

Pub. No.: TI-1681

Date: May, 1998

FURUNO®

TECHNICAL INFORMATION

**TYPE TESTING DATA
for submission to FCC**

MARINE SSB RADIO TELEPHONE

MODEL FS-1503

**FURUNO ELECTRIC CO., LTD.
NISHINOMIYA CITY, JAPAN**

Pub. No. : TI- 1681

Date : May, 1998

May 22, 1998

All data herein contained is true and correct to my best knowledge.

May 22, 1998

M. Hamane

Misao Hamane
Manager
Radio Engineering Division, Section 3
Research and Development Division
FURUNO ELECTRIC CO., LTD.

***** CONTENTS *****

1	GENERAL INFORMATION	4
1.1	Specifications	
1.2	List of Test Equipment Used	
2	IDENTIFICATION OF EQUIPMENT	7
3	RF POWER OUTPUT	8
4	MODULATION CHARACTERISTICS	11
4.1	Audio Frequency Response	
4.2	Power Limiting vs Audio Input Voltage	
4.3	Modulation Characteristics on H3E	
5	OCCUPIED BANDWIDTH	18
6	EMISSION LIMITATIONS	40
7	SPURIOUS EMISSIONS AT ANTENNA TERMINALS	62
8	FIELD STRENGTH OF SPURIOUS RADIATION	85
9	FREQUENCY STABILITY	91
10	SUPPRESSION OF INTERFERENCE FROM RECEIVER	99
11	RADIOTELEPHONE ALARM GENERATOR	100
12	TRANSMITTER POWER ADJUSTMENT PROCEDURE	103
13	PHOTOGRAPHS TO REVEAL EQUIPMENT CONSTRUCTION AND LAYOUT	104
14	TECHNICAL DESCRIPTION OF EQUIPMENT	108
14.1	Function of Active Devices	
14.2	Circuit Description	
15	CIRCUIT DIAGRAMS	
16	OPERATOR'S MANUAL	(Separate Cover)

1 GENERAL INFORMATION

1.1 Specifications

(a) Manufacturer:	Furuno Electric Co., Ltd., Japan
(b) Model:	FS- 1503 (Serial No. 3513-0014)
(c) Frequency Range:	1.6 to 27.5 MHz (transmit) 0.1 to 29.9 MHz (receive)
(d) Class of Emission:	J3E (LSB) J3E (USB) H3E F1B, J2B F3C (receive only)
(e) Power Supply:	13.6 V DC 1.5 A (receive) 30 A (max) (transmit)
(f) Dimensions & Weight:	Transceiver, 112 mm (H) x 265 mm (W) x 306 mm (D) 5.7 kg Antenna Coupler, 416 mm (H) x 286 mm (W) x 90 mm (D) 2.6 kg approx.

1.2 List of Test Equipment Used

(a) SPECTRUM ANALYZER

Manufacturer: Takeda Riken
Model: TR 4173
S/No: 85580030

(b) 50 Ω LOAD/ WATT METER:

Manufacturer: Tokyo Denpa
Model: DJ 522-OH-2
DC to 30 MHz: 50 Ω 250/500 W
S/No: 46507

(c) DC POWER SUPPLY

Manufacturer: Takasago
Model: GP 035-50R
0 to 35 VDC, 0 to 50 A
S/No: 13086029

(d) PLOTTER

Manufacturer: EPSON
Model: HI-80
S/No: 02006569

(e) BROADBAND ROD ANTENNA

Manufacturer: AILTECH
Model: 95010-1
10 kHz to 40 MHz
S/No: 496

(f) BICONICAL ANTENNA

Manufacturer: ELECTRO METRICS
Model: BIA-25
20 MHz to 220 MHz
S/No: 2650

(g) FREQUENCY COUNTER:

Manufacturer: TAKEDA RIKEN
Model: TR5824
10 Hz to 600 MHz: 5×10^{-8} /day
S/NO.: 41930036

(h) AUDIO SIGNAL GEN (2 ea.):

Manufacturer: KENWOOD
Model: AG-253

Pub. No. : TI- 1681

Date : May, 1998

50 Hz to 1 00 MHz, 600 Ω
1100026 & 709003

S/No:

(i) AUDIO VOLT METER:

Manufacturer:

Kikusui Electronics Corp.:

Model:

161E

S/No:

2961776

(j) OSCILLOSCOPE:

Manufacturer:

SONY TEKTRONIX

Model:

2445

S/No:

B02576

(k) STORAGE OSCILLOSCOPE:

Manufacturer:

TEKTRONIX

Model:

2330

S/No:

300462

(L) MODULATION ANALYZER:

Manufacturer:

HEWLETT PACKERD

Model:

8901B

S/No:

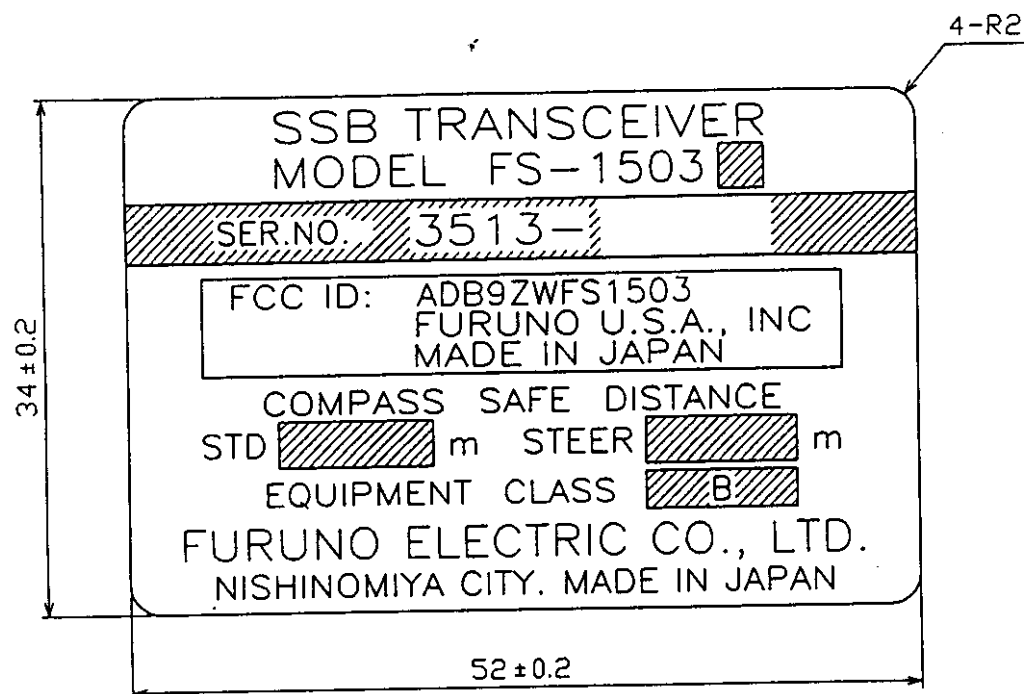
2718A01184

2 IDENTIFICATION OF EQUIPMENT (FCC Rule Part 2.925)

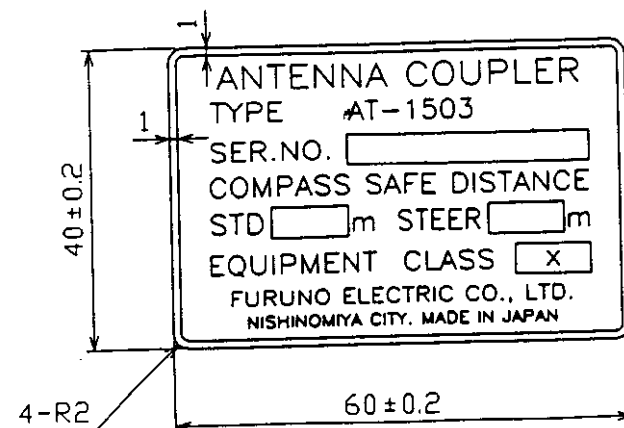
The following nameplates are permanently fixed on the equipment.

FCC ID: ADB9ZWFS1503
Material of nameplate: Polyester film t 188 μ

ON TRANSCEIVER UNIT:



ON ANTENNA COUPLER UNIT:



3 RF POWER OUTPUT (FCC Rules Part 80.215 & 2.985)

3.1 Method of Measurement

The FS-1503 is connected with measuring equipment as shown in Fig. 3.1.

Supply voltage is set to 13.6 VDC. An ammeter is connected in series with collector of each final stage transistor. Test is made under normal environmental condition.

2 Audio Signal Generators generating each 400 Hz and 1800 Hz at an equal level are adjusted to produce transmitter RF output power 150 W_{pep}. Collector current is then measured.

Measurement is made on every test frequency on class of emission J3E. On 2182 kHz, measurement is also made on H3E, but with a single tone 1500 Hz.

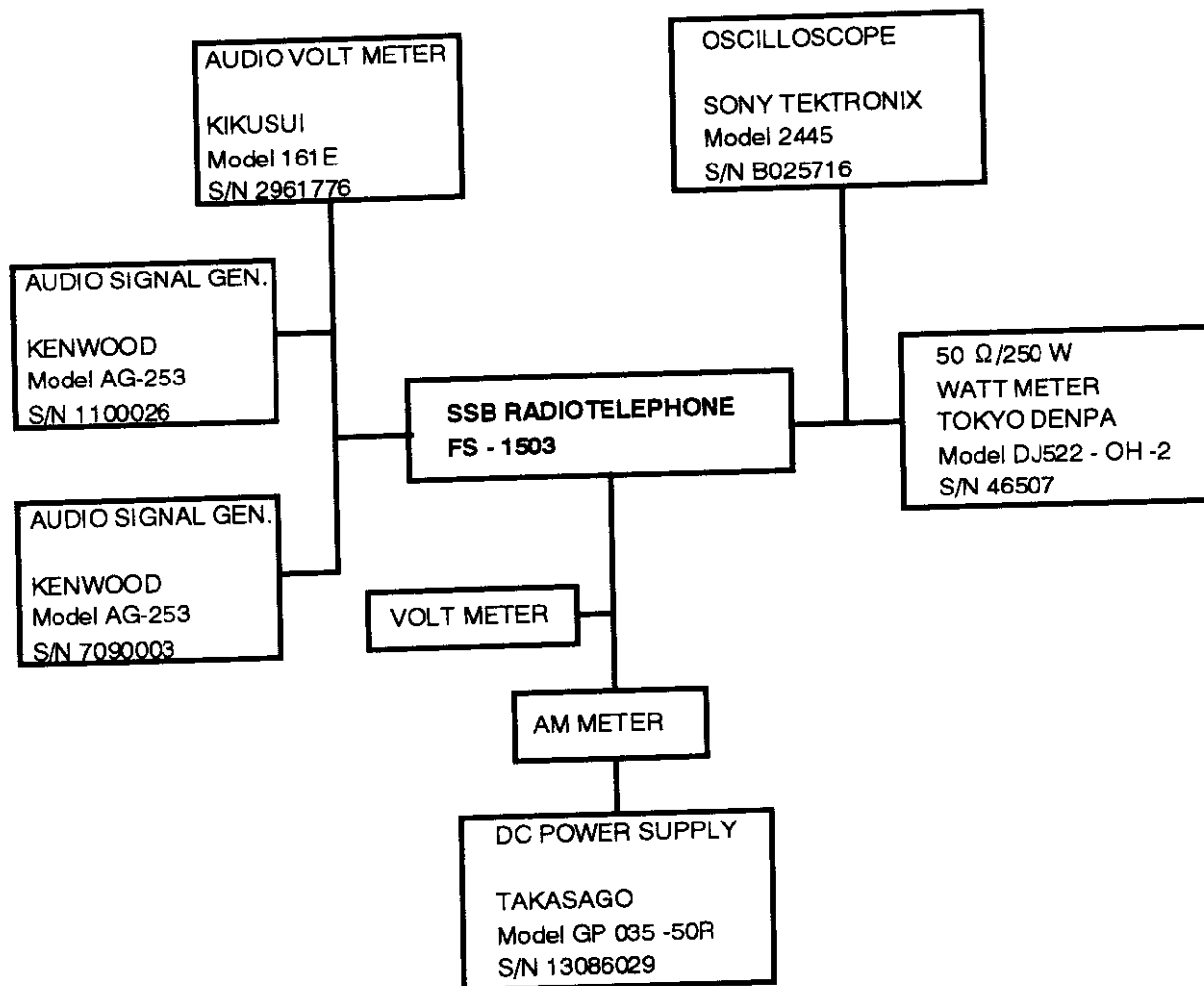


Fig. 3.1

3.2 Test Result

Results are shown in Table 3.1

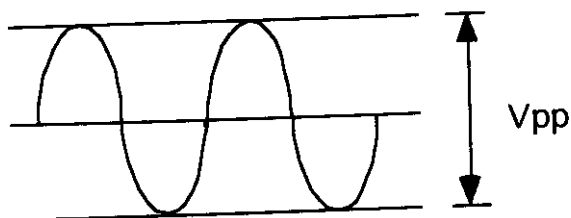
Table 3.1

Frequency	Class of Emission	Supply Voltage	Collector Current	PEP
1605.0 kHz	J3E	13.6 V	15.5 A	140 W
2182.0 kHz	H3E	13.6 V	15.0 A	150 W
2182.0 kHz	J3E	13.6 V	15.3 A	150 W
3023.0 kHz	J3E	13.6 V	15.5 A	150 W
4065.0 kHz	J3E	13.6 V	17.0 A	150 W
6200.0 kHz	J3E	13.6 V	17.5 A	150 W
8195.0 kHz	J3E	13.6 V	17.0 A	140 W
12230.0 kHz	J3E	13.6 V	17.0 A	120 W
16360.0 kHz	J3E	13.6 V	16.0 A	110 W
18780.0 kHz	J3E	13.6 V	14.5 A	110 W
22000.0 kHz	J3E	13.6 V	16.0 A	115 W
25070.0 kHz	J3E	13.6 V	15.0 A	100 W

Power is calculated by doubling the readout of Wattmeter showing average power as explained in paragraph 3.3 below.

3.3 Relation between Average Power and Peak Envelope Power

3.3.1 CW (Single Tone):



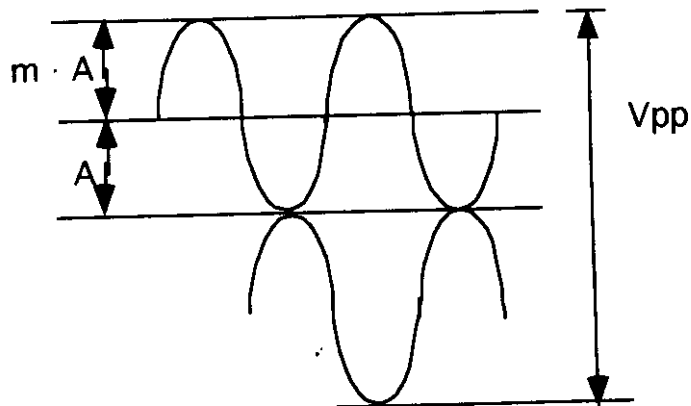
$$\text{Average power: } P_a = \frac{(V_{pp}/2\sqrt{2})^2}{R_L} = \frac{V_{pp}^2}{8 R_L}$$

$$\text{PEP: } P_p = \frac{(V_{pp}/2\sqrt{2})^2}{R_L} = \frac{V_{pp}^2}{8 R_L}$$

Therefore;

$$P_a = P_p$$

3.3.2 AM:



$$\text{Average power: } P_a = \left(1 + \frac{m^2}{2}\right) \cdot P_c$$

where, P_c : carrier power, m : depth of modulation

$$\text{while, } P_c = \frac{(A/\sqrt{2})^2}{R_L} = \frac{A^2}{2R_L}$$

$$\text{and, } V_{pp} = 2(1 + m) \cdot A$$

$$\text{Therefore, } P_c = \frac{1}{2R_L} \cdot \left(\frac{V_{pp}}{2(1 + m)}\right)^2 = \frac{V_{pp}^2}{8(1 + m)^2 \cdot R_L}$$

$$\text{Therefore, } P_a = \left(1 + \frac{m^2}{2}\right) \cdot \frac{V_{pp}^2}{8(1 + m)^2 \cdot R_L}$$

$$\text{PEP: } P_p = \frac{(V_{pp}/2\sqrt{2})^2}{R_L} = \frac{V_{pp}^2}{8R_L}$$

$$\text{Therefore, } P_a = \left(1 + \frac{m^2}{2}\right) \cdot \frac{P_p}{(1 + m)^2}$$

$$\text{or, } P_p = \frac{(1 + m)^2}{1 + m^2/2} \cdot P_a$$

$m = 1$	: $P_p = 2.67 P_a$
$m = 0.8$	: $P_p = 2.47 P_a$
$m = 0.5$	: $P_p = 2.1 P_a$

4 MODULATION CHARACTERISTICS (FCC Rule Part 2.987)

4.1 Audio Frequency Response (FCC Rules Part 2.987(a) & 80.213)

4.1.1 Method of Measurement

The FS-1503 is connected with measuring equipment as shown in Fig. 4.1.1.

A single audio tone is applied to the transmitter and varied over the range 100 to 5000 Hz. Output power is measured for variation of audio frequency with the output level 30 W referred to as 0 dB.

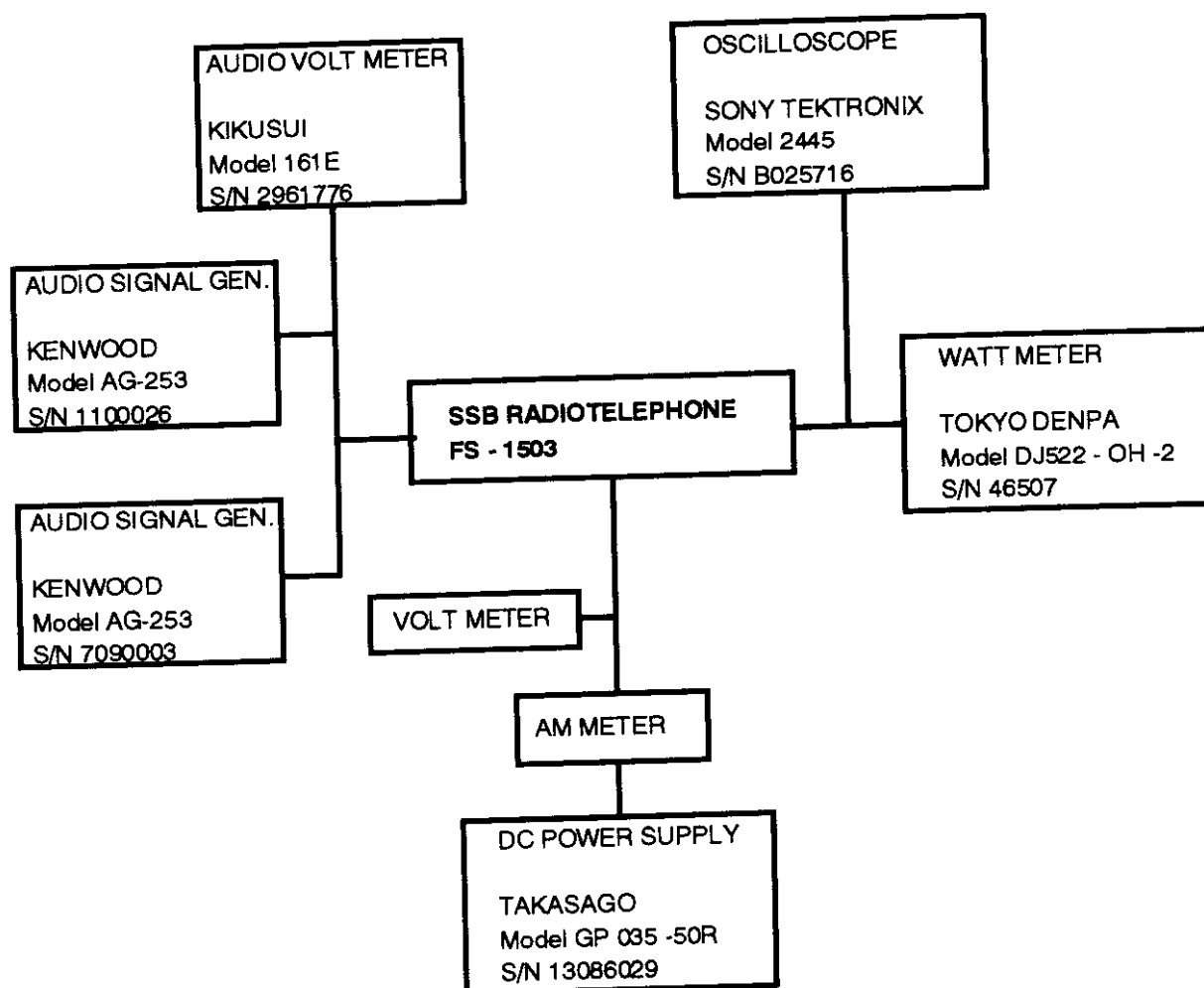


Fig. 4.1.1

4.1.2 Test Result

1. Output level for respective audio frequency is plotted in Fig. 4.1.2.
2. Carrier levels on each mode are as in Table 4.1.1A.

Table 4.1.1A

		below pep	Standard
J3E	Suppressed Carrier mode	55 dB	at least 40 dB
H3E	Full carrier mode	3.8 dB	3 - 6 dB

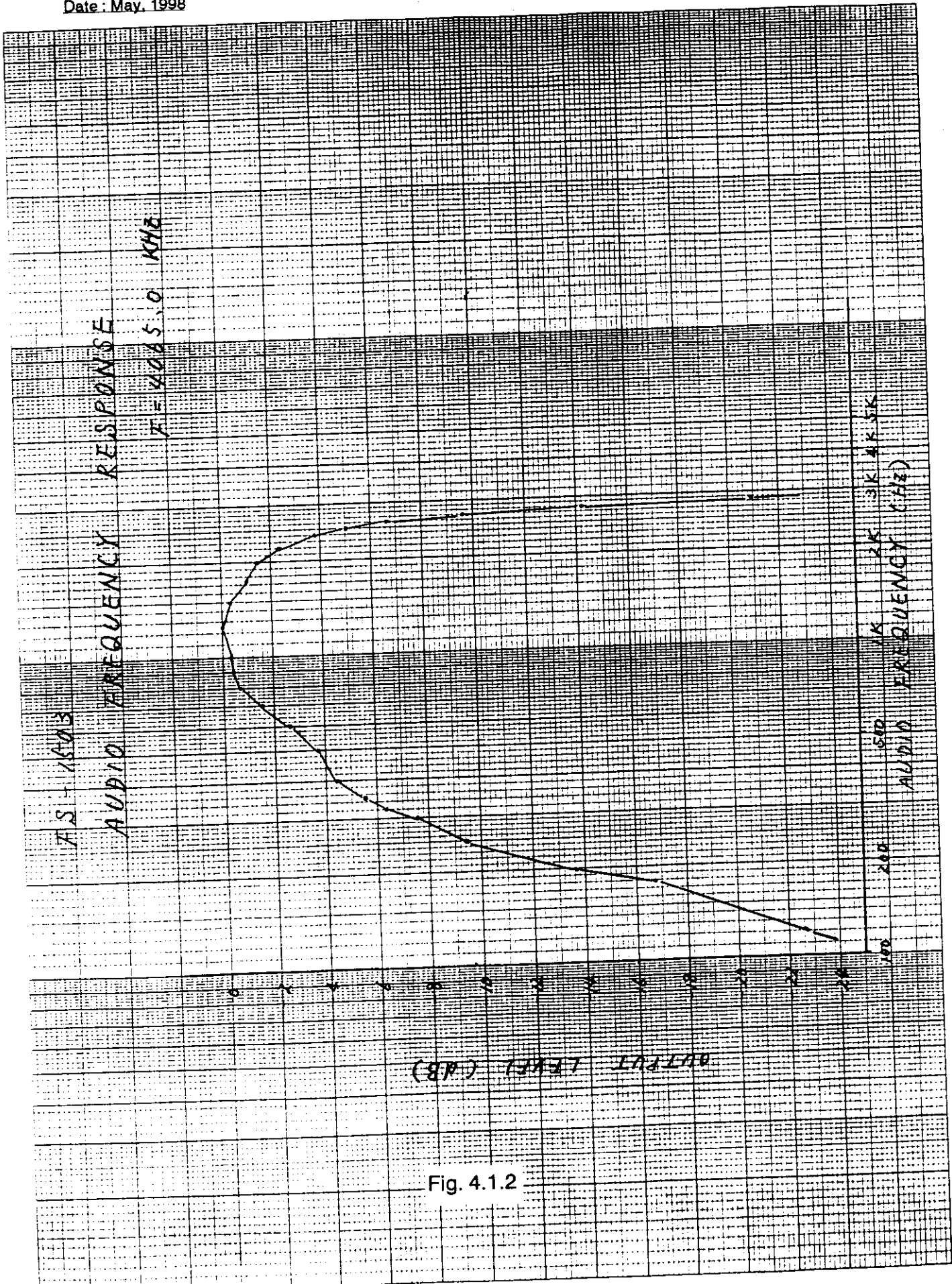


Fig. 4.1.2

4.2 Power Limiting vs Audio Input Voltage (FCC Rule Part 2.987(c))

4.2.1 Method of Measurement

The FS-1503 is connected with measuring equipment as shown in Fig. 4.2.1.

2 audio tones of 400 Hz and 1800 Hz are applied to the transmitter in equal level.
The input level is varied and PEP is measured.

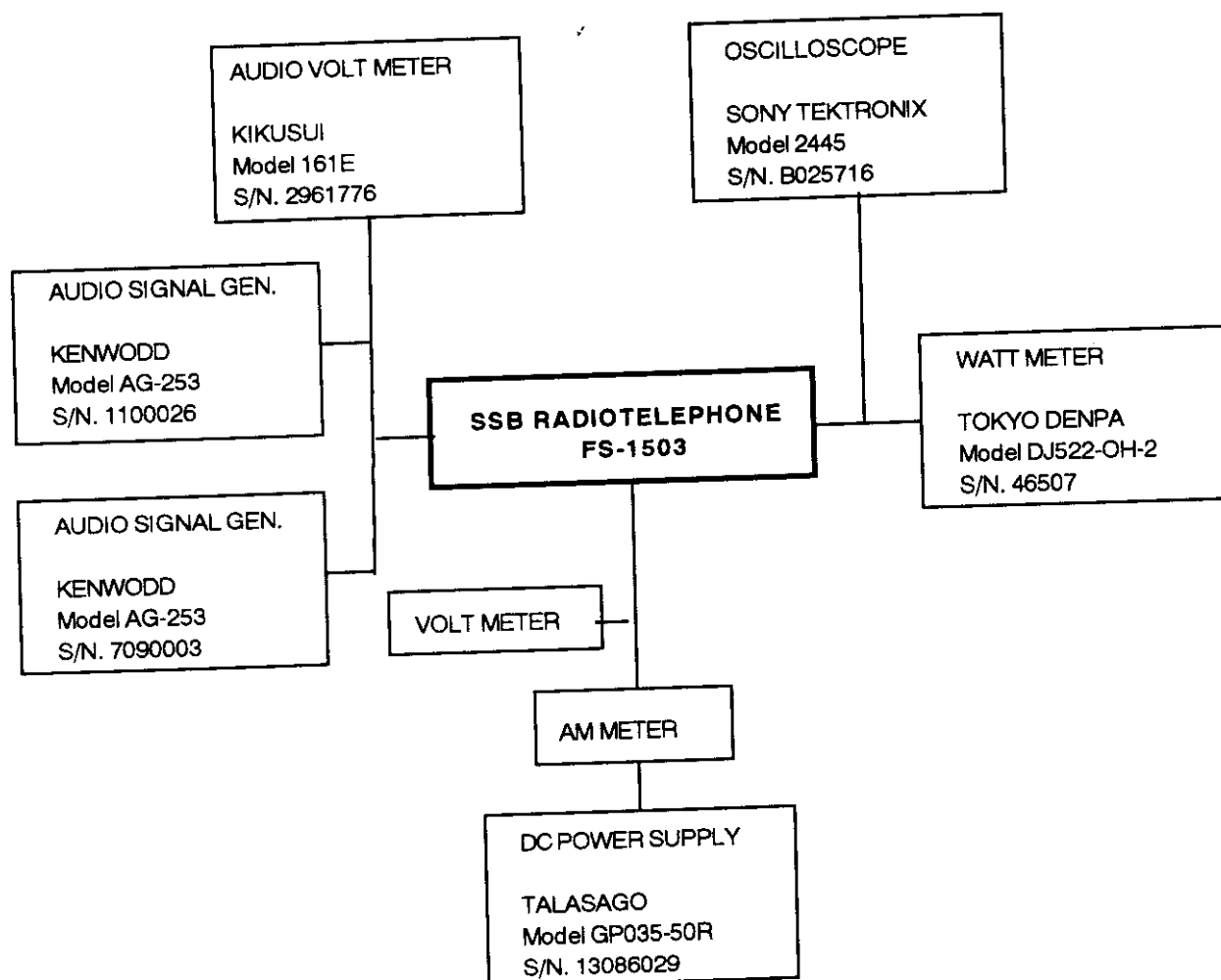


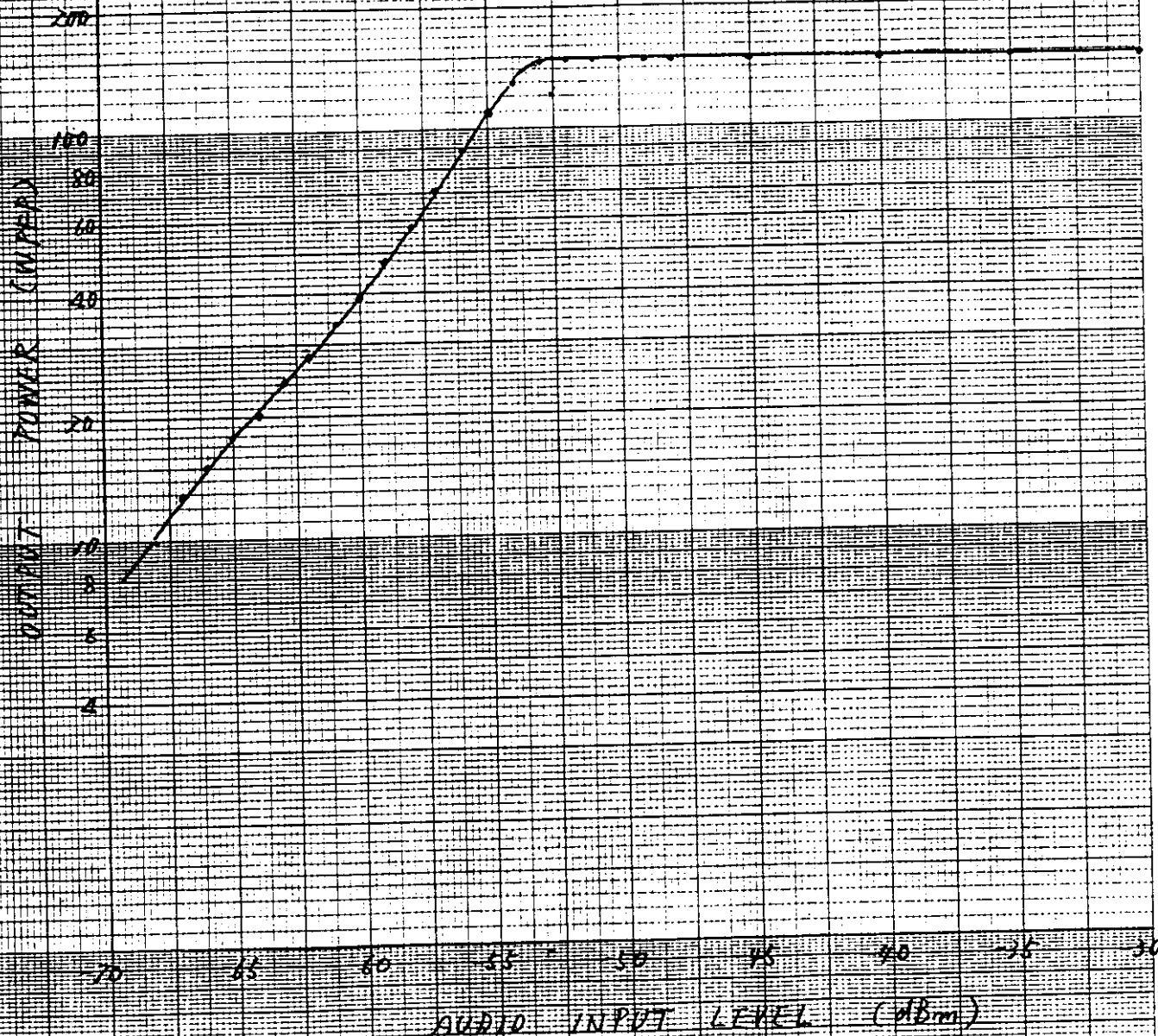
Fig. 4.2.1

4.2.2 Test Result

Measurement is made on frequency 4065 kHz. The results are shown in Fig. 4.2.2.

FS-1503

POWER LIMITING VS AUDIO INPUT



F = 4000 Hz

Fig. 4.2.2 Power Limiting vs Audio Input Voltage

4.3 Modulation Characteristics on H3E

4.3.1 Method of Measurement

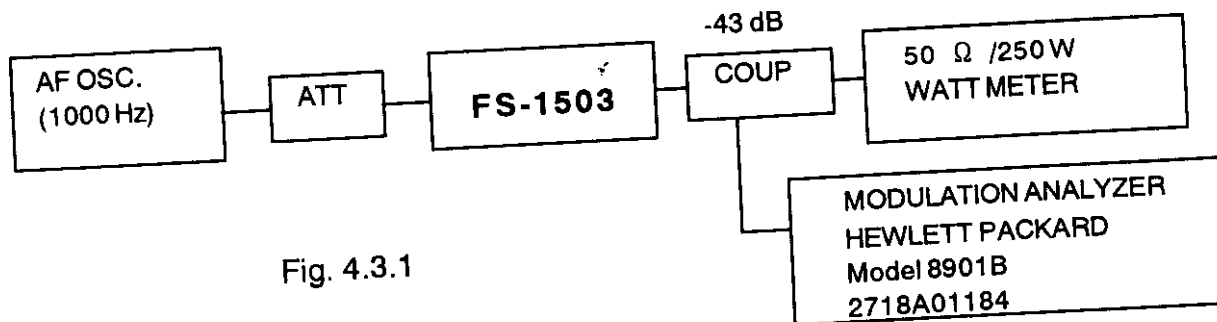


Fig. 4.3.1

Transmit frequency is set to 2182 kHz. A single audio tone of 1000 Hz is applied to the transmitter mic input. The tone level is varied and modulation percentage measured for each level step.

4.3.2 Test Result

The results are shown in graph form in Fig. 4.3.2.

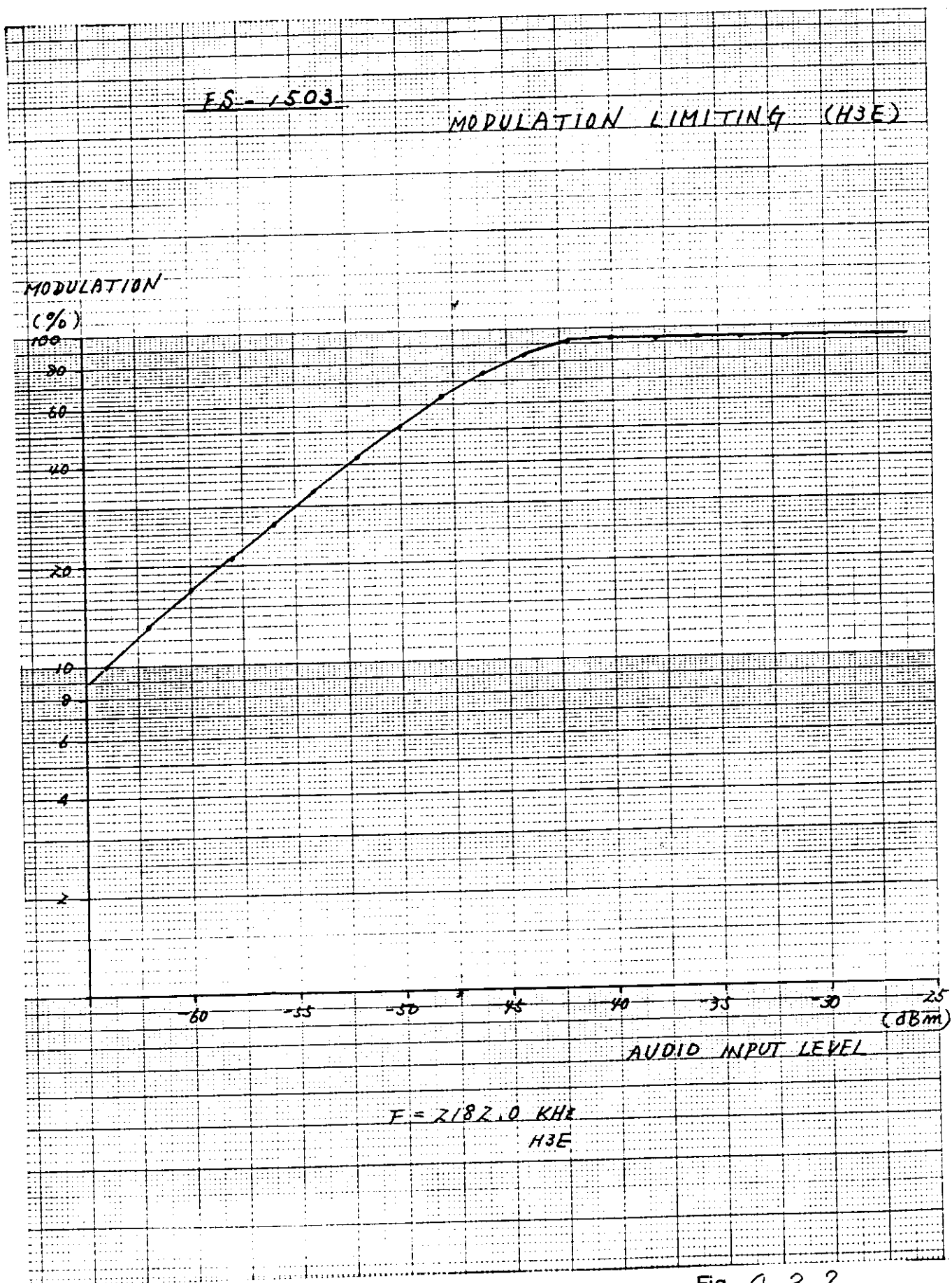


Fig. 4.3.2

5 OCCUPIED BANDWIDTH (FCC Rule Part 2.989)

5.1 Method of Measurement

The FS-1503 is connected with measuring equipment as shown in Fig. 5.1.

2 audio tones of 400 Hz and 1800 Hz are applied, in equal level, to the transmitter. The level is adjusted to 10 dB above the level producing PEP output of 150 W for test frequencies 4 MHz or below. On H3E a single tone is used.

The output is monitored with Spectrum Analyzer with settings of span 50 kHz, IF bandwidth (resolution bandwidth) 300 Hz and video bandwidth 300 Hz.

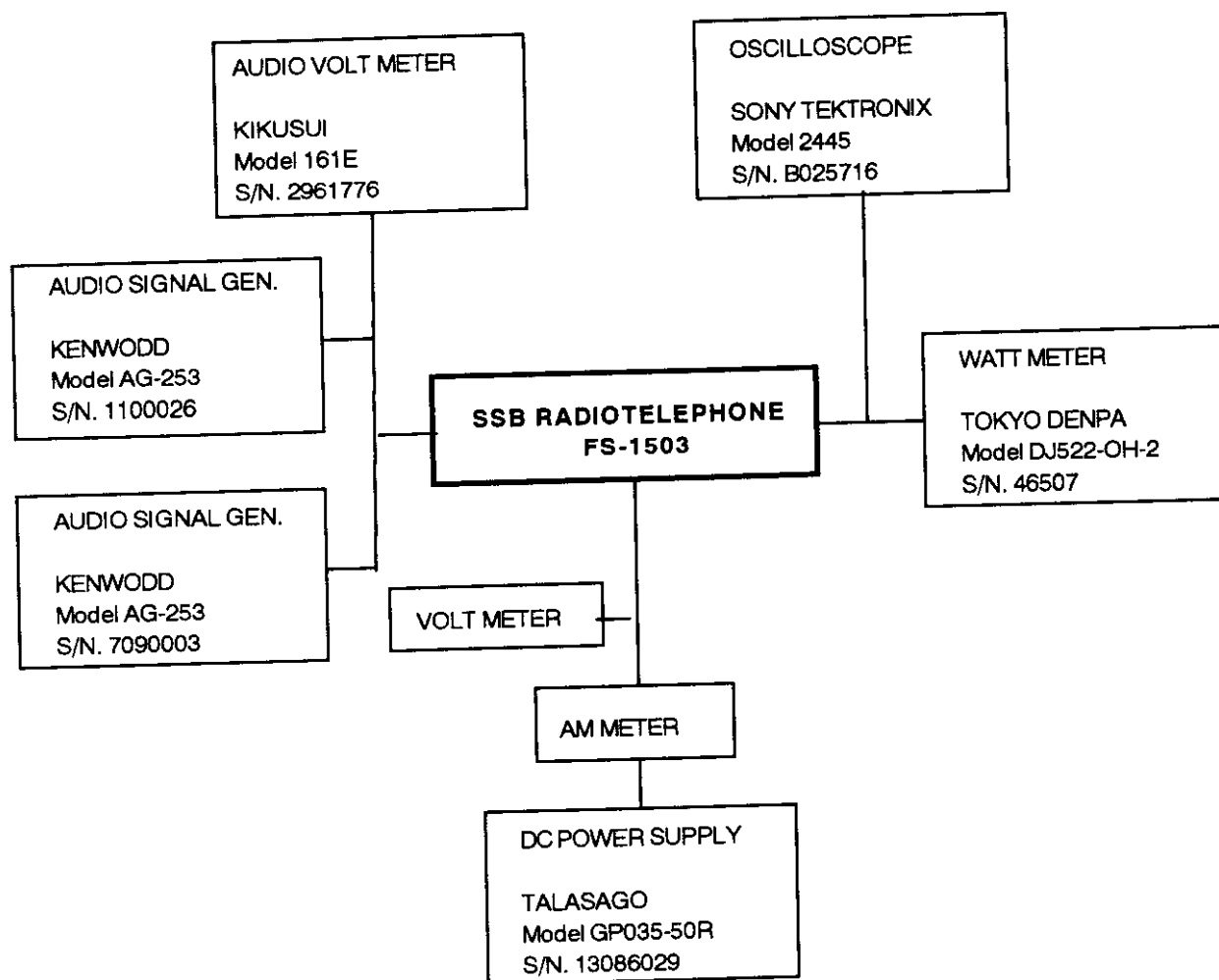


Fig. 5.1

5.2 Test Result

Results are shown in Fig. 5.2 through 5.22. Occupied bandwidth is a bandwidth in which 99 % of the mean power radiated falls.

