Tactical Technologies Inc.

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Part 90 Testing

CST-2001/V Synthesized Voice Transmitter

FCC ID: IP92K1V

Performed by Tactical Technologies Inc.
1701 Second Ave
Folsom, PA 19033
610-522-0106

August 24, 2000

The audio frequency response, low pass filter test, occupied bandwidth, and frequency stability in this application for FCC Type Certification have been performed under my direct supervision. To the best of my knowledge these tests were conducted in accordance with the procedures outlined in Part 2 and Part 90 of the Commission's Rules and Regulations.

I am presently employed by Tactical Technologies Inc. in Folsom, Pennsylvania as a Design Engineer. My prior experience consists of 10 years of designing and testing communications products in the VHF portion of the spectrum.

Sincerely,

Jeffrey N. Olson
Engineer
Tactical Technologies Inc.

A. INTRODUCTION

The following data are submitted in connection with this Application for Type Certification in accordance with Part 2, Subpart J, and Part 90, Subparts B,D, and I of the FCC Rules and Regulations.

B. INFORMATION REQUIRED BY PART 2 - Paragraph 2.981

This section provides data as required by the following Paragraphs: 2.983,2.985,2.987,2.989,2.993,2.995,2.997,2.999 and 2.1003.

2.983 (a) See Form 731
2.983 (b) See Form 731
2.983 (c) Quantity production is anticipated
2.983(d)(1) - (d)(3) See Form 731
2.983)d)(4) The maximum transmitter power output is .25 Watt.
(5) RF final amplifier: At 6.00 Vdc and .08 Adc, Po = .25W.
(6) The function of each active device is included in the exhibits section of this application.
(7) Complete circuit diagrams are included.
(8) Operating instructions are included in the exhibits section of this application.
(9) Complete tune-up procedures are included in the exhibits section of this application.
(10) A description of all circuitry and devices provided for determining and stabilizing frequency is included in the exhibits section of this application.
(11) A description of any circuits and devices employed for suppression of spurious radiation, for limiting modulation, and for limiting power in the exhibits section of this application.
(12) N/A
2.983(e) The data required by Paragraphs 2.985 through 2.987, inclusive, measured in accordance with the procedures contained in Paragraph 2.999, are included in Section E of this application.
(f) A photograph or drawing of the equipment identification plate or label showing the information to be placed thereon is included in the exhibits section of this application.
(g) The required 8 x 10 photographs revealing equipment construction and layout are included in the exhibits section of this application.
(h) N/A
(i) N/A
2.997 The frequency spectrum investigation for spurious emissions per Paragraphs 2.991 and 2.993 include from the lowest frequency within the transmitter to at least the 10th harmonic of the carrier frequency.
2.999 The measurement procedures employed are in accordance with the requirements set forth in Paragraph 2.947.
2.1003 The identification label complies with the requirements of this Paragraph and Paragraph 2.925.

C. SUBMISSION OF EQUIPMENT FOR TESTING - Paragraph 2.943

Upon request, the test sample will promptly be made available by Radiation Science Inc.

D. DESCRIPTION OF MEASUREMENT FACILITIES - Paragraph 2.947

The open-field tests were performed on the 3 meter range maintained by Radiation Science Inc. Complete description and measurement data have been placed on file with the Commission.

E. TEST DATA

This section contains results of measurements required by Parts 2 and 90 of the rules. Data are presented in tabular and/ or graphical form, and measurement procedures are described within the text of each reported test. The test sample operated on 154.6000 MHz.

1. RF POWER OUTPUT - Paragraphs [2.985,2.983(d)(5),90.205(b)]

Measurements pertaining to the power output of the transmitter were performed by the manufacturer. To the best of my knowledge, these tests were conducted in accordance with the procedures outlined in Parts 2 and 90 of the Commissions Rules and regulations. The data presented on Table 1 demonstrates compliance with the appropriate technical standards.

