# ENGINEERING TEST REPORT

## VHF CHANNEL MODULE II (REPEATER)
## Model No.: CMDVHF
## FCC ID: LO6-CMDVHF

*Applicant:* **FUTURECOM SYSTEMS GROUP INC.**
*3277 Langstaff Road*
*Concord, Ontario*
*Canada, L4K 5P8*

***Tested in Accordance With***

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

**UltraTech's File No.: FSG-030FTX**

| | |
|---|---|
| This Test report is Issued under the Authority of<br>Tri M. Luu, Professional Engineer,<br>Vice President of Engineering<br>UltraTech Group of Labs<br><br>Date: Jan. 23, 2002 | |
| Report Prepared by: Tri M. Luu<br><br>Issued Date: Jan. 23, 2002 | Tested by: Hung Trinh, EMI/RFI Technician &<br>Wayne Wu, EMI/RFI Engineer<br><br>Test Dates: Jan. 17 - 22, 2002 |

*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 | • Exhibit 1: Submittal check lists<br>• Exhibit 2: Introduction<br>• Exhibit 3: Performance Assessment<br>• Exhibit 4: EUT Operation and Configuration during Tests<br>• Exhibit 5: Summary of test Results<br>• Exhibit 6: Measurement Data<br>• Exhibit 7: Measurement Uncertainty<br>• Exhibit 8: Measurement Methods | OK |
| 1 | Test Report - Plots of Measurement Data | • 99% OBW: Plots # 1 to 16<br>• Emission Masks: Plots # 17 to 44<br>• Spurious/Harmonic Emissions: Plots # 45 to 50<br>• Transient Frequency Behavior: Plots # 51 to 62 | OK<br>OK<br>OK<br>OK<br>OK |
| 2 | Test Setup Photos | Photos # 1 to 2 | OK |
| 3 | External Photos of EUT | Photos # 1 to 2 | OK |
| 4 | Internal Photos of EUT | Photos of 1 to 8 | OK |
| 5 | Cover Letters | • Letter from Ultratech for Certification Request<br>• Letter from the Applicant to appoint Ultratech to act as an agent<br>• Letter from the Applicant to request for Confidentiality Filing | OK<br>OK<br>OK |
| 6 | Attestation Statements | • Manufacturer's declaration | OK |
| 7 | ID Label/Location Info | ID Label<br>Location of ID Label | OK<br>OK |
| 8 | Block Diagrams | Block diagrams # 1 to 1 | OK |
| 9 | Schematic Diagrams | Schematic diagrams # 1 to 1 | OK |
| 10 | Parts List/Tune Up Info | | OK |
| 11 | Operational Description | | OK |
| 12 | RF Exposure Info | | OK |
| 13 | Users Manual | | OK |

# EXHIBIT 2. INTRODUCTION

## 2.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Parts 2 and 90 |
| **Title:** | Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 90 |
| **Purpose of Test:** | To gain FCC Certification Authorization for Radio operating in the frequency bands 138-174 MHz (12.5 kHz and 25 kHz Channel Spacings). |
| **Test Procedures:** | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |

## 2.2. RELATED SUBMITAL(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 &<br>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 |

# EXHIBIT 3. PERFORMANCE ASSESSMENT

## 3.1. CLIENT INFORMATION

| APPLICANT | |
|---|---|
| **Name:** | FUTURECOM SYSTEMS GROUP INC. |
| **Address:** | 3277 Langstaff Road<br>Concord, Ontario<br>Canada, L4K 5P8 |
| **Contact Person:** | Adam J. Kolanski<br>Phone #: 905-660-5548<br>Fax #: 905-660-6858<br>Email Address: adamk@futurecom.com |

| MANUFACTURER | |
|---|---|
| **Name:** | MOTOROLA INC. |
| **Address:** | 8000 West Sunrise Boulevard<br>Fort Lauderdale, Florida<br>USA 33322 |
| **Contact Person:** | Adam J. Kolanski<br>Phone #: 905-660-5548<br>Fax #: 905-660-6858<br>Email Address: adamk@futurecom.com |

## 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

| | |
|---|---|
| **Brand Name:** | FUTURECOM SYSTEMS GROUP INC. |
| **Product Name:** | VHF CHANNEL MODULE II (REPEATER) |
| **Model Name or Number:** | CMDVHF |
| **Serial Number:** | Pre-production |
| **Type of Equipment:** | Non-broadcast Radio Transceivers |
| **External Power Supply:** | N/A |
| **Transmitting/Receiving Antenna Type:** | Non-integral, Antenna gain limit = 15 dBi maximum |
| **Primary User Functions of EUT:** | Futurecom Model CMDVHF is fully software configurable synthesized, narrow band device. It's purpose is to receive a single RF channel, amplify, filter, process the channel signal and re-transmit it. The transmitter signal can be frequency different from that of the received signal Repeater Mode or on the same frequency-On Channel Repeater Mode. The operation of the CMDVHF is fully transparent to the users. |

## 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | [ ] Portable<br>[ ] Mobile<br>[ x ] Fixed Base station (fixed use) |
| **Intended Operating Environment:** | [ x ] Commercial<br>[ x ] Light Industry & Heavy Industry |
| **Power Supply Requirement:** | 27.6 Vdc, 3 Amps |
| **RF Output Power Rating:** | 32 Watts (conducted) |
| **Operating Frequency Range:** | 138-174 MHz |
| **Duty cycle:** | Continuous |
| **RF Output Impedance:** | 50 Ohms |
| **Channel Spacing:** | 12.5 kHz & 25 kHz |
| **Occupied Bandwidth (99%):** | 9.7 kHz for FM voice modulation (12.5 kHz Ch. Sp.)<br>8.9 kHz for FM data modulation (12.5 kHz Ch. Sp.)<br>14.6 kHz for FM voice modulation (25 kHz Ch. Sp.)<br>13.4 kHz for FM data modulation (25 kHz Ch. Sp.) |
| **Emission Designation*:** | 11K0F3E, 16K0F3E, 14K6F1D and 19K6F1D |
| **Digital Oscillator Frequencies:** | 96 MHz, 93.6 MHz, 29.4912 MHz |
| **Radio Oscillator Frequencies:** | 14.4 MHz, 16 MHz, 32.768 kHz,<br>RX IF: 109.65 MHz, 156 kHz, Lo=Rx+109.65 MHz |
| **Antenna Connector Type:** | SMA female |

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

1. For FM Voice Modulation:

(a) Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = 3 KHz
$B_n$ = 2M + 2DK = 2(3) + 2(2.5)(1) = **11 KHz**
emission designation: 11K0F3E

(b) Channel Spacing = 25 KHz, D = 5 KHz max, K = 1, M = 3 KHz
$B_n$ = 2M + 2DK = 2(3) + 2(5)(1) = **16 KHz**
emission designation: 16K0F3E

2. For FM Digital Modulation:

(a) Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = Data Rate in kb/s / Level of FM, Level of FM = 2
M = 9.6/2 kb/s, FM Level 2.
$B_n$ = 2M + 2DK = 2(9.6/2) + 2(2.5)(1) = **14.6 KHz**
emission designation: 14K6F1D

(b) Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = Data Rate in kb/s / Level of FM, Level of FM = 4
M = 9.6/2 kb/s, FM Level 2.
$B_n$ = 2M + 2DK = 2(9.6/2) + 2(5)(1) = **19.6 KHz**
emission designation: 14K6F1D

## 3.4. LIST OF EUT'S PORTS

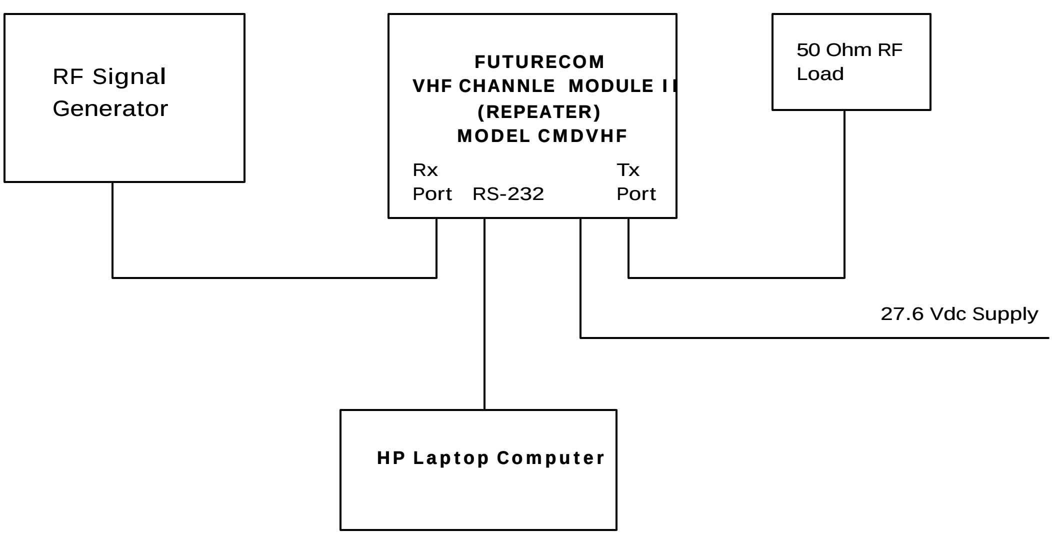
| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | Rx Port | 1 | SMA Female | Shielded coaxial |
| 2 | Tx Port | 1 | SMA Female | Shielded coaxial |
| 3 | I/O Port | 1 | DIN-8 Female | Shielded cable |

