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Jan. 28, 2002

Icom America, Inc.  
2380 116<sup>th</sup> Ave. N.E.  
Bellevue, Washington 98004  
USA

Attn.: Mr. Masaaki Takahashi

Subject: Certification Testing in Accordance with FCC 47 CFR, Parts 2 & 90 - Licensed Non-Broadcast Mobile Radio Transceivers for Occupational Use Operating in the Frequency Band 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings).

Product: Mobile VHF FM Transceiver  
Model: IC-F520  
FCC ID: AFJIC-F520

Dear Mr. Takahashi,

The product sample has been tested in accordance with **FCC 47 CFR, Parts 2 and 90 - Licensed Non-Broadcast Mobile Radio Transceivers for Occupational Use Operating in the Frequency Band 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings)**, and the results and observation were recorded in the engineering report, Our File No.: ICOM35-FTX

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

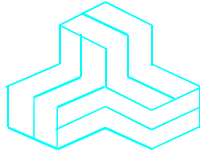
Yours truly,



Tri Minh Luu, P.Eng  
Vice President - Engineering

Encl.

# ENGINEERING TEST REPORT



**Mobile VHF FM Transceiver**  
**Model No.: IC-F520**  
**FCC ID: AFJIC-F520**

*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 & 90**  
**Licensed Non-Broadcast Mobile Radio Transceivers for Occupational Use**  
**Operating in the Frequency Band 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings)**

**UltraTech's File No.: ICOM35-FTX**

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

Date: Jan. 28, 2002



Report Prepared by: Tri Luu

Issued Date: Jan. 28, 2002

Tested by: Hung Trinh, RFI/EMI Technician

Test Dates: Jan. 23-28, 2001

*The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*

## UltraTech

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## 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 Data Plots         | <ul style="list-style-type: none"> <li>Occupied Bandwidth, Plots # 1 to 6</li> <li>Emission Mask D, Plots # 7 to 9</li> <li>Emission Mask B, Plot # 9 to 12</li> <li>Spurious Emissions at Antenna Terminals, Plots # 13 to 24</li> <li>Transient Frequency Behavior, Plots # 25 to 32</li> </ul>                                                                                                    | OK<br>OK<br>OK<br>OK<br>OK |
| 2         | Test Setup Photos       | Radiated Emissions Test Setup Photos, Photo # 1 to 2                                                                                                                                                                                                                                                                                                                                                 | OK                         |
| 3         | External Photos of EUT  | External EUT Photos                                                                                                                                                                                                                                                                                                                                                                                  | OK                         |
| 4         | Internal Photos of EUT  | Internal EUT Photos                                                                                                                                                                                                                                                                                                                                                                                  | OK                         |
| 5         | Cover Letters           | Letter from Ultratech for Certification Request                                                                                                                                                                                                                                                                                                                                                      | OK                         |
| 6         | Attestation Statements  | <ul style="list-style-type: none"> <li>Letter from the Applicant to appoint Ultratech to act as an agent</li> <li>Letter from the Applicant to request for Confidentiality Filing</li> <li>Confirmation to meet the FCC Rules, Parts 90.203(e) and (g)</li> <li>Blocked Frequency</li> </ul>                                                                                                         | OK                         |
| 7         | ID Label/Location Info  | ID Label<br>Location of ID Label                                                                                                                                                                                                                                                                                                                                                                     | OK                         |
| 8         | Block Diagram           | Block Diagram                                                                                                                                                                                                                                                                                                                                                                                        | OK                         |
| 9         | Schematic Diagrams      | <ul style="list-style-type: none"> <li>Schematic Diagrams</li> </ul>                                                                                                                                                                                                                                                                                                                                 | OK                         |
| 10        | Parts List/Tune Up Info | <ul style="list-style-type: none"> <li>Parts List</li> </ul>                                                                                                                                                                                                                                                                                                                                         | OK                         |
| 11        | Operational Description | RF Exposure Info                                                                                                                                                                                                                                                                                                                                                                                     | OK                         |
| 12        | RF Exposure Info        | Not applicable                                                                                                                                                                                                                                                                                                                                                                                       | OK                         |
| 13        | Users Manual            | Icom Instruction Manual                                                                                                                                                                                                                                                                                                                                                                              | OK                         |

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## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

|                         |                                                                                                                                                                                                                                                                                                              |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Reference:</b>       | FCC Parts 2 and 90                                                                                                                                                                                                                                                                                           |
| <b>Title:</b>           | Telecommunication – 47 Code of Federal Regulations (CFR), Parts 2 and 90                                                                                                                                                                                                                                     |
| <b>Purpose of Test:</b> | To gain FCC Certification Authorization for Radio Operating in the Frequency Band 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings).                                                                                                                                                                        |
| <b>Test Procedures:</b> | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |

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

None

### 2.3. NORMATIVE REFERENCES

| Publication                 | Year         | Title                                                                                                                                                               |
|-----------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC CFR Parts 0-19 & 80-End | 2000         | Code of Federal Regulations – Telecommunication                                                                                                                     |
| ANSI C63.4                  | 1992         | 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         | 1997<br>1998 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment                                                         |
| CISPR 16-1                  |              | Specification for Radio Disturbance and Immunity measuring apparatus and methods                                                                                    |

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## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

| APPLICANT              |                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Name:</b>           | Icom Incorporated                                                                                                                                 |
| <b>Address:</b>        | 1-1-32, Kamiminami<br>Hirano-ku, 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<br>Hirano-ku, 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>                        | Mobile VHF FM Transceiver                                                            |
| <b>Model Name or Number:</b>                | IC-F520                                                                              |
| <b>Serial Number:</b>                       | Pre-production sample                                                                |
| <b>Type of Equipment:</b>                   | Licensed Non-Broadcast Mobile Radio<br>Communication Equipment for Occupational Use. |
| <b>External Power Supply:</b>               | N/A                                                                                  |
| <b>Transmitting/Receiving Antenna Type:</b> | Non-Integral. The antenna will be mounted outside of<br>the vehicle.                 |
| <b>Accessory</b>                            | ICOM Condenser Microphone, Model HM-100N                                             |

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### 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER                               |                                                           |
|-------------------------------------------|-----------------------------------------------------------|
| Equipment Type:                           | Mobile                                                    |
| Intended Operating Environment:           | [ x ] Commercial<br>[ x ] Light Industry & Heavy Industry |
| Power Supply Requirement:                 | 13.6 Vdc, 5.1 A                                           |
| Nominal RF Output Conducted Power Rating: | 25.0 Watts hi & 2.5 Watts lo                              |
| Operating Frequency Range:                | 136-174MHz                                                |
| RF Output Impedance:                      | 50 Ohms                                                   |
| Channel Spacing:                          | 12.5 kHz and 25 kHz                                       |
| Frequency Tolerance                       | 2.5ppm                                                    |
| Emission Designation*:                    | 11K0F3E and 16K0F3E                                       |
| Antenna Connector Type:                   | N Female Connector                                        |

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

For FM Voice Modulation:

Channel Spacing = 12.5 kHz, D = 2.5 kHz max. allowed, K = 1, M = 3 kHz

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

Emission Designation: 11K0F3E

Channel Spacing = 25 kHz, D = 5 kHz max. allowed, K = 1, M = 3 kHz

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

Emission Designation: 16K0F3E

### 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 Connector      | 1                         | N Female Connector       | Shielded Coaxial                   |
| 2           | SP/MIC                 | 1                         | Speaker /Microphone Jack | Shielded                           |

#### **NOTE:**

*Ports of the EUT which in normal operation were connected to ancillary equipment through interconnecting cables via a representative interconnecting cable to simulate the input/output characteristics. RF input/output was correctly terminated to the 50 Ohms RF Load.*

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## EXHIBIT 4. EUT OPERATION 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: | 13.6 Vdc, 5.1 A |

### 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>    | None                                                                                                                     |
| <b>Special Hardware Used:</b>    | None                                                                                                                     |
| <b>Transmitter Test Antenna:</b> | The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load.                                     |

| Transmitter Test Signals                           |                                                                                                            |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Frequency Band(s):</b>                          | Near lowest, near middle & near highest frequencies of each frequency band(s) that the transmitter covers: |
| ▪ 136-174 MHz                                      | • 136.10, 155.10 and 173.90 MHz                                                                            |
| <b>Transmitter Wanted Output Test Signals:</b>     |                                                                                                            |
| ▪ RF Power Output (measured maximum output power): | 26.3 Watts hi & 2.7 Watts lo (measured at antenna terminal)                                                |
| ▪ Normal Test Modulation:                          | FM modulation with 2.5 kHz sine wave signal.                                                               |
| ▪ Modulating Signal Source:                        | External                                                                                                   |

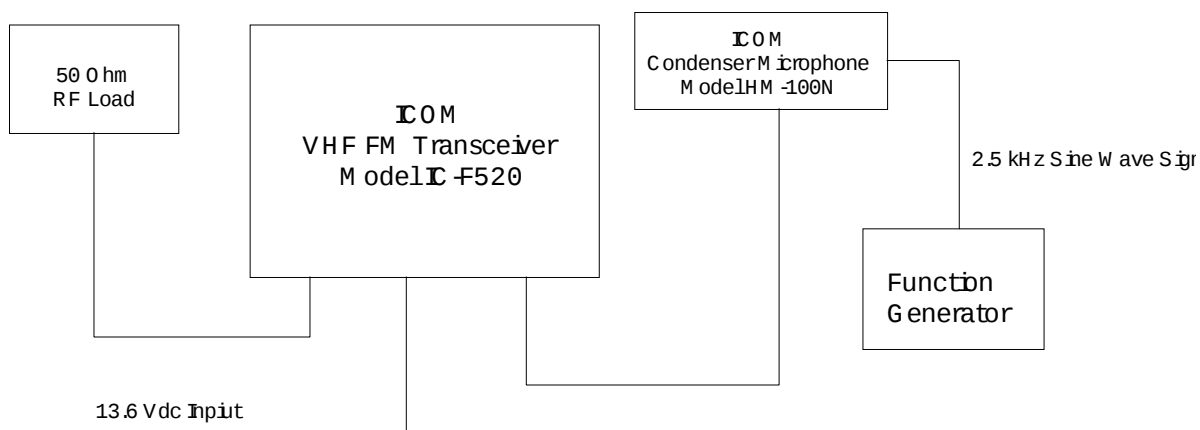
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### 4.3. TEST SAMPLE SETUP



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## 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 site 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: August 8, 2001.

