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.

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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

	50 Hz to 1 00 MHz, 600 Ω
S/No:	1100026 & 709003

(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

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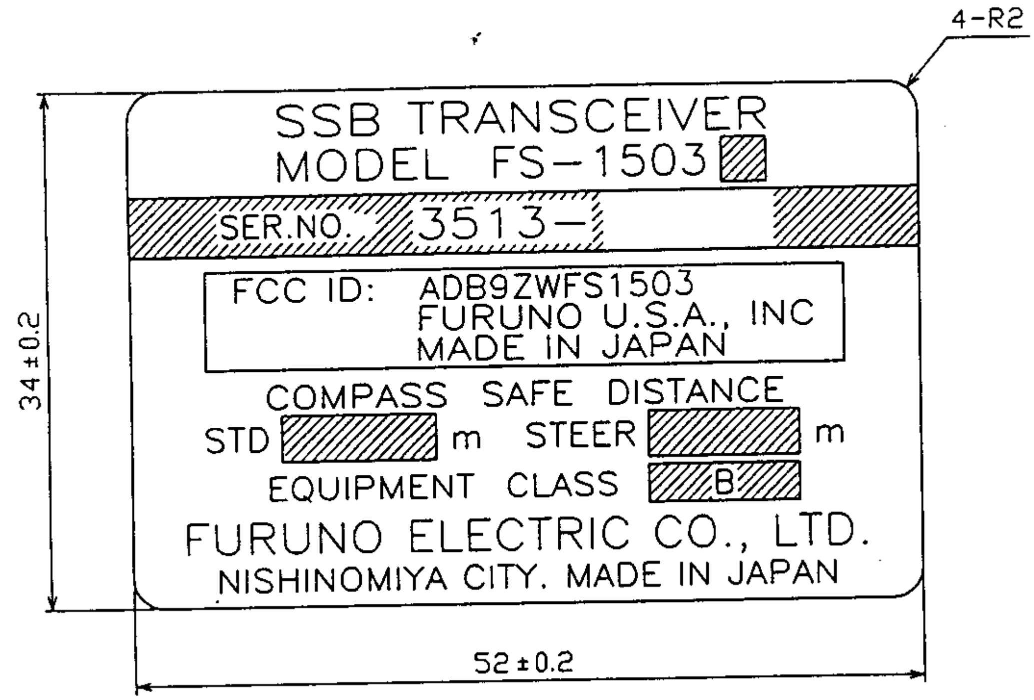
2 IDENTIFICATION OF EQUIPMENT (FCC Rule Part 2.925)

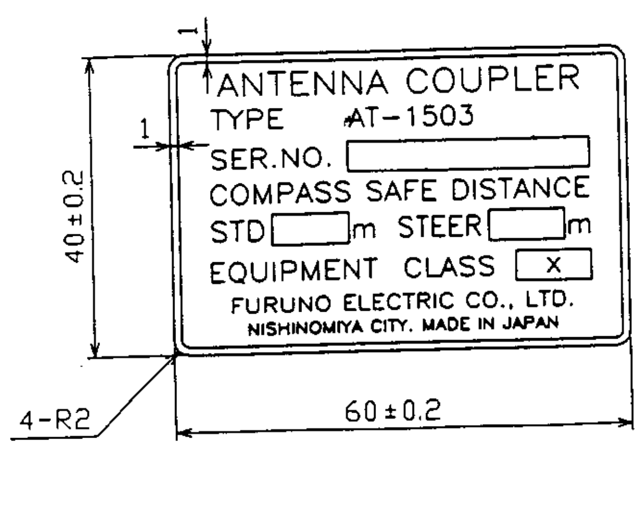
The following nameplates are permanently fixed on the equipment.

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 Wpep. Collector current is then measured.