## 3.5. ANCILLARY EQUIPMENT

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

| **Ancillary Equipment # 1** | |
|---|---|
| Description: | Laptop computer |
| Brand name: | Hewlett Packard |
| Model Name or Number: | 5500 CS |
| Serial Number: | TW63138246 |
| Cable Length & Type: | Shielded |
| Connected to EUT's Port: | RS-232 |

## 3.6. BLOCK DIAGRAM OF TEST SETUP



# EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 27.6 Vdc, 3 Amps |

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

| | |
|---|---|
| **Operating Modes:** | The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data. |
| **Special Test Software:** | Futurecom PC software is used to configure the EUT to operate in a required test mode per test requirements. |
| **Special Hardware Used:** | None |
| **Transmitter Test Antenna:** | The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load. |

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):**<br><br>▪ 138-174 MHz band: | Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers:<br><br>▪ 138, 156 and 174 MHz |
| **Transmitter Wanted Output Test Signals:**<br><br>▪ RF Power Output (measured maximum output power):<br>▪ Normal Test Modulation<br>▪ Modulating signal source: | <br><br>▪ 32 Watts (conducted)<br><br>▪ FM<br>▪ External analog and data source |

| **Receiver Wanted Input Test Signals:** | |
|---|---|
| ▪ RF Input signal was set at the maximum RF input rating of: | ▪ 0 dBm |
| ▪ Normal Test Modulation | ▪ FM |
| ▪ Modulating signal source: | ▪ External analog and data source |

# EXHIBIT 5. SUMMARY OF TEST RESULTS

## 5.1. LOCATION OF TESTS

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

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

  The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Aug. 08, 2001.

## 5.2. APPLICABILITY & SUMMARY OF 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 | N/A for fixed base station |
| **90.213 & 2.1055** | Frequency Stability | Yes |
| **90.242(b)(8) & 2.1047(a)** | Audio Frequency Response | Yes |
| **90.210 & 2.1047(b)** | Modulation Limiting | Yes |
| **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 |
| **VHF CHANNEL MODULE II (REPEATER), Model No.: CMDVHF**, by **FUTURECOM SYSTEMS GROUP INC.** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices**. The engineering test report has been documented and kept in file and it is available anytime upon FCC request. | | |

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

None

## 5.4. DEVIATION OF STANDARD TEST PROCEDURES

None

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

## 6.1. TEST PROCEDURES

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

# 6.5. RF POWER OUTPUT @ FCC 2.1046 & 90.205

## 6.5.1. Limits @ FCC 90.205

Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.205 for specification details.

## 6.5.2. Method of Measurements

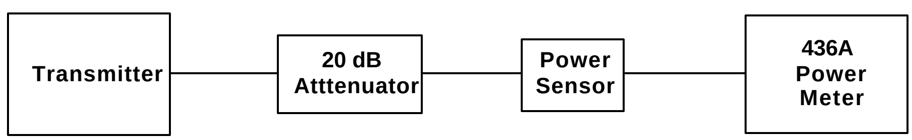
Refer to Exhibit 8, § 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

## 6.5.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Attenuator(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

- Power at RF Power Output Terminals




## 6.5.5. Test Data

| Transmitter Output Channel | Fundamental Frequency (MHz) | Measured (Average) Power (Watts) | Power Rating (Watts) |
|---|---|---|---|
| Lowest | 138.0 | 32 | 32 |
| Middle | 156.0 | 32 | 32 |
| Highest | 174.0 | 32 | 32 |

## 6.6. RF EXPOSURE REQUIRMENTS @ 1.1310 & 2.1091

NOT APPLICABLE FOR FIXED BASE STATION

## 6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213

### 6.7.1. Limits @ FCC 90.213

Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.213 for specification details.

| FREQUENCY RANGE (MHz) | FIXED & BASE STATIONS (ppm) | | |
|---|---|---|---|
| | 6.25 kHz | 12.5 kHz | 25 kHz |
| 138-174 MHz | 0.5 | 1.5 | 2.5 |

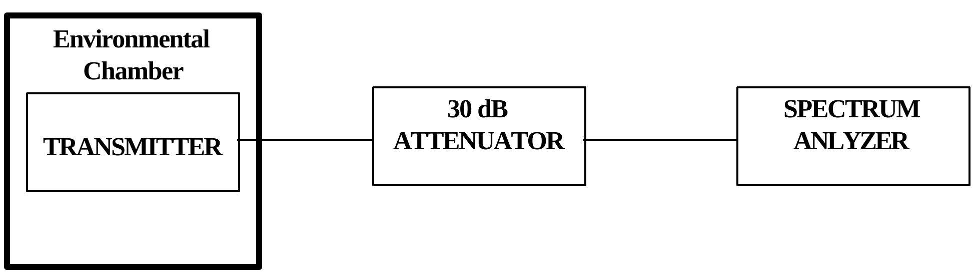
### 6.7.2. Method of Measurements

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/ EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Attenuator(s) | Bird | .. | … | DC – 22 GHz |
| Temperature & Humidity Chamber | Tenney | T5 | 9723B | $-40^o$ to $+60^o$ C range |

### 6.7.4. Test Arrangement



## 6.7.5. Test Data

| | |
|---|---|
| **Product Name:**<br>**Model No.:** | **VHF CHANNEL MODULE II (REPEATER)**<br>**CMDVHF** |
| **Center Frequency:** | 138 MHz |
| **Full Power Level:** | 36.7 dBm |
| **Frequency Tolerance Limit:** | 1.5 ppm or 207 Hz at 138 MHz |
| **Max. Frequency Tolerance Measured:** | +0.72 ppm or +100 Hz |
| **Input Voltage Rating:** | 27.6 Vdc, 3 Amps |

| **CENTER FREQUENCY & RF POWER OUTPUT VARIATION** | | | |
|---|---|---|---|
| **Ambient Temperature ($^oC$)** | **Supply Voltage (Nominal) 27.6 Volts dc** | **Supply Voltage (85% of Nominal) 23.5 Volts dc** | **Supply Voltage (115% of Nominal) 31.7 Volts dc** |
| | **Hz** | **Hz** | **Hz** |
| **-30** | +26 | N/A | N/A |
| **-20** | +36 | N/A | N/A |
| **-10** | +9 | N/A | N/A |
| **0** | +16 | N/A | N/A |
| **+10** | +16 | N/A | N/A |
| **+20** | +3 | +3 | +10 |
| **+30** | +40 | N/A | N/A |
| **+40** | +96 | N/A | N/A |
| **+50** | +100 | N/A | N/A |

# 6.8. AUDIO FREQUENCY RESPONSE @ FCC 2.1047(A) & 90.242(B)(8)

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

Recommended audio filter attenuation characteristics are give below:

| RF Band | Audio band | Minimum Attenuation Rel. to 1 kHz Attenuation |
|---|---|---|
| 406.1 – 960 MHz | 3 –20 kHz<br>20 – 30 kHz | 60 $\log_{10}(f/3)$ dB where f is in kHz<br>50dB |

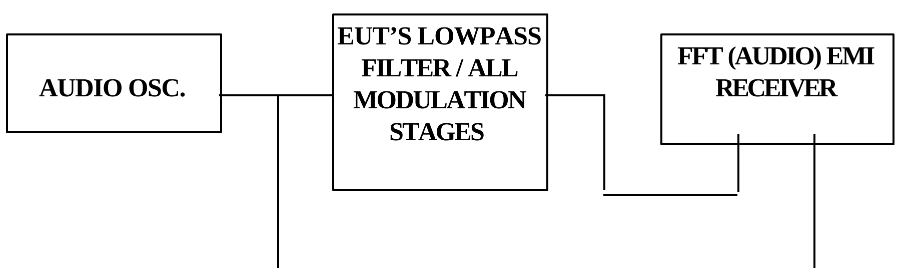
## 6.8.2. Method of Measurements

The rated audio input signal was applied to the input of the audio lowpass 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.