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

| FCC Paragraph                   | Test Requirements                                        | Applicability (Yes/No) |
|---------------------------------|----------------------------------------------------------|------------------------|
| 90.205 & 2.1046                 | RF Power Output                                          | Yes                    |
| 1.1307, 1.1310, 2.1091 & 2.1093 | RF Exposure Limit                                        | Yes                    |
| 90.213 & 2.1055                 | Frequency Stability                                      | Yes                    |
| 2.1047(a) & 90.242(b)(8)        | Audio Frequency Response                                 | Yes                    |
| 90.210 & 2.1047(b)              | Modulation Limiting                                      | Yes                    |
| 90.209 90.210 & 2.1049          | Emission Limitation & Emission Mask                      | Yes                    |
| 90.210, 2.1057 & 2.1051         | Emission Limits - Spurious Emissions at Antenna Terminal | Yes                    |
| 90.210, 2.1057 & 2.1053         | Emission Limits - Field Strength of Spurious Emissions   | Yes                    |
| 90.214                          | Transient Frequency Behavior                             | Yes                    |

### 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 C63.4:1992 and CISPR 16-1.

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

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

---

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## 6.5. RF POWER OUTPUT @ FCC 2.1046 & 90.205

### 6.5.1. Limits @ FCC 90.205

Refer to 47 CFR § 90.205 for specification details.

### 6.5.2. Method of Measurements

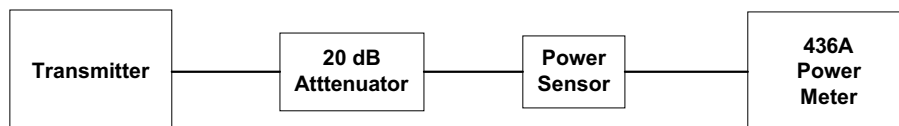
Refer to sections 8.1 and 8.2 of this test report for measurement methods.

- The transmitter terminal was coupled to the power meter through a 30 dB attenuator
- Power of the transmitter channel near the lowest, middle and highest of each frequency block/band were measured using the power meter, and the reading was corrected by added the calibrated attenuator's attenuation value and cable loss.
- The RF Output was turned on with standard modulation applied.

### 6.5.3. Test Equipment List

| Test Instruments | Manufacturer    | Model No. | Serial No. | Frequency Range                   |
|------------------|-----------------|-----------|------------|-----------------------------------|
| Attenuator(s)    | Bird            | ...       | ...        | DC – 22 GHz                       |
| Attenuator(s)    | Weinschel Corp  | 24-20-34  | BJ2357     | DC – 8.5 GHz                      |
| Power Meter      | Hewlett Packard | 436A      | 1725A02249 | 10 kHz – 50 GHz, sensor dependent |
| Power Sensor     | Hewlett Packard | 8481A     | 2702A68983 | 10 MHz – 18 GHz                   |

### 6.5.4. Test Arrangement



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## 6.5.5. Test Data

### RF Power at RF Output Port

| Transmitter Channel Output                        | Fundamental Frequency (MHz) | Measured Power (dBm) | Power Rating (dBm) |
|---------------------------------------------------|-----------------------------|----------------------|--------------------|
| High Power, Narrow Band (12.5kHz channel spacing) |                             |                      |                    |
| Lowest                                            | 136.10                      | 44.2                 | 44.0               |
| Middle                                            | 155.10                      | 44.2                 | 44.0               |
| Highest                                           | 173.90                      | 44.0                 | 44.0               |
| High Power, Wide Band (25kHz channel spacing)     |                             |                      |                    |
| Lowest                                            | 136.10                      | 44.2                 | 44.0               |
| Middle                                            | 155.10                      | 44.2                 | 44.0               |
| Highest                                           | 173.90                      | 44.0                 | 44.0               |
| Low Power, Narrow Band (12.5kHz channel spacing)  |                             |                      |                    |
| Lowest                                            | 136.10                      | 34.1                 | 34.0               |
| Middle                                            | 155.10                      | 34.3                 | 34.0               |
| Highest                                           | 173.90                      | 34.3                 | 34.0               |
| Low Power, Wide Band (25kHz channel spacing)      |                             |                      |                    |
| Lowest                                            | 136.10                      | 34.2                 | 34.0               |
| Middle                                            | 155.10                      | 34.3                 | 34.0               |
| Highest                                           | 173.90                      | 34.3                 | 34.0               |

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## 6.6. RF EXPOSURE REQUIRMENTS @ 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).

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

| Frequency Range (MHz)                                          | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm <sup>2</sup> ) | Average Time (minutes) |
|----------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|------------------------|
| <b>(A) Limits for Occupational/Control Exposures</b>           |                               |                               |                                     |                        |
| 30-300                                                         | 61.4                          | 0.163                         | 1.0                                 | 6                      |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                        |
| 30-300                                                         | 27.5                          | 0.073                         | 0.2                                 | 30                     |

F = Frequency in MHz

### 6.6.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091 and Public Notice DA 00-705 (March 30, 2000)

- 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

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**Calculation Method of RF Safety Distance**

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

Where: P: power input to the antenna in mW  
EIRP: Equivalent (effective) isotropic radiated power.  
S: power density mW/cm<sup>2</sup>  
G: numeric gain of antenna relative to isotropic radiator  
r: distance to centre of radiation in cm

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

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

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

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

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### 6.6.3. Test Data

#### **Antenna Gain Limit specified by Manufacturer: 0 dBi**

| Measured Maximum RF Conducted Power (dBm) | Calculated EIRP (dBm) | Laboratory's Recommended Minimum RF Safety Distance r (cm) | Manufacturer's specified antenna separation distance (cm) |
|-------------------------------------------|-----------------------|------------------------------------------------------------|-----------------------------------------------------------|
| 44.2                                      | 44.2                  | 45.8                                                       | 85 cm                                                     |

**Note 1:** RF EXPOSURE DISTANCE LIMITS :  $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$   
 For Occupational/Controlled Exposure  $S = 1.0 \text{ mW/cm}^2$

| Evaluation of RF Exposure Compliance Requirements                                                                                                                                          |                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RF Exposure Requirements                                                                                                                                                                   | Compliance with FCC Rules                                                                                                                                                        |
| Minimum calculated separation distance between antenna and persons required: 45.8 cm                                                                                                       | Manufacturer' instruction for separation distance between antenna and persons required: 85 cm meter.<br>Please refer to page # b of the Users/ Manual and FCC RF Exposure folder |
| 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 page # b of the Users/ Manual and FCC RF Exposure folder                                                                                                         |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits                                                                                    | Please refer to page # b of the Users/ Manual and FCC RF Exposure folder                                                                                                         |
| Any other RF exposure related issues that may affect MPE compliance                                                                                                                        | RF Safety Training for compliance with Occupational Use/Control Exposure                                                                                                         |

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## 6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213

### 6.7.1. Limits @ FCC 90.213

Refer to 47 CFR §90.213 for specification details.

| Frequency Range<br>(MHz) | Channel Spacing<br>(kHz) | Frequency Stability (ppm) |
|--------------------------|--------------------------|---------------------------|
|                          |                          | Mobile Stations           |
|                          |                          | > 2 Watts                 |
| 138-174                  | 25                       | 5.0                       |
|                          | 12.5                     | 2.5                       |

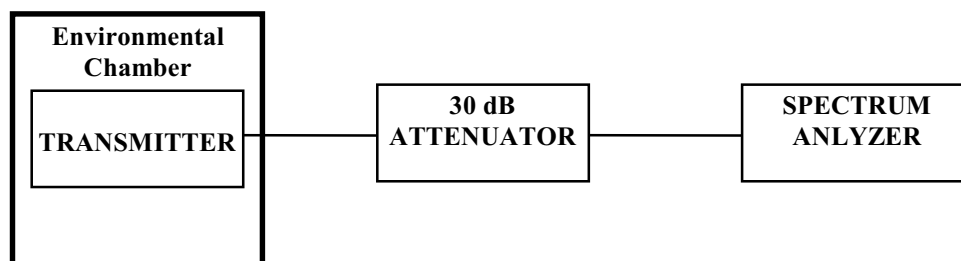
### 6.7.2. Method of Measurements

Refer to Exhibit 8, § 8.3 of this report for measurement details

### 6.7.3. Test Equipment List

| Test Instruments                  | Manufacturer    | Model No. | Serial No. | Frequency Range      |
|-----------------------------------|-----------------|-----------|------------|----------------------|
| EMI Receiver/<br>EMI Receiver     | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz     |
| Attenuator(s)                     | Bird            | ..        | ...        | DC – 22 GHz          |
| Temperature & Humidity<br>Chamber | Tenney          | T5        | 9723B      | -40° to +60° C range |

### 6.7.4. Test Arrangement



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## 6.7.5. Test Data

|                                                |                                                |
|------------------------------------------------|------------------------------------------------|
| <b>Product Name:</b>                           | <b>Mobile VHF FM Transceiver</b>               |
| <b>Model No.:</b>                              | <b>IC-F520</b>                                 |
| <b>Center Frequency:</b>                       | 136.10 MHz                                     |
| <b>Full Power Level:</b>                       | 26.3 Watts                                     |
| <b>Frequency Tolerance Limit (Worst Case):</b> | $\pm 2.5$ ppm or $\pm 340.25$ Hz at 136.10 MHz |
| <b>Max. Frequency Tolerance Measured:</b>      | +270 Hz or +2.0 ppm                            |
| <b>Input Voltage Rating:</b>                   | 13.6 Vdc, 5.1 A                                |

| CENTER FREQUENCY & RF POWER OUTPUT VARIATION |                                              |                                                     |                                                      |
|----------------------------------------------|----------------------------------------------|-----------------------------------------------------|------------------------------------------------------|
| Ambient Temperature<br>(°C)                  | Supply Voltage<br>(Nominal)<br>13.6 Volts dc | Supply Voltage<br>(85% of Nominal)<br>11.6 Volts dc | Supply Voltage<br>(115% of Nominal)<br>15.6 Volts dc |
|                                              | Hz                                           | Hz                                                  | Hz                                                   |
| -30                                          | -60                                          | N/A                                                 | N/A                                                  |
| -20                                          | -80                                          | N/A                                                 | N/A                                                  |
| -10                                          | -100                                         | N/A                                                 | N/A                                                  |
| 0                                            | -70                                          | N/A                                                 | N/A                                                  |
| +10                                          | -50                                          | N/A                                                 | N/A                                                  |
| +20                                          | +9                                           | +40                                                 | +9                                                   |
| +30                                          | -10                                          | N/A                                                 | N/A                                                  |
| +40                                          | +54                                          | N/A                                                 | N/A                                                  |
| +50                                          | +270                                         | N/A                                                 | N/A                                                  |