2. MODULATION CHARACTERISTICS - Paragraph [2.987(a), 90.211]

Measurements pertaining to the modulation characteristics were performed by the manufacture. To the best of my knowledge, these tests were conducted in accordance with the procedures outlined in Parts 2 and 90 of the Commission's Rules and regulations. The data presented on figures 1 and 2 demonstrates compliance with the appropriate technical standards.

3. OCCUPIED BANDWIDTH - Paragraphs [2.989(c)(1), 90.209(c)]

Figures 3 and 4 contain pictures taken from a Hewlett Packard 8558B Spectrum Analyzer. The transmitter was modulated with a sine wave tone at 2500 Hz at a level 16 dB above the required to produce 50% modulation at the frequency maximum response. Paragraph 90.209(c) requires that the mean power of emissions shall be attenuated below the mean output power of the transmitter by the following amounts.

(a) On any frequency removed from the assigned frequency by more than 50% but not more than 100% of the authorized bandwidth (at least 25db)

(b) On any frequency removed from the assigned frequency by more than 100% but not more that 250% of the authorized bandwidth (at least 35db).

(c) On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth [at least 50 + log(w) dB or 80 dB, whichever is the lesser attenuation].

4. SPURIOUS EMISSIONS AT THE 50 OHM TEST POINT ON THE TRANSMITTER [2.991, 90.209(c)]

The transmitter was modulated per paragraph 2.989(c)(1). The spectrum was checked with the spectrum analyzer from 10 MHz to the 10th harmonic of the carrier frequency. Observed emissions not reported are attenuated more than 20 dB below the permissible value of 44 dB, i,e., 50 + log (.25W) = 44 dB given by Section 90.209(c)(3). The data in Table 1 verifies that the test sample complies with Paragraph 90.209(c)(3).

TABLE 1
CONDUCTED SPURIOUS EMISSIONS DATA

EMISSION FREQUENCY (MHz)		EMISSION LEVEL (dBc)	FCC LIMIT (dBc)
154.6	REFEERENCE	+24 dBm	44
309.2		-52	44
463.8		-58	44
618.4		-75	44
773.0		>-75	44
927.6		>-75	44
1082.2		>-75	44
1236.8		>-75	44
1391.4		>-75	44
1546.0		>-75	44

5. FIELD STRENGTH OF SPURIOUS RADIATION - Paragraphs [2.993,2.997,90.209(c)(3)]

Measurements were made on the three meter range maintained by Radiation Science Inc. to quantify spurious emission level that] are radiated directly from the cabinet, control circuits, power leads and intermediate circuit elements under normal conditions of installation and operation.

Particular attenuation was paid to harmonics of the carrier frequency as well as those frequencies removed from the carrier by multiples of the oscillator frequency. Data is submitted in Table 2 showing the magnitude of harmonics and other spurious emissions from 30 MHz through the 10th harmonic.

The test sample was placed on a non-conductive table one meter above the ground plane in order to determine the maximum level at each emission. Both horizontal and vertical site antenna polarization were employed. The antenna was raised 1 to 4 meters in height and the equipment under test was rotated 360 degrees to minimize the emission.

The reference level for spurious radiation was taken as a ideal dipole excited by the measured output power according to the following relationship:

$$E = (49.2\ P)1/2\ /\ R$$

Where: E = electric-field intensity in Volts/meter
P = transmitted power in Watts
R = distance in meters

For this case: E = 1.17 V/M = 121.4 dBu/m

The permissible value of spurious emissions is equal to less than 121.4 dBu/m - (50 + log(.25) = 77.4 dBu/m.

Any observed spurious emissions not reported were more than 20 db below the permitted level.

