ENGINEERING TEST REPORT

LOWBAND VHF/FM TRANSCEIVER
MODEL NO.: TFM-30

FCC ID: IMATFM-30

FCC PART 2 & PART 90, SUBPART I
RADIO SERVICES FOR COMMERCIAL/INDUSTRIAL USES

UltraTech's FILE NO.: TIL11FT

Tested for:

TECHNISONIC INDUSTRIES LIMITED
250 Watline Avenue
Mississauga, Ontario
Canada, L4Z 1P4

Tested by:

UltraTech - Group of Labs
4181 Sladeview Crescent, Unit 33
Mississauga, Ontario
Canada L5L 5R2

Report Prepared by: Dan Huynh

DATE: February 8, 1999

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1. EXHIBIT 1 – SUMMARY OF TEST RESULTS & GENERAL STATEMENT OF CERTIFICATION

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
90.205 & 2.985	RF Power Output	Yes
90.213 & 2.995	Frequency Stability	Yes
90.242(b)(8) & 2.987(a)	Audio Frequency Response	Not applicable to new standard. However, tests are attempted to be done due to FCC's recommendation.
90.210 & 2.987(b)	Modulation Limiting	Yes
90.210 & 2.989	Emission Masks	Yes
90.210, 2.997 & 2.991	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
90.210, 2.997 & 2.993	Emission Limits - Field Strength of Spurious Emissions	Yes
90.214	Transient Frequency Behavior	N/A

LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30, by **TECHNISONIC INDUSTRIES LIMITED** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices**. The engineering test report has been documented and kept in file and it is available anytime upon FCC request.

TESTIMONIAL AND STATEMENT OF CERTIFICATION

THIS IS TO CERTIFY:

1) *THAT the application was prepared either by, or under the direct supervision of the undersigned.*

2) *THAT the measurement data supplied with the application was taken under my direction and supervision.*

3) *THAT the data was obtained on representative production units, representative.*

4) *THAT, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.*

Certified by:

Tri Minh Luu, P. Eng.
V.P., Engineering

DATE: February 8, 1999

2. EXHIBIT 2 - GENERAL INFORMATION

2.1. APPLICANT

TECHNISONIC INDUSTRIES LIMITED
250 Watline Avenue
Mississauga, Ontario
Canada, L4Z 1P4

Applicant's Representative: Mr. Steve McIntosh

2.2. MANUFACTURER

TECHNISONIC INDUSTRIES LIMITED
250 Watline Avenue
Mississauga, Ontario
Canada, L4Z 1P4

2.3. DESCRIPTION OF EQUIPMENT UNDER TESTS

PRODUCT NAME:	LOWBAND VHF/FM TRANSCEIVER
MODEL NO.:	TFM-30
SERIAL NUMBER:	Pre-production
TYPE OF EQUIPMENT:	Radio Services Transmitters
SERVICES AREAS:	Commercial/Industrial
OPERATING FREQ.:	30 – 50 MHz
CHANNEL SPACINGS	20 kHz
POWER RATING:	10 Watts max.
OUTPUT IMPEDANCE:	50 Ohms
DUTY CYCLE:	Continuous
99% BANDWIDTH:	7.0 kHz
EMISSION DESIGNATION:	13K8F3E

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

(i) For FM Voice Modulation:

- Channel Spacing = 20 kHz, D = 3.9 KHz max. measured, K = 1, M = 3 KHz
  $B_n = 2M + 2DK = 2(3) + 2(3.9)(1) = 13.8$ kHz
  emission designation: 13K8F3E

INPUT SUPPLY: 28 Vdc

ASSOCIATED DEVICES: N/A

FCC ID: IMATFM-30

INTERFACE PORTS: (1) VHF RF IN/OUT (BNC)
(2) DB15 Port
(3) DB9 Port

2.4. RELATED SUBMITTALS)/GRANT

Not applicable

2.5. TEST METHODOLOGY

These tests were conducted on a sample of the equipment for the purpose of certification compliance with Code of Federal Regulations, Parts 2 & 90, Subpart I, Radio Services Operating in the Frequency Band 30 - 50 MHz.

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.

2.6. TEST FACILITY

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: September 20, 1998.

The above test site is also filed with Interference Technology International Ltd (ITI - An EC Directive on EMC).

2.7. UNITS OF MEASUREMENTS

Measurements of conducted emissions are reported in units of dB referenced to one microvolt [dB(uV)].

Measurements of radiated emissions are reported in units of dB referenced to one microvolt per meter [dB(uV)/m] at the distance specified in the report, wherever it is applicable.

3. EXHIBIT 3 - SYSTEM TEST CONFIGURATION

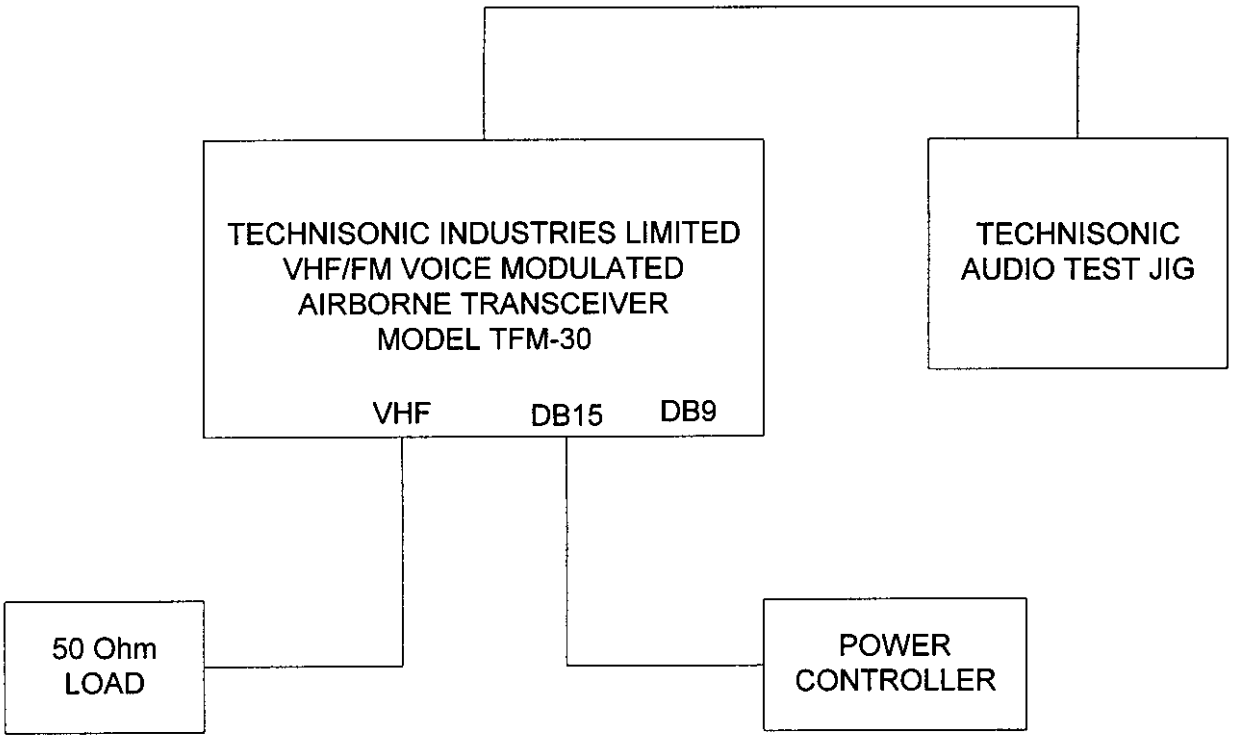
3.1. TEST SYSTEM DETAILS

The following peripherals, FCC identifiers and types interconnecting cables were used with the EUT for testing:

(1) **EUT**: TECHNISONIC INDUSTRIES LIMITED, LOWBAND VHF/FM TRANSCEIVER, Model : TFM-30,
RF Cable: Shielded
Power Supply Cable: Non-shielded

(2) **TEST JIG**: Technisonic Test Jig for Voice Radio Transmitters and Receivers

3.2. BLOCK DIAGRAMS OF TEST SET-UP



3.4. JUSTIFICATION

No deviation, in both configuration and operation manners, different from normal operation were required.

3.5. EUT OPERATING CONDITION

Transmitter was turned on continuously for testing. The transmitter's carrier was modulated with modulating signal as mentioned in the test data.

3.6. SPECIAL ACCESSORIES

No special accessories were required.

3.7. EQUIPMENT MODIFICATIONS

Not required.

4. EXHIBIT 4 - TEST DATA

4.1. POWER AND ANTENNA HEIGHT @ FCC 90.205

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 90, Para. 90.205:- Please refer to FCC CFR 47, Part 80 to End, Para. 90.205 for specification details.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

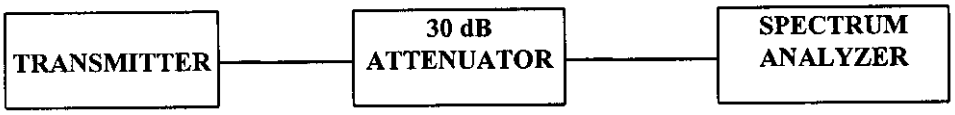
- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird Attenuator, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

Refer to FCC @ 2.985

(a) For transmitter other than single sideband, independent sideband and controlled carrier radiotelephone, power rf output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of the current and voltage on the circuit elements specified in 2.983(d)(5). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 27, 1999

MEASUREMENT DATA

PEAK POWER MEASUREMENT AT THE ANTENNA TERMINAL

TEST CONFIGURATION

- *The transmitter terminal was coupled to the Spectrum Analyzer through a 30 dB attenuator*
- *Power of the transmitter channel near the lowest, middle and highest of each frequency block/band were measured using the power meter, and the reading was corrected by added the calibrated attenuator's attenuation value and cable loss.*
- *The RF Output was turned on with no modulation.*

TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	MEASURED PEAK POWER (Watts)	PEAK POWER RATING (Watts)
--	30	10	10
--	40	10	10
--	50	10	10

ERP Measurements: -Appropriate antenna type, and adjustment of power output for effective radiated power (ERP) to meet FCC limits will be performed by the manufacturer at location of installation.

