SEA, Inc. of Delaware

APPLICATION FOR CERTIFICATION

MODEL SEA 157 VHF TRANSCEIVER

AND DSC CONTROLLER

CONTAINS:

LIST OF EXHIBITS,
EXHIBIT A AND
EXHIBITS 1 THROUGH 13

APRIL 10, 2000

FCC IDENTIFIER: BZ6SEA157

LIST OF EXHIBITS

FCC IDENTIFIER: BZ6SEA175

LIST OF EXHIBITS - CONTINUED

FCC IDENTIFICATION LABEL SAMPLE

SEE SEPARATE ATTACHMENT

with

SAMPLE EQUIPMENT LABEL FOR SEA 157

REAR PANEL DRAWING OF SEA 157 SHOWING LABEL LOCATION

FCC IDENTIFIER: BZ6SEA157

LIST OF FIGURES

LIST OF FIGURES, continued

EXHIBIT 1

INTRODUCTION

SEA, Inc. of Delaware (SEA) is pleased to submit this Application For Certification of our VHF FM Marine Transceiver/DSC Controller, model SEA 157. SEA, Inc. seeks Certification of the SEA 157 under Part 80.203 et. seq.

The model SEA 157 is designed to meet the requirements of Part 80 as it pertains to vhf radiotelephones for use on boats and ships and at private (simplex) marine coast stations. The model SEA 157 is capable of simplex or semi-duplex operation as appropriate on all currently authorized marine vhf frequencies in the 156-162 MHz band. It also contains all international (ITU) channels. Furthermore, the model SEA 157 is equipped with an integral DSC Controller which complies with the general requirements for Class D in accordance with 80.203(n), 80.225, Rec. ITU-R M.493-9, "Digital Selective-Calling System for use in the Maritime Mobile Service"and RTCM paper 56-95/SC101-STD.

Basic features of this Marine VHF FM Transceiver/DSC Controller include a transmitter frequency range of 156.0 to 157.5 MHz controlled by a 12.5 kHz step frequency synthesizer. The transceiver can operate in either simplex or semi-duplex modes. The receiver can operate over a range of 155 to 164 MHz. Transmitter and receiver channel selection is controlled by the front panel keypad. A list of standard U.S. and international (ITU) marine vhf channel frequencies is prestored in read-only-memory by channel number. Direct frequency entry is not allowed. The transmitter develops 25 watts or 1 watt of carrier power and power level may be selected by the operator. Automatic reduction of carrier power to 1 watt is provided on channels 13 (156.650 MHz) and 67 (156.3 MHz). A manual high power override capability is also present on these channels per Part 80.215(g)(3). The operating system does not allow voice transmission on the digital selective calling channel (70), 156.525 MHz.

Operating requirements compliance. The SEA 157 is equipped to operate on all currently authorized channels in the 156-162 MHz band. Its operator on/off select, transmit/receive select and channel select controls are all readily accessible and can be changed as fast as the operator can push the buttons. The SEA 157 is fully capable of operation in compliance with the following requirements as they apply to telephony operations in the 156-162 MHz band:

Land (private coast): Parts 80.67(a), 80.71
Ships: Parts 80.80, 80.143, 80.148

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Compulsory ships compliance: The SEA 157 is capable of complying with these requirements as they pertain to vhf radiotelephones or vhf watch receivers operating in the 156-162 MHz band:

Subpart R (300 Gross tons): Parts 80.871, 80.873, 80.874. See Exhibits 4 and 5 for transmitter power output and modulation characteristics. See Exhibit 12 for receiver sensitivity measurements and statements concerning certain receiver characteristics required by Part 80.874.

Subpart S (Small passenger boats): Parts 80.905, 80.911, 80.913. See Exhibits 4 and 5 for transmitter power output and modulation characteristics. See Exhibit 12 for receiver sensitivity measurements.

Subpart T (Vessels on the Great Lakes): Parts 80.956, 80.959, 80.961. See Exhibit 4 for transmitter power output. See Exhibit 12 for receiver sensitivity measurements.

Subpart U (Bridge-to-Bridge Act): Parts 80.1011 and 80.1013 The SEA 157 is capable of transmission and reception on 156.650 MHz (Channel 13).

Subpart E (General Technical Standards): The SEA 157 incorporates a VHF DSC Controller which complies with the general requirements for Class D as specified in 80.203(n), 80.225, Rec. ITU-R M.493-9 and RTCM 56-95/SC101-STD.

NAME OF APPLICANT, Part 2.1033(c)(1)

SEA, Inc. of Delaware, 7030 220th St. S.W., Mountlake Terrace WA, 98043 --- Manufacturer and Applicant ---

EQUIPMENT IDENTIFICATION, Part 2.1033(c)(2)

Model SEA 157, VHF FM Marine Transceiver/DSC Controller

FCC Identifier: BZ6SEA157

INSTALLATION AND OPERATING INSTRUCTIONS, Part 2.1033(c)(3)

See Enclosed Operating and Installation Manual

EXHIBIT 2

TECHNICAL DESCRIPTION, Part 2.1033(c)

TYPE OF EMISSION, Parts 2.1033(c)(4) and 80.207(d)

VOICE Mode: 16K0G3E DSC Mode: 13K5G2B

Note: The necessary bandwidths were determined from the tables in Part 2.202(g) based on highest modulation frequency of 3000 Hz and peak frequency deviation of 5000 Hz.

FREQUENCY RANGE, Part 2.1033(c)(5):

Transmit: 156.0 to 157.5 MHz
Receive: 155.0 to 164.0 MHz

RANGE OF OPERATING POWER LEVELS, Part 2.1033(c)(6):

Two carrier power levels are provided: 25 watts and 1 watt. Power level is held constant by a servo loop operating from a sample of the RF output. See Part 2.1033(c)(10) below for details.

MAXIMUM POWER LEVEL, Part 2.1033(c)(7): 25 watts carrier.

The transmitter complies with 80.215(c)(1),(e) and (g) concerning allowable maximum power, manual and automatic power reduction and manual power override.

DC VOLTAGES AND CURRENTS APPLIED TO FINAL AMPLIFIER,

Part 2.1033(c)(8):

Test conditions:

DC voltage measured at pin 3 (Hi dc) of rf power amplifier module U8 which is the dc power input point to final power amplifier stage (See transmitter schematic diagram in Instruction Manual). DC current measured into same pin as above. Transmitter operated on a frequency in the middle of its range and set to 25 watts average output power.

DC Voltage: 13.1 Volts DC Current: 4.5 Amps

TUNE-UP PROCEDURE, Part 2.1033(c)(9)

See Preliminary SEA 157 Instruction Manual (Enclosed), Chapter 4, "Installation" and Chapter 6, "Maintenance".

FCC IDENTIFIER: BZ6SEA157

FREQUENCY DETERMINING AND STABLILIZATION CIRCUITS,
Part 2.1033(c)(10)

Please refer to the following diagrams for this discussion:

SEA 157 Functional Block Diagram, Figure 6.1 and Mainboard Schematic Diagram, in the Preliminary SEA 157 Instruction Manual (Enclosed).

General: The frequency determining circuits perform within $\pm$ 5 ppm frequency stability limits over the temperature range of at least -20 to +50 C

Detailed discussion: The SEA 157 uses a 21.850 MHz master crystal oscillator (part of U10 located on RF Mainboard) as the master transmitter frequency reference. This oscillator, with its associated components, is the sole source of both transmitter and receiver frequency stability. It's frequency is divided by 1748 to provide the 12.5 kHz reference for the VHF frequency synthesizer.

The single loop synthesizer uses LSI circuit synthesizer chip (U10) which contains a dual modulus prescaler, frequency dividers and a phase detector with tri-state output. Phase pulses from the phase detector are integrated by the loop filter and the resulting voltage provides the tuning control for the voltage controlled oscillator (VCO Module, Q1).

During transmission, the VCO operates directly at the transmitter output frequency in the 156 MHz band and is phase and frequency locked to an integer multiple of the master oscillator frequency divided by 1748 (12.5 kHz). The frequency of the synthesizer is equal to (N/1748)x21.850 MHz; e.g., the value of N is 12,544 for a synthesizer output frequency of 156.800 MHz. The VCO changes frequency in exact proportion to any change in the 21.850 MHz master oscillator frequency. A one ppm change in master oscillator frequency would result in a one ppm change in transmitter output frequency.

Any circuit failure which causes the VCO to depart from a stable phase-locked condition results in lengthening of the phase pulses on pin 8 of U10. These pulses are detected as a logic level change by an input port on the microcomputer. The microcomputer then disables transmission.

The master oscillator (part of U10) is a Colpitts type which uses a 21.850 MHz, high stability AT-cut fundamental mode crystal (Y1) tightly bound to a positive temperature coefficient thermistor (PTC) which is used as a crystal heater at temperatures below zero degrees C.

The crystal oscillator components include a negative temperature coefficient capacitor (C103) to compensate for capacity variations in U10 with temperature. Without the PTC installed, the oscillator holds within ± 5 ppm frequency stability limits over -10 to +60 degrees C. The crystal itself, as opposed to the other oscillator circuitry, dominates the frequency stability at extreme temperatures. The PTC has a sharp knee in its temperature characteristic curve so that its power dissipation increases dramatically below zero degrees C ambient. The PTC delivers an adequate amount of heat to the crystal to keep the crystal case temperature above -10 degrees C for ambient temperatures down to -30 degrees C. Thus the crystal is maintained above the lowest temperature beyond which it would otherwise exceed the 5 ppm limit. At normal room temperatures or above, the PTC has negligible effect on the oscillator frequency.

DESCRIPTION OF MODULATION LIMITING, POWER LIMITING AND SPURIOUS RADIATION SUPPRESSION CIRCUITRY, Part 2.1033(c)(10)

Several circuits in the transmitter play a significant role in reducing unwanted emissions, limiting output power and limiting peak frequency deviation. These circuits are described below beginning at the audio section and progressing through to the RF output port. Please refer to the transmitter-receiver-synthesizer schematics in the Instruction Manual for specific circuits.

1. Audio Preemphasis, Clipping and Filtering: The SEA 157 employs a Digital Signal Processor (DSP) system which uses digital technology to provide the required audio preemphasis and clipping functions that are required for effective Frequency Modulation. The DSP system also provides an effective bandpass filter to limit the frequency response of the transmitter audio circuitry to prevent excessive bandwidth of the transmitted signal.

Transmitter audio from the microphone is applied to CODEC U6 which, in conjunction with program routines running in the DSP chip U5, provides audio preemphasis, clipping and finally an audio bandpass filter. These digital routines shape the transmitter audio response and provide appropriate protection against excessive deviation under audio overdrive conditions.

2. RF Amplifier Chain: Consisting of Q9, Q10 and U16, the transmitter RF chain uses tuned narrowband amplifiers so that unwanted frequencies are not amplified.

3. RF Output Lowpass Filter: This seven-pole low pass filter which is just prior to the antenna terminal attenuates harmonics of the transmitter output frequency.

4. Automatic Power Control (APC) System: This is a digital negative feedback control system which continuously monitors and, if necessary, corrects the output power level at the antenna terminals. C119 samples the RF voltage at the RF power amplifier output terminal. Diode D34 converts the RF signal to a dc level proportional to the output power level and the dc signal is fed to A/D converter, U15. The digitized signal is then applied to the DSP chip and subjected to a power control routine which, through D/A converter U17, drives dc amplifier (Q5 and Q13) to provide the correct dc supply voltage to Q9 and the first stage of U16. This in turn creates the proper RF drive to the final amplifier stage. Two reference comparison levels are used in the control routine which correspond to 1 watt and 25 watt output levels. When adjusted according to the alignment instructions, the APC system will closely maintain the 1 w or 25 w output level (as selected) over a wide range of power supply voltages and ambient temperatures. The final RF power amplifier stage cannot produce more than about 30 watts even in the unlikely event that the automatic power control system should fail.

EXHIBIT 3

INTRODUCTION TO TRANSMITTER MEASUREMENTS, Part 2.1033(c)(14)

Exhibits 4 through 9 on the following pages present the required measured transmitter performance data for parts 2.1046 through 2.1057. The appropriate Part 80 references are also included in each exhibit.

Please note: Receiver data and measurements for receiver type acceptance per 80.874 can be found in Exhibit 11.

CERTIFICATION OF TEST DATA, Part 2.909

Please see page 3-2 for the test supervisor's statement.

MEASUREMENT PROCEDURES, Parts 2.947, 2.1041

Specific measurement procedures and test setup diagrams are presented along with the resultant data for each of the tests prescribed by parts 2.1046 through 2.1057.

TEST EQUIPMENT LIST, pp. 2.947(d)

The equipment used for the tests is listed on page 3-3

STATEMENT OF TEST SUPERVISOR, Part 2.911

This is to certify that the undersigned supervised the technical tests included in this report and to the best of my knowledge, the data and facts are correct.

The engineering qualifications of the undersigned are as follows:

1. Three years attendance as E.E. undergraduate at the University of Washington. Specific technical education in the U.S. Navy and the Boeing Airplane Company.

2. Holder of FCC First Class Radiotelephone license with Ship's Radar Endorsement for over 30 years. Present holder of General Radiotelephone License #PG-13-21992. Holder of various amateur radio licenses since 1952. Presently holding K7KDU for over 40 years.

3. Over 38 years professional experience at radar and communications equipment design with the following organizations: The Boeing Company, Raytheon, Inc., Northern Radio Company and SEA, Inc. (Company co-founder, chief engineer).

Should you require further information regarding this application, please contact me at (425)771-2182. For your greater convenience the SEA Inc. WATS line number is 1-800-426-1330.

Signed,

G. William Forgey Date
Vice President, Engineering
SEA, Inc. of Delaware

Note: Signed copy provided as separate attachment

TEST EQUIPMENT LIST, Part 2.947(d)

ITEM	DESCRIPTION	MODEL
1.	Audio Sinewave Generator	HP3325A
2.	Audio Step Attenuator	HP350A
3.	RF Wattmeter	Bird 4410a, 4410-6 Element
4.	50W, 20 dB Attenuator	JWF IND. 50HF-020-50
5.	Power Splitter	Minicircuits ZFDC-10-1
6.	50 Ohm Termination	Tektronix 011-0049-01
7.	Oscilloscope	Tektronix 2465A
8.	Spectrum Analyzer	Hewlett-Packard 8568B
9.	DC Power Supply	Hewlett-Packard 6269B
10.	True RMS Voltmeter	Fluke 87
11.	RF Signal Generator	Fluke 8080A
12.	Frequency Counter	HP5384A
13.	Frequency Standard	HP58503A
14.	Environmental Chamber	Tenney Jr.
15.	DC Power Supply	NEWMAR 115-12-35
16.	Modulation Analyzer	HP8901A
17.	Distortion Analyzer	HP333A
18.	Plotter	HP7470A
19.	10 dB attenuator	Minicircuits CAT-10

EXHIBIT 4

RF POWER OUTPUT, Parts 2.1046(a), 2.1046(c) and 80.215

APPLICABLE RULES:

Part 80.215(a)(2):	G3E emissions rated by carrier power.
Part 80.215(c)(1):	Coast stations allowed 50 W max., 156-162 MHz.
Part 80.215(e)(1):	Ship stations 156-162 MHz, 25 watts max., reducible to one watt or less.
Part 80.215(g):	Ship station carrier power at least 8 watts, not greater than 25 watts. Battery supply voltage between 12.2 and 13.7 vdc.
Part 80.215(g)(1):	Transmitter reducible to 1 watt or less.
Part 80.215(g)(3):	Automatic carrier reduction to one watt or less on 156.375 and 156.650 MHz with manual override capability to full power.
Part 80.911(d):	Transmit power at least 15 watts after 10 minutes operation with 11.5 V supply.
Part 80.959(c):	Transmit power at least 10 watts after 10 minutes operation with 11.5 V supply.

PROCEDURE:

The transmitter was tested on two frequencies, 156.050 MHz and 157.425 MHz, representing the lower and upper edges of the transmitter's tuning range. The radio was tuned up in accordance with the alignment procedure in the instruction manual. A 50 ohm power attenuator was attached to the antenna terminals. No modulation was applied during the tests.

The radio was powered through its normally supplied power cable by a laboratory power supply. Power supply voltage was normally set to 13.6 VDC.

Please refer to the test set-up diagram, Figure 4.1.

Prior to making the actual power measurements, the test setup was calibrated to compensate for losses between the transmitter output and the spectrum analyzer display. The spectrum analyzer reference level was adjusted so that the carrier line just touched the top of the screen. This occured at a reference level of +13.8 dBm indicating 44-13.8 = 30.2 dB loss between transmitter and spectrum analyzer.

The transmitter was keyed on both the test frequencies and at both 25 and 1 watt power levels. Readings were taken from both the spectrum analyzer and the wattmeter.

The wattmeter slug was changed from the 25 watt version used in the 25 watt tests to a one watt version for the one watt tests. The manufacturer states the accuracy of the wattmeter is ± 5% for full scale deflection.

Operating note per 80.215(g)(3): When either of channels 13 (156.650 MHz) or 67 (156.375 MHz) is selected for transmission in the USA channels mode, the transmitter power is automatically reduced to one watt. The transmitter power can be manually overridden back to full 25 watt power on these two channels by pressing and holding down the "1 watt" key during transmission.

To ensure compliance with 80.215(g), another test was performed in which the power supply voltage was varied from 13.7 down to 12.2 vdc while in the 25 watt mode on 156.05 MHz. The wattmeter was monitored for any variation in power from the 25 watt level.

A final test was run to ensure the transmitter is capable of compliance with Parts 80.911(d) and 80.959(c). The transmitter was operated continuously for 10 minutes with 11.5 volts at its supply terminals. The wattmeter was monitored to see if the output power remained above 15 watts.

RESULTS:

Frequency MHz	Power Setting	Wattmeter Watts	Wattmeter Equiv.dBm	Spectrum Analyzer, dBm
156.050	25 W	24.5	+44	13.7 + 30.2 = +43.9
157.425	25 W	24	+44	13.6 + 30.2 = +43.8
156.050	1 W	.95	+30	-0.3 + 30.2 = +29.9
157.425	1 W	.98	+30	-0.2 + 30.2 = +30

Since the wattmeter was deflected full scale in each condition above, and the full scale wattmeter accuracy is 5%, the actual power is known within .25 dB. The spectrum analyzer is not quite as accurate in measuring absolute power but serves to insure that emission limitations are not violated during the tests.

In the second test the output power dropped from 24.5 to 23.8 watts as the power supply voltage was varied from 13.7 down to 12.2 vdc.

In the final test, the output power started at 23.5 watts and after 10 minutes it was still 23.5 watts.

FIGURE 4.1
TEST SETUP
RF POWER OUTPUT
2.1046(a)(c)

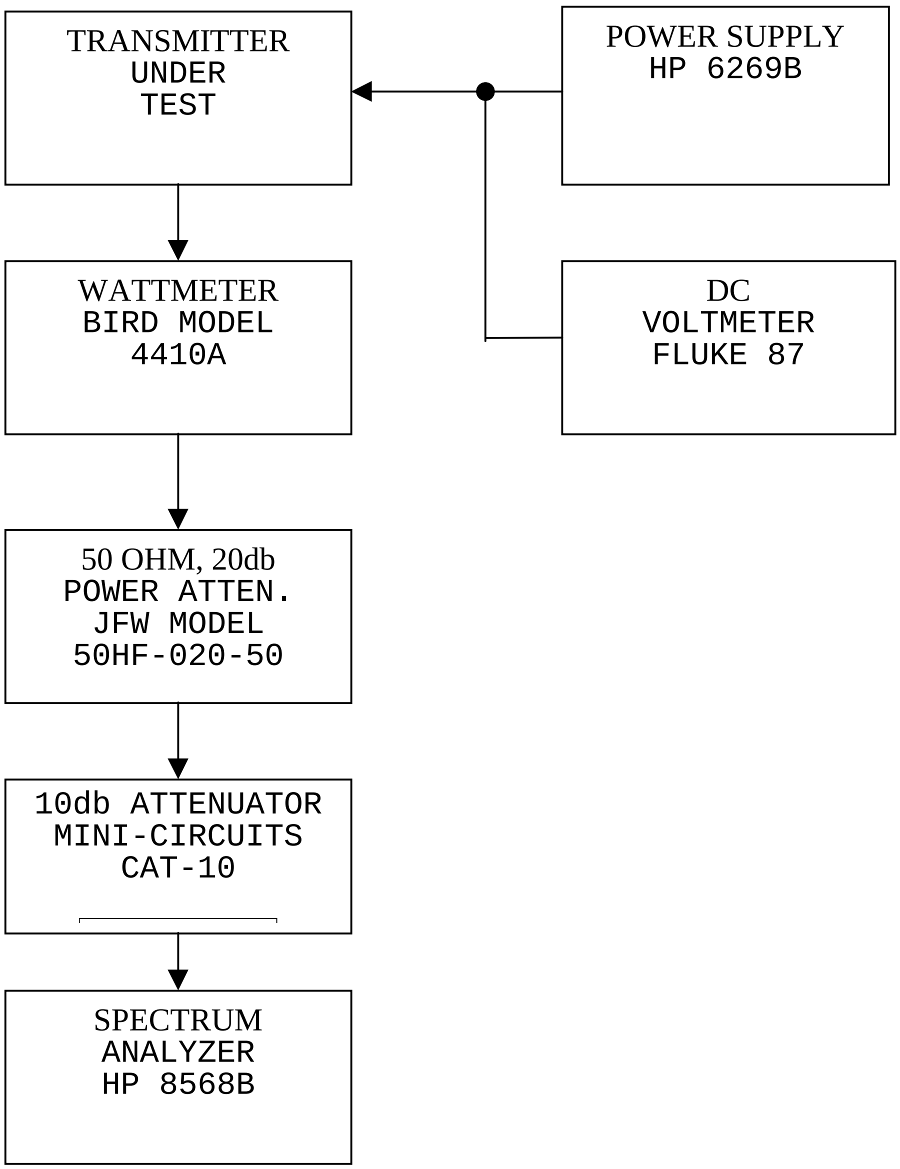


EXHIBIT 5

MODULATION FREQUENCY RESPONSE AND MODULATION LIMITING, PARTS 2.1047(a)(b)

APPLICABLE RULES:

Parts 80.205(a),(b),: 80.213(d)	Maximum frequency deviation for G3E emission is 5 kHz (5 kHz = 100%).
Parts 80.213(a)(2): 80.873(b) 80.911(b)	Must maintain peak modulation between 75 and 100%.
Part 80.213(b):	Modulation limiter required.

