# ENGINEERING TEST REPORT

## Signal Booster II
## Model No.: 61-65-50
## FCC ID: EZZ5PI616550

*Applicant:*

**TX RX Systems, Inc.**
*8625 Industrial Parkway*
*Angola, NY 14006*
*USA*

***Tested in Accordance With***

**Federal Communications Commission (FCC)**
**47 CFR Parts 2 and 90 (Subpart I)**

**UltraTech's File No.: TXRX-017F90**

| | |
|---|---|
| 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: August 28, 2006 | |
| Report Prepared by: Dan Huynh<br><br>Issued Date: August 28, 2006 | Tested by: Hung Trinh, EMI/RFI Technician<br><br>Test Dates: June 22 - August 8, 2006 |

- *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.*


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| ANSI | FC | VCI | Canada | NVLAP | BSMI |
|---|---|---|---|---|---|
| 0685 | 31040/SIT | C-1376 | 46390-2049 | 200093-0 | SL2-IN-E-1119R |

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# EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type | Description of Contents | Quality Check (OK) |
|---|---|---|---|
| -- | Test Report | • Exhibit 1: Submittal check lists<br>• Exhibit 2: Introduction<br>• Exhibit 3: Performance Assessment<br>• Exhibit 4: EUT Operation and Configuration during Tests<br>• Exhibit 5: Summary of test Results<br>• Exhibit 6: Measurement Data<br>• Exhibit 7: Measurement Uncertainty | OK |
| 1 | Test Setup Photos | Radiated Emission Setup Photos | OK |
| 2 | External Photos of EUT | External Photos | OK |
| 3 | Internal Photos of EUT | Internal Photos | 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 | -- | -- |
| 6 | ID Label/Location Info | ID Label and Location of ID Label | OK |
| 7 | Block Diagrams | Block Diagram | OK |
| 8 | Schematic Diagrams | Schematics | OK |
| 9 | Parts List/Tune Up Info | Parts List/ Tuning Procedures | OK |
| 10 | Operational Description | Operational Description | OK |
| 11 | RF Exposure Info | See Section 6.6 of this test report for MPE evaluation | OK |
| 12 | User's Manual | Installation and Operation Manual for the Two-Way Signal Booster System | OK |

# EXHIBIT 2. INTRODUCTION

## 2.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Parts 2 and 90 |
| **Title:** | Code of Federal Regulations (CFR), Title 47 - Telecommunication, Parts 2 and 90 (Subpart I). |
| **Purpose of Test:** | To gain FCC Certification Authorization for Radio operating in the frequency band 406-430 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:** | Commercial, industrial or business |

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

None.

## 2.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|---|---|---|
| FCC CFR Parts 0-19, 80-End | 2005 | Code of Federal Regulations – Telecommunication |
| ANSI C63.4 | 2003 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| CISPR 22 & EN 55022 | 2003 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 |
| TIA-603-C | 2004 | Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards. |

# EXHIBIT 3. PERFORMANCE ASSESSMENT

## 3.1. CLIENT INFORMATION

| APPLICANT | |
|---|---|
| **Name:** | TX RX Systems, Inc. |
| **Address:** | 8625 Industrial Parkway<br>Angola, NY 14006<br>USA |
| **Contact Person:** | William J. Aquino<br>Phone #: 716-549-4700 ext 5019<br>Fax #: 716-549-4772<br>Email Address: baquino@birdtechnologies.com |

| MANUFACTURER | |
|---|---|
| **Name:** | TX RX Systems, Inc. |
| **Address:** | 8625 Industrial Parkway<br>Angola, NY 14006<br>USA |
| **Contact Person:** | William J. Aquino<br>Phone #: 716-549-4700 ext 5019<br>Fax #: 716-549-4772<br>Email Address: baquino@birdtechnologies.com |

## 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

| | |
|---|---|
| **Brand Name:** | TX RX Systems, Inc. |
| **Product Name:** | Signal Booster II |
| **Model Name or Number:** | 61-65-50 |
| **Type of Equipment:** | Non-broadcast Radio Communication Equipment |
| **External Power Supply:** | N/A |
| **Primary User functions of EUT:** | Signal Booster II extends radio coverage into areas where abrupt propagation losses prevent reliable communication. |
| **Transmitting/Receiving Antenna Type:** | Non-Integral |

## 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | Base station (fixed use) |
| **Intended Operating Environment:** | Commercial, industrial or business environment |
| **Power Supply Requirement:** | 100 to 240 VAC; 50 / 60 Hz or +24 to +27 VDC (Backup DC Power) |
| **RF Input Power Rating:** | 0 dBm for single channel input |
| **RF Output Power Rating:** | 32 dBm (1.6 W) |
| **Operating Frequency Range:** | 406-430 MHz |
| **RF Output Impedance:** | 50 Ohms |
| **Occupied Bandwidth (99%):** | Booster (The 99% OBW of the rf output signal is the same as that of the rf input signal from a FCC certified transmitter) |
| **Emission Designation:** | • F1D<br>• F3E<br>• G3E |
| **Antenna Connector Type:** | N Female |
| **Antenna Description:** | • Outdoor antenna: The antenna gain limit is 10 dB<br>• In-building antenna: radiating coaxial cable or a network ¼ wave whip antenna (gain not exceed 0 dB) |

| RECEIVER | |
|---|---|
| **Equipment Type:** | Base station (fixed use) |
| **Intended Operating Environment:** | Commercial, industrial or business environment |
| **Power Supply Requirement:** | 100 to 240 VAC; 50 / 60 Hz or +24 to +27 VDC (Backup DC Power) |
| **Operating Frequency Range:** | 406-430 MHz |

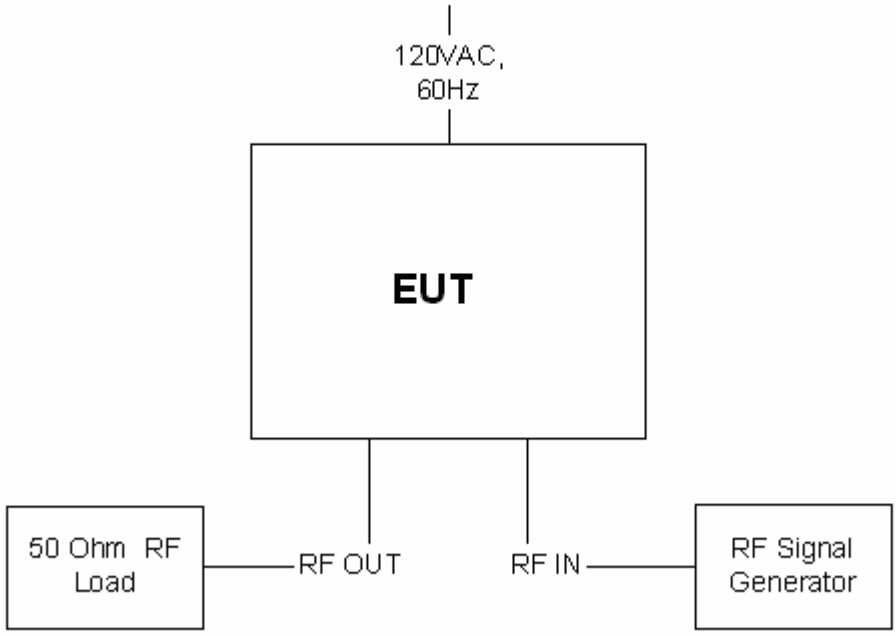
## 3.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | Downlink In / Uplink out | 1 | N female | Shielded |
| 2 | Uplink In / Downlink out | 1 | N female | Shielded |
| 3 | Backup DC power | 1 | 2 term barrier | Non-shielded |
| 4 | Alarm contacts | 1 | 6 term barrier | Non-shielded |
| 5 | AC Line Filter | 1 | Spade Lugs | -- |
| 6 | Accessory AC outlet | 2 | AC duplex receptacles | -- |

## 3.5. ANCILLARY EQUIPMENT

None.

## 3.6. GENERAL TEST SETUP



# EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 120 VAC 60 Hz or +24 (Backup DC Power) |

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

| | |
|---|---|
| **Operating Modes:** | The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data. |
| **Special Test Software:** | N/A |
| **Special Hardware Used:** | N/A |
| **Transmitter Test Antenna:** | The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load. |

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):** | 406-430 MHz |
| **Frequency(ies) Tested:**<br>(Near lowest, near middle and near highest frequencies in the frequency range of operation.) | 406.1 MHz, 418.0 MHz and 430.0 MHz |
| **RF Power Output (measured maximum output power):**<br><br>**Normal Test Modulation:**<br><br>**Modulating signal source:** | 1.8 Watts<br><br>Unmodulated, F1D, F3E & G3E<br><br>External |

# EXHIBIT 5. SUMMARY OF TEST RESULTS

## 5.1. LOCATION OF TESTS

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

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site 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 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June 20, 2006.

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

| FCC Section(s) | Test Requirements | Applicability (Yes/No) |
|---|---|---|
| 2.1046 & 90.205 | RF Power Output & Intermodulation | Yes |
| 1.1307, 1.1310, 2.1091 & 2.1093 | RF Exposure Limit | Yes |
| 2.1055 & 90.213 | Frequency Stability | (1)Not applicable for amplifier |
| 2.1047(a) & 90.242(b)(8) | Audio Frequency Response | (2)Not applicable for amplifier |
| 2.1047(b) & 90.210 | Modulation Limiting | (2)Not applicable for amplifier |
| 2.1049 & 90.210 | Occupied Bandwidth, Emission Limitation & Emission Mask | Yes |
| 2.1051, 2.1057 & 90.210 | Emission Limits - Spurious Emissions at Antenna Terminal | Yes |
| 2.1053, 2.1057 & 90.210 | Emission Limits - Field Strength of Spurious Emissions | Yes |
| **Signal Booster II**, **Model No.: 61-65-50** by **TX RX Systems, Inc.** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices**. The engineering test report has been documented and it is available upon request. | | |

Notes:

(1) Test is not applicable, the EUT is not designed to generate or translate frequencies, it only amplifies the signal it receives.
(2) Test is not applicable, the EUT does not contain modulation circuitry.

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

None.

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

## 6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ULTRATECH Test Procedures, File # ULTR P001-2004, ANSI C63.4 and TIA-603-C.

## 6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

## 6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4, TIA-603-C and CISPR 16-1.

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

Signal boosters extend radio coverage into areas where abrupt propagation losses prevent reliable communication. This system receives an RF signal, raises its power level, and couples it to an antenna or leaky (radiating) coaxial cable system so that it can be re-radiated. No frequency translation (conversion) occurs with this device.

## 6.5. RF POWER OUTPUT & INTERMODULATION [§§ 2.1046 & 90.205]

### 6.5.1. Limits

See FCC 47 CFR 90.205 for specification details.

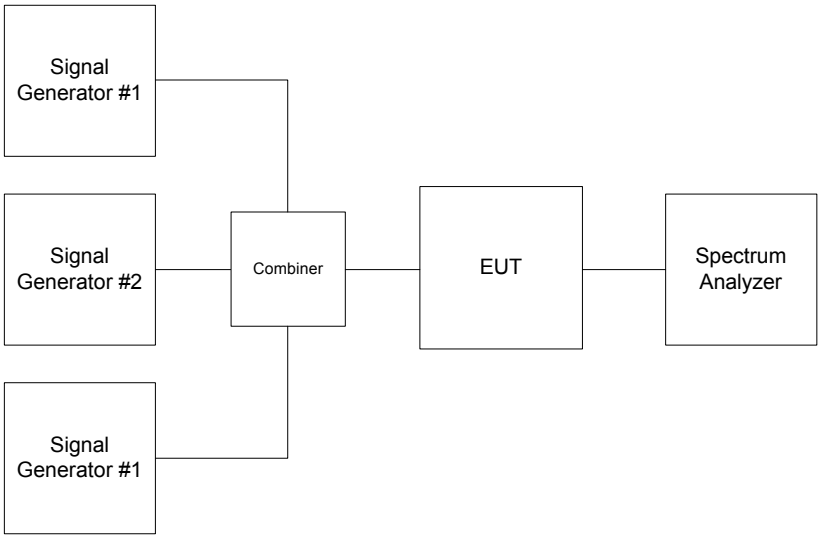
### 6.5.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and TIA-603-C

### 6.5.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Signal Generator | Gigatronic | 6061A | 5130586 | 10 kHz - 1050 MHz |
| Signal Generator | Fluke | 6061A | 4770301 | 10 kHz - 1050 MHz |
| Signal Generator | Gigatronic | 6061A | 5130408 | 10 kHz - 1050 MHz |
| Combiner | Mini-Circuit | 15542 | 0105 | 1 MHz – 1 GHz |
| Spectrum Analyzer | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz |

### 6.5.4. Test Arrangement



## 6.5.5. Test Data

### 6.5.5.1. RF POWER OUTPUT with MODULATION, SINGLE CHANNEL, MAXIMUM RF IN = 0 dBm

#### *6.5.5.1.1. 120 VAC Input*

| Test Frequency (MHz) | Modulation | Total RF Output Powerat Antenna Port (dBm) | RF Output Power Ratings at Antenna Port (dBm) |
|---|---|---|---|
| 406.1 | F1D/F3E/G3E | 32.48 | 32 |
| 418.0 | F1D/F3E/G3E | 31.61 | 32 |
| 430.0 | F1D/F3E/G3E | 31.30 | 32 |

#### *6.5.5.1.2. 27 VDC Input*

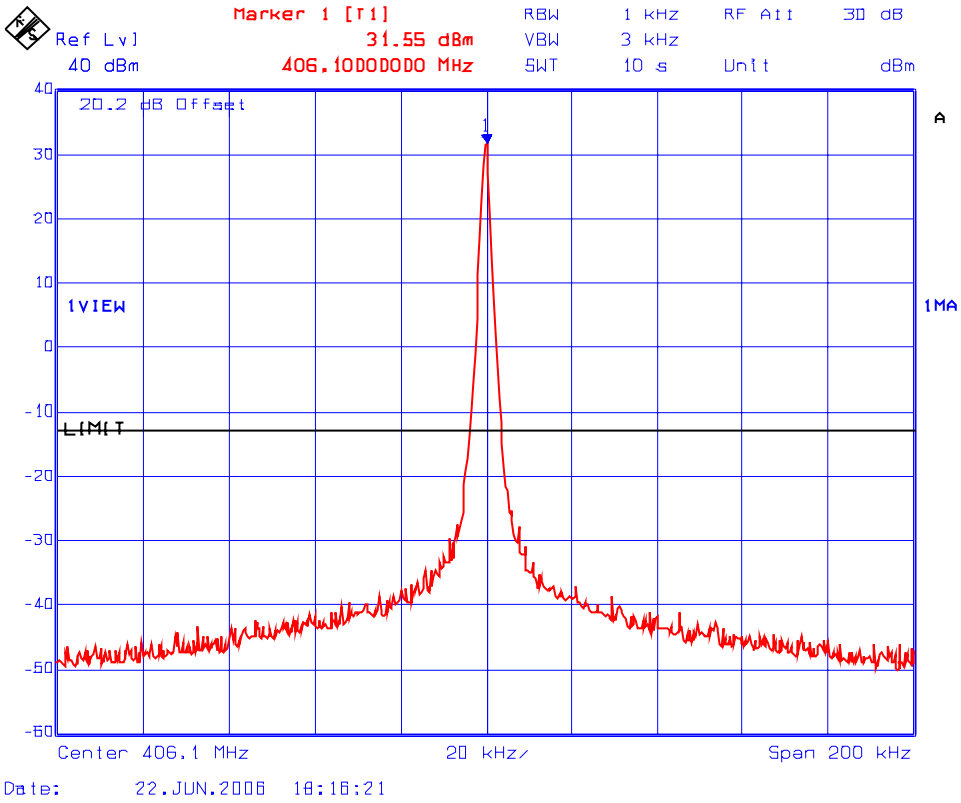
| Test Frequency (MHz) | Modulation | Total RF Output Powerat Antenna Port (dBm) | RF Output Power Ratings at Antenna Port (dBm) |
|---|---|---|---|
| 406.1 | F1D/F3E/G3E | 32.48 | 32 |
| 418.0 | F1D/F3E/G3E | 31.61 | 32 |
| 430.0 | F1D/F3E/G3E | 31.30 | 32 |

### 6.5.5.2. INTERMODULATION & PEAK POWERS IN 406.1-430 MHz BAND – NO MODULATION

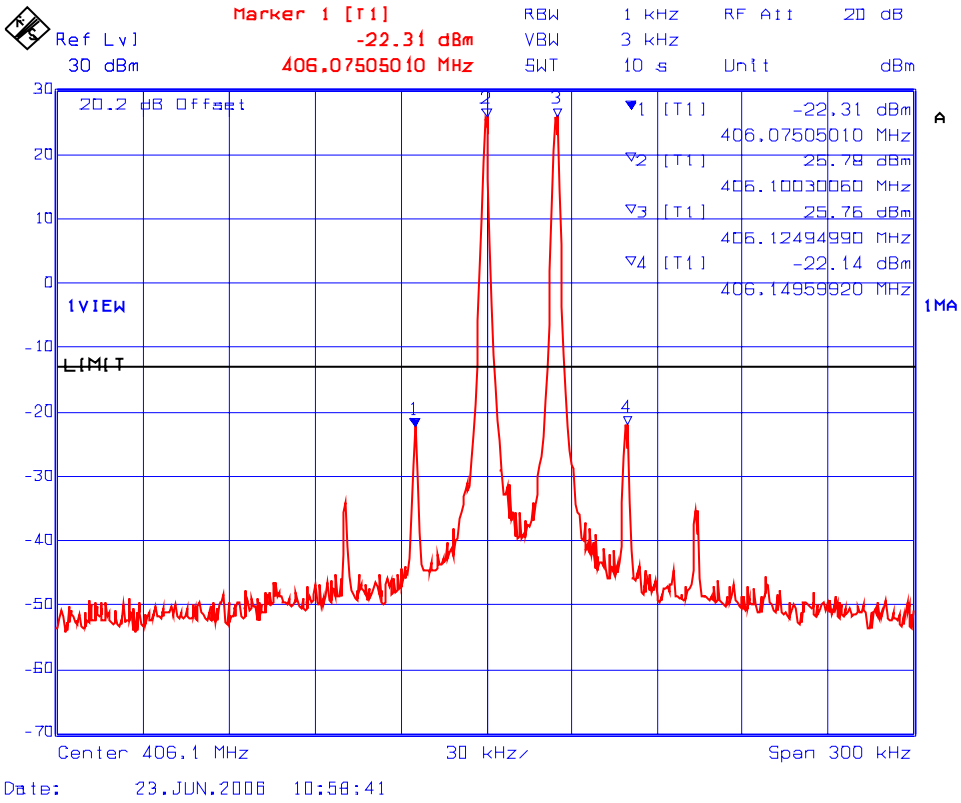
| Frequency (MHz) | Number of In/Out Channels | Modulation | Maximum RF Input (conducted) (dBm) | Maximum RF Output (conducted) (dBm) |
|---|---|---|---|---|
| 4061 | 1 | unmodulated | 0 | 31.55 |
| 406.1<br>406.125 | 2 | unmodulated | -54.17 | 25.78 |
| 406.1<br>406.125<br>406.150 | 3 | unmodulated | -55.14 | 24.78 |
| | | | | |
| 418 | 1 | unmodulated | 0 | 31.75 |
| 418<br>418.025 | 2 | unmodulated | -53.82 | 25.25 |
| 418<br>418.025<br>418.050 | 3 | unmodulated | -55.21 | 24.08 |
| | | | | |
| 430 | 1 | unmodulated | 0 | 30.65 |
| 430<br>429.975 | 2 | unmodulated | -52.79 | 24.54 |
| 430<br>429.975<br>429.950 | 3 | unmodulated | -53.98 | 23.34 |

See the following plots for intermodulation in the 406-430 MHz band.

