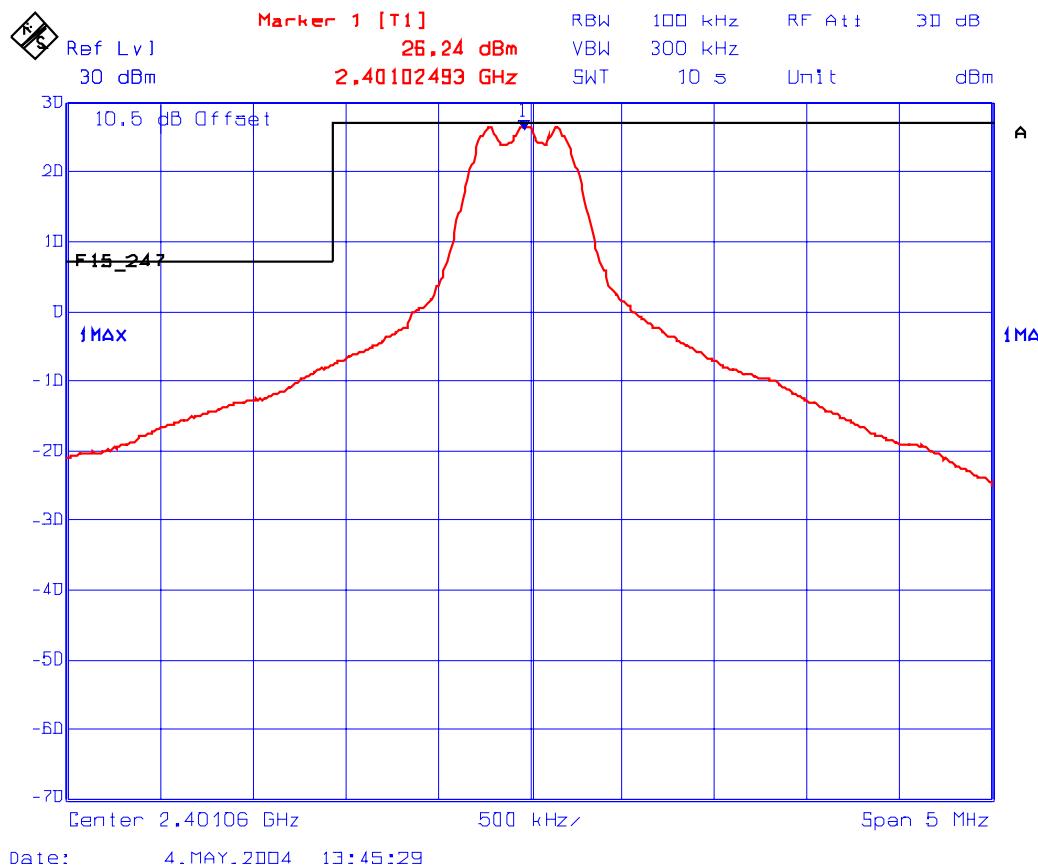
| Test Instruments  | Manufacturer          | Model No.              | Serial No. | Frequency Range |
|-------------------|-----------------------|------------------------|------------|-----------------|
| Spectrum Analyzer | Rohde & Schwarz       | FSEK20/B4/B21          | 834157/005 | 9 kHz – 40 GHz  |
| Attenuator        | Weinschel Corporation | 41-10-12               | 46231      | DC – 18 GHz     |
| High Pass Filter  | K & L                 | 11SH10-4000/T12000-0/0 | 4          | 2 – 26 GHz      |

### 6.10.5. Test Data

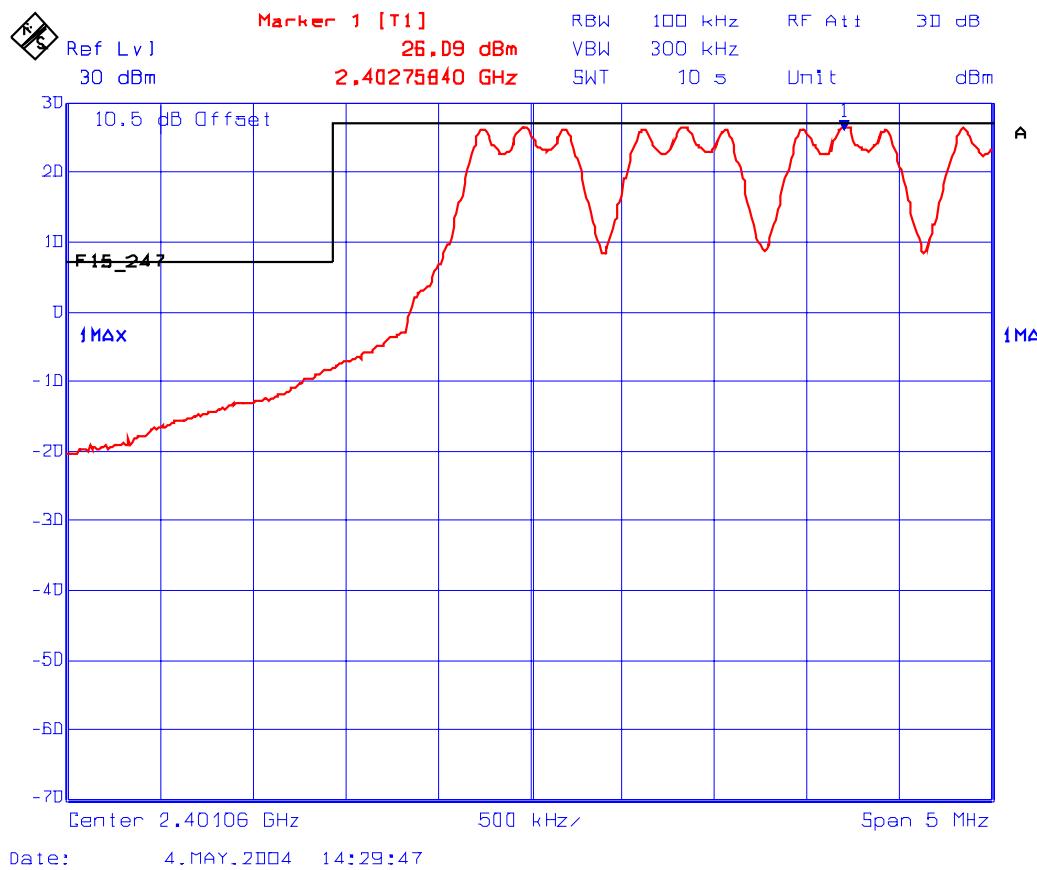
### 6.10.5.1. *Band-Edge RF Conducted Emissions*

Refer to the following test data plots (24 to 31) for measurement results:

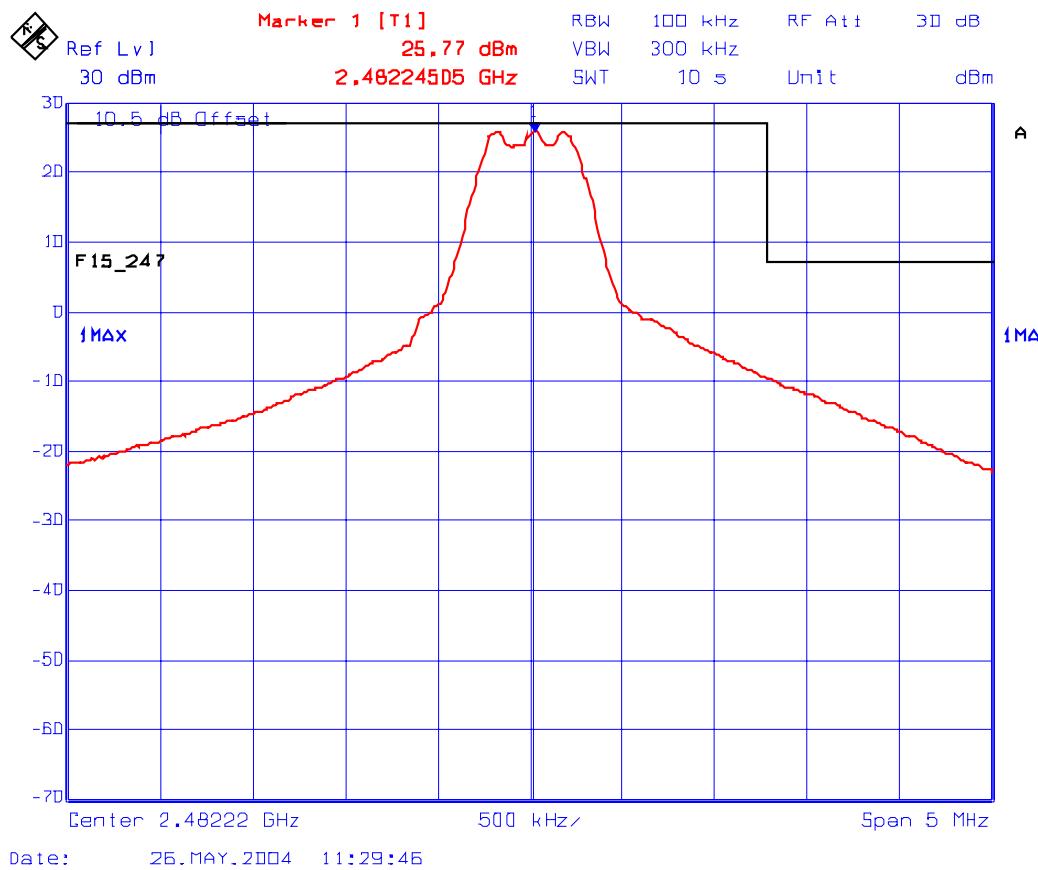
Plot 24:  
Band-Edge RF Conducted Emissions (Base Station)  
Low End of Frequency Band  
Single Frequency Mode



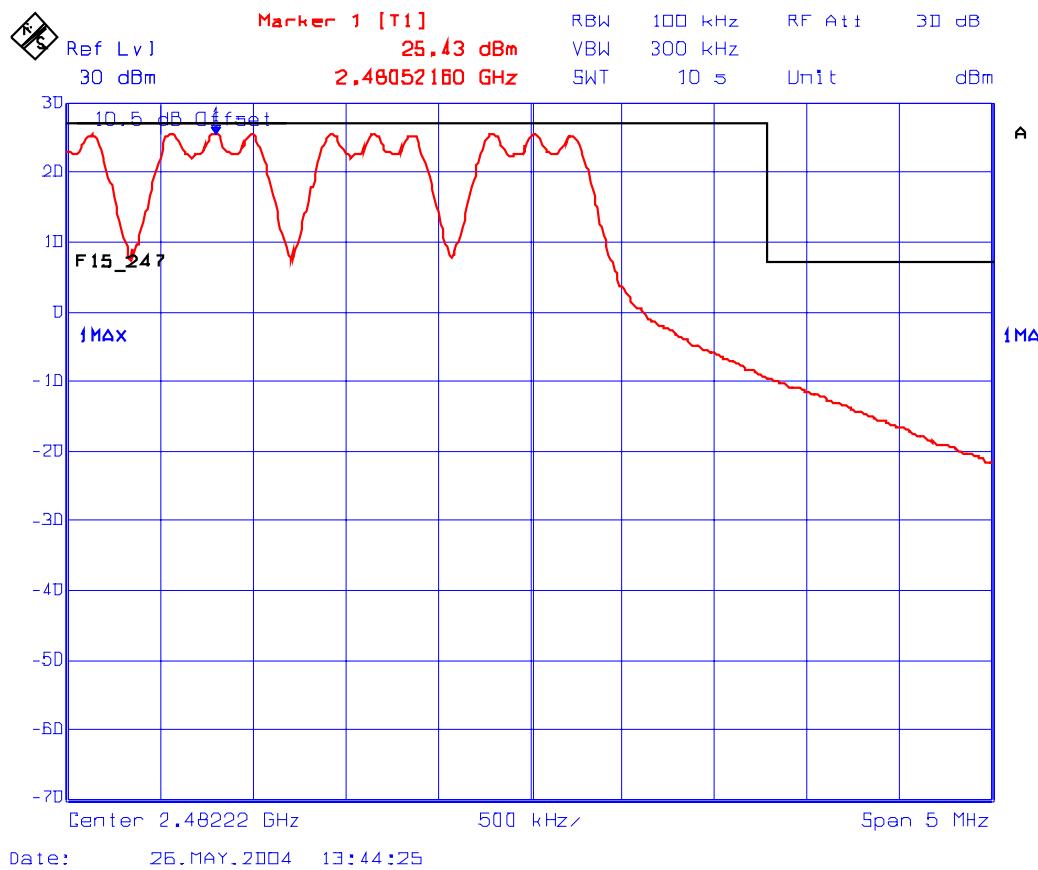
Plot 25:  
Band-Edge RF Conducted Emissions (Base Station)  
Low End of Frequency Band  
Pseudorandom Channel Hopping Mode



