ENGINEERING REPORT
FOR
TYPE ACCEPTANCE

FCC ID	:	**FRW4WJRT-138F**
APPLICANT	:	**Global-Wulfsberg Systems** **Division of Sundstrand Data Control Inc.** **6400 Wilkinson Drive,** **PRESCOTT, Arizona U.S.A. 86301**
EQUIPMENT	:	**VHF/FM Aircraft Transceiver**
BRAND NAME	:	**FLEXCOMM**
MODEL NO.	:	**RT-138F**
SERVICE OR RULE	:	**F.C.C. Rules and Regulations** **Parts 2, 74 and 90 (Title 47 C.F.R.)**
TESTING LABORATORY	:	Tele-Radio Systems Limited 1536 Columbia Street, North Vancouver, B.C. CANADA V7J 1A4 TEL : 604-985-0511 FAX : 604-985-1072 ENVOY: TELERADIO.VCR GRZ1388
CERTIFYING ENGINEER	:	W. R. Tracey, P.E.
PROJECT	:	**89-05**
DATE	:	**March, 1989**

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1.0 INTRODUCTION

Tele-Radio Systems Limited has been authorized by **Global-Wulfsberg Systems, Prescott, Arizona**, to conduct type acceptance tests and prepare a test report, on their behalf.

This Engineering Report details tests conducted in accordance with Parts 2, 74 and 90 of the F.C.C. Rules and Regulations, on a **Global-Wulfsberg Systems Model RT-138F VHF/FM Aircraft Transceiver.**

The Model RT-138F transceiver is intended for aircraft use on authorized frequencies in the 138 - 174 MHz frequency band, to communicate primarily with land mobile, portable, and base station radios.

Paragraph references throughout this report are to applicable paragraphs from the F.C.C. Rules and Regulations (Title 47, C.F.R.). In general, the data in this report is presented in the same sequence as the applicable covering paragraphs in Part 2, Sub-Part J, of the F.C.C. Rules and Regulations.

2.0 TEST FACILITIES

All tests were carried out at the North Vancouver, B.C. laboratory of Tele-Radio Systems Limited or at their R.F. Field Measurement Site (an amended description of the measurement site and test facilities used for radiated emission measurements was filed August 25, 1987, with the F.C.C. laboratory (Attention Mr. Charles Cobbs), relating to a submission of an application for Computing Device Certification, F.C.C. ID: FZW4N9 328668). Calibration of all test equipment used is traceable to N.B.S. or N.R.C. (Canada) Standards.

3.0 CERTIFICATION OF DATA CONCERNING TYPE ACCEPTANCE APPLICATION FOR F.C.C. ID: FRW4WJRT-138F

I certify that all tests were performed, and this Type Acceptance application and Test Report prepared, under my supervision, on behalf of **GLOBAL-WULFSBERG SYSTEMS.**

To the best of my knowledge and belief, the facts set forth in the accompanying technical data are true and correct.

TELE-RADIO SYSTEMS LIMITED

W. R. Tracey

William R. Tracey, P.E.
(Professional Engineer,
Province of British Columbia
Canada
Registration No. 4248)

APPLICANT: **GLOBAL-WULFSBERG SYSTEMS**

F.C.C. ID: **FRW4WJRT-138F**

PROJECT : **89-05**

DATE : **March 17, 1989**

3.1 QUALIFICATIONS OF CERTIFYING ENGINEER

CURRICULUM VITAE — William R. Tracey

DATE OF BIRTH: **1931 April 04**

ACADEMIC & PROFESSIONAL QUALIFICATIONS:

B.A.Sc (Electrical Engineering)	University of British Columbia, 1955
Registered Professional Engineer (Previously registered in Quebec and Ontario)	Province of British Columbia, 1962

SUMMARY OF EXPERIENCE:

More than thirty years of engineering and management experience in Canada and overseas, in utility operations control, industrial instrumentation application and sales, telephone and data-communication apparatus design and manufacture, radio systems design, telephone system design, consulting in control-system and telecommunication system design in industry and various governments and their agencies. Consulting in strategic planning, forecasting, preparation of new plant facilities for administration and manufacturing.

Positions held include, director, president, vice-president manufacturing, vice-president engineering, chief engineer, manager of engineering.

EMPLOYMENT HISTORY:

May 1983 - Systek Engineering Ltd.
North Vancouver, B.C.
(Systek Engineering until May, 1987)

Principal engineer and president, consulting in telecommunications system design and in corporate management.

September through December, 1985, limited-term faculty member, Simon Fraser University, Burnaby, B.C.

Sep 81 - May 83 — Glenayre Electronics Ltd.
Vancouver, B.C.

Manager of Engineering. Responsible for technical staff of about 60 engineers, scientists and others carrying out the Research and Development and Production Engineering functions of the company.

May 77 - Sep 81 — Tele-Radio Systems Limited
Woodbridge, Ontario

Director and Vice-President Manufacturing, previously Vice-President Engineering Services.

EMPLOYMENT HISTORY...continued:

Jan 68 - May 77 — Hoyles Niblock International Ltd. Vancouver, B.C. and Hoyles Niblock Overseas Limited Tehran, Iran

Manager, Telephone and Telecontrol Systems Engineering (for International); Regional Manager, Middle East (for Overseas).

Mar 64 - Dec 67 — Tele-Radio Systems Limited Woodbridge, Ontario

Director and Chief Engineer

1962 - 1964 — The Foxboro Company Ltd. Montreal, Quebec (Vancouver Office)

Sales Engineer, assisting customers in the application of industrial instrumentation to pipelines, oil refineries, petro-chemical plants, pulp and paper plants, food-processing and similar industries.

1956 - 1962 — Trans Mountain Oil Pipe Line Company Vancouver, B.C. (now Trans Mountain Pipe Line Company Ltd.)

Electrical and Communications Engineer

1955 - 1956 — Northern Electric Company Ltd. Montreal, Quebec (now Northern Telecom Ltd.)

Engineer, Dial System Planning

OTHER CURRENT ACTIVITIES AND ASSOCIATIONS:

Member, Electronic Manufacturers' Association of B.C. (Treasurer 1985-87). EMABC representative to Working Committee for the Wireless Communications Research Centre.

Chairman, Electronics Advisory Committee, British Columbia Institute of Technology.

Member, Electronics Advisory Committee, Vancouver Community College (VVI).

Director, Dynapro Systems Inc., Vancouver, B.C.

Member, IEEE; Member Western Canada Telecommunications Council.

President, North Shore Amateur Radio Club.

4.Ø EXPOSITORY STATEMENT; Para. 2.983(a) - (d):

4.1 Name of Applicant; Para. 2.983(a):

(i) Applicant : **GLOBAL-WULFSBERG SYSTEMS**

(ii) Manufacturer : **Same as Applicant**

(iii) Relationship of applicant to manufacturer: **Same Company**

4.2 Identification of Equipment; Para. 2.983(b):

(i) Model No. : **RT-138F**

(ii) Serial No. : **E2**

(iii) F.C.C. ID : **FRW4WJRT-138F**

4.3 Production Quantity; Para. 2.983(c):

Quantity production of the Model RT-138F is planned.

4.4 Type of Emission; Para. 2.983(d)(1):

16K0F3E

4.5 Frequency Range; Para. 2.983(d)(2):

138 - 174 MHz

4.6 Range of Operating Power Levels; Para. 2.983(d)(3):

10 watts (nominal)

4.7 Maximum Power Rating; Para. 2.983(d)(4):

The maximum power rating is **10 watts.** This is the power rating to be stated in the Radio Equipment List or station authorization.

4.8 D.C. Voltages & Currents Into Final Amplifier; Para. 2.983(d)(5):

Refer also to RF Power Output and Input measurement data in Section 6.1 of this Engineering Report.

R.F. Power Output : **10.0 watts**

DC Voltage to Final Amplifier Transistor: **17.7 volts**

DC Current to Final Amplifier Transistor: **0.93 amperes**

4.9 Function of Semi-Conductors and Active Circuit Devices; Para. 2.983(d)(6):

Refer to Exhibit (B), Section 2, "RT-138F Theory of Operation" for a description of the RT-138F circuitry, including functions of semi-conductors and active circuit devices. The portions of the transceiver circuitry relating to the transmitter are detailed as follows, in Exhibit (B), Section 2:

*General Description: Page 3, Para. 3.1, 3.2

Synthesizer Circuit: Page 4 - 8, Para. 3.3

Transmitter Circuit: Page 8, Para. 3.4
Page 11 - 12, Para. 3.4.4, 3.5
Page 20 - 22, Para. 3.5.6

Power Supply Circuit: Page 30 - 32

*The general description, page 3, makes reference to Block Diagram 148-014540. This drawing is contained in Section 5 (first drawing).