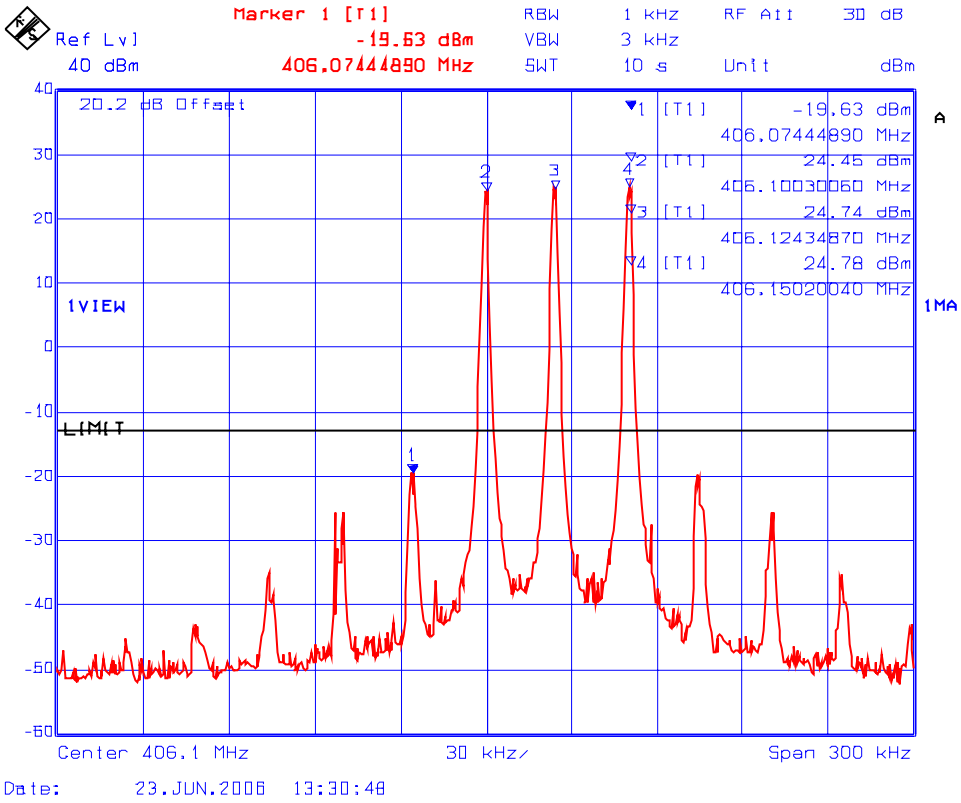
**Plot 6.5.5.2.1** Intermodulation with 1 RF Input 406.1 - 430 MHz
Fc: 406.1 MHz; RF Input: 0dBm



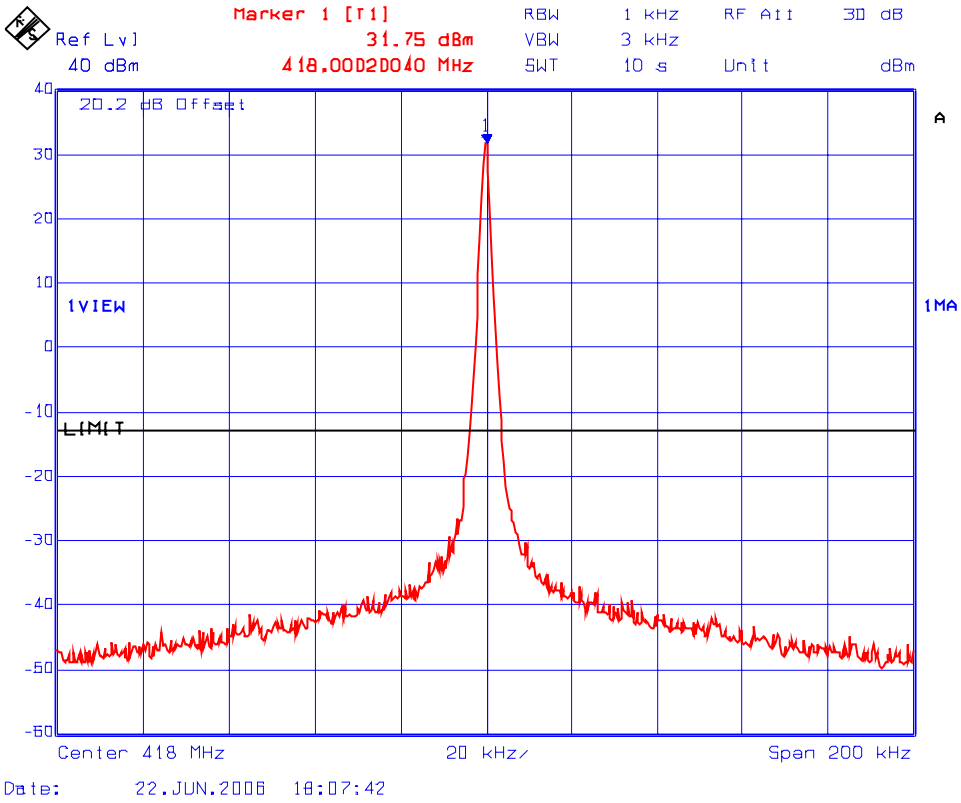
**Plot 6.5.5.2.2** Intermodulation with 2 RF signals input/output in 406.1 – 430 MHz
Fc: 406.1 MHz & Fc + 25 kHz
RF Input 1: -54.17dBm, RF Input 2: -54.17dBm



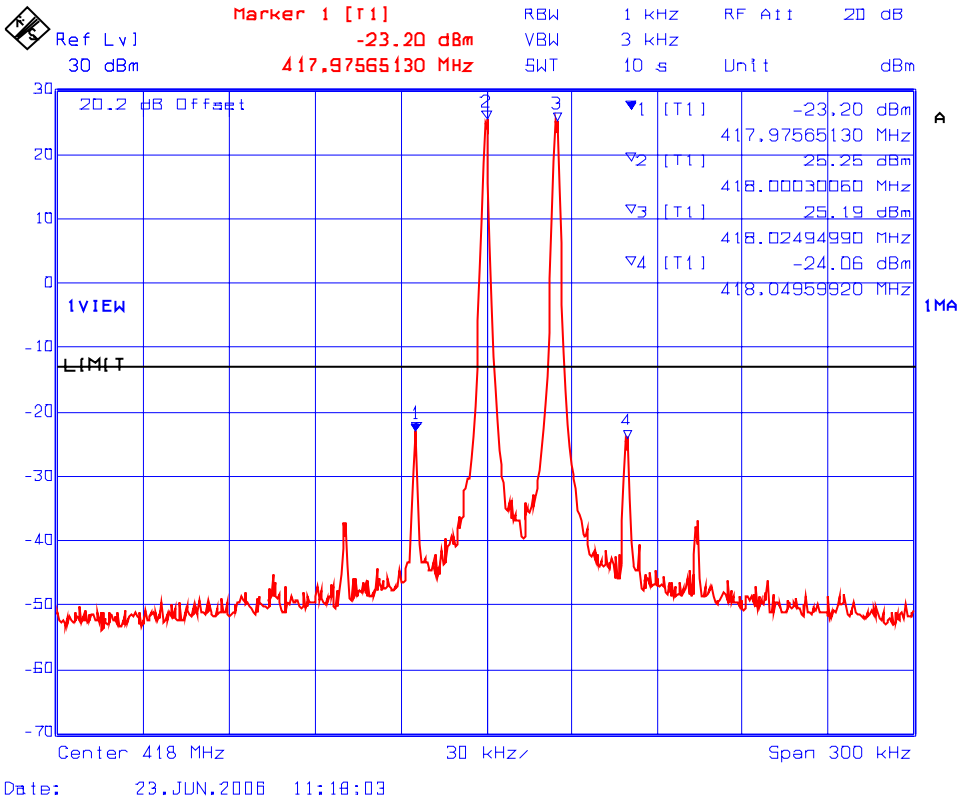
**Plot 6.5.5.2.3** Intermodulation with 3 RF signal inputs/outputs in 406.1 – 430 MHz
Fc: 406.1 MHz, Fc + 25 kHz, & Fc + 50 kHz
RF Input 1: -55.14dBm, RF Input 2: -55.14dBm, RF Input 3: -55.14dBm



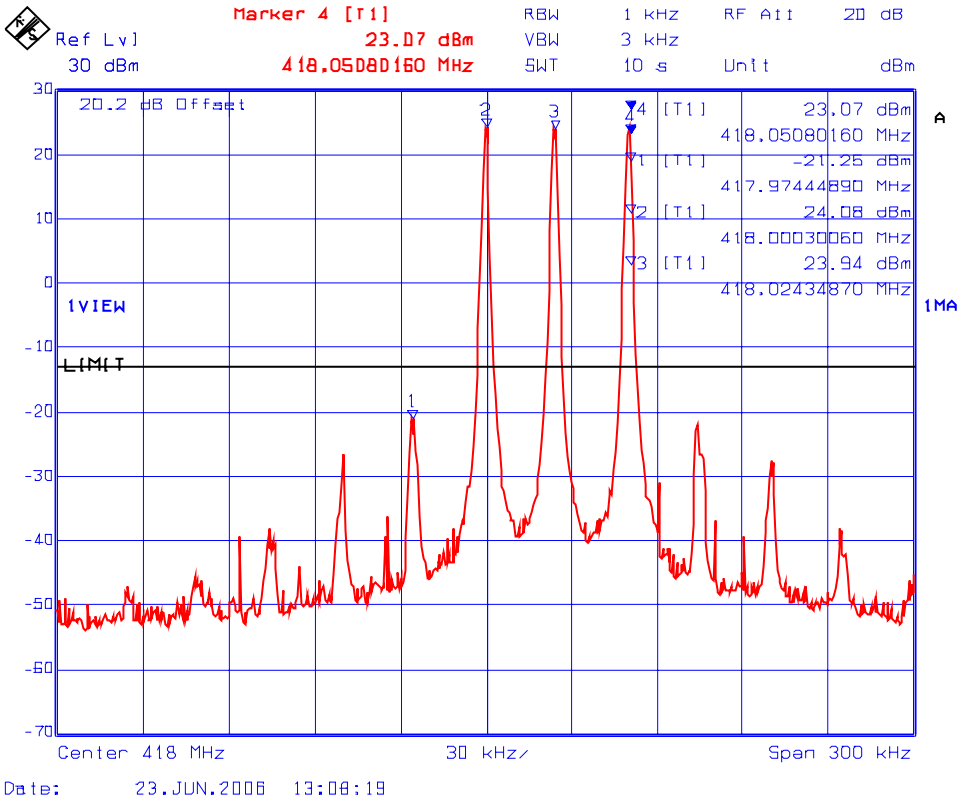
**Plot 6.5.5.2.4** Intermodulation with 1 RF Input 406.1 - 430 MHz
Fc= 418 MHz; RF Input: 0dBm



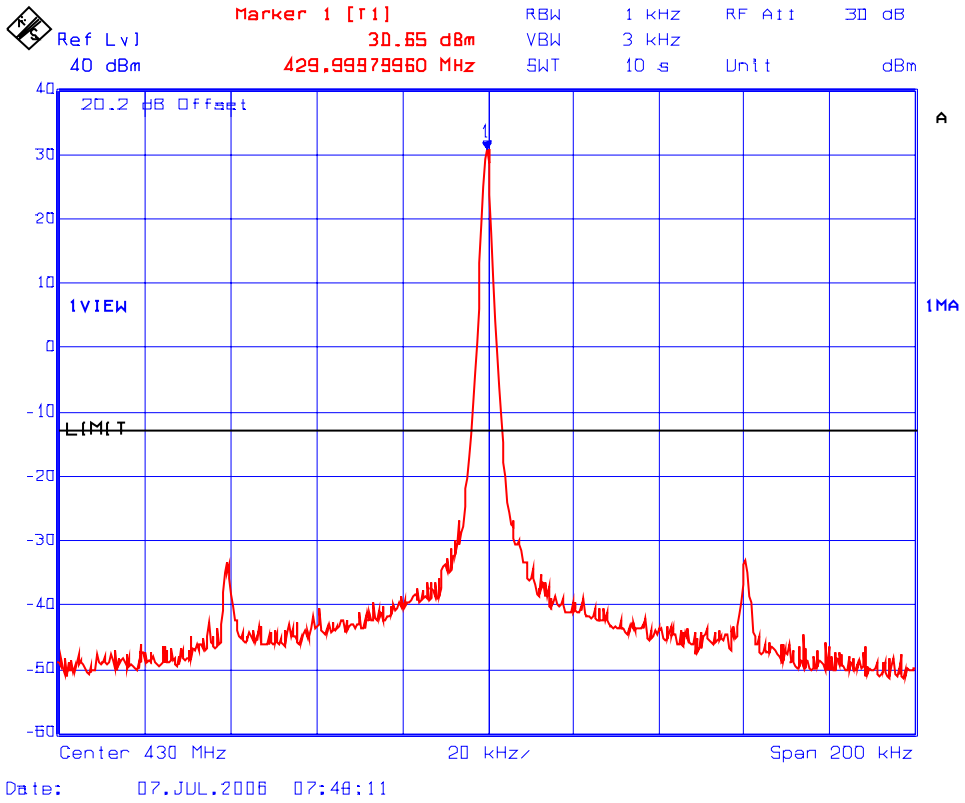
**Plot 6.5.5.2.5** Intermodulation with 2 RF signal inputs/outputs in 406.1 – 430 MHz
Fc: 418 MHz & Fc + 25 kHz
RF Input 1: -53.82dBm, RF Input 2: -53.82dBm



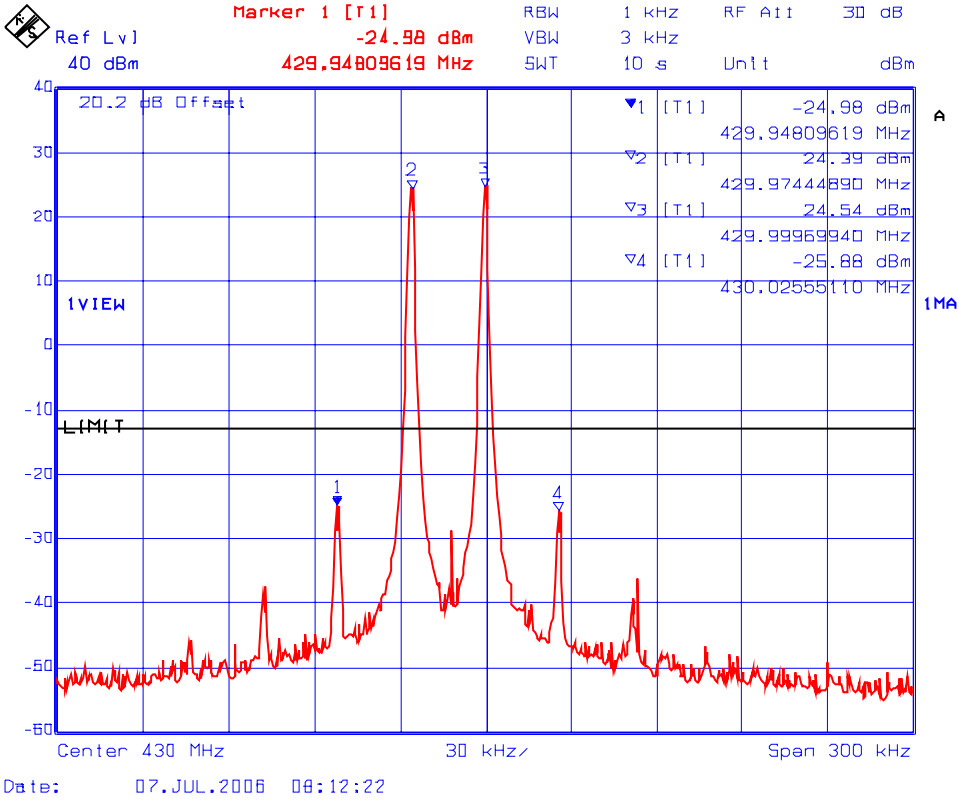
**Plot 6.5.5.2.6** Intermodulation with 3 RF signal inputs/outputs in 406.1 – 430 MHz
Fc: 418 MHz, Fc + 25 kHz, & Fc + 50 kHz
RF Input 1: -55.21dBm, RF Input 2: -55.21dBm, RF Input 3: -55.21dBm



