ENGINEERING TEST REPORT

OEM Radio Packet Modem
Model No.: PNS-816D
FCC ID: QEZPNS-816D

Applicant:

Palmnet System Co., Ltd.
5th ACE TECHNO TOWER II, 197-7 Kuro-Dong
Kuro-Ku, Seoul
South Korea 152-847

Tested in Accordance With

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

UltraTech's File No.: PNS-001F90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: July 2, 2002	
Report Prepared by: Dan Huynh Issued Date: July 2, 2002	Tested by: Hung Trinh, RFI/EMI Technician Test Dates: May 27-29, 2002

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

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TABLE OF CONTENTS

EXHIBIT 1. SUBMITTAL CHECK LIST 1

EXHIBIT 2. INTRODUCTION 2

2.1. SCOPE 2
2.2. RELATED SUBMITTAL(S)/GRANT(S) 2
2.3. NORMATIVE REFERENCES 2

EXHIBIT 3. PERFORMANCE ASSESSMENT 3

3.1. CLIENT INFORMATION 3
3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION 3
3.3. EUT'S TECHNICAL SPECIFICATIONS 4
3.4. LIST OF EUT'S PORTS 4
3.5. ANCILLARY EQUIPMENT 4

EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS 5

4.1. CLIMATE TEST CONDITIONS 5
4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS 5

EXHIBIT 5. SUMMARY OF TEST RESULTS 6

5.1. LOCATION OF TESTS 6
5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS 6
5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES 6

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS 7

6.1. TEST PROCEDURES 7
6.2. MEASUREMENT UNCERTAINTIES 7
6.3. MEASUREMENT EQUIPMENT USED 7
6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER 7
6.5. RF POWER OUTPUT @ FCC 2.1046 & 90.205 8
6.5.1. Limits @ FCC 90.205 8
6.5.2. Method of Measurements 8
6.5.3. Test Equipment List 8
6.5.4. Test Arrangement 8
6.5.5. Test Data 8
6.6. RF EXPOSURE REQUIREMENTS @ 1.1310 & 2.1091 9
6.6.1. Limits 9
6.6.2. Method of Measurements 9
6.6.3. Test Data 10
6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213 11
6.7.1. Limits @ FCC 90.213 11
6.7.2. Method of Measurements 11
6.7.3. Test Equipment List 11
6.7.4. Test Arrangement 11
6.7.5. Test Data 12
6.8. MODULATION LIMITING @ FCC 2.1047(B) & 90.210 13
6.8.1. Limits @ FCC 2.1047(b) and 90.210 13

6.8.2. Method of Measurements 13
6.8.3. Test Equipment List 13
6.8.4. Test Arrangement 13
6.8.5. Test Data 14
6.9. EMISSION MASK @ FCC 2.1049, 90.209 & 90.210 15
6.9.1. Limits @ FCC 90.209 & 90.210 15
6.9.2. Method of Measurements 15
6.9.3. Test Equipment List 15
6.9.4. Test Arrangement 15
6.9.5. Test Data 15
6.10. SPURIOUS EMISSIONS AT ANTENNA TERMINALS @ FCC 2.1051 & 90.210 16
6.10.1. Limits @ 90.210 16
6.10.2. Method of Measurements 16
6.10.3. Test Equipment List 16
6.10.4. Test Arrangement 16
6.10.5. Test Data 17
6.11. FIELD STRENGTH OF SPURIOUS RADIATION @ FCC 2.1053 & 90.210 18
6.11.1. Limits @ FCC 90.210 18
6.11.2. Method of Measurements 18
6.11.3. Test Equipment List 18
6.11.4. Test Data 19

EXHIBIT 7. MEASUREMENT UNCERTAINTY 21

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY 21

EXHIBIT 8. MEASUREMENT METHODS 22

8.1. CONDUCTED POWER MEASUREMENTS 22
8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD 23
8.2.1. Maximizing RF Emission Level (E-Field) 23
8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method 24
8.3. FREQUENCY STABILITY 26
8.4. EMISSION MASK 27
8.5. SPURIOUS EMISSIONS (CONDUCTED) 27