PROCEDURE:

The transceiver and test equipment were set up as shown in Figure 5.1. The transmitter was first tuned up on the desired test frequency in accordance with the instruction manual. A 50 ohm resistive power attenuator was attached to the antenna terminals.

The transmitter was modulated by connecting an audio sine wave generator, variable from 100 to 5000 Hz with constant output amplitude, to the microphone input terminals through an audio step attenuator.

The oscilloscope was used to monitor both the amount of clipping at the CODEC output (Pin 3 on VCO module ASY-0157-03) and the audio input voltage at the microphone terminals.
The frequency modulation analyzer serves as a calibrated receiver. Its demodulated baseband audio output bandwidth was set to 15 kHz at -3dB. Its output amplitude is a linear function of transmitter peak deviation or percent modulation. The audio voltmeter was calibrated so that 0 dB represented 100% percent modulation or 5 kHz peak deviation.

Three tests were conducted. The first test used an audio drive level that did not quite cause audio clipping at the frequency of highest gain in the transmitter audio circuits. The second test was at a medium audio drive level sufficient to produce 100% modulation at some audio frequency. The third test was performed at an audio drive level sufficient to produce audio limiter clipping at frequencies between 300 and 3000 Hz. The peak-peak sinusoidal microphone terminal levels were recorded and compared with the level produced at the microphone terminals by the normally supplied microphone.

RESULTS:

Audio voltage at microphone input terminals:

Test 1, low audio drive: 14 mV p-p
Test 2, med. audio drive: 40 mV p-p
Test 3, high audio drive: 110 mV p-p

Plots of modulation level vs. frequency are provided in Figures 5.2, 5.3, and 5.4 resulting from the three tests. In each case zero dB represents 100% modulation (5 kHz peak deviation).

The effect of preemphasis is readily seen in Figure 5.2 for modulating frequencies below about 2500 Hz. Attenuation of the audio lowpass filter dominates the response above 3000 Hz.

During normal voice transmission, the peak to peak audio voltage at the microphone terminals is approx. 40 mV. Inspection of the deviation measuring instrument indicate peak deviation averaging about 90% or 4.5 kHz.

Three additional modulation plots which display deviation vs. audio drive level at 500 Hertz, 1000 Hertz and 2500 Hertz are provided in Figures 5.5, 5.6 and 5.7. In each case, the applied audio level was varied from a level 30 dB below the nominal 0 dB reference level of 40 mV peak-to-peak to a level 20 dB above nominal. These plots demonstrate that the transmitter limiter operates effectively over the nominal voice bandpass.

AUDIO LOWPASS FILTER RESPONSE, Part 2.1047(a):

APPLICABLE RULE:

Part 80.213(e): Audio low pass filter required between modulation limiter and modulated RF stage. Attenuation relative to 1 kHz in range 3 to 20 kHz must be 60 log(f/3) dB or at least 50 dB above 20 kHz.

PROCEDURE:

Note: In the SEA 157, all audio baseband processing is accomplished in the system DSP chip. Microphone audio is applied to the DSP chip, U6, and is then subjected to the required signal manipulation through use of software controlled digital routines. (SEE "Description of Modulation Limiting, Power Limiting and Spurious Radiation Suppression Circuitry" on Page 2-3 of this report for a complete description of this processing).

See Figure 5.8 for the test setup diagram. A constant amplitude audio sine wave generator was connected to the CODEC microphone input, (Pin 21, U6).

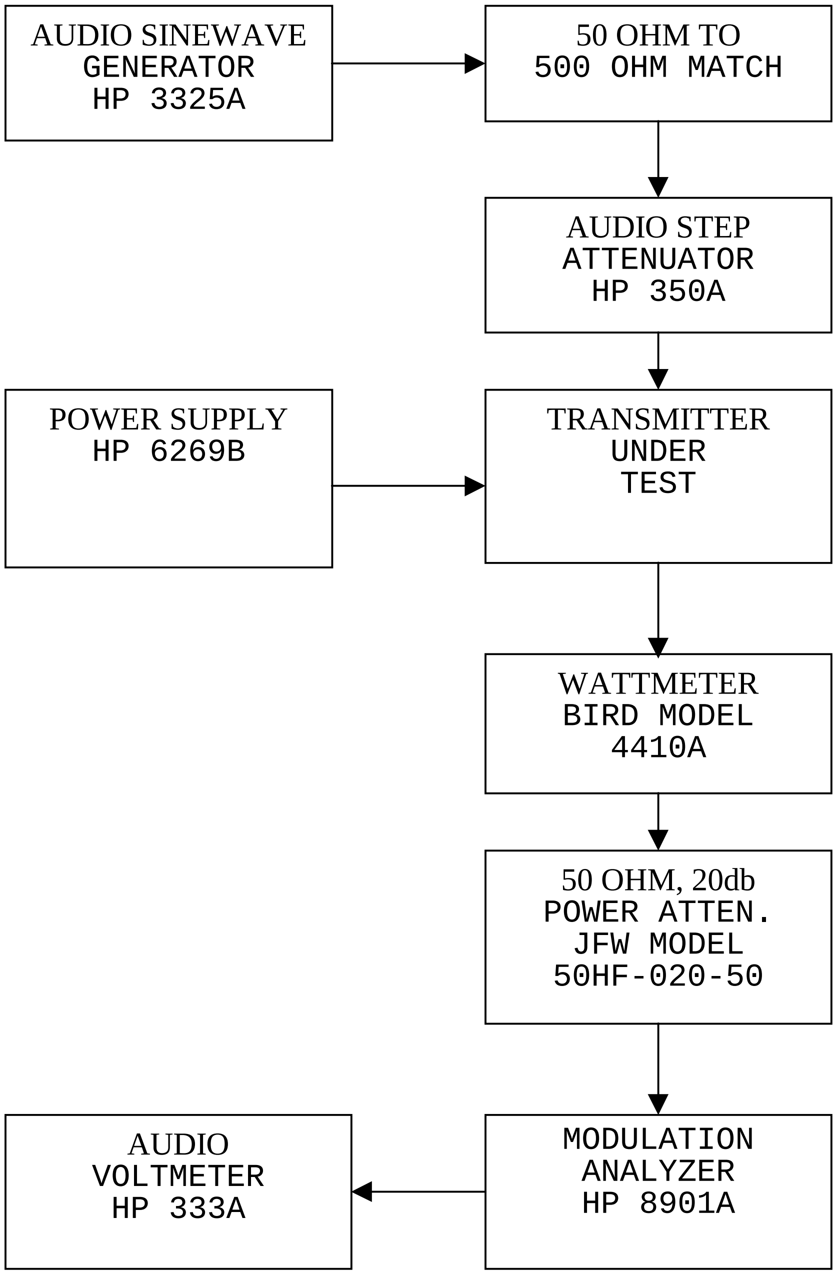
The audio generator was first adjusted to 1000 Hz and its amplitude was set to 20 millivolts RMS. This resulted in 0.89 volts RMS at the CODEC Tx Audio output, (Pin 36 of U6). The audio voltmeter was set to zero dB as a reference.

The audio generator frequency was then increased in steps to 100 kHz and adequate data was taken from the audio voltmeter to allow a smooth plot of attenuation vs. frequency.

RESULTS:

Please see Figure 5.9 for the frequency response plot of the audio low pass filter between 1 kHz and 100 kHz. Included on the same sheet are the graphical limits described by the formula in Part 80.213(e). The filter complies with the required attenuation limits. The filter noise floor is reached at about 5 kHz.

FIGURE 5.1
TEST SETUP
MODULATION FREQUENCY RESPONSE
AND MODULATION LIMITING
2.1047(a)(b)



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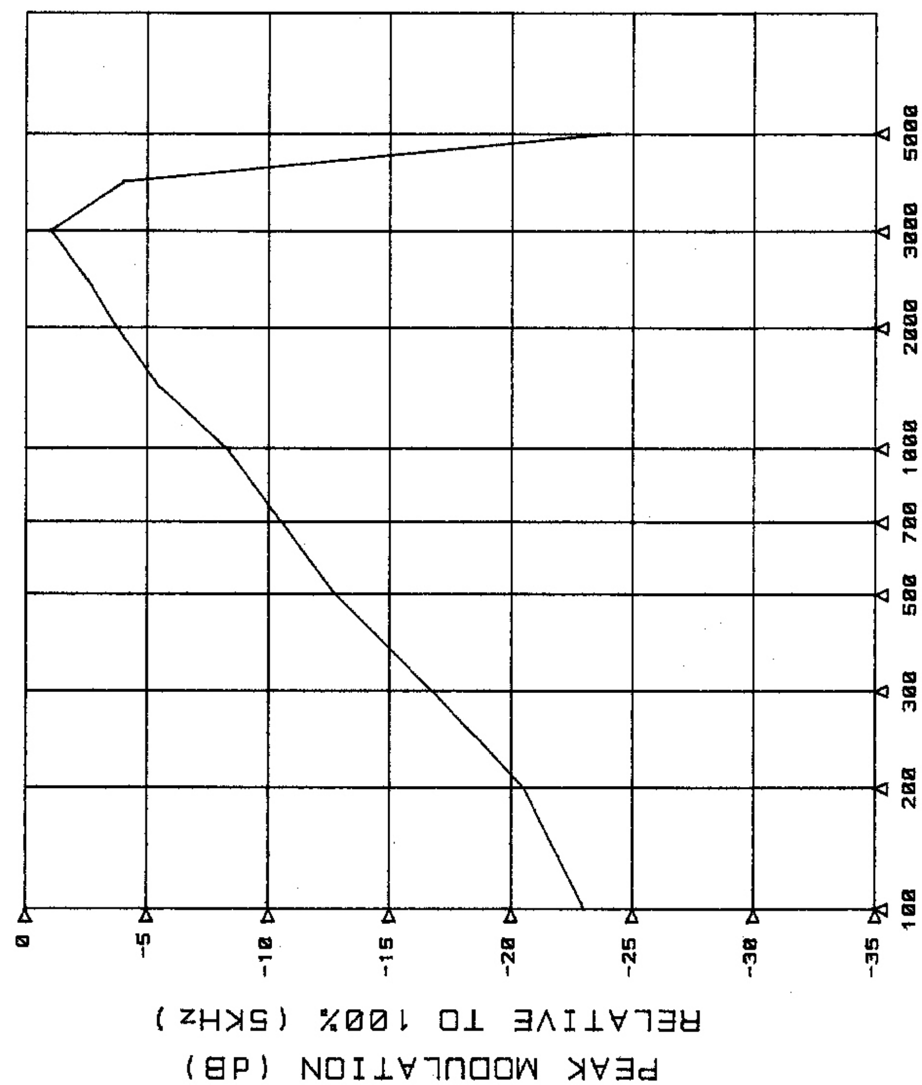


FIGURE 5.2 MODULATION FREQUENCY RESPONSE (Hz)
WITH LOW AUDIO DRIVE 2.1047(a)(b)

FCC IDENTIFIER: BZ6SEA157

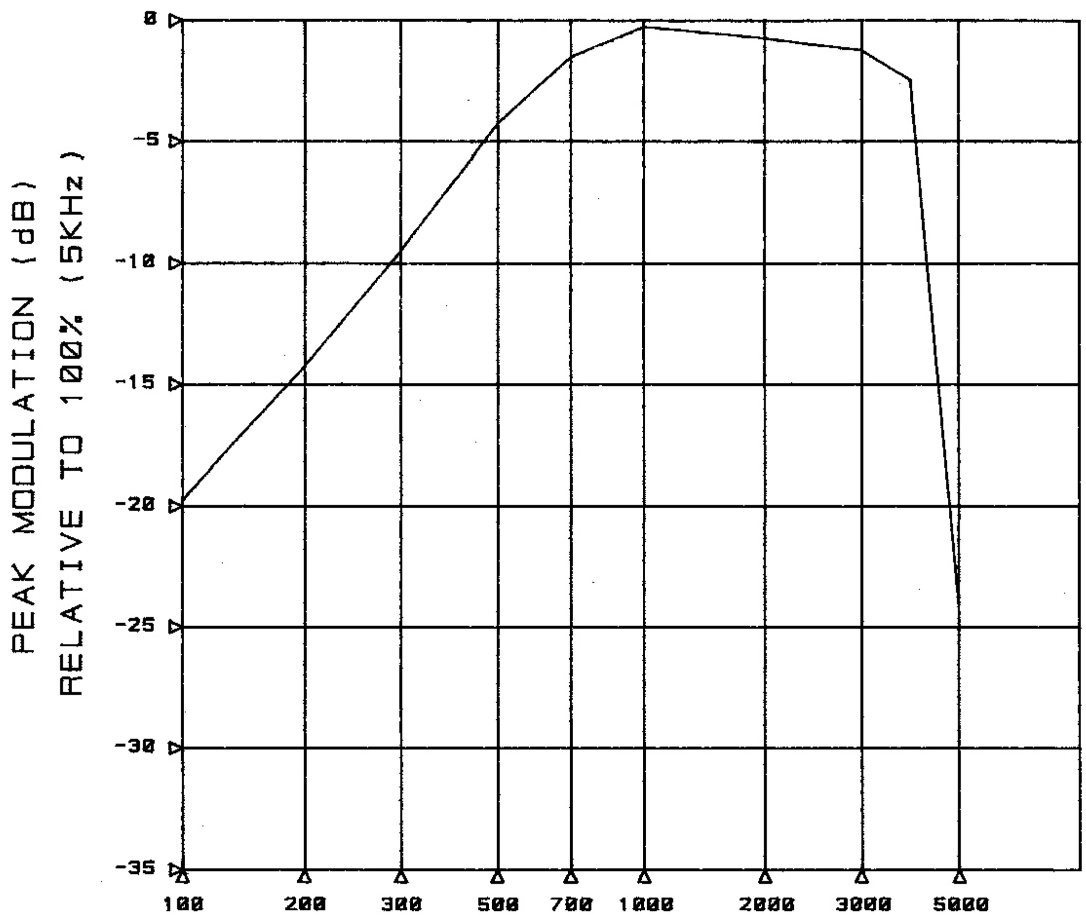


FIGURE 5.3 MODULATION FREQUENCY RESPONSE (Hz) WITH MEDIUM AUDIO DRIVE 2.1047(a)(b)

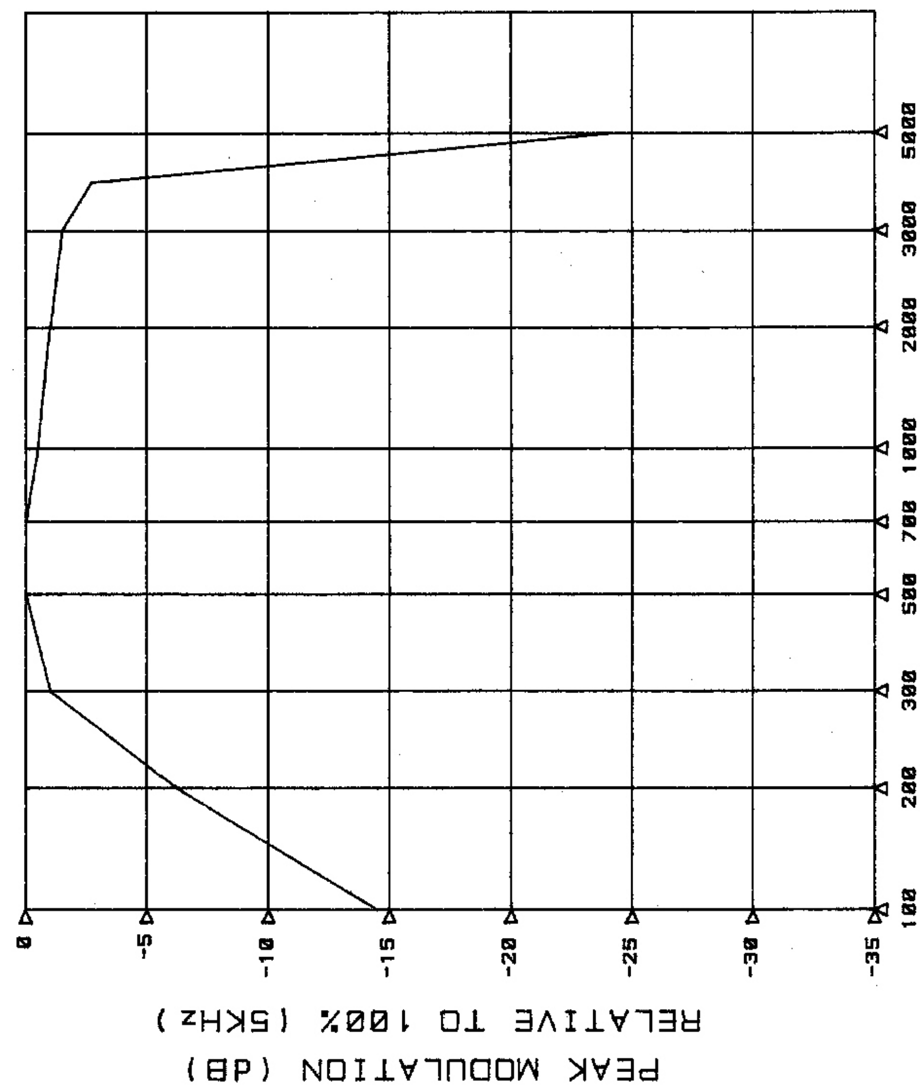


FIGURE 5.4 MODULATION FREQUENCY RESPONSE (Hz)
WITH HIGH AUDIO DRIVE 2.1047(a)(b)