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## 6.8. 99% OCCUPIED BANDWIDTH & EMISSION MASK @ FCC 2.1049, 90.209 & 90.210

### 6.8.1. Limits @ FCC 90.209 & 90.210

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

| Frequency Band (MHz) | Channel Spacing (kHz) | Authorized Bandwidth (kHz) | Recommended Frequency Deviation (KHz) | Applicable Emissions Mask                     |                                                  |
|----------------------|-----------------------|----------------------------|---------------------------------------|-----------------------------------------------|--------------------------------------------------|
|                      |                       |                            |                                       | Mask for equipment with audio low pass filter | Mask for equipment without audio low pass filter |
| 138-174              | 25<br>12.5            | 20<br>11.25                | 5<br>2.5                              | B<br>D                                        | C<br>D                                           |

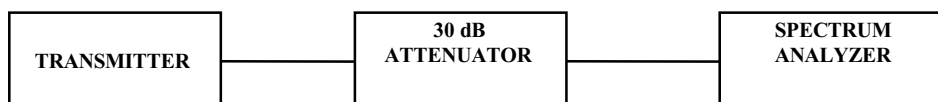
### 6.8.2. Method of Measurements

Refer to § 8.4 of this report for measurement details

### 6.8.3. Test Equipment List

| Test Instruments               | Manufacturer    | Model No. | Serial No. | Frequency Range  |
|--------------------------------|-----------------|-----------|------------|------------------|
| Spectrum Analyzer/EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Attenuator(s)                  | Bird            | ..        | ...        | DC – 22 GHz      |
| Audio Oscillator               | Hewlett Packard | HP 204C   | 0989A08798 | DC to 1.2 MHz    |

### 6.8.4. Test Arrangement



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## 6.8.5. Test Data

### 6.8.5.1. 99% Occupied Bandwidth

Conform. Please refer to Plots # 1 through # 6 in Annex 1 for Details of measurements

| Frequency (MHz) | Channel Spacing (kHz) | Measured 99% OBW (kHz) | Recommended maximum 99% OBW |
|-----------------|-----------------------|------------------------|-----------------------------|
| 136.10          | 12.5                  | 8.1                    | 11.25                       |
| 155.10          | 12.5                  | 8.2                    | 11.25                       |
| 173.90          | 12.5                  | 8.1                    | 11.25                       |
| 136.10          | 25.0                  | 12.8                   | 20                          |
| 155.10          | 25.0                  | 13.4                   | 20                          |
| 173.90          | 25.0                  | 13.1                   | 20                          |

### 6.8.5.2. Emission Masks

Conform. Please refer to Plots # 7 to 9 in Annex 1 for Details of Mask D Measurements for 12.5 kHz Channel Spacing

Conform. Please refer to Plots # 10 to 12 in Annex 1 for Details of Mask B Measurements for 25 kHz Channel Spacing

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## 6.9. AUDIO FREQUENCY RESPONSE @ FCC 2.1047(a) AND 90.242(B)(8)

### 6.9.1. Limits @ FCC 2.1047(a) and 90.242(b)(8)

No limit is required by FCC for audio frequency response. However, FCC recommends the Audio Frequency Response to be tested to show the roll-off curve at 3 kHz.

Recommended Limits: The attenuation of lowpass filter between the frequencies of 3 kHz and 20 kHz shall be greater than the attenuation at 1kHz by at least:  $60\log_{10}(f/3)$  decibels where "f" is the frequency in kHz. At frequency above 20 kHz, the attenuation shall be 50 dB greater than the attenuation at 1 kHz.

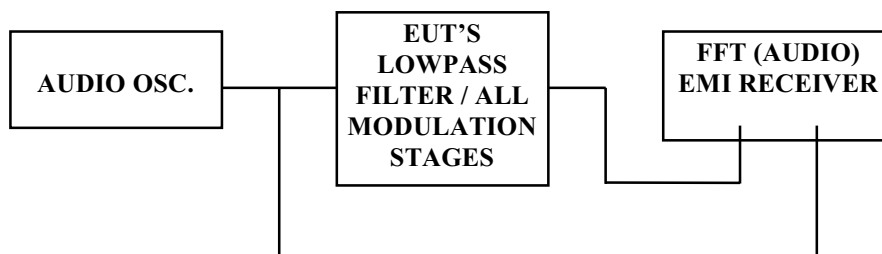
### 6.9.2. Method of Measurements

The rated audio input signal was applied to the input of the audiolowpass filter (or of all modulation stages) using an audio oscillator, this input signal level and its corresponding output signal were then measured and recorded using the FFT (Audio) EMI Receiver. Tests were repeated at different audio signal frequencies from 0 to 50 kHz.

### 6.9.3. Test Equipment List

| Test Instruments         | Manufacturer    | Model No. | Serial No. | Frequency Range                            |
|--------------------------|-----------------|-----------|------------|--------------------------------------------|
| FFT (audio) EMI Receiver | Advantest       | R9211E    | ...        | 10 mHz – 100 kHz,<br>1 MHz Input Impedance |
| Audio Oscillator         | Hewlett Packard | HP 204C   | 0989A08798 | DC to 1.2 MHz                              |

### 6.9.4. Test Arrangement



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## 6.9.5. Test Data

### 6.9.5.1. 12.5 kHz Channel Spacing

| FREQUENCY<br>(kHz) | AUDIO<br>IN<br>(dBV) | AUDIO<br>OUT<br>(dBV) | ATTEN.<br>(OUT - IN)<br>(dB) | ATTEN.<br>wrt. 1 kHz<br>(dB) | FCC LIMIT<br>@22.915D<br>(dB) | PASS/<br>FAIL |
|--------------------|----------------------|-----------------------|------------------------------|------------------------------|-------------------------------|---------------|
| 0.20               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | 0                             | PASS          |
| 0.40               | -46.8                | -23.3                 | 23.5                         | -9.7                         | 0.0                           | PASS          |
| 0.60               | -46.8                | -19.0                 | 27.8                         | -5.4                         | 0.0                           | PASS          |
| 0.80               | -46.8                | -15.8                 | 31.0                         | -2.2                         | 0.0                           | PASS          |
| 1.00               | -46.8                | -13.6                 | 33.2                         | 0.0                          | 0.0                           | PASS          |
| 1.50               | -46.8                | -11.3                 | 35.5                         | 2.3                          | 0.0                           | PASS          |
| 2.00               | -46.8                | -11.0                 | 35.8                         | 2.6                          | 0.0                           | PASS          |
| 2.50               | -46.8                | -11.2                 | 35.6                         | 2.4                          | 0.0                           | PASS          |
| 3.00               | -46.8                | -12.1                 | 34.7                         | 1.5                          | 0.0                           | PASS          |
| 3.50               | -46.8                | -19.3                 | 27.5                         | -5.7                         | -4.0                          | PASS          |
| 4.00               | -46.8                | -42.3                 | 4.5                          | -28.7                        | -7.5                          | PASS          |
| 4.50               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -10.6                         | PASS          |
| 5.00               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -13.3                         | PASS          |
| 6.00               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -18.1                         | PASS          |
| 7.00               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -22.1                         | PASS          |
| 8.00               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -25.6                         | PASS          |
| 9.00               | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -28.6                         | PASS          |
| 10.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -31.4                         | PASS          |
| 20.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -49.4                         | PASS          |
| 22.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -50.0                         | PASS          |
| 24.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -50.0                         | PASS          |
| 26.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -50.0                         | PASS          |
| 28.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -50.0                         | PASS          |
| 30.00              | -46.8                | <-70.0                | <-23.2                       | <-56.4                       | -50.0                         | PASS          |

\* The Audio Input Level = STD MOD LEVEL + 10 dB  
 Where STD Modulation Level is the audio input level at 1 KHz and Frequency Deviation = 60% of the maximum frequency deviation

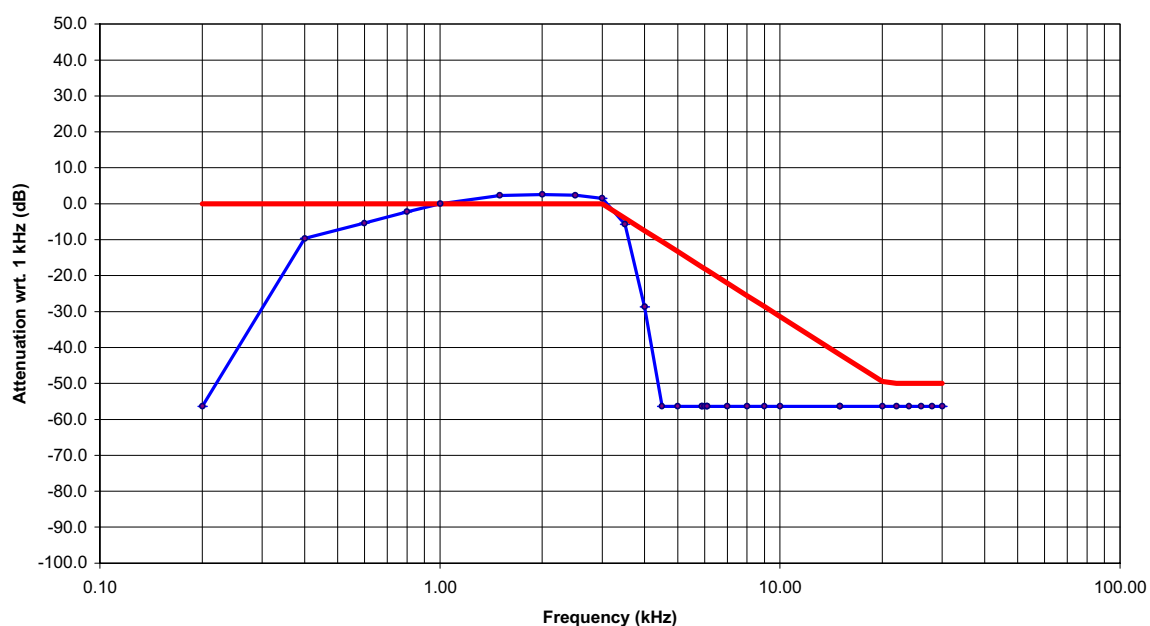
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**AUDIO FREQUENCY REPSONSE @ FCC 2.987(a) & 90.242b(8)**  
**VHF FM Transceiver, Model IC-F520 (12.5 kHz Channel Spacing)**



