A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the HJC-FRS transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The HJC-FRS is a portable, battery operated, UHF, frequency modulated transceiver intended for 12.5 kHz channel family radio service applications in the 462.5625-467.7125 MHz band. It operates from a nominal 3.6 Vdc battery supply. Output power rating is 0.5 watts ERP.

B. GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE (Paragraph 2.983 of the Rules)

1. Name of applicant: Vigor Sports Inc.

2. Identification of equipment: FCC ID: KA9HJC-FRS

   a. The equipment identification label is shown in Appendix 1.
   b. Photographs of the equipment are included in Appendix 2.

3. Quantity production is planned.

4. Technical description:

   a. 11k0F3E emission
   b. Frequency range: 462.5625 - 467.7125 MHz.
   c. Operating power of transmitter is fixed at the factory at less than 0.5 W ERP.
   d. Maximum power permitted is 0.5 watts, and the HJC-FRS fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

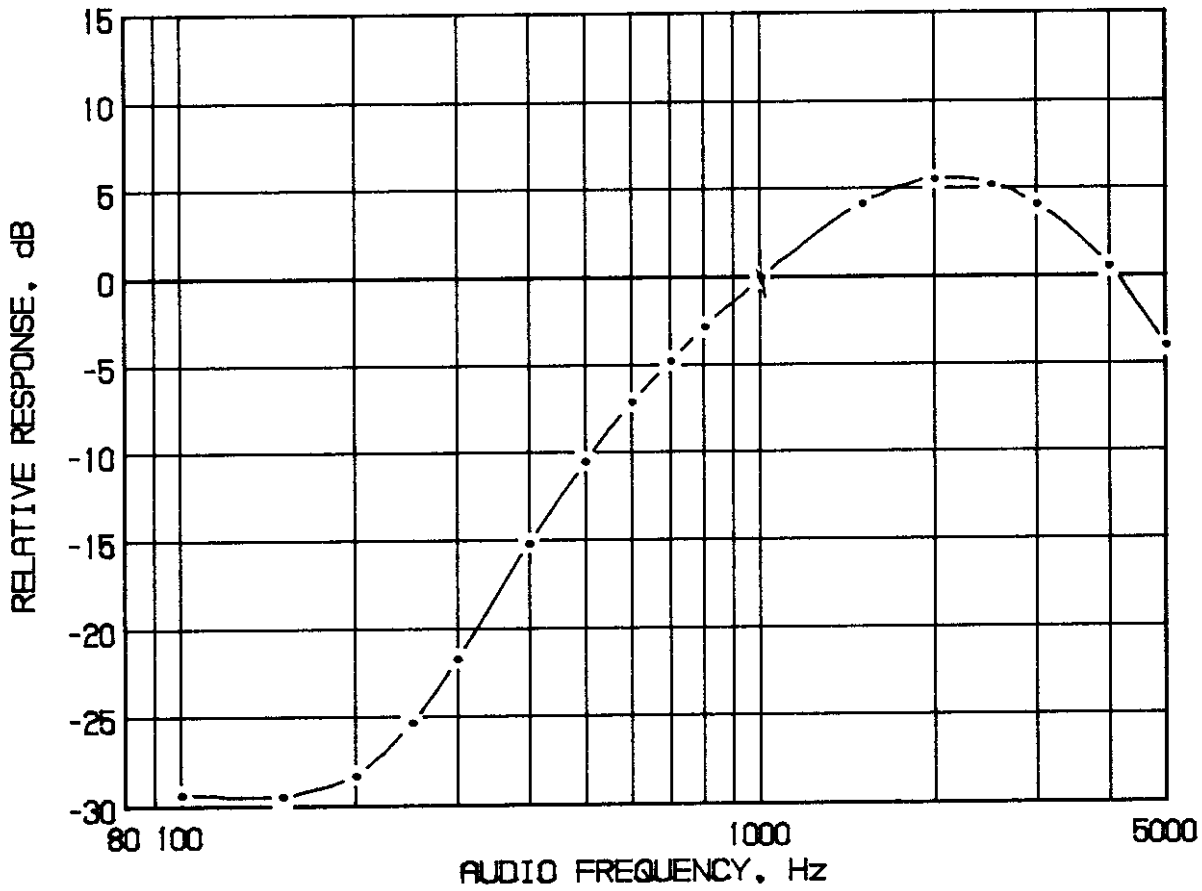
      Collector voltage: 3.5 Vdc
      Collector current: 0.27 A

   f. Function of each active semiconductor device: See Appendix 3.
   g. Complete circuit diagram is included in Appendix 4.
   h. A draft instruction book is submitted as Appendix 5.
   i. The transmitter tune-up procedure is included in Appendix 6.
   j. A description of circuits for stabilizing frequency is included in Appendix 7.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
   l. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