REF -10.0 dBm ATT 10 dB

10 dB/

CAL. ON

CENTER

1.6061

VBW
MHz

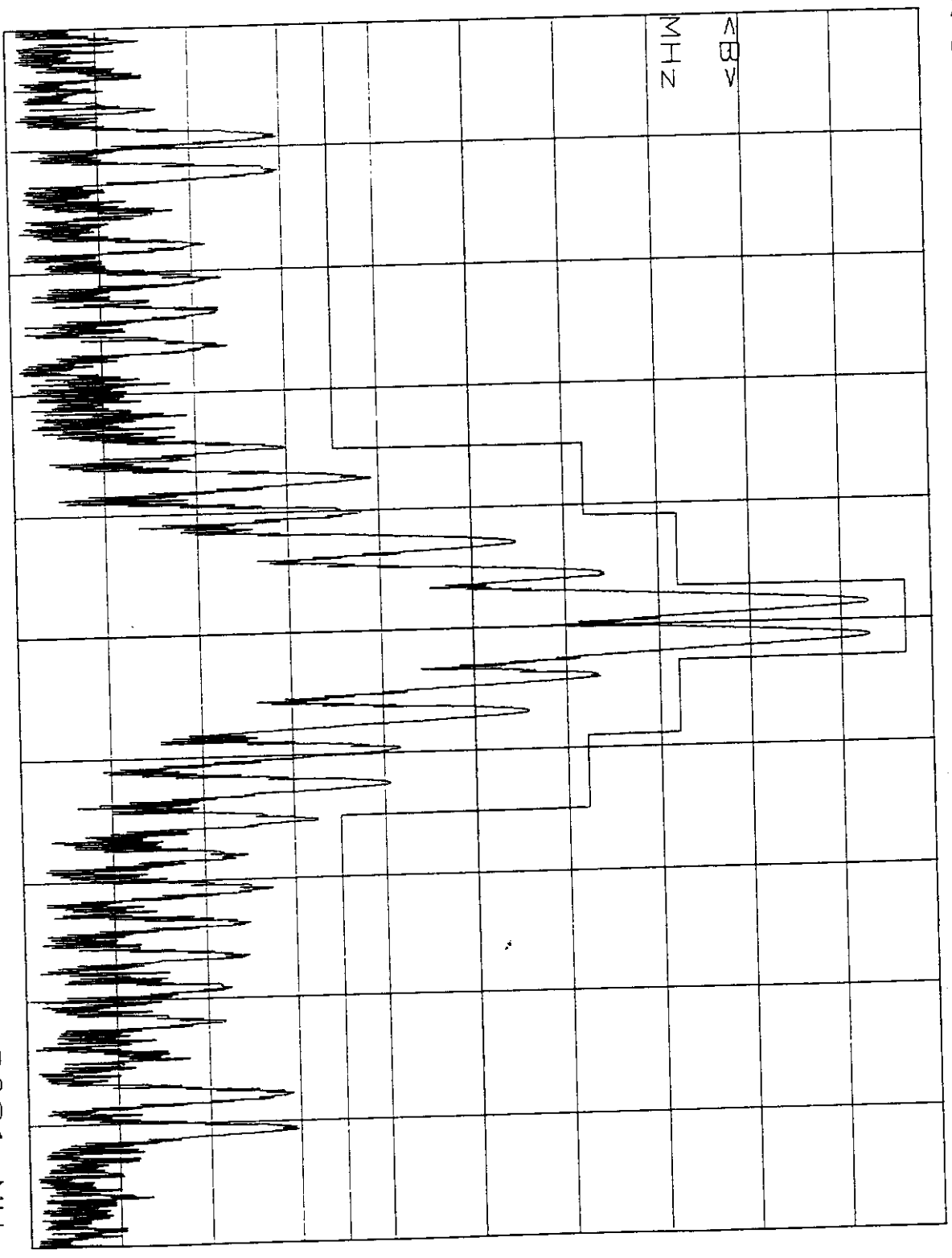
RBW

300 Hz

VBW

300 Hz

Fig. 5.2



SWP 3 s

SPAN 50.0 kHz

CENTER 1.6061 MHz

REF -10.0 dBm ATT 10 dB

10 dB/

CAL. ON

CENTER

2.1831

MHz

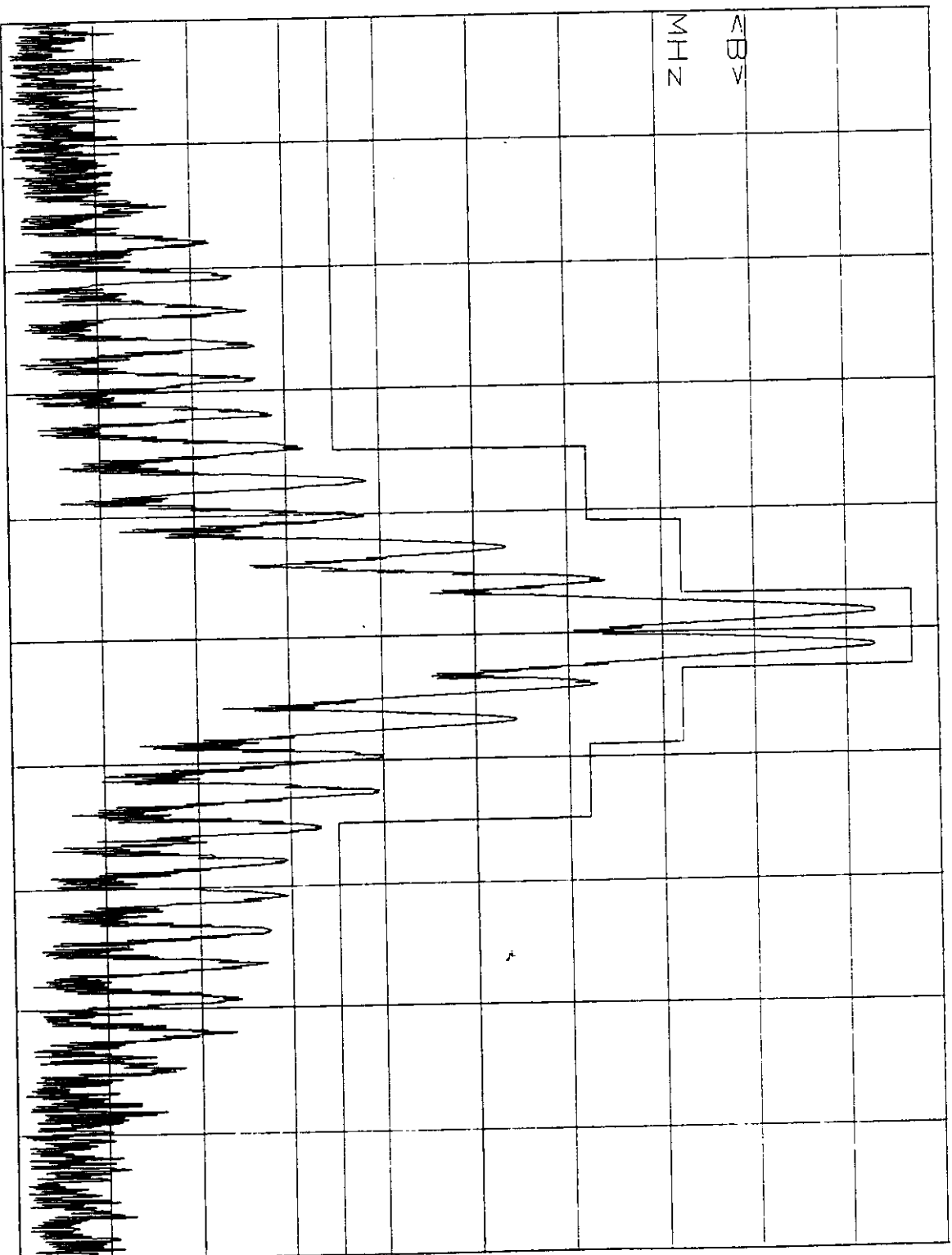
RBW

300 Hz

VBW

300 Hz

Fig. 5.3



$f = 2182 \text{ kHz}$ H3E

REF -10.0 dBm ATT 10 dB

10 dB/

CAL. ON

CENTER

2.1827

MHz

RBW

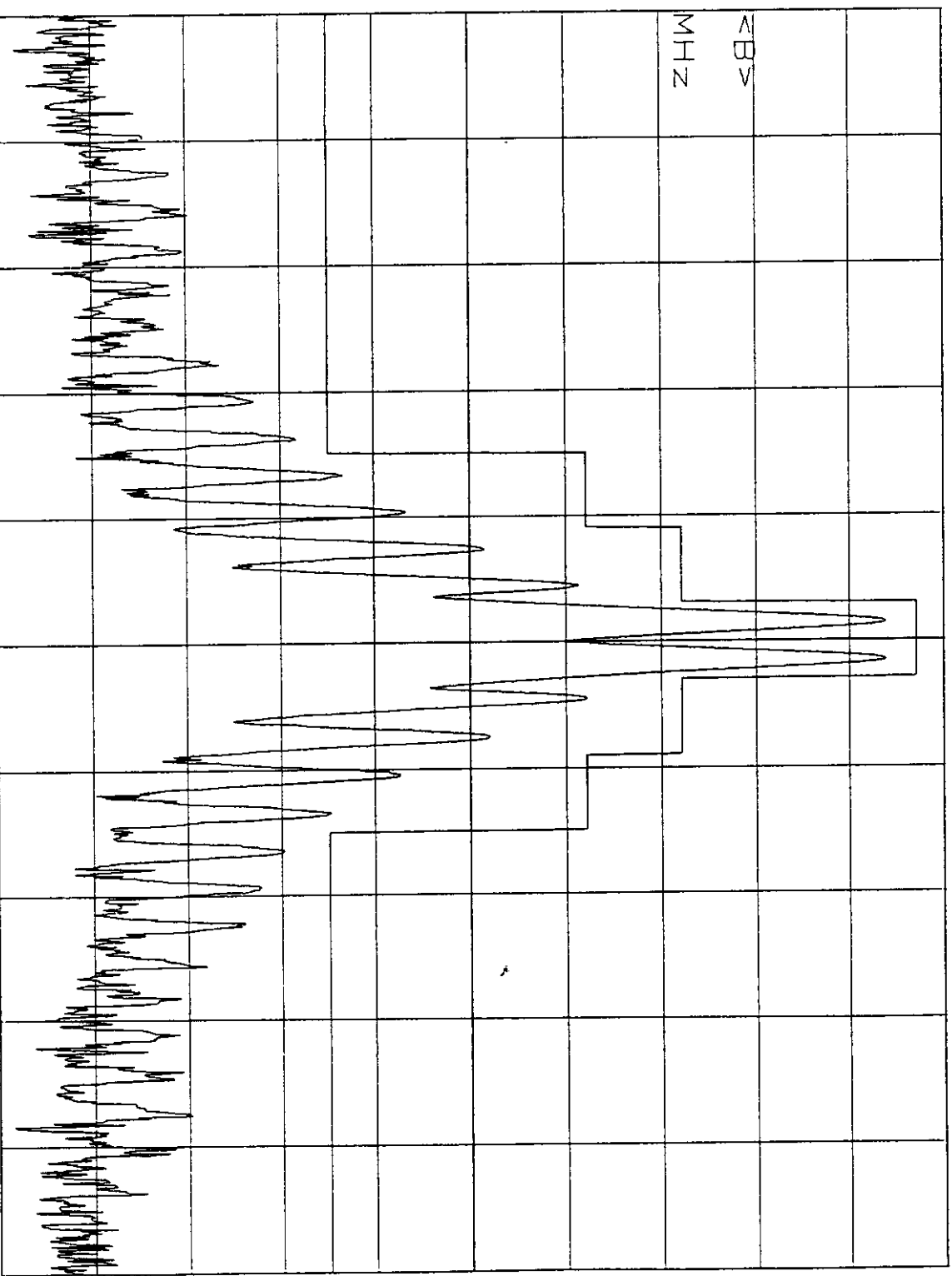
300 Hz

POS PK

VBW

300 Hz

Fig.5.4



SWP 3 s

SPAN 50.0 kHz

CENTER 2.1827 MHz

REF -10.0 dBm ATT 10 dB

10 dB/

CAL. ON

CENTER

3.0241
MHz

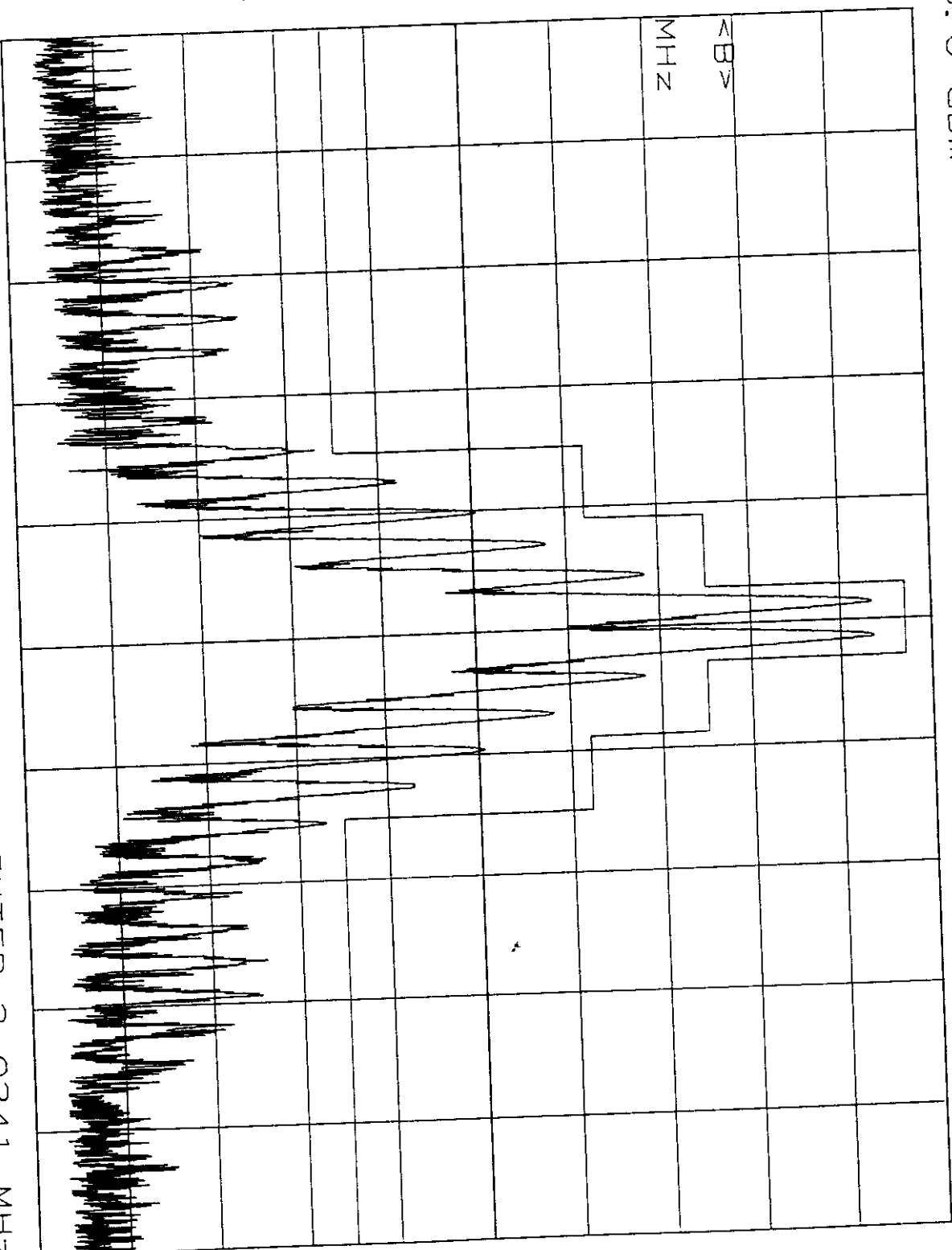
RBW

300 Hz

VBW

300 Hz

Fig. 5.5



SWP 3 S

SPAN 50.0 kHz

CENTER 3.0241 MHz

REF -10.0 dBm ATT 10 dB

10 dB/

CAL. ON

RBW

300 Hz

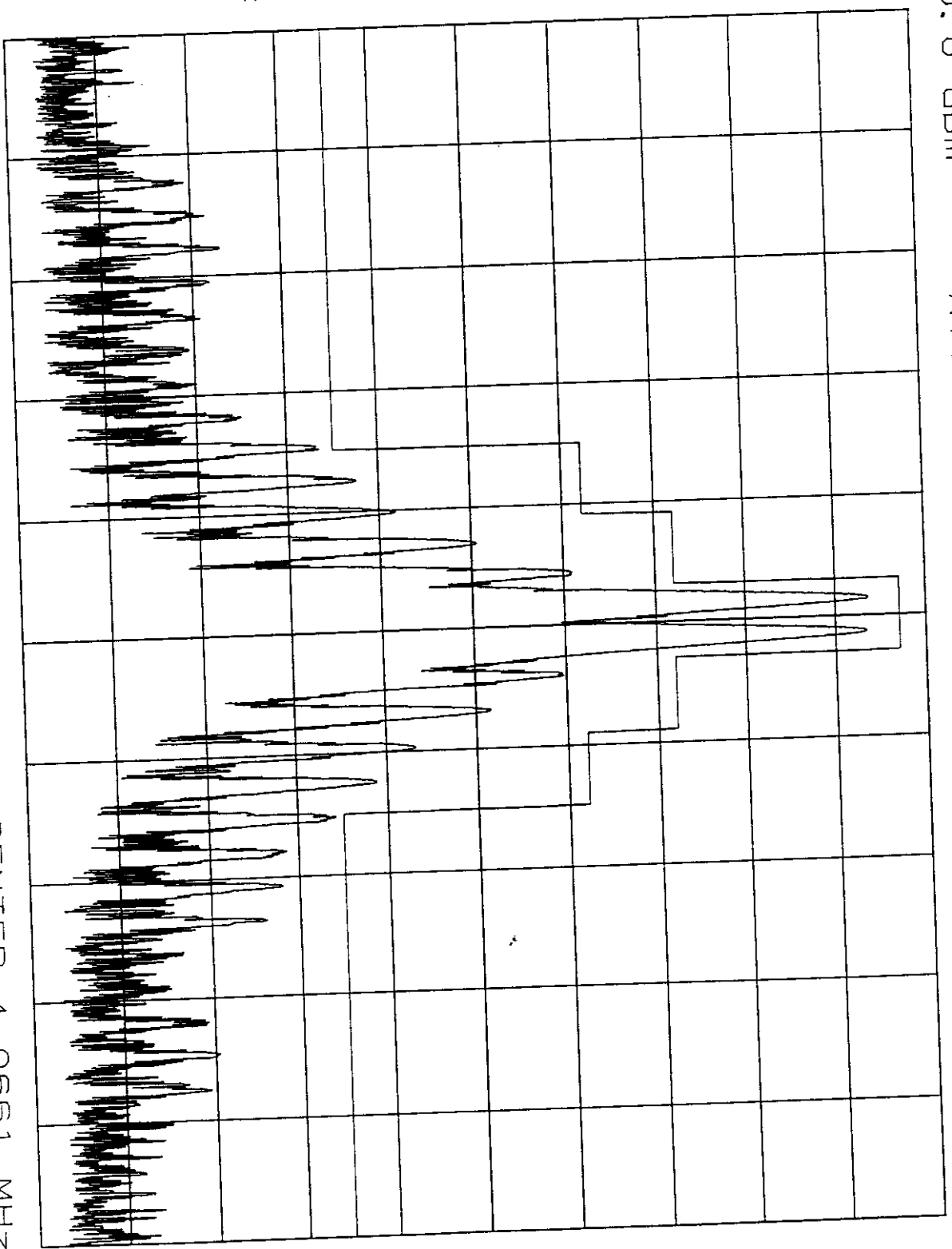
RBW

300 Hz

VBW

300 Hz

Fig. 5.6



SWP 3 s

SPAN 50.0 kHz

CENTER 4.0661 MHz

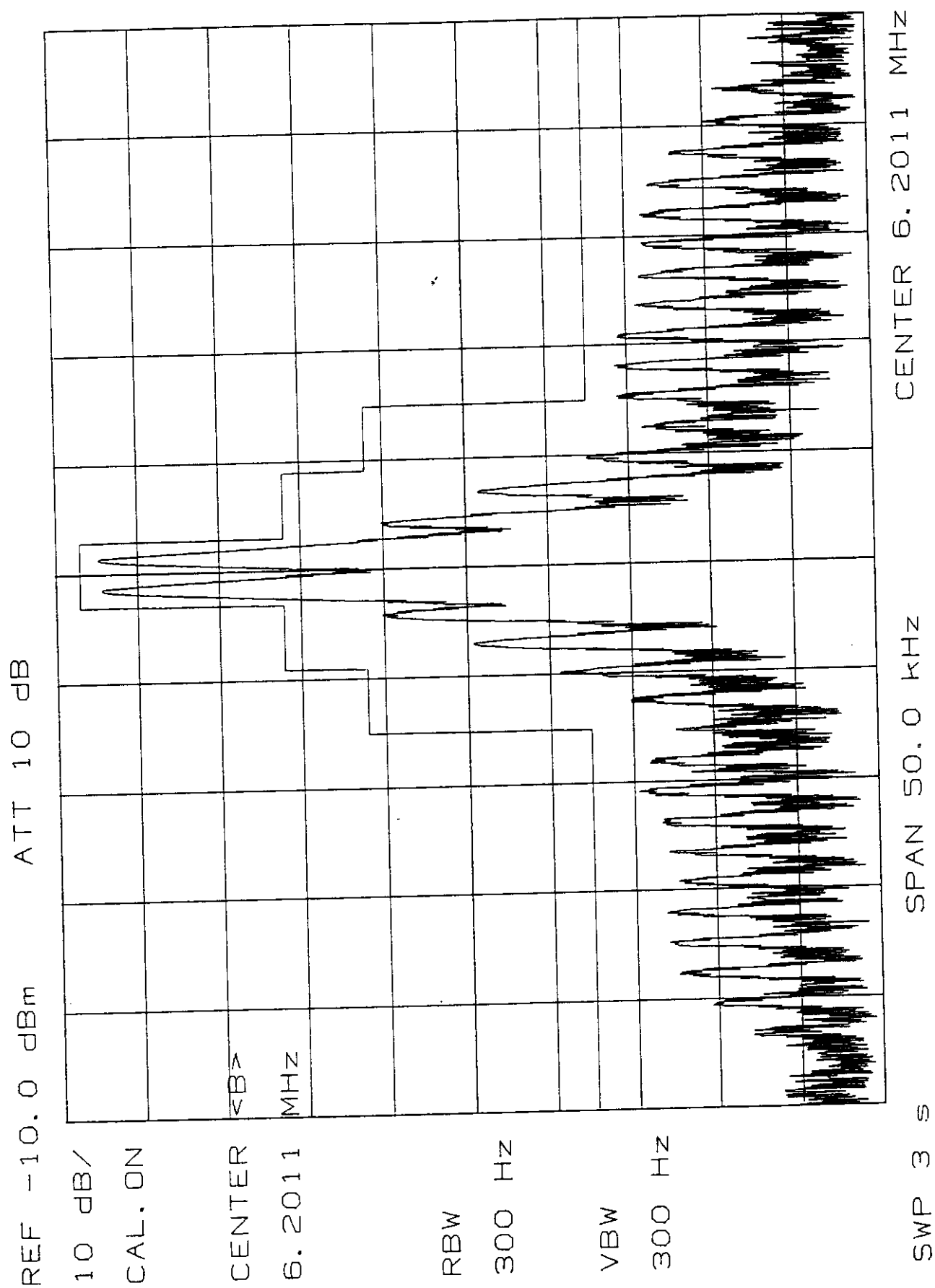


Fig. 5.7

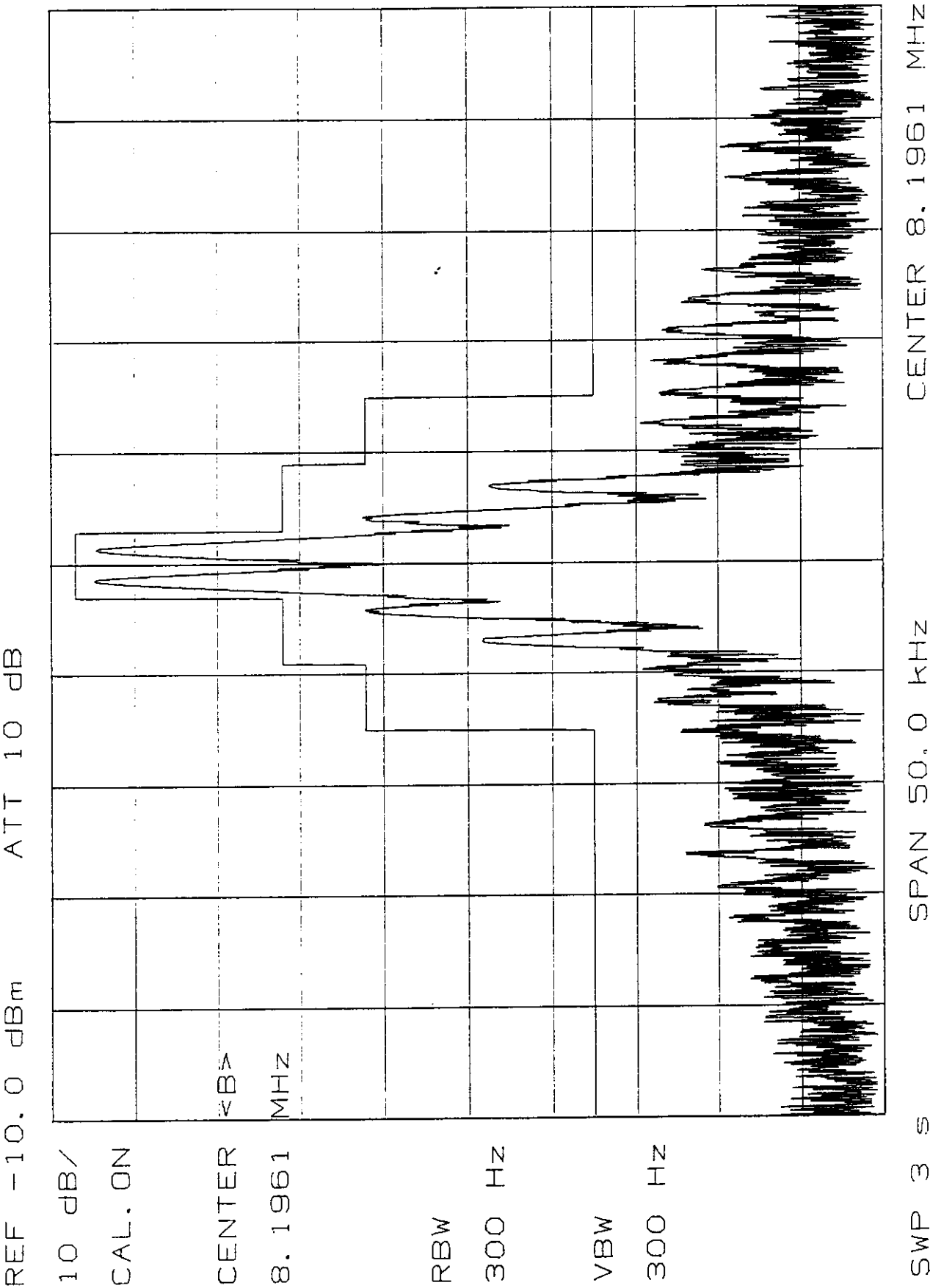


Fig. 5.8

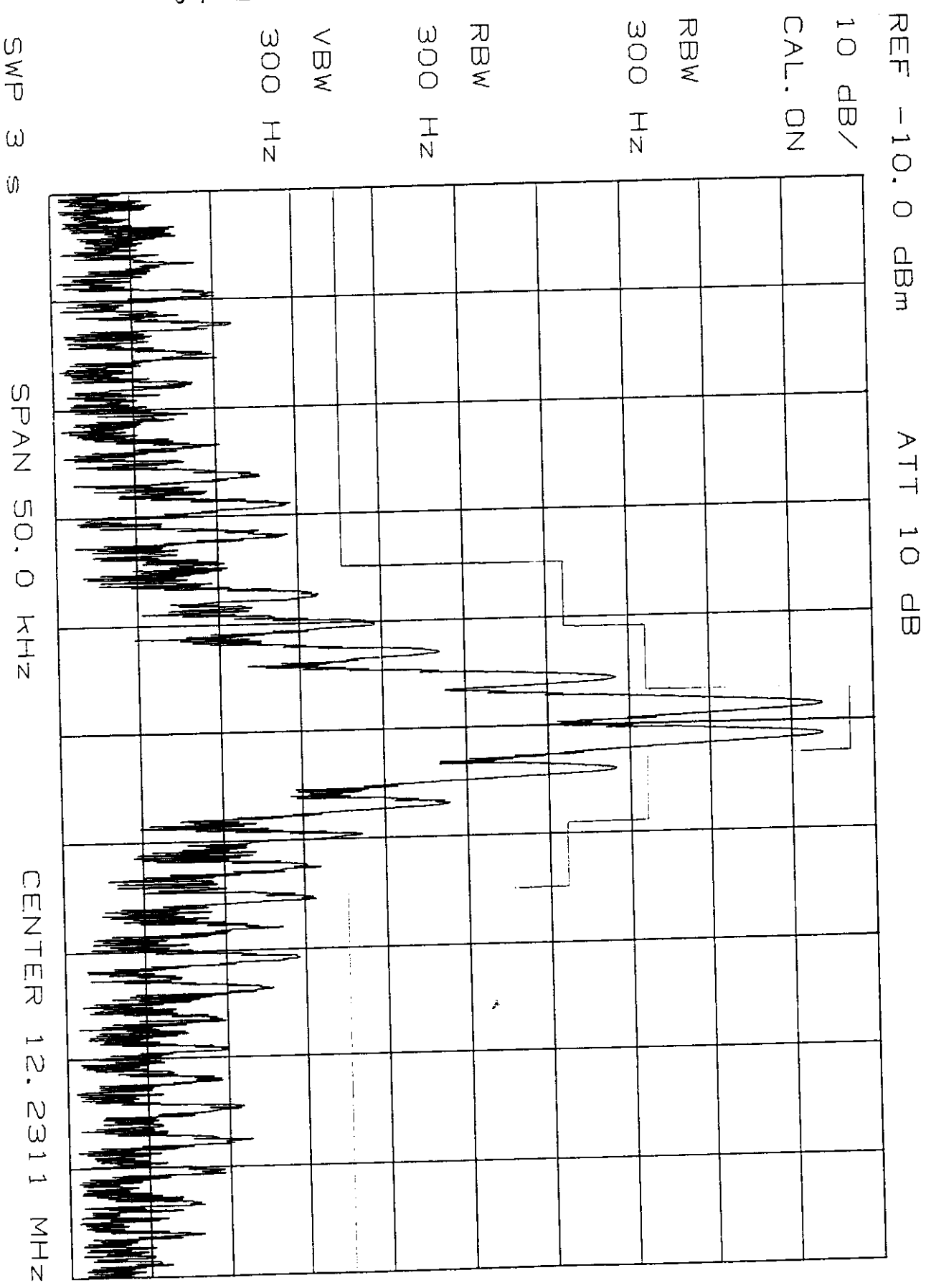


Fig. 5.9

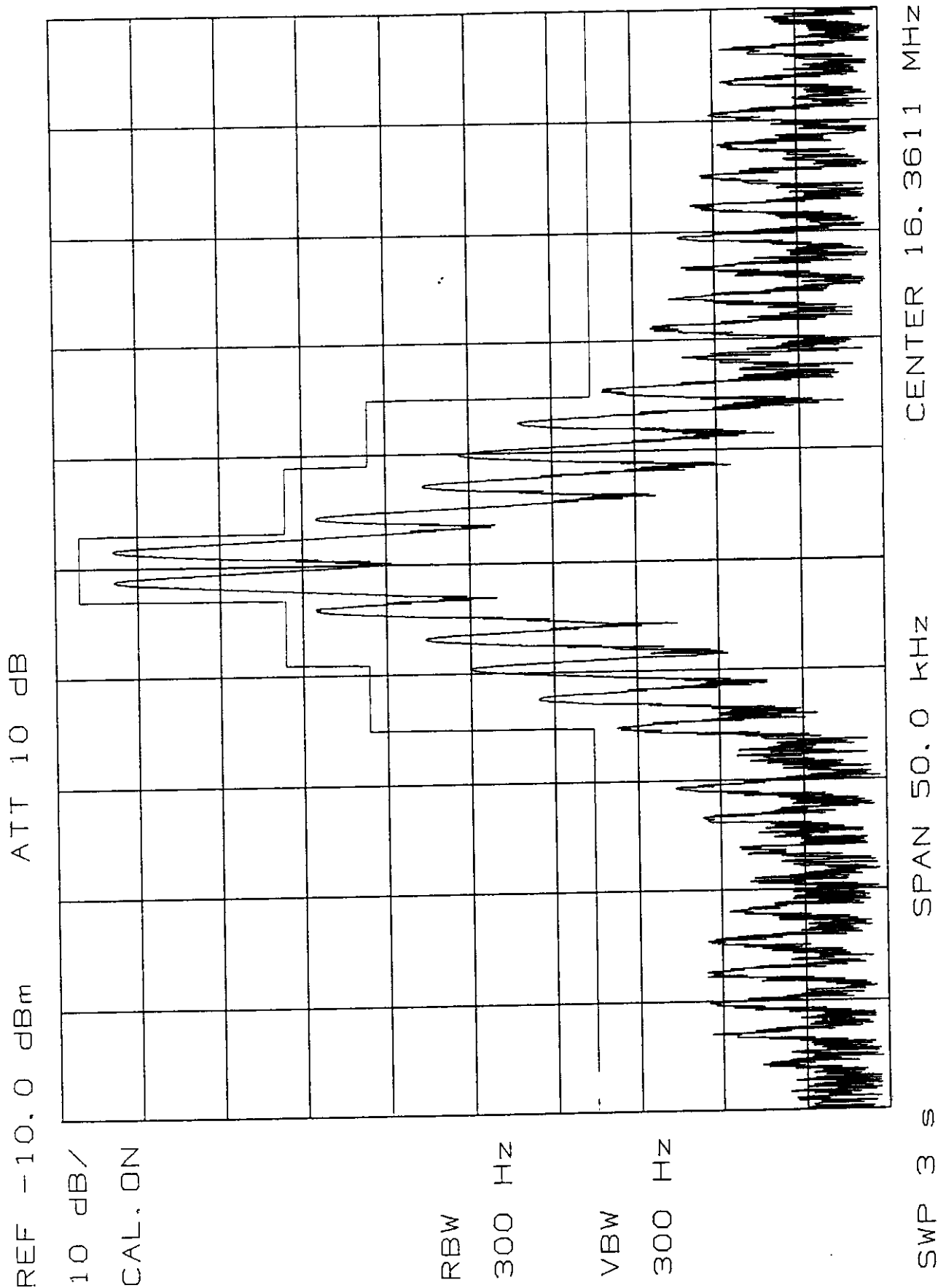


Fig. 5.10

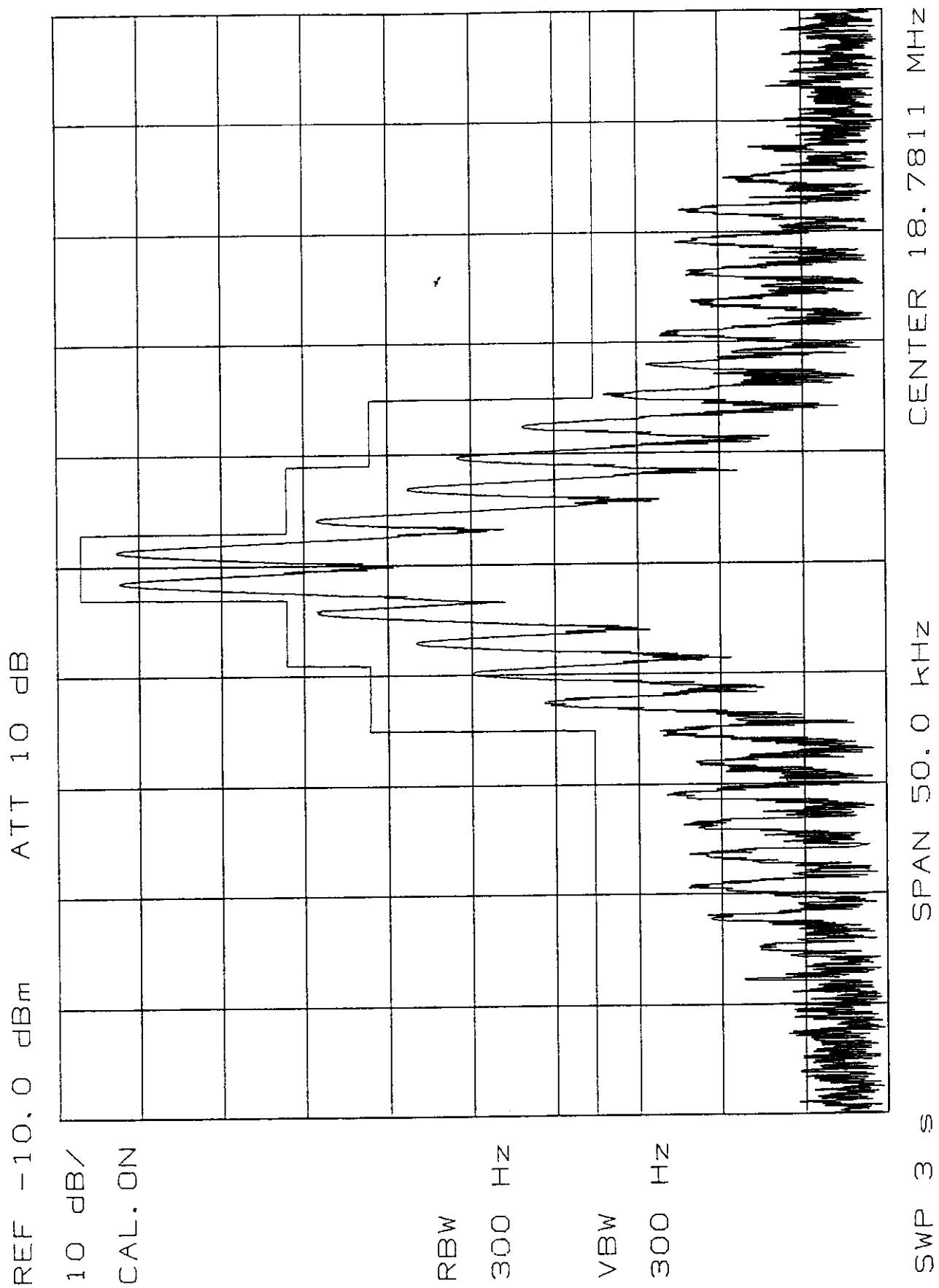