## 6.8.3. 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 |

## 6.8.4. Test Arrangement

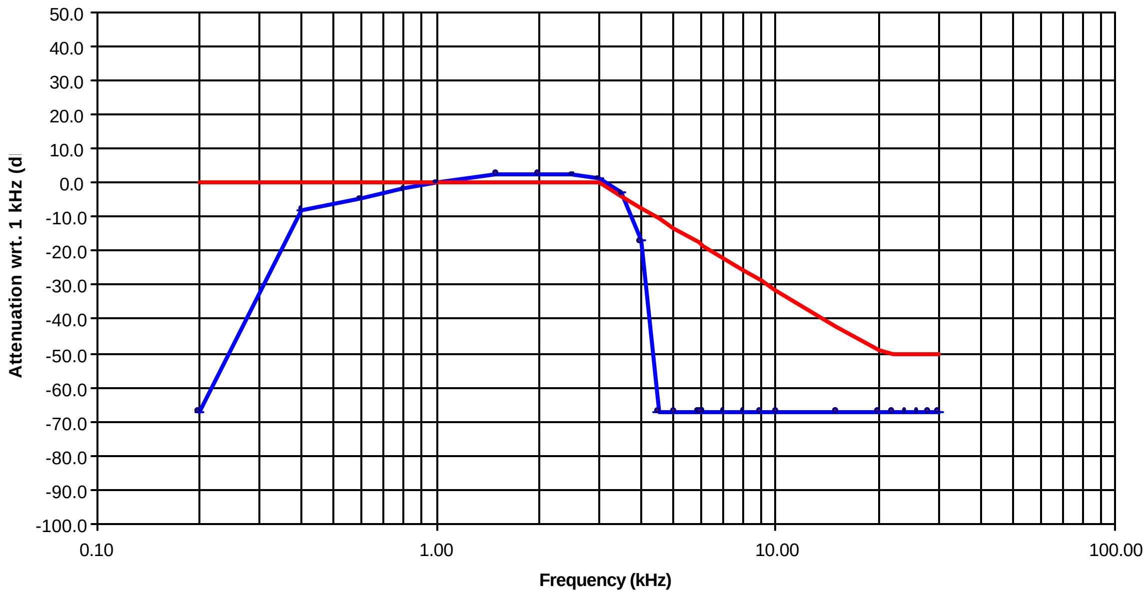


## 6.8.5. Test Data

### *6.8.5.1. 12.5 kHz Channel Spacing - Audio Frequency Response of all Modulation States*

| FREQUENCY (kHz) | AUDIO IN (dBV) | AUDIO OUT (dBV) | ATTEN. (OUT - IN) (dB) | ATTEN. wrt. 1 kHz (dB) | FCC LIMIT @22.915D (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|
| 0.20 | -10.9 | <-80.0 | <-69.1 | <-67.0 | 0 | PASS |
| 0.40 | -10.9 | -21.1 | -10.2 | -8.1 | 0.0 | PASS |
| 0.60 | -10.9 | -17.7 | -6.8 | -4.7 | 0.0 | PASS |
| 0.80 | -10.9 | -15.0 | -4.1 | -2.0 | 0.0 | PASS |
| 1.00 | -10.9 | -13.0 | -2.1 | 0.0 | 0.0 | PASS |
| 1.50 | -10.9 | -10.5 | 0.4 | 2.5 | 0.0 | PASS |
| 2.00 | -10.9 | -10.5 | 0.4 | 2.5 | 0.0 | PASS |
| 2.50 | -10.9 | -10.7 | 0.2 | 2.3 | 0.0 | PASS |
| 3.00 | -10.9 | -11.8 | -0.9 | 1.2 | 0.0 | PASS |
| 3.50 | -10.9 | -16.2 | -5.3 | -3.2 | -4.0 | PASS |
| 4.00 | -10.9 | -30.2 | -19.3 | -17.2 | -7.5 | PASS |
| 4.50 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -10.6 | PASS |
| 5.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -13.3 | PASS |
| 6.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -18.1 | PASS |
| 7.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -22.1 | PASS |
| 8.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -25.6 | PASS |
| 9.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -28.6 | PASS |
| 10.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -31.4 | PASS |
| 20.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -49.4 | PASS |
| 22.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -50.0 | PASS |
| 24.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -50.0 | PASS |
| 26.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -50.0 | PASS |
| 28.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -50.0 | PASS |
| 30.00 | -10.9 | <-80.0 | <-69.1 | <-67.0 | -50.0 | PASS |

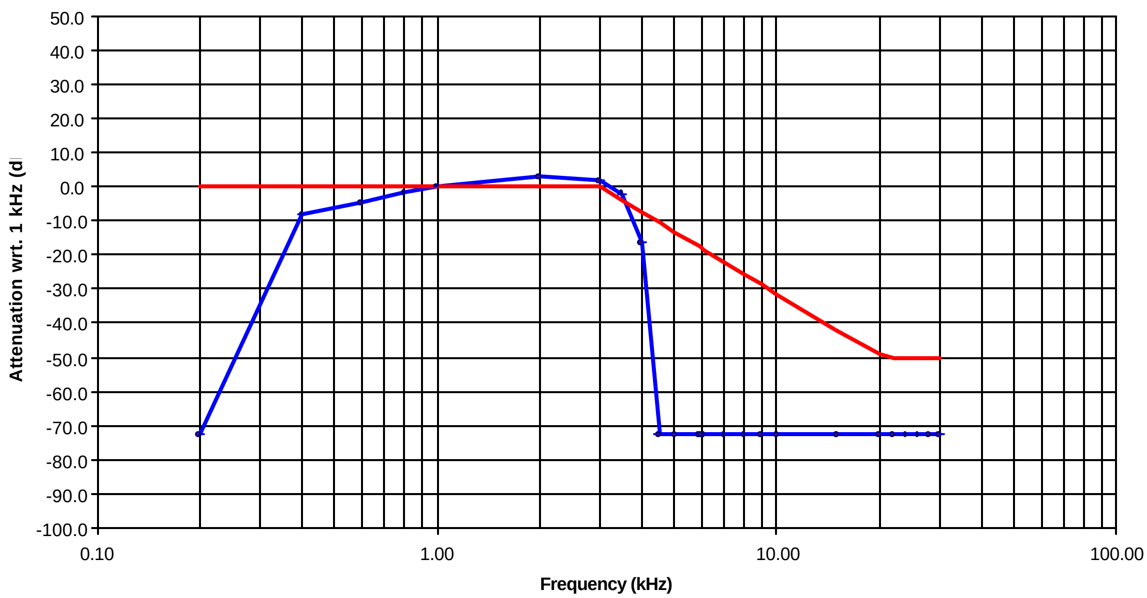
**AUDIO FREQUENCY REPSONSE OF ALL MODULATION STATES**
**FCC 2.987(a) & 90.242b(8)**
**Futurecom VHF Channel Module II (Repeater), Model CMDVHF**



### *6.8.5.2. 25 kHz Channel Spacing - Audio Frequency Response of all Modulation States*

| FREQUENCY (kHz) | AUDIO IN (dBV) | AUDIO OUT (dBV) | ATTEN. (OUT - IN) (dB) | ATTEN. wrt. 1 kHz (dB) | FCC LIMIT @22.915D (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|
| 0.20 | -11.5 | <-80.0 | <-68.5 | <-72.7 | 0 | PASS |
| 0.40 | -11.5 | -15.5 | -4.0 | -8.2 | 0.0 | PASS |
| 0.60 | -11.5 | -12.2 | -0.7 | -4.9 | 0.0 | PASS |
| 0.80 | -11.5 | -9.3 | 2.2 | -2.0 | 0.0 | PASS |
| 1.00 | -11.5 | -7.3 | 4.2 | 0.0 | 0.0 | PASS |
| 2.00 | -11.5 | -4.5 | 7.0 | 2.8 | 0.0 | PASS |
| 3.00 | -11.5 | -5.7 | 5.8 | 1.6 | 0.0 | PASS |
| 3.50 | -11.5 | -9.5 | 2.0 | -2.2 | -4.0 | PASS |
| 4.00 | -11.5 | -23.8 | -12.3 | -16.5 | -7.5 | PASS |
| 4.50 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -10.6 | PASS |
| 5.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -13.3 | PASS |
| 6.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -18.1 | PASS |
| 7.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -22.1 | PASS |
| 8.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -25.6 | PASS |
| 9.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -28.6 | PASS |
| 10.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -31.4 | PASS |
| 20.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -49.4 | PASS |
| 22.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -50.0 | PASS |
| 24.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -50.0 | PASS |
| 26.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -50.0 | PASS |
| 28.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -50.0 | PASS |
| 30.00 | -11.5 | <-80.0 | <-68.5 | <-72.7 | -50.0 | PASS |