TABLE 2
FIELD STRENGTH OF RADIATED EMISSION

POWER LEVEL Dbm	EMISSION FREQUENCY Mhz	ANTENNA POLARITY (H,V)	EMISSION LEVEL dbuv/m	EMISSION LEVEL Dbc	FCC LIMIT Dbc
24	154.6	V	72.2	Reference	
	309.2	V	13.0	59.2	44
	463.8	V	19.0	53.2	44
	618.4	V	17.5	54.7	44
	927.6	V	23.0	49.2	44
	1082.2	V	23.0	49.2	44
	154.6	H	87.2	Reference	
	309.2	H	27.0	60.2	44
	463.8	H	26.5	60.7	44
	618.4	H	27.5	59.7	44
	927.6	H	31.0	56.2	44
	1082.2	H	24.0	63.2	44

Table 2 measurements were made by Radiation Science Inc., they calculated them out for Part 15 not Part [90.209].
The above measurements were copied from there test result paper and calculated for Part [90.209(c)(3).
The data from Table 2 verifies that the test sample complies with Paragraph 90.209(c)(3).

6. FREQUENCY STABILITY - Paragraphs 2.995, 90.213

Measurements of the frequency stability versus temperature was made at temperatures ranging from -30 degrees C to +50 degrees C. At each temperature, the unit was exposed to the test chamber ambient for a minimum of 30 minutes after the temperature had stabilized within plus or minus one degree of the desired temperature. Following a 30 minute "soak" at each temperature, the frequency was measured within one minute after application of power. The test temperature was sequenced in the order shown in Table 3 starting at -30 degrees Celsius.

The nominal primary power supply voltage of 6.00 vdc was used, and the frequency was measured with a Hewlett Packard 5253B Frequency Counter.

TABLE 3
FREQUENCY STABILITY VS. TEMPERATURE

TEMPERATURE C	FREQUENCY MHz
-30	154.599655
-20	154.599641
-10	154.599667
0	154.599690
+10	154.599704
+20	154.599700
+30	154.599694
+40	154.599670
+50	154.599665

The values are within 5 ppm (.000773 MHz) of the assigned frequency as stated in Paragraph 90.213. Thus, the test sample complies with Paragraph 90.213.

The output frequency as a function of supply voltage was measured, and the results are given below in Table 4.

TABLE 4
FREQUENCY STABILITY
POWER SUPPLY VOLTAGE VS. OUTPUT FREQUENCY

POWER SUPPLY VOLTAGE (%)	(Vdc)	OUTPUT FREQUENCY (MHz)
115	7.2	154.599690
100	6.0	154.599690
85	4.8	154.599690

These values are within 5 ppm of the assigned frequency. The test sample complies with Paragraph 90.213.

CST-2001/V
FCC ID# IP92K51V
S/N 136
Two Channel Synthesized Transmitter
Frequency Range
154 - 174 MHz
Power Output 250 mw
Audio Pre-Emphasis and Low Pass Filter vs. Input Signal

Input Signal Level -60 dBm Frequency Hz	Output Level	Pre-Emphasis 6Dbm/Octive Scaled +1/-3	Low Pass Filter 12 dBm/Octave
300	400mvpp	-15.3Dbm	-10.24Dbm	.
500	600mvpp	-11.7Dbm	-6.71Dbm	.
750	1100mvpp	-6.5Dbm	-1.45Dbm	.
1000	1300mvpp	-5.1Dbm	0.00Dbm	.
1500	1800mvpp	-2.3Dbm	+2.82Dbm	.
2000	2000mvpp	-1.3Dbm	+3.74Dbm	.
2500	3250mvpp	+2.8Dbm	+7.95Dbm	.
2700	4000mvpp	+4.7Dbm	+9.76Dbm	.
3000	3500mvpp	+3.5Dbm	+8.60Dbm	.

Low Pass Filter

4000	-9.00Dbc
5000	-16.00Dbc
6000	-22.00Dbc
7000	-27.00Dbc
8000	-31.00DBC
9000	-35.00Dbc
10000	-38.00Dbc
15000	-50.00Dbc
20000	-60.00Dbc

All audio distortion measurements at the above frequencies were less than 10%.
Distortion measurements were made with a B&W Model 400 Distortion Meter.
Audio output measurements were made with a Tektronix Oscilloscope OS-245 and a Hewlett Packard 3551A Audio generator.
All low pass filter measurements were made applying an audio generator to the microphone input, and monitoring the output of the transistor on a Hewlett Packard 8558B Spectrum Analyzer at 5 kHz bandwidth.

