ENGINEERING TEST REPORT

UHF Radio Transceiver Module
Model No.: RA1001
FCC ID: GM3RA1001

Applicant:

Psion Teklogix Inc.
2100 Meadowvale Blvd.
Mississauga, Ontario
Canada, L5N 7J9

Tested in Accordance With

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

UltraTech's File No.: TEK-464FCC90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: April 13, 2005	LICENSED PROFESSIONAL ENGINEER T.M. LUU PROVINCE OF ONTARIO
Report Prepared by: Dan Huynh Issued Date: April 13, 2005	Tested by: Dan Huynh Test Dates: April 6-7, 2005

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

UltraTech

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FC	VCI	Canada	NVLAP	BSMI	IT	UL
31040/SIT	C-1376	46390-2049	200093-0	SL2-IN-E-1119R	00-034	

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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 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	Yes
1	Test Setup Photos	Test Setup Photos	N/A
2	External Photos of EUT	External EUT Photos	N/A
3	Internal Photos of EUT	Internal EUT Photos	N/A
4	Cover Letters	▪ Letter from Ultratech for Certification Request ▪ Letter from the Applicant to appoint Ultratech to act as an agent	Yes
5	Attestation Statements	--	--
6	ID Label/Location Info	ID Label/Location Info	N/A
7	Block Diagrams	Block Diagrams	N/A
8	Schematic Diagrams	Schematic Diagrams	N/A
9	Parts List/Tune Up Info	Parts List/Tune Up Info	N/A
10	Operational Description	Operational Description	N/A
11	RF Exposure Info	RF Exposure Info	See original filing
12	Users Manual	Users Manual	N/A

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Code of Federal Regulations (CFR), Title 47, Telecommunication **-** Parts 2 & 90
Purpose of Test:	To obtain FCC Certification Authorization for Radio operating in the frequency band 435-470 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA- 603 (01-Nov-2002) - Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.

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

None

2.3. NORMATIVE REFERENCES

Publication	**Year**	**Title**
FCC CFR Parts 0-19, 80-End	2004	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	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 16-1-1	2004	Specification for Radio Disturbance and Immunity measuring apparatus and methods
TIA/EIA 603, Edition B	01-Nov-2002	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Psion Teklogix Inc.
Address:	2100 Meadowvale Blvd. Mississauga, Ontario Canada, L5N 7J9
Contact Person:	Mr. Sada Dharwarkar Phone #: 905-812-6200 Fax #: 905-812-6301 Email Address: Sada.Dharwarker@psionteklogix.com

MANUFACTURER	
Name:	Psion Teklogix Inc.
Address:	2100 Meadowvale Blvd. Mississauga, Ontario Canada, L5N 7J9
Contact Person:	Mr. Sada Dharwarkar Phone #: 905-812-6200 Fax #: 905-812-6301 Email Address: Sada.Dharwarker@psionteklogix.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:	Psion Teklogix Inc.
Product Name:	UHF Radio Transceiver Module
Model Name or Number:	RA1001
Serial Number:	Preproduction
Type of Equipment:	Non-broadcast Radio Communication Equipment
External Power Supply:	Using DC voltage from a host system
Transmitting/Receiving Antenna Type:	Non-integral

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Modular Transceiver
Intended Operating Environment:	Commercial, Light Industry & Heavy Industry
Power Supply Requirement:	DC 5 Volts
RF Output Power Rating:	1.0 Watts
Operating Frequency Range:	435-470 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	12.5 kHz and 25 kHz
Maximum Duty Cycle:	50%
Maximum Data Rate:	9600 bps (for 12.5 kHz channel spacing); 19200 bps (for 25 kHz channel spacing)
Emission Designation*:	9K00F1D and 18K0F1D
Oscillator Frequencies:	44 MHz, 14.67 MHz, 45 MHz (Rx IF), Lo. Osc. = Rx Freq-45 MHz
Antenna Description:	For Mobile: The antenna gain limit is 2 dBi For Fixed, Base: The antenna gain limit is 12 dBi

***Necessary Bandwidth Calculation**:

For FM Digital Modulation:

12.5 KHz Channel Spacing:

D = 2.1 KHz max.; K = 1; Level of FM = 4; M = Data Rate in kb/s / Level of FM = 9.69.6/4 kb/s

