ENGINEERING TEST REPORT

VHF ANALOG RADIO TRANSCEIVER
Model No.: TFM-138
FCC ID: IMATFM-138

Applicant: ***Technisonic Industries Ltd.***
240 Traders Blvd E,
Mississauga, Ontario
Canada, L4Z 1W7

Tested in Accordance With

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

UltraTech's File No.: TIL-049FCC90

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

Date: August 29, 2005

Report Prepared by: Dharmajit Solanki, RFI Engineer	Tested by: Hung Trinh, EMI/RFI Technician
Issued Date: August 29, 2005	Test Dates: : January 11 – 20, 1999

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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31040/SIT C-1376 46390-2049 200093-0 SL2-IN-E-1119R 00-034

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 90
Purpose of Test:	To gain FCC Class II Permissive change Certification Authorization for Radio operating in the frequency bands 138-174 MHz (12.5 kHz and 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.

1.2. RELATED SUBMITAL(S)/GRANT(S)

None

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2004	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
TIA-603-B	2002	Land Mobile FM or PM Communications Equipment
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 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	TECHNISONIC INDUSTRIES LTD.
Address:	240 Traders Blvd E Mississauga, Ontario Canada, L4Z 1W7
Contact Person:	Richard Dalacker Phone #: 905-890-2113 Fax #: 905-890-5338 Email Address: rdalacker@til.ca

MANUFACTURER	
Name:	TECHNISONIC INDUSTRIES LTD.
Address:	240 Traders Blvd E Mississauga, Ontario Canada, L4Z 1W7
Contact Person:	Richard Dalacker Phone #: 905-890-2113 Fax #: 905-890-5338 Email Address: rdalacker@til.ca

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name:	TECHNISONIC INDUSTRIES LTD.
Product Name:	VHF ANALOG RADIO TRANSCEIVER
Model Name or Number:	TFM-138
Serial Number:	Test sample
Type of Equipment:	Non-broadcast Radio Transceiver used as Airborne Station
Transmitting/Receiving Antenna Type:	Non-integral,
Primary User Functions of EUT:	To provide secondary (voice) communications in low altitude (primarily helicopter) environment.

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	[ ] Portable [x] Mobile [ ] Base station (fixed use)
Intended Operating Environment:	[ ] Commercial [ ] Light Industry & Heavy Industry [x] Airbone
Power Supply Requirement:	28 Vdc
RF Output Power Rating:	Low : 1W, High : 10W
Operating Frequency Range:	136-174 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	12.5 kHz & 25 kHz
Occupied Bandwidth (99%):	9.3 kHz (12.5 kHz Channel Spacing) 13.8 kHz (25 kHz Channel Spacing)
Emission Designations*:	9K8F3E (12.5 kHz Channel Spacing) 16K0F3E (25 kHz Channel Spacing)

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

Bandwidth Calculations :

Carson's Rule for FM modulation is utilized to compute the bandwidth shown in the FCC emission designator.
Carson's Rule is: BW = 2 x (M+DK), where M = Maximum modulating frequency, D = Deviation

1. For FM Voice Modulation:

   Channel Spacing = 12.5 KHz, D = 1.9 KHz max. measured, K = 1, M = 3 KHz
   B_n = 2M + 2DK = 2(3) + 2(1.9)(1) = 9.8 KHz
   emission designation: 9K8F3E

2.4. BLOCK DIAGRAM OF TEST SETUP

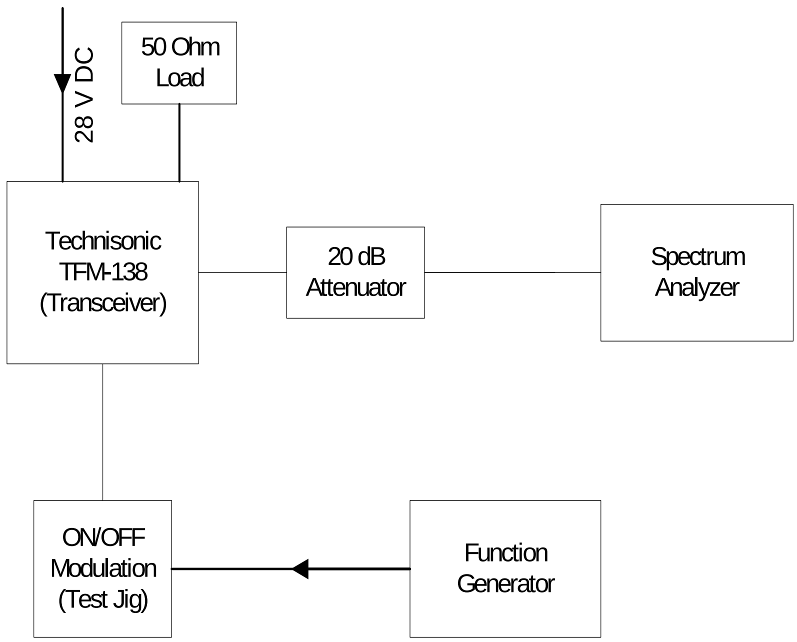


EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	28 V DC

3.2. 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:	N/A
Special Hardware Used:	N/A
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): ▪ 138-174 MHz band:	Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers: ▪ 138.0, 150.0 and 174.0 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 10 Watts (Max.) ▪ FM ▪ External analog source

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

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

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

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

4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	APPLICABILITY (YES/NO)
90.205 & 2.1046	RF Power Output	N/A
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	N/A
90.213 & 2.1055	Frequency Stability	N/A
2.1047(a)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation.
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	N/A
90.214	Transient Frequency Behavior	Yes
90.423	Operation on board aircraft	Yes

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

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

5.2. 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.

5.3. 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.

5.4. 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.

5.5. AUDIO FREQUENCY RESPONSE @ FCC 2.1047(A)

5.5.1. Limits @ FCC 2.1047(a)

Recommended audio filter attenuation characteristics are given below:

RF Band	Audio band	Minimum Attenuation Rel. to 1 kHz Attenuation
138 – 174 MHz	3 –20 kHz 20 – 30 kHz	60 $\log_{10}(f/3)$ dB where f is in kHz 50dB

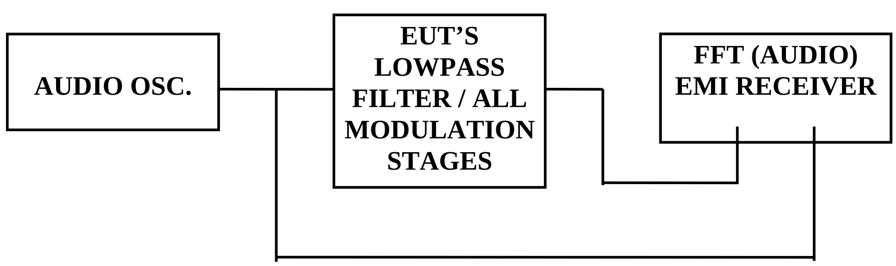
5.5.2. Method of Measurements

The rated audio input signal was applied to the input of the audio low-pass 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.

