UltraTech
Group of Labs

31040/SIT

C-1376

Canada
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SL2-IN-E-1119R

entela

3000 Bristol Circle,
Oakville, Ontario,
Canada L6H 6G4

Tel.: (905) 829-1570
Fax.: (905) 829-8050

Website: www.ultratech-labs.com
Email: vic@ultratech-labs.com

Feb. 30, 2004

**TIMCO ENGINEERING INC.**
P.O. Box 370
849 N.W. State Road 45
Newberry, Florida
USA 32669

**Subject:** **FCC Certification Authorization Application under FCC PART 15, Subpart C, Sec. 15.247 - Frequency Hopping Spread Spectrum Transmitters operating in the frequency band 902 - 928 MHz.**

**Product:** **900 MHz Spread Spectrum OEM Transceiver**
**Model No.:** **MHX920**
**FCC ID:** **NS904P10**

Dear Sir/Madam

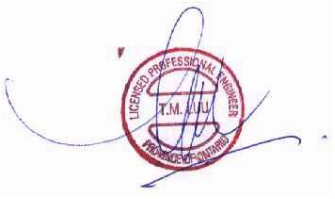
As appointed agent for Microhard Systems Inc., we would like to submit the application to the Federal Communications Commission for certification of the above product. Please review all necessary files uploaded to FCC OET site for detailed information.

- Modular Transmitter Approval Request:- This application is subject to the FCC certification for a modular transceiver, please kindly refer to the Section 6.5 of the submitted test report for clarification of compliance for this modular transmitter with FCC Public Notice DA 00-1407.

- The transmitter complies with FCC 2.1091 with the minimum RF safety distance of 23 cm.

If you have any queries, please do not hesitate to contact us.

Yours truly,




Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

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Feb. 30, 2004

**Microhard Systems Inc.**
110, 1144-29th Ave N.E.
Calgary, AB
Canada, T2E 7P1

**Attn.:** **Mr. Hany Shenouda**

**Subject:** **FCC Certification Application Testing under FCC PART 15, Subpart C, Sec. 15.247 - Frequency Hopping Spread Spectrum Transmitters operating in the frequency band 902 - 928 MHz.**

**Product:** **900 MHz Spread Spectrum OEM Transceiver**
**Model No.:** **MHX920**
**FCC ID:** **NS904P10**

Dear Shenouda,

The product sample, as provided by you, has been tested and found to comply with **FCC PART 15, Subpart C, Sec. 15.247 - Frequency Hopping Spread Spectrum Transmitters operating in the frequency band 902 - 928 MHz.**

- Modular Transmitter Approval Request:- This application is subject to the FCC certification for a modular transceiver, please kindly refer to the Section 6.5 of the submitted test report for clarification of compliance for this modular transmitter with FCC Public Notice DA 00-1407.

- The transmitter complies with FCC 2.1091 with the minimum RF safety distance of 23 cm.

Enclosed you will find copies of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

# ENGINEERING TEST REPORT

## 900 MHz Spread Spectrum OEM Transceiver
## Model No.: MHX920

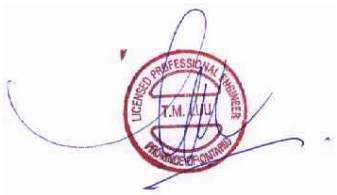
**FCC ID: NS904P10**

*Applicant:* **Microhard Systems Inc.**
*110, 1144-29th Ave N.E.*
*Calgary, AB*
*Canada, T2E 7P1*

***In Accordance With***

**FEDERAL COMMUNICATIONS COMMISSION (FCC)**
**PART 15, SUBPART C, SEC. 15.247**
**Frequency Hopping Spread Spectrum Transmitters**
**operating in the frequency band 902 - 928 MHz**

**UltraTech's File No.: MCRS-001FCC15C**

| | |
|---|---|
| This Test report is Issued under the Authority of<br>Tri M. Luu, Professional Engineer,<br>Vice President of Engineering<br>UltraTech Group of Labs<br><br>Date: Feb. 30, 2004 |  |
| Report Prepared by: Tri Luu, P.Eng.<br><br>Issued Date: Feb. 30, 2004 | Tested by: Hung Trinh, RFI Technologist<br><br>Test Dates: Feb. 25-28, 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

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com Email: vic@ultratech-labs.com, Email: tri.luu@sympatico.ca

# TABLE OF CONTENTS

# EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type | Description of Contents | Quality Check (OK) |
|---|---|---|---|
| | Test Report | Test Report | OK |
| 1 | Test Setup Photos | Photos # 1 to 12 | OK |
| 2 | External Photos of EUT | Photos # 1 to 9 | OK |
| 3 | Internal Photos of EUT | Photos of 1 to 2 | OK |
| 4 | Cover Letters | • Letter from Ultratech for Certification Request<br>• Letter from the Applicant to appoint Ultratech to act as an agent<br>• Letter from the Applicant to request for Confidentiality Filing | OK |
| 5 | Attestation Statements | • Statement of compliance to FCC 15.247(a), (g) and (h) | OK |
| 6 | ID Label/Location Info | • ID Label<br>• Location of ID Label | OK |
| 7 | Block Diagrams | Block Diagrams | Note (1) |
| 8 | Schematic Diagrams | Schematic Diagrams | Note (1) |
| 9 | Parts List/Tune Up Info | Parts List/Tune Up Info | Note (1) |
| 10 | Operational Description | Operational Description | Note (1) |
| 11 | RF Exposure Info | RF Exposure Info | OK |
| 12 | Users Manual | Users Manual | OK |

Note (1): This document will be submitted to FCC TCB directly by the applicant.

# EXHIBIT 1. INTRODUCTION

## 1.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Part 15, Subpart C, Section 15.247 |
| **Title** | Telecommunication - Code of Federal Regulations, CFR 47, Part 15 |
| **Purpose of Test:** | To obtain FCC Certification Authorization for Frequency Hopping Spread Spectrum Transmitters operating in the Frequency Band 902.4 - 927.6 MHz . |
| **Test Procedures** | 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. |
| **Environmental Classification:** | • Residential<br>• Light-industry, Commercial<br>• Industry |

## 1.2. RELATED SUBMITAL(S)/GRANT(S)

None

## 1.3. NORMATIVE REFERENCES

| Publication | YEAR | Title |
|---|---|---|
| FCC CFR Parts 0-19 | 2003 | Code of Federal Regulations – Telecommunication |
| ANSI C63.4 | 2001 | 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 | 2003 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment |
| CISPR 16-1 | 2003 | 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 |
| FCC Public Notice DA 00-1407 | 2000 | Part 15 Unlicensed Modular Transmitter Approval |

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1. CLIENT INFORMATION

| **APPLICANT**: | |
|---|---|
| **Name:** | Microhard Systems Inc. |
| **Address:** | 110, 1144-29th Ave N.E.<br>Calgary, AB<br>Canada, T2E 7P1 |
| **Contact Person:** | Mr. Hany Shenouda<br>Phone #: 403 248-0028<br>Fax #: 403 248 2762<br>Email Address: shenouda@microhardcorp.com |

| **MANUFACTURER:** | |
|---|---|
| **Name:** | Microhard Systems Inc. |
| **Address:** | 110, 1144-29th Ave N.E.<br>Calgary, AB<br>Canada, T2E 7P1 |
| **Contact Person:** | Mr. Hany Shenouda<br>Phone #: 403 248-0028<br>Fax #: 403 248 2762<br>Email Address: shenouda@microhardcorp.com |

## 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

| | |
|---|---|
| **Brand Name** | Microhard Systems Inc. |
| **Product Name** | 900 MHz Spread Spectrum OEM Transceiver |
| **Model Name or Number** | MHX920 |
| **Serial Number** | Preporduction |
| **Type of Equipment** | Frequency Hopping Spread Spectrum Transmitters |
| **Input Power Supply Type** | • External DC Sources: 4.0 - 5.5 Volts |
| **Primary User Functions of EUT:** | Provide data communication link through air |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | ▪ Mobile<br>▪ Base station (fixed use) |
| **Intended Operating Environment:** | ▪ Residential<br>▪ Commercial, light industry & heavy industry |
| **Power Supply Requirement:** | 4..0 - 5.5 Vdc |
| **RF Output Power Rating:** | 0.95 mWatts to 1.0 Watt |
| **Operating Frequency Range:** | 902.4 - 927.6 MHz |
| **RF Output Impedance:** | 50 Ohms |
| **Channel Spacing:** | 280 kHz and 400 kHz |
| **Duty Cycle:** | 100% |
| **20 dB Bandwidth:** | ▪ 236.5 kHz for 280 kHz Channel Spacing<br>▪ 298.2 kHz for 400 kHz X=Channel Spacing |
| **Modulation Type:** | CP FSK |
| **Channel Spacing** | 280 kHz or 400 kHz selectable |
| **Emission Designation:** | Frequency Hopping Spread Spectrum |
| **Spectral Density** | 1 Watts/MHz<br>(Power output at the antenna / bandwidth of the RF output spectrum) |
| **Antenna Description:** | Please refer to the antenna list below |

## 2.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | I/O port | 1 | Pin- header | Direct mounted on the system motherboard |
| 2 | RF Port | 1 | MCX/RSMA | Shielded coaxial cable with unique coupling connectors |

## 2.5. APPROVED ANTENNAS

| Group | Part Number | Description |
|---|---|---|
| **Quarter Wave** | | |
| | MHS031010 | <1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Right Angle |
| | MHS031020 | <1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight |
| | MHS031030 | <1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Right Angle MHS |
| | MHS031040 | <1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight MHS |
| | MHS031050 | <1.5dBi, 900MHz 1/4 Wave Antenna MCX Right Angle MHS |
| | MHS031060 | <1.5dBi, 900MHz 1/4 Wave Antenna Reverse SMA Straight |
| **Rubber Ducky** | | |
| | MHS031000 | 2dBi, 900MHz Rubber Ducky Antenna RPTNC Swivel |
| | MHS031070 | 2dBi, 900MHz Rubber Ducky Antenna Reverse SMA Swivel |
| | MHS031080 | 2dBi, 900MHz Rubber Ducky Antenna Reverse SMA Straight |
| **Transit Antennas** | | |
| | MHS031210 | 3dBd, 900 MHz Transit Antenna with Ground Plane |
| | MHS031220 | 3dBd, 900MHz Transit Antenna No Ground Plane |
| | MHS031230 | 3dBd, 900MHz Transit Antenna Permanent Mount GP |
| | MHS031240 | 3dBd, 900MHz Transit Antenna Permanent Mount NGP |
| | | ***Mounts for Transit Antennas have a RPTNC Pigtail*** |
| **Yagi Antennas** | | |
| | MHS031311 | 6dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail |
| | MHS031431 | 6.5dBd, 900MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail |
| | MHS031501 | 9dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail |
| | MHS031441 | 10dBd, 900 MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail |
| | MHS031451 | 11dBd, 900 MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail |
| | MHS031401 | 12dBd, 900MHz Yagi Directional Antenna Antenex, RPTNC Pigtail |
| | MHS031411 | 12dBd, 900MHz Yagi Directional Antenna Bluewave, RPTNC Pigtail |
| **Omni Directional** | | |
| | MHS031251 | 3dBd, 900MHz Omni Directional Antenna Antenex, RPTNC Pigtail |
| | MHS031461 | 3dBd, 900 MHz Omni Directional Antenna Bluewave, RPTNC Pigtail |
| | MHS031321 | 6dBd, 900MHz Omni Directional Antenna Antenex, RPTNC Pigtail |
| | MHS031471 | 6dBd, 900 MHz Omni Directional Antenna Bluewave, RPTNC Pigtail |

⚠ WARNING:

**Changes or modifications not expressly approved by Microhard Systems Inc. could void the user's authority to operate the equipment. This device has been tested with MCX and Reverse Polarity SMA connectors with the antennas listed in Appendix A When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions). Please Contact Microhard Systems Inc. if you need more information.**

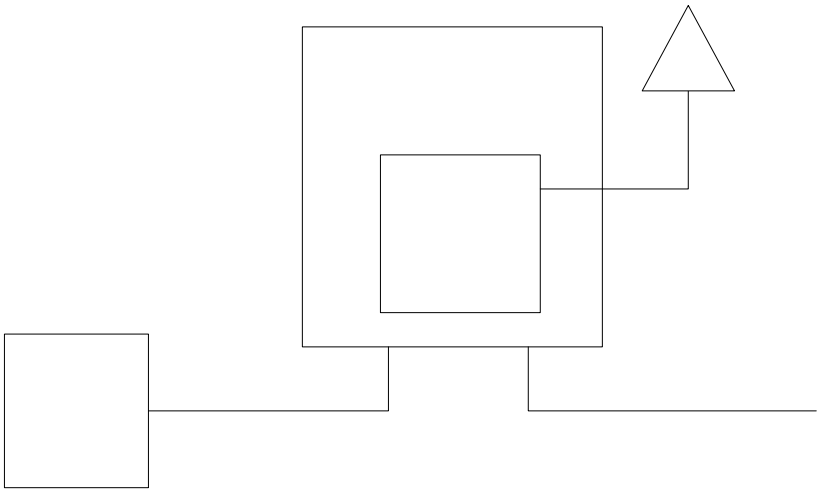
## 2.6. ANCILLARY EQUIPMENT

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: | OMNIBOOK Laptop |
| Brand name: | Hewlett Packard |
| Model Name or Number: | DN-2100 |
| FCC Certification | FCC DoC |
| Serial Number: | TW63403246 |
| Connected to EUT's Port: | The laptop RS232 port is connected to EUT with respect to the test jig |

| **Ancillary Equipment # 2** | |
|---|---|
| Description: | Test Jig |
| Brand name: | Microhard |
| Model No.: | -- |
| FCC ID: | -- |
| S/N: | -- |
| Connected to EUT's Port: | The EUT was diretly mounted on the test jig for testing purpose only. |

## 2.7. GENERAL TEST SETUP



# EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 5.5 Vdc |

## 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

| | |
|---|---|
| **Operating Modes:** | ▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements.<br>▪ The EUT operates in normal Frequency Hopping mode for occupancy duration, and frequency separation. |
| **Special Test Software:** | Special software is provided by the Applicant to disable the hopping function, to select and to operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing. |
| **Special Hardware Used:** | A Microhard test jig is required to be used to connect the EUT with a computer for changing test configuration. |
| **Transmitter Test Antenna:** | The EUT is tested with the antenna fitted in a manner typical of normal intended use as a non-integral antenna equipment. |

| **Transmitter Test Signals:** | |
|---|---|
| **Frequencies:**<br>▪ 902.4 - 927.6 MHz band: | Lowest, middle and highest channel frequencies tested:<br>902.4, 915 and 927.6 MHz |
| **Transmitter Wanted Output Test Signals:**<br><br>▪ RF Power Output (measured maximum output power):<br>▪ Normal Test Modulation<br>▪ Modulating signal source: | <br><br>▪ 1 Watts (conducted) and 36 dBm EIRP maximum<br><br>▪ CP FSK<br>▪ Internal |

# EXHIBIT 4. SUMMARY OF TEST RESULTS

## 4.1. 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, 16'(L) by 12'(W) by 12'(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: Feb. 24, 2004.

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

| FCC PARAGRAPH. | TEST REQUIREMENTS | COMPLIANCE (YES/NO) |
|---|---|---|
| Public Notice DA 00-1407 | Part 15 Unlicensed Modular Transmitter Approval | Yes |
| 15.207(a) | AC Power Line Conducted Emissions Measurements (Transmit & Receive) | Yes |
| 15.247(a)(1) & 15.247(a)(1)(i) | Hopping Channel Frequency Characteristics | Yes |
| 15.247(b)(2)&(4) | Peak Output Power | Yes |
| 1.1307, 1.1310, 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 associated Radio Receiver operating in 902.4 - 927.6 MHz is exempted from FCC authorization . The engineering test report can be provided upon FCC requests. | | |

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

None

# EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

## 5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 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.

## 5.2. 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 7 for Measurement Uncertainties.

## 5.3. 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.

## 5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER:

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

## 5.5. UNLICENSED MODULAR TRANSMITETR APPROVAL REQUIREMENTS @ FCC PUBLIC NOTICE DA 00-1407 (JUNE 26, 2000)

In order to satisfy FCC requirements for equipment authorization for modular transmitters, the transmitters shall meet the following parameters:

| | **Requirements for Modular Transmitters** | **Manufacturer's Clarification** | **Laboratory's Comments** |
|---|---|---|---|
| (a) | In order to be considered a transmitter module, the device must be complete RF transmitter, i.e., it must have its own reference oscillator (e.g., VCO), antenna, etc…. The only connectors to the module, if any, may be power supply and modulation/data inputs | ✓ The transmitter is completed with its own reference oscillator, antenna.<br>✓ Only connectors provide are dc supply, data and rf ports are provided with the modular transmitter | Satisfactory |
| (b) | Compliance with FCC RF Exposure requirements may, in some instances, limit the output power of a module and/or the final applications in which the approved module may be employed | ✓ The radio is intended for use in all applications (portable, mobile and base). It complies with SAR test with body tissue<br>✓ The radio is intended for use with mobile or fixed base stations only. It complies with MPE per 2.1091 & 1.1307 | Satisfactory |
| (c) | While the applicant for a device into which an authorized module is installed is not required to obtain a new authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for the device (e.g., a WLAN into which the authorized module is installed still be authorized as PC peripheral, subject to the appropriate equipment authorization) | ✓ The equipment under complies with FCC Part15, Subpart B, Class B – Unintentional radiators | Satisfactory |
| (d) | In the case of a modular transceiver, the modular approval policy only applies to the transmitter portion of such devices. Pursuant to section 15.101(b), the receiver portion will either be subject to Verification, or it will not be subject to any authorization requirements (unless if is a Scanning Receiver, in which case it is also subject to Certification, pursuant to Section 15.101(a) | ✓ The receiver operates in the band above 960 MHz; therefore, the FCC authorization for the receiver is exempted. | Satisfactory |

| | Requirements for Modular Transmitters | Manufacturer's Clarification | Laboratory's Comments |
|---|---|---|---|
| (e) | The holder of the grant of equipment authorization (Grantee) of the module is responsible for the compliance of the module in its final configuration, provided that the OEM, integrator, and /or end user has complied with all of the instructions provided by the Grantee which indicate installation and/or operating conditions necessary for compliance. | End-users must comply with the following instruction sated in the users' manual:<br>✓ Labeling requirement for equipment using this modular transmitter.<br>✓ RF Exposure Warning for compliance with FCC Rules 2.1091 and 1.1307 when the radio is used in a mobile or base system | Satisfactory |

In order to obtain a modular transmitter approval, a cover letter requesting modular approval must be submitted and the numbered requirements identified below must be addressed in the application for equipment authorization:

| | Requirements for Modular Transmitters | Manufacturer's Clarification | Laboratory's Comments |
|---|---|---|---|
| 1. | The modulator transmitter must have its own RF shielding. This is intended to ensure that the module does not have to reply upon the shielding provided by the device into which it is installed in order for all modular transmitter emissions to comply with Part 15 limits. It is also intended to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Such coupling may result in non-complaint operation. | ✓ The modular transmitter has its own RF shielding | Satisfactory |
| 2. | The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation. | ✓ The modular transmitter has buffered modulation/data inputs | Satisfactory |
| 3. | The modular transmitter must have its own power supply regulation. This is intended to ensure that the module will comply with Part 15 requirements regardless of the design of the power supplying circuitry in the device into which the module is installed. | ✓ The modular transmitter has its own power supply regulation. | Satisfactory |

| | Requirements for Modular Transmitters | Manufacturer's Clarification | Laboratory's Comments |
|---|---|---|---|
| 4. | The modular transmitter must comply with the antenna requirements of section 15.203 and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules. | ✓ The radio and its associated antennas are provided with the special coupling antenna connectors (MCX or reversed SMA). | Satisfactory |
| 5 | The modular transmitter must be tested in a stand-alone configuration, i.e., the module must not be inside another device during testing. This is intended to demonstrate that the module is capable of complying with Part 15 emission limits regardless of the device into which it is eventually installed. Unless the transmitter module will be battery powered, it must comply with the AC conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will marketed with the module (see Section 15.27(a)). The length of these lines shall be length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (See Section 15.31(I)). | ✓ The modular transmitter was tested in a stand-alone configuration | Satisfactory |

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

| FCC Section | FCC Rules | |
|---|---|---|
| 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 | 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.<br><br>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:<br>• The application (or intended use) of the EUT<br>• The installation requirements of the EUT<br>• The method by which the EUT will be marketed | ✓ The transmitter is completed with its own reference oscillator, antenna.<br>✓ Only connectors provide are dc supply, data and rf ports are provided with the modular transmitter |
| 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 | Please refer to Sec. 2.3 of this test report for details of antenna information |
| 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. | Conform. Please refer to Operational Description for detailed information. |
| 15.247(a) | Pseudo Frequency Hopping Sequence:<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 | Conform. Please refer to Operational Description for detailed information. |
| 15.247(a) | Equal Hopping Frequency Use:<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). | Conform. Please refer to Operational Description for detailed information. |

| FCC Section | FCC Rules | |
|---|---|---|
| 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 | Conform. Please refer to Operational Description for detailed information. |
| 15.247(h) | Describe how the EUT complies with the requirement that it not have the ability to coordinated with other FHSS is an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters | Conform. Please refer to Operational Description for detailed information. |
| Public Notice DA 00-705 | System Receiver Input Bandwidth: 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. | Conform. Please refer to Operational Description for detailed information. |
| Public Notice DA 00-705 | System Receiver Hopping Capability: Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals | Conform. Please refer to Operational Description for detailed information. |

# 5.7. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.207(A)

## 5.7.1. Limits

The equipment shall meet the limits of the following table:

| | CLASS B LIMITS | | |
|---|---|---|---|
| **Test Frequency Range (MHz)** | **Quasi-Peak (dBμV)** | **Average* (dBμV)** | **Measuring Bandwidth** |
| 0.15 to 0.5 | 66 to 56* | 56 to 46* | RBW = 9 kHz<br>VBW ≥ 9 kHz for QP<br>VBW = 1 Hz for Average |
| 0.5 to 5 | 56 | 46 | RBW = 9 kHz<br>VBW ≥ 9 kHz for QP<br>VBW = 1 Hz for Average |
| 5 to 30 | 60 | 50 | RBW = 9 kHz<br>VBW ≥ 9 kHz for QP<br>VBW = 1 Hz for Average |

* Decreasing linearly with logarithm of frequency

## 5.7.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.2 of this test report & ANSI C63.4

## 5.7.3. 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 μH |
| 12'x16'x12' RF Shielded Chamber | RF Shielding | … | .. | … |

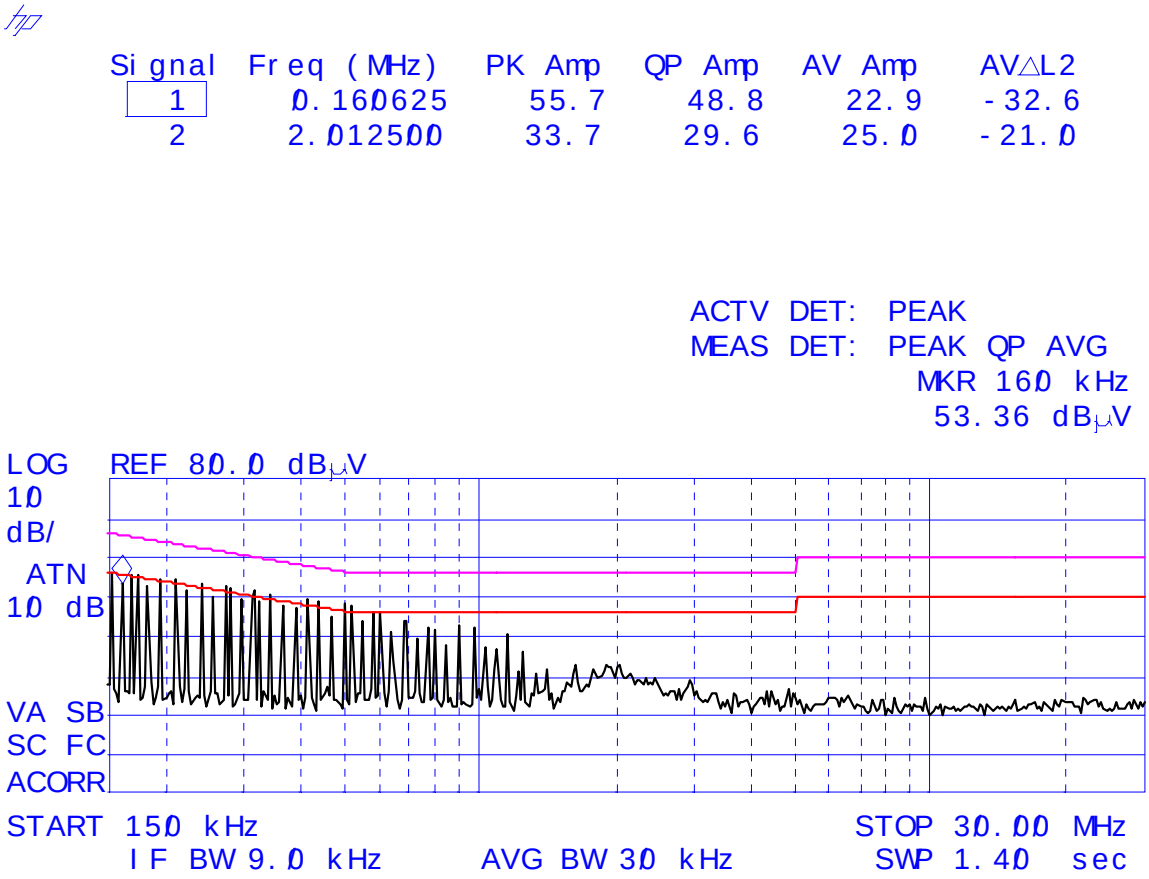
## 5.7.4. Photographs of Test Setup

Refer to the Photographs #1 & #2 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

## 5.7.5. Test Data

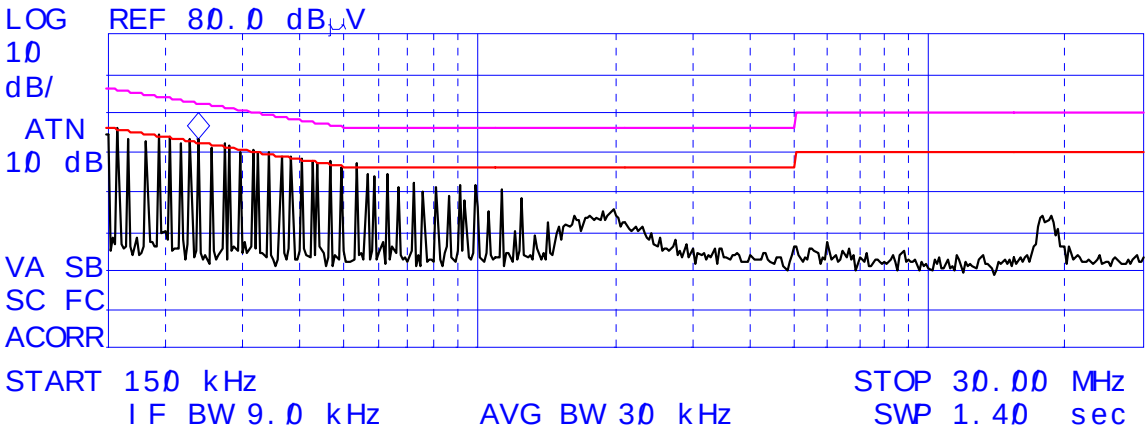
Please Refer to Plots # 1 and 2 for AC powerline Conducted emissions measurements at AC mains of an external power supply that supply the power to the test jig and MHX920 Module.

| Plot #1: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT | | | |
|---|---|---|---|
| Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE | | Temp: 22°C | Humidity: 12% |
| Line Tested : Line 1 | Line Voltage : 120Vac 60Hz | Test Tech: betty | Test Date: Mar 4th, 2004 |
| Standard : FCC15 Class B | Comments: Measurements was conducted at the AC mains of off-shelf external linear AC-DC power supply that connected to the test jig + MHX920 | | |



| Plot #2: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT | | | |
|---|---|---|---|
| Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE | | Temp: 22°C | Humidity: 12% |
| Line Tested : Line 2 | Line Voltage : 120Vac 60Hz | Test Tech: betty | Test Date: Mar 4th, 2004 |
| Standard : FCC15 Class B | Comments: Measurements was conducted at the AC mains of off-shelf external linear AC-DC power supply that connected to the test jig + MHX920 | | |

| Signal | Freq (MHz) | PK Amp | QP Amp | AV Amp | AV△L2 |
|---|---|---|---|---|---|
| 1 | 0.241325 | 53.1 | 46.7 | 20.8 | -31.2 |
| 2 | 2.0325000 | 36.6 | 32.6 | 28.9 | -17.1 |






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

# 5.8. HOPPING CHANNEL CARRIER FREQUENCY CHARACTERISTICS @ FCC CFR 47, PARA 15.247(A)(1) & (A)(1)(I)

## 5.8.1. Limits

- **FCC CFR 47, Para 15.247(a)(1)**:- 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 pseudorandomly 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.