4.2. FREQUENCY STABILITY @ FCC 90.213

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 90, Sub. I, Para. 90.213

The carrier frequency of each transmitter shall be maintained within the following tolerances from the assigned frequencies.

FREQUENCY RANGE (MHz)	FIXED & BASE STATIONS (PPM)	MOBILE STATIONS (PPM)	
		> 2 W	≤ 2 W
30 – 50 MHz	20.0	20.0	50.0

CLIMATE CONDITION:

Standard Temperature and Humidity: Please refer to Measurement Data

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Tenney Temp. & Humidity Chamber, Model T5, S/N: 9723B
- Bird Attenuator, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

Refer to FCC @ 2.995

(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:

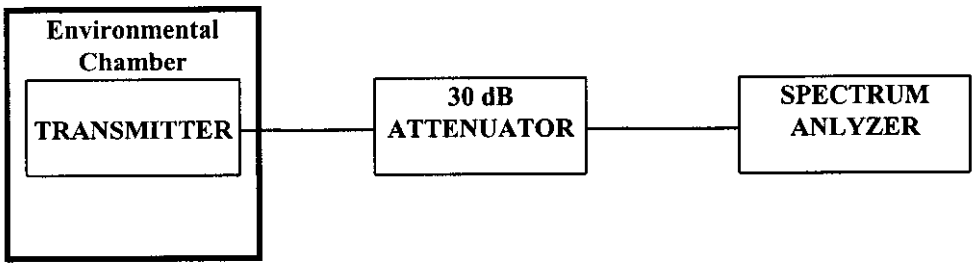
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(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).

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: February 1, 1999

MEASUREMENT DATA

FREQUENCY STABILITY

TEST CONFIGURATION

- *The transmitter was placed inside the environmental chamber, and its output terminal was coupled to the Spectrum Analyzer through a 30 dB attenuator.*
- *One transmitter channel frequency was tested.*
- *The DUT was supplied by a variable power supply.*
- *The environmental chamber was cycled down to -30° C. When the chamber reaches -30° C, the EUT was powered on with the nominal voltage level, with the transmitter keyed off. The terminal remained in the chamber at -30°C for a period of 1 hour. After 1 hour the transmitter was continuously keyed on, at **full power**. The transmitter frequency of the terminal was measured from the spectrum analyzer every minute for a period of 10 minutes.*
- *After 10 minutes the variable power supply was adjusted to supply the EUT with voltage of 85% nominal voltage level and measurement was repeated.*
- *After 10 minutes the variable power supply was adjusted to supply the EUT with voltage of 115% nominal voltage level and measurement was repeated,*
- *When the measurement complete, the transmitter was keyed off and the chamber was cycled up to 10° C steps. The EUT remained powered up (unkeyed) at -20° C for a minimum period of 1 hour, after which the measurements will be made as outlined above.*
- *The above was repeated for -10, 0, 20, 30, 40 and 50 degrees Celsius.*

Product Name **Model No.**	**LOWBAND VHF/FM TRANSCEIVER** **MODEL NO.: TFM-30**
Centre Frequency	40 MHz
Full Power Level	10 Watts
Frequency Tolerance Limit	800 Hz or 0.002% @ 40 MHz
Max. Frequency Tolerance Measured	90 Hz or 0.00023% @ 40 MHz
Base/Mobile/Portable	-30 to +50 degree C, 85% to 115%

		CENTRE FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 28 Volts dc		Supply Voltage (85% of Nominal) 23.8 Volts dc		Supply Voltage (115% of Nominal) 32.2 Volts dc	
AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	Hz	dB	Hz	dB	Hz	dB
-30	0	-30	N/A	N/A	N/A	N/A	N/A
	1	-60	N/A	N/A	N/A	N/A	N/A
	2	-90	N/A	N/A	N/A	N/A	N/A
	3	-30	N/A	N/A	N/A	N/A	N/A
	4	-60	N/A	N/A	N/A	N/A	N/A
	5	-90	N/A	N/A	N/A	N/A	N/A
	6	-30	N/A	N/A	N/A	N/A	N/A
	7	-60	N/A	N/A	N/A	N/A	N/A
	8	-30	N/A	N/A	N/A	N/A	N/A
	9	-60	N/A	N/A	N/A	N/A	N/A
	10	-60	N/A	N/A	N/A	N/A	N/A

Continued..

		CENTRE FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 28 Volts dc		Supply Voltage (85% of Nominal) 23.8 Volts dc		Supply Voltage (115% of Nominal) 32.2 Volts dc	
AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	Hz	dB	Hz	dB	Hz	dB
-20	0	-90	N/A	N/A	N/A	N/A	N/A
	1	-60	N/A	N/A	N/A	N/A	N/A
	2	-90	N/A	N/A	N/A	N/A	N/A
	3	-30	N/A	N/A	N/A	N/A	N/A
	4	-60	N/A	N/A	N/A	N/A	N/A
	5	-60	N/A	N/A	N/A	N/A	N/A
	6	-60	N/A	N/A	N/A	N/A	N/A
	7	-60	N/A	N/A	N/A	N/A	N/A
	8	-90	N/A	N/A	N/A	N/A	N/A
	9	-60	N/A	N/A	N/A	N/A	N/A
	10	90	N/A	N/A	N/A	N/A	N/A
-10	0	-30	N/A	N/A	N/A	N/A	N/A
	1	-60	N/A	N/A	N/A	N/A	N/A
	2	-30	N/A	N/A	N/A	N/A	N/A
	3	-30	N/A	N/A	N/A	N/A	N/A
	4	-60	N/A	N/A	N/A	N/A	N/A
	5	-30	N/A	N/A	N/A	N/A	N/A
	6	-60	N/A	N/A	N/A	N/A	N/A
	7	0	N/A	N/A	N/A	N/A	N/A
	8	-30	N/A	N/A	N/A	N/A	N/A
	9	-60	N/A	N/A	N/A	N/A	N/A
	10	0	N/A	N/A	N/A	N/A	N/A
0	0	-30	N/A	N/A	N/A	N/A	N/A
	1	-60	N/A	N/A	N/A	N/A	N/A
	2	0	N/A	N/A	N/A	N/A	N/A
	3	-60	N/A	N/A	N/A	N/A	N/A
	4	-90	N/A	N/A	N/A	N/A	N/A
	5	-60	N/A	N/A	N/A	N/A	N/A
	6	-30	N/A	N/A	N/A	N/A	N/A
	7	-60	N/A	N/A	N/A	N/A	N/A
	8	-30	N/A	N/A	N/A	N/A	N/A
	9	-60	N/A	N/A	N/A	N/A	N/A
	10	-30	N/A	N/A	N/A	N/A	N/A

Continued..

		CENTRE FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 28 Volts dc		Supply Voltage (85% of Nominal) 23.8 Volts dc		Supply Voltage (115% of Nominal) 32.2 Volts dc	
AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	Hz	dB	Hz	dB	Hz	dB
+10	0	-30	N/A	N/A	N/A	N/A	N/A
	1	-30	N/A	N/A	N/A	N/A	N/A
	2	-60	N/A	N/A	N/A	N/A	N/A
	3	-30	N/A	N/A	N/A	N/A	N/A
	4	0	N/A	N/A	N/A	N/A	N/A
	5	-30	N/A	N/A	N/A	N/A	N/A
	6	-60	N/A	N/A	N/A	N/A	N/A
	7	-30	N/A	N/A	N/A	N/A	N/A
	8	-30	N/A	N/A	N/A	N/A	N/A
	9	-60	N/A	N/A	N/A	N/A	N/A
	10	0	N/A	N/A	N/A	N/A	N/A
+25	0	-30	-0.1	30	-0.1	30	0
	1	0	-0.1	0	-0.1	-30	0
	2	-30	-0.1	0	-0.1	30	0
	3	-30	-0.1	0	-0.1	0	0
	4	-30	-0.1	60	-0.1	0	0
	5	0	-0.1	0	-0.1	0	0
	6	0	-0.1	60	-0.1	0	0
	7	-30	-0.1	0	-0.1	-30	0
	8	30	-0.1	30	-0.1	0	0
	9	-30	-0.1	0	-0.1	0	0
	10	0	-0.1	30	-0.1	-30	0
+30	0	30	N/A	N/A	N/A	N/A	N/A
	1	0	N/A	N/A	N/A	N/A	N/A
	2	-30	N/A	N/A	N/A	N/A	N/A
	3	0	N/A	N/A	N/A	N/A	N/A
	4	-30	N/A	N/A	N/A	N/A	N/A
	5	0	N/A	N/A	N/A	N/A	N/A
	6	30	N/A	N/A	N/A	N/A	N/A
	7	0	N/A	N/A	N/A	N/A	N/A
	8	30	N/A	N/A	N/A	N/A	N/A
	9	0	N/A	N/A	N/A	N/A	N/A
	10	30	N/A	N/A	N/A	N/A	N/A

Continued..