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

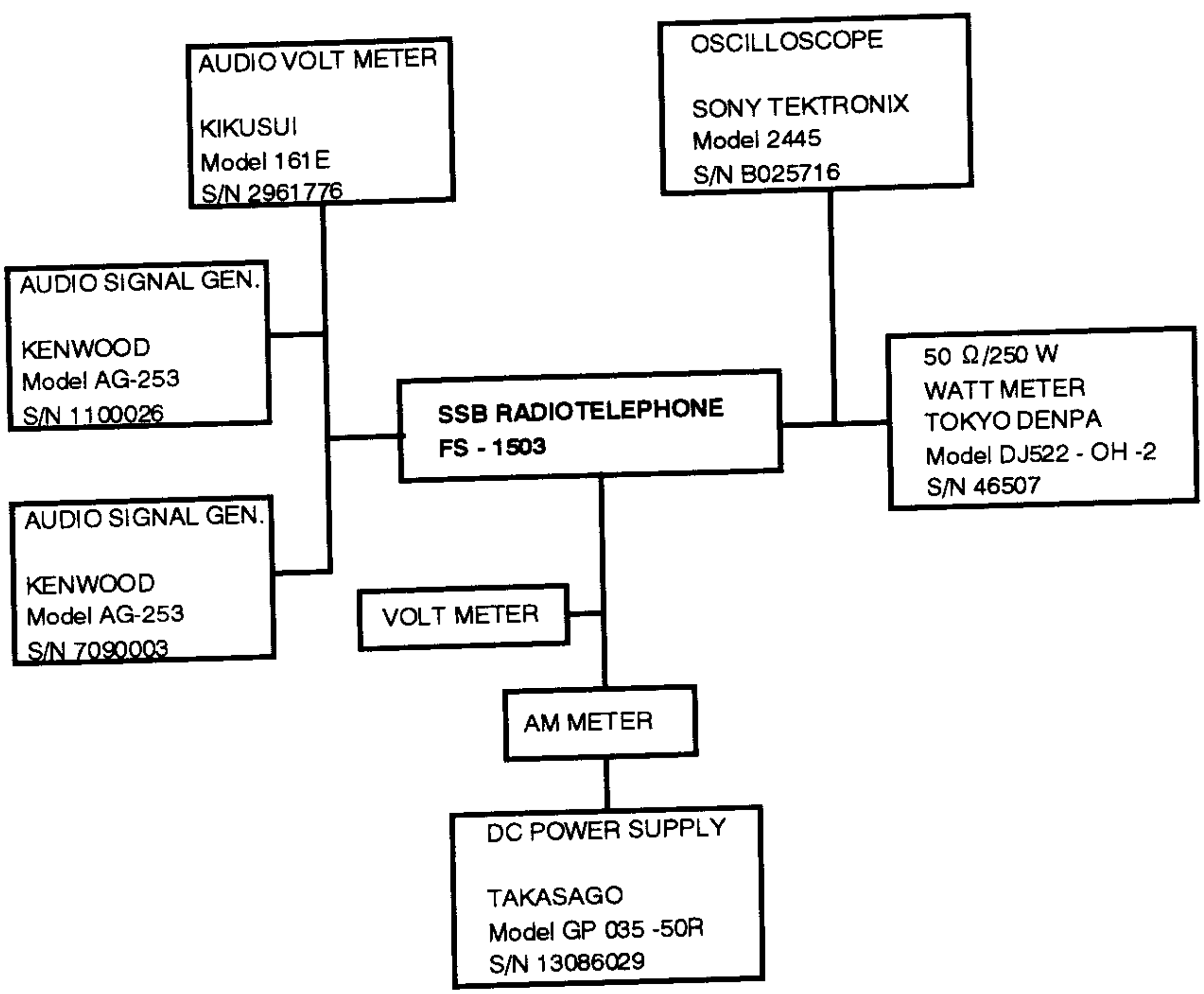


Fig. 3.1

3.2 Test Result

Results are shown in Table 3.1

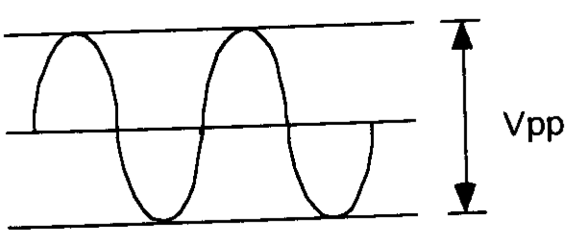
Table 3.1

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):

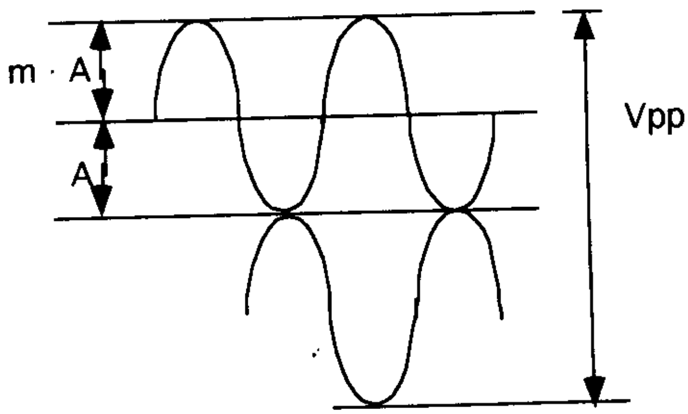


$$\text{Average power: } Pa = \frac{(Vpp/2\sqrt{2})^2}{R_L} = \frac{Vpp^2}{8\,R_L}$$

$$\text{PEP: } Pp = \frac{(Vpp/2\sqrt{2})^2}{R_L} = \frac{Vpp^2}{8\,R_L}$$

Therefore; $Pa = Pp$

3.3.2 AM:



Average power: $Pa = \left(1 + \frac{m^2}{2}\right) \cdot Pc$

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

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

and, $Vpp = 2\,(1 + m) \cdot A$

Therefore, $Pc = \frac{1}{2R_L} \cdot \left(\frac{Vpp}{2(1 + m)}\right)^2 = \frac{Vpp^2}{8(1 + m)^2 \cdot R_L}$

Therefore, $Pa = \left(1 + \frac{m^2}{2}\right) \cdot \frac{Vpp^2}{8(1 + m)^2 \cdot R_L}$

PEP: $Pp = \frac{(Vpp/2\sqrt{2})^2}{R_L} = \frac{Vpp^2}{8R_L}$

Therefore, $Pa = \left(1 + \frac{m^2}{2}\right) \cdot \frac{Pp}{(1 + m)^2}$

or, $Pp = \frac{(1 + m)^2}{1 + m^2/2} \cdot Pa$

m = 1 : Pp = 2.67 Pa
m = 0.8 : Pp = 2.47 Pa
m = 0.5 : Pp = 2.1 Pa

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.