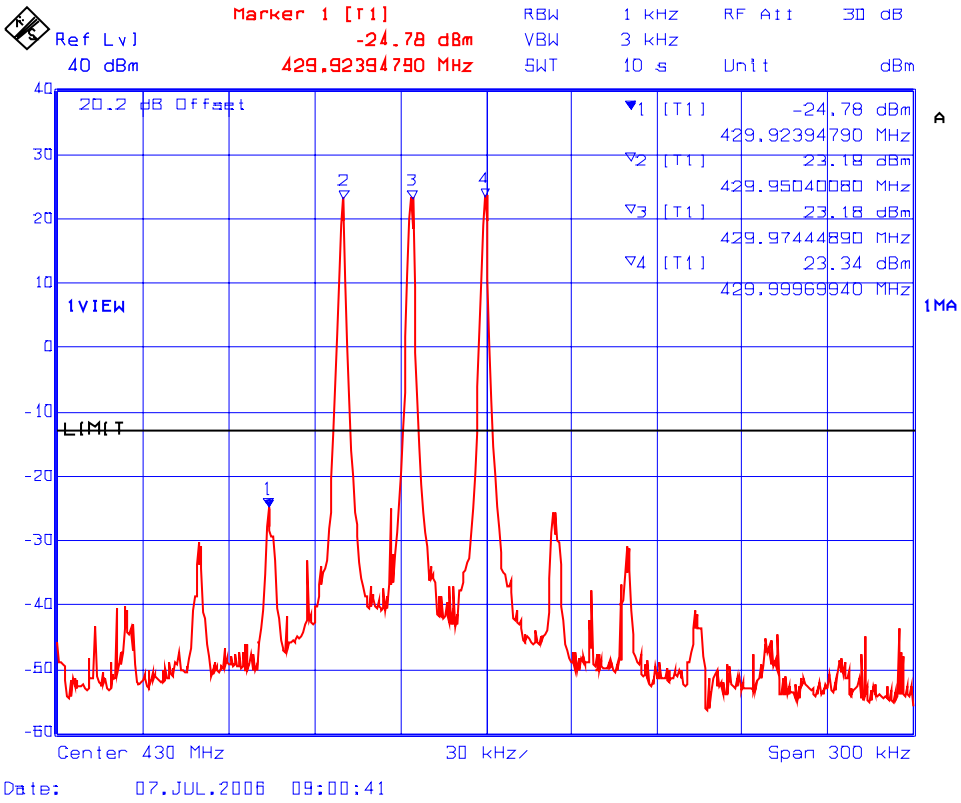
**Plot 6.5.5.2.7** Intermodulation with 1 RF Input 406.1 – 430 MHz
Fc= 430 MHz; RF Input: 0dBm



**Plot 6.5.5.2.8** Intermodulation with 2 RF signal inputs/outputs in 406.1 – 430 MHz
Fc: 430 MHz & Fc - 25 kHz
RF Input 1: -52.79dBm, RF Input 2: -52.97dBm



**Plot 6.5.5.2.9** Intermodulation with 3 RF signal inputs/outputs in 406.1 – 430 MHz
Fc: 430 MHz, Fc - 25 kHz, & Fc - 50 kHz
RF Input 1: -53.98dBm, RF Input 2: -54.15dBm, RF Input 3: -54.24dBm



## 6.6. RF EXPOSURE REQUIREMENTS [§§ 1.1310 & 2.1091]

### 6.6.1. Limits

**FCC 1.1310:**- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

f = frequency in MHz
* = Plane-wave equivalent power density

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

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

### 6.6.2. Method of Measurements

Refer to FCC @ 1.1310 and 2.1091

- 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

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

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

### 6.6.3. Test Data

Antenna Gain Limit specified by Manufacturer: 0 dB (In-building Antenna) & 10 dB (Outdoor Antenna)

| (1) Lowest Frequency (MHz) | Measured RF Conducted Power (dBm) | Calculated EIRP (dBm) | (2) Calculated Minimum RF Safety Distance r (cm) | Manufacturer's Specified Separation Distance (cm) |
|---|---|---|---|---|
| **In-building Antenna (≤0 dB)** | | | | |
| 406.1 | 32.48 | 34.63 | 29 | 30 |
| **Outdoor Mounted Antenna (≤10 dB)** | | | | |
| 406.1 | 32.48 | 44.63 | 92 | 100 |

(1) The calculation is based on the lowest frequency (406.1 MHz) and the highest conducted power (32.48 dBm) for the worst case.
(2) The minimum separation distance between the antenna and bodies of users are calculated using the following equation:

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

**In-building Antenna (≤ 0 dB gain):**

EIRP = 34.63 dBm = $10^{(34.63/10)}$ mW
S = f/1500 = 406.1/1500 mW/cm$^2$ (General Population/ Uncontrolled Exposure)

$r = (EIRP/4\Pi S)^{1/2} = (10^{(34.63/10)}) / (4\Pi(406.1/1500))^{1/2} = 29.4$ cm

**Outdoor Mounted Antenna (≤ 10 dB gain):**

EIRP = 44.63 dBm = $10^{(44.63/10)}$ mW
S = f/1500 = 406.1/1500 mW/cm$^2$ (General Population/ Uncontrolled Exposure)

$r = (EIRP/4\Pi S)^{1/2} = (10^{(44.63/10)}) / (4\Pi(406.1/1500))^{1/2} = 92.4$ cm

| Evaluation of RF Exposure Compliance Requirements | |
|---|---|
| **RF Exposure Requirements** | **Compliance with FCC Rules** |
| Minimum calculated separation distance between antenna and persons required:<br><br>▪ Indoor Antenna: 29.4 cm<br>▪ Outdoor Antenna: 92.6 cm | Manufacturer' instruction for separation distance between antenna and persons required:<br><br>Indoor Antenna: 30 cm<br>Outdoor Antenna: 100 cm |
| Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement | Please refer to User's Manual for details. |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits | Refer to User's Manual for RF Exposure Information. |
| Any other RF exposure related issues that may affect MPE compliance | None. |

## 6.7. OCCUPIED BANDWIDTH [§ 2.1049]

### 6.7.1. Limits

The spectral shape of the output should look similar to input for all modulations.

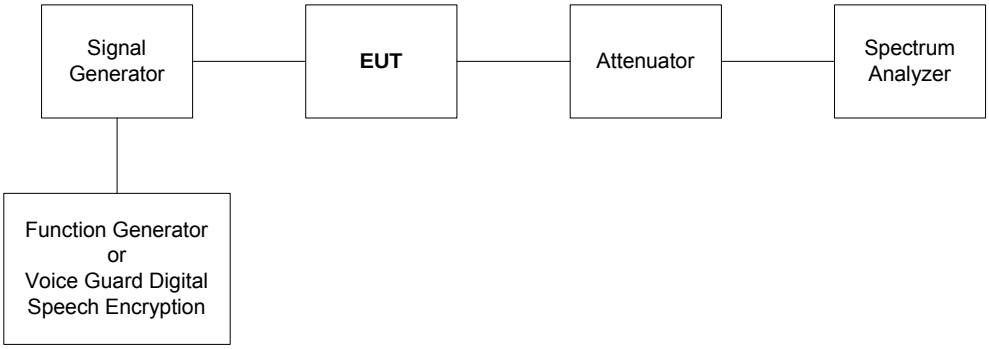
### 6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 for measurement details.

### 6.7.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz |
| Function Generator | Stanford Research Systems | DS345 | 34591 | 1Hz -30.2 MHz |
| Voice Guard Digital Speech Encryption | General Electric | 9600-SW | 9614517 | -- |
| Attenuator | Weinschel Corp | 48-30-34 | BM5354 | DC - 18 GHz |

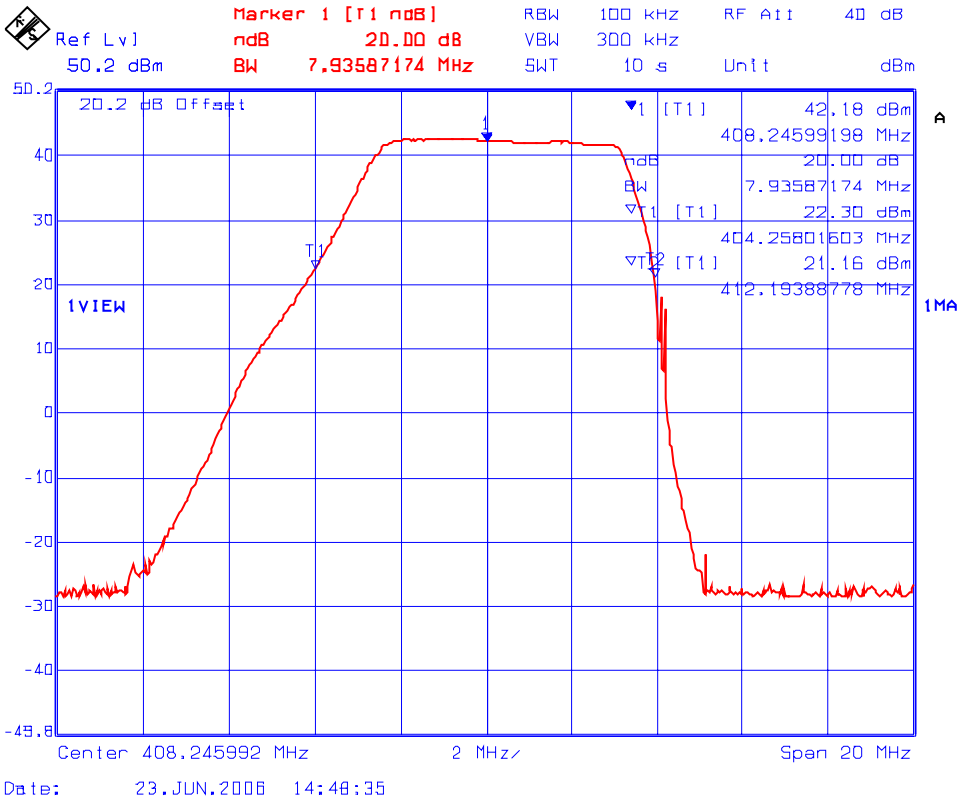
### 6.7.4. Test Arrangement



## 6.7.5. Test Data

### 6.7.5.1. Passband Gain

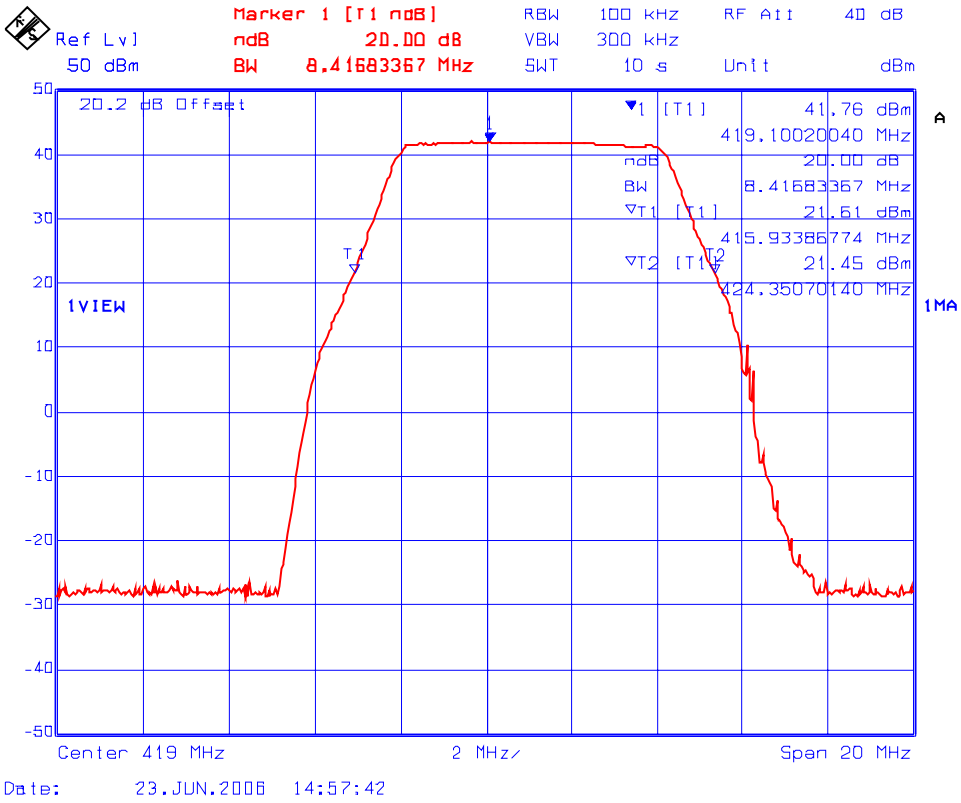
**Plot 6.7.5.1.1** 20dB Passband Gain of the 406.1 – 411.1 MHz Band
RF Input: 0dBm, Tracking from 400 – 450 MHz, Max Gain: 42.10 dB



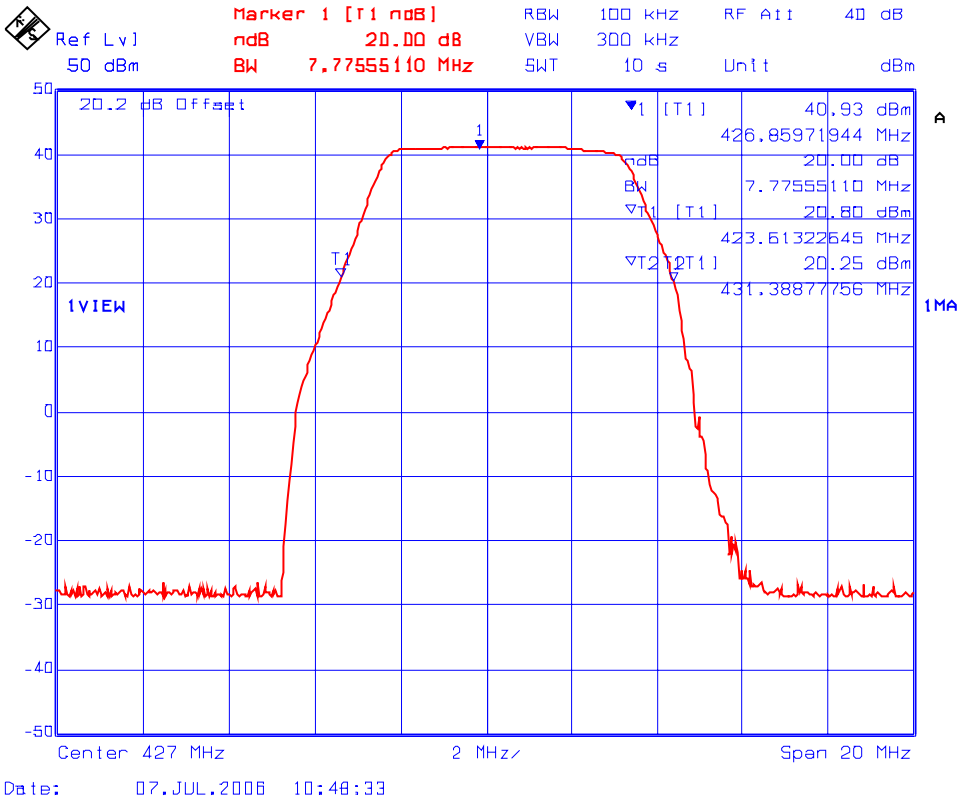



*All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot 6.7.5.1.2** 20dB Passband Gain of the 417.1 – 423.1 MHz Band
RF Input: 0dBm, Tracking from 400 – 450 MHz, Max Gain: 41.76 dB

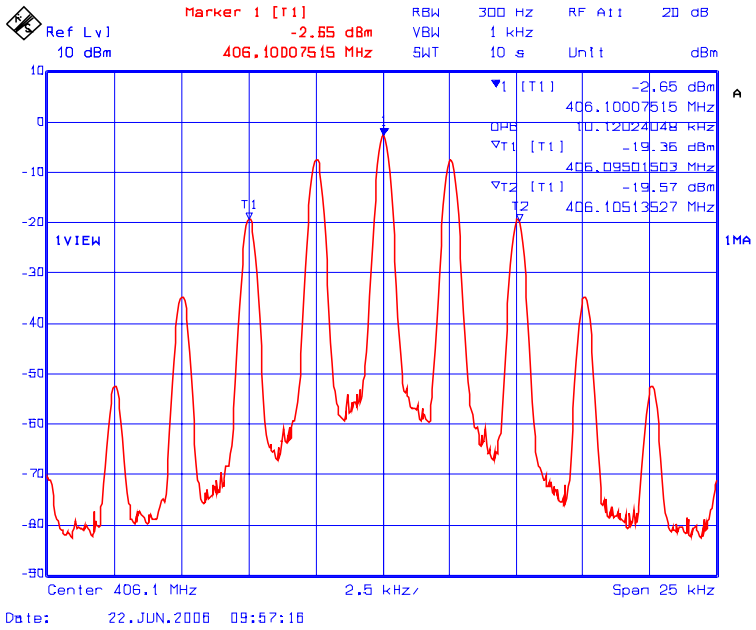


**Plot 6.7.5.1.3** 20dB Passband Gain of the 425 – 430 MHz Band
RF Input: 0dBm, Tracking from 400 – 450 MHz, Max Gain: 40.93 dB