FCC IDENTIFIER: BZ6SEA157

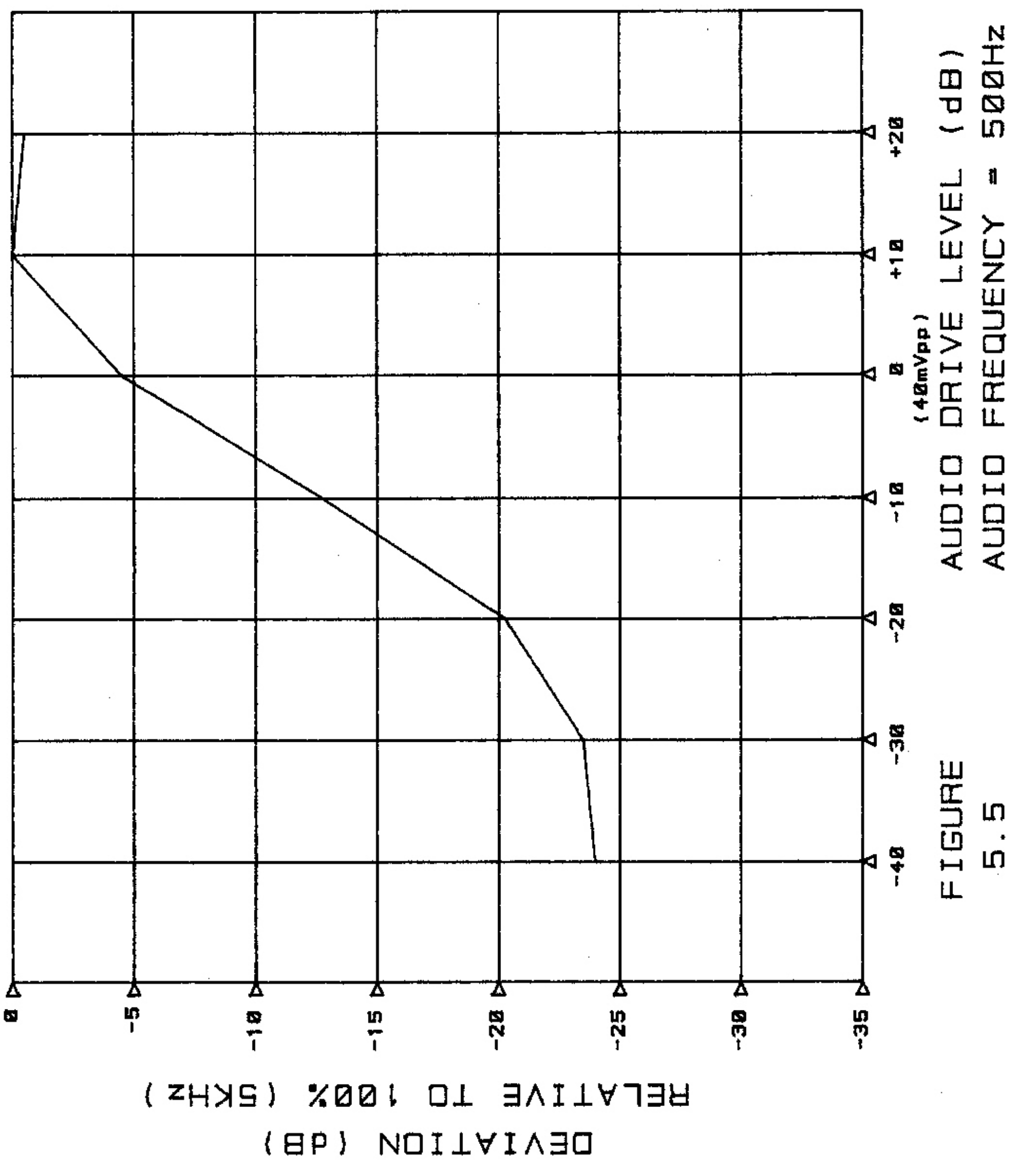


FIGURE 5.5

2.1047(a)(b)

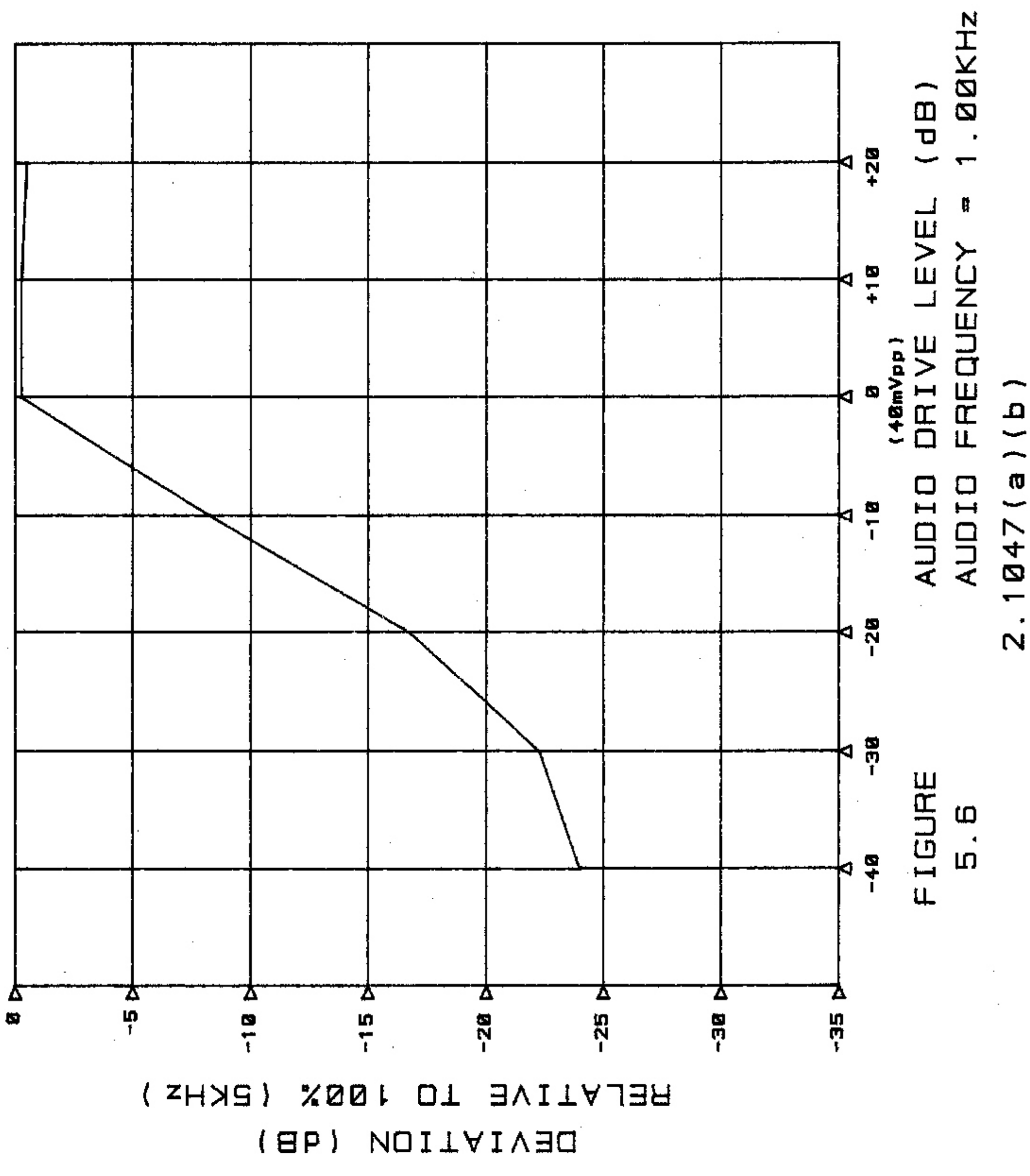


FIGURE 5.6

2.1047(a)(b)

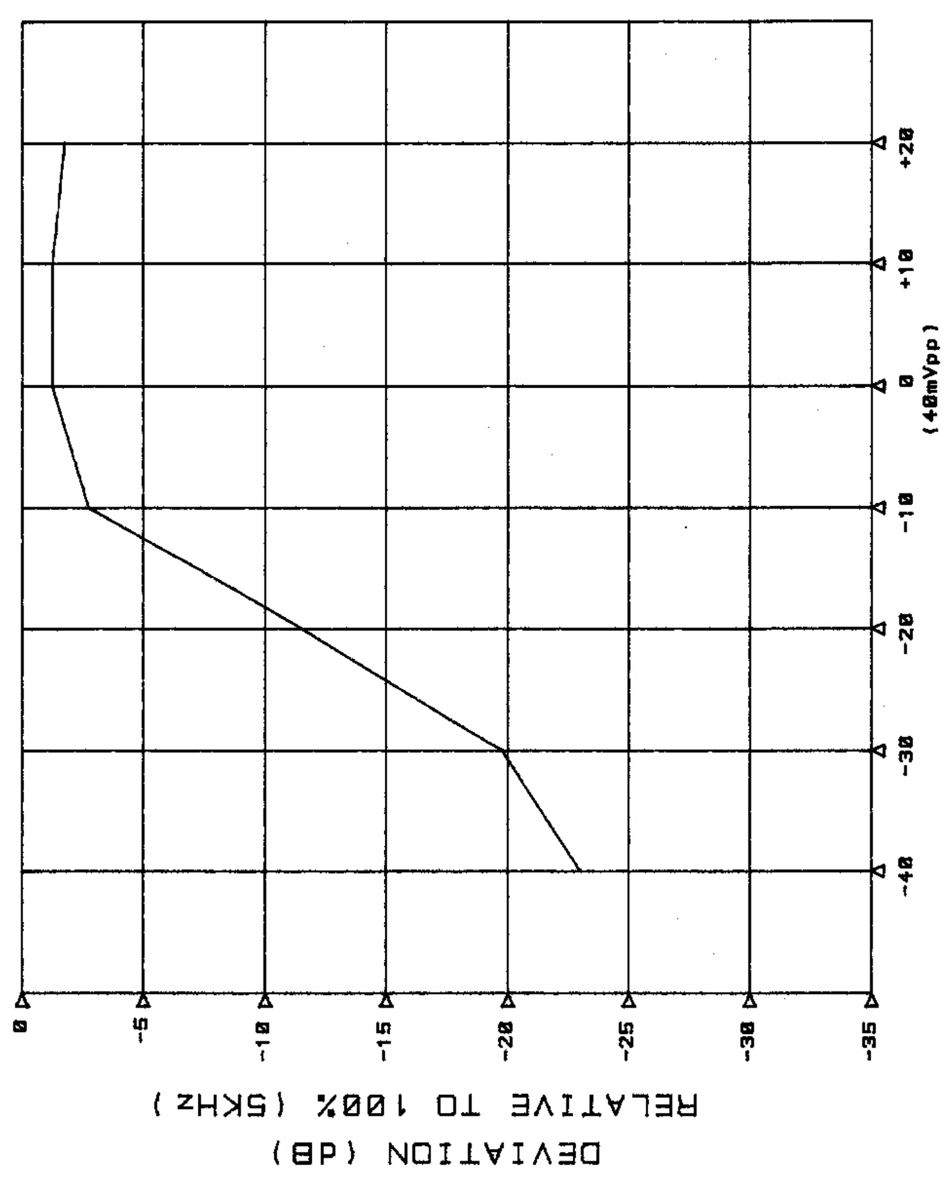
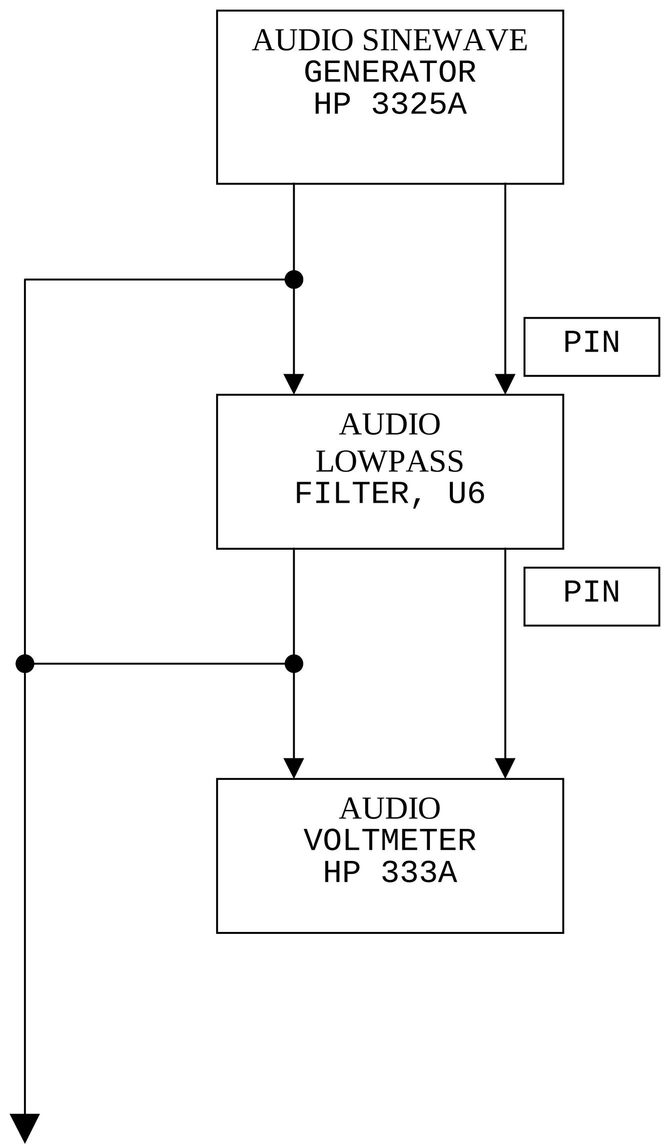


FIGURE 5.7

AUDIO DRIVE LEVEL (dB)
AUDIO FREQUENCY = 2.50KHz

2.1047(a)(b)

FIGURE 5.8
TEST SETUP
FREQUENCY RESPONSE OF
AUDIO LOWPASS FILTER
2.1047(a)



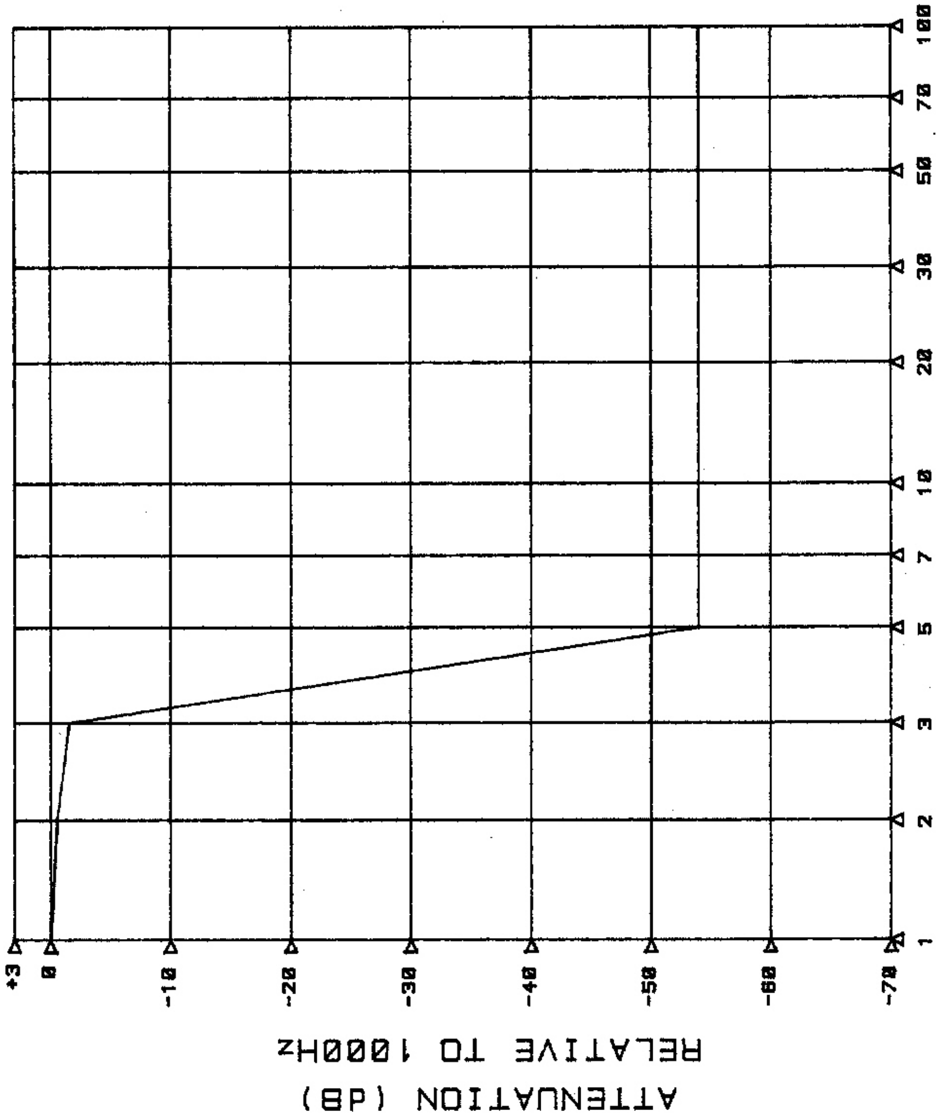


FIGURE 5.9 AUDIO LOWPASS FILTER
FREQUENCY RESPONSE (KHz)
2.1047(e)

EXHIBIT 6

OCCUPIED BANDWIDTH MEASUREMENT, Part 2.1049(c)(1)

APPLICABLE RULES:

Part 80.205(a): Authorized bandwidth 20 kHz for G3E emission with 5 kHz peak deviation.

Part 80.211(f): Attenuation with respect to mean power: At least 25 dB, removed 50 to 100% of authorized bandwidth; 35 dB for 100 to 250%; 43 + 10 log (mean power) for greater than 250%.

PROCEDURE:

Please refer to Figure 6.1 for the test setup used.

The tests were performed at two frequencies, 156.05 MHz and 157.425 MHz, one each near the lower and upper edges of the transmitter frequency range, and at each frequency the transmitter was operated first at the 25 watt carrier level, then at the 1 watt carrier level. The transmitter was initially tuned up in accordance with the instruction manual. A 50 ohm resistive power attenuator was attached to the antenna terminals. The normally supplied power cable was used between the laboratory power supply and the transmitter. The power supply was set to 13.6 vdc at its output terminals.

The calibration procedure for the spectrum analyzer absolute power reference display level was the same as for the RF Power Output Test, Exhibit 4. For each power level the spectrum analyzer reference level was adjusted to reflect mean power at the top of the graticule. The in-line wattmeter was monitored to insure that the 25 watt or 1 watt carrier power output level was maintained as appropriate for the test being conducted.

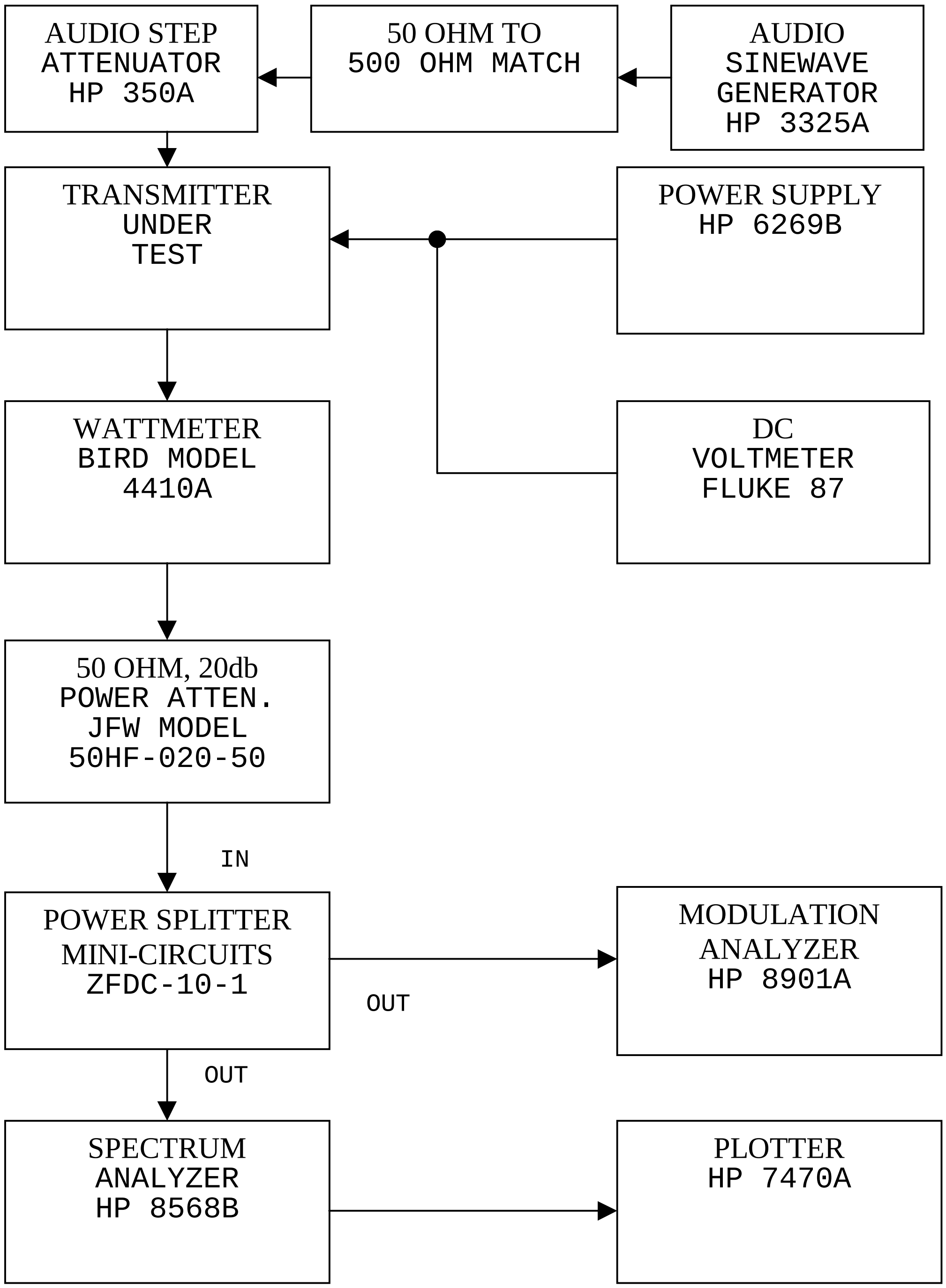
Sinusoidal audio modulation at 2500 Hz was applied to the microphone terminals. The transmitter audio gain is maximum at 2500 Hz. The sine wave amplitude was first set to produce 50% modulation (2.5 kHz peak deviation as measured by the modulation analyzer's peak deviation indicator) and its amplitude was then increased by 16 dB before the spectrum analyzer plots were taken.

