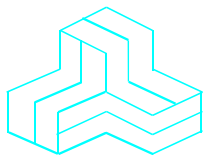


# ENGINEERING TEST REPORT



**UHF Transceiver**  
**Model No.: IC-F43DT/DS**  
**FCC ID: AFJ272105**

*Applicant:*

**ICOM Incorporated**  
1-1-32, Kamiminami, Hirano-ku  
Osaka  
Japan, 547-0003

**Tested in Accordance With**

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

**UltraTech's File No.: ICOM-112F90**

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

Date: July 19, 2005



Report Prepared by: Dan Huynh

Tested by: Wayne Wu

Issued Date: July 19, 2005

Test Dates: July 5-6, 2005

- 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  
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File #: ICOM-115F90  
July 19, 2005

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

## EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type            | Description of Contents                                                                                                                                                                                                                                                                                                                                                                     | Quality Check (OK) |
|-----------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| --        | Test Report             | <ul style="list-style-type: none"><li>Exhibit 1: Submittal check lists</li><li>Exhibit 2: Introduction</li><li>Exhibit 3: Performance Assessment</li><li>Exhibit 4: EUT Operation and Configuration during Tests</li><li>Exhibit 5: Summary of test Results</li><li>Exhibit 6: Measurement Data</li><li>Exhibit 7: Measurement Uncertainty</li><li>Exhibit 8: Measurement Methods</li></ul> | OK                 |
| 1         | Test Setup Photos       | Radiated Emissions Test Setup Photos                                                                                                                                                                                                                                                                                                                                                        | N/A                |
| 2         | External Photos of EUT  | External EUT Photos                                                                                                                                                                                                                                                                                                                                                                         | N/A                |
| 3         | Internal Photos of EUT  | Internal EUT Photos                                                                                                                                                                                                                                                                                                                                                                         | N/A                |
| 4         | Cover Letters           | Cover Letter                                                                                                                                                                                                                                                                                                                                                                                | OK                 |
| 5         | Attestation Statements  | <ul style="list-style-type: none"><li>Letter from the Applicant to Appoint Ultratech to Act as an Agent</li><li>Applicant Part 90 Attestation</li></ul>                                                                                                                                                                                                                                     | OK                 |
| 6         | ID Label/Location Info  | <ul style="list-style-type: none"><li>ID Label</li><li>Location of ID Label</li></ul>                                                                                                                                                                                                                                                                                                       | N/A                |
| 7         | Block Diagrams          | Block Diagram                                                                                                                                                                                                                                                                                                                                                                               | N/A                |
| 8         | Schematic Diagrams      | Schematics                                                                                                                                                                                                                                                                                                                                                                                  | N/A                |
| 9         | Parts List/Tune Up Info | <ul style="list-style-type: none"><li>Parts List</li><li>Adjustment for IC-F43DT/DS</li></ul>                                                                                                                                                                                                                                                                                               | N/A                |
| 10        | Operational Description | Circuit Description                                                                                                                                                                                                                                                                                                                                                                         | N/A                |
| 11        | RF Exposure Info        | See SAR Test Report for Details.                                                                                                                                                                                                                                                                                                                                                            | N/A                |
| 12        | Users Manual            | Instruction Manual                                                                                                                                                                                                                                                                                                                                                                          | N/A                |

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## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

|                         |                                                                                                                                                                                                                        |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Reference:</b>       | FCC Parts 2 and 90                                                                                                                                                                                                     |
| <b>Title:</b>           | Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 90                                                                                                                                           |
| <b>Purpose of Test:</b> | Class II Permissive Change:<br>1) The addition of 25 kHz channel spacing.<br>2) The aggregate of 2 adjacent 6.25 kHz channelization channels to operates under 12.5 kHz channel spacing.                               |
| <b>Test Procedures:</b> | Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA-603 (01-Nov-2002) – Land Mobile FM or PM Communications Equipment Measurement and performance Standards. |

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

None.

### 2.3. NORMATIVE REFERENCES

| Publication                | Year         | Title                                                                                                                                                               |
|----------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC CFR Parts 0-19, 80-End | 2004         | 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 |
| TIA/EIA 603, Edition B     | 01-Nov-2002  | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards                                                                                 |
| TIA-102.CAAA-B             | October 2004 | Digital C4FM/CQPSK Transceiver Measurement Methods.                                                                                                                 |

## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

| APPLICANT              |                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Name:</b>           | ICOM Incorporated                                                                                                                                 |
| <b>Address:</b>        | 1-1-32, Kamiminami, Hirano-ku<br>Osaka<br>Japan, 547-0003                                                                                         |
| <b>Contact Person:</b> | Mr. Takashi Aoki<br>Phone #: +81-66-793-5302<br>Fax #: +81-66-793-0013<br>Email Address: <a href="mailto:export@icom.co.jp">export@icom.co.jp</a> |

| MANUFACTURER           |                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Name:</b>           | ICOM Incorporated                                                                                                                                 |
| <b>Address:</b>        | 1-1-32, Kamiminami, Hirano-ku<br>Osaka<br>Japan, 547-0003                                                                                         |
| <b>Contact Person:</b> | Mr. Takashi Aoki<br>Phone #: +81-66-793-5302<br>Fax #: +81-66-793-0013<br>Email Address: <a href="mailto:export@icom.co.jp">export@icom.co.jp</a> |

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

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

|                                             |                                                                         |
|---------------------------------------------|-------------------------------------------------------------------------|
| <b>Brand Name:</b>                          | ICOM Incorporated                                                       |
| <b>Product Name:</b>                        | UHF Transceiver                                                         |
| <b>Model Name or Number:</b>                | IC-F43DT/DS                                                             |
| <b>Serial Number:</b>                       | 0000001                                                                 |
| <b>Type of Equipment:</b>                   | Licensed Non-Broadcast UHF portable transceiver for voice communication |
| <b>External Power Supply:</b>               | N/A                                                                     |
| <b>Transmitting/Receiving Antenna Type:</b> | Non-integral                                                            |
| <b>Primary User Functions of EUT:</b>       | Voice communication in occupational environment.                        |

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### 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER                     |                                                                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Equipment Type:                 | Portable                                                                                                                             |
| Intended Operating Environment: | Commercial, Industrial or Business                                                                                                   |
| Power Supply Requirement:       | 7.2 VDC nominal                                                                                                                      |
| RF Output Power Rating:         | 4 Watts High and 1 Watt Low                                                                                                          |
| Operating Frequency Range:      | 450-512 MHz                                                                                                                          |
| RF Output Impedance:            | 50 Ohms                                                                                                                              |
| Channel Spacing:                | 25 kHz, 12.5 kHz and 6.25 kHz                                                                                                        |
| Emission Designation*:          | 16K0F3E<br>11K0F3E, 11K0F7E, 11K0F7D<br>4K00F1E, 4K00F1D                                                                             |
| Antenna Connector Type:         | J Type Connector                                                                                                                     |
| Antenna Description:            | Manufacturer: ICOM Inc.<br>Antenna Type: Helical antenna<br>Model Number: FA-57U<br>Operating Frequency: 440-470MHz<br>Gain: -3.0dBi |

\* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

For FM Voice Modulation:

Channel Spacing = 25 KHz, D = 5 KHz max, K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(5)(1) = \underline{16 \text{ KHz}}$

Emission designation: 16K0F3E

Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = \underline{11 \text{ KHz}}$

Emission designation: 11K0F3E

### 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           | Antenna                | 1                         | J Type         | N/A                                |
| 2           | SP/MIC Jack            | 1                         | Plug-in Jack   | N/A                                |

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## 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: | 7.2 VDC Nominal |

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

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

| Transmitter Test Signals                                                                                                                                                 |                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Frequency Band(s):</b>                                                                                                                                                | 450-512 MHz                                                                         |
| <b>Test Frequency(ies):</b><br>(Near lowest, near middle & near highest frequencies in the frequency range of operation.)                                                | 450.05, 485.05 and 511.95 MHz                                                       |
| <b>Transmitter Wanted Output Test Signals:</b><br><br>Transmitter Power (measured maximum output power):<br><br>Normal Test Modulation:<br><br>Modulating signal source: | <br><br>4 Watts High & 1 Watt Low<br><br>FM Voice and Digital (PN9)<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.

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: January 10, 2005.

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

| FCC Section(s)                     | Test Requirements                                        | Applicability Yes/No) |
|------------------------------------|----------------------------------------------------------|-----------------------|
| 90.205 & 2.1046                    | RF Power Output                                          | Yes                   |
| 1.1307, 1.1310,<br>2.1091 & 2.1093 | RF Exposure Limit                                        | See original filing.  |
| 90.213 & 2.1055                    | Frequency Stability                                      | See original filing.  |
| 90.242(b)(8) &<br>2.1047(a)        | Audio Frequency Response                                 | See original filing.  |
| 90.210 & 2.1047(b)                 | Modulation Limiting                                      | See original filing.  |
| 90.210 & 2.1049                    | Emission Limitation & Emission Mask                      | Yes                   |
| 90.210, 2.1057 &<br>2.1051         | Emission Limits - Spurious Emissions at Antenna Terminal | See original filing.  |
| 90.210, 2.1057 &<br>2.1053         | Emission Limits - Field Strength of Spurious Emissions   | See original filing.  |
| 90.214                             | Transient Frequency Behavior                             | See original filing.  |

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

None.

### 5.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

---

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

### **6.1. TEST PROCEDURES**

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

### **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 and CISPR 16-1-1.

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

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

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

### 6.5.1. Limits

Please refer to FCC 47 CFR 90.205 for specification details.

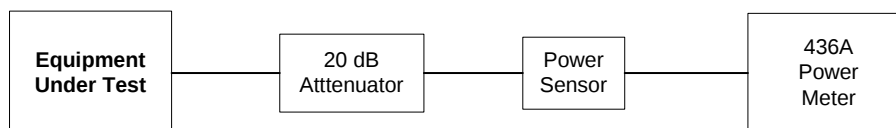
### 6.5.2. Method of Measurements

Refer to Exhibit 8, Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

### 6.5.3. Test Equipment List

| Test Instruments | Manufacturer    | Model No. | Serial No. | Frequency Range                      |
|------------------|-----------------|-----------|------------|--------------------------------------|
| Attenuator       | Weinschel Corp  | 23-20-34  | BH7876     | DC – 18 GHz                          |
| Power Meter      | Hewlett Packard | 436A      | 2016A07747 | 100 kHz – 26.5 GHz, sensor dependent |
| Power Sensor     | Hewlett Packard | 8481A     | 2552A51276 | 10 MHz – 18 GHz                      |

### 6.5.4. Test Arrangement



### 6.5.5. Test Data

| Fundamental Frequency (MHz) | Measured (Average) Power (dBm) | Power Rating (dBm) |
|-----------------------------|--------------------------------|--------------------|
| High Power Level, 4 Watts   |                                |                    |
| 450.05                      | 36.16                          | 36                 |
| 485.05                      | 35.52                          | 36                 |
| 511.95                      | 35.46                          | 36                 |
| Low Power Level, 1 Watt     |                                |                    |
| 450.05                      | 29.96                          | 30                 |
| 485.05                      | 30.14                          | 30                 |
| 511.95                      | 29.81                          | 30                 |

## 6.6. OCCUPIED BANDWIDTH & EMISSION MASK [§§ 2.1049, 90.209 & 90.210]

### 6.6.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

| Frequency Range (MHz) | Maximum Authorized BW (KHz) | Channel Spacing (KHz) | Recommended Frequency Deviation (KHz) | FCC Applicable Mask |
|-----------------------|-----------------------------|-----------------------|---------------------------------------|---------------------|
| 421-512               | 20                          | 25                    | 5                                     | Mask B              |
| 421-512               | 11.25                       | 12.5                  | 2.5                                   | Mask D              |

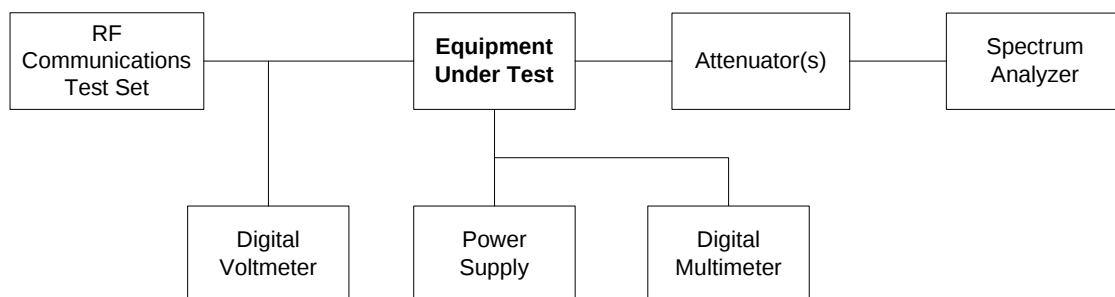
### 6.6.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this report for measurement details and TIA-102.CAAA-B.