B_n = 2M + 2DK = 2(9.6/4) + 2(2.1)(1) = 9 kHz
Emission designation: 9K00F1D

25 kHz Channel Spacing:

D = 4.2 kHz max.; K = 1; Level of FM = 4; M = Data Rate in kb/s / Level of FM = 19.2/4 kb/s

B_n = 2M + 2DK = 2(19.2/4) + 2(4.2)(1) = 18 kHz
Emission designation: 18K0F1D

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3.4. 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:	Radio TestJig
Brand name:	Psion Teklogix Inc.
Model Name or Number:	72214
Serial Number:	0028
Cable Length & Type:	N/A
Connected to EUT's Port:	PCMCIA Type III slot

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^{o}C
Humidity:	51%
Pressure:	102 kPa
Power input source:	DC 5 Volts

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 & Hardware:	The test software incorporated with the Psion Teklogix Test Jig was used for testing
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):	435-470 MHz
Test Frequency(ies): (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	435, 450 and 470 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation: ▪ Modulating signal source:	 1 Watt FM Level 4 at 9600/19200 bps internal data source Internal

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EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

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

- 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: January 10, 2005

5.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes (See Note 1)
90.213 & 2.1055	Frequency Stability	Yes (See Note 1)
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	N/A for data equipment
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 (See Note 1)
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes (See Note 1)
90.214	Transient Frequency Behavior	Yes (See Note 1)
UHF Radio Transceiver Module, **Model No.: RA1001**, by **Psion Teklogix 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 upon request.		

Note 1: See original filing test report for details

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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 and CISPR 16-1-1.

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 [47 CFR §§ 2.1046 & 90.205]

6.5.1. Limits

Please refer to FCC 47 CFR 90.205 for specification details.

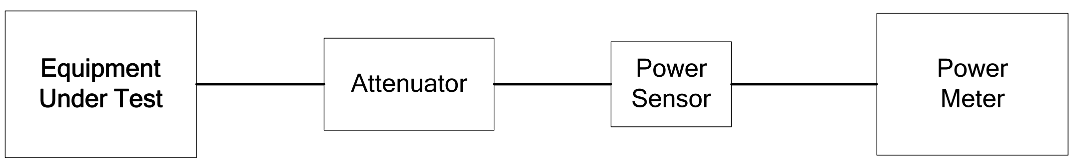
6.5.2. Method of Measurements

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

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
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



6.5.5. Test Data

Fundamental Frequency (MHz)	Measured (Average) Power (Watts)	Power Rating (Watts)
435	1.0	1.0
450	1.0	1.0
470	0.9	1.0

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6.6. MODULATION LIMITING [47 CFR §§ 2.1047(b) & 90.210]

6.6.1. Limits

Recommended frequency deviation characteristics are given below:

- 2.5 kHz for 12.5 kHz channel spacing
- 5 kHz for 25 kHz channel spacing

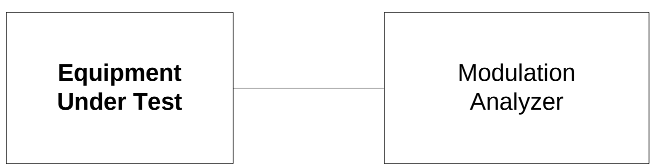
6.6.2. Method of Measurements

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.

6.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Modulation Analyzer	Hewlett Packard	8901B	3226A04606	150 kHz -1300 MHz

6.6.4. Test Arrangement



6.6.5. Test Data

Data Modulation Limiting: FM modulation with random data and modulation limiter set at a maximum frequency deviation

Test Frequency (MHz)	Data Baud Rate	Peak Deviation (kHz)	Maximum Limit (kHz)
435	19200	4.13	5
450	19200	4.17	5
470	19200	4.06	5

6.7. EMISSION MASK [47 CFR §§ 2.1049, 90.209 & 90.210]

6.7.1. Limits

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

Frequency Band (MHz)	Maximum Authorized BW (KHz)	Channel Spacing (KHz)	Recommended Frequency Deviation (KHz)	FCC Applicable Mask
403-512	11.25	12.5	2.5	Mask D –Data
403-512	20	25	5	Mask C –Data