RESULTS:

Spectrum plots for the four measurements are presented in Figures 6.2, 6.3, 6.4, and 6.5. Emission limits described by 80.211(f) are also plotted for the appropriate power level.

FCC IDENTIFIER: BZ6SEA157

FIGURE 6.1
TEST SETUP
OCCUPIED BANDWIDTH
2.1049(c)(1)



FCC IDENTIFIER: BZ6SEA157

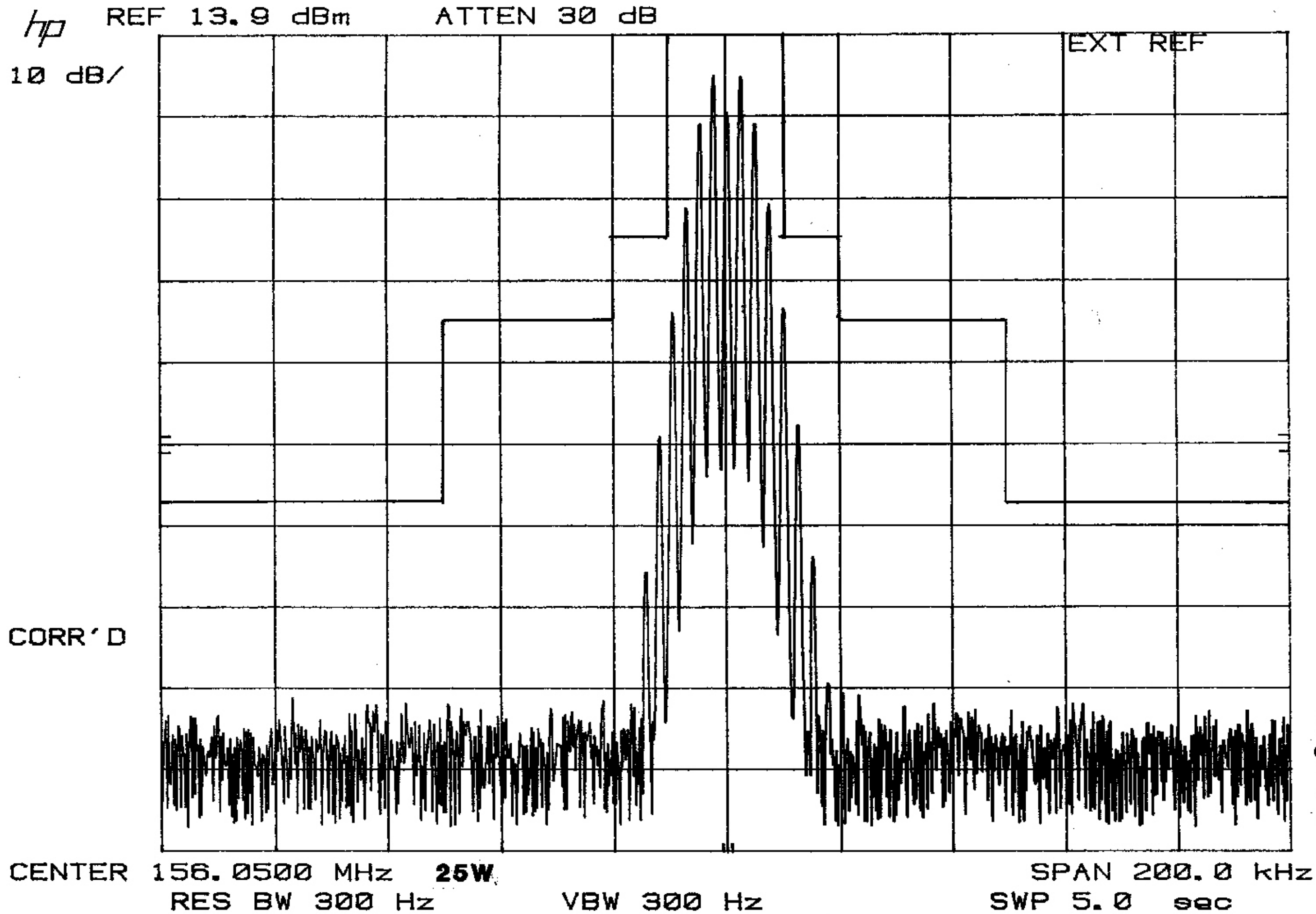


Figure 6.2

FCC PART 2.1049(c)(1)

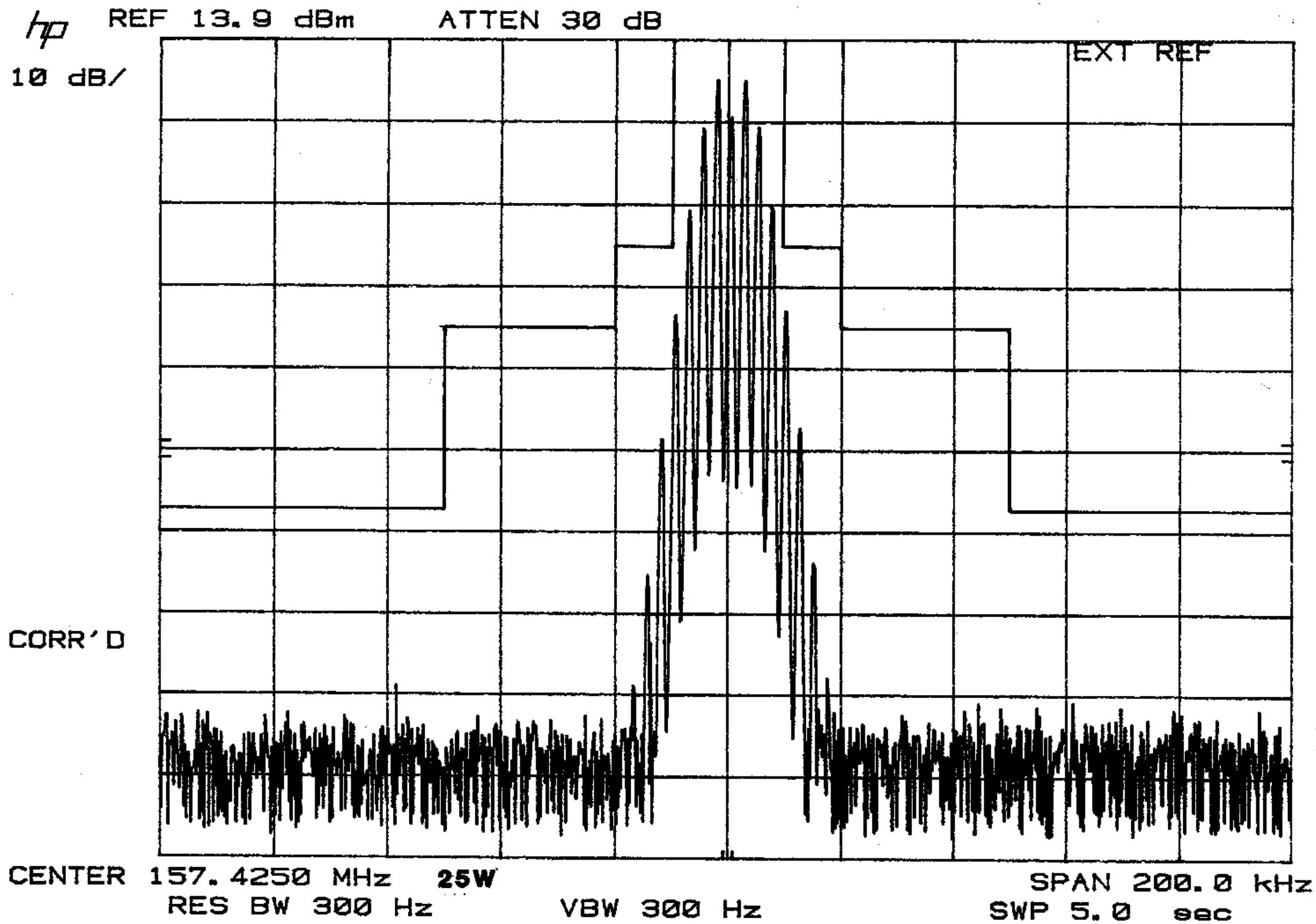


Figure 6.3 **FCC PART 2.1049(c)(1)**

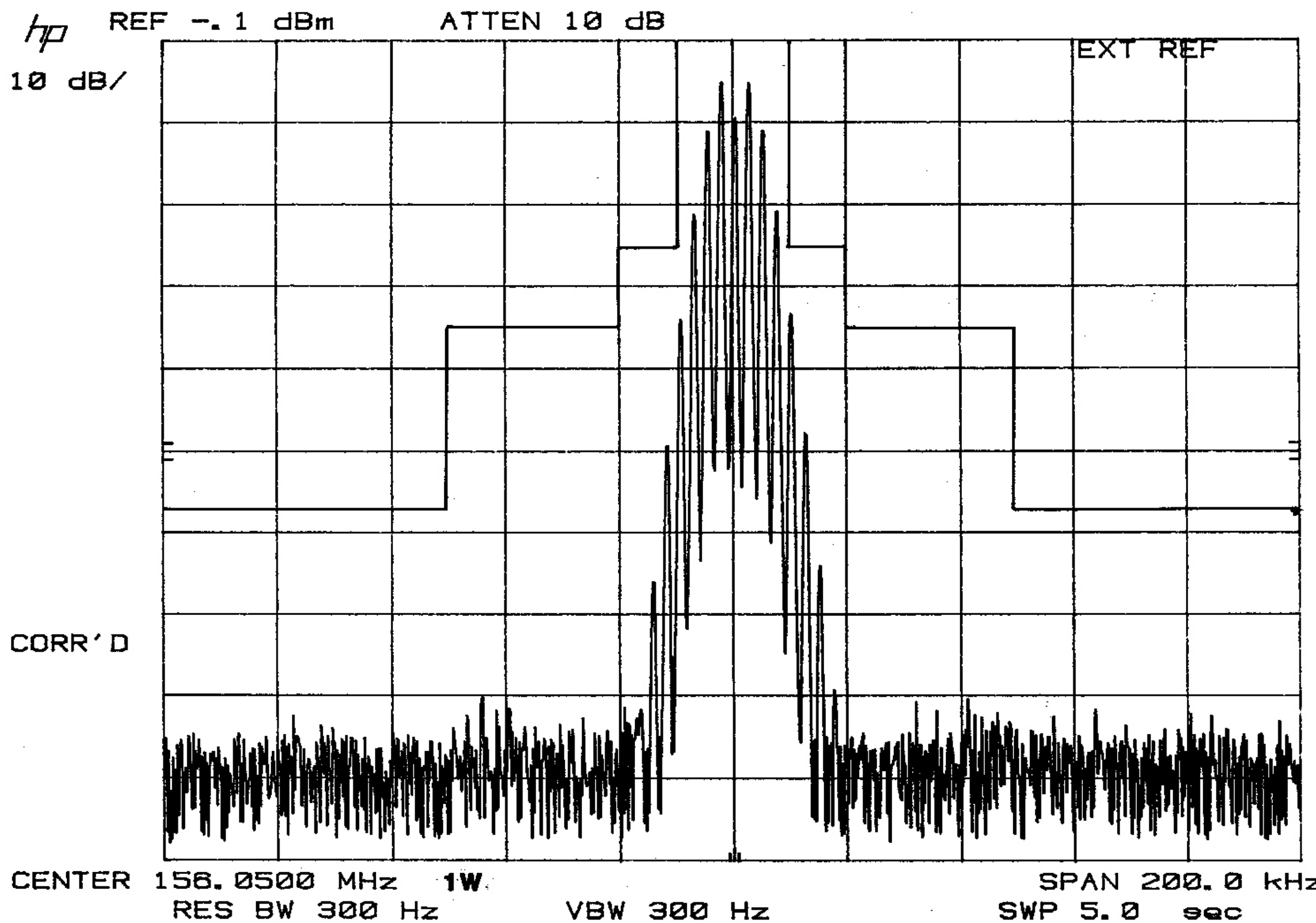


Figure 6.4 FCC PART 2.1049(c)(1)

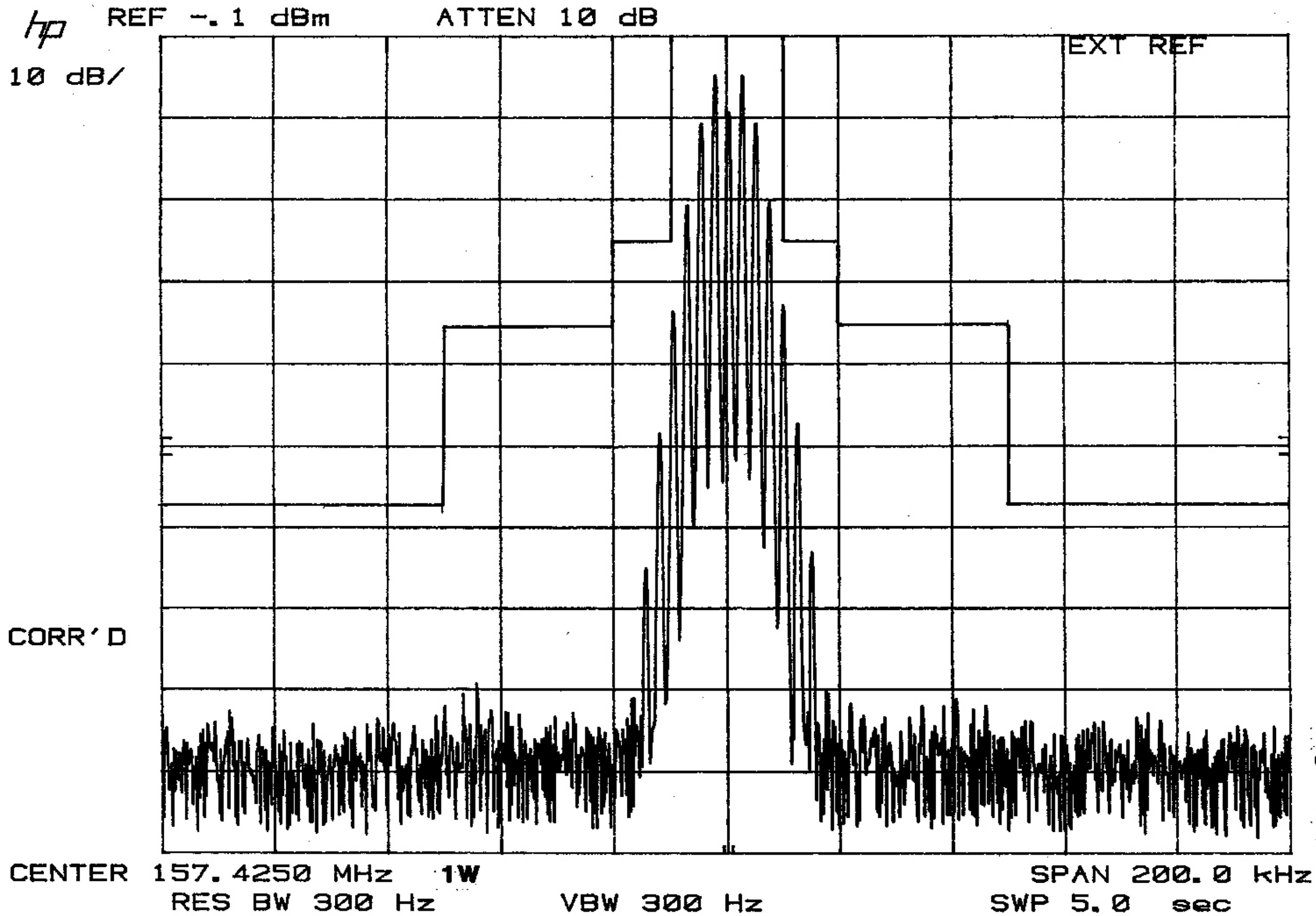


Figure 6.5 FCC PART 2.1049(c)(1)

EXHIBIT 6

OCCUPIED BANDWIDTH MEASUREMENT, Part 2.1049(c)(1)

APPLICABLE RULES:

Part 80.205(a): Authorized bandwidth 20 KHz for G3E emission with 5 KHz deviation.

Part 80.207(a): Authorizes the brief use of DSC signals (13K5G2B emission designator) in accordance with Part 80.225.

PROCEDURE:

The SEA 157 was set up as shown in Figure 6.1.

The internal DSC Controller was set up to generate a constant dot pattern of the type that initiates all DSC calls. This consists of an FSK signal with two tones at 1700 Hz $\underline{+}$400 Hz. The dot pattern is alternating MARK (1300 Hz) and SPACE (2099 Hz) tones generated at a 1200 baud rate. The DSC operates exclusively on these tones and at this baud rate. The SEA 157 produces a continuous phase bandpass filtered FSK signal.

The first test frequency selected was the DSC calling frequency of 156.525 MHz (Channel 70). The equipment was set to the test frequency and the 1 watt power output level was verified. The dot pattern was then initiated and the resulting emission measured. The emission spectrum plot is presented in Figure 6.6.

The second test frequency selected was 156.050 (Channel 01A). The equipment was set to the test frequency and the power output level of 25 watts was verified. The dot pattern was then initiated and the resulting emission measured. The emission spectrum plot is presented in Figure 6.7

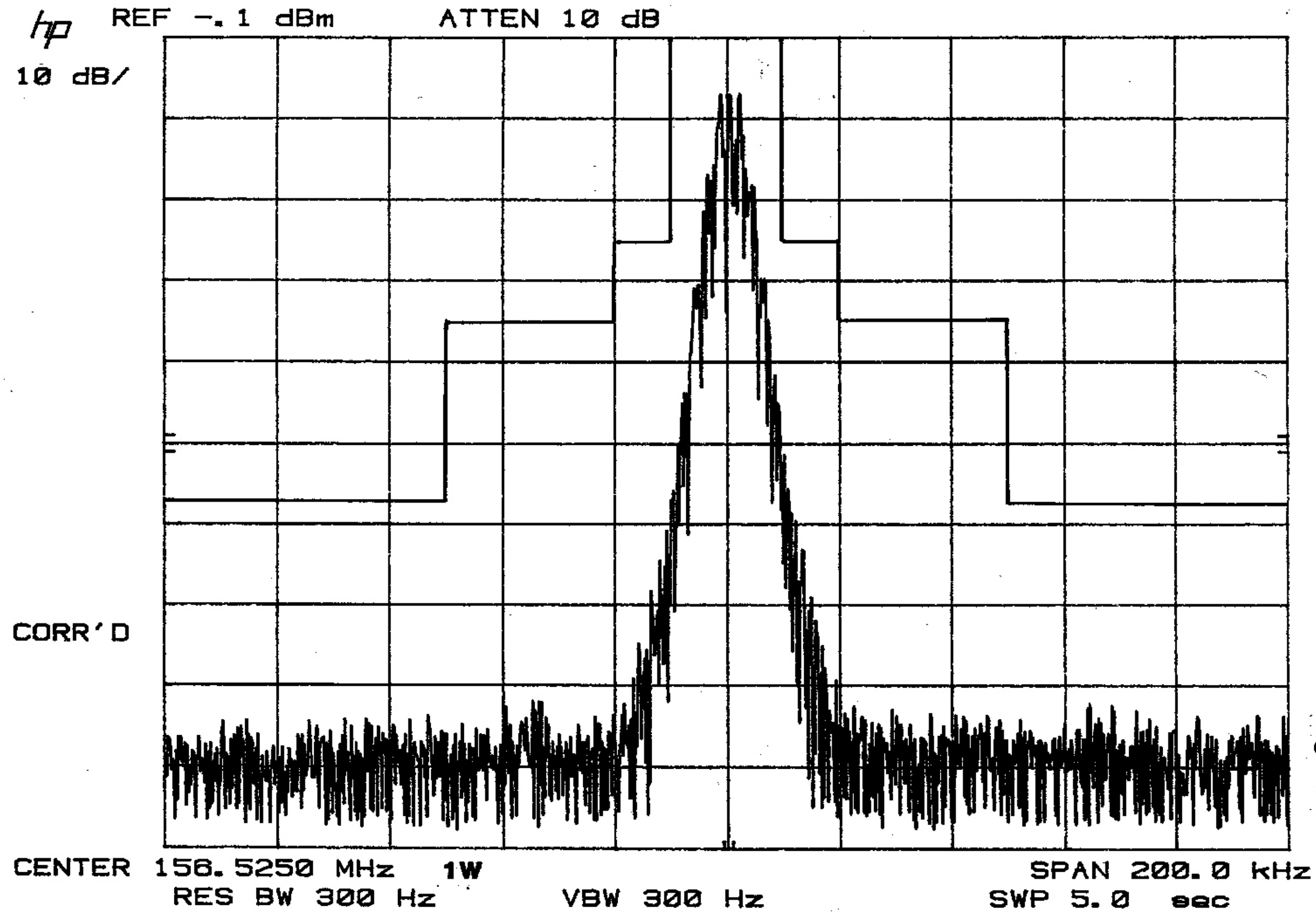


Figure 6.6

FCC PART 2.1049(c)(1)