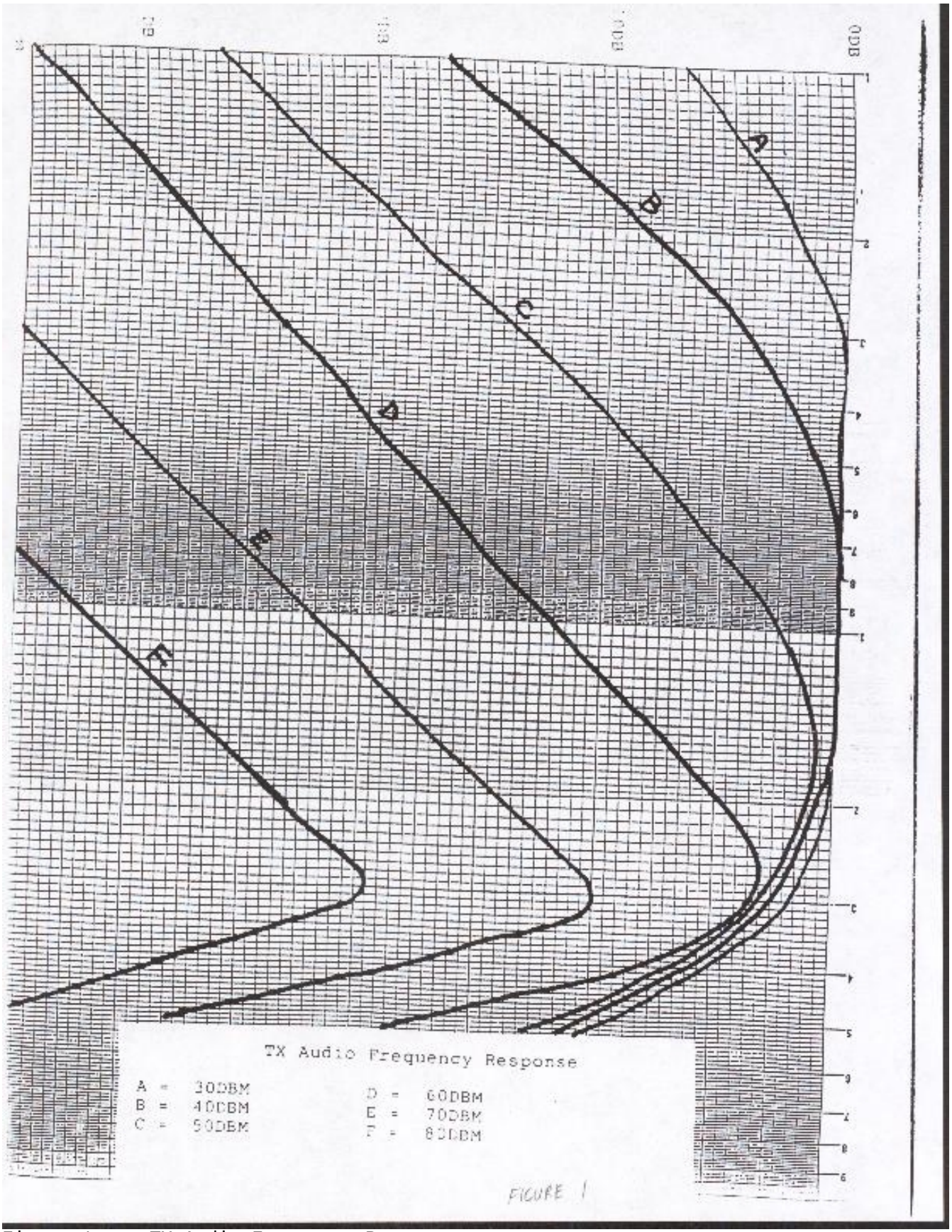


Figure 1 - TX Audio Frequency Response