4.10 Complete Circuit Diagram; Para. 2.983(d)(7):

Schematic and Block Diagrams for the RT-138F transmitter are contained in Section 5 of Exhibit (B) (which also contains Pictorial Diagrams, attached to the pertinent Schematic Diagrams).

4.11 Instruction Book; Para. 2.983(d)(8):

- Exhibit (B) accompanying this submission is the preliminary Technical Manual for the Model RT-138F Transceiver.
- The information contained in Exhibit (B) will be available in a Service Manual, at a later date.

4.12 Tune-Up Procedure at Nominal Operating Power; Para. 2.983(d)(9):

Exhibit (B), Section 3, of this submission, contains the alignment instructions for the RT-138F radio. Pages 3 to 6 and 13 to 14 inclusive, contain transmitter alignment procedures.

4.13 Circuitry and Devices for Determining and Stabilizing Frequency; Para. 2.983(d)(10):

Refer to Exhibit (B), Section 2, page 9, Para. 3.3.3.3 for a description of the temperature controlled crystal oscillator, operating at **12.8 MHz**, which provides the Synthesizer reference frequency. The VCO Control Board (A-11) Schematic, dwg. no. 152-014231, in Section 5 of Exhibit (B), details the reference oscillator circuit (Y1, Q1 and associated components, including HR1, heater). All DC voltages to the transmitter, including the Synthesizer circuitry, are regulated.

4.14 Circuits for Suppression of Spurious Radiation, Limiting of Modulation and Limiting of Power; Para. 2.983(d)(11):

i) Suppression of Spurious Radiation:

Refer to Power Amplifier schematic (dwg. 152-0201-000, "R/T Assembly", in Exhibit (B), Section 5, for details of Low Pass Filter Circuit between Power Amplifier and Antenna Output Connector. This filter consists of capacitors C5 - C13, and inductors L3 to L6. The filter circuit reduces transmitter harmonic frequencies to a very low level at the antenna connector. The filter is also described in Exhibit (B), Section 2, Para. 3.4.5.2 (page 12).

ii) Limiting of Modulation:

The transmitter audio processing circuitry of the RT-138F is detailed in Exhibit (B), on pages 20 - 21 of Section 2, (Para. 3.5.6). Refer also to Exhibit (B), Section 5, "Flexcomm DVP Audio Board", Schematic Diagram 152-0164-050 sheet 2, for circuit details of transmitter audio processing circuitry.

iii) Limiting of Power:

Maximum transmitter power is limited to a nominal 10 watts, by the fixed circuit components in the transceiver. The normal range of power output over the 138 - 174 MHz frequency range is 8 to 11 watts (12 watts maximum). All DC voltages to the transmitter are provided from a regulated power supply, detailed in Section 2, Para. 3.7 to 3.7.7, in Exhibit (B). The DC voltage to the RF power output transistor is regulated at +28 VDC nominal. All DC voltages are referenced to the +5 VDC regulated source. This reference voltage has "over voltage protection", as detailed in Exhibit (B), Section 2, on page 32 (para. 3.7.5), and "current limiting" (para. 3.7.6).

4.15 Operator Selection of Programming of Transmitter Frequencies; Para. 90.203(e) - (h):

The Model RT-138F Transceiver, when used with the C-1000 Control Unit, permits the operator to select any frequency within the range of the transceiver (138 - 174 MHz). The Model RT-138F transceiver is intended for operation aboard aircraft, in accordance with Para. 90.423 of the F.C.C. Rules. This equipment therefore is exempt from the requirements of sub-para. (e), (f) and (g) of Para. 90.203, because the requirements of sub-para. 90.203(h)(1) & (2), regarding aircraft use, apply.

5.0 TEST PROCEDURES AND CONDITIONS:

5.1 Measurement Procedures; Para. 2.947(a), (b) and (c):

Measurement procedures, used during the type acceptance tests detailed herein, followed good engineering practice and were in accordance with accepted procedure, and as specified in the applicable sections of the F.C.C. Rules. The measurement methods are further detailed in Section 6.0 of this report, in the sub-section covering the relevant test data, in accordance with Para. 2.947, sub-paragraphs (b) and (c).

5.2 Test Equipment; Para. 2.947(d):

The following items of test equipment were used during the tests detailed herein. Numbers opposite each item on the left refer to the block diagrams of the test set-ups, where each item is numbered, so as to refer to this list.

ITEM	EQUIPMENT	MANUFACTURER	MODEL NO.
1	Voltmeter, AC/DC	Fluke	8000A
2	Ammeter	Avo	Model 8
3	RF Wattmeter	Sierra	185-A-150
4	AC Voltmeter	Ballantine	323
5	FM Modulation Meter	Racal	9009
6	Audio Signal Generator	Hewlett-Packard	200SR
7	Spectrum Analyzer	Hewlett-Packard	8558B
8	Spectrum Analyzer	Polarad	SA84WA
9	Power Supply, DC output	Heathkit	IP-2715
10	Antenna, Biconical 20 - 200 MHz	A.H. Systems	SAS-200/540
11	Antennas, Tuned Dipole type; with coaxial cable "baluns"; range (a) 200-500 MHz, (b) 400-1000 MHz	Tele-Radio Systems Limited	
12	Antenna, Log Periodic (1-12 GHz)	A.H. Systems	SAS-200/511
13	Signal Generator (40-940 MHz)	General Radio	1021
14	Signal Generator (800-2100 MHz)	Hewlett-Packard	614A
15	Signal Generator (0.05-82 MHz)	Logimetrics	925
16	Signal Generator (1.8-4 GHz)	Hewlett-Packard	616A
17	Environmental Chamber	Thermotron	S1.2
18	Frequency Counter	Philips	PM6615
19	Attenuator; 20 dB, 100 watt	Sierra	662-A20
20	Oscilloscope	Phillips	3260E
21	Pyrometer, with probe	Newport	264-3
22	Step Attenuator; 0-100 dB	Measurements	M-600
23	Battery; 12V Lead-Acid type (2)		
24	Coaxial Termination; 5 watt, 50 ohms	Bird	80M

5.3 Test Conditions for Transmitter Type Acceptance Tests:

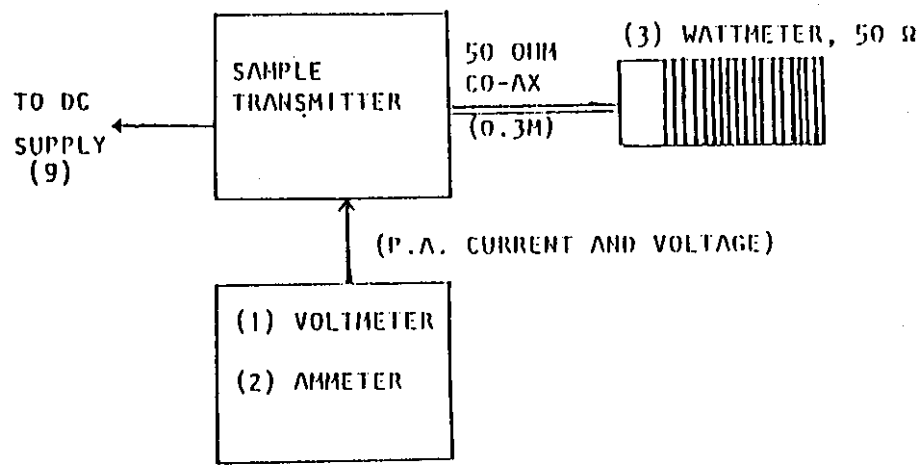
The following conditions applied throughout the measurements described herein (except during temperature and voltage variation vs. frequency stability tests, or where otherwise stated in this report):

Supply Voltage	:	**27.5 VDC (nominal Aircraft battery voltage)**
Temperature	:	**+22°C ±2°**
Transmitter Output Frequency:		**156.0 MHz**
Transmitter Power Output	:	**10 watts**