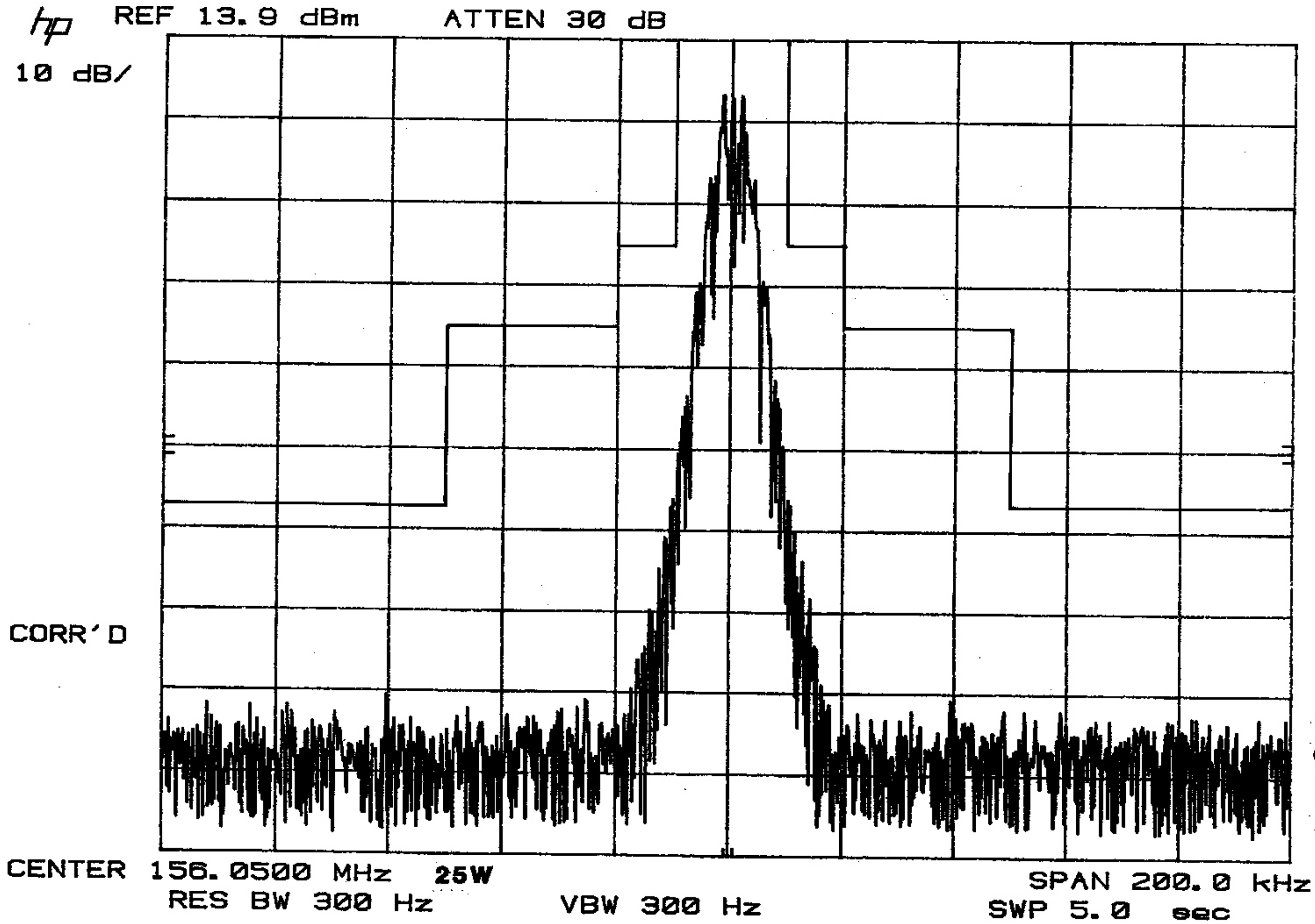


Figure 6.7 **FCC PART 2.1049(c)(1)**

EXHIBIT 7

SPURIOUS EMISSIONS AT ANTENNA TERMINALS, Part 2.1051

APPLICABLE RULES:

2.1057: Frequencies investigated should include from lowest radio frequency generated to 10th harmonic of carrier frequency, etc.

80.211(f)(3): Spurious emissions should be attenuated at least 43 + 10 log (mean power) dB.

PROCEDURE:

Please refer to Figure 7.1 for the test setup diagram.

Spurious emission tests were performed for two transmitter output frequencies, 156.05 MHz and 157.425 MHz, one each near the lower and upper frequency range of the transmitter. The transmitter was tuned up in accordance with the alignment procedure in the instruction manual. The transmitter dc power supply and modulation conditions were the same as those used for the Occupied Bandwidth Test, Exhibit 6. The in-line wattmeter was monitored to insure that the desired 25 watt or 1 watt carrier output level was maintained during spurious emission testing.

The frequency spectrum was carefully searched in accordance with Part 2.1057 from below the lowest radio frequency generated in the unit (21.850 MHz) to 1600 MHz, which is greater than ten times the highest frequency of the transmitter. This was done for each of the two transmitter fundamental output frequencies.

The spectrum investigation included but was not limited to the following list of frequencies:

Frequency	Description
21.850 MHz = fmo	Master carrier crystal oscillator.
2fmo, 3fmo, etc.	Harmonics of the above up to 70th.
2fo, 3fo, etc.	Harmonics of the desired channel frequency up to the 10th.
fo/2, fo/3, fo/4	Subharmonics of the desired channel.

NOTE: This transmitter uses NO multiplier stages.

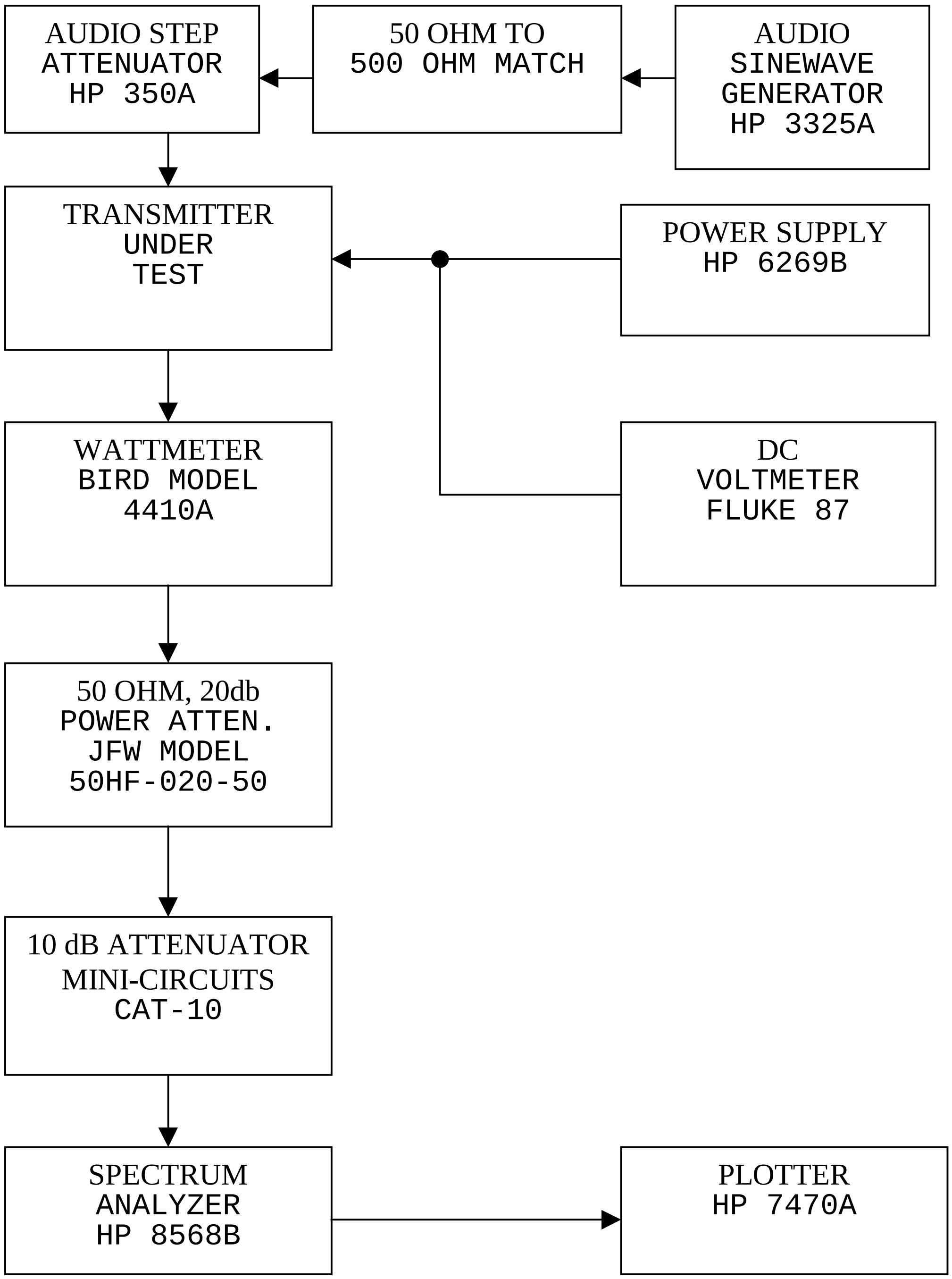
Four spectrum plots were generated; one for each of the four combinations of output frequency and power. The plots are wideband scans (0 to 1600 MHz) to give a indication of spurious outputs relative to the appropriate carrier mean power level. The reference level of the spectrum analyzer was set so that rated power, i.e., 44 dBm or 30 dBm as appropriate, was displayed at the very top of the plot at the carrier frequency. A red limit line is drawn on the plot at the maximum permitted spurious level of -13 dBm.

RESULTS:

Note that 43 + 10 log(25) = 57 dB and 25 watts = +44 dBm. The highest allowable spurious level is thus 44 - 57 = -13 dBm. This remains true for 1 watt carrier power: 43 + 10 log 1 = 43 dB and 1 watt = +30 dBm, therefore 30 - 43 = -13 dBm is the absolute maximum spurious level for either transmitter output power level.

See Figure 7.2 for the 156.050 MHz, 25 watt case.
See Figures 7.3 for the 157.425 MHz, 25 watt case.
See Figures 7.4 for the 156.050 MHz, 1 watt case.
See Figures 7.5 for the 157.425 MHz, 1 watt case.