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex Number	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Report – Test Data Plots	• 99% Emission Bandwidth, Plots # 1 to 3. • Emission Mask G, Plots # 4 to 6. • Spurious Emissions at Antenna Terminals, Plots # 7 to 15	OK
2	Test Setup Photos	Radiated Emissions Test Setup Photos	OK
3	External EUT Photos	External EUT Photos	OK
4	Internal EUT Photos	Internal EUT Photos	OK
5	Cover Letters	• Letter from Ultratech for Certification Request • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK
6	Attestation Statements	--	--
7	ID Label/Location Info	ID Label Location of ID Label	OK
8	Block Diagrams	Block Diagram	OK
9	Schematic Diagrams	Schematics	OK
10	Parts List/Tune Up Info	PCB and Parts List	OK
11	Operational Description	Detailed Operational Description	OK
12	RF Exposure Info	See Section 6.6 of this Test Report for RF Exposure Requirements	OK
13	Users Manual	PNS-816D User's Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Telecommunication – 47 Code of Federal Regulations (CFR) Parts 2 & 90
Purpose of Test:	To gain FCC Certification Authorization for Radio operating in the frequency band 806-825 MHz (25 kHz Channel Spacing).
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 SUBMITTAL(S)/GRANT(S)

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2001	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 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Palmnet System Co., Ltd.
Address:	5th ACE TECHNO TOWER II, 197-7 Kuro-Dong Kuro-Ku, Seoul South Korea, 152-847
Contact Person:	Mr. Brian Kim Phone #: (822) 2634-2574 Fax #: (822) 2634-2576 Email Address: brian.kim@pnsa.net

MANUFACTURER	
Name:	Palmnet System Co., Ltd.
Address:	5th ACE TECHNO TOWER II, 197-7 Kuro-Dong Kuro-Ku, Seoul South Korea, 152-847
Contact Person:	Mr. Brian Kim Phone #: (822) 2634-2574 Fax #: (822) 2634-2576 Email Address: brian.kim@pnsa.net

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:	Palmnet System Co., Ltd.
Product Name:	OEM Radio Packet Modem
Model Name or Number:	PNS-816D
Serial Number:	Test Sample
Type of Equipment:	Licensed Non-Broadcast Radio Communication Equipment
External Power Supply:	N/A
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	Wireless data communication module modem

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	[ ] Portable [x] Mobile [x] Base station (fixed use)
Intended Operating Environment:	[x] Commercial [x] Light Industry & Heavy Industry
Power Supply Requirement:	3.9 Vdc
RF Output Power Rating:	2 Watts
Operating Frequency Range:	806-825 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 kHz
(1)Occupied Bandwidth (99%):	16.58 kHz
(2)Emission Designation:	19K6F1D
Oscillator Frequency:	12.8 MHz
Antenna Connector Type:	MMCX

NOTES:

(1) See Annex 1 Test Data Plots # 1 to 3 for detailed measurements.

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

FM Digital Modulation

Channel Spacing = 25 kHz, D = 5 kHz max., Level of FM = 4, K = 1,
M = Data Rate in kb/s / Level of FM = 19.2/4 kb/s

$B_n = 2M + 2DK = 2(19.2/4) + 2(5)(1) = 19.6$ kHz
Emission Designation: 19K6F1D

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Antenna	1	MMCX	Terminated with 50 Ohms RF Load
2	Serial Connector	1	ZIP, 30 Pin	Non-shielded

3.5. ANCILLARY EQUIPMENT

The radio device was connected to the following ancillary/peripheral equipment necessary to exercise the functions and features of the EUT.