- **FCC CFR 47, Para 15.247(a)(1)(i)**:- operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

## 5.8.2. Method of Measurements

Refer to FCC 15.247(a)(1), FCC Public Notice DA 00-705 & ANSI C63.4

**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 = 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 = RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

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

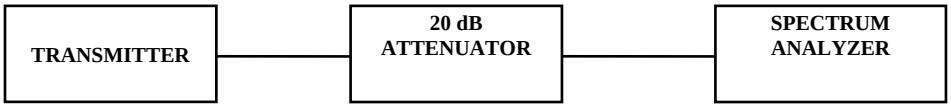
The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:
- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW = RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

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 = 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.

## 5.8.3. Test Arrangement




## 5.8.4. 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 |
| Microwave Amplifier | Hewlett Packard | 83017A | .. | 1 GHz – 26.5 GHz 34-38 dB gain |
| Horm Antenna | EMCO | 3115 | 9701-5061 | 1 – 18 GHz |

## 5.8.5. Test Data

### *5.8.5.1. 280 kHz Channel Spacing Operation*

**20 dB BANDWIDTH MEASUREMENTS**

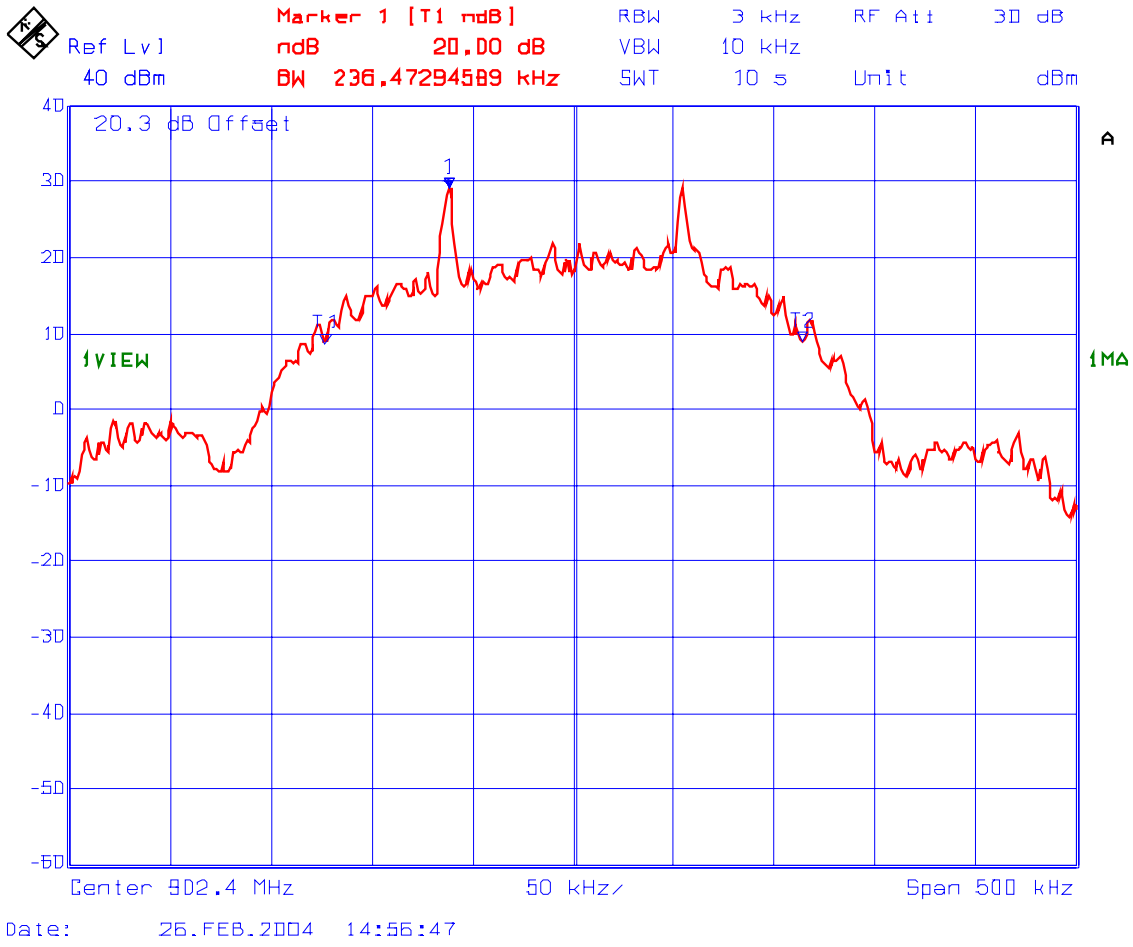
| CHANNEL FREQUENCY (MHz) | MEASURED CHANNEL SEPARATION (kHz) | 20 dB BANDWIDTH (MHz) | PASS/FAIL |
|---|---|---|---|
| 902.4 | 280 | 236.5 | PASS |
| 915.0 | 280 | 230.5 | PASS |
| 927.6 | 280 | 228.5 | PASS |

**Note**: 20 dB occupied bandwidth shall be less than hopping channel frequency separation.

| Test Description | FCC Specification | Measured Values | Comments |
|---|---|---|---|
| Channel Hopping Frequency Separation | minimum of 25 KHz or 20dB BW whichever is greater. | 280 kHz | Pass |
| Number hopping frequencies vs. average time of occupancy | If the 20 dB bandwidth of the hopping channel is less than 250 kHz:<br>• the system shall use at least 50 hopping frequencies<br>• average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period<br>• The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz | • Min. 20 dB BW = 228.5 kHz<br>• Minimum 50 hopping channels<br>• Average time of occupancy = 0.38 seconds in 20 second period<br>• Max. 20 dB BW = 236.5 kHz | Pass<br>Pass<br>Pass<br>Pass |

*** Please refer to Plots # 3 to 9 for detailed measurements of the above parameters.

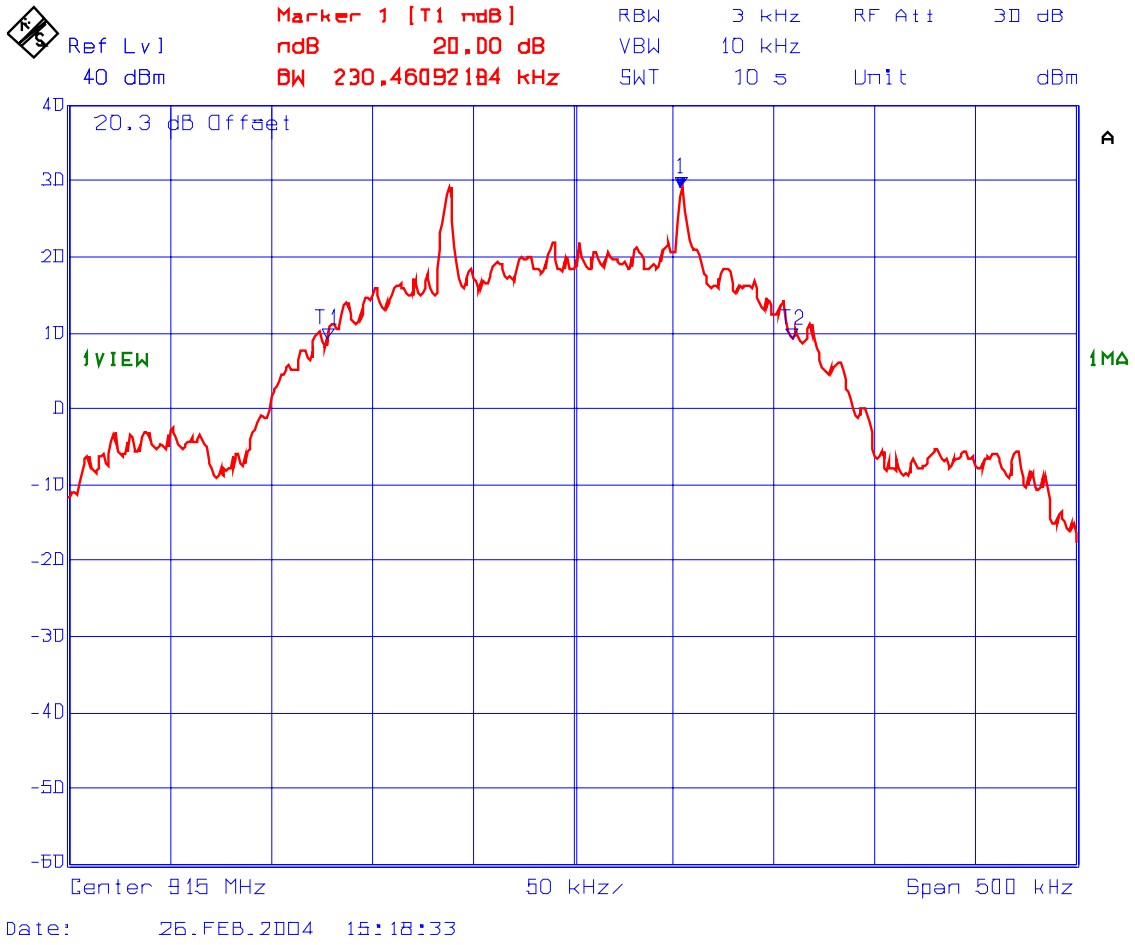
## Plot #3: 20 dB Bandwidth @ 280 kHz Channel Spacing, Channel Freq.: 902.4 MHz






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

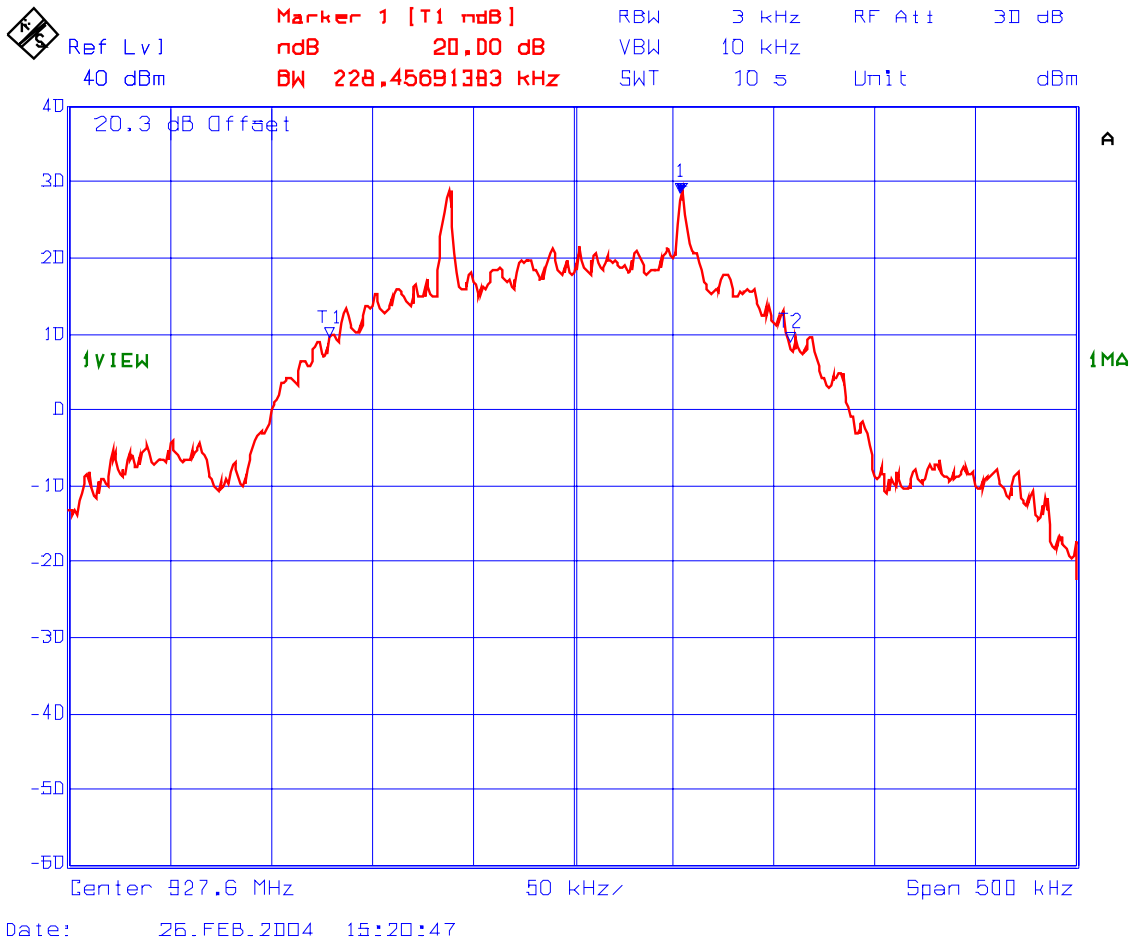
## Plot #4: 20 dB Bandwidth @ 280 kHz Channel Spacing, Channel Freq.: 915.0 MHz






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

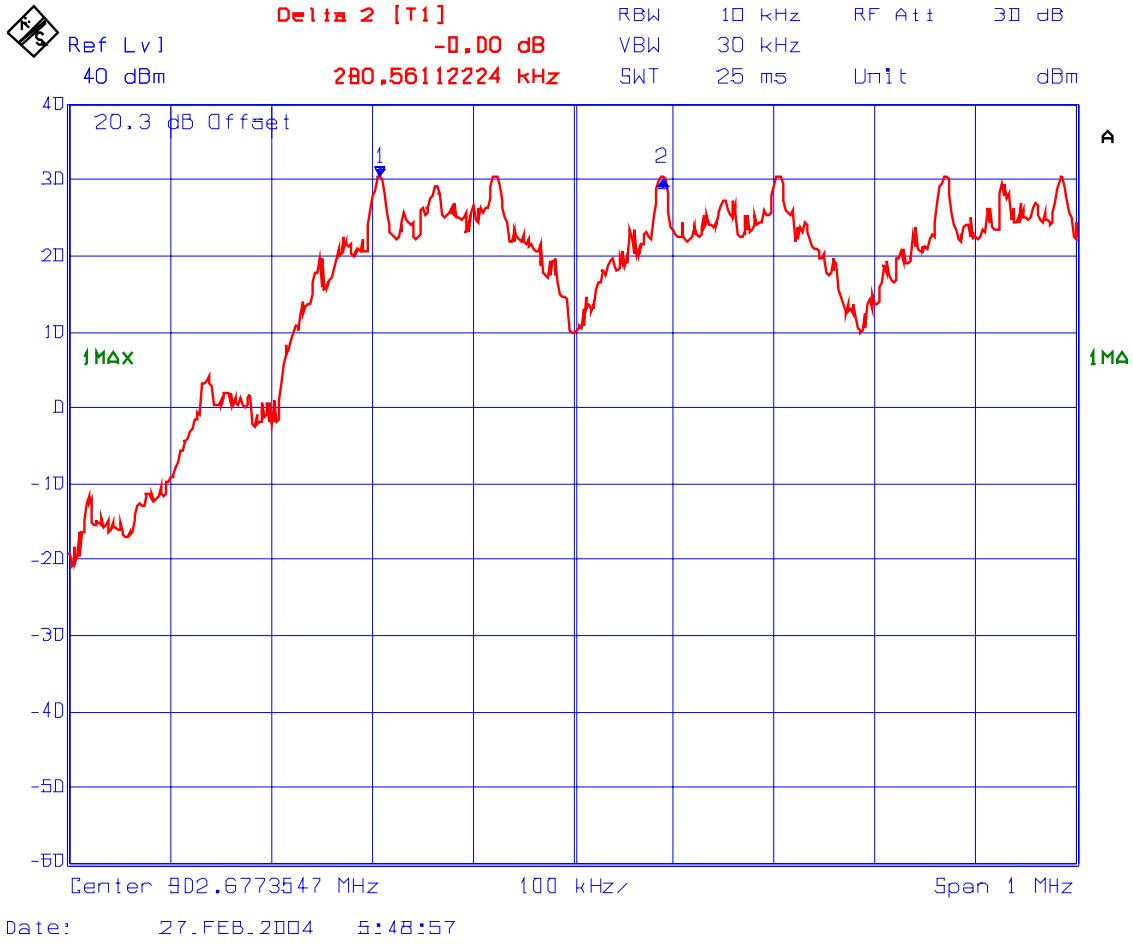
## Plot #5: 20 dB Bandwidth @ 280 kHz Channel Spacing, Channel Freq.: 927.6 MHz






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

## Plot #6: Channel Separation Measurement @ 280 kHz Channel Spacing

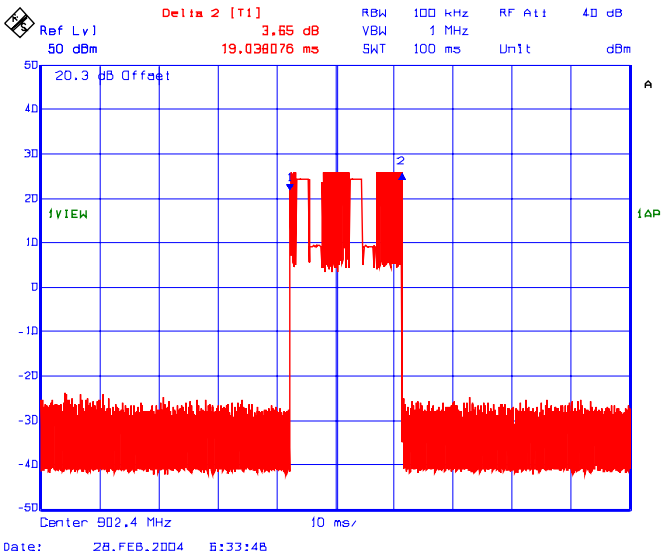


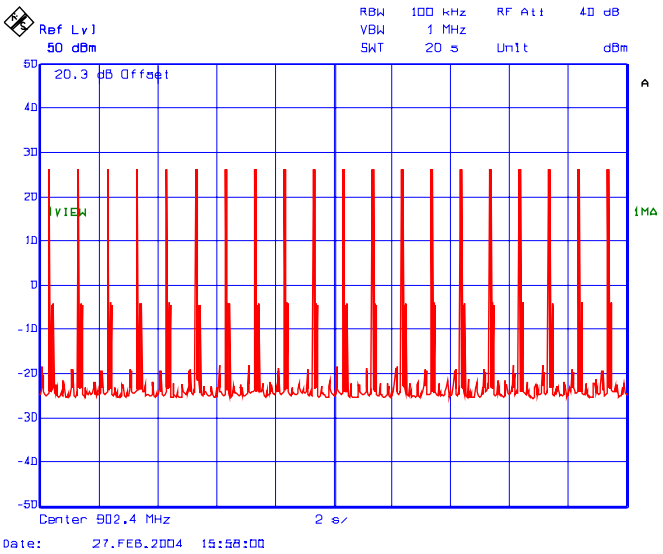



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot #7: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing**
**Channel Frequency: 902.4 MHz**

**Time of occupancy of 902.4 MHz = 19.04 mS x 20 = 380.8 mS or 0.38 Sec.**



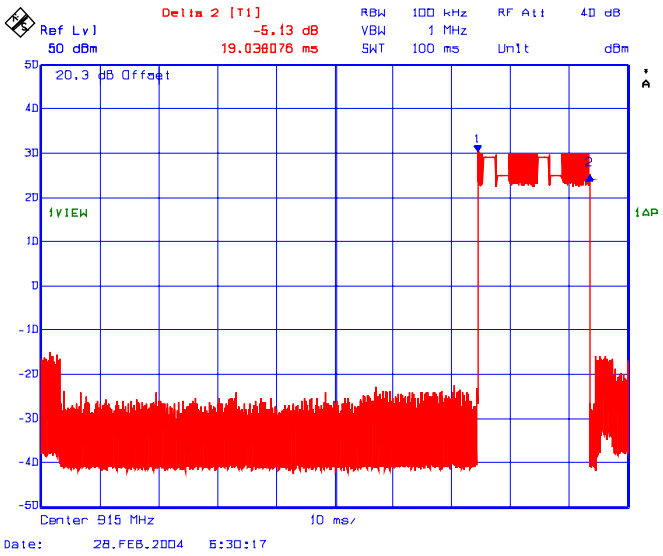



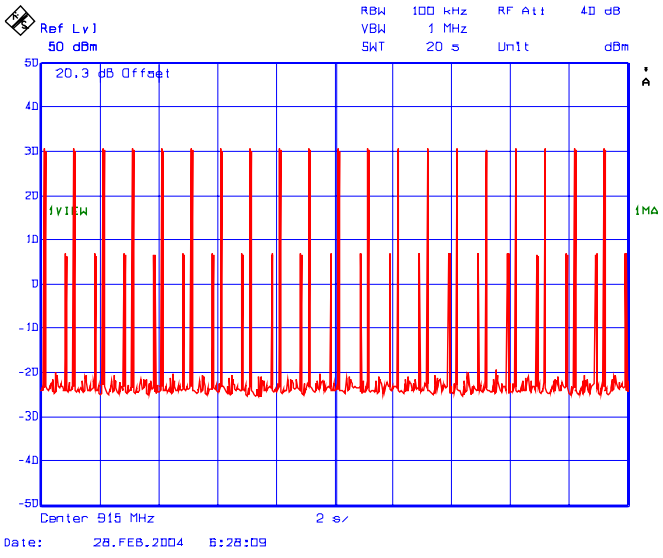



- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #8: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing**
**Channel Frequency: 915 MHz**

**Time of occupancy of 915 MHz = 19.04 mS x 20 = 380.8 mS or 0.38 Sec.**



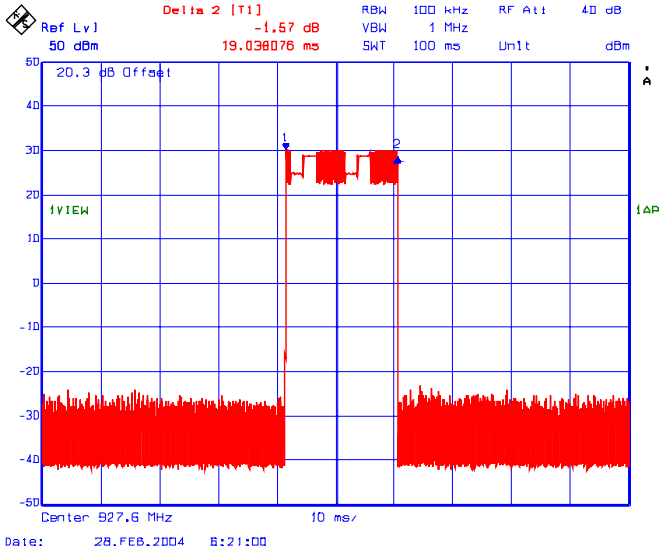



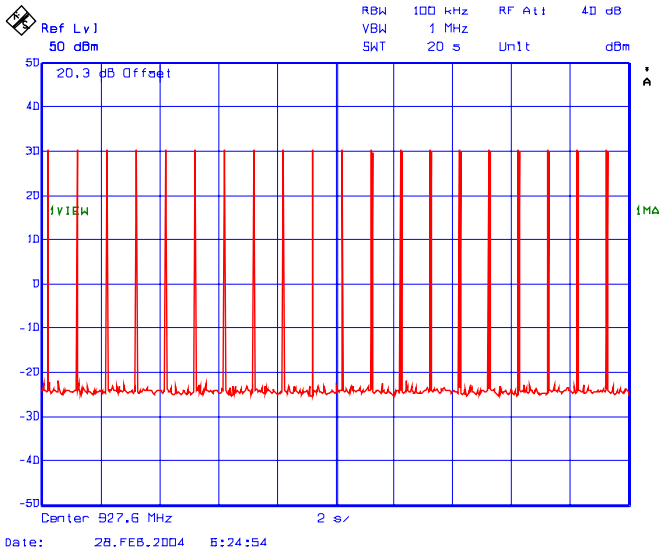



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot #9: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing**
**Channel Frequency: 927.6MHz**

**Time of occupancy of 927.6 MHz = 19.04 mS x 20 = 380.8 mS or 0.38 Sec.**






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

### *5.8.5.2. 400 kHz Channel Spacing Operation*

**20 dB BANDWIDTH MEASUREMENTS**

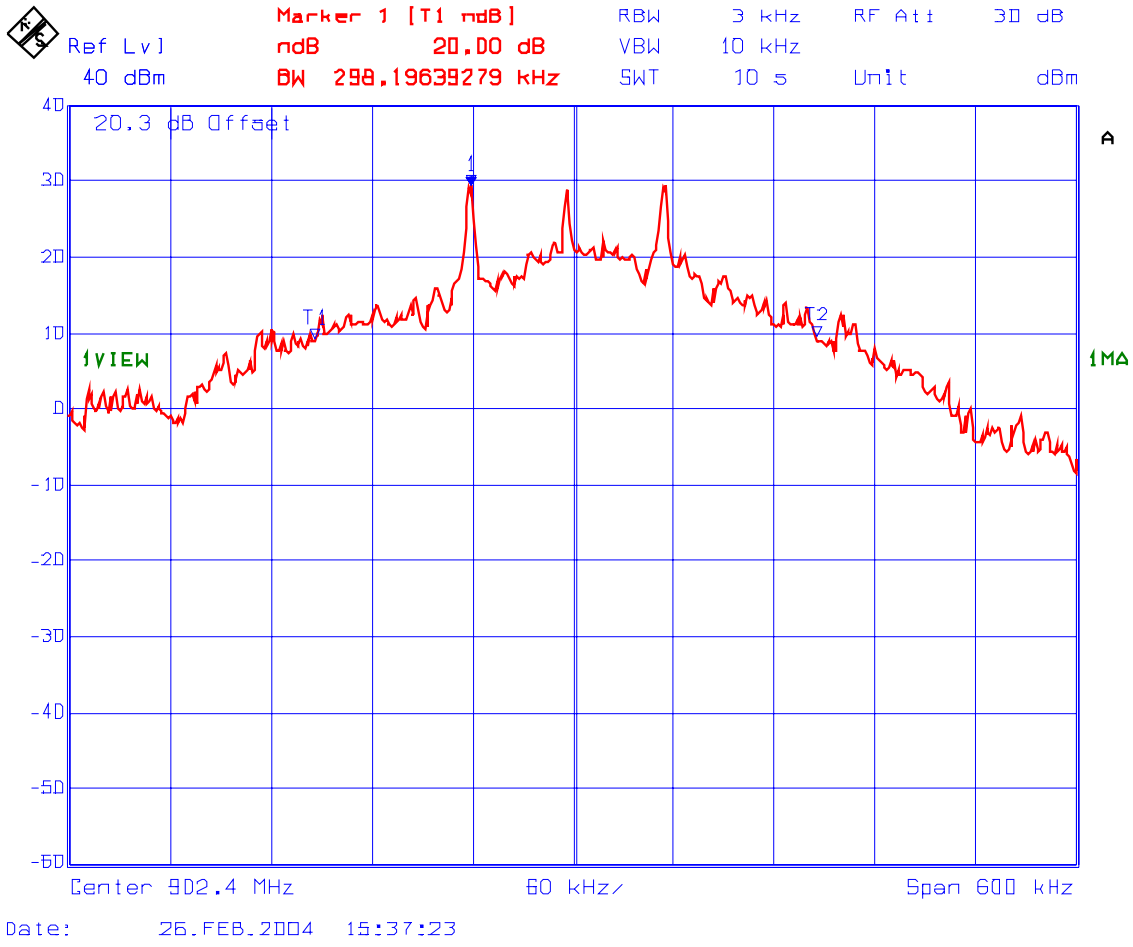
| CHANNEL FREQUENCY (MHz) | MEASURED CHANNEL SEPARATION (kHz) | 20 dB BANDWIDTH (MHz) | MINIMUM LIMIT (MHz) | PASS/FAIL |
|---|---|---|---|---|
| 902.4 | 400.0 | 298.2 | 0.5 | PASS |
| 915.0 | 400.0 | 298.2 | 0.5 | PASS |
| 927.6 | 400.0 | 298.2 | 0.5 | PASS |

**Note**: 20 dB occupied bandwidth shall be less than hopping channel frequency separation.

| Test Description | FCC Specification | Measured Values | Comments |
|---|---|---|---|
| Channel Hopping Frequency Separation | minimum of 25 KHz or 20dB BW whichever is greater. | 400 kHz | Pass |
| Number hopping frequencies vs. average time of occupancy | if the 20 dB bandwidth of the hopping channel is 250 kHz or greater the system shall use:<br>• at least 25 hopping frequencies<br>• average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.<br>• The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz | • 20 dB BW = 298.2 kHz<br>• 50 hopping channels minimum<br>• Average time of occupancy = 0.3 seconds in 10 second period<br>• 20 dB BW = 298.2 kHz | Pass<br>Pass<br>Pass<br>Pass |