FIGURE 1

MODULATION FREQUENCY RESPONSE

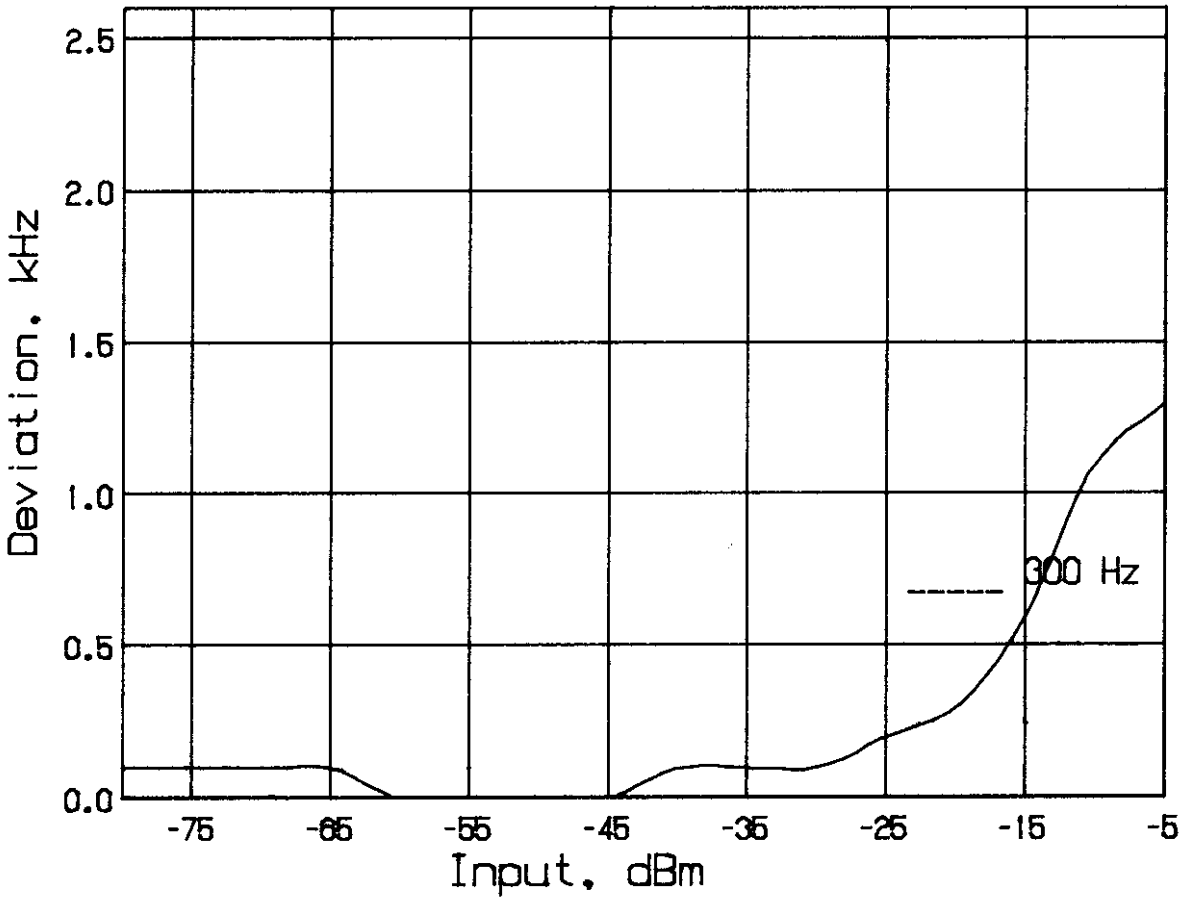


MODULATION FREQUENCY RESPONSE
FCC ID: KA9HJC-FRS

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

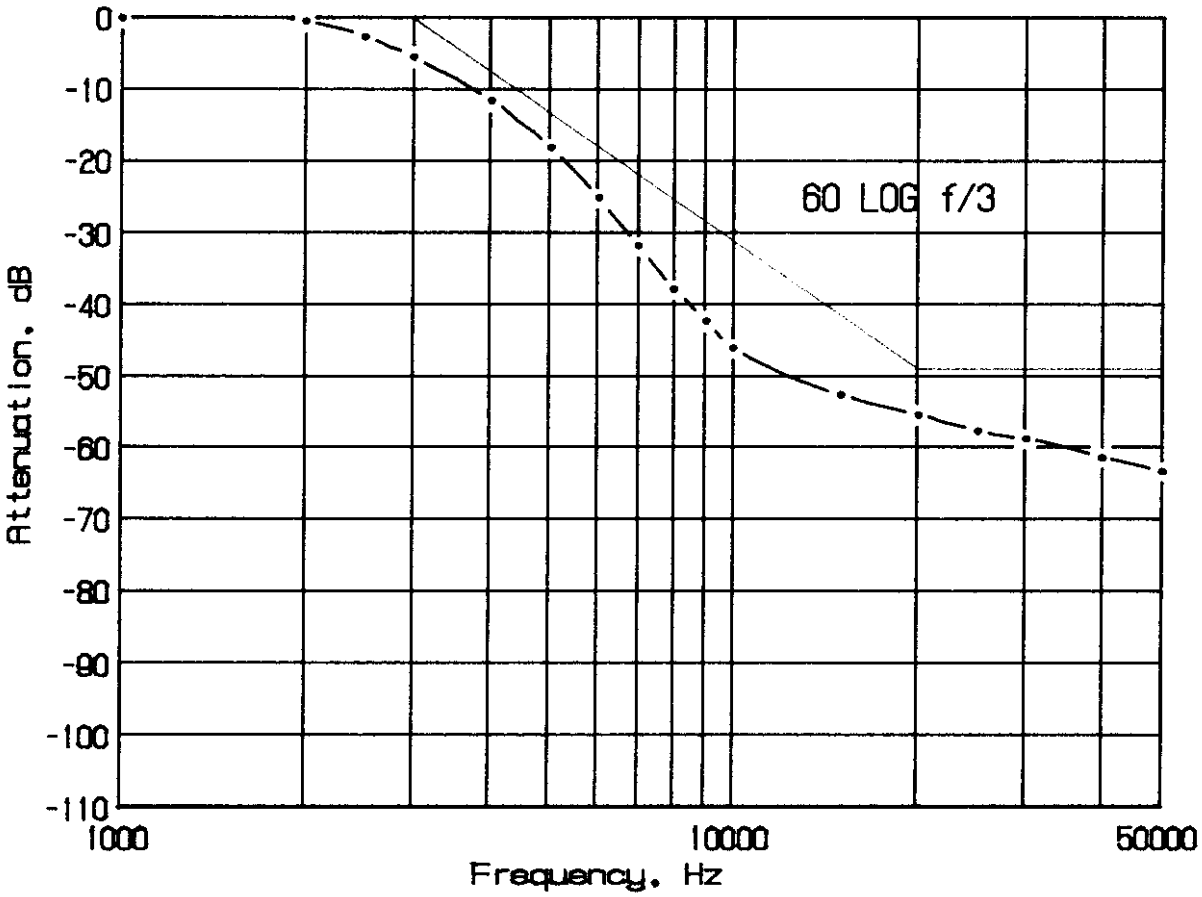


AUDIO LIMITER CHARACTERISTICS
FCC ID: KA9HJC-FRS

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

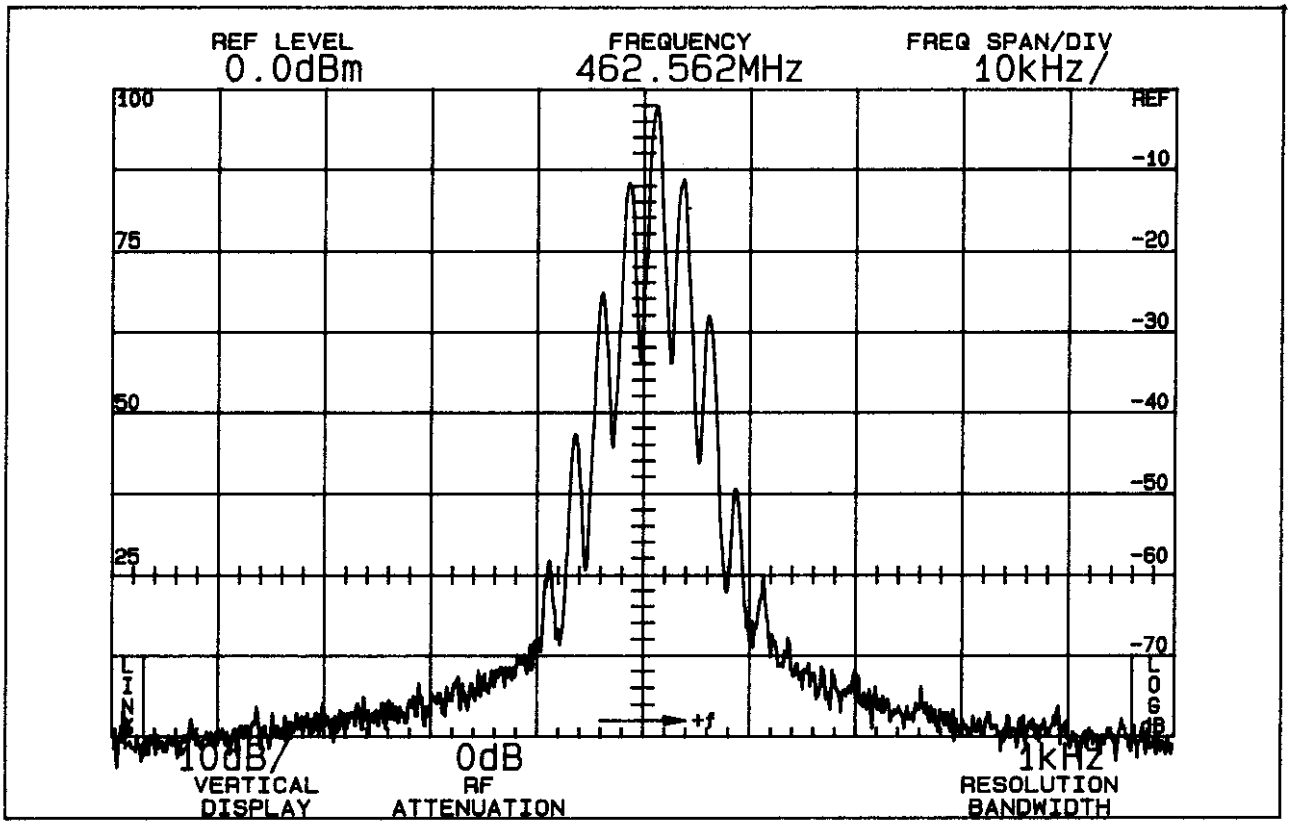


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: KA9HJC-FRS

FIGURE 3

FIGURE 4

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 12.5 kHz (6.25-12.5 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (12.5-31.25 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 31.25 kHz)	43+10LogP = 40 (P = 0.498)

OCCUPIED BANDWIDTH
FCC ID: KA9HJC-FRS

FIGURE 4

D. MODULATION CHARACTERISTICS (Continued)

The plots are within FCC limits. The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

E. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS (Paragraph 2.991 of the Rules)