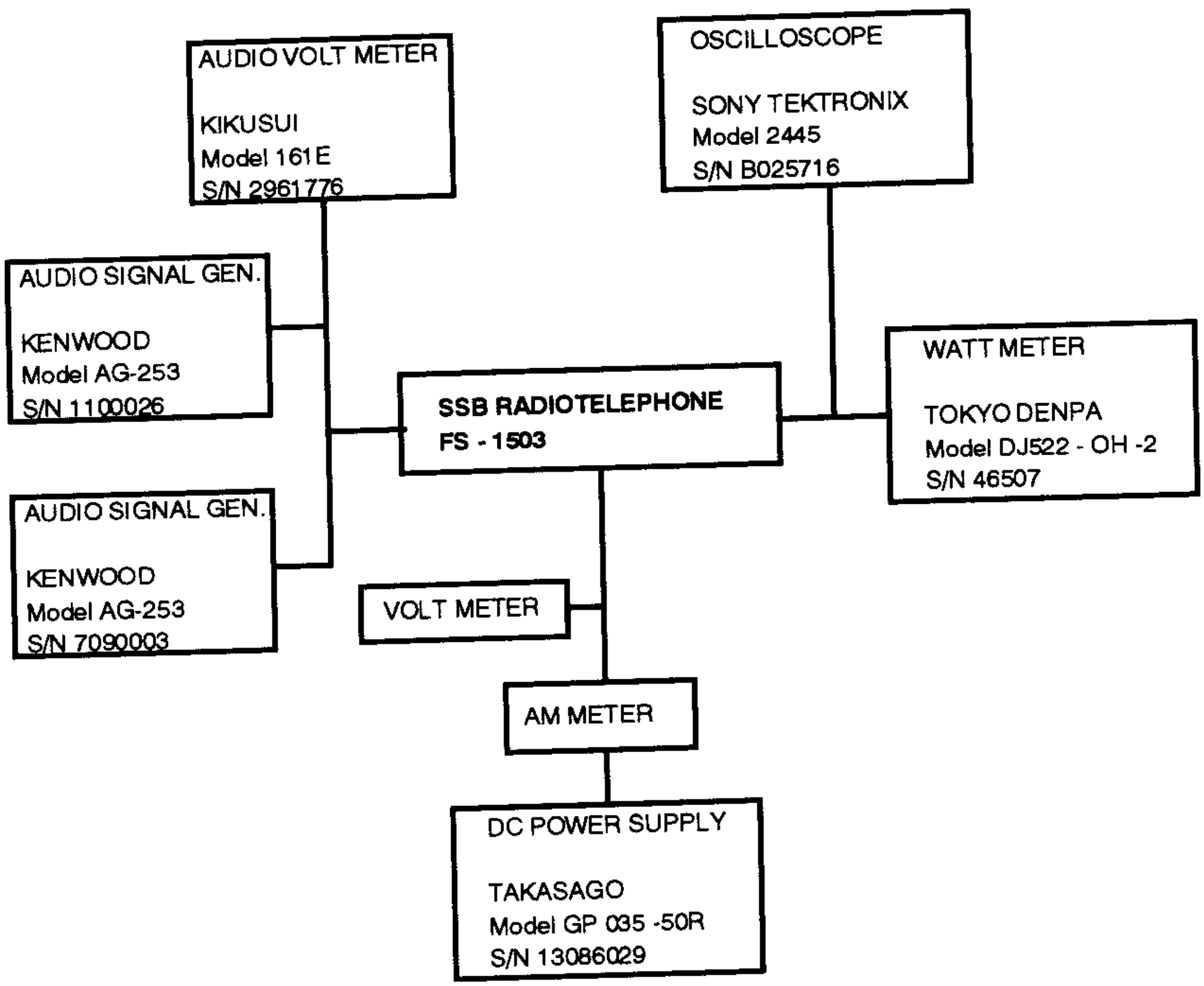


Fig. 4.1.1

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

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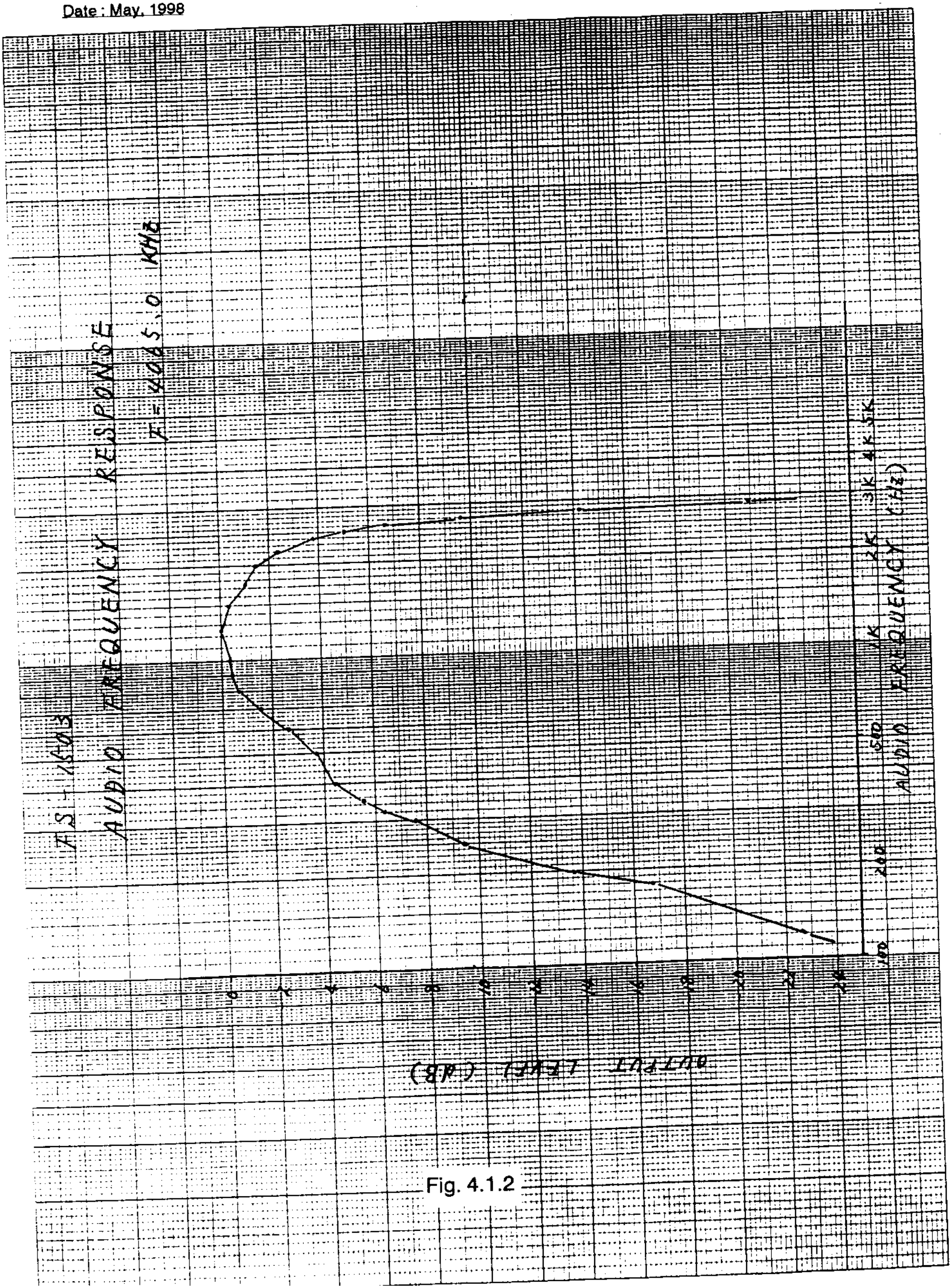

Fig. 4.1.2

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.