		CENTRE FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 28 Volts dc		Supply Voltage (85% of Nominal) 23.8 Volts dc		Supply Voltage (115% of Nominal) 32.2 Volts dc	
AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	Hz	dB	Hz	dB	Hz	dB
+40	0	0	N/A	N/A	N/A	N/A	N/A
	1	0	N/A	N/A	N/A	N/A	N/A
	2	0	N/A	N/A	N/A	N/A	N/A
	3	0	N/A	N/A	N/A	N/A	N/A
	4	30	N/A	N/A	N/A	N/A	N/A
	5	0	N/A	N/A	N/A	N/A	N/A
	6	0	N/A	N/A	N/A	N/A	N/A
	7	-30	N/A	N/A	N/A	N/A	N/A
	8	0	N/A	N/A	N/A	N/A	N/A
	9	0	N/A	N/A	N/A	N/A	N/A
	10	0	N/A	N/A	N/A	N/A	N/A
+50	0	0	N/A	N/A	N/A	N/A	N/A
	1	30	N/A	N/A	N/A	N/A	N/A
	2	0	N/A	N/A	N/A	N/A	N/A
	3	30	N/A	N/A	N/A	N/A	N/A
	4	0	N/A	N/A	N/A	N/A	N/A
	5	0	N/A	N/A	N/A	N/A	N/A
	6	-30	N/A	N/A	N/A	N/A	N/A
	7	0	N/A	N/A	N/A	N/A	N/A
	8	-30	N/A	N/A	N/A	N/A	N/A
	9	0	N/A	N/A	N/A	N/A	N/A
	10	-30	N/A	N/A	N/A	N/A	N/A

4.3. AUDIO FREQUENCY RESPONSE @ FCC 2.987(A) & 90.242(B)(8)

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 2, Sub. J, Para. 2.987(a) & 90.242(b)(8)

No longer required by FCC. However, FCC recommends the Audio Frequency Response to be tested to observe the roll-off curve at 3 kHz.

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

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

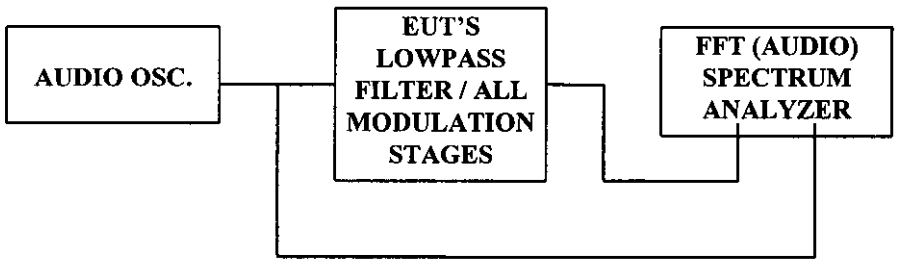
TEST EQUIPMENT:

- Audio Oscillator, HP, Model 204C, OUT FREQ.: 0-1.2 MHz, S/N: 0989A08798
- FFT (Audio) Spectrum Analyzer, Advantest, Model R9211E, Input Impedance: 1M-Ohms, Freq. Range: 10 mHz - 100 kHz.

METHOD OF MEASUREMENTS:

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

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 29, 1999

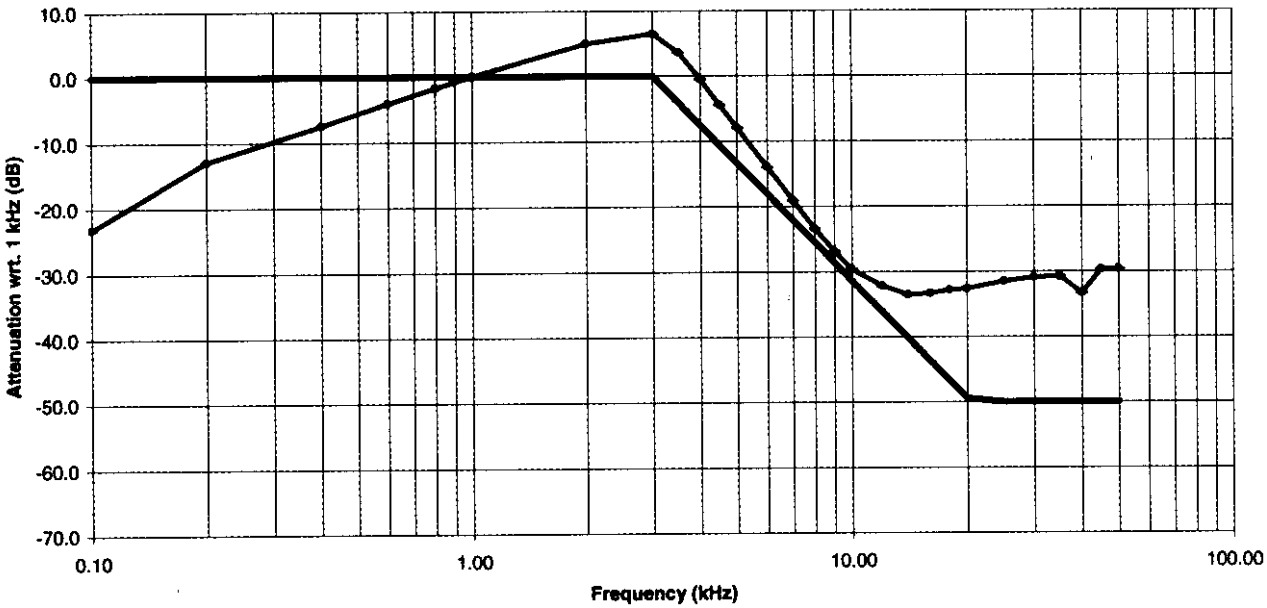
MEASUREMENT DATA

AUDIO FREQUENCY RESPONSE OF ALL MODULATION STATES

Carrier Frequency: 40 MHz, Channel Spacing: 20 kHz

FREQUENCY (kHz)	AUDIO IN (dBV)	AUDIO OUT (dBV)	ATTEN. (OUT – IN) (dB)	ATTEN. Wrt. 1kHz (dB)	FCC LIMIT @ 90.242(b)(8) (dB)	PASS/ FAIL
0.10	-14.9	-61.8	-46.9	-23.2	--	NO LIMIT
0.20	-14.9	-51.5	-36.6	-12.9	--	NO LIMIT
0.40	-14.9	-46.1	-31.2	-7.5	--	NO LIMIT
0.60	-14.9	-42.6	-27.7	-4.0	--	NO LIMIT
0.80	-14.9	-40.3	-25.4	-1.7	--	NO LIMIT
1.00	-14.9	-38.6	-23.7	0.0	--	NO LIMIT
2.00	-14.9	-33.6	-18.7	5.0	--	NO LIMIT
3.00	-14.9	-32.1	-17.2	6.5	0.0	NO LIMIT
3.50	-14.8	-34.9	-20.1	3.6	-4.0	NO LIMIT
4.00	-14.8	-39.0	-24.2	-0.5	-7.5	NO LIMIT
4.50	-14.8	-42.9	-28.1	-4.4	-10.6	NO LIMIT
5.00	-14.9	-46.5	-31.6	-7.9	-13.3	NO LIMIT
6.00	-14.9	-52.5	-37.6	-13.9	-18.1	NO LIMIT
7.00	-14.9	-57.6	-42.7	-19.0	-22.1	NO LIMIT
8.00	-14.9	-62.0	-47.1	-23.4	-25.6	NO LIMIT
9.00	-14.9	-65.5	-50.6	-26.9	-28.6	NO LIMIT
10.00	-14.9	-68.2	-53.3	-29.6	-31.4	NO LIMIT
12.00	-14.9	-70.8	-55.9	-32.2	-36.1	NO LIMIT
14.00	-14.8	-72.0	-57.2	-33.5	-40.1	NO LIMIT
16.00	-14.9	-71.9	-57.0	-33.3	-43.6	NO LIMIT
18.00	-14.9	-71.4	-56.5	-32.8	-46.7	NO LIMIT
20.00	-14.9	-71.2	-56.3	-32.6	-49.4	NO LIMIT
25.00	-14.9	-70.1	-55.2	-31.5	-50.0	NO LIMIT
30.00	-14.9	-69.5	-54.6	-30.9	-50.0	NO LIMIT
35.00	-14.9	-69.3	-54.4	-30.7	-50.0	NO LIMIT
40.00	-14.9	-71.9	-57.0	-33.3	-50.0	NO LIMIT
45.00	-14.9	-68.3	-53.4	-29.7	-50.0	NO LIMIT
50.00	-14.9	-68.2	-53.3	-29.6	-50.0	NO LIMIT

AUDIO LOW PASS FILTER FREQUENCY REPSONSE
(20 kHz Channel Spacing)
TECHNISONIC LOWBAND VHF/FM TRANSCEIVER
Carrier Frequency: 40 MHz



4.4. MODULATION LIMITING @ FCC 90.210

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 2, Sub. J, Para. 2.987(b) & FCC Part 90, Subpart I, Para. 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 (recommended: 1.25 kHz for 6.25 kHz Channel Spacing System, 2.5 kHz for 12.5 kHz Channel Spacing and 5 kHz for 25 kHz Channel Spacing System).

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

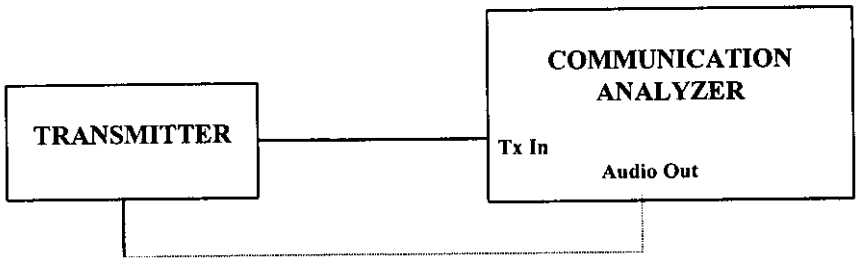
- Communication Analyzer, Rohde & Schawrz, Model SMFO2, S/N: 879988/057, 0.4 - 1000 MHz including AF & RF Signal Generators, SINAD, DISTORTION, DEVIATION meters and etc...