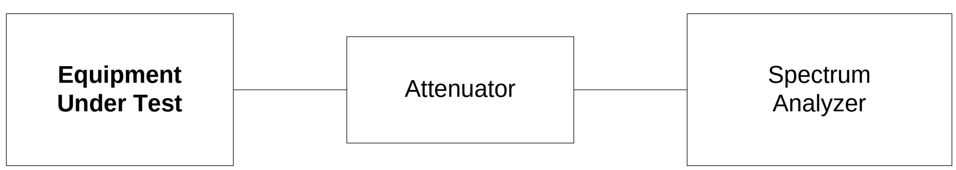
6.7.2. Method of Measurements

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	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator	Weinschel Corp	23-20-34	BH7876	DC-18 GHZ

6.7.4. Test Arrangement



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

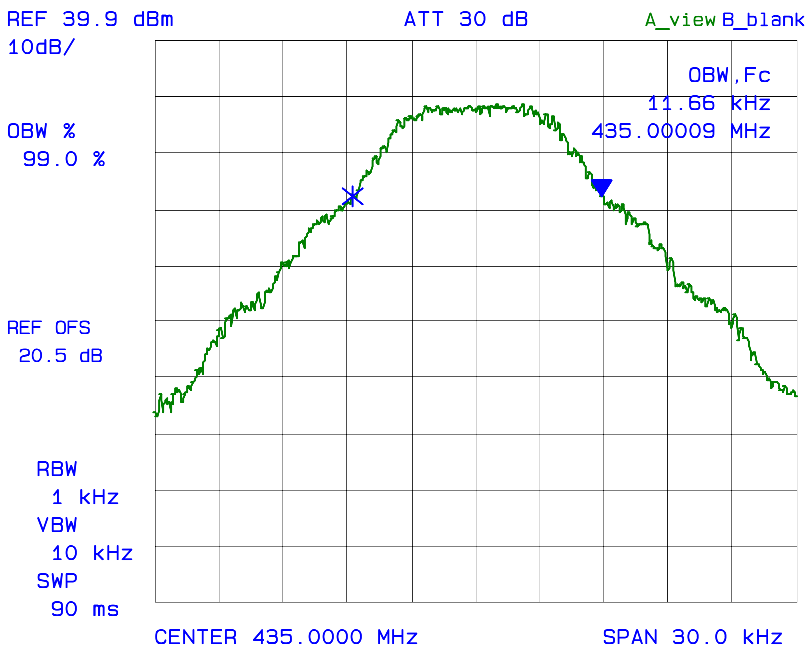
6.7.5. Test Data

6.7.5.1. 99% Occupied Bandwidth

Frequency (MHz)	Channel Spacing (kHz)	Measured 99% OBW (kHz)	Authorized Bandwidth (kHz)
435	25	11.66	20
450	25	11.67	20
470	25	11.57	20

*Please refer to plots (1 to 3) for detailed measurements

Plot 1: 99% Occupied Bandwidth
Test Frequency: 435 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz



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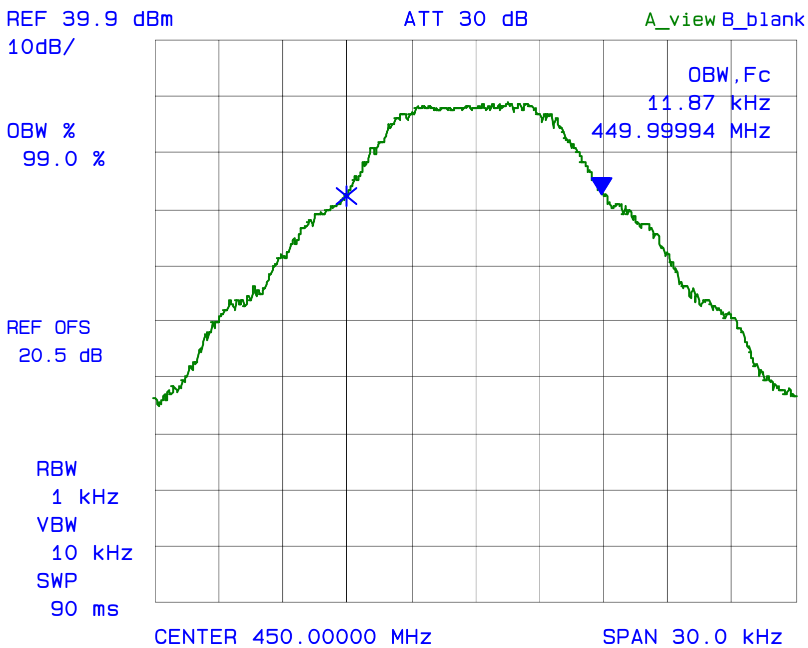
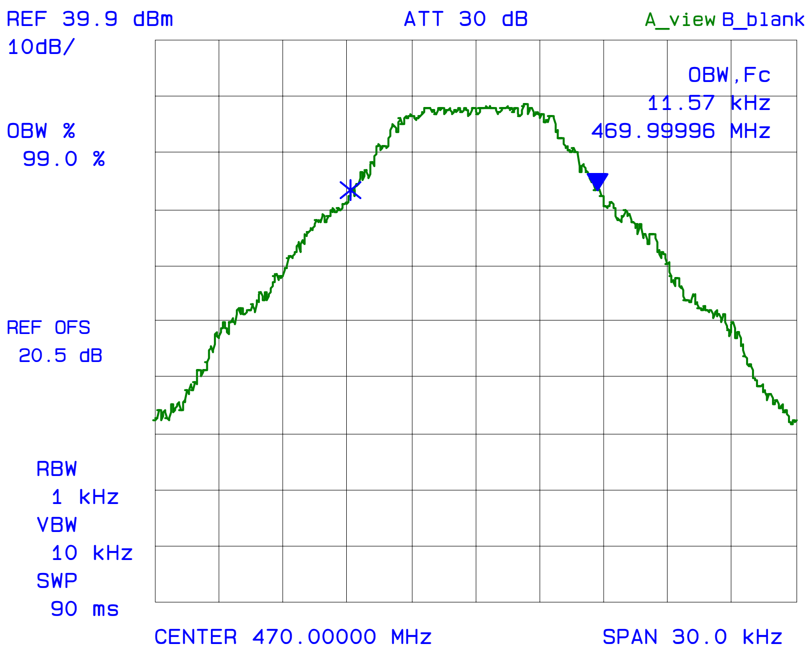
Plot 2: 99% Occupied Bandwidth
Test Frequency: 450 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz



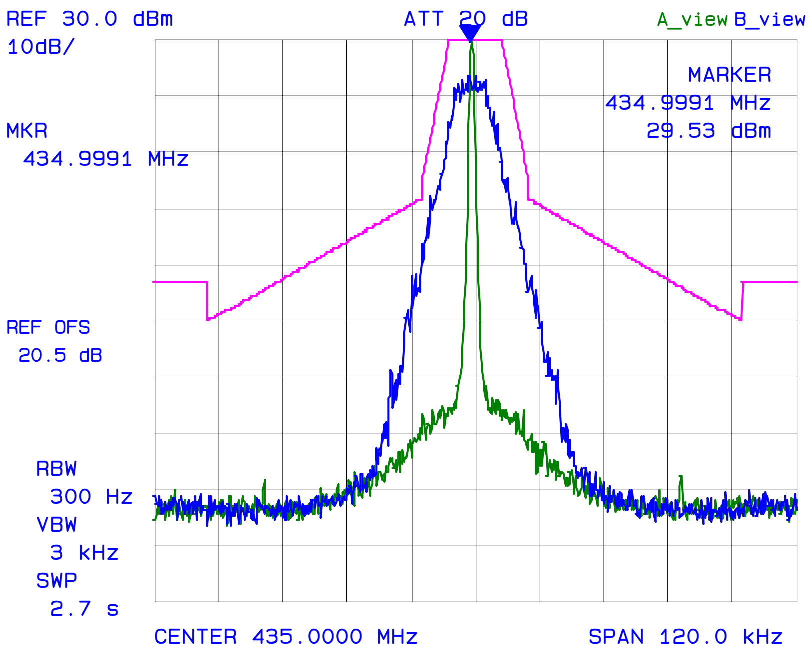
Plot 3: 99% Occupied Bandwidth
Test Frequency: 470 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz



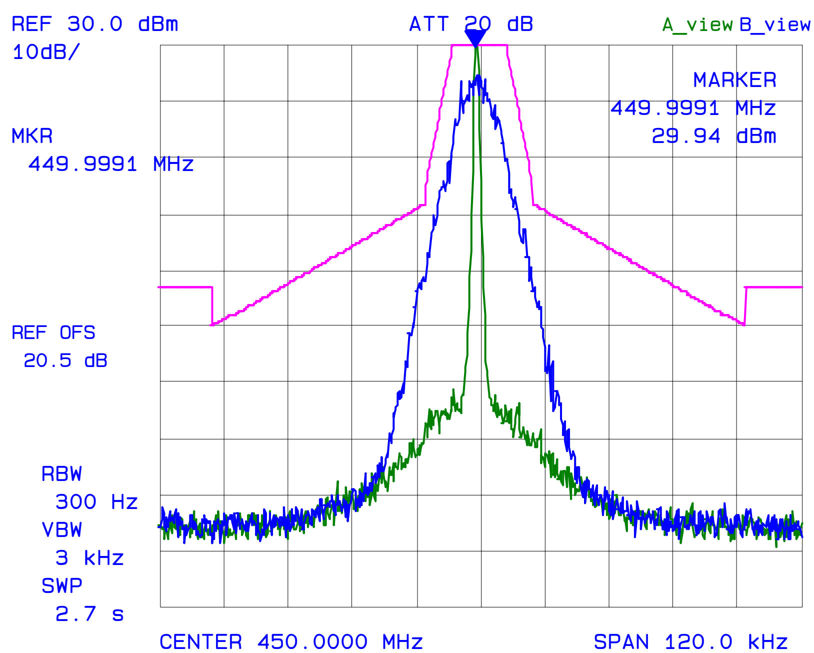
6.7.5.2. Emission Masks

Conform. Please refer to plots (4-6) for details of measurements of emission mask C

Plot 4: Emission Mask C
Test Frequency: 435 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz



Plot 5: Emission Mask C
Test Frequency: 450 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz



Plot 6: Emission Mask C
Test Frequency: 435 MHz
FM Modulation with data @ 19200 bps, Max. Frequency Deviation: 4.2 kHz

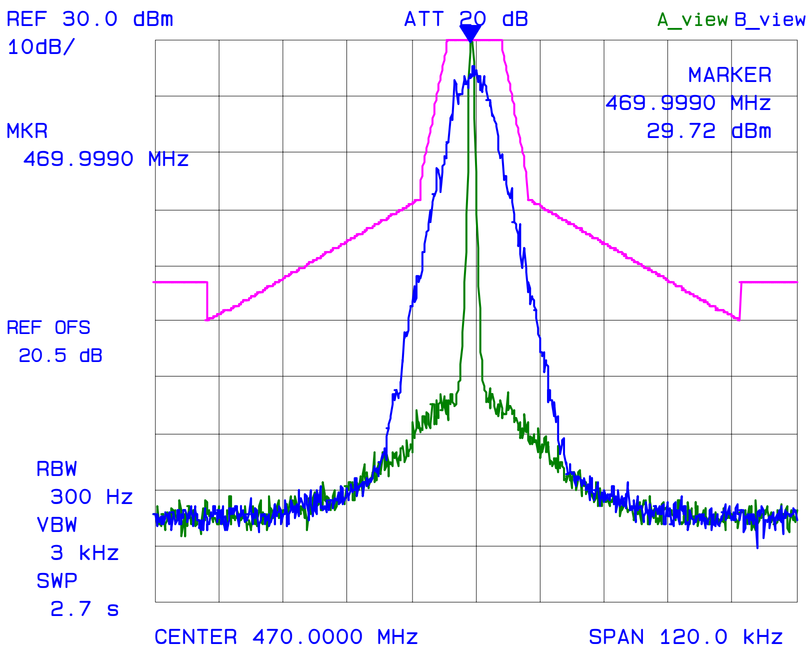


EXHIBIT 7. MEASUREMENT UNCERTAINTY

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 Directivity	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 Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits $20Log(1\pm\Gamma_1\Gamma_R)$	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.