**AUDIO FREQUENCY REPSONSE OF ALL MODULATION STATES**
**FCC 2.987(a) & 90.242b(8)**
**Futurecom VHF Channel Module II (Repeater), Model CMDVHF**



# 6.9. MODULATION LIMITING @ FCC 2.1047(B) & 90.210

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

Recommended frequency deviation characteristics are give below:

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

## 6.9.2. Method of Measurements

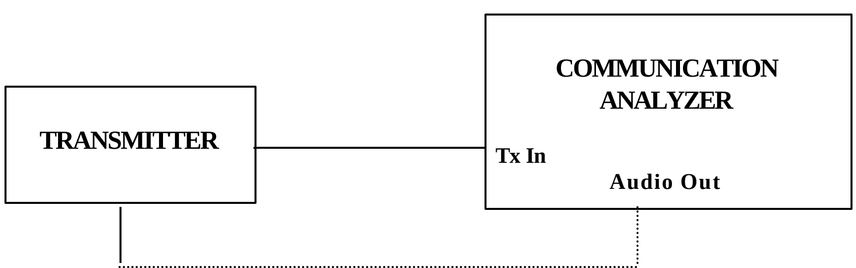
**For Audio Transmitter**:- The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

**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.

## 6.9.3. 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 |

## 6.9.4. Test Arrangement



## 6.9.5. Test Data

### *6.9.5.1. Data Modulation Limiting: FM Modulation with Random Data and Modulation Limiter set at a Maximum Frequency Deviation (Factory Setting).*

#### *6.9.5.1.1. 12.5 kHz Channel Spacing*

| Data Baud Rate | Peak Deviation (kHz) | Maximum Limit (kHz) |
|---|---|---|
| 9600 b/s | 2.4 | 2.5 |

#### *6.9.5.1.2. 25 kHz Channel Spacing*

| Data Baud Rate | Peak Deviation (kHz) | Maximum Limit (kHz) |
|---|---|---|
| 9600 b/s | 4.6 | 5.0 |

### 6.9.5.2. Voice Modulation Limiting:

#### 6.9.5.2.1. 12.5 kHz Channel Spacing

| MODULATING SIGNAL LEVEL | PEAK FREQUENCY DEVIATION (kHz) at the following modulating frequency: | | | | | MAXIMUM LIMIT |
|---|---|---|---|---|---|---|
| (mVrms) | 0.1 kHz | 0.5 kHz | 1.0 kHz | 3.0 kHz | 5.0 kHz | (kHz) |
| 10 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 2.5 |
| 20 | 0.0 | 0.0 | 0.1 | 0.3 | 0.0 | 2.5 |
| 40 | 0.0 | 0.1 | 0.2 | 0.6 | 0.0 | 2.5 |
| 60 | 0.0 | 0.2 | 0.3 | 0.9 | 0.0 | 2.5 |
| 80 | 0.0 | 0.2 | 0.4 | 1.2 | 0.0 | 2.5 |
| 100 | 0.0 | 0.3 | 0.6 | 1.4 | 0.0 | 2.5 |
| 200 | 0.0 | 0.5 | 0.7 | 1.9 | 0.0 | 2.5 |
| 400 | 0.0 | 1.1 | 2.1 | 2.0 | 0.0 | 2.5 |
| 600 | 0.0 | 1.6 | 2.1 | 2.1 | 0.0 | 2.5 |
| 800 | 0.0 | 2.1 | 2.0 | 2.1 | 0.0 | 2.5 |
| 1000 | 0.2 | 2.3 | 2.0 | 2.1 | 0.0 | 2.5 |
| 2000 | 0.5 | 1.9 | 2.0 | 2.1 | 0.0 | 2.5 |
| 4000 | 1.2 | 2.4 | 2.0 | 2.2 | 0.0 | 2.5 |
| 6000 | 1.9 | 2.5 | 2.0 | 2.2 | 0.0 | 2.5 |
| 8000 | 2.0 | 2.5 | 2.0 | 2.2 | 0.0 | 2.5 |
| 10000 | 2.1 | 2.5 | 2.0 | 2.2 | 0.0 | 2.5 |

Voice Signal Input Level = STD MOD Level + 16 dB = 49.5 dBmVrms + 16 = 65.5 dBmV or 1893 mV

| MODULATING FREQUENCY (KHz) | PEAK FREQUENCY DEVIATION (KHz) | MAXIMUM LIMIT (KHz) |
|---|---|---|
| 0.1 | 0.7 | 2.5 |
| 0.2 | 1.8 | 2.5 |
| 0.4 | 2.0 | 2.5 |
| 0.6 | 2.3 | 2.5 |
| 0.8 | 1.9 | 2.5 |
| 1.0 | 2.1 | 2.5 |
| 1.2 | 2.2 | 2.5 |
| 1.4 | 2.2 | 2.5 |
| 1.6 | 2.2 | 2.5 |
| 1.8 | 2.2 | 2.5 |
| 2.0 | 2.1 | 2.5 |
| 2.5 | 2.1 | 2.5 |
| 3.0 | 2.1 | 2.5 |
| 3.5 | 1.5 | 2.5 |
| 4.0 | 1.2 | 2.5 |
| 4.5 | 0.9 | 2.5 |
| 5.0 | 0.7 | 2.5 |
| 6.0 | 0.4 | 2.5 |
| 7.0 | 0.4 | 2.5 |
| 8.0 | 0.1 | 2.5 |
| 9.0 | 0.1 | 2.5 |
| 10.0 | 0.1 | 2.5 |

### *6.9.5.2.2. 25 kHz Channel Spacing*

| MODULATING SIGNAL LEVEL | PEAK FREQUENCY DEVIATION (kHz) at the following modulating frequency: | | | | | MAXIMUM LIMIT |
|---|---|---|---|---|---|---|
| **(mVrms)** | **0.1 kHz** | **0.5 kHz** | **1.0 kHz** | **3.0 kHz** | **5.0 kHz** | **(kHz)** |
| 10 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 5 |
| 20 | 0.0 | 0.1 | 0.2 | 0.6 | 0.0 | 5 |
| 40 | 0.0 | 0.2 | 0.6 | 1.2 | 0.0 | 5 |
| 60 | 0.0 | 0.3 | 0.7 | 1.8 | 0.0 | 5 |
| 80 | 0.0 | 0.4 | 0.9 | 2.4 | 0.0 | 5 |
| 100 | 0.0 | 0.6 | 1.1 | 3.0 | 0.0 | 5 |
| 200 | 0.0 | 1.1 | 2.3 | 3.9 | 0.0 | 5 |
| 400 | 0.0 | 2.2 | 4.1 | 4.1 | 0.0 | 5 |
| 600 | 0.0 | 3.3 | 4.1 | 4.2 | 0.0 | 5 |
| 800 | 0.0 | 4.1 | 4.0 | 4.3 | 0.0 | 5 |
| 1000 | 0.0 | 4.7 | 4.0 | 4.3 | 0.0 | 5 |
| 2000 | 1.0 | 3.6 | 4.1 | 4.3 | 0.0 | 5 |
| 4000 | 2.3 | 4.7 | 4.1 | 43 | 0.0 | 5 |
| 6000 | 3.7 | 5.0 | 4.1 | 4.3 | 0.0 | 5 |
| 8000 | 4.0 | 5.0 | 4.1 | 4.4 | 0.0 | 5 |
| 10000 | 4.0 | 5.0 | 4.1 | 4.4 | 0.0 | 5 |