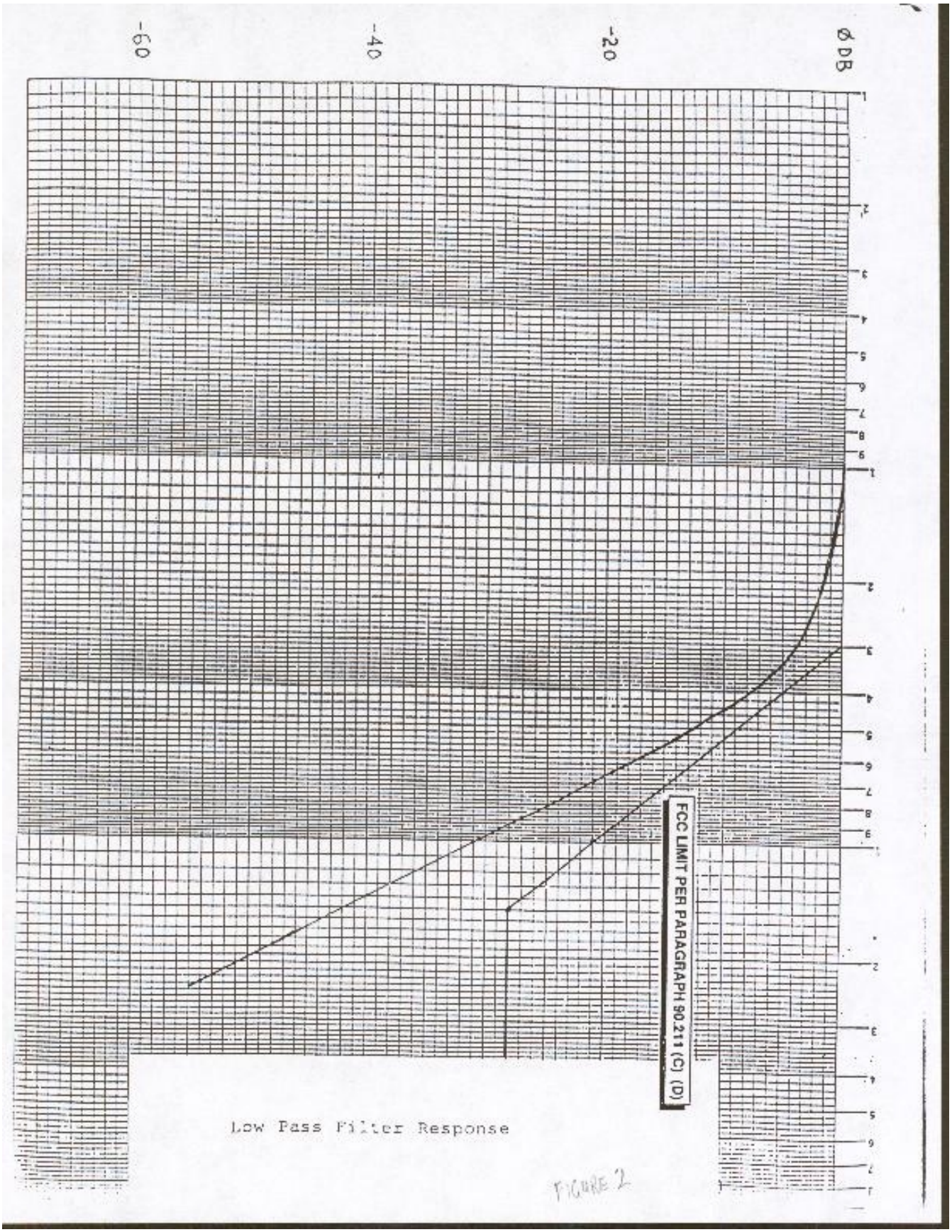
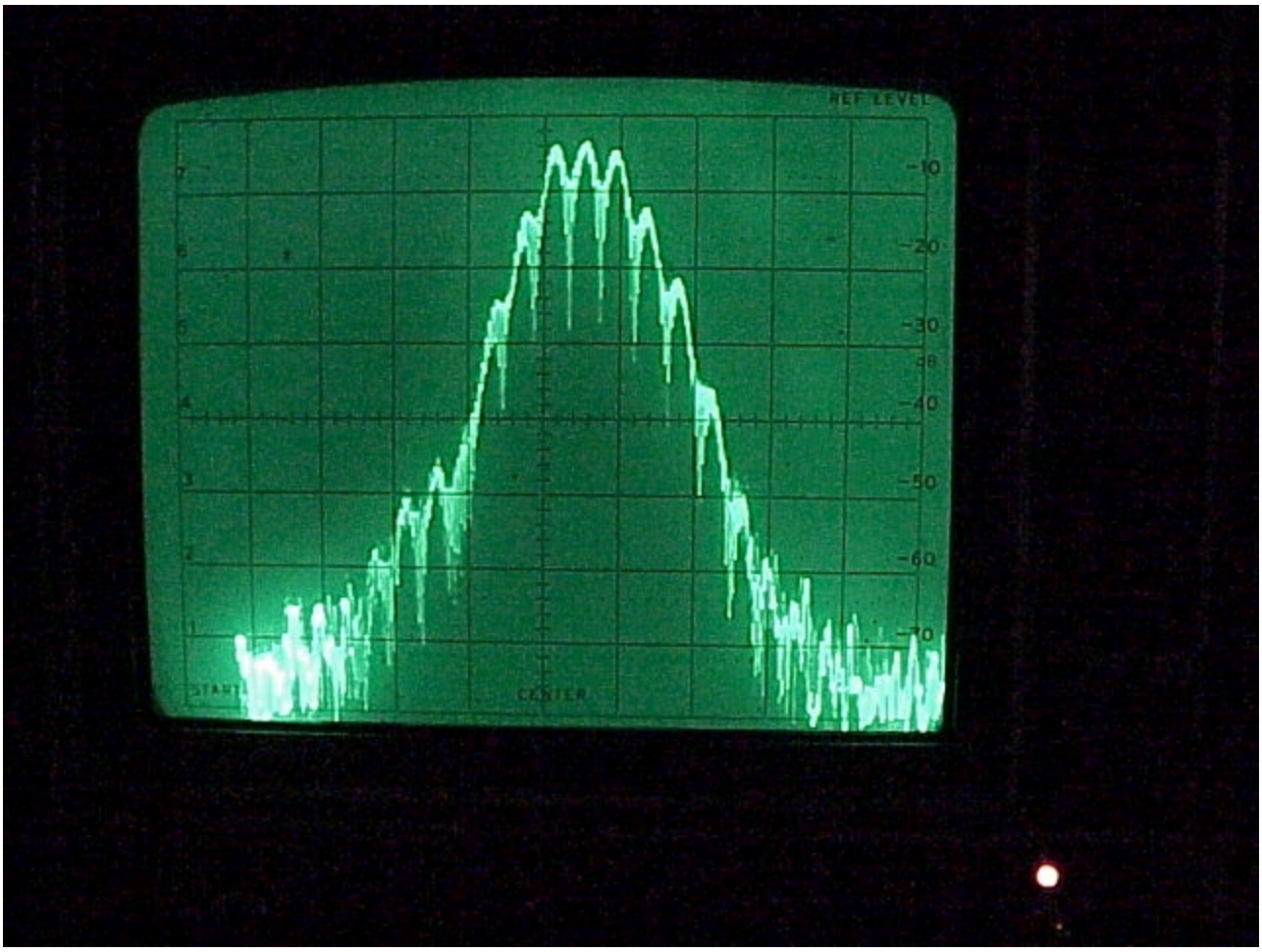