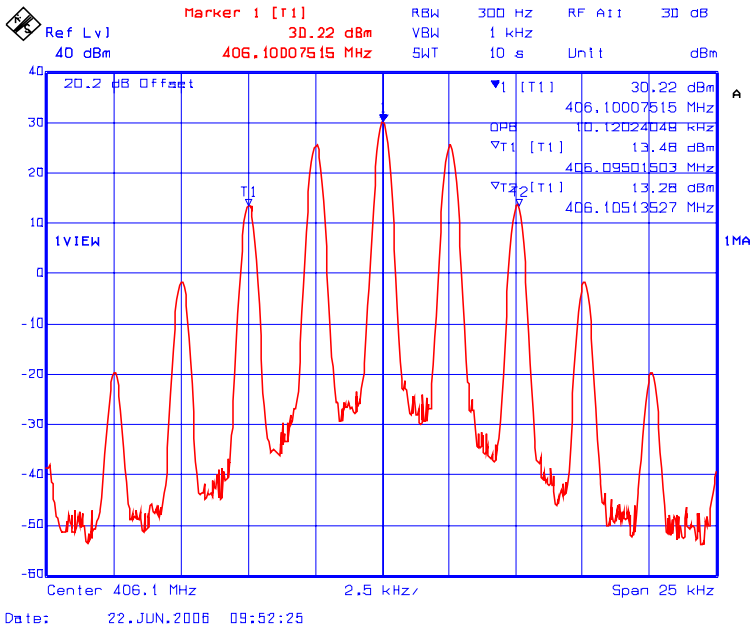


### 6.7.5.2. Occupied Bandwidth

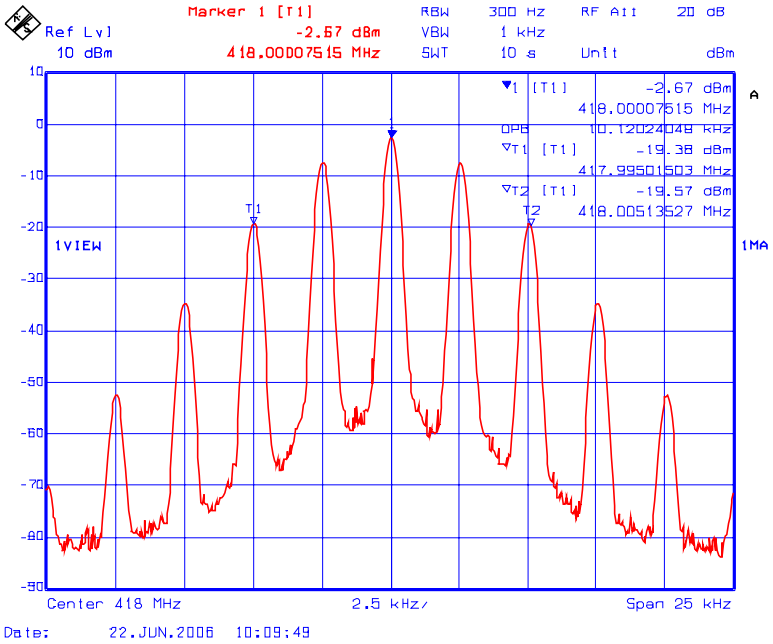
**Plot 6.7.5.2.1** 99% Occupied Bandwidth – RF Input
Fc: 406.1 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



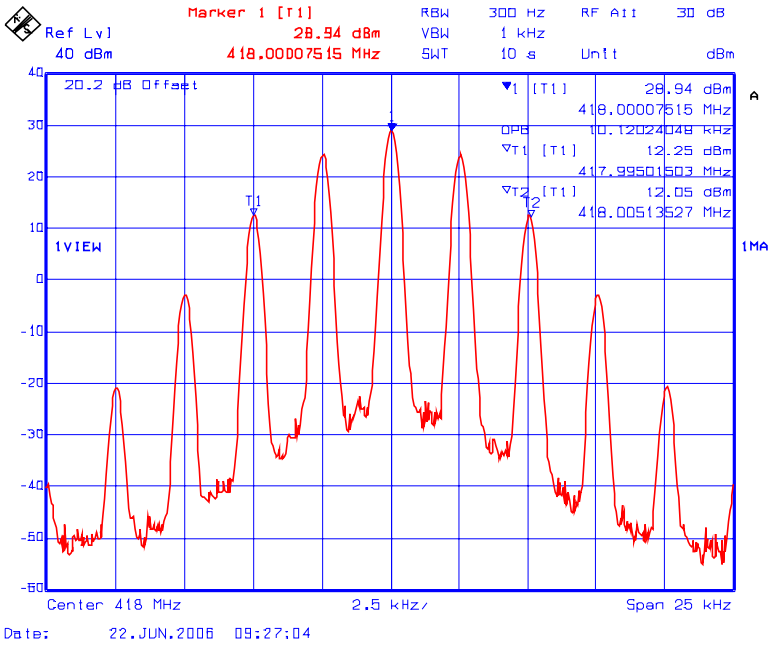

**Plot 6.7.5.2.2** 99% Occupied Bandwidth – RF Output
Fc: 406.1 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



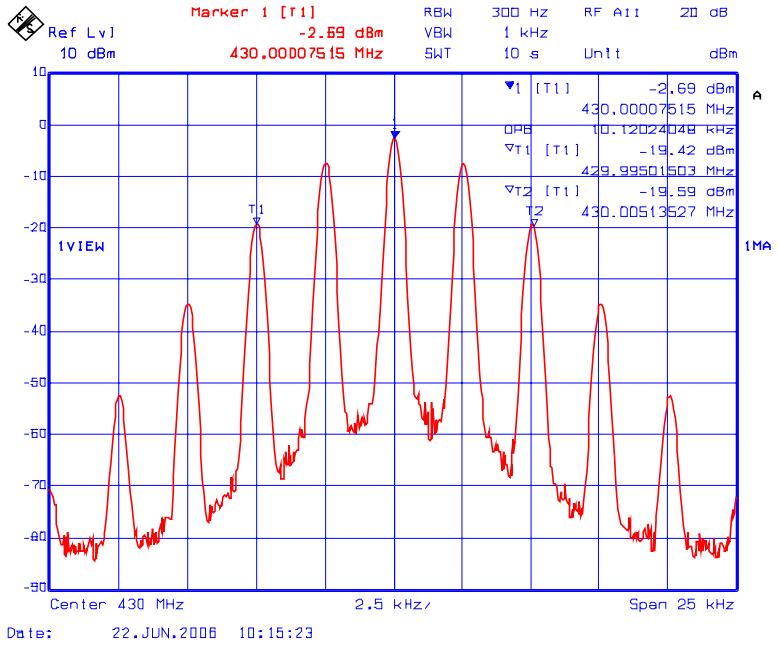
**Plot 6.7.5.2.3** 99% Occupied Bandwidth – RF Input
Fc: 418 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



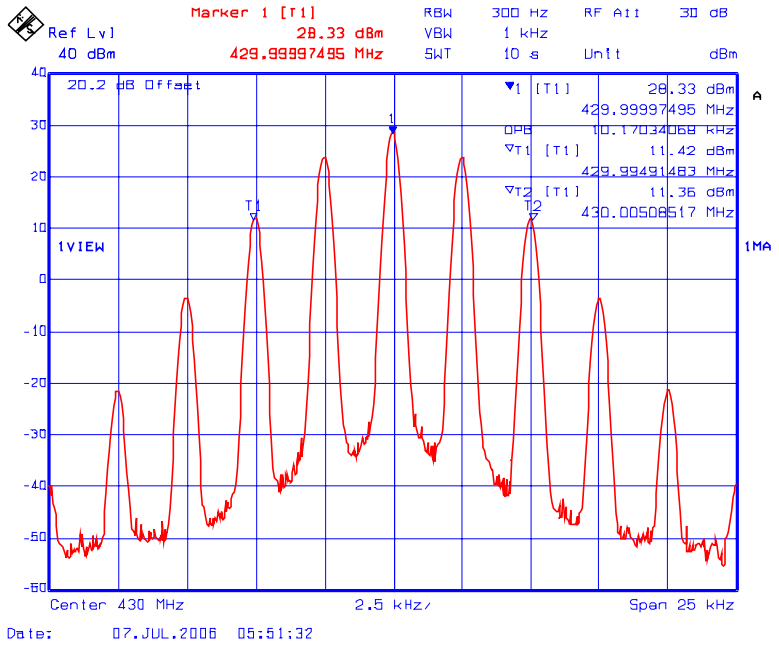

**Plot 6.7.5.2.4** 99% Occupied Bandwidth – RF Output
Fc: 418 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



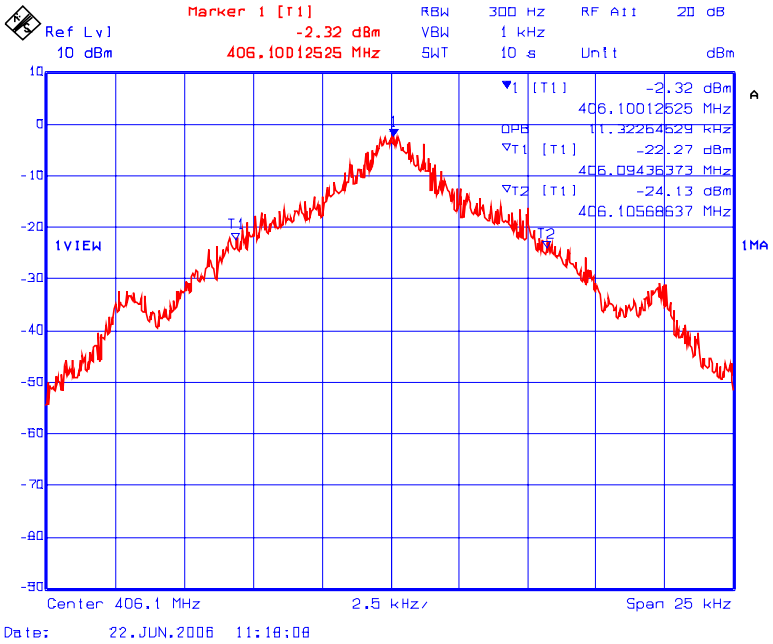
**Plot 6.7.5.2.5** 99% Occupied Bandwidth – RF Input
Fc: 430 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



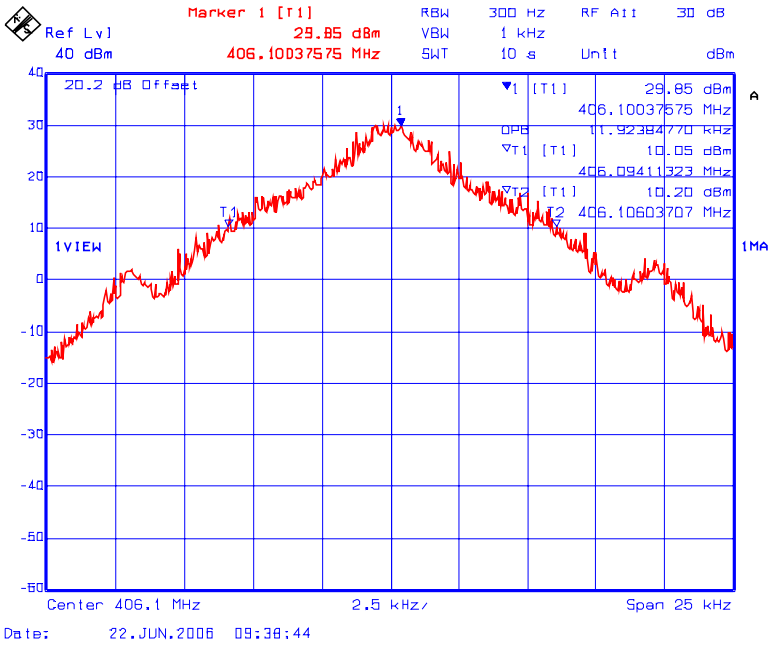

**Plot 6.7.5.2.6** 99% Occupied Bandwidth – RF Output
Fc: 430 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



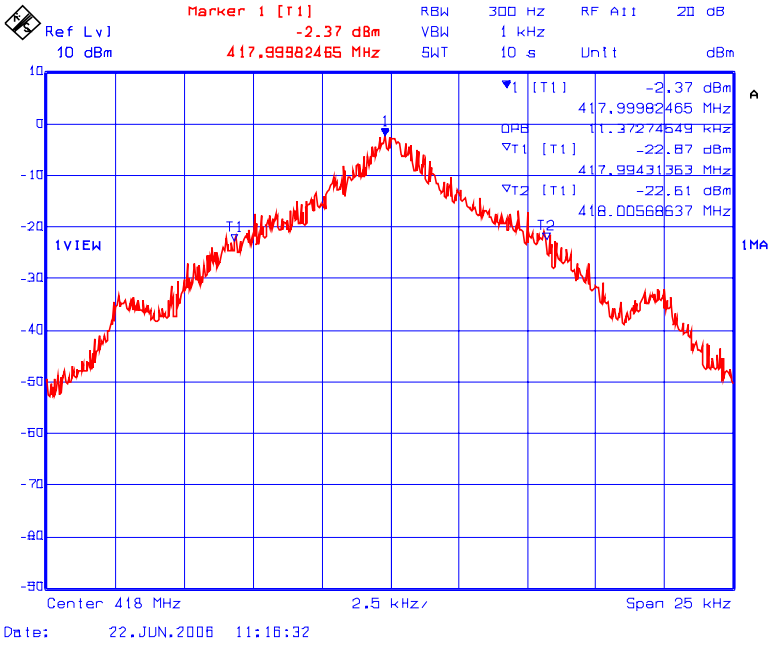
**Plot 6.7.5.2.7** 99% Occupied Bandwidth – RF Input
Fc: 406.1 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



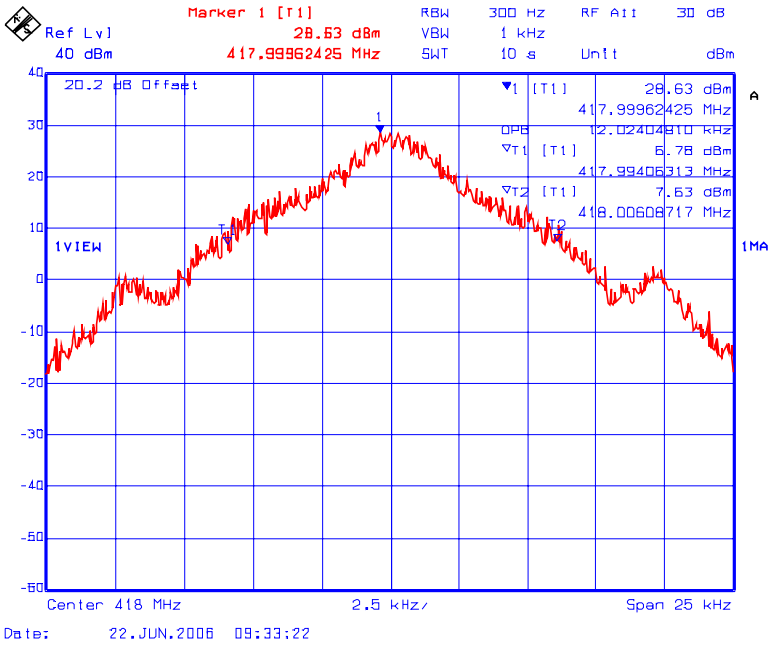

**Plot 6.7.5.2.8** 99% Occupied Bandwidth – RF Output
Fc: 406.1 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



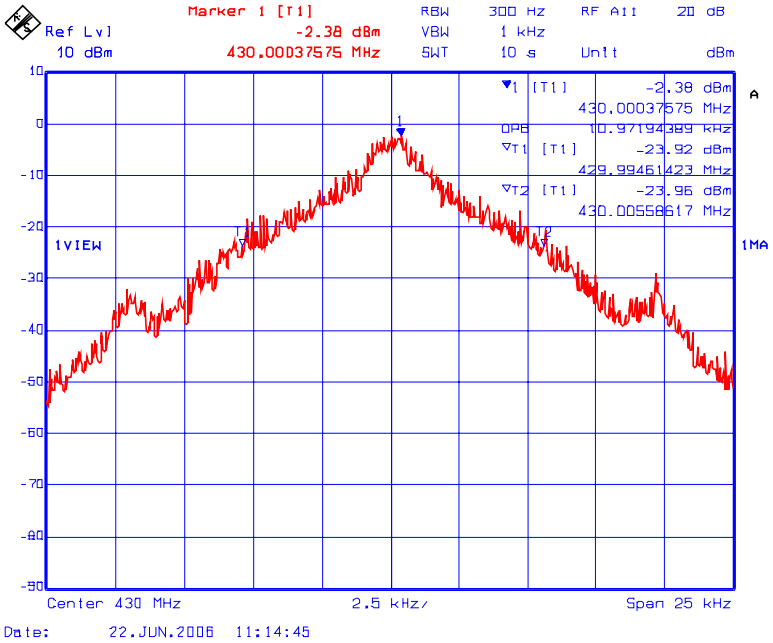
**Plot 6.7.5.2.9** 99% Occupied Bandwidth – RF Input
Fc: 418 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



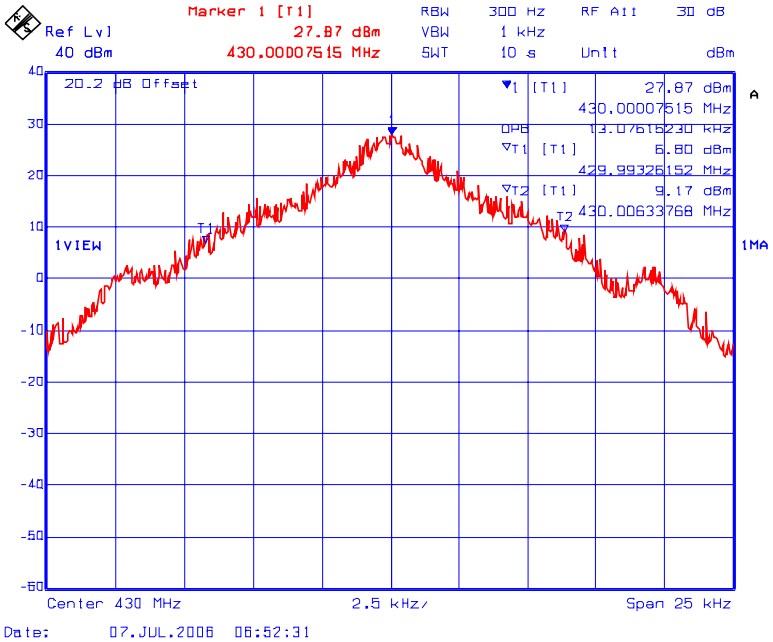

**Plot 6.7.5.2.10** 99% Occupied Bandwidth – RF Output
Fc: 418 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



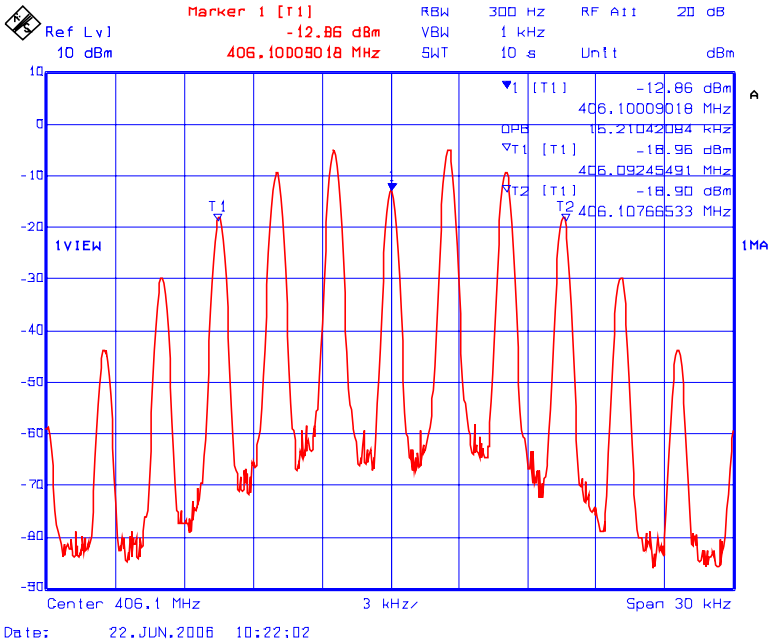
**Plot 6.7.5.2.11** 99% Occupied Bandwidth – RF Input
Fc: 430 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