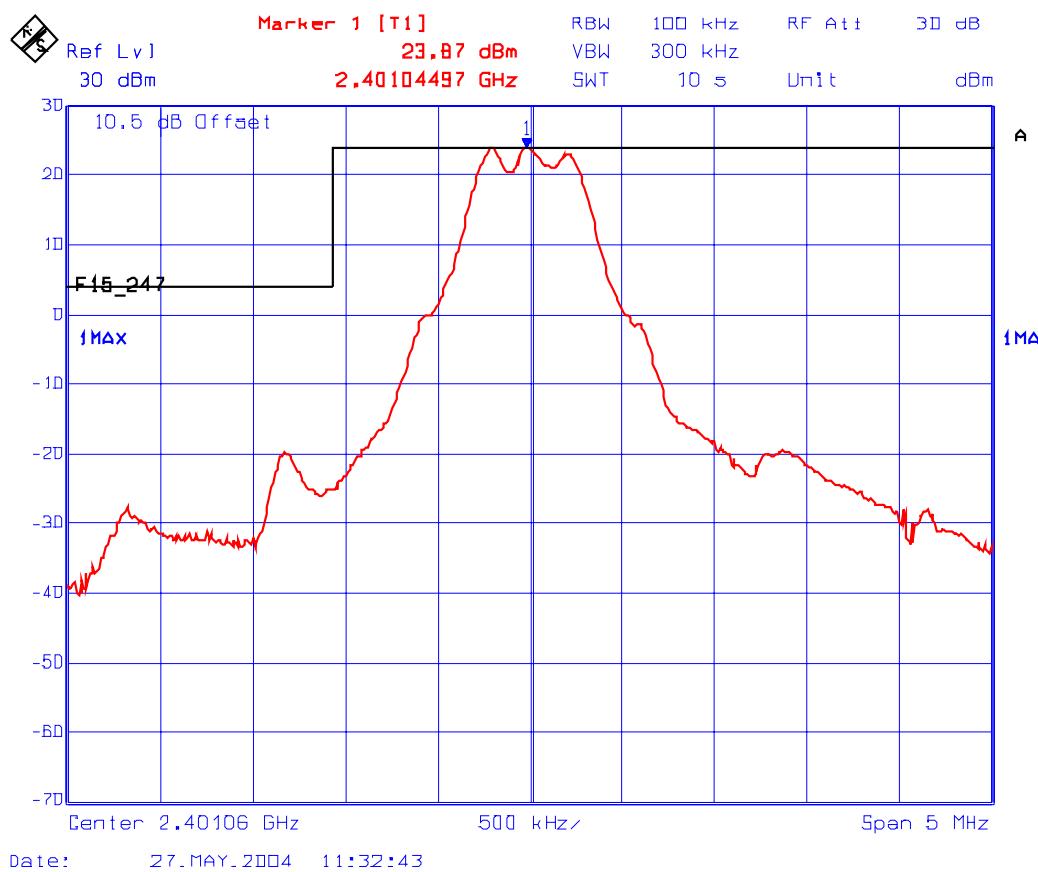
Plot 26:  
Band-Edge RF Conducted Emissions (Base Station)  
High End of Frequency Band  
Single Frequency Mode



Plot 27:  
Band-Edge RF Conducted Emissions (Base Station)  
High End of Frequency Band  
Pseudorandom Channel Hopping Mode



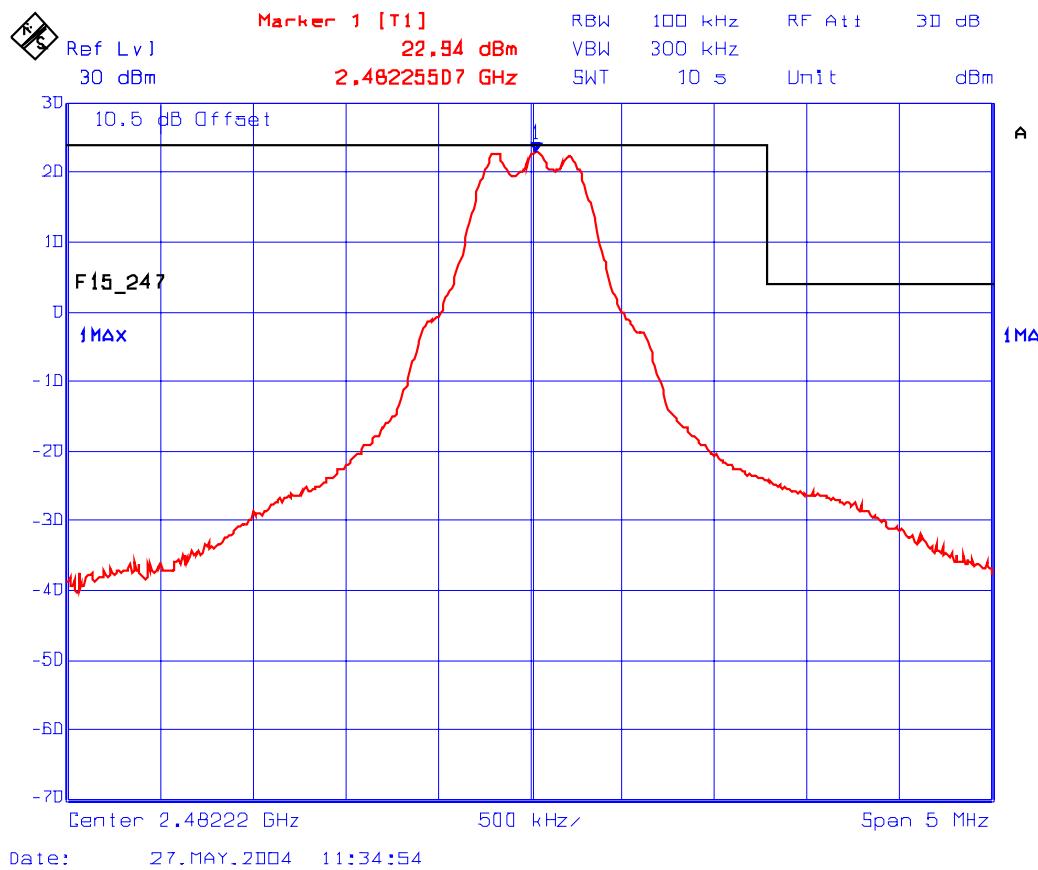
Plot 28:  
Band-Edge RF Conducted Emissions (Handset)  
Low End of Frequency Band  
Single Frequency Mode



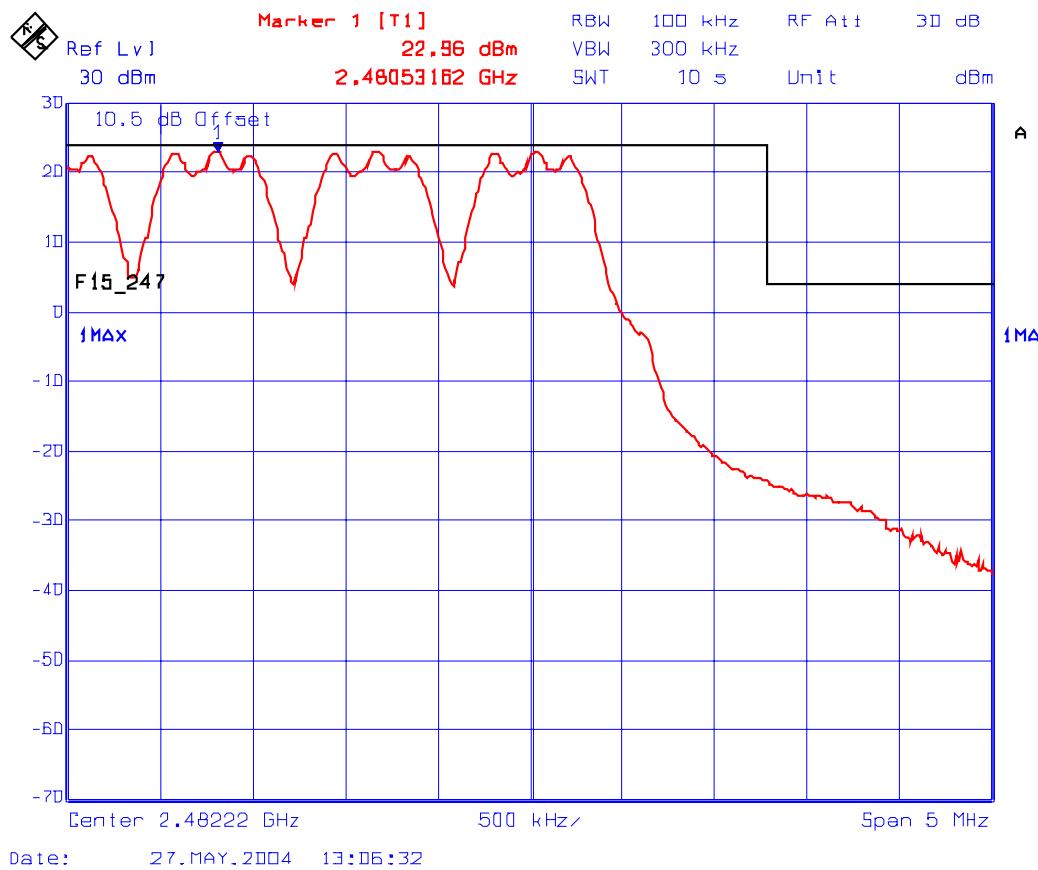
Plot 29:  
Band-Edge RF Conducted Emissions (Handset)  
Low End of Frequency Band  
Pseudorandom Channel Hopping Mode



Plot 30:  
Band-Edge RF Conducted Emissions (Handset)  
High End of Frequency Band  
Single Frequency Mode



Plot 31:  
Band-Edge RF Conducted Emissions (Handset)  
High End of Frequency Band  
Pseudorandom Channel Hopping Mode



### 6.10.5.2. Transmitter Spurious RF Conducted Emissions

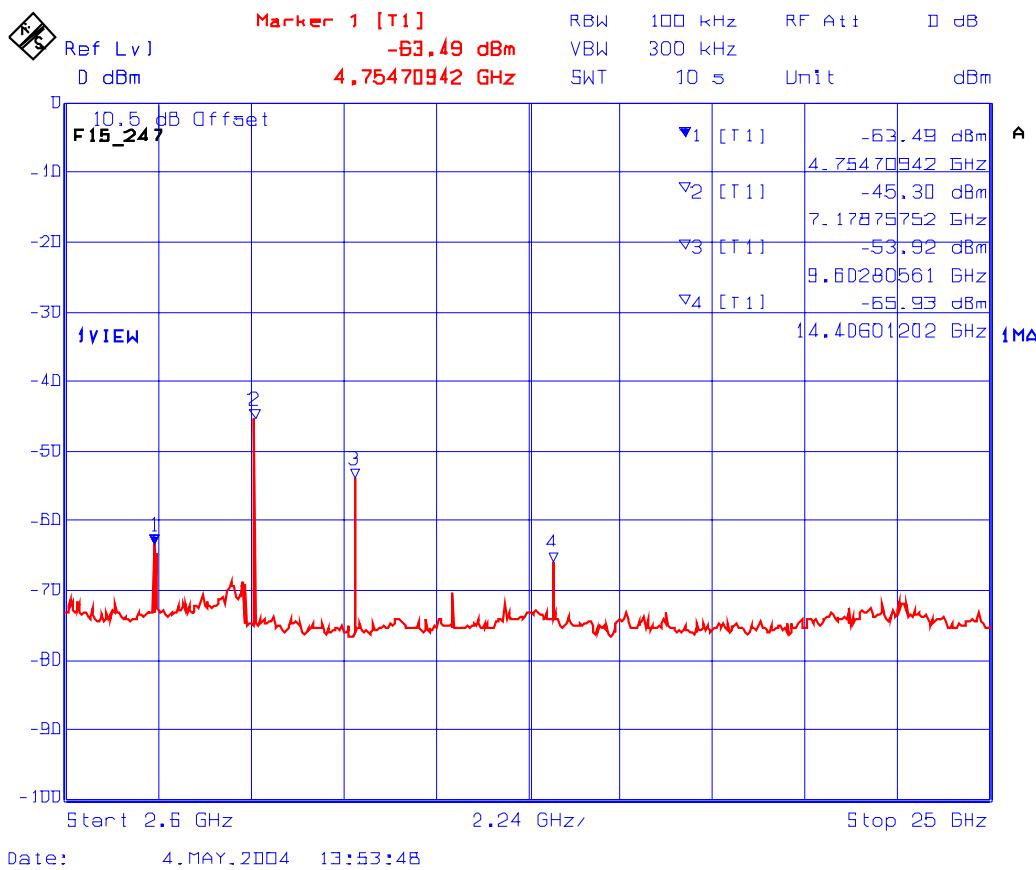
#### 6.10.5.2.1. Lowest Frequency (2401.056 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data plots (32 to 35) for measurement results.