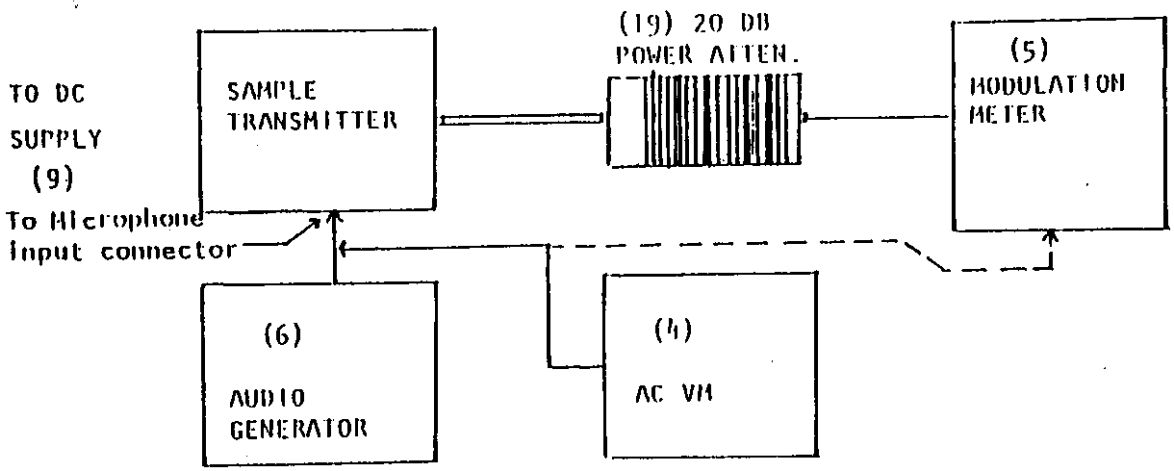
5.4 Test Set-Up Diagrams:

Diagrams of Test Set-Ups, used for type acceptance tests detailed in this report, are contained in this sub-section. Item numbers for test equipments shown on the diagrams refer to the Test Equipment List, Section 5.2 of this report.

SECTIONS 5.4.1 & 5.4.2:

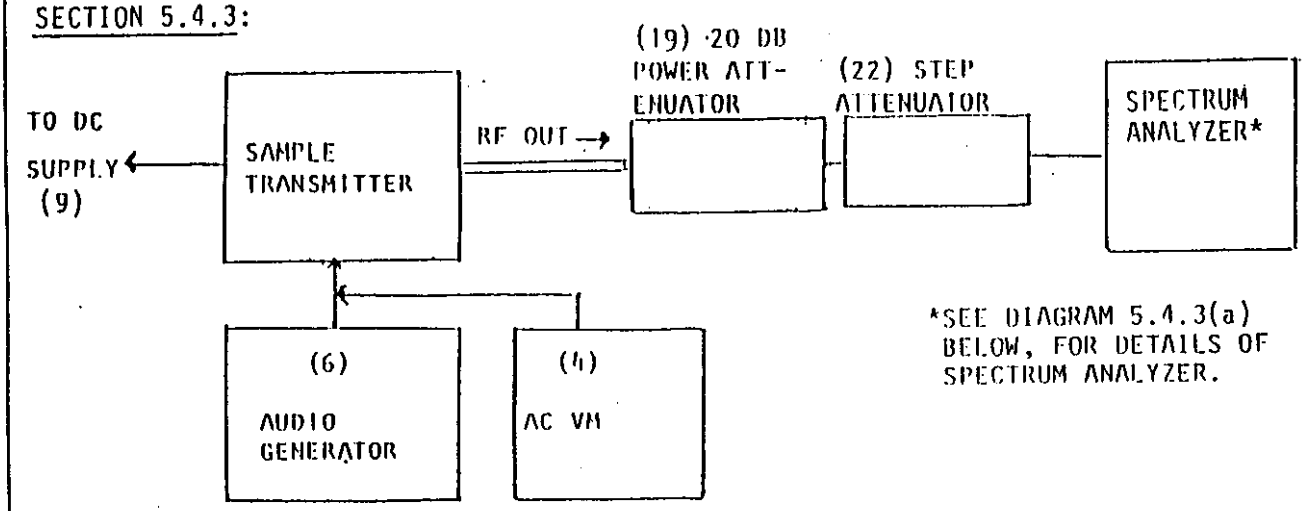


5.4.1 TEST SET-UP FOR R.F. POWER OUTPUT MEASUREMENTS (INCL. DC INPUT POWER)

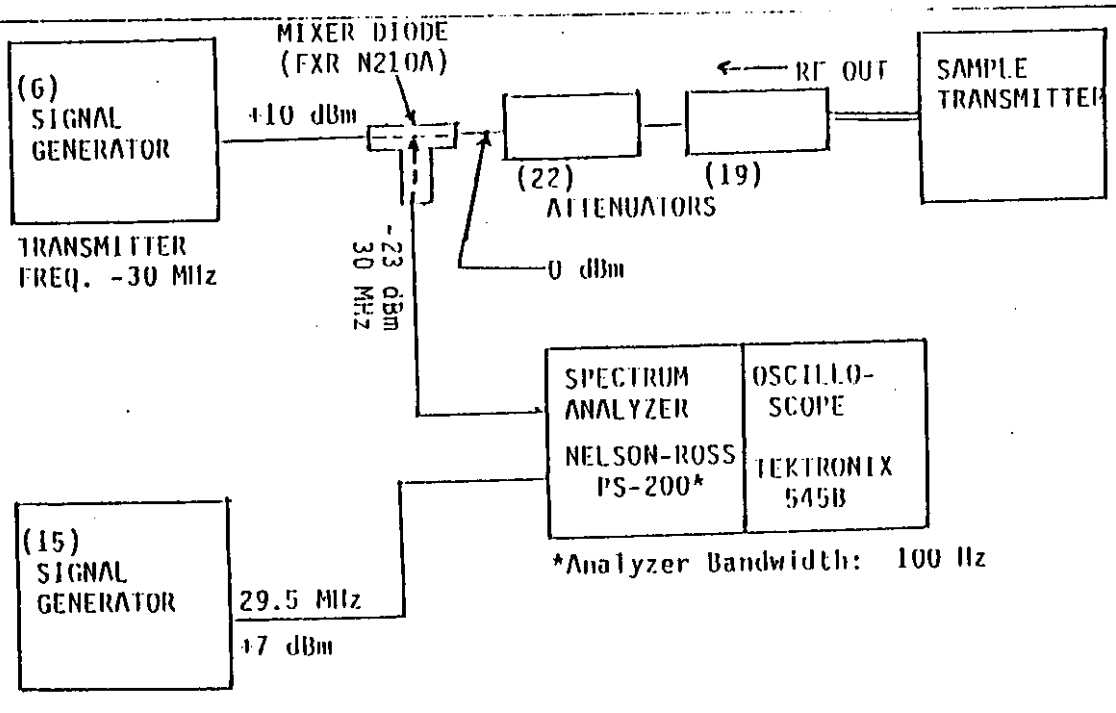


5.4.2 TEST SET UP-FOR TRANSMITTER MODULATION CHARACTERISTICS MEASUREMENTS (EXCEPT POST-LIMITER FILTER WHEN MEASURED SEPARATELY)

SECTION 5.4.3:



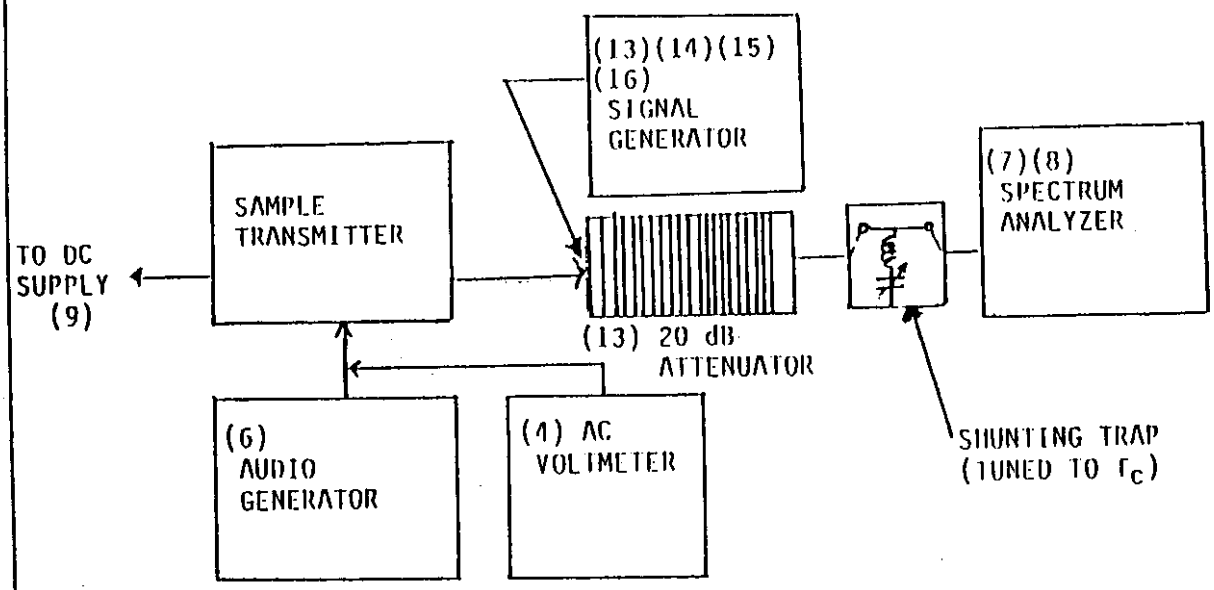
5.4.3 TEST SET-UP FOR OCCUPIED BANDWIDTH MEASUREMENTS