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### 6.9.5.2. 25 kHz Channel Spacing

| FREQUENCY<br>(kHz) | AUDIO<br>IN<br>(dBV) | AUDIO<br>OUT<br>(dBV) | ATTEN.<br>(OUT - IN)<br>(dB) | ATTEN.<br>wrt. 1 kHz<br>(dB) | FCC LIMIT<br>@22.915D<br>(dB) | PASS/<br>FAIL |
|--------------------|----------------------|-----------------------|------------------------------|------------------------------|-------------------------------|---------------|
| 0.20               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | 0                             | PASS          |
| 0.40               | -46.8                | -17.6                 | 29.2                         | -10.2                        | 0.0                           | PASS          |
| 0.60               | -46.8                | -12.4                 | 34.4                         | -5.0                         | 0.0                           | PASS          |
| 0.80               | -46.8                | -9.5                  | 37.3                         | -2.1                         | 0.0                           | PASS          |
| 1.00               | -46.8                | -7.4                  | 39.4                         | 0.0                          | 0.0                           | PASS          |
| 1.50               | -46.8                | -5.7                  | 41.1                         | 1.7                          | 0.0                           | PASS          |
| 2.00               | -46.8                | -5.3                  | 41.5                         | 2.1                          | 0.0                           | PASS          |
| 2.50               | -46.8                | -5.2                  | 41.6                         | 2.2                          | 0.0                           | PASS          |
| 3.00               | -46.8                | -5.6                  | 41.2                         | 1.8                          | 0.0                           | PASS          |
| 3.50               | -46.8                | -12.1                 | 34.7                         | -4.7                         | -4.0                          | PASS          |
| 4.00               | -46.8                | -35.1                 | 11.7                         | -27.7                        | -7.5                          | PASS          |
| 4.50               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -10.6                         | PASS          |
| 5.00               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -13.3                         | PASS          |
| 6.00               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -18.1                         | PASS          |
| 7.00               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -22.1                         | PASS          |
| 8.00               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -25.6                         | PASS          |
| 9.00               | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -28.6                         | PASS          |
| 10.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -31.4                         | PASS          |
| 20.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -49.4                         | PASS          |
| 22.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -50.0                         | PASS          |
| 24.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -50.0                         | PASS          |
| 26.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -50.0                         | PASS          |
| 28.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -50.0                         | PASS          |
| 30.00              | -46.8                | <-70.0                | <-23.2                       | <-62.6                       | -50.0                         | PASS          |

\* The Audio Input Level = STD MOD LEVEL + 10 dB  
 Where STD Modulation Level is the audio input level at 1 KHz and Frequency Deviation = 60% of the maximum frequency deviation

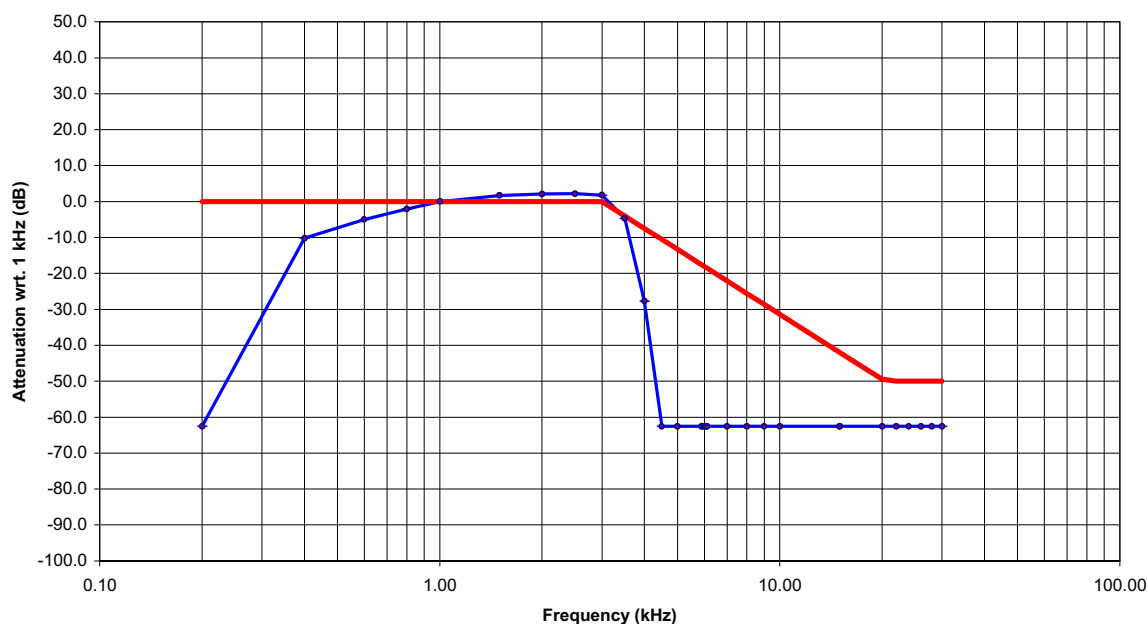
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**AUDIO FREQUENCY RESPONSE @ FCC 2.987(a) & 90.242b(8)**  
**VHF FM Transceiver, Model IC-F520 (25 kHz Channel Spacing)**



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## 6.10. MODULATION LIMITING @ FCC 2.1047(b) & 90.210

### 6.10.1. Limits @ FCC 2.1047(b) and 90.210

Recommended frequency deviation characteristics are given below:

- 2.5 kHz for 12.5 kHz Channel Spacing
- 5 kHz for 25 kHz Channel Spacing System

### 6.10.2. Method of Measurements

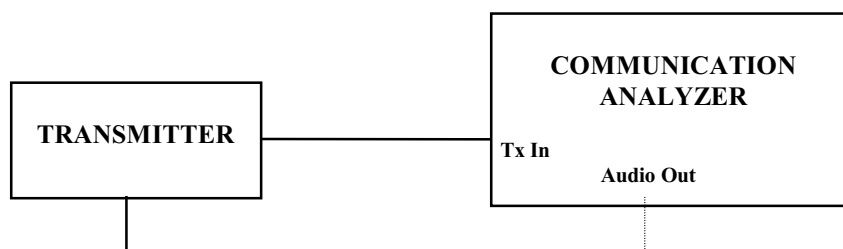
**For Audio Transmitter:** The carrier frequency deviation was measured with the tone input signal level varied from 0Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

**For Data Transmitter with Maximum Frequency Deviation set by Factory-** The EUT was set at maximum frequency deviation, and its peak frequency deviation was then measured using EUT's internal random data source.

### 6.10.3. Test Equipment List

| Test Instruments       | Manufacturer    | Model No. | Serial No. | Frequency Range                                                                                     |
|------------------------|-----------------|-----------|------------|-----------------------------------------------------------------------------------------------------|
| Communication Analyzer | Rohde & Schawrz | SMF02     | 879988/057 | 400 kHz - 1000 MHz including AF & RF Signal Generators, SINAD, DISTORTION, DEVIATION meters and etc |

### 6.10.4. Test Arrangement



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## 6.10.5. Test Data

### 6.10.5.1. 12.5 KHz Spacing Operation

| MODULATING<br>SIGNAL LEVEL<br>(mVrms) | PEAK FREQUENCY DEVIATION (kHz)<br>at the following modulating frequency: |         |         |         |         | MAXIMUM<br>LIMIT<br>(kHz) |
|---------------------------------------|--------------------------------------------------------------------------|---------|---------|---------|---------|---------------------------|
|                                       | 0.1 kHz                                                                  | 0.5 kHz | 1.0 kHz | 3.0 kHz | 5.0 kHz |                           |
| 2                                     | 0.7                                                                      | 0.8     | 0.9     | 1.6     | 0.4     | 2.5                       |
| 4                                     | 0.7                                                                      | 0.8     | 1.0     | 1.7     | 0.4     | 2.5                       |
| 6                                     | 0.7                                                                      | 0.8     | 1.2     | 1.7     | 0.4     | 2.5                       |
| 8                                     | 0.7                                                                      | 0.9     | 1.3     | 1.7     | 0.4     | 2.5                       |
| 10                                    | 0.7                                                                      | 1.0     | 1.5     | 1.7     | 0.4     | 2.5                       |
| 14                                    | 0.7                                                                      | 1.0     | 1.8     | 1.7     | 0.4     | 2.5                       |
| 16                                    | 0.7                                                                      | 1.2     | 2.1     | 1.7     | 0.4     | 2.5                       |
| 18                                    | 0.7                                                                      | 1.2     | 2.2     | 1.7     | 0.4     | 2.5                       |
| 20                                    | 0.7                                                                      | 1.2     | 2.3     | 1.7     | 0.4     | 2.5                       |
| 25                                    | 0.7                                                                      | 1.2     | 2.5     | 1.7     | 0.4     | 2.5                       |
| 30                                    | 0.7                                                                      | 1.3     | 2.5     | 1.7     | 0.4     | 2.5                       |
| 35                                    | 0.7                                                                      | 1.7     | 2.5     | 1.7     | 0.4     | 2.5                       |
| 40                                    | 0.7                                                                      | 1.7     | 2.5     | 1.7     | 0.4     | 2.5                       |
| 45                                    | 0.7                                                                      | 1.7     | 2.5     | 1.7     | 0.4     | 2.5                       |
| 50                                    | 0.8                                                                      | 1.8     | 2.5     | 1.7     | 0.4     | 2.5                       |

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Voice Signal Input Level = STD MOD Level + 16 dB = 20dBmVrms + 16 = **36 dBmVrms**

| MODULATING<br>FREQUENCY (KHz) | PEAK FREQUENCY<br>DEVIATION (KHz) | MAXIMUM LIMIT<br>(KHz) |
|-------------------------------|-----------------------------------|------------------------|
| 0.1                           | 1.1                               | 2.5                    |
| 0.2                           | 2.2                               | 2.5                    |
| 0.4                           | 1.6                               | 2.5                    |
| 0.6                           | 2.3                               | 2.5                    |
| 0.8                           | 2.5                               | 2.5                    |
| 1.0                           | 2.5                               | 2.5                    |
| 1.2                           | 2.2                               | 2.5                    |
| 1.4                           | 2.1                               | 2.5                    |
| 1.6                           | 2.1                               | 2.5                    |
| 1.8                           | 2.1                               | 2.5                    |
| 2.0                           | 2.1                               | 2.5                    |
| 2.5                           | 2.0                               | 2.5                    |
| 3.0                           | 1.8                               | 2.5                    |
| 3.5                           | 0.9                               | 2.5                    |
| 4.0                           | 0.1                               | 2.5                    |
| 4.5                           | 0.1                               | 2.5                    |
| 5.0                           | 0.1                               | 2.5                    |
| 6.0                           | 0.1                               | 2.5                    |
| 7.0                           | 0.1                               | 2.5                    |
| 8.0                           | 0.1                               | 2.5                    |
| 9.0                           | 0.1                               | 2.5                    |
| 10.0                          | 0.1                               | 2.5                    |