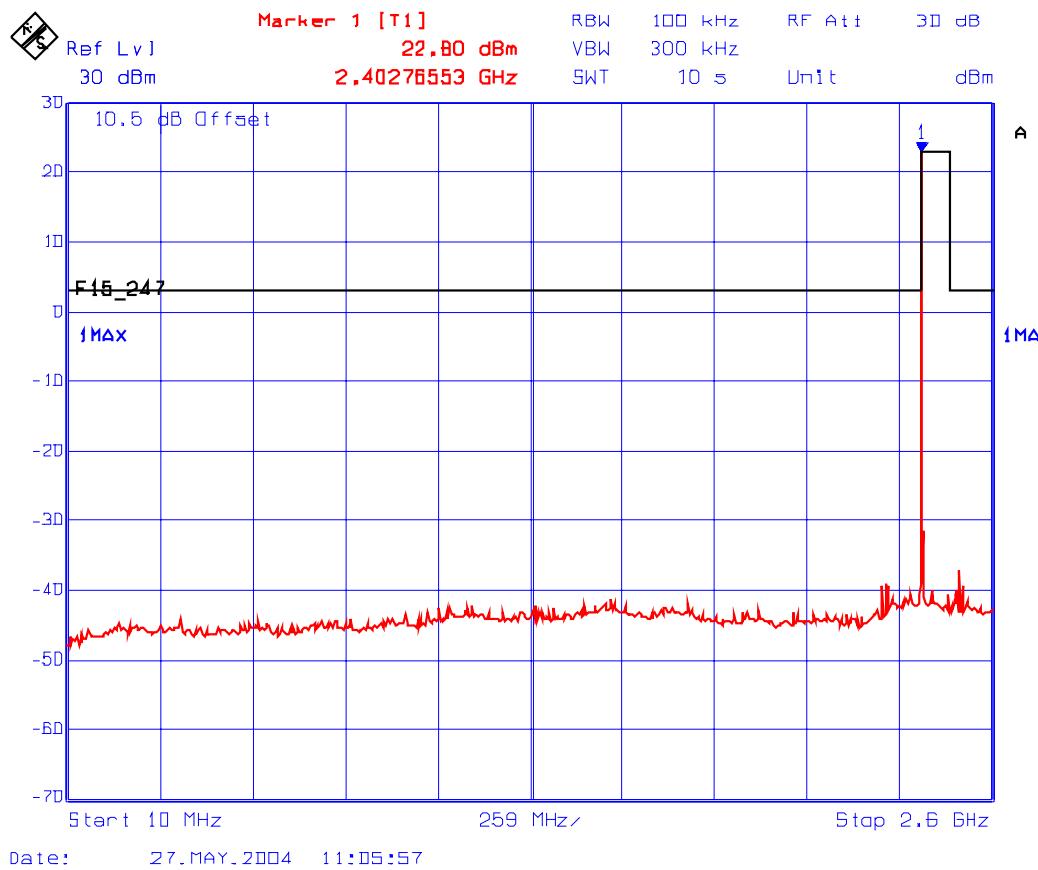
Plot 32:  
Spurious RF Conducted Emissions (Base Station)  
Test Frequency: 2401.056 MHz (CH 00)



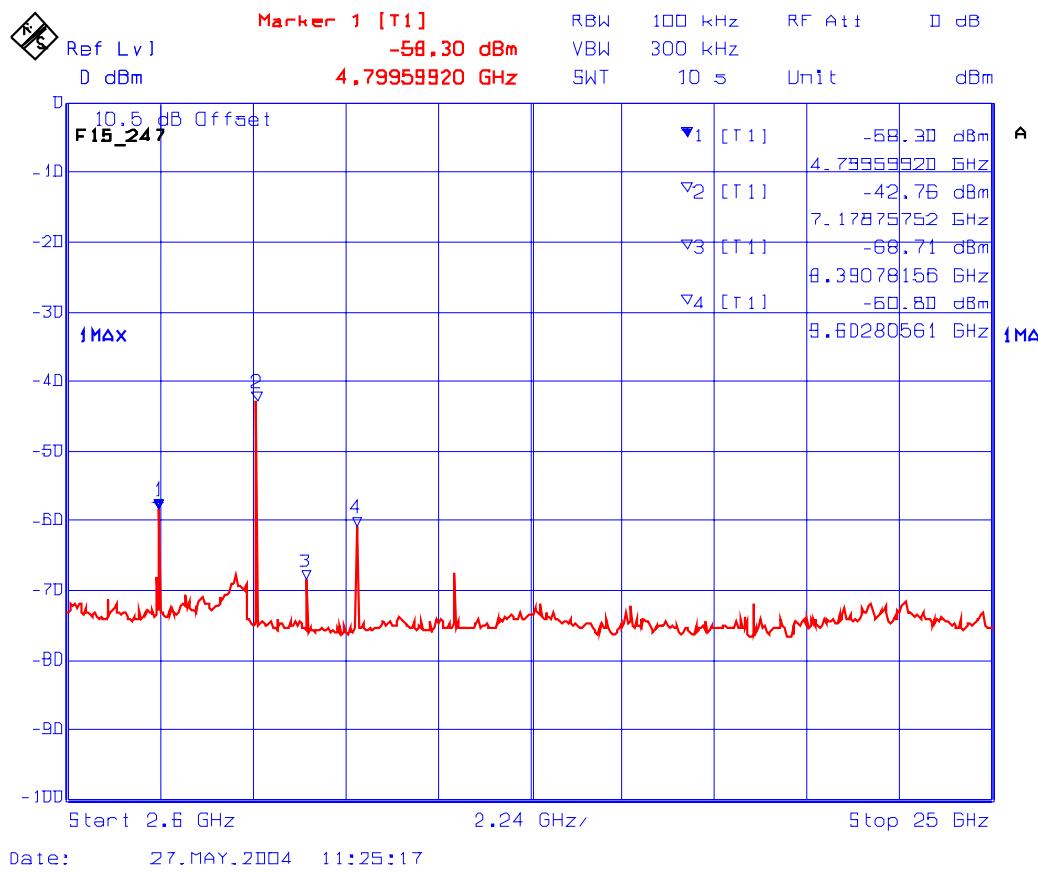
Plot 33:  
Spurious RF Conducted Emissions (Base Station)  
Test Frequency: 2401.056 MHz (CH 00)



Plot 34:  
Spurious RF Conducted Emissions (Handset)  
Test Frequency: 2401.056 MHz (CH 00)



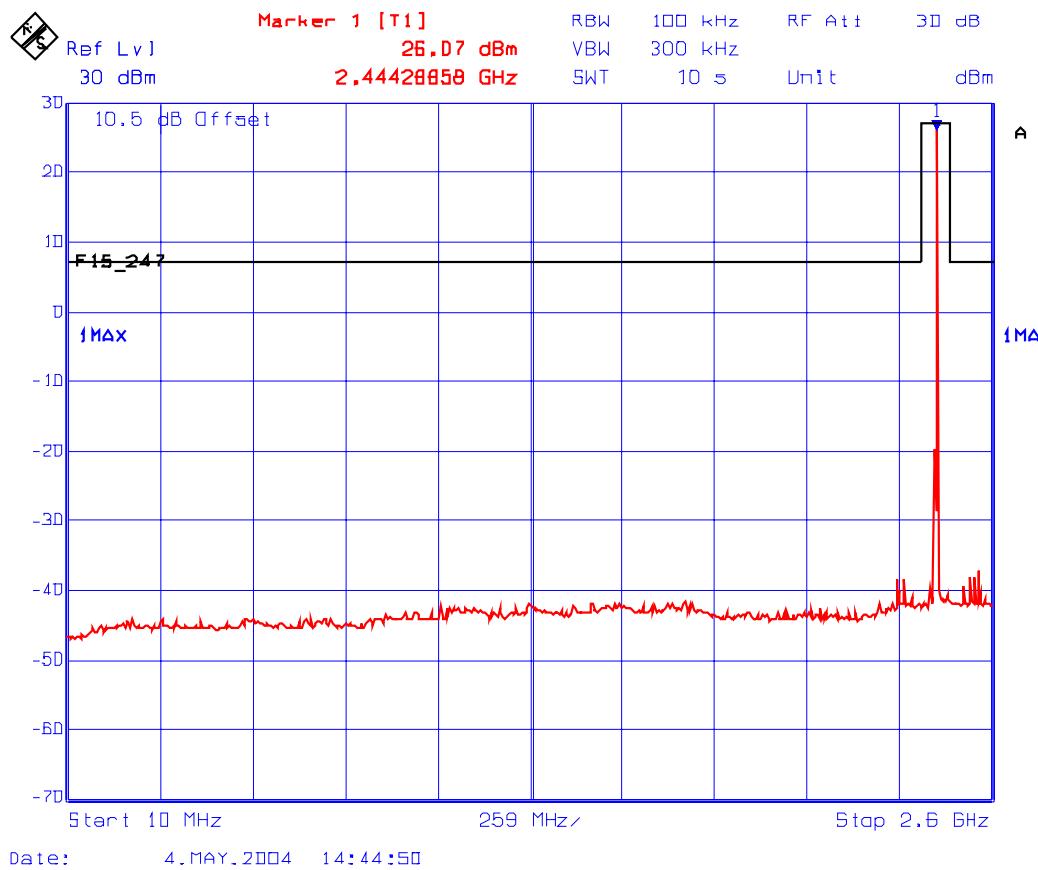
Plot 35:  
Spurious RF Conducted Emissions (Handset)  
Test Frequency: 2401.056 MHz (CH 00)



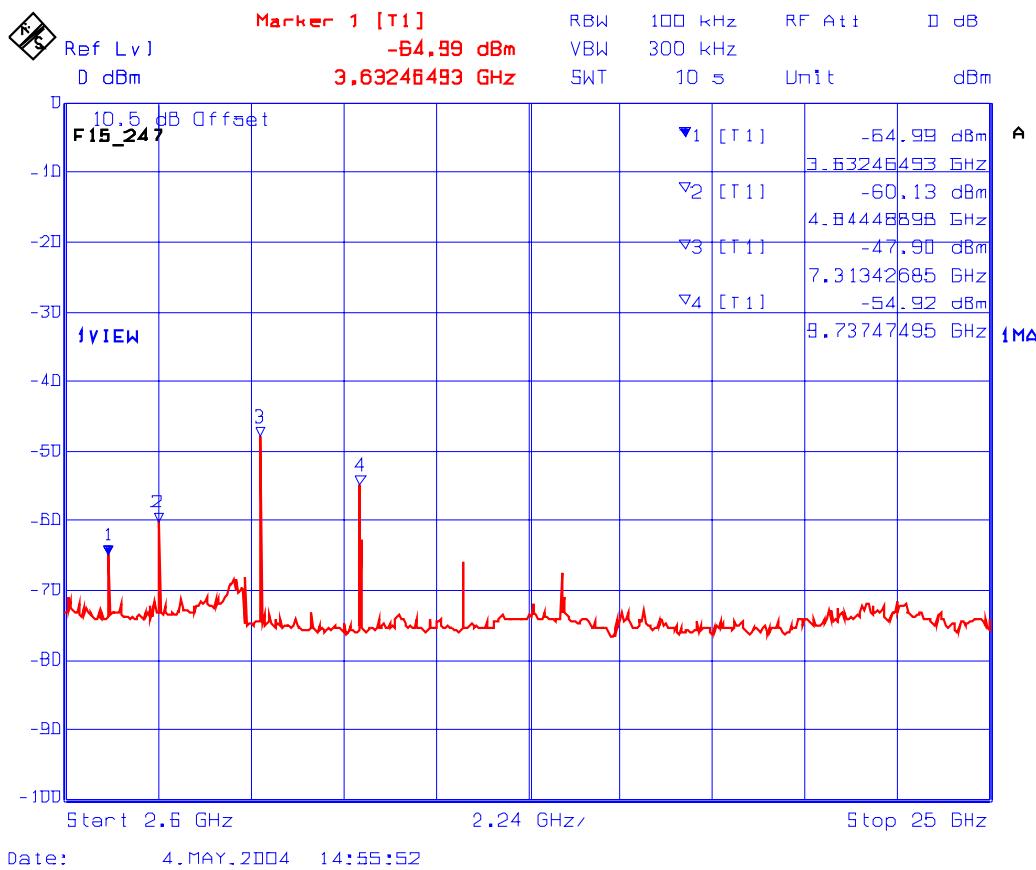
#### 6.10.5.2.2. Middle Frequency (2441.664 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data plots (36 to 39) for measurement results.

Plot 36:  
Spurious RF Conducted Emissions (Base Station)  
Transmitter Frequency: 2441.664 MHz (CH 47)



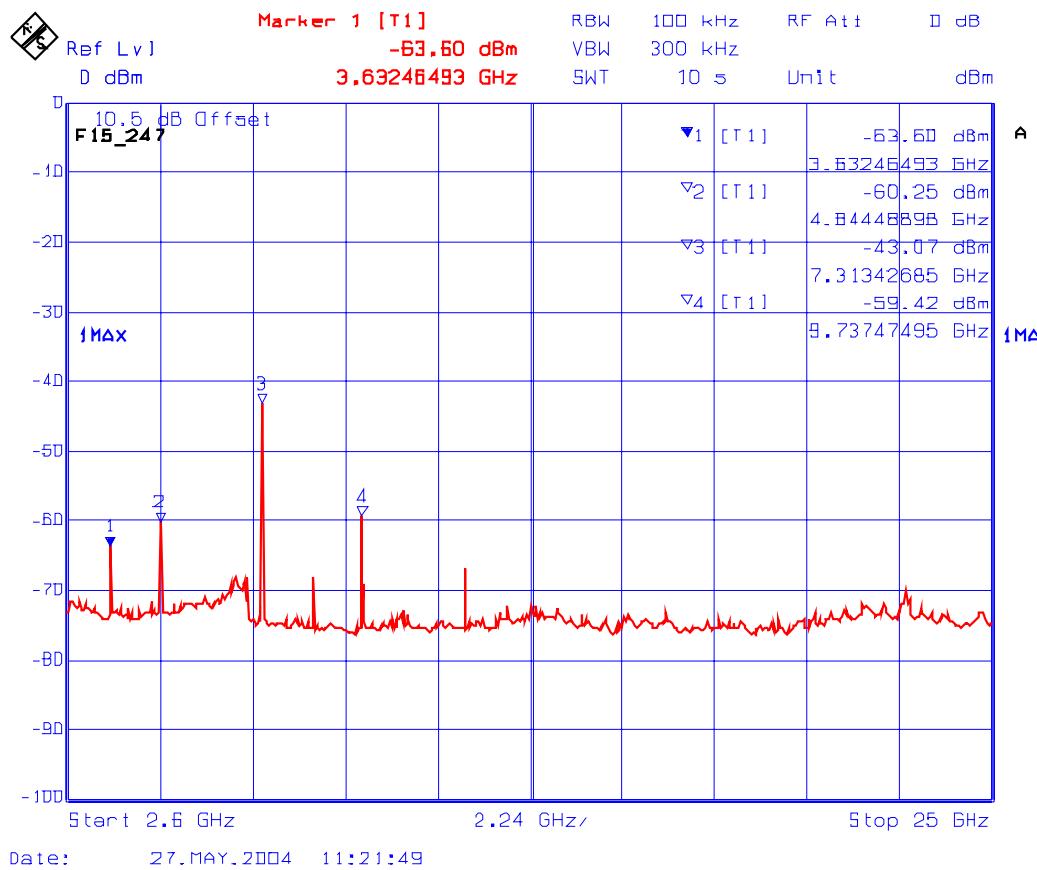
Plot 37:  
Spurious RF Conducted Emissions (Base Station)  
Transmitter Frequency: 2441.664 MHz (CH 47)