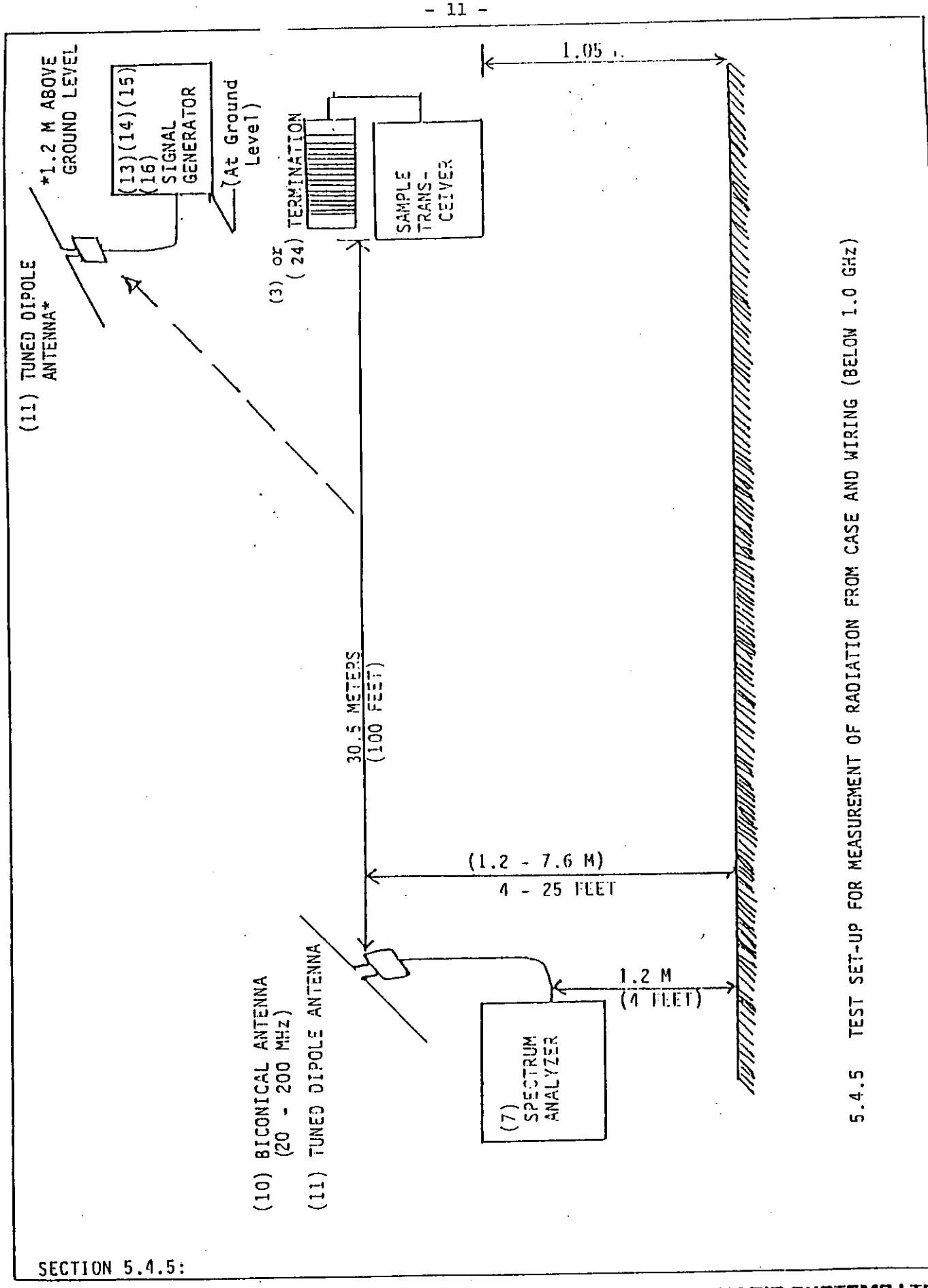
NOTE: For sideband spectra below -60 dB (ref. unmodulated carrier) use Hewlett-Packard Model 8558B Analyzer, with 1.0 kHz bandwidth setting, in place of above test set-up.

5.4.3(a) TEST SET-UP FOR SPECTRUM ANALYZER, AS USED FOR OCCUPIED BANDWIDTH TESTS.

SECTION 5.4.4:



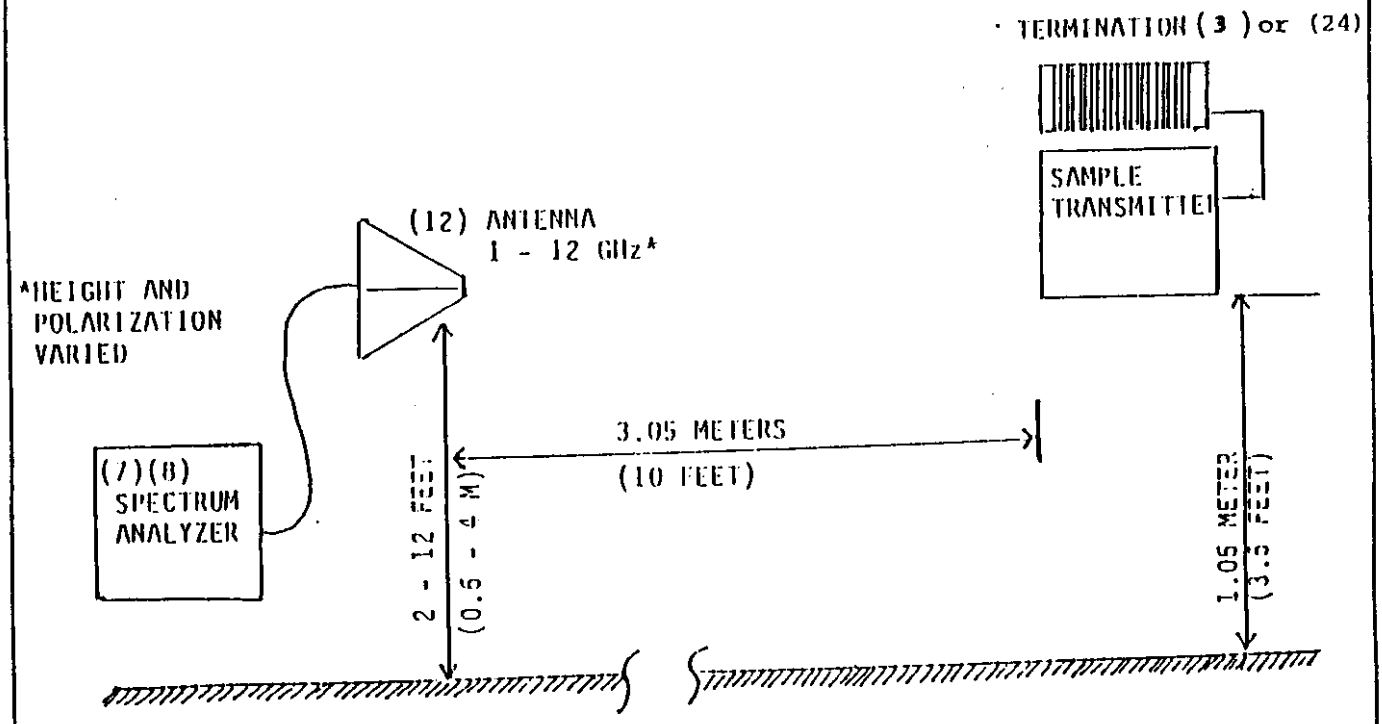
5.4.4 TEST SET-UP FOR SPURIOUS EMISSION MEASUREMENTS AT ANTENNA TERMINALS.