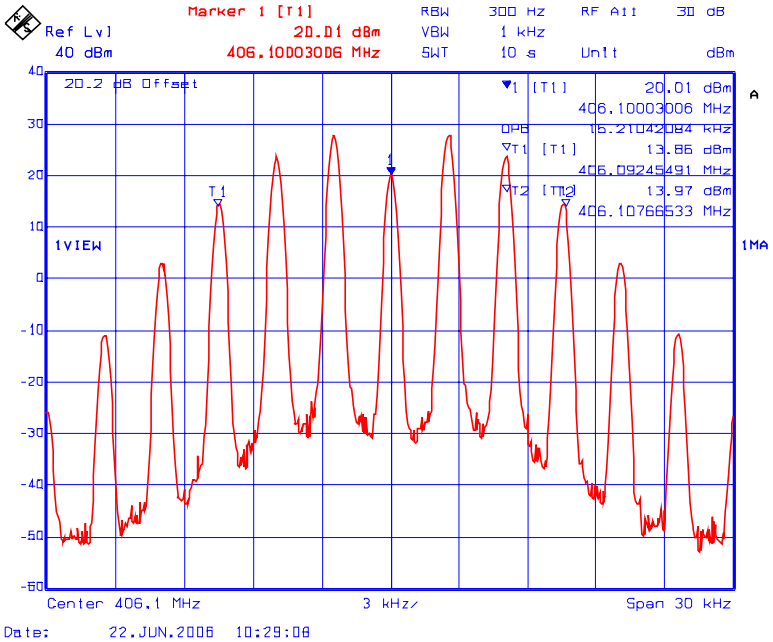

**Plot 6.7.5.2.12** 99% Occupied Bandwidth – RF Output
Fc: 430 MHz, 12.5 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



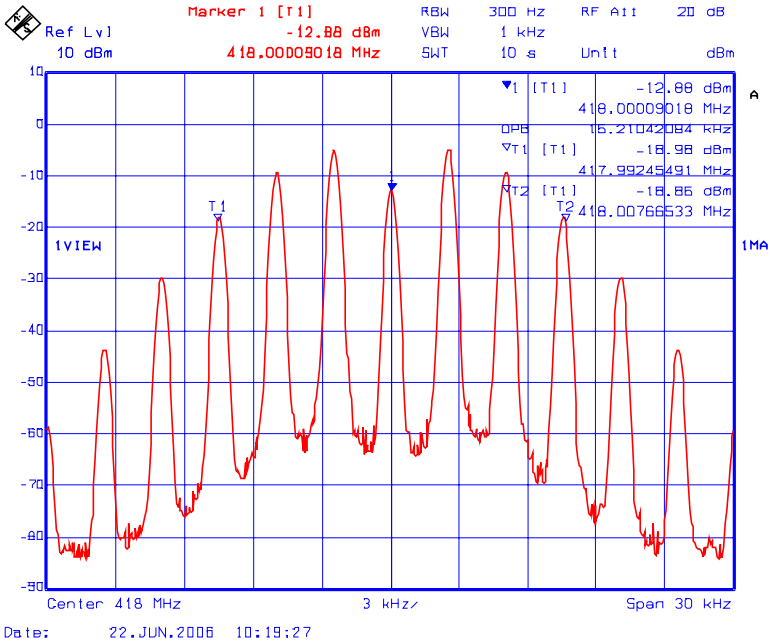
**Plot 6.7.5.2.13** 99% Occupied Bandwidth – RF Input
Fc: 406.1 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



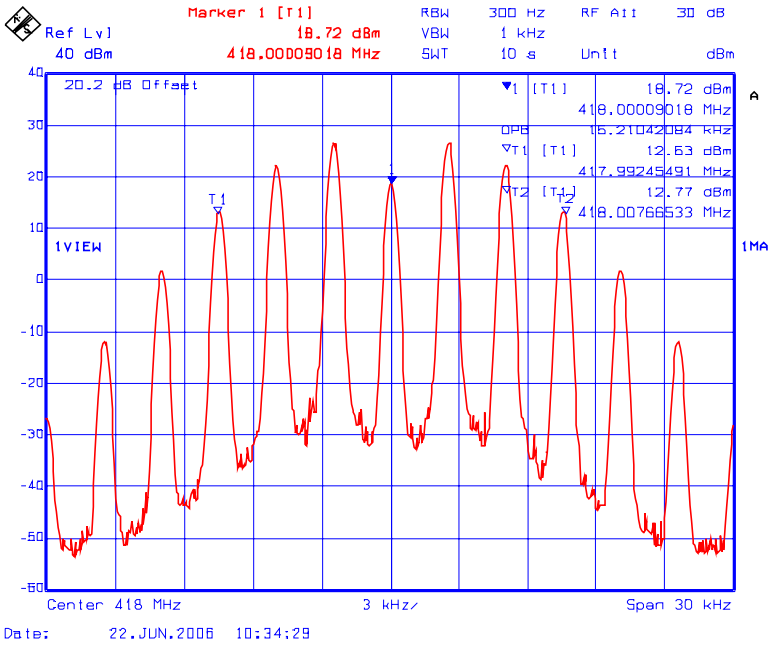

**Plot 6.7.5.2.14** 99% Occupied Bandwidth – RF Output
Fc: 406.1 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



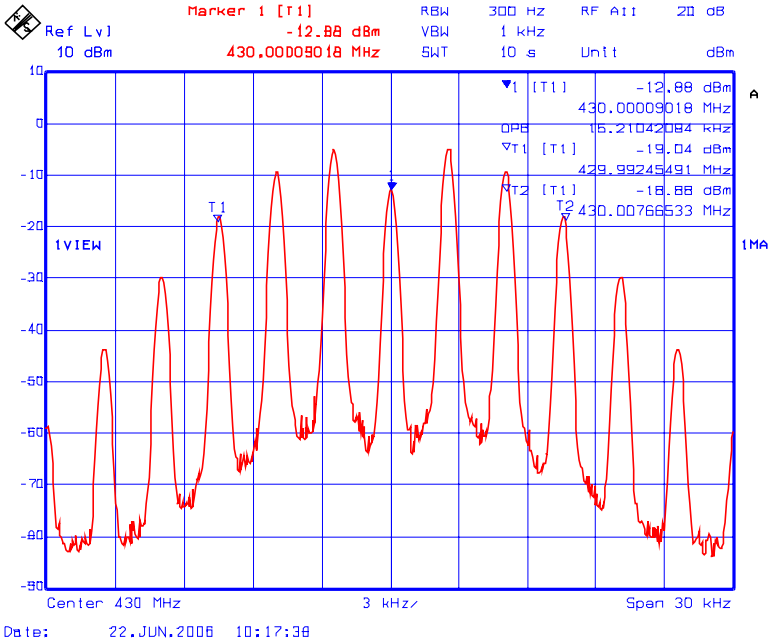
**Plot 6.7.5.2.15** 99% Occupied Bandwidth – RF Input
Fc: 418 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



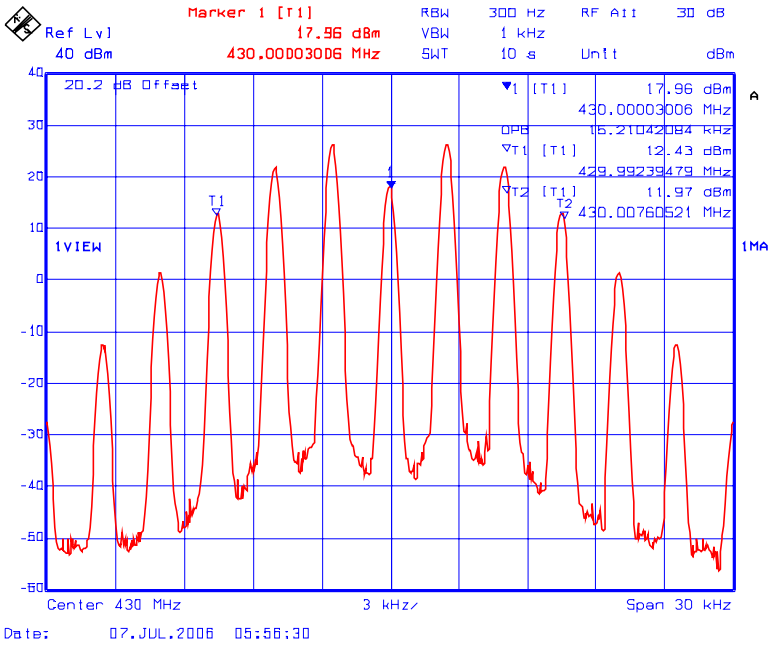

**Plot 6.7.5.2.16** 99% Occupied Bandwidth – RF Output
Fc: 418 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



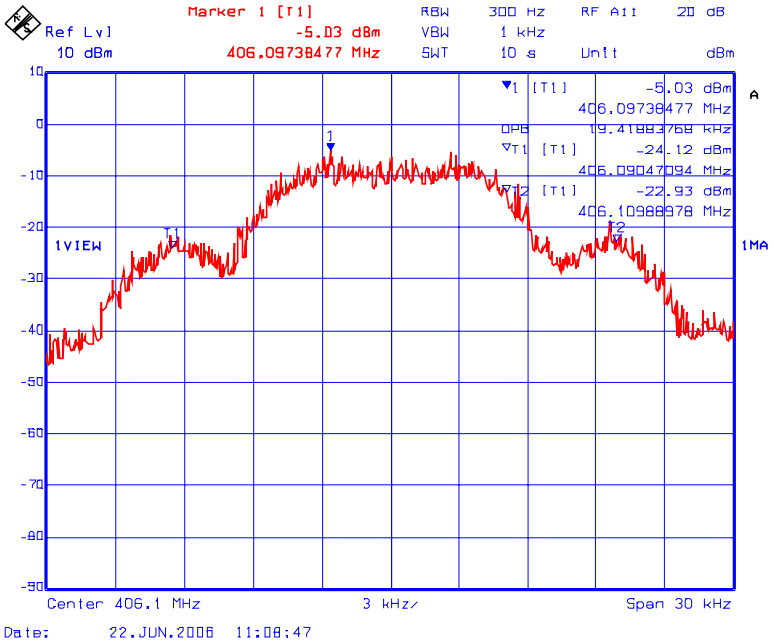
**Plot 6.7.5.2.17** 99% Occupied Bandwidth – RF Input
Fc: 430 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



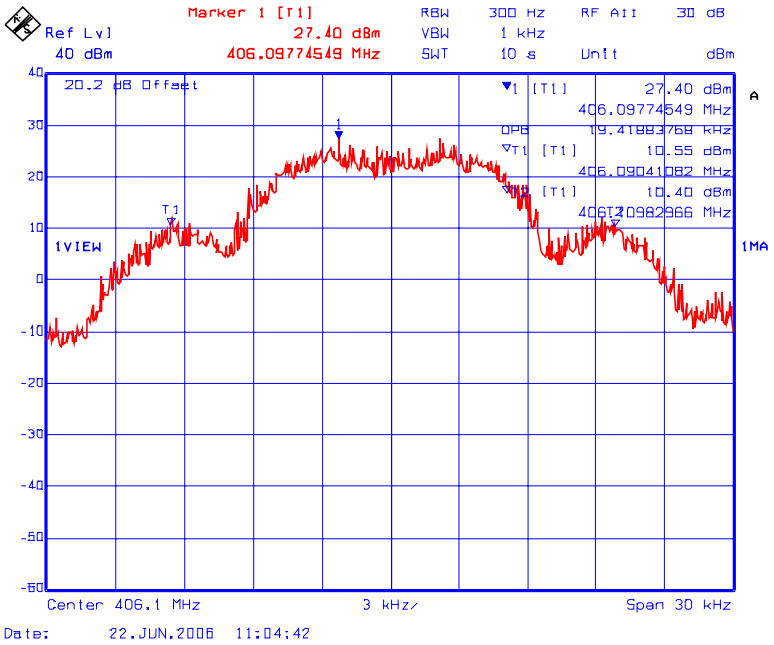

**Plot 6.7.5.2.18** 99% Occupied Bandwidth – RF Output
Fc: 430 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with 2.5 kHz Sine wave signal



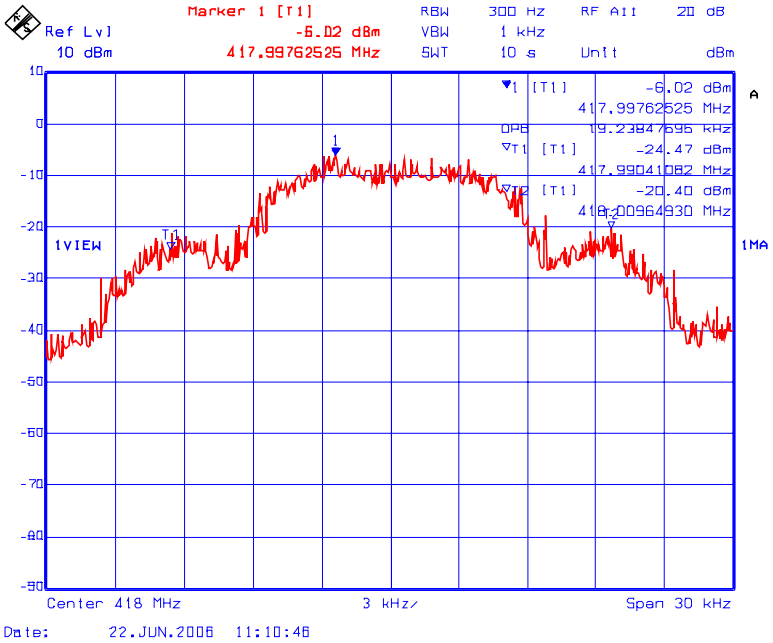
**Plot 6.7.5.2.19** 99% Occupied Bandwidth – RF Input
Fc: 406.1 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



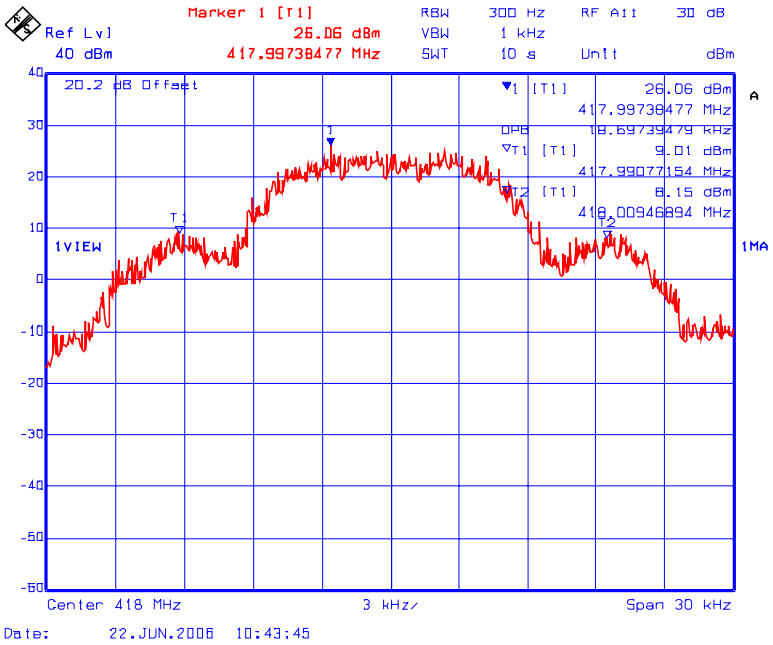

**Plot 6.7.5.2.20** 99% Occupied Bandwidth – RF Output
Fc: 406.1 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



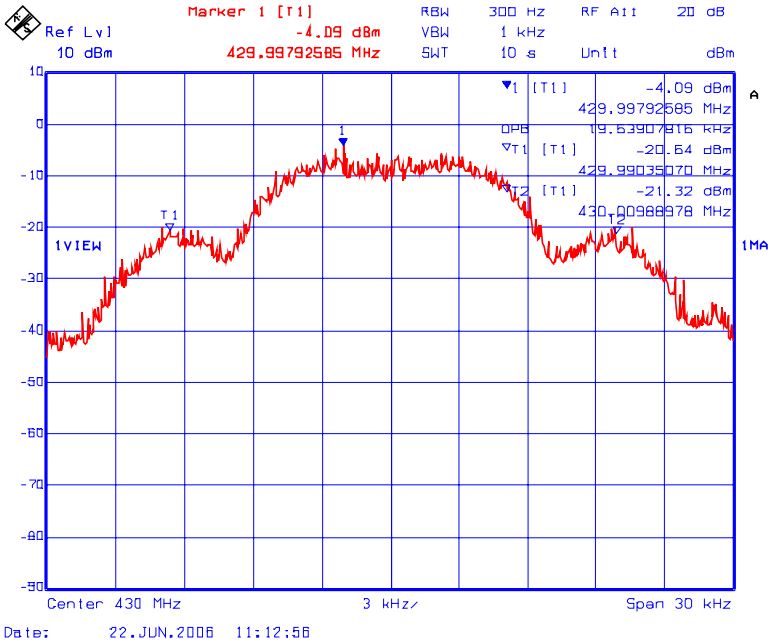
**Plot 6.7.5.2.21** 99% Occupied Bandwidth – RF Input
Fc: 418 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



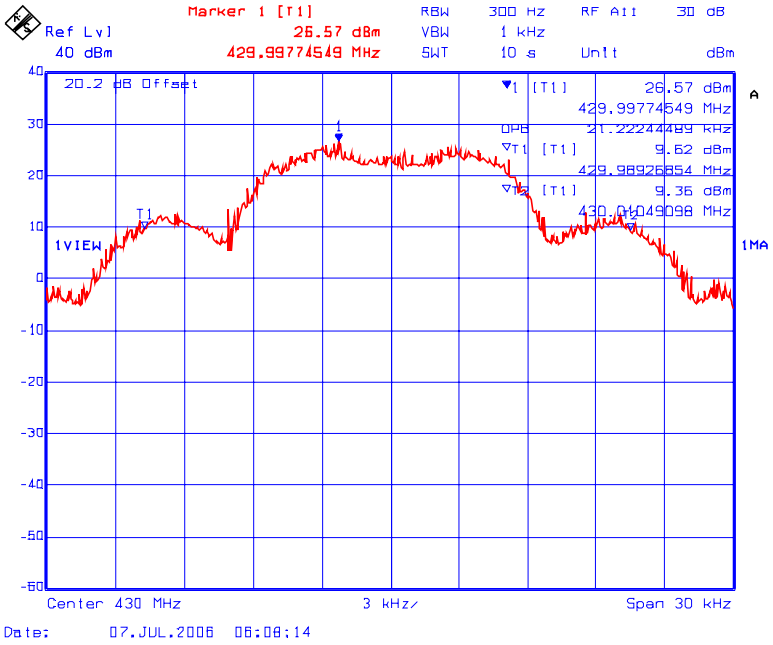

**Plot 6.7.5.2.22** 99% Occupied Bandwidth – RF Output
Fc: 418 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



**Plot 6.7.5.2.23** 99% Occupied Bandwidth – RF Input
Fc: 430 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source




**Plot 6.7.5.2.24** 99% Occupied Bandwidth – RF Output
Fc: 430 MHz, 25 kHz Channel Spacing; Modulation: FM modulation with an external 9600 b/s random data source



## 6.8. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051 & 90.210]

### 6.8.1. Limits

At least 50 + 10*log(P in Watts) dBc.