1. Palmnet System Co., Ltd RPM Test Board Rev. A
2. Toshiba Laptop, Model 1605CDS/4.3, SN: 1027387CU

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:	3.9 Vdc

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:	Test software provided by Palmnet System Co., Ltd to configured the EUT for different test modes
Special Hardware Used:	Palmnet System Co., Ltd RPM Test Board Rev. A
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ω RF Load.

Transmitter Test Signals	
Frequency Band(s): ▪ 806 - 825 MHz	Near lowest, near middle & near highest frequencies in each frequency band(s) that the transmitter covers: ▪ 806.0125 MHz, 815.0875 MHz and 824.9875 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): 2 Watts ▪ Normal Test Modulation: FM with 19.2 kbps random data rate ▪ Modulating Signal Source: External	

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

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

Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above 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 08, 2001.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC 47 CFR SECTION(S)	TEST REQUIREMENTS	APPLICABILITY (YES/NO)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	Radiofrequency Radiation Exposure Evaluation	Yes
90.213 & 2.1055	Frequency Stability	Yes
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	N/A
90.210 & 2.1047(b)	Modulation Limiting	Tested to the recommended limits
90.210 & 2.1049	Emission Limitation & Emission Masks	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
OEM Radio Packet Modem, Model No.: **PNS-816D,** by **Palmnet System Co., Ltd.** has also been tested and found to comply with FCC Part 15, Subpart B - Radio Receivers and Class B Digital Devices. The engineering test report has been documented and kept in file and it is available upon FCC request.		

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

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

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in 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 47 CFR, Part 90, Subpart I, Para. 90.205 for specification details.

6.5.2. Method of Measurements

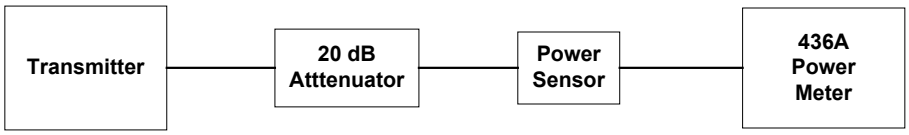
Please refer to Exhibit 8, section 8.1 (Conducted) for test procedures and test setup.

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Attenuator	Weinschel Corp	24-20-34	BK-2804	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 Channel Output	Fundamental Frequency (MHz)	Measured Power (dBm)	Power Rating (dBm)
Lowest	806.0125	33.0	33.0
Middle	815.0875	32.9	33.0
Highest	824.9875	32.9	33.0

6.6. RF EXPOSURE REQUIREMENTS @ 1.1310 & 2.1091

6.6.1. Limits

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

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

F = Frequency in MHz

6.6.2. Method of Measurements

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

- Spread spectrum transmitters operating under section 15.247 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

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

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

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

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones., 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)

6.6.3. Test Data

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	Compliance with FCC Rules
Minimum calculated separation distance between antenna and persons required: ***24.3 cm**	Manufacturer' instruction for separation distance between antenna and persons required: **25 cm**. Please refer to the User's Manual for RF Exposure information.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Please refer to the User's Manual for RF Exposure information.
Any other RF exposure related issues that may affect MPE compliance	None.

*RF Exposure distance limits calculation:

$r = (PG/4\Pi S)^{1/2}$

$S = F/1500 = 806/1500\ mW/cm^2$ (F is the lowest frequency in the operating band)
$P = 33\ dBm = 10^{(33/10)}\ mW$ (Maximum power measured at antenna terminals)
$G = 3\ dBi = 10^{(3/10)}$ numeric (Highest antenna gain to be used with this device)

$r = [(10^{(33/10)})\ (10^{(3/10)}) / 4\Pi\ (806/1500)]^{1/2} = 24.3\ cm$

Therefore, 25 cm is the minimum separation distance required to comply with RF exposure requirements.