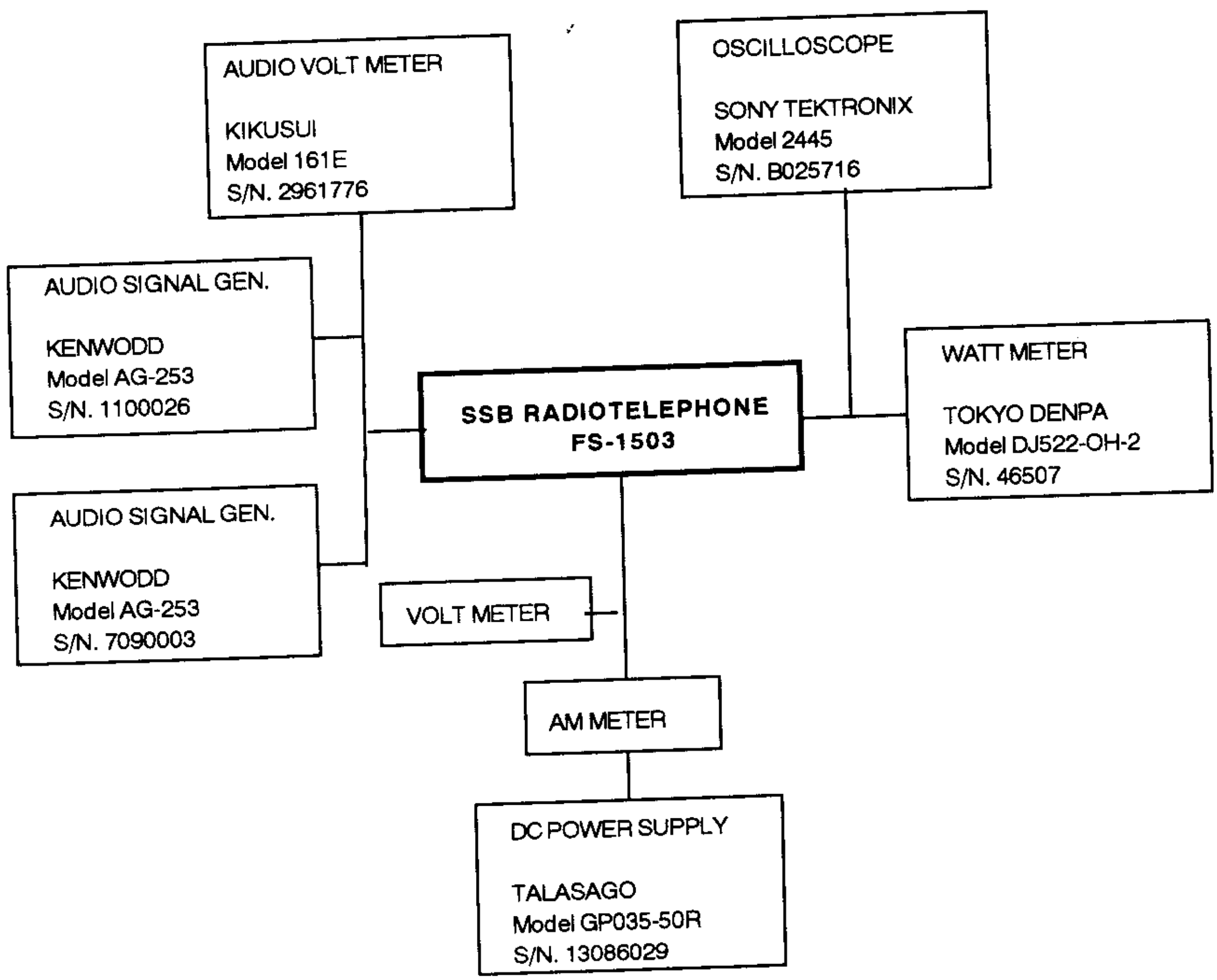

Fig. 4.2.1

4.2.2 Test Result

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

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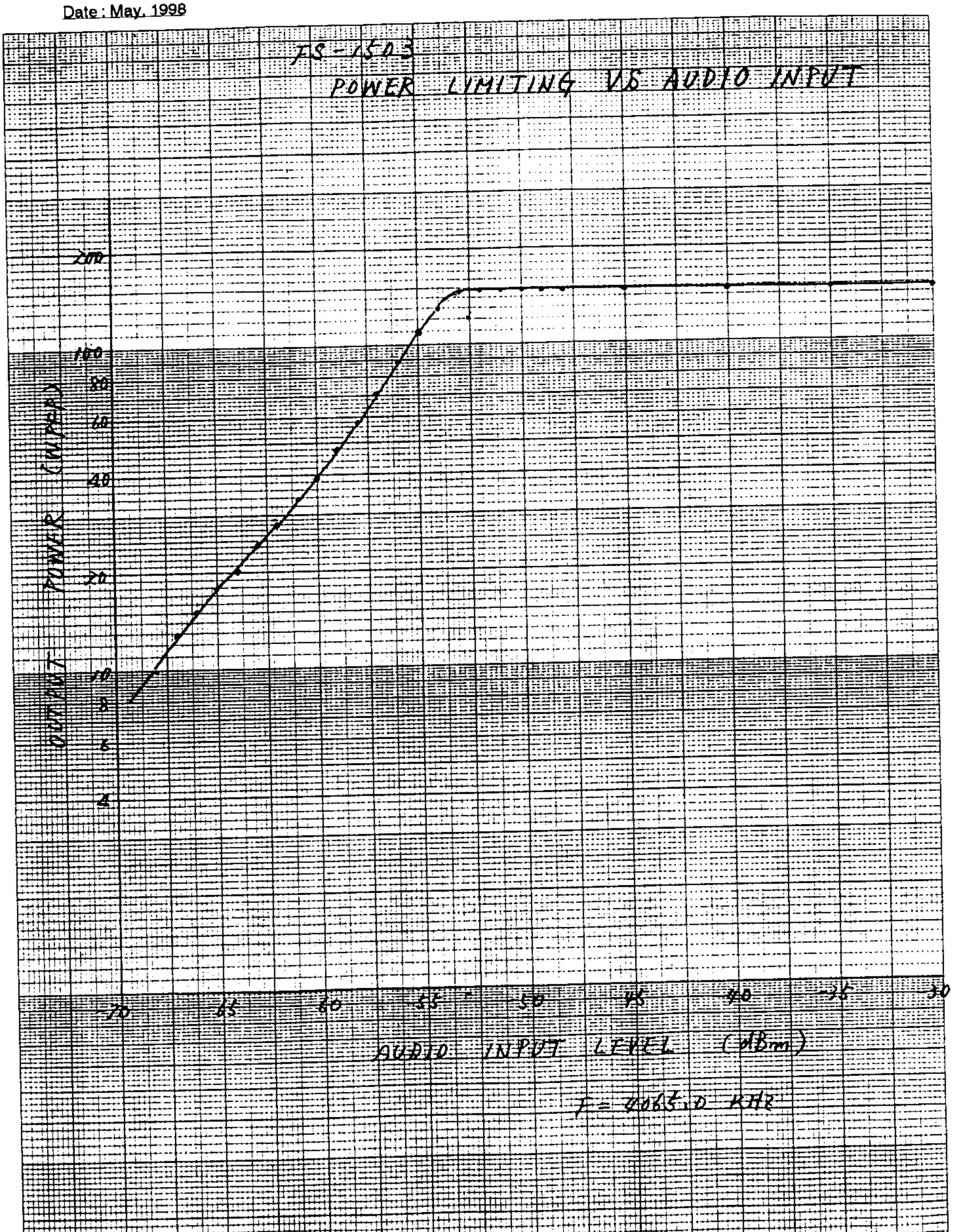