Voice Signal Input Level = STD MOD Level + 16 dB = 49.5 dBmVrms + 16 = 65.5 dBmV or 1892 mV

| MODULATING FREQUENCY (KHz) | PEAK FREQUENCY DEVIATION (KHz) | MAXIMUM LIMIT (KHz) |
|---|---|---|
| 0.1 | 1.4 | 5 |
| 0.2 | 3.6 | 5 |
| 0.4 | 4.0 | 5 |
| 0.6 | 4.7 | 5 |
| 0.8 | 3.7 | 5 |
| 1.0 | 4.2 | 5 |
| 1.2 | 4.4 | 5 |
| 1.4 | 4.5 | 5 |
| 1.6 | 4.9 | 5 |
| 1.8 | 4 .4 | 5 |
| 2.0 | 4.3 | 5 |
| 2.5 | 4 .2 | 5 |
| 3.0 | 4.3 | 5 |
| 3.5 | 3.1 | 5 |
| 4.0 | 2.4 | 5 |
| 4.5 | 3.9 | 5 |
| 5.0 | 0.3 | 5 |
| 6.0 | 0.3 | 5 |
| 7.0 | 0.3 | 5 |
| 8.0 | 0.3 | 5 |
| 9.0 | 0.3 | 5 |
| 10.0 | 0.3 | .5 |

## 6.10. EMISSION MASK @ FCC 2.1049, 90.208 & 90.210

### 6.10.1. Limits @ FCC 90.209 & 90.210

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

| Frequency Range (MHz) | Maximum Authorized BW (KHz) | Channel Spacing (KHz) | Recommended Frequency Deviation (KHz) | FCC Applicable Mask |
|---|---|---|---|---|
| 138-174 | 20.0 | 25.0 | 5.0 | • Mask B – Voice<br>• Mask C – Data |
| 138-174 | 11.25 | 12.5 | 2.5 | • Mask D – Voice & Data |

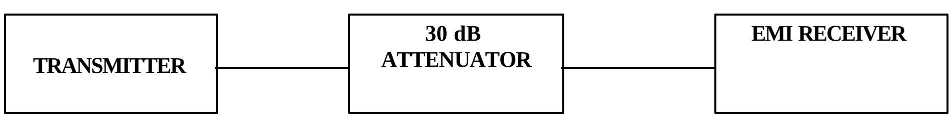
### 6.10.2. Method of Measurements

Refer to Exhibit 8, § 8.4 of this report for measurement details

### 6.10.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| EMI Receiver/ 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 |

### 6.10.4. Test Arrangement



### 6.10.5. Test Data

**General Comments**:

- The RF input signal was set at the EUT's maximum RF input rating of 0.0 dBm.
- It was noticed during tests that the RF output signals in "translator mode" or "transmitter mode" are exactly identical.
- Since the EUT can work as a translator or transmitter, tests were performed on both RF input and output signals for comparison for deviation after translation.
- It was also found from the below measurements that the 99% OBW of the RF output signals are always slightly smaller than those of the RF input signals. Thus, we can conclude that RF output signals always meet the FCC requirements with any RF input source that meet FCC rules.

#### 6.10.5.1. 99% Occupied Bandwidth of RF Output Signal at Tx Port vs. RF input Signal at Rx Port

##### 6.10.5.1.1. 12.5 kHz Channel Spacing, FM Voice Modulation, Translator/Transmitter Mode.

| RF Output Frequency (MHz) | Channel Spacing (kHz) | Modulation | EUT Operating Mode | Measured 99% OBW of RF Input Signal (156 MHz, 0dBm) apply to Rx Port (kHz) | Measured 99% OBW (kHz) | Recommended 99% OBW (kHz) |
|---|---|---|---|---|---|---|
| 138 | 12.5 | FM modulation with 2.5 kHz sine wave signal | Translator | 9.9 | 9.6 | 10.125 |
| 156 | 12.5 | FM modulation with 2.5 kHz sine wave signal | Translator | 9.9 | 9.7 | 10.125 |
| 174 | 12.5 | FM modulation with 2.5 kHz sine wave signal | Translator | 9.9 | 9.7 | 10.125 |

- Please refer to Plots # 1 to 4 in Annex 1 for detailed measurements. Plot #1 shows the RF input signal to EUT's Rx Port and Plots # 2 to 4 show the translated RF output signal at Tx Port.
- The 99% OBW measurements were checked when the EUT was set in "transmitter mode" and the results were found to be the same as those in "translator mode"

### *6.10.5.1.2. 12.5 kHz Channel Spacing, FM Data Modulation, Translator/Transmitter Mode.*

| RF Output Frequency (MHz) | Channel Spacing (kHz) | Modulation | EUT Operating Mode | Measured 99% OBW of RF Input Signal (156 MHz, 0dBm) apply to Rx Port (kHz) | Measured 99% OBW (kHz) | Recommended 99% OBW (kHz) |
|---|---|---|---|---|---|---|
| 138 | 12.5 | FM modulation with 9600 b/s random data | Translator | 9.5 | 8.7 | 10.125 |
| 156 | 12.5 | FM modulation with 9600 b/s random data | Translator | 9.5 | 8.7 | 10.125 |
| 174 | 12.5 | FM modulation with 9600 b/s random data | Translator | 9.5 | 8.9 | 10.125 |

- Please refer to Plots # 5 to 8 in Annex 1 for detailed measurements. Plot #5 shows the RF input signal to EUT's Rx Port and Plots # 6 to 8 show the translated RF output signal at Tx Port.
- The 99% OBW measurements were checked when the EUT was set in "transmitter mode" and the results were found to be the same as those in "translator mode"

### *6.10.5.1.3. 25 kHz Channel Spacing, FM Voice Modulation, Translator/Transmitter Mode*

| RF Output Frequency (MHz) | Channel Spacing (kHz) | Modulation | EUT Operating Mode | Measured 99% OBW of RF Input Signal (156 MHz, 0dBm) apply to Rx Port (kHz) | Measured 99% OBW (kHz) | Recommended 99% OBW (kHz) |
|---|---|---|---|---|---|---|
| 138 | 25 | FM modulation with 2.5 kHz sine wave signal | Translator | 14.7 | 14.6 | 20.0 |
| 156 | 25 | FM modulation with 2.5 kHz sine wave signal | Translator | 14.7 | 14.6 | 20.0 |
| 174 | 25 | FM modulation with 2.5 kHz sine wave signal | Translator | 14.7 | 14.7 | 20.0 |

- Please refer to Plots # 9 to 12 in Annex 1 for detailed measurements. Plot #9 shows the RF input signal to EUT's Rx Port and Plots # 10 to 12 show the translated RF output signal at Tx Port.
- The 99% OBW measurements were checked when the EUT was set in "transmitter mode" and the results were found to be the same as those in "translator mode"

### *6.10.5.1.4. 25 kHz Channel Spacing, FM Data Modulation, Translator/Transmitter Mode.*

| RF Output Frequency (MHz) | Channel Spacing (kHz) | Modulation | EUT Operating Mode | Measured 99% OBW of RF Input Signal (156 MHz, 0dBm) apply to Rx Port (kHz) | Measured 99% OBW (kHz) | Recommended 99% OBW (kHz) |
|---|---|---|---|---|---|---|
| 138 | 25 | FM modulation with 9600 b/s random data | Translator | 13.8 | 13.0 | 20.0 |
| 156 | 25 | FM modulation with 9600 b/s random data | Translator | 13.8 | 13.4 | 20.0 |
| 174 | 25 | FM modulation with 9600 b/s random data | Translator | 13.8 | 13.3 | 20.0 |

- Please refer to Plots # 13 to 16 in Annex 1 for detailed measurements. Plot #13 shows the RF input signal to EUT's Rx Port and Plots # 14 to 16 show the translated RF output signal at Tx Port.
- The 99% OBW measurements were checked when the EUT was set in "transmitter mode" and the results were found to be the same as those in "translator mode"

### 6.10.5.2. Emission Masks of RF Output Signal at Tx Port vs. RF Input Signal at Rx Port

**General Comments**:

- The RF input signal was set at the EUT's maximum RF input rating of 0.0 dBm.
- It was noticed during tests that the RF output signals in "translator mode" or "transmitter mode" are exactly identical.
- Since the EUT can work as a translator or transmitter, tests were performed on both RF input and output signals for comparison for deviation after translation.

#### 6.10.5.2.1. Emission Mask D: 12.5 kHz Channel Spacing, FM Modulation with 2.5 KHz Sine Wave Signal, "Translator" Mode.

Conforms with FCC Mask D. Please refer to Plots # 17 to 20 in Annex 1 for detailed measurements. Plot #17 shows the RF input signal applied to EUT's Rx Port and Plots # 18 to 20 show the translated RF output signal at Tx Port.

#### 6.10.5.2.2. Emission Mask D: 12.5 kHz Channel Spacing, FM Modulation with 9600 b/s Random Data Signal, "Translator" Mode.