6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213

6.7.1. Limits @ FCC 90.213

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

Frequency Range (MHz)	Fixed and Base Stations (ppm)	Mobile Stations (ppm)	
		> 2 Watts	≤ 2 Watts
806-821	* 1.5	2.5	2.5

* Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

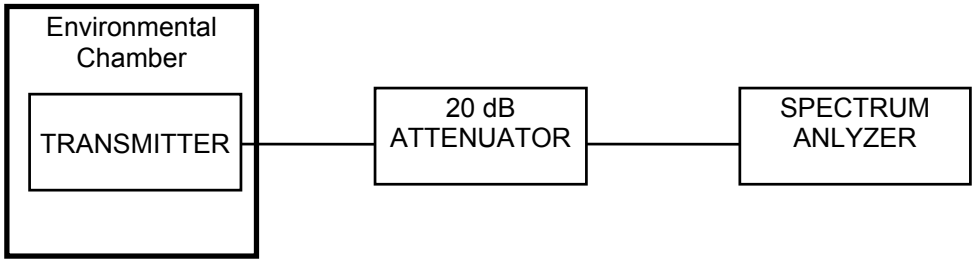
6.7.2. Method of Measurements

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

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator	Weinschel Corp	24-20-34	BK-2804	DC – 8.5 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40° to +60 ° C range

6.7.4. Test Arrangement



6.7.5. Test Data

Product Name: **Model No.:**	OEM Radio Packet Modem PNS-816D
Center Frequency:	806.0125 MHz
Full Power Level:	2 Watts
Frequency Tolerance Limit:	2015 Hz at 806.0125 MHz (2.5 ppm)
Max. Frequency Tolerance Measured:	+1600 Hz (2.0 ppm)
Input Voltage Rating:	3.9 V

CENTER FREQUENCY & RF POWER OUTPUT VARIATION			
Ambient Temperature (^{o}C)	**Supply Voltage (Nominal) 3.9 Volts**	**Supply Voltage (85% of Nominal) 3.315 Volts**	**Supply Voltage (115% of Nominal) 4.485 Volts**
	Hz	**Hz**	**Hz**
-30	+1600	n/a	n/a
-20	+1050	n/a	n/a
-10	-750	n/a	n/a
0	-550	n/a	n/a
+10	-350	n/a	n/a
+20	0	-450	0
+30	-50	n/a	n/a
+40	-50	n/a	n/a
+50	+50	n/a	n/a

6.8. MODULATION LIMITING @ FCC 2.1047(b) & 90.210

6.8.1. Limits @ FCC 2.1047(b) and 90.210

The EUT shall be installed with a modulation limiter, which limits the deviation of the FM carrier less than manufacturer's setting provided that the rf output spectrum must meet the required MASK

Recommendation:

- 1.25 kHz for 6.25 kHz Channel Spacing System
- 2.5 kHz for 12.5 kHz Channel Spacing
- 5 kHz for 25 kHz Channel Spacing System

6.8.2. Method of Measurements

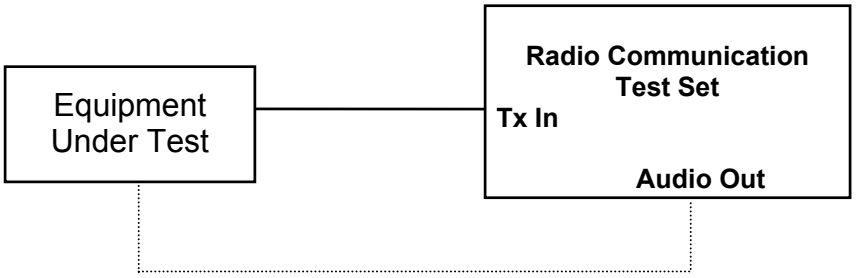
For Audio Transmitter: The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

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.

6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Radio Communication Test Set	Marconi Instruments	2955	132037/226	400kHz - 1000 MHz

6.8.4. Test Arrangement



6.8.5. Test Data

6.8.5.1. Data Modulation Limiting: FM modulation with random data and Modulation Limiter set at a Maximum Frequency Deviation (Factory Setting).