Fig. 4.2.2 Power Limiting vs Audio Input Voltage

4.3 Modulation Characteristics on H3E

4.3.1 Method of Measurement

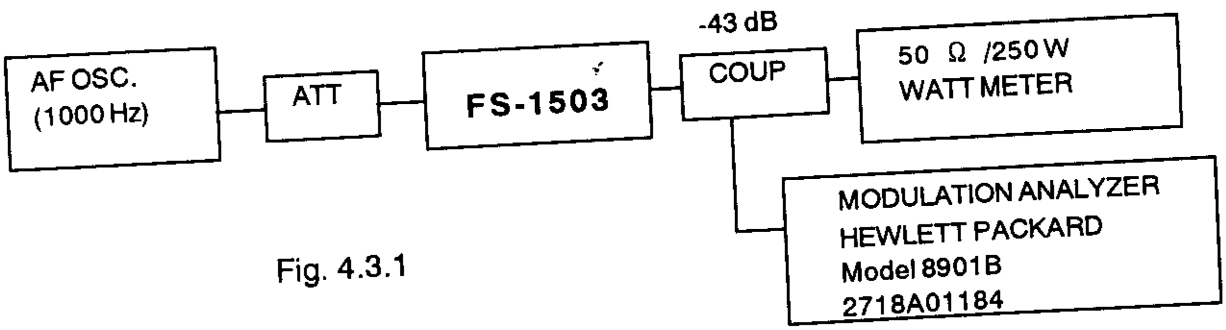

Fig. 4.3.1

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.