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### 6.10.5.2. 25 KHz Spacing Operation

| MODULATING<br>SIGNAL LEVEL<br>(mVrms) | PEAK FREQUENCY DEVIATION (kHz)<br>at the following modulating frequency: |         |         |         |         | MAXIMUM<br>LIMIT<br>(kHz) |
|---------------------------------------|--------------------------------------------------------------------------|---------|---------|---------|---------|---------------------------|
|                                       | 0.1 kHz                                                                  | 0.5 kHz | 1.0 kHz | 3.0 kHz | 5.0 kHz |                           |
| 2                                     | 1.3                                                                      | 1.3     | 1.4     | 2.8     | 1.3     | 5                         |
| 4                                     | 1.3                                                                      | 1.3     | 1.6     | 3.6     | 1.3     | 5                         |
| 6                                     | 1.3                                                                      | 1.4     | 1.9     | 3.7     | 1.3     | 5                         |
| 8                                     | 1.3                                                                      | 1.4     | 2.2     | 3.8     | 1.3     | 5                         |
| 10                                    | 1.3                                                                      | 1.5     | 2.9     | 3.8     | 1.1     | 5                         |
| 12                                    | 1.3                                                                      | 1.6     | 3.3     | 3.8     | 1.0     | 5                         |
| 14                                    | 1.3                                                                      | 1.6     | 3.6     | 3.8     | 0.9     | 5                         |
| 16                                    | 1.3                                                                      | 1.7     | 3.9     | 3.8     | 0.9     | 5                         |
| 18                                    | 1.3                                                                      | 1.8     | 4.2     | 3.8     | 0.8     | 5                         |
| 20                                    | 1.3                                                                      | 1.9     | 4.5     | 3.8     | 0.7     | 5                         |
| 25                                    | 1.3                                                                      | 2.4     | 5.0     | 3.8     | 0.6     | 5                         |
| 30                                    | 1.3                                                                      | 2.9     | 5.0     | 3.8     | 0.5     | 5                         |
| 35                                    | 1.3                                                                      | 3.2     | 5.0     | 3.8     | 0.4     | 5                         |
| 40                                    | 1.3                                                                      | 3.0     | 5.0     | 3.8     | 0.3     | 5                         |
| 45                                    | 1.0                                                                      | 3.1     | 5.0     | 3.8     | 0.3     | 5                         |
| 50                                    | 1.0                                                                      | 3.4     | 5.0     | 3.8     | 0.3     | 5                         |

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Voice Signal Input Level = STD MOD Level + 16 dB = 20dBmVrms + 16 = **36 dBmVrms**

| MODULATING<br>FREQUENCY (KHz) | PEAK FREQUENCY<br>DEVIATION (KHz) | MAXIMUM LIMIT<br>(KHz) |
|-------------------------------|-----------------------------------|------------------------|
| 0.1                           | 2.1                               | 5                      |
| 0.2                           | 4.2                               | 5                      |
| 0.4                           | 3.3                               | 5                      |
| 0.6                           | 4.6                               | 5                      |
| 0.8                           | 5.0                               | 5                      |
| 1.0                           | 5.0                               | 5                      |
| 1.2                           | 4.3                               | 5                      |
| 1.4                           | 3.9                               | 5                      |
| 1.6                           | 3.9                               | 5                      |
| 1.8                           | 3.9                               | 5                      |
| 2.0                           | 3.9                               | 5                      |
| 2.5                           | 3.9                               | 5                      |
| 3.0                           | 3.7                               | 5                      |
| 3.5                           | 2.1                               | 5                      |
| 4.0                           | 0.3                               | 5                      |
| 4.5                           | 0.2                               | 5                      |
| 5.0                           | 0.1                               | 5                      |
| 6.0                           | 0.1                               | 5                      |
| 7.0                           | 0.1                               | 5                      |
| 8.0                           | 0.1                               | 5                      |
| 9.0                           | 0.1                               | 5                      |
| 10.0                          | 0.1                               | 5                      |

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## 6.11. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS @ FCC 90.210

### 6.11.1. Limits @ 90.210

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

| FCC Rules     | Frequency Range                                                                                            | Attenuation Limit (dBc)                  |
|---------------|------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 90.210(b)&(c) | 10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio | 43+10*log(P)                             |
| 90.210(d)     | 10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio | 50+10*log(P) or 70 dBc whichever is less |

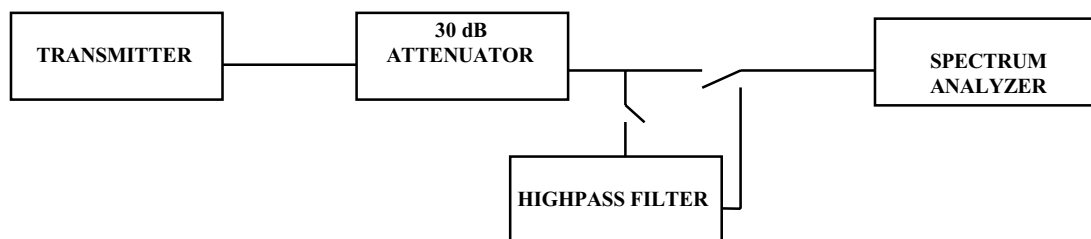
### 6.11.2. Method of Measurements

Refer to Exhibit 8 § 8.5 of this report for measurement details

### 6.11.3. Test Equipment List

| Test Instruments               | Manufacturer    | Model No. | Serial No.  | Frequency Range                                |
|--------------------------------|-----------------|-----------|-------------|------------------------------------------------|
| Spectrum Analyzer/EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103  | 9 kHz – 26.5 GHz                               |
| Attenuator(s)                  | Bird            | ..        | ...         | DC – 22 GHz                                    |
| Audio Oscillator               | Hewlett Packard | HP 204C   | 0989A08798  | DC to 1.2 MHz                                  |
| Highpass Filter, Microphase    | Microphase      | CR220HID  | IIT111000AC | Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz |

### 6.11.4. Test Arrangement



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## 6.11.5. Test Data

### REMARKS:

The transmitter antenna conducted pre-scans showed there was no difference when the product operated with the following modes:

- (1) 12.5 kHz Channel Spacing, FM voice modulation
- (2) 12.5 kHz Channel Spacing, FM data modulation
- (3) 25 kHz Channel Spacing, FM voice modulation and
- (4) 25 kHz Channel Spacing, FM voice modulation

The EUT's configuration (1) was tested with the most stringent limit of  $50 + 10 \cdot \log(P \text{ in Watts})$  for the worst case.

#### 6.11.5.1. Lowest Frequency (136.10 MHz, 12.5 kHz Channel Spacing, RF Output Power: Hi)

Fundamental Frequency: 136.10 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 44.2 dBm or 26.3 Watts  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(26.3) = 64.2 \text{ dBc}$  (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                                | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |       | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                   | (dBm)                                      | (dBc) |                |                |               |
| 270.20                                                                                                                                                                                                                            | -49.0                                      | -93.2 | -64.2          | -29.0          | PASS          |
| 542.40                                                                                                                                                                                                                            | -50.7                                      | -94.9 | -64.2          | -30.7          | PASS          |
| <ul style="list-style-type: none"> <li>The emissions were scanned from 10 MHz to 2GHz and all emissions less than 30 dB below FCC Limits were recorded.</li> <li>Refer to plots # 13 &amp; 14 for measurements details</li> </ul> |                                            |       |                |                |               |

#### 6.11.5.2. Middle Frequency (155.1 MHz, 12.5 kHz Channel Spacing, RF Output Power: Hi)

Fundamental Frequency: 155.1 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 44.2 dBm or 26.3 Watts  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(26.3) = 64.2 \text{ dBc}$  (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                                | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |       | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                   | (dBm)                                      | (dBc) |                |                |               |
| 310.20                                                                                                                                                                                                                            | -45.1                                      | -89.3 | -64.2          | -25.1          | PASS          |
| <ul style="list-style-type: none"> <li>The emissions were scanned from 10 MHz to 2GHz and all emissions less than 30 dB below FCC Limits were recorded.</li> <li>Refer to plots # 15 &amp; 16 for measurements details</li> </ul> |                                            |       |                |                |               |

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**6.11.5.3. Highest Frequency (155.1 MHz, 12.5 kHz Channel Spacing, RF Output Power: Hi)**

Fundamental Frequency: 173.9 MHz, Narrow Band (12.5kHz channel spacing)

RF Output Power: 44.0 dBm or 25.0 Watts

Modulation: FM modulation with 2.5 kHz sine wave signal

FCC Limit:  $50 + 10 \cdot \log(25.0) = 64.0$  dBc (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                             | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |       | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                | (dBm)                                      | (dBc) |                |                |               |
| 347.80                                                                                                                                                                                                                         | -37.4                                      | -81.4 | -64.0          | -17.4          | PASS          |
| 521.70                                                                                                                                                                                                                         | -42.6                                      | -86.6 | -64.0          | -22.6          | PASS          |
| <ul style="list-style-type: none"><li>The emissions were scanned from 10 MHz to 2GHz and all emissions less than 30 dB below FCC Limits were recorded.</li><li>Refer to plots # 17 &amp; 18 for measurements details</li></ul> |                                            |       |                |                |               |

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#### 6.11.5.4. Lowest Frequency (136.10 MHz, 12.5 kHz Channel Spacing, RF Output Power: Lo)

Fundamental Frequency: 136.10 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 34.1 dBm or 2.6 Watts  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(2.6) = 54.2$  dBc (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                                 | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |       | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                    | (dBm)                                      | (dBc) |                |                |               |
| 270.20                                                                                                                                                                                                                             | -50.4                                      | -84.5 | -54.2          | -30.3          | PASS          |
| <ul style="list-style-type: none"> <li>The emissions were scanned from 10 MHz to 2 GHz and all emissions less than 30 dB below FCC Limits were recorded.</li> <li>Refer to plots # 19 &amp; 20 for measurements details</li> </ul> |                                            |       |                |                |               |