Data Baud Rate	Peak Frequency Deviation (kHz)	Recommended Limit (kHz)
19200	6.7	5

Remark: The peak frequency deviation was found to be higher than the recommended limit. However, this limit is no longer mandatory.

6.8.5.2. Voice Modulation Limiting

Not applicable.

6.9. EMISSION MASK @ FCC 2.1049, 90.209 & 90.210

6.9.1. 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 Max. Frequency Deviation (kHz)	FCC Applicable Mask
806-821/ 851-866	20	25	5	MASK B (Voice) & MASK G (Data)

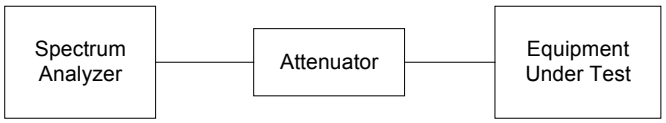
6.9.2. Method of Measurements

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

6.9.3. 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	Weinschel Corp	24-20-34	BK-2804	DC – 8.5 GHz

6.9.4. Test Arrangement



6.9.5. Test Data

Conform. Please refer to test data plots # 4 to 6 in Annex 1 for details of measurements

6.10. SPURIOUS EMISSIONS AT ANTENNA TERMINALS @ FCC 2.1051 & 90.210

6.10.1. Limits @ 90.210

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

FCC Rules	Worst Case Emissions Limit	Attenuation Limit (dBc)
FCC 90.210(g)	FCC 90.210 (g)	43 + 10 log (P), P is output power in watts

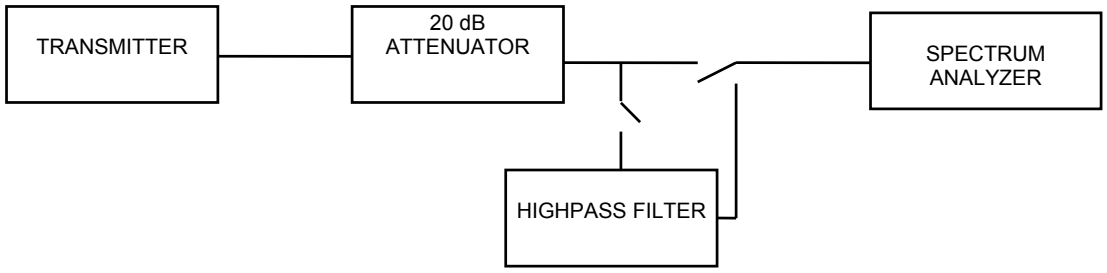
6.10.2. Method of Measurements

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

6.10.3. 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	Weinschel Corp	24-20-34	BK-2804	DC – 8.5 GHz
Highpass Filter	K & L Microwave	11SH10-1500/ T8000-0/0	2	Cut-off Frequency at 1500 MHz

6.10.4. Test Arrangement



6.10.5. Test Data

6.10.5.1. Near Lowest Frequency (806.0125 MHz)

The emissions were scanned from 10 MHz to 9 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 7 to 9 in Annex 1 for measurement results.

6.10.5.2. Near Middle Frequency (815.0875 MHz)

The emissions were scanned from 10 MHz to 9 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 10 to 12 in Annex 1 for measurement results.

6.10.5.3. Near Highest Frequency (824.9875 MHz)

The emissions were scanned from 10 MHz to 9 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 13 to 15 in Annex 1 for measurement results.

6.11. FIELD STRENGTH OF SPURIOUS RADIATION @ FCC 2.1053 & 90.210

6.11.1. Limits @ FCC 90.210

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

FCC Rules	Worst Case Emissions Limit	Attenuation Limit (dBc)
FCC 90.210(g)	FCC 90.210 (g)	43 + 10 log (P), P is output power in watts

6.11.2. Method of Measurements

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

If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.

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
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)

6.11.3. 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 nomimal
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

6.11.4. Test Data

Remarks:

(1) The radiated emissions were performed at 3 meters distance.