### 6.6.3. Test Equipment List

| Test Instruments           | Manufacturer    | Model No. | Serial No. | Frequency Range       |
|----------------------------|-----------------|-----------|------------|-----------------------|
| RF Communications Test Set | Hewlett Packard | 8920B     | US39064699 | RF 30M-1G AF DC-25KHz |
| Digital Voltmeter          | Hewlett-Packard | 3456A     | 2015A04523 | DC-250 KHz            |
| Spectrum Analyzer          | Advantest       | R3271     | 15050203   | 100Hz-26.5GHz         |
| Attenuator                 | Weinschel Corp  | 23-20-34  | BH7876     | DC-18 GHz             |
| Digital Multimeter         | Tenma           | 72-6202   | 2080027    | DC-100 kHz            |
| Power Supply               | Tenma           | 72-6153   | --         | DC 0-20 V, 0-10A.     |

### 6.6.4. Test Arrangement



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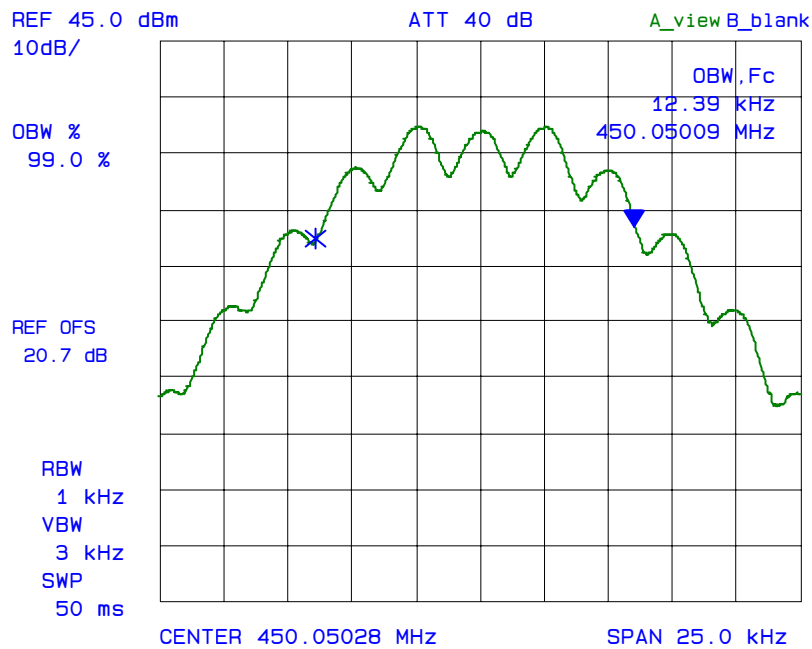
## 6.6.5. Test Data

### 6.6.5.1. 99% Occupied Bandwidth

| Frequency (MHz) | Channel Spacing (kHz) | Modulation                       | *Measured 99% OBW at Maximum Freq. Deviation (kHz) | Maximum Authorized Bandwidth (kHz) |
|-----------------|-----------------------|----------------------------------|----------------------------------------------------|------------------------------------|
| 405.05          | 25                    | FM with 2.5 kHz sine wave signal | 12.39                                              | 20                                 |
| 485.05          | 25                    | FM with 2.5 kHz sine wave signal | 12.25                                              | 20                                 |
| 511.95          | 25                    | FM with 2.5 kHz sine wave signal | 12.18                                              | 20                                 |
|                 |                       |                                  |                                                    |                                    |
| 405.05          | 12.5                  | Digital – PN9                    | 11.01                                              | 11.25                              |
| 485.05          | 12.5                  | Digital – PN9                    | 10.93                                              | 11.25                              |
| 511.95          | 12.5                  | Digital – PN9                    | 10.84                                              | 11.25                              |

\*Refer to the following test data plots (1 through 6) for details.

Plot # 1:  
Occupied Bandwidth  
Carrier Frequency: 405.05 MHz  
Channel Spacing: 25 kHz  
Power: 4 W  
Modulation: FM with 2.5 kHz sine wave signal



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## Plot # 2:

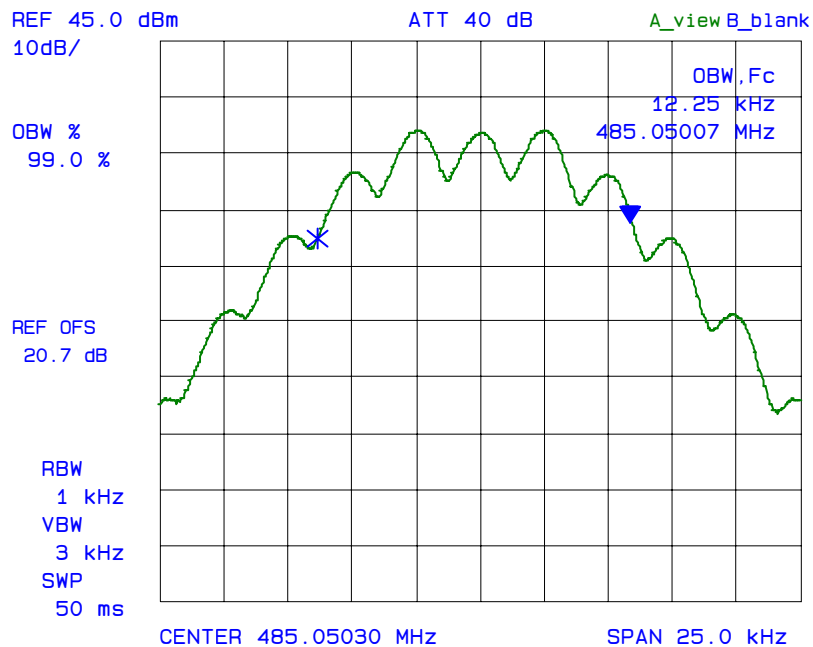
Occupied Bandwidth

Carrier Frequency: 485.05 MHz

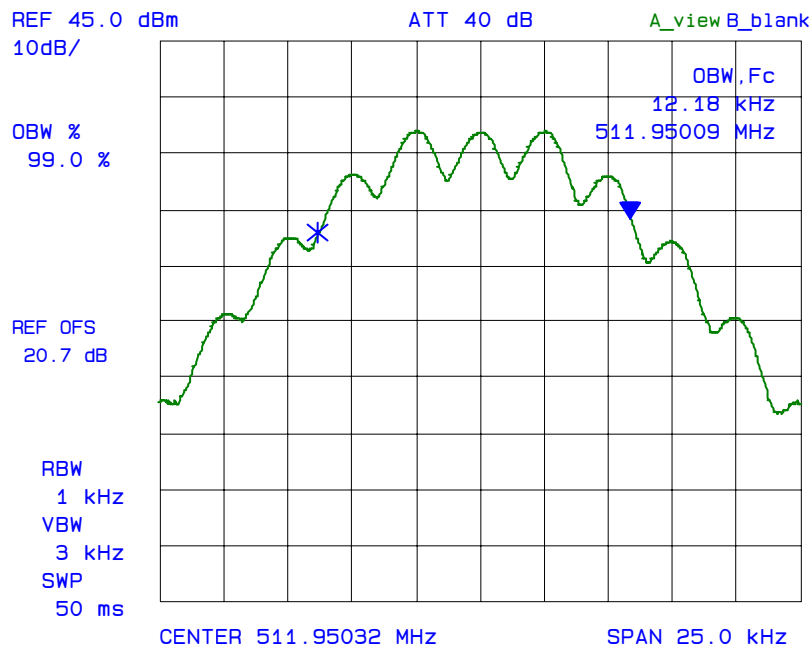
Channel Spacing: 25 kHz

Power: 4 W

Modulation: FM with 2.5 kHz sine wave signal



Plot # 3:  
Occupied Bandwidth  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 25 kHz  
Power: 4 W  
Modulation: FM with 2.5 kHz sine wave signal