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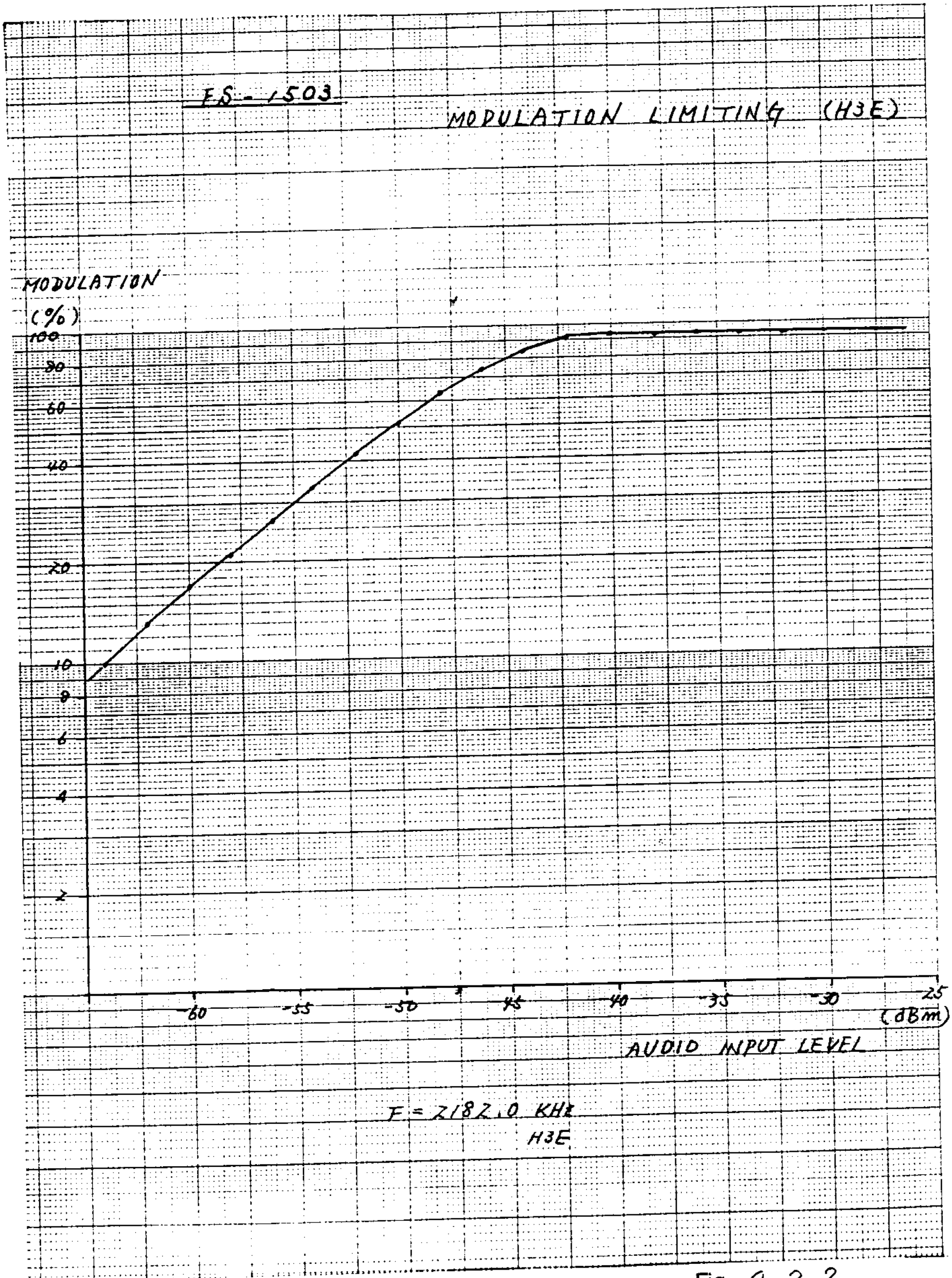

Fig. 4.3.2

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.