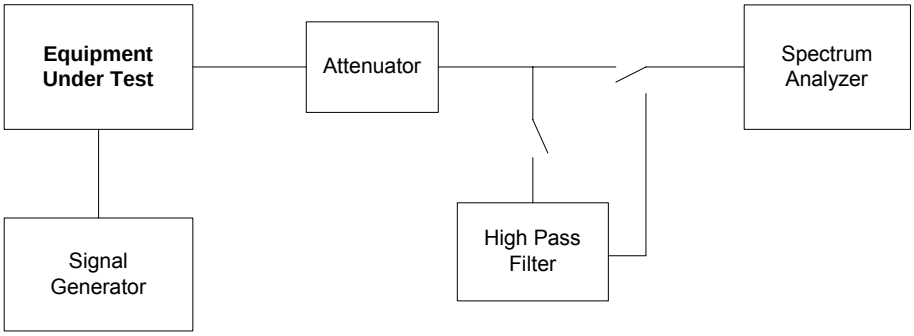
### 6.8.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and TIA-603-C.

### 6.8.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz |
| Attenuator | Weinschel Corp | 46-20-34 | BM1347 | DC - 18 GHz |
| High Pass Filter | K & L | 11SH10-1500/T8000-O/O | 2 | 2 - 18 GHz |
| Signal Generator | Gigatronic | 6061A | 5130586 | 10 kHz - 1050 MHz |

### 6.8.4. Test Arrangement



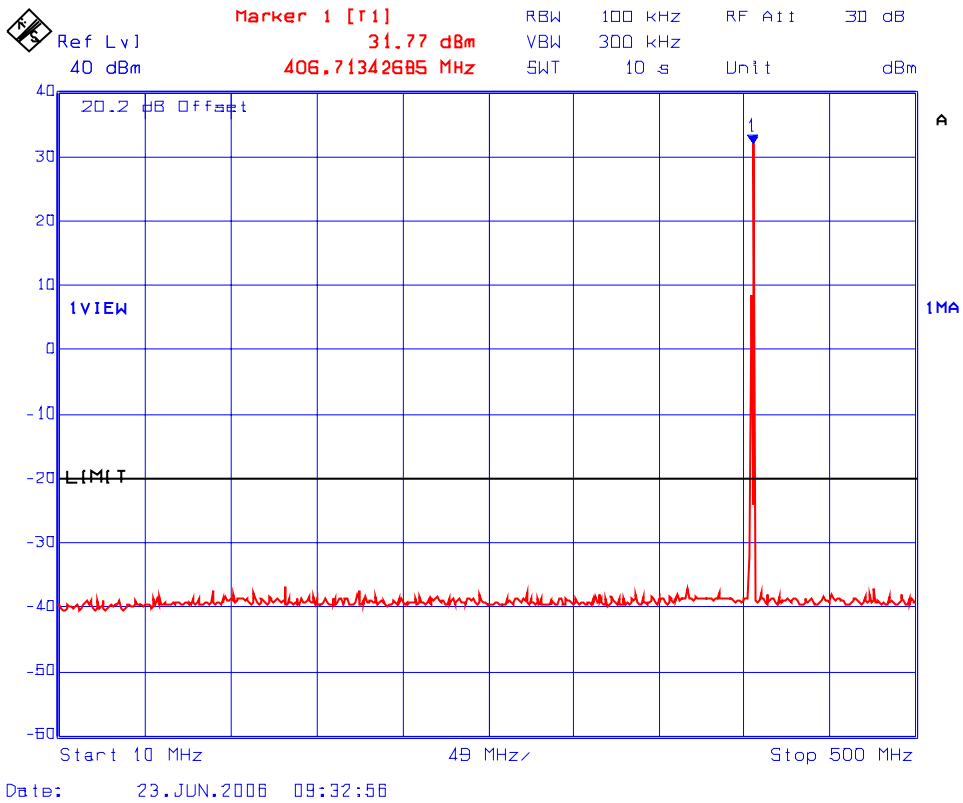
## 6.8.5. Test Data

**Remarks:**

(1) There was no difference in spurious/harmonic emissions on pre-scans for all different modulations. Therefore, the rf spurious/harmonic emissions in this section would be performed without modulation and it shall represent for all different modulations required.
(2) The emissions were scanned from 10 MHz to 5 GHz.

Fundamental Frequency: 406.1 (1 channel input/output)
Modulation: Unmodulated

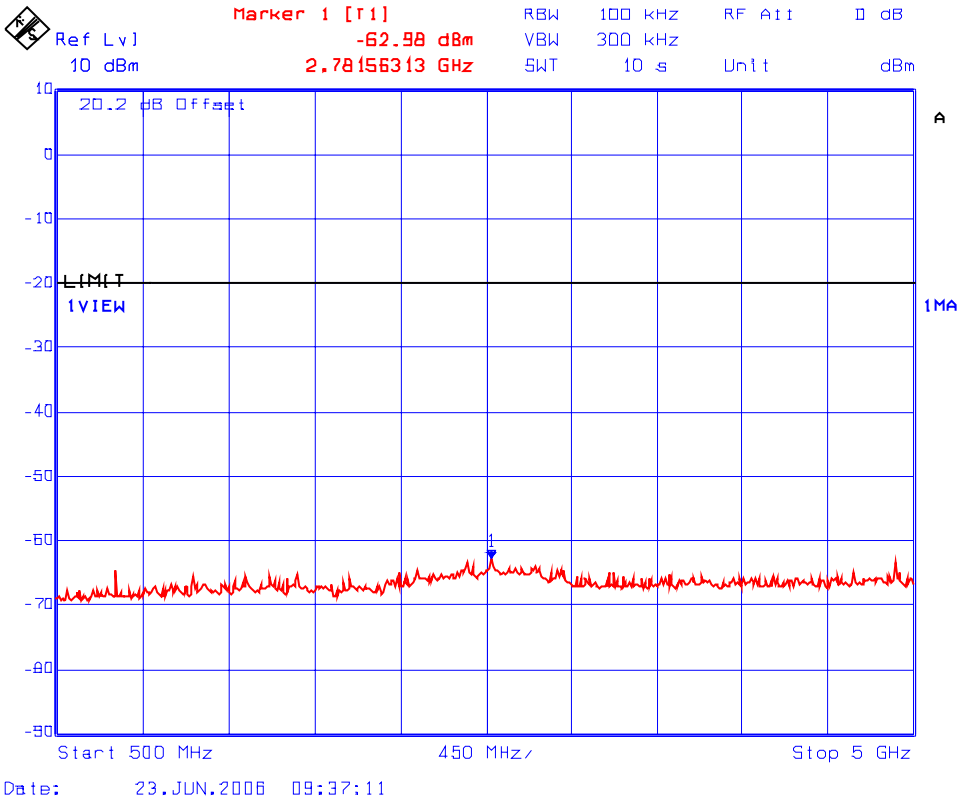
**Plot 6.8.5.1** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 406.1 MHz





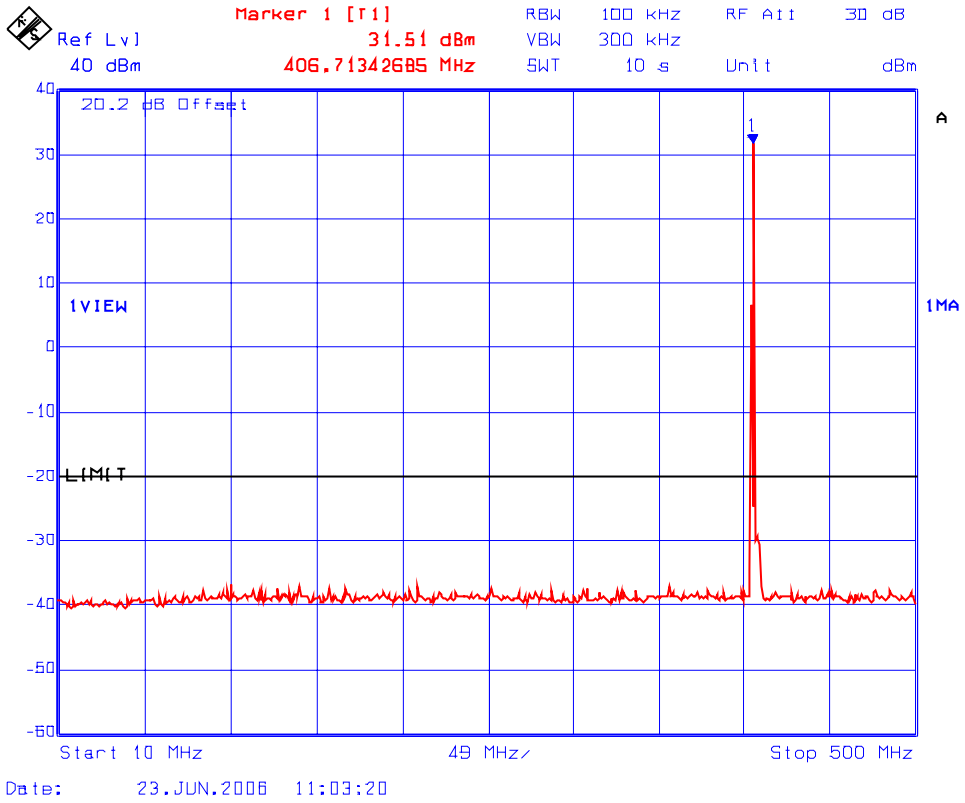

*All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

**Plot 6.8.5.2** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 406.1 MHz

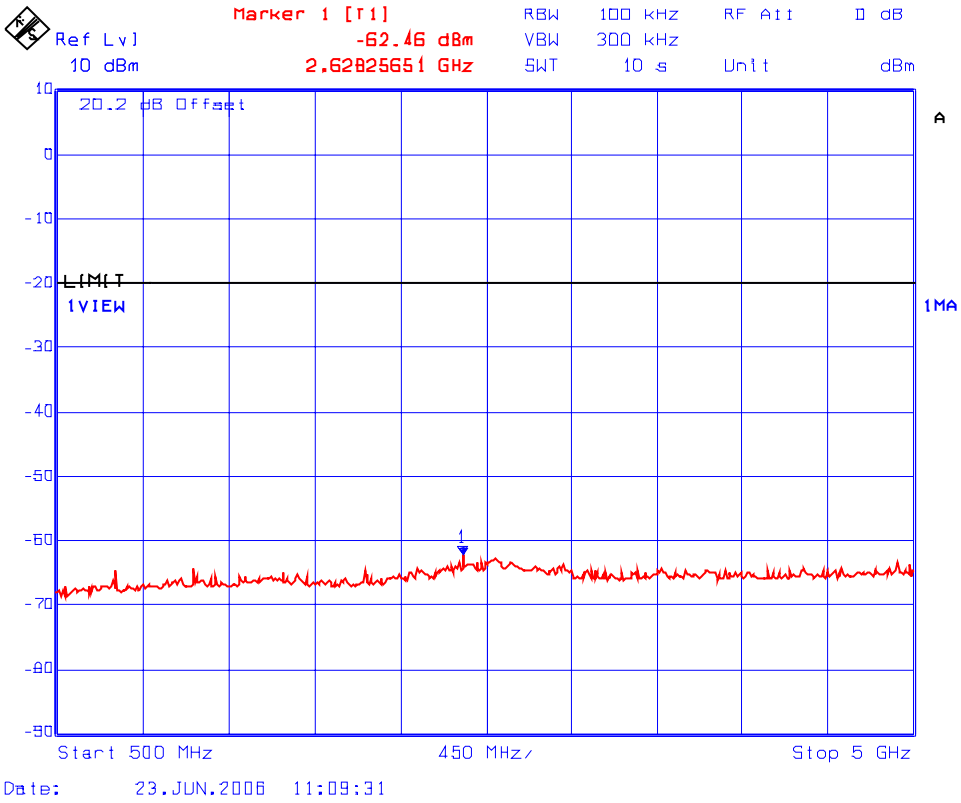


Fundamental Frequency: 406.1 MHz and 406.125 MHz (2 channels input/output)
Modulation: Unmodulated

**Plot 6.8.5.3** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 406.1 MHz & Fc + 25 kHz;

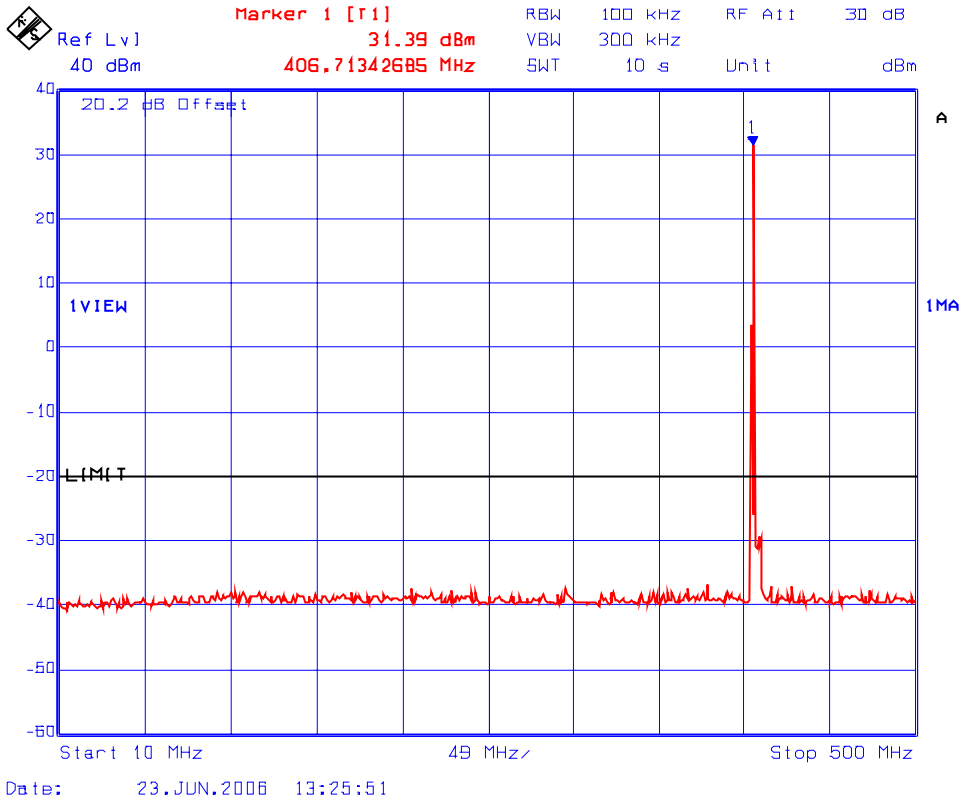


**Plot 6.8.5.4** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 406.1 MHz & Fc + 25 kHz

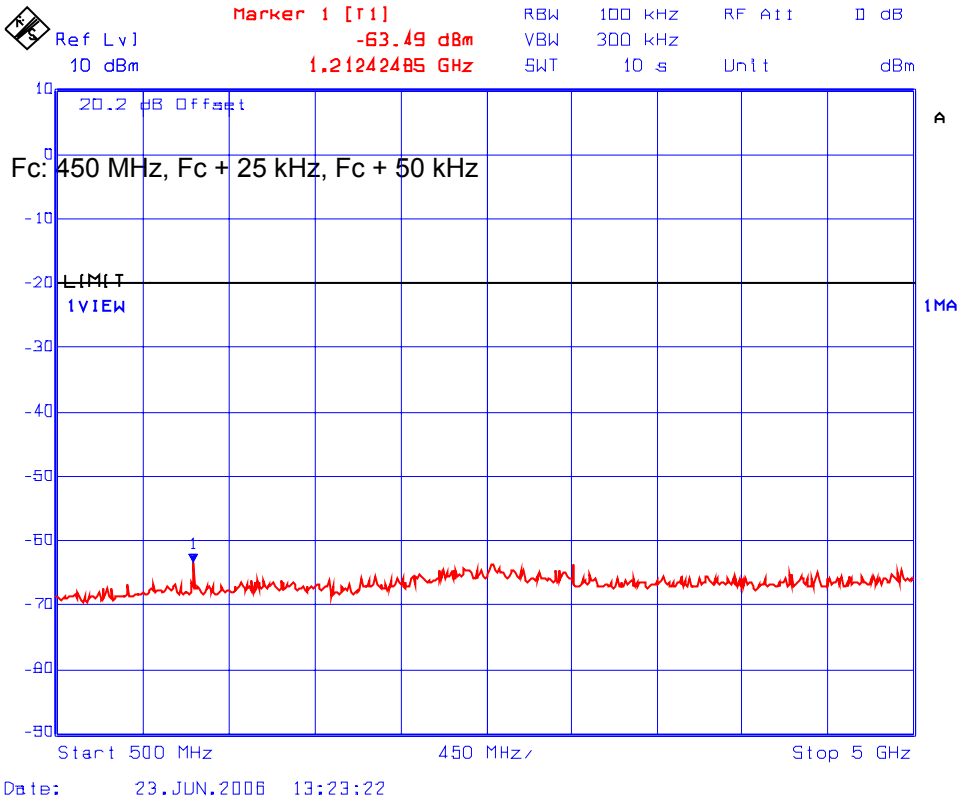


Fundamental Frequency: 406.1 MHz, 406.125 MHz, 406.150 MHz (3 channel inputs/outputs)
Modulation: Unmodulated