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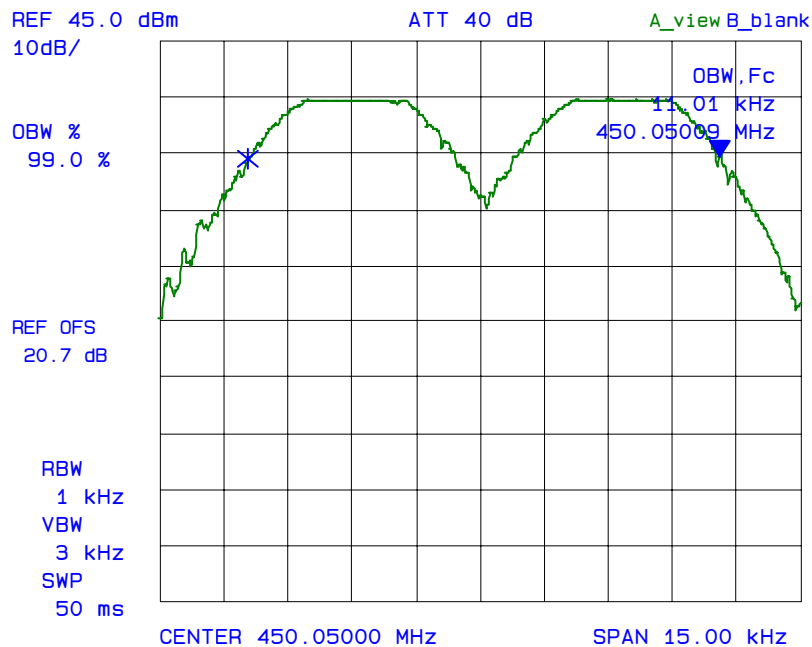
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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Plot # 4:  
Occupied Bandwidth  
Carrier Frequency: 405.05 MHz  
Channel Spacing: 12.5 kHz  
Power: 4 W  
Modulation: Digital – PN9



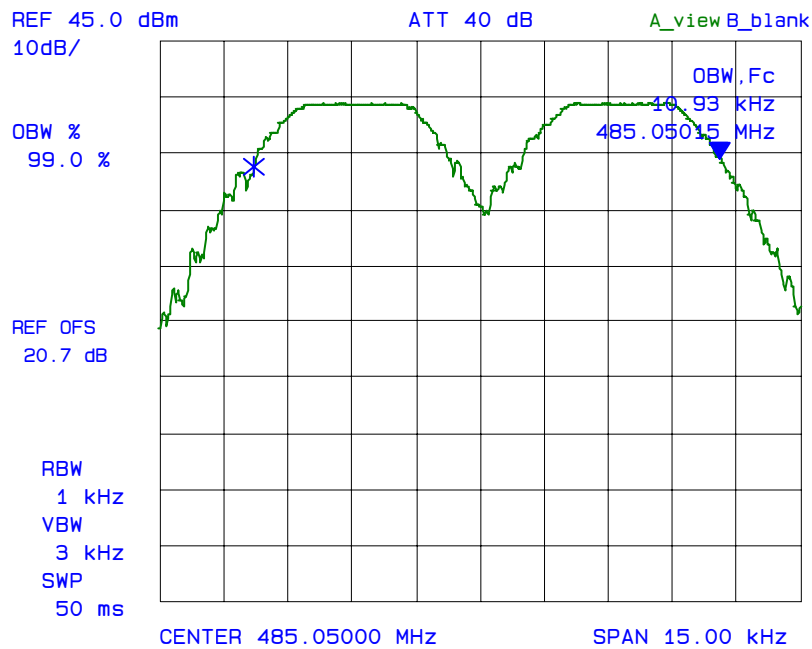
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Plot # 5:  
Occupied Bandwidth  
Carrier Frequency: 485.05 MHz  
Channel Spacing: 12.5 kHz  
Power: 4 W  
Modulation: Digital – PN9



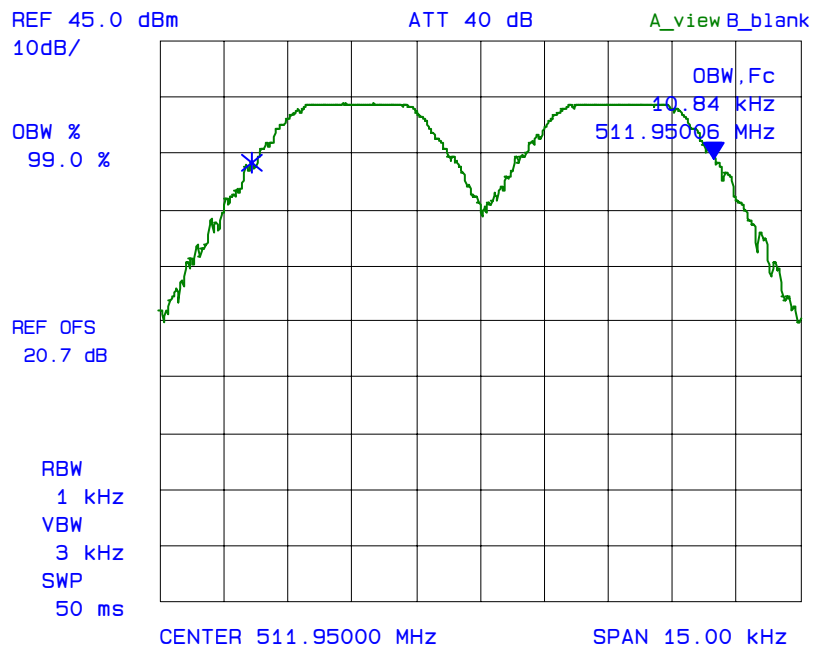
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Plot # 6:  
Occupied Bandwidth  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 12.5 kHz  
Power: 4 W  
Modulation: Digital – PN9



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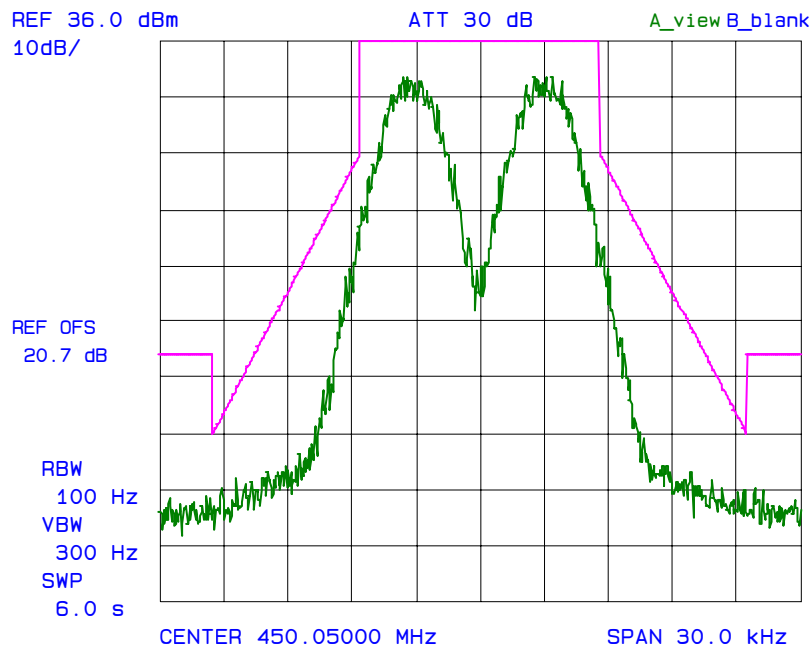
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### 6.6.5.2. Emission Masks

Conform. See the following test data plots (7 - 18) for details.