Conforms with FCC Mask D. Please refer to Plots # 21 to 24 in Annex 1 for detailed measurements. Plot # 21 shows the RF input signal applied to EUT's Rx Port and Plots # 22 to 24 show the translated RF output signal at Tx Port.

#### 6.10.5.2.3. Emission Mask B: 25 kHz Channel Spacing, FM Modulation with 2.5 KHz Sine Wave Signal, "Translator" Mode.

Conforms with FCC Mask B. Please refer to Plots # 25 to 28 in Annex 1 for detailed measurements. Plot # 25 shows the RF input signal applied to EUT's Rx Port and Plots # 26 to 28 show the translated RF output signal at Tx Port.

#### 6.10.5.2.4. Emission Mask C: 25 kHz Channel Spacing, FM Modulation with 9600 b/s Random Data Signal, "Translator" Mode.

Conforms with FCC Mask D. Please refer to Plots # 29 to 32 in Annex 1 for detailed measurements. Plot # 29 shows the RF input signal applied to EUT's Rx Port and Plots # 30 to 32 show the translated RF output signal at Tx Port.

### *6.10.5.2.5. Emission Mask D: 12.5 kHz Channel Spacing, FM Modulation with 2.5 KHz Sine Wave Signal, "Transmitter" Mode.*

Conforms with FCC Mask D. Please refer to Plots # 33 to 35 in Annex 1 for detailed measurements of the RF output signal at Tx Port. The RF input signal applied to the Rx Port was not required for this test.

### *6.10.5.2.6. Emission Mask D: 12.5 kHz Channel Spacing, FM Modulation with 9600 b/s Random Data Signal, "Transmitter" Mode.*

Conforms with FCC Mask D. Please refer to Plots # 36 to 38 in Annex 1 for detailed measurements of the RF output signal at Tx Port. The RF input signal applied to the Rx Port was not required for this test.

### *6.10.5.2.7. Emission Mask C: 25 kHz Channel Spacing, FM Modulation with 9600 b/s Random Data Signal, "Transmitter" Mode.*

Conforms with FCC Mask C. Please refer to Plots # 39 to 41 in Annex 1 for detailed measurements of the RF output signal at Tx Port. The RF input signal applied to the Rx Port was not required for this test.

### *6.10.5.2.8. Emission Mask B: 25 kHz Channel Spacing, FM Modulation with 2.5 KHz Sine Wave Signal, "Transmitter" Mode.*

Conforms with FCC Mask B. Please refer to Plots # 42 to 44 in Annex 1 for detailed measurements of the RF output signal at Tx Port. The RF input signal applied to the Rx Port was not required for this test.

# 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) – Voice & data | 10 MHz to Lowest frequency of the radio to 10$^{th}$ harmonic of the highest frequency of the radio | 43+10*log(P) or -13 dBm |
| 90.210(d) – Voice & data | 10 MHz to Lowest frequency of the radio to 10$^{th}$ harmonic of the highest frequency of the radio | 50+10*log(P) or -20 dBm or 70 dBc whichever is less |

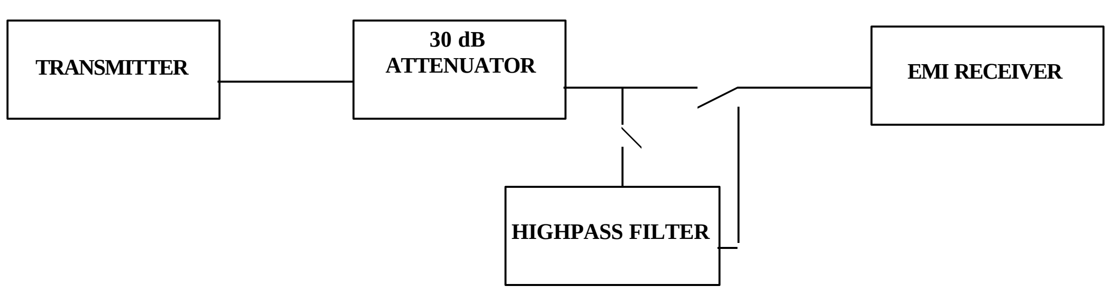
## 6.11.2. Method of Measurements

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 |
|---|---|---|---|---|
| EMI Receiver/ 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 | IITI11000AC | Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz |

## 6.11.4. Test Arrangement



### 6.11.5. Plots

Please refer to plots # 45 through # 50 in Annex 1 for details of measurements

### 6.11.6. Test Data

**Remarks**:

- Per our preliminary scans, the transmitter conducted emissions at the Tx Port were scanned from 10 MHz to 2 GHz at lowest frequency (138 MHz), middle frequency (156 MHz) and highest frequency (174 MHz) were the same with the following test configurations:

  (1) 12.5 kHz channel spacing, FM voice modulation, translator mode
  (2) 12.5 kHz channel spacing / FM digital modulation, translator mode
  (3) 12.5 kHz channel spacing, FM voice modulation, transmitter mode
  (4) 12.5 kHz channel spacing / FM digital modulation, transmitter mode
  (5) 25 kHz channel spacing, FM voice modulation, translator mode
  (6) 25 kHz channel spacing / FM digital modulation, translator mode
  (7) 25 kHz channel spacing, FM voice modulation, transmitter mode
  (8) 25 kHz channel spacing / FM digital modulation, transmitter mode

  Therefore, the final tests with configuration (1) will be performed and recorded with the lowest limit of 50 + 10*Log(P in Watts) for worst case among 12.5 kHz and 25 kHz channel spacing operations.

- The RF Input level at the Rx Port was applied at its maximum rated value of 0.0 dBm per manufacturer's specification.

### 6.11.6.1. Lowest Frequency (138 MHz)

RF Output Frequency: 138 MHz
Channel Spacing Mode: 12.5 kHz
RF Test Mode: Translator
RF Input Level: 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz
RF Output Power: 45.0 dBm dBm (conducted)
RF IN/OUT Modulation: FM modulation with 2.5 kHz Sine Wave Signal
FCC Limit: 50 + 10*log(32 watts) = 65.1 dBc

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 276.00 | -38.9 | -83.9 | -65.1 | -18.8 | PASS |
| 414.00 | -30.5 | -75.5 | -65.1 | -10.4 | PASS |
| 552.00 | -50.7 | -95.7 | -65.1 | -30.6 | PASS |
| 1242.00 | -51.6 | -96.6 | -65.1 | -31.5 | PASS |
| 1380.00 | -51.3 | -96.3 | -65.1 | -31.2 | PASS |
| 1518.00 | -48.2 | -93.2 | -65.1 | -28.1 | PASS |
| 1656.00 | -49.2 | -94.2 | -65.1 | -29.1 | PASS |
| 1794.00 | -49.7 | -94.7 | -65.1 | -29.6 | PASS |

- The emissions were scanned from 10 MHz to 2 GHz and all emissions within 30 dB below the limits were Recorded.
- Please refer to plots # 45 through # 46 in Annex 1 for details of measurements

### *6.11.6.2. Middle Frequency (156.0 MHz)*

RF Output Frequency: 156 MHz
Channel Spacing Mode: 12.5 kHz
RF Test Mode: Translator
RF Input Level: 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz
RF Output Power: 45.0 dBm dBm (conducted)
RF IN/OUT Modulation: FM modulation with 2.5 kHz Sine Wave Signal
FCC Limit: 50 + 10*log(32 watts) = 65.1 dBc

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 312.00 | -39.8 | -84.8 | -65.1 | -19.7 | PASS |
| 468.00 | -25.1 | -70.1 | -65.1 | -5.0 | PASS |
| 624.00 | -45.5 | -90.5 | -65.1 | -25.4 | PASS |
| 1092.00 | -51.8 | -96.8 | -65.1 | -31.7 | PASS |
| 1248.00 | -50.0 | -95.0 | -65.1 | -29.9 | PASS |
| 1404.00 | -46.9 | -91.9 | -65.1 | -26.8 | PASS |
| 1560.00 | -47.1 | -92.1 | -65.1 | -27.0 | PASS |
| 1716.00 | -46.0 | -91.0 | -65.1 | -25.9 | PASS |

- The emissions were scanned from 10 MHz to 2 GHz and all emissions within 30 dB below the limits were recorded.
- Please refer to Plots # 47 through # 48 in Annex 1 for details of measurements

### *6.11.6.3. Highest Frequency (174.0 MHz)*

RF Output Frequency: 174 MHz
Channel Spacing Mode: 12.5 kHz
RF Test Mode: Translator
RF Input Level: 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz
RF Output Power: 45.0 dBm dBm (conducted)
RF IN/OUT Modulation: FM modulation with 2.5 kHz Sine Wave Signal
FCC Limit: 50 + 10*log(32 watts) = 65.1 dBc