5.4.5 TEST SET-UP FOR MEASUREMENT OF RADIATION FROM CASE AND WIRING (BELOW 1.0 GHz)

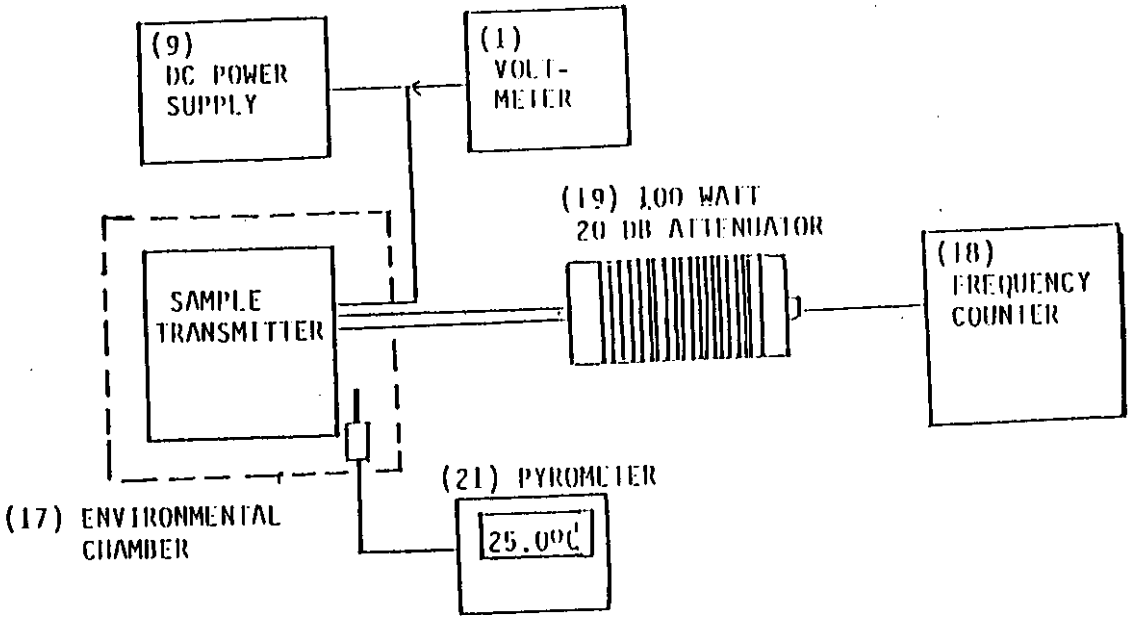
SECTION 5.4.5:

SECTION 5.4.6:



5.4.6 TEST SET-UP FOR MEASUREMENT OF RADIATION FROM CASE AND WIRING ABOVE 1000 MHZ

SECTION 5.4.7:

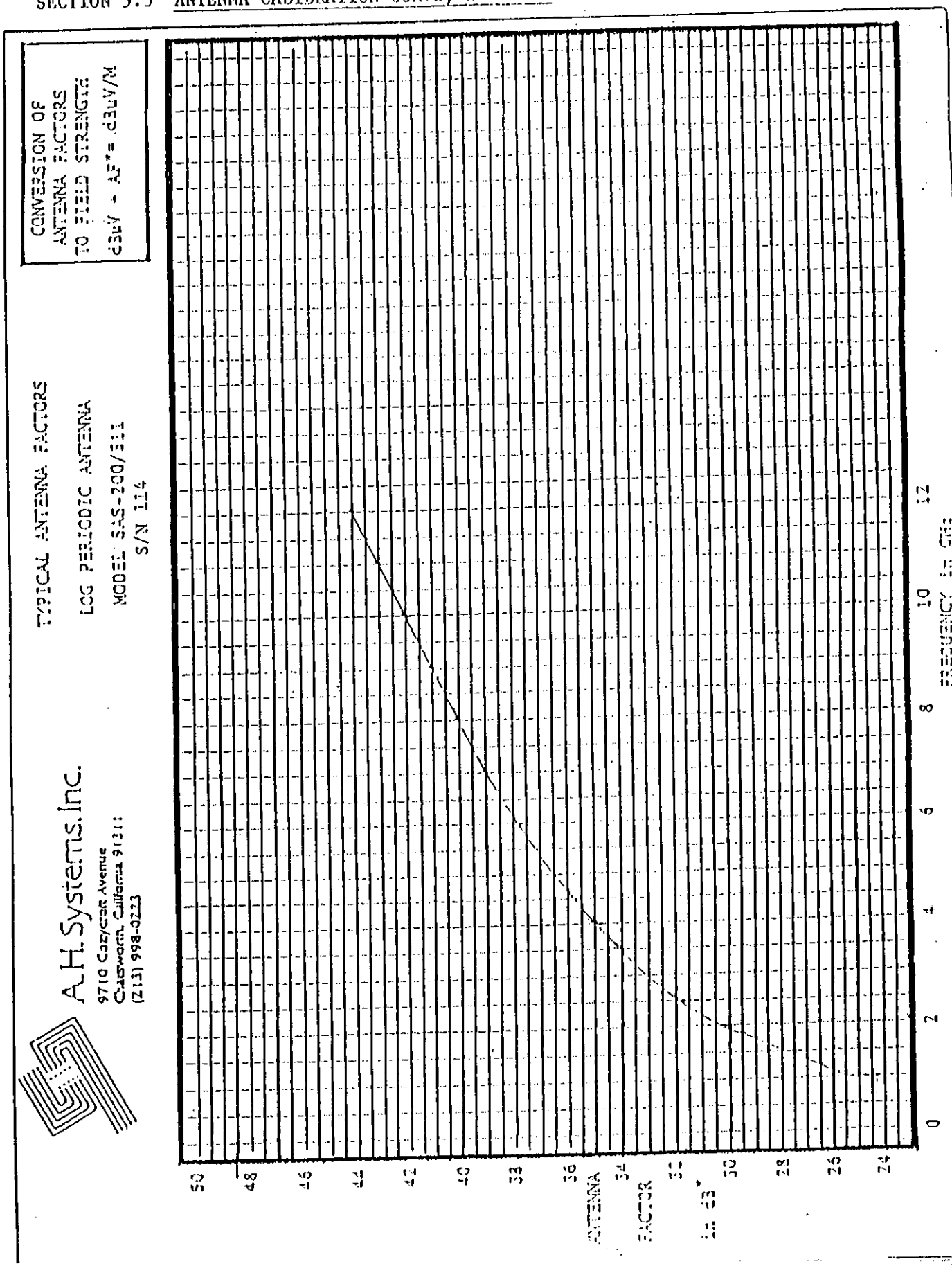


5.4.7 TEST SET-UP FOR:

a) TRANSMITTER FREQUENCY VS TEMPERATURE

b) TRANSMITTER FREQUENCY VS SUPPLY VOLTAGE

SECTION 5.5 ANTENNA CALIBRATION CURVE, 1-12 GHz:



6.0 MEASUREMENT DATA FOR TYPE ACCEPTANCE; Para. 2.983(e):

6.1 R.F. Power Output; Para. 2.985(a):

Radio Frequency Power Output was measured (after alignment of the transmitter, by the manufacturer). DC power supplied to the R.F. output transistor was also measured; refer to the test set-up diagram, Section 5.4.1 of this report. Results were as follows:

R.F. Power Output :	**10 watts**
DC Collector Current:	**0.93 amperes**
DC Collector Voltage:	**17.7 volts**
DC Input Power to Final Amplifier :	**16.5 watts**