Fig. 5.11

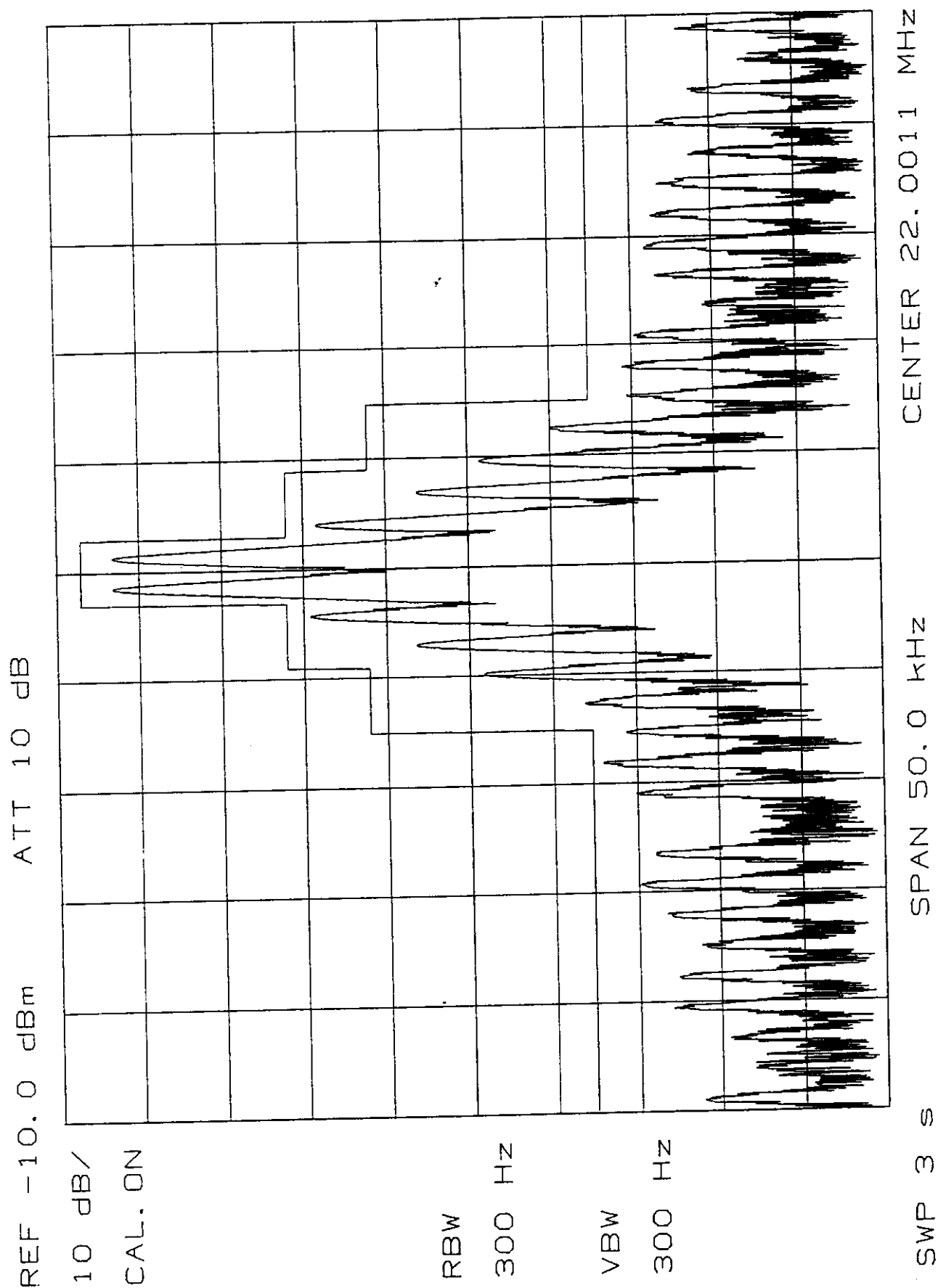


Fig. 5.12

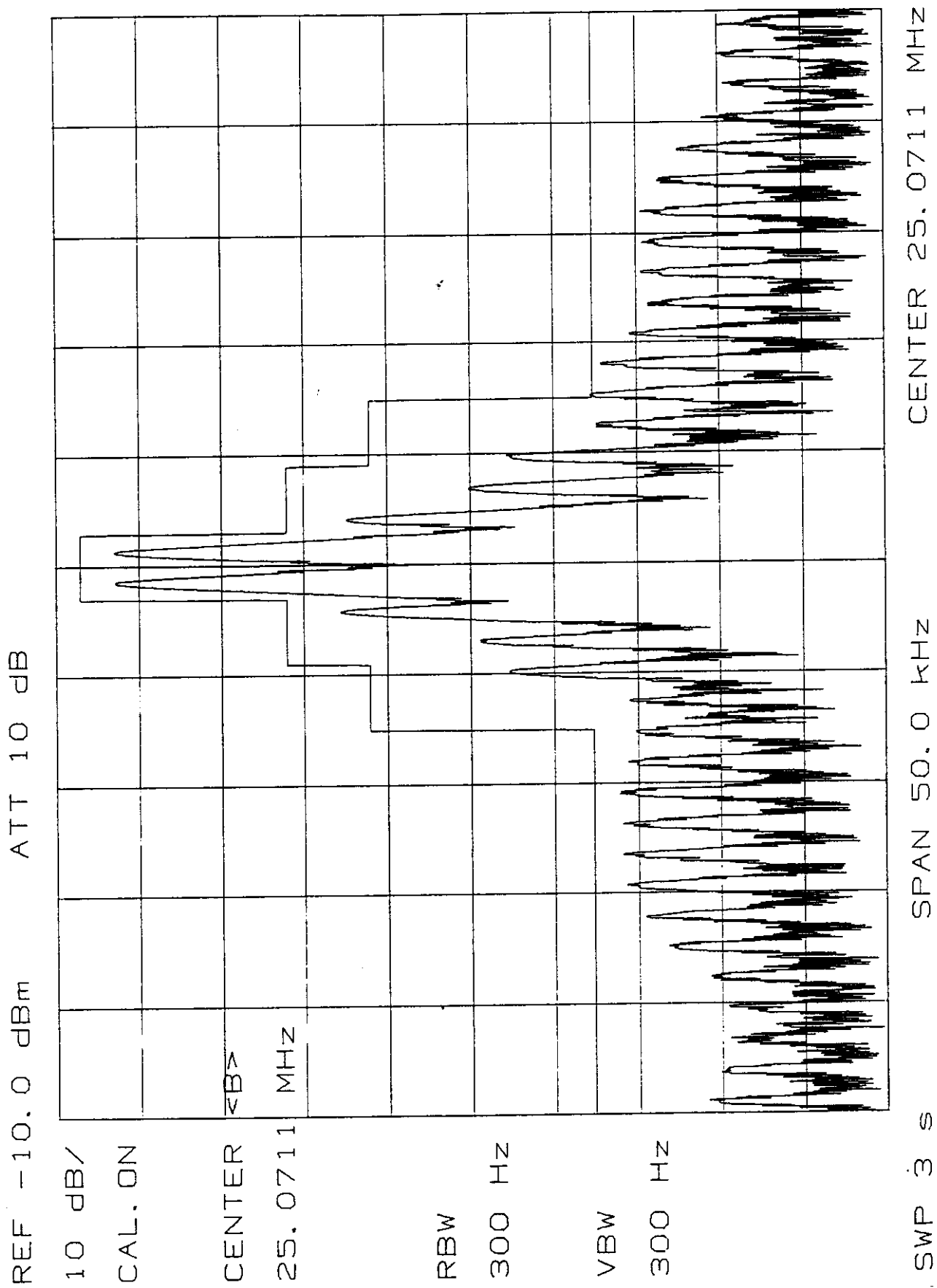


Fig. 5.13

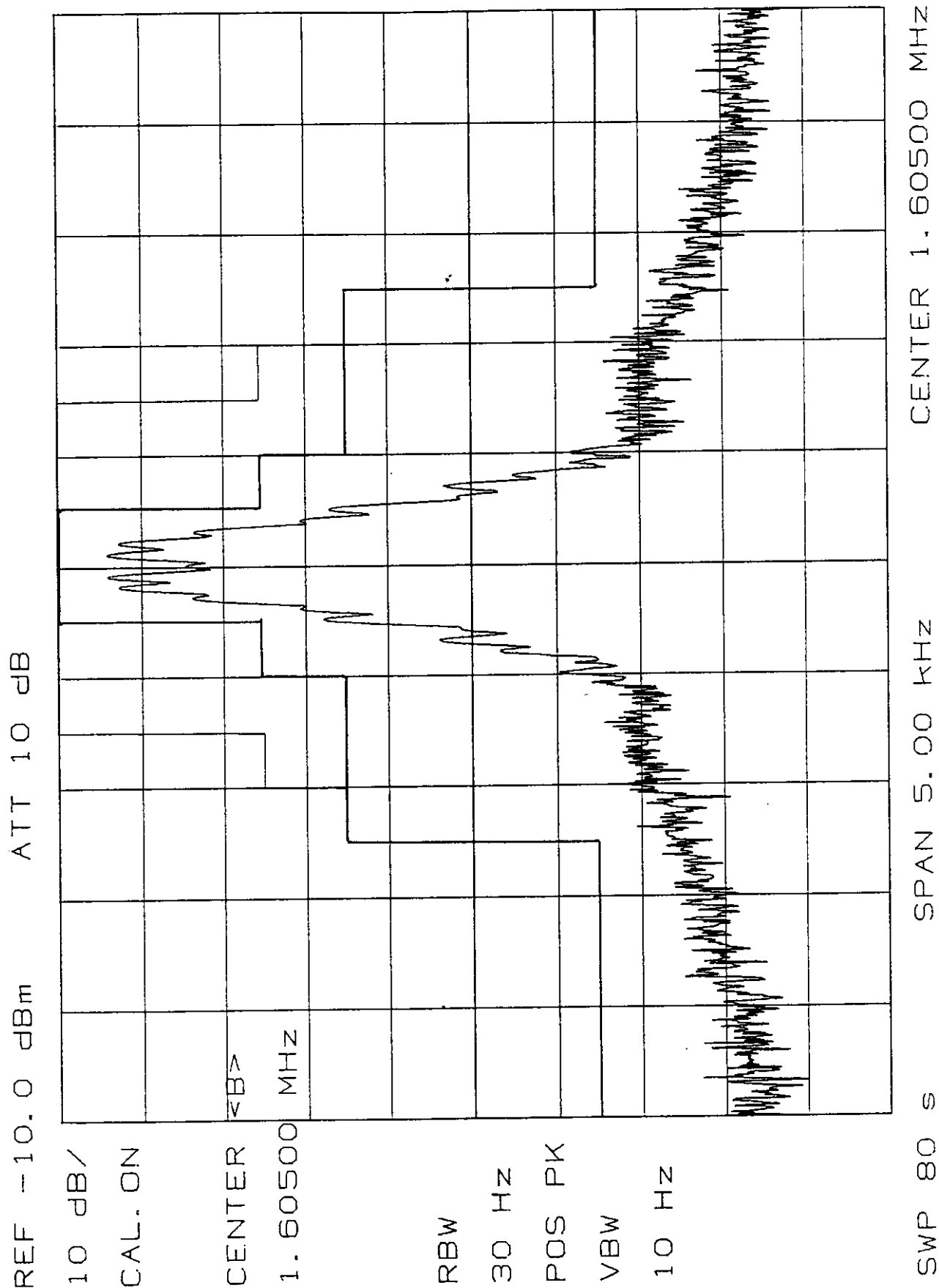


Fig. 5.14

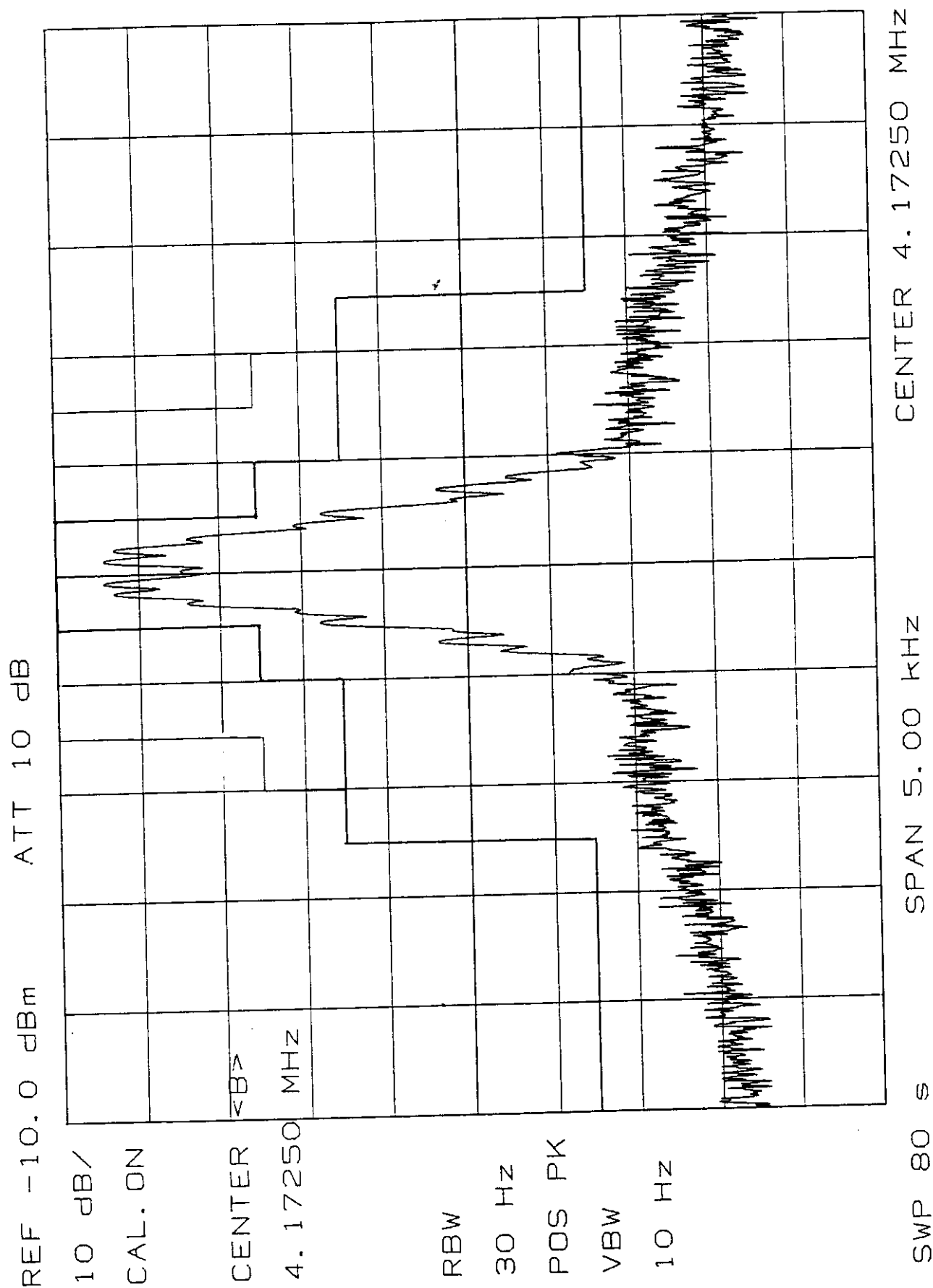


Fig. 5.15

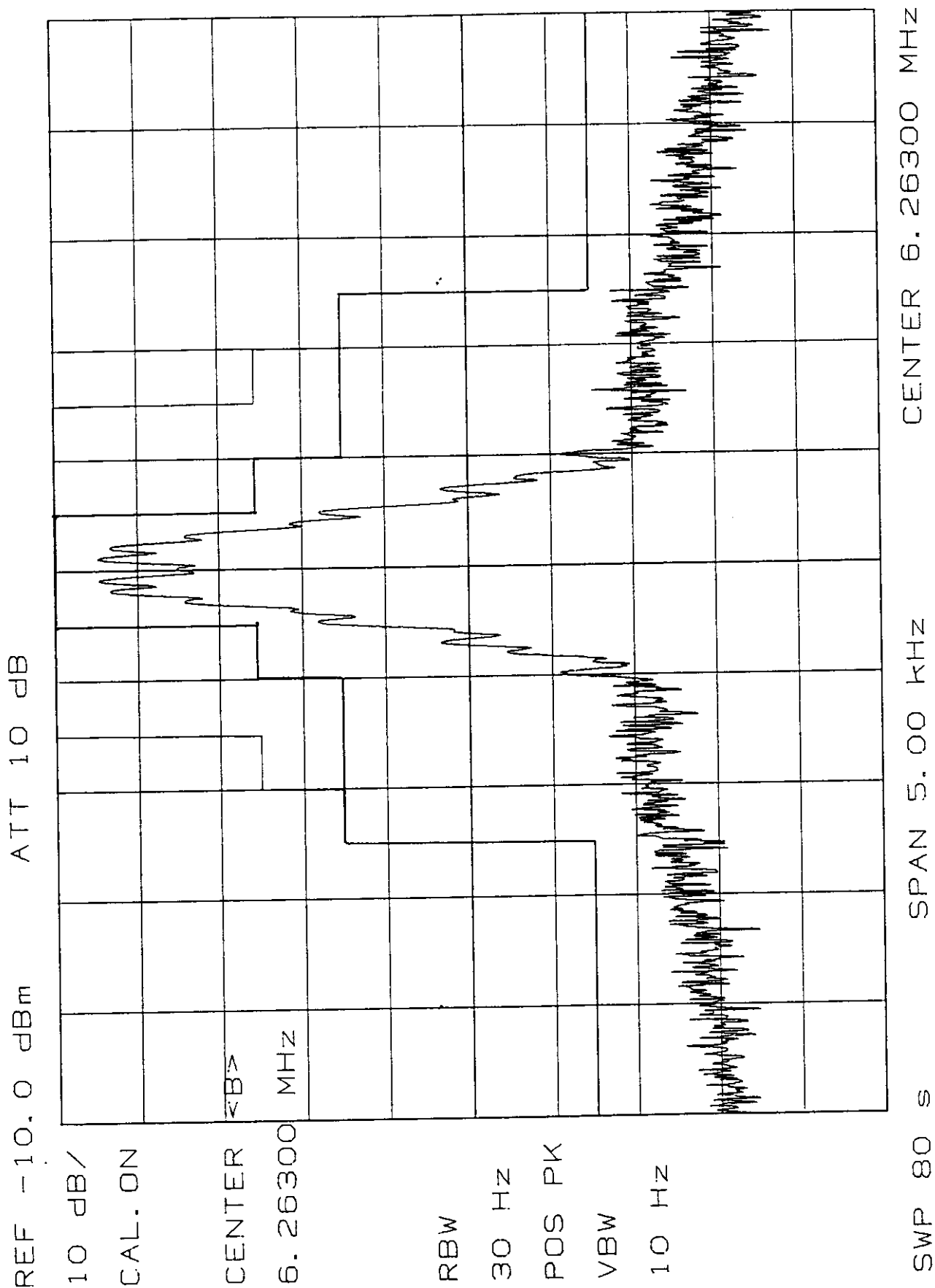


Fig. 5.16

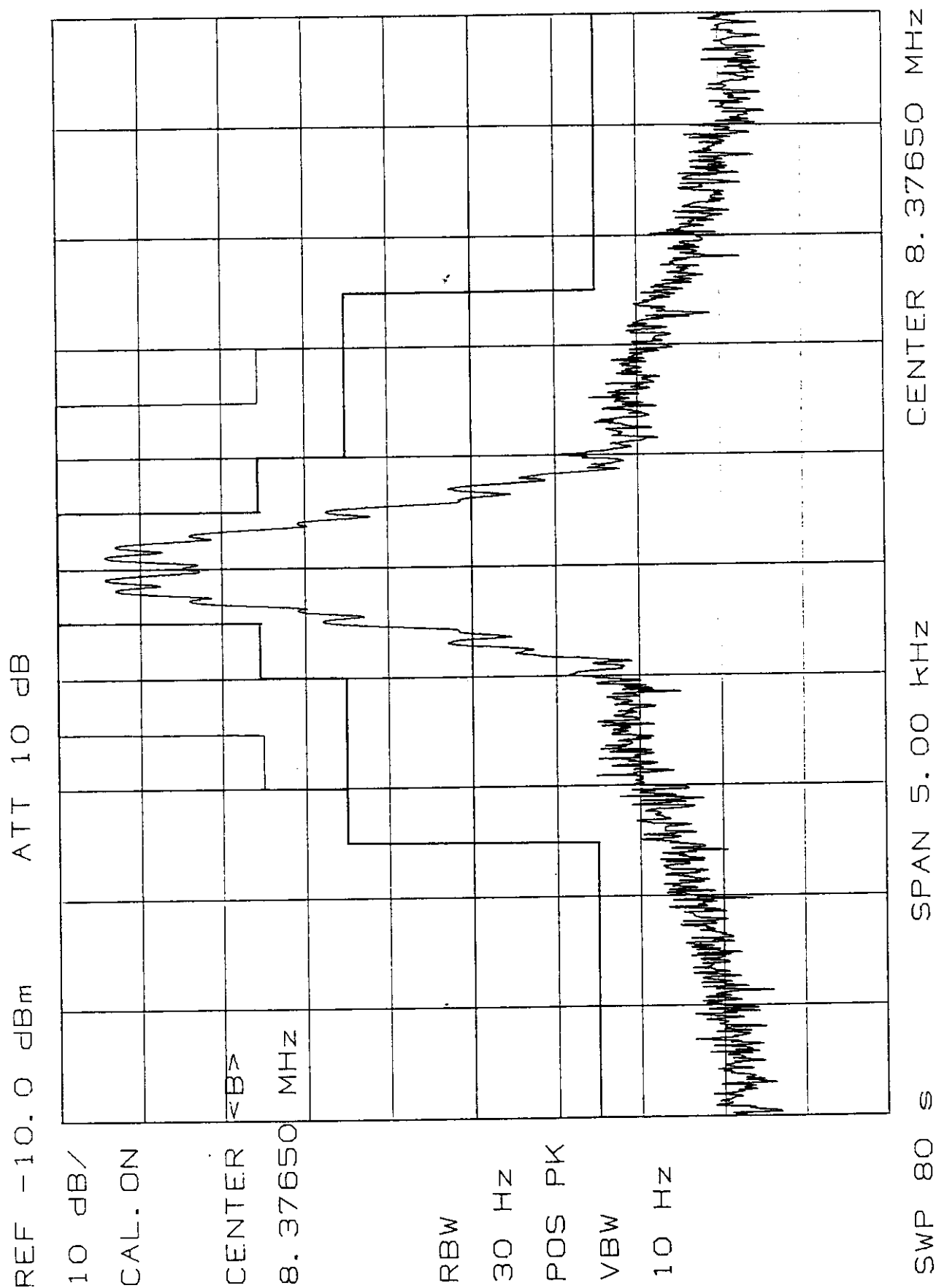


Fig. 5.17

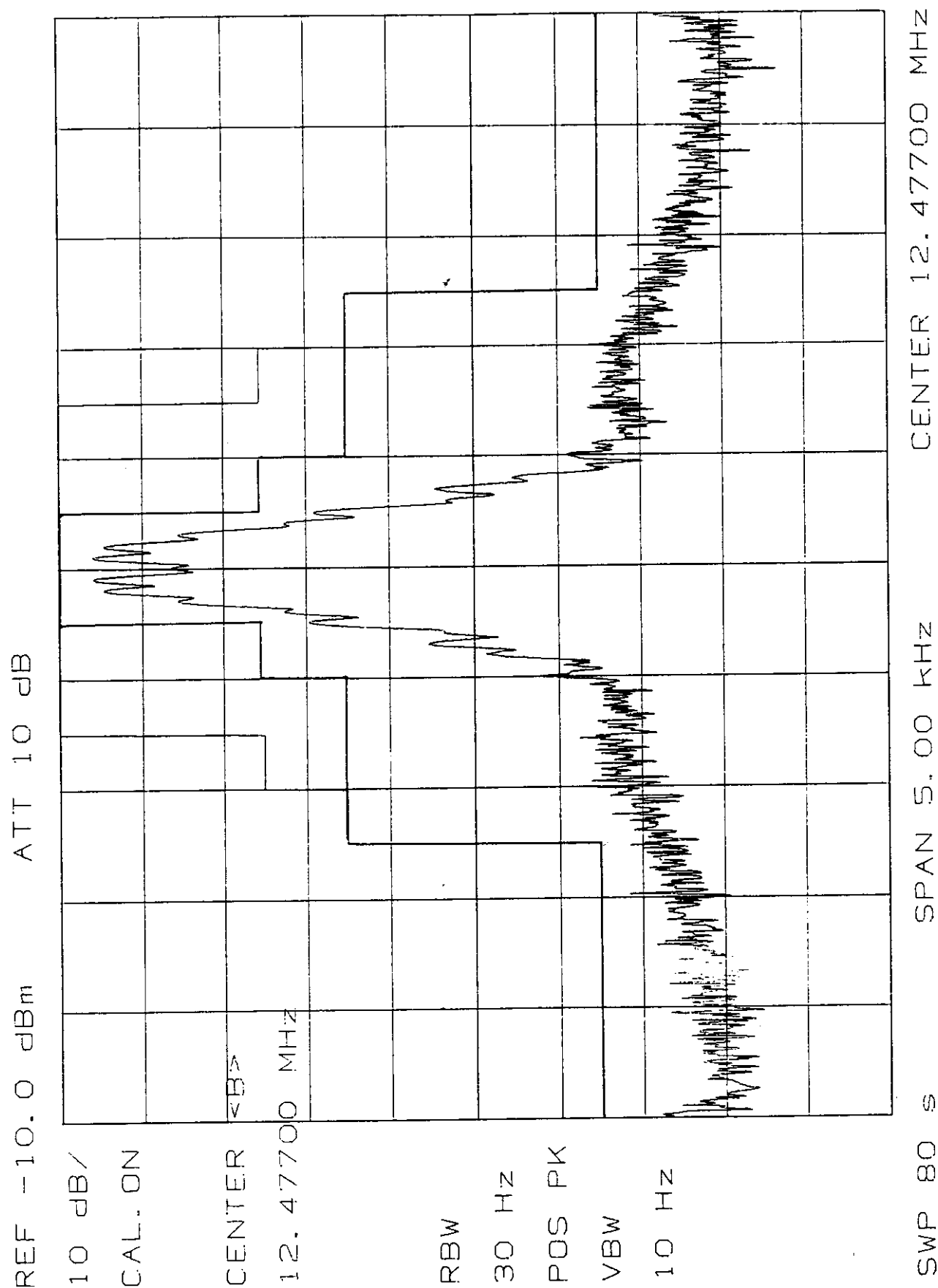


Fig. 5.18

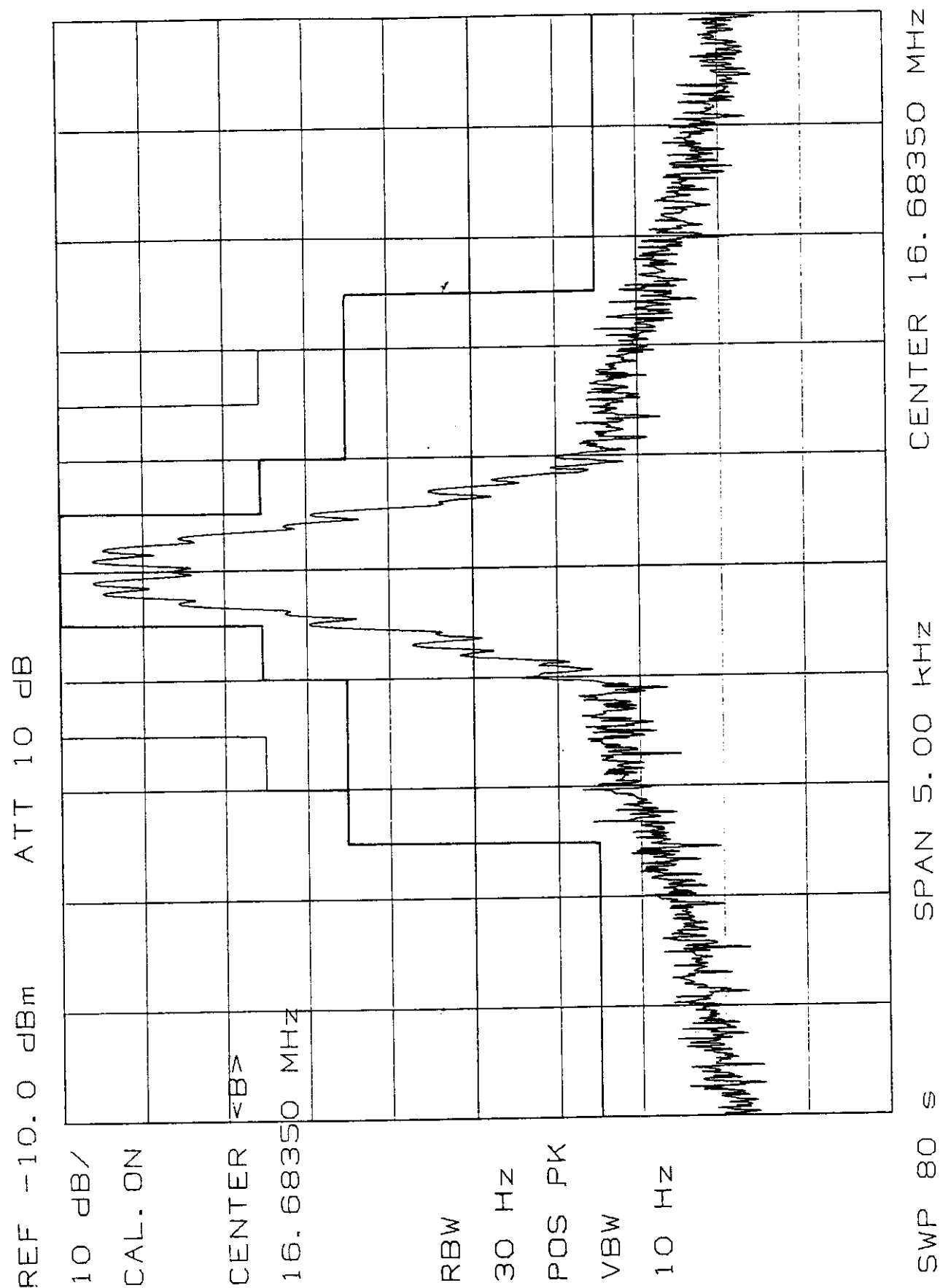


Fig. 5.19

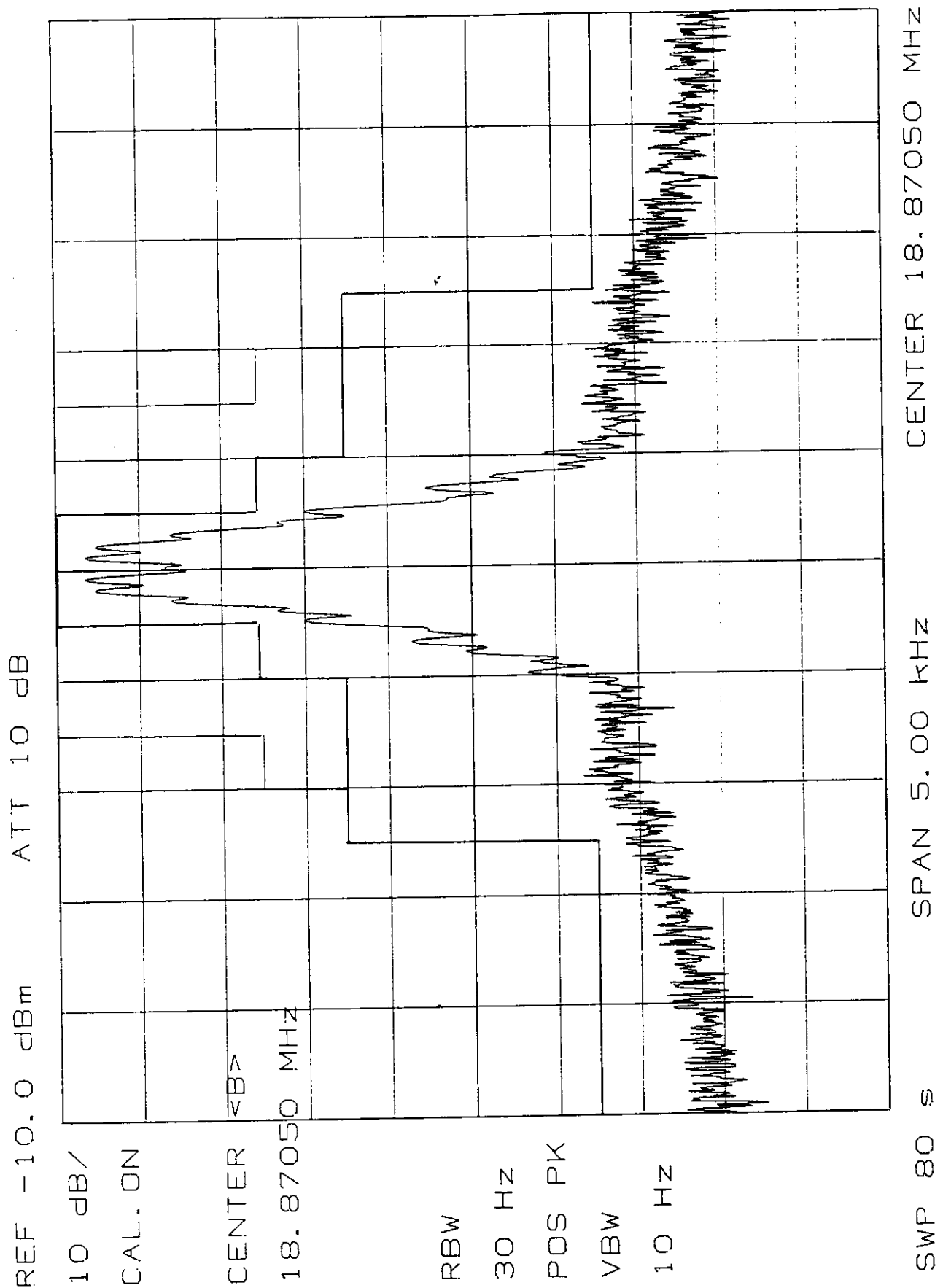


Fig. 5.20

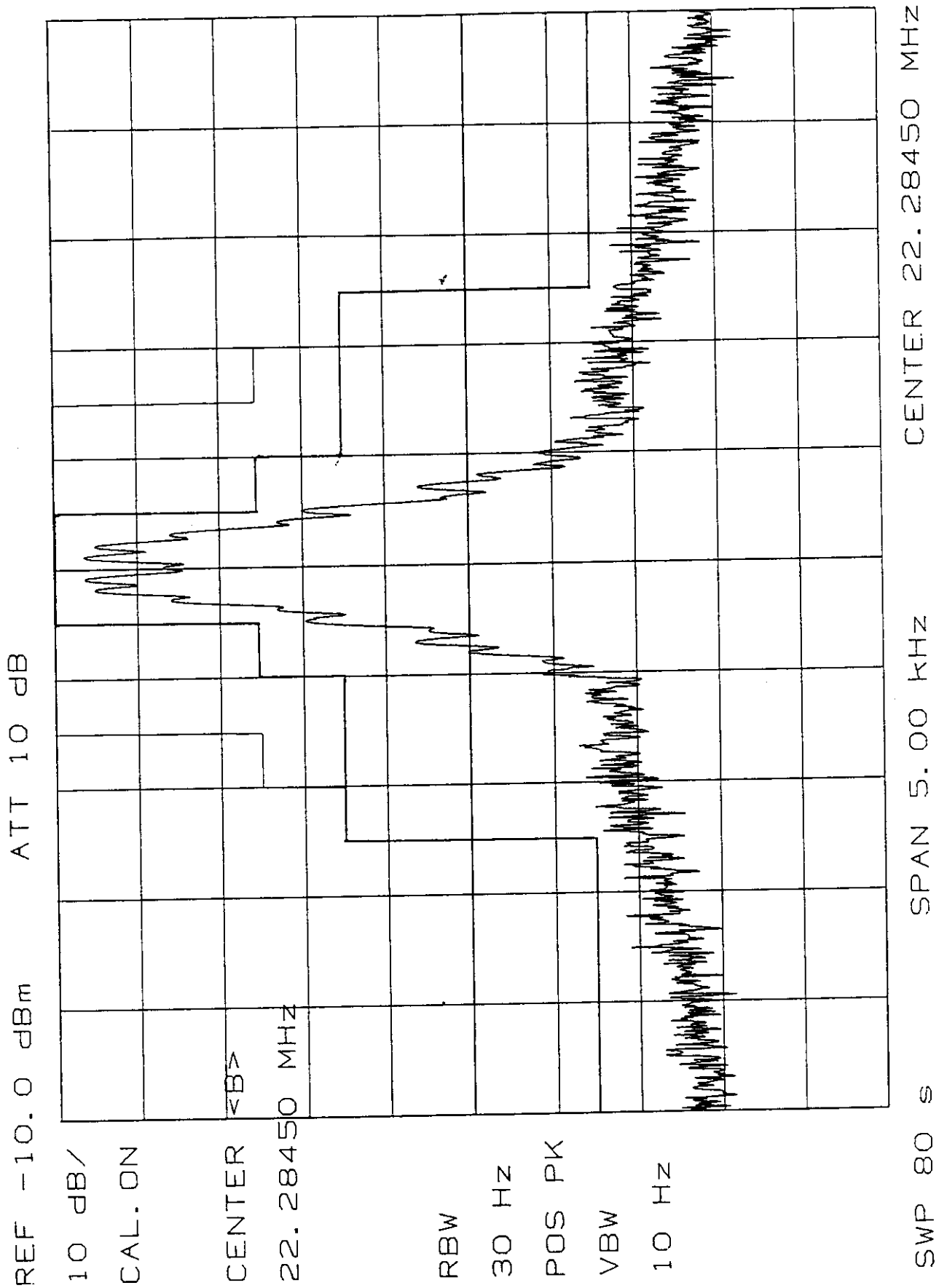


Fig. 5.21

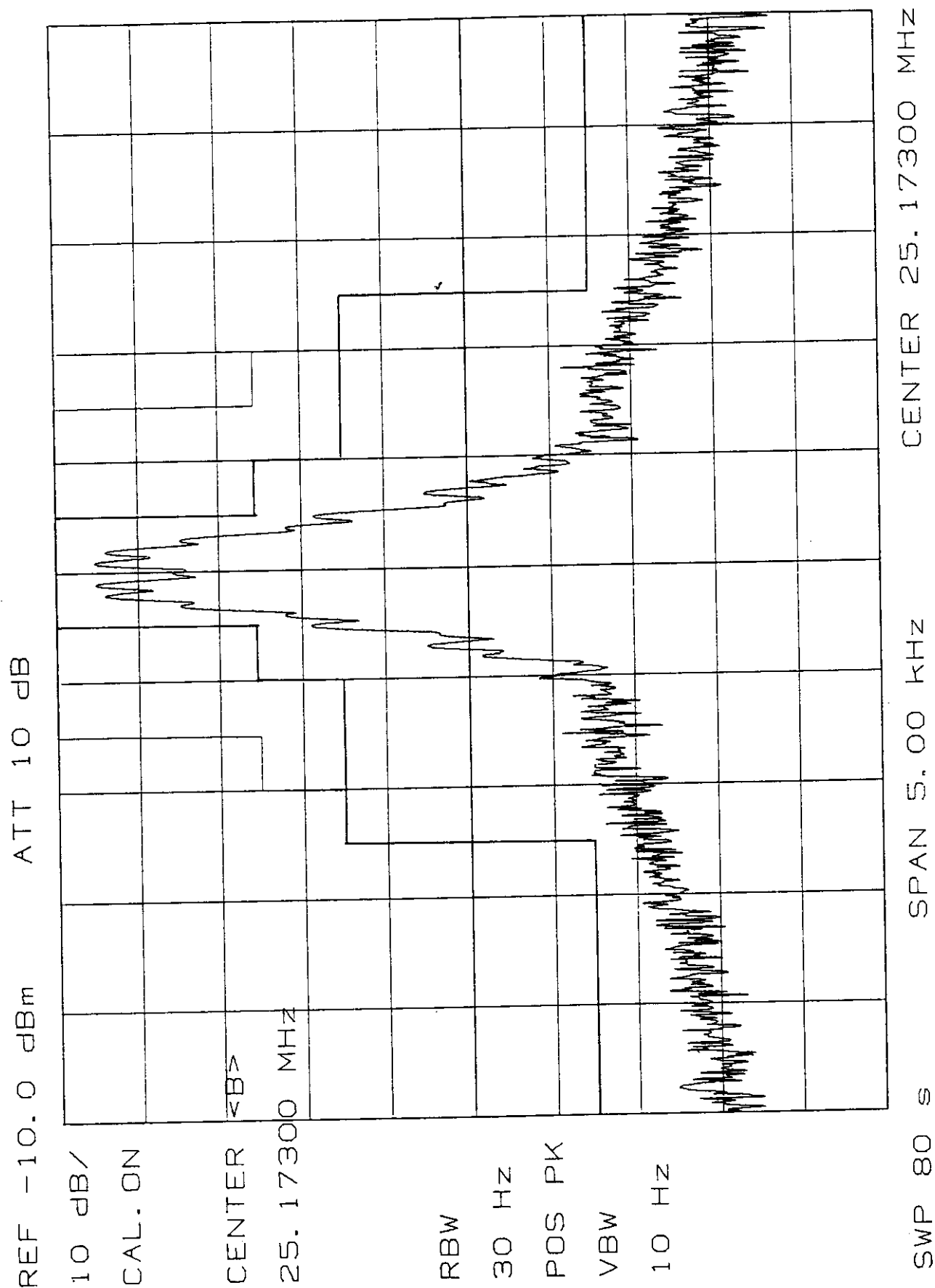


Fig. 5.22

6 EMISSION LIMITATIONS (FCC Rule Part 80.211)

6.1 Method of Measurement

The FS-1503 is connected with measuring equipment as in Fig. 6.1.

The transmitter is modulated with 2 audio tones 400 Hz and 1800 Hz in equal level. The input level is adjusted to 10 dB above the level producing PEP output of 150 W.

Spectrum over the frequency range ± 10 kHz of each test frequency is observed.

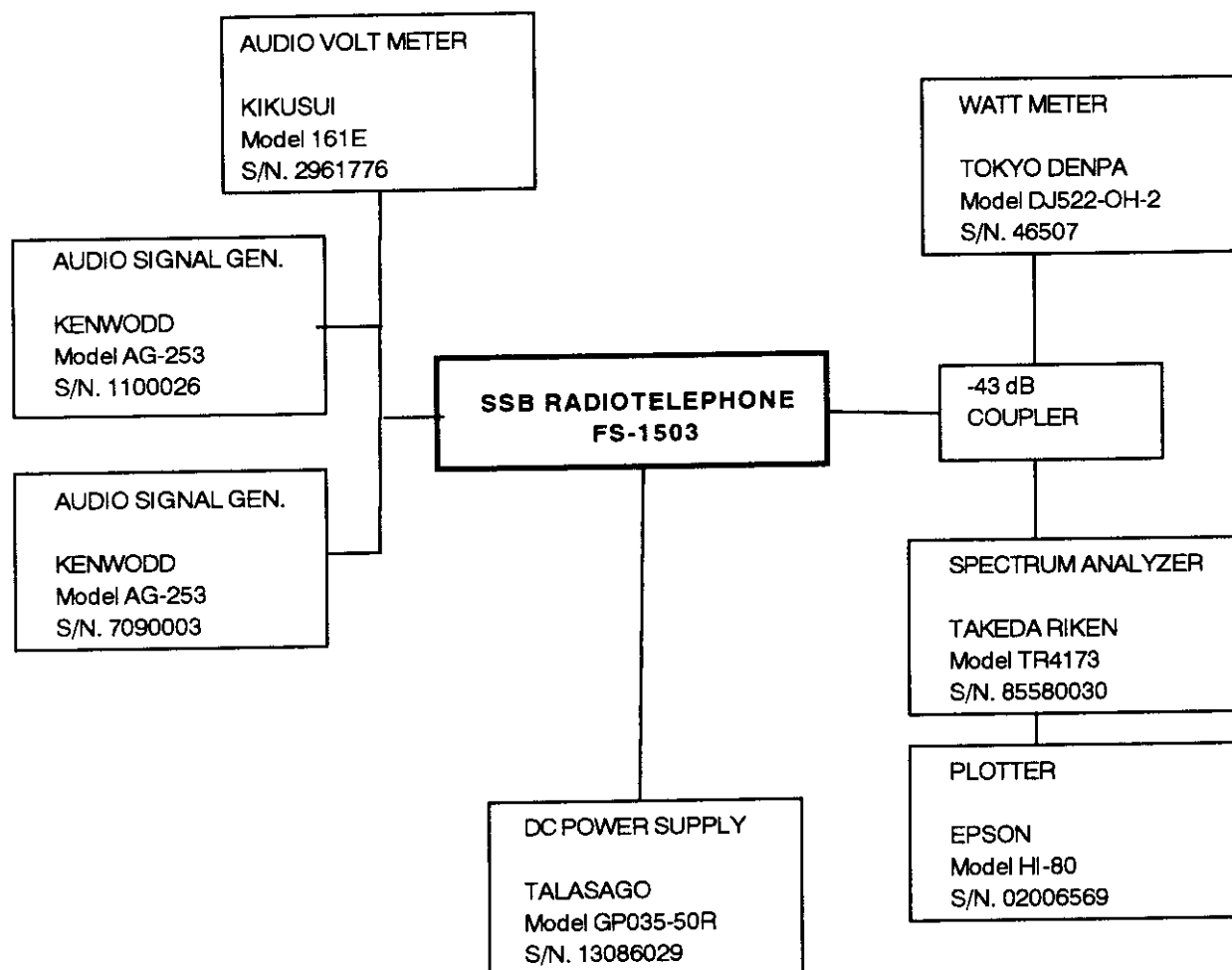


Fig. 6.1

6.2 Test Result

Figures 6.2 through 6.22 are hardcopies of Spectrum Analyzer screen on each test frequency.