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 348.00 | -23.9 | -68.9 | -65.1 | -3.8 | PASS |
| 522.00 | -37.3 | -82.3 | -65.1 | -17.2 | PASS |
| 870.00 | -47.9 | -92.9 | -65.1 | -27.8 | PASS |
| 1218.00 | -46.8 | -91.8 | -65.1 | -26.7 | PASS |
| 1392.00 | -50.9 | -95.9 | -65.1 | -30.8 | PASS |
| 1566.00 | -43.3 | -88.3 | -65.1 | -23.2 | PASS |
| 1914.00 | -44.4 | -89.4 | -65.1 | -24.3 | PASS |

- The emissions were scanned from 10 MHz to 2 GHz and all emissions within 30 dB below the limits were recorded.
- Please refer to plots # 49 through # 50 in Annex 1 for details of measurements

# 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:

| Frequency Range (MHz) | Maximum Authorized BW (KHz) | Channel Spacing (KHz) | Recommended Frequency Deviation (KHz) | FCC Applicable Mask |
|---|---|---|---|---|
| 138-174 | 20.0 | 25.0 | 5.0 | • 90.210(b): Mask B – Voice<br>• 90.210(c): Mask C – Data |
| 138-174 | 11.25 | 12.5 | 2.5 | • 90.210(d): Mask D – Voice & Data |

## 6.12.2. Method of Measurements

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

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

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

## 6.12.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer/ EMI Receiver | Hewlett Packard | HP 8546A | … | 9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors. |
| RF Amplifier | Com-Power | PA-102 | | 1 MHz to 1 GHz, 30 dB gain nominal |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 GHz, 30 dB nominal |
| Biconilog Antenna | EMCO | 3142 | 10005 | 30 MHz to 2 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-434 | 30 GHz – 1 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-440 | 30 GHz – 1 GHz |
| Horn Antenna | EMCO | 3155 | 9701-5061 | 1 GHz – 18 GHz |
| Horn Antenna | EMCO | 3155 | 9911-5955 | 1 GHz – 18 GHz |
| RF Signal Generator | Hewlett Packard | HP 83752B | 3610A00457 | 0.01 – 20 GHz |

### 6.12.4. Test Setup

Please refer to Photo # 1 to # 2 in Annex 2 for detailed of test setup.

### 6.12.5. Test Data

**Remarks**:

- Per our preliminary scans, the transmitter radiated emissions at the Tx Port were scanned from 10 MHz to 2 GHz at lowest frequency (138 MHz), middle frequency (156 MHz) and highest frequency (174 MHz) were the same with the following test configurations:

  (1) 12.5 kHz channel spacing, FM voice modulation, translator mode
  (2) 12.5 kHz channel spacing / FM digital modulation, translator mode
  (3) 12.5 kHz channel spacing, FM voice modulation, transmitter mode
  (4) 12.5 kHz channel spacing / FM digital modulation, transmitter mode
  (5) 25 kHz channel spacing, FM voice modulation, translator mode
  (6) 25 kHz channel spacing / FM digital modulation, translator mode
  (7) 25 kHz channel spacing, FM voice modulation, transmitter mode
  (8) 25 kHz channel spacing / FM digital modulation, transmitter mode

  Therefore, the final tests with configuration (1) will be performed and recorded with the lowest limit of 50 + 10*Log(P in Watts) for worst case among 12.5 kHz and 25 kHz channel spacing operations.

- The RF Input level at the Rx Port was applied at its maximum rated value of 0.0 dBm per manufacturer's specification.

### 6.12.5.1. Lowest Frequency (138 MHz)

| | |
|---|---|
| RF Output Frequency: | 138 MHz |
| Channel Spacing Mode: | 12.5 kHz |
| RF Test Mode: | Translator |
| RF Input Level: | 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz |
| RF Output Power: | 45.0 dBm dBm (conducted) |
| RF IN/OUT Modulation: | FM modulation with 2.5 kHz Sine Wave Signal |
| FCC Limit: | 50 + 10*log(32 watts) = 65.1 dBc |
| The emissions were scanned from 10 MHz to 2 GHz, and all rf emissions in this band were at least 90 dB below the carrier. Therefore, no measurement within 20 dB below the limit of 65.1 dBc was recorded | |

### 6.12.5.2. Near Middle Frequency (156.0 MHz)

| | |
|---|---|
| RF Output Frequency: | 156 MHz |
| Channel Spacing Mode: | 12.5 kHz |
| RF Test Mode: | Translator |
| RF Input Level: | 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz |
| RF Output Power: | 45.0 dBm dBm (conducted) |
| RF IN/OUT Modulation: | FM modulation with 2.5 kHz Sine Wave Signal |
| FCC Limit: | 50 + 10*log(32 watts) = 65.1 dBc |
| The emissions were scanned from 10 MHz to 2 GHz, and all rf emissions in this band were at least 90 dB below the carrier. Therefore, no measurement within 20 dB below the limit of 65.1 dBc was recorded | |

### 6.12.5.3. Highest Frequency (174.0 MHz)

| | |
|---|---|
| RF Output Frequency: | 156 MHz |
| Channel Spacing Mode: | 12.5 kHz |
| RF Test Mode: | Translator |
| RF Input Level: | 0.0 dBm as rated by manufacturer (conducted) @ 156 MHz |
| RF Output Power: | 45.0 dBm dBm (conducted) |
| RF IN/OUT Modulation: | FM modulation with 2.5 kHz Sine Wave Signal |
| FCC Limit: | 50 + 10*log(32 watts) = 65.1 dBc |
| The emissions were scanned from 10 MHz to 2 GHz, and all rf emissions in this band were at least 90 dB below the carrier. Therefore, no measurement within 20 dB below the limit of 65.1 dBc was recorded | |

# 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 [1, 2] | Maximum frequency difference [3] | All equipment |
|---|---|---|
| | | 150 to 174 MHz |
| Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels | | |
| $t_1$ [4] | ± 25.0 kHz | 5.0 ms |
| $t_2$ | ± 12.5 kHz | 20.0 ms |
| $t_3$ [4] | ± 25.0 kHz | 5.0 ms |
| Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels | | |
| $t_1$ [4] | ± 12.5 kHz | 5.0 ms |
| $t_2$ | ± 6.25 kHz | 20.0 ms |
| $t_3$ [4] | ± 12.5 kHz | 5.0 ms |

1 $t_{on}$ 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.

2 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.

3 Difference between the actual transmitter frequency and the assigned transmitter frequency.

4 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

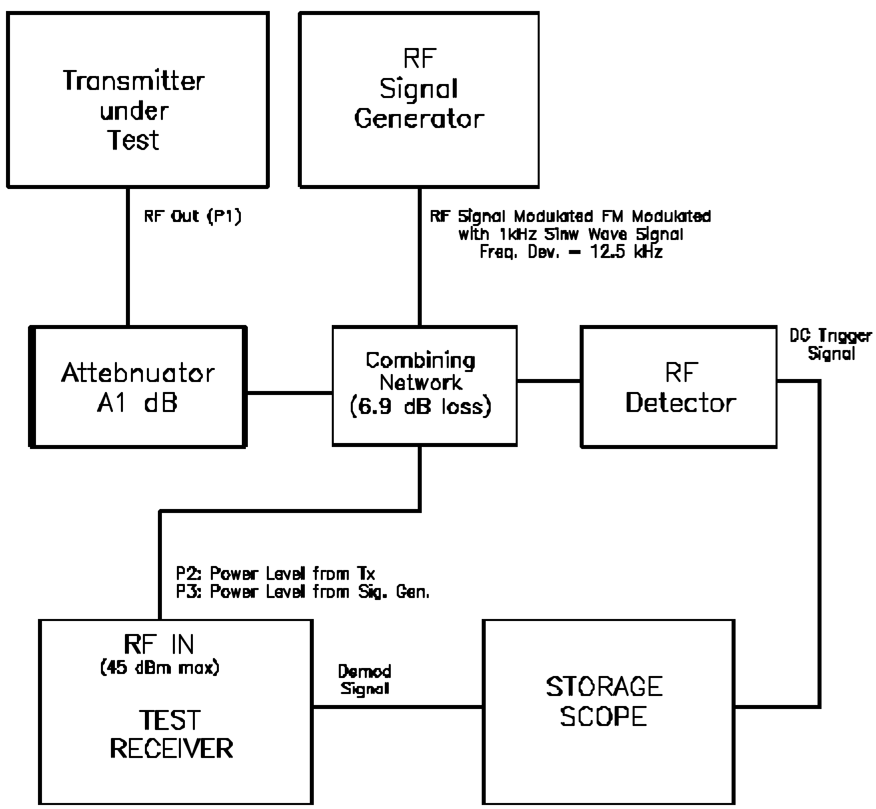
Refer to Exhibit 8, § 8.6 of this test report and ANSI/TIA/EIA - 603 - 1992, Sec. 2.2.19, Page 83