6.2 Modulation Characteristics; Para. 2.987:

6.2.1 Frequency Response; Para. 2.987(a):

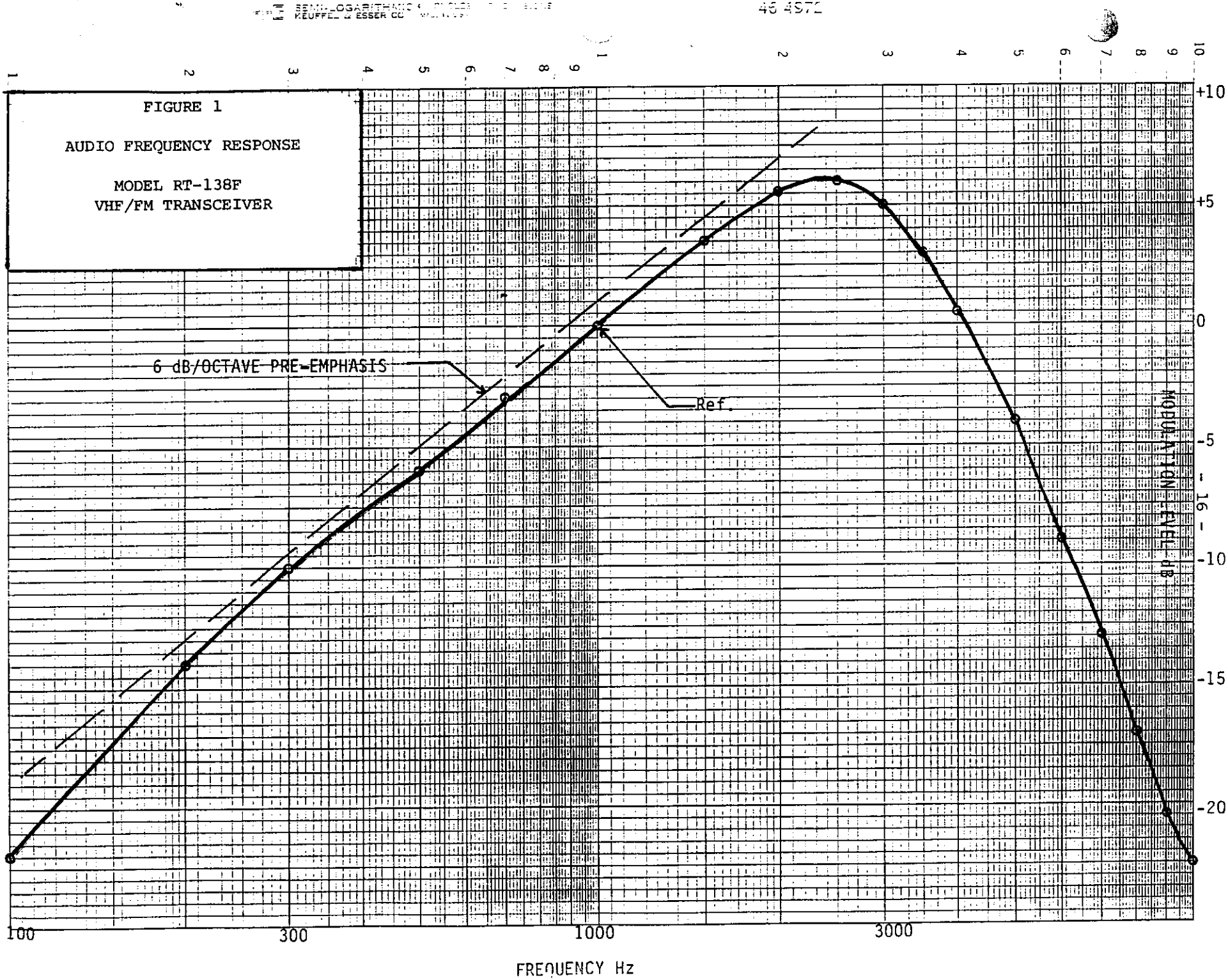
Measurement of transmitter audio frequency response was made with the equipment set up as shown in the block diagram, Section 5.4.2 of this report. Zero dB reference was established as the audio input required to give 30% modulation (±1.5 kHz deviation) at 1000 Hz. The audio input frequency was varied over the range 100 to 10,000 Hz, with the audio input level held constant. Variations of the transmitter modulation were noted on the Modulation Meter (the A.F. output of the Modulation Meter was fed to an AC Voltmeter),

Figure 1 following, is a curve of Transmitter Audio Frequency Response.

FIGURE 1

AUDIO FREQUENCY RESPONSE

MODEL RT-138F
VHF/FM TRANSCEIVER



6.2.2 Modulation Limiting Characteristics; Para. 2.987(b):

To measure modulation limiting characteristics, the audio input was varied from zero, up to a level of 20 dB above that giving 50% modulation (±2.5 kHz deviation) at 300 Hz (lowest gain frequency). Modulation percentage was noted for various audio input levels. The test set-up used was the same (diagram 5.4.2) as that shown for Modulation Frequency Response measurements. Figure 2 following shows curves of modulation percentage versus audio input level for 300, 1000 and 2500 Hz.

6.2.3 Post Limiter Filter; Para. 2.987(a):

The Model RT-138F transmitter meets bandwidth limits of Para. 90.209(f); it is therefore exempt from the audio low-pass filter requirements of Para. 90.211(d). The overall audio frequency response of the transmitter modulation circuitry, from 3 to 10 kHz, as shown on the Audio Frequency Response graph, Figure 1 of this report, indicates a 20 dB/Octave attenuation slope.

6.3 Bandwidth Occupied; Para. 2.989:

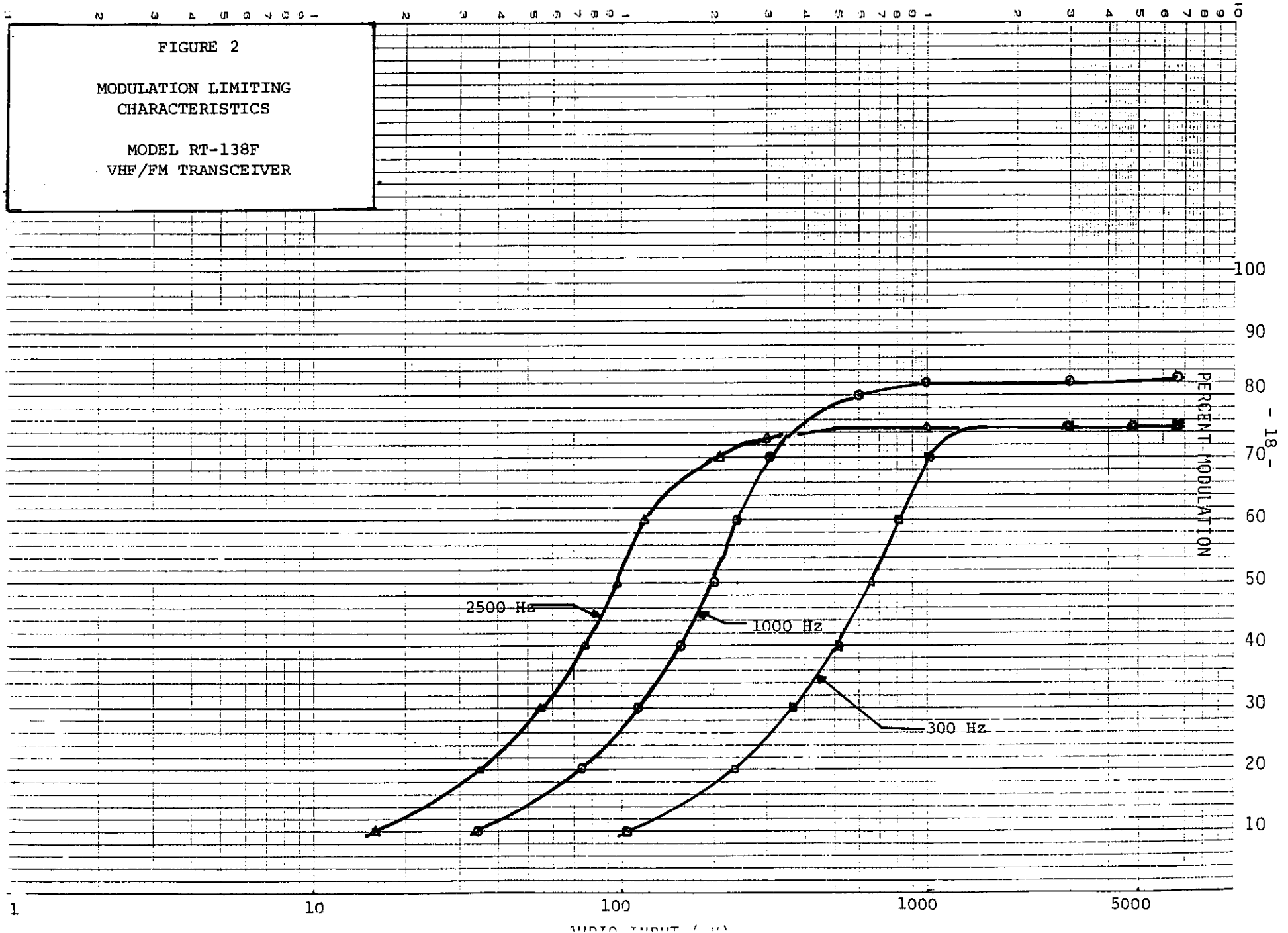
Occupied Bandwidth was measured in accordance with the above noted paragraph of the F.C.C. Rules and Regulations. A sample of the transmitter output was displayed on a spectrum analyzer and side bands were observed up to 50 kHz each side of centre frequency, and down to -70 dB. Modulation was removed and the level of the transmitter carrier was observed and recorded to determine the zero dB reference. The test set-up is illustrated in diagrams 5.4.3 and 5.4.3(a) of this report.

The following Figure 3, indicates the frequency and levels of the observed modulation spectra, with 0 dB being the level of the unmodulated carrier. F.C.C. limits as specified in Para. 90.209(f) of the Rules and Regulations, for 20 kHz authorized bandwidth, are also shown.