The HJC-FRS has a permanently attached antenna. There is no connector for an external antenna. Therefore, no antenna terminal conducted measurements were made.

F. DESCRIPTION OF RADIATED SPURIOUS MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility was accepted for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an accepted site.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the Maxon FRS-214 were made with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMCO 3115 horn to 4.8 GHz.

The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 3.6 Vdc.

The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

The measurement system was capable of detecting signals 100 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit (12 MHz), to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 3.

TABLE 3

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 3.6 Vdc, 0.498 watts

Spurious Frequency MHz	Radiated Field uV/m @ 3M	dB Below Carrier Reference[1]
462.563	1650061.0	0.0V
925.126	7970.8	46.3V
1387.689	4050.4	52.2V
1850.252	2070.1	58.0V
2312.814	5761.0	49.1H
2775.377	3353.5	53.8H
3237.940	1237.4	62.5H*
3700.503	762.1	66.7V*
4163.066	266.1	75.9H*
4625.629	312.6	74.5H*

Required: 43+10 Log(P) = 40

[1]Worst-case polarization, H-Horizontal, V-Vertical.

*Reference data only, more than 20 dB below FCC limit.

All other spurious from 12 MHz to the tenth harmonic were 20 dB or more below FCC limit.

Power:

$P = (F.1.xd)^2/49.2$

$= (1.65x3)^2/49.2$

$= 0.498$ W

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2))

Measurement of frequency stability versus temperature was made at temperatures from -20°C to +50°C. At each temperature, the unit was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following the 1 hour soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 4, starting with -20°C.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital thermometer. The transmitter output stage was terminated in a dummy load. Primary supply was 3.6 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 462.5625 MHz. No transient keying effects were observed.