Plot 38:  
Spurious RF Conducted Emissions (Handset)  
Transmitter Frequency: 2441.664 MHz (CH 47)



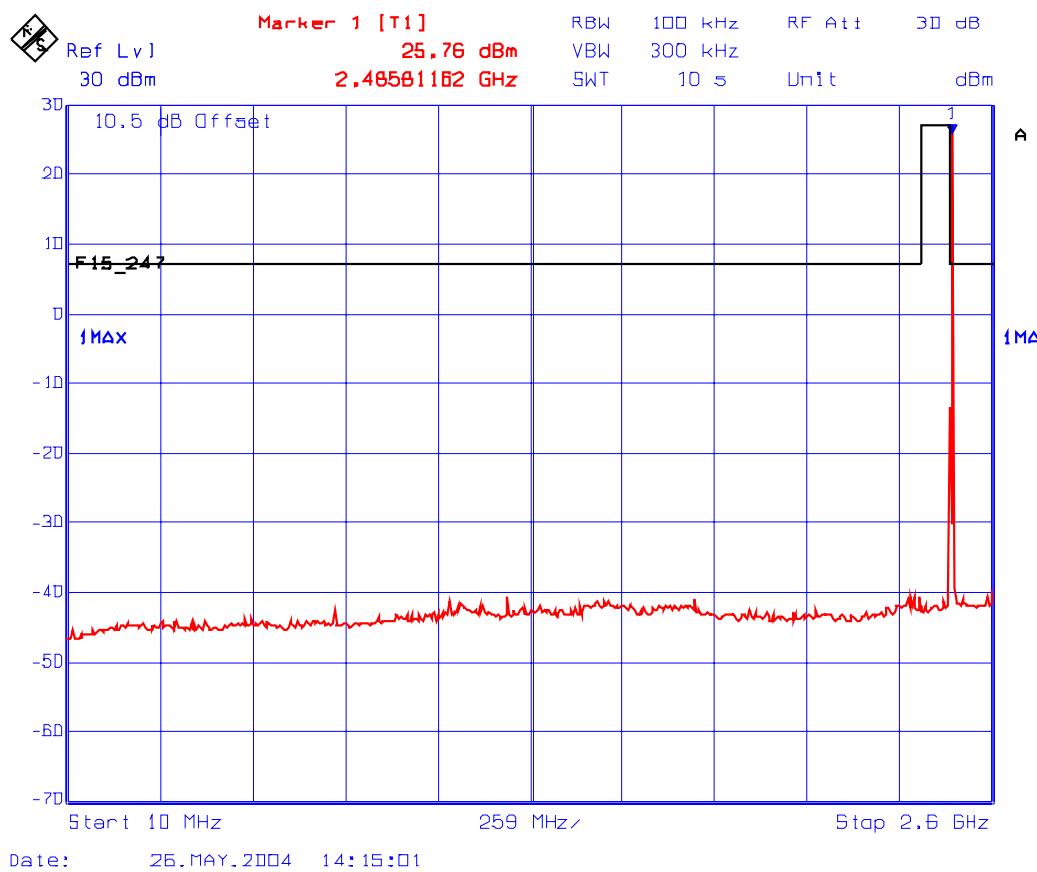
Plot 39:  
Spurious RF Conducted Emissions (Handset)  
Test Frequency: 2441.664 MHz (CH 47)



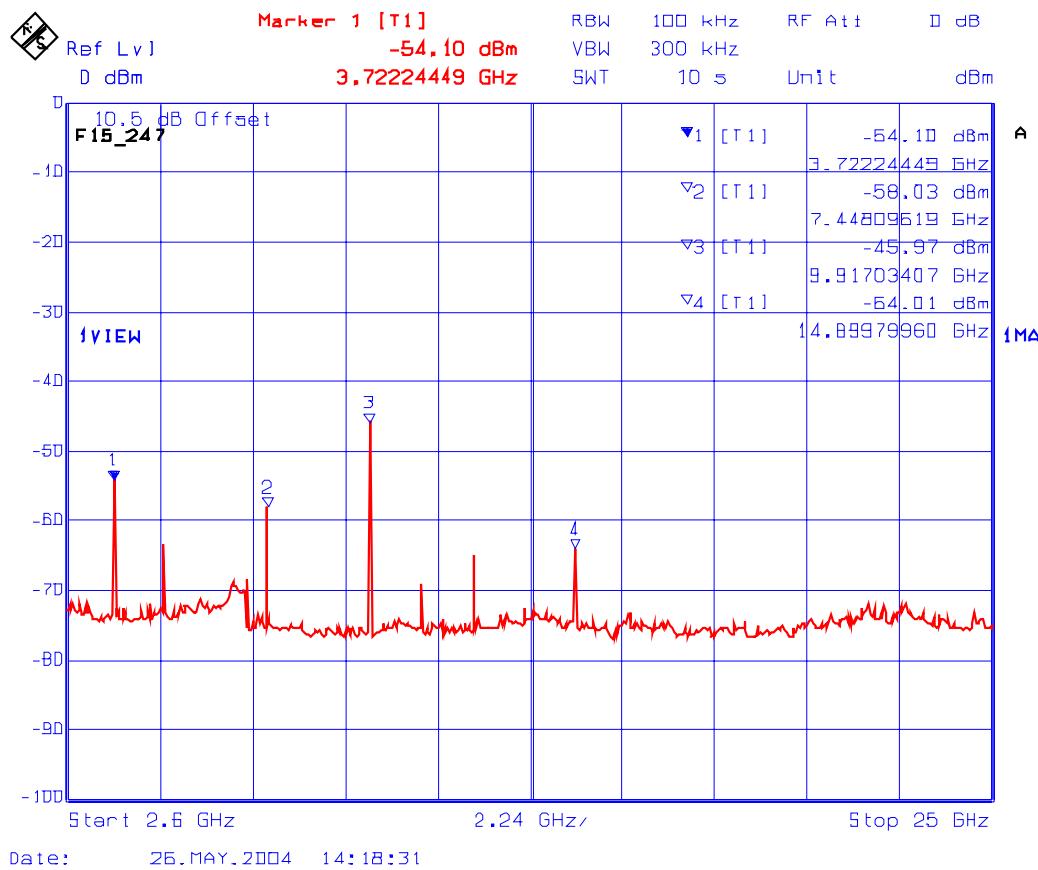
#### 6.10.5.2.3. Highest Frequency (2482.272 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data plots (40 to 43) for measurement results.

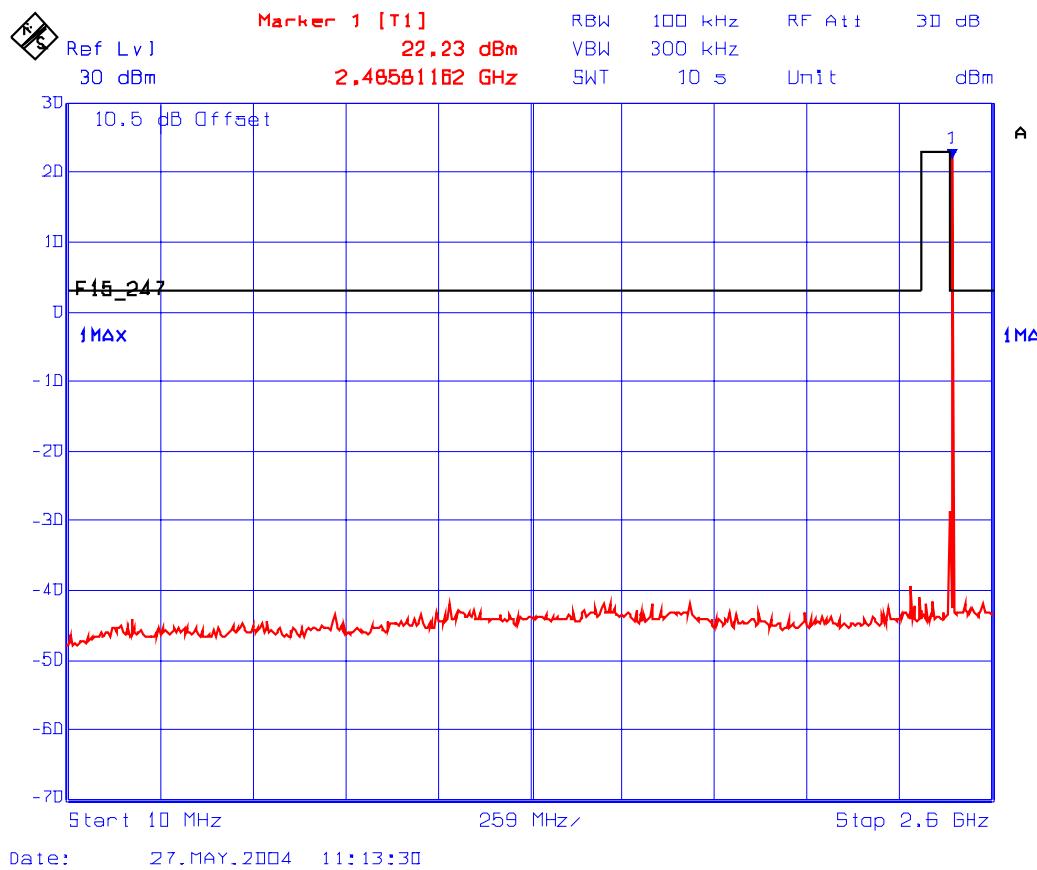
Plot 40:  
Spurious RF Conducted Emissions (Base Station)  
Test Frequency: 2482.272 MHz (CH 94)



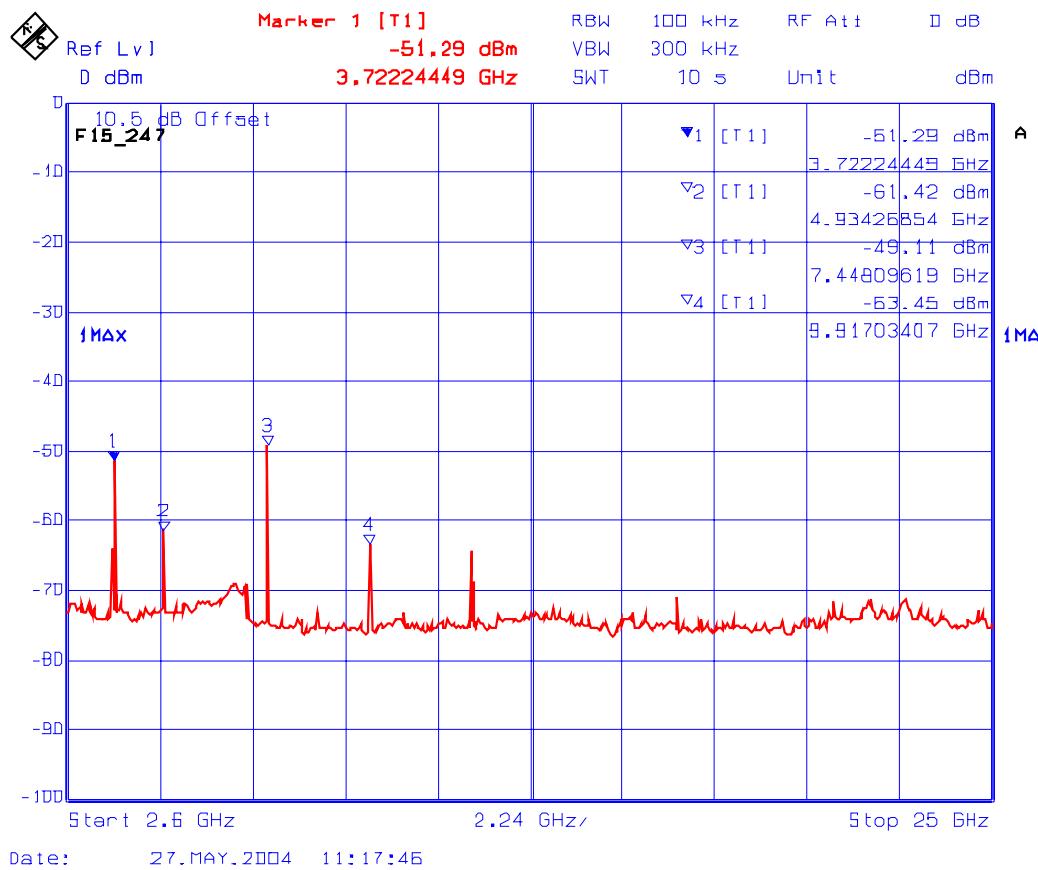
Plot 41:  
Spurious RF Conducted Emissions (Base Station)  
Test Frequency: 2482.272 MHz (CH 94)



Plot 42:  
Spurious RF Conducted Emissions (Handset)  
Test Frequency: 2482.272 MHz (CH 94)



Plot 43:  
Spurious RF Conducted Emissions (Handset)  
Test Frequency: 2482.272 MHz (CH 94)



## 6.11. TRANSMITTER BAND-EDGE & SPURIOUS RADIATED EMISSIONS AT 3 METERS [47 CFR §§ 15.247(c), 15.209 & 15.205]

### 6.11.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

In addition, radiated emissions, which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (see Section 15.205(c)).

#### Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.
- The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in section 15.35 for limiting peak emissions apply.

### 47 CFR 15.205(a) - Restricted Frequency Bands

| MHz                            | MHz                 | MHz           | GHz              |
|--------------------------------|---------------------|---------------|------------------|
| 0.090–0.110 .....              | 16.42–16.423        | 399.9–410     | 4.5–5.15         |
| <sup>1</sup> 0.495–0.505 ..... | 16.69475–16.69525   | 608–614       | 5.35–5.46        |
| 2.1735–2.1905 .....            | 16.80425–16.80475   | 960–1240      | 7.25–7.75        |
| 4.125–4.128 .....              | 25.5–25.67          | 1300–1427     | 8.025–8.5        |
| 4.17725–4.17775 .....          | 37.5–38.25          | 1435–1626.5   | 9.0–9.2          |
| 4.20725–4.20775 .....          | 73–74.6             | 1645.5–1646.5 | 9.3–9.5          |
| 6.215–6.218 .....              | 74.8–75.2           | 1660–1710     | 10.6–12.7        |
| 6.26775–6.26825 .....          | 108–121.94          | 1718.8–1722.2 | 13.25–13.4       |
| 6.31175–6.31225 .....          | 123–138             | 2200–2300     | 14.47–14.5       |
| 8.291–8.294 .....              | 149.9–150.05        | 2310–2390     | 15.35–16.2       |
| 8.362–8.366 .....              | 156.52475–156.52525 | 2483.5–2500   | 17.7–21.4        |
| 8.37625–8.38675 .....          | 156.7–156.9         | 2655–2900     | 22.01–23.12      |
| 8.41425–8.41475 .....          | 162.0125–167.17     | 3260–3267     | 23.6–24.0        |
| 12.29–12.293 .....             | 167.72–173.2        | 3332–3339     | 31.2–31.8        |
| 12.51975–12.52025 .....        | 240–285             | 3345.8–3358   | 36.43–36.5       |
| 12.57675–12.57725 .....        | 322–335.4           | 3600–4400     | ( <sup>2</sup> ) |
| 13.36–13.41.                   |                     |               |                  |

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

<sup>2</sup> Above 38.6

### 47 CFR 15.209(a) -- Field Strength Limits within Restricted Frequency Bands --

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|-----------------|-----------------------------------|-------------------------------|
| 0.009 - 0.490   | 2,400 / F (kHz)                   | 300                           |
| 0.490 - 1.705   | 24,000 / F (kHz)                  | 30                            |
| 1.705 - 30.0    | 30                                | 30                            |
| 30 - 88         | 100                               | 3                             |
| 88 - 216        | 150                               | 3                             |
| 216 - 960       | 200                               | 3                             |
| Above 960       | 500                               | 3                             |

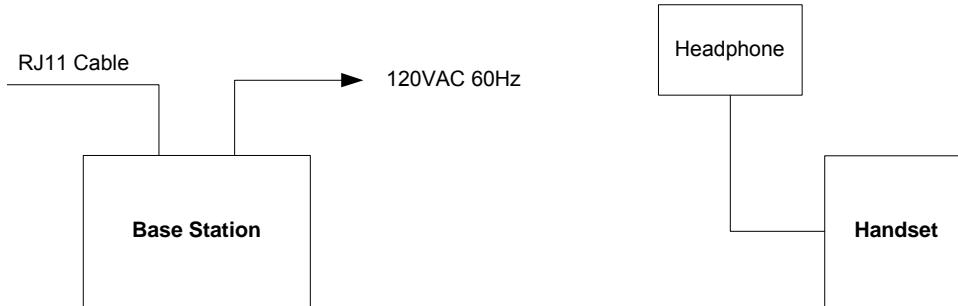
### 6.11.2. Method of Measurements

Refer to Section 8.4 of this test report and ANSI C63.4 for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For measurement below 1 GHz, set RBW = 100 KHz, VBW  $\geq$  100 KHz, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Sections 15.35(b) and (c).

### 6.11.3. Test Arrangement



### 6.11.4. Test Equipment List

| Test Instruments    | Manufacturer    | Model No.     | Serial No. | Frequency Range   |
|---------------------|-----------------|---------------|------------|-------------------|
| Spectrum Analyzer   | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz    |
| Microwave Amplifier | Hewlett Packard | 83051A        | 3611A01947 | 40 MHz to 50 GHz  |
| Biconilog Antenna   | EMCO            | 3143          | 1029       | 20 MHz to 2 GHz   |
| Horn Antenna        | EMCO            | 3155          | 9701-5061  | 1 GHz – 18 GHz    |
| Horn Antenna        | EMCO            | 3160-09       | ..         | 18 GHz – 26.5 GHz |
| Horn Antenna        | EMCO            | 3160-10       | ..         | 26.5 GHz – 40 GHz |
| Mixer               | Tektronix       | 118-0098-00   | ..         | 18 GHz – 26.5 GHz |
| Mixer               | Tektronix       | 119-0098-00   | ..         | 26.5 GHz – 40 GHz |

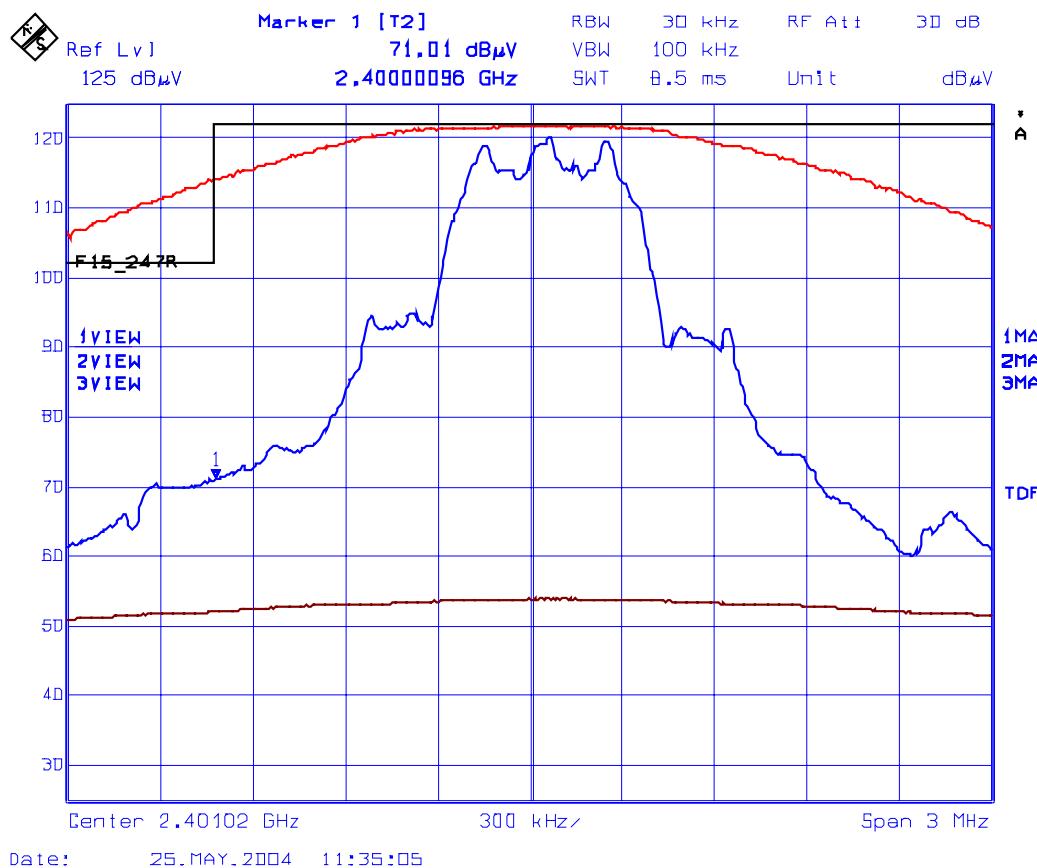
### 6.11.5. Test Data

The following test results are the worst-case measurements:

#### 6.11.5.1. Band-Edge RF Radiated Emissions @ 3 Meters

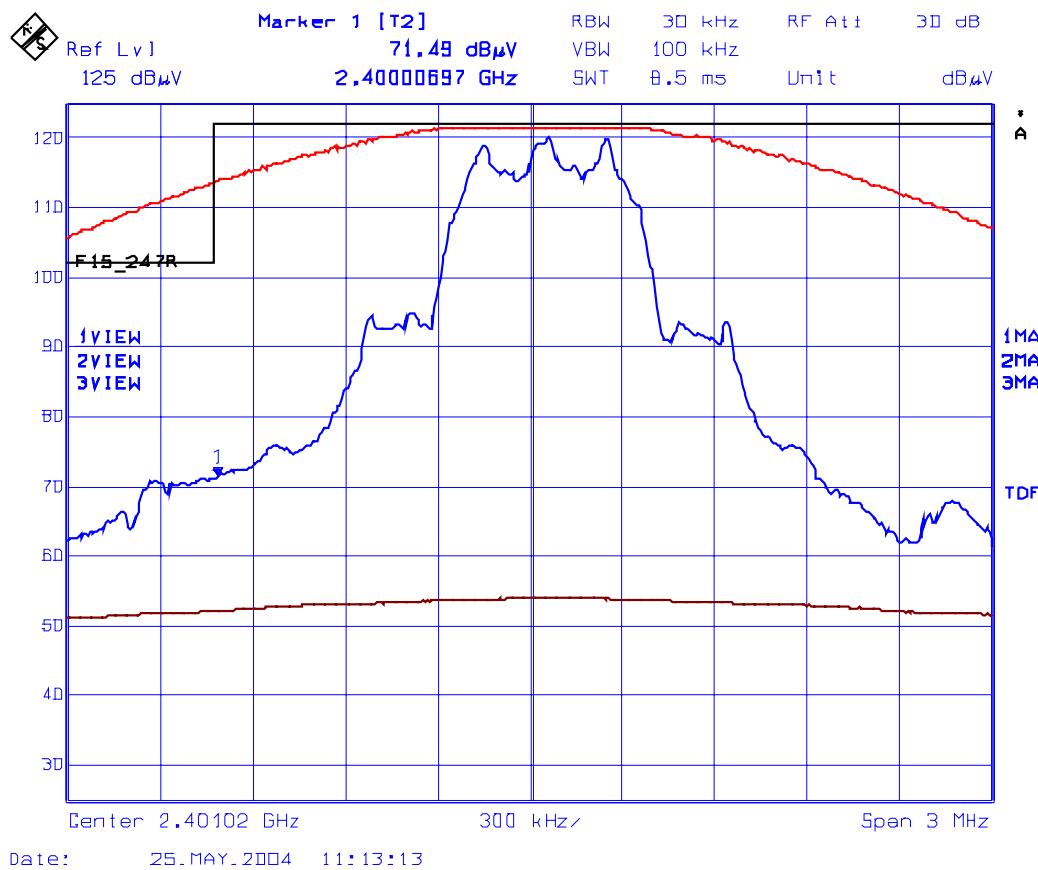
Refer to the following test data plots (44 to 51) for measurement results:

Plot 44:  
Band-Edge RF Radiated Emissions @ 3 meters (Base Station)  
Low End of Frequency Band  
Vertical Polarization



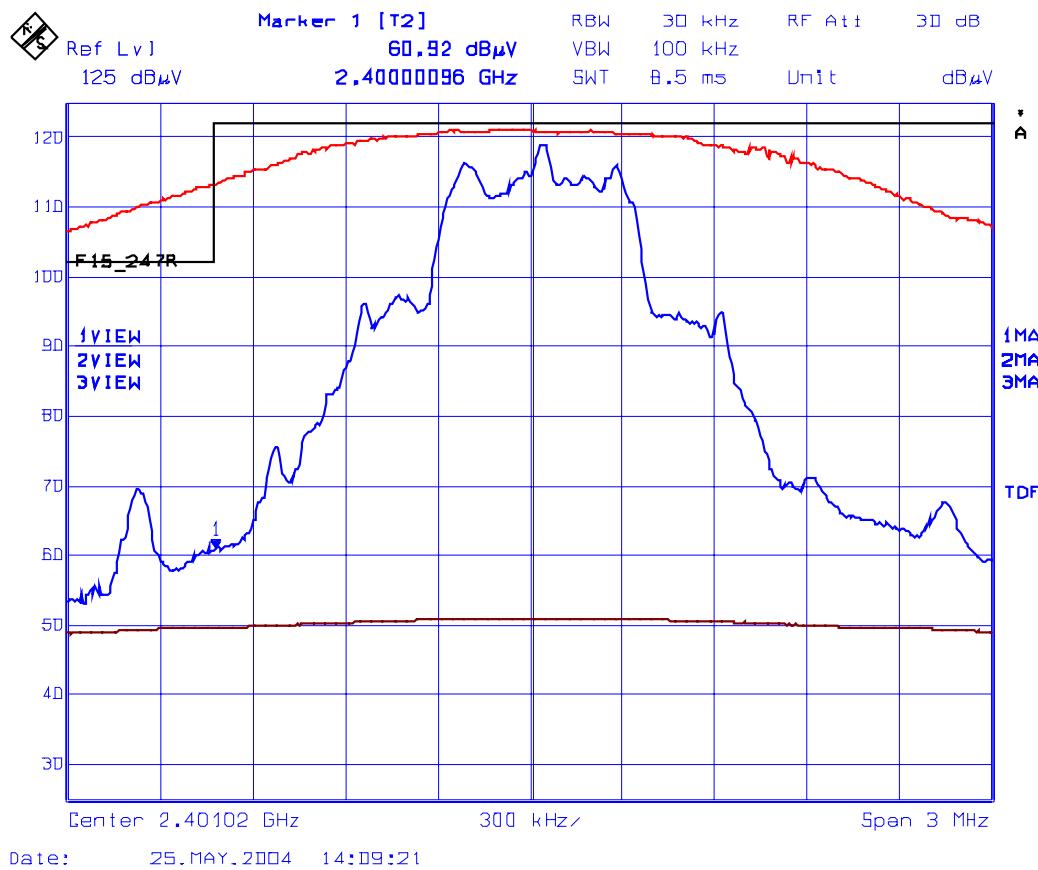
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 113.90 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 71.01 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 52.08 dB $\mu$ V/m