5.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Modulation Analyzer	Hewlett Packard	8910B	3226A04606	150 kHz – 1300 MHz
Function Generator	Stanford Research Systems	DS345	34591	1µHz – 30.2 MHz
FFT Digital Spectrum	Advantest	R9211E	82020336	--
Attenuator	Weinschel Crop.	46-20-34	BM1347	DC-18 GHz

5.5.4. Test Arrangement



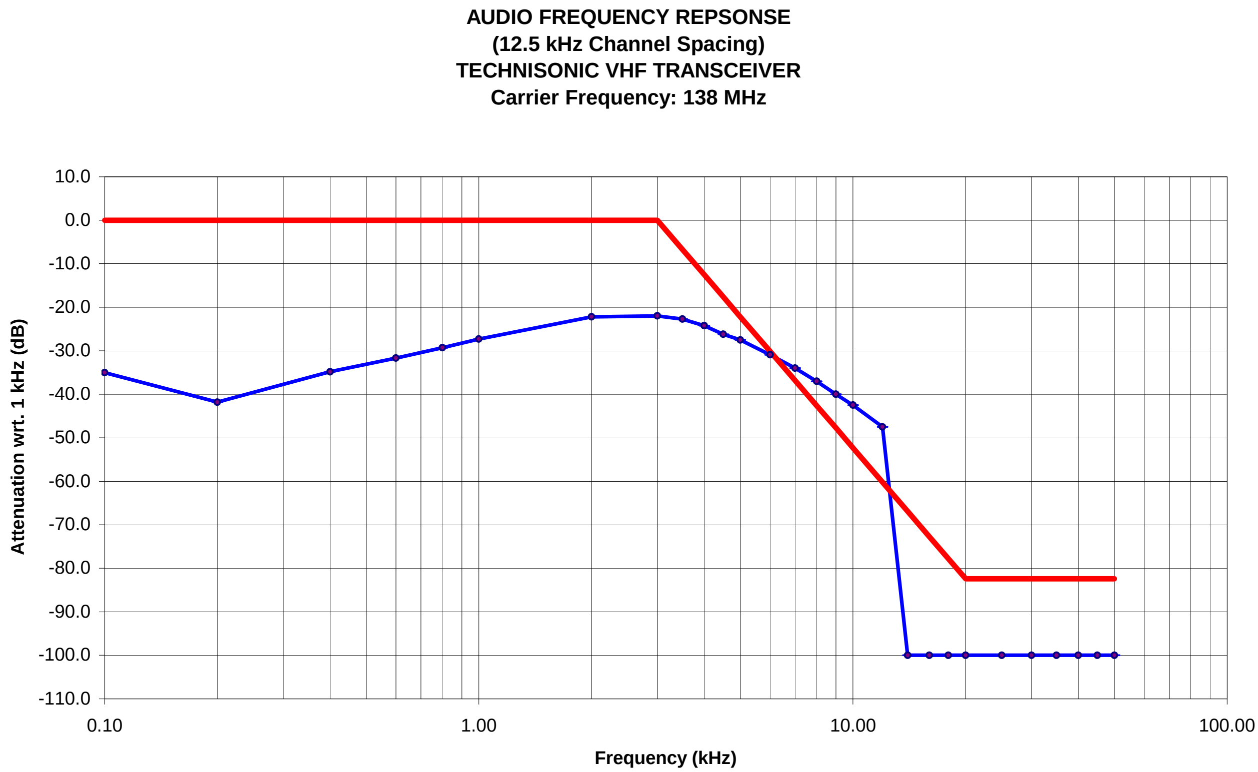
5.5.5. Test Data

AUDIO LOW PASS FREQUENCY RESPONSE

Carrier Frequency: 138 MHz
Channel Spacing: 12.5 kHz

FREQUENCY (kHz)	AUDIO IN (dBV)	AUDIO OUT (dBV)	ATTEN. (OUT – IN) (dB)	ATTEN. Wrt. 1kHz (dB)	RSS-119, ISSUE 5, SEC. 6.6 TABLE 4 LIMIT (dB)	PASS/ FAIL
0.10	-16.0	<-50.0	<-34.0	<-35.0	0.0	No Limit
0.20	-16.2	-57.0	-40.8	-41.8	0.0	No Limit
0.40	-16.2	-50.0	-33.8	-34.8	0.0	No Limit
0.60	-16.3	-47.0	-30.7	-31.7	0.0	No Limit
0.80	-16.2	-44.5	-28.3	-29.3	0.0	No Limit
1.00	-16.6	-42.9	-26.3	-27.3	0.0	No Limit
2.00	-16.3	-37.5	-21.2	-22.2	0.0	No Limit
3.00	-16.2	-37.2	-21.0	-22.0	0.0	No Limit
3.50	-16.9	-38.6	-21.7	-22.7	-6.7	No Limit
4.00	-16.2	-39.4	-23.2	-24.2	-12.5	No Limit
4.50	-16.9	-42.1	-25.2	-26.2	-17.6	No Limit
5.00	-16.9	-43.4	-26.5	-27.5	-22.2	No Limit
6.00	-16.9	-46.8	-29.9	-30.9	-30.1	No Limit
7.00	-16.5	-49.5	-33.0	-34.0	-36.8	No Limit
8.00	-16.9	-52.9	-36.0	-37.0	-42.6	No Limit
9.00	-16.3	-55.3	-39.0	-40.0	-47.7	No Limit
10.00	-16.3	-57.8	-41.5	-42.5	-52.3	No Limit
12.00	-16.6	-63.1	-46.5	-47.5	-60.2	No Limit
14.00	-16.9	-100.0	-100.0	-100.0	-66.9	No Limit
16.00	-16.9	-100.0	-100.0	-100.0	-72.7	No Limit
18.00	-16.5	-100.0	-100.0	-100.0	-77.8	No Limit
20.00	-16.5	-100.0	-100.0	-100.0	-82.4	No Limit
25.00	-16.3	-100.0	-100.0	-100.0	-82.4	No Limit
30.00	-16.7	-100.0	-100.0	-100.0	-82.4	No Limit
35.00	-16.7	-100.0	-100.0	-100.0	-82.4	No Limit
40.00	-16.6	-100.0	-100.0	-100.0	-82.4	No Limit
45.00	-16.4	-100.0	-100.0	-100.0	-82.4	No Limit
50.00	-16.9	-100.0	-100.0	-100.0	-82.4	No Limit

*REMARK: The above test was performed for manufacturer reference.


AUDIO FREQUENCY REPSONSE
(12.5 kHz Channel Spacing)
TECHNISONIC VHF TRANSCEIVER
Carrier Frequency: 138 MHz
Attenuation wrt. 1 kHz (dB)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-110.0
0.10
1.00
10.00
100.00
Frequency (kHz)

5.6. MODULATION LIMITING @ FCC 2.1047(B)

5.6.1. Limits @ FCC 2.1047(b)

Recommended frequency deviation characteristics are give below:

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

5.6.2. Method of Measurements

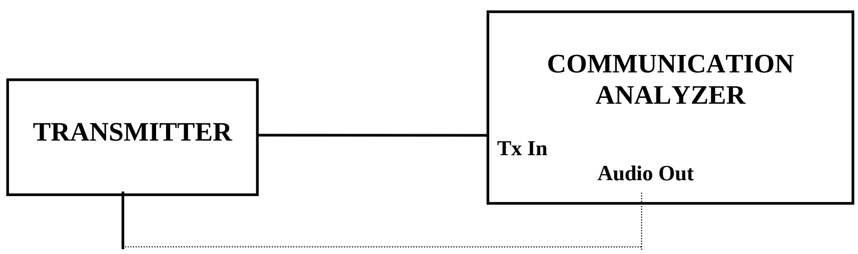
For Audio Transmitter:- The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

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.

5.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Modulation Analyzer	Hewlett Packard	8910B	3226A04606	150 Khz – 1300 MHZ
Function Generator	Stanford Research Systems	DS345	34591	1µHz – 30.2 MHz
Attenuator	Weinchel Corp.	46-20-34	BM1347	DC – 18 GHz

5.6.4. Test Arrangement



5.6.5. Test Data

5.6.5.1. Voice Modulation Limiting:

5.6.5.1.1. 12.5 kHz Channel Spacing

MODULATION LIMITING FOR AN AUDIO TRANSMITTER

Carrier Frequency: 138 MHz
Channel Spacing: 12.5 kHz

MODULATING SIGNAL LEVEL	PEAK FREQUENCY DEVIATION (kHz) at the following modulating frequency:					SUGGESTED LIMIT
(Vrms)	0.1 KHz	0.5 KHz	1.0 KHz	3.0 KHz	5.0 KHz	(KHz)
0.01	0.1	0.1	0.2	0.3	0.2	2.5
0.02	0.1	0.2	0.2	0.4	0.2	2.5
0.04	0.1	0.2	0.3	0.7	0.4	2.5
0.06	0.1	0.3	0.5	0.9	0.5	2.5
0.08	0.2	0.3	0.6	1.2	0.7	2.5
0.10	0.2	0.4	0.7	1.5	0.8	2.5
0.20	0.2	0.7	1.4	1.7	1.1	2.5
0.30	0.2	1.0	1.7	1.7	1.1	2.5
0.40	0.2	1.4	1.8	1.7	1.1	2.5
0.50	0.3	1.7	1.8	1.7	1.1	2.5
0.60	0.4	1.8	1.8	1.8	1.1	2.5
0.70	0.4	1.8	1.8	1.8	1.1	2.5
0.80	0.5	1.8	1.8	1.8	1.2	2.5
0.90	0.6	1.8	1.8	1.8	1.2	2.5
1.00	0.7	1.8	1.8	1.8	1.2	2.5
1.20	0.9	1.8	1.9	1.8	1.2	2.5