*** Please refer to Plots # 10 to 16 for detailed measurements of the above parameters.

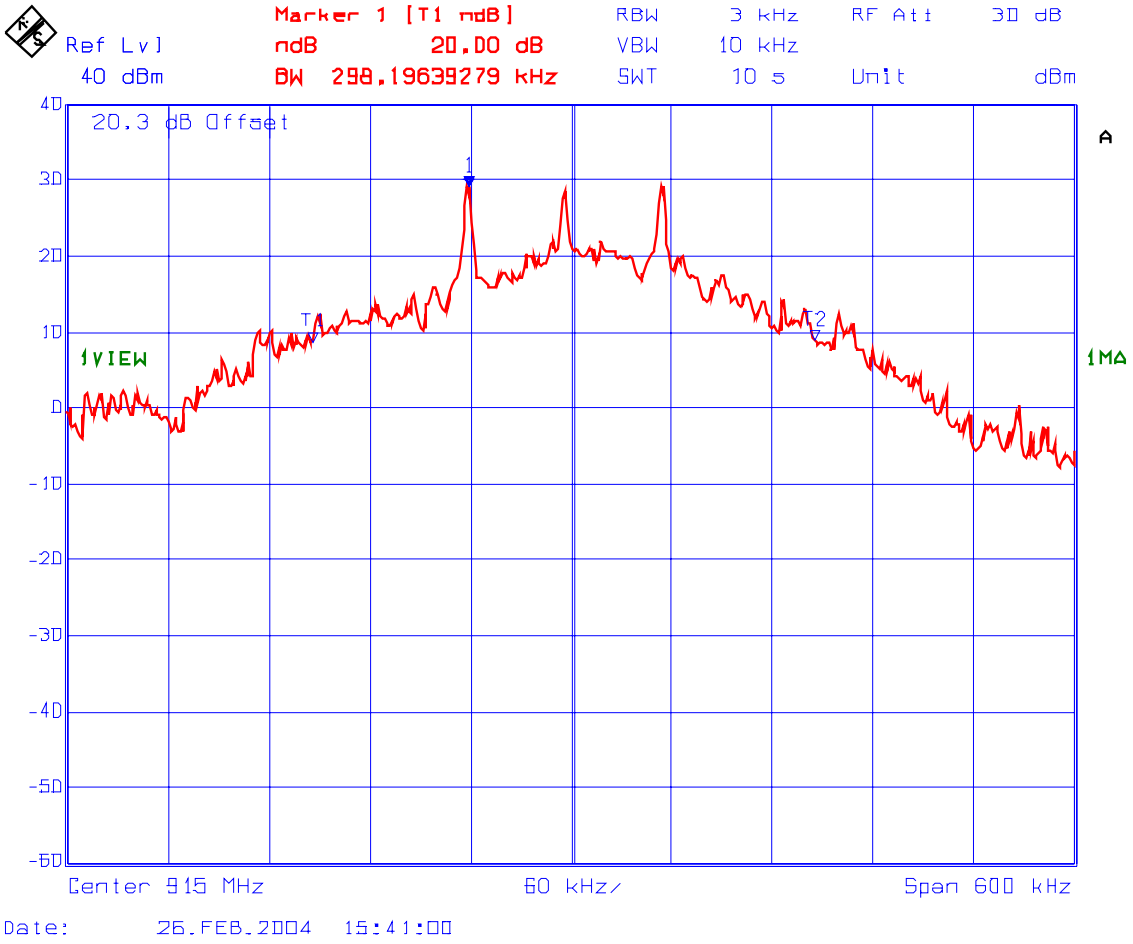
## Plot #10: 20 dB Bandwidth @ 400 kHz Channel Spacing, Channel Freq.: 902.4 MHz






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

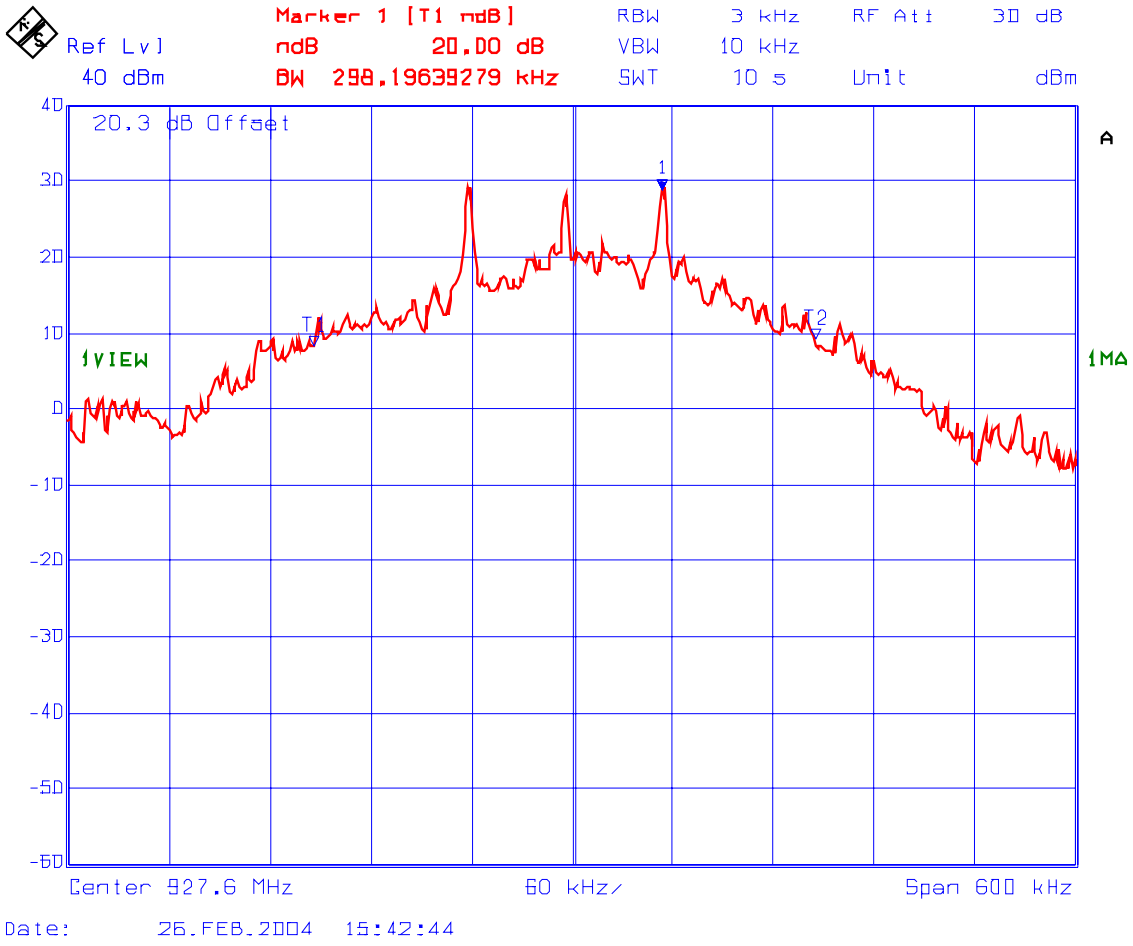
## Plot #11: 20 dB Bandwidth @ 400 kHz Channel Spacing, Channel Freq.: 915 MHz






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

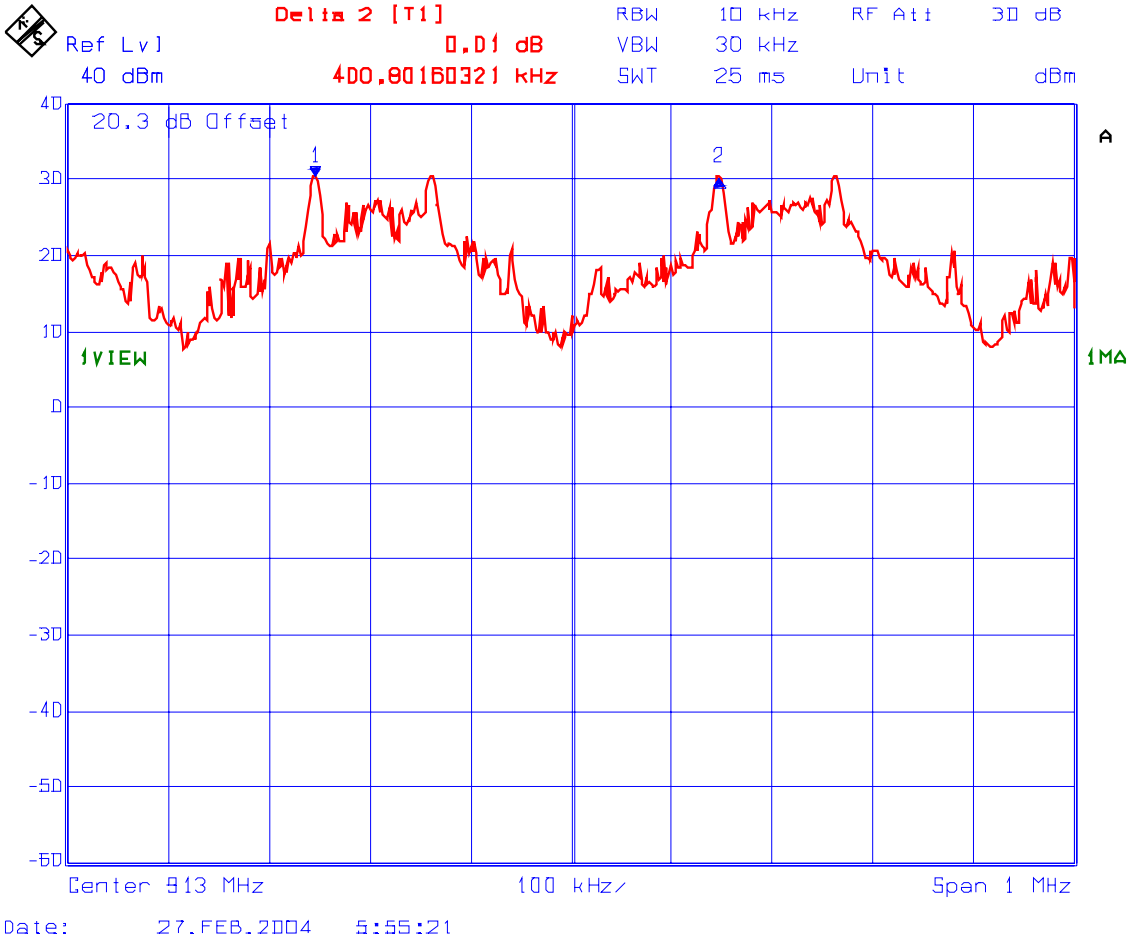
## Plot #12: 20 dB Bandwidth @ 400 kHz Channel Spacing, Channel Freq.: 927.6 MHz






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

## Plot #13: Channel Separation Measurement @ 280 kHz Channel Spacing

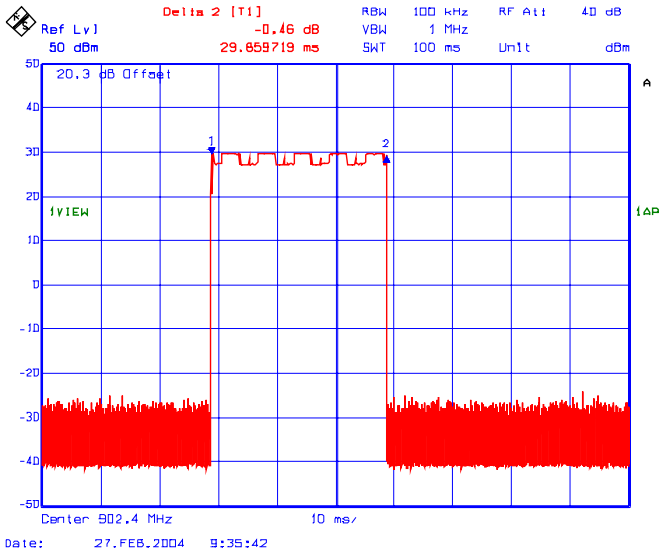


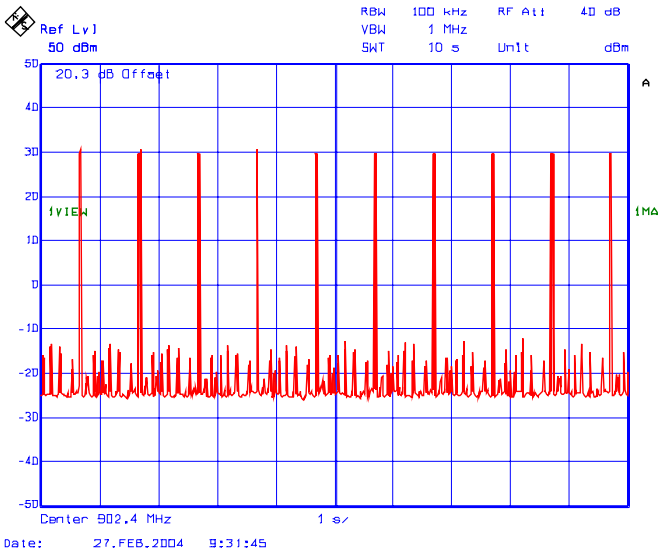



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## Plot #14: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing Channel Frequency: 902.4 MHz

**Time of occupancy of 902.4 MHz = 29.9 mS x 10 = 299 mS or 0.30 Sec.**



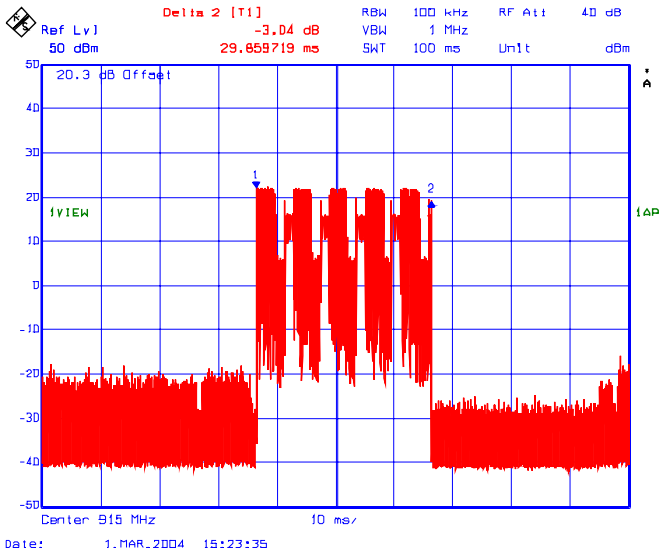



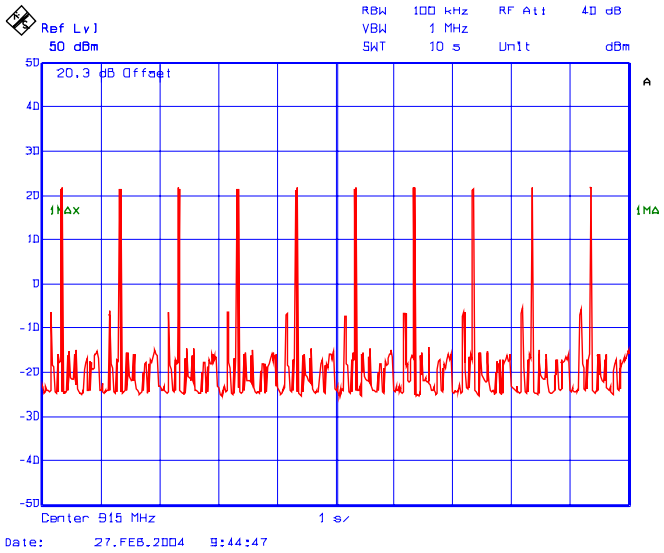



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## Plot #15: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing
## Channel Frequency: 915 MHz

**Time of occupancy of 915 MHz = 29.9 mS x 10 = 299 mS or 0.30 Sec.**



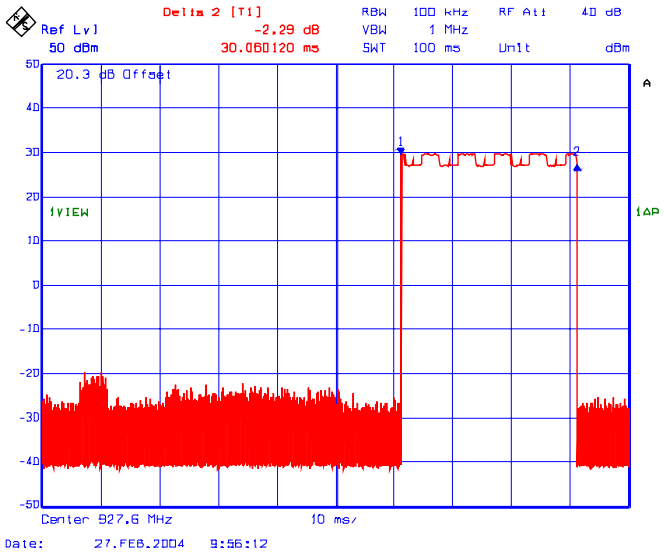



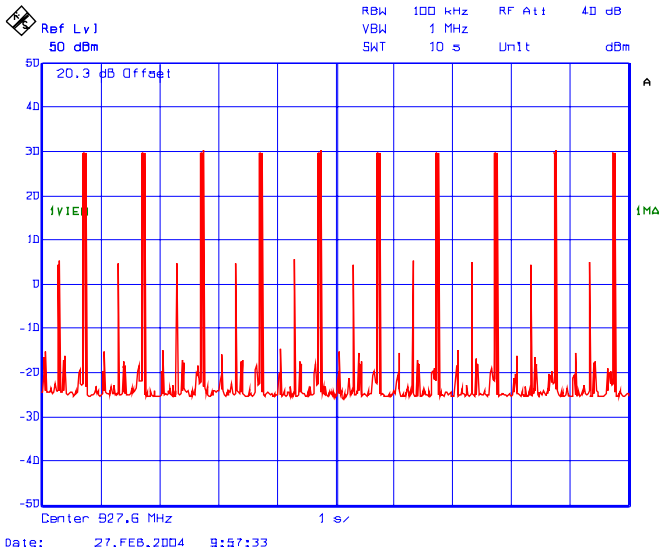



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## Plot #16: Time of Channel Occupancy Measurement @ 280 kHz Channel Spacing
## Channel Frequency: 927.6 MHz

**Time of occupancy of 927.6 MHz = 30.1 mS x 10 = 301 mS or 0.30 Sec.**






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

# 5.9. PEAK OUTPUT POWER & EFFECTIVE RADIATED POWER (EIRP) @ FCC 15.247(B)(2)(4)

## 5.9.1. Limits

**15.247(b)(2)** - For frequency hopping systems operating in the 902–928 MHz band:

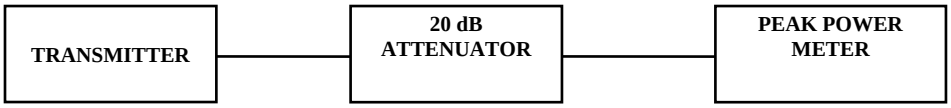
- 1 watt for systems employing at least 50 hopping channels; and
- 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted

**15.247(b)(4)** - If transmitting antennas of directional gain greater than 6 dBd are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBd.

## 5.9.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.3 of this test report, FCC 15.247(b)(1)&(3), FCC Public Notice DA 00-705 & ANSI C63.4

## 5.9.3. Test Arrangement




## 5.9.4. 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 |
| Peak Power Meter & Peak Power Sensor | Hewlett Packard | 8900 8481A | 2131A00124 2551A01965 | 0.1-18 GHz 50 Ohms Input |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 GHz |
| Horn Antenna | EMCO | 3155 | 9701-5061 | 1 GHz – 18 GHz |
| Horn Antenna | EMCO | 3155 | 9911-5955 | 1 GHz – 18 GHz |

## 5.9.5. Test Data

**Duty cycle: 100%**

### *5.9.5.1. Peak Conducted Power for any Antenna Gain less than 6 dBi*

| Transmitter Channel | Frequency (MHz) | Antenna Gain G (dBi) | (wideband) Minimum Peak Power P @ Antenna Port (dBm) | (wideband) MaximumPeak Power P @ Antenna Port (dBm) | Peak Power Limit (Conducted) (dBm) | Peak Power Limit (EIRP) (dBm) |
|---|---|---|---|---|---|---|
| Lowest | 902.4 | ≤ 6.0 | -0.22 | 30.0 | 30.0 | 36.0 |
| Middle | 915.0 | ≤ 6.0 | -0.22 | 30.0 | 30.0 | 36.0 |
| Highest | 927.6 | ≤ 6.0 | -0.22 | 30.0 | 30.0 | 36.0 |

### *5.9.5.2. Peak Conducted Power for any Antenna Gain = 12 dBi*

| Transmitter Channel | Frequency (MHz) | Antenna Gain G (dBi) | (wideband) Minimum Peak Power P @ Antenna Port (dBm) | (wideband) MaximumPeak Power P @ Antenna Port (dBm) | Peak Power Limit (Conducted) (dBm) | Peak Power Limit (EIRP) (dBm) |
|---|---|---|---|---|---|---|
| Lowest | 902.4 | 12.0 | -0.22 | 24.0 | 30.0 | 36.0 |
| Middle | 915.0 | 12.0 | -0.22 | 24.0 | 30.0 | 36.0 |
| Highest | 927.6 | 12.0 | -0.22 | 24.0 | 30.0 | 36.0 |

### *5.9.5.3. Peak Conducted Power for 6 dBi < Antenna Gain < 12 dBi*

For antenna gain greater than 6 dBi and less than 12 dBi, the peak conducted power (Pc) shall be set by the manufacturer to allow maximum of 36.0 dm EIRP. This peak conducted power (Pc) can be calculated as follows with respect to the antenna gain:

**Pc = EIRP (dBm) - G (dBi) ≤ 36.0 dBm**

**Please refer to Page 3 of the Users Manual for the Instruction of power setting.**

# 5.10. RF EXPOSURE REQUIRMENTS @ FCC 15.247(B)(4), 1.1310 & 2.1091

## 5.10.1. Limits

- **FCC 15.247(b)(4):** 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).

**LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Average Time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Control Exposures** | | | | |
| 300-1500 | ... | ... | F/300 | 6 |
| 1500-100,000 | ... | ... | 5 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 300-1500 | ... | ... | F/1500 | 6 |
| 1500-100,000 | ... | ... | 1.0 | 30 |

F = Frequency in MHz

## 5.10.2. 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 $mW/cm^2$
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

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

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

- 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)

## 5.10.3. Test Data

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

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

Where: $S = F_{min}/1500$ W/cm$^2$

EIRP (in mW) = maximum EIRP measured in Section 5.8 of this test report

| Frequency (MHz) | Maximum Measured peak EIRP (dBm) | Laboratory's Recommended Minimum RF Safety Distance r (cm) | Manufacturer's specification in User's Manual |
|---|---|---|---|
| 902 – 928 | 36.0 | 23 cm | 23 cm |

| Evaluation of RF Exposure Compliance Requirements | |
|---|---|
| **RF Exposure Requirements** | **Compliance with FCC Rules** |
| Minimum calculated separation distance between antenna and persons required: 23 cm | Manufacturer' instruction for separation distance between antenna and persons required: 23 cm. Please refer to page # iii of the Users/ Manual and FCC RF Exposure folder |
| Antenna installation and device operating instructions for installers | Please refer to page # 4 of the Users/ Manual and FCC RF Exposure folder |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits | Please refer to page # iii of the Users/ Manual and FCC RF Exposure folder |
| Any other RF exposure related issues that may affect MPE compliance | N/A |

# 5.11. TRANSMITTER BAND-EDGE & SPURIOUS EMISSIONS (CONDUCTED), FCC CFR 47, PARA. 15.247(C)

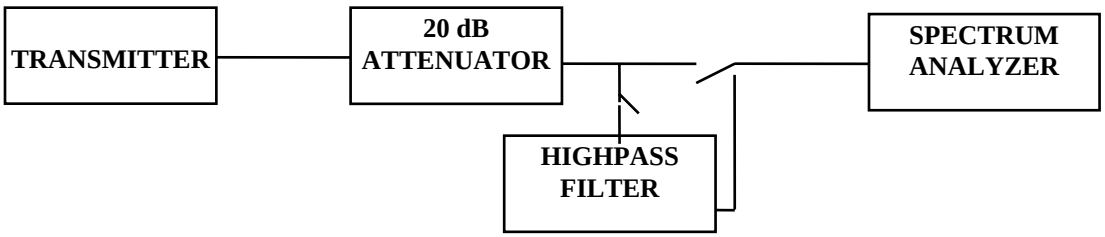
## 5.11.1. Limits

In any 100 kHz bandwidth outside the 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 § 15.209(a) is not required.

## 5.11.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 of this test report, FCC 15.247(c) , FCC Public Notice DA 00-705 & ANSI C63.4

## 5.11.3. Test Arrangement




## 5.11.4. 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 |

## 5.11.5. Test Data

### *5.11.5.1. Conducted Band-edge Spurious Emissions with no hopping and during hopping operation*

Please refer to Plots # 17 to 24 for detailed measurements of band-edge conducted emissions.

### *5.11.5.2. Lowest Frequency (902.4 MHz, RF Output: 30 dBm max., Channel Spacing: 280 kHz / 400 kHz)*

***Note:** Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 904.20 | 30.0 | PEAK | 30.0 | 0.0 | PASS |
| 1808.40 | -18.2 | PEAK | 10.0 | -28.2 | PASS |
| 5425.20 | -40.2 | PEAK | 10.0 | -50.2 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 25 to 26 for detailed measurements.

### *5.11.5.3. Middle Frequency (915 MHz, RF Output: 30 dBm max., Channel Spacing: 280 kHz / 400 kHz)*

***Note:** Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 915.00 | 30.0 | PEAK | 30.0 | 0.0 | PASS |
| 1830.00 | -15.9 | PEAK | 10.0 | -25.9 | PASS |
| 5490.00 | -37.3 | PEAK | 10.0 | -47.3 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 27 to 28 for detailed measurements.

### *5.11.5.4. Highest Frequency (927.6 MHz, RF Output: 30 dBm max., Channel Spacing: 280 kHz / 400 kHz)*

***Note:** Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 927.60 | 30.0 | PEAK | 30.0 | 0.0 | PASS |
| 1855.20 | -13.7 | PEAK | 10.0 | -23.7 | PASS |
| 5565.60 | -35.3 | PEAK | 10.0 | -45.3 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 29 to 30 for detailed measurements.

### 5.11.5.5. Lowest Frequency (902.4 MHz, RF Output: -0.22 dBm Min., Channel Spacing: 280 kHz / 400 kHz)

*** Note:** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 902.4 | -0.2 | PEAK | 30.0 | -30.2 | PASS |
| 249.0 | -55.8 | PEAK | -20.2 | -35.6 | PASS |
| 642.2 | -56.0 | PEAK | -20.2 | -35.8 | PASS |
| 1804.8 | -28.5 | PEAK | -20.2 | -8.3 | PASS |
| 2707.2 | -70.1 | PEAK | -20.2 | -49.9 | PASS |
| 3609.6 | -67.9 | PEAK | -20.2 | -47.7 | PASS |
| 4512.0 | -79.4 | PEAK | -20.2 | -59.2 | PASS |
| 5414.4 | -61.9 | PEAK | -20.2 | -41.7 | PASS |
| 6316.8 | -63.4 | PEAK | -20.2 | -43.2 | PASS |
| 7219.2 | -75.0 | PEAK | -20.2 | -54.8 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 31 to 32 for detailed measurements.

### 5.11.5.6. Middle Frequency (915 MHz, RF Output: -0.22 dBm min., Channel Spacing: 280 kHz / 400 kHz)

*** Note:** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 915.0 | -0.2 | PEAK | 30.0 | -30.2 | PASS |
| 250.4 | -56.0 | PEAK | -20.2 | -35.8 | PASS |
| 653.5 | -56.1 | PEAK | -20.2 | -35.9 | PASS |
| 1830.0 | -30.5 | PEAK | -20.2 | -10.3 | PASS |
| 2745.0 | -73.3 | PEAK | -20.2 | -53.1 | PASS |
| 3660.0 | -73.8 | PEAK | -20.2 | -53.6 | PASS |
| 4575.0 | -60.9 | PEAK | -20.2 | -40.7 | PASS |
| 5490.0 | -67.6 | PEAK | -20.2 | -47.4 | PASS |
| 6405.0 | -77.1 | PEAK | -20.2 | -56.9 | PASS |
| 7320.0 | -74.1 | PEAK | -20.2 | -53.9 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 33 to 34 for detailed measurements.