Plot # 7:  
Emission Mask D  
Carrier Frequency: 450.05 MHz  
Channel Spacing: 12.5 kHz  
Power: 4 W  
Modulation: Digital – PN9



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Plot # 8:

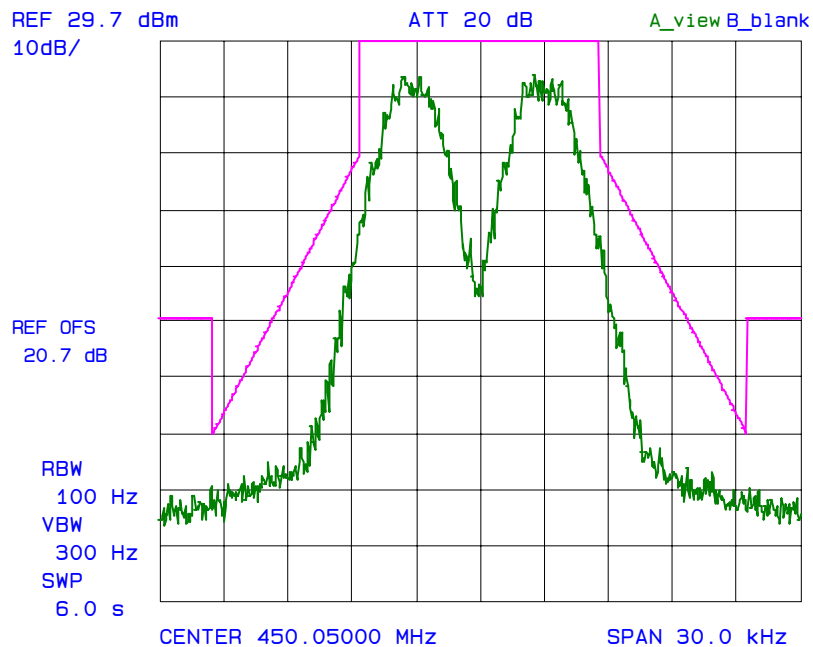
Emission Mask D

Carrier Frequency: 450.05 MHz

Channel Spacing: 12.5 kHz

Power: 1 W

Modulation: Digital – PN9

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Plot # 9:

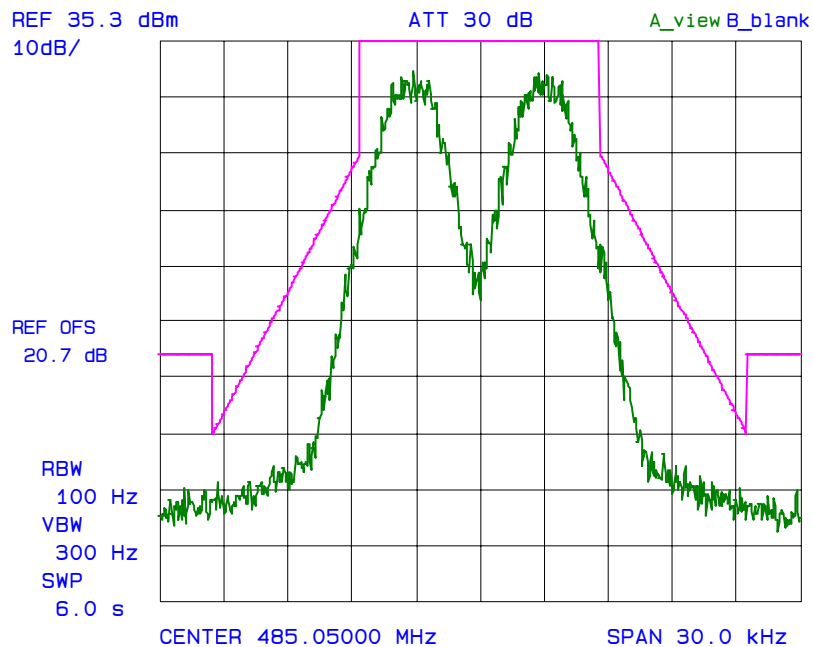
Emission Mask D

Carrier Frequency: 485.05 MHz

Channel Spacing: 12.5 kHz

Power: 4 W

Modulation: Digital – PN9

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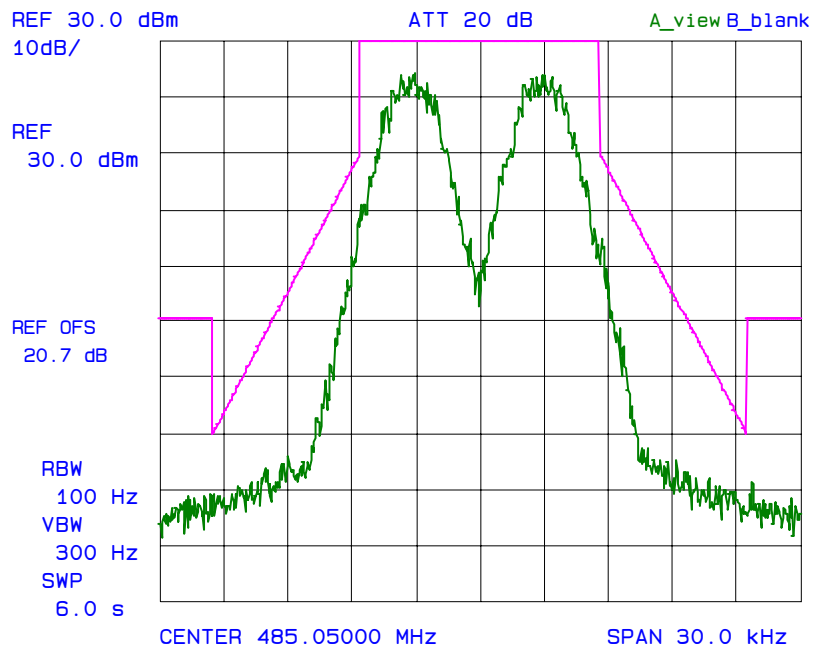
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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Plot # 10:  
Emission Mask D  
Carrier Frequency: 485.05 MHz  
Channel Spacing: 12.5 kHz  
Power: 1 W  
Modulation: Digital – PN9