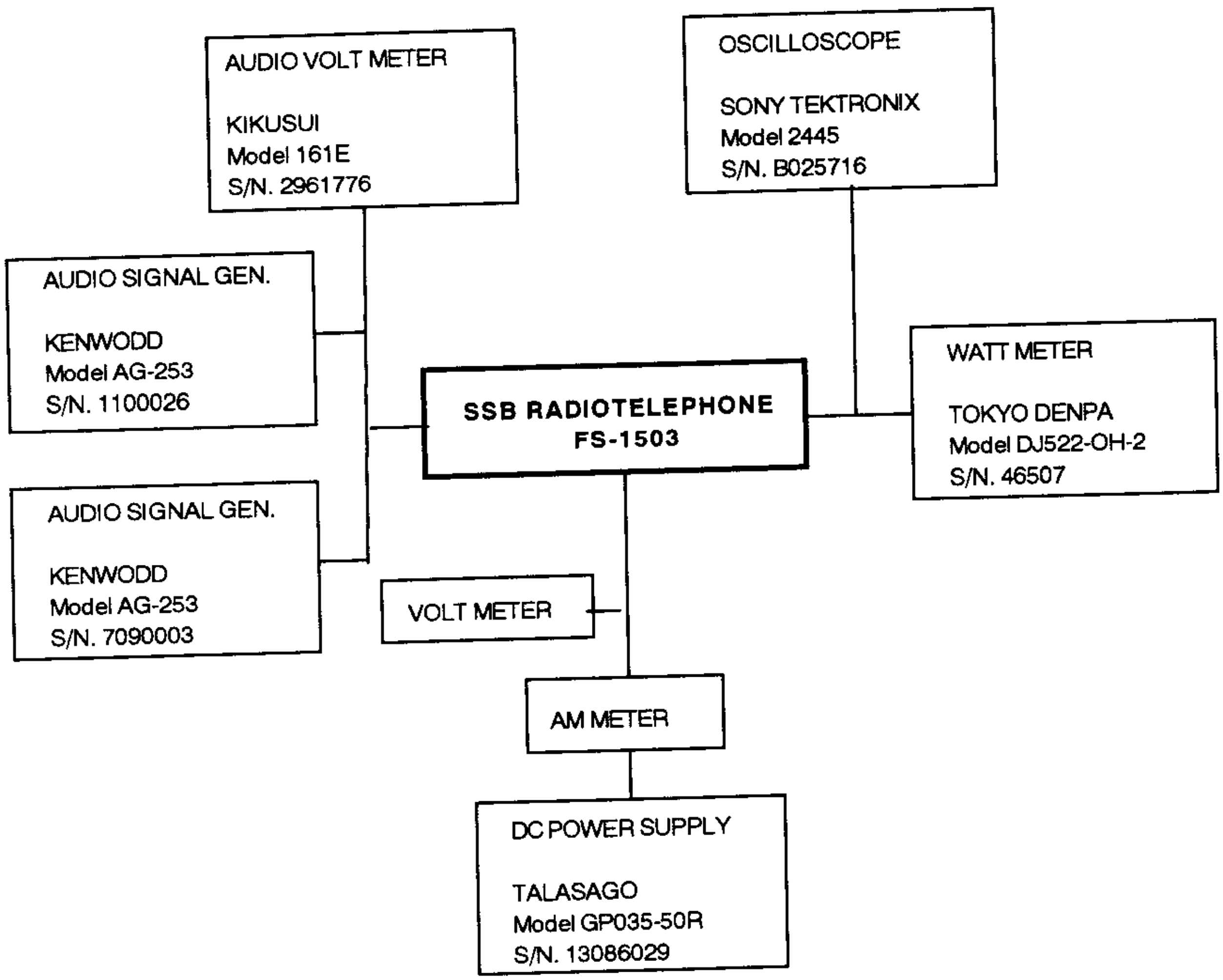

Fig. 5.1

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.