FIGURE 7.1
TEST SETUP
SPURIOUS EMISSIONS AT
ANTENNA TERMINALS



FCC IDENTIFIER: BZ6SEA157

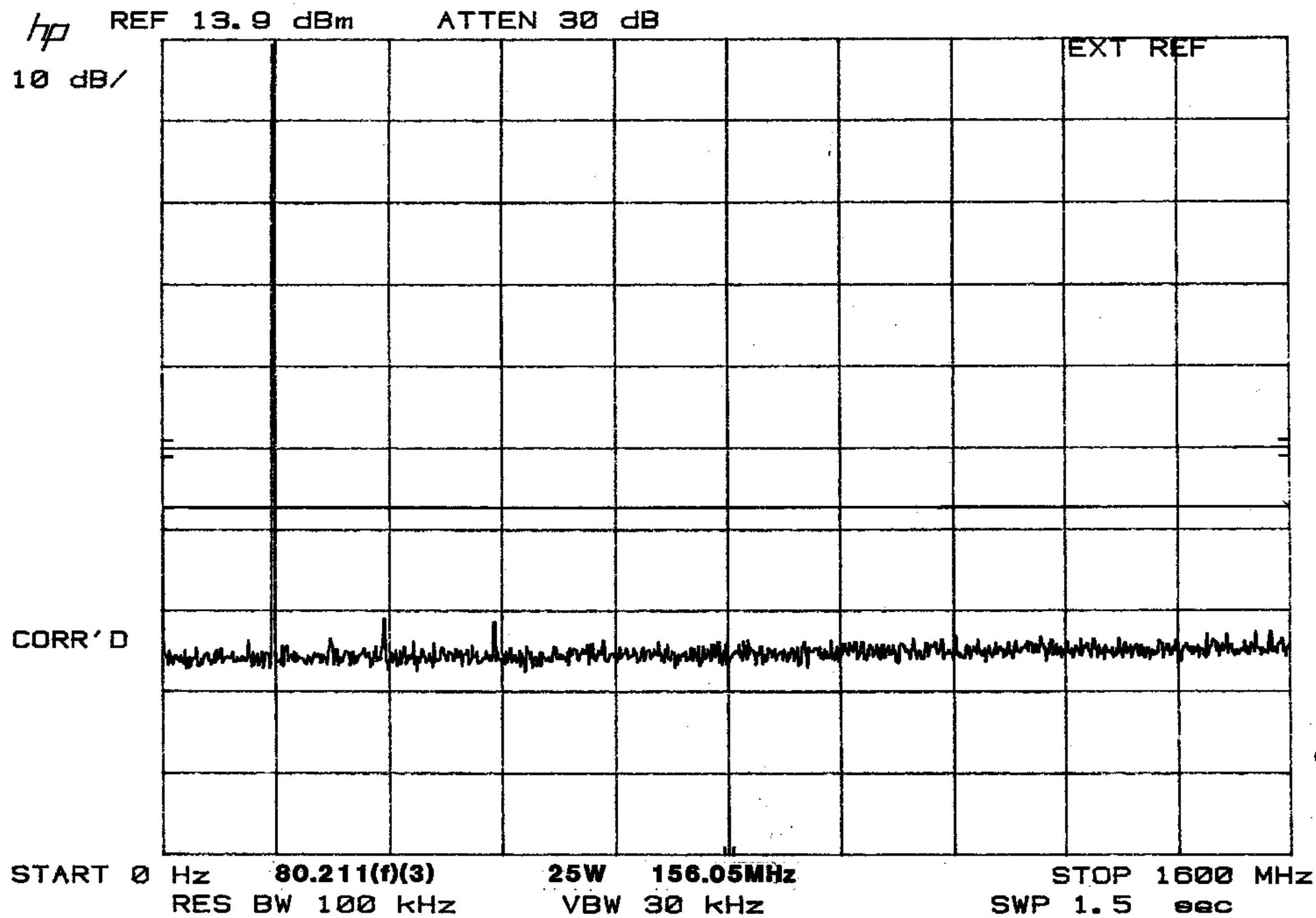


Figure 7.2

FCC PART 2.1057

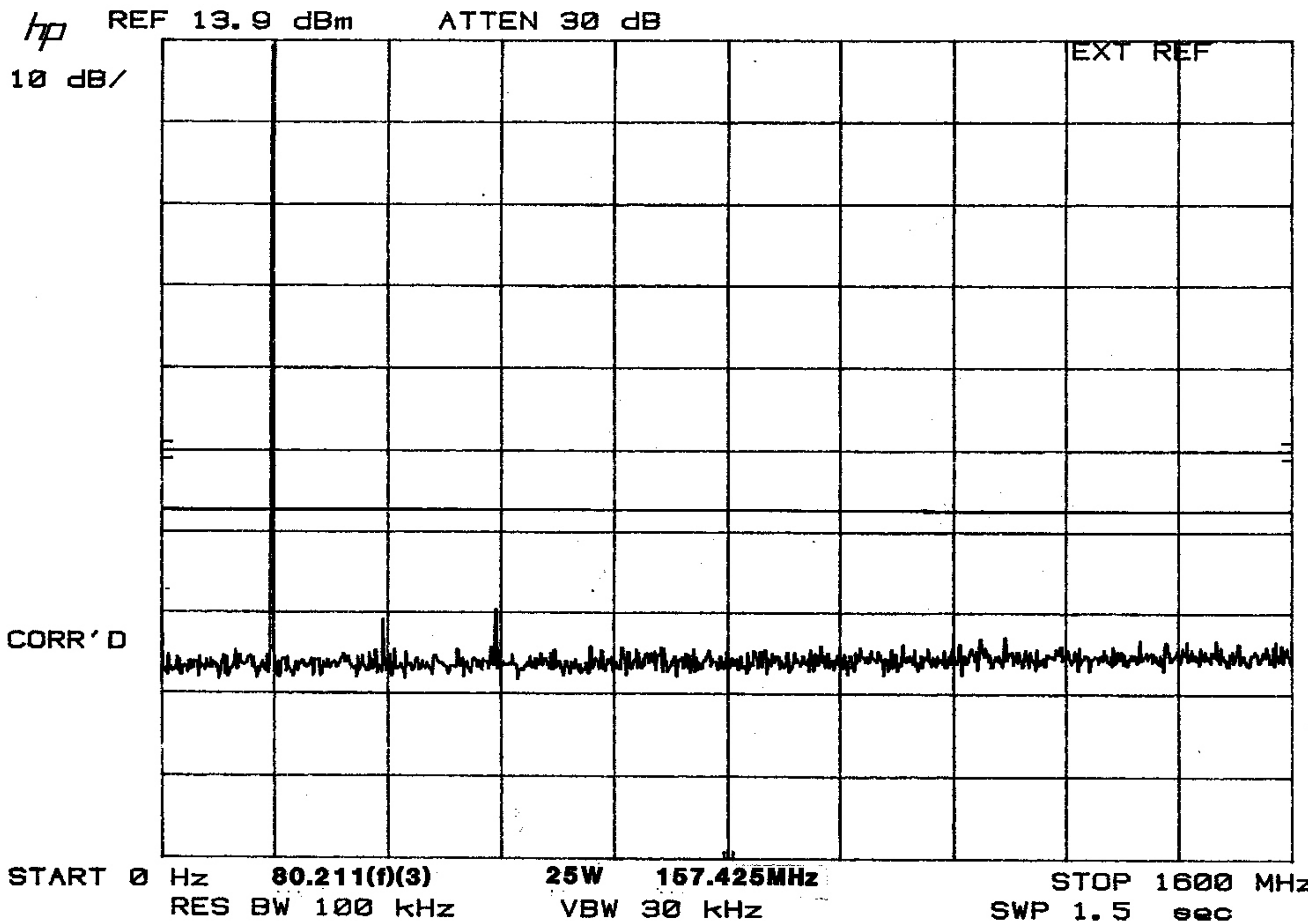


Figure 7.3

FCC PART 2.1057

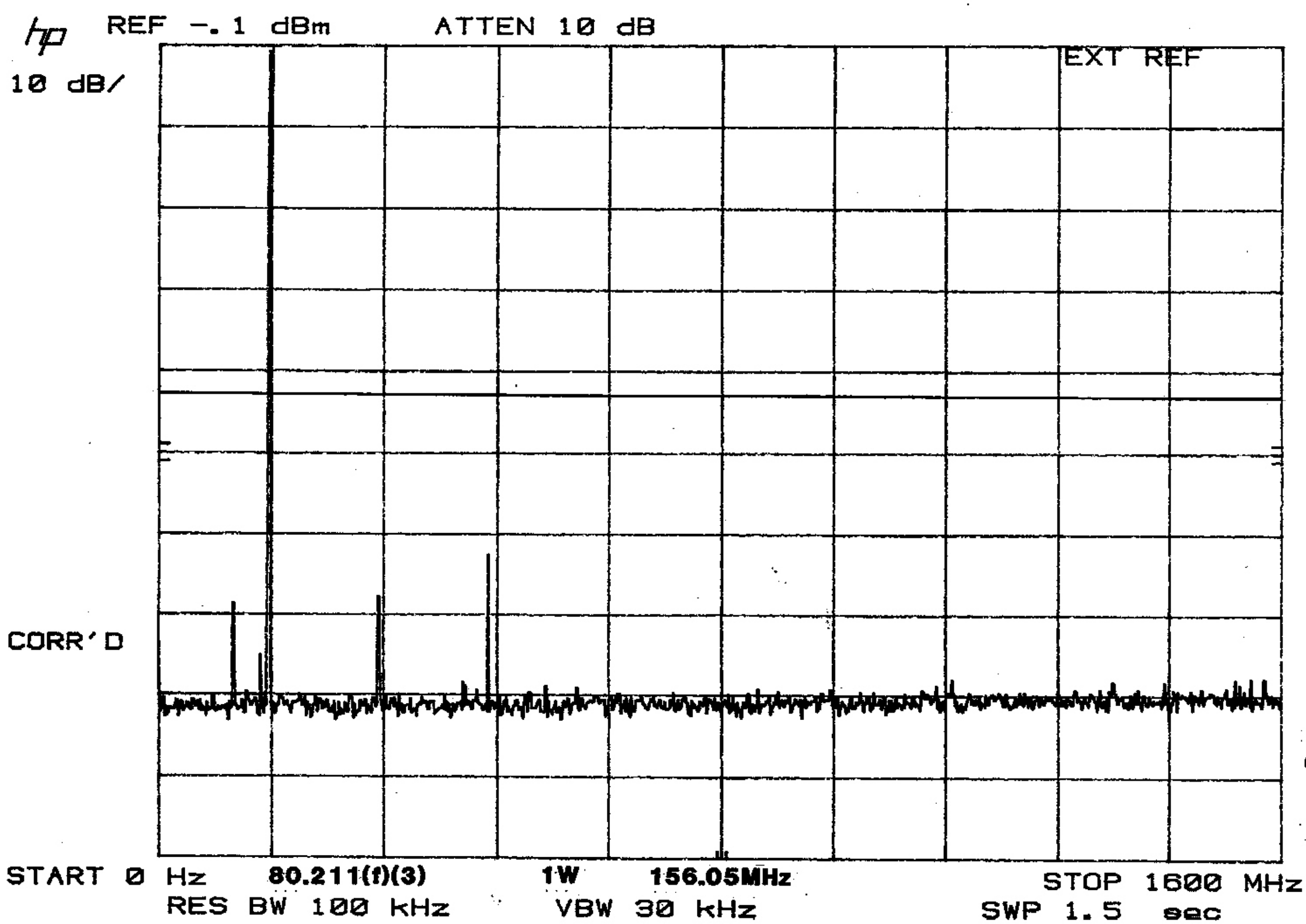


Figure 7.4

FCC PART 2.1057

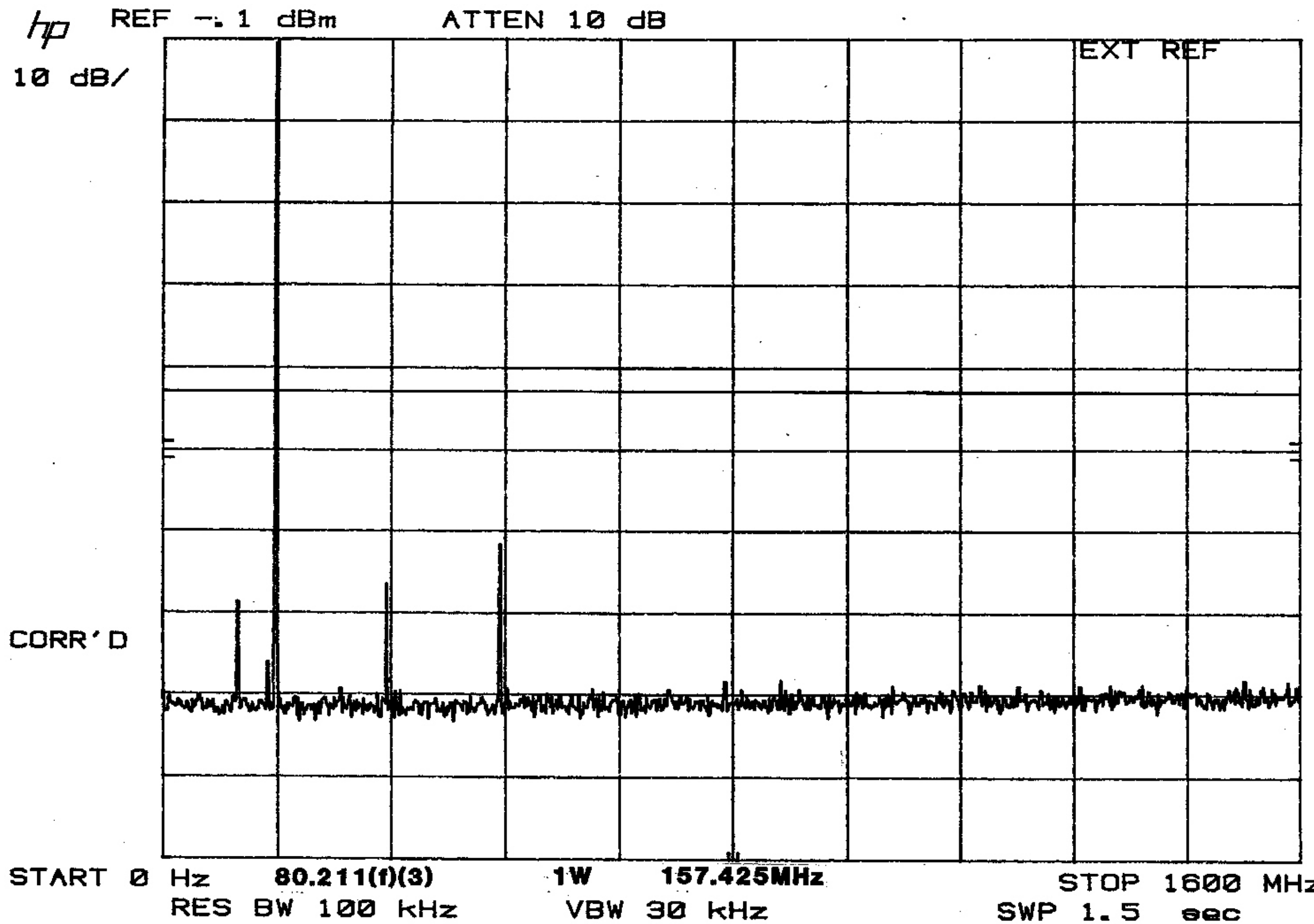


Figure 7.5

FCC PART 2.1057

EXHIBIT 8

FIELD STRENGTH OF SPURIOUS RADIATION, Part 2.1053(b)(2)

ALLOWABLE LIMIT, Per 80.211(f)

The attenuation referenced to amplitude P required on any frequency beyond 250 percent of the authorized bandwidth is 43 + 10 log(P), where P = the mean power in watts in the authorized band. For the maximum rated power for this service (25 watts or +44 dBm), this formula results in an absolute spurious power limit of -13 dBm. [10 log(25) = 14, + 43 = 57. Mean power (25 watts) = +44 dBm. +44 dBm - 57 dB = -13 dBm.]

FREQUENCY RANGE OF MEASUREMENTS, Part 2.1057:

Given that: (1) The spurious emissions tests of Exhibit 7 revealed no significant energy conducted to the antenna port below 20 MHz, (2) The device under test does not facilitate effective radiators for energy below 20 MHz (wavelength ≥15 m) and, (3) Measuring antennas are somewhat impractical for use below 20 MHz, the tester limited the search for spurious radiation to frequencies above 20 MHz. The test equipment used was capable of measurements up to 2000 MHz, which was the upper limit of the measurements made.

TEST PROCEDURE USED, Part 2.947(a)(2), 2.1041:

EIA/TIA SP-2218 Clause 2.2.12, (Similar to section 5 of EIA-152-B).

TEST EQUIPMENT LIST, 2.947(d):

See ACME site equipment list (Figure 8.6, Page 8-9).

MEASUREMENT PROCEDURE

General: Radiated spurious emissions are emissions from the equipment when transmitting into a non-radiating load on a frequency or frequencies which are outside a defined occupied bandwidth.

RADIATION TEST SITE INFORMATION: Please see Figure 8.4 (Page 8-7) for the radiation test site plan. Tests were performed at ACME Testing (Acme, WA) with the equipment inside of a 75-foot diameter (23m) non-metallic radome shelter. The site was on a level surface of uniform electrical characteristics, clear of metal objects and overhead wires. The site was situated in a rural area, largely free of undesired signals such as ignition noise and other transmitter emissions. The device under test (DUT) was placed on a 1 meter high platform resting on a turntable essentially flush with the groundplane. The platform was remotely controllable so the tester was able to search different radials about the device for undesired emissions. A conductive ground plane extended well beyond 3 meters away from both the DUT and the measuring antenna pole.

MEASURING ANTENNA INFORMATION: The measuring antenna in use was mounted to a non-conductive pole with a moveable horizontal boom. The boom permitted the tester to raise and lower the center of the measuring antenna from 1m to 4m above ground level. The pole was spaced such that the measuring antenna would be 3 meters from the DUT while the antenna was 1 meter above the groundplane. The measuring antenna feedline cable was laid horizontally with the boom back to the supporting mast where it continued downward to the spectrum analyzer positioned under the groundplane. A tabulation of attenuation versus frequency for the cables connected between the spectrum analyzer and the measuring antenna was prepared prior to testing. No reflecting objects were within 3 meters of either the DUT or the measuring antenna while measurements were made. Thee different antennas were used for searching each frequency band of spurious measurements (See test equipment list). Each antenna used was linearly polarized and correlated to an equivalent dipole.

EQUIPMENT INSTALLATION: Please see Figure 8.5 (Page 8-8) for the equipment test setup. The transmitter had been tuned up on the desired test frequency. A 50 watt, 50 ohm dummy load was connected directly to the RF output port of the transmitter. This combined equipment was placed on the platform and power was applied. The power cable was draped over the platform and extended to within 0.1 meter of the grounplane. The power supply used to power the transmitter rested at ground level on the turntable.

TEST FREQUENCIES: The search for radiated spurious emissions was conducted with the transmitter operating on the lowest standard operating frequency, the highest standard operating frequency and a mid-band frequency. These frequencies were:

Channel 1A(156.050 MHz)
Channel 88(157.425 MHz)
Channel 19(156.950 MHz)

TEST PROCEDURE: For each frequency band of spurious measurement, the appropriate measuring antenna was installed.

Testing for spurious emissions was performed at a distance of 3 meters. (At 3 meters, no spurious products were detectable in the range 20 to 156 MHz, so no 10 meter measurements were necessary.) For each spurious frequency of interest, the measuring antenna was raised and lowered on the mast to obtain a maximum reading on the spectrum analyzer with the measuring antenna horizontally polarized. The turntable was the rotated to obtain a maximum reading. Each maximum reading was recorded. This process was repeated with the measuring antenna vertically polarized. All levels were recorded in dBuV/m and then mathematically converted to the dipole equivalent ERP. The test site 3 meter field strength calibration is maintained on a regular basis by ACME Testing personnel in accordance with ANSI C63.4.

Frequencies investigated included but were not limited to the following:

Frequency	Description
43.7, 65.55 MHz, etc.	Harmonics of master crystal oscillator
2fo, 3fo, etc.	Harmonics of the desired channel frequency up to the 9th
fo/2, fo/3, etc.	Subharmonics of the desired channel

Sample calc: 3 x fo = 468.15 MHz (horiz. polarization):

Maximized S.A. reading was 79.1 dbuV/m. The dipole equivalent ERP limit is -13 dBm which converts to 84 dBuV/m max allowed if the 4.3 dB reflection-factor for 3 meter distance is included.

Spurious margin below allowed maximum is 84 - 79.1 = 4.9 dB The Dipole equivalent ERP = -13 dBm - 4.9 = -17.9 dBm. Note that this example was the worst case spurious signal found.

RESULTS:

Figures 8-1 through 8-3 (Pages 8-4 through 8-6) are the computer generated printouts of the spurious signals found at the ACME test site. Figure 8-1 illustrates the spurious signals generated at Channel 1A (156.050 MHz), Figure 8-2 illustrates similar data for Channel 19 (156.950 MHz) and Figure 8-3 illustrates similar data for Channel 88 (157.425 MHz).

PRODUCT EMISSIONS

FCC CFR47, PART 80, 80.211(f)   Data File: SEA 157, CH 1A, RAD SPURS, 4/5/00

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS dBuV/m	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB	COMMENTS
1	312.084	84.3	62.2	-22.1	PK	H	100	75	16.1	
2	468.146	84.3	54.9	-29.4	PK	H	133	120	20.2	
3	624.179	84.3	49.2	-35.1	PK	H	180	303	22.4	
4	780.230	84.3	47.7	-36.6	PK	H	142	316	24.8	
5	936.304	84.3	43.7	-40.6	PK	H	122	283	27.2	
6	1092.34	84.3	54.7	-29.6	PK	V	129	6	29.6	
7	1248.39	84.3	51.8	-32.5	PK	V	107	360	29.9	
8	1404.44	84.3	57.0	-27.3	PK	V	104	22	30.1	
9	1560.46	84.3	48.4	-35.9	PK	V	100	30	30.6	

Figure 8.1

FCC CFR47, PART 80, 80.211(f) Data File: SEA 157, CH 19 RAD SPURS, 4/5/00

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS dBuV/m	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB	COMMENTS
1	313.86	84.3	61.4	-22.9	PK	H	100	84	16.1	
2	470.834	84.3	58.5	-25.8	PK	H	101	110	20.3	
3	627.791	84.3	44.8	-39.5	PK	H	143	250	22.4	
4	784.736	84.3	48.5	-35.8	PK	H	131	316	24.8	
5	941.714	84.3	42.8	-41.5	PK	H	120	271	27.3	
6	1098.64	84.3	52.2	-32.2	PK	V	129	12	29.7	
7	1255.59	84.3	53.7	-30.6	PK	V	113	360	29.9	
8	1412.54	84.3	56.3	-28.0	PK	V	113	26	30.2	
9	1569.49	84.3	49.0	-35.3	PK	V	100	12	30.6	

Figure 8.2

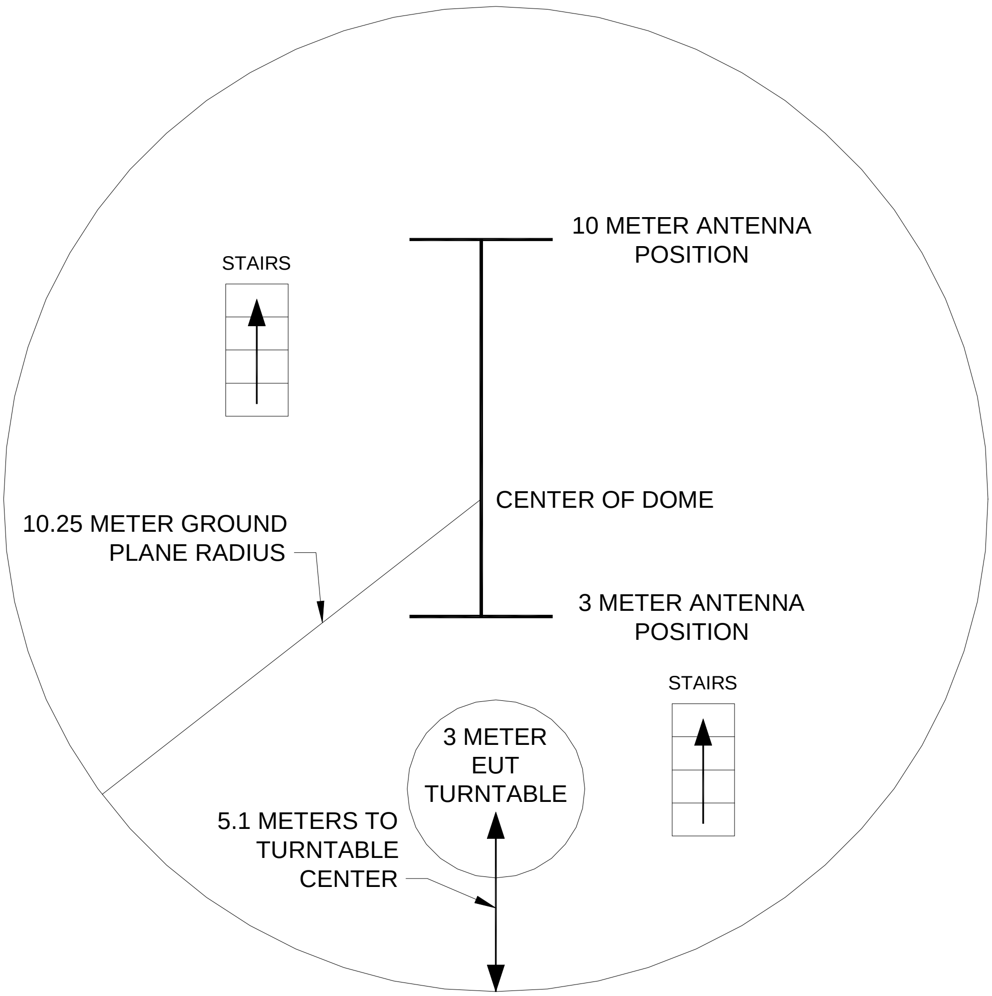
PRODUCT EMISSIONS

FCC CFR47, PART 80, 80.211(f)   Data File: SEA 157, CH 88, RAD SPURS, 4/5/00

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS dBuV/m	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB	COMMENTS
1	314.832	84.3	62.0	-22.3	PK	H	110	66	16.2	
2	472.262	84.3	58.1	-26.2	PK	H	100	122	20.3	
3	629.695	84.3	46.8	-37.5	PK	H	145	300	22.4	
4	787.114	84.3	47.3	-37.1	PK	H	140	320	24.9	
5	944.559	84.3	43.4	-40.9	PK	H	123	269	27.4	
6	1101.96	84.3	46.2	-38.1	PK	V	111	289	29.7	
7	1259.39	84.3	53.5	-30.8	PK	V	118	0	29.9	
8	1416.81	84.3	56.4	-27.9	PK	V	111	21	30.2	
9	1574.23	84.3	48.6	-35.8	PK	V	100	359	30.7	

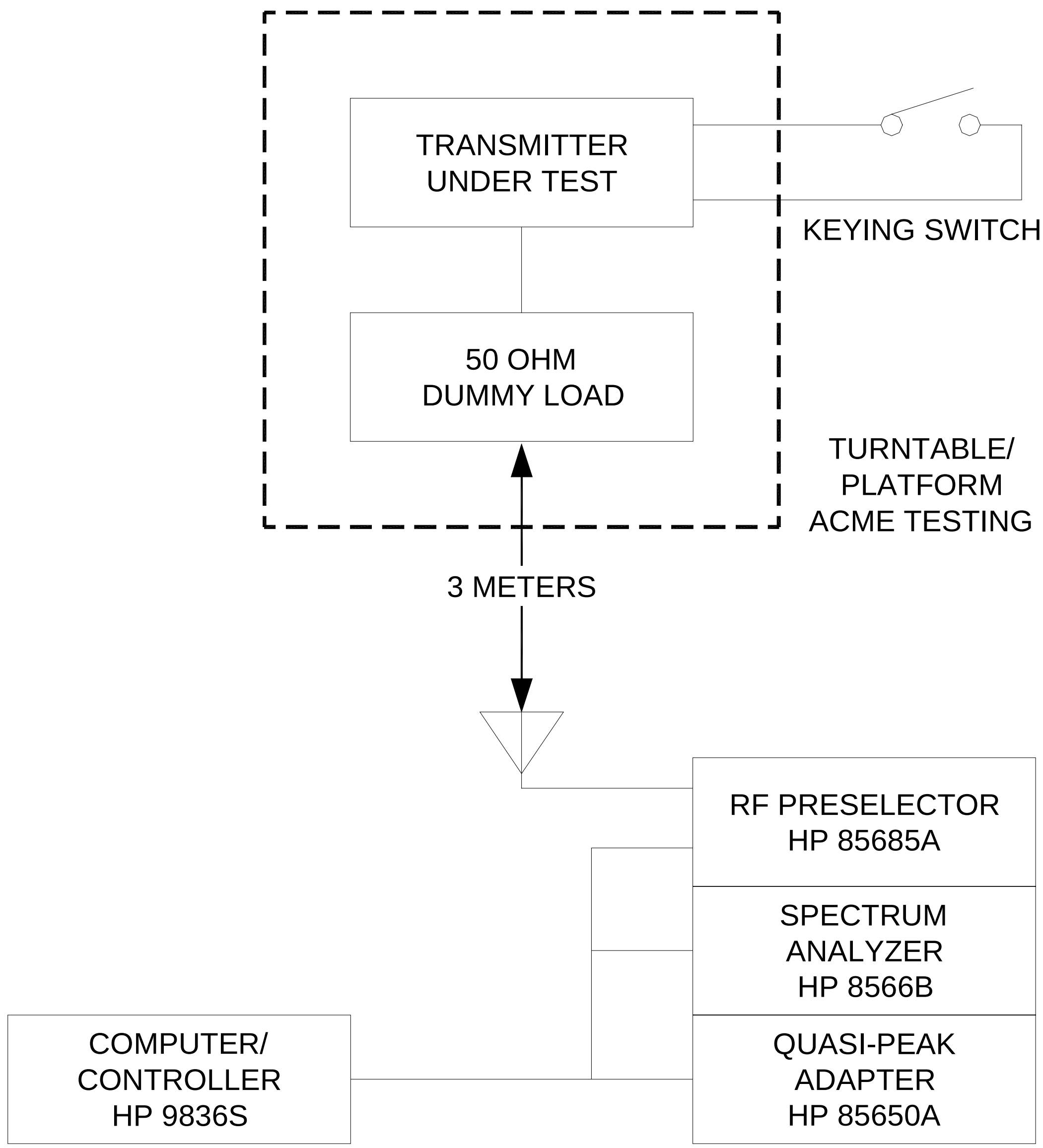
Figure 8.3

FIGURE 8.4
ACME SITE PLAN



FCC IDENTIFIER: BZ6SEA157

FIGURE 8.5
FIELD STRENGTH OF SPURIOUS
RADIATION FIELD TEST SETUP
2.1053



10 Meter Site Test Equipment

- ⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001
- ⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001
- ⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000
- ⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Serial Number ACMERS1, Calibrated: 1 September 1999, Calibration due Date: 01 September 2000
- ⇒ Broadband Biconical Antenna (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000
- ⇒ Broadband Log Periodic Antenna (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2853, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000
- ⇒ EUT Turntable Position Controller: EMCO 1061-3M, Serial Number 9003-1441, No Calibration Required
- ⇒ Antenna Mast with Controller: EMCO 1051, Serial Number 9002-1457, No Calibration Required
- ⇒ Double Ridge Guide Horn Antenna: EMCO 3115, Serial Number 9807-5534, Calibrated: 30 December 1999, Calibration due Date: 30 December 2000

Figure 8.6

EXHIBIT 9

FREQUENCY STABILITY MEASUREMENTS, Part 2.1055

GENERAL:

All frequency stability measurements in this exhibit were performed at a channel frequency fo = 157.000 MHz. No external modulation was applied to the transmitter. Although it was not shown in the test setup diagrams, the HP105A laboratory frequency standard was connected to the frequency counter for all frequency measurements.