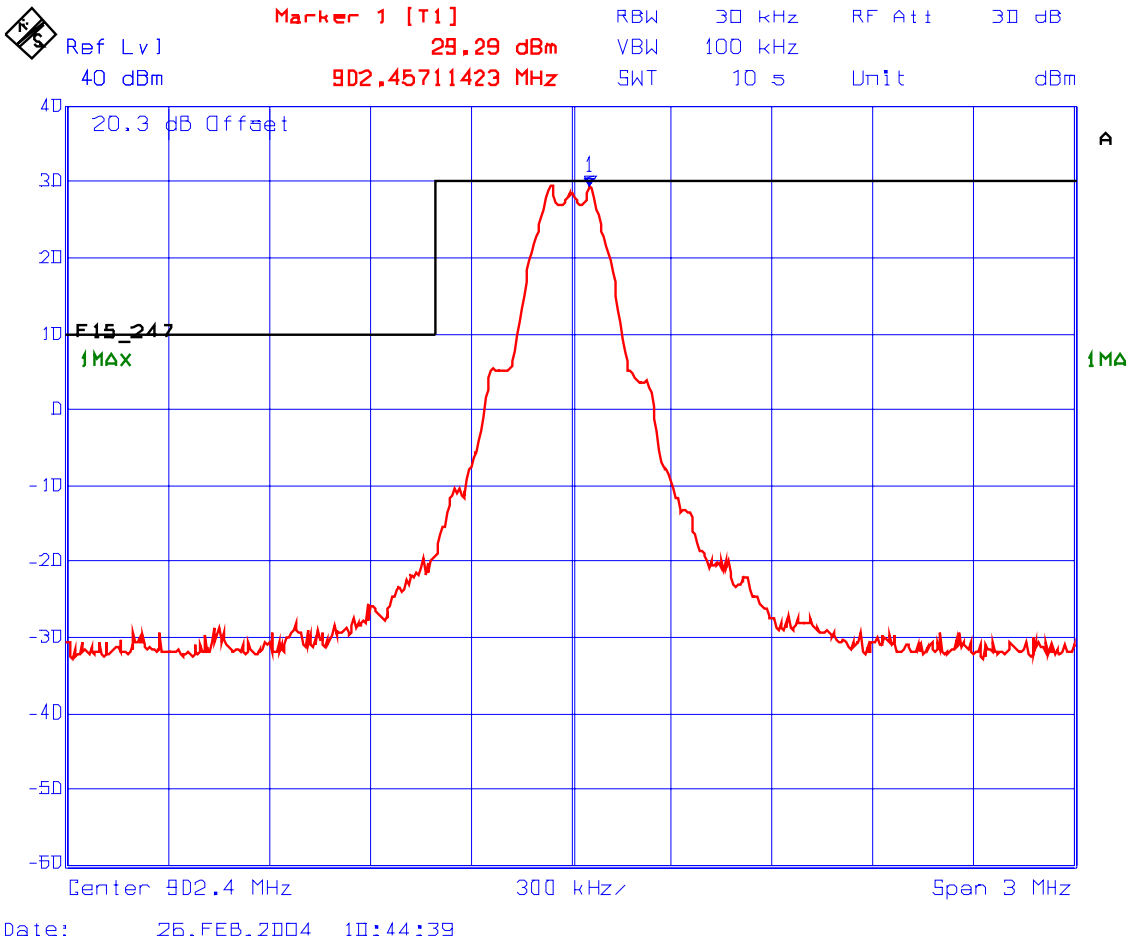
### *5.11.5.7. Highest Frequency (927.6 MHz, RF Output: -0.22 dBm min., Channel Spacing: 280 kHz / 400 kHz)*

**** Note:** Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

| FREQUENCY (MHz) | RF LEVEL (dBm) | DETECTOR USED (PEAK/QP) | LIMIT (dBm) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|
| 927.6 | -0.2 | PEAK | 30.0 | -30.2 | PASS |
| 249.0 | -55.5 | PEAK | -20.2 | -35.3 | PASS |
| 666.2 | -55.9 | PEAK | -20.2 | -35.7 | PASS |
| 1855.2 | -24.6 | PEAK | -20.2 | -4.4 | PASS |
| 2782.8 | -73.6 | PEAK | -20.2 | -53.4 | PASS |
| 3710.4 | -69.8 | PEAK | -20.2 | -49.6 | PASS |
| 4638.0 | -75.2 | PEAK | -20.2 | -55.0 | PASS |
| 5565.6 | -56.8 | PEAK | -20.2 | -36.6 | PASS |
| 6493.2 | -71.7 | PEAK | -20.2 | -51.5 | PASS |
| 7420.8 | -77.9 | PEAK | -20.2 | -57.7 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions less 50 dB below the limits were recorded.
- Please refer to Plots # 35 to 36 for detailed measurements.

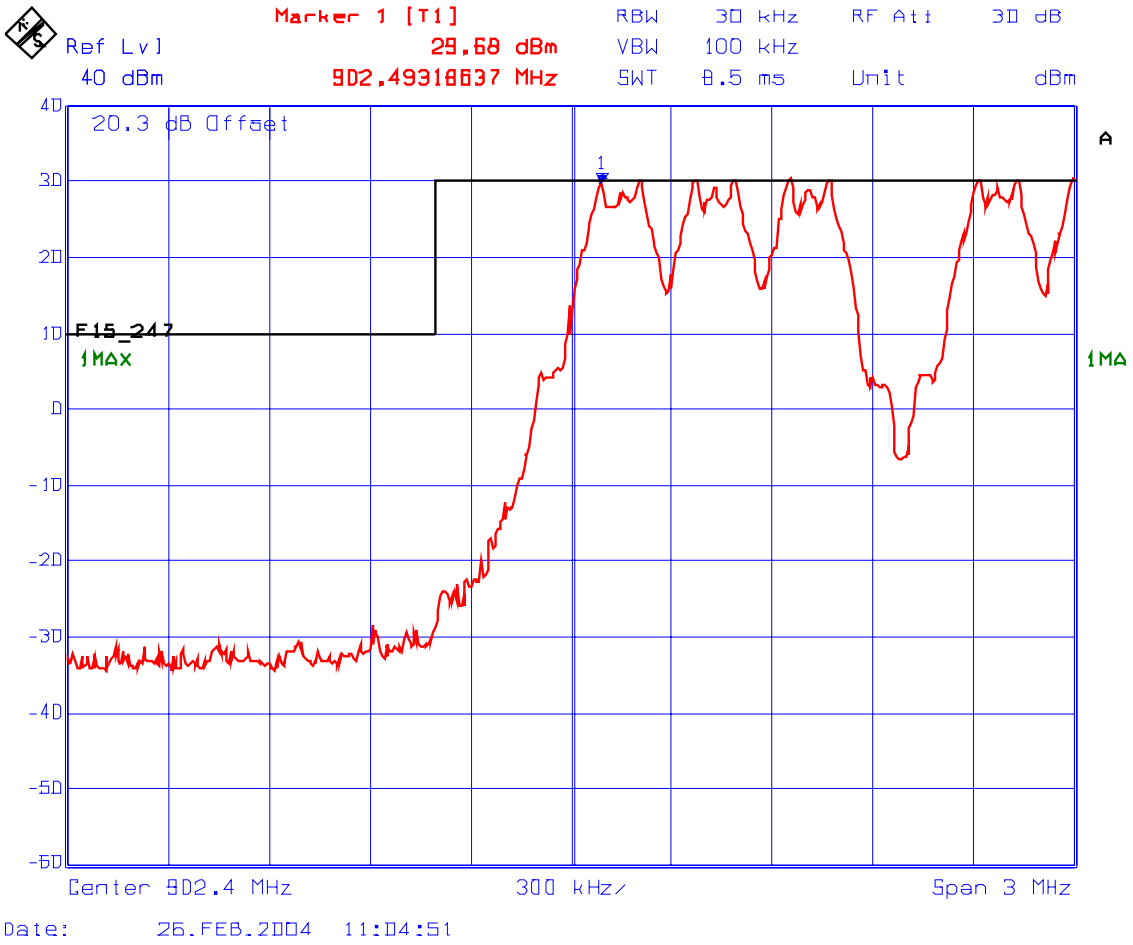
**Plot #17:** **Lower Band-Edge Conducted Emissions**
**Test Mode: Lowest Single Channel @ 902.4 MHz (manufacturer's test mode only),**
**Channel Spacing: 280 kHz**






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

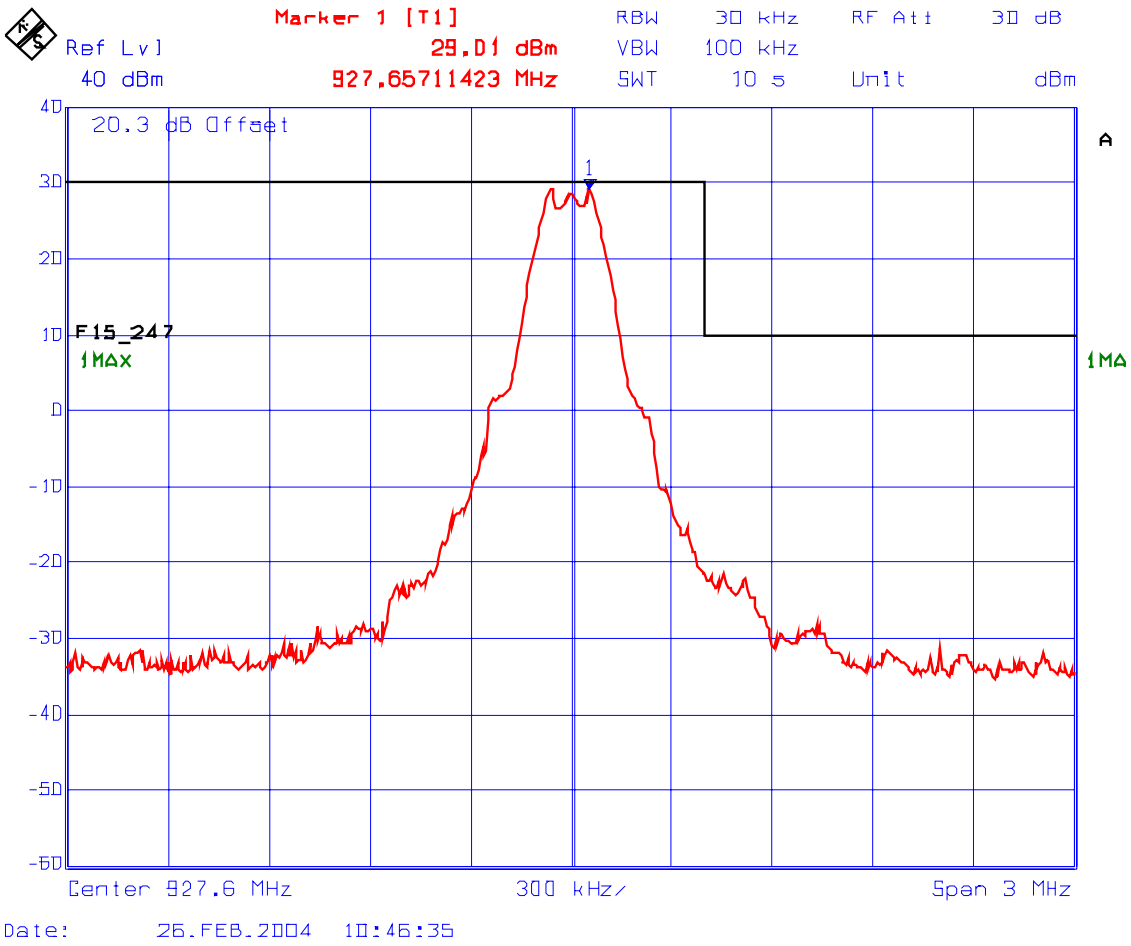
**Plot #18:** **Lower Band-Edge Conducted Emissions**
**Test Mode: All channels hopping as intended operation (manufacturer's test mode only), Channel Spacing: 280 kHz**



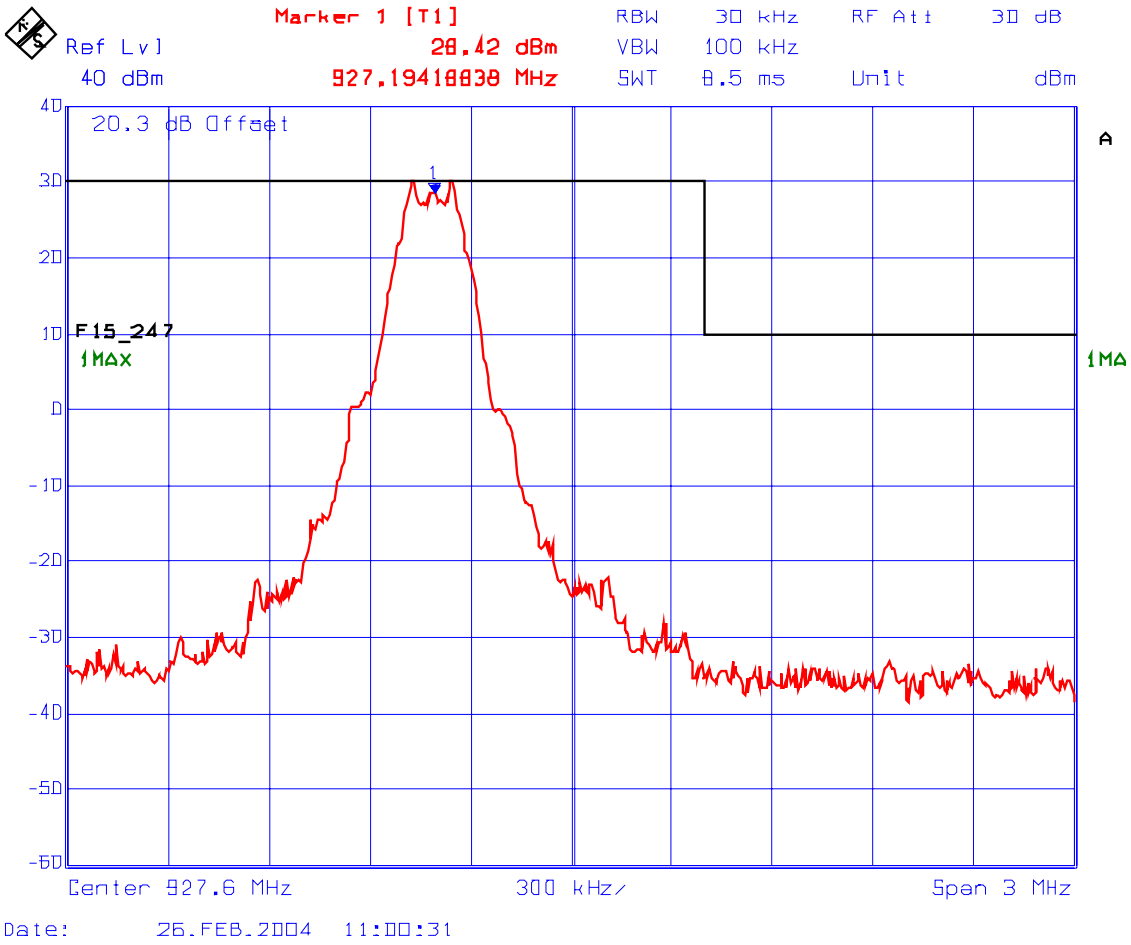



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot #19:** **Upper Band-Edge Conducted Emissions**
**Test Mode: Lowest Single Channel @ 927.6 MHz (manufacturer's test mode only),**
**Channel Spacing: 280 kHz**



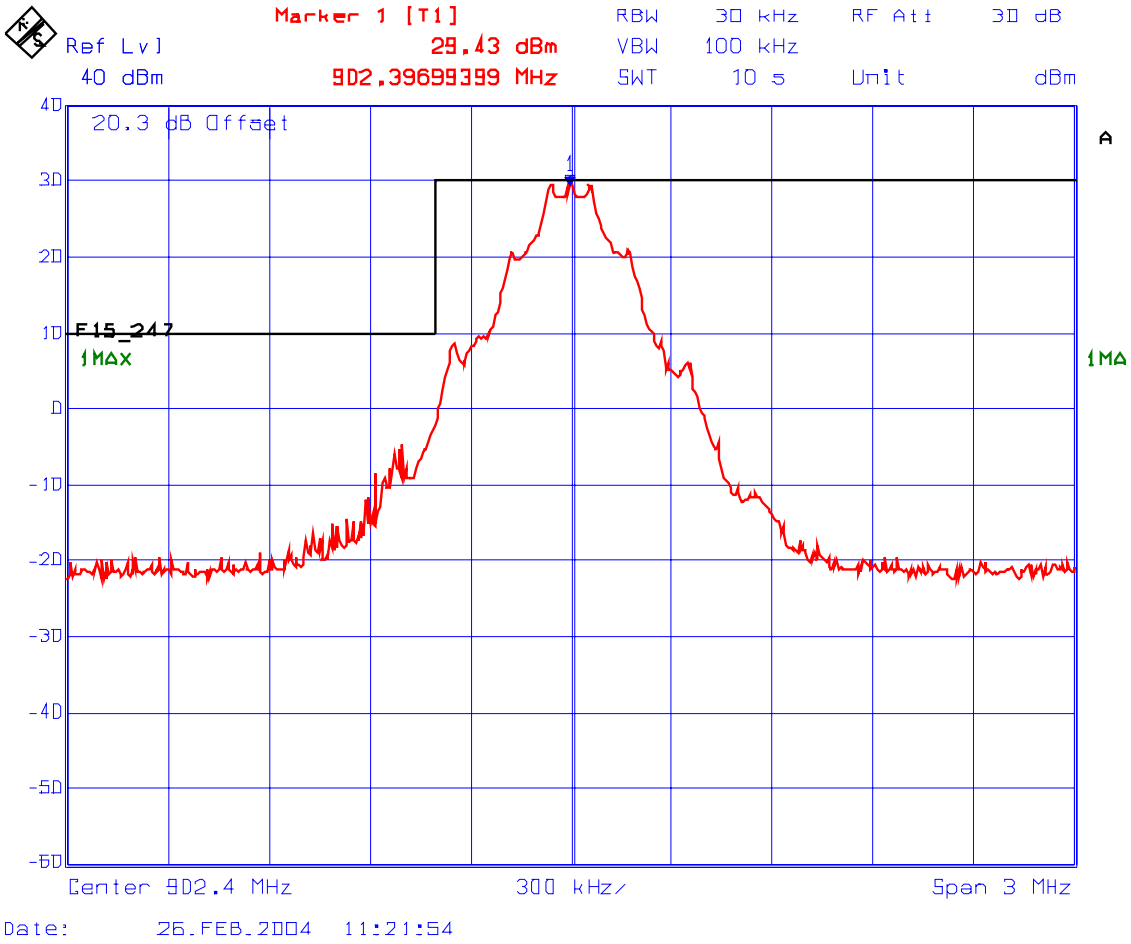
**Plot #20:** **Upper Band-Edge Conducted Emissions**
**Test Mode: All channels hopping as intended operation (manufacturer's test mode only), Channel Spacing: 280 kHz**






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

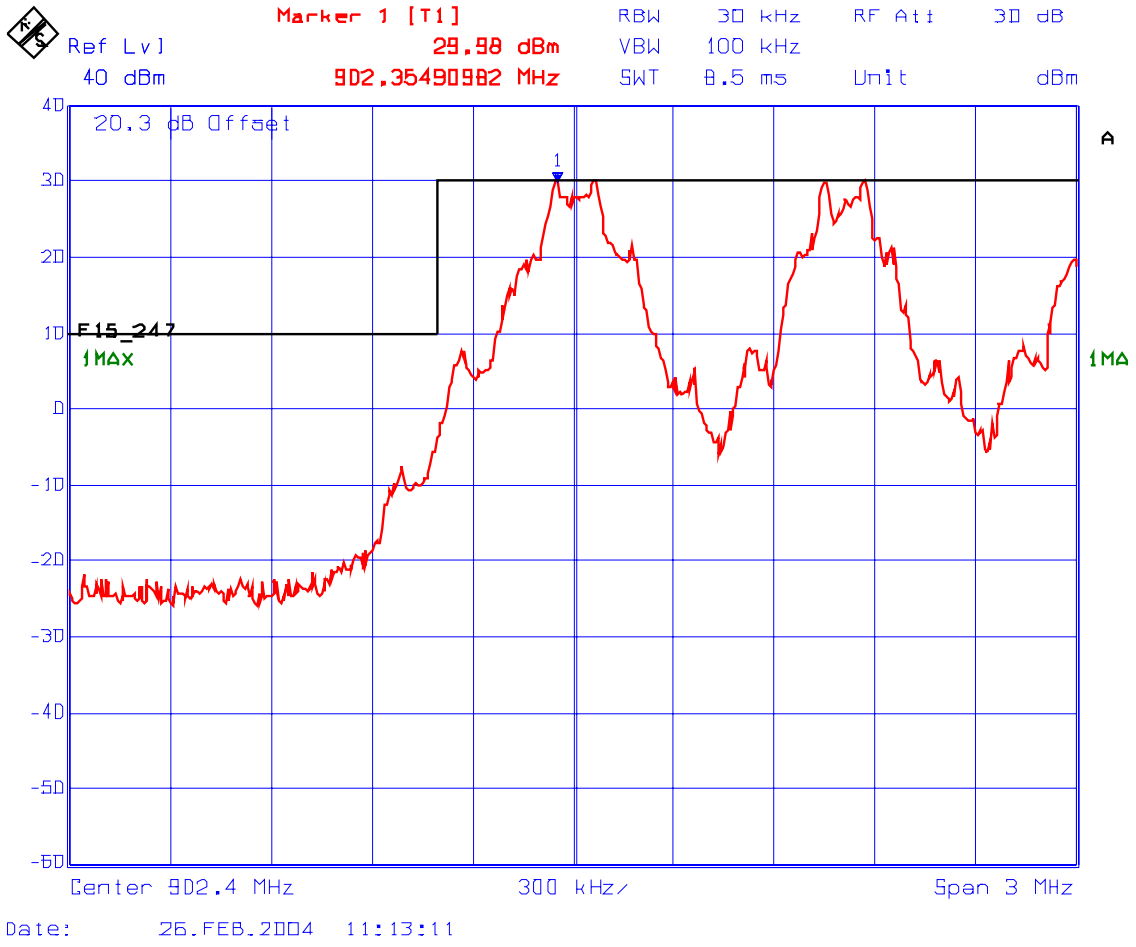
**Plot #21:** **Lower Band-Edge Conducted Emissions**
**Test Mode: Lowest Single Channel @ 902.4 MHz (manufacturer's test mode only),**
**Channel Spacing: 400 kHz**






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

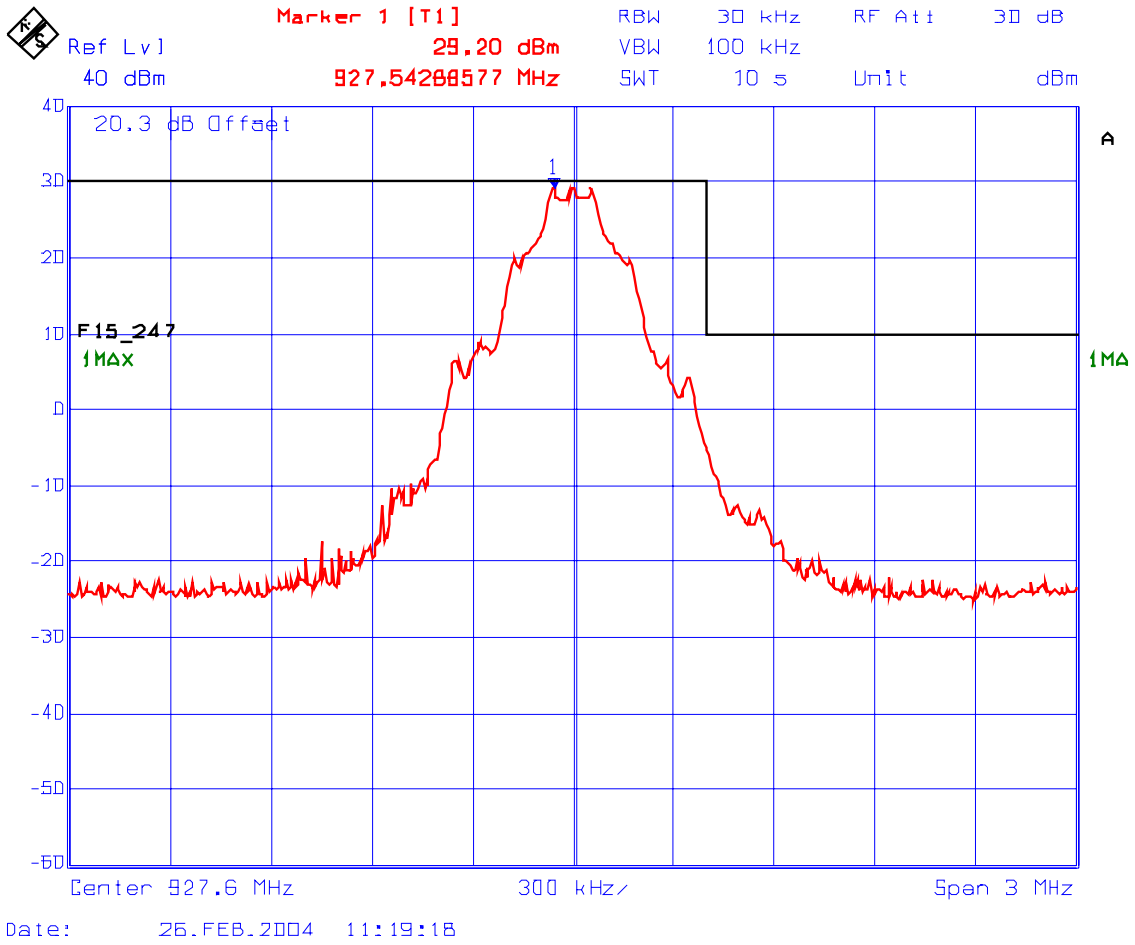
**Plot #22:** **Lower Band-Edge Conducted Emissions**
**Test Mode: All channels hopping as intended operation (manufacturer's test mode only), Channel Spacing: 400 kHz**






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

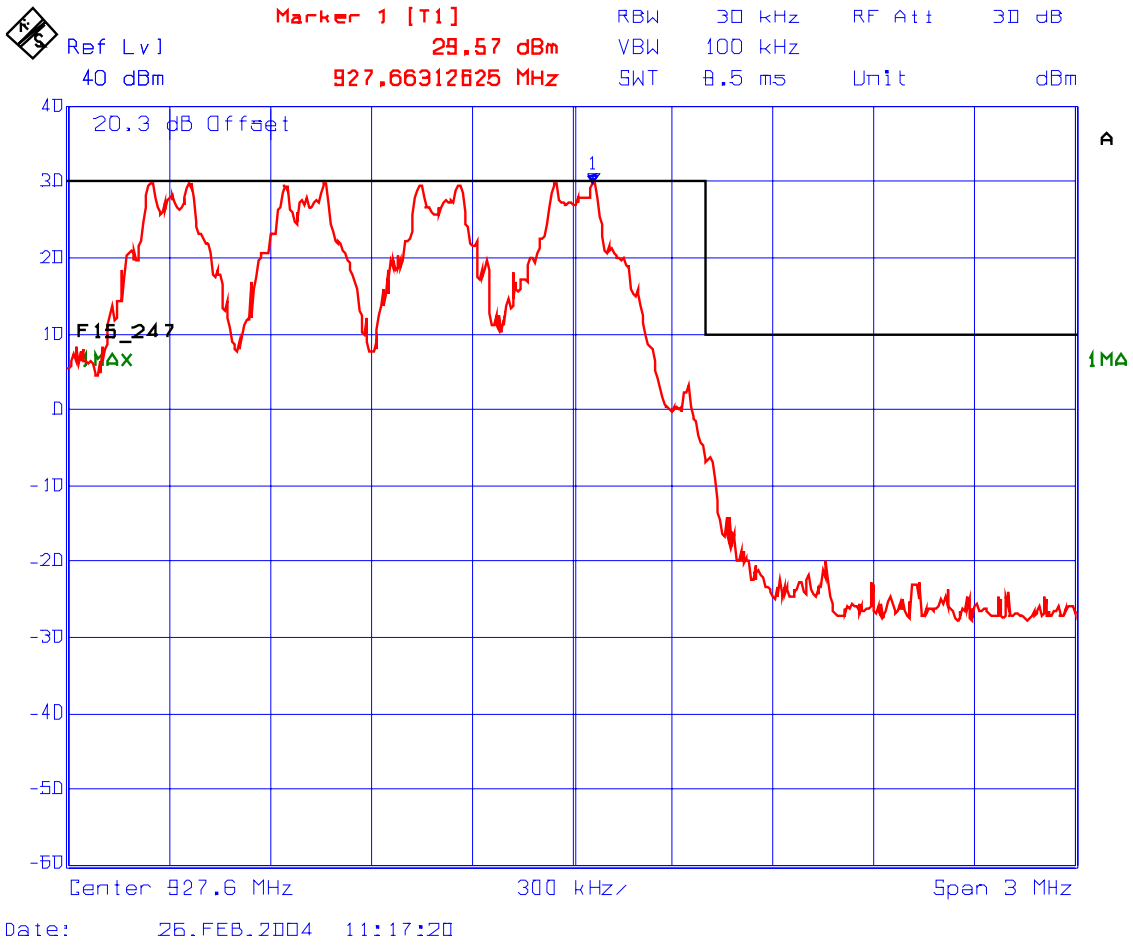
**Plot #23:** **Upper Band-Edge Conducted Emissions**
**Test Mode: Lowest Single Channel @ 927.6 MHz (manufacturer's test mode only),**
**Channel Spacing: 400 kHz**






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

**Plot #24:** **Upper Band-Edge Conducted Emissions**
**Test Mode: All channels hopping as intended operation (manufacturer's test mode only), Channel Spacing: 400 kHz**