#### 6.11.5.5. Middle Frequency (155.1 MHz, 12.5 kHz Channel Spacing, RF Output Power: Lo)

Fundamental Frequency: 155.1 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 34.3 dBm or 2.7 Watts  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(2.7) = 54.3$  dBc (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                                 | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |        | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|--------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                    | (dBm)                                      | (dBc)  |                |                |               |
| 10 MHz - 2 GHz                                                                                                                                                                                                                     | <-54.6                                     | <-88.9 | -54.3          | <-34.6         | PASS          |
| <ul style="list-style-type: none"> <li>The emissions were scanned from 10 MHz to 2 GHz and all emissions less than 30 dB below FCC Limits were recorded.</li> <li>Refer to plots # 21 &amp; 22 for measurements details</li> </ul> |                                            |        |                |                |               |

#### 6.11.5.6. Highest Frequency (155.1 MHz, 12.5 kHz Channel Spacing, RF Output Power: Lo)

Fundamental Frequency: 173.9 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 34.3 dBm or 2.7 Watts  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(25.0) = 54.3$  dBc (dB below the carrier)

| FREQUENCY<br>(MHz)                                                                                                                                                                                                                 | TRANSMITTER CONDUCTED<br>ANTENNA EMISSIONS |       | LIMIT<br>(dBc) | MARGIN<br>(dB) | PASS/<br>FAIL |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|----------------|----------------|---------------|
|                                                                                                                                                                                                                                    | (dBm)                                      | (dBc) |                |                |               |
| 347.80                                                                                                                                                                                                                             | -43.9                                      | -78.2 | -54.3          | -23.9          | PASS          |
| <ul style="list-style-type: none"> <li>The emissions were scanned from 10 MHz to 2 GHz and all emissions less than 30 dB below FCC Limits were recorded.</li> <li>Refer to plots # 23 &amp; 24 for measurements details</li> </ul> |                                            |       |                |                |               |

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## 6.12. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ FCC 90.210

### 6.12.1. Limits @ FCC 90.210

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

| FCC Rules     | Frequency Range                                                                                            | Attenuation Limit (dBc)                  |
|---------------|------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 90.210(b)&(c) | 10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio | 43+10*log(P)                             |
| 90.210(d)     | 10 MHz to Lowest frequency of the radio to 10 <sup>th</sup> harmonic of the highest frequency of the radio | 50+10*log(P) or 70 dBc whichever is less |

### 6.12.2. Method of Measurements

Refer to Exhibit 8, § 8.2 of this report for measurement details

### 6.12.3. Test Equipment List

| Test Instruments                   | Manufacturer    | Model No. | Serial No. | Frequency Range                                                 |
|------------------------------------|-----------------|-----------|------------|-----------------------------------------------------------------|
| Spectrum Analyzer/<br>EMI Receiver | Advantest       | R3271     | 15050203   | 100 Hz to 32 GHz with external mixer for frequency above 32 GHz |
| Microwave Amplifier                | Hewlett Packard | HP 83017A | 3116A00661 | 1 GHz to 26.5 GHz                                               |
| Active Loop Antenna                | EMCO            | 6507      | 8906-1167  | 1 kHz – 30 MHz                                                  |
| Biconilog Antenna                  | EMCO            | 3143      | 1029       | 20 MHz to 2 GHz                                                 |
| Horn Antenna                       | EMCO            | 3155      | 9701-5061  | 1 GHz – 18 GHz                                                  |
| Horn Antenna with Mixer            | EMCO            | 3160-09   | 1007       | 18 GHz – 26.5 GHz                                               |
| Horn Antenna with Mixer            | EMCO            | 3160-10   | 1001       | 26.5 GHz – 40 GHz                                               |

### 6.12.4. Test Data

#### Remark:

- (1) The spurious/harmonic emissions from 25 kHz Channel Spacing operation was found to be the same as those of 12.5 kHz Channel Spacing operation. Therefore, 12.5 KHz Channel Spacing was chosen to be tested for worst case since it's limit is more stringent.
- (2) The RF Output Power was set to "hi" (26.3 Watts) for measuring the worst case of emissions
- (3) The emissions were scanned from 10 MHz to 2 GHz and all emissions within 20 dB below the limits were recorded.

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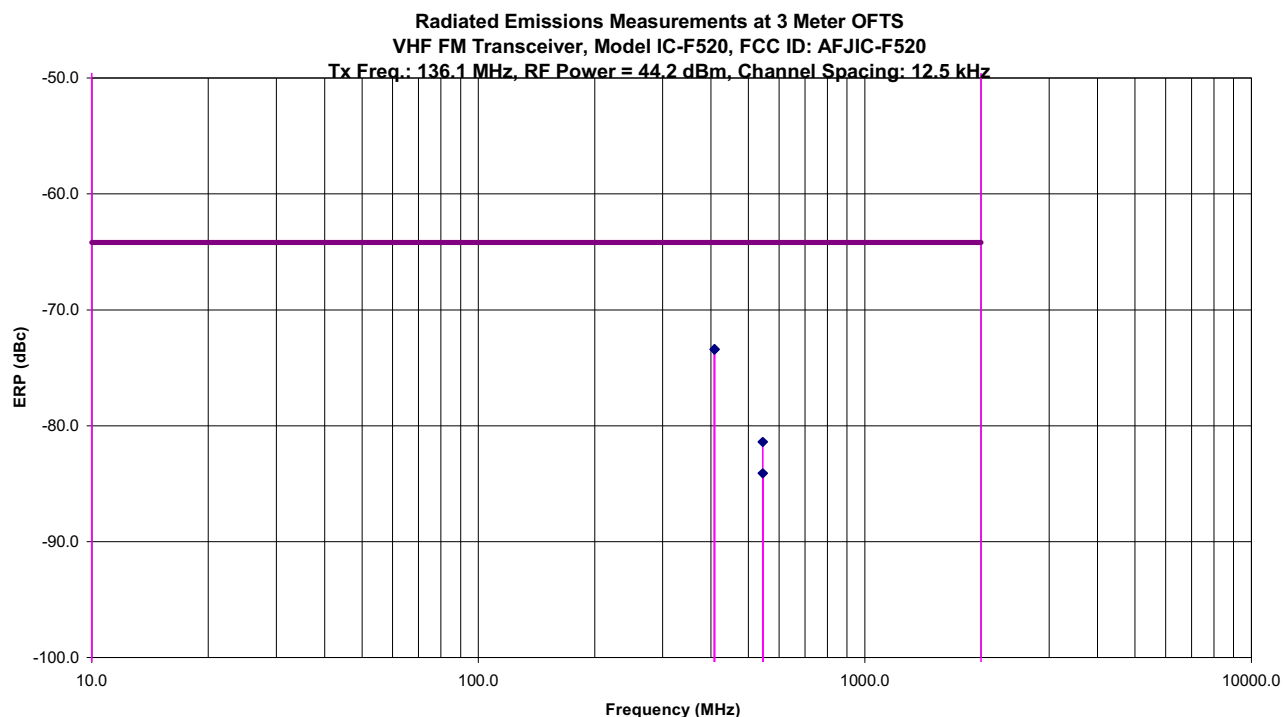
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#### 6.12.4.1. Lowest Frequency (136.10 MHz) - Hi Power

Fundamental Frequency: 136.10 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 44.2 dBm or 26.3 Watts, ERP = 44.2 dBm - 2.15 dB = 42.1 dBm wrt. 0 dBi antenna gain  
 Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(26.3) = 64.2$  dBc (dB below the carrier)

| Frequency (MHz) | E-Field Level @3m (dBμV/m) | ERP Measured by Substitution Method |       | EMI Receiver Detector (Peak/QP) | Antenna Plane (H/V) | Limit (dBc) | Margin (dB) | Pass / Fail |
|-----------------|----------------------------|-------------------------------------|-------|---------------------------------|---------------------|-------------|-------------|-------------|
|                 |                            | (dBm)                               | (dBc) |                                 |                     |             |             |             |
| 408.30          | 68.6                       | -31.3                               | -73.4 | PEAK                            | V                   | -64.2       | -9.2        | PASS        |
| 408.30          | 72.8                       | -31.3                               | -73.4 | PEAK                            | H                   | -64.2       | -9.2        | PASS        |
| 544.40          | 64.2                       | -39.3                               | -81.4 | PEAK                            | V                   | -64.2       | -17.2       | PASS        |
| 544.40          | 62.6                       | -42.0                               | -84.1 | PEAK                            | H                   | -64.2       | -19.9       | PASS        |

➤ The rf emissions were scanned from 10 MHz to 2 GHz, all emissions less than 20 dB below the FCC limit (-20dBm or -64.2 dBc) were recorded.



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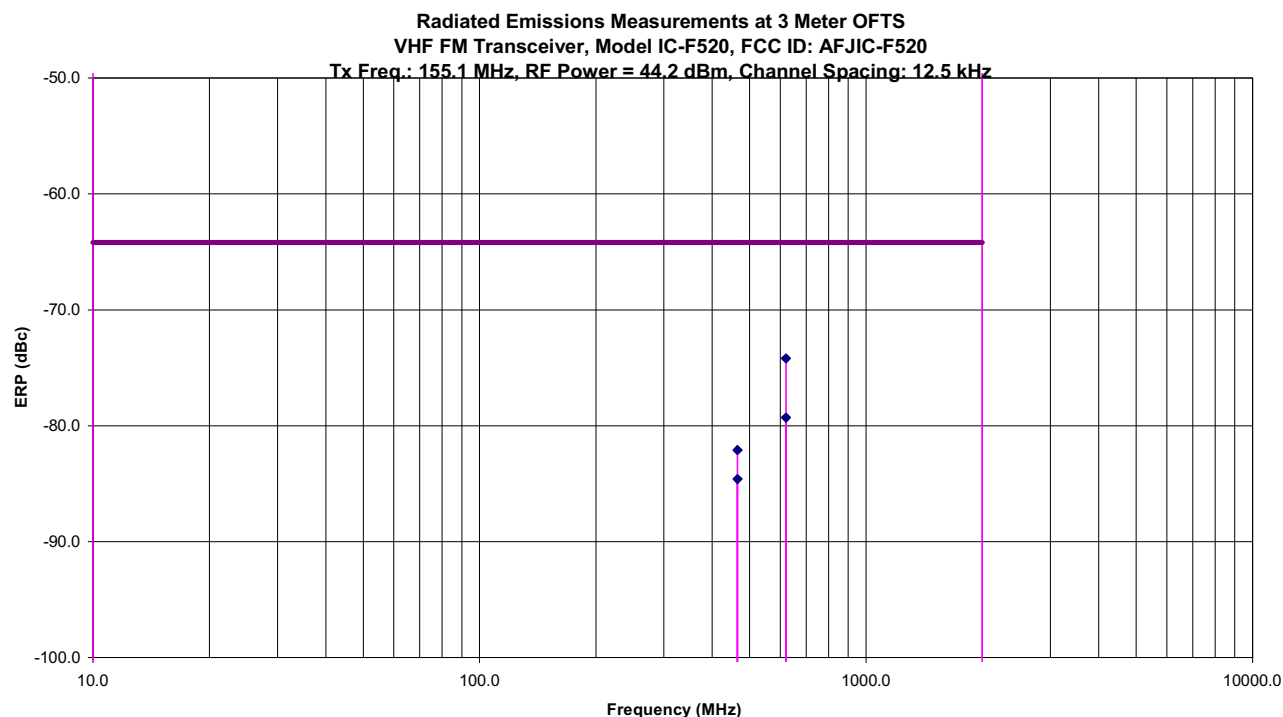
#### 6.12.4.2. Middle Frequency (155.10 MHz) - Hi Power