Carrier Frequency: 138 MHz
Channel Spacing: 12.5 kHz

MODULATING FREQUENCY (KHz)	PEAK FREQUENCY DEVIATION (KHz)	SUGGESTED LIMIT (KHz)
0.1	0.2	2.5
0.2	0.3	2.5
0.4	0.6	2.5
0.6	0.8	2.5
0.8	1.1	2.5
1.0	1.3	2.5
1.2	1.6	2.5
1.4	1.7	2.5
1.6	1.8	2.5
1.8	1.8	2.5
2.0	1.8	2.5
2.5	1.8	2.5
3.0	1.8	2.5
3.5	1.7	2.5
4.0	1.6	2.5
4.5	1.3	2.5
5.0	1.1	2.5
6.0	0.7	2.5
7.0	0.6	2.5
8.0	0.4	2.5
9.0	0.4	2.5
10.0	0.3	2.5

5.7. EMISSION MASK @ FCC 2.1049 & 90.210

5.7.1. 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
138-174	11.25	12.5	2.5	• Mask D – Voice & Data

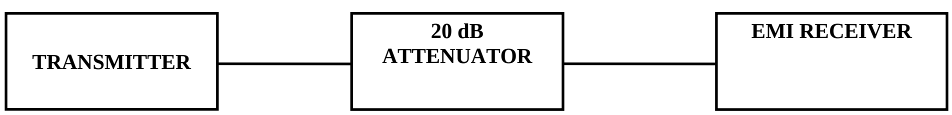
5.7.2. Method of Measurements

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

5.7.3. 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
Audio Oscillator	Hewlett Packard	HP 204C	0989A08798	DC to 1.2 MHz

5.7.4. Test Arrangement



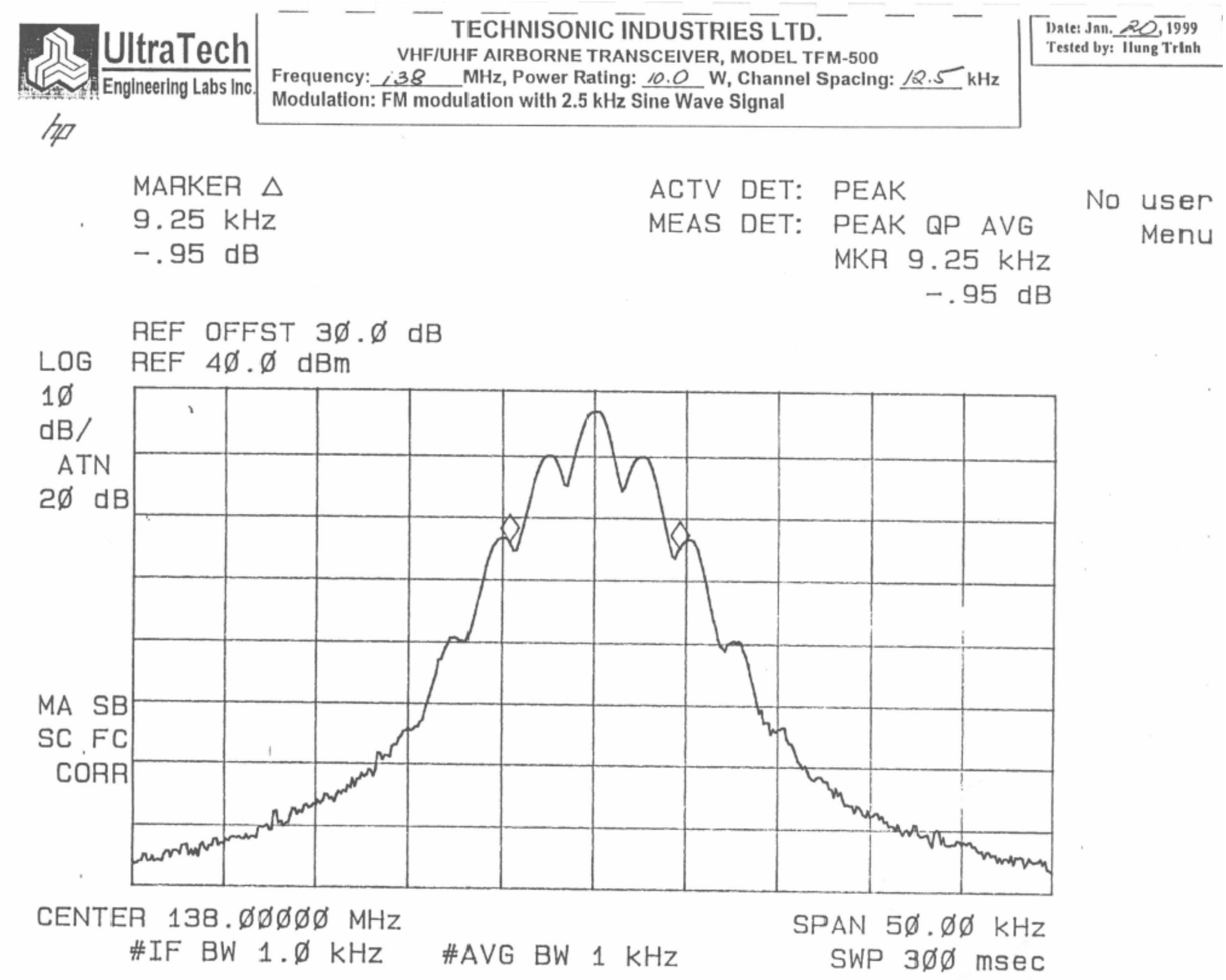
5.7.5. Test Data

5.7.5.1. 99% Occupied Bandwidth

Frequency (MHz)	Channel Spacing (kHz)	Modulation	Measured 99% OBW (kHz)	Recommended 99% OBW (kHz)
138.0	12.5	FM Modulation with 2.5 kHz Sine Wave Signal	9.25	11.125