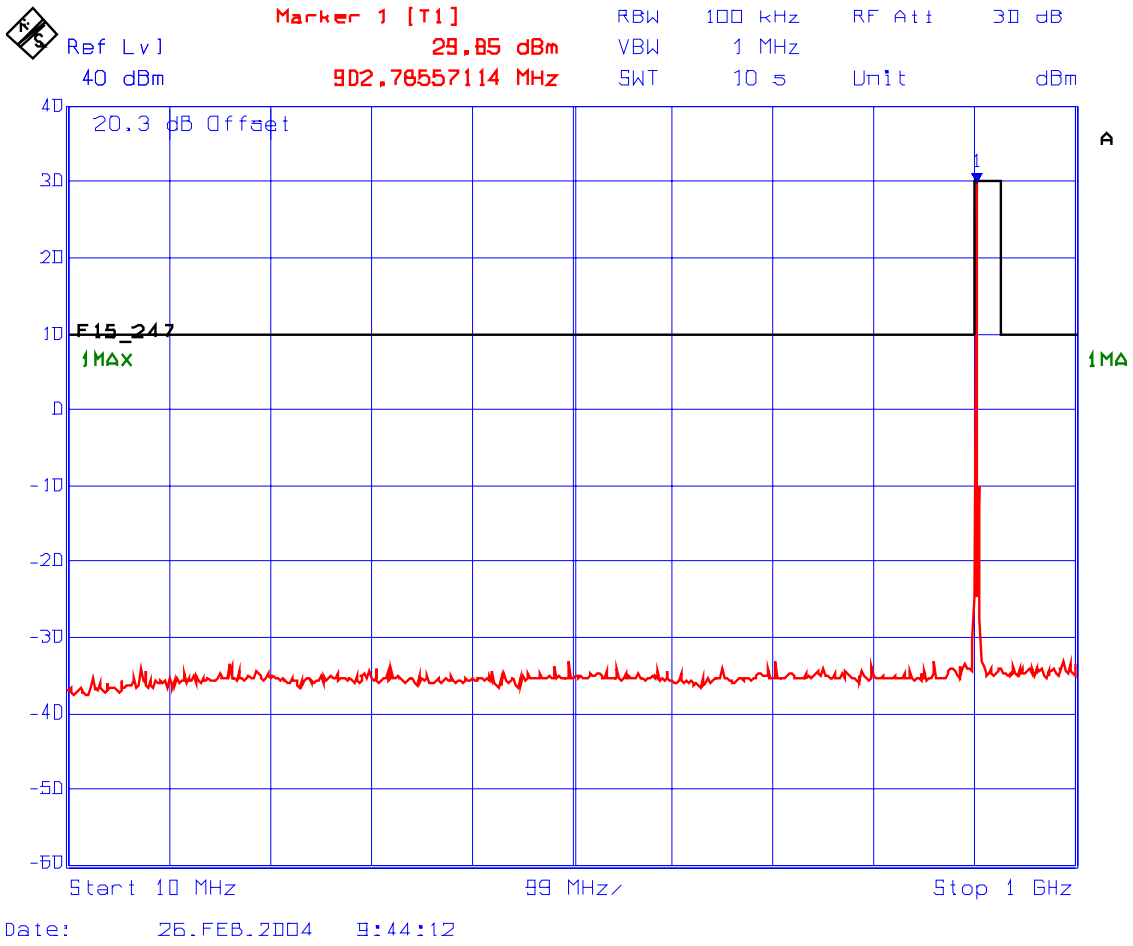



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot #25:** **Spurious RF Conducted Emissions**

**Test Mode: 902.4 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

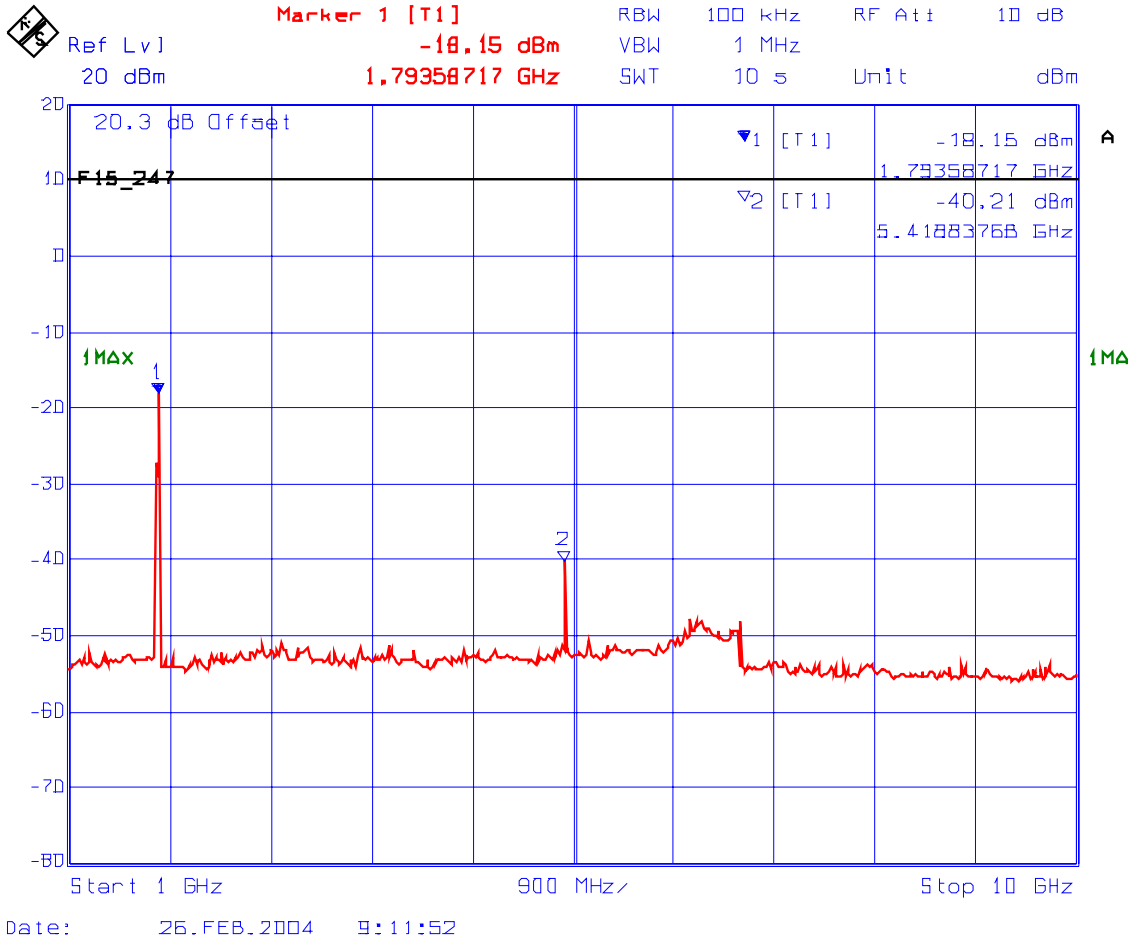





- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #26:** **Spurious RF Conducted Emissions**
**Test Mode: 902.4 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

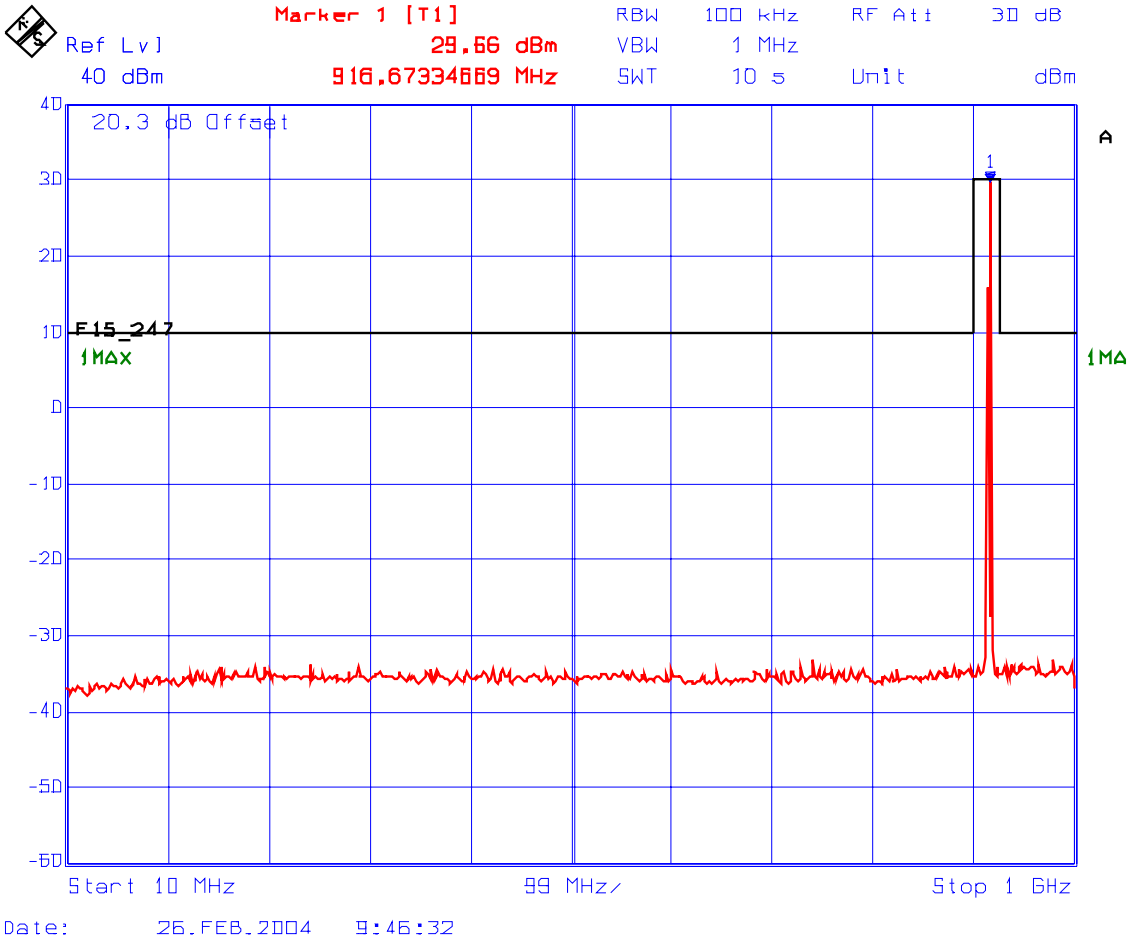





- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #27:** **Spurious RF Conducted Emissions**
**Test Mode: 915 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

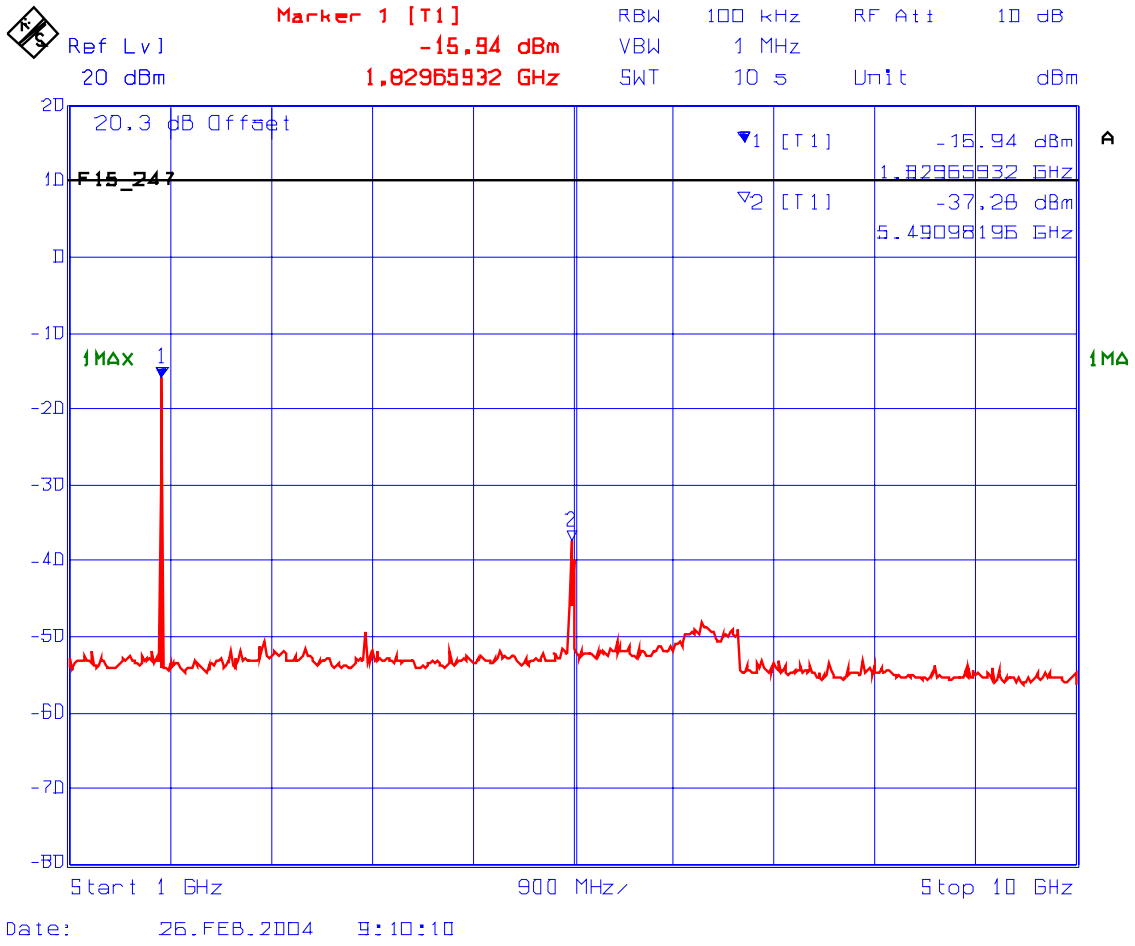





- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #28:** **Spurious RF Conducted Emissions**
**Test Mode: 915 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

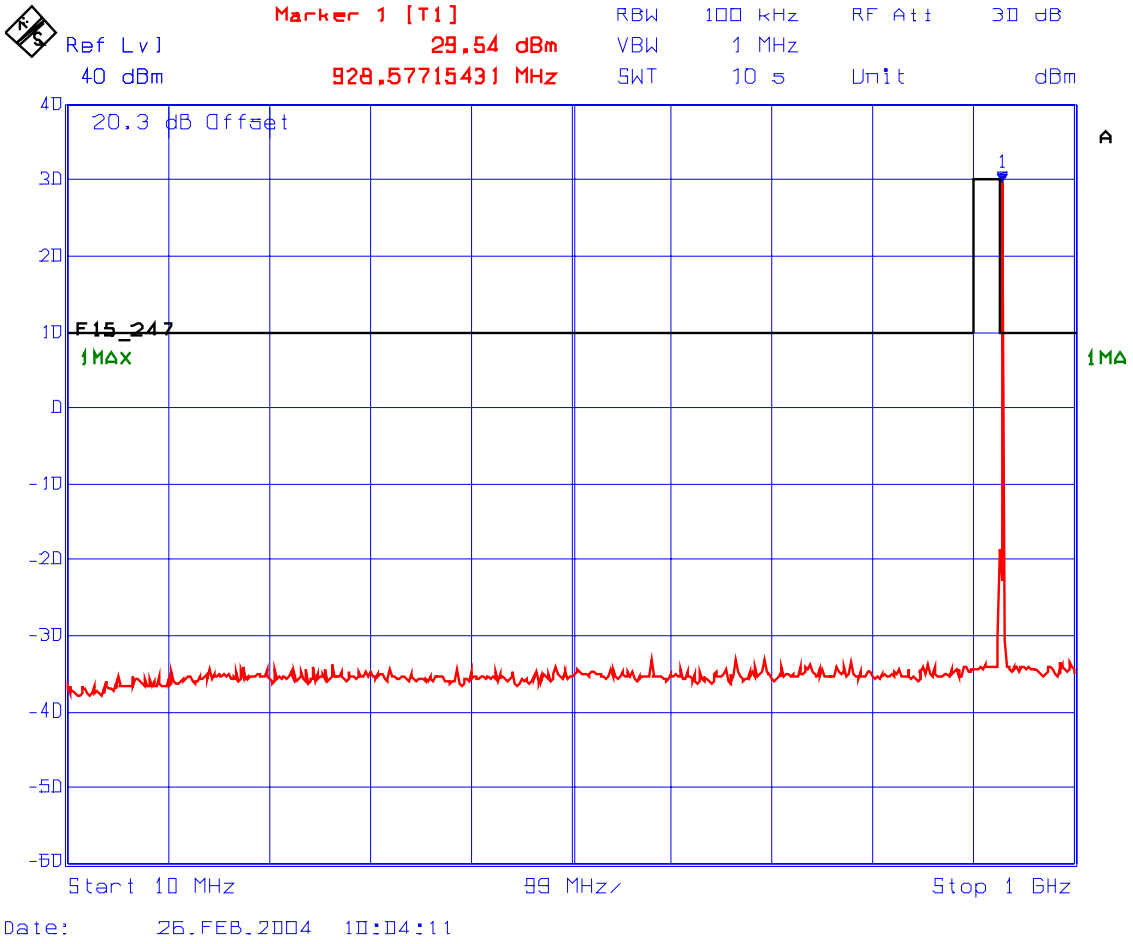





- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #29:** **Spurious RF Conducted Emissions**
**Test Mode: 927.6 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*

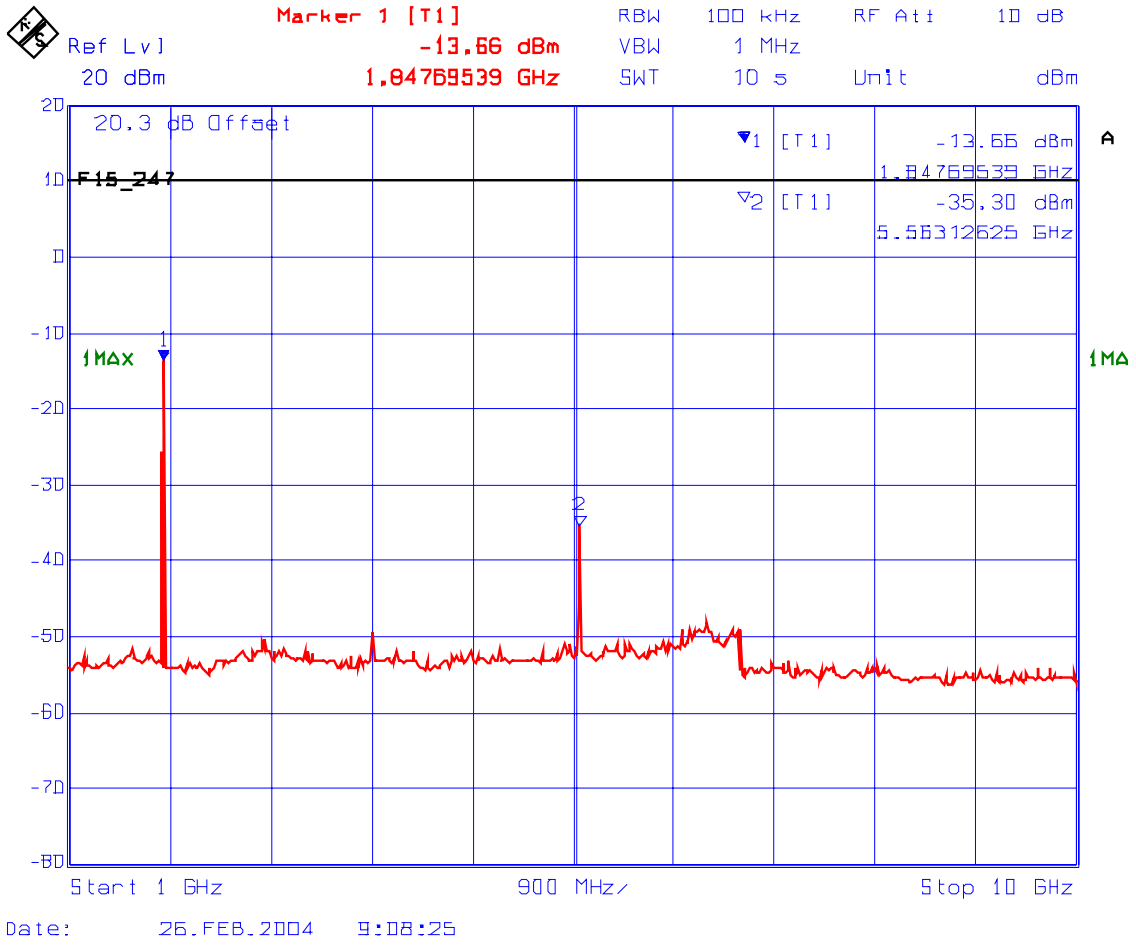





- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

**Plot #30:** **Spurious RF Conducted Emissions**
**Test Mode: 927.6 MHz, RF Output: 1 Watt, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



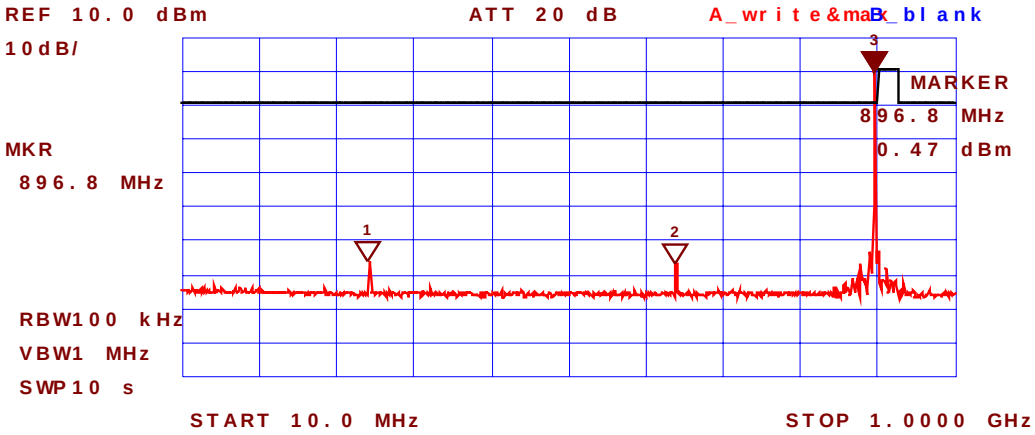



- ***All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)***

## Plot #31: Spurious RF Conducted Emissions

**Test Mode: 902.4 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



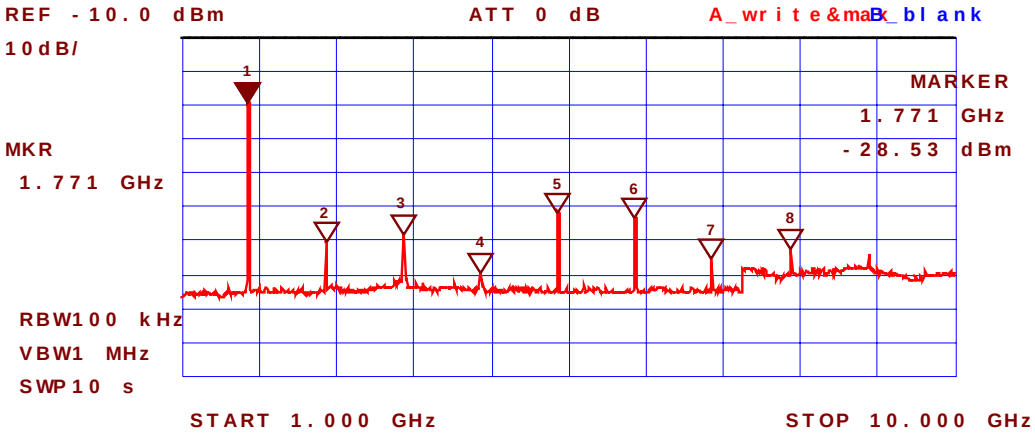

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 249.0 MHz | -55.75 dBm | A |
| No. 2: | 642.2 MHz | -56.03 dBm | A |
| No. 3: | 896.8 MHz | 0.47 dBm | A |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

## Plot #32: Spurious RF Conducted Emissions

**Test Mode: 902.4 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



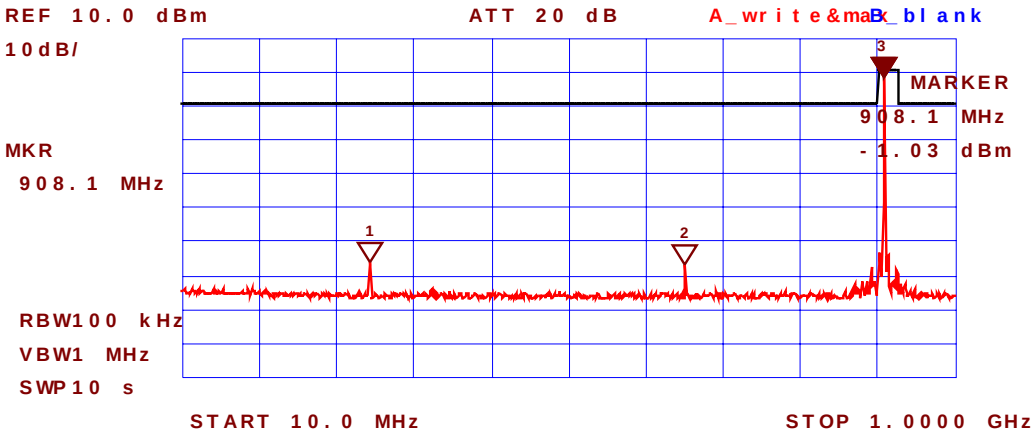

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 1.771 GHz | -28.53 dBm | A |
| No. 2: | 2.671 GHz | -70.09 dBm | A |
| No. 3: | 3.571 GHz | -67.94 dBm | A |
| No. 4: | 4.471 GHz | -79.44 dBm | A |
| No. 5: | 5.371 GHz | -61.88 dBm | A |
| No. 6: | 6.271 GHz | -63.44 dBm | A |
| No. 7: | 7.159 GHz | -75.03 dBm | A |
| No. 8: | 8.084 GHz | -72.22 dBm | A |
| : | | | |

## Plot #33: Spurious RF Conducted Emissions

**Test Mode: 915 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



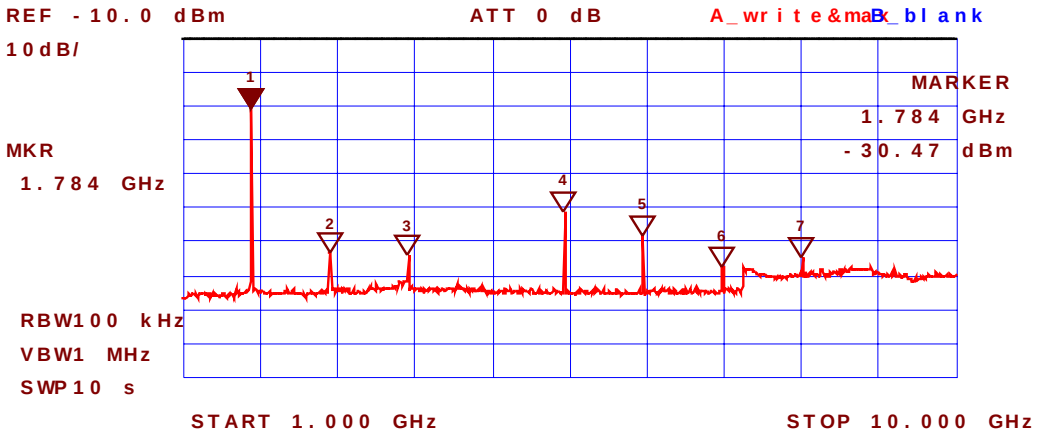

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 250.4 MHz | -55.97 dBm | A |
| No. 2: | 653.5 MHz | -56.09 dBm | A |
| No. 3: | 908.1 MHz | -1.03 dBm | A |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| Δ: | | | |

## Plot #34: Spurious RF Conducted Emissions

**Test Mode: 915 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



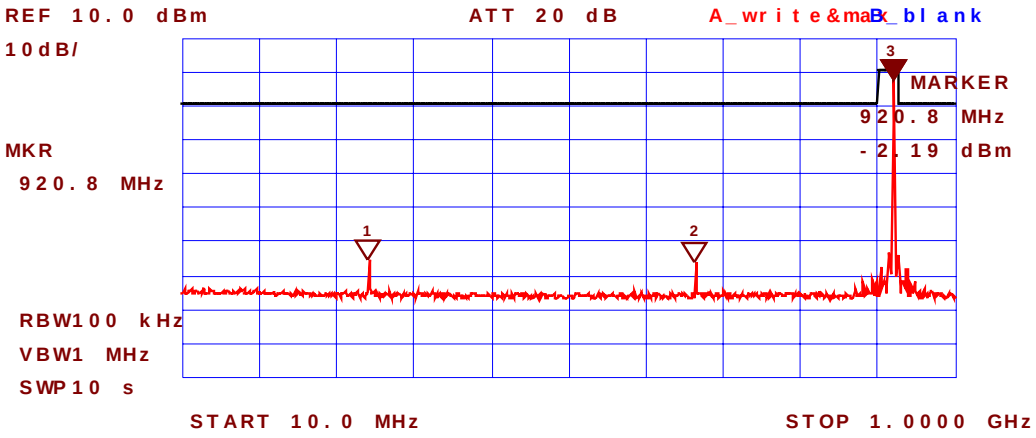

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 1.784 GHz | -30.47 dBm | A |
| No. 2: | 2.710 GHz | -73.34 dBm | A |
| No. 3: | 3.610 GHz | -73.78 dBm | A |
| No. 4: | 5.436 GHz | -60.91 dBm | A |
| No. 5: | 6.349 GHz | -67.59 dBm | A |
| No. 6: | 7.274 GHz | -77.06 dBm | A |
| No. 7: | 8.200 GHz | -74.09 dBm | A |
| No. 8: | | | |
| : | | | |

## Plot #35: Spurious RF Conducted Emissions

**Test Mode: 927.6 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*



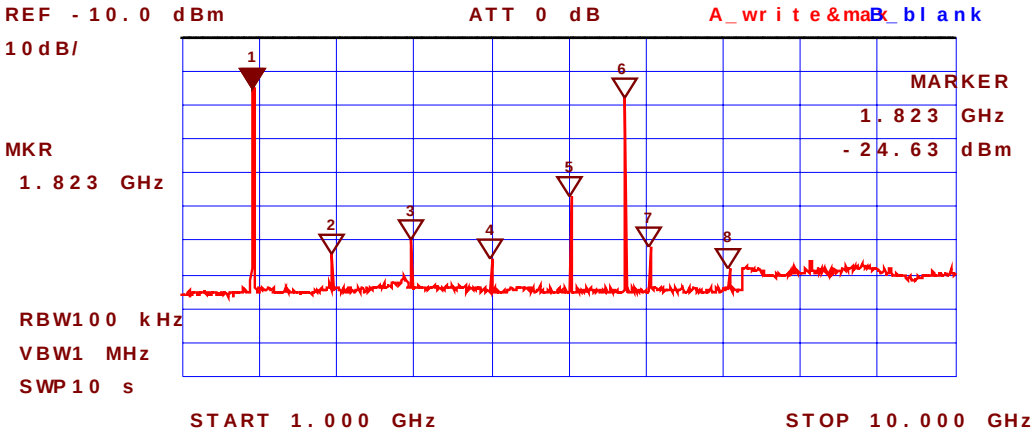

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 249.0 MHz | -55.50 dBm | A |
| No. 2: | 666.2 MHz | -55.88 dBm | A |
| No. 3: | 920.8 MHz | -2.19 dBm | A |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

## Plot #36: Spurious RF Conducted Emissions

**Test Mode: 927.6 MHz, RF Output: 0.95 mWatts, Channel Spacing: 280 kHz / 400 kHz***

***Note:*** *Test results were the same for both 280 kHz and 400 kHz Channel spacing operations.*




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 1.823 GHz | -24.63 dBm | A |
| No. 2: | 2.736 GHz | -73.56 dBm | A |
| No. 3: | 3.661 GHz | -69.81 dBm | A |
| No. 4: | 4.587 GHz | -75.19 dBm | A |
| No. 5: | 5.513 GHz | -56.84 dBm | A |
| No. 6: | 6.143 GHz | -27.88 dBm | A |
| No. 7: | 6.439 GHz | -71.72 dBm | A |
| No. 8: | 7.364 GHz | -77.94 dBm | A |

# 5.12. TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205

## 5.12.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

**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.
- **@ FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

**FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands**

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 162.0125 - 167.17 | 2310 - 2390 | 9.3 - 9.5 |
| 0.49 – 0.51 | 167.72 - 173.2 | 2483.5 - 2500 | 10.6 - 12.7 |
| 2.1735 - 2.1905 | 240 - 285 | 2655 - 2900 | 13.25 - 13.4 |
| 8.362 - 8.366 | 322 - 335.4 | 3260 - 3267 | 14.47 - 14.5 |
| 13.36 - 13.41 | 399.9 - 410 | 3332 - 3339 | 14.35 - 16.2 |
| 25.5 – 25.67 | 608 - 614 | 3345.8 - 3358 | 17.7 - 21.4 |
| 37.5 – 38.25 | 960 - 1240 | 3600 - 4400 | 22.01 - 23.12 |
| 73 - 75.4 | 1300 - 1427 | 4500 - 5250 | 23.6 - 24.0 |
| 108 – 121.94 | 1435 - 1626.5 | 5350 - 5460 | 31.2 - 31.8 |
| 123 – 138 | 1660 - 1710 | 7250 - 7750 | 36.43 - 36.5 |
| 149.9 – 150.05 | 1718.8 - 1722.2 | 8025 - 8500 | Above 38.6 |
| 156.7 – 156.9 | 2200 - 2300 | 9000 - 9200 | |

**FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)**
**-- Field Strength Limits within Restricted Frequency Bands --**

| FREQUENCY (MHz) | FIELD STRENGTH LIMITS (microvolts/m) | 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 |

## 5.12.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 of this test report and **ANSI 63.4-1992, Para. 8** 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 Section 15.35(b) and (c).