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.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 29, 1999

MEASUREMENT DATA

MODULATION LIMITING FOR AN AUDIO TRANSMITTER

Carrier Frequency: 40 MHz, Channel Spacing: 20 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)
0.1	0.2	0.5	0.9	2.1	0.5	5.0
0.2	0.3	0.9	1.7	3.5	0.8	5.0
0.4	0.4	1.8	1.7	3.8	0.9	5.0
0.6	0.6	2.4	3.2	3.9	0.9	5.0
0.8	0.8	2.4	3.3	3.9	0.9	5.0
1.0	0.9	2.9	3.3	3.9	0.9	5.0
1.2	1.1	3.0	3.3	3.9	0.9	5.0
1.4	1.2	3.1	3.3	3.9	1.0	5.0
1.6	1.4	3.1	3.4	3.9	1.0	5.0
1.8	1.6	3.2	3.4	3.9	1.0	5.0
2.0	1.8	3.2	3.4	3.9	1.0	5.0
2.5	2.2	3.2	3.4	3.9	1.0	5.0
3.0	2.6	3.2	3.4	3.9	1.1	5.0
3.5	3.0	3.2	3.4	3.9	1.1	5.0
4.0	3.2	3.2	3.4	3.9	1.1	5.0

Carrier Frequency: 40 MHz, Channel Spacing: 20 kHz

MODULATING FREQUENCY (KHz)	PEAK FREQUENCY DEVIATION (KHz)	SUGGESTED LIMIT (KHz)
0.1	1.1	5.0
0.2	2.4	5.0
0.4	2.8	5.0
0.6	3.2	5.0
0.8	3.3	5.0
1.0	3.4	5.0
1.2	3.3	5.0
1.4	3.2	5.0
1.6	3.2	5.0
1.8	3.2	5.0
2.0	3.4	5.0
2.5	3.9	5.0
3.0	3.9	5.0
3.5	2.9	5.0
4.0	1.9	5.0
4.5	1.3	5.0
5.0	0.9	5.0
6.0	0.6	5.0
7.0	0.5	5.0
8.0	0.4	5.0
9.0	0.3	5.0
10.0	0.3	5.0

4.5. EMISSION MASKS @ FCC 90.210

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 90, Sub. I, Para. 90.210

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

FREQUENCY RANGE (MHz)	Recommended OBW (KHz)	CHANNEL SPACING (KHz)	Recommended FREQ. DEVIATION (KHz)	FCC APPLICABLE MASK
25-50	20	20.0	5.0	90.210(b): Mask B – Audio & Voice

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird Attenuator, 50 Ohm IN/OUT
- Audio Oscillator, HP, Model 204C, SN: 0989A08798, Output: 0-1.2 MHz, 5 Vrms.

METHOD OF MEASUREMENTS:

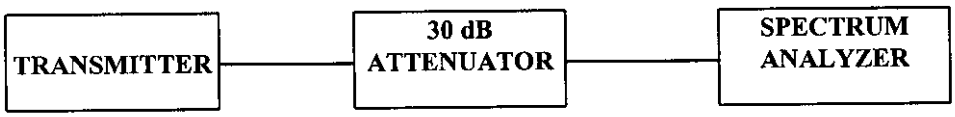
FCC CFR 47, Para. 2.989 - Out-of-Band Emissions:

The Emission Masks was measured with the Spectrum Analyzer controls set as shown on the test results (RBW ≥ 300 Hz, VBW ≥ 300 Hz and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

Voice or Digital Modulation Through a Voice Input Port @ 2.989(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 @ 2.989(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 descretion of the user.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 27, 1999

MEASUREMENT DATA

Please see attached plots for detailed measurements.

UltraTech Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.

FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30

Frequency: 30 **MHz, Power Rating:** 10 **W, Channel Spacing:** 20 **kHz**

Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27**, 1999**
Tested by: Hung Trinh

hp

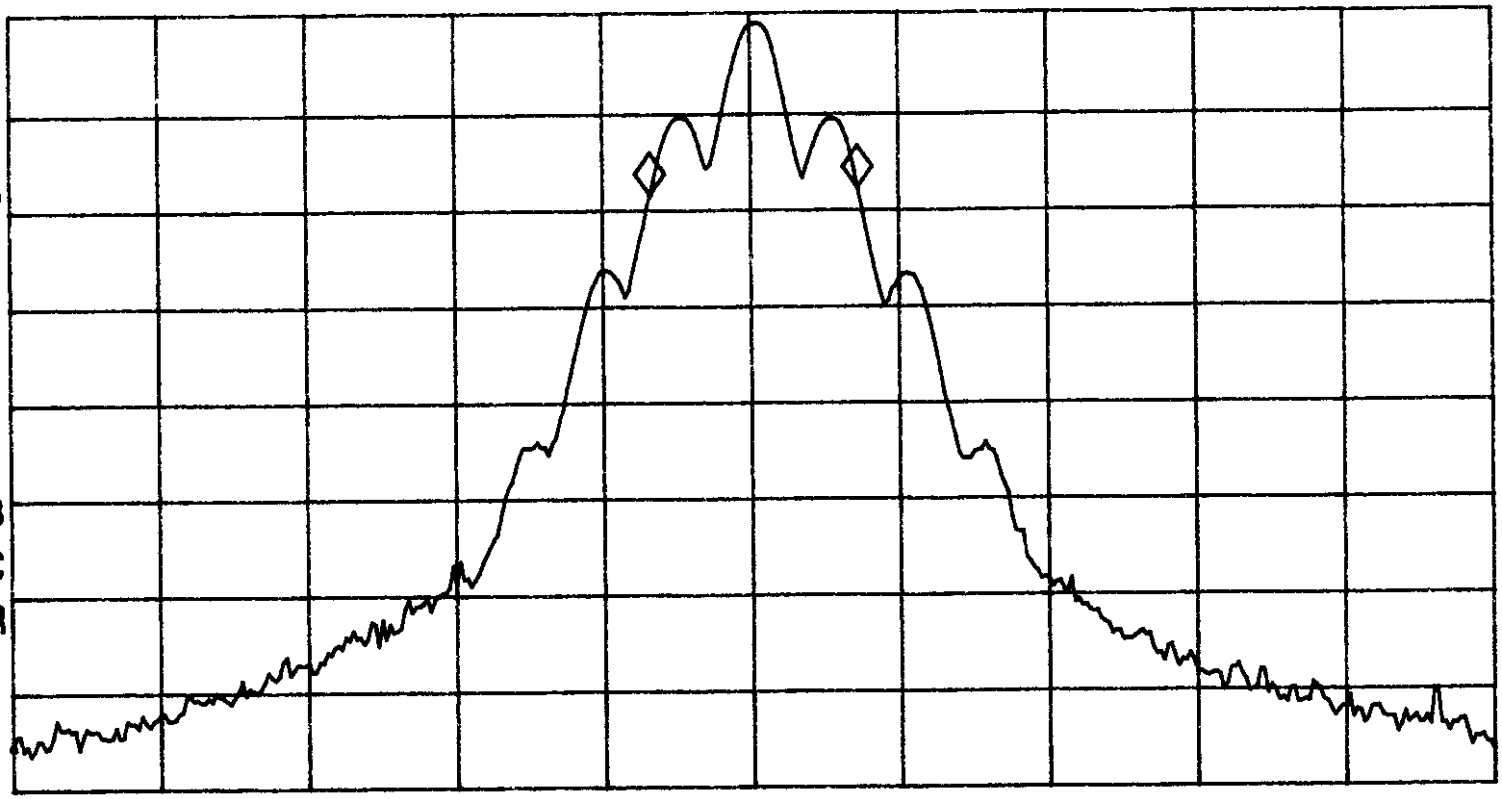
MARKER Δ
7.ØØ kHz
.68 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 7.ØØ kHz
.68 dB

No user Menu

REF OFFST 3Ø.Ø dB
LOG REF 4Ø.Ø dBm

99% OBW



CENTER 3Ø.ØØØØØ MHz
SPAN 5Ø.ØØ kHz
#IF BW 1.Ø kHz
AVG BW 1 kHz
SWP 3ØØ msec

UltraTech Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.

FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30

Frequency: 30 **MHz, Power Rating:** 10 **W, Channel Spacing:** 20 **kHz**

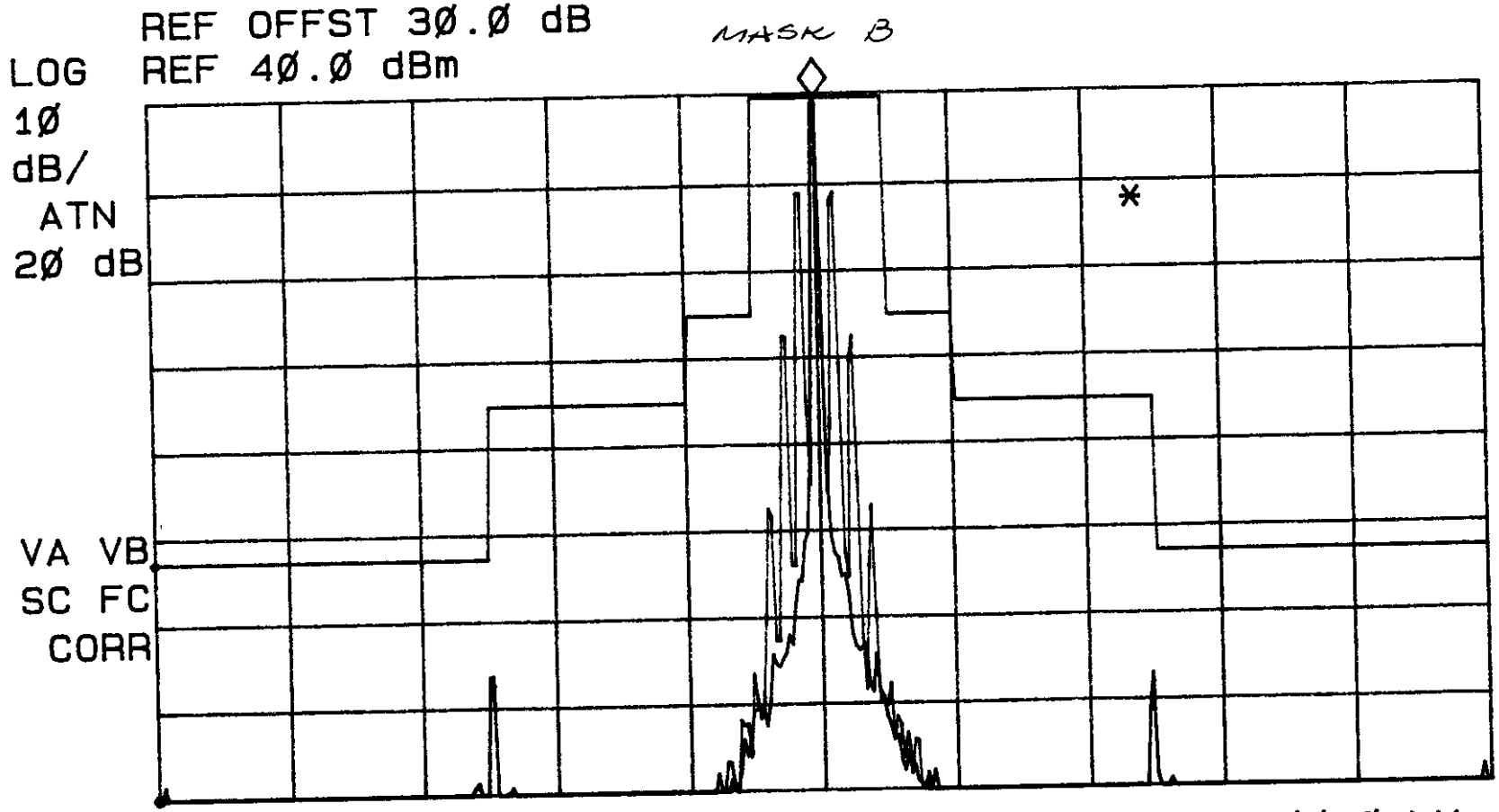
Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27, **1999**
Tested by: Hung Trinh

hp

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 30.0002 MHz
39.57 dBm

No user Menu



UltraTech Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.

FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30

Frequency: 40 **MHz, Power Rating:** 10 **W, Channel Spacing:** 20 **kHz**

Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27, **1999**
Tested by: Hung Trinh

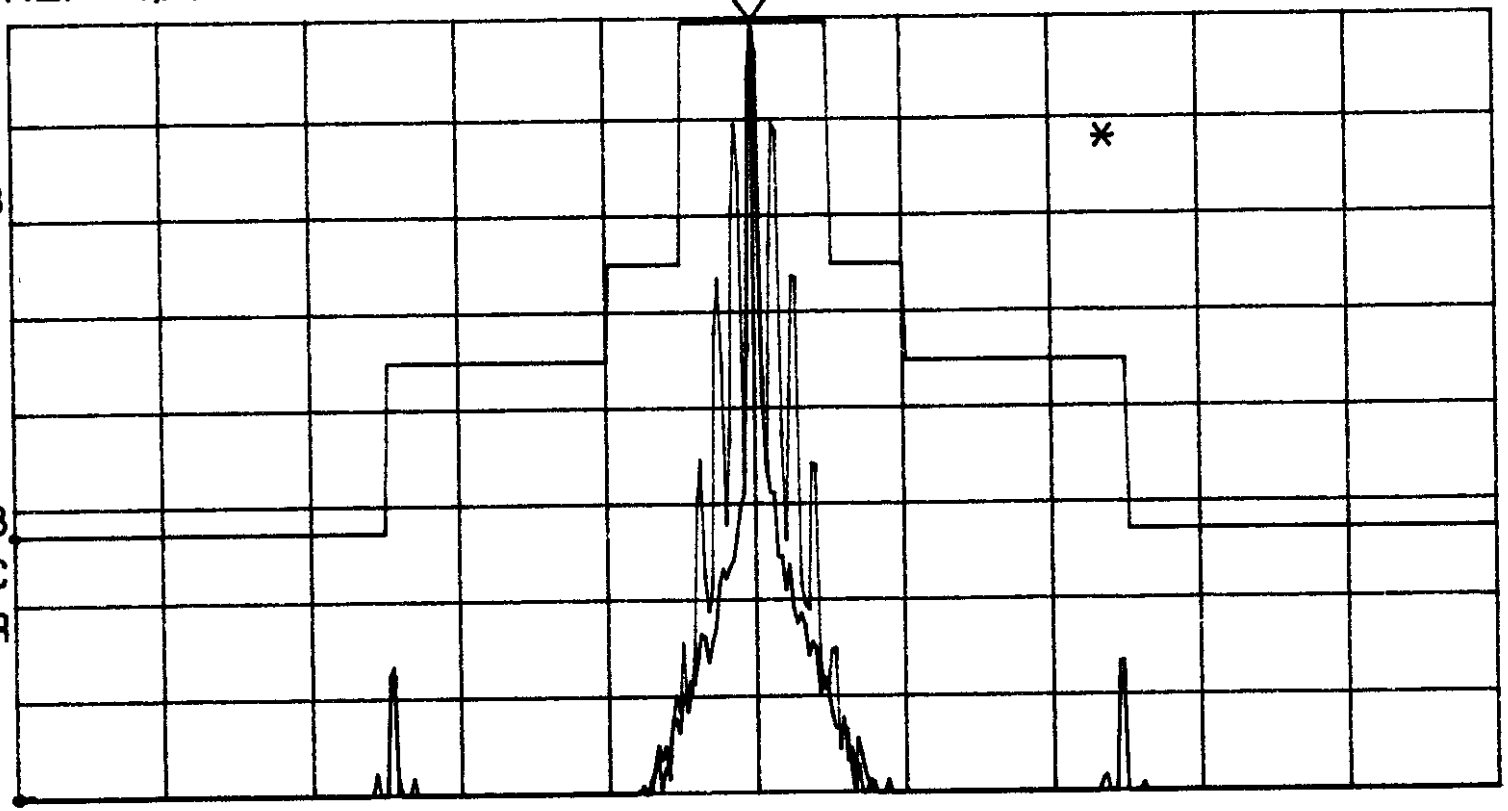
hp

REF LEVEL
40.1 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 40.0000 MHz
39.81 dBm

No user Menu

REF OFFST 30.0 dB
LOG REF 40.1 dBm
MASK B
10 dB/
ATN 30 dB
VA VB
SC FC
CORR



CENTER 40.0000 MHz
#IF BW 300 Hz
AVG BW 300 Hz
SPAN 200.0 kHz
SWP 6.67 sec

UltraTech
Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.
FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30
Frequency: 50 MHz, Power Rating: 10 W, Channel Spacing: 20 kHz
Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27, 1999
Tested by: Hung Trinh

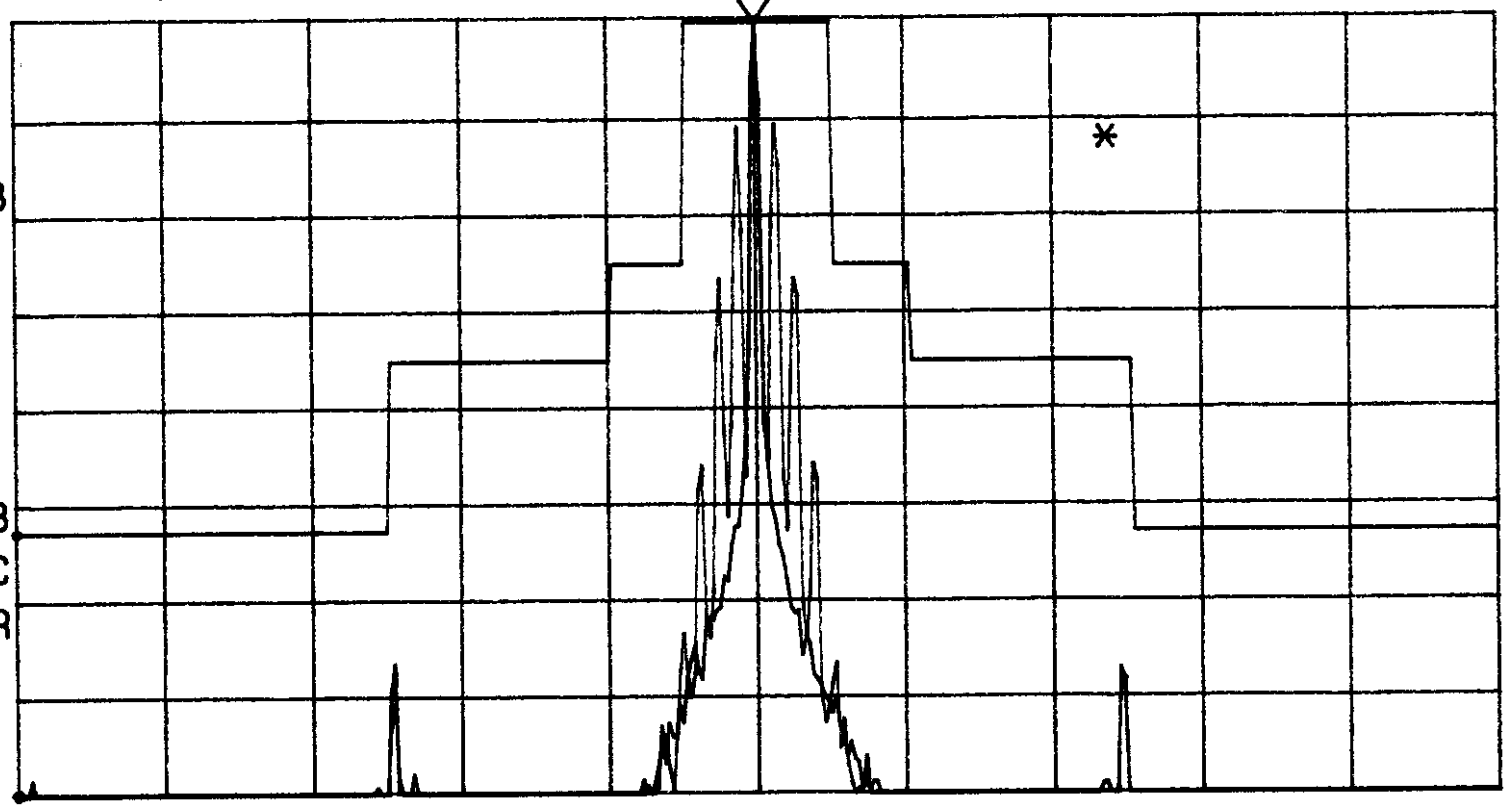
hp

REF LEVEL
40.2 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 50.0000 MHz
39.75 dBm

No user Menu

REF OFFST 30.0 dB
LOG REF 40.2 dBm
MASK B
10 dB/
ATN 30 dB
VA VB
SC FC
CORR



CENTER 50.0000 MHz
SPAN 200.0 kHz
#IF BW 300 Hz
AVG BW 300 Hz
SWP 6.67 sec

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

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER, Model No.: TFM-30**

FCC REQUIREMENTS:

FCC Part 90, Sub. I, Para. 90.210

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

FREQUENCY RANGE (MHz)	Recommended OBW (KHz)	CHANNEL SPACING (KHz)	Recommended FREQ. DEVIATION (KHz)	FCC SPECIFICATION LIMITS (Para. No.)
25-50	20	20	5.0	90.210(b): Mask B – Audio & Voice

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird Attenuator, 50 Ohm IN/OUT
- Hihpass Filter, Microphase, P/N: CR220HIB, S/N: IITI11000AB, cut-off freq.: 600 MHz.
- Audio Oscillator, HP, Model 204C, SN: 0989A08798, Output: 0-1.2 MHz, 5 Vrms.