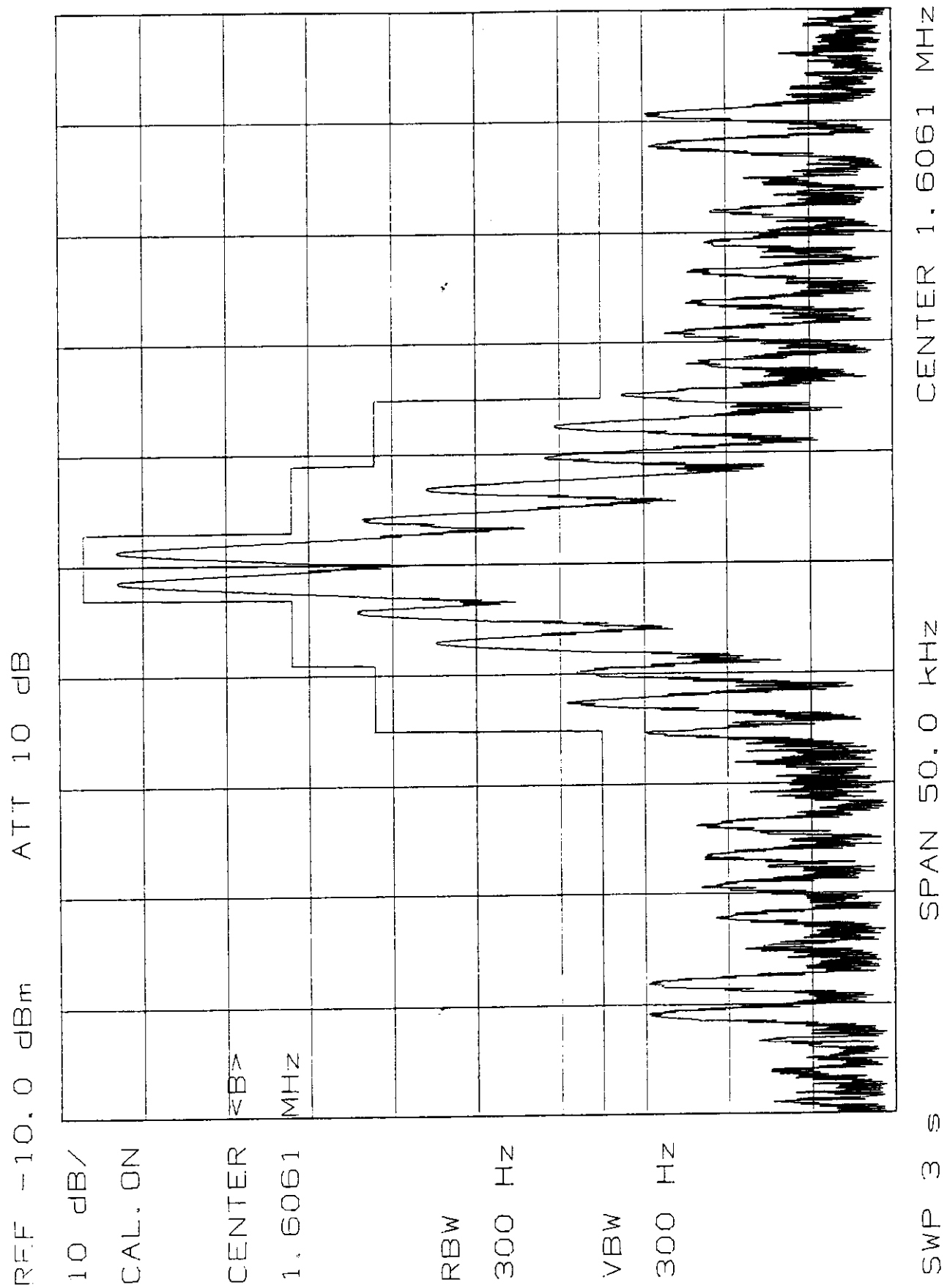


Fig. 6.2

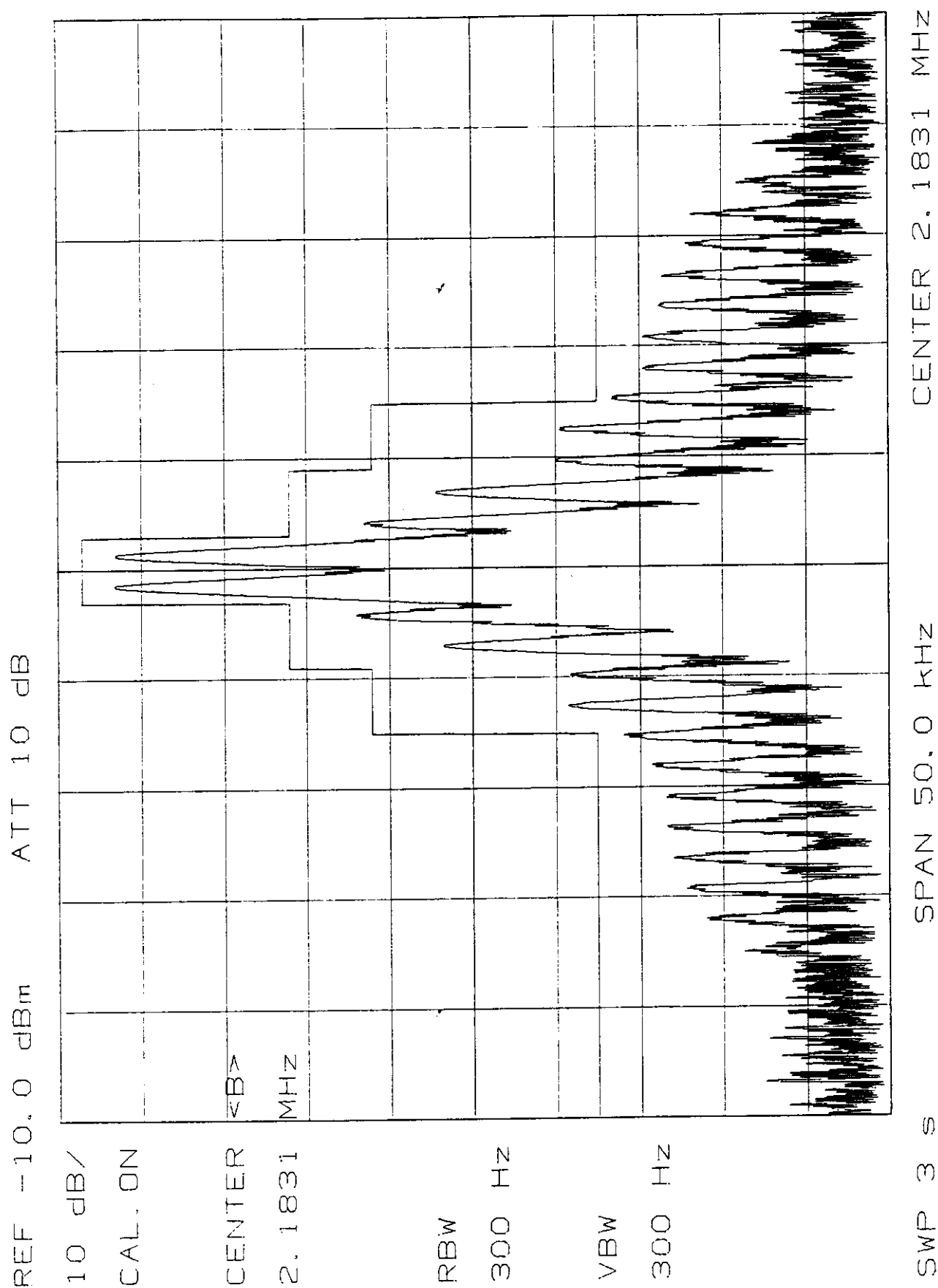
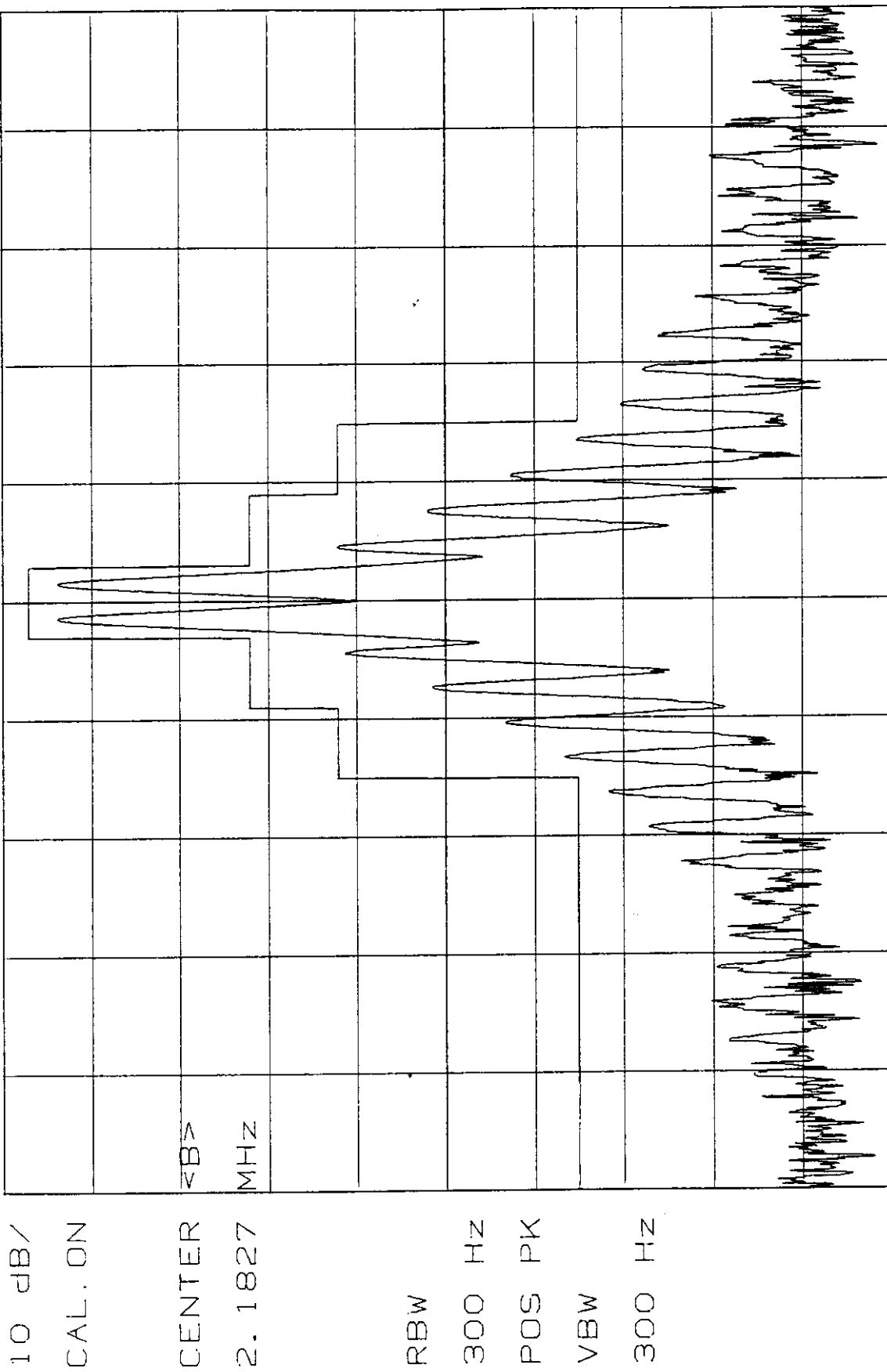