Conform. Please refer to the below plot#1 for details of measurements

Plot # 1

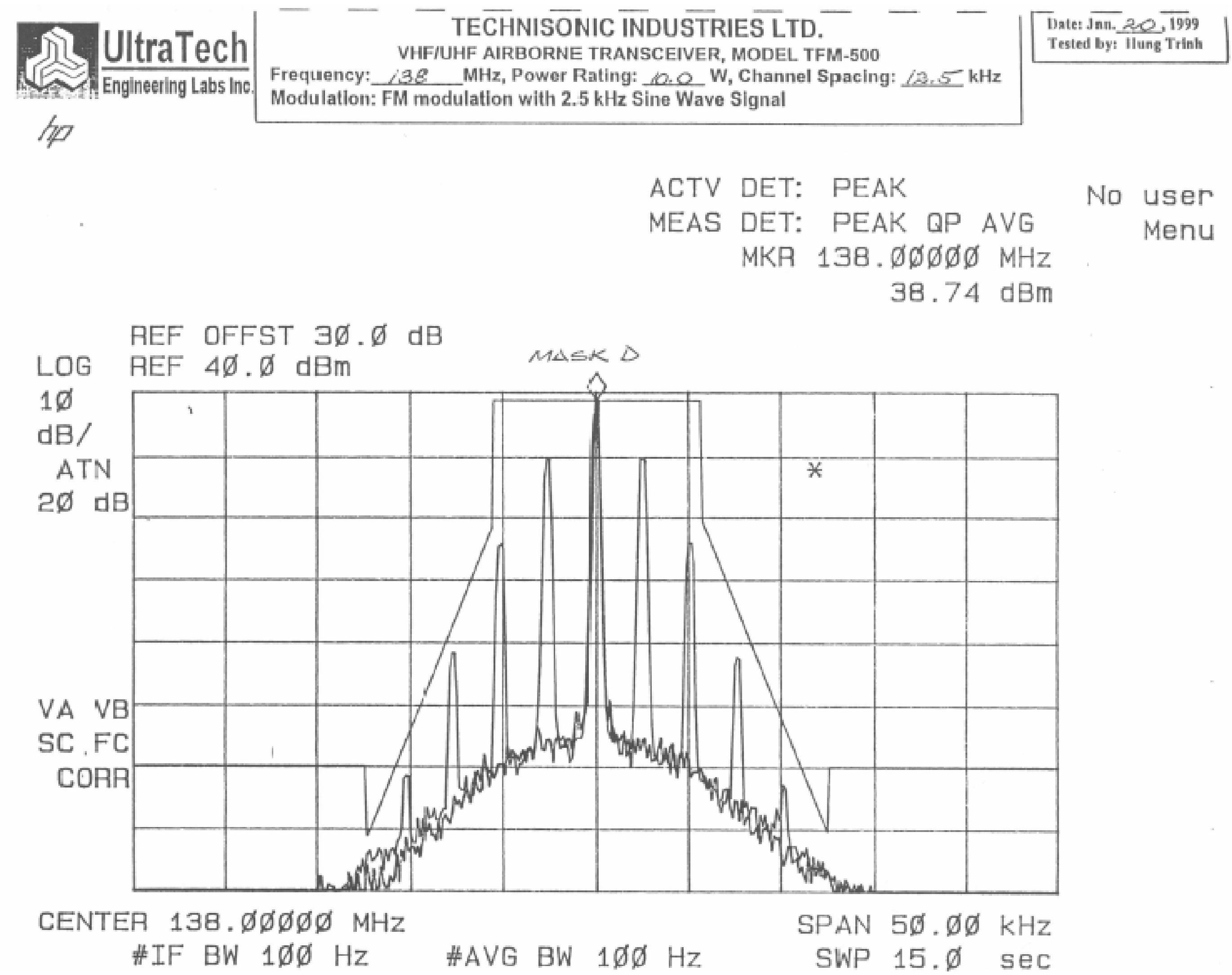


5.7.5.2. Emission Masks

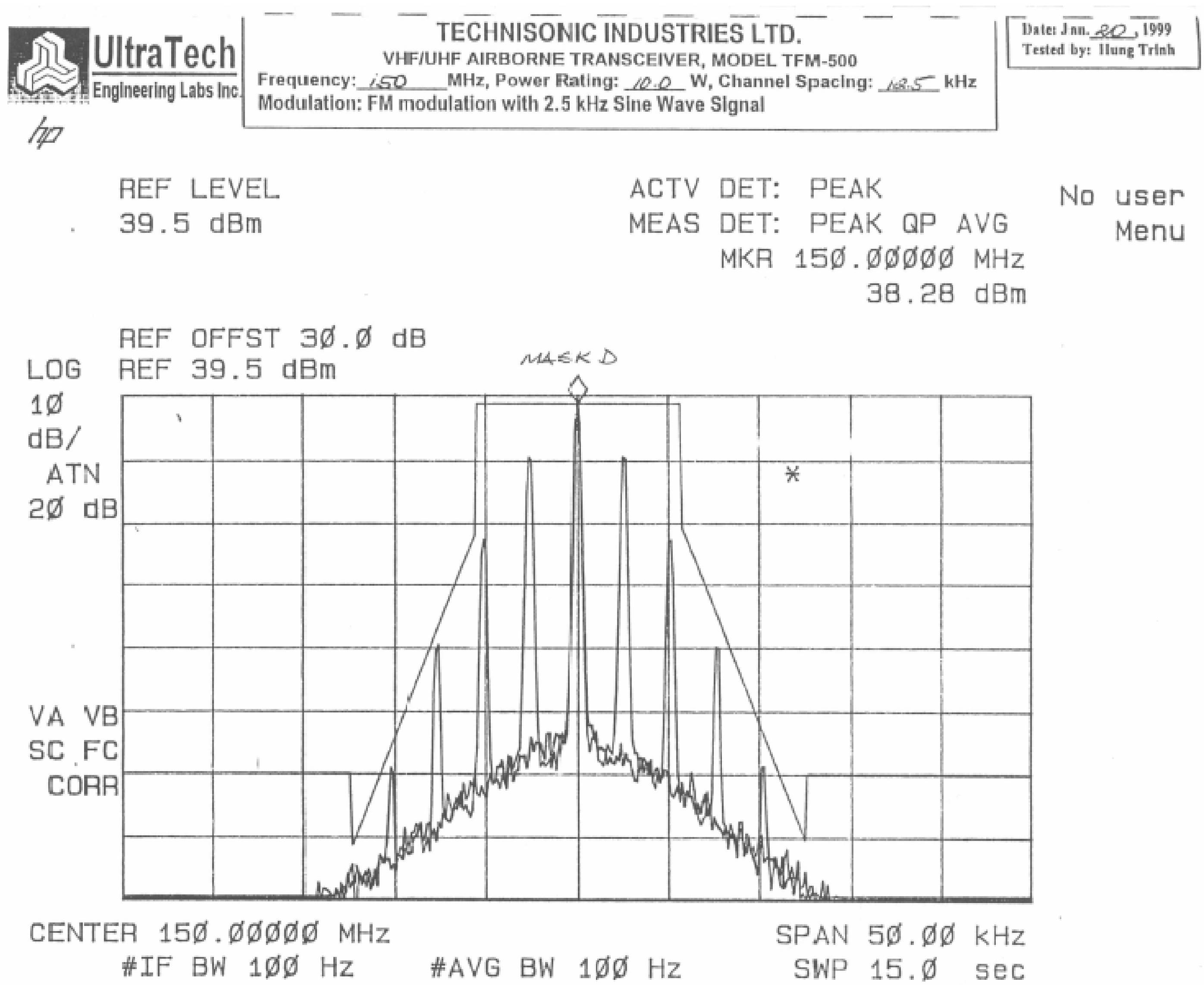
Conform. See the following test data plots (2 to 4) for details.

- Please refer to Plots# 2 to 4 for details of Emission Mask D for FM Voice Modulation Measurements in High Power mode for 12.5 kHz channel spacing operation.