TABLE 4

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE

462.5625 MHz, 3.6 Vdc, 0.498 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-20.1	462.562878	0.8
-10.7	462.562655	0.3
- 0.9	462.562434	-0.1
10.2	462.562437	-0.1
20.5	462.562580	0.2
31.3	462.562742	0.5
40.3	462.562860	0.8
50.2	462.562893	0.8
Maximum frequency error:	462.562893	
	462.562500	
	+ .000393 MHz	

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of ± 0.001156 MHz, which corresponds to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

I. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE
(Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 3.6 volt rating to below the battery end point. A Fluke 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 5

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

462.5625 MHz, 3.6 Vdc Nominal; 0.498 W

Supply Voltage		Output Frequency, MHz	p.p.m.
4.14	115%	462.562567	0.1
3.96	110%	462.562570	0.2
3.78	105%	462.562572	0.2
3.60	100%	462.562580	0.2
3.42	95%	462.562556	0.1
3.24	90%	462.562426	-0.2
3.06	85%	462.562252	-0.5
2.88*	80%	462.562254	-0.5

Maximum frequency error: 462.562500
462.562252

\- .000248 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m) or a maximum of ± 0.001156 MHz, corresponding to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

*Battery end point.

APPENDIX 6

TRANSMITTER ALIGNMENT

FIVE (5) PAGE ALIGNMENT PROCEDURE FOLLOWS THIS SHEET

ALIGNMENT PROCEDURE

1) PHASE LOOKED LOOP AND CPU SECTION

STEP	SETTING	CONNECTION	ADJUST	ADJUST FOR
1	Frequency adjustment ; Mode : Receive Volume : Optional Squelch : Optional CH Selector : 1	Frequency counter to output pin_16 of IC501	CRYSTAL	12.80MHz ±2.5PPM
2	CPU Voltage check ; Mode : Receive Volume : Optional Squelch : Optional CH Selector : Optional	Connect DC volt. Meter to P2 Of IC405 On Cpu Board. (Alignment Layout CPU Section)		Indication on DC voltmeter must be 4.5~5.5volt.
3	VCO Voltage adjustment ; Mode : Receive Volume : Optional Squelch : Optional CH Selector : 1	Connect DC voltage meter to pin_2 of Test Pin on VCO board (Figure-1)		Adjust 1.~1.2 VDC at CH.1 in Rx mode

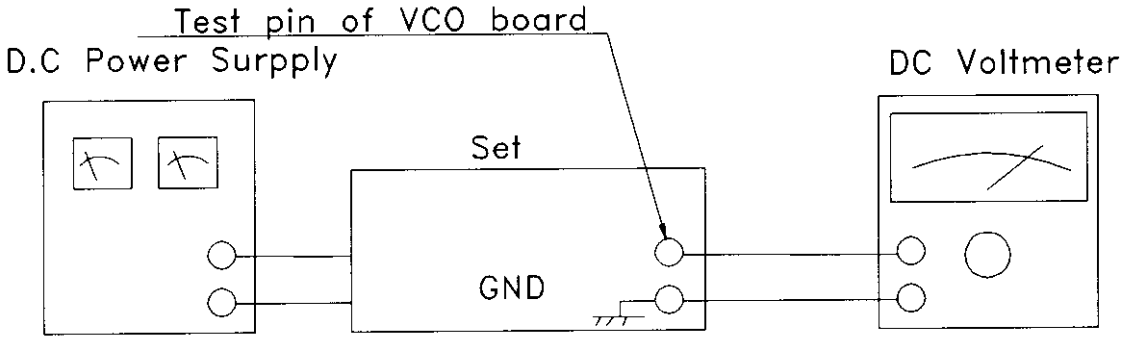
2) TRANSMITTER SECTION

STEP	SETTING	CONNECTION	ADJUST	ADJUST FOR
1	RF Power stage ; Mode : Transmit Volume : Optional Squelch : Optional CH Selector : 1	Connect dummy load and RF power meter to the external ANT-jack on the set (Figure-2)	RV-101	Adjust RV-125. indication on the power meter(0.5W)
2	Second harmonic check ; Mode : Transmit Volume : Optional Squelch : Optional CH Selector : 1	Connect RF power Meter with dummy Load to spectrum Analyzer through Coupler/-40dB atten To EXT-ANT. jack on the set (Figure-3).		At no modulation, The power of any spurious emission on the spectrum analyzer shall not exceed -36dBm when frequency range is 9kHz ~ 1GHz.
3	Frequency check ; Mode : Transmit Volume : Optional Squelch : Optional CH Selector : 1	Connect dummy load and frequency counter through coupler to RF power meter. Also connect power meter to EXT-ANT. jack on the set. (Figure-4)	TC501	Make sure that the indication of the transmitter freq. Is 462.5625MHz±2.5PPM on the frequency counter.
4	MAX deviation check ; Mode : Transmit Volume : Optional Squelch : Optional CH Selector : 1	Connect dummy load and modulation meter through coupler to RF power meter. Also connect power meter to EXT-ANT. Jack on the set. Connect oscillator to microphone jack. (Figure-5)	RV-402	adjust RV-402 so that the indication of the modulation meter is 2.5KHz± 0.2KHz.