FREQUENCY STABILITY VS. TEMPERATURE, Part 2.1055(a)(b)

APPLICABLE RULE:

Part 80.209(a): Frequency tolerance: Coast stations, 3 to 100 watts, 5 ppm; ship stations 10 ppm.

PROCEDURE:

The transmitter was enclosed in the environmental chamber. It was connected to and monitored by the equipment shown in the test setup diagram, Figure 9.1. The chamber was then lowered to -30 degrees C and sufficient time was allowed for the temperature to stabilize. The transmitter was keyed and its output frequency was recorded. The frequency was monitored for a period of time sufficient to observe any significant frequency change due to keying. The thermistor heating device power does not cycle on and off. The procedure was repeated in 10 degree C increments up to and including +55 degrees C. Both the thermometer and the thermocouple temperature sensing equipment indicated the desired temperature within 2 degrees C during all measurements.

RESULTS:

A plot of frequency versus temperature is presented in Figure 9.3 along with 5 ppm limit lines. There were no noticeable effects on the frequency due to keying. Note that the frequency stability is well within the allowable limits and that the plot produces the classic upside down "lazy S" curve.

FREQUENCY STABILITY VS. ELAPSED TIME AFTER PRIMARY VOLTAGE APPLICATION, Part 2.1055(c)

PROCEDURE:

The transmitter and associated test equipment were set up as shown in Figure 9.1. Primary power to the transmitter was removed. Chamber temperature was lowered to -20 degrees C and sufficient time was allowed for the temperature to stabilize. Primary power was applied to the transmitter. The transmitter was keyed and frequency measurements made every 30 seconds after power application until sufficient measurements were obtained to indicate clearly that the frequency had stabilized within the allowable tolerance. The procedure was repeated at 0 degrees C and +30 degrees C. The chamber temperature was maintained within 2 degrees C of the desired test temperature during all measurements.

RESULTS:

Please see Figures 9.4, 9.5, and 9.6 which are plots of frequency vs. time for -20 degrees C, 0 degrees C and +30 degrees C, respectively. Limit lines at 5 ppm are shown for convenience. Based on the above measurements, the worst case time for the frequency to stabilize within the applicable tolerance is specified in the instruction manual supplied to the user.

FREQ. STABILITY VS. PRIMARY SUPPLY VOLTAGE, Part 2.1055(d)

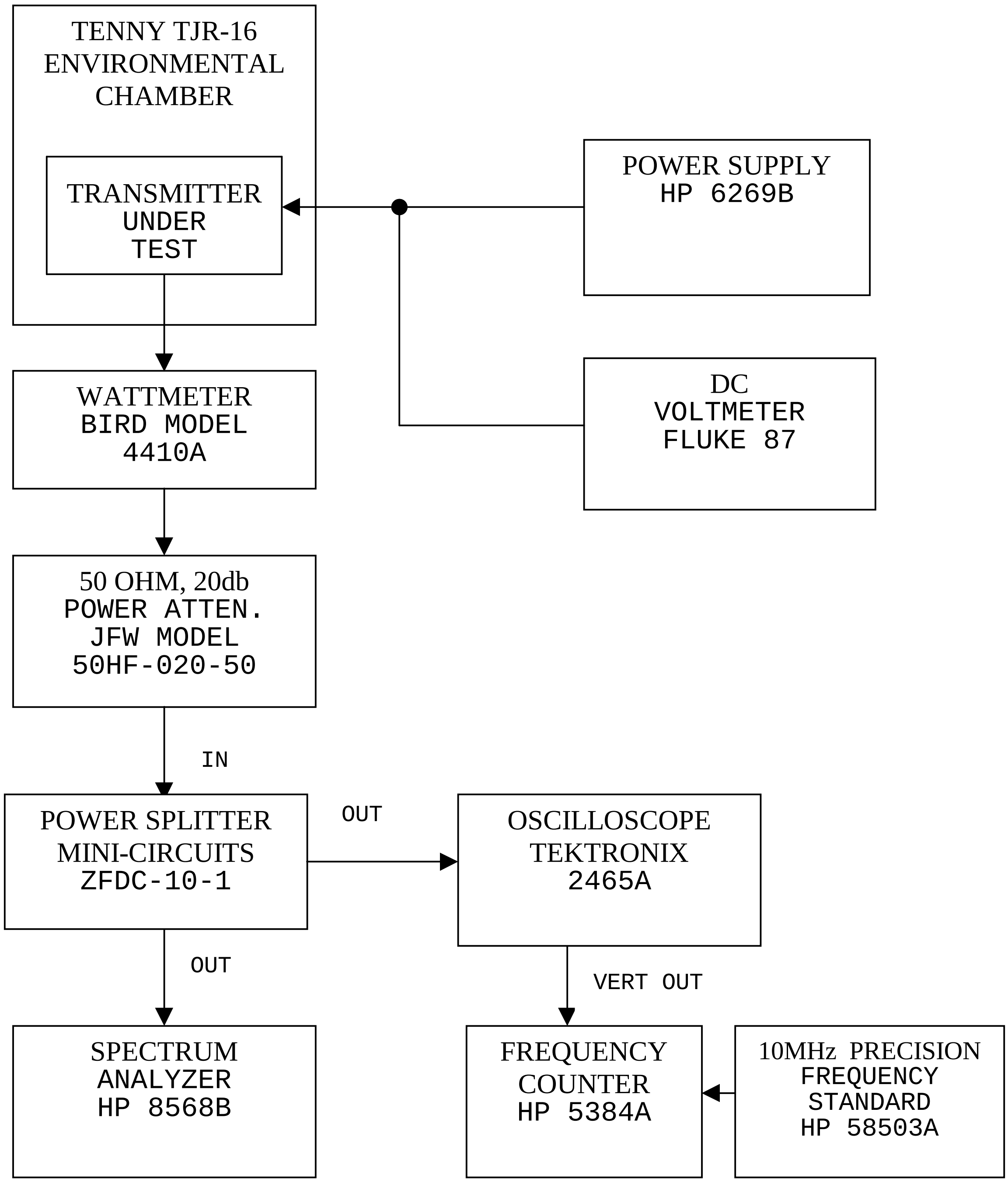
PROCEDURE:

The transmitter and associated test equipment were setup as shown in Figure 9.2. The power cable normally supplied with the equipment was connected between the power supply and the transmitter. The power supply was set to 100% of the nominal supply voltage, the transmitter was keyed and the frequency recorded. The primary supply voltage was then varied from 85% to 115% of the nominal supply voltage in 5% increments. The time required for the transmitter frequency to stabilize after setting the power supply to each new voltage was negligible.

RESULTS:

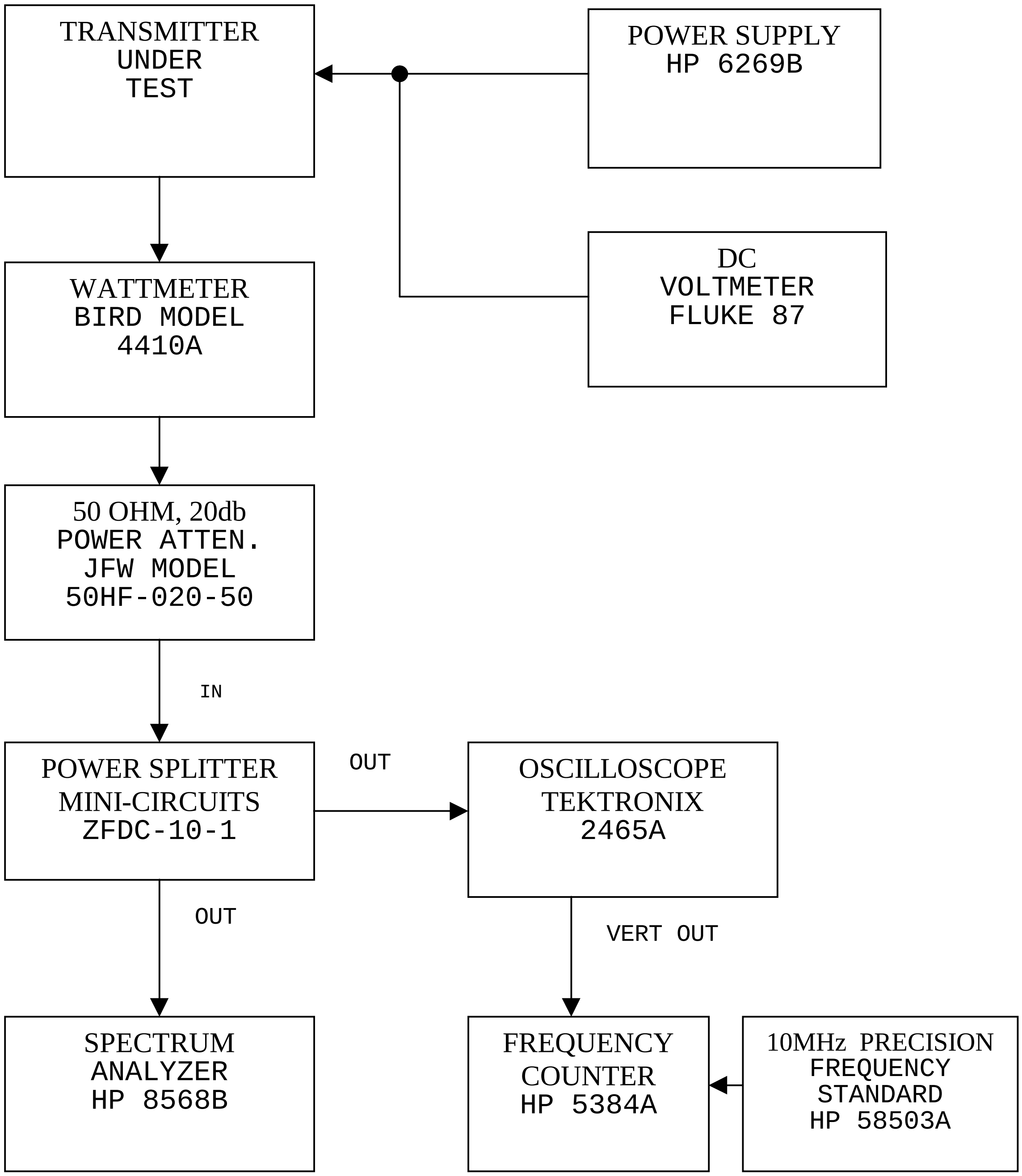
Please refer to Figure 9.7 for the plot of frequency versus voltage. There were no noticeable effects on the frequency due to keying and unkeying the transmitter or due to heating element cycling. (The crystal heating element thermistor does not cycle.)

FIGURE 9.1
TEST SETUP
FREQUENCY STABILITY VERSUS
TEMPERATURE AND TIME
80.209(a)



FCC IDENTIFIER: BZ6SEA157

FIGURE 9.2
TEST SETUP
FREQUENCY STABILITY VERSUS
PRIMARY SUPPLY VOLTAGE
2.1055(d)



FCC IDENTIFIER: BZ6SEA157

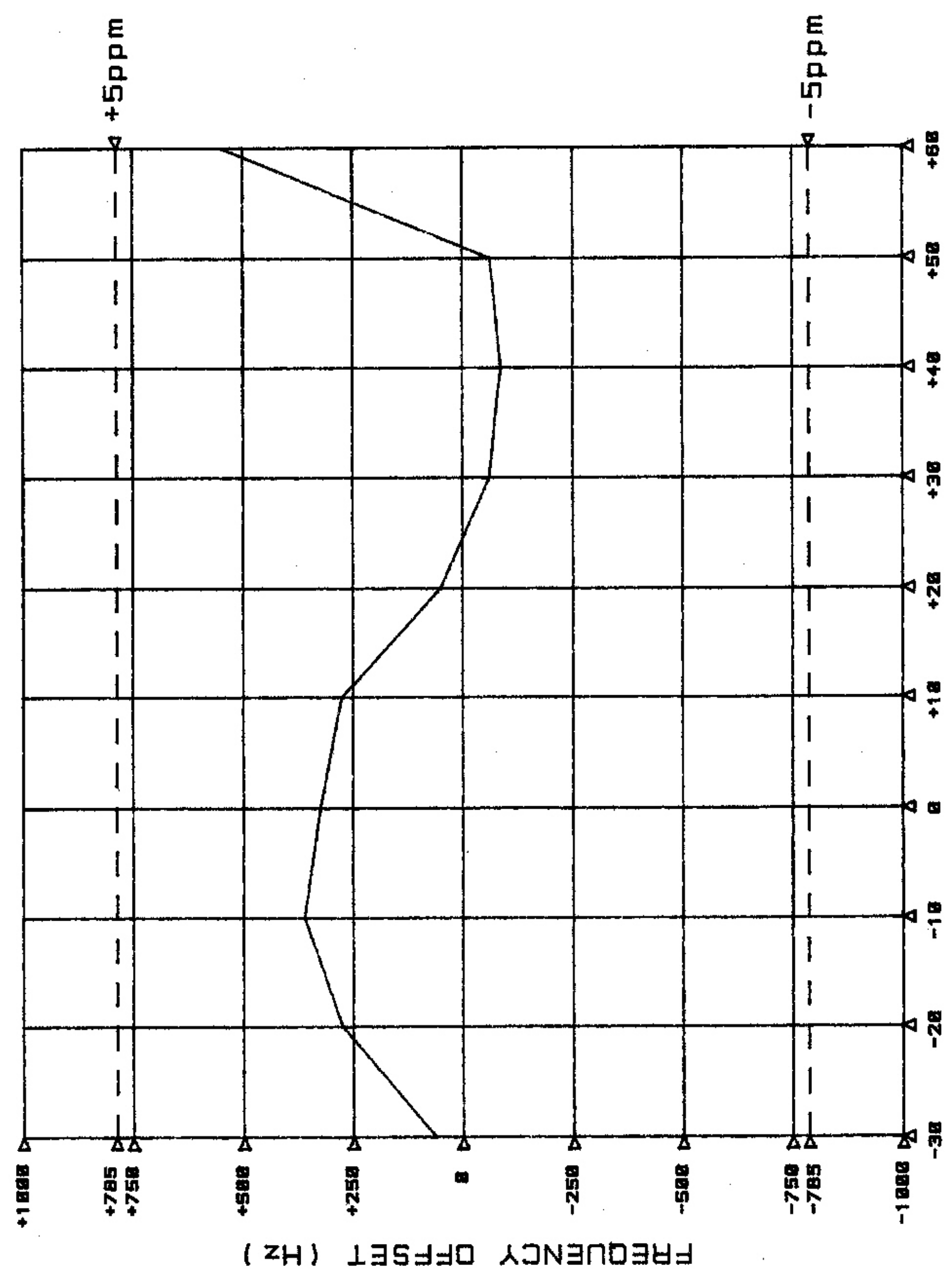


FIGURE 9.3 FREQUENCY STABILITY VERSUS TEMPERATURE

Fo = 157.000MHz

(2.1055) 80.209(a)

FCC IDENTIFIER: BZ6SEA157

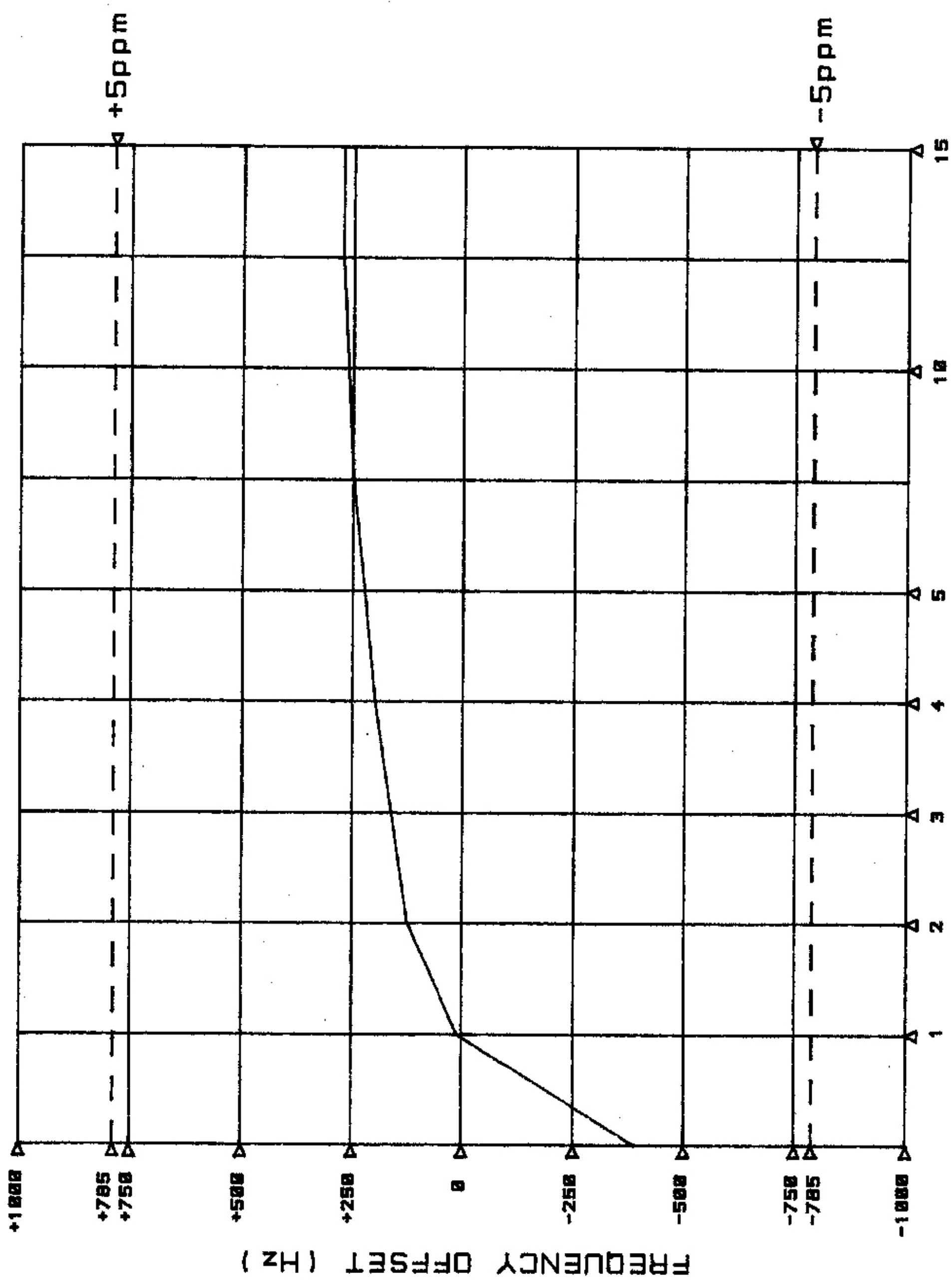


FIGURE 9.4
2.1055(c)