Fig. 6.3

$f = 2182 \text{ kHz}$ $H3E$

ATT 10 dB

REF -10.0 dBm



CENTER 2.1827 MHz

SPAN 50.0 kHz

SWP 3 s

Fig. 6.4

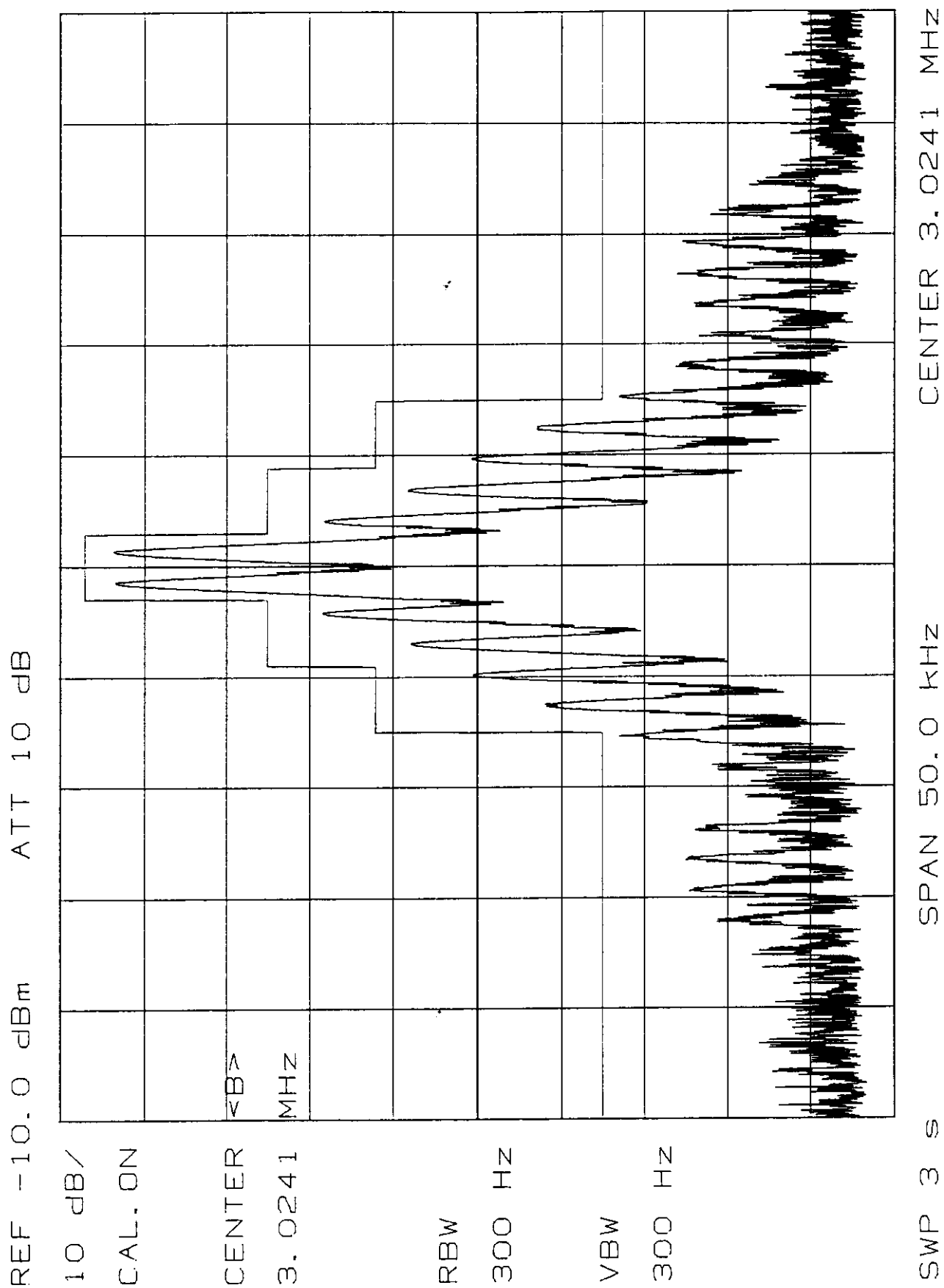


Fig. 6.5

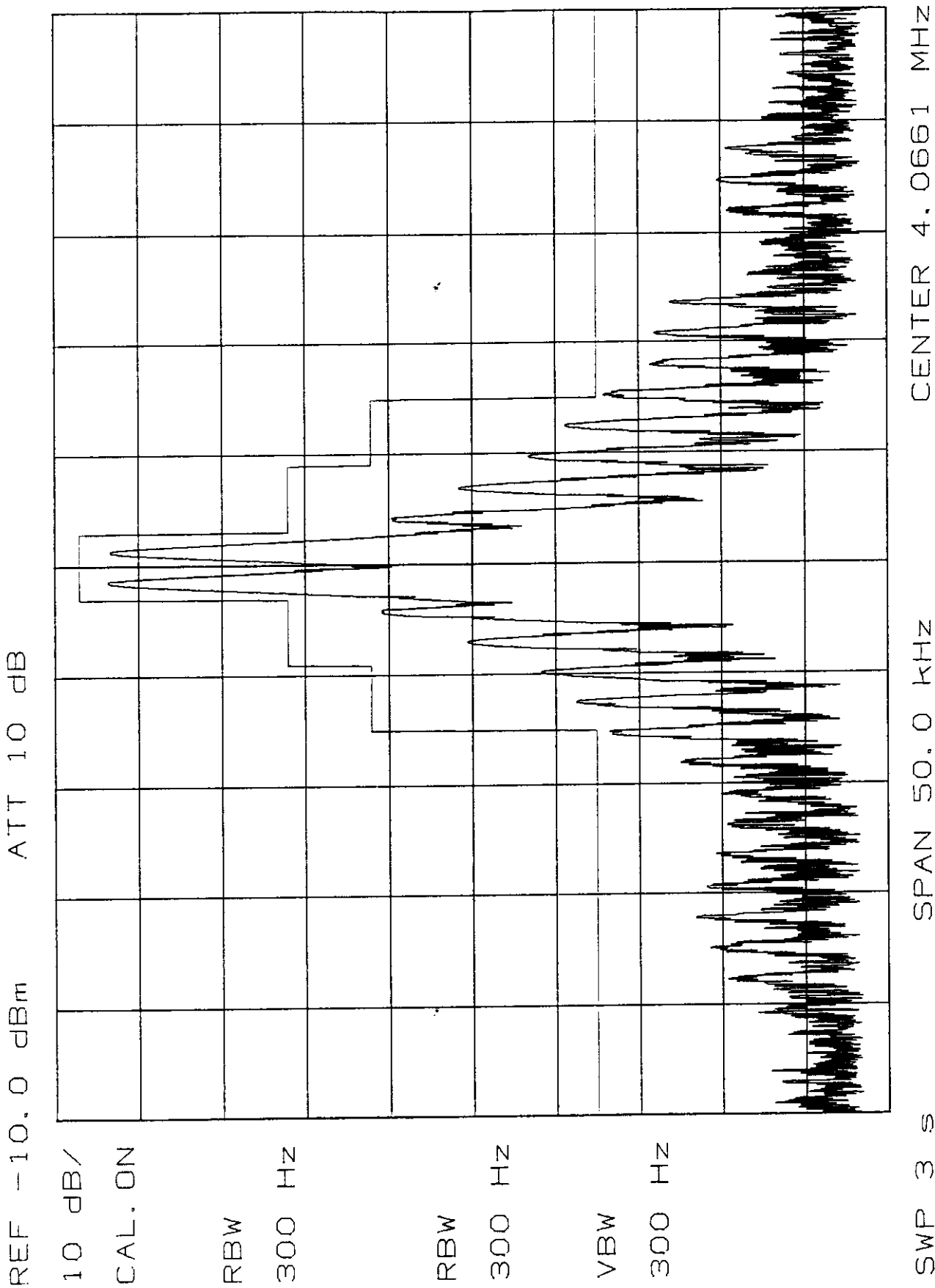


Fig. 6.6

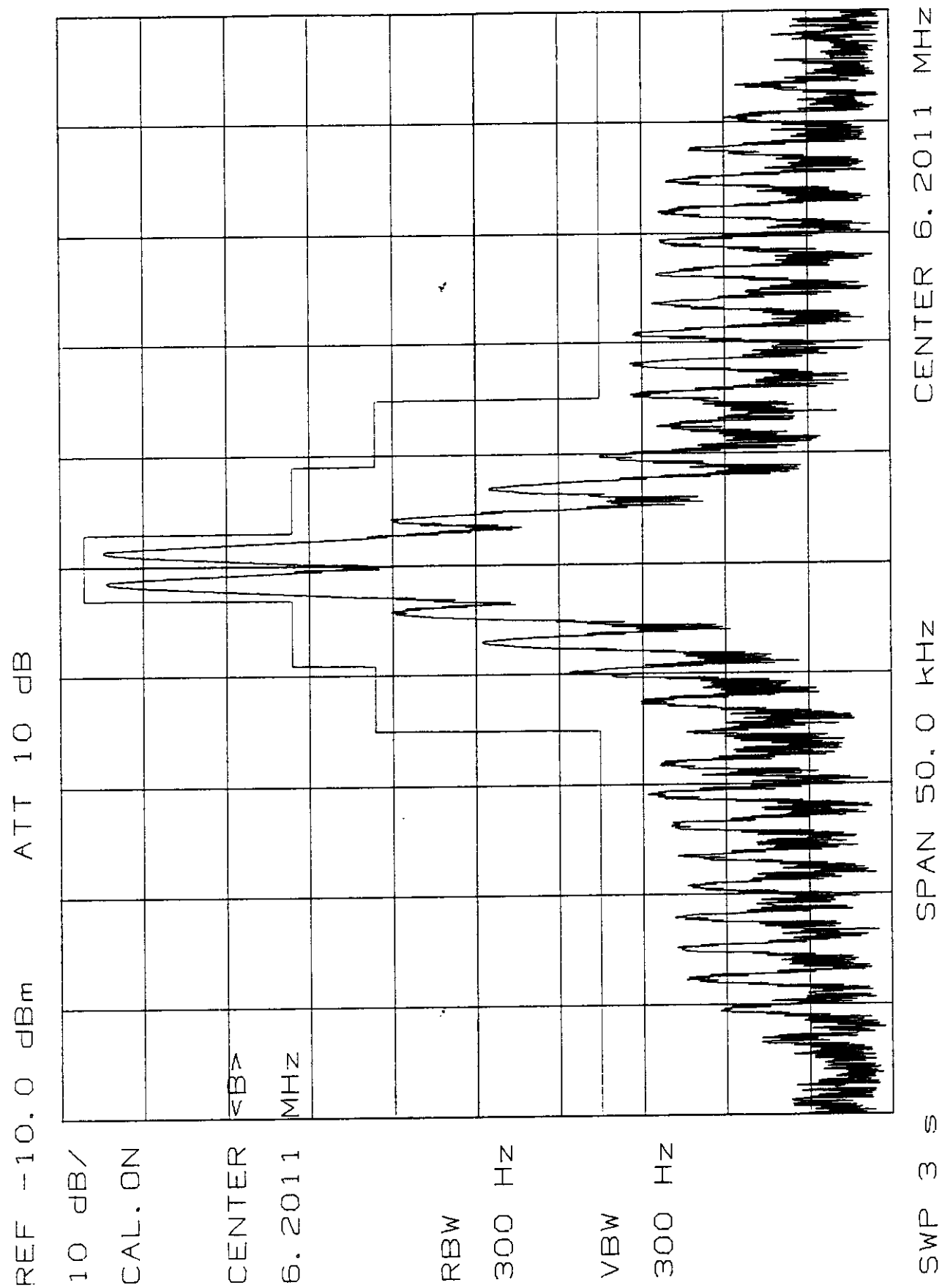


Fig. 67

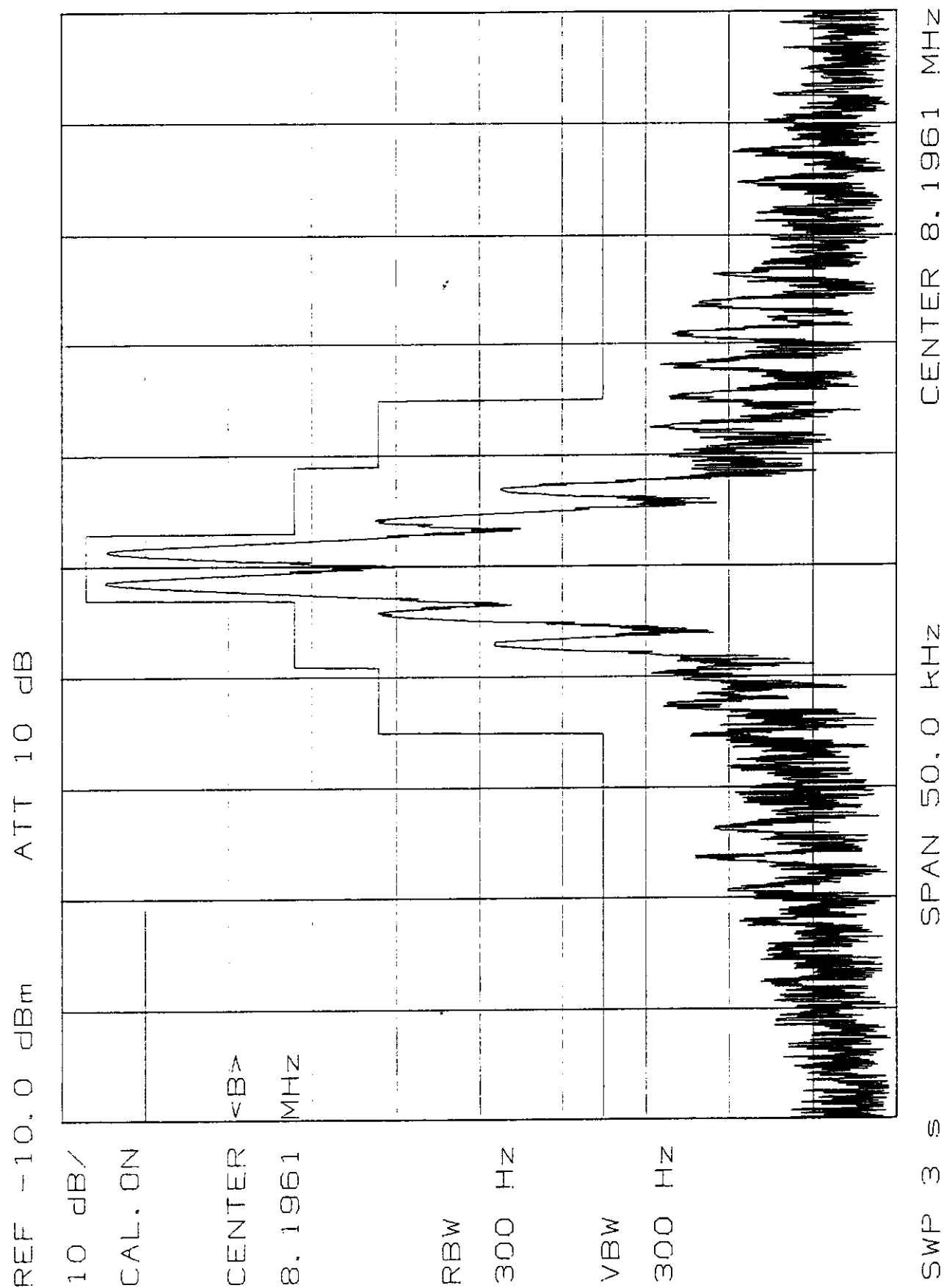


Fig. 6.8

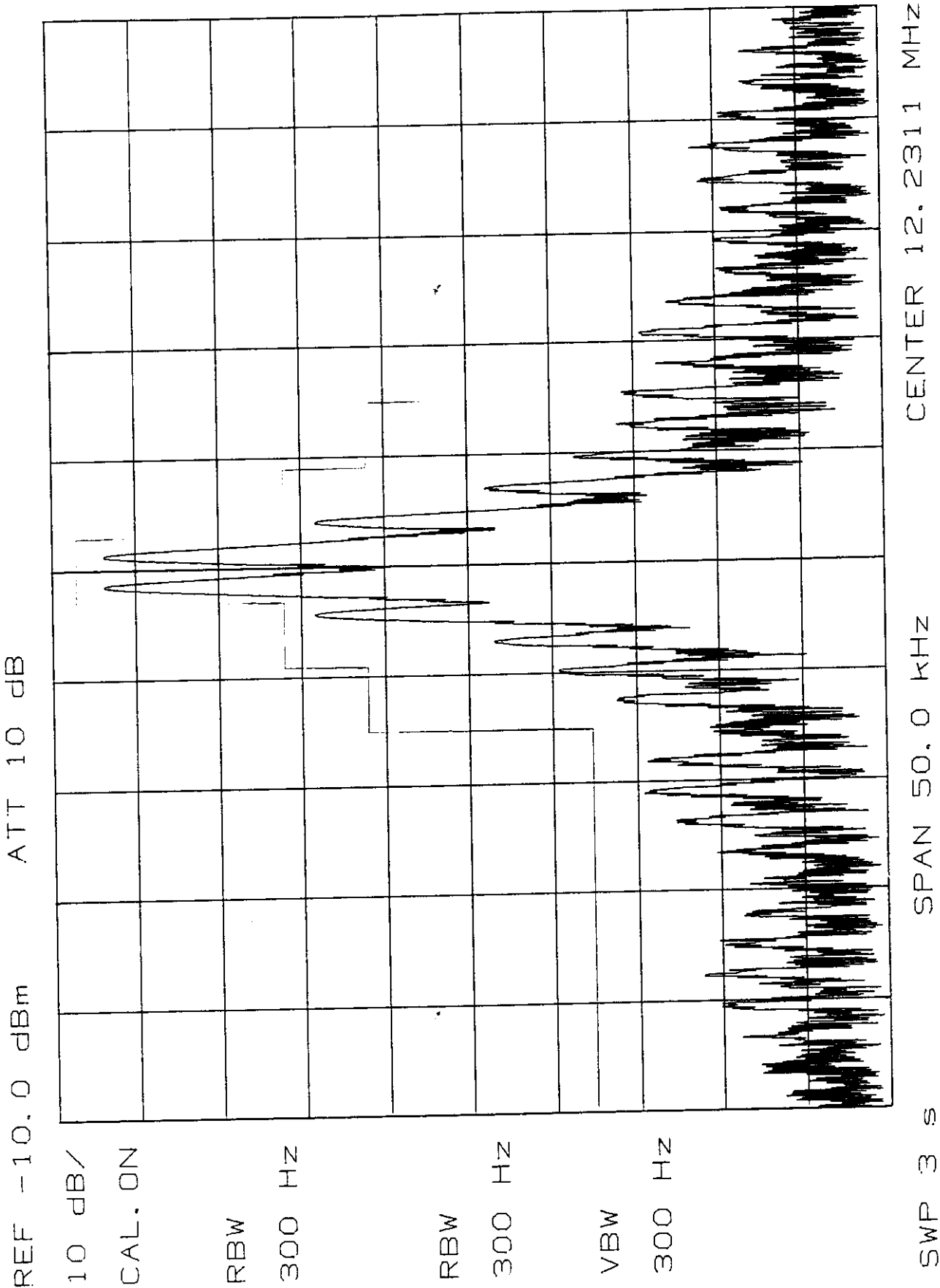


Fig. 6.9

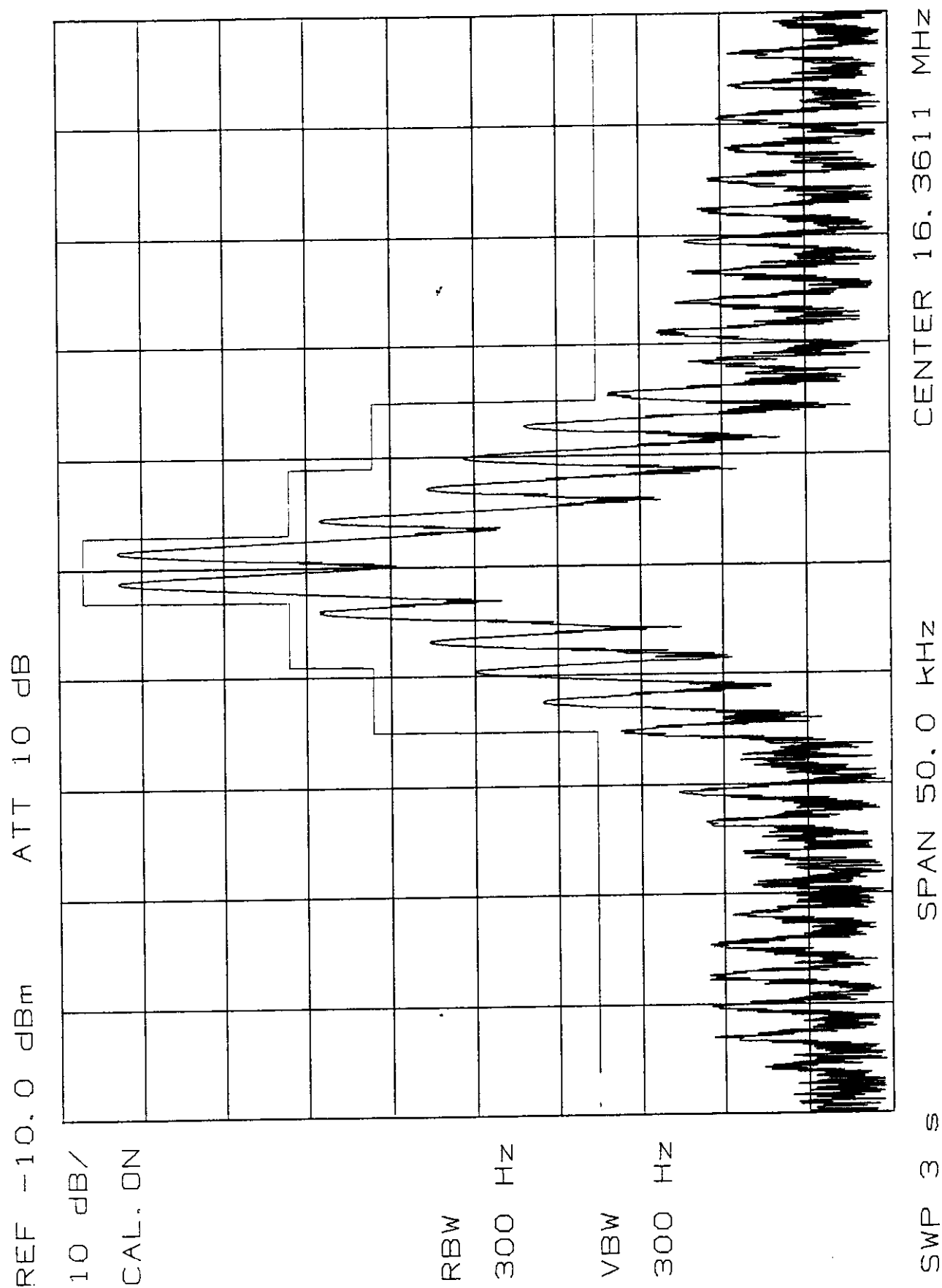


Fig. 6.10

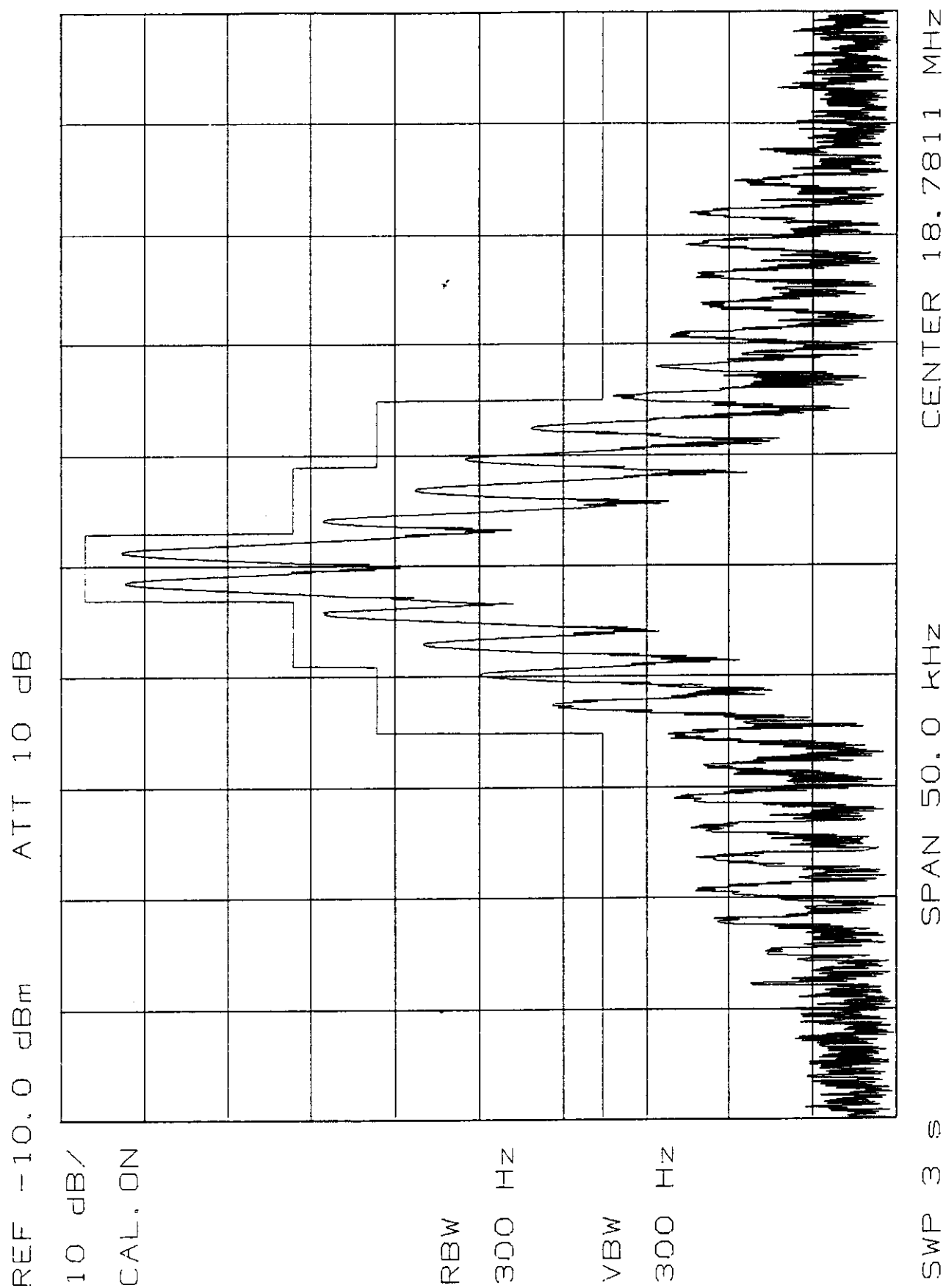


Fig. 6.11

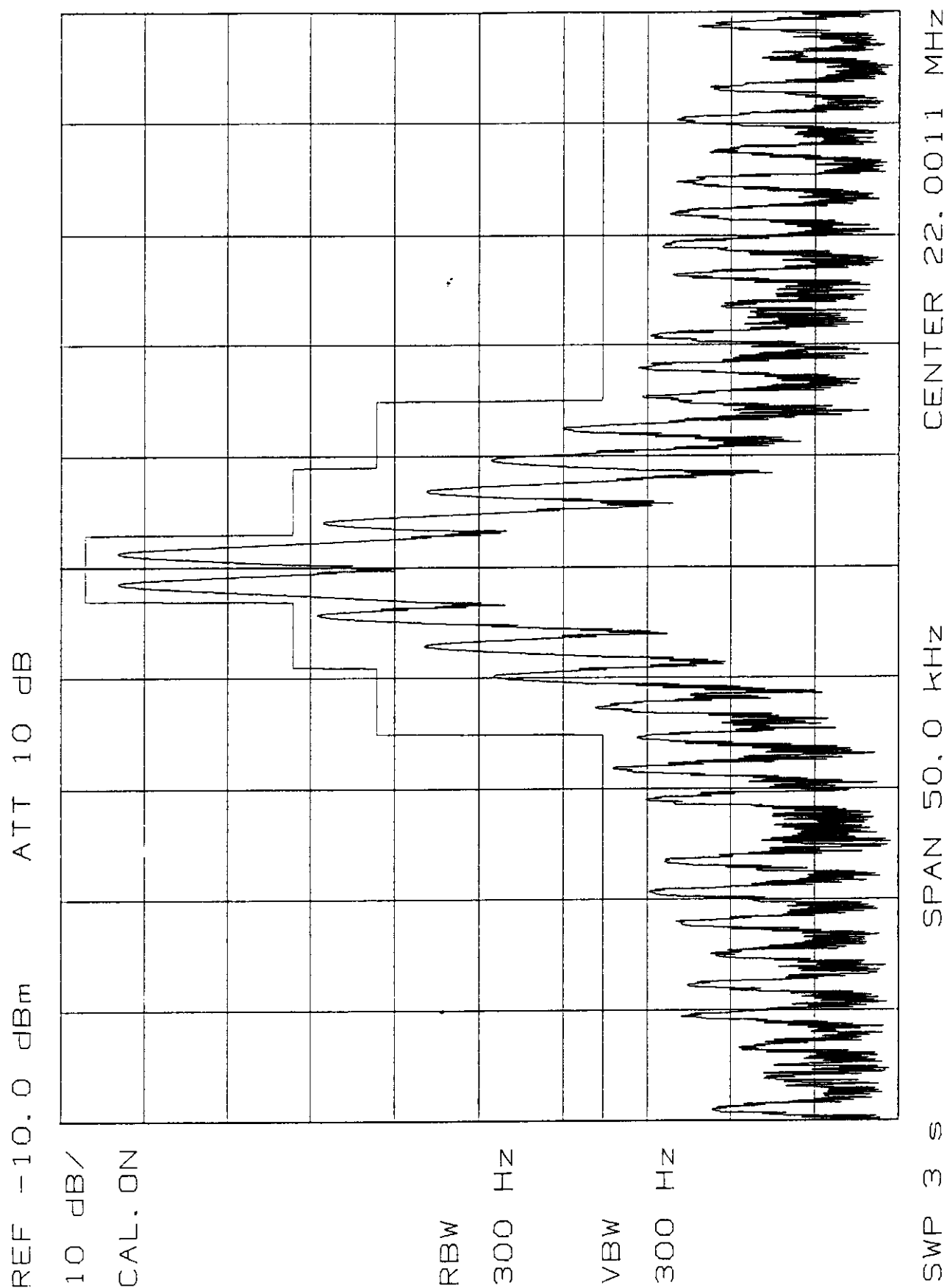


Fig. 6.12

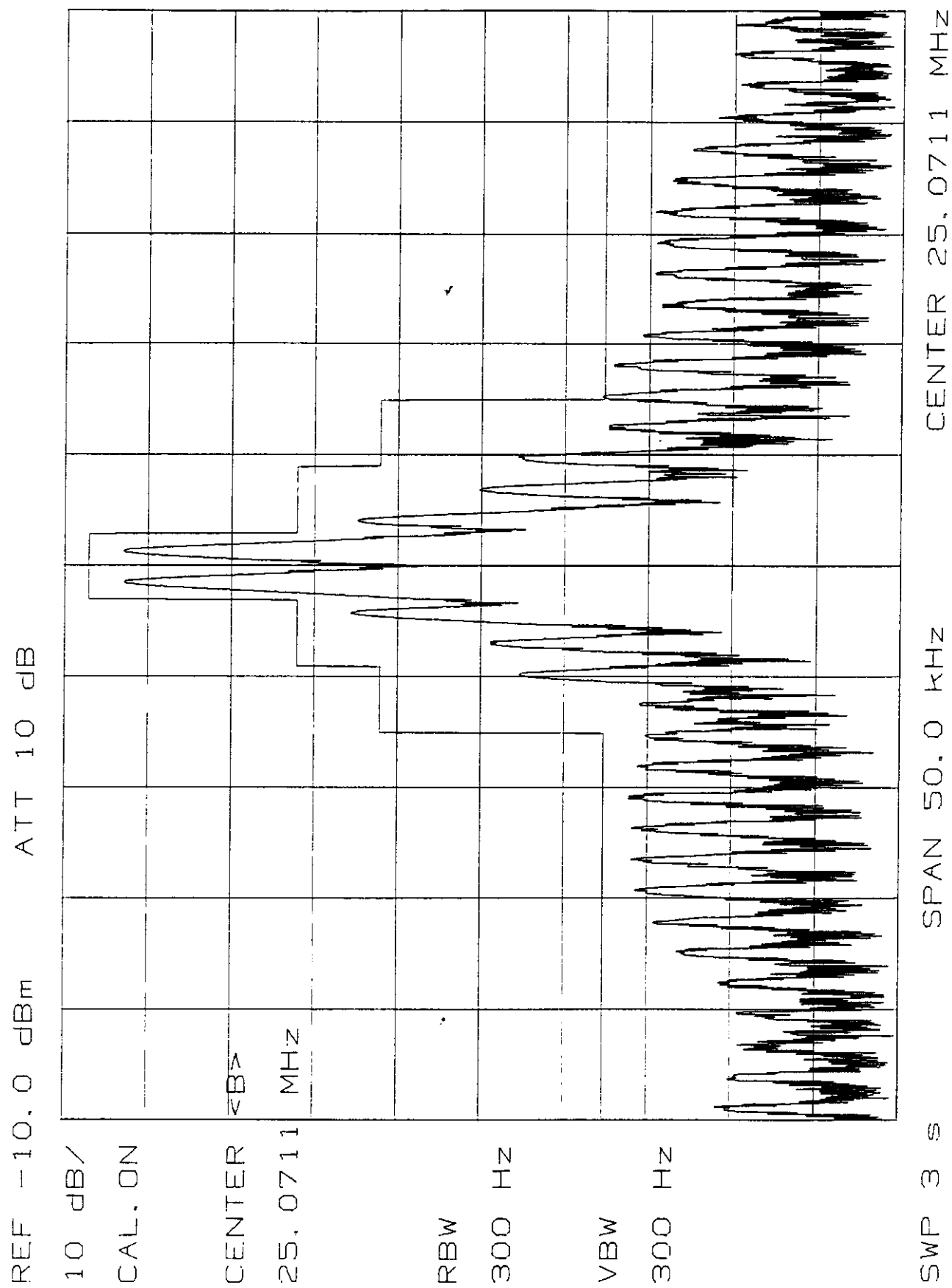


Fig. 6.13

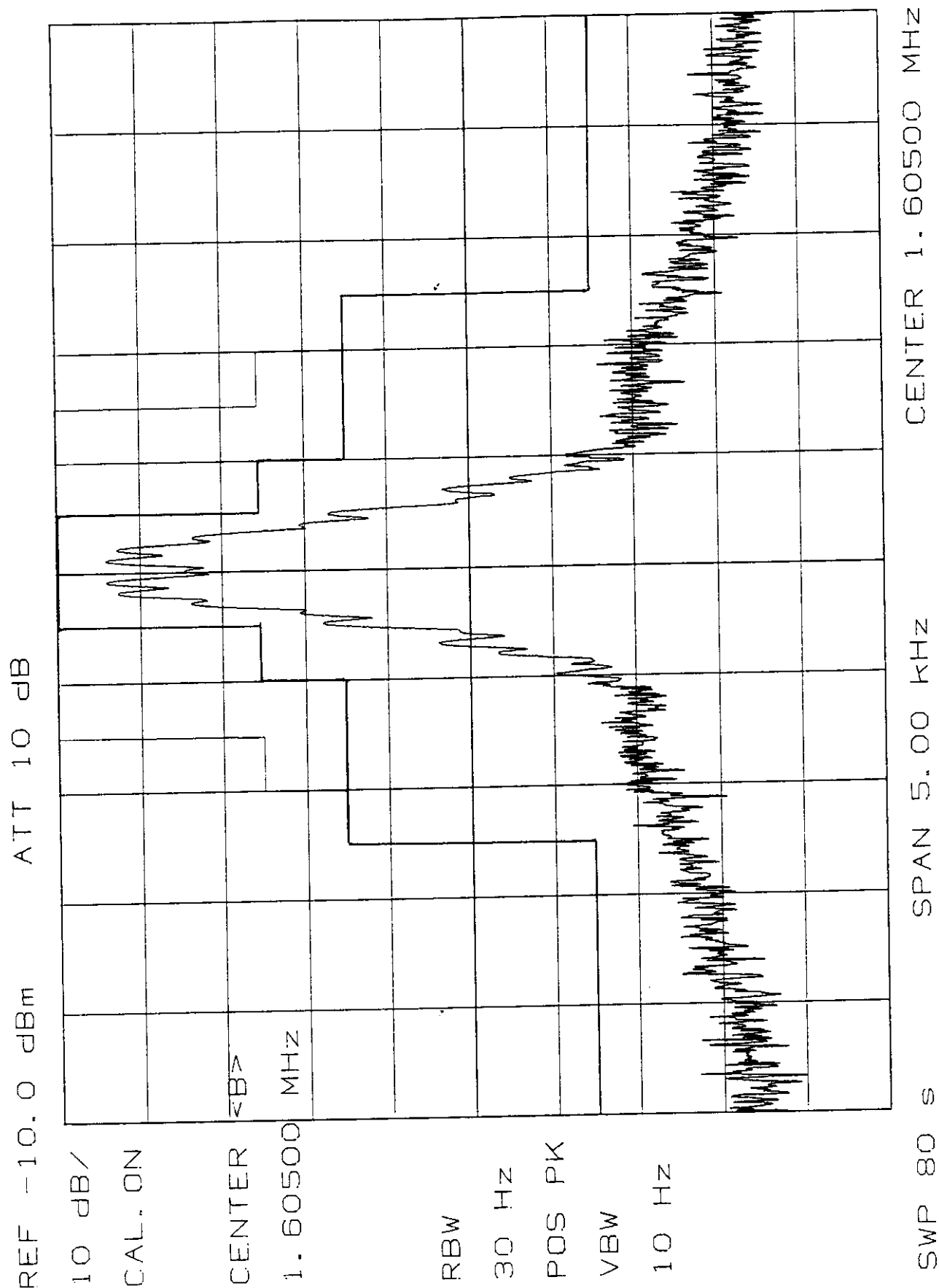


Fig. 6.14

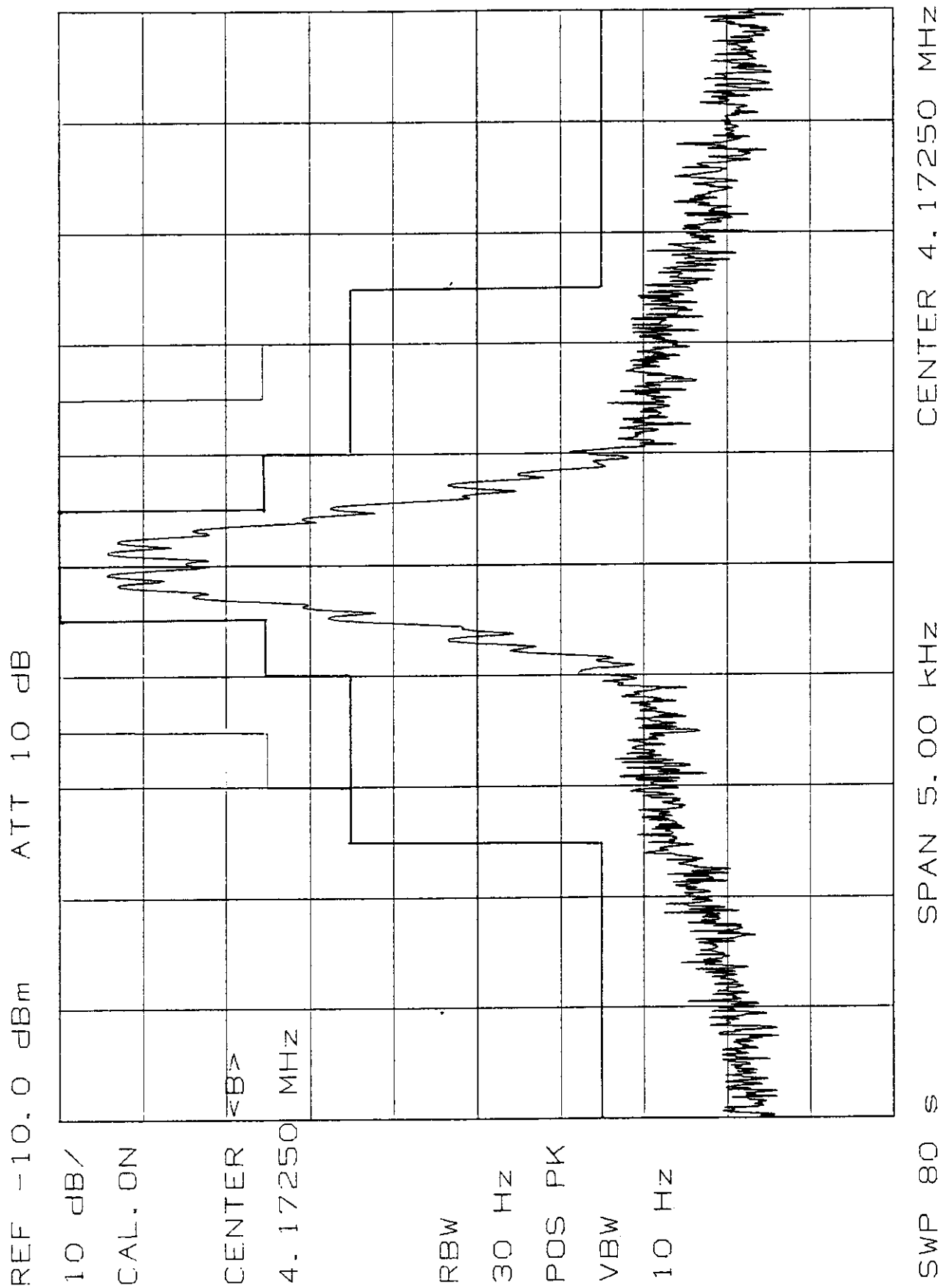


Fig. 6.15

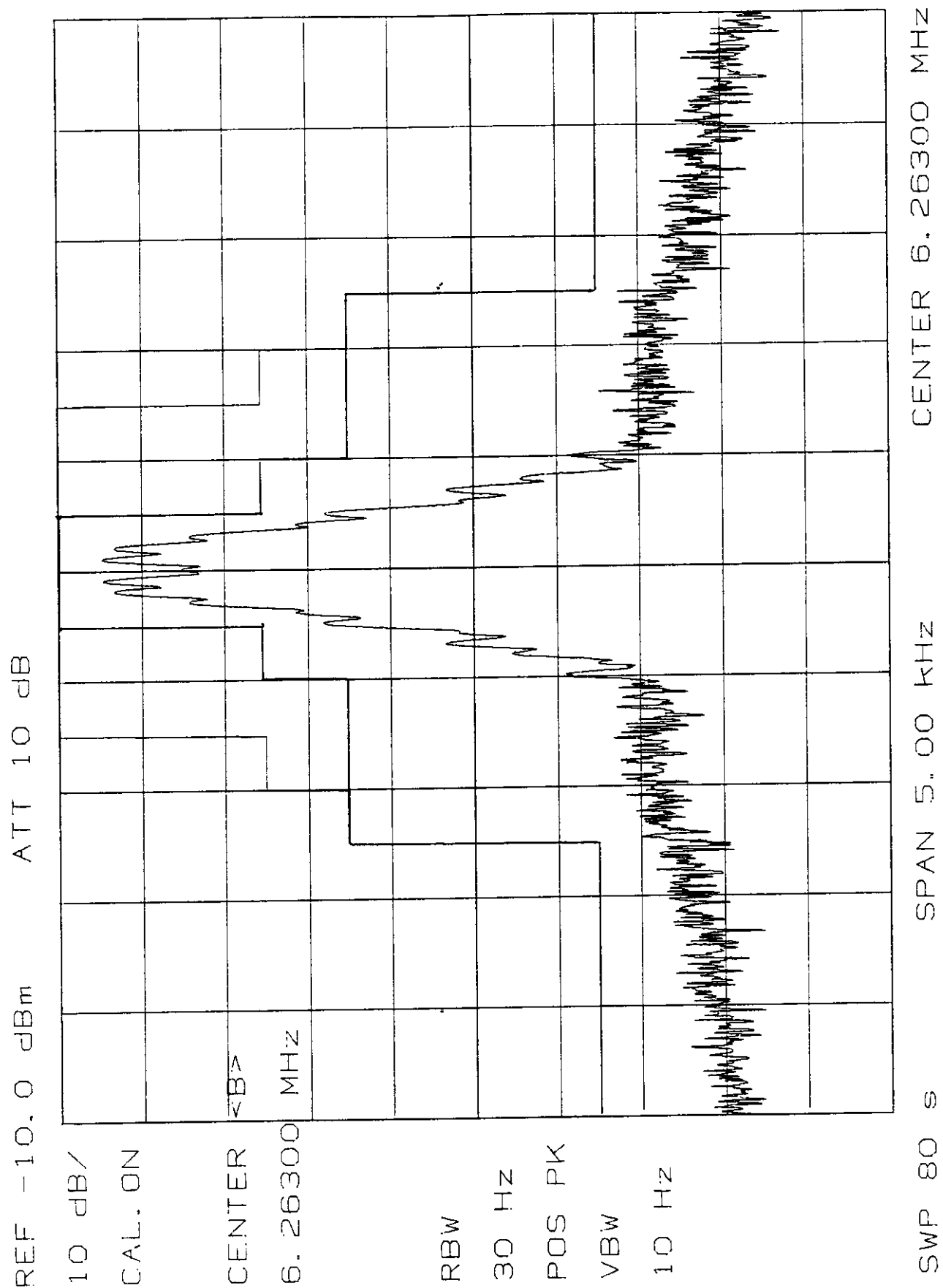


Fig. 6.16

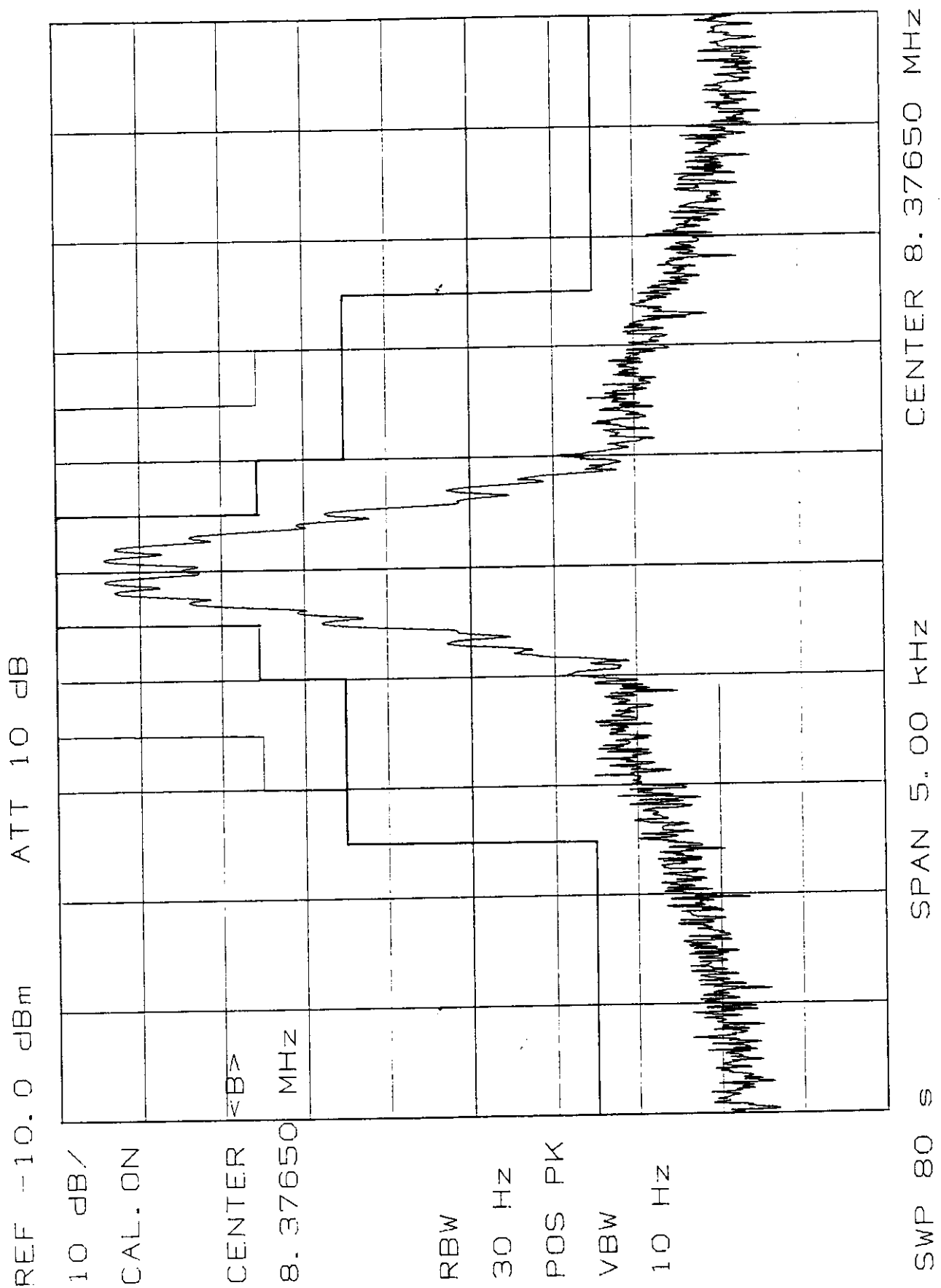


Fig. 6.17

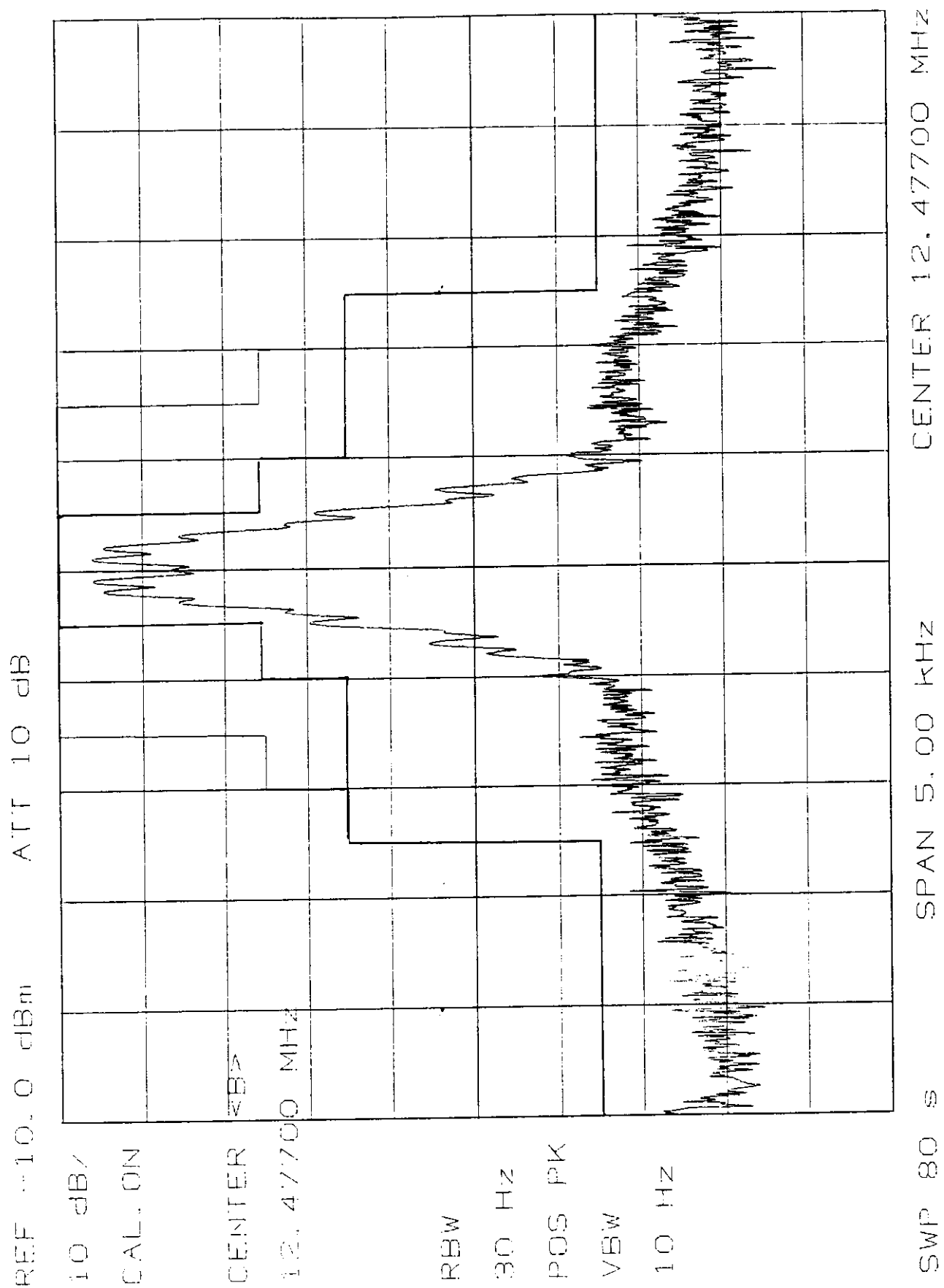


Fig. 6.18

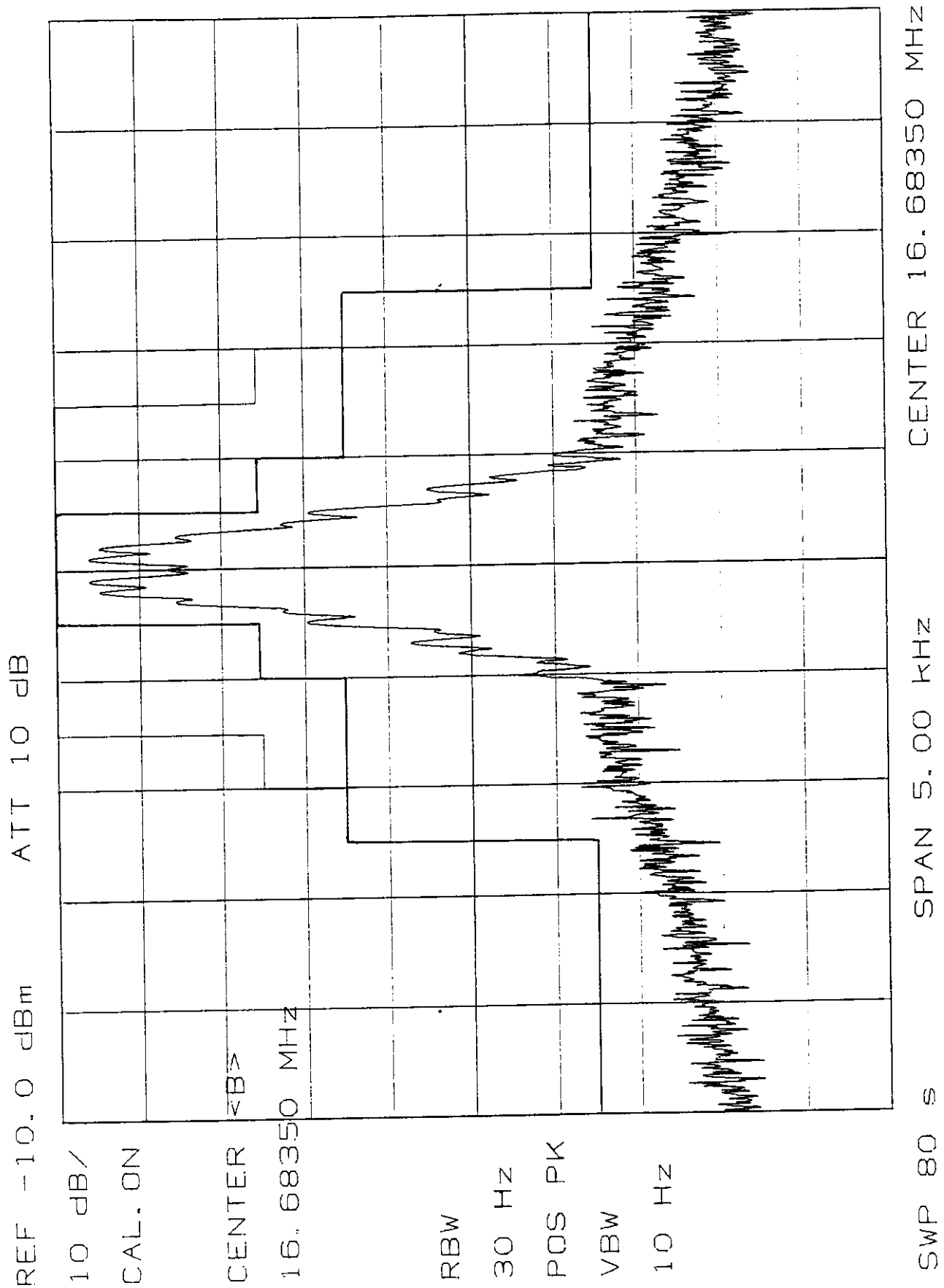


Fig. 6.19

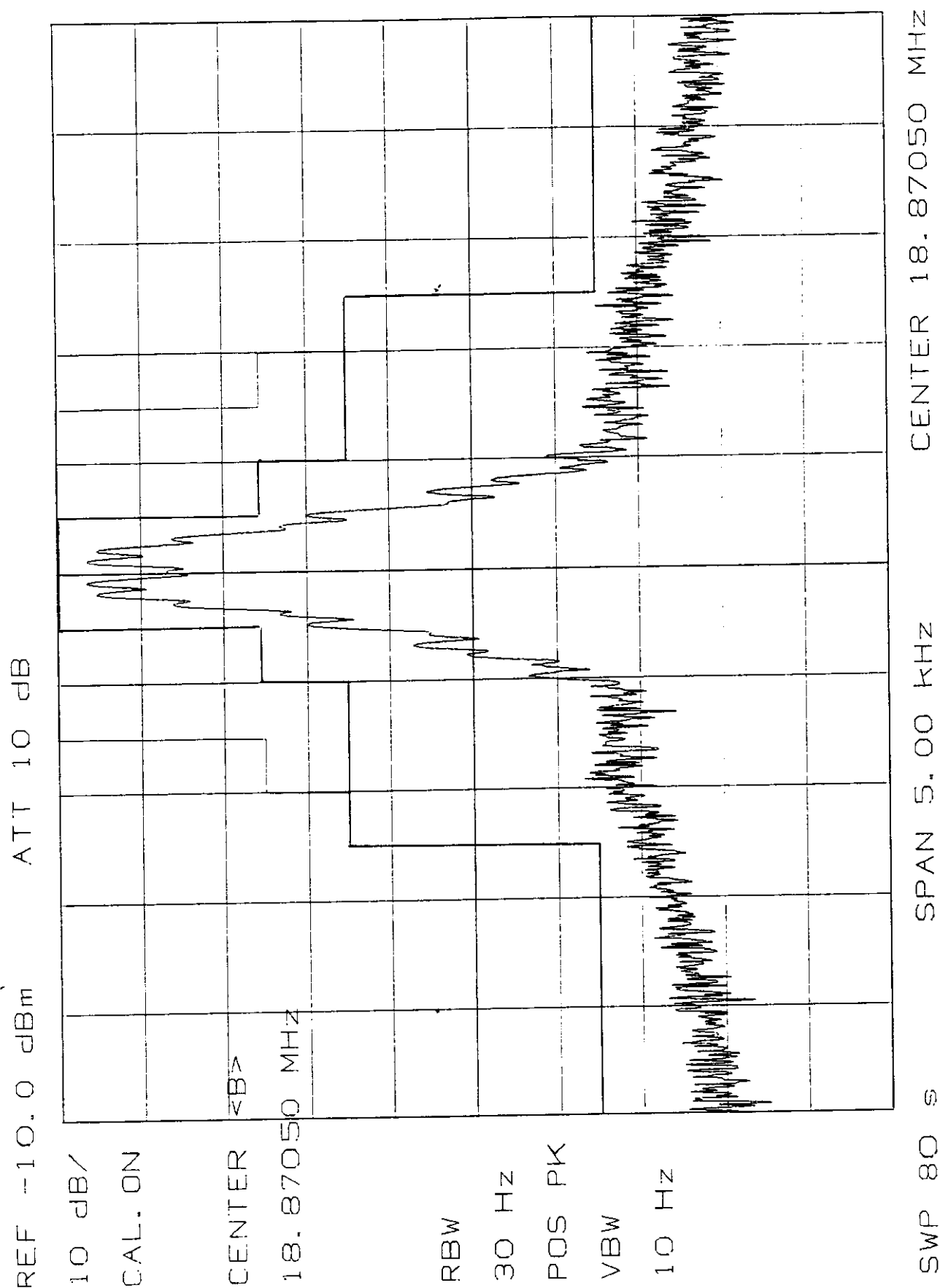


Fig. 6.20

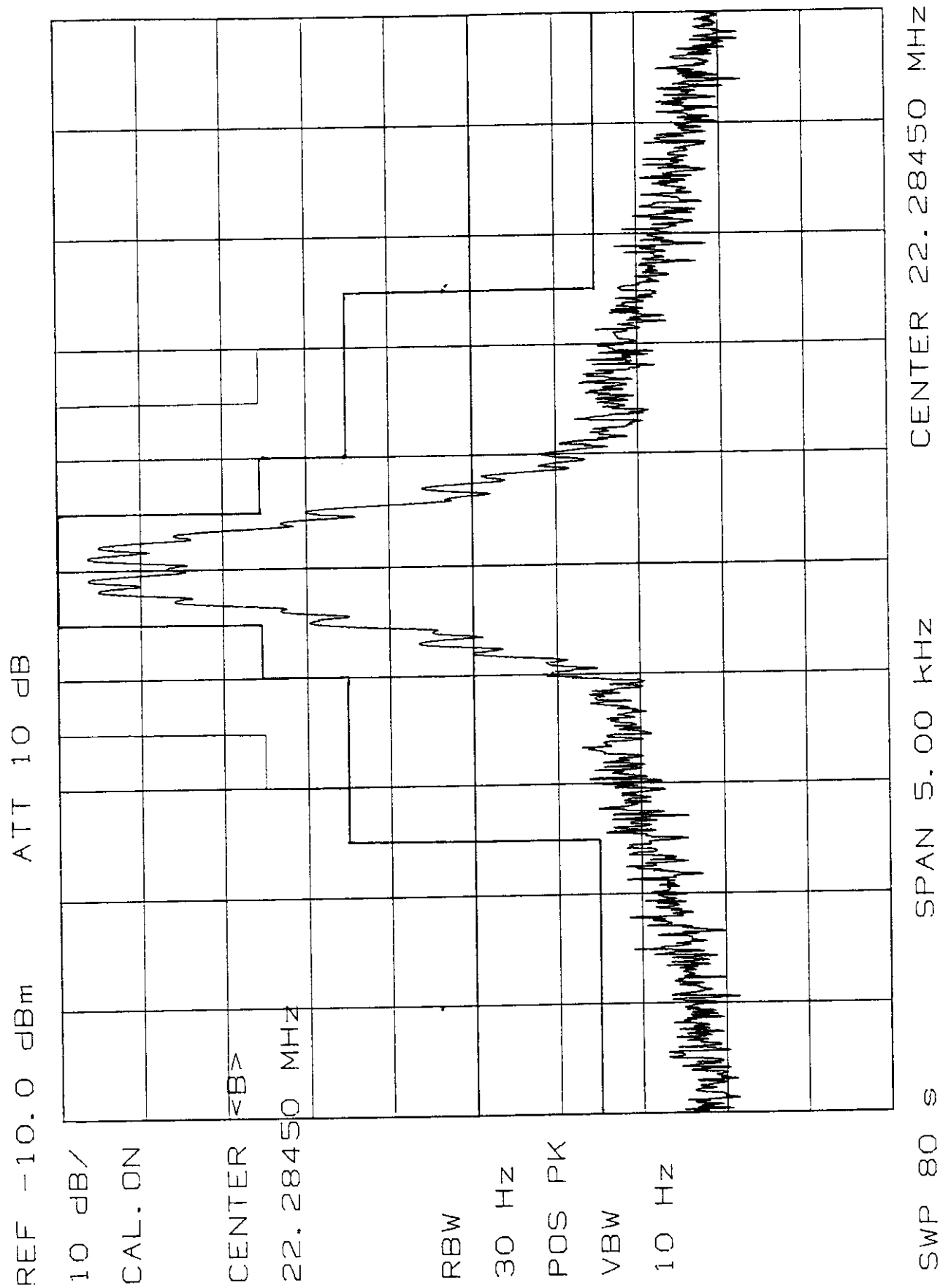


Fig. 6.21

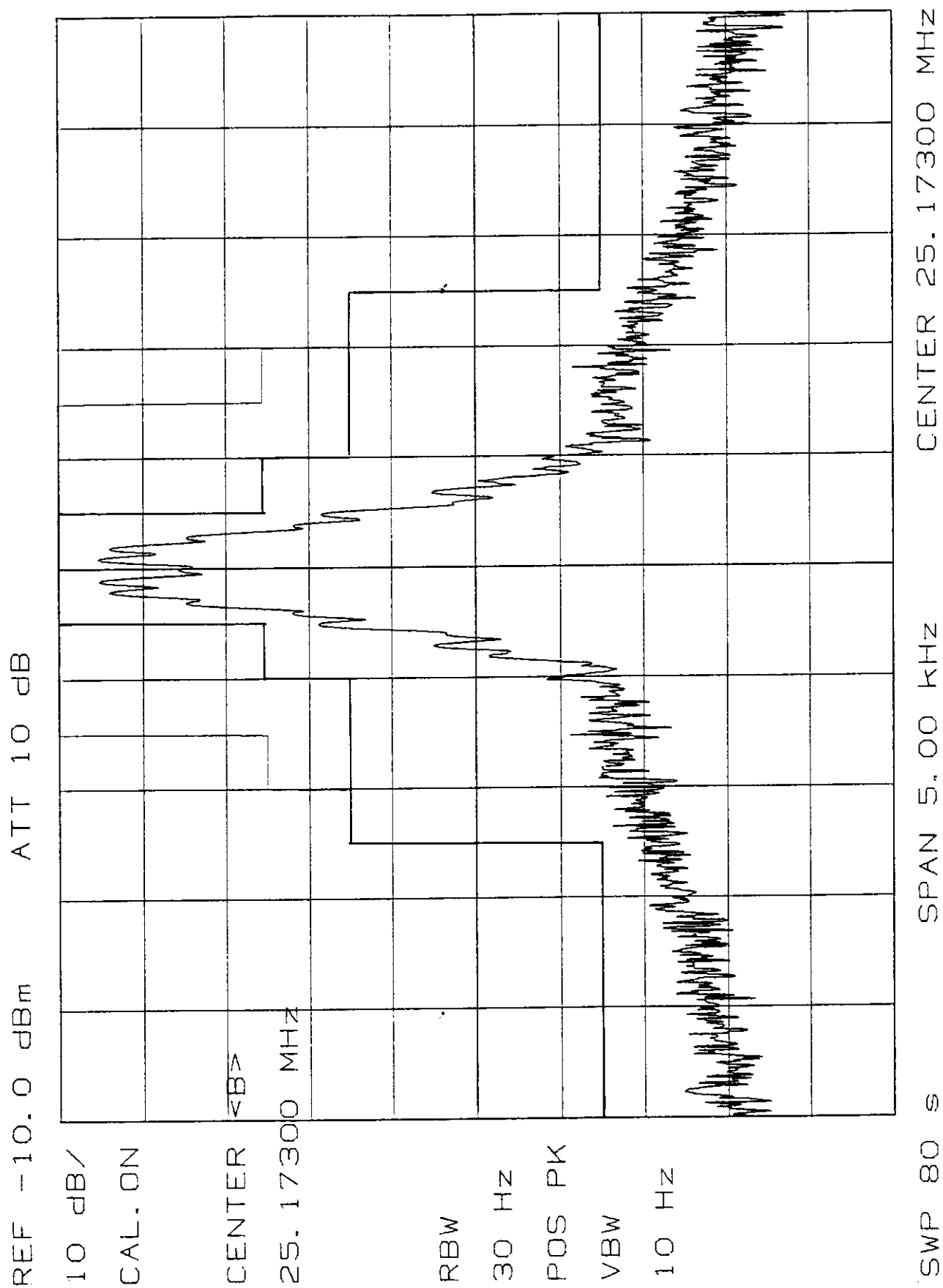


Fig. 6.22

7 SPURIOUS EMISSIONS AT ANTENNA TERMINAL (FCC Rule Part 2.991)

7.1 Method of Measurement

The transmitter is connected with measuring equipment as in Fig. 7.1.

The transmitter is modulated with 2 audio tones 400 Hz and 1800 Hz in equal level.
The input level is adjusted to 10 dB above the level producing PEP output of 150 W.

7.2 Test Result

Figures 7.2 through 7.23 are hardcopies of Spectrum Analyzer screen on each test frequency. On test frequencies above 4 MHz spectrum is observed with 2 sweep rates.