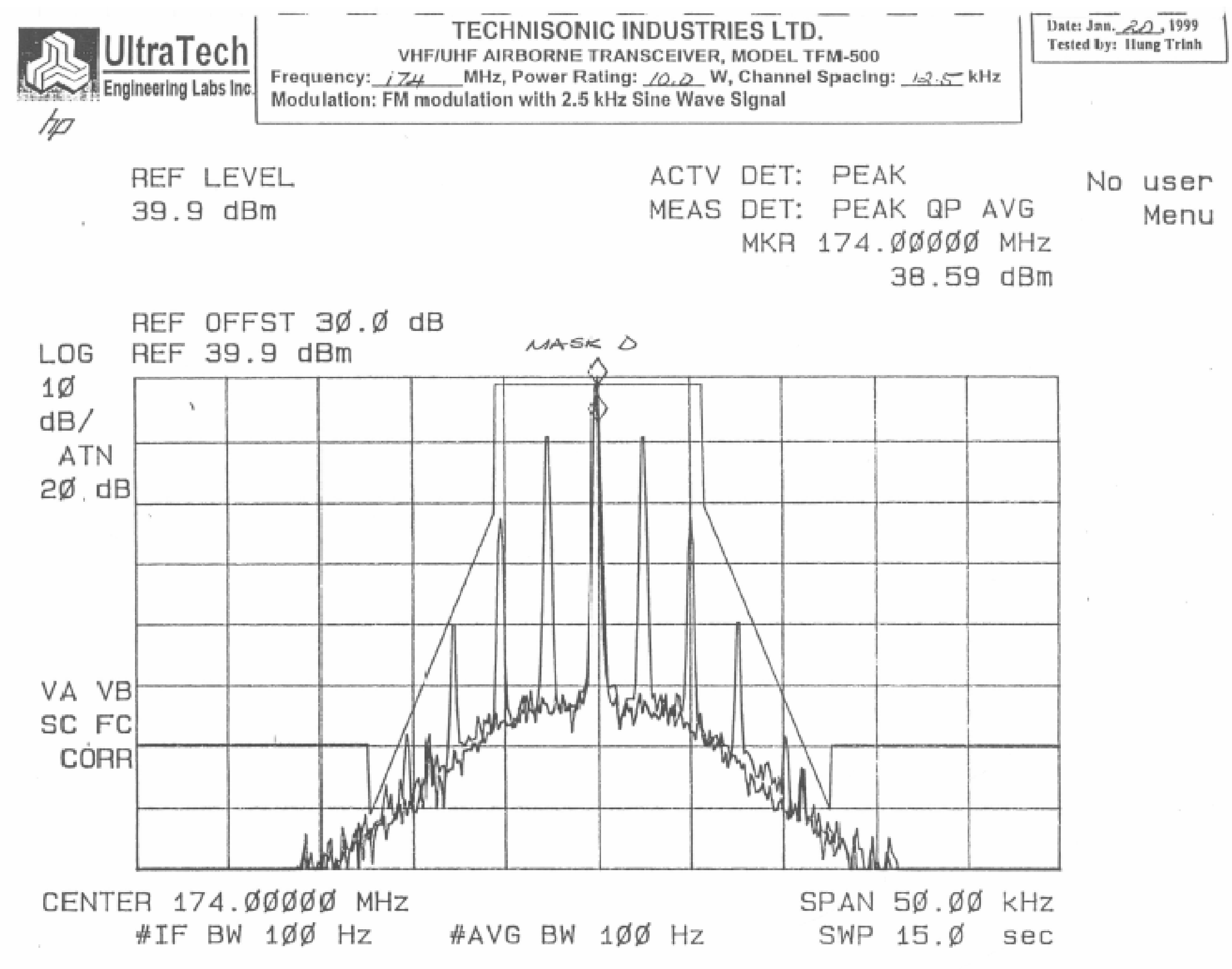
Plot # 2 Emission Mask D, High Power, Freq. 138.0 MHz
FM Modulation with 2.5 kHz Sine wave signal, 12.5 kHz Channel Spacing



Plot # 3 **Emission Mask D, High Power, Freq. 150.0 MHz**
FM Modulation with 2.5 kHz Sine wave signal, 12.5 kHz Channel Spacing



Plot # 4 Emission Mask D, High Power, Freq. 174.0 MHz
FM Modulation with 2.5 kHz Sine wave signal, 12.5 kHz Channel Spacing



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

5.8.1. 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) – Voice	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

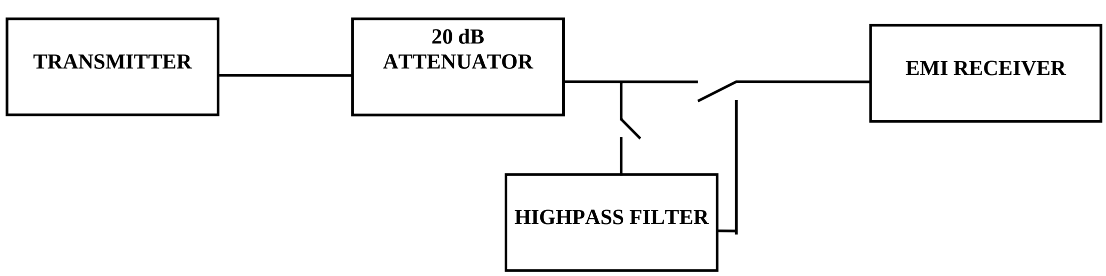
5.8.2. Method of Measurements

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

5.8.3. 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

5.8.4. Test Arrangement



5.8.5. Test Data

Remarks:

- The transmitter conducted emissions were scanned from 10 MHz to 5 GHz at 12.5 kHz and 25 kHz channel spacing / FM voice modulation and the results were found the same. The following tables show test data measured with the transmitter set at 25 kHz channel spacing / FM voice modulation as representative.
- The most stringent limit = 50 + 10*log(P in watts) were applied for both 12.5 kHz and 25 kHz channel spacing operation for worst case of measurements.

* **Remark**: Since the only difference between 12.5 kHz and 25 kHz Channel Spacing operation is the adjustment of frequency deviation limiter (only can be done by software), tests was done with 25 kHz Channel Spacing operation and the results were compared against the limits for 12.5 kHz Channel Spacing operation to represent the worst case.

Fundamental Frequency: 138 MHz, 25 kHz Channel Spacing
RF Output Power: 10 Watts
Modulation: FM modulation with 2.5 kHz Sine Wave signal, freq. Dev. = 3.9 kHz

FREQUENCY (MHz)	RF LEVEL (dBm)	* LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
277.3	-25.1	-20.0	-5.1	PASS
415.9	-21.3	-20.0	-1.3	PASS
2054.0	-29.8	-20.0	-9.8	PASS
2708.0	-30.0	-20.0	-10.0	PASS
The emissions were scanned from 10 MHz to 5 GHz and all emissions less 30 dB below the limits were recorded.				

Fundamental Frequency: 150 MHz, 25 kHz Channel Spacing
RF Output Power: 10 Watts
Modulation: FM modulation with 2.5 kHz Sine Wave signal, freq. Dev. = 3.9 kHz

FREQUENCY (MHz)	RF LEVEL (dBm)	* LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
302.1	-24.2	-20.0	-4.2	PASS
453.0	-24.4	-20.0	-4.4	PASS
2223.0	-30.3	-20.0	-10.3	PASS
2899.0	-29.9	-20.0	-9.9	PASS
The emissions were scanned from 10 MHz to 5 GHz and all emissions less 30 dB below the limits were recorded.				

Fundamental Frequency: 174 MHz, 25 kHz Channel Spacing
RF Output Power: 10 Watts
Modulation: FM modulation with 2.5 kHz Sine Wave signal, freq. Dev. = 3.9 kHz

FREQUENCY (MHz)	RF LEVEL (dBm)	*LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
349.1	-23.7	-20.0	-3.7	PASS
524.8	-24.8	-20.0	-4.8	PASS
1840.0	-30.3	-20.0	-10.3	PASS
2760.0	-30.3	-20.0	-10.3	PASS

The emissions were scanned from 10 MHz to 5 GHz and all emissions less 30 dB below the limits were recorded.

5.9. TRANSIENT FREQUENCY BEHAVIOR @ 90.214

5.9.1. 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
		138 to 174 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels		
t_1 [4] t_2 t_3 [4]	± 25.0 kHz ± 12.5 kHz ± 25.0 kHz	5.0 ms 20.0 ms 5.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels		
t_1 [4] t_2 t_3 [4]	± 12.5 kHz ± 6.25 kHz ± 12.5 kHz	5.0 ms 20.0 ms 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.