**Plot 6.8.5.5** Conducted Spurious Emission with 3 RF Signals Input/Output
Fc: 406.1 MHz, Fc + 25 kHz, Fc + 50 kHz

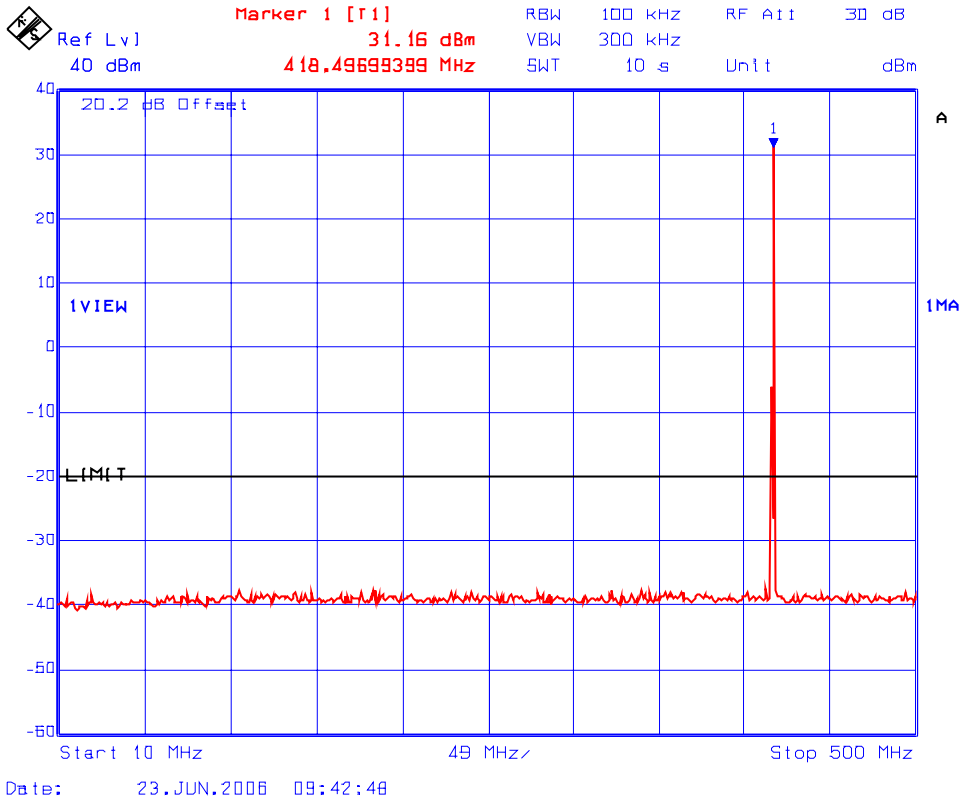


**Plot 6.8.5.6** Conducted Spurious Emission with 3 RF Signals Input/Output
Fc: 406.1 MHz, Fc + 25 kHz, Fc + 50 kHz

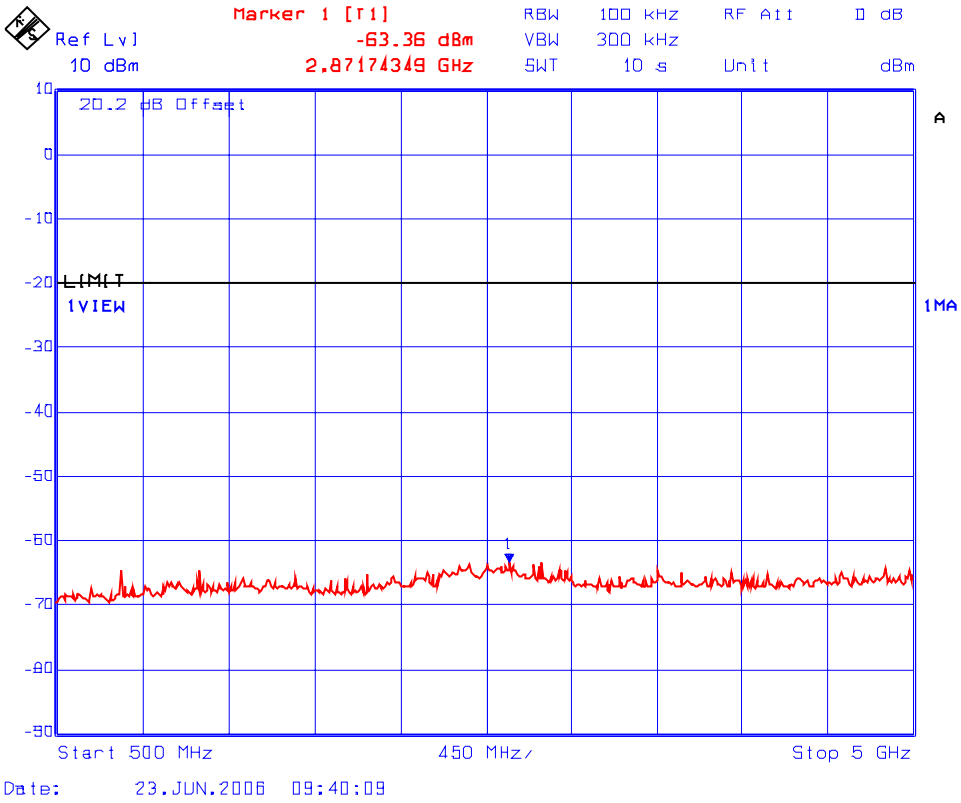


Fundamental Frequency: 418 MHz, 1 RF Signal input/output
Modulation: Unmodulated

**Plot 6.8.5.7** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 418 MHz

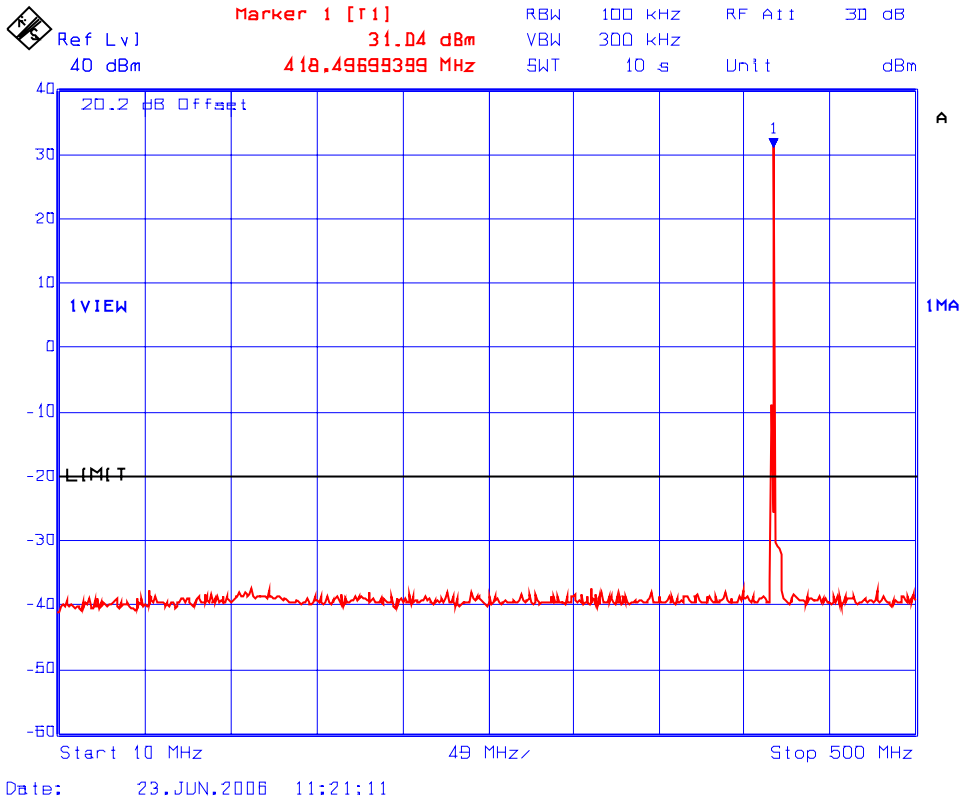


**Plot 6.8.5.8** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 418 MHz

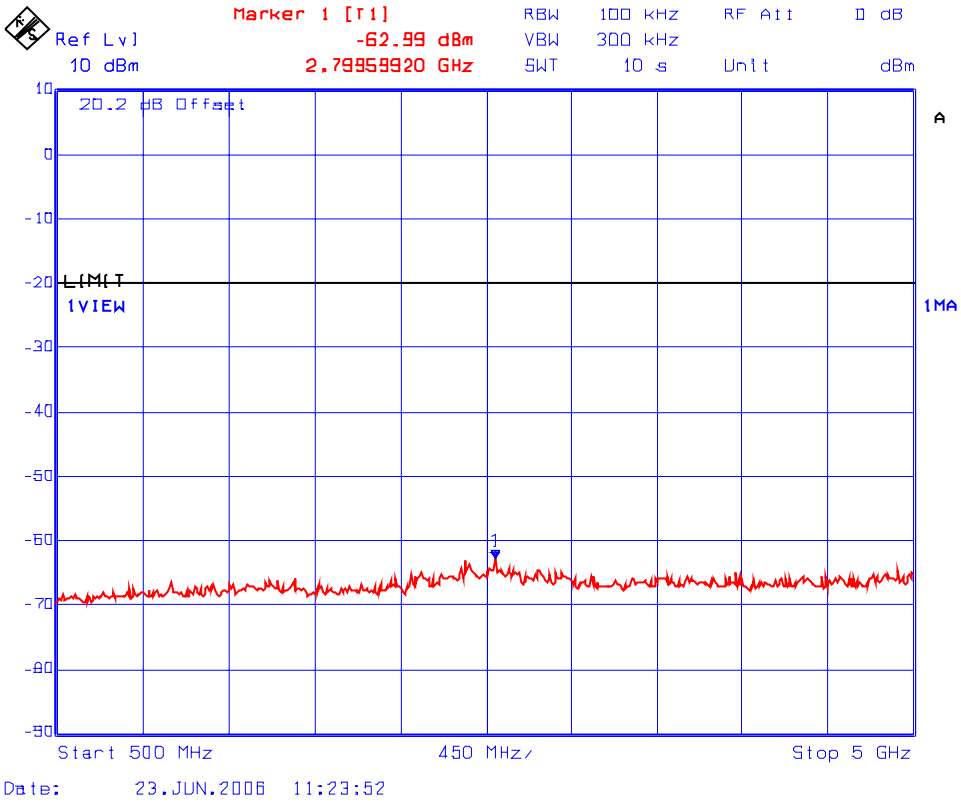


Fundamental Frequency: 418 MHz, 418.025 (2 channels input/output)
Modulation: Unmodulated

**Plot 6.8.5.9** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 418 MHz, Fc + 25 kHz

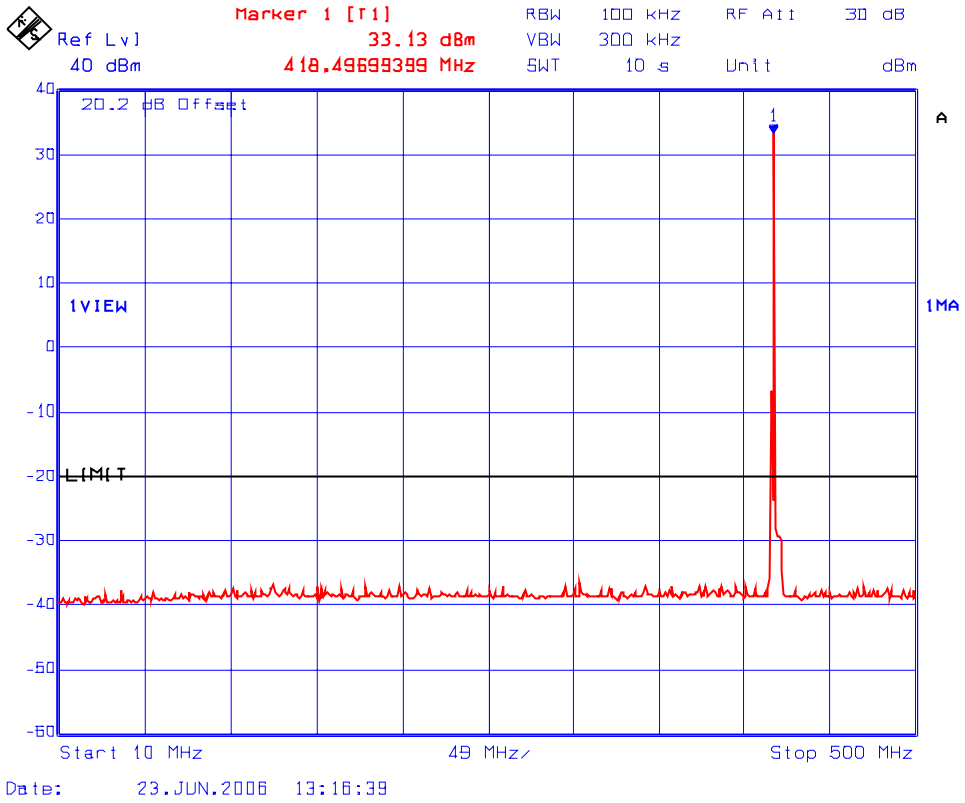


**Plot 6.8.5.10** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 418 MHz, Fc + 25 kHz

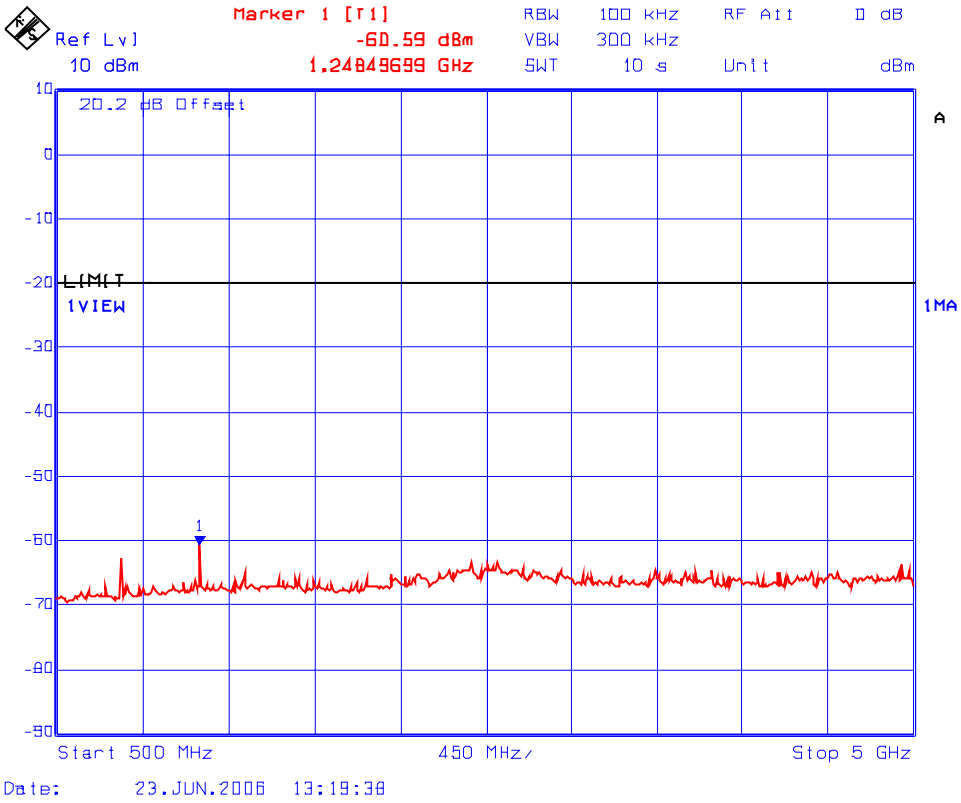


Fundamental Frequency: 418 MHz, 418.025, 418.050 (3 channels input/output)
Modulation: Unmodulated