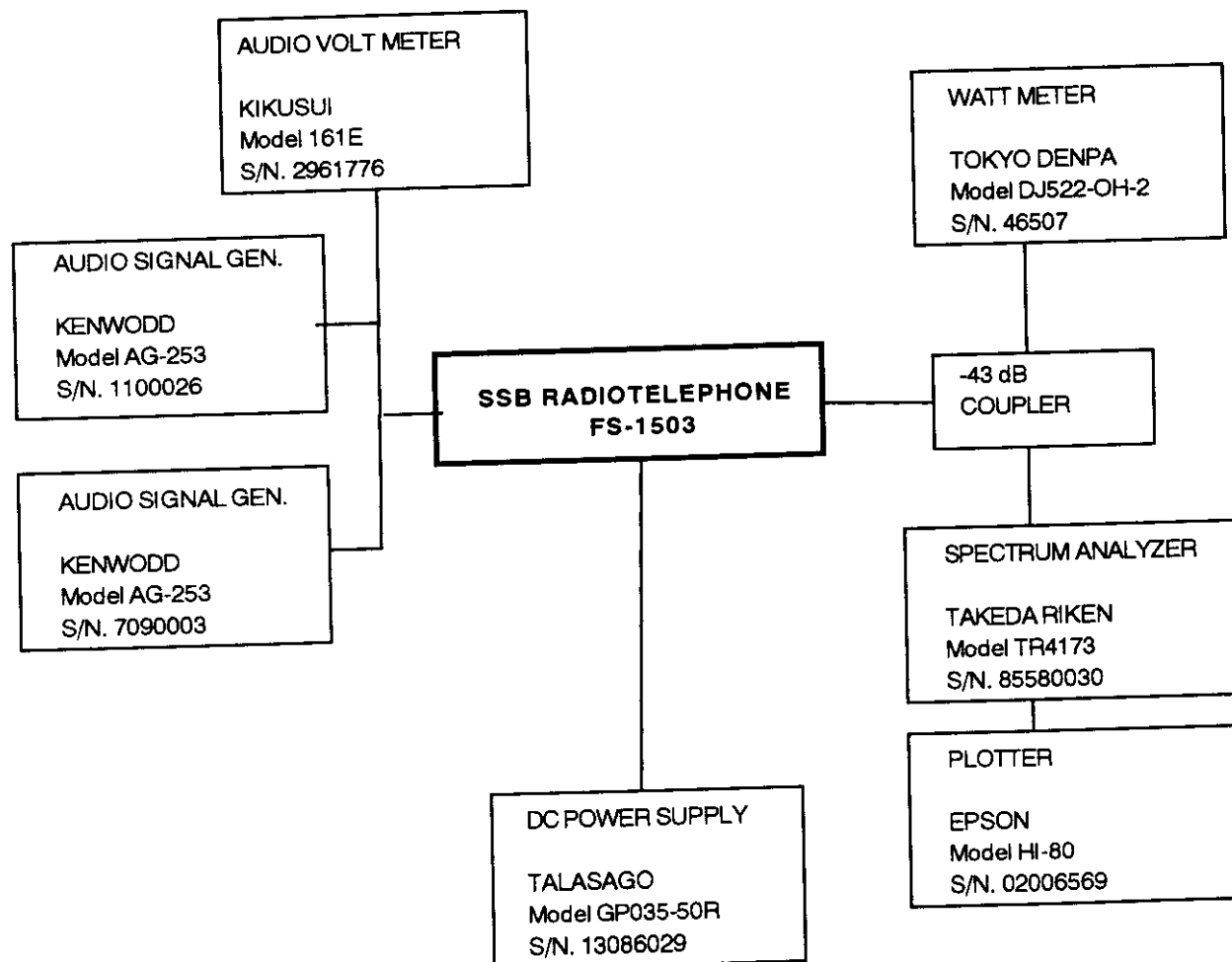


Fig. 7.1

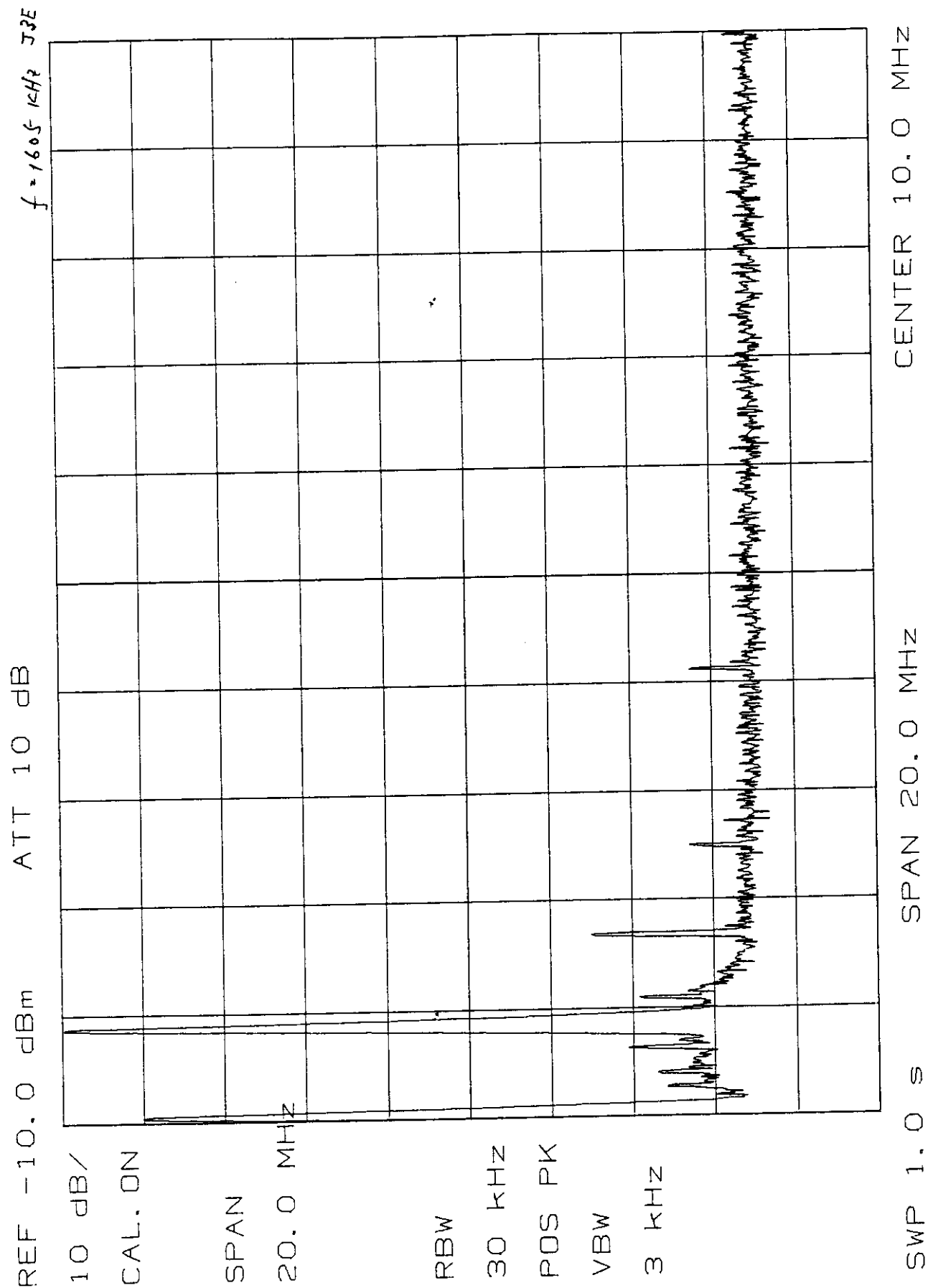


Fig. 7.2

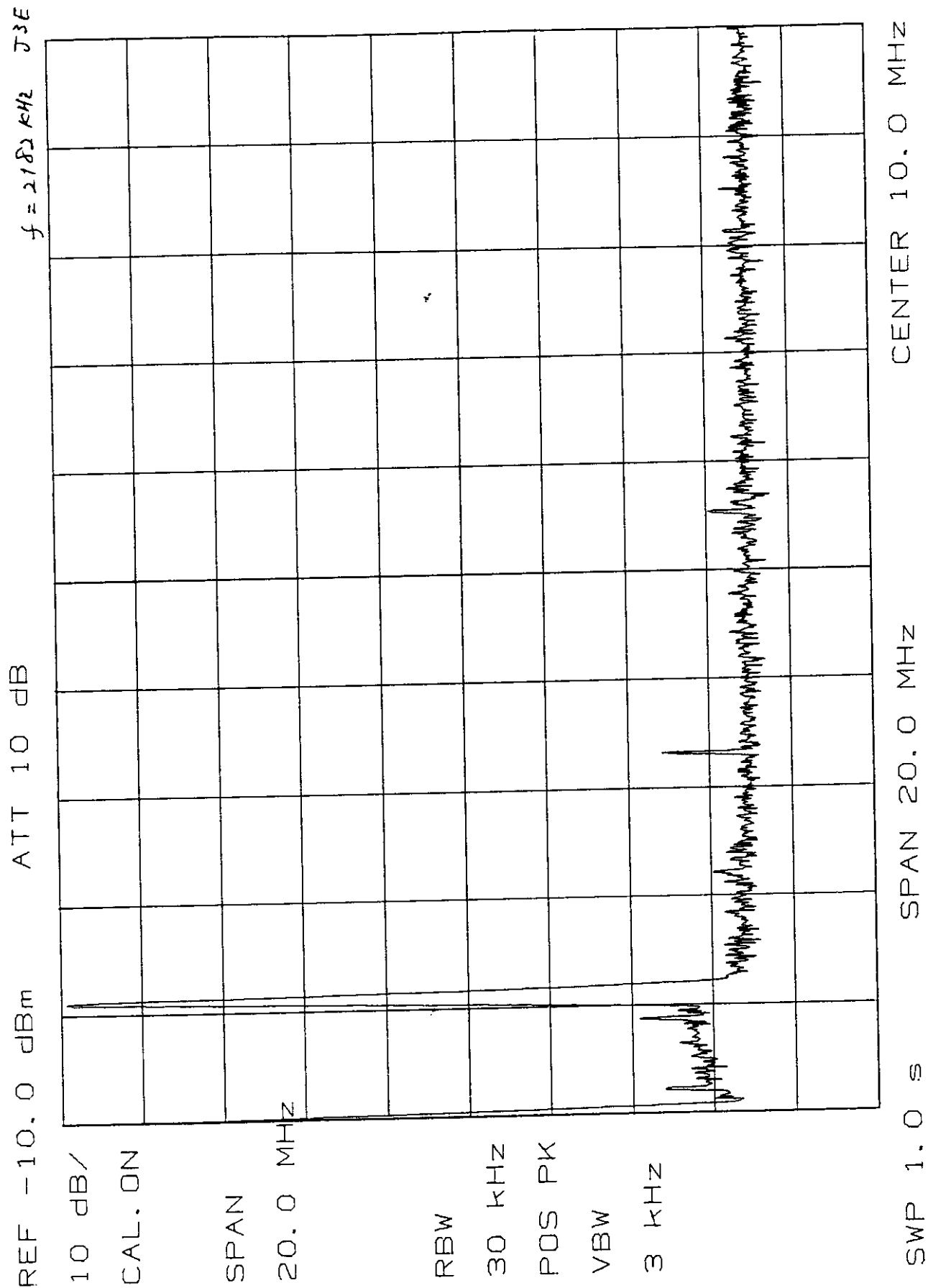


Fig. 7.3

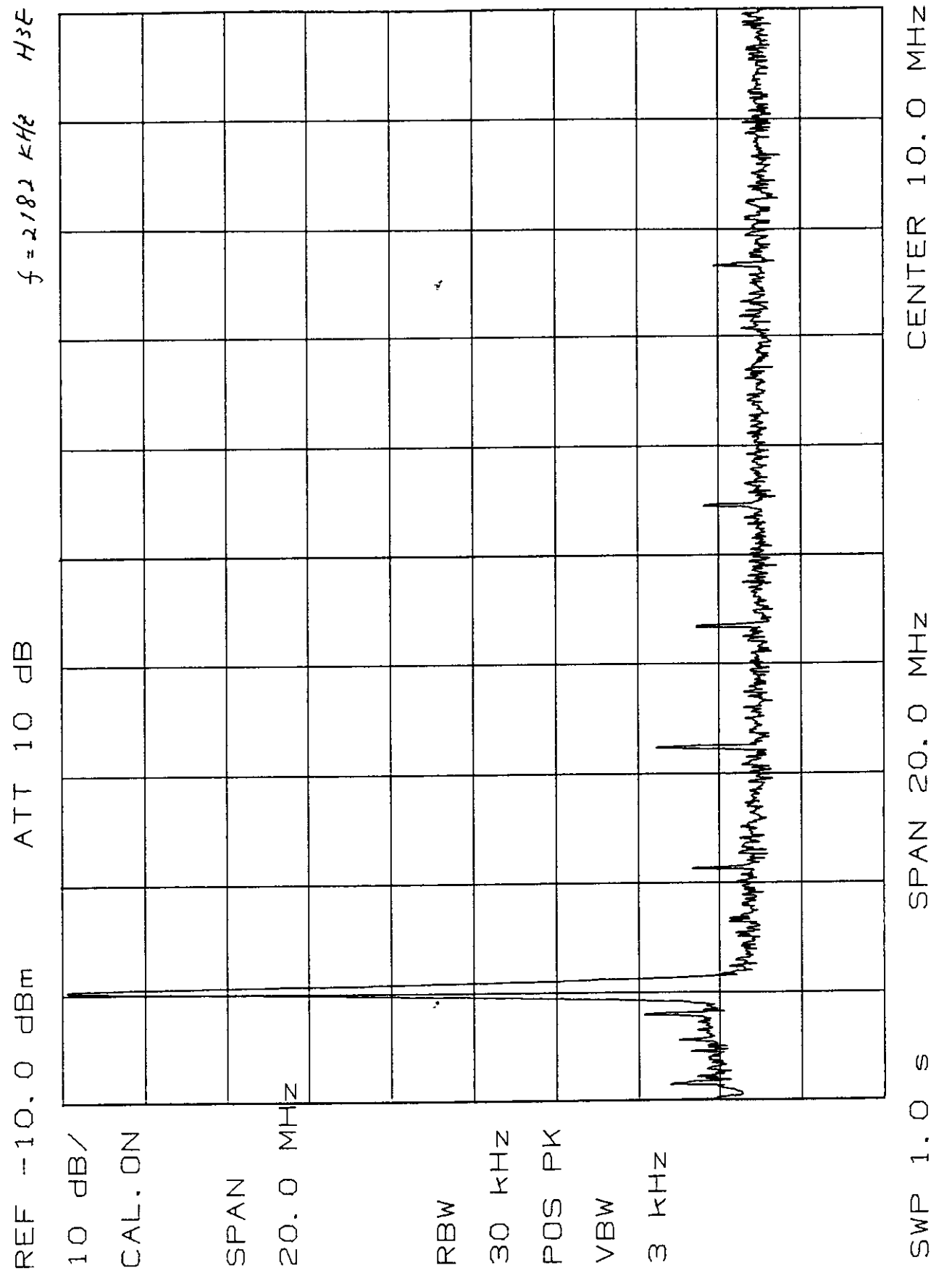


Fig. 7.4

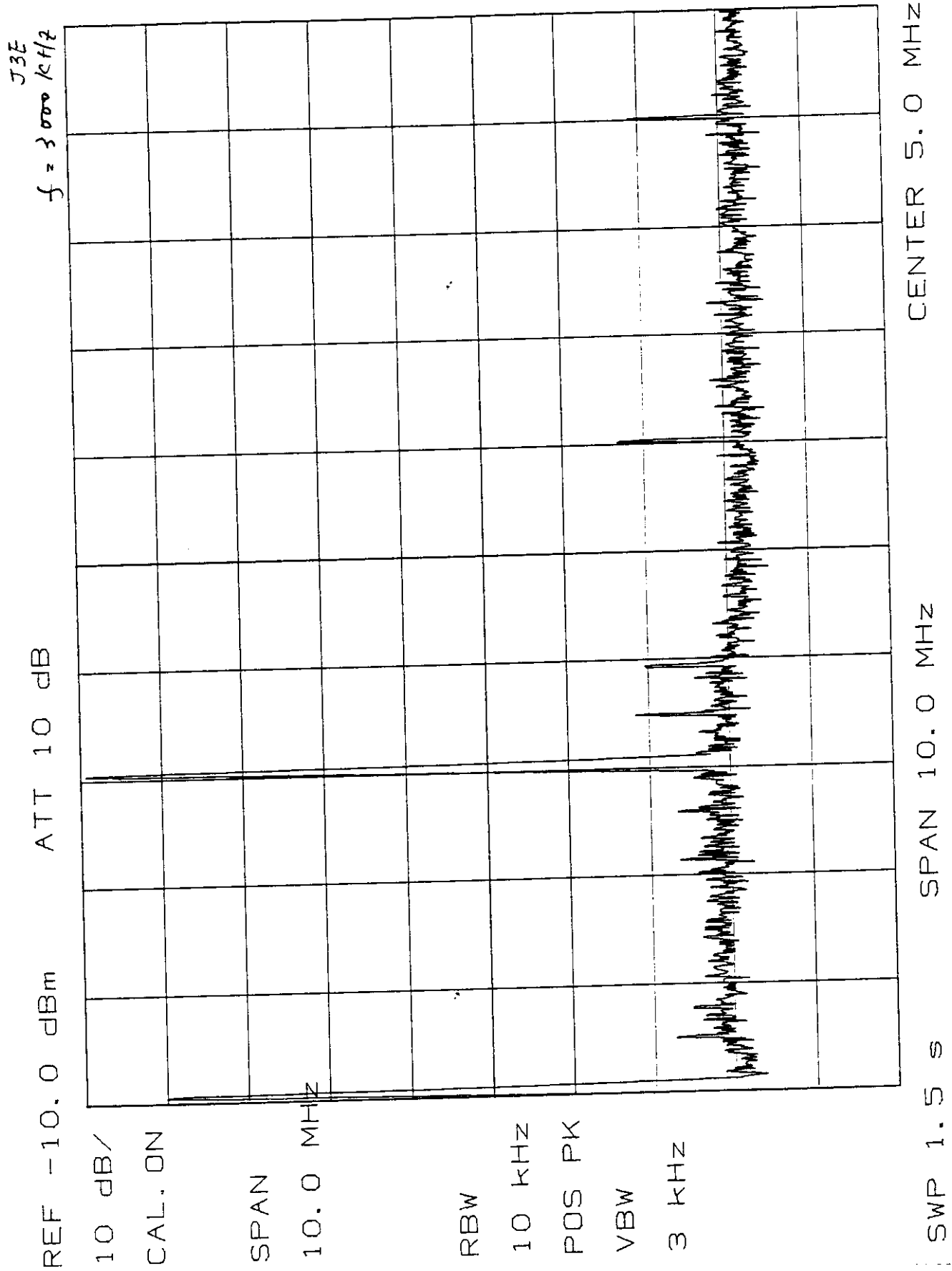


Fig. 7.5

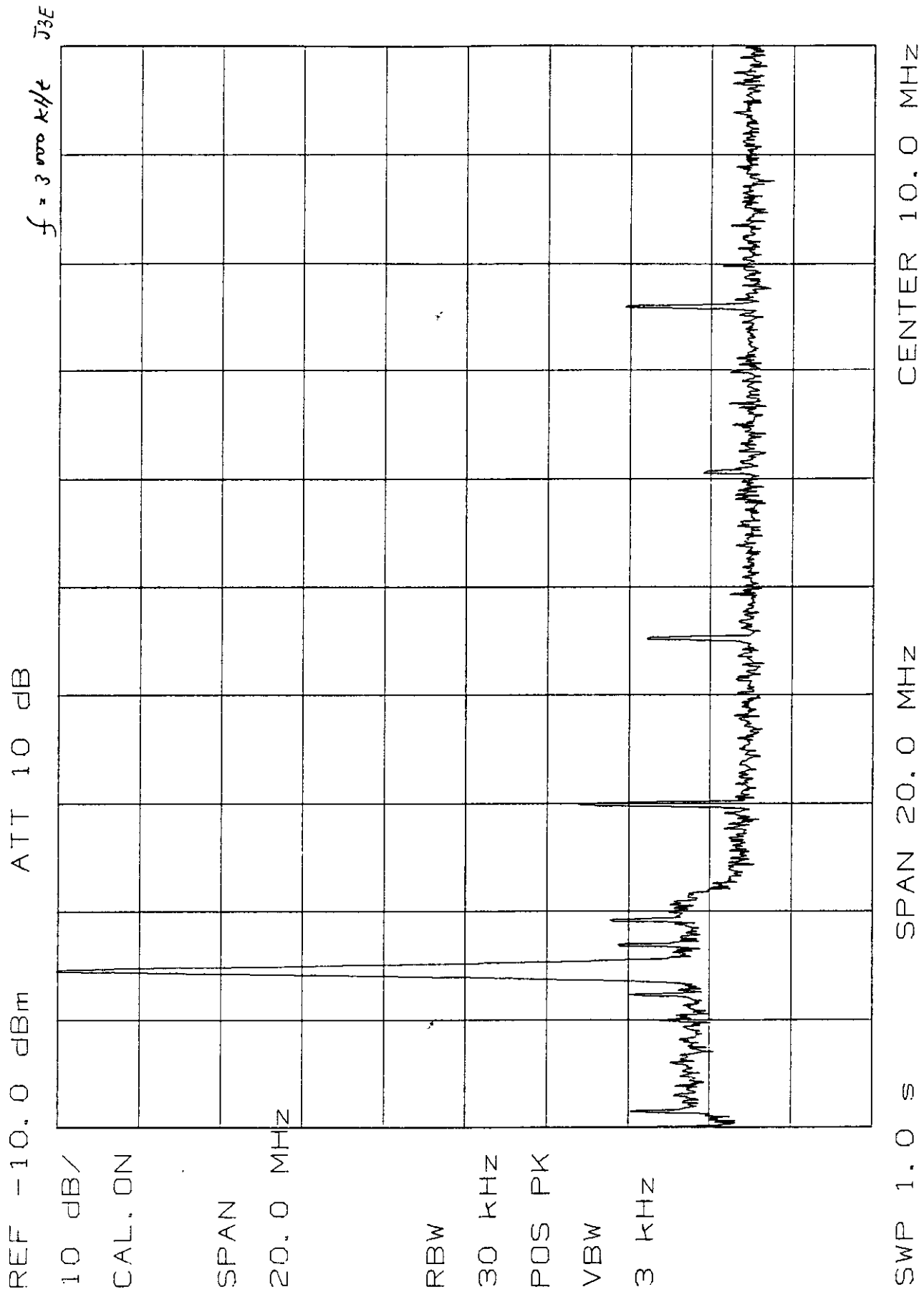
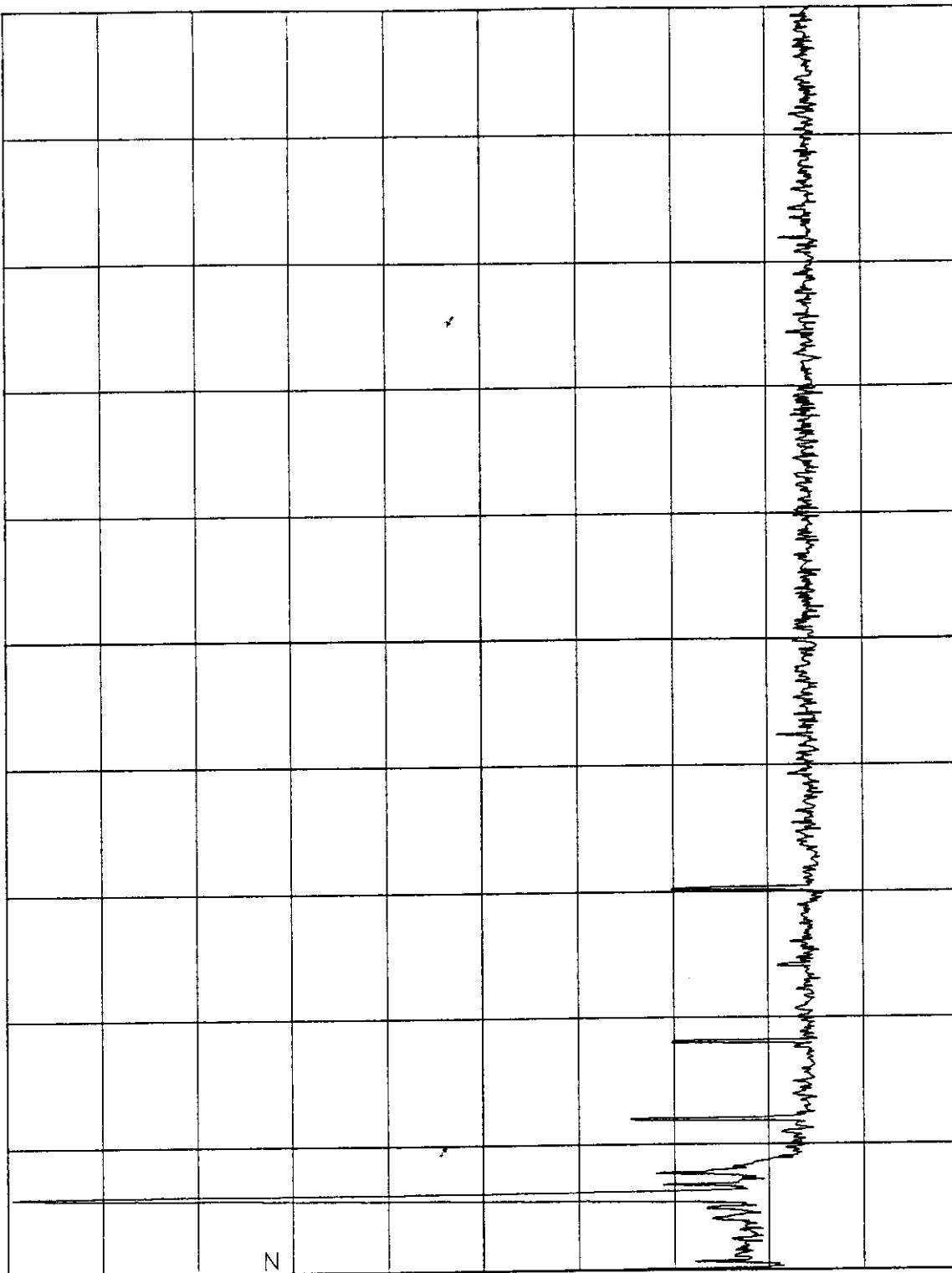