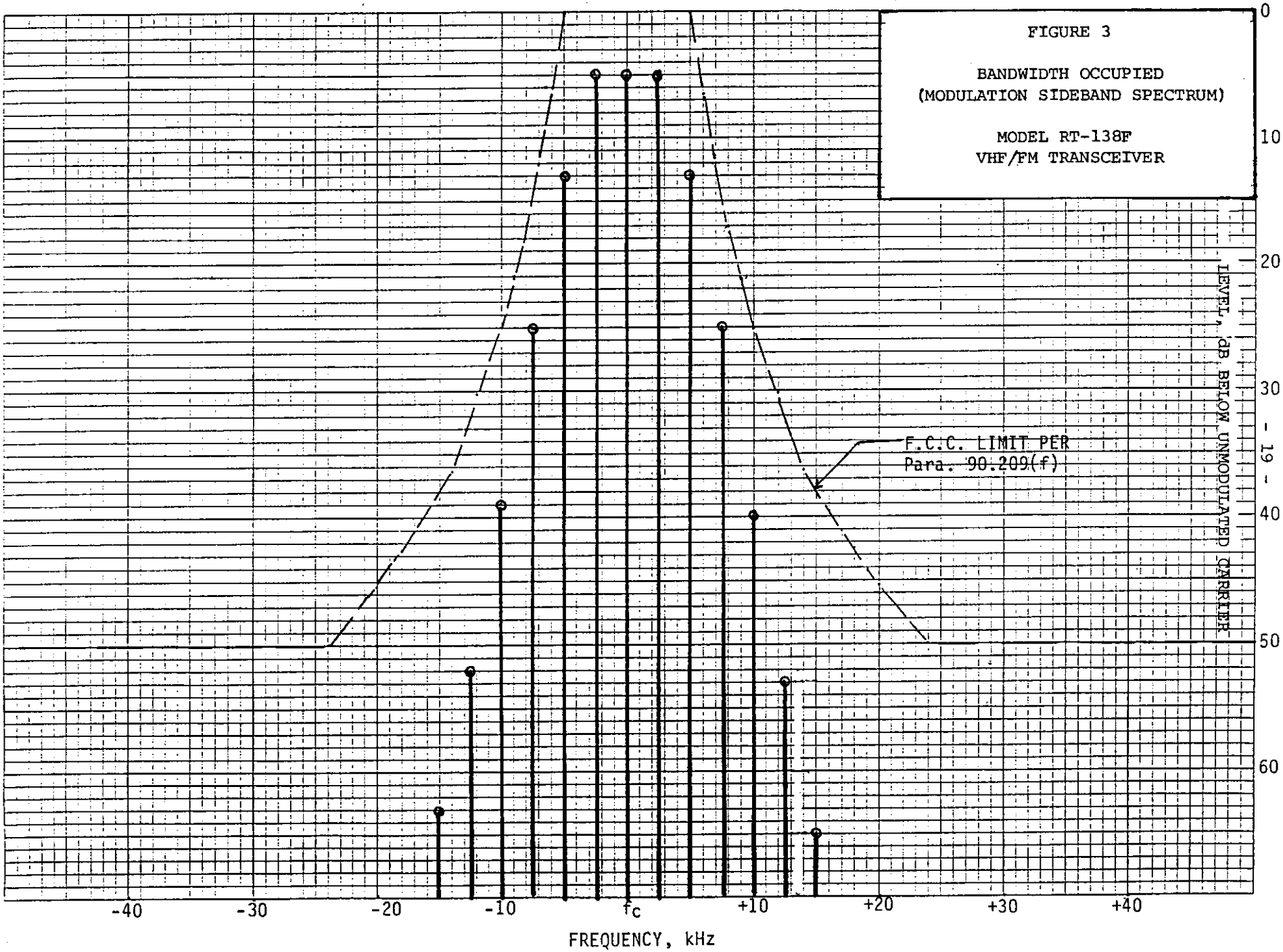
FIGURE 2

MODULATION LIMITING CHARACTERISTICS

MODEL RT-138F
VHF/FM TRANSCEIVER



Ko-174 2-M



6.4 Spurious Emissions; Para. 2.991, 2.993:

The permitted maximum level of spurious emission, (as per Para. 90.209(f) of the F.C.C. Rules and Regulations) is 43 + $10\log_{10}$ Mean Power Output; = 53 dB below level of 10 watt carrier.

6.4.1 Radio Frequency Voltage
Measurements at Antenna Terminals; Para. 2.991:

The transmitter was modulated with a 2500 Hz audio signal 16 dB above that giving 50% modulation at 2500 Hz. The transmitter R.F. output was fed to a 50 ohm Power Attenuator, attenuated 20 dB and thence fed to a spectrum analyzer. The spurious signal level from the transmitter was confirmed by injecting the output from an accurately calibrated generator into the attenuator in place of the transmitter output. Using spectrum analyzers the spectrum was searched from **12.8 MHz to 1.74 GHz**. All spurious signals less than 20 dB below the F.C.C. limits were noted and recorded. The test set-up is shown in Section 5.4.4 of this report.

Spurious Emissions at the antenna terminals are tabulated below:

Spurious Emission Frequency	Description of Spurious	Spurious Emission Level Relative to Carrier	F.C.C. Max. Level Relative to Carrier
12.8 MHz to 1.74 GHz	**All Spurious Emissions**	**<-73 dB**	**-53 dB**

All spurious were more than 20 dB below the F.C.C. limits, over the 12.8 to 1740 MHz range.

6.4.2 Field Strength Measurement of Spurious Radiations; Para. 2.993:

(a) Below 1000 MHz:

Measurement of spurious radiation from the case of the sample transceiver was conducted essentially in accordance with EIA Standard RS-152B. Details of the test equipment and measurement site are included in "Description of Measurement Facilities Used for Radiated Emission Tests" which has been submitted August 25, 1987, to the F.C.C. laboratory, in connection with an application for a Class B Computing Equipment certification (FCC ID: FZW4N9 328668).

Spectrum Analyzers were the same as used for Antenna Conducted spurious measurements. Tuned dipole (½-wavelength) antennas were used for receiving, and transmitting substitution signals, at each frequency of appreciable radiation (except in the 20 - 200 MHz range where a broad band bi-conical antenna was used for receiving).

The adjustable dipole antennas used with the Field Intensity Receivers were set up at a distance of 100 feet from the sample transceiver for the final measurement. Antenna height and polarization were varied over a 4 to 25 foot elevation and from vertical to horizontal polarization to obtain maximum received signal level.

The transmitter output was fed to a Sierra 185A-150, 50 ohm wattmeter, and the output power noted for reference. The transceiver was mounted in a normal horizontal position on the test stand and was powered by two fully charged 12 volt lead-acid batteries in series. A block diagram of the test set-up is shown in Section 5.4.5 of this report.

The spectrum was viewed over the range from **12.8 to 1000 MHz.** For each frequency where appreciable radiation was measured, the receiving antenna height and polarization were not changed, by the transceiver was replaced by a dipole antenna tuned to the frequency of measurement and fed by a signal generator set to the same frequency. The signal generator output was increased to give the same level as the spurious radiation after the transmitting dipole was first adjusted to give maximum received signal level.

The output levels of the substitution signal generator were recorded in decibels referred to 1 milliwatt. The carrier level of the transmitter was **10 watts or +40 dBm.**

6.4.2 Field Strength
Measurement of Spurious Radiation; Para. 2.993...continued:

(a) Below 1000 MHz...continued:

The attenuation of the spurious emissions in decibels is in accordance with the following formula:

Spurious Attenuation (dB) is calculated as follows:

$$= 10 \log_{10} \frac{\text{Transmitter Power (Wattmeter; 10 watts)}}{\text{Substitute Signal Generator Output}}$$

= (+40 dBm) - (Substitute Signal Generator Output, dBm)

Measured values of spurious radiation by the above method were as follows (all spurious levels higher than 20 dB below the specified FCC limit were noted and recorded).

Spurious Frequency MHz	Substitute Signal Generator Output, dBm	Spurious Level Relative to Carrier, dB	F.C.C. Max. Level Ref. Carrier
12.8 to 1000 MHz	**<-33**	**<-73**	**-53 dB**

All spurious emissions in the range from 12.8 to 1000 MHz were more than 20 dB below the F.C.C. specified limits.