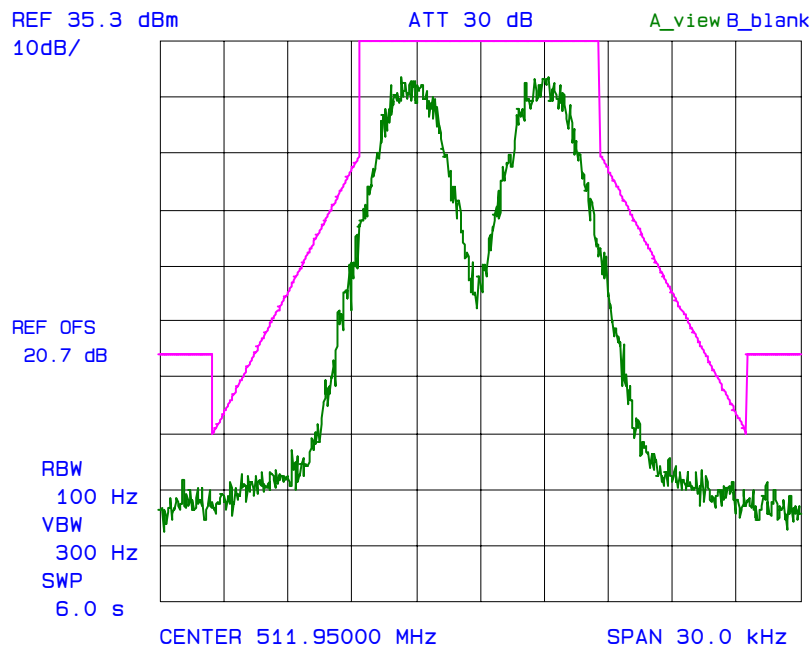
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Plot # 11:  
Emission Mask D  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 12.5 kHz  
Power: 4 W  
Modulation: Digital – PN9



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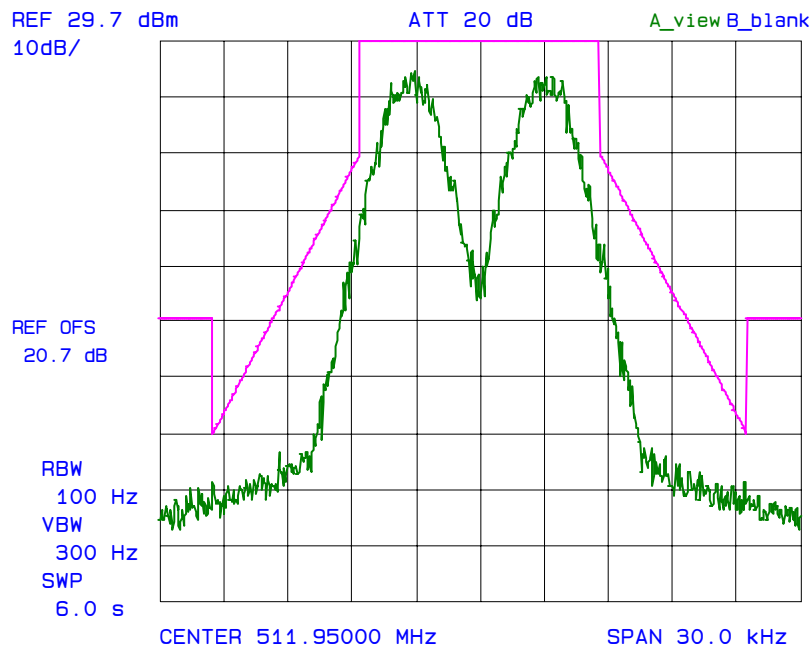
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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Plot # 12:  
Emission Mask D  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 12.5 kHz  
Power: 1 W  
Modulation: Digital – PN9



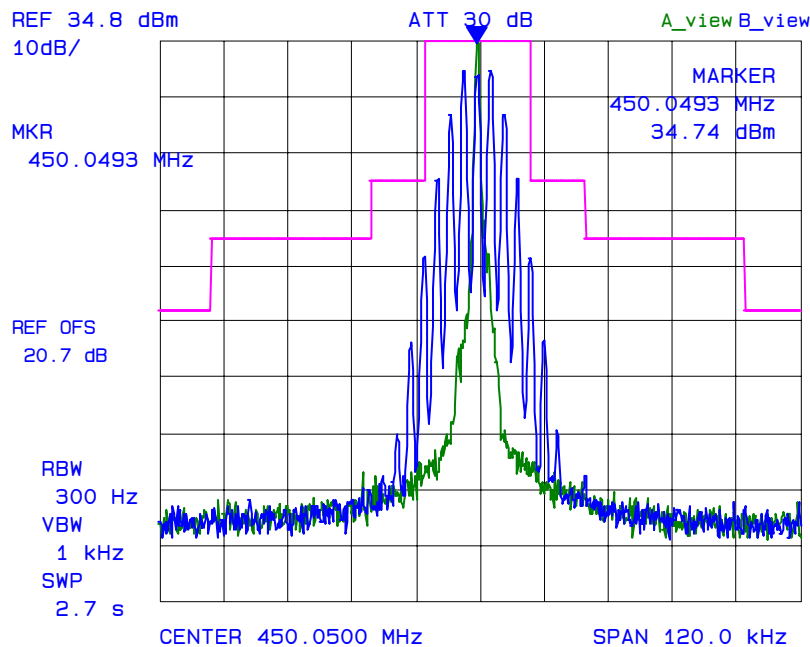
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Plot # 13:  
Emission Mask B  
Carrier Frequency: 450.05 MHz  
Channel Spacing: 25 kHz  
Power: 4 W  
Modulation: FM with 2.5 kHz sine wave signal



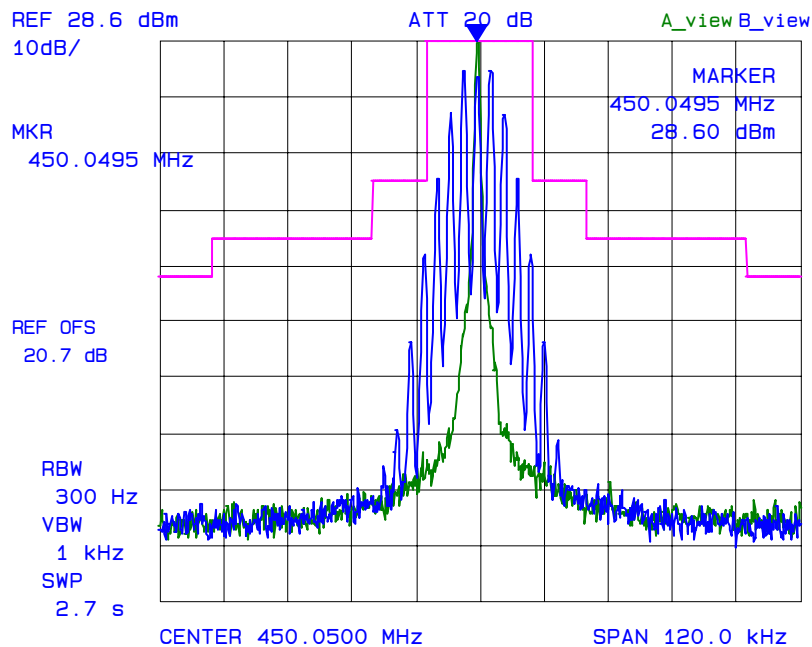
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Plot # 14:  
Emission Mask B  
Carrier Frequency: 450.05 MHz  
Channel Spacing: 25 kHz  
Power: 1 W  
Modulation: FM with 2.5 kHz sine wave signal