Fig. 7.6

f = 3000 kHz J3E

ATT 10 dB

REF -10.0 dBm



10 dB/

CAL. ON

SPAN

50.0 MHz

RBW

30 kHz

POS PK

VBW

3 kHz

SWP 3 s

SPAN 50.0 MHz

CENTER 25.0 MHz

Fig. 7.7

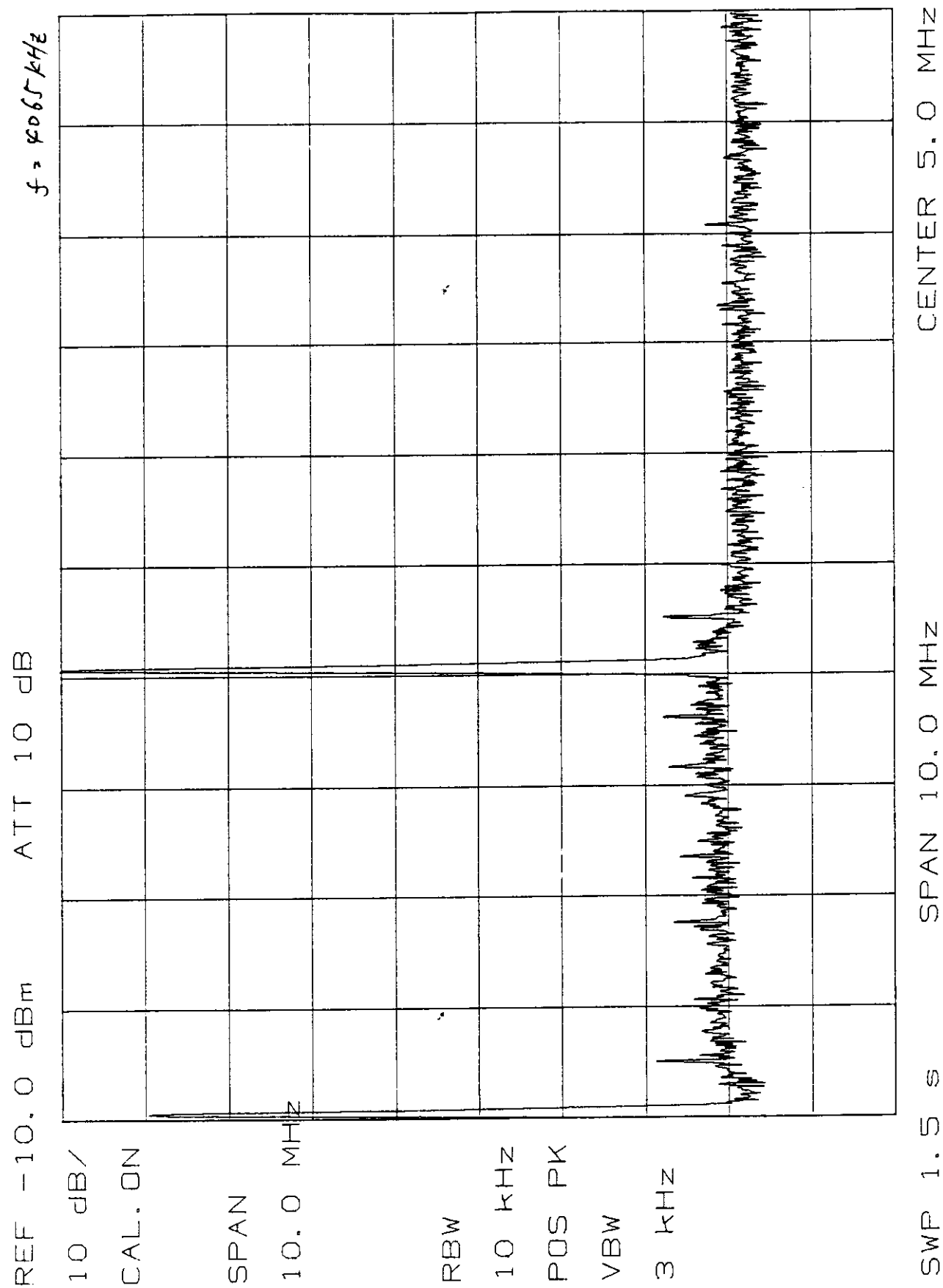


Fig. 7.8

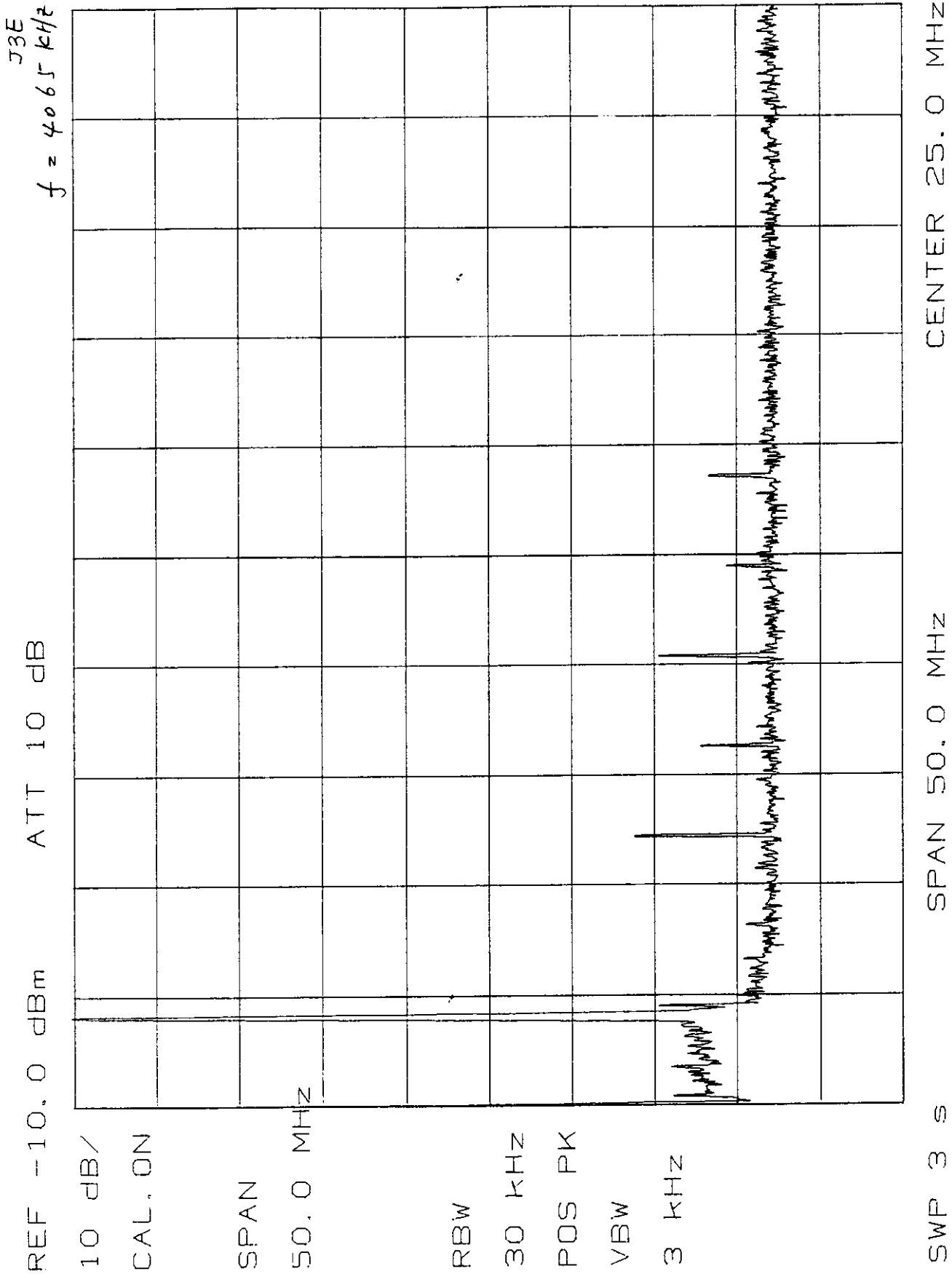


Fig. 7.9

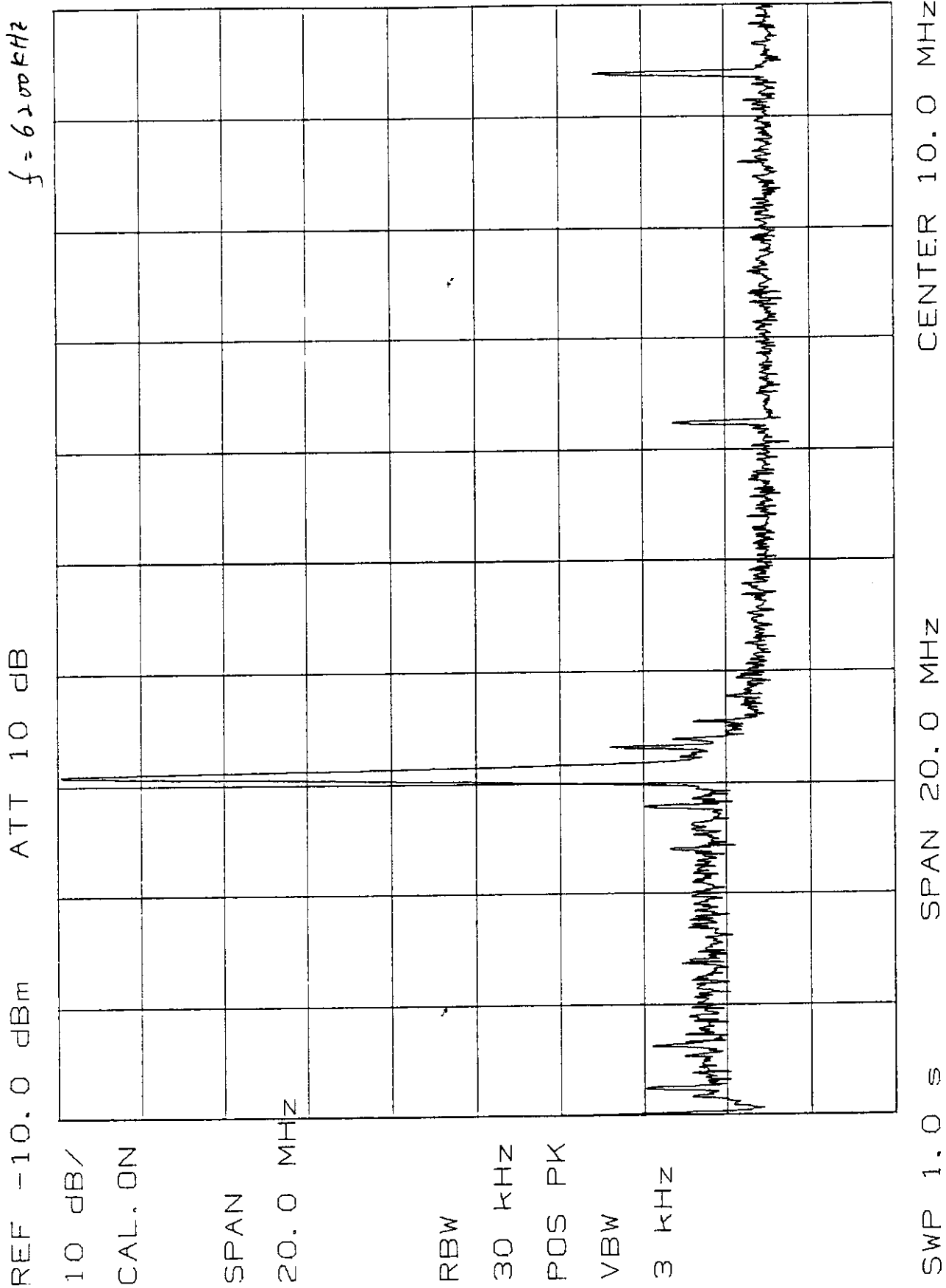


Fig. 7.10

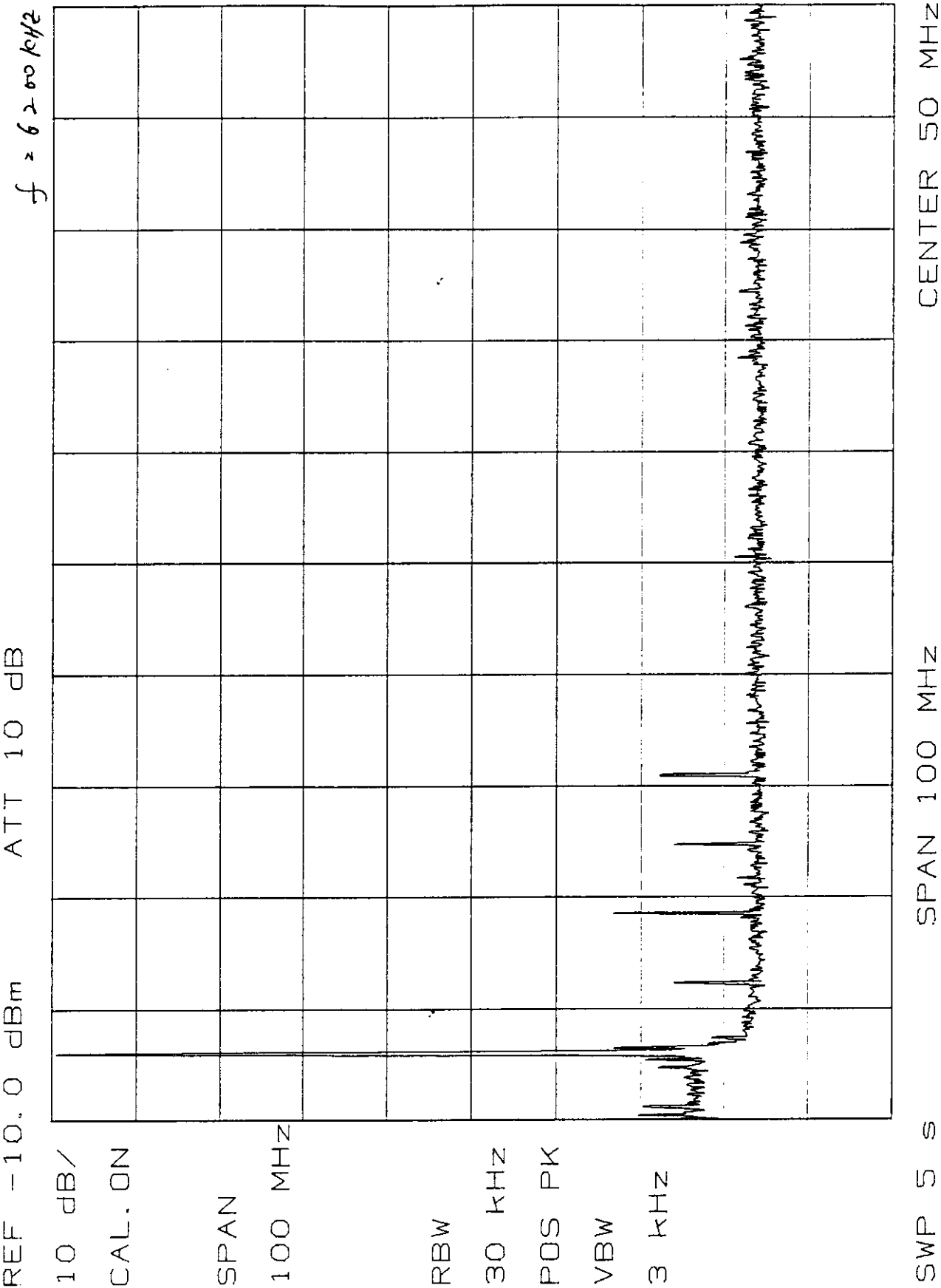


Fig. 7.11

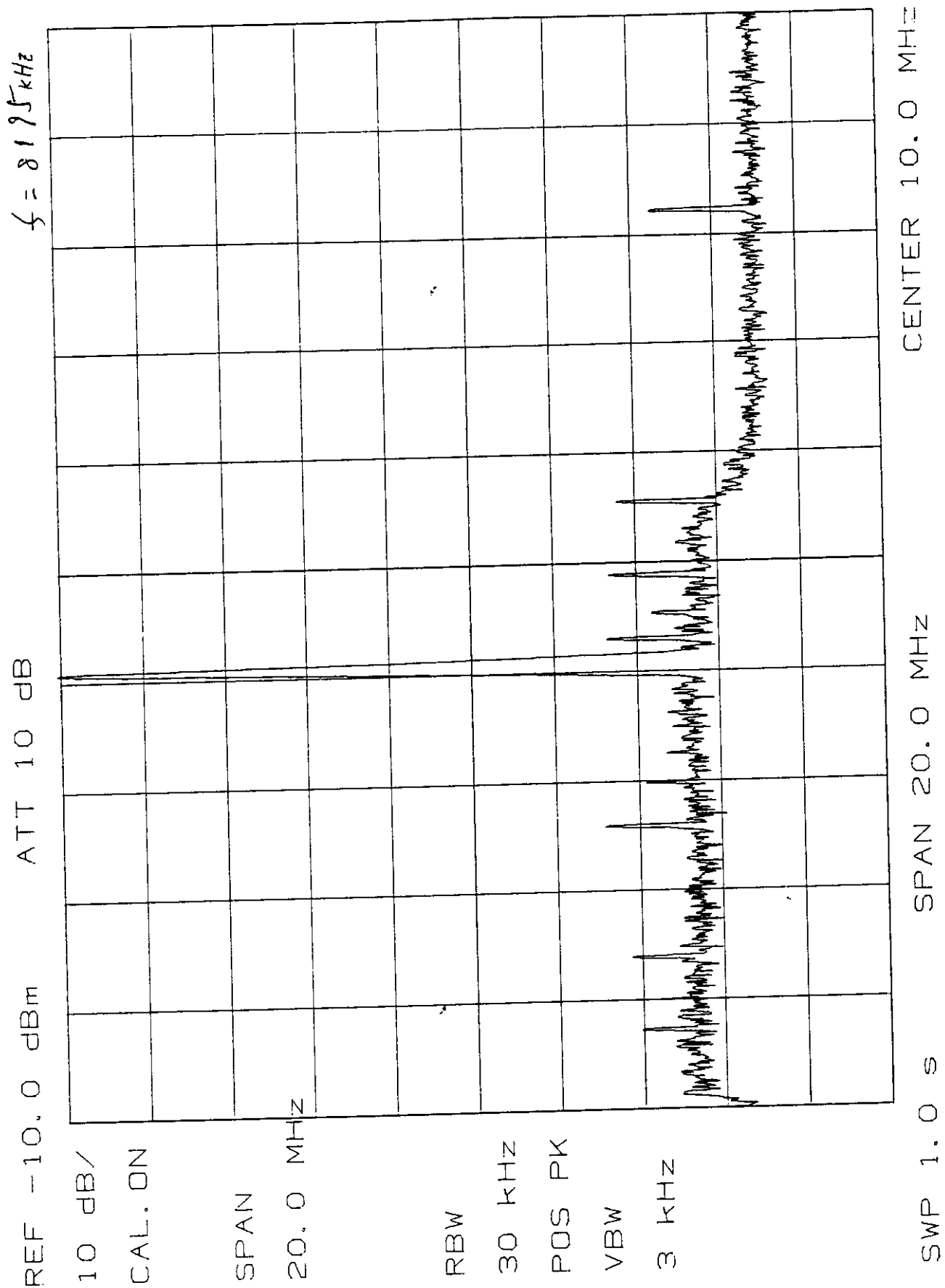


Fig. 7.12

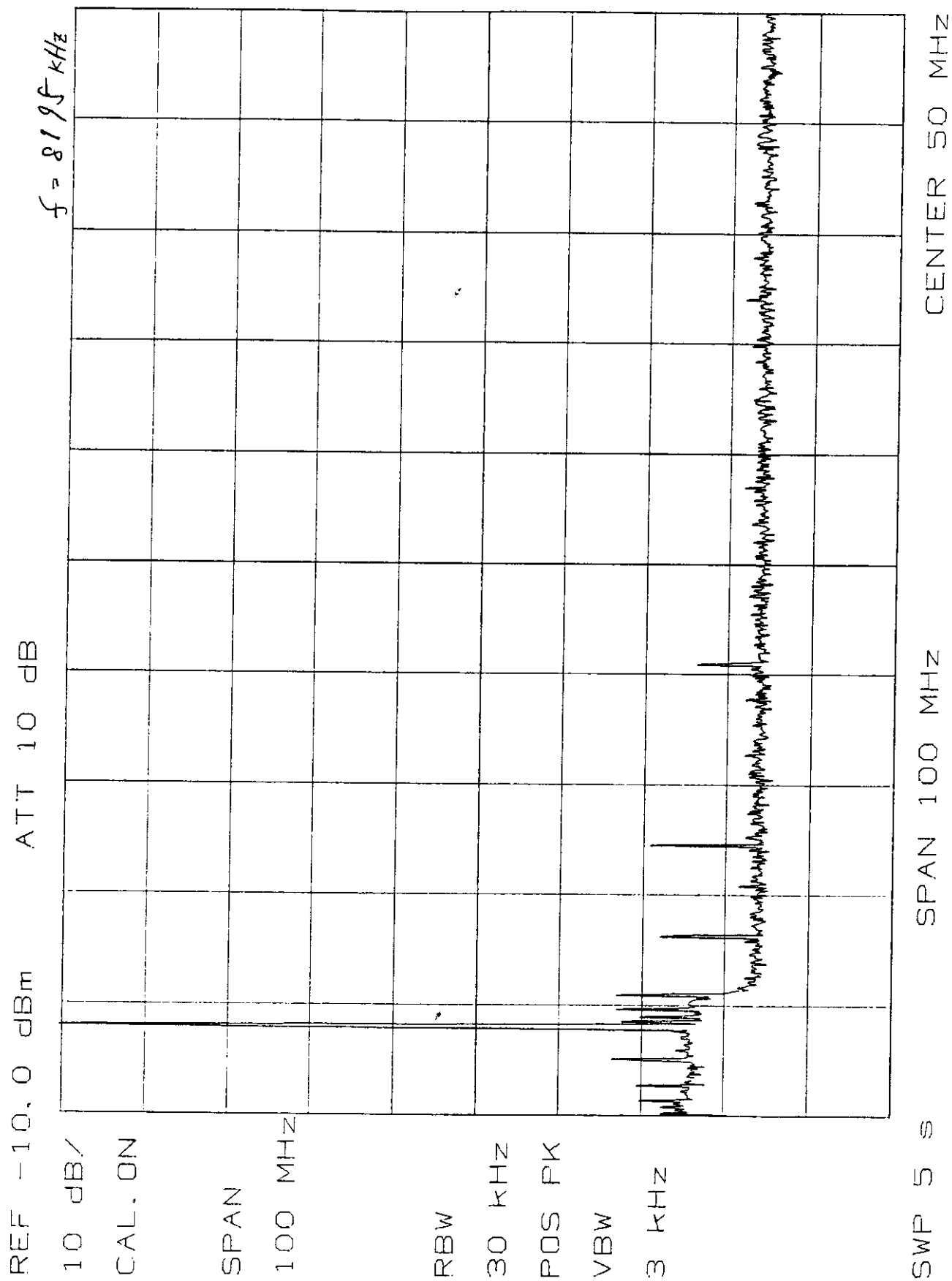


Fig. 7.13

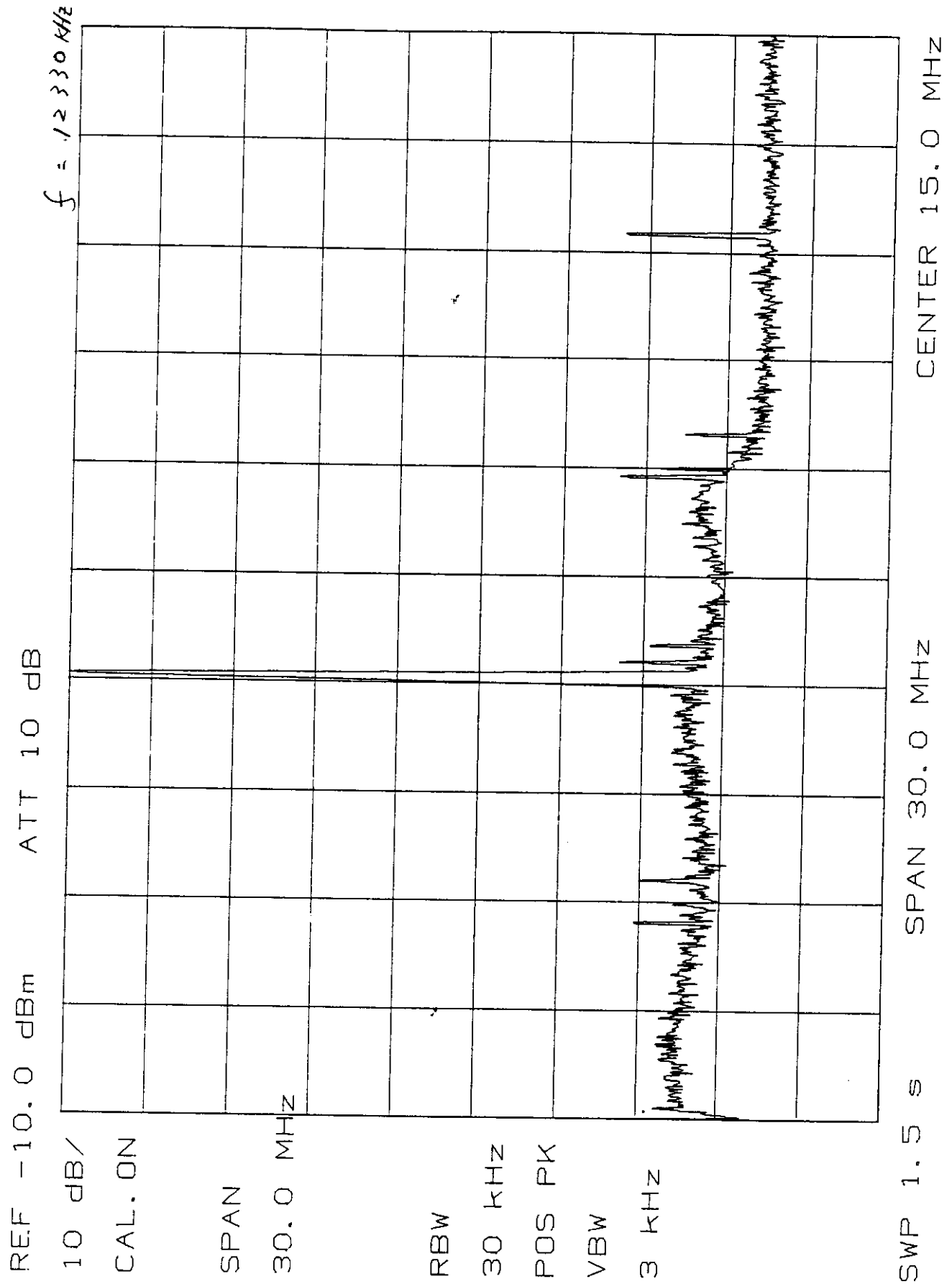


Fig. 7.14

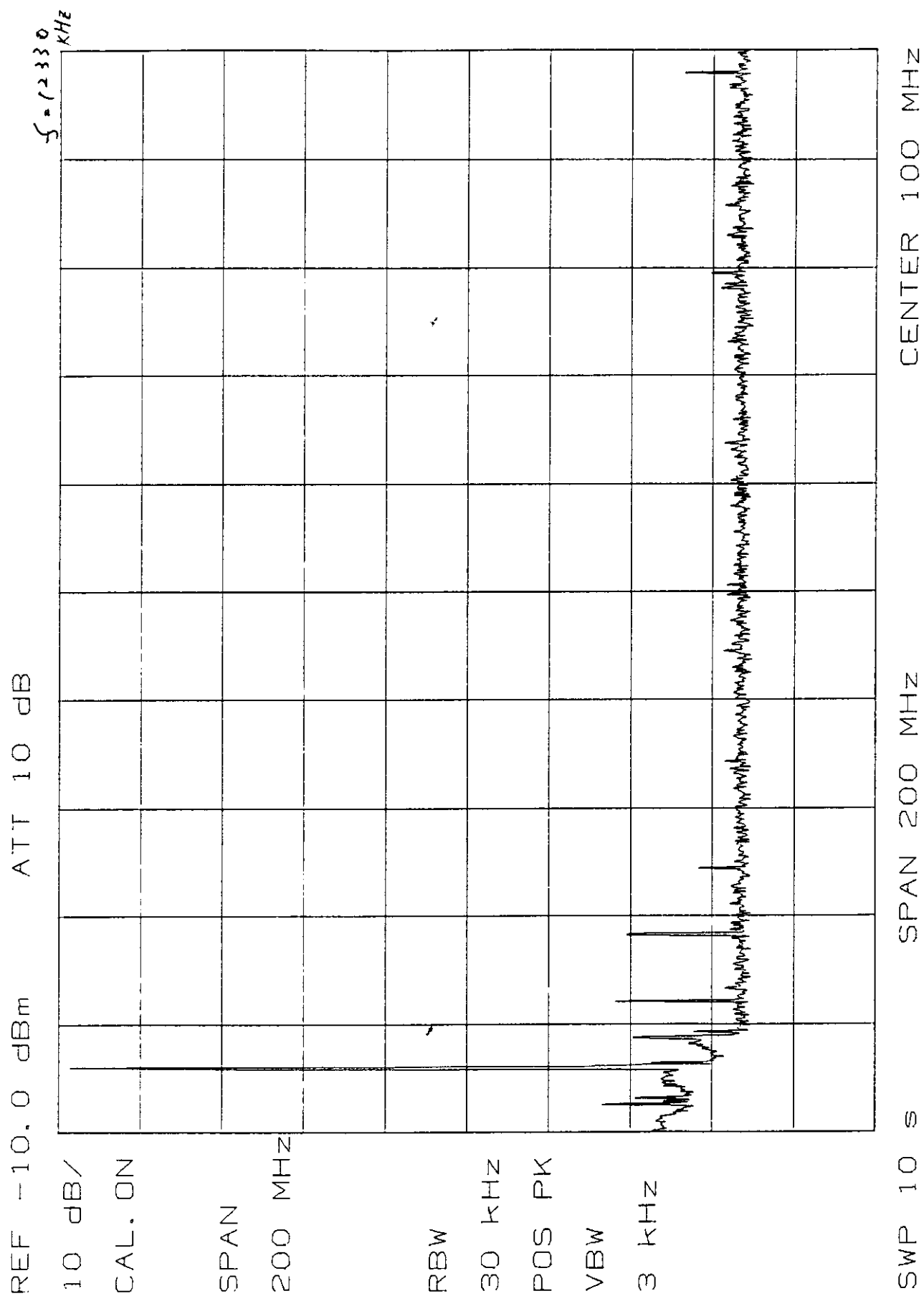


Fig. 7.15

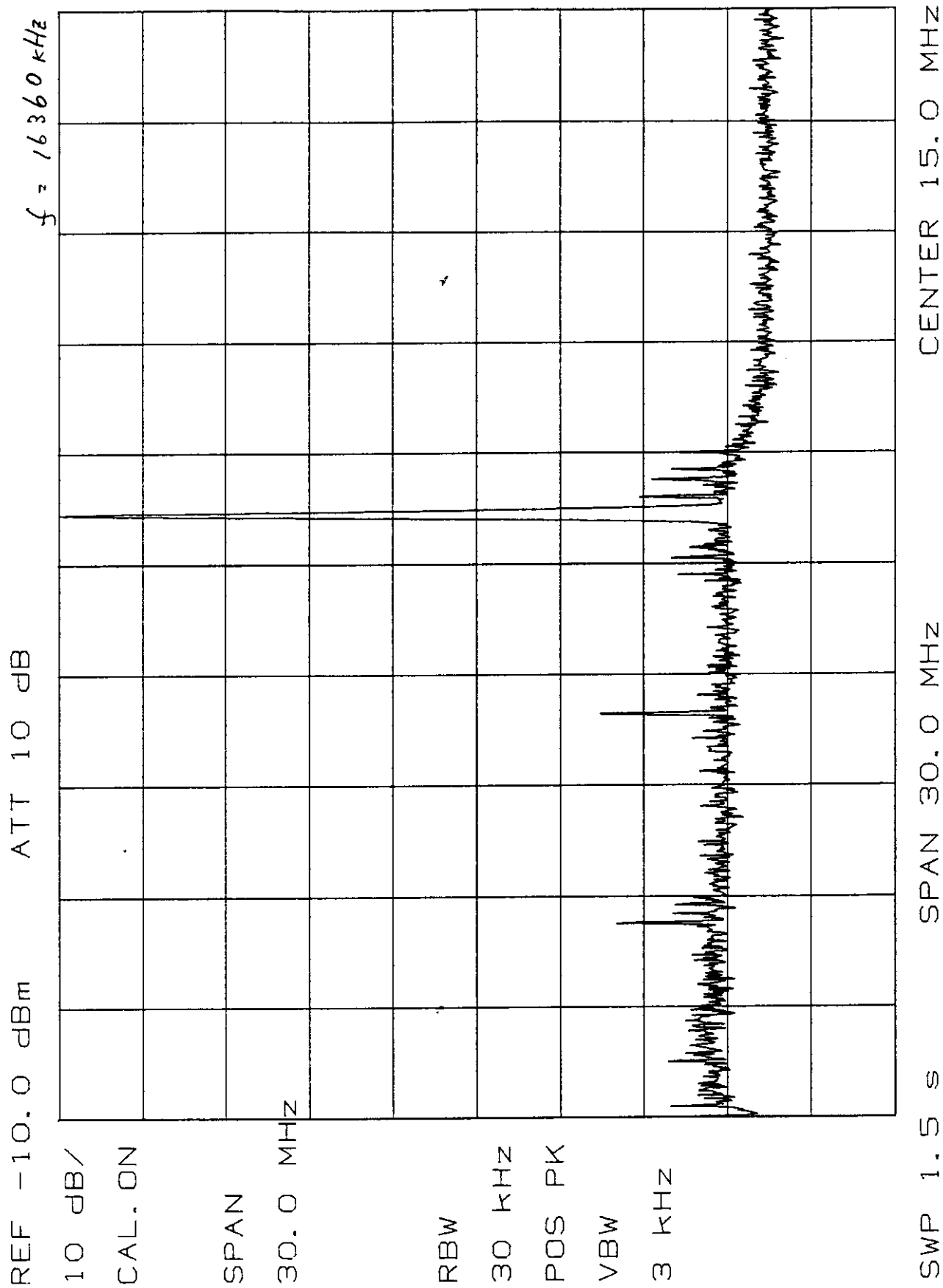


Fig. 7.16

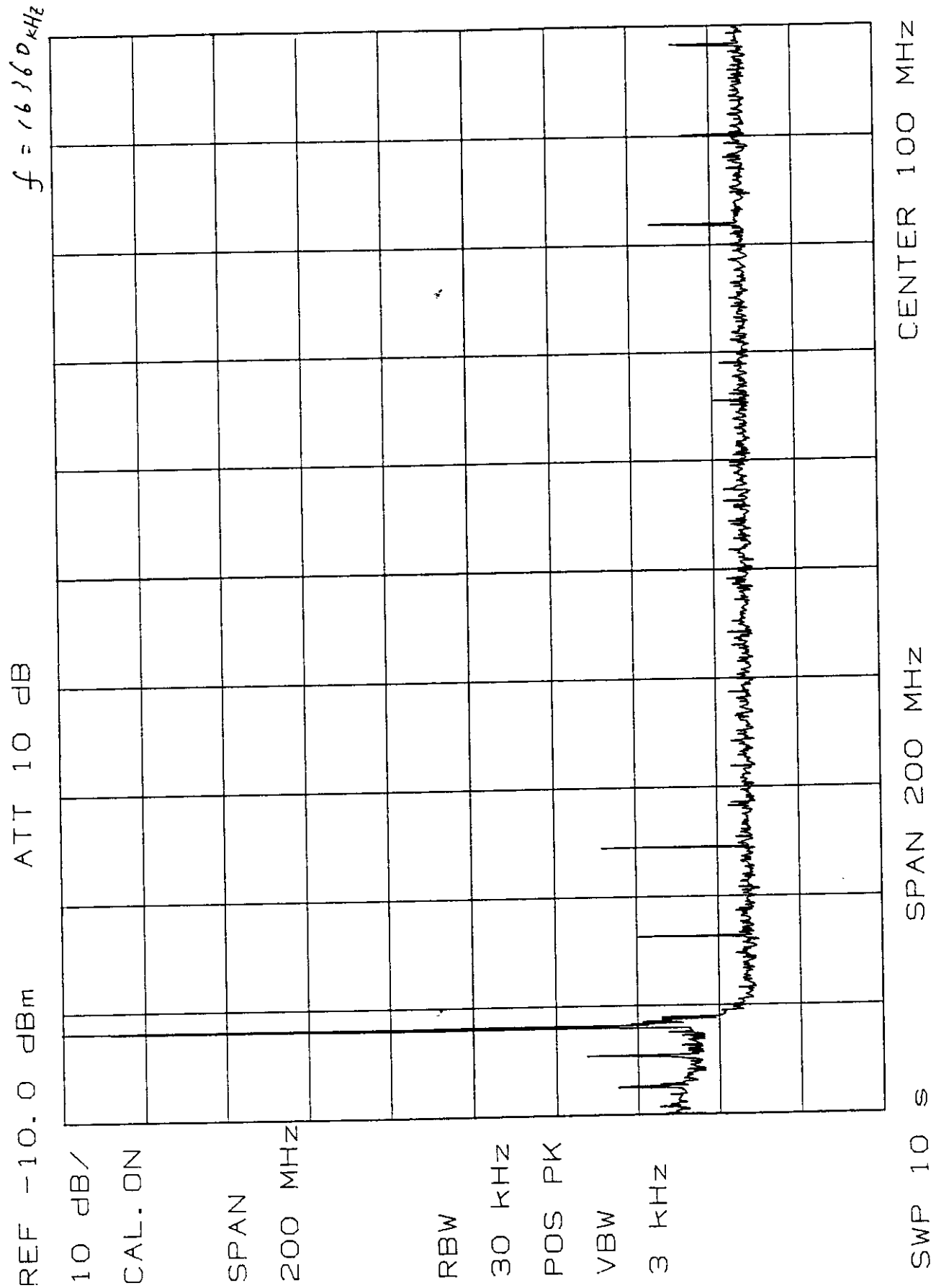


Fig. 7.17

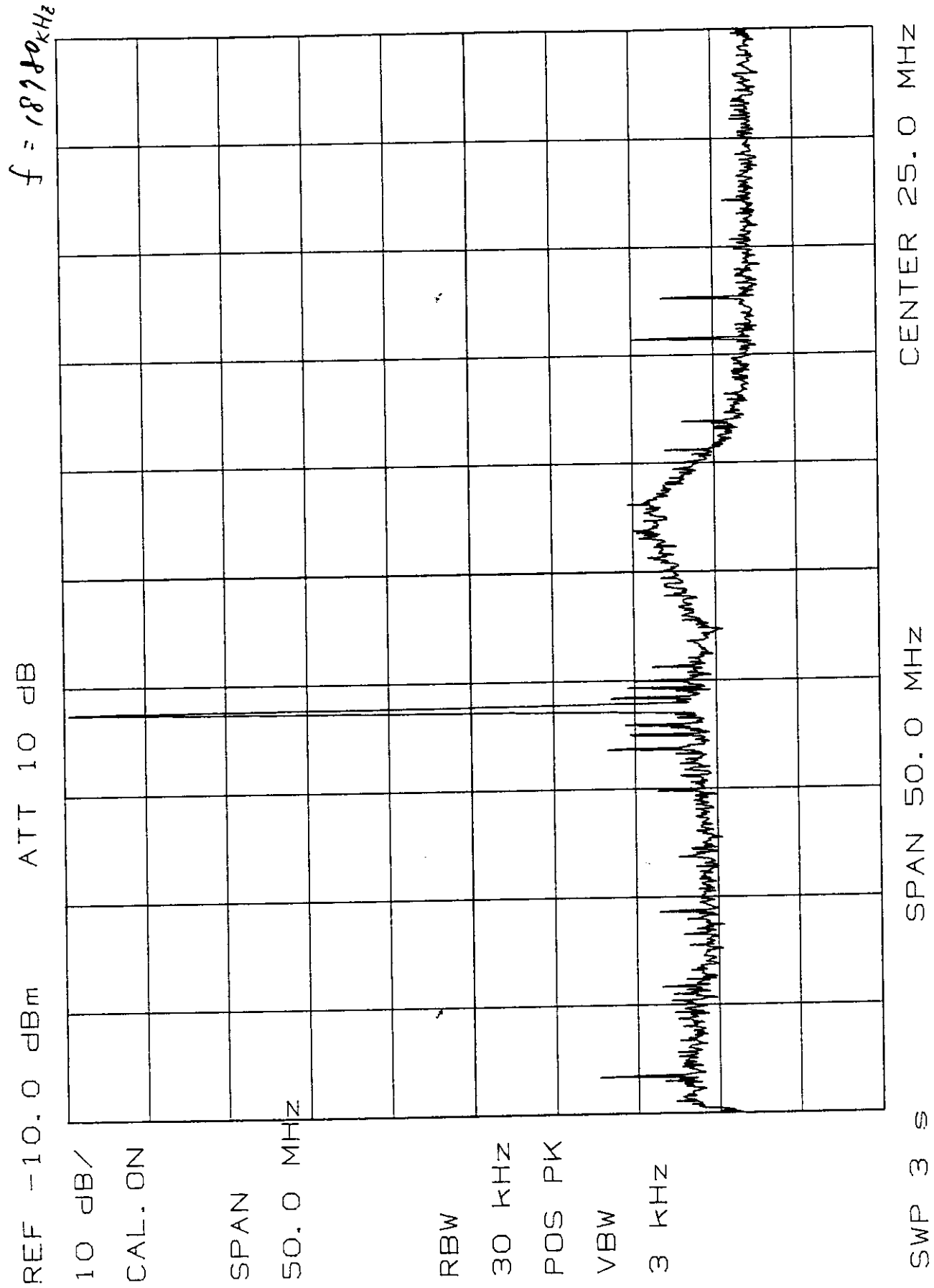


Fig. 7.18

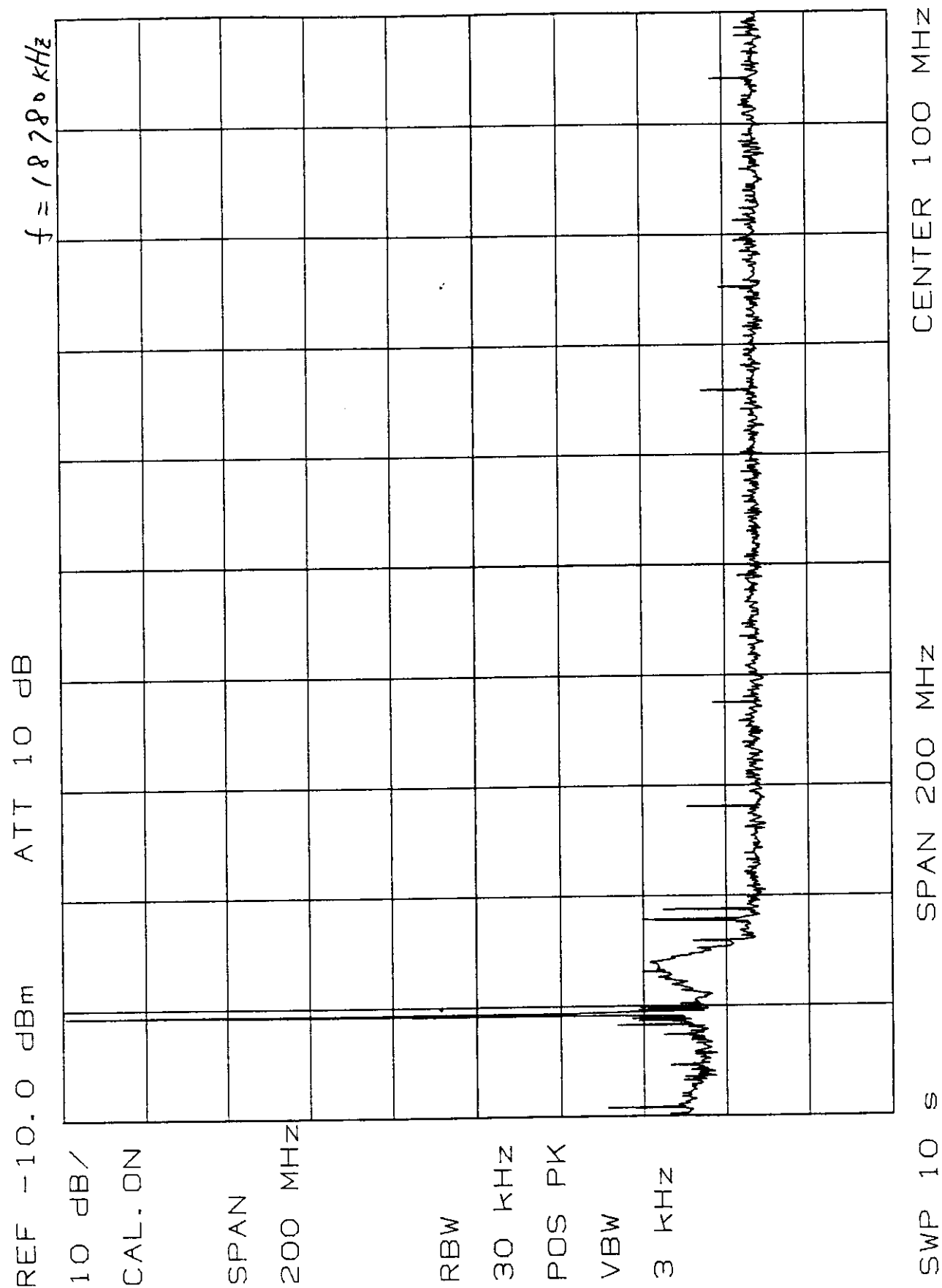


Fig. 7.19

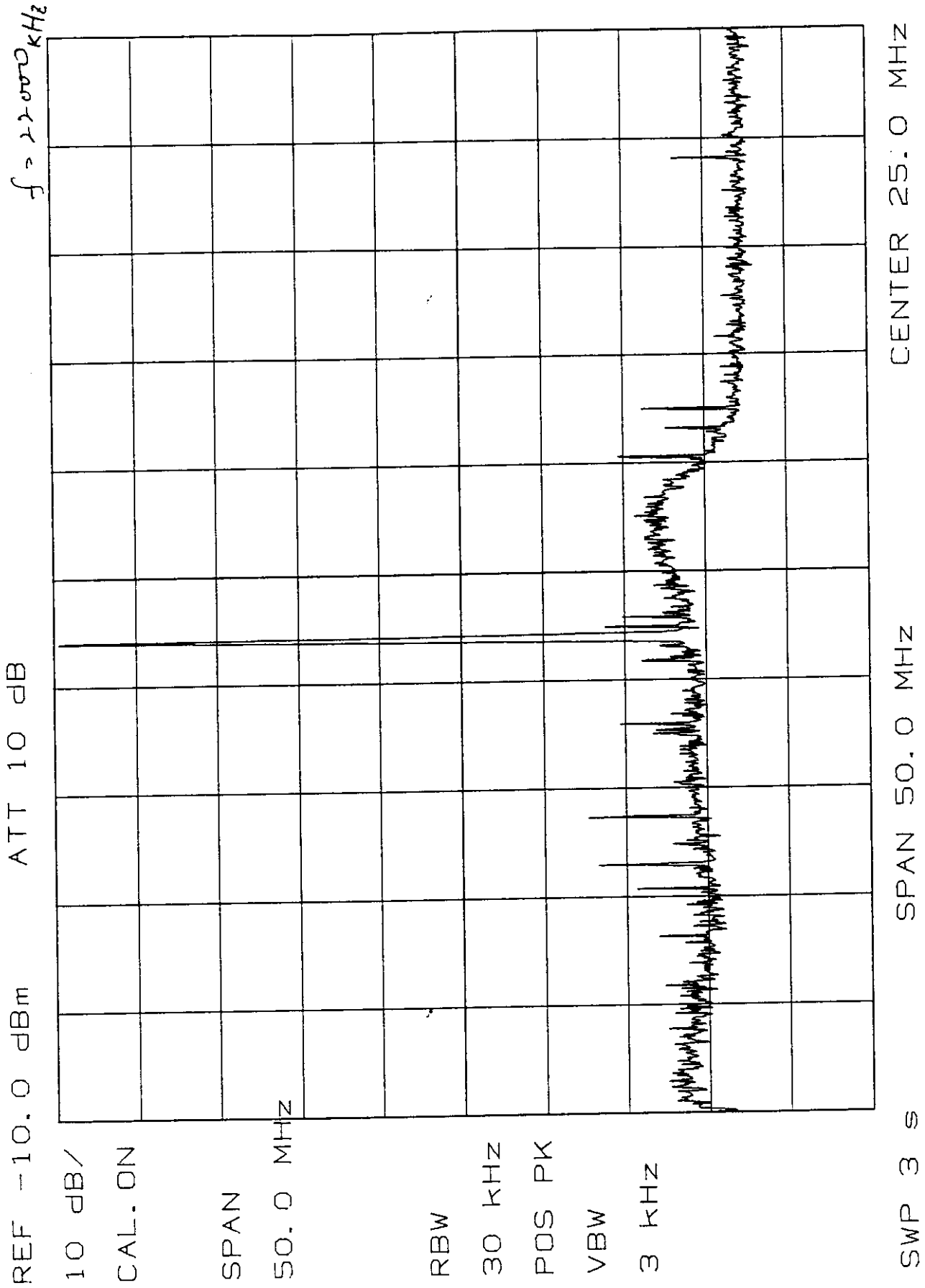


Fig. 7.20

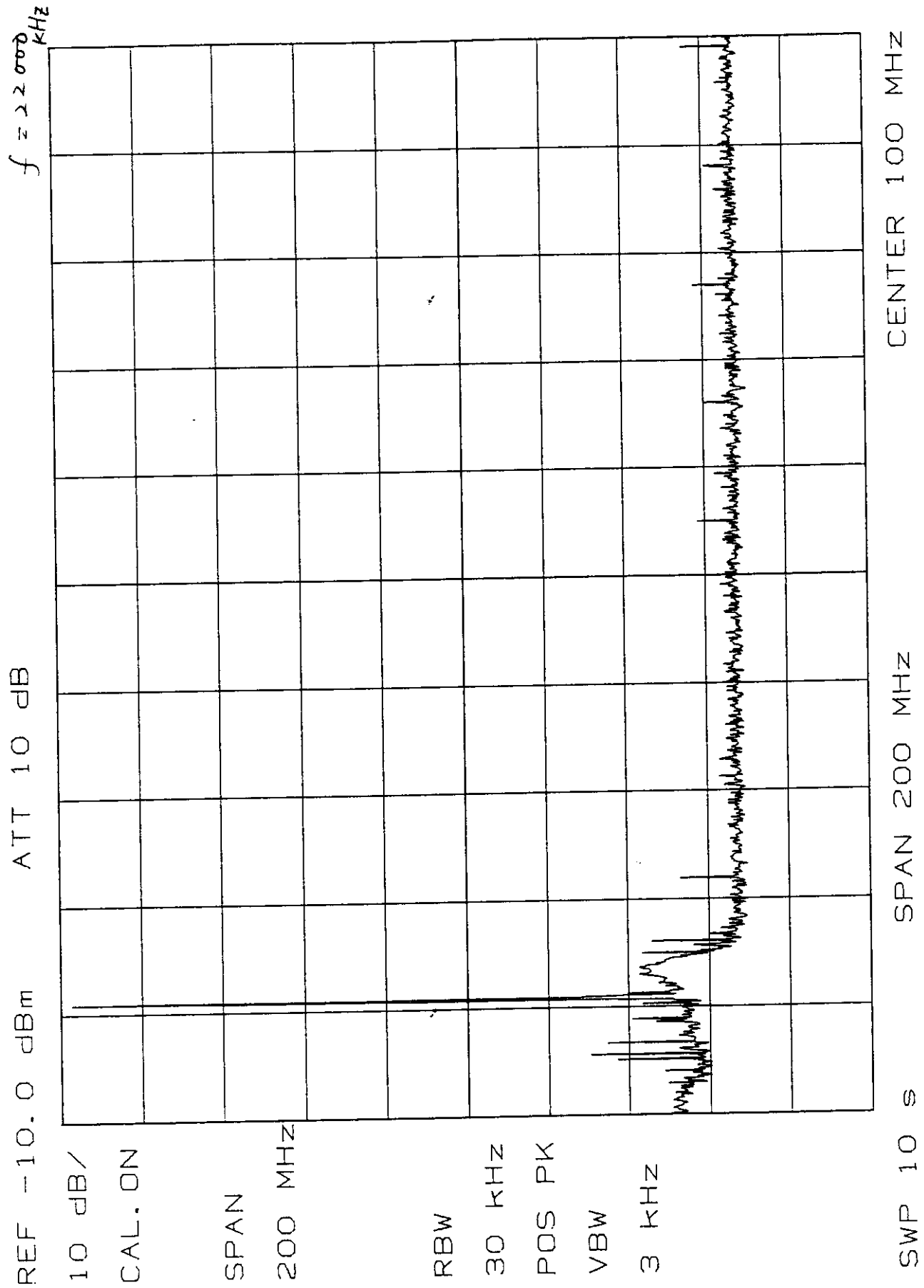


Fig. 7.21

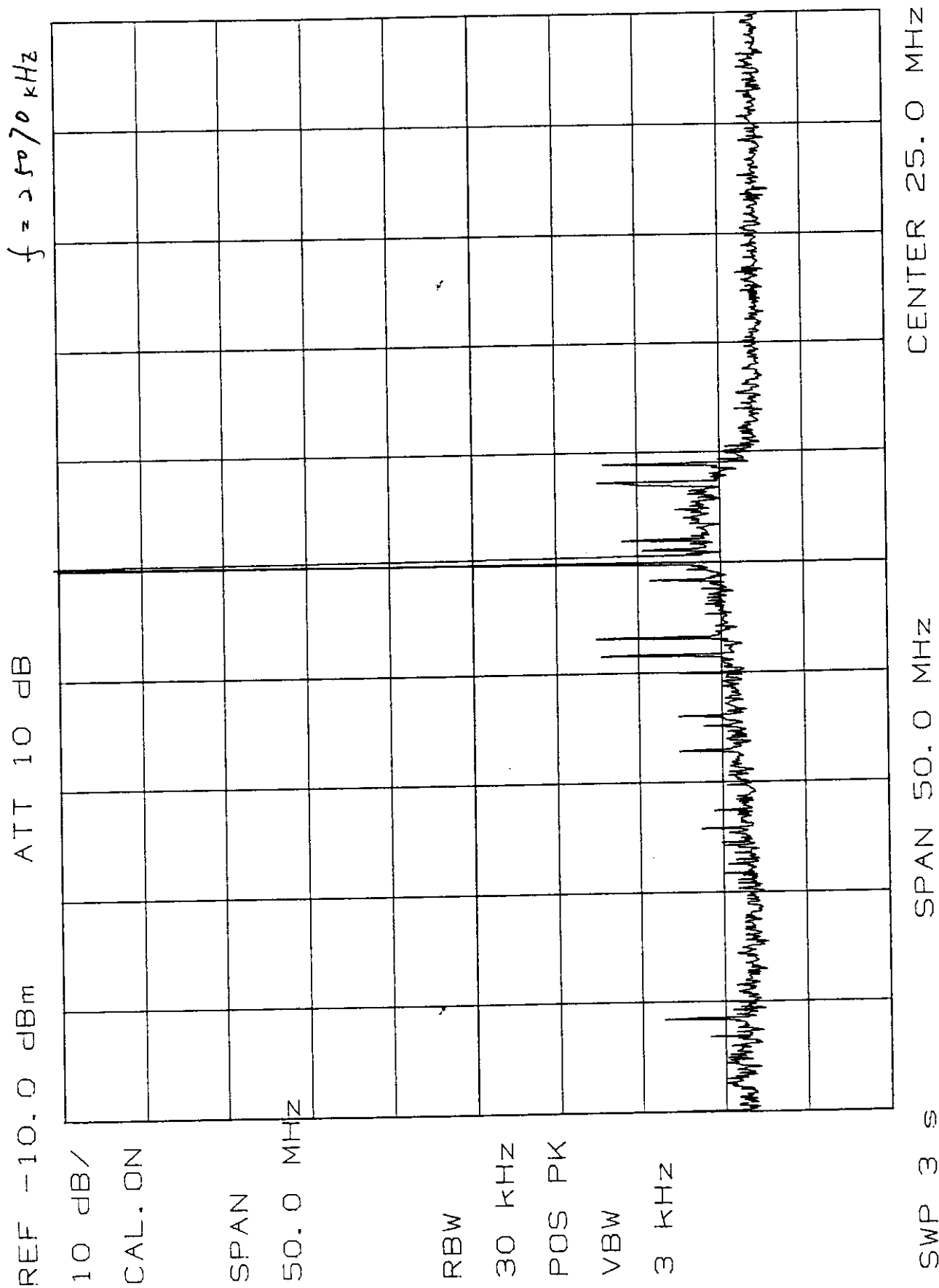


Fig. 7.22

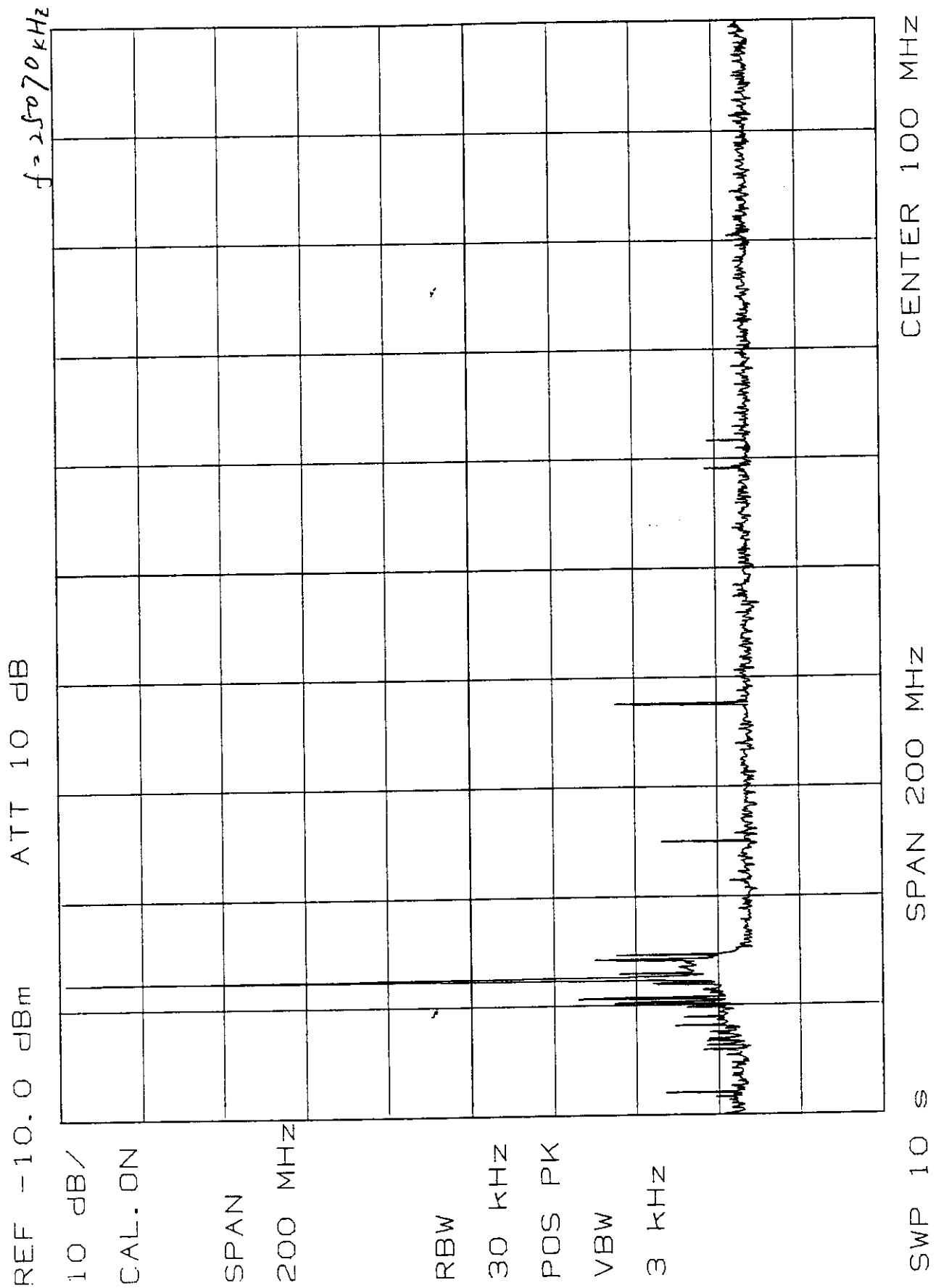


Fig. 7.23

8 FIELD STRENGTH OF SPURIOUS RADIATION (FCC Rule Part 2.993)

8.1 Method of Measurement

The transmitter is connected with measuring equipment as in Fig. 8.1.

Supplied with 13.6 VDC the transmitter is modulated with 2 audio tones 400 Hz and 1800 Hz in equal level. The input level is adjusted to 10 dB above the level producing PEP output of 150 W.

According to "Reference Data for Radio Engineers", fourth edition, ITT:

Power density P at a distance R (meters) due to power P_t emitted from an isotropic antenna in free space is expressed:

$$P = P_t / 4R^2 \text{ (W/m}^2\text{)}$$

Power density expressed in field strength E (V/m) is at any point:

$$P = E^2 / 120$$

where 120 is a resistance value of free space.

Therefore,

$$\begin{aligned} E &= (120 P)^{1/2} \\ &= (120 P_t / 4R^2)^{1/2} \\ &= (30 P_t)^{1/2} / R \end{aligned}$$

Field strength due to PEP 150 W at a distance 10 m is:

$$\begin{aligned} E &= \sqrt{30 \times 150} / 10 \\ &= 6.7 \text{ (V/m)} \end{aligned}$$

$$\text{Put } 1 \text{ } \mu\text{V/m} = 0 \text{ dB}\mu$$

$$6.7 \text{ V/m} = 134 \text{ dB}\mu \text{ (reference level)}$$

With this reference level, field strength of spurious emitted from the FS-1503 is measured by Spectrum Analyzer.

Measurement is made for each test frequency within DC to 300 MHz, especially on harmonics of carrier frequency F_c , 456.5 kHz (Intermediate Frequency) and its harmonics, 54.4565 MHz (2nd LO frequency) and $(54.4565 + F_c)$ MHz the level is recorded.

Measurement is made for each of 3 planes of the FS-1503 to search the plane where most spurious radiation is found.