(2) Lowest ERP of the carrier = EIRP – 2.15 dB = Pc + G - 2.15 dB = 33.0 dBm (conducted) + 0 dBi – 2.15 dB = 30.85 dBm

6.11.4.1. Near Lowest Frequency (806.0125 MHz)

Fundamental Frequency:	806.0125 MHz
ERP:	30.85 dBm
Modulation:	FM with 19.2 kbps random data rate

Frequency (MHz)	E-Field @3m (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP Measured by Substitution Method		Limit (dBc)	Margin (dB)
				(dBm)	(dBc)		
1612.025	75.66	Peak	V	-28.65	59.50	43.85	-15.7
1612.025	75.63	Peak	H	-29.15	60.00	43.85	-16.2
2418.038	71.72	Peak	V	-31.95	62.80	43.85	-19.0
3224.050	72.50	Peak	V	-30.15	61.00	43.85	-17.2
3224.050	72.78	Peak	H	-30.65	61.50	43.85	-17.7
6448.100	72.94	Peak	V	-30.35	61.20	43.85	-17.4
The emissions were scanned from 10 MHz to 9 GHz and all emissions within 20 dB below the limits were recorded.							

6.11.4.2. Near Middle Frequency (815.0875 MHz)

Fundamental Frequency:	815.0875 MHz
ERP:	30.85 dBm
Modulation:	FM with 19.2 kbps random data rate

Frequency (MHz)	E-Field @3m (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP Measured by Substitution Method		Limit (dBc)	Margin (dB)
				(dBm)	(dBc)		
1630.175	78.66	Peak	V	-28.95	59.80	43.85	-16.0
1630.175	75.84	Peak	H	-28.55	59.40	43.85	-15.6
2445.263	76.72	Peak	V	-26.85	57.70	43.85	-13.9
3260.350	72.75	Peak	V	-29.95	60.80	43.85	-17.0
3260.350	71.31	Peak	H	-32.25	63.10	43.85	-19.3
6520.700	70.78	Peak	V	-32.95	63.80	43.85	-20.0
6520.700	72.63	Peak	H	-30.60	61.45	43.85	-17.6
The emissions were scanned from 10 MHz to 9 GHz and all emissions within 20 dB below the limits were recorded.							

6.11.4.3. Near Highest Frequency (824.9875 MHz)

Fundamental Frequency:	824.9875 MHz
ERP:	30.85 dBm
Modulation:	FM with 19.2 kbps random data rate

Frequency (MHz)	E-Field @3m (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP Measured by Substitution Method		Limit (dBc)	Margin (dB)
				(dBm)	(dBc)		
1649.975	81.47	Peak	V	-21.95	52.80	43.85	-9.0
1649.975	77.00	Peak	H	-28.05	58.90	43.85	-15.1
2474.963	76.75	Peak	V	-26.95	57.80	43.85	-14.0
2474.963	71.69	Peak	H	-32.65	63.50	43.85	-19.7
3299.950	70.84	Peak	V	-32.55	63.40	43.85	-19.6
3299.950	70.59	Peak	H	-32.55	63.40	43.85	-19.6
6599.900	71.78	Peak	V	-32.25	63.10	43.85	-19.3
The emissions were scanned from 10 MHz to 9 GHz and all emissions within 20 dB below the limits were recorded.							