Plot 45:  
 Band-Edge RF Radiated Emissions @ 3 meters (Base Station)  
 Low End of Frequency Band  
 Horizontal Polarization



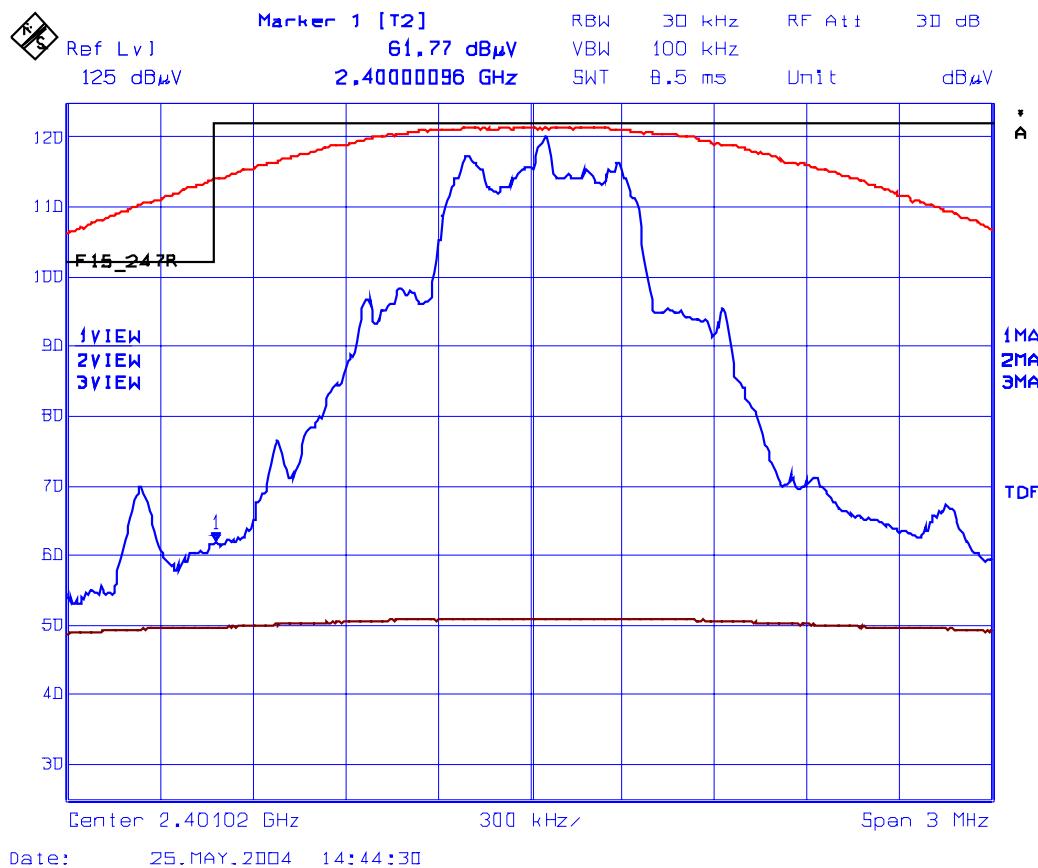
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 113.67 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 71.49 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 52.14 dB $\mu$ V/m

Plot 46:  
Band-Edge RF Radiated Emissions @ 3 meters (Handset)  
Low End of Frequency Band  
Vertical Polarization



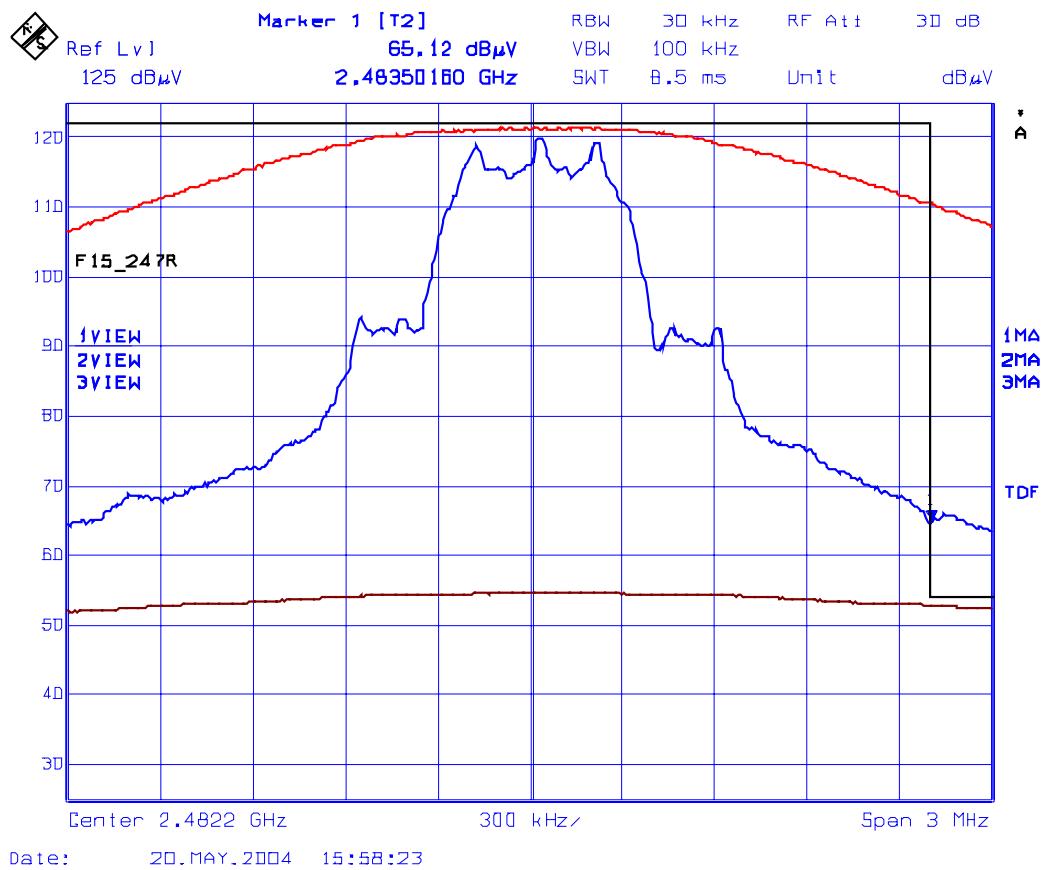
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 113.23 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 60.92 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 49.56 dB $\mu$ V/m

Plot 47:  
 Band-Edge RF Radiated Emissions @ 3 meters (Handset)  
 Low End of Frequency Band  
 Horizontal Polarization



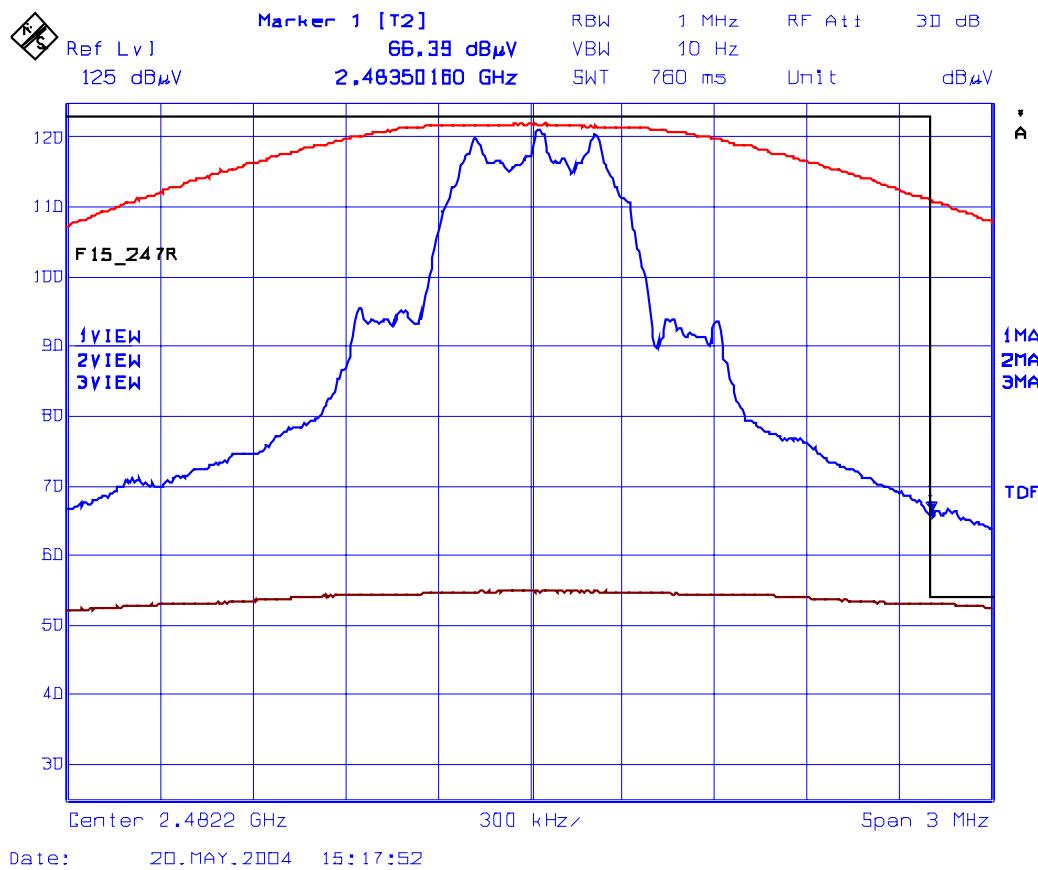
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 113.84 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 61.77 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 49.85 dB $\mu$ V/m

Plot 48:  
Band-Edge RF Radiated Emissions @ 3 meters (Base Station)  
Upper End of Frequency Band  
Vertical Polarization



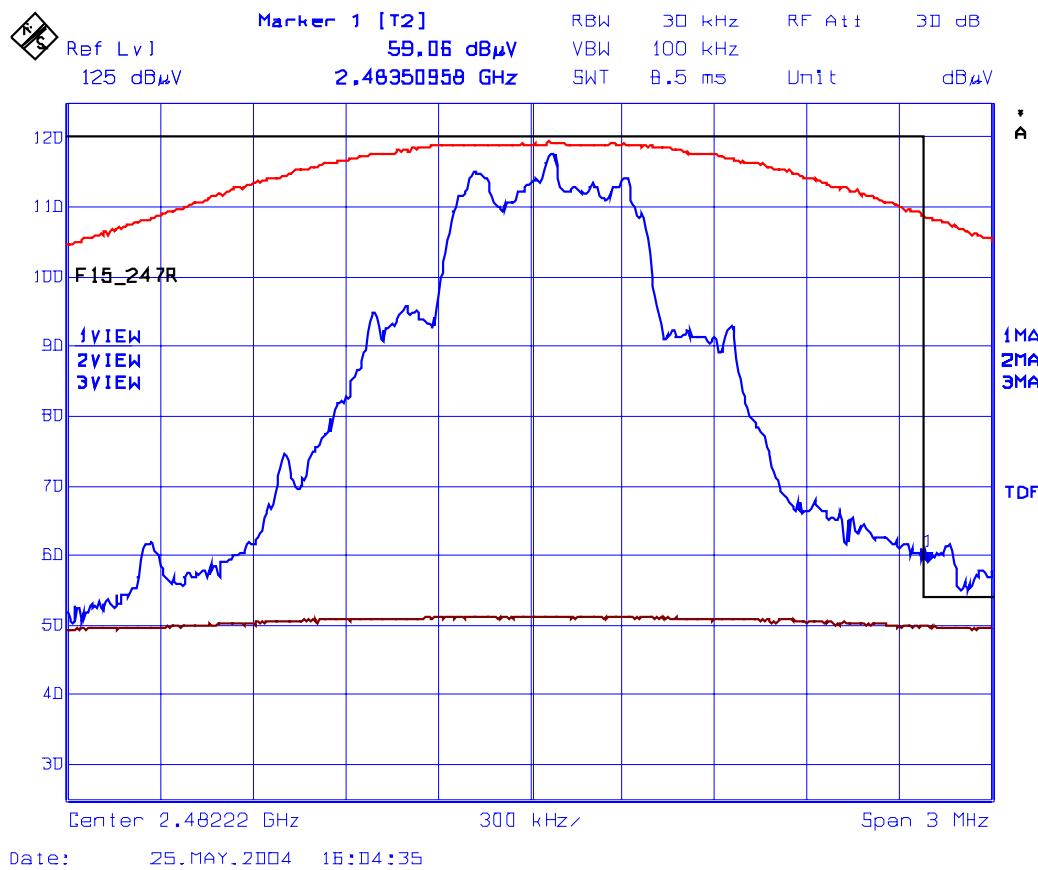
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 110.27 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 65.12 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 52.68 dB $\mu$ V/m