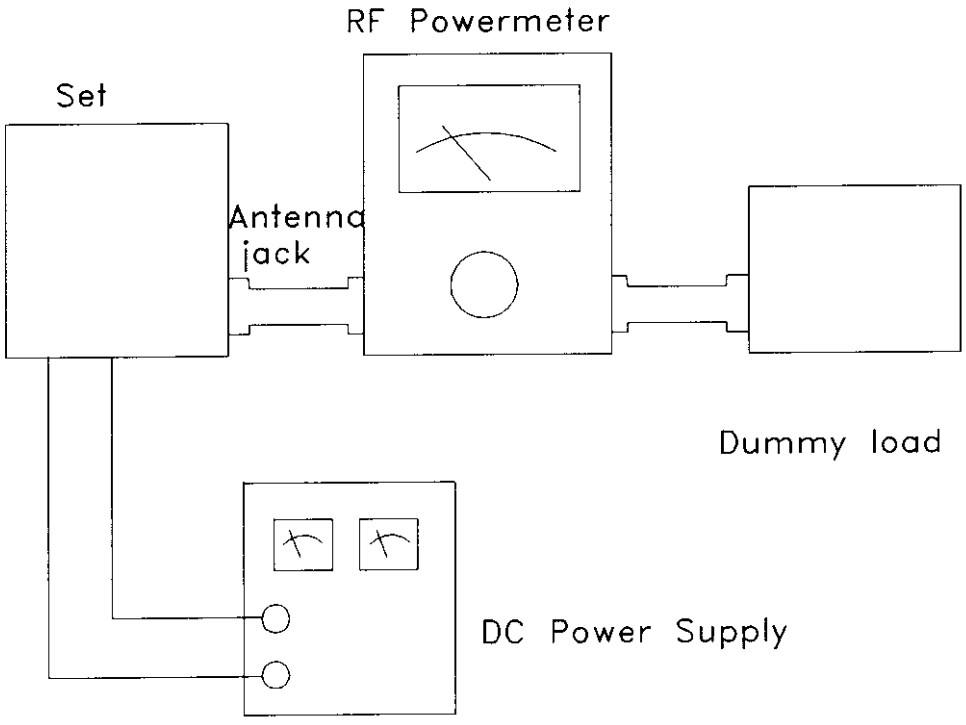
3) RECEIVER SECTION

STEP	SETTING	CONNECTION	ADJUST	ADJUST FOR
1	RX sensitivity ; Mode : Receiver Volume : Half clockwise Squelch : Turn to counterclockwise CH Selector : 1 SSG : 462.5625MHz 1KHZ AF 3KHZ DEV. -115dBm	Connect RF signal generator to external ANT. jack. Connect Sinadder and distortion meter across EXT-Speaker out jack with 16Ω dummy load (Figure-6)	T201	Adjust the parts of tuning circuitry for 12dB SINADDER