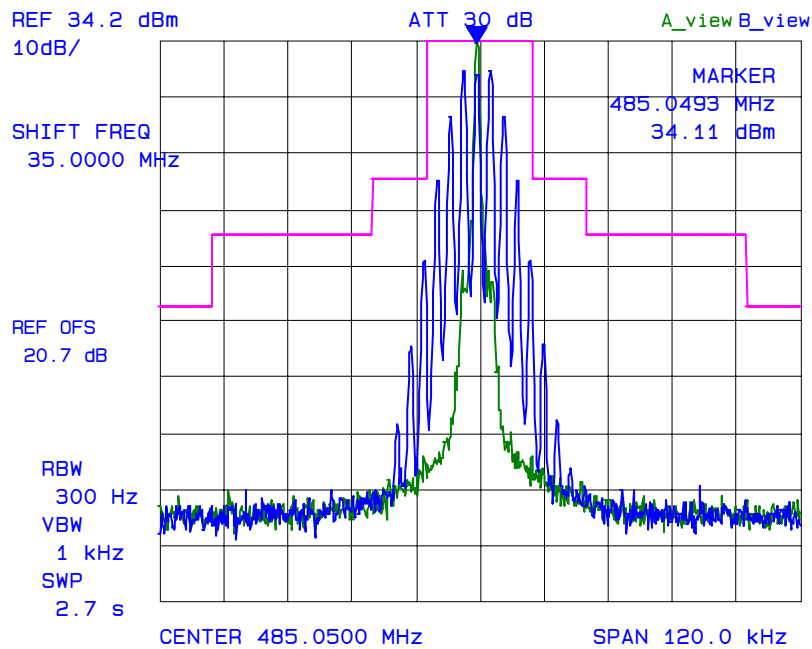
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Plot # 15:  
Emission Mask B  
Carrier Frequency: 485.05 MHz  
Channel Spacing: 25 kHz  
Power: 4 W  
Modulation: FM with 2.5 kHz sine wave signal



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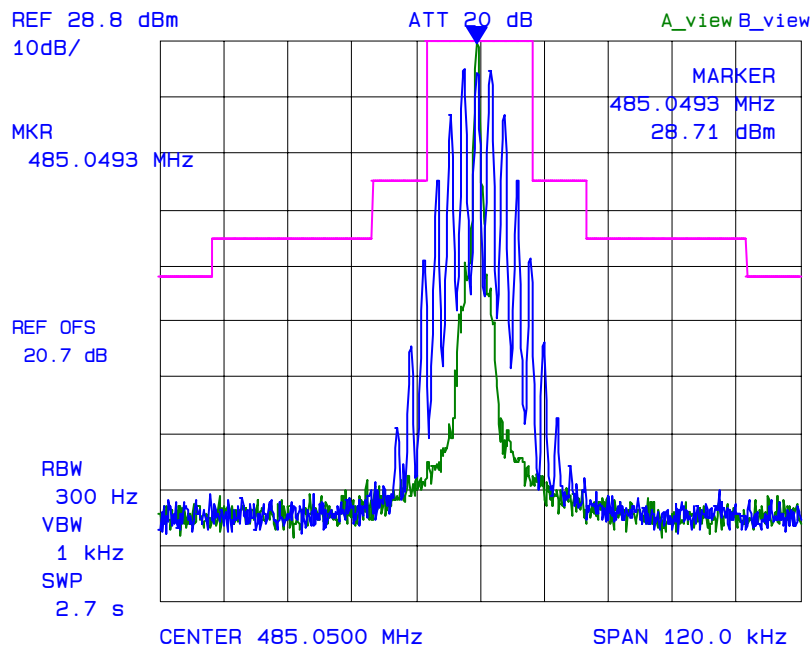
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Plot # 16:  
Emission Mask B  
Carrier Frequency: 485.05 MHz  
Channel Spacing: 25 kHz  
Power: 1 W  
Modulation: FM with 2.5 kHz sine wave signal



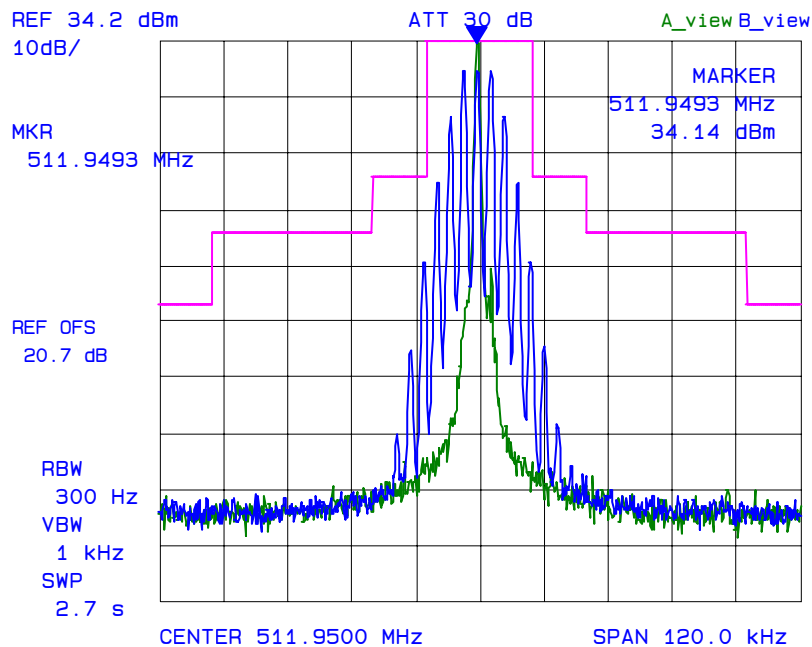
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Plot # 17:  
Emission Mask B  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 25 kHz  
Power: 4 W  
Modulation: FM with 2.5 kHz sine wave signal



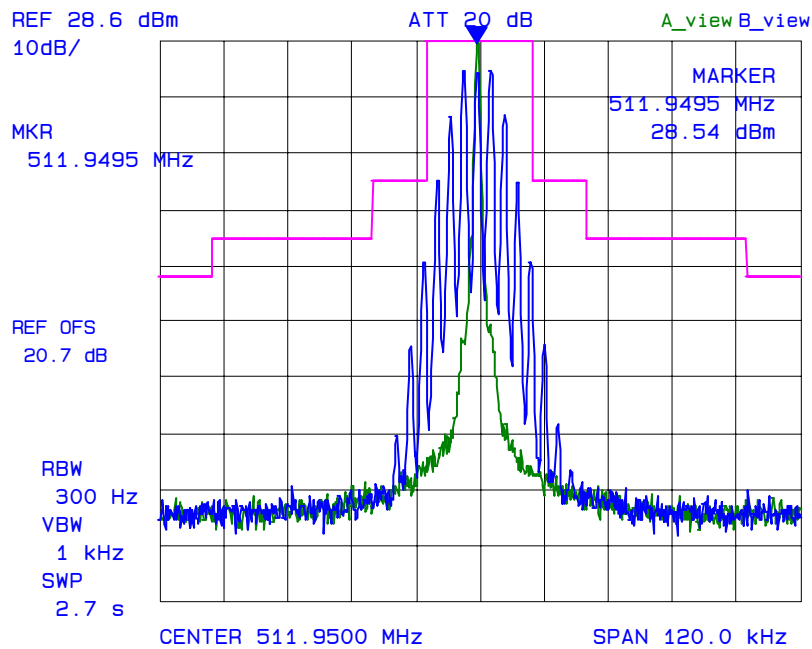
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Plot # 18:  
Emission Mask B  
Carrier Frequency: 511.95 MHz  
Channel Spacing: 25 kHz  
Power: 1 W  
Modulation: FM with 2.5 kHz sine wave signal



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

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

## EXHIBIT 8. MEASUREMENT METHODS

### 8.1. CONDUCTED POWER MEASUREMENTS

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

Test procedure shall be as follows:

**Step 1:** Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver 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,  $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$  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.