## 6.13.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| RF Synthesized Signal Generator | Fluke | 6061A | … | 10 kHz – 1GHz<br>13 dBm output max. @ 50 Ohms |
| Communication Analyzer (Test Receiver) | Rohde & Schwarz | SMFP2 | 879988/057 | GHz<br>including SINAD, S/N, Modulation meters, AF & RF signal generators and etc.... |
| Network Combiner | Mini-circuit | 15542 | … | DC to 22 GHz<br>(7 dB insertion loss) |
| Digital Storage Scope | Phillips | 3320A | DQ 646 | DC - 5 MHz |
| 67297 RF Detector, | Herotex | DZ122-553 | 63400 | .. |

## 6.13.4. Test Arrangement

The following drawings show details of the test setup for radiated emissions measurements



## 6.13.5. Plots

Please refer to plots # 51 through # 62 in Annex 1 for details of measurements

## 6.13.6. Test Data

### *6.13.6.1. 12.5 kHz Channel Spacing Operation*

| Test Configuration #1: Unmodulated | | |
|---|---|---|
| Time Interval | Transient Frequency | Transient Frequency Limit |
| $t_1$ (10 ms)<br>Switch ON Condition | 0 | 12.5 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0<br>0 | 6.25 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 12.5 kHz |
| Test Configuration #2: FM modulation with 1 KHz Sine Wave, Freq. Dev.: 2.5 KHz | | |
| $t_1$ (10 ms)<br>Switch ON Condition | 0 | 12.5 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0 | 6.25 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 12.5 kHz |
| Test Configuration #3: FM modulation with 9600 b/s random data, , Freq. Dev.: 2.5 KHz | | |
| $t_1$ (10 ms)<br>Switch ON Condition | 0 | 12.5 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0 | 6.25 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = $\pm$ 207 Hz<br>(1.5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 12.5 kHz |

### 6.13.6.2. 25 kHz Channel Spacing Operation

| Test Configuration #1: Unmodulated | | |
|---|---|---|
| Time Interval | Transient Frequency | Transient Frequency Limit |
| $t_1$ (10 ms)<br>Switch ON Condition | -4.8 kHz | 25 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0 | 12.5 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = ± 345 Hz<br>(5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = ± 345 Hz<br>(5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 25 kHz |
| Test Configuration #2: FM modulation with 1 KHz Sine Wave, Freq. Dev.: 5.0 KHz | | |
| $t_1$ (10 ms)<br>Switch ON Condition | -11.2 kHz | 25 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0 | 12.5 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = ± 345 Hz<br>(5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = ± 345 Hz<br>(5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 25 kHz |
| Test Configuration #3: FM modulation with 9600 b/s random data, , Freq. Dev.: 5 KHz | | |
| $t_1$ (10 ms)<br>Switch ON Condition | 0 | 25 kHz |
| $t_2$ (25 ms)<br>Switch On Condition | 0 | 12.5 kHz |
| After $t_2$ (10 ms)<br>Switch On Condition | 0 | FCC Limit = ± 207 Hz<br>(1.5 ppm @ 138 MHz) |
| Before $t_3$ (10 ms)<br>Switch Off Condition | 0 | FCC Limit = ± 207 Hz<br>(1.5 ppm @ 138 MHz) |
| $t_3$ (10 ms)<br>Switch Off Condition | 0 | 25 kHz |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

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

## 7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

# EXHIBIT 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).
- I f the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

**Step 1**: Duty Cycle measurements 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 = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

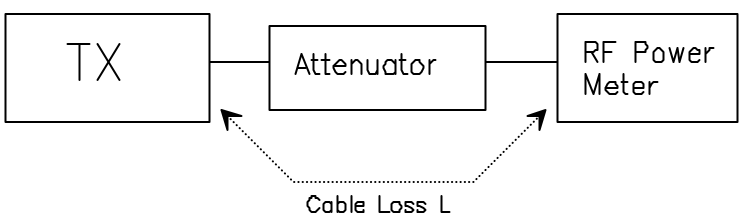
**Step 2**: Calculation of Average EIRP. See Figure 1

- 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 dBi, according to the formula:

**EIRP = A + G + 10log(1/x)**

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

**Figure 1.**



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

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

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

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

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

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

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

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + 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 $360^o$ 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 dB**
Total Correction factor in EMI Receiver # 2 = L2 – L1 + G1

Where:

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

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

**Figure 2**

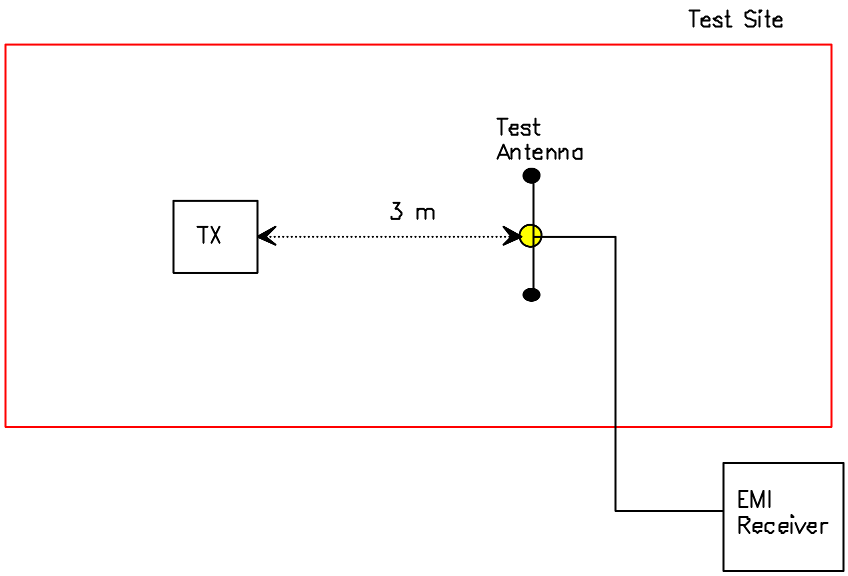
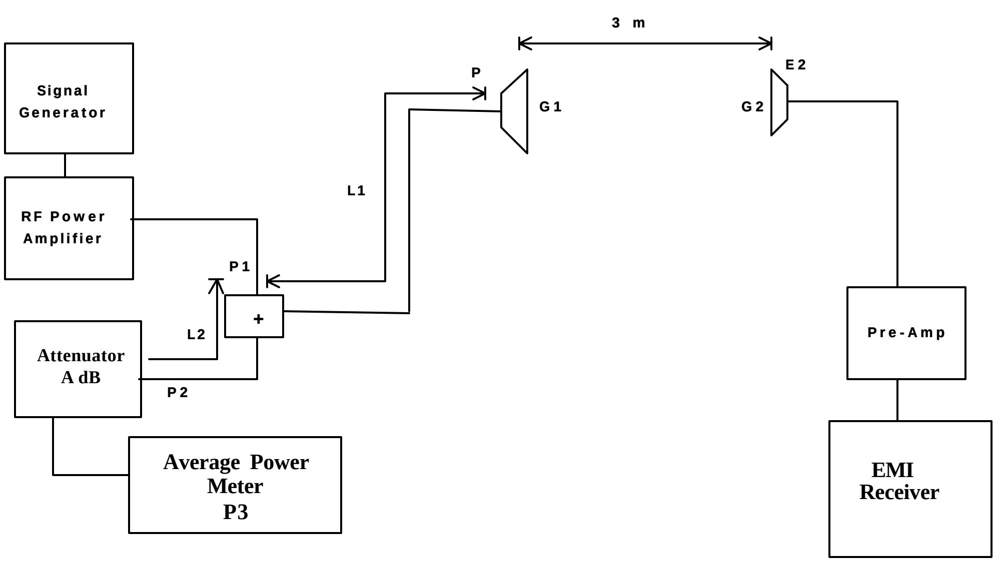



**Figure 3**



## 8.3. 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).

## 8.4. EMISSION MASK

**Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i)**:- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ±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 ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

**FCC CFR 47, 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 $10^{th}$ 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 CFR 47, 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.

## 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 ±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 ±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 $t_{on}$. 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 $t_3$.