5.9.2. Method of Measurements

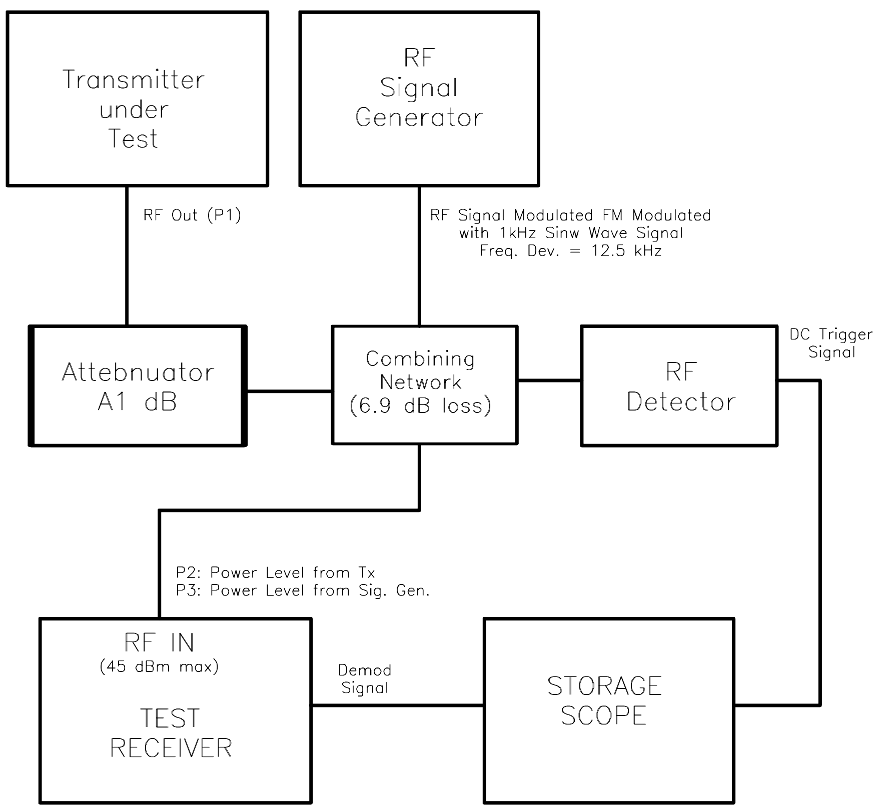
Refer to Exhibit 8, § 8.6 of this test report and ANSI/TIA/EIA - 603 - 1992, Sec. 2.2.19, Page 83

5.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Function Generator	Stanford Research Systems	DS345	34591	1μHz – 30.2 MHz
Signal Generator	Gigatronic	6061A	5130408	10 kHz – 1050 MHz
Infinium Oscilloscope	Hewlett Packard	54810A	US3838019	--
RF Detector	Narda	503A-03	0105	0.01 – 18 GHz
Modulation Analyzer	Hewlett Packard	8910B	3226A04606	150 kHz – 1300 MHz
Attenuator	Weinschel Corp.	46-20-34	BM1347	DC-18 GHz

5.9.4. Test Arrangement

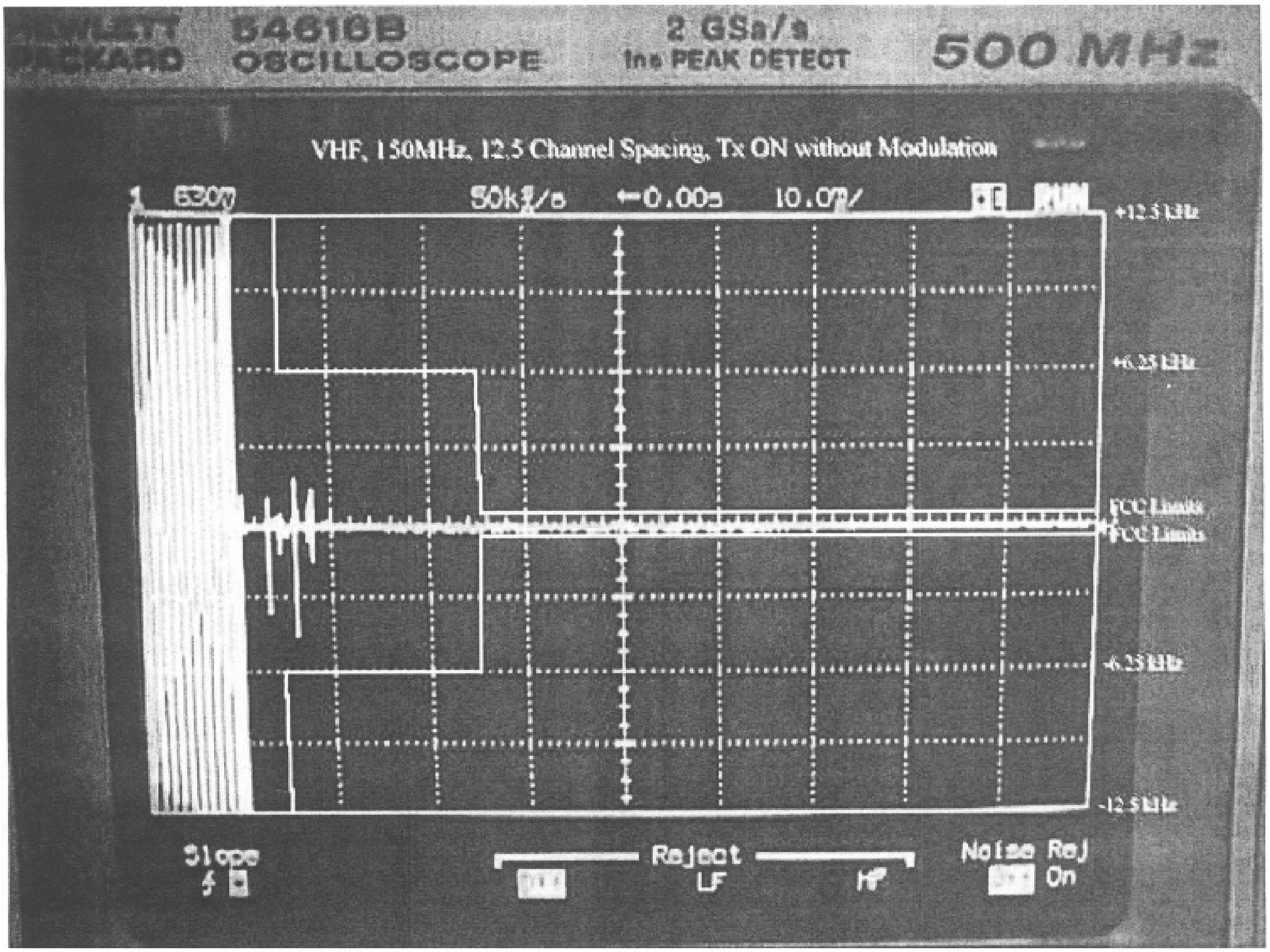
The following drawings show details of the test setup for radiated emissions measurements