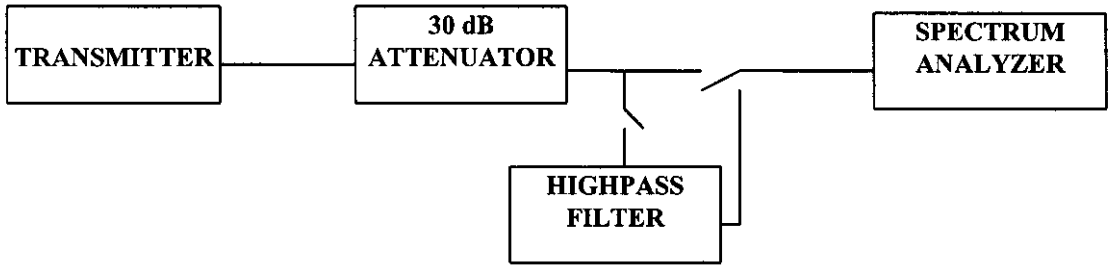
METHOD OF MEASUREMENTS:

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.989, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 100 kHz, VBW = 100 kHz and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated:- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10th 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. 2.991 - 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 2.989 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 28, 1999

MEASUREMENT DATA

SPURIOUS & HARMONIC EMISSIONS
AT THE TRANSMITTER ANTENNA TERMINAL

TEST CONFIGURATION

- *The transmitter was coupled to the Spectrum Analyzer through a 30 dB attenuator.*
- *The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 30 dB*
- *The channel frequencies (Low, Middle and High) was established on the extreme edges of the operating band, both upper and lower at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case.*

Fundamental Frequency: 30 MHz, 20 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
60.0	-21.4	-13.0	-8.4	PASS
90.0	-20.4	-13.0	-7.4	PASS

The emissions were scanned from 10 MHz to 1 GHz and all significant signals not less than 20 dB below the limits were recorded.

Fundamental Frequency: 40 MHz, 20 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
80.0	-19.3	-13.0	-6.3	PASS
120.0	-21.4	-13.0	-8.4	PASS

The emissions were scanned from 10 MHz to 1 GHz and all significant signals not less than 20 dB below the limits were recorded.

Fundamental Frequency: 50 MHz, 20 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
100.0	-17.6	-13.0	-4.6	PASS
150.0	-21.1	-13.0	-8.1	PASS

The emissions were scanned from 10 MHz to 1 GHz and all significant signals not less than 20 dB below the limits were recorded.

UltraTech Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.

FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30

Frequency: 30 MHz, Power Rating: 10 W, Channel Spacing: 20 kHz

Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 28, 1999
Tested by: Hung Trinh

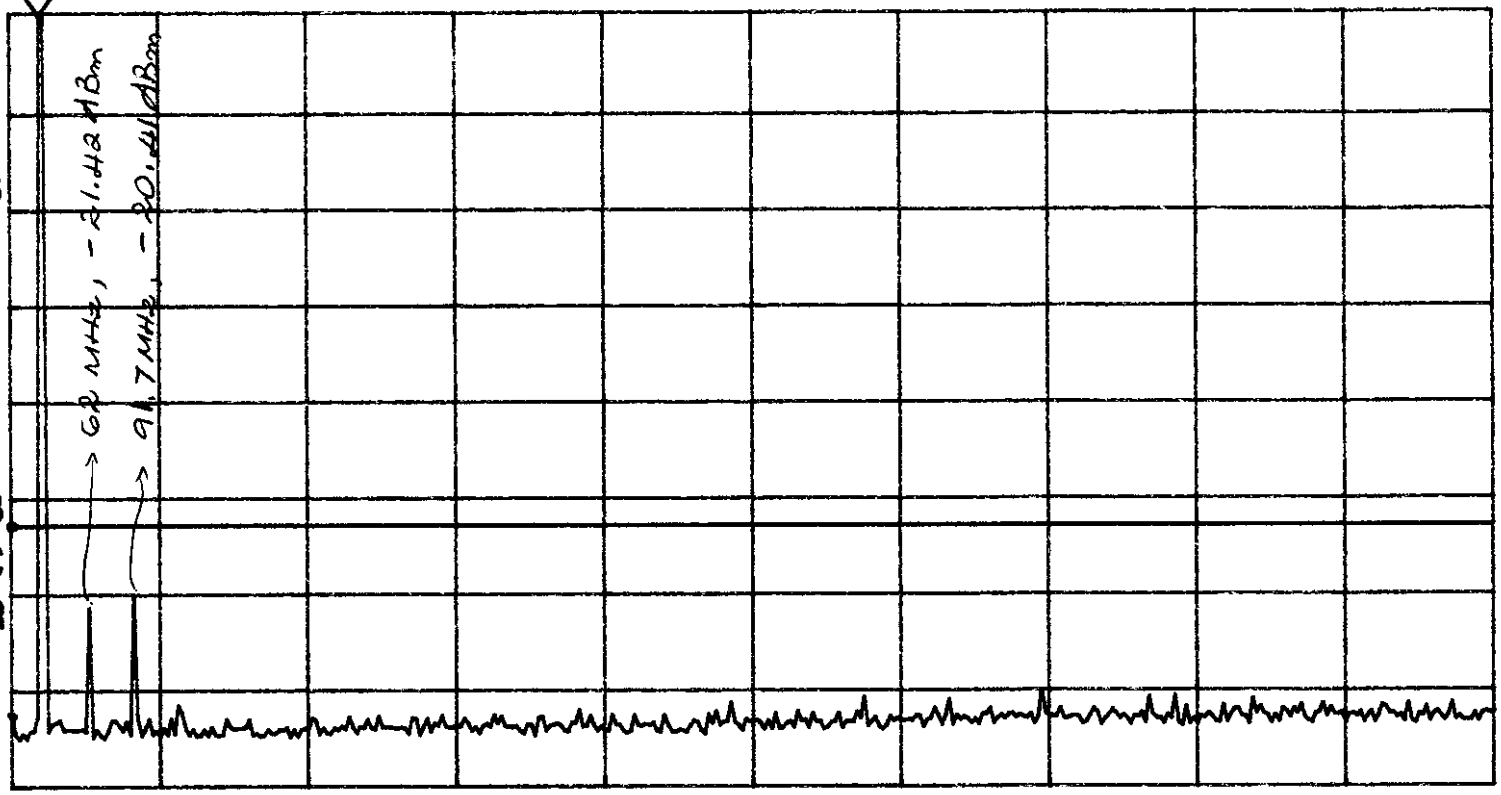
hp

MARKER
29.8 MHz
39.73 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 29.8 MHz
39.73 dBm

No user Menu

REF OFFST 3Ø.Ø dB
LOG REF 4Ø.Ø dBm
1Ø dB/
ATN 2Ø dB



MA SB
SC FC
CORR

START 1Ø.Ø MHz
STOP 1.ØØØØ GHz
IF BW 12Ø kHz
AVG BW 3ØØ kHz
SWP 2Ø6 msec

UltraTech
Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.
FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30
Frequency: 440 MHz, Power Rating: 10 W, Channel Spacing: 20 kHz
Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27, 1999
Tested by: Hung Trinh