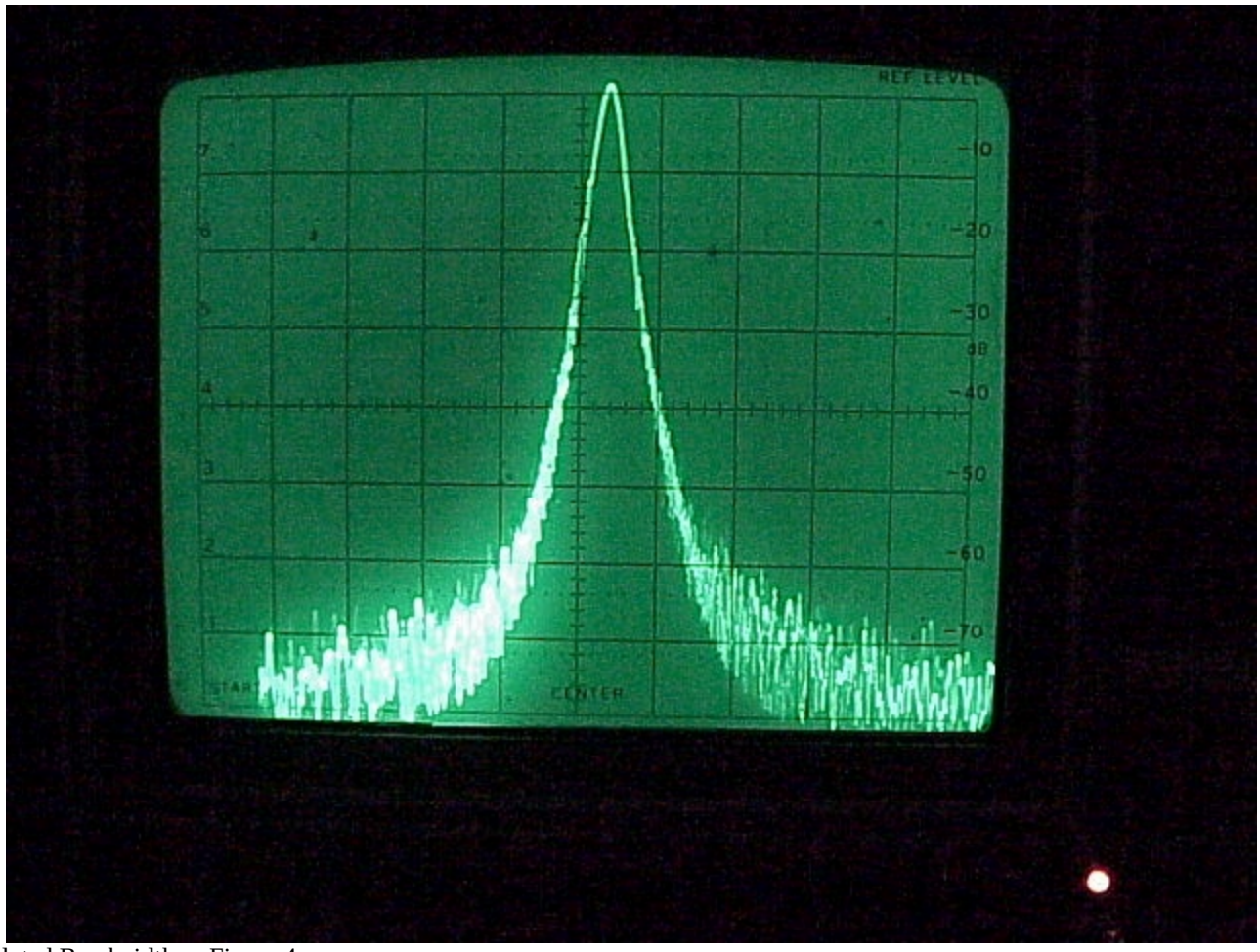


Figure 2 - Low Pass Filter Response



Modulated Bandwidth - Figure 3



Unmodulated Bandwidth - Figure 4