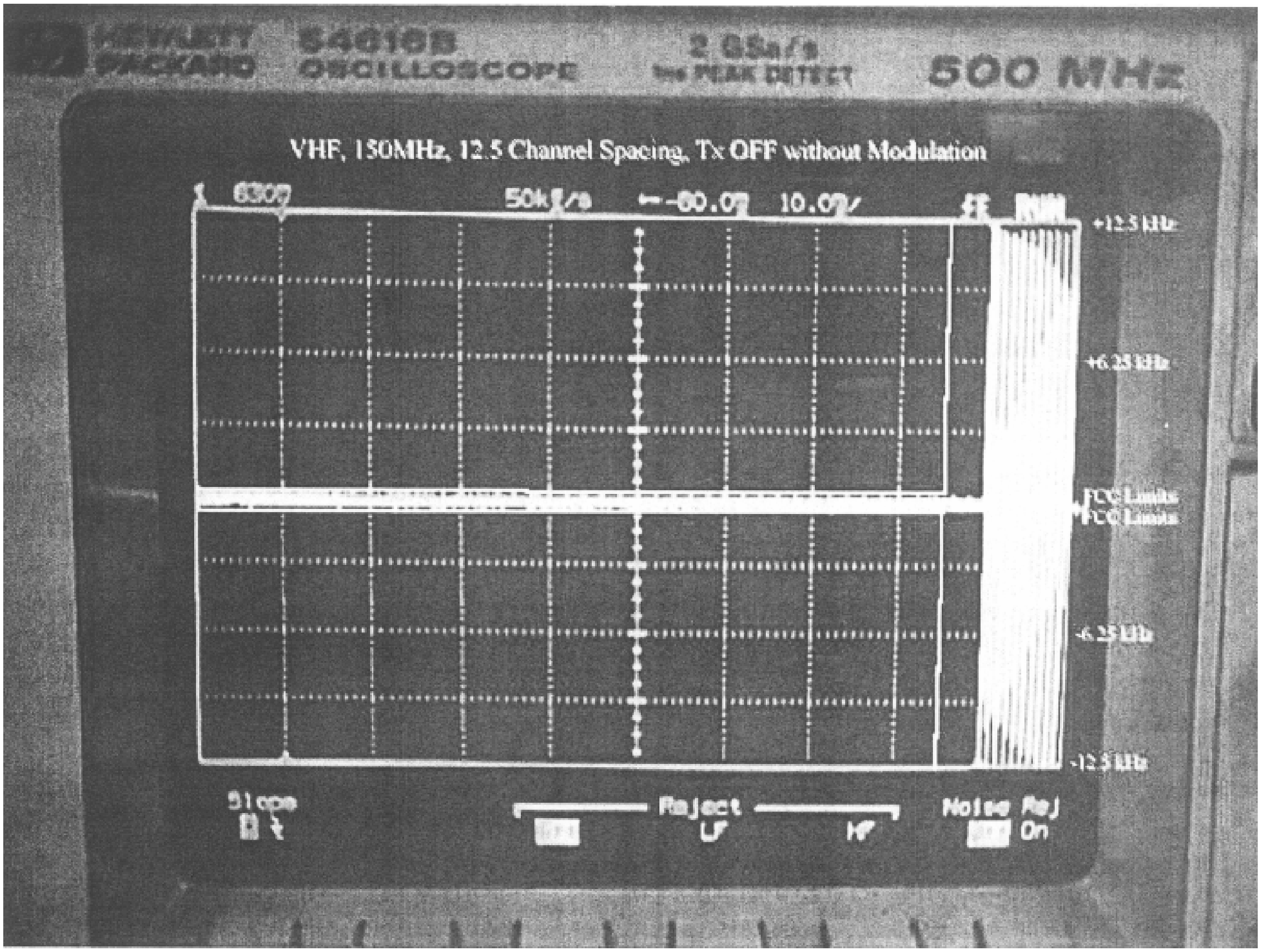
5.9.5. Test Data

5.9.5.1. 12.5 kHz Channel Spacing Operation

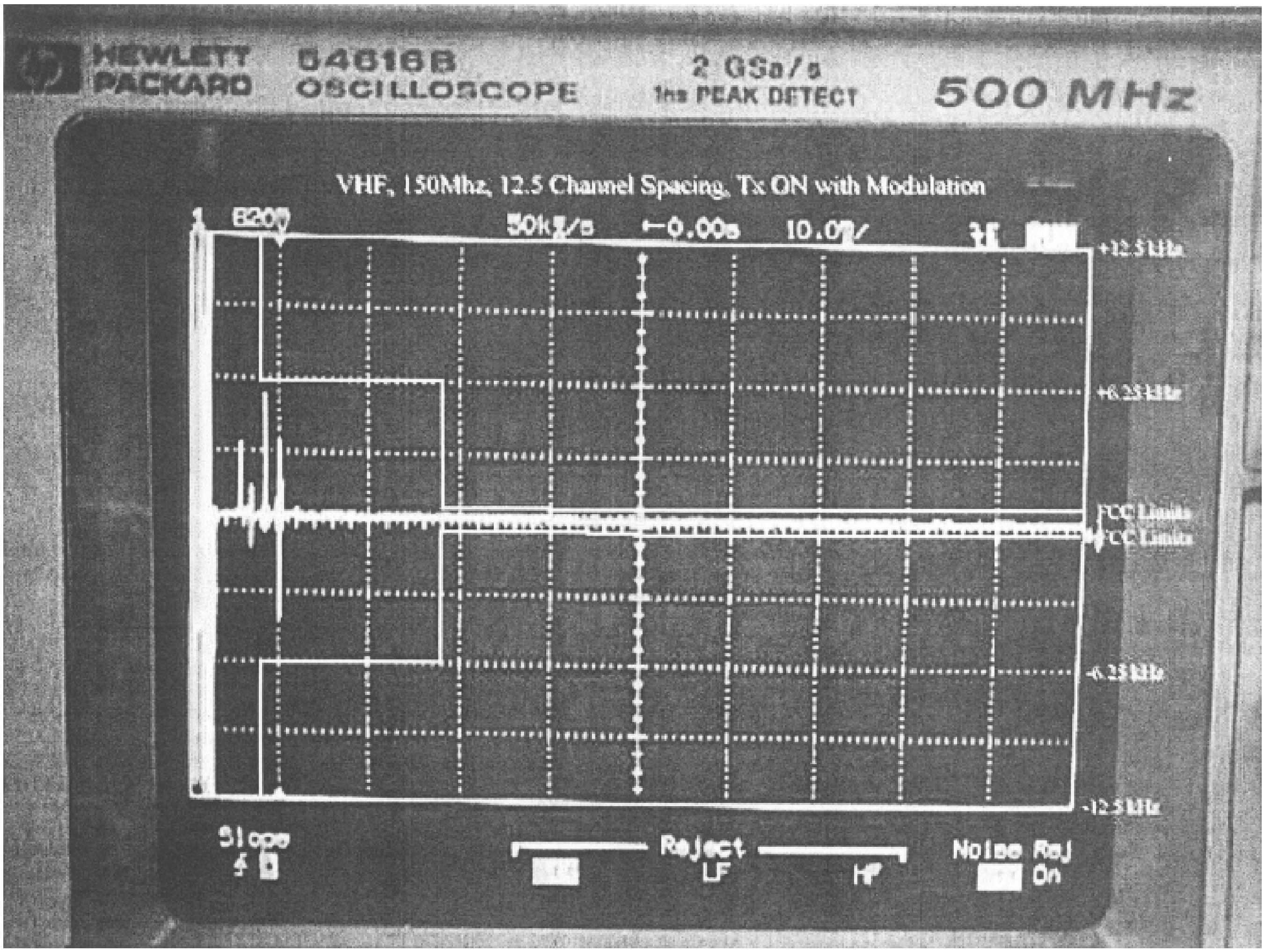
Plot # 5: Transient Frequency Behavior, 12.5 kHz Ch.Spacing, Freq.: 150MHz
Modulation: Unmodulated
Description: Switch on condition t_{on}, t_1, and t_2



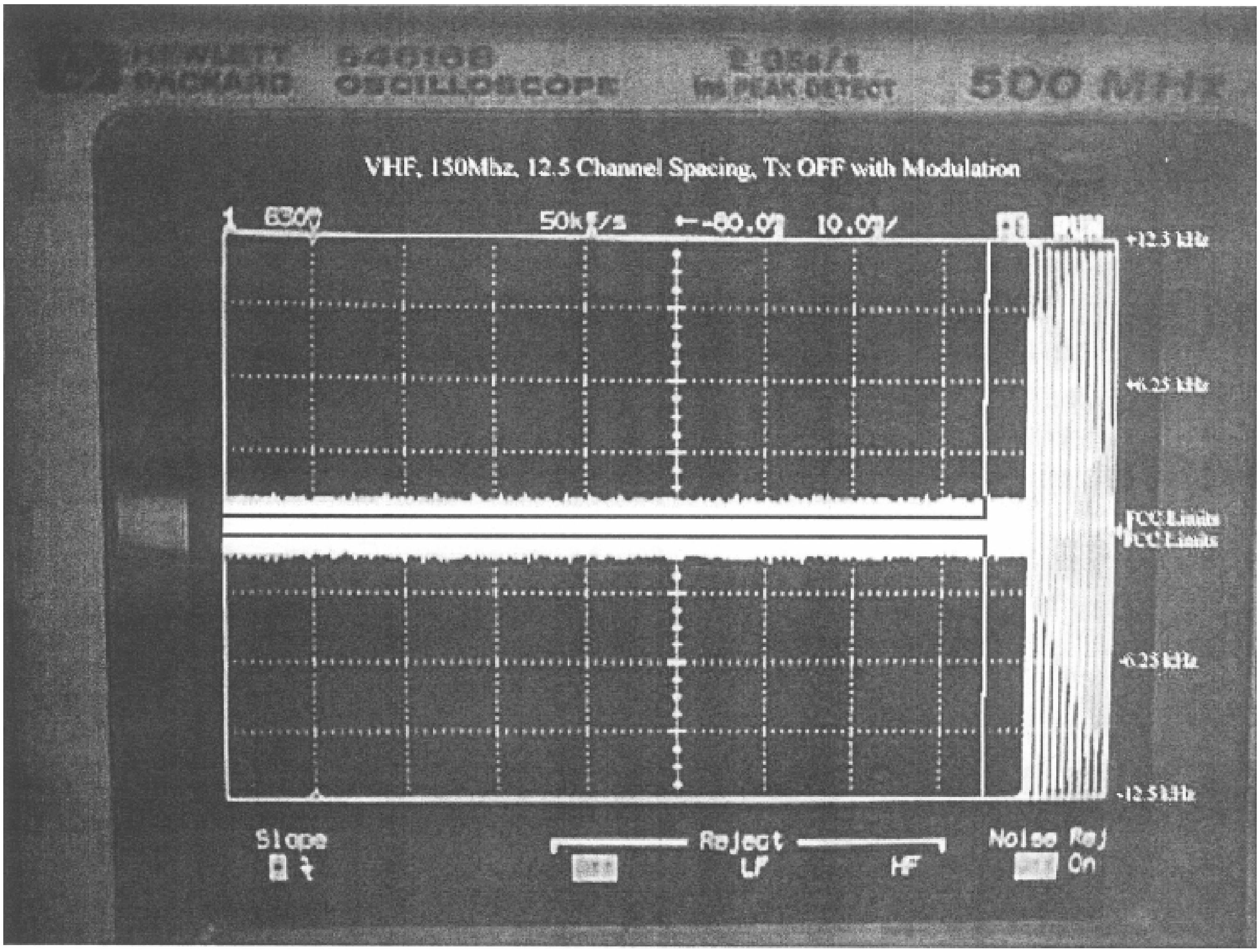
Plot # 6: Transient Frequency Behavior, 12.5 kHz Ch.Spacing, Freq.: 150MHz
Modulation: Unmodulated
Description: Switch off condition t_3, t_{off}