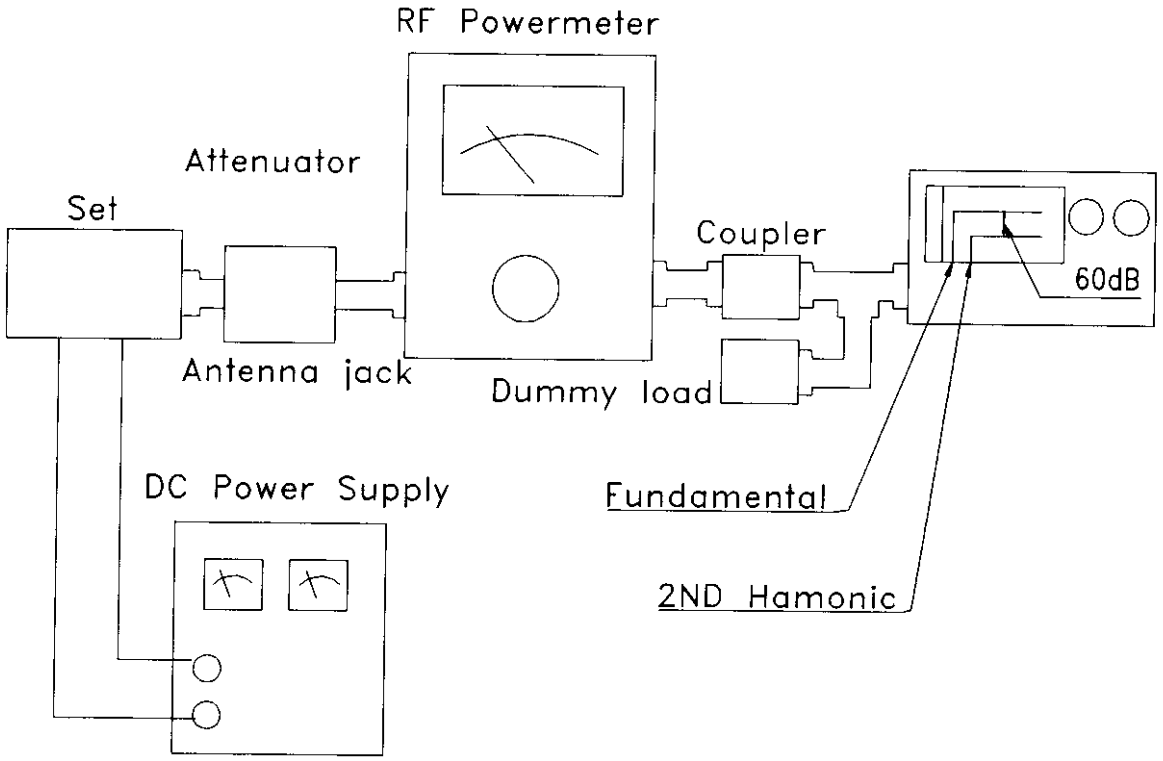
TEST EQUIPMENT SET-UP



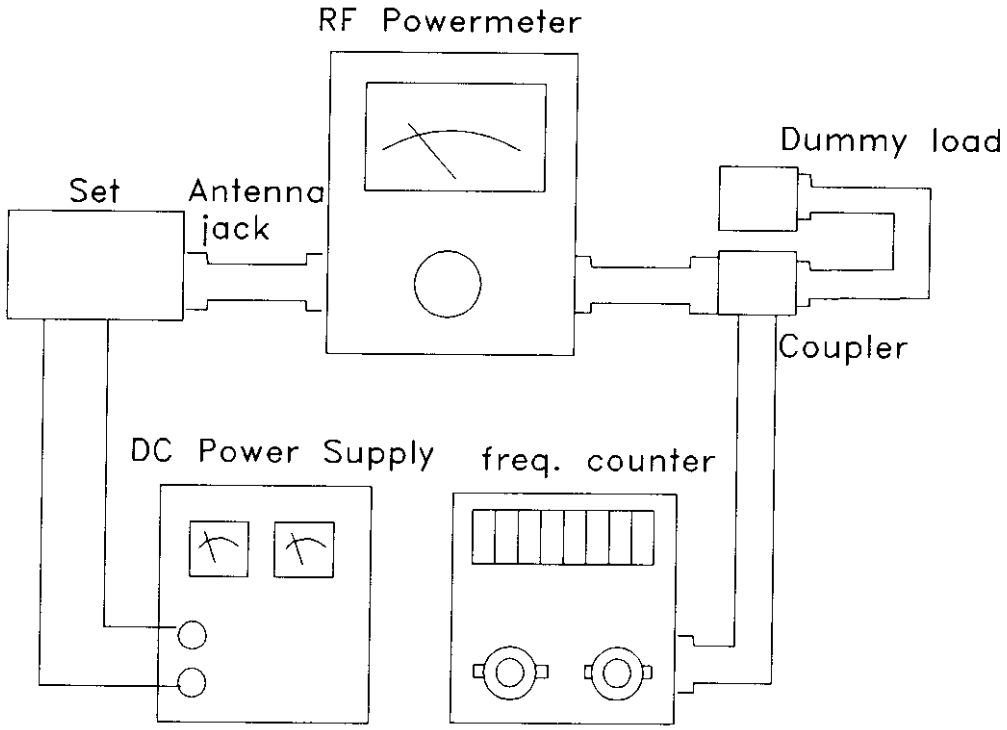
(FIGURE 1)