## 5.12.3. Test Arrangement

Please refer to Test Arrangement in Sec. 5.5.3 for details of test setup for emission measurements.

## 5.12.4. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer/ EMI Receiver | Advantest | R3271 | 15050203 | 100 Hz to 32 GHz with external mixer for frequency above 32 GHz |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 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 |

## 5.12.5. Plots

The following plots graphically represent the test results recorded in the above Test Data Table.

## 5.12.6. Test Data

### *5.12.6.1. Radiated Band-edge Spurious Emissions with no hopping and during hopping operation*

**Note**: Based on our band-edge conducted emissions, the band-edge radiated emissions for the 400 kHz channel spacing were tested to represent the worst case. Please refer to Plots # 37 to 56 for detailed measurements.

### *5.12.6.2. Transmitter Spurious Emissions @ 3 meters*

#### 5.12.6.2.1. Test Configuration # 1: Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi

**Note**: The **Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi** was tested and represent for same type of antennas and gain that listed on Page 9 of the Users Manual.

##### 5.12.6.2.1.1. Lowest Frequency 902.4 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 902.40 | 126.7 | -- | V | -- | -- | -- | -- |
| 902.40 | 121.2 | -- | H | -- | -- | -- | -- |
| 1804.80 | 87.5 | 87.32 | V | 54.0 | 106.7 | -19.4 | PASS |
| 1804.80 | 87.56 | 87.31 | H | 54.0 | 106.7 | -19.4 | PASS |
| 2707.20 | 53.63 | 51.25 | V | 54.0 | 106.7 | -55.5 | PASS |
| 2707.20 | 54.53 | 51.09 | H | 54.0 | 106.7 | -2.9 | *PASS |
| 3609.60 | 48.72 | 42.48 | V | 54.0 | 106.7 | -11.5 | *PASS |
| 3609.60 | 51.69 | 48.25 | H | 54.0 | 106.7 | -5.8 | *PASS |
| 4512.00 | 50.34 | 43.11 | V | 54.0 | 106.7 | -10.9 | *PASS |
| 4512.00 | 48.72 | 39.91 | H | 54.0 | 106.7 | -14.1 | *PASS |
| 5414.00 | 51.84 | 45.19 | V | 54.0 | 106.7 | -8.8 | *PASS |
| 5414.00 | 52.44 | 47.2 | H | 54.0 | 106.7 | -6.8 | *PASS |
| 6316.00 | 49.84 | 40.43 | V | 54.0 | 106.7 | -66.3 | PASS |
| 6316.00 | 51.22 | 45.27 | H | 54.0 | 106.7 | -61.4 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.1.2. Middle Frequency 915 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 915.00 | 125.7 | -- | V | -- | -- | -- | -- |
| 915.00 | 122.5 | -- | H | -- | -- | -- | -- |
| 1830.00 | 83.13 | 80.7 | V | 54.0 | 105.7 | -25.0 | PASS |
| 1830.00 | 83.72 | 83.51 | H | 54.0 | 105.7 | -22.2 | PASS |
| 2745.00 | 49.99 | 44.48 | V | 54.0 | 105.7 | -9.5 | *PASS |
| 2745.00 | 48.16 | 43.66 | H | 54.0 | 105.7 | -10.3 | *PASS |
| 3669.00 | 48.5 | 36.12 | V | 54.0 | 105.7 | -69.6 | PASS |
| 3669.00 | 51.28 | 48.51 | H | 54.0 | 105.7 | -5.5 | *PASS |
| 4575.00 | 49.59 | 38.47 | V | 54.0 | 105.7 | -15.5 | *PASS |
| 4575.00 | 49.69 | 44.46 | H | 54.0 | 105.7 | -9.5 | *PASS |
| 5490.00 | 55.84 | 53.07 | V | 54.0 | 105.7 | -52.6 | PASS |
| 5490.00 | 55.91 | 53.2 | H | 54.0 | 105.7 | -52.5 | PASS |
| 6405.00 | 49.28 | 41.6 | V | 54.0 | 105.7 | -64.1 | PASS |
| 6405.00 | 49.52 | 42.18 | H | 54.0 | 105.7 | -63.5 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.1.3. Highest Frequency 927.6 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 927.60 | 124.5 | -- | V | -- | -- | -- | -- |
| 927.60 | 120.1 | -- | H | -- | -- | -- | -- |
| 1855.00 | 81.7 | 80.6 | V | 54.0 | 104.5 | -23.9 | PASS |
| 1855.00 | 79.6 | 78.9 | H | 54.0 | 104.5 | -25.7 | PASS |
| 2782.80 | 53.3 | 50.0 | V | 54.0 | 104.5 | -4.0 | *PASS |
| 2782.80 | 52.1 | 48.9 | H | 54.0 | 104.5 | -5.1 | *PASS |
| 3710.40 | 50.9 | 46.3 | V | 54.0 | 104.5 | -7.7 | *PASS |
| 3710.40 | 52.8 | 49.4 | H | 54.0 | 104.5 | -4.6 | *PASS |
| 4638.00 | 46.8 | 40.0 | V | 54.0 | 104.5 | -14.0 | *PASS |
| 4638.00 | 48.4 | 39.3 | H | 54.0 | 104.5 | -14.7 | *PASS |
| 5564.60 | 59.4 | 57.7 | V | 54.0 | 104.5 | -46.8 | PASS |
| 5564.60 | 57.3 | 55.2 | H | 54.0 | 104.5 | -49.3 | PASS |
| 6493.20 | 50.5 | 45.0 | V | 54.0 | 104.5 | -59.5 | PASS |
| 6493.20 | 49.7 | 43.1 | H | 54.0 | 104.5 | -61.4 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.2. Test Configuration # 2: Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi

**Note**: The **Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi** was tested and represent for the other same type of antennas and gain that listed on Page 9 of the Users Manual.

#### 5.12.6.2.2.1. Lowest Frequency 902.4 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 902.4 | 132.3 | -- | V | -- | -- | -- | -- |
| 902.4 | 123.3 | -- | H | -- | -- | -- | -- |
| 1804.8 | 67.5 | 67.4 | V | 54.0 | 112.3 | -44.9 | PASS |
| 1804.8 | 55.8 | 54.2 | H | 54.0 | 112.3 | -58.1 | PASS |
| 2707.2 | 52.4 | 48.7 | V | 54.0 | 112.3 | -5.3 | *PASS |
| 2707.2 | 50.9 | 44.5 | H | 54.0 | 112.3 | -9.5 | *PASS |
| 3609.6 | 47.5 | 39.2 | V | 54.0 | 112.3 | -14.8 | *PASS |
| 3609.6 | 47.7 | 41.0 | H | 54.0 | 112.3 | -13.0 | *PASS |
| 4512.0 | 49.0 | 42.3 | V | 54.0 | 112.3 | -11.7 | *PASS |
| 4512.0 | 48.5 | 40.0 | H | 54.0 | 112.3 | -14.0 | *PASS |
| 5414.4 | 53.3 | 48.6 | V | 54.0 | 112.3 | -5.5 | *PASS |
| 5414.4 | 51.3 | 41.5 | H | 54.0 | 112.3 | -12.5 | *PASS |
| 6493.2 | 52.5 | 45.7 | V | 54.0 | 112.3 | -66.6 | PASS |
| 6493.2 | 58.8 | 56.3 | H | 54.0 | 112.3 | -56.0 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.2.2. Middle Frequency 915 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 915.00 | 128.4 | -- | V | -- | -- | -- | -- |
| 915.00 | 122.0 | -- | H | -- | -- | -- | -- |
| 1830.0 | 70.7 | 70.3 | V | 54.0 | 108.4 | -38.1 | PASS |
| 1830.0 | 58.2 | 57.6 | H | 54.0 | 108.4 | -50.8 | PASS |
| 2745.0 | 52.0 | 49.2 | V | 54.0 | 108.4 | -4.8 | *PASS |
| 2745.0 | 50.6 | 46.2 | H | 54.0 | 108.4 | -7.8 | *PASS |
| 3660.0 | 46.5 | 36.3 | V | 54.0 | 108.4 | -17.7 | *PASS |
| 3660.0 | 49.4 | 44.4 | H | 54.0 | 108.4 | -9.6 | *PASS |
| 4575.0 | 47.0 | 36.8 | V | 54.0 | 108.4 | -17.2 | *PASS |
| 4575.0 | 47.7 | 36.3 | H | 54.0 | 108.4 | -17.7 | *PASS |
| 5490.0 | 56.2 | 52.8 | V | 54.0 | 108.4 | -55.6 | PASS |
| 5490.0 | 57.2 | 55.0 | H | 54.0 | 108.4 | -53.4 | PASS |
| 6405.0 | 51.5 | 45.0 | V | 54.0 | 108.4 | -63.4 | PASS |
| 6405.0 | 55.4 | 50.0 | H | 54.0 | 108.4 | -58.4 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.2.3. Highest Frequency 927.6 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 927.60 | 130.7 | -- | V | -- | -- | -- | -- |
| 927.60 | 122.7 | -- | H | -- | -- | -- | -- |
| 1855.2 | 71.5 | 71.0 | V | 54.0 | 110.7 | -39.7 | PASS |
| 1855.2 | 58.0 | 57.0 | H | 54.0 | 110.7 | -53.7 | PASS |
| 2782.8 | 54.2 | 52.4 | V | 54.0 | 110.7 | -1.6 | *PASS |
| 2782.8 | 50.5 | 47.1 | H | 54.0 | 110.7 | -6.9 | *PASS |
| 3710.4 | 47.3 | 40.6 | V | 54.0 | 110.7 | -13.5 | *PASS |
| 3710.4 | 49.1 | 45.1 | H | 54.0 | 110.7 | -8.9 | *PASS |
| 4638.0 | 49.9 | 44.1 | V | 54.0 | 110.7 | -9.9 | *PASS |
| 4638.0 | 50.9 | 45.1 | H | 54.0 | 110.7 | -9.0 | *PASS |
| 5565.6 | 61.4 | 59.8 | V | 54.0 | 110.7 | -50.9 | PASS |
| 5565.6 | 55.6 | 51.8 | H | 54.0 | 110.7 | -58.9 | PASS |
| 6493.2 | 51.9 | 45.2 | V | 54.0 | 110.7 | -65.5 | PASS |
| 6493.2 | 50.6 | 43.5 | H | 54.0 | 110.7 | -67.2 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.3. Test Configuration # 3: Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd

**Note**: The **Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd** was tested and represent for the other same type of antennas and gain that listed on Page 9 of the Users Manual.

#### 5.12.6.2.3.1. Lowest Frequency 902.4 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 902.40 | 125.8 | -- | V | -- | -- | -- | -- |
| 902.40 | 127.1 | -- | H | -- | -- | -- | -- |
| 1804.8 | 77.5 | 76.8 | V | 54.0 | 107.1 | -30.3 | PASS |
| 1804.8 | 72.3 | 71.7 | H | 54.0 | 107.1 | -35.4 | PASS |
| 2707.2 | 53.3 | 51.9 | V | 54.0 | 107.1 | -2.2 | *PASS |
| 2707.2 | 50.6 | 47.0 | H | 54.0 | 107.1 | -7.0 | *PASS |
| 3609.6 | 49.7 | 44.0 | V | 54.0 | 107.1 | -10.1 | *PASS |
| 3609.6 | 49.5 | 44.7 | H | 54.0 | 107.1 | -9.3 | *PASS |
| 4512.0 | 50.1 | 43.4 | V | 54.0 | 107.1 | -10.7 | *PASS |
| 4512.0 | 49.1 | 43.6 | H | 54.0 | 107.1 | -10.4 | *PASS |
| 5414.4 | 55.5 | 52.1 | V | 54.0 | 107.1 | -1.9 | *PASS |
| 5414.4 | 52.5 | 48.5 | H | 54.0 | 107.1 | -5.5 | *PASS |
| 6316.8 | 54.3 | 51.1 | V | 54.0 | 107.1 | -56.0 | PASS |
| 6493.2 | 54.3 | 49.4 | H | 54.0 | 107.1 | -57.7 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.3.2. Middle Frequency 915 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 915.00 | 127.7 | -- | V | -- | -- | -- | -- |
| 915.00 | 128.4 | -- | H | -- | -- | -- | -- |
| 1830.0 | 82.5 | 82.3 | V | 54.0 | 108.4 | -26.1 | PASS |
| 1830.0 | 74.5 | 74.0 | H | 54.0 | 108.4 | -34.4 | PASS |
| 2745.0 | 52.3 | 49.3 | V | 54.0 | 108.4 | -4.7 | *PASS |
| 2745.0 | 51.9 | 44.7 | H | 54.0 | 108.4 | -9.3 | *PASS |
| 3660.0 | 48.0 | 39.0 | V | 54.0 | 108.4 | -15.0 | *PASS |
| 3660.0 | 51.3 | 46.8 | H | 54.0 | 108.4 | -7.2 | *PASS |
| 4575.0 | 47.9 | 38.2 | V | 54.0 | 108.4 | -15.8 | *PASS |
| 4575.0 | 50.6 | 43.8 | H | 54.0 | 108.4 | -10.2 | *PASS |
| 5490.0 | 56.3 | 54.1 | V | 54.0 | 108.4 | -54.3 | PASS |
| 5490.0 | 60.0 | 57.7 | H | 54.0 | 108.4 | -50.7 | PASS |
| 6405.0 | 53.0 | 47.7 | V | 54.0 | 108.4 | -60.7 | PASS |
| 6405.0 | 51.8 | 45.9 | H | 54.0 | 108.4 | -62.5 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.3.3. Highest Frequency 927.6 MHz (RF Output Power: 1 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 927.60 | 125.0 | -- | V | -- | -- | -- | -- |
| 927.60 | 125.2 | -- | H | -- | -- | -- | -- |
| 1855.2 | 82.88 | 82.52 | V | 54.0 | 105.2 | -22.7 | PASS |
| 1855.2 | 84.34 | 84.16 | H | 54.0 | 105.2 | -21.0 | PASS |
| 2782.8 | 52.9 | 50.78 | V | 54.0 | 105.2 | -3.2 | *PASS |
| 2782.8 | 52.56 | 49.01 | H | 54.0 | 105.2 | -5.0 | *PASS |
| 3710.4 | 48.12 | 39.36 | V | 54.0 | 105.2 | -14.6 | *PASS |
| 3710.4 | 46.25 | 38.55 | H | 54.0 | 105.2 | -15.5 | *PASS |
| 4638.0 | 47.82 | 38.12 | V | 54.0 | 105.2 | -15.9 | *PASS |
| 4638.0 | 46.69 | 38.03 | H | 54.0 | 105.2 | -16.0 | *PASS |
| 5565.6 | 56.22 | 53.61 | V | 54.0 | 105.2 | -51.6 | PASS |
| 5565.6 | 58.59 | 56.42 | H | 54.0 | 105.2 | -48.8 | PASS |
| 6493.2 | 52.11 | 47.53 | V | 54.0 | 105.2 | -57.7 | PASS |
| 6493.2 | 52.19 | 44.39 | H | 54.0 | 105.2 | -60.8 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.4. Test Configuration # 4: Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd

**Note**: The **Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd** was tested and represent for the worst case of all other same type of antennas with lower gains that listed on Page 9 of the Users Manual.

#### 5.12.6.2.4.1. Lowest Frequency 902.4 MHz (RF Output Power: 0.61 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 902.40 | 134.9 | -- | V | -- | -- | -- | -- |
| 902.40 | 134.5 | -- | H | -- | -- | -- | -- |
| 1804.8 | 77.22 | 77.07 | V | 54.0 | 114.9 | -37.8 | PASS |
| 1804.8 | 70.52 | 70.14 | H | 54.0 | 114.9 | -44.8 | PASS |
| 2707.2 | 53.18 | 50.63 | V | 54.0 | 114.9 | -3.4 | *PASS |
| 2707.2 | 48.39 | 44.67 | H | 54.0 | 114.9 | -9.3 | *PASS |
| 3609.6 | 49.39 | 42.42 | V | 54.0 | 114.9 | -11.6 | *PASS |
| 3609.6 | 49.99 | 44.19 | H | 54.0 | 114.9 | -9.8 | *PASS |
| 4512.0 | 48.15 | 37.11 | V | 54.0 | 114.9 | -16.9 | *PASS |
| 4512.0 | 49.42 | 38.46 | H | 54.0 | 114.9 | -15.5 | *PASS |
| 5414.4 | 55.69 | 51.95 | V | 54.0 | 114.9 | -2.1 | *PASS |
| 5414.4 | 55.52 | 52.12 | H | 54.0 | 114.9 | -1.9 | *PASS |
| 6493.2 | 58.4 | 54.78 | V | 54.0 | 114.9 | -60.1 | PASS |
| 1804.8 | 77.22 | 77.07 | V | 54.0 | 114.9 | -37.8 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.4.2. Middle Frequency 915 MHz (RF Output Power: 0.61 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 915.00 | 133.47 | -- | V | -- | -- | -- | -- |
| 915.00 | 134.47 | -- | H | -- | -- | -- | -- |
| 1830.0 | 70.87 | 70.81 | V | 54.0 | 114.5 | -43.7 | PASS |
| 1830.0 | 66.75 | 66.26 | H | 54.0 | 114.5 | -48.2 | PASS |
| 2745.0 | 48.55 | 46.32 | V | 54.0 | 114.5 | -7.7 | *PASS |
| 2745.0 | 51.67 | 46.84 | H | 54.0 | 114.5 | -7.2 | *PASS |
| 3660.0 | 49.25 | 43.25 | V | 54.0 | 114.5 | -10.8 | *PASS |
| 3660.0 | 48.6 | 41.05 | H | 54.0 | 114.5 | -13.0 | *PASS |
| 4575.0 | 50.04 | 43.8 | V | 54.0 | 114.5 | -10.2 | *PASS |
| 4575.0 | 50.51 | 43.57 | H | 54.0 | 114.5 | -10.4 | *PASS |
| 5490.0 | 56.11 | 52.43 | V | 54.0 | 114.5 | -62.1 | PASS |
| 5490.0 | 58.65 | 55.85 | H | 54.0 | 114.5 | -58.7 | PASS |
| 6405.0 | 53.51 | 49.7 | V | 54.0 | 114.5 | -64.8 | PASS |
| 6405.0 | 56.77 | 53.22 | H | 54.0 | 114.5 | -61.3 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.4.3. Highest Frequency 927.6 MHz (RF Output Power: 0.61 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 927.6 | 133.7 | -- | V | -- | -- | -- | -- |
| 927.6 | 130.5 | -- | H | -- | -- | -- | -- |
| 1855.2 | 72.74 | 72.48 | V | 54.0 | 113.7 | -41.2 | PASS |
| 1855.2 | 74.59 | 74.13 | H | 54.0 | 113.7 | -39.6 | PASS |
| 2782.8 | 52.84 | 49.59 | V | 54.0 | 113.7 | -4.4 | *PASS |
| 2782.8 | 50.62 | 46.95 | H | 54.0 | 113.7 | -7.1 | *PASS |
| 3710.4 | 47.14 | 35.38 | V | 54.0 | 113.7 | -18.6 | *PASS |
| 3710.4 | 47.25 | 38.14 | H | 54.0 | 113.7 | -15.9 | *PASS |
| 4638.0 | 48.38 | 36.78 | V | 54.0 | 113.7 | -17.2 | *PASS |
| 4638.0 | 46.79 | 36.49 | H | 54.0 | 113.7 | -17.5 | *PASS |
| 5565.6 | 54.62 | 51.11 | V | 54.0 | 113.7 | -62.6 | PASS |
| 5565.6 | 58.12 | 55.67 | H | 54.0 | 113.7 | -58.0 | PASS |
| 6493.2 | 53.18 | 43.81 | V | 54.0 | 113.7 | -69.9 | PASS |
| 6493.2 | 55.17 | 48.09 | H | 54.0 | 113.7 | -65.6 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.5. Test Configuration # 5: Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd

**Note**: The **Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd** was tested and represent for the worst case of all other same type of antennas with lower gains that listed on Page 9 of the Users Manual.

#### 5.12.6.2.5.1. Lowest Frequency 902.4 MHz (RF Output Power: 0.15 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 902.4 | 134.8 | -- | V | -- | -- | -- | -- |
| 902.4 | 136.3 | -- | H | -- | -- | -- | -- |
| 1804.8 | 76.11 | 75.91 | V | 54.0 | 116.3 | -40.4 | PASS |
| 1804.8 | 71.85 | 71.46 | H | 54.0 | 116.3 | -44.8 | PASS |
| 2707.2 | 52.4 | 49.42 | V | 54.0 | 116.3 | -4.6 | *PASS |
| 2707.2 | 50.53 | 47.21 | H | 54.0 | 116.3 | -6.8 | *PASS |
| 3609.6 | 46.03 | 34.15 | V | 54.0 | 116.3 | -19.9 | *PASS |
| 3609.6 | 47.93 | 37.13 | H | 54.0 | 116.3 | -16.9 | *PASS |
| 4512.0 | 47.71 | 34.69 | V | 54.0 | 116.3 | -19.3 | *PASS |
| 4512.0 | 48.28 | 37.66 | H | 54.0 | 116.3 | -16.3 | *PASS |
| 5414.4 | 52.84 | 47.93 | V | 54.0 | 116.3 | -6.1 | *PASS |
| 5414.4 | 53.31 | 46.6 | H | 54.0 | 116.3 | -7.4 | *PASS |
| 6493.2 | 55.24 | 50.61 | V | 54.0 | 116.3 | -65.7 | PASS |
| 6493.2 | 53.79 | 49.04 | H | 54.0 | 116.3 | -67.3 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

### 5.12.6.2.5.2. Middle Frequency 915 MHz (RF Output Power: 0.15 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 915.0 | 133.1 | -- | V | -- | -- | -- | -- |
| 915.0 | 130.8 | -- | H | -- | -- | -- | -- |
| 1830.0 | 74.3 | 74.2 | V | 54.0 | 113.1 | -38.9 | PASS |
| 1830.0 | 72.9 | 72.6 | H | 54.0 | 113.1 | -40.5 | PASS |
| 2745.0 | 50.9 | 44.4 | V | 54.0 | 113.1 | -9.6 | *PASS |
| 2745.0 | 52.5 | 47.3 | H | 54.0 | 113.1 | -6.7 | *PASS |
| 3660.0 | 48.9 | 36.3 | V | 54.0 | 113.1 | -17.7 | *PASS |
| 3660.0 | 47.7 | 38.9 | H | 54.0 | 113.1 | -15.1 | *PASS |
| 4575.0 | 46.7 | 35.6 | V | 54.0 | 113.1 | -18.4 | *PASS |
| 4575.0 | 47.2 | 38.3 | H | 54.0 | 113.1 | -15.7 | *PASS |
| 5490.0 | 53.1 | 47.9 | V | 54.0 | 113.1 | -65.2 | PASS |
| 5490.0 | 55.7 | 51.8 | H | 54.0 | 113.1 | -61.3 | PASS |
| 6405.0 | 53.8 | 47.5 | V | 54.0 | 113.1 | -65.6 | PASS |
| 6405.0 | 51.4 | 44.9 | H | 54.0 | 113.1 | -68.2 | PASS |