**Plot 6.8.5.11** Conducted Spurious Emission with 3 RF Signals Input/Output
Fc: 418 MHz, Fc + 25 kHz, Fc + 50 kHz

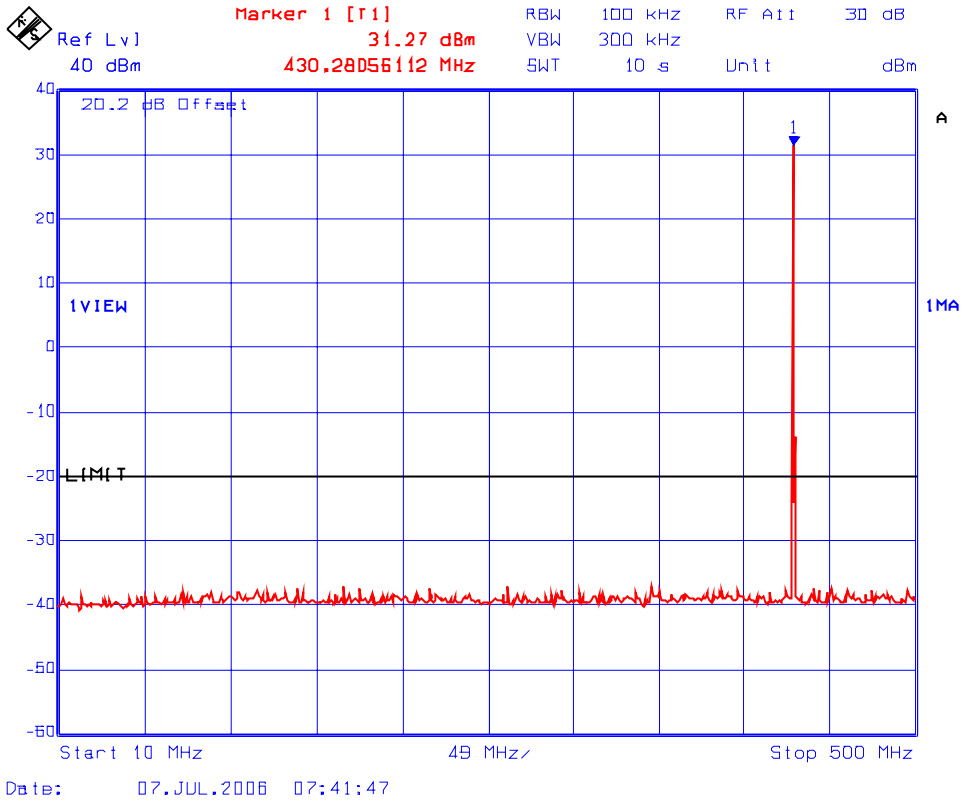


**Plot 6.8.5.12** Conducted Spurious Emission with 3 RF Signals Input/Output
Fc: 418 MHz, Fc + 25 kHz, Fc + 50 kHz

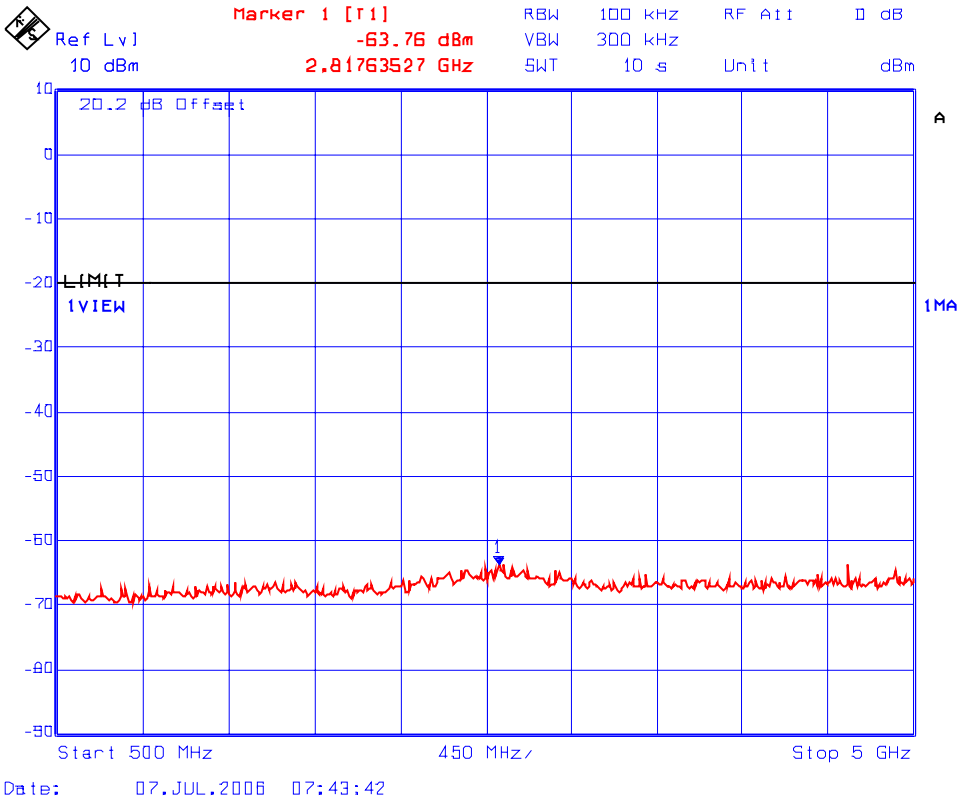


Fundamental Frequency: 430 MHz, 1 RF Signal input/output
Modulation: Unmodulated

**Plot 6.8.5.13** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 430 MHz

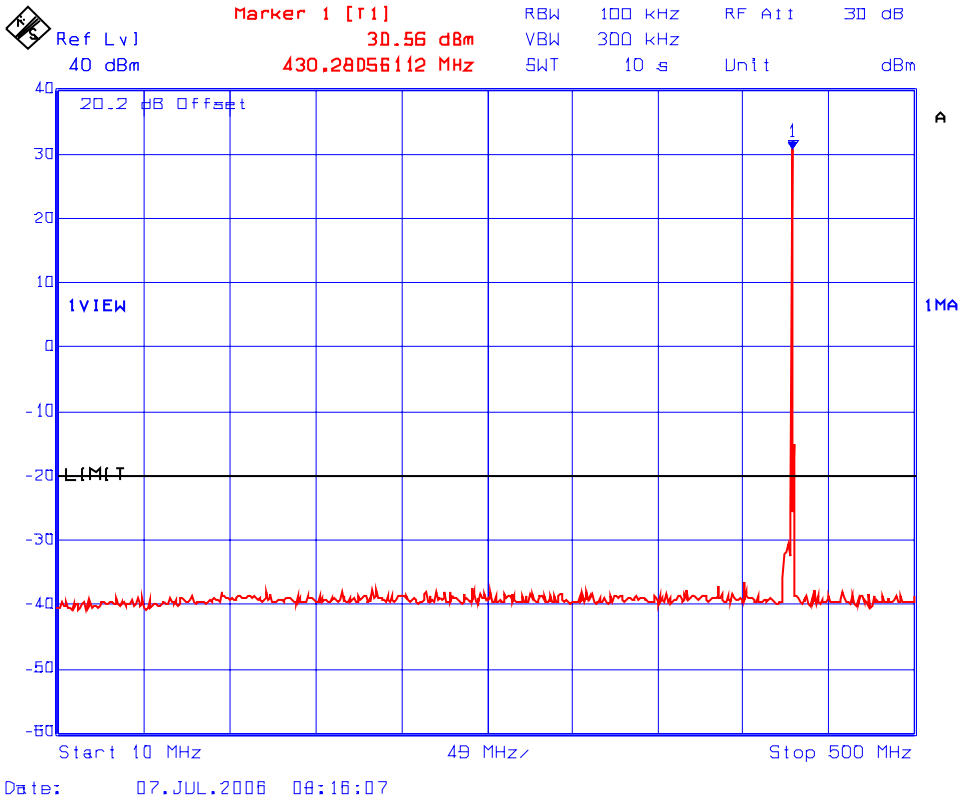


**Plot 6.8.5.14** Conducted Spurious Emission with 1 RF Signal Input/Output
Fc: 430 MHz

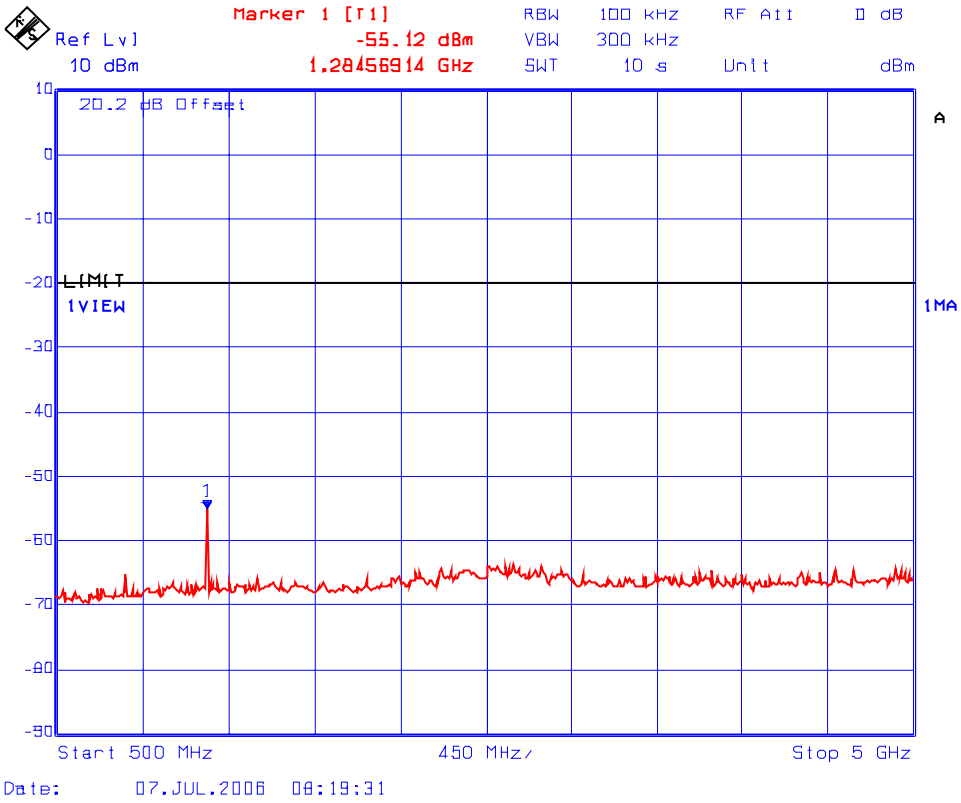


Fundamental Frequency: 430 MHz, 429.975 MHz (2 channels input/output)
Modulation: Unmodulated

**Plot 6.8.5.15** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 430 MHz, Fc - 25 kHz

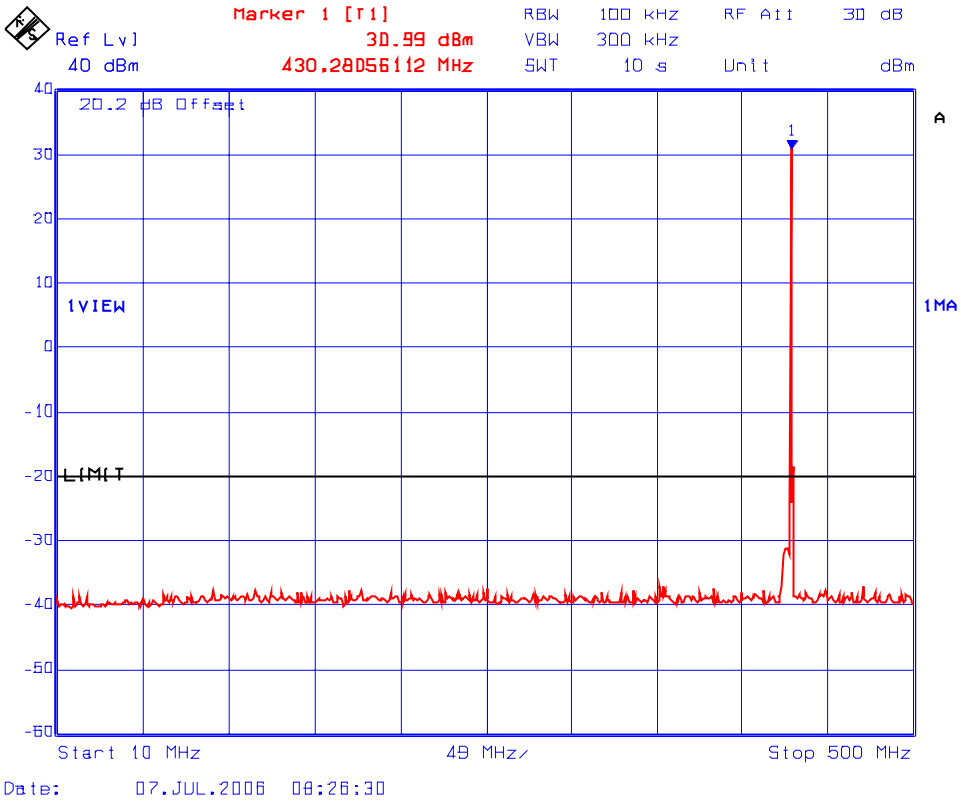


**Plot 6.8.5.16** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 430 MHz, Fc - 25 kHz

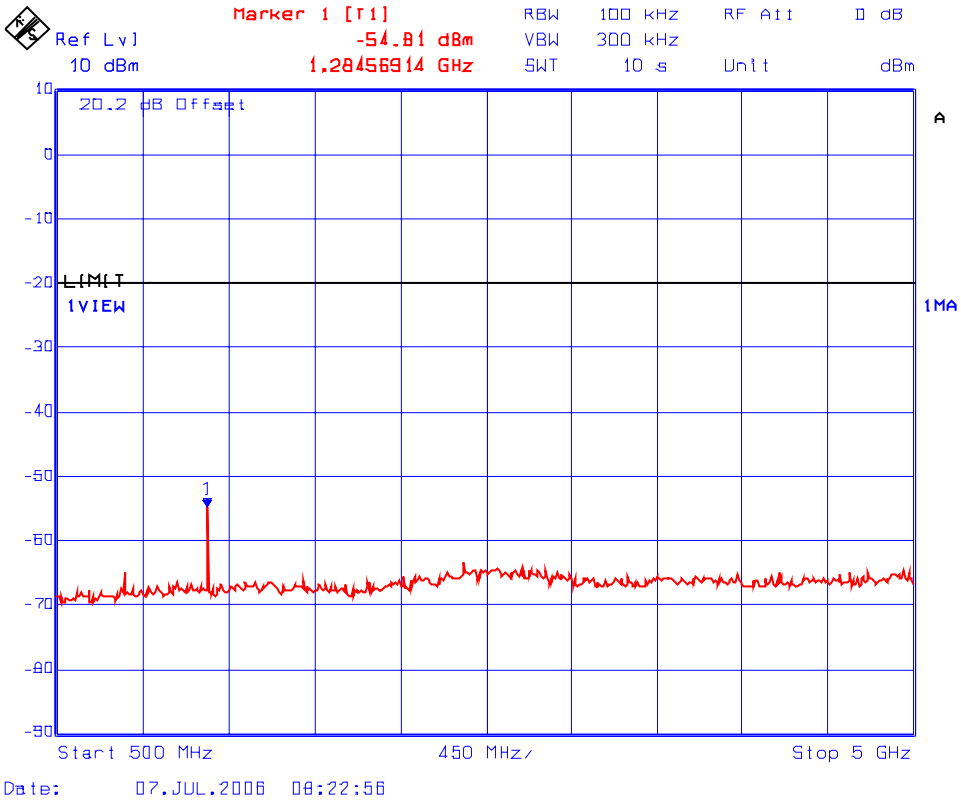


Fundamental Frequency: 430 MHz, 429.975 MHz, 429.95 MHz (3 channels input/output)
Modulation: Unmodulated

**Plot 6.8.5.17** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 430 MHz, Fc - 25 kHz, Fc – 50 kHz



**Plot 6.8.5.18** Conducted Spurious Emission with 2 RF Signals Input/Output
Fc: 430 MHz, Fc - 25 kHz, Fc – 50 kHz



## 6.9. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053 & 90.210]

### 6.9.1. Limits

At least 50+10*log(P in Watts) dBc.

### 6.9.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, Section 8.2 of this report and its value in dBc is calculated as follows:

(1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
(2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest ERP of the carrier = EIRP – 2.15 dB = Pc + G - 2.15 dB = Pc dBm (conducted) + 0 dBi – 2.15 dB
(3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

**ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)**

### 6.9.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz |
| RF Amplifier | Com-Power | PA-102 | | 1 MHz to 1 GHz, 30 dB gain nominal |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 GHz, 30 dB nominal |
| Biconilog Antenna | EMCO | 3142 | 10005 | 30 MHz to 2 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-434 | 30 GHz – 1 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-440 | 30 GHz – 1 GHz |
| Horn Antenna | EMCO | 3155 | 9701-5061 | 1 GHz – 18 GHz |
| Horn Antenna | EMCO | 3155 | 9911-5955 | 1 GHz – 18 GHz |
| RF Signal Generator | Hewlett Packard | HP 83752B | 3610A00457 | 0.01 – 20 GHz |

## 6.9.4. Test Data

**Remarks:**

(1) There was no difference in spurious/harmonic emissions on pre-scans for all different modulations. Therefore, the rf spurious/harmonic emissions in this section would be performed without modulation and it shall represent for all different modulations required.

(2) The RF spurious/harmonic emission characteristics for narrow band and wide band operation are indistinguishable. Therefore, the following radiated emissions were performed at 12.5 kHz channel spacing (narrow band) operation, and the results were compared with the more stringent limit of 50+10*log (P in watts) for the worst case.

### 6.9.4.1. Lowest Frequency (406.1 MHz)

| | |
|---|---|
| **Carrier Frequency(MHz):** | 406.1 |
| **Power(dBm):** | 32.48 |
| **Limit(dBc):** | 52.48 |

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method | | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| | | | | (dBm) | (dBc) | | |
| The emissions were scanned from 30 MHz to 5 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the permissible limits. | | | | | | | |

### 6.9.4.2. Middle Frequency (418 MHz)

| | |
|---|---|
| **Carrier Frequency(MHz):** | 418 |
| **Power(dBm):** | 31.61 |
| **Limit(dBc):** | 51.61 |

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method | | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| | | | | (dBm) | (dBc) | | |
| The emissions were scanned from 30 MHz to 5 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the permissible limits. | | | | | | | |

### 6.9.4.3. Highest Frequency (430 MHz)

| | |
|---|---|
| **Carrier Frequency(MHz):** | 430 |
| **Power(dBm):** | 31.30 |
| **Limit(dBc):** | 51.30 |

| Frequency (MHz) | E-Field dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method | | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| | | | | (dBm) | (dBc) | | |
| The emissions were scanned from 30 MHz to 5 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the permissible limits. | | | | | | | |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

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

## 7.1. 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 20Log(1±$\Gamma_1\Gamma_R$) | U-Shaped | +1.1<br><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