FREQUENCY STABILITY VERSUS TIME (MINUTES)
AT -20 DEGREES C
Fo = 157.000MHz

FCC IDENTIFIER: BZ6SEA157

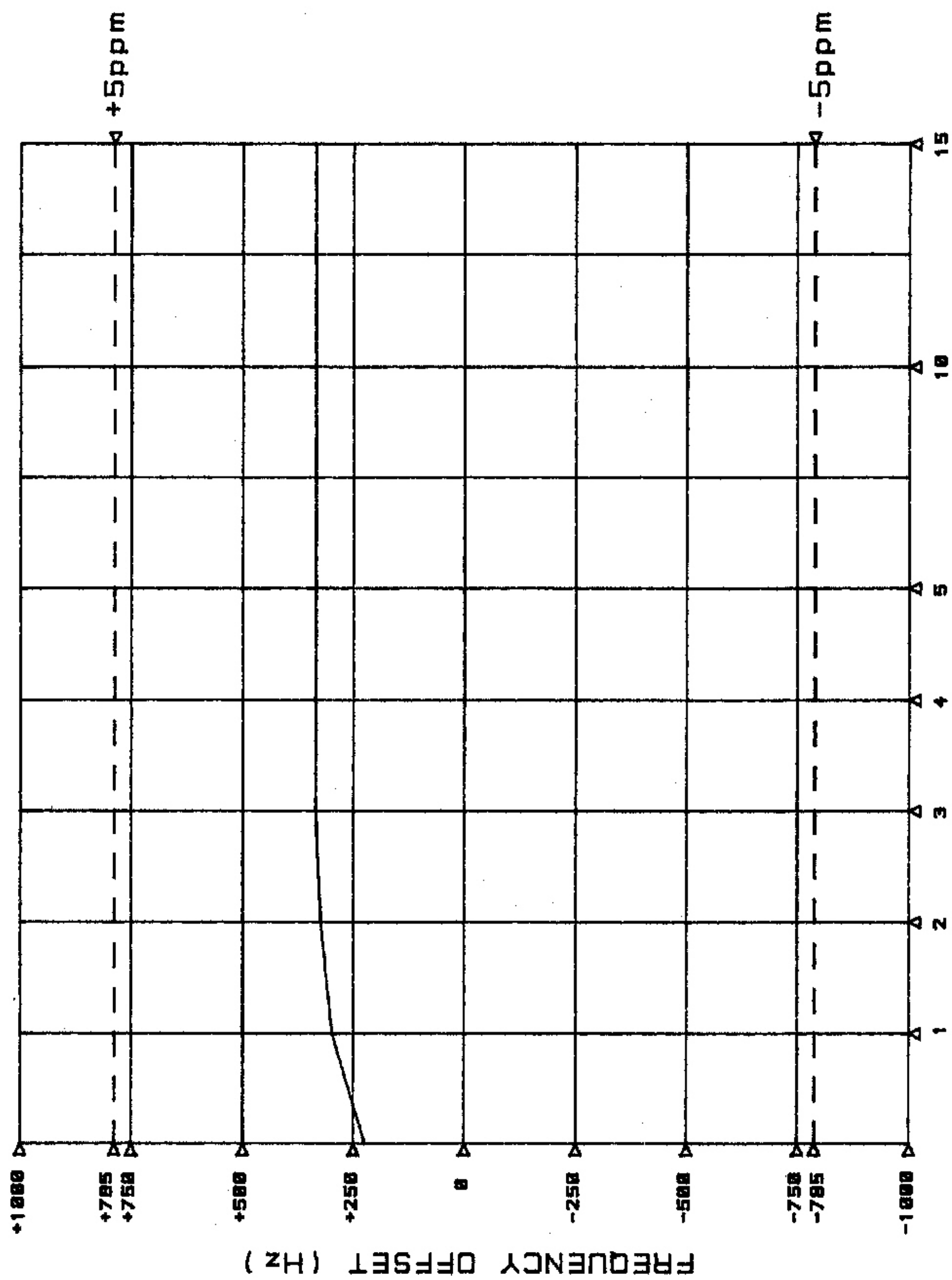


FIGURE 9.5 2.1055(c)

FREQUENCY STABILITY VERSUS TIME (MINUTES)
AT Ø DEGREES C
Fo = 157.000MHz

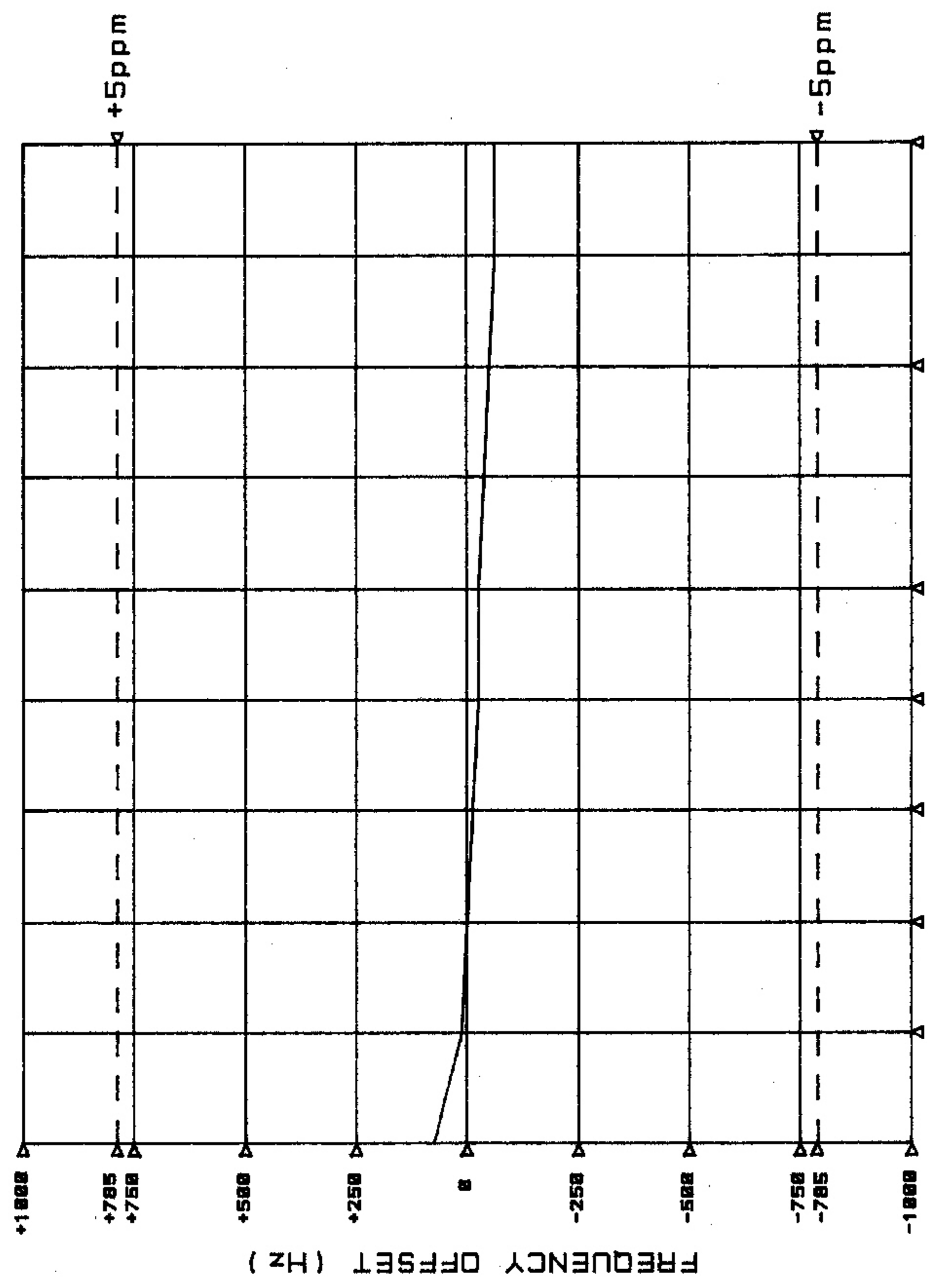


FIGURE 9.6 2.1055(c)

FREQUENCY STABILITY VERSUS TIME (MINUTES)
AT +30 DEGREES C
Fo = 157.000MHz

FCC IDENTIFIER: BZ6SEA157

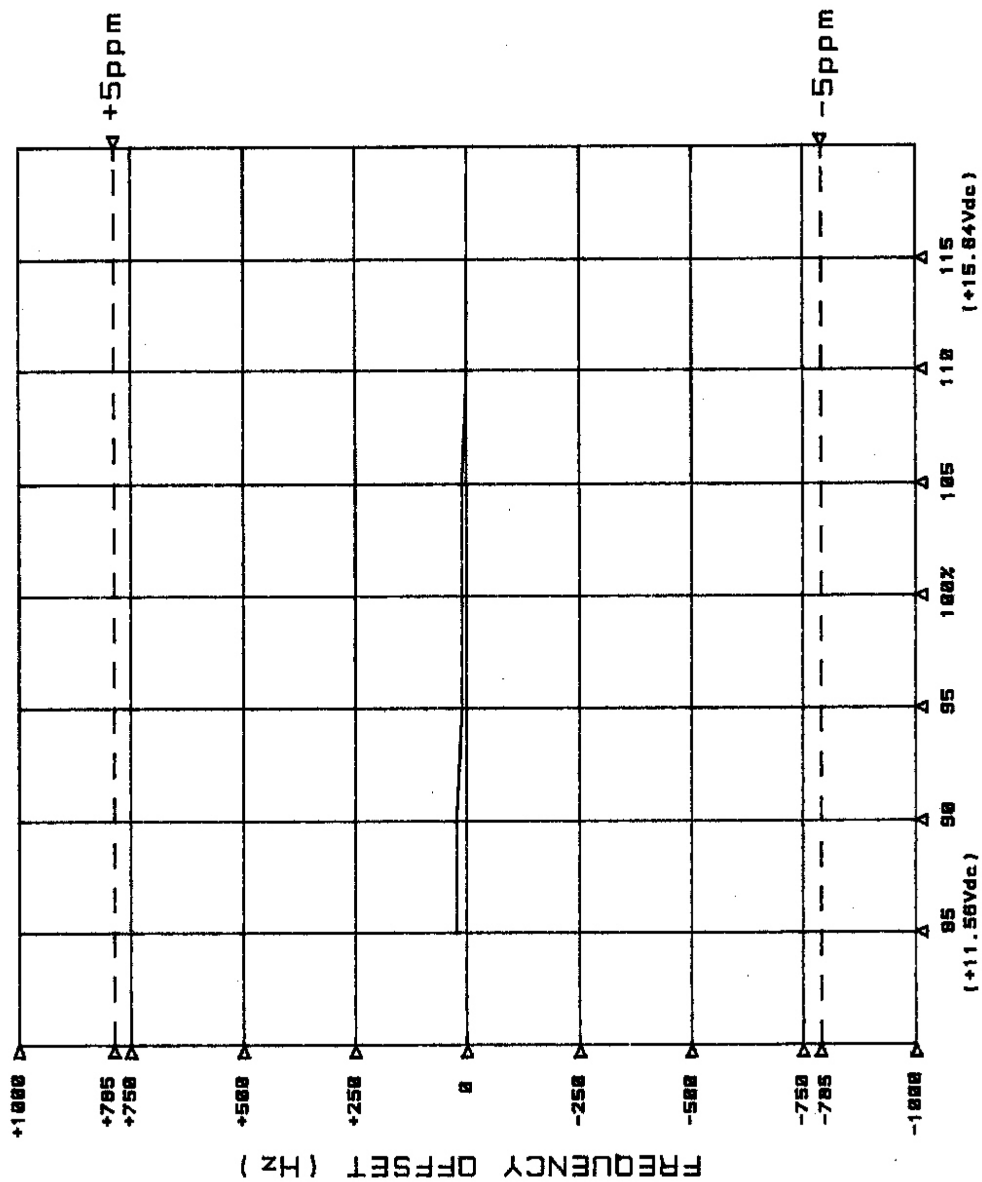


FIGURE 9.7 FREQUENCY STABILITY VERSUS PRIMARY SUPPLY VOLTAGE (% OF NOMINAL +13.6Vdc)

2.1055(d) Fo = 157.000MHz

EXHIBIT 10

EQUIPMENT PHOTGRAPHS, Part 2.1033(c)(12)

Four photographs, Figures 10.1 through 10.4, follow this page. They constitute front and rear views of the complete radiotelephone and front and rear views of the Mainboard Assembly (FAB-0157-01) on which all of the radiotelephone circuitry is installed.

Note: Photographs are provided in two separate attachments for internal and external photos.

EXHIBIT 11

RECEIVER DATA AND MEASUREMENTS

Note: Please see page 11-3 for additional discussion of the requirements of Part 80.874.

RECEIVER SENSITIVITY, Parts 80.874(b), 80.913(d), 80.961(b)

PROCEDURE:

Please refer to Figure 11.1 for the test setup. The receiver antenna terminals were driven by a frequency modulated signal generator. Its speaker output terminals were connected to a 4 ohm resistive load and to an audio distortion analyzer for measuring SINAD. In each of the following three methods, the receiver was tested on five frequencies, representing the bottom end, channels 6, 13, 16 and a frequency near the top end of the frequency range.

Three measurement methods were used. The first used the method prescribed by EIA RS-204 for determining "reference sensitivity". In this method the signal generator is modulated with a 1 kHz sinusoidal tone at 60% modulation, i.e., 3 kHz peak frequency deviation. Its output amplitude is set so that both 12 dB SINAD and at least 50% rated audio output power (2 watts for the SEA 157) is obtained simultaneously. The volume control was set near maximum for this test.

The second measurement method is taken from the description in 80.913(f). The signal generator was modulated with a 400 Hz tone to 30%, i.e., 1.5 kHz peak deviation. A six dB signal-to-noise (S/N) is required. It is reasonable to expect the audio output harmonic distortion to be less than the noise at this weak signal level, so it is assumed that SINAD = (S+N)/N = S/N + 1. Converting to dB, 6 dB S/N is equivalent to 7 dB SINAD. The signal amplitude was therefore adjusted for 7 dB SINAD to make the measurement.

The third measurement method is based on the requirement to measure 20 dB signal-to-noise sensitivity in 80.961(b). Here a 1000 Hertz tone modulated to 60% was used. The decibel difference between SINAD and S/N is negligible at 20 dB SINAD so the RF generator amplitude was adjusted to produce 20 dB SINAD.

RESULTS:

Please refer to the table below. The allowable limit is the last entry in each column.

SENSITIVITY, MICROVOLTS

Frequency	Method 1	Method 2	Method 3
156.050 MHz	.29	.25	.45
156.300 MHz	.29	.24	.41
156.650 MHz	.28	.23	.40
156.800 MHz	.28	.23	.40
162.025 MHz	.26	.21	.38
Limit	.50	1.00	2.00

SUPPRESSION OF INTERFERENCE ABOARD SHIPS, Part 80.217

PROCEDURE:

Part 80.217(b) specifies maximum power versus frequency that receivers required by statute or treaty may deliver into an artificial antenna. In this case, the artificial antenna consists of the 50 ohm resistive input impedance of a laboratory spectrum analyzer.

The receiver was operated on two frequencies, 156.05 MHz and 163.275 MHz, representing the upper and lower range of the receiver. The respective local oscillator frequencies for these two receiving frequencies were 201.05 MHz and 208.275 MHz. The receiver antenna terminals were connected to the 50 ohm input port of the spectrum analyzer.

On each receiver frequency, the spectrum analyzer was tuned slowly across the spectrum from 50 kHz to 1000 MHz using a 100 kHz resolution bandwidth to assure the noise floor would be well below the signal levels specified by the second chart in 80.217(b). The power of each spurious receiver output was checked.

RESULTS:

All spurious receiver signals were well below 400 microwatts which is equivalent to -4 dBm. The strongest output occurred at the receiver local oscillator frequencies at approximately -62 dBm.

EXPOSITORY STATEMENTS REGARDING PART 80.874

Reception of G3E emissions, Part 80.874(a): The SEA 157 receiver receives G3E and G2B emissions. This capability is evidenced by the signal generator modulation used in the sensitivity test reported earlier in this exhibit. The channels required by 80.871(d) can be found in the channel charts in the preliminary instruction/service manual. The receiver is designed to be used with typical vertically polarized antennas matched to 50-ohm unbalanced coaxial antenna lead-in cable.

Receiver sensitivity, Part 80.874(b): Please see the results of the Method 1 sensitivity measurements presented earlier in this exhibit. Since no specific measurement method is specified by this rule, it is assumed that the well known sensitivity measurement method specified in EIA RS-204C is suitable.

Audio output power, Part 80.874(c): The EIA RS-204(c) sensitivity measurement method used in Method 1 of the earlier presented Sensitivity Measurements, requires audio output of at least 50% of rated audio power or two watts for the SEA 157. This serves to demonstrate a reasonable audio output capability. The SEA 157 internal speaker is rated for at least two watts and the external speaker wiring can provide four watts to an external four ohm speaker.

Audio muting, Part 80.874(d): The SEA 157 receiver audio is automatically muted during transmission. Please refer to the Reciever Schematic Diagram and the Mainboard Schematic Diagram in the preliminary instruction/service manual. Note that receiver audio from the demodulator integrated circuit U1 is routed to the mainboard audio power amplifier through the CODEC, U6. The CODEC acts as a sophisticated audio processor under control of the microprocessor U5. During transmission intervals, the CODEC is programmed to mute the receiver audio.

FIGURE 11.1
TEST SETUP
RECEIVER SENSITIVITY AND LEAKAGE
FCC PARTS 80.874, 80.217

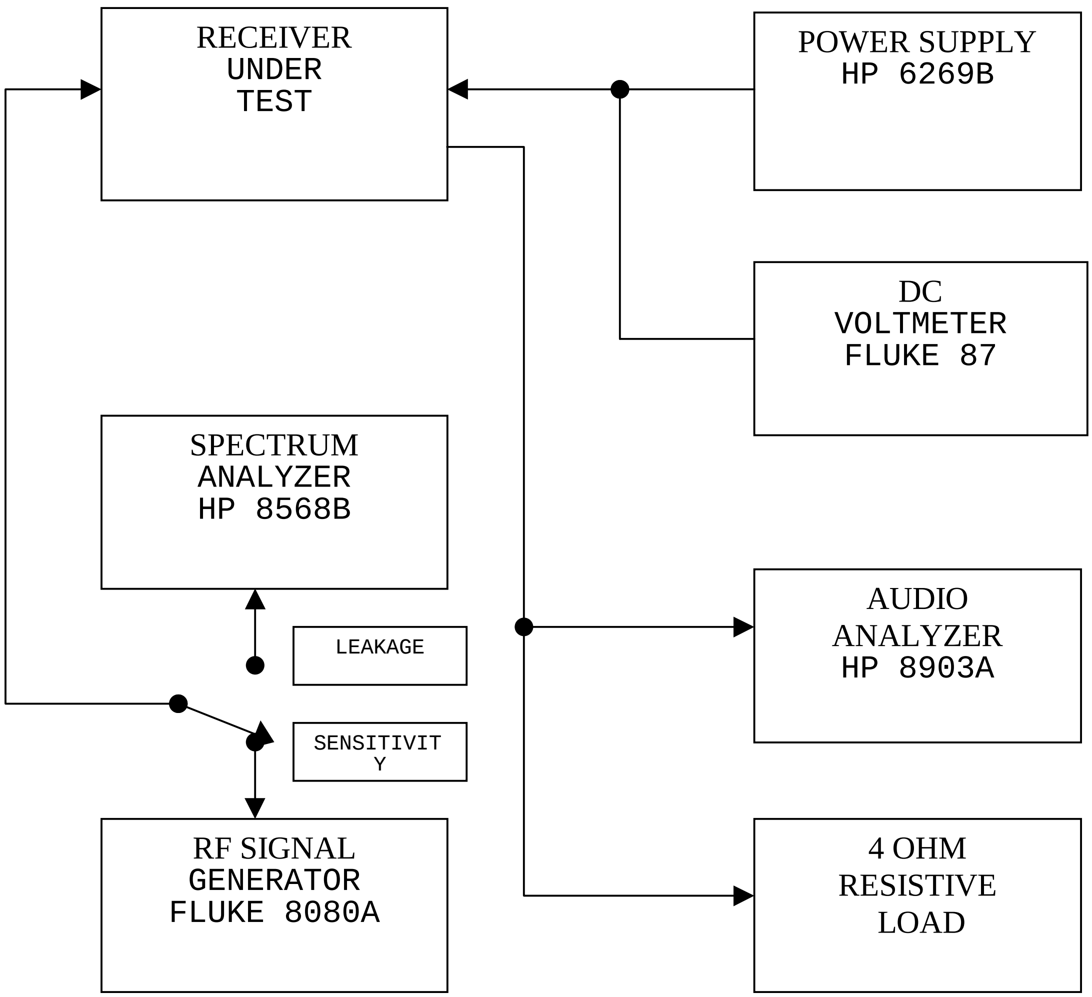


EXHIBIT 12

DECLARATION OF COMPLIANCE FOR SEA 157 DSC CONTROLLER
FCC PART 80, Subpart E Part 80.203(n)

The SEA 157 VHF Radiotelephone/DSC Controller (FCC IDENTIFIER: BZ6SEA157) incorporates a Class D Digital Selective Calling Controller. The DSC Controller complies with FCC regulations given in 47 CFR 80.203(n) as well as 47 CFR 80.225. This encompasses compliance with the following documents which are included by reference:

80.203(n)	
80.225(a)	ITU-R Recommendation M.493-9
	RTCM 56-95/SC101-STD

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Note: Signed copy provided as separate attachment