The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

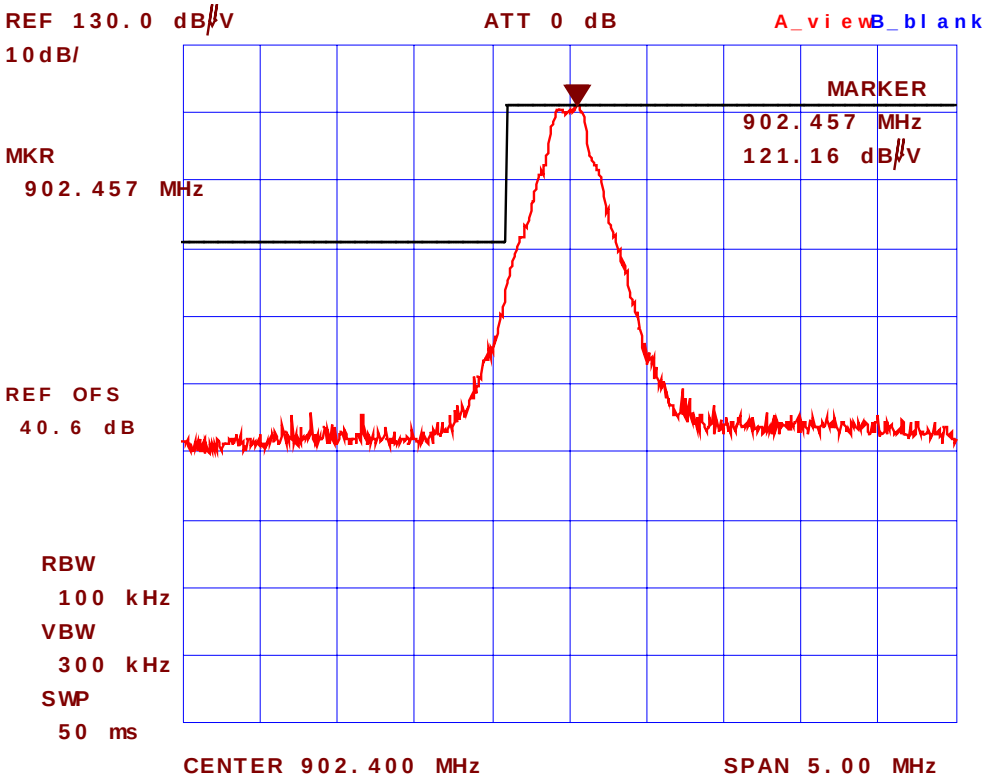
### 5.12.6.2.5.3. Highest Frequency 927.6 MHz (RF Output Power: 0.15 Watt peak, 400 kHz Channel Spacing)

| FREQUENCY (MHz) | RF PEAK LEVEL @3m (dBuV/m) | RF AVG LEVEL @ 3m (dBuV/m) | ANTENNA PLOARIZATION (H/V) | LIMIT 15.209 (dBuV/m) | LIMIT 15.247 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 927.60 | 134.3 | -- | V | -- | -- | -- | -- |
| 927.60 | 133.9 | -- | H | -- | -- | -- | -- |
| 1855.2 | 76.3 | 76.1 | V | 54.0 | 114.3 | -38.2 | PASS |
| 1855.2 | 75.7 | 75.3 | H | 54.0 | 114.3 | -39.0 | PASS |
| 2782.8 | 52.1 | 49.0 | V | 54.0 | 114.3 | -5.0 | *PASS |
| 2782.8 | 49.7 | 47.3 | H | 54.0 | 114.3 | -6.7 | *PASS |
| 3710.4 | 48.9 | 41.6 | V | 54.0 | 114.3 | -12.4 | *PASS |
| 3710.4 | 46.9 | 40.1 | H | 54.0 | 114.3 | -13.9 | *PASS |
| 4638.0 | 49.5 | 39.1 | V | 54.0 | 114.3 | -14.9 | *PASS |
| 4638.0 | 48.3 | 39.6 | H | 54.0 | 114.3 | -14.4 | *PASS |
| 5565.6 | 55.1 | 50.5 | V | 54.0 | 114.3 | -63.8 | PASS |
| 5565.6 | 56.0 | 52.2 | H | 54.0 | 114.3 | -62.2 | PASS |
| 6493.2 | 51.2 | 49.4 | V | 54.0 | 114.3 | -65.0 | PASS |
| 6493.2 | 51.9 | 44.5 | H | 54.0 | 114.3 | -69.8 | PASS |

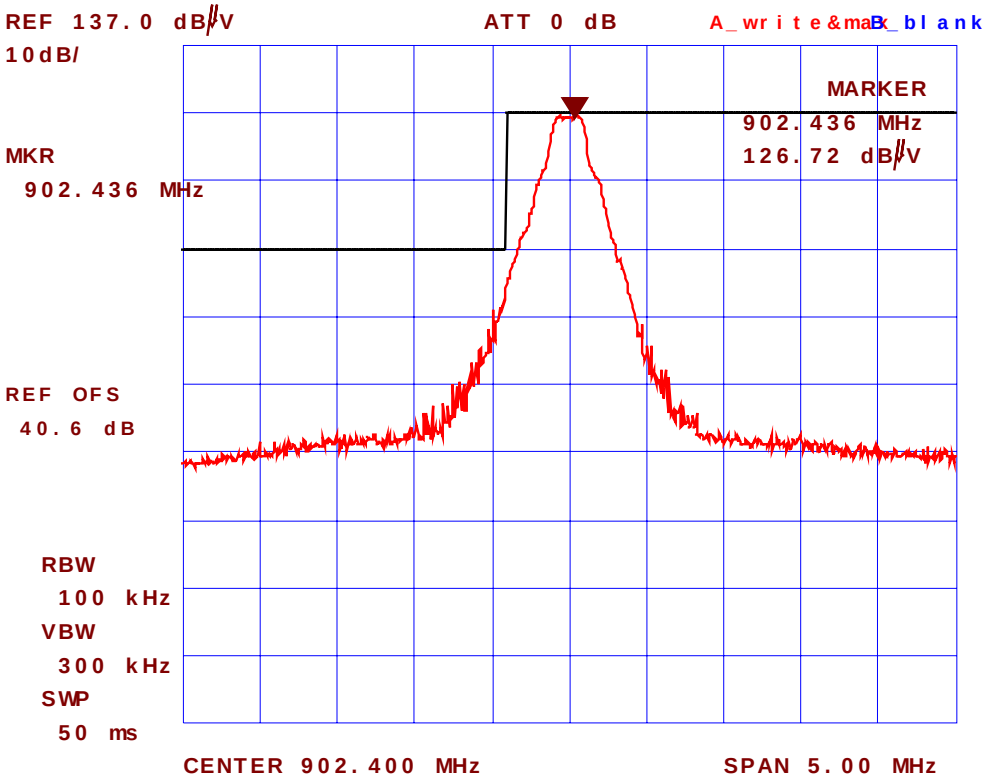
The emissions were scanned from 10 MHz to 10 GHz and all emissions less 70 dB below the limits were recorded.

* The frequency fall in the FCC restricted band @ FCC 15.205 and the Limits FCC 15.209 are applied.

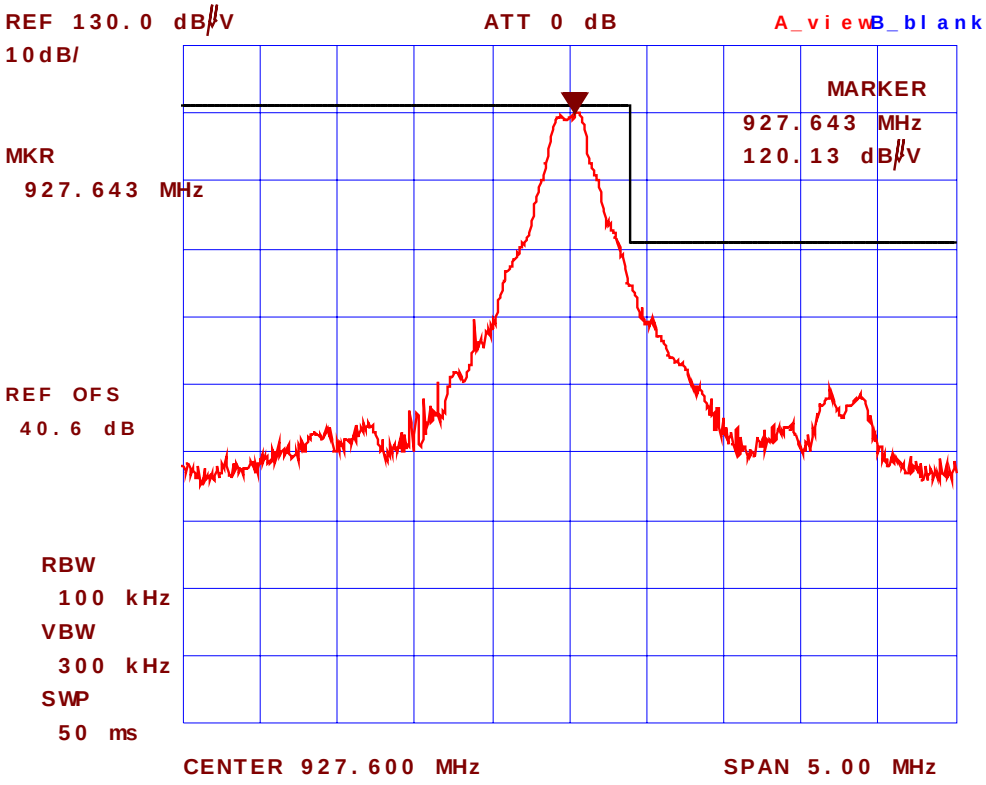
**Plot #37:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 1: Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi Microhard, Lowest channel frequency: 902.4 MHz**



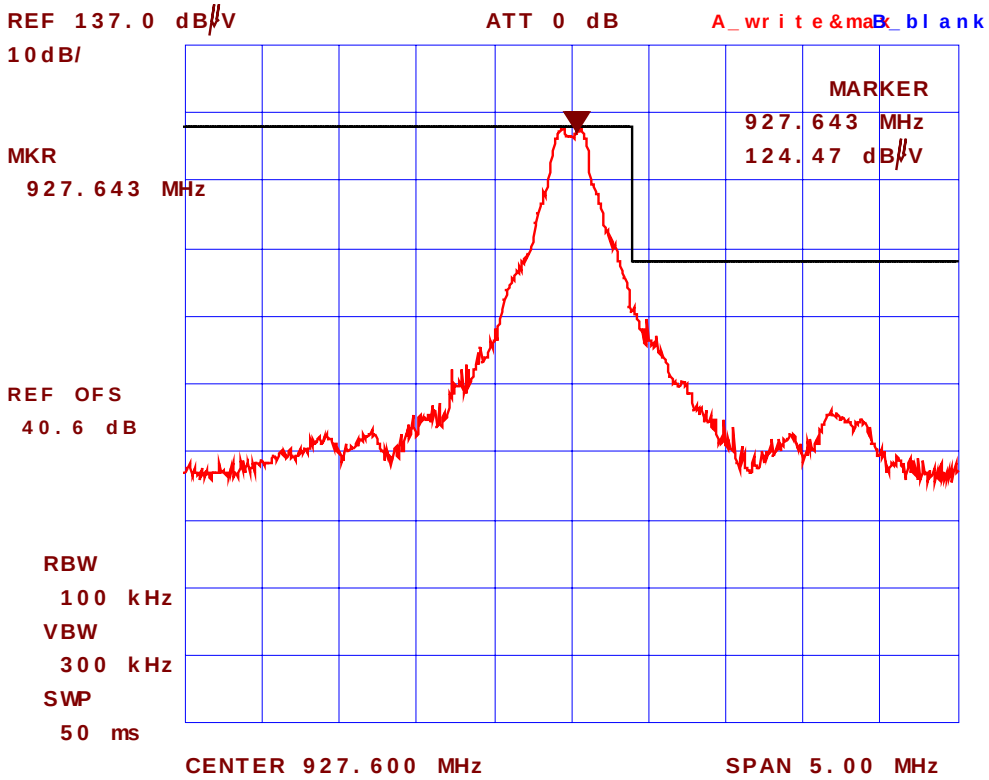
**Plot #38:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 1: Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi Microhard, Lowest channel frequency: 902.4 MHz**



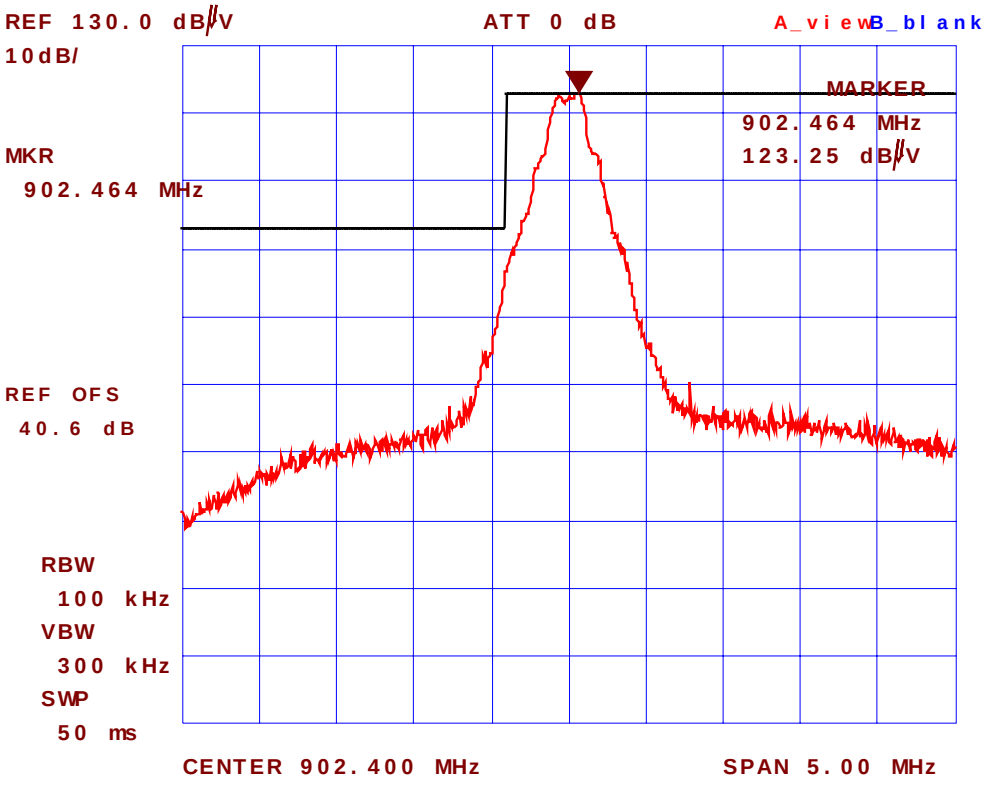
**Plot #39:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 1: Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi Microhard, Highest channel frequency: 927.6 MHz**



**Plot #40:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 1: Microhard MHX920 with ¼ Wave Antenna, Microhard P/N: MHS031060, Gain: 1.5 dBi Microhard, Highest channel frequency: 927.6 MHz**



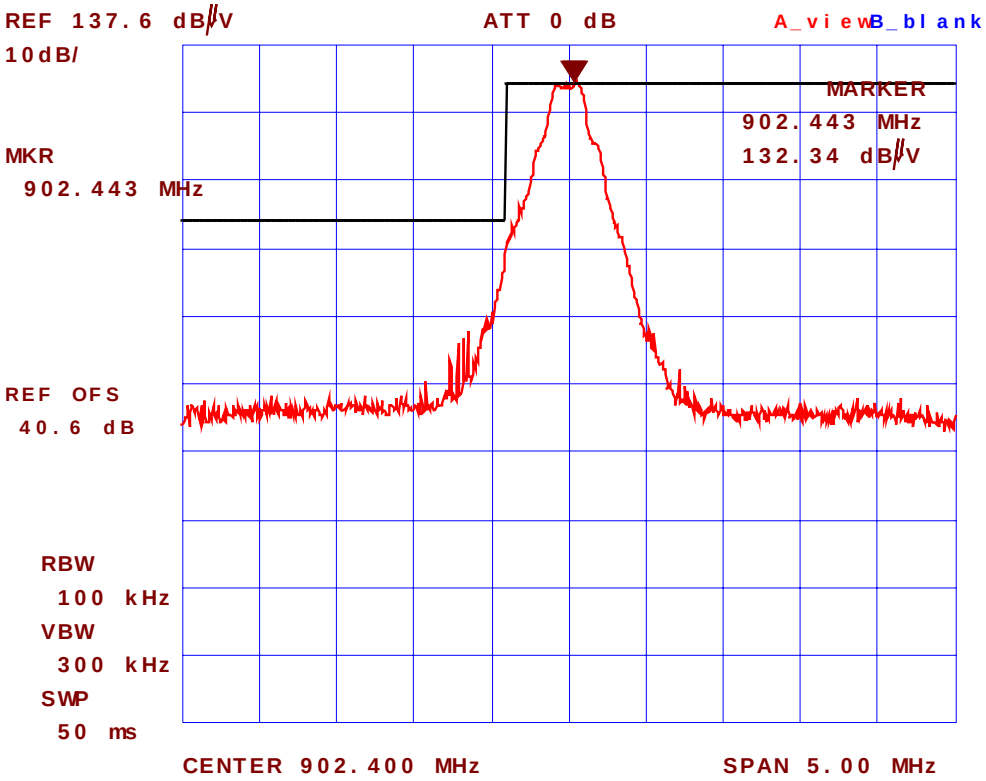
**Plot #41:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal**
**Test Configuration # 2: Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi, Lowest channel frequency: 902.4 MHz**






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

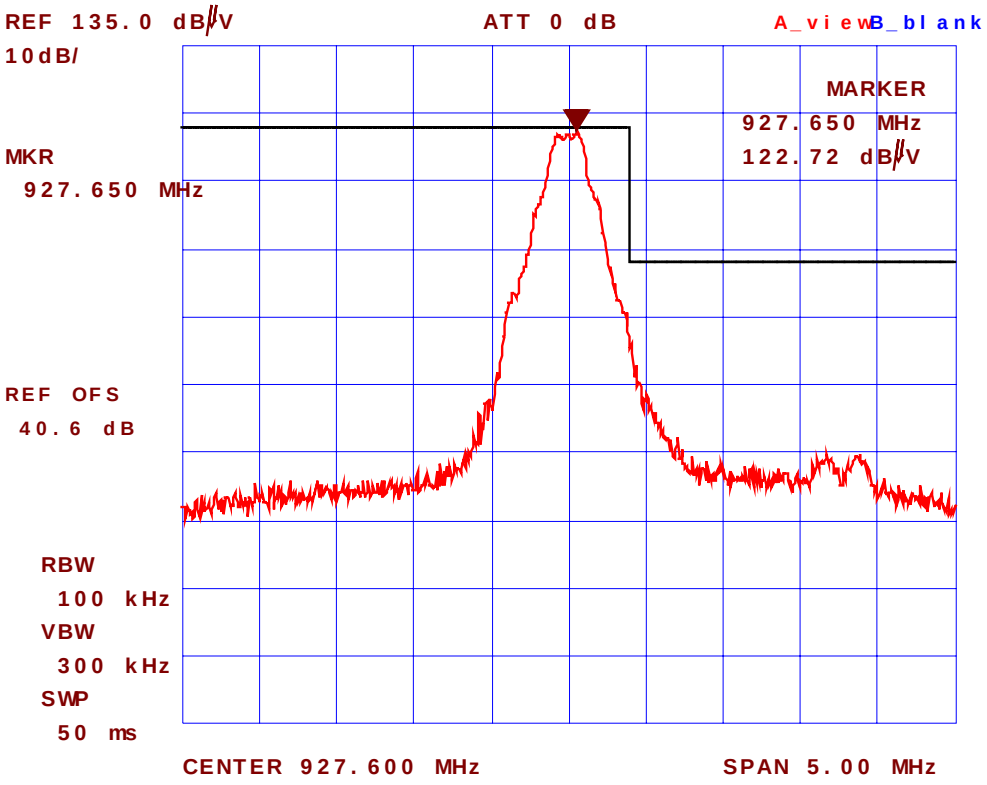
**Plot #42:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 2: Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi, Lowest channel frequency: 902.4 MHz**



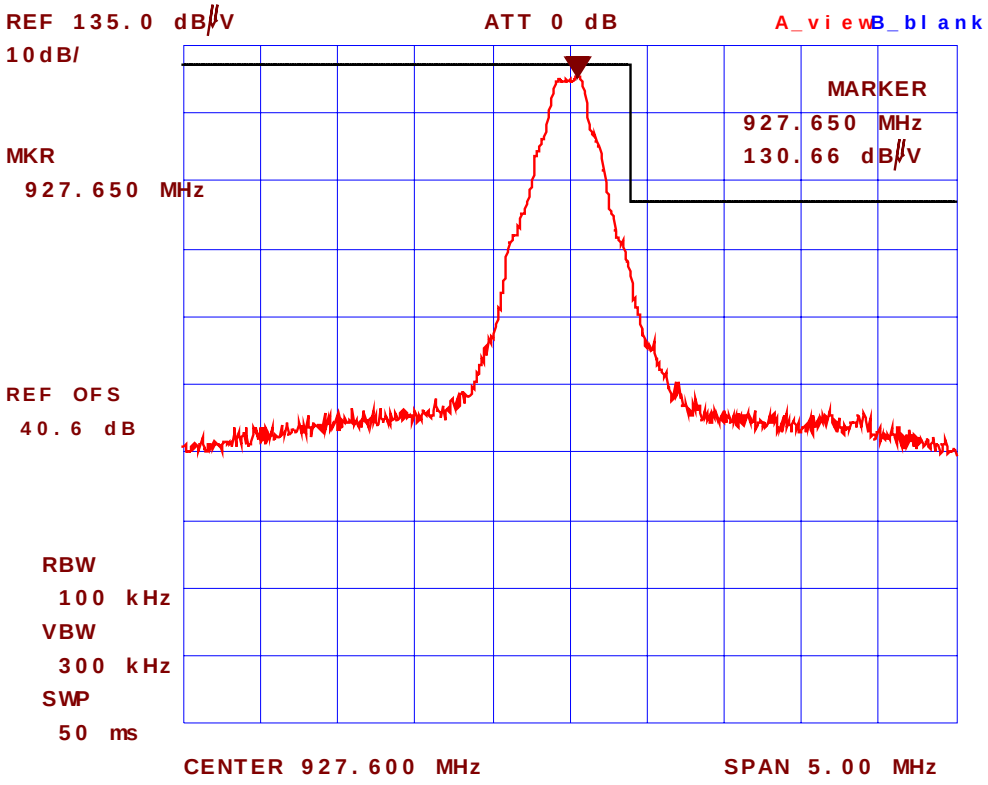



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

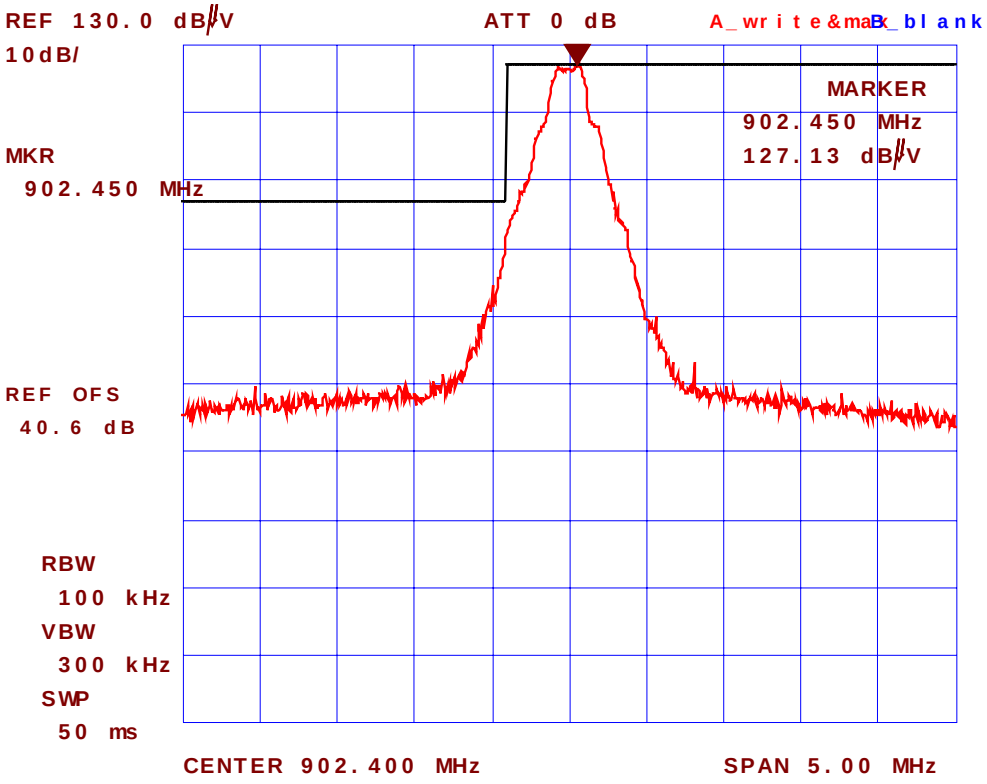
**Plot #43:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal**
**Test Configuration # 2: Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi, Highest channel frequency: 927.6 MHz**



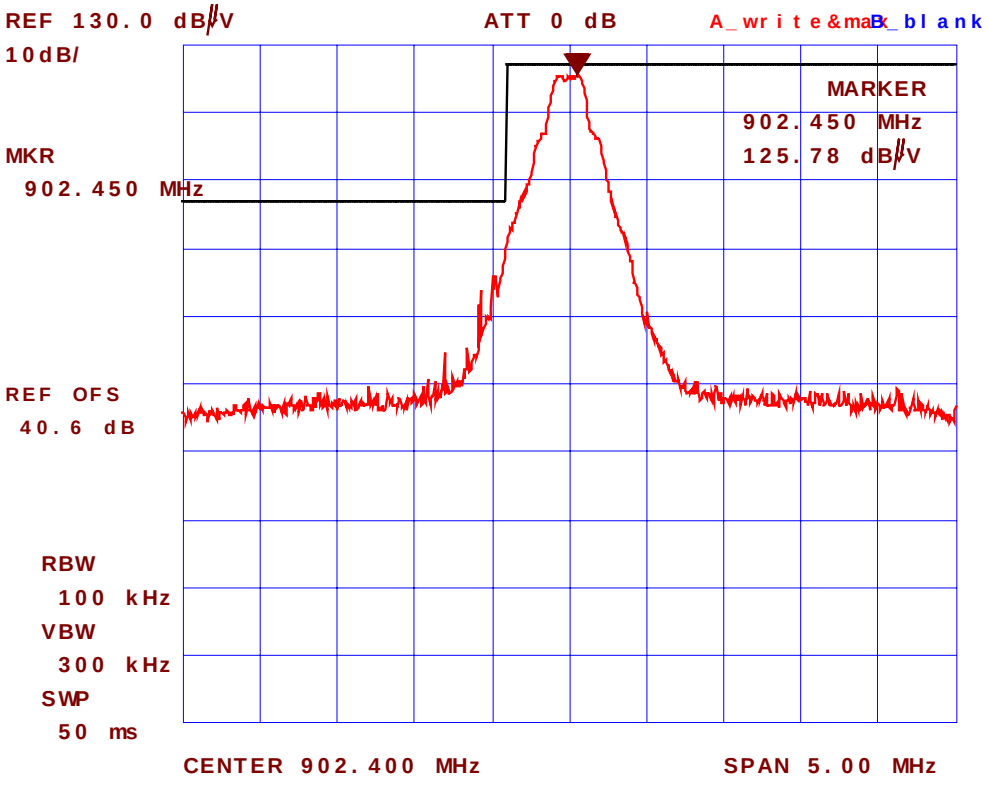
**Plot #44:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 2: Microhard MHX920 with Rubber Ducky Swivel Antenna, Microhard P/N: MHS031000, Gain: 2 dBi, Highest channel frequency: 927.6 MHz**



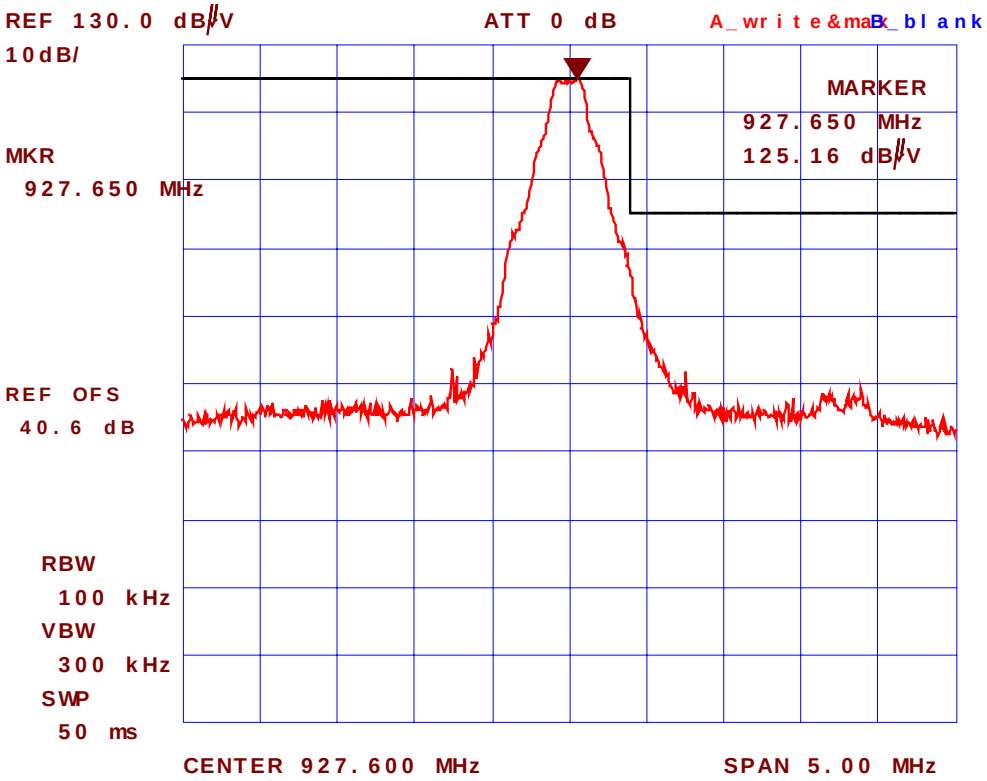
**Plot #45:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 3: Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd, Lowest channel frequency: 902.4 MHz**