Plot 49:  
 Band-Edge RF Radiated Emissions @ 3 meters (Base Station)  
 Upper End of Frequency Band  
 Horizontal Polarization



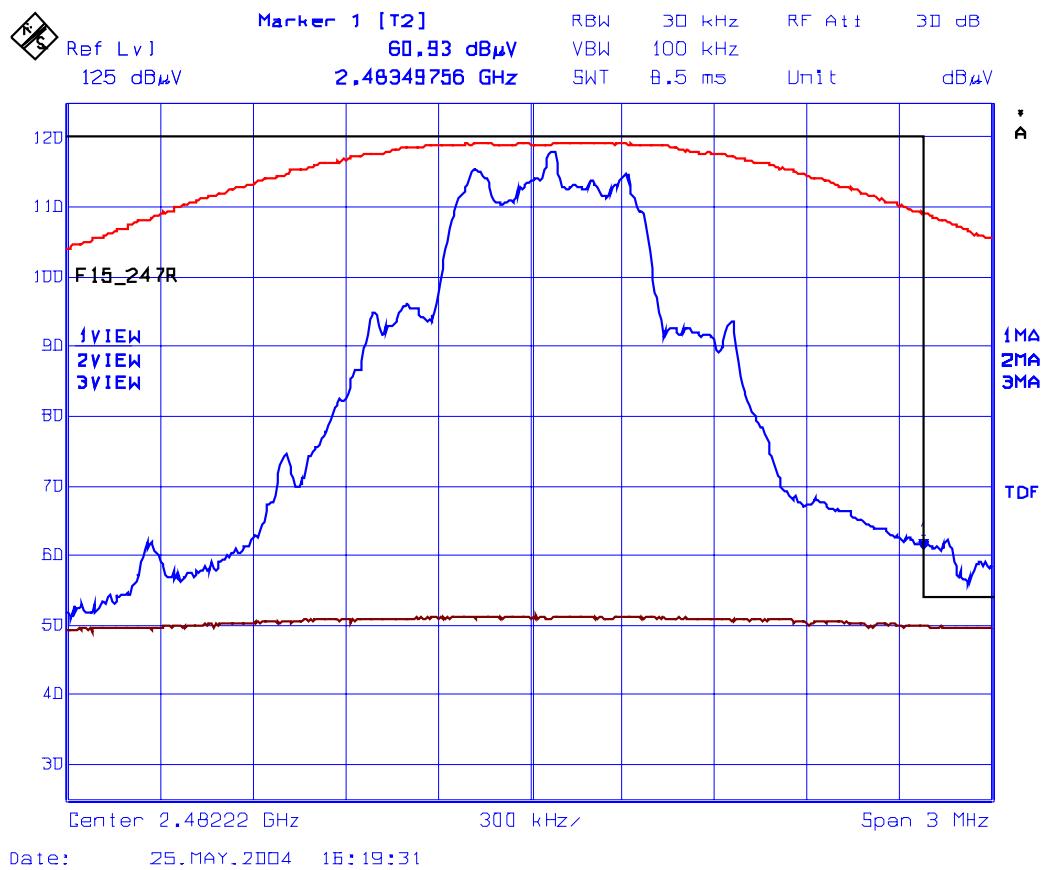
- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 110.82 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 66.39 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 52.87 dB $\mu$ V/m

Plot 50:  
Band-Edge RF Radiated Emissions @ 3 meters (Handset)  
Upper End of Frequency Band  
Vertical Polarization



— Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 108.38 dB $\mu$ V/m  
— Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 59.06 dB $\mu$ V/m  
— Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 49.79 dB $\mu$ V/m

Plot 51:  
Band-Edge RF Radiated Emissions @ 3 meters (Handset)  
Upper End of Frequency Band  
Horizontal Polarization



- Trace 1: RBW= 1 MHz, VBW= 3 MHz, level: 108.90 dB $\mu$ V/m
- Trace 2: RBW= 30 kHz, VBW= 100 kHz, level: 60.93 dB $\mu$ V/m
- Trace 3: RBW= 1 MHz, VBW= 10 Hz, level: 49.76 dB $\mu$ V/m

**6.11.5.2. Spurious Radiated Emissions @ 3 Meters**

Fundamental Frequency: 2401.056 MHz (CH 00)  
 Test Frequency Range: 30 MHz – 25 GHz

| Frequency (MHz)     | RF Peak Level (dB $\mu$ V/m) | RF Avg Level (dB $\mu$ V/m) | Antenna Plane (H/V) | Limit 15.209 (dB $\mu$ V/m) | Limit 15.247 (dB $\mu$ V/m) | Margin (dB) | Pass/Fail |
|---------------------|------------------------------|-----------------------------|---------------------|-----------------------------|-----------------------------|-------------|-----------|
| <b>Base Station</b> |                              |                             |                     |                             |                             |             |           |
| 2401.056            | 121.49                       | --                          | V                   | --                          | --                          | --          | --        |
| 2401.056            | 121.67                       | --                          | H                   | --                          | --                          | --          | --        |
| 4802.112            | 56.62                        | 35.74                       | V                   | 54.0                        | 101.7                       | -18.3       | Pass*     |
| 4802.112            | 58.34                        | 36.07                       | H                   | 54.0                        | 101.7                       | -17.9       | Pass*     |
| 7203.168            | 63.09                        | 39.37                       | V                   | 54.0                        | 101.7                       | -14.6       | Pass*     |
| 7203.168            | 63.78                        | 39.56                       | H                   | 54.0                        | 101.7                       | -14.4       | Pass*     |
| <b>Handset</b>      |                              |                             |                     |                             |                             |             |           |
| 2401.056            | 120.90                       | --                          | V                   | --                          | --                          | --          | --        |
| 2401.056            | 121.21                       | --                          | H                   | --                          | --                          | --          | --        |
| 4802.112            | 67.51                        | 36.23                       | V                   | 54.0                        | 101.2                       | -17.8       | Pass*     |
| 4802.112            | 63.03                        | 35.97                       | H                   | 54.0                        | 101.2                       | -18.0       | Pass*     |
| 7203.168            | 58.83                        | 36.61                       | V                   | 54.0                        | 101.2                       | -17.4       | Pass*     |
| 7203.168            | 60.18                        | 38.05                       | H                   | 54.0                        | 101.2                       | -16.0       | Pass*     |

All other spurious emissions and harmonics are attenuated more than 20 dB below the permissible limit.

\* Emission inside restricted bands.

Fundamental Frequency: 2441.664 MHz (CH 47)  
 Test Frequency Range: 30 MHz – 25 GHz

| Frequency (MHz)  | RF Peak Level (dB $\mu$ V/m) | RF Avg Level (dB $\mu$ V/m) | Antenna Plane (H/V) | Limit 15.209 (dB $\mu$ V/m) | Limit 15.247 (dB $\mu$ V/m) | Margin (dB) | Pass/Fail |
|--|------------------------------|-----------------------------|---------------------|-----------------------------|-----------------------------|-------------|-----------|
| <b>Base Station</b>  |                              |                             |                     |                             |                             |             |           |
| 2441.664   | 120.05                       | --                          | V                   | --                          | --                          | --          | --        |
| 2441.664   | 120.78                       | --                          | H                   | --                          | --                          | --          | --        |
| 4883.328   | 55.59                        | 35.39                       | V                   | 54.0                        | 100.8                       | -18.6       | Pass*     |
| 4883.328   | 56.34                        | 35.66                       | H                   | 54.0                        | 100.8                       | -18.3       | Pass*     |
| 7324.992   | 63.55                        | 40.13                       | V                   | 54.0                        | 100.8                       | -13.9       | Pass*     |
| 7324.992   | 65.86                        | 40.56                       | H                   | 54.0                        | 100.8                       | -13.4       | Pass*     |
| <b>Handset</b>   |                              |                             |                     |                             |                             |             |           |
| 2441.664   | 120.15                       | --                          | V                   | --                          | --                          | --          | --        |
| 2441.664   | 121.02                       | --                          | H                   | --                          | --                          | --          | --        |
| 4883.328   | 67.65                        | 36.21                       | V                   | 54.0                        | 101.0                       | -17.8       | Pass*     |
| 4883.328   | 63.62                        | 36.31                       | H                   | 54.0                        | 101.0                       | -17.7       | Pass*     |
| 7324.992   | 57.50                        | 38.21                       | V                   | 54.0                        | 101.0                       | -15.8       | Pass*     |
| 7324.992   | 58.63                        | 38.05                       | H                   | 54.0                        | 101.0                       | -16.0       | Pass*     |
| All other spurious emissions and harmonics are attenuated more than 20 dB below the permissible limit. |                              |                             |                     |                             |                             |             |           |

\* Emission inside restricted bands.

Fundamental Frequency: 2482.272 MHz (CH 94)  
 Test Frequency Range: 30 MHz – 25 GHz

| Frequency (MHz)  | RF Peak Level (dB $\mu$ V/m) | RF Avg Level (dB $\mu$ V/m) | Antenna Plane (H/V) | Limit 15.209 (dB $\mu$ V/m) | Limit 15.247 (dB $\mu$ V/m) | Margin (dB) | Pass/Fail |
|--|------------------------------|-----------------------------|---------------------|-----------------------------|-----------------------------|-------------|-----------|
| <b>Base Station</b>  |                              |                             |                     |                             |                             |             |           |
| 2482.272   | 121.30                       | --                          | V                   | --                          | --                          | --          | --        |
| 2482.272   | 121.87                       | --                          | H                   | --                          | --                          | --          | --        |
| 4964.544   | 58.06                        | 35.92                       | V                   | 54.0                        | 101.9                       | -18.1       | Pass*     |
| 4964.544   | 56.63                        | 36.47                       | H                   | 54.0                        | 101.9                       | -17.5       | Pass*     |
| 7446.816   | 62.48                        | 39.77                       | V                   | 54.0                        | 101.9                       | -14.2       | Pass*     |
| 7446.816   | 61.95                        | 40.17                       | H                   | 54.0                        | 101.9                       | -13.8       | Pass*     |
| <b>Handset</b>   |                              |                             |                     |                             |                             |             |           |
| 2482.272   | 119.07                       | --                          | V                   | --                          | --                          | --          | --        |
| 2482.272   | 119.20                       | --                          | H                   | --                          | --                          | --          | --        |
| 4964.544   | 66.55                        | 36.22                       | V                   | 54.0                        | 99.2                        | -17.8       | Pass*     |
| 4964.544   | 64.02                        | 36.32                       | H                   | 54.0                        | 99.2                        | -17.7       | Pass*     |
| 7446.816   | 54.80                        | 37.91                       | V                   | 54.0                        | 99.2                        | -16.1       | Pass*     |
| 7446.816   | 55.69                        | 37.99                       | H                   | 54.0                        | 99.2                        | -16.0       | Pass*     |
| All other spurious emissions and harmonics are attenuated more than 20 dB below the permissible limit. |                              |                             |                     |                             |                             |             |           |

\* Emission inside restricted bands.

## EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

### 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION<br>(Line Conducted)   | PROBABILITY<br>DISTRIBUTION | UNCERTAINTY (dB) |             |
|--|-----------------------------|------------------|-------------|
|  |                             | 9-150 kHz        | 0.15-30 MHz |
| EMI Receiver specification   | Rectangular                 | $\pm 1.5$        | $\pm 1.5$   |
| LISN coupling specification  | Rectangular                 | $\pm 1.5$        | $\pm 1.5$   |
| Cable and Input Transient Limiter calibration  | Normal (k=2)                | $\pm 0.3$        | $\pm 0.5$   |
| Mismatch: Receiver VRC $\Gamma_1 = 0.03$<br>LISN VRC $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$<br>Uncertainty limits $20\text{Log}(1+\Gamma_1\Gamma_R)$ | U-Shaped                    | $\pm 0.2$        | $\pm 0.3$   |
| System repeatability   | Std. deviation              | $\pm 0.2$        | $\pm 0.05$  |
| Repeatability of EUT   | --                          | --               | --          |
| Combined standard uncertainty  | Normal                      | $\pm 1.25$       | $\pm 1.30$  |
| Expanded uncertainty U   | Normal (k=2)                | $\pm 2.50$       | $\pm 2.60$  |

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

## 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION<br>(Radiated Emissions)   | PROBABILITY<br>DISTRIBUTION | UNCERTAINTY (+ dB)              |               |
|--|-----------------------------|---------------------------------|---------------|
|  |                             | 3 m                             | 10 m          |
| Antenna Factor Calibration   | Normal (k=2)                | <u>+1.0</u>                     | <u>+1.0</u>   |
| Cable Loss Calibration   | Normal (k=2)                | <u>+0.3</u>                     | <u>+0.5</u>   |
| EMI Receiver specification   | Rectangular                 | <u>+1.5</u>                     | <u>+1.5</u>   |
| Antenna Directivity  | Rectangular                 | <u>+0.5</u>                     | <u>+0.5</u>   |
| Antenna factor variation with height   | Rectangular                 | <u>+2.0</u>                     | <u>+0.5</u>   |
| Antenna phase center variation   | Rectangular                 | 0.0                             | <u>+0.2</u>   |
| Antenna factor frequency interpolation   | Rectangular                 | <u>+0.25</u>                    | <u>+0.25</u>  |
| Measurement distance variation   | Rectangular                 | <u>+0.6</u>                     | <u>+0.4</u>   |
| Site imperfections   | Rectangular                 | <u>+2.0</u>                     | <u>+2.0</u>   |
| Mismatch: Receiver VRC $\Gamma_1 = 0.2$<br>Antenna VRC $\Gamma_R = 0.67(Bi) 0.3 (Lp)$<br>Uncertainty limits $20\log(1+\Gamma_1\Gamma_R)$ | U-Shaped                    | <u>+1.1</u><br><br><u>-1.25</u> | <u>+0.5</u>   |
| System repeatability   | Std. Deviation              | <u>+0.5</u>                     | <u>+0.5</u>   |
| Repeatability of EUT   |                             | -                               | -             |
| Combined standard uncertainty  | Normal                      | +2.19 / -2.21                   | +1.74 / -1.72 |
| Expanded uncertainty U   | Normal (k=2)                | +4.38 / -4.42                   | +3.48 / -3.44 |

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

## EXHIBIT 8. MEASUREMENT METHODS

### 8.1. GENERAL TEST CONDITIONS

The following test conditions shall be applied throughout the tests covered in this report.