6.4.2 Field Strength Measurements of Spurious Radiation...continued:

(b) Field Strength Measurements of Spurious Emissions in 1000 to 1740 MHz Range Using Calibrated Test Antenna:

Measurements of radiated spurious emissions in the range from **1000 to 1740 MHz** were conducted on the Model **RT-138F** Transceiver using a broadband log periodic antenna with a calibration curve provided by the manufacturer (copy in Section 5.5 of this report).

The field intensity which would be produced by the transmitter carrier, operating into a ½-wavelength dipole antenna (gain: x 1.64), at a distance of 30.5 meters (100 feet) was calculated using the following formula:

$$\text{Field Strength, dB}/\mu\text{V/m} = 20 \log_{10} \left(\frac{\sqrt{30 P_t G}}{D} \right) + 120 \text{ dB}$$

where: P_t is transmitter power, watts; G is 1.64; D is 30.5 meters.

The spurious emissions from the transceiver case and associated wiring were measured at a distance of 3.05 meters (10 feet). Measured levels were extrapolated to 30.5 meters by including a factor of -20 dB. Levels from the calibrated test antenna into the spectrum analyzer were measured in dB over 1 microvolt; the distance factor and antenna factor were then applied to indicate the resultant field at 30.5 meters distance (100 feet), in dB over 1 microvolt per meter. The field strength at 30.5 meters was compared to the calculated carrier level as radiated from a ½-wave dipole and is expressed in the dB in the table of results following.

Spurious levels at 30.5 meters (100 feet) are tabulated on the following page.

The test set-up used for measurement of radiation above 1000 MHz is shown in Section 5.4.6 of this report.

6.4.2 Field Strength Measurements of Spurious Radiation...continued:

(b) Field Strength Measurements above 1000 MHz - Tabulation of Data:

Sample Equipment : **Model RT-138F**

Transmitter Frequency : **156.0 MHz**

Transmitter Power Output : **10 watts**

Field at 30.5 meters from: 10 watts into a ½-wave dipole: 117 dBμV/m

Distance at which measured: **3.05 meters**

Spurious Frequency MHz	Spurious Level, dBμV @ 50 Ohms	Antenna Factor, dB	Distance Factor, dB	Spurious Levels at 30.5 Meters (100 Feet) dB Ref. 1 μV/m	dB Ref. Carrier	F.C.C. Max. Level Ref. Carrier
1000 - 1740	<+38.5 to <+35	+25.5 to +29.0	-20	<+44	<-73	-53 dB

All spurious emissions were more than 20 dB below the F.C.C. specified limits, in the 1000 to 1740 MHz range.

6.5 Frequency Stability; Para. 2.995:

6.5.1 Temperature; Para. 2.995(a)(1), (b) and (c):

The frequency of the transmitter, operating at room ambient temperature (+25°C), had been adjusted by the manufacturer to the nominal assigned frequency (**156.Ø MHz**).

The transceiver was placed in an environmental chamber, with the primary power turned off. The temperature of the chamber was varied over the range of -3Ø°C to +5Ø°C, stabilizing the temperature every 1Ø°C. At each 1Ø°C step the primary power was then applied for a period of one minute, at which time the transmitter was keyed for a 5 second period and its frequency measured at the end of the period. Figure 5 following is a curve of frequency variation vs. temperature. The test set-up for frequency stability measurements is shown in Section 5.4.7 of this report.

The Model RT-138F incorporates the reference oscillator crystal in a temperature controlled oven. In accordance with the requirements of Para. 2.995(c) of the F.C.C. Rules, the transmitter frequency was measured at one minute intervals for ten minutes, after applying primary power. The variation from nominal frequency after 1 minute of applying primary power, and after the frequency had stabilized, are shown below:

Temperature	Frequency After 1 Minute	Stabilization Time	Stabilized Frequency
- 3Ø °C	**- 7Ø Hz**	**6 minutes**	**-1ØØ Hz**
Ø °C	**- 2Ø**	**2 "**	**- 3Ø**
+ 3Ø °C	**<±1Ø**	**1 "**	**- 1Ø**

NOTE: All frequencies measured were well within the F.C.C. limit of ±Ø.ØØØ5%, or ±78Ø Hz at 156.Ø MHz, after 1 minute, and after stabilization. The maximum variation noted was -13Ø Hz, at -3Ø°C, after two minutes with primary power on.

6.5.2 Primary Supply Voltage; Para. 2.995(d)(1) and (3):

The primary supply voltage was varied in steps from 2Ø% above the nominal operating voltage of **27.5 VDC**, down to 2Ø% below the nominal. (Manufacturer's limits are ±2Ø%).

The frequency was recorded, and is detailed on Figure 6 following, in graphical format. The test set-up shown in Section 5.4.7 also applies to this test; the environmental chamber was set to +25°C.

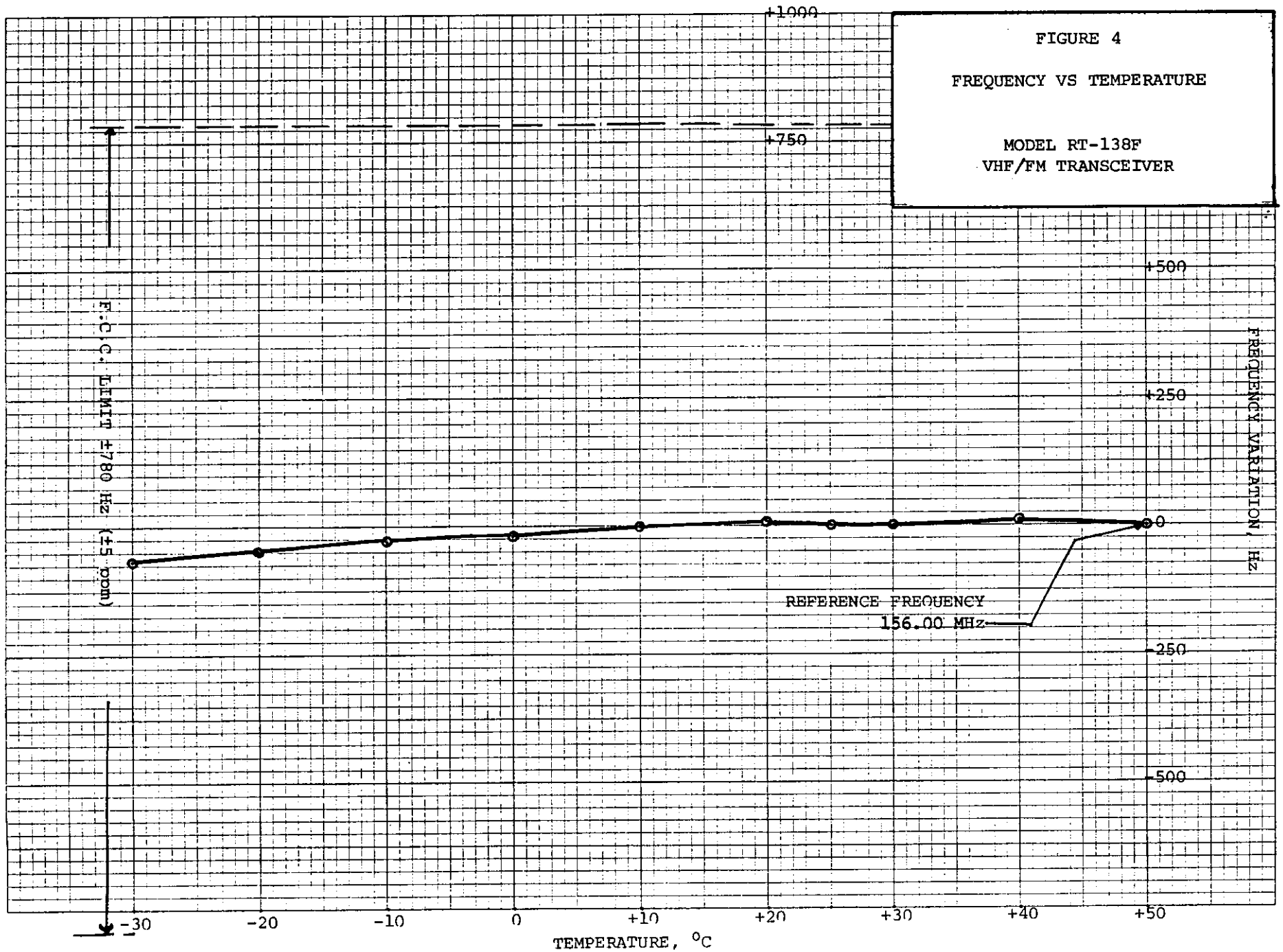


FIGURE 5

FREQUENCY VS PRIMARY VOLTAGE

MODEL RT-138F
VHF/FM TRANSCEIVER