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 $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -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)

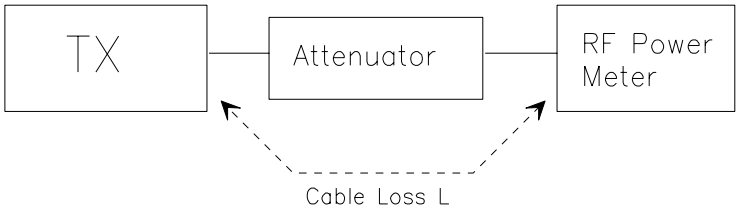
The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);

The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in 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 were performed with full rf output power and modulation.
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
(e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level
- ➢ Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
- ➢ E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(f) Set the EMI Receiver #1 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 #1(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 calculates 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:	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

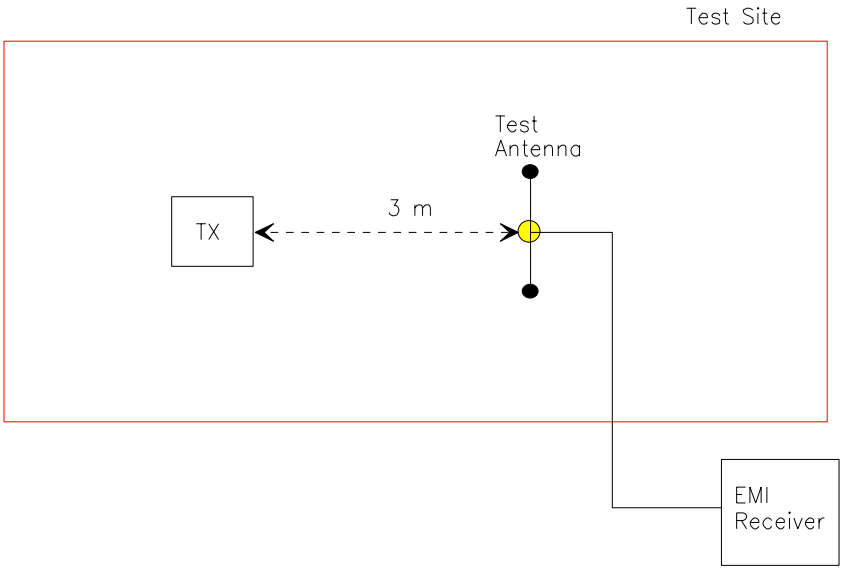
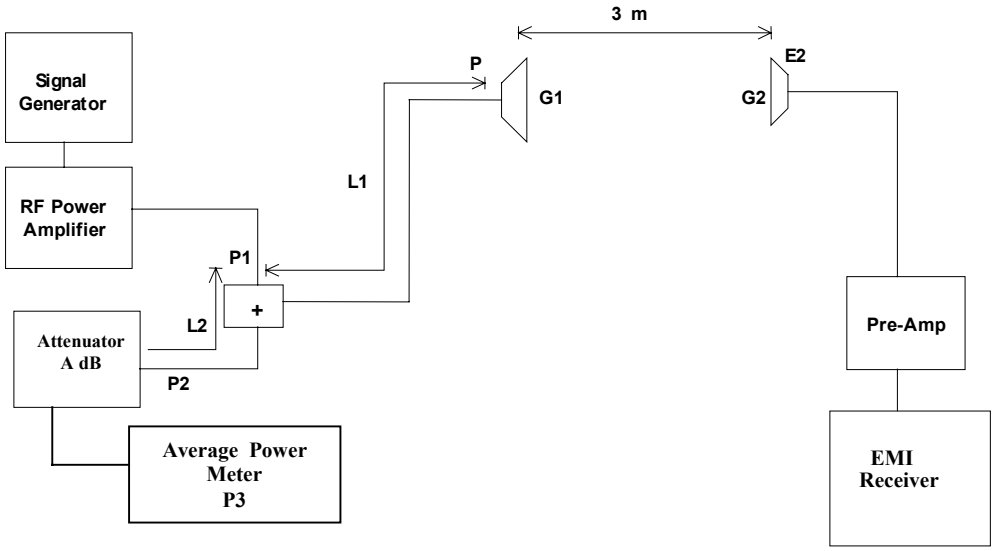


Figure 3



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)(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.: ±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:

For 25 kHz Channel Spacing: RBW = 300 Hz
For 12.5 kHz or 6.25 kHz Channel Spacings: RBW = 100 Hz

In 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 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^{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 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.