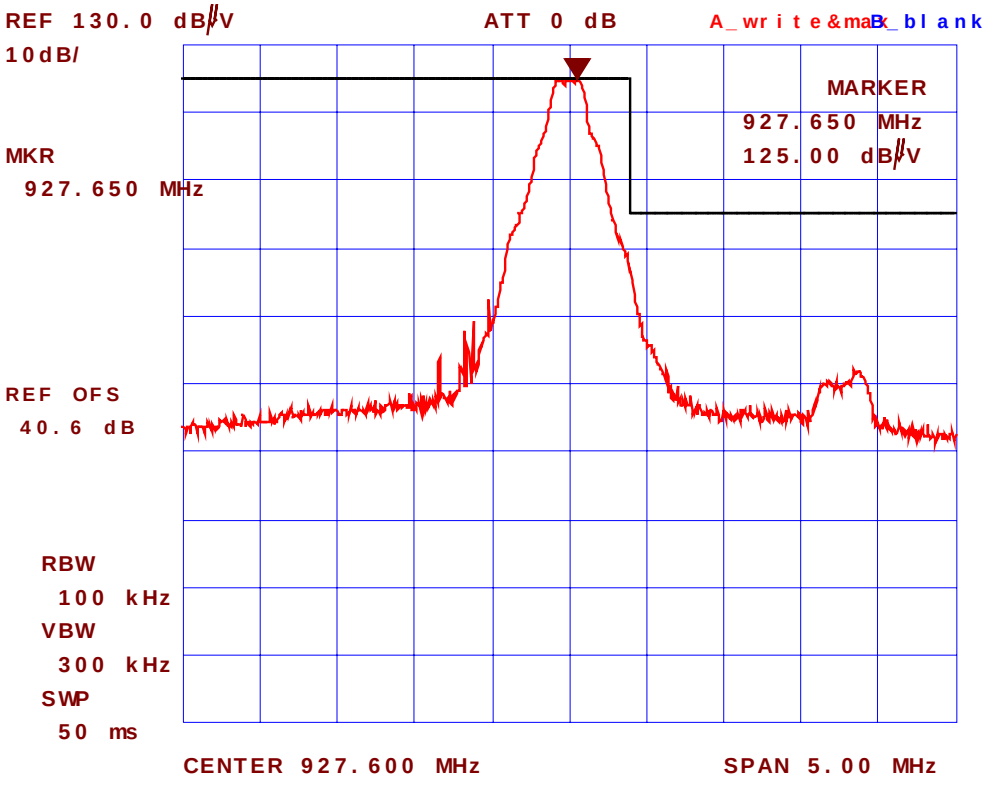
**Plot #46:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 3: Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd, Lowest channel frequency: 902.4 MHz**



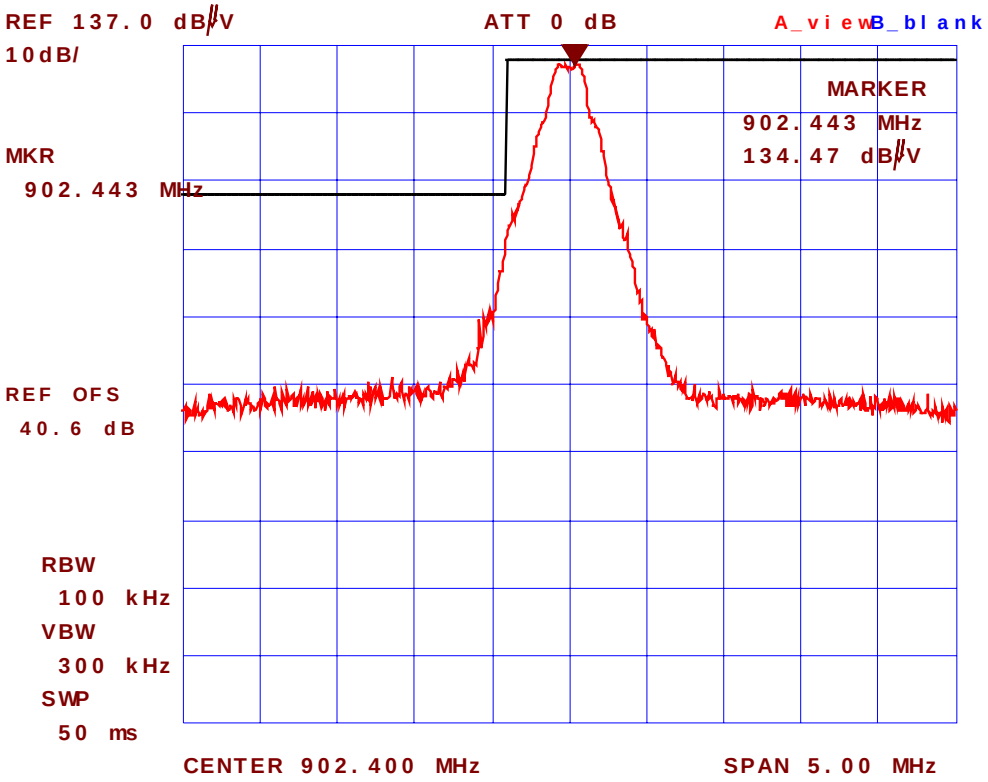
**Plot #47:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 3: Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd, Highest channel frequency: 927.6 MHz**



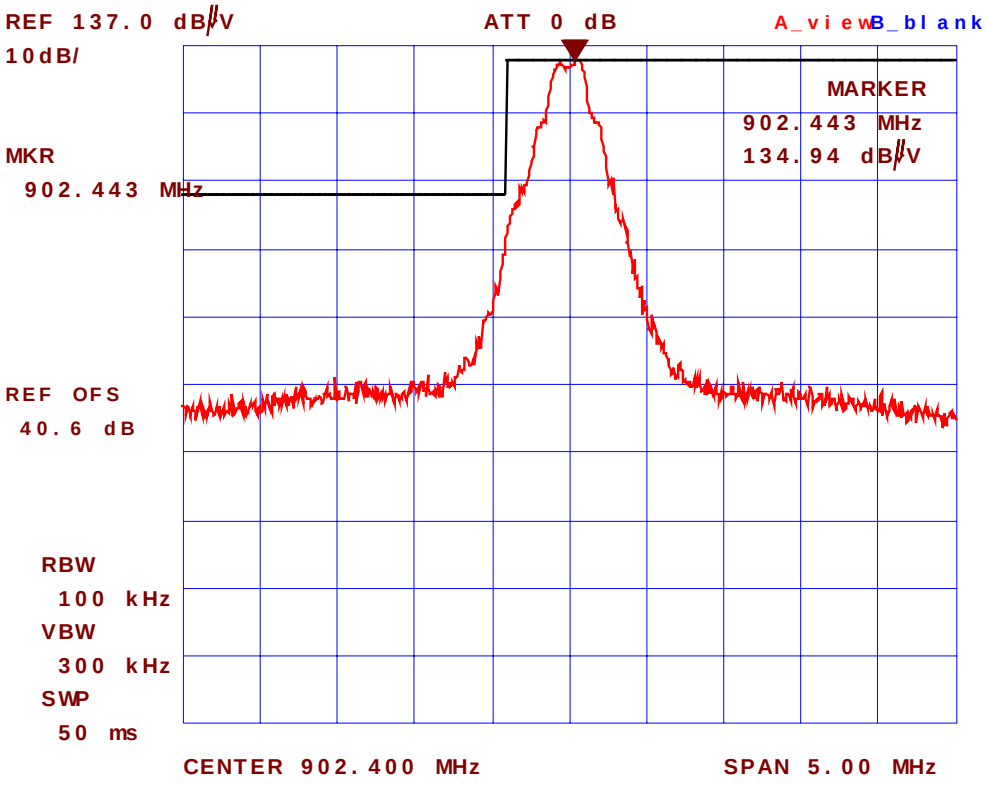
**Plot #48:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 3: Microhard MHX920 with Transit Antenna, Microhard P/N: MHS031220, Gain: 3 dBd, Highest channel frequency: 927.6 MHz**



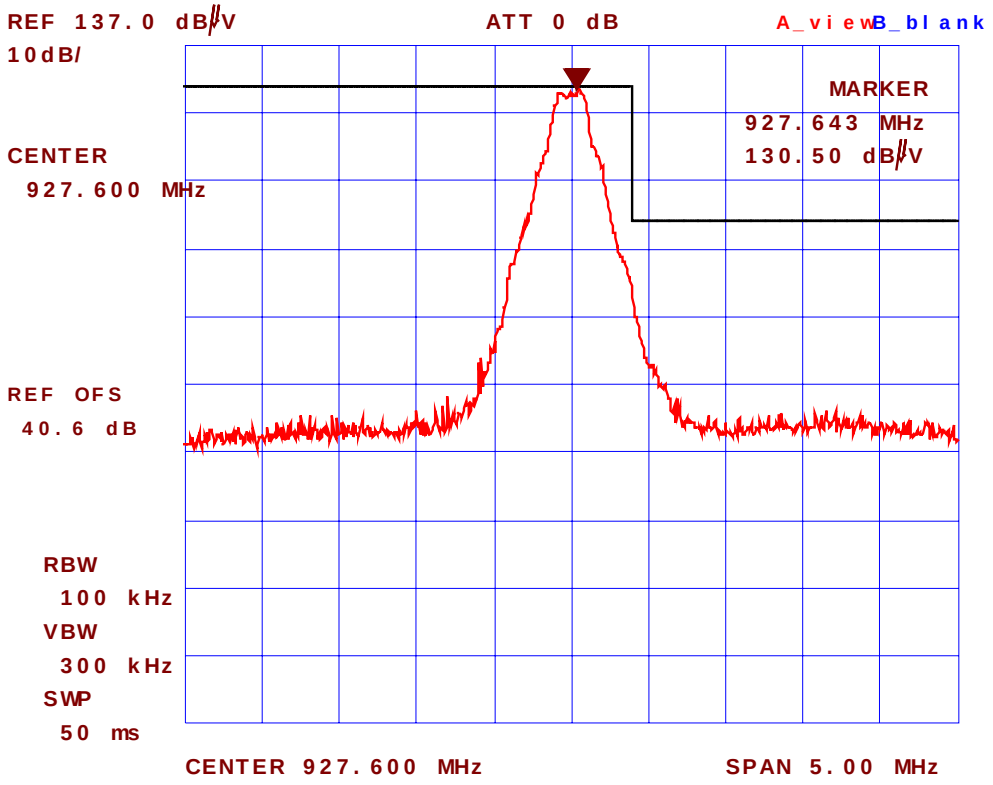
**Plot #49:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal**
**Test Configuration # 4: Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd, Lowest channel frequency: 902.4 MHz**



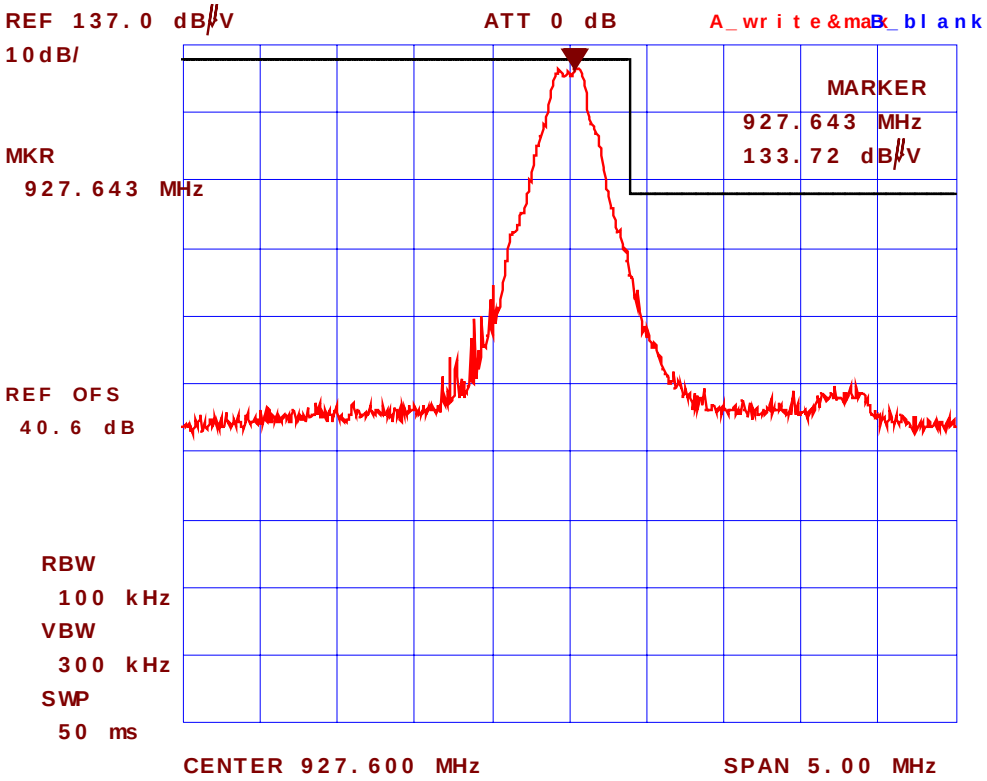
**Plot #50:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 4: Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd, Lowest channel frequency: 902.4 MHz**



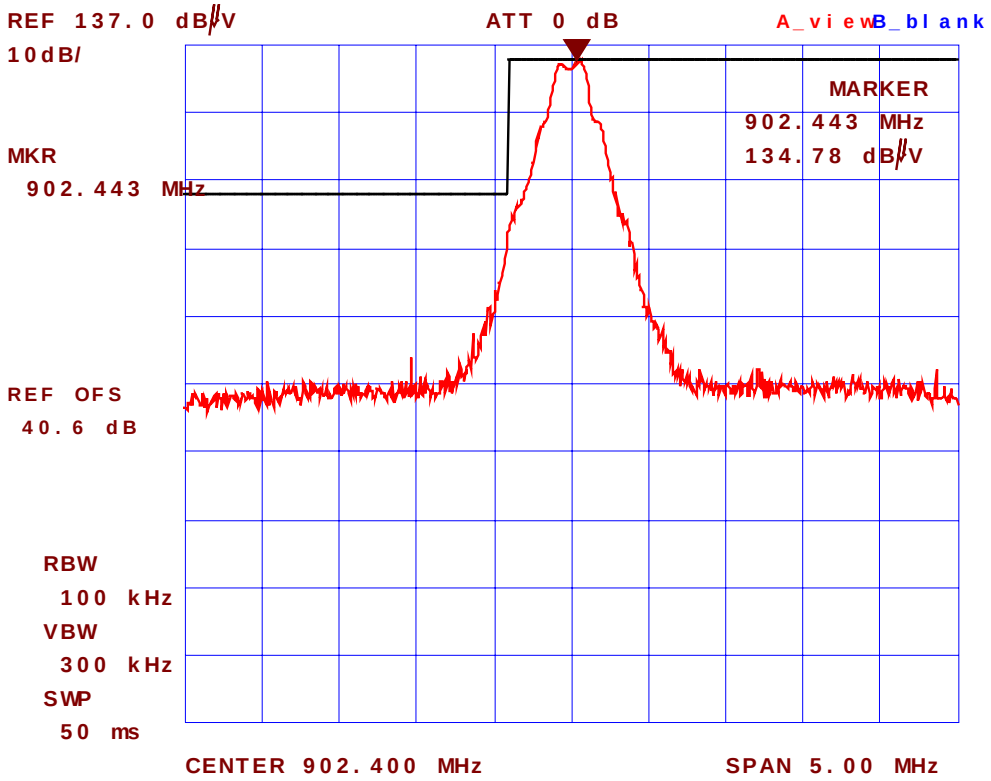
**Plot #51:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal**
**Test Configuration # 4: Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd, Highest channel frequency: 927.6 MHz**



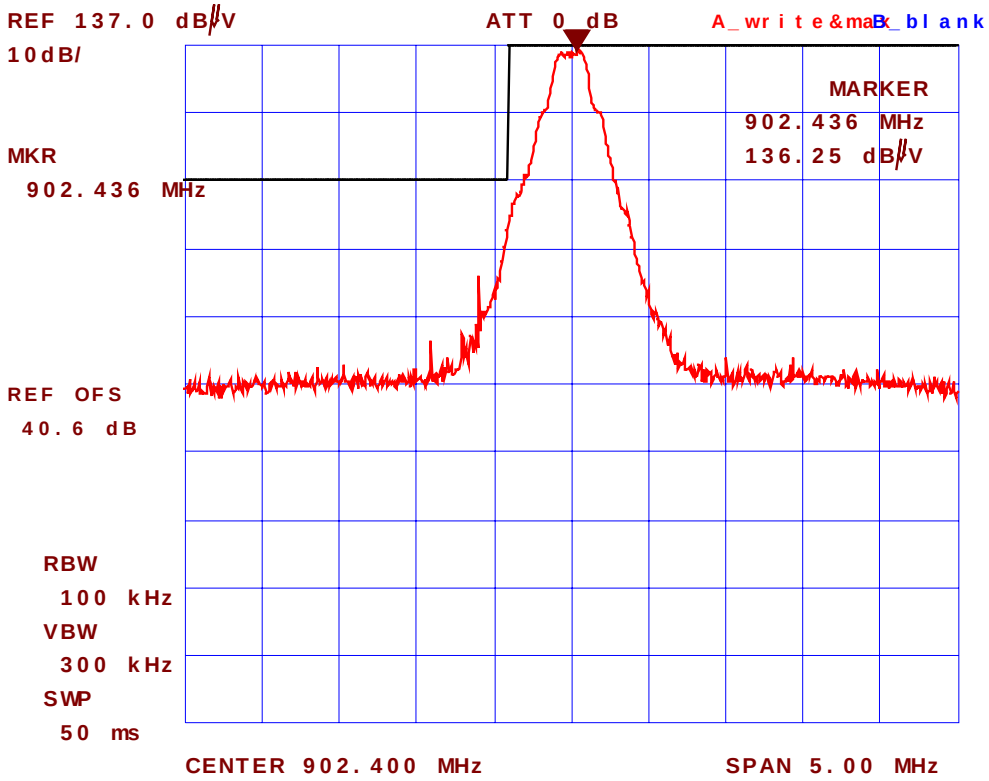
**Plot #52:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical**
**Test Configuration # 4: Microhard MHX920 with Omni Directional Antenna, Microhard P/N: MHS031471, Gain: 6 dBd, Highest channel frequency: 927.6 MHz**



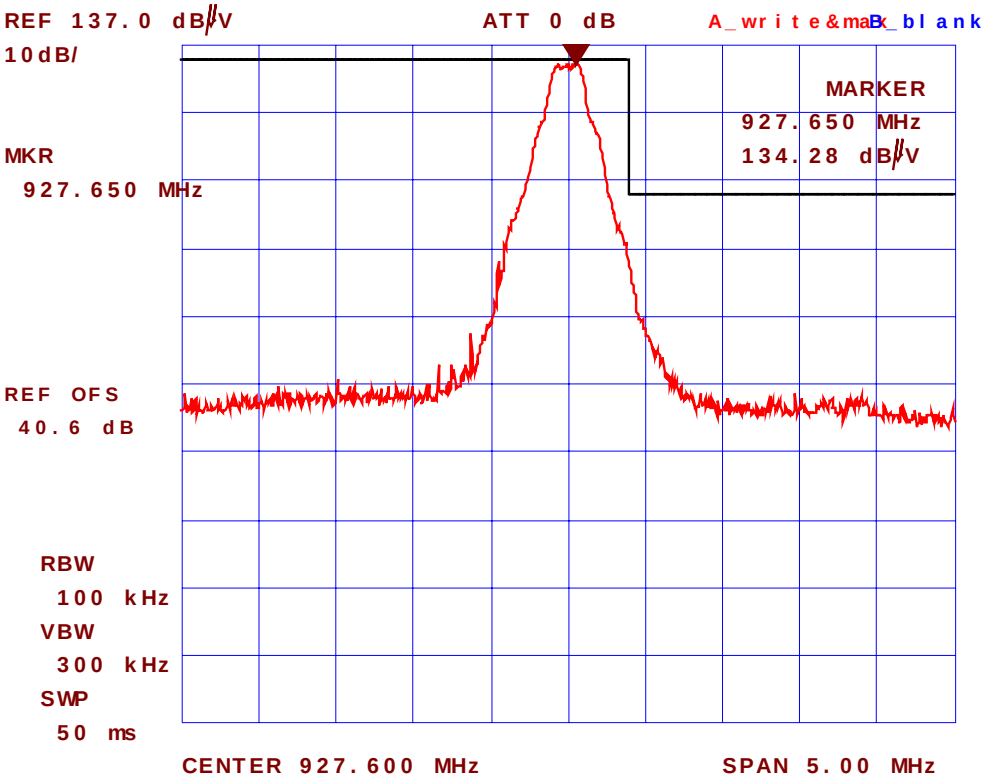
**Plot #53:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 5: Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd, Lowest channel frequency: 902.4 MHz**



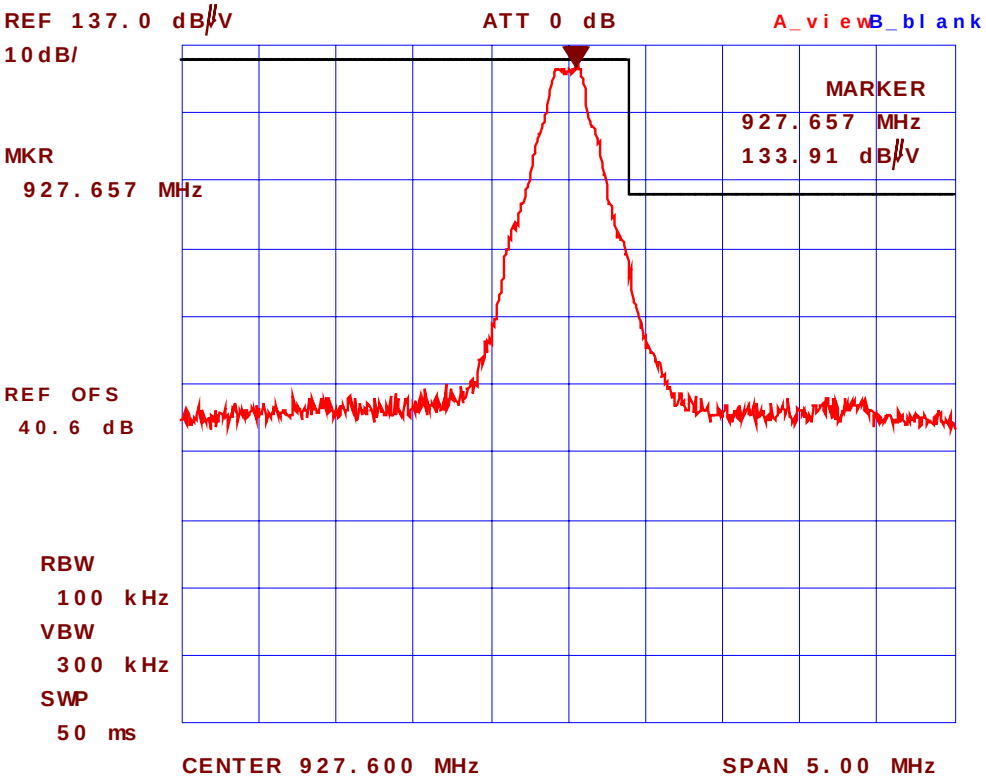
**Plot #54:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical Test Configuration # 5: Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd, Lowest channel frequency: 902.4 MHz**



**Plot #55:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Horizontal Test Configuration # 5: Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd, Highest channel frequency: 927.6 MHz**



**Plot #56:** **Band-Edge Radiated Emissions @ 3 meters, Rx Antenna: Vertical Test Configuration # 5: Microhard MHX920 with Yagi Antenna, Microhard P/N: MHS031441, Gain: 12 dBd, Highest channel frequency: 927.6 MHz**



# EXHIBIT 6. MEASUREMENT UNCERTAINTY

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

## 6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

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

## 6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Radiated Emissions) | PROBABILITY DISTRIBUTION | UNCERTAINTY (± dB) | |
|---|---|---|---|
| | | 3 m | 10 m |
| Antenna Factor Calibration | Normal (k=2) | ±1.0 | ±1.0 |
| Cable Loss Calibration | Normal (k=2) | ±0.3 | ±0.5 |
| EMI Receiver specification | Rectangular | ±1.5 | ±1.5 |
| Antenna Directivit | Rectangular | +0.5 | +0.5 |
| Antenna factor variation with height | Rectangular | ±2.0 | ±0.5 |
| Antenna phase center variation | Rectangular | 0.0 | ±0.2 |
| Antenna factor frequency interpolation | Rectangular | ±0.25 | ±0.25 |
| Measurement distance variation | Rectangular | ±0.6 | ±0.4 |
| Site imperfections | Rectangular | ±2.0 | ±2.0 |
| Mismatch: Receiver VRC $\Gamma_1 = 0.2$<br>Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp)<br>Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$ | U-Shaped | +1.1<br>-1.25 | ±0.5 |
| System repeatability | Std. Deviation | ±0.5 | ±0.5 |
| 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:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

# EXHIBIT 7. MEASUREMENT METHODS

## 7.1. GENERAL TEST CONDITIONS

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

### 7.1.1. 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.

### 7.1.2. Normal power source

#### *7.1.2.1. 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.

#### *7.1.2.2. 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.

### 7.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at the following frequencies:
  - The lowest operating frequency,
  - The middle operating frequency and
  - The highest operating frequency

- 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

## 7.2. 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, 16'(L) by 16'(W) by 12'(H).
- The test was performed were made over the frequency range from 450 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 3.2 of the 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 450 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.

- ***Broad-band ac Powerline conducted emissions***:- If the EUT exhibits ac Powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If

the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

## 7.3. EFFECTIVE RADIATED POWER

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- I f 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

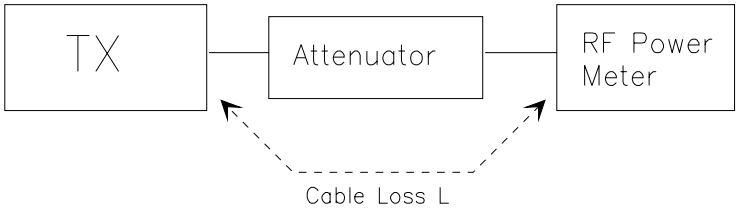
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with $0<x<1$, is measure and recorded in the 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:

**Peak EIRP = P + G**
**Average EIRP = Peak EIRP + 10log(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 stilled 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**

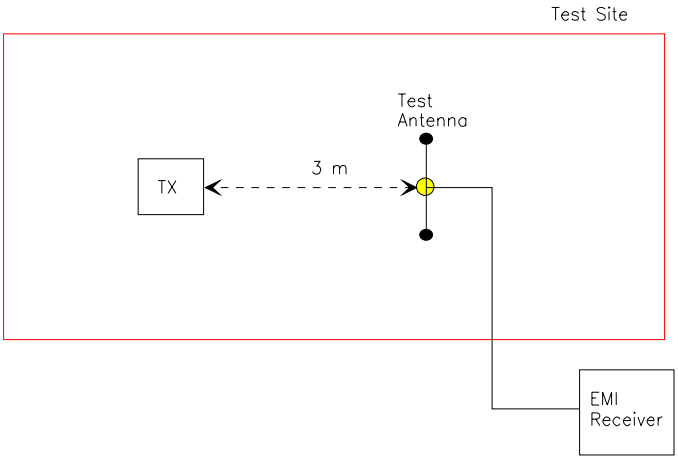
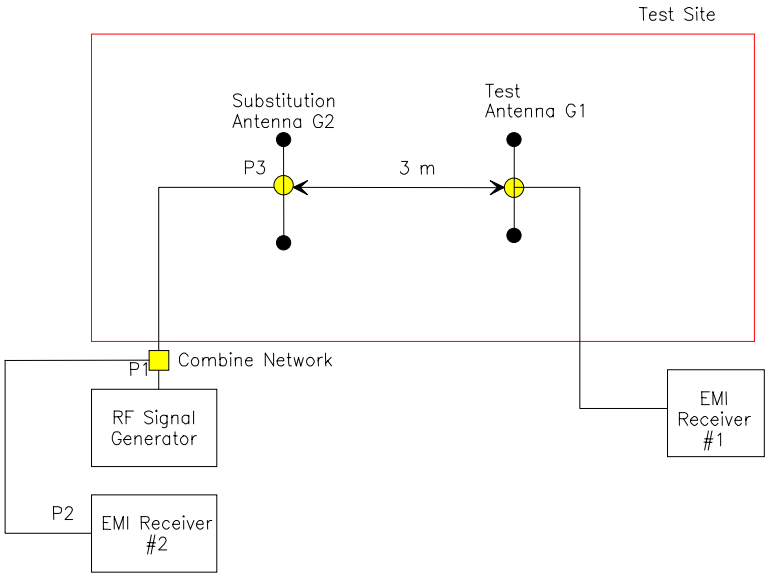



**Figure 3**




P3 = P2 + Insertion Loss (P1–P3
EIRP = P3 + G2

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 subparagraph of this Section.
- Submit this plot.
- A peak responding power meter may be used instead of a spectrum analyzer.

## 7.4. 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$^{th}$ harmonic of the highest frequency generated by the EUT.

### 7.4.1. 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 = 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 10th harmonic. Typically, sevral plots are required to cover this entire span.
- RBW = 100 kHz
- VBW = 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

## 7.4.2. 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 < 1GHz and RBW = 1 MHz for f ≥ 1 GHz
   - VBW = RBW
   - Sweep = auto
   - Detector function = peak
   - Trace = max hold
   - Follows the guidelines in ANSI C63.4-1992 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:

   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 dBuV 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:

Field Level = 60 + 7.0 + 1.0 - 30 = 38.0 dBuV/m.
Field Level = $10^{(38/20)}$ = 79.43 uV/m.

- 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 10log(dwell time/100mS) 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:

Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

Step3: 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.

Step4: 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.

Step5: 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.

Step6: 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.

Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

## 7.5. 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:

### 7.5.1. 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 C63.4-1992 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

### 7.5.2. Spurious RF conducted emissions

The demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247©, 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 C62-4:1994 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 15.247©. 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