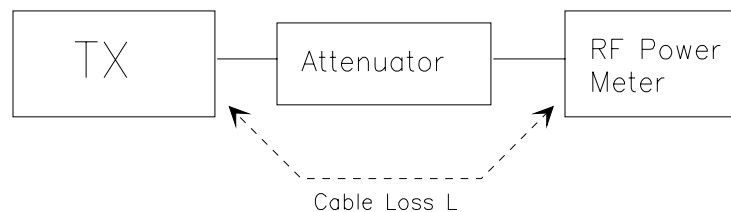
**Step 2:** Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average 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 "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{EIRP} = A + G + 10\log(1/x)$$

{X = 1 for continuous transmission =>  $10\log(1/x) = 0 \text{ dB}$ }

**Figure 1.**



## 8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

### 8.2.1. MAXIMIZING RF EMISSION LEVEL (E-FIELD)

- (a) The measurements were performed with full rf output power and modulation.
- (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 BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
- (e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor  
 $E \text{ (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Total Correction Factor (dB/m)}$

- (f) Set the EMI Receiver and #2 as follows:

Center Frequency: test frequency  
Resolution BW: 100 kHz  
Video BW: same  
Detector Mode: positive  
Average: off  
Span: 3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through  $360^\circ$  about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies.

### 8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

- (a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency: equal to the signal source  
Resolution BW: 10 kHz  
Video BW: same  
Detector Mode: positive  
Average: off  
Span: 3 x the signal bandwidth

- (b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor  
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.  
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
  - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
  - ◆ HORN antenna for frequency above 1 GHz }.(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.  
(f) Use one of the following antenna as a receiving antenna:
  - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
  - ◆ HORN antenna for frequency above 1 GHz }.(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.  
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.  
(i) Tune the EMI Receivers to the test frequency.  
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.  
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.  
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.  
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.  
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$EIRP = P + G1 = P3 + L2 - L1 + A + G1$$

$$ERP = EIRP - 2.15 \text{ dB}$$

$$\text{Total Correction factor in EMI Receiver \# 2} = L2 - L1 + G1$$

Where: P: Actual RF Power fed into the substitution antenna port after corrected.  
P1: Power output from the signal generator  
P2: Power measured at attenuator A input  
P3: Power reading on the Average Power Meter  
EIRP: EIRP after correction  
ERP: ERP after correction

- (o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)  
(p) Repeat step (d) to (o) for different test frequency  
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.  
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

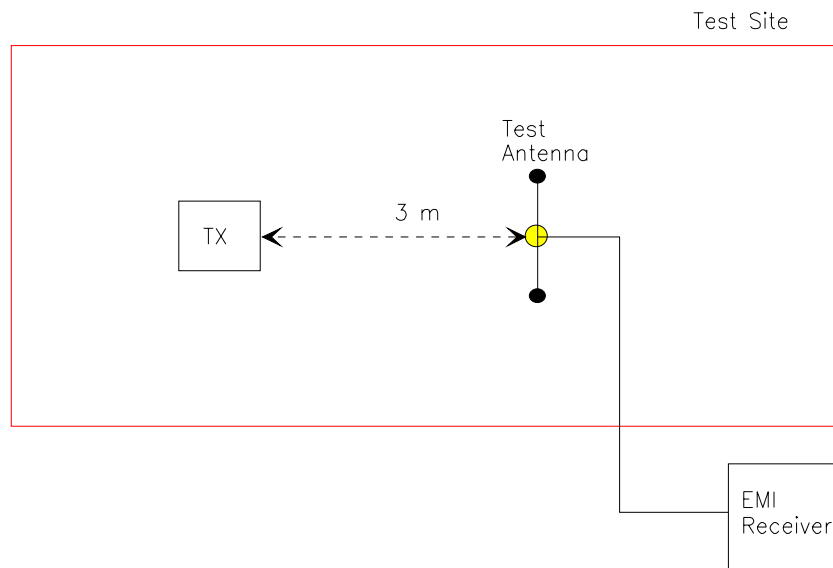
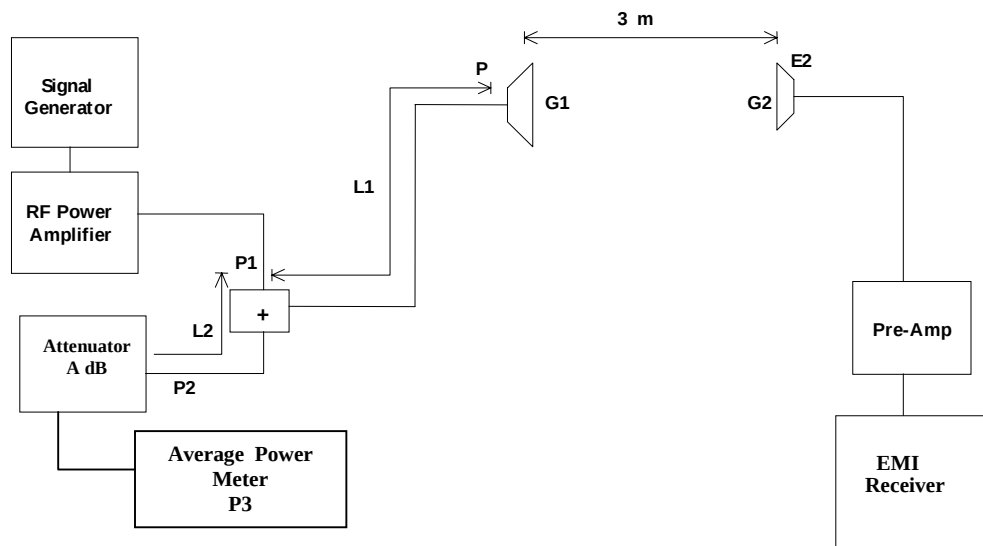


Figure 3



### 8.3. EMISSION MASK

**Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i)**:- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.:  $\pm 2.5$  KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

**Digital Modulation Through a Data Input Port @ 2.1049(h)**:- Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

- (1) For 25 kHz Channel Spacing: RBW = 300 Hz
- (2) For 12.5 kHz or 6.25 kHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.