Plot # 7: Transient Frequency Behavior, 12.5 kHz Ch.Spacing, Freq.: 150MHz
Modulation: FM modulation with 2.5 kHz sine wave signal
Description: Switch on condition t_{on}, t_1, and t_2



Plot # 8: Transient Frequency Behavior, 12.5 kHz Ch.Spacing, Freq.: 150MHz
Modulation: FM modulation with 2.5 kHz sine wave signal
Description: Switch off condition t_3, t_{off}



5.10. OPERATION ON BOARD AIRCRAFT @ 90.423

5.10.1. Conditions for Operating Mobile Station on Board Aircraft

	Conditions	**Compliance**
1.	Operations are limited to aircraft that are flown at altitudes below 1.6 km (1 mi) above the earth's surface	Yes, It will be used in the Helicopter flown at altitude below 1.6 km.
2.	Transmitters are to operate with an output power not to exceed 10 watts	Yes, Max rated output power is 10 watts
3.	Operations are secondary to land based systems.	Yes
4.	Such other conditions, including additional reduction of altitude and power limitations, as may be required to minimize the interference potential to land based systems.	Yes, acceptable.

EXHIBIT 6. MEASUREMENT UNCERTAINTY

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

6.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY ($\pm$ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	$\pm$1.0	$\pm$1.0
Cable Loss Calibration	Normal (k=2)	$\pm$0.3	$\pm$0.5
EMI Receiver specification	Rectangular	$\pm$1.5	$\pm$1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	$\pm$2.0	$\pm$0.5
Antenna phase center variation	Rectangular	0.0	$\pm$0.2
Antenna factor frequency interpolation	Rectangular	$\pm$0.25	$\pm$0.25
Measurement distance variation	Rectangular	$\pm$0.6	$\pm$0.4
Site imperfections	Rectangular	$\pm$2.0	$\pm$2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	$\pm$0.5
System repeatability	Std. Deviation	$\pm$0.5	$\pm$0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

EXHIBIT 7. MEASUREMENT METHODS

7.1. 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.

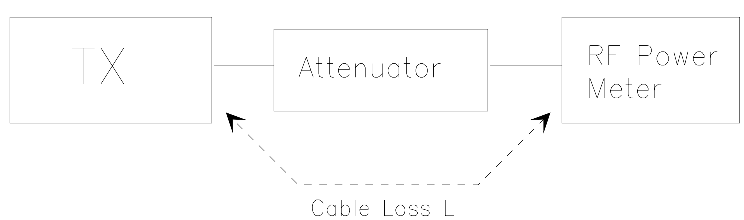
Step 2: Calculation of Average EIRP. See Figure 1

- 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.



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

7.2.1. 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

7.2.2. 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

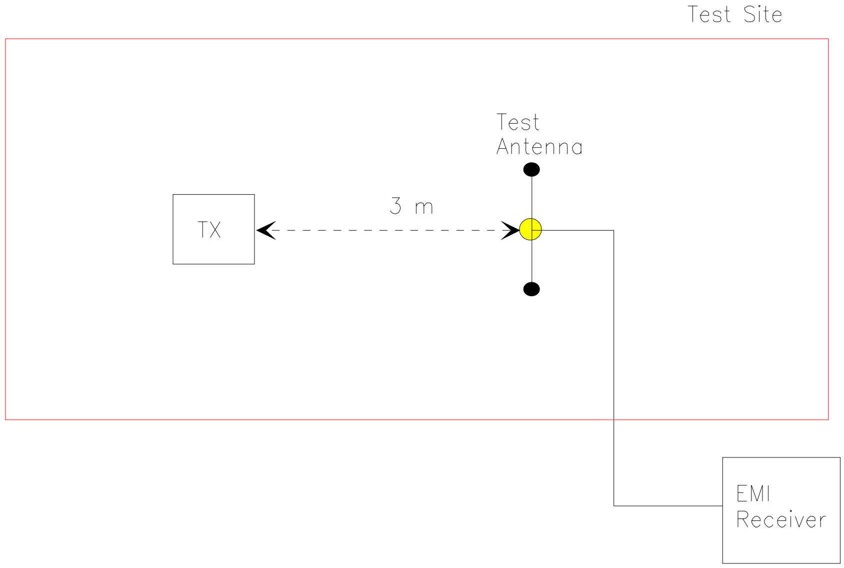
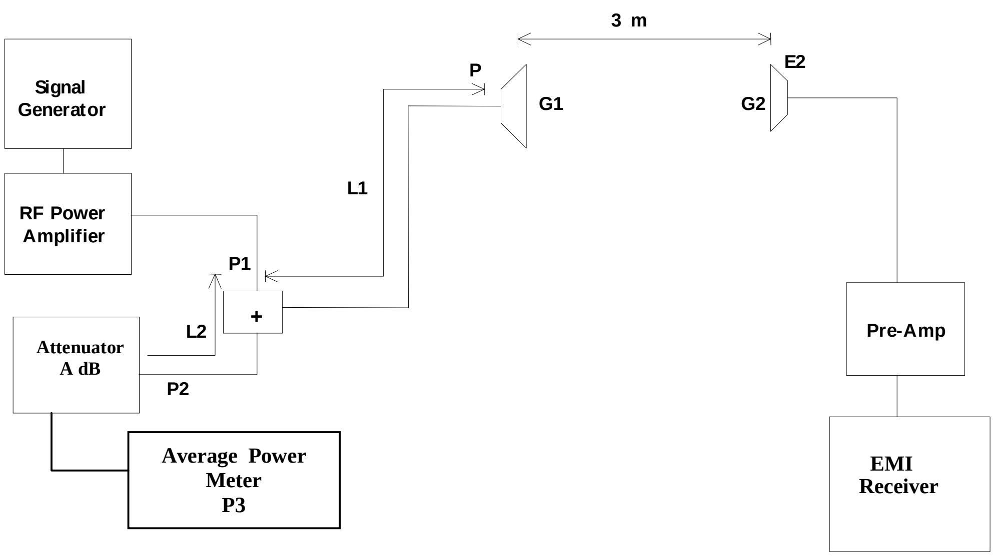


Figure 3



7.3. EMISSION MASK

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

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

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

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

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

7.4. SPURIOUS EMISSIONS (CONDUCTED)

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

FCC 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.

7.5. 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.