Fundamental Frequency: 155.1 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 44.2 dBm or 26.3 Watts, , ERP = 44.2 dBm - 2.15 dB = 42.1 dBm wrt. 0 dBi antenna gain

Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(26.3) = 64.2 \text{ dBc (dB below the carrier)}$

| Frequency (MHz) | E-Field Level @3m (dBμV/m) | ERP Measured by Substitution Method |       | EMI Receiver Detector (Peak/QP) | Antenna Plane (H/V) | Limit (dBc) | Margin (dB) | Pass / Fail |
|-----------------|----------------------------|-------------------------------------|-------|---------------------------------|---------------------|-------------|-------------|-------------|
|                 |                            | (dBm)                               | (dBc) |                                 |                     |             |             |             |
| 465.30          | 59.4                       | -42.5                               | -84.6 | PEAK                            | V                   | -64.2       | -20.4       | PASS        |
| 465.30          | 63.3                       | -40.0                               | -82.1 | PEAK                            | H                   | -64.2       | -17.9       | PASS        |
| 620.40          | 70.5                       | -32.1                               | -74.2 | PEAK                            | V                   | -64.2       | -10.0       | PASS        |
| 620.40          | 67.6                       | -37.2                               | -79.3 | PEAK                            | H                   | -64.2       | -15.1       | PASS        |

➤ The rf emissions were scanned from 10 MHz to 2 GHz, all emissions less than 20 dB below the FCC limit (-20dBm or -64.2 dBc) were recorded.



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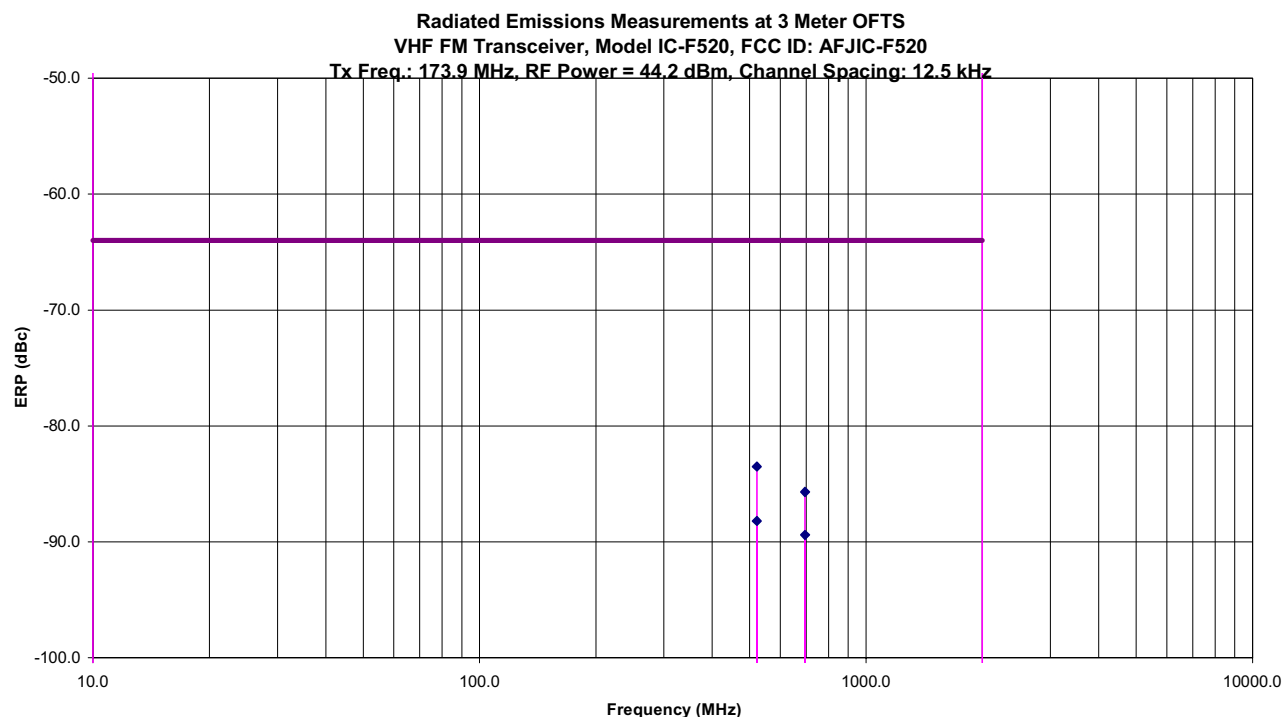
### 6.12.4.3. Highest Frequency (173.90 MHz) - Hi Power

Fundamental Frequency: 173.9 MHz, Narrow Band (12.5kHz channel spacing)  
 RF Output Power: 44.0 dBm or 25.0 Watts, , ERP = 44.0 dBm - 2.15 dB = 41.9 dBm wrt. 0 dBi antenna gain

Modulation: FM modulation with 2.5 kHz sine wave signal  
 FCC Limit:  $50 + 10 \cdot \log(25.0) = 64.0$  dBc (dB below the carrier)

| Frequency (MHz) | E-Field Level @3m (dBμV/m) | ERP Measured by Substitution Method |       | EMI Receiver Detector (Peak/QP) | Antenna Plane (H/V) | Limit (dBc) | Margin (dB) | Pass / Fail |
|-----------------|----------------------------|-------------------------------------|-------|---------------------------------|---------------------|-------------|-------------|-------------|
|                 |                            | (dBm)                               | (dBc) |                                 |                     |             |             |             |
| 521.70          | 62.8                       | -41.6                               | -83.5 | PEAK                            | V                   | -64.0       | -19.5       | PASS        |
| 521.70          | 56.1                       | -46.3                               | -88.2 | PEAK                            | H                   | -64.0       | -24.2       | PASS        |
| 695.60          | 56.4                       | -43.8                               | -85.7 | PEAK                            | V                   | -64.0       | -21.7       | PASS        |
| 695.60          | 55.0                       | -47.5                               | -89.4 | PEAK                            | H                   | -64.0       | -25.4       | PASS        |

➤ The rf emissions were scanned from 10 MHz to 2 GHz, all emissions less than 20 dB below the FCC limit (-20dBm or -64 dBc) were recorded.



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## 6.13. TRANSIENT FREQUENCY BEHAVIOR @ 90.214

### 6.13.1. Limits

Transient frequencies must be within the maximum frequency difference limits during the time intervals indicated:

| Time intervals <sup>1, 2</sup>                                                      | Maximum frequency difference <sup>3</sup> | All equipment  |
|-------------------------------------------------------------------------------------|-------------------------------------------|----------------|
|                                                                                     |                                           | 150 to 174 MHz |
| Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels   |                                           |                |
| t <sub>1</sub> <sup>4</sup>                                                         | ± 25.0 kHz                                | 5.0 ms         |
| t <sub>2</sub>                                                                      | ± 12.5 kHz                                | 20.0 ms        |
| t <sub>3</sub> <sup>4</sup>                                                         | ± 25.0 kHz                                | 5.0 ms         |
| Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels |                                           |                |
| t <sub>1</sub> <sup>4</sup>                                                         | ± 12.5 kHz                                | 5.0 ms         |
| t <sub>2</sub>                                                                      | ± 6.25 kHz                                | 20.0 ms        |
| t <sub>3</sub> <sup>4</sup>                                                         | ± 12.5 kHz                                | 5.0 ms         |

Notes:

- $t_{on}$  is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.  
 $t_1$  is the time period immediately following  $t_{on}$ .  
 $t_2$  is the time period immediately following  $t_1$ .  
 $t_3$  is the time period from the instant when the transmitter is turned off until  $t_{off}$ .  
 $t_{off}$  is the instant when the 1 kHz test signal starts to rise.
- During the time from the end of  $t_2$  to the beginning of  $t_3$ , the frequency difference must not exceed the limits specified in § 90.213.
- Difference between the actual transmitter frequency and the assigned transmitter frequency.
- If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

### 6.13.2. Method of Measurements

Refer to Exhibit 8, § 8.6 of this test report and ANSI/TIA/EIA - 603 - 1992, Sec. 2.2.19, Page 83

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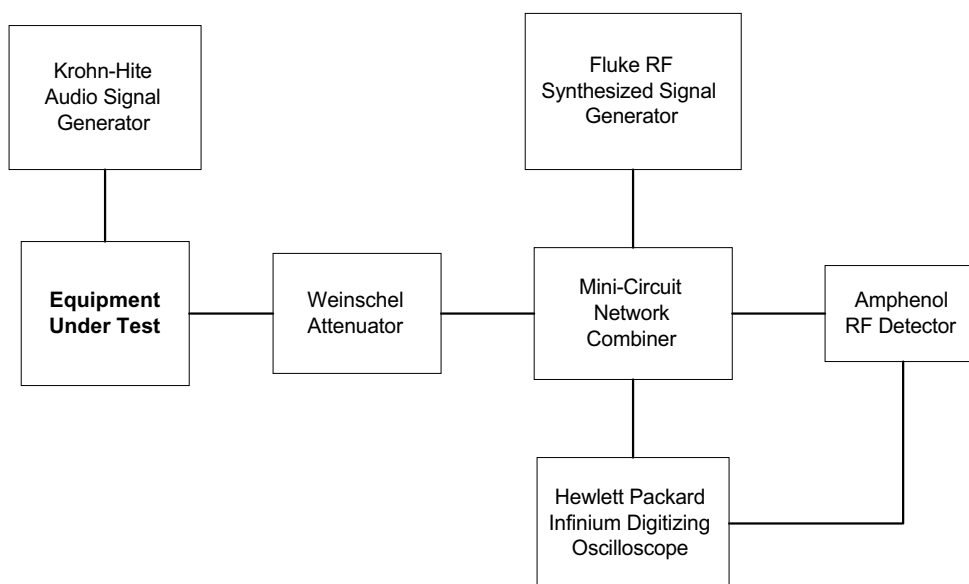
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### 6.13.3. Test Equipment List

| Test Instruments                 | Manufacturer        | Model No.     | Serial No. | Frequency Range        |
|----------------------------------|---------------------|---------------|------------|------------------------|
| Audio Signal Generator           | Krohn-Hite          | 2000          | 462        | 0.03 Hz ~ 30 MHz       |
| RF Synthesized Signal Generator  | Fluke               | 6061A         | 4770301    | 10 kHz – 1050 MHz      |
| Radio Communication Test Set     | Marconi Instruments | 2955          | 132037/226 | 400kHz - 1000 MHz      |
| Network Combiner                 | Mini-Circuit        | 15542         | --         | DC to 32 GHz           |
| Infinium Digitizing Oscilloscope | Hewlett Packard     | 54810A        | US38380192 | DC to 500 MHz, 1 Gsa/s |
| RF Detector                      | Amphenol            | UG-1094/U1050 | --         | --                     |
| Attenuator                       | Weinschel Corp      | 2320-34       | BH-7876    | DC – 18 GHz            |

### 6.13.4. Test Arrangement



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### 6.13.5. Test Data

#### Remark:

Test data plots for the following results can be found in Annex 1, plots # 25 to 32.