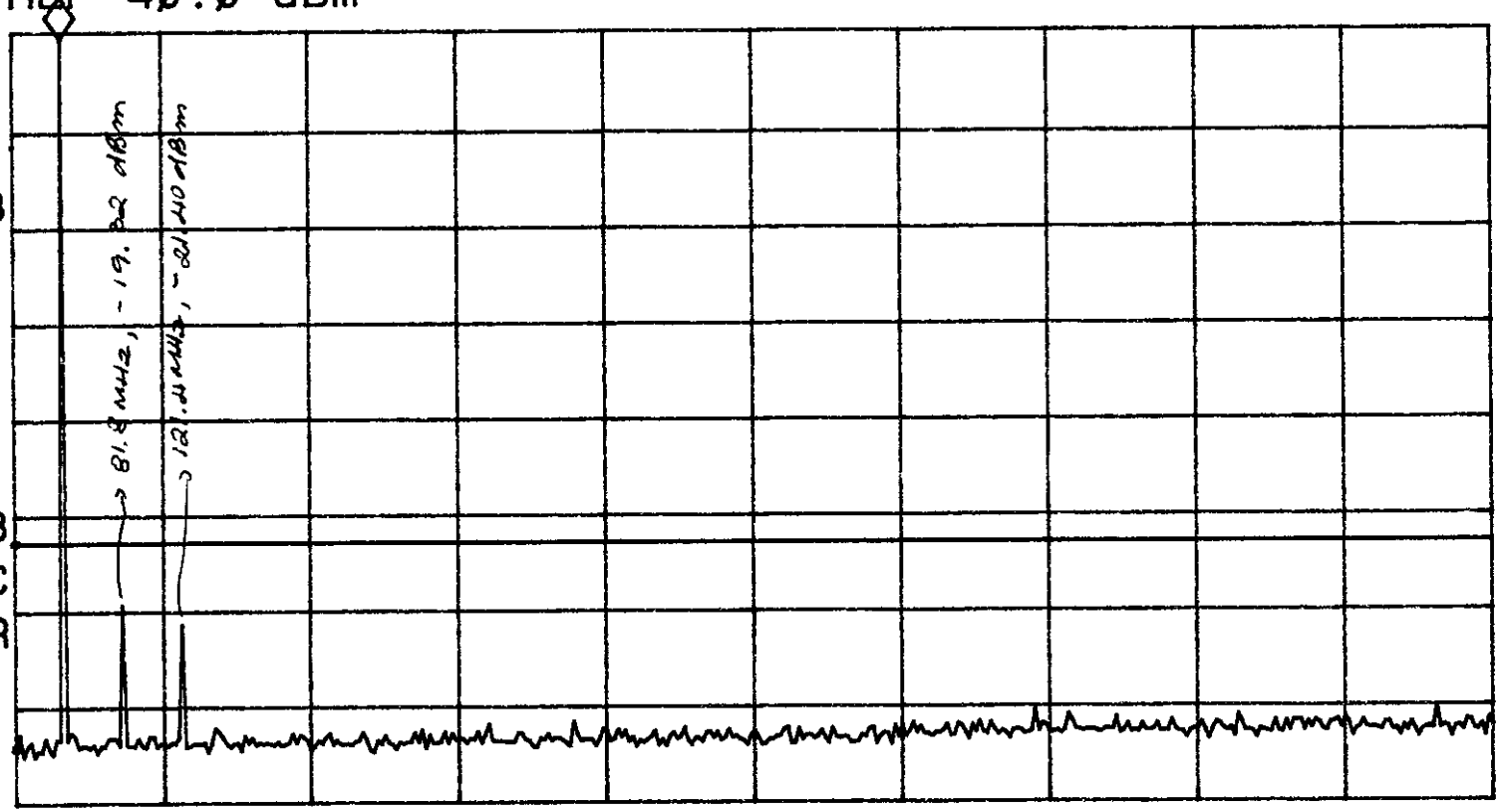
hp

MARKER
42.2 MHz
39.34 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 42.2 MHz
39.34 dBm

No user Menu

REF OFFST 3Ø.Ø dB
LOG REF 4Ø.Ø dBm
1Ø dB/
ATN 2Ø dB



MA SB
SC FC
CORR

START 1Ø.Ø MHz
STOP 1.ØØØØ GHz
IF BW 12Ø kHz AVG BW 3ØØ kHz SWP 2Ø6 msec

UltraTech
Engineering Labs Inc.

TECHNISONIC INDUSTRIES LTD.
FM VOICE MODULATED RADIO TRANSCEIVER, MODEL TFM-30
Frequency: 50 **MHz, Power Rating:** 10 **W, Channel Spacing:** 20 **kHz**
Modulation: FM modulation with 2.5 kHz Sine Wave Signal

Date: Jan. 27**, 1999**
Tested by: Hung Trinh

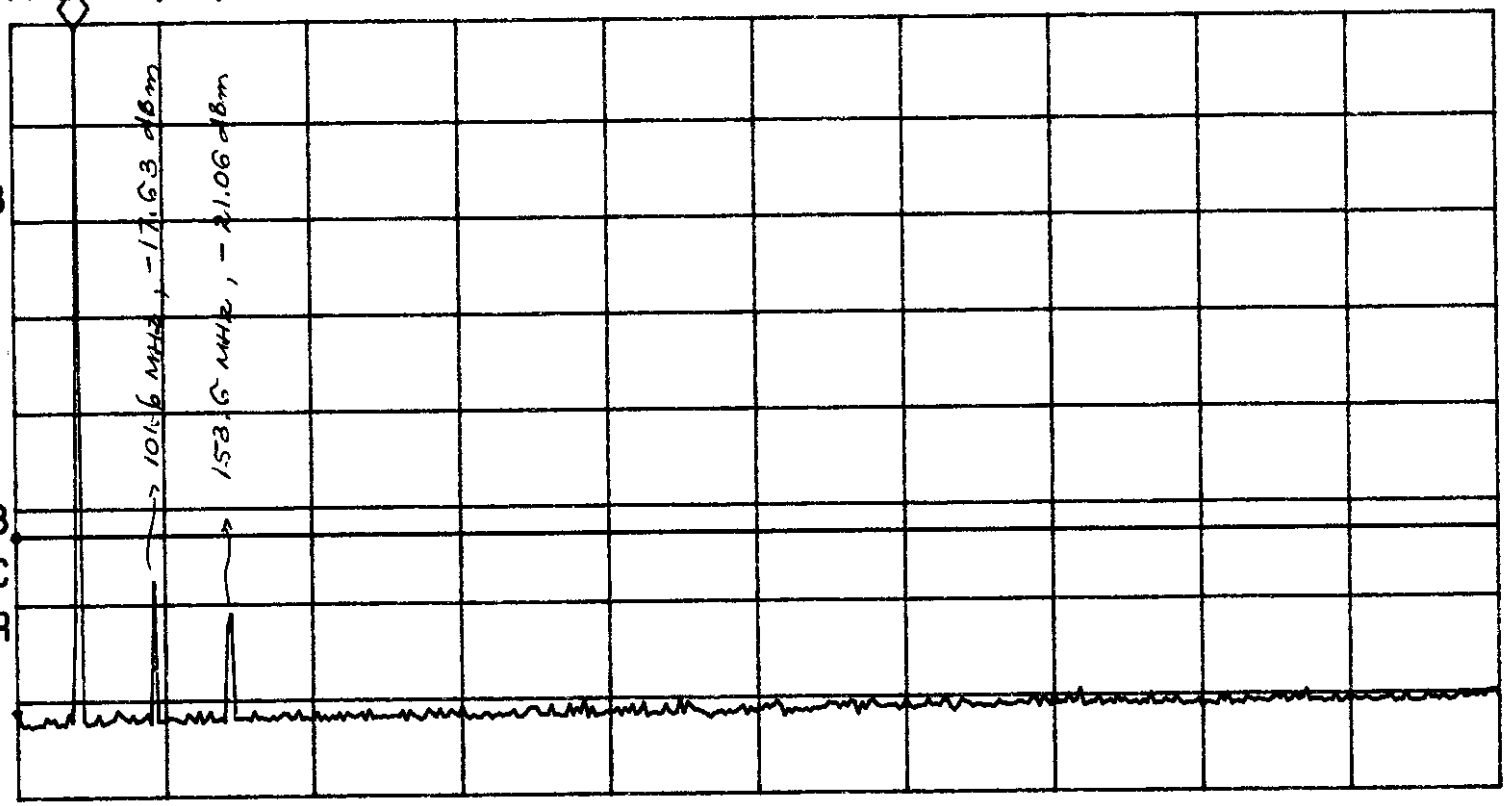
hp

MARKER
52.1 MHz
39.41 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 52.1 MHz
39.41 dBm

No user
Menu

REF OFFST 3Ø.Ø dB
LOG REF 4Ø.Ø dBm
1Ø
dB/
ATN
2Ø dB



MA SB
SC FC
CORR

START 1Ø.Ø MHz
STOP 1.ØØØØ GHz
IF BW 12Ø kHz
AVG BW 3ØØ kHz
SWP 2Ø6 msec

4.7. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ FCC 90.210

PRODUCT NAME: **LOWBAND VHF/FM TRANSCEIVER,**
Model No.: TFM-30

FCC REQUIREMENTS:

FCC Part 90, Sub. I, Para. 90.210

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

FREQUENCY RANGE (MHz)	Recommended OBW (KHz)	CHANNEL SPACING (KHz)	Recommended FREQ. DEVIATION (KHz)	FCC SPECIFICATION LIMITS (Para. No.)
30-50	20	20.0	5.0	90.210(b): Mask B – Audio & Voice

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 21 °C
- Relative humidity: 43%

POWER INPUT:

28 Vdc.

TEST EQUIPMENT:

1. EMI Receiver System/Spectrum Analyzer, Hewlett Packard, Model 8546A, Input +25dBm max., 9KHz-5.6GHz, 50 Ohms, built-in Peak, Quasi-Peak & Average Detectors, Pre-Amplifier and Tracking Signal Generator. This System includes: (1) HP 85460A RF Filter Section, S/N: 3448A00236 and (2) HP 85462A Receiver RF Section/Display, S/N: 3520A00248.
2. Spectrum Analyzer, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
3. Microwave Amplifier, HP, Model 83017A, Frequency Range 1 to 22GHz, 30dB gain nominal, low noise floor type.
4. Active Loop Antenna, Emco, Model 6502, SN 9104-2611, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms.
5. BiconiLog Antenna, Emco, Model 3142, SN 10005, 30-2000 MHz @ 50 Ohms.
6. Log Periodic Antenna, AH System, Model SAS-200/518, SN: 343, Frequency Range: 1GHz-18GHz.
7. FCC Listed Open Field Test Site.
8. Audio Oscillator, HP, Model 204C, SN: 0989A08798, Output: 0-1.2 MHz, 5 Vrms.

METHOD OF MEASUREMENTS:

Refer to **ANSI 63.4**, Para. 8 for detailed radiated emissions measurement procedures.