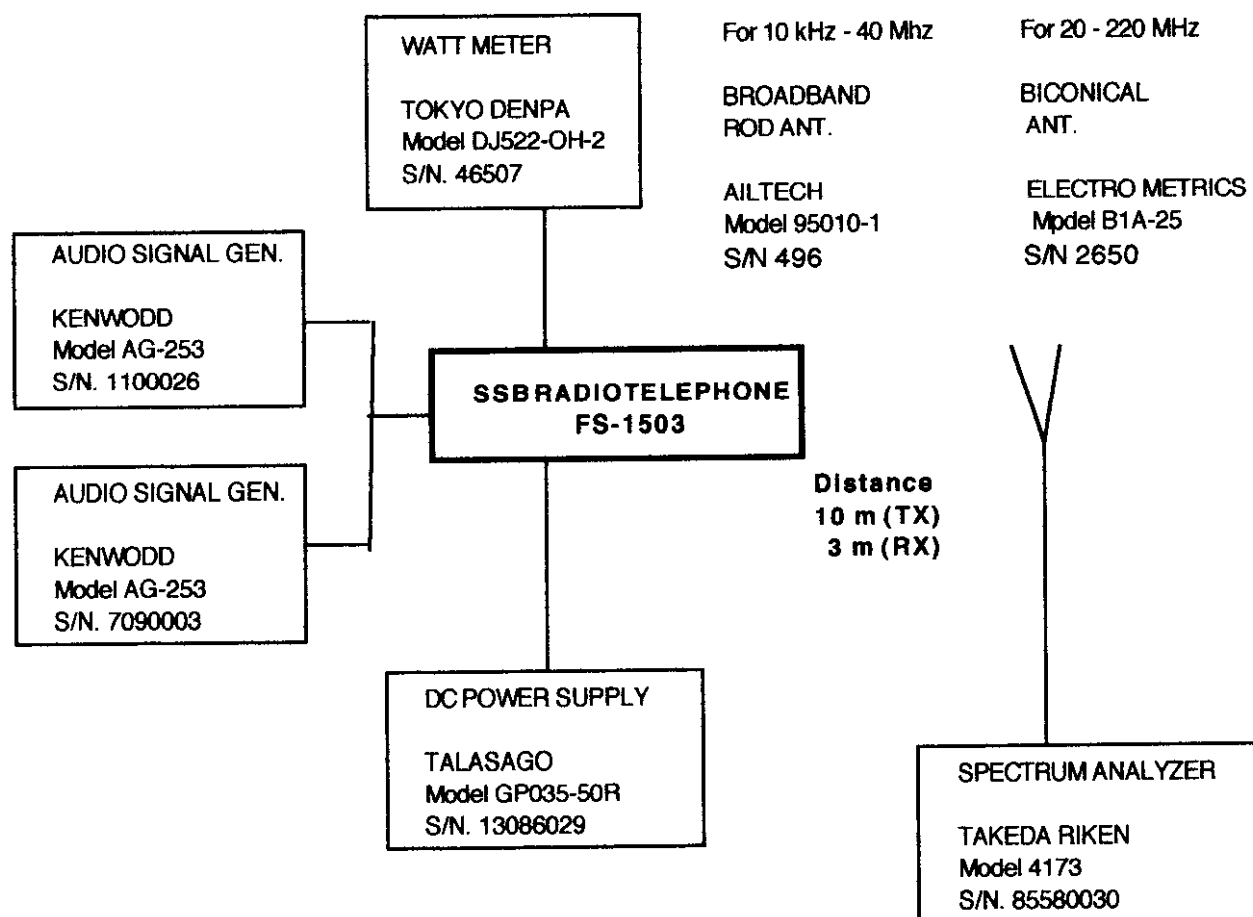


Fig. 8.1

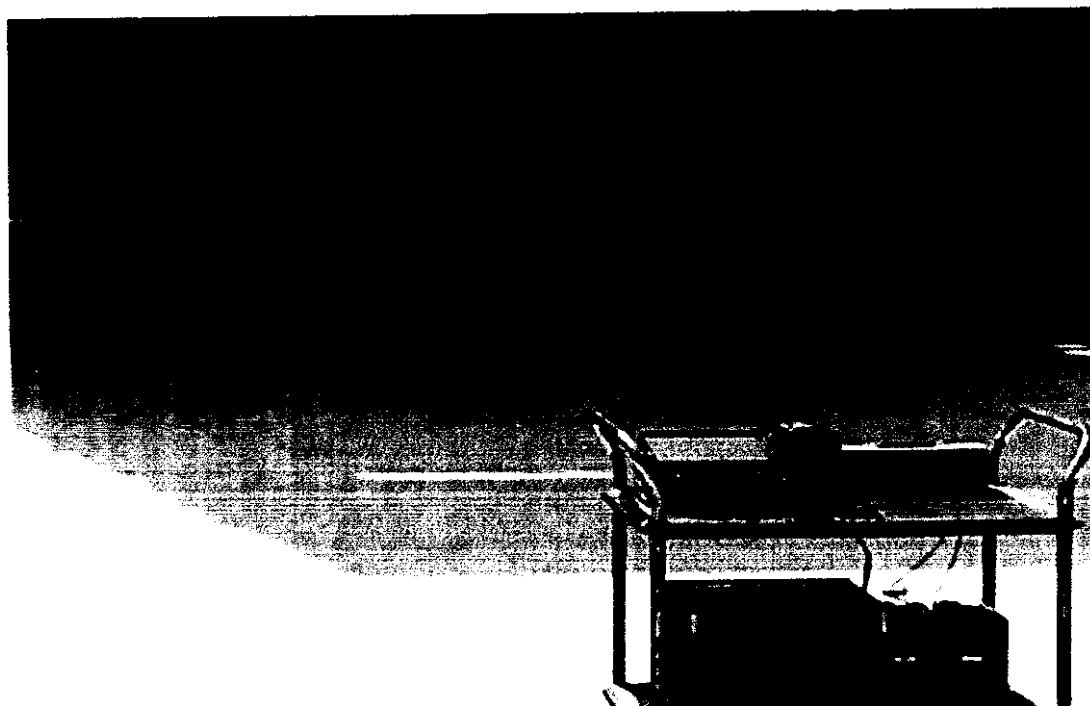


Photo showing the Test Site:
Roof of 6 story building as always done for Marine Radar Measurements

8.2 Test Result

Tables 8.1 through 8.10 show the results.

Table 8.1 Fc:1605.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$	None detected to 120 dB
$3 \times F_c$	
$4 \times F_c$	
$5 \times F_c$	
$6 \times F_c$	
$7 \times F_c$	
$8 \times F_c$	
$9 \times F_c$	
$10 \times F_c$	
456.5 kHz (3rd IF)	
913.0 kHz (2 $\times$ 3rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.2 Fc: 2182.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$	None detected to 120 dB
$3 \times F_c$	
$4 \times F_c$	
$5 \times F_c$	
$6 \times F_c$	
$7 \times F_c$	
$8 \times F_c$	
$9 \times F_c$	
$10 \times F_c$	
456.5 kHz (3rd IF)	
913.0 kHz (2 $\times$ 3rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.3

Fc: 3023.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$	None detected to 120 dB
$3 \times F_c$	
$4 \times F_c$	
$5 \times F_c$	
$6 \times F_c$	
$7 \times F_c$	
$8 \times F_c$	
$9 \times F_c$	
$10 \times F_c$	
456.5 kHz (3rd IF)	
913.0 kHz (2 × 3rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.4

Fc: 4065.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$	None detected to 120 dB
$3 \times F_c$	
$4 \times F_c$	
$5 \times F_c$	
$6 \times F_c$	
$7 \times F_c$	
$8 \times F_c$	
$9 \times F_c$	
$10 \times F_c$	
456.5 kHz (3rd IF)	
913.0 kHz (2 × 3rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.5 Fc: 8195.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.6 Fc: 12230.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Table 8.7 Fc: 16360.0 kHz

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Fc: 18780.0 kHz

Table 8.8

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Fc: 22000.0 kHz

Table 8.9

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

Fc: 25070.0 kHz

Table 8.10

Spurious Frequency	Cabinet Radiation below Reference Level
$2 \times F_c$, $3 \times F_c$, $4 \times F_c$, $5 \times F_c$, $6 \times F_c$, $7 \times F_c$, $8 \times F_c$, $9 \times F_c$, and $10 \times F_c$	None detected to 120 dB
456.5 kHz (3rd IF)	
913.0 kHz (2×3 rd IF)	
54.0 MHz (2nd LO)	
54.4565 MHz (2nd IF)	
54.4565 + Fc MHz (1st LO)	

9 FREQUENCY STABILITY (FCC Rule Part 2.995)

9.1 Method of Measurement

The FS-1503 stored in the chamber, is connected with measuring equipment as in Fig. 9.1.

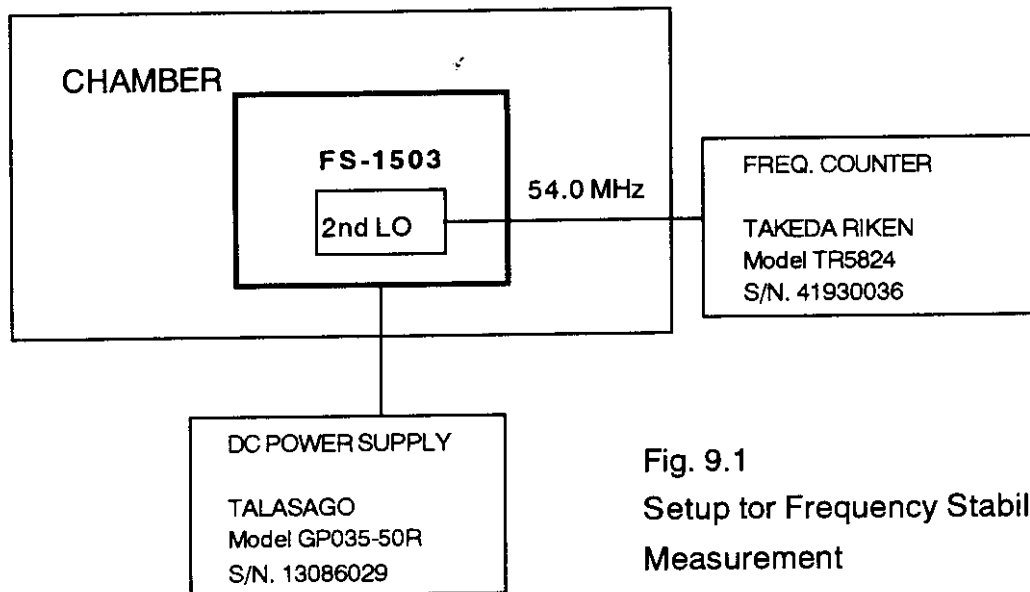


Fig. 9.1
Setup for Frequency Stability
Measurement

With the power switch off, the FS-1503 is left in the chamber until thermal equilibrium is achieved. Power is then applied and, after 15 minutes of warm-up, the reference oscillator frequency is measured. Measurements are made within the temperature range -30°C to $+50^{\circ}\text{C}$ at 10°C interval, by applying 85 % (11.56 V), 100% (13.6 V), and 115% (15.64V) of the rated DC supply voltage.

Frequency stability measurements are also performed in cold start conditions (no warm-up period). For the purpose of these measurements, change in the reference oscillator frequency is plotted in the function of the lapse of time up to 60 minutes. The FS-1503 is tested at -30°C , -20°C , 0°C and $+30^{\circ}\text{C}$.

9.2 Test Result

The results are shown in Figures 9.2 through 9.4, and Figures 9.5 through 9.8, respectively.

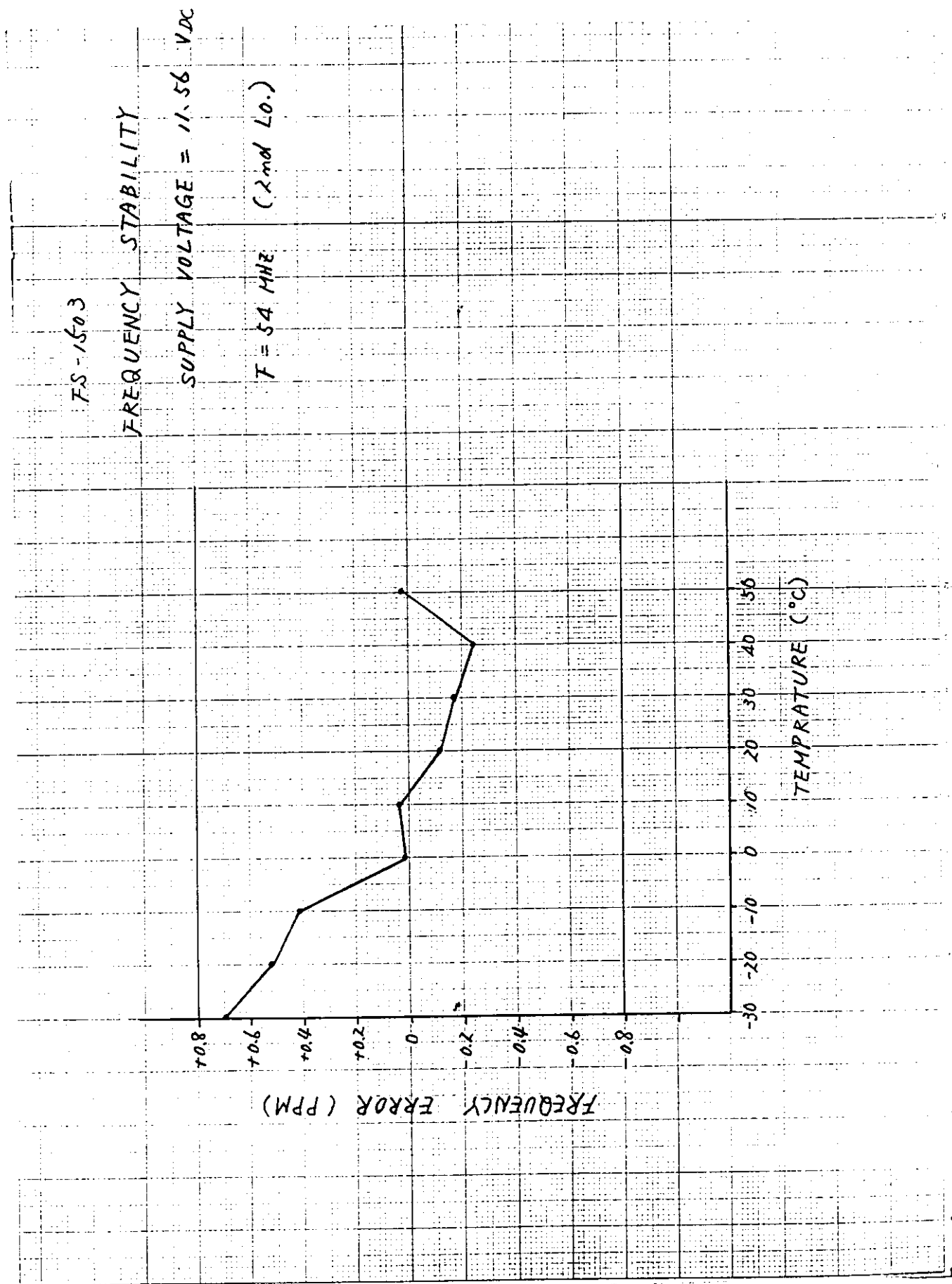


Fig. 9.2

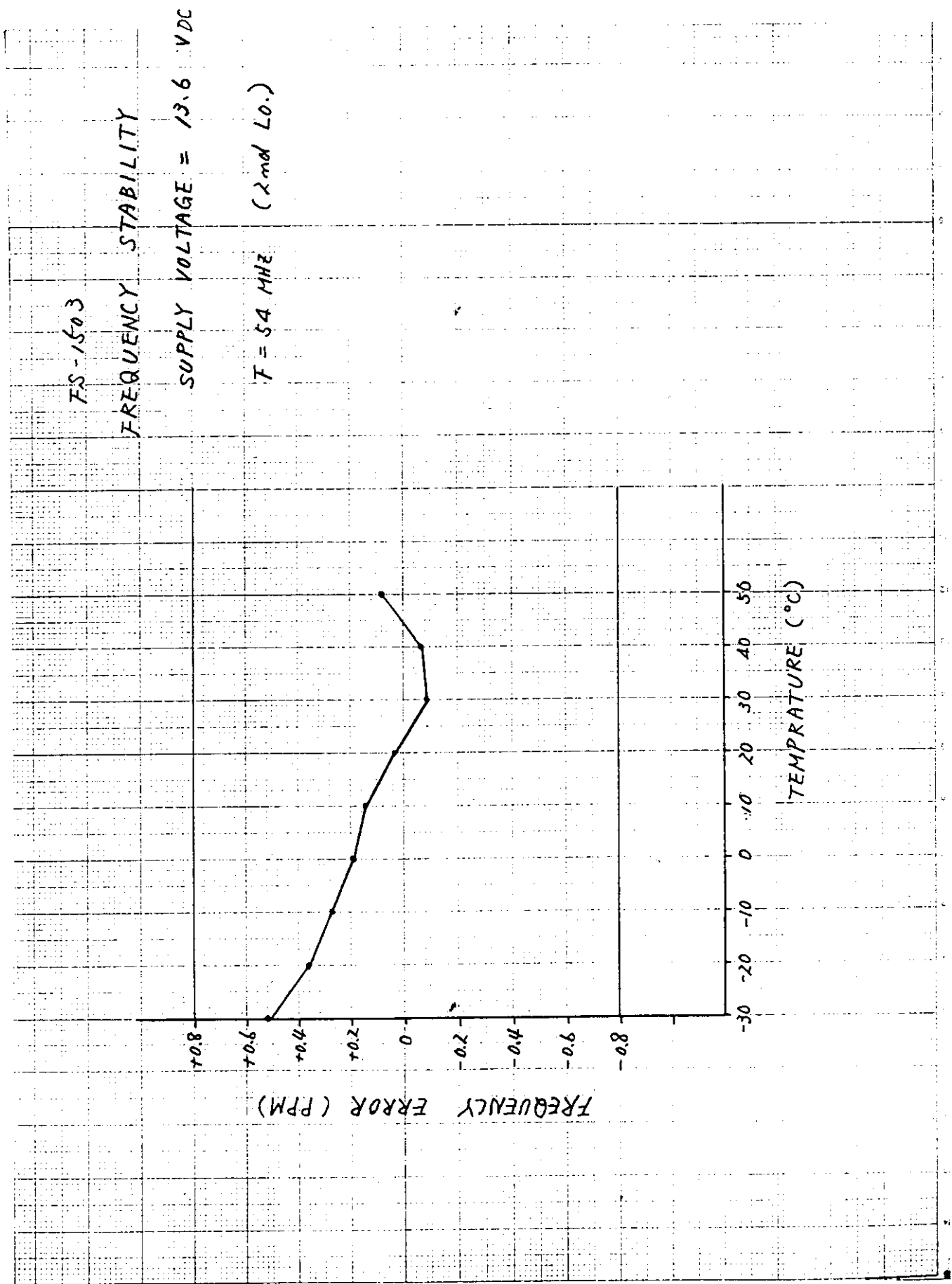


Fig. 9.3

FS-1503

FREQUENCY STABILITY

SUPPLY VOLTAGE = 15.64 VDC

F = 54 MHz (2nd LO.)

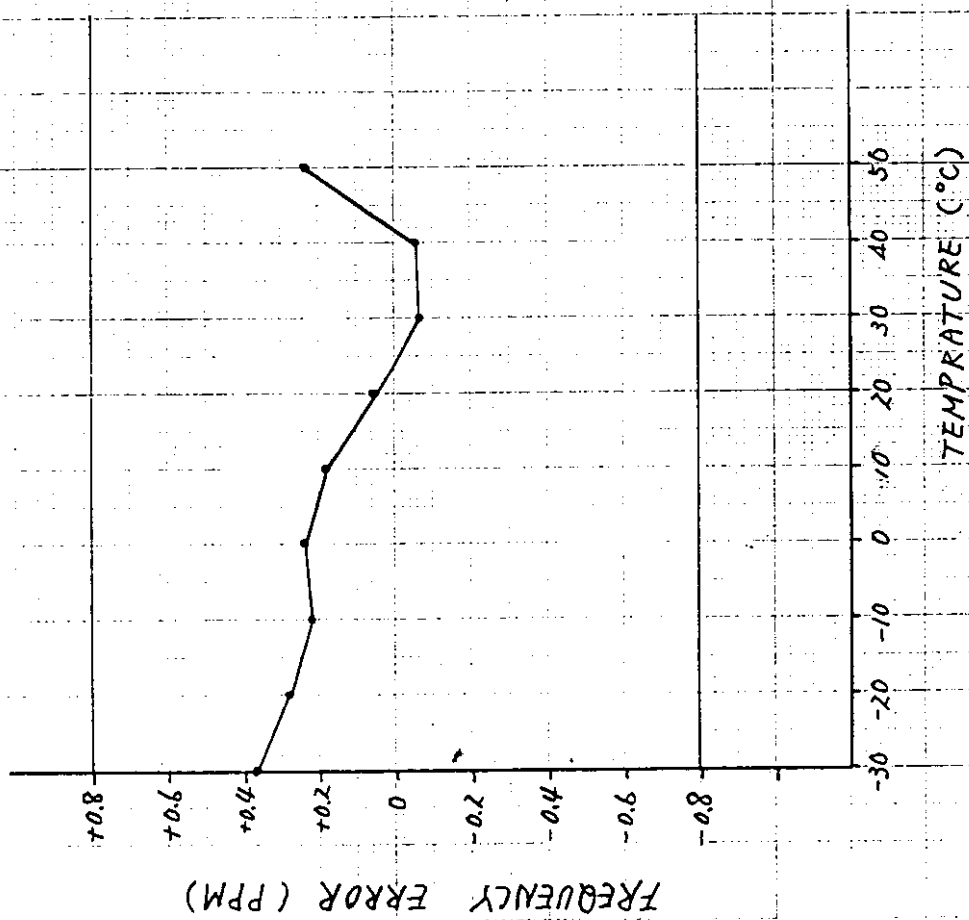


Fig. 9.4

Date: May, 1998

FS-1503

FREQUENCY STABILITY

(COLD START)

SUPPLY VOLTAGE = 13.6 V DC

F = 54 MHz (2nd LO.)

-30°C

FREQUENCY ERROR (PPM)

TIME (MINUTES)

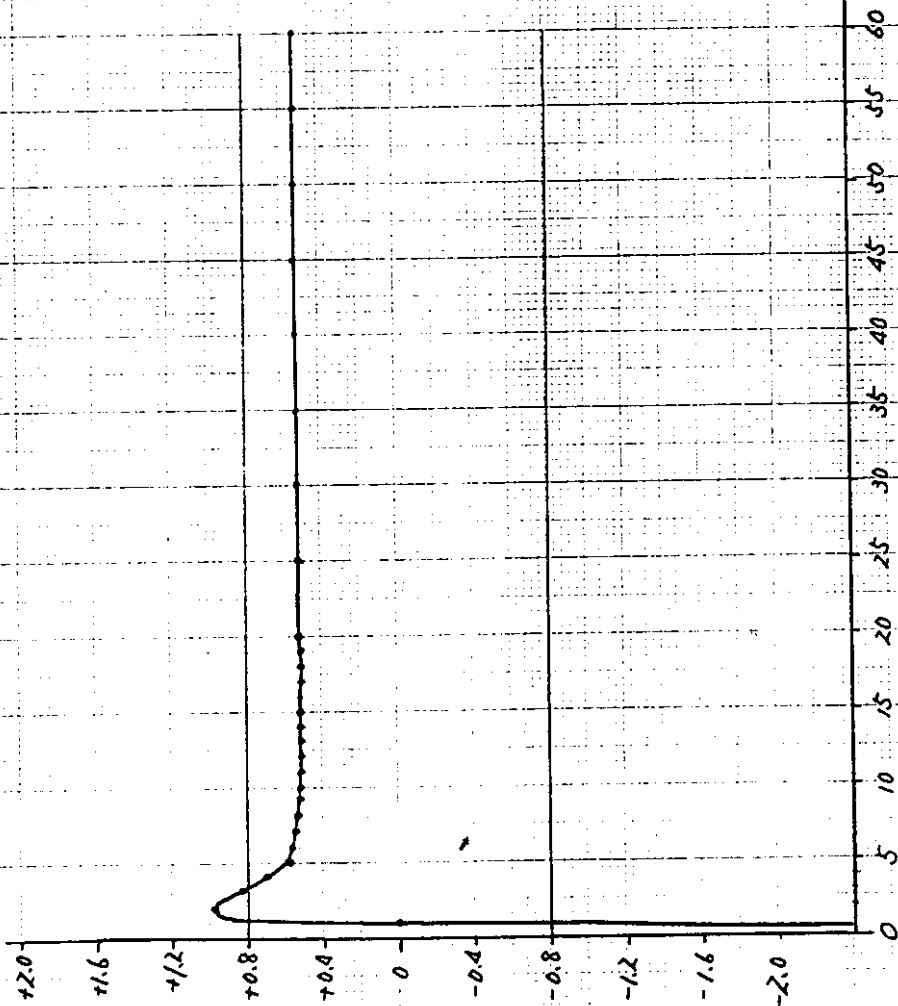


Fig. 9.5

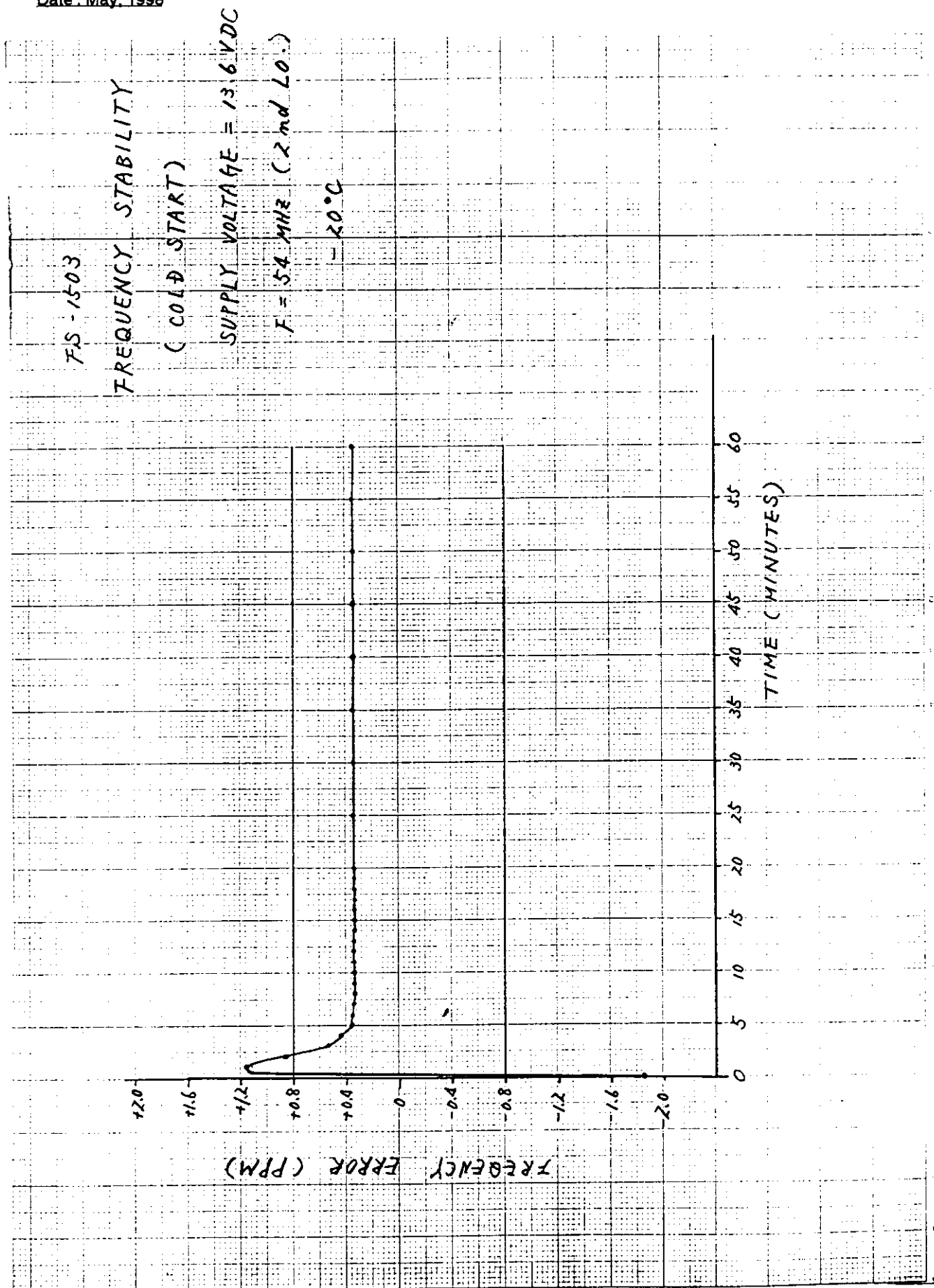


Fig. 9.6

FS-1503

FREQUENCY STABILITY

(COLD START)

SUPPLY VOLTAGE = 13.6 VDC

F = 54 MHz (2nd LO.)

0°C

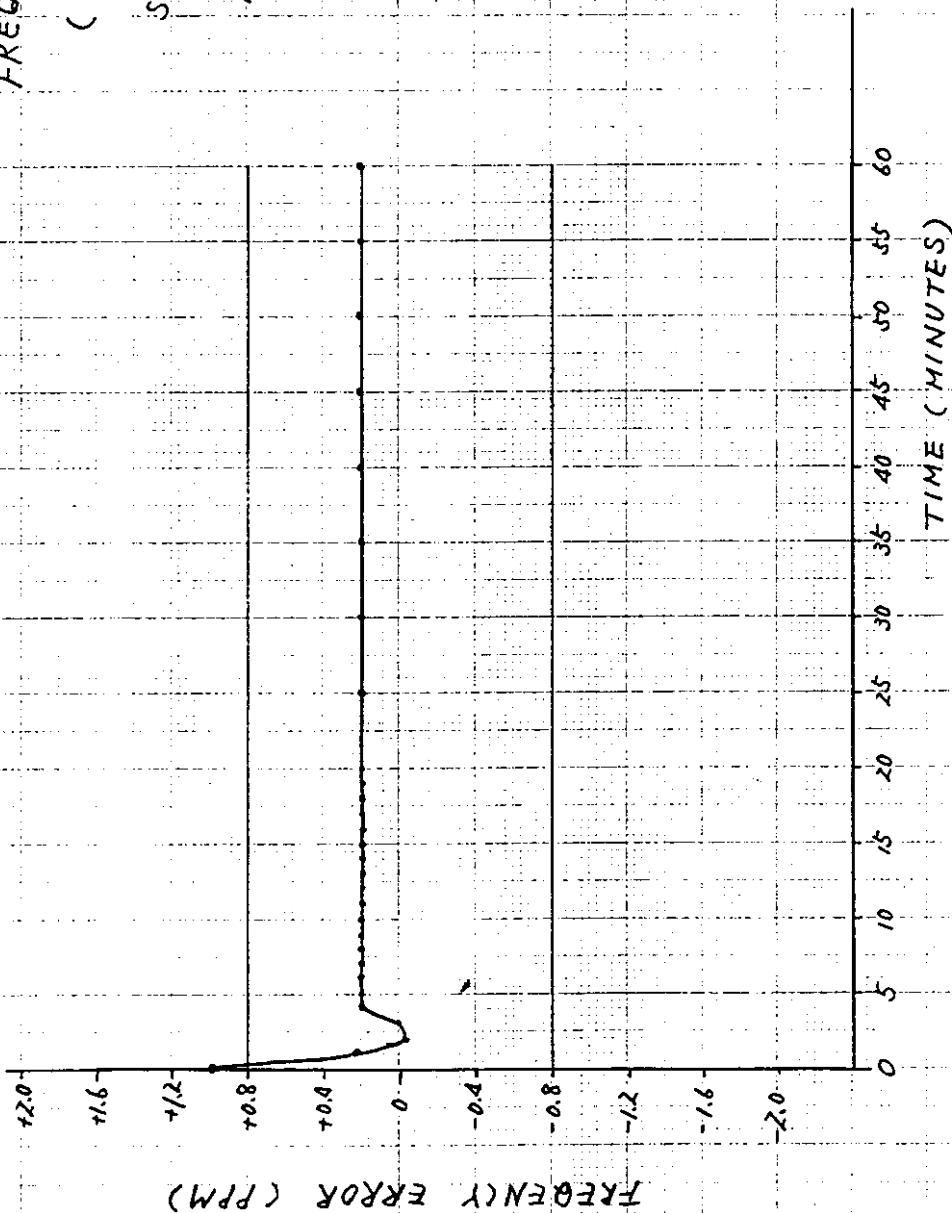


Fig. 9.7

FS-1503

FREQUENCY STABILITY

(COLD START)

SUPPLY VOLTAGE = 13.6 VDC

F = 54 MHz (2nd LO.)

+30°C

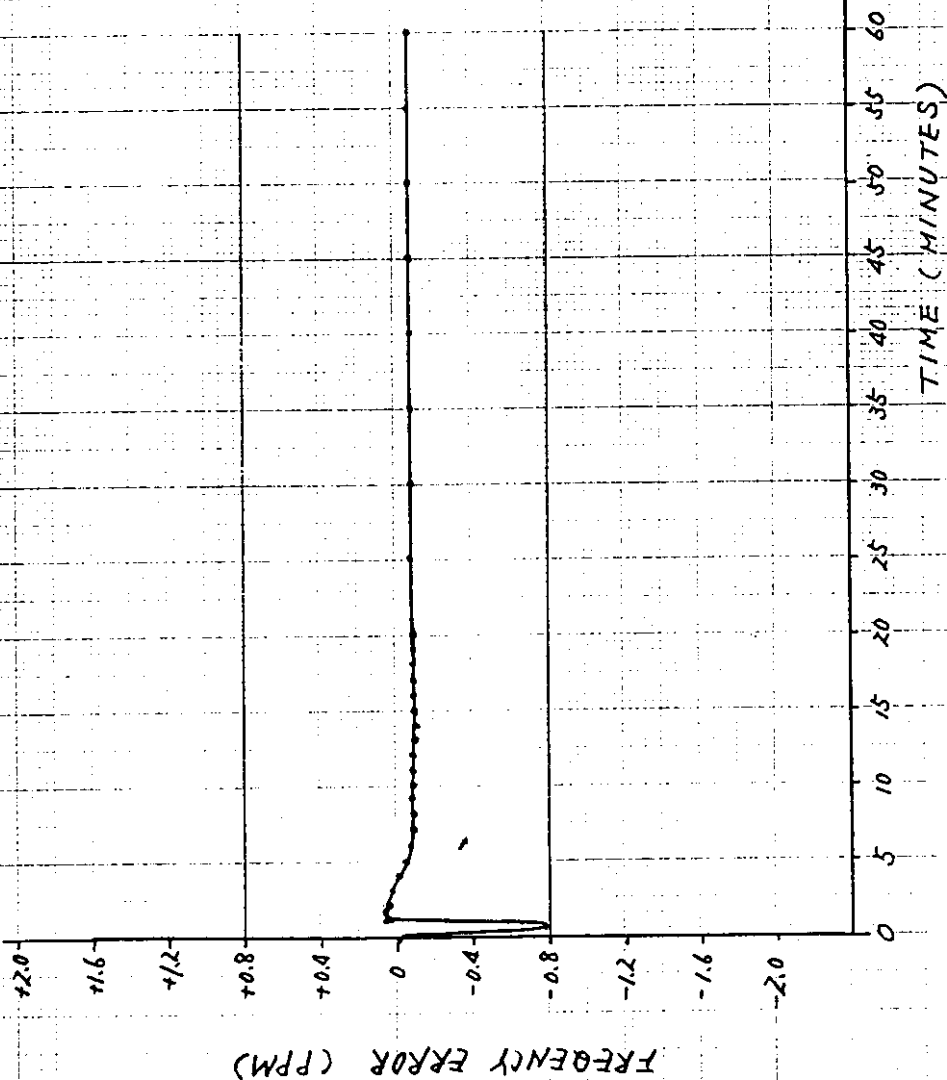


Fig. 9.8

10 SUPPRESSION OF INTERFERENCE FROM RECEIVER (FCC Rules Part 80.217 & 2.993)

10.1 Method of Measurement

Cabinet radiation is measured by the same setup with Fig. 8.1, and the distance between the FS-1503 and the receiving antenna is set to 3 meters to expand dynamic range.

10.2 Test Result

10.2.1 Cabinet radiation

The results are shown in Table 10.1.

Table 10.1

Frequency Range	Measurement at 3 m	Converted to 1 n.m.
DC - 30 MHz	Instrument's noise level: Less than 16 dB μ (6 μ V/m)	Less than 0.01 μ V/m
30 - 100 MHz	Instrument's noise level: Less than 35 dB μ (56 μ V/m)	Less than 0.09 μ V/m
100 - 220 MHz	Instrument's noise level: Less than 35 dB μ (56 μ V/m)	Less than 0.09 μ V/m

10.2.2 Spurious emission at receiver antenna terminal (FCC Rule Part 2.991)

The results are shown in Table 10.2.

Table 10.2

Frequency Range	Measurement
DC - 30 MHz	Instrument's noise level: Less than -85 dBm (3 pW)
30 - 100 MHz	Instrument's noise level: Less than -85 dBm (3 pW)
100 - 300 MHz	Instrument's noise level: Less than -85 dBm (3 pW)

11 RADIOTELEPHONE ALARM GENERATOR (FCC Rule Part 80.221)

The radiotelephone alarm signal is generated by U6 of B03 CPU (05P0665). The signal is output at Pin 49 of U6, and applied to U19 AF SELECT IC of B04 TX/RX (05P0666).

Tolerance of the frequencies and duration of the two tones is very excellent as it is controlled by the CPU clock signal. The interval between successive tone is theoretically zero.

11.1 Setup for Measurement

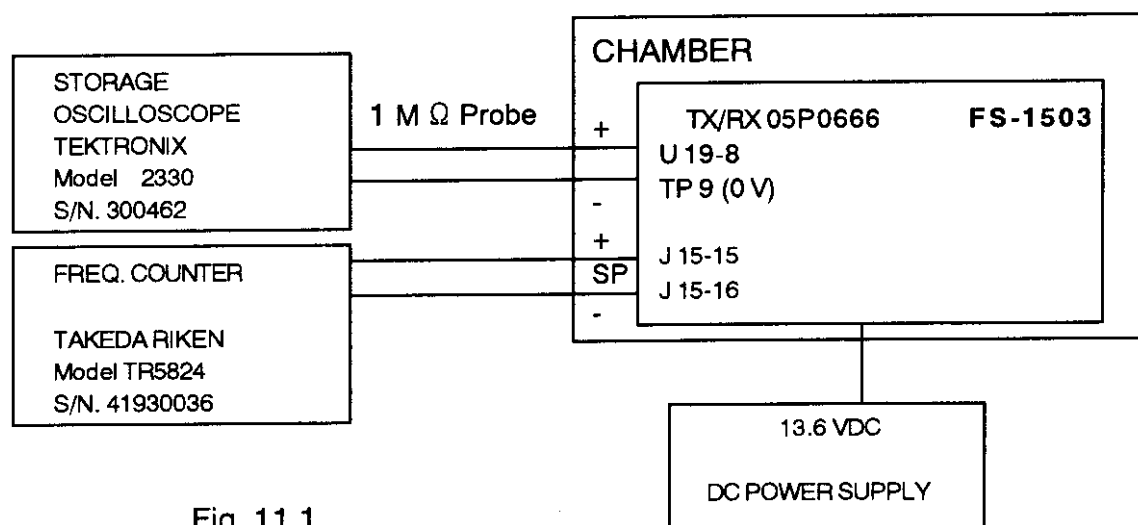


Fig. 11.1

11.2 Measurement Procedure

- 1) Turn on the FS-1503.
- 2) Measurement of Two-Tone Alarm Signals:
Press the touchpads [START/STOP].
Measurement is done at the pin 8 of U19 and TP9 on B04 (TX/RX) with the oscilloscope.

Design criteria: 1300 Hz tone for 250 milliseconds
2200 Hz tone for 250 milliseconds
Duration 45 seconds

Special requirements for automatically generating the radiotelephone alarm signal.
(Measurements started in 30 minutes after the temperature chamber has reached the equilibrium.)

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
TONE FREQ.	1300 Hz	±19.5 Hz	+2	+2	+2	+3	+4	+5	+5	+5	+5
	2200 Hz	±33 Hz (±1.5 %)	+8	+8	+8	+9	+10	+10	+11	+11	+11

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
DURATION OF EACH TONE	1300 Hz	250 ± 10 ms	250	250	250	250	250	250	250	250	250
	2200 Hz	250 ± 10 ms	251	251	251	250	250	250	250	250	250

[illegible]

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
AMPLITUDE RATIO		within 1.6 dB	0.24	0.21	0.21	0.18	0.19	0.21	0.23	0.25	0.25

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
	H2B	at least 70 %	86	88	88	90	92	92	92	92	92
	J2B	within 3 dB of rated PEP	-0.8	-0.6	-0.5	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6

Dimmable to fully extinguished.

[illegible]

- (8) After generating the radiotelephone alarm signal or after manual interruption the device must be immediately ready to repeat the signal:

Yes.

- (9) The transmitter must be automatically switched from the stand-by condition to the transmit condition at the start and return to the stand-by condition at the conclusion of the radiotelephone alarm signal:

Yes.

12 TRANSMITTER POWER ADJUSTMENT PROCEDURE

SSB RADIO TELEPHONE

Model FS-1503

12.1 Set-up

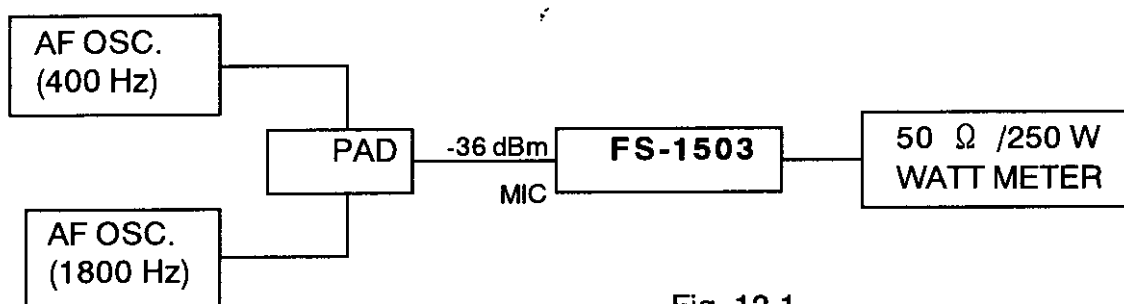


Fig. 12.1

12.2 Procedure

- (a) Set transmit frequency to ITU 401 and select SSB as class of emission.
- (b) Apply two tones simultaneously at frequencies of 400 Hz and 1800 Hz with equal amplitudes to MIC input of FS-1503 at a level of -36 dBm.
- (d) Key the transmitter and adjust R156 (TX GAIN) on B04 05P0666 to obtain 150 Wpep.
- (e) For adjustment of H3E carrier level, cut off tone signals and select H3E as class of emission. Key the transmitter and adjust R101 (H3E CARR) on B04 05P0666 to obtain 37.5 to 50 Wpep.