#### • 12.5 kHz Channel Spacing Operation

| Time Interval                                                                    | Maximum Transient Frequency | Transient Frequency Limit                             |
|----------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------|
| Test Configuration #1: FM with 1 kHz Sine Wave Signal, Freq Dev = $\pm 12.5$ kHz |                             |                                                       |
| $t_1$ (5 ms)<br>Switch ON Condition                                              | 4.0 kHz                     | 12.5 kHz                                              |
| $t_2$ (20 ms)<br>Switch On Condition                                             | 0                           | 12.5 kHz                                              |
| After $t_2$ (5 ms)<br>Switch On Condition                                        | 0                           | FCC Limit = $\pm 1100$ Hz<br>(2.5 ppm @ 136.10 MHz)   |
| Before $t_3$ (5 ms)<br>Switch Off Condition                                      | 0                           | FCC Limit = $\pm 1100$ Hz<br>(2.5 ppm @ 136.10 MHz)   |
| $t_3$ (5 ms)<br>Switch Off Condition                                             | 0                           | 12.5 kHz                                              |
| Test Configuration #2: Unmodulated                                               |                             |                                                       |
| $t_1$ (5 ms)<br>Switch ON Condition                                              | 4.0kHz                      | 12.5 kHz or no limit for RF Output<br>Power < 6 Watts |
| $t_2$ (20 ms)<br>Switch On Condition                                             | 0                           | 12.5 kHz                                              |
| After $t_2$ (5 ms)<br>Switch On Condition                                        | 0                           | FCC Limit = $\pm 1000$ Hz<br>(2.5 ppm @ 136.10 MHz)   |
| Before $t_3$ (5 ms)<br>Switch Off Condition                                      | 0                           | FCC Limit = $\pm 1000$ Hz<br>(2.5 ppm @ 136.10 MHz)   |
| $t_3$ (5 ms)<br>Switch Off Condition                                             | 1.6 kHz                     | 25 kHz or no limit for RF Output<br>Power < 6 Watts   |

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• **25 kHz Channel Spacing Operation**

| Time Interval                                                                  | Maximum Transient Frequency | Transient Frequency Limit                          |
|--------------------------------------------------------------------------------|-----------------------------|----------------------------------------------------|
| Test Configuration #1: FM with 1 kHz Sine Wave Signal, Freq Dev = $\pm 25$ kHz |                             |                                                    |
| $t_1$ (5 ms)<br>Switch ON Condition                                            | +0.45                       | 25 kHz                                             |
| $t_2$ (20 ms)<br>Switch On Condition                                           | 0                           | 25 kHz                                             |
| After $t_2$ (5 ms)<br>Switch On Condition                                      | 0                           | FCC Limit = $\pm 680.5$ Hz<br>(5 ppm @ 136.10 MHz) |
| Before $t_3$ (5 ms)<br>Switch Off Condition                                    | 0                           | FCC Limit = $\pm 680.5$ Hz                         |
| $t_3$ (5 ms)<br>Switch Off Condition                                           | 0                           | 25 kHz                                             |
| Test Configuration #2: Unmodulated                                             |                             |                                                    |
| $t_1$ (5 ms)<br>Switch ON Condition                                            | +3.125                      | 25 kHz                                             |
| $t_2$ (20 ms)<br>Switch On Condition                                           | 0                           | 25 kHz                                             |
| After $t_2$ (5 ms)<br>Switch On Condition                                      | 0                           | FCC Limit = $\pm 680.5$ Hz<br>(5 ppm @ 136.10 MHz) |
| Before $t_3$ (5 ms)<br>Switch Off Condition                                    | 0                           | FCC Limit = $\pm 680.5$ Hz<br>(5 ppm @ 136.10 MHz) |
| $t_3$ (5 ms)<br>Switch Off Condition                                           | 0                           | 25 kHz                                             |

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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 $20\text{Log}(1+\Gamma_1\Gamma_R)$ | 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:

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

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## 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.

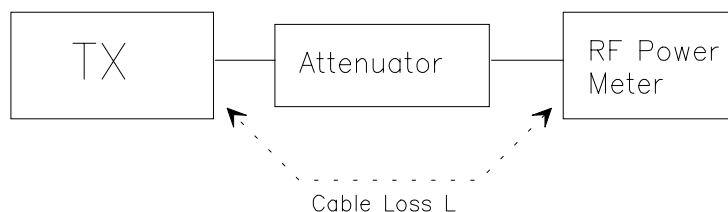
**Step 2:** Calculation of Average EIRP. See Figure 1

- 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:

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

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

**Figure 1.**



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

### 8.2.1. Maximizing RF Emission Level (E-Field)

- (a) The measurements was 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

$E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (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

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## 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:

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Figure 2

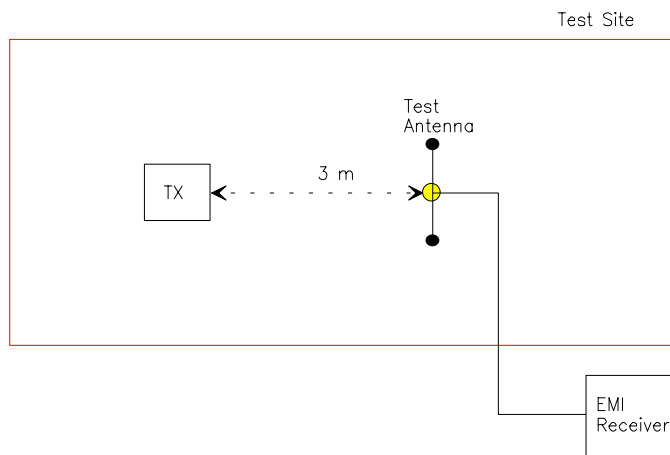
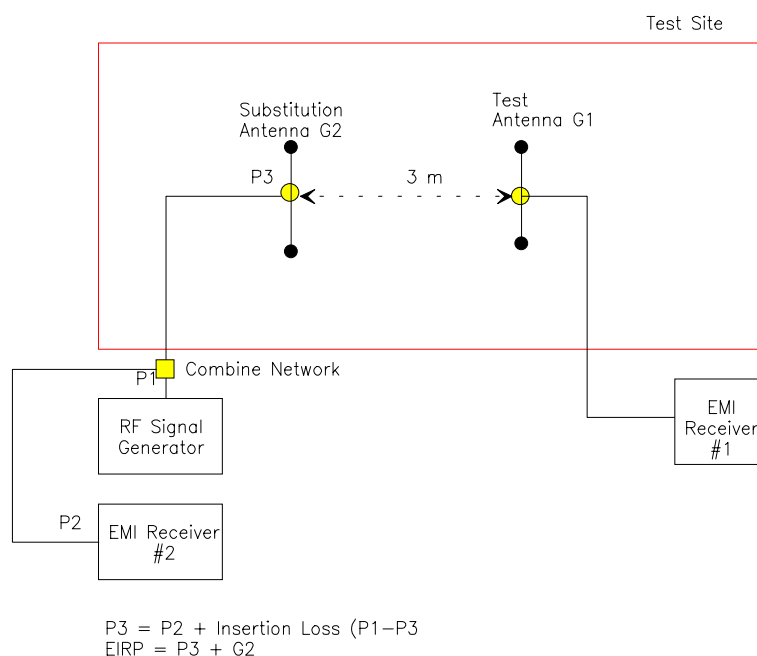


Figure 3



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### 8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

- (a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.
- (b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.
- (d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:
  - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
  - (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
  - (3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.
- (e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

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## 8.4. EMISSION MASK

**Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(1)**- 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.

## 8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 kHz minimum, VBW  $\geq$  RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

**FCC 47 CFR, Para. 2.1057 - Frequency spectrum to be investigated**- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10<sup>th</sup> harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

**FCC 47 CFR, Para. 2.1051 - Spurious Emissions at Antenna Terminal**- The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

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## 8.6. TRANSIENT FREQUENCY BEHAVIOR

1. Connect the transmitter under tests as shown in the above block diagram
2. Set the signal generator to the assigned frequency and modulate with a 1 kHz tone at  $\pm 12.5$  kHz deviation and its output level to be 50 dB below the transmitter rf output at the test receiver end.
3. Set the horizontal sweep rate on the storage scope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone from the Demodulator Output Port (DOP) of the Test Receiver. Adjust the vertical scale amplitude control of the scope to display the 1000 Hz at  $\pm 4$  divisions vertical Center at the display.
4. Adjust the scope so it will trigger on an increasing magnitude from the RF trigger signal of the transmitter under test when the transmitter was turned on. Set the controls to store the display.
5. The output at the DOP, due to the change in the ratio of the power between the signal generator input power and transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it will show the 1 kHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be  $t_m$ . The trace should be maintained within the allowed divisions during the period  $t_1$  and  $t_2$ .
6. During the time from the end of  $t_2$  to the beginning of  $t_3$  the frequency difference should not exceed the limits set by the FCC in Part 90.214 and the outlined in the Carrier Frequency Stability sections. The allowed limit is equal to FCC frequency tolerance limits specified in FCC 90.213.
7. Repeat the above steps when the transmitter was turned off for measuring  $t_3$ .

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