#### 8.1.1. Normal temperature and humidity

- Normal temperature: +15°C to +35°C
- Relative Humidity: +20% to 75%

The actual values during tests shall be recorded in the test report.

#### 8.1.2. Normal power source

##### 8.1.2.1. *Mains Voltage*

The nominal test voltage of the equipment to be connected to mains shall be the nominal mains voltage which is the declared voltage or any of the declared voltages for which the equipment was designed.

The frequency of test power source corresponding to the AC mains shall be between 59 Hz and 61 Hz.

##### 8.1.2.2. *Battery Power Source.*

For operation from battery power sources, the nominal test voltage shall be as declared by the equipment manufacturer. This shall be recorded in the test report.

#### 8.1.3. Operating Condition of Equipment under Test

- All tests shall be performed with the device operating at the number of frequencies in each band specified in the following table:

| Frequency range over which device operates | Number of frequencies | Location in the range of operation           |
|--|-----------------------|--|
| 1 MHz or less                              | 1                     | Middle.                                      |
| 1 to 10 MHz                                | 2                     | 1 near top and 1 near bottom.                |
| More than 10 MHz                           | 3                     | 1 near top, 1 near middle and 1 near bottom. |

- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers

## 8.2. METHOD OF MEASUREMENTS - AC MAINS CONDUCTED EMISSIONS

- AC Mains conducted emissions measurements were performed in accordance with the standard against appropriate limits for each detector function.
- The test was performed in the shielded room, 24'(L) x 16'(W) x 8'(H).
- The test was performed were made over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, AC Mains conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlet. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in this test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (9 KHz RBW, VBW > RBW), frequency span 150 kHz to 30 MHz.
- The maximum conducted emission for a given mode of operation was found by using the following step-by-step procedure:
  - Step1. Monitor the frequency range of interest at a fixed EUT azimuth.
  - Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
  - Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.
  - Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.
- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW > RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and AVERAGE detector mode (10 kHz RBW, 1 Hz VBW). The final highest RF signal levels and frequencies were record.

### 8.3. EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

#### Step 1: Duty Cycle measurements

- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter,  $x = \text{Tx on} / (\text{Tx on} + \text{Tx off})$  with  $0 < x < 1$ , is measured and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

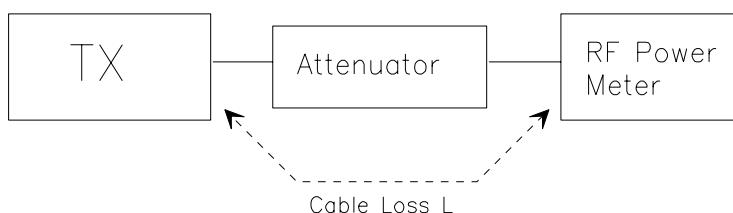
#### Step 2: Calculation of Peak and Average EIRP

- The peak output power of the transmitter shall be determined using a wideband, calibrated RF Peak Power Meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "P" (in dBm);
- The Average EIRP shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{Peak EIRP} = P + G$$

$$\text{Average EIRP} = \text{Peak EIRP} + 10\log(1/x)$$

Figure 1



**Step 3:** Substitution Method. See Figure 2

- (a) The measurements was performed in the absence of modulation (un-modulated)
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The dipole test antenna was used and tuned to the transmitter carrier frequency.
- (e) The spectrum analyzer was tuned to transmitter carrier frequency. The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (f) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (g) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (h) The substitution dipole antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution dipole antenna was placed in vertical polarization. The test dipole antenna was lowered or raised as necessary to ensure that the maximum signal is still received.
- (i) The input signal to the substitution antenna was adjusted in level until an equal or a known related level to that detected from the transmitter was obtained in the test receiver. The maximum carrier radiated power is equal to the power supply by the generator.
- (j) The substitution antenna gain and cable loss were added to the signal generator level for the corrected ERP level.
- (k) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
- (l) Actual gain of the EUT's antenna is the difference of the measured ERP and measured RF power at the RF port. Correct the antenna gain if necessary.

**Figure 2**

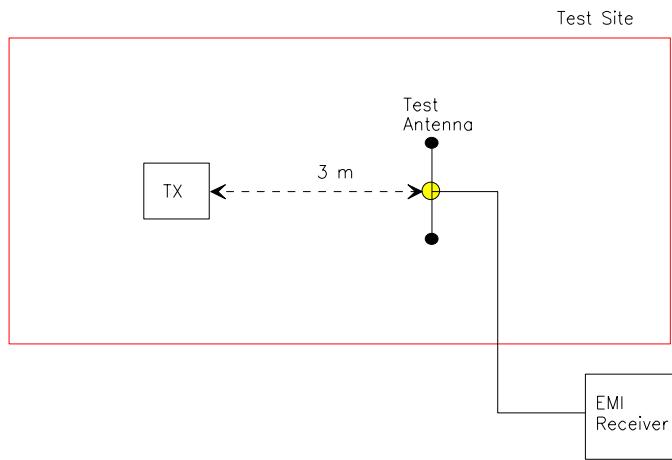
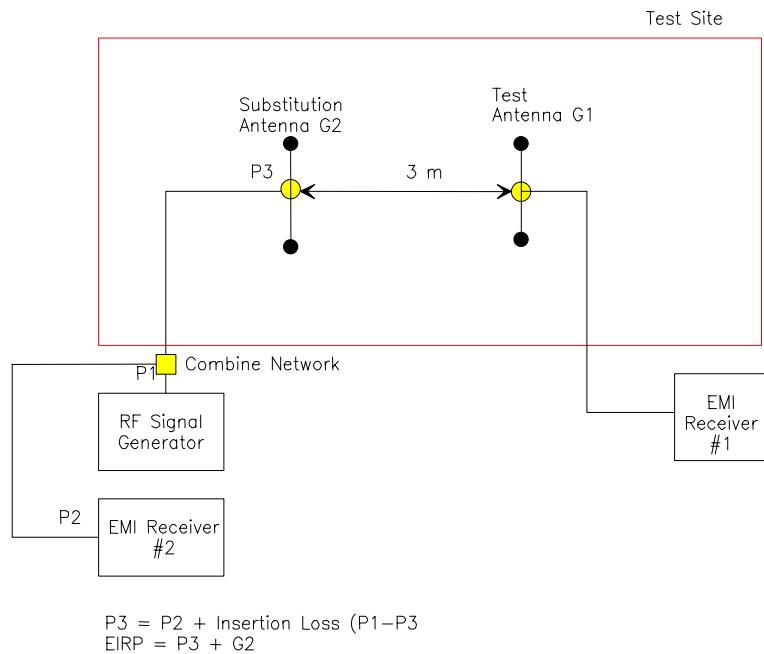


Figure 3



Use the following spectrum analyzer settings:

- Span = approximately 5 times the 20 dB BW, centered on a hopping channel
- RBW > 20 dB BW of the emission measured
- VBW = RBW
- Trace = max hold
- Allow the trace to stabilize
- Use the marker-to-marker function to set the marker to the peak of the emission.
- The indicated level is the peak output power (with the addition of the external attenuation and cable loss).
- The limit is specified in one of the subparagraphs of this Section.
- Submit this plot.
- A peak responding power meter may be used instead of a spectrum analyzer.

## 8.4. SPURIOUS EMISSIONS (CONDUCTED & RADIATED)

For both conducted and radiated measurements, the spurious emissions were scanned from the lowest frequency generated by the EUT or 10 MHz whichever is lower to 10<sup>th</sup> harmonic of the highest frequency generated by the EUT.

### 8.4.1. Band-Edge and Spurious Emissions (Conducted)

#### Band-Edge Compliance of RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
- RBW = 1 % of the span
- VBW  $\geq$  RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge
- Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission.
- The marker-delta value now displayed must comply with the limit specified
- Now, using the same instrument settings, enable the hopping function of the EUT
- Allow the trace to stabilize
- Follow the same procedure listed above to determine if any spurious emissions cause by the hopping function also comply with the specify limits.
- Submit this plot

#### Spurious RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the in-band-emission and all spurious emissions (e.g. harmonics) from the lowest frequency generated in the EUT up through the 10<sup>th</sup> harmonic. Typically, several plots are required to cover this entire span.
- RBW = 100 kHz
- VBW  $\geq$  RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the any spurious emission recorded. The level displayed must comply with the limit specified in this Section.
- Submit this plot

#### 8.4.2. Spurious Emissions (Radiated)

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC, Industry Canada, ACA/Austel, NVLap and ITI.
- Radiated emissions measurements were made using the following test instruments:
  1. Calibrated EMCO BiconiLog antenna in the frequency range from 30 MHz to 2000 MHz.
  2. Calibrated Emco Horn antennas in the frequency range above 1000 MHz (1GHz - 40 GHz).
  3. The test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:
    - RBW = 100 kHz for  $f < 1\text{GHz}$  and RBW = 1 MHz for  $f \geq 1\text{GHz}$
    - VBW  $\geq$  RBW
    - Sweep = auto
    - Detector function = peak
    - Trace = max hold
    - Follows the guidelines in ANSI C63.4 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc.. A pre-amp and highpass filter are required for this test, in order to provide the measuring system with sufficient sensitivity.
    - Allow the trace to stabilize.
    - The peak reading of the emission, after being corrected by the antenna correction factor, cable loss, pre-amp gain, etc.... is the peak field strength which comply with the limit specified in Section 15.35(b)

#### Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$\boxed{FS = RA + AF + CF - AG}$$

Where FS = Field Strength  
RA = Receiver/Analyzer Reading  
AF = Antenna Factor  
CF = Cable Attenuation Factor  
AG = Amplifier Gain

Example: If a receiver reading of 60.0 dB $\mu$ V is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:

$$\begin{aligned} \text{Field Level} &= 60 + 7.0 + 1.0 - 30 = 38.0 \text{ dB}\mu\text{V/m.} \\ \text{Field Level} &= 10^{(38/20)} = 79.43 \mu\text{V/m.} \end{aligned}$$

- Submit this test data
- Now set the VBW to 10Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100ms, then the reading obtained may be further adjusted by a "duty cycle correction factor", derived from  $10\log(\text{dwell time}/100\text{mS})$  in an effort to demonstrate compliance with the 15.209.
- Submit test data

### **Maximizing The Radiated Emissions:**

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.
- During this process, cables and peripheral devices were manipulated within the range of likely configuration.
- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement were explored to produce the highest amplitude signal relative to the limit.

The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

- Step 1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.
- Step 2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
- Step 3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.
- Step 4: Move the antenna over its full allowable range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.
- Step 5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.
- Step 6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.
- Step 7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

## 8.5. ALTERNATIVE TEST PROCEDURES

If the antenna conducted tests cannot be performed on this device, radiated tests show compliance with the peak output power limit specified in Section 15.247(b) and the spurious RF conducted emission limit specified in Section 15.247(c) are acceptable. As stated previously, a pre-amp, and, in the later case, a high pass filter, are required for the following measurements:

### 8.5.1. Peak Power Measurements

Calculate the transmitter's peak power using the following equation:

$$E = 30PG/d$$
$$P = (Ed)^2/30G$$

Where:

- E: measured maximum fundamental field strength in V/m. Utilizing a RBW, the 20 dB bandwidth of the emission VBW > RBW, peak detector function. Follow the procedures in C63.4 with respect to maximizing the emission
- G is numeric gain of the transmitting antenna with reference to an isotropic radiator
- D is the distance in meters from which the field strength was measured
- P is the distance in meters from which the field strength was measured

### 8.5.2. Spurious RF conducted emissions

To demonstrate compliance with the spurious RF conducted emission requirement of Section 15.2479(c), use the following spectrum analyzer settings:

- Span = wide enough to fully capture the emission being measured
- RBW = 100 kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Measure the field strength of both the fundamental and all spurious emissions with these settings.
- Follow the procedures C63.4 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247C. Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions listed above must be followed