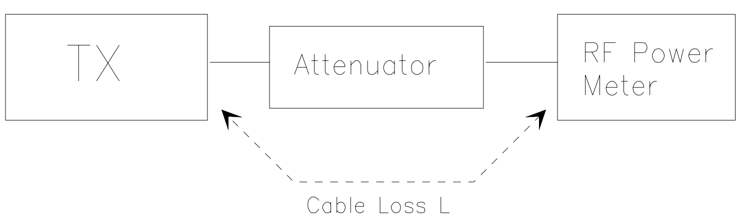
Step 2: Calculation of Average EIRP. See Figure 1

- 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 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

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

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

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

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

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (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:

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

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

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Figure 2

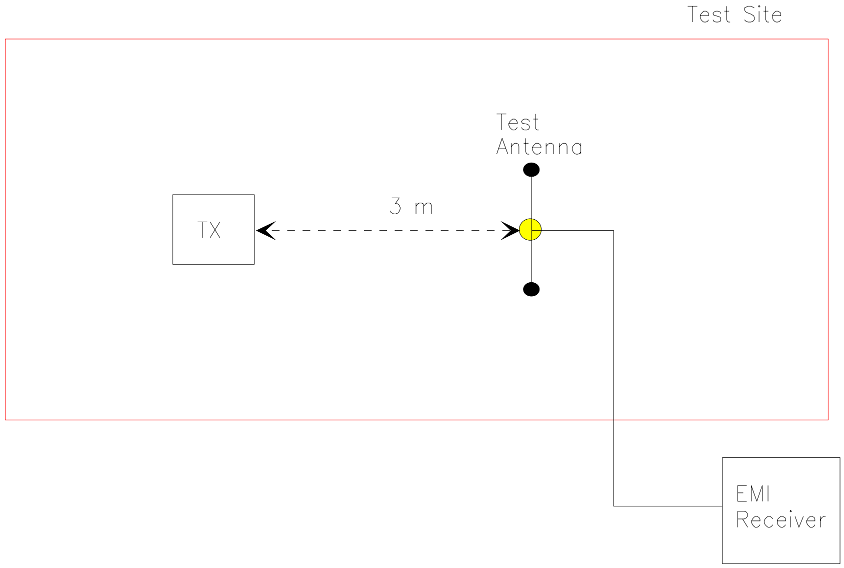
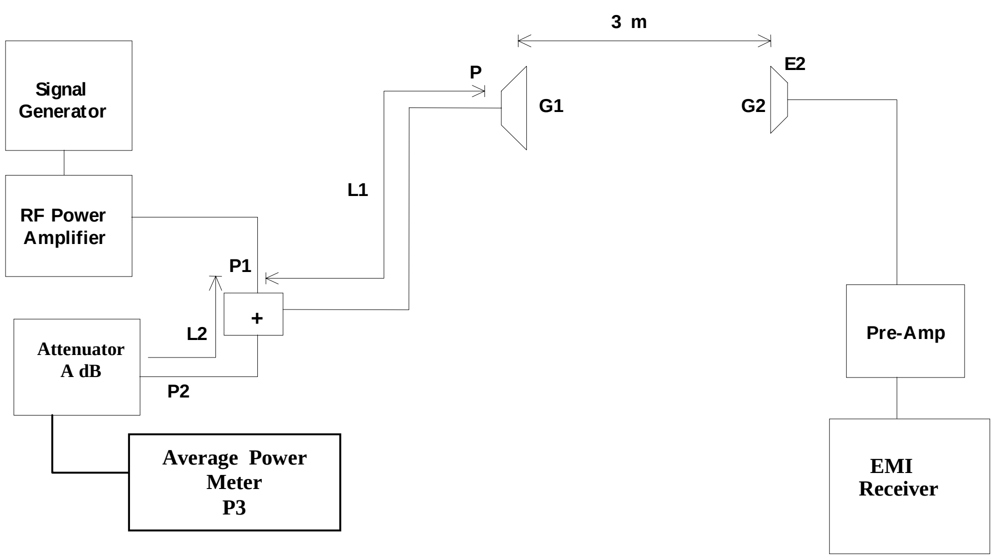


Figure 3



8.3. EMISSION MASK

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

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

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

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

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