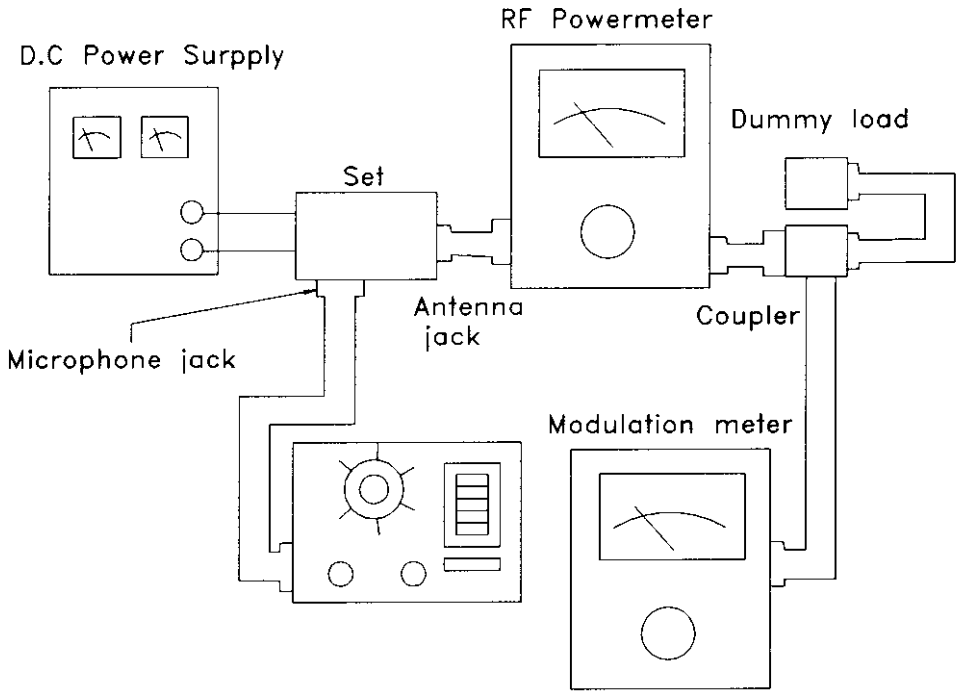
(FIGURE 2)



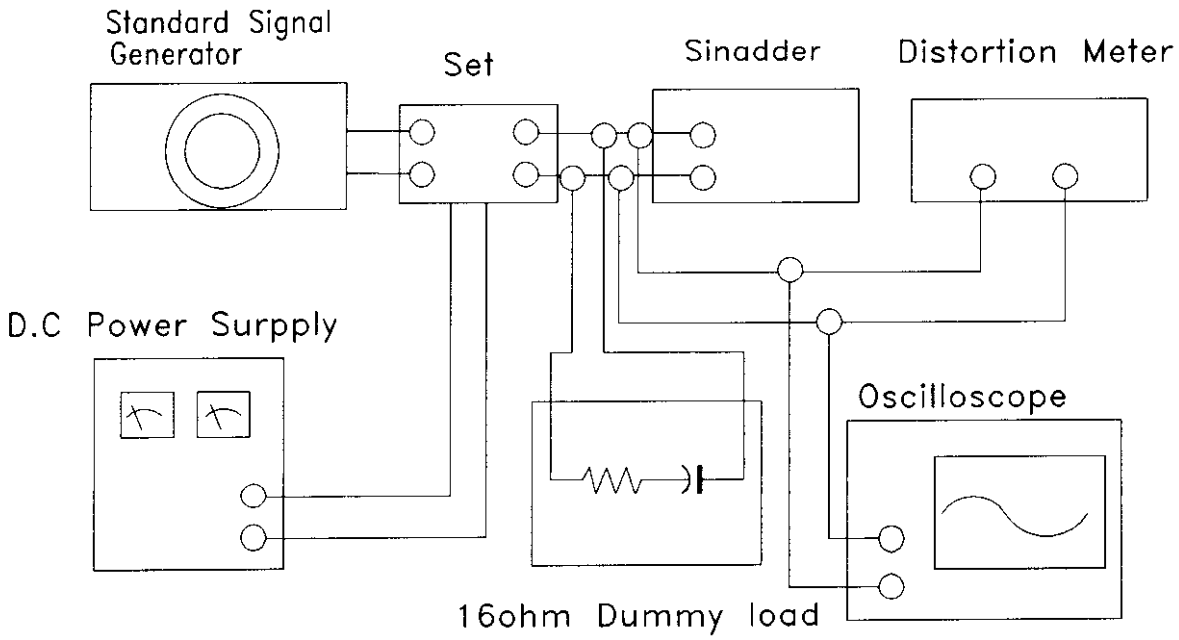
(FIGURE 3)



(FIGURE 4)



(FIGURE 5)



(FIGURE 6)

APPENDIX 7

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

SYNTHESIZER

A phase locked loop (PLL) circuit establishes and stabilizes operating frequency.

The data for producing necessary frequencies is established by the CPU on the digital board.

The frequency stability of the Tx/Rx is maintained by the TCXO, which generates a stable frequency of 12.8 MHz.