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.989, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 100 kHz, VBW = 100 kHz and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.997 - 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. 2.993 - Field Strength Spurious Emissions

(a) Measurements was made to detect spurious emissions radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data were supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph 2.989(c) as appropriate. For equipment operating on frequencies below 1 GHz , an Open Field Test is normally required, with the measuring instrument antenna located in the far field at all test frequencies. In event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurement will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with the reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

(b) Measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

METHOD OF CALCULATION FOR TRANSMITTED POWER (P) FROM THE MEASURED FIELD STRENGTH LEVEL (E):

According to IEC 801-3, the power density can be calculated as follows:

$S = P / (4xPIxD^2)$ Where: S: Power density in watts per square meter
P: Transmitted power in watts
PI: 13.1415
D: Distance in meters

The power density S (W/m^2) and electric field E (V/m) is related by:

$$S = E^2/(120xPI)$$

Accordingly, the field intensity of isotropic radiator in free space can be expressed as follows:

$$E = (30xP)^{1/2}/D = 5.5x(P)^{1/2}/D$$

For Halfwave dipole antenna or other antennas correlated to dipole in direction of maximum radiation:

$$S = (1.64xP)/(4xPIxD^2)$$
$$E = (49.2xP)^{1/2}xD = 7.01x(P)^{1/2}/D$$

$$P = (ExD/7.01)^2$$

Calculation of transmitted power P (dBM) given a measured field intensity E (dBuV/m):

$P(W) = [E(V/m)xD/7.01]^2$
$P(mW) = P(W)x1000$
=> $P(dBm) = 10logP(mW)$
$= 20logE(V/m) + 20log(D) - 20log(7.01) + 10log1000$
$= E(dBV/m) + 20logD + 13$
$= E(dBuV/m) - 120 + 20log(D) + 13$
$= E(dBuV/m) + 20log(D) - 107$

The Transmitted Power @ D = 3 Meters

P(dBm) = E(dBuV/m) - 97.5

TEST RESULTS: Conforms.

TESTED PERSONNEL: Hung Trinh, RFI Technician

DATE: January 28, 1999

MEASUREMENT DATA

RADIATED EMISSIONS MEASUREMENTS @ 3 METERS

TEST CONFIGURATION

- *The channel frequencies (Low, Middle and High) was established at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 90.238(a). The absolute level of each emission shall not be greater than -20 dBm.*
- *For measuring radiated emissions at frequencies below 1 GHz, the Spectrum Analyzer was set as 100 kHz RBW, 100 KHz VBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *For measuring radiated emissions at frequencies above 1 GHz, the Spectrum Analyzer was set as 1 MHz RBW, 1 MHz VBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *All rf emissions from the lowest frequency generated by the transmitter (...) upto the 10th harmonic of fundamental were scanned, and only emissions less than 20 dB below the limits (-20 dBm) were recorded.*

Fundamental Frequency: 30 MHz, 20 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 (dBuV/m)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
62	27.7	-69.8	PEAK	V	-13.0	-56.8	PASS
62	29.3	-68.2	PEAK	H	-13.0	-55.2	PASS
93	39.0	-58.5	PEAK	V	-13.0	-45.5	PASS
93	28.4	-69.1	PEAK	H	-13.0	-56.1	PASS
124	37.8	-59.8	PEAK	V	-13.0	-46.8	PASS
124	32.8	-64.7	PEAK	H	-13.0	-51.7	PASS
155	27.0	-70.5	PEAK	V	-13.0	-57.5	PASS
155	29.3	-68.2	PEAK	H	-13.0	-55.2	PASS
217	28.7	-68.8	PEAK	V	-13.0	-55.8	PASS
248	26.5	-71.0	PEAK	V	-13.0	-58.0	PASS
248	28.9	-68.6	PEAK	H	-13.0	-55.6	PASS
279	31.8	-65.7	PEAK	V	-13.0	-52.7	PASS
279	32.2	-65.3	PEAK	H	-13.0	-52.3	PASS
310	32.9	-64.6	PEAK	V	-13.0	-51.6	PASS
310	30.7	-66.8	PEAK	H	-13.0	-53.8	PASS

No other significant rf radiated emissions from the transmitter were found in the frequency band from 10 MHz to 1 GHz. All other emissions must be more than 45 dB below the FCC. limits.

Fundamental Frequency: 40 MHz, 20 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 (dBuV/m)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
82	22.8	-74.7	PEAK	V	-13.0	-61.7	PASS
123	36.0	-61.5	PEAK	V	-13.0	-48.5	PASS
123	34.6	-62.9	PEAK	H	-13.0	-49.9	PASS
164	33.4	-64.1	PEAK	V	-13.0	-51.1	PASS
164	29.8	-67.7	PEAK	H	-13.0	-54.7	PASS
205	35.5	-62.0	PEAK	V	-13.0	-49.0	PASS
205	31.4	-66.2	PEAK	H	-13.0	-53.2	PASS
246	26.7	-70.8	PEAK	V	-13.0	-57.8	PASS
246	31.5	-66.0	PEAK	H	-13.0	-53.0	PASS
287	35.2	-62.3	PEAK	V	-13.0	-49.3	PASS
287	32.7	-64.8	PEAK	H	-13.0	-51.8	PASS
328	29.6	-67.9	PEAK	V	-13.0	-54.9	PASS
328	29.1	-68.4	PEAK	H	-13.0	-55.4	PASS
369	31.9	-65.6	PEAK	V	-13.0	-52.6	PASS
369	38.1	-59.5	PEAK	H	-13.0	-46.5	PASS
410	38.8	-58.7	PEAK	V	-13.0	-45.7	PASS
410	35.6	-61.9	PEAK	H	-13.0	-48.9	PASS

No other significant rf radiated emissions from the transmitter were found in the frequency band from 10 MHz to 1 GHz. All other emissions must be more than 45 dB below the FCC limits.

Fundamental Frequency: 50 MHz, 20 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 (dBuV/m)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
102	40.1	-57.4	PEAK	V	-13.0	-44.4	PASS
102	37.2	-60.3	PEAK	H	-13.0	-47.3	PASS
153	34.7	-62.8	PEAK	V	-13.0	-49.8	PASS
153	31.3	-66.3	PEAK	H	-13.0	-53.3	PASS
204	34.1	-63.4	PEAK	V	-13.0	-50.4	PASS
204	38.4	-59.1	PEAK	H	-13.0	-46.1	PASS
255	30.6	-66.9	PEAK	V	-13.0	-53.9	PASS
255	31.0	-66.5	PEAK	H	-13.0	-53.5	PASS
306	36.3	-61.2	PEAK	V	-13.0	-48.2	PASS
306	43.0	-54.5	PEAK	H	-13.0	-41.5	PASS
357	35.4	-62.1	PEAK	V	-13.0	-49.1	PASS
357	40.8	-56.7	PEAK	H	-13.0	-43.7	PASS
408	48.2	-49.3	PEAK	V	-13.0	-36.3	PASS
408	46.1	-51.4	PEAK	H	-13.0	-38.4	PASS
459	37.3	-60.2	PEAK	V	-13.0	-47.2	PASS
459	41.1	-56.4	PEAK	H	-13.0	-43.4	PASS
510	38.1	-59.4	PEAK	V	-13.0	-46.4	PASS
510	43.6	-53.9	PEAK	H	-13.0	-40.9	PASS

No other significant rf radiated emissions from the transmitter were found in the frequency band from 10 MHz to 1 GHz. All other emissions must be more than 36 dB below the FCC limits.

5. EXHIBIT 5 - GENERAL TEST PROCEDURES

5.1. AC POWERLINE CONDUCTED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- AC Powerline Conducted Emissions were performed in the shielded room, 16'(L) by 12'(W) by 12'(H).
- Conducted power-line measurements were made over the frequency range from 450 KHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, ac power-line conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlets. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (10 KHz RBW, 10 KHz VBW), frequency span 450KHz-30MHz.

- The maximum conducted emission for a given mode of operation was found by using the following step-by-step procedure:

  Step1. Monitor the frequency range of interest at a fixed EUT azimuth.

  Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being perfomed.

  Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.

- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and 10 KHz VBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and the final highest RF signal level and frequency was record.

- ***Broad-band ac powerline conducted emissions***:- If the EUT exhibits ac powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

5.2. ELECTRICAL FIELD RADIATED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- The radiated emission measurements were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC.

- Radiated emissions measurements were made using the following test instruments:

  1. Calibrated EMCO biconilogl antenna in the frequency range from 30 MHz to 2000 MHz.
  2. Calibrated A.H. Systems log periodic antenna in the frequency range above 1000 MHz (1GHz - 18 GHz).
  3. Calibrated EMI receiver or spectrum analyzer and pre-selector. In general, the spectrum analyzer would be used as follows:

     – The rf electric field levels were measured with the spectrum analyzer set to PEAK detector (100 KHz RBW and 100 KHz VBW).

     – If any rf emission was observed to be a broadBand noise, the spectrum analyzer's CISPR QUASI-PEAK detector (120 KHz RBW and 1MHz VBW) was then set to measure the signal level.

     – If the signal being measured was narrowband and the ambient field was broadBand, the bandwidth of the spectrum analyzer was reduced.

- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.

- During this process, cables and peripheral devices were manipulated within the range of likely configuration.

- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement (each variable within bounds specified elsewhere) were explored to produce the highest amplitude signal relative to the limit.

  The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

  Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

  Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

  Step4: Move the antenna over its full allowed range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

  Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

  Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

  Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where	FS	=	Field Strength
	RA	=	Receiver/Analyzer Reading
	AF	=	Antenna Factor
	CF	=	Cable Attenuation Factor
	AG	=	Amplifier Gain

Example: If a receiver reading of 60.0 dBuV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:.

Field Level = 60 + 7.0 + 1.0 - 30 = 38.0 dBuV/m.

Field Level = $10^{(38/20)}$ = 79.43 uV/m.

Notes: The frequency and amplitude of at least six highest conducted emissions relative to the limit are recorded unless such emissions are more than 20 dB below the limit. If less than six emissions are within 20dB of the limit, the background or receiver noise level shall be reported at representative frequencies.

6. EXHIBIT 6 - INFORMATION RELATED TO EQUIPMENT UNDER TESTS

6.1. FCC ID LABELLING AND SKETCH OF FCC LABEL LOCATION

Refer to the attached sheets

6.2. PHOTOGRAPHS OF EQUIPMENT UNDER TEST

Refer to the attached photographs

6.3. SYSTEM BLOCK DIAGRAM(S)

Refer to the attached sheets

6.4. SCHEMATIC DIAGRAMS

Refer to the attached sheets

6.5. USER'S MANUAL WITH "FCC INFORMATION TO USER STATEMENTS"

Refer to the attached Users' manual