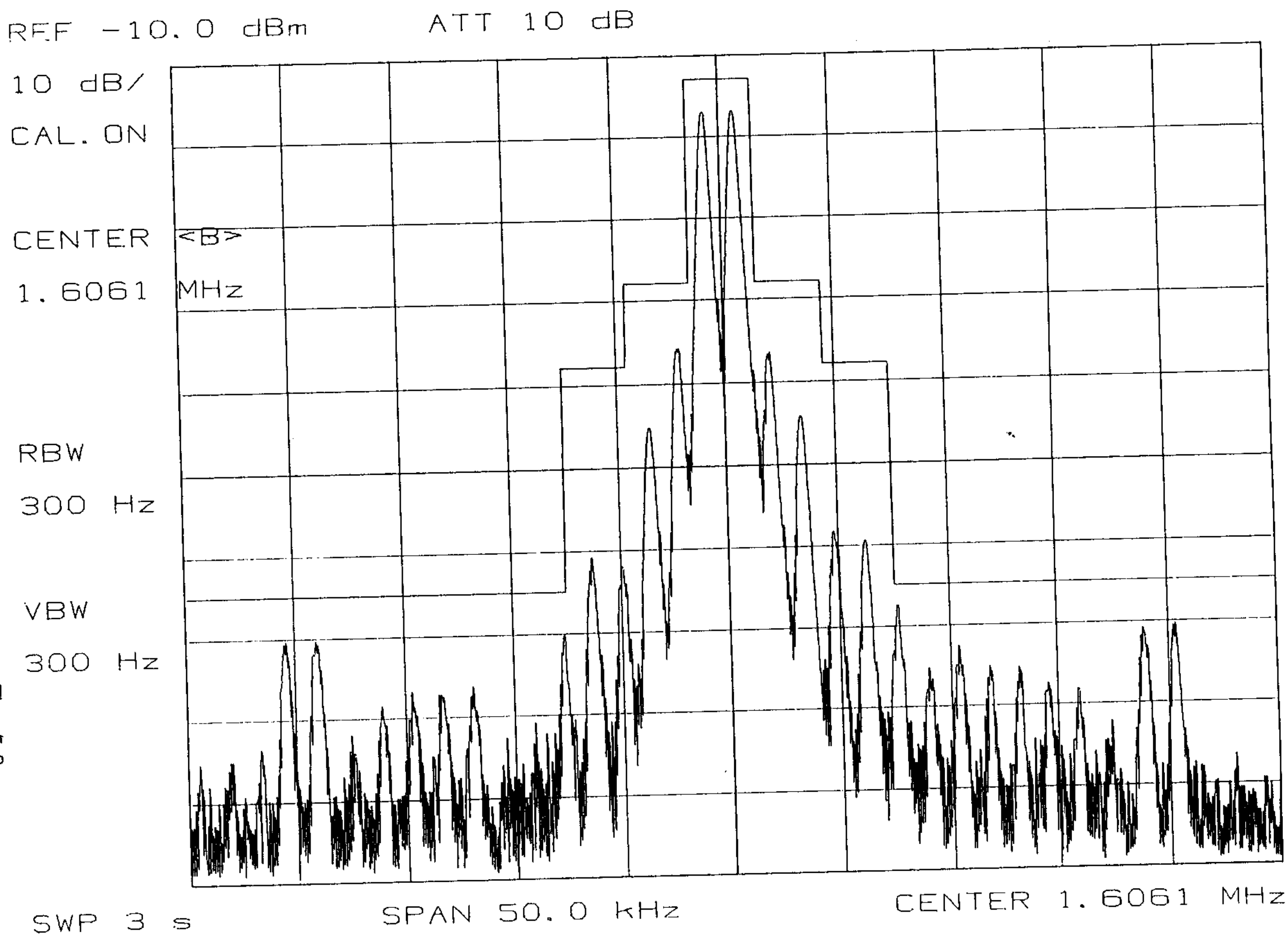

Fig. 5.2

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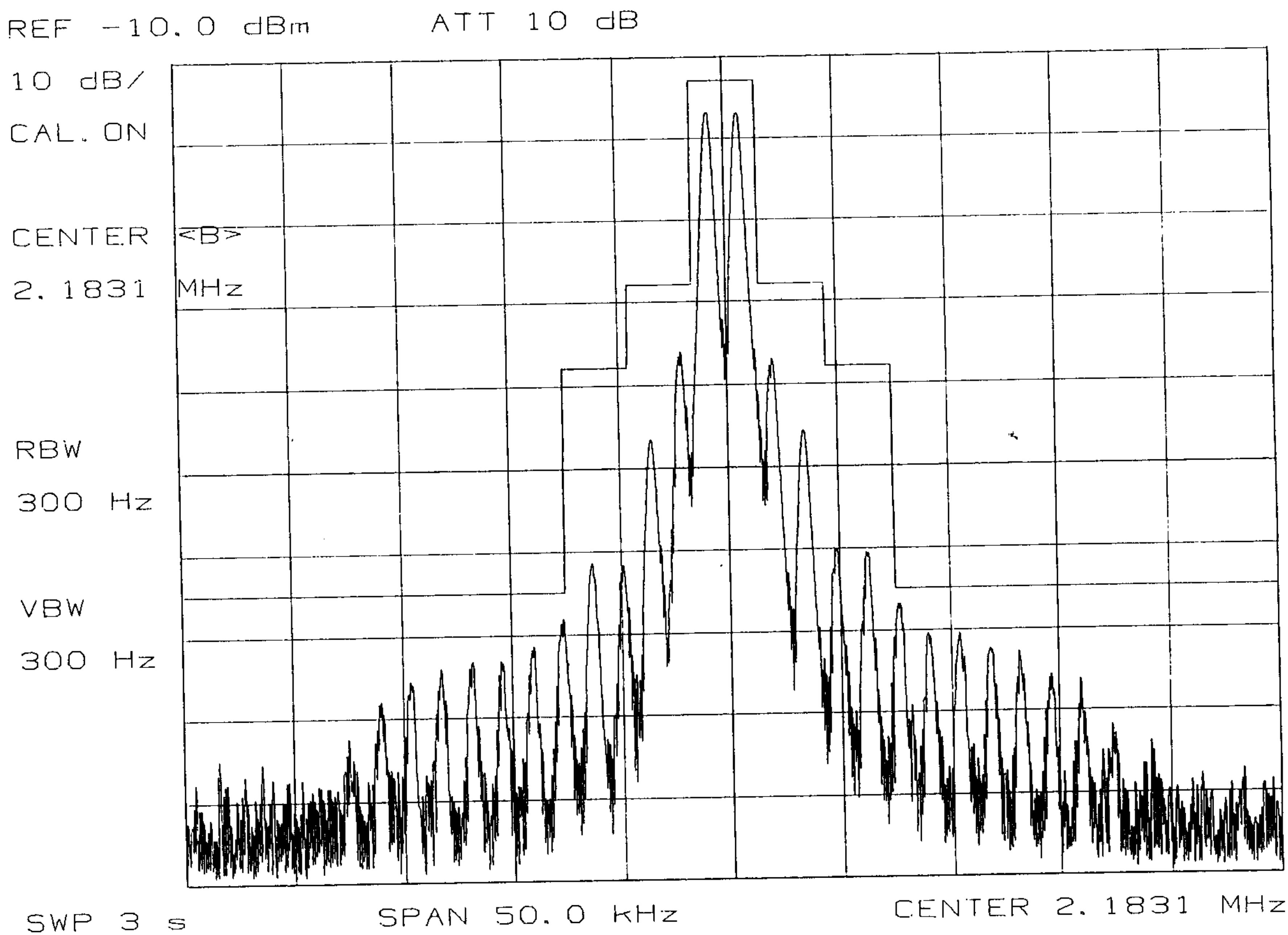
REF −10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
2.1831 MHz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 2.1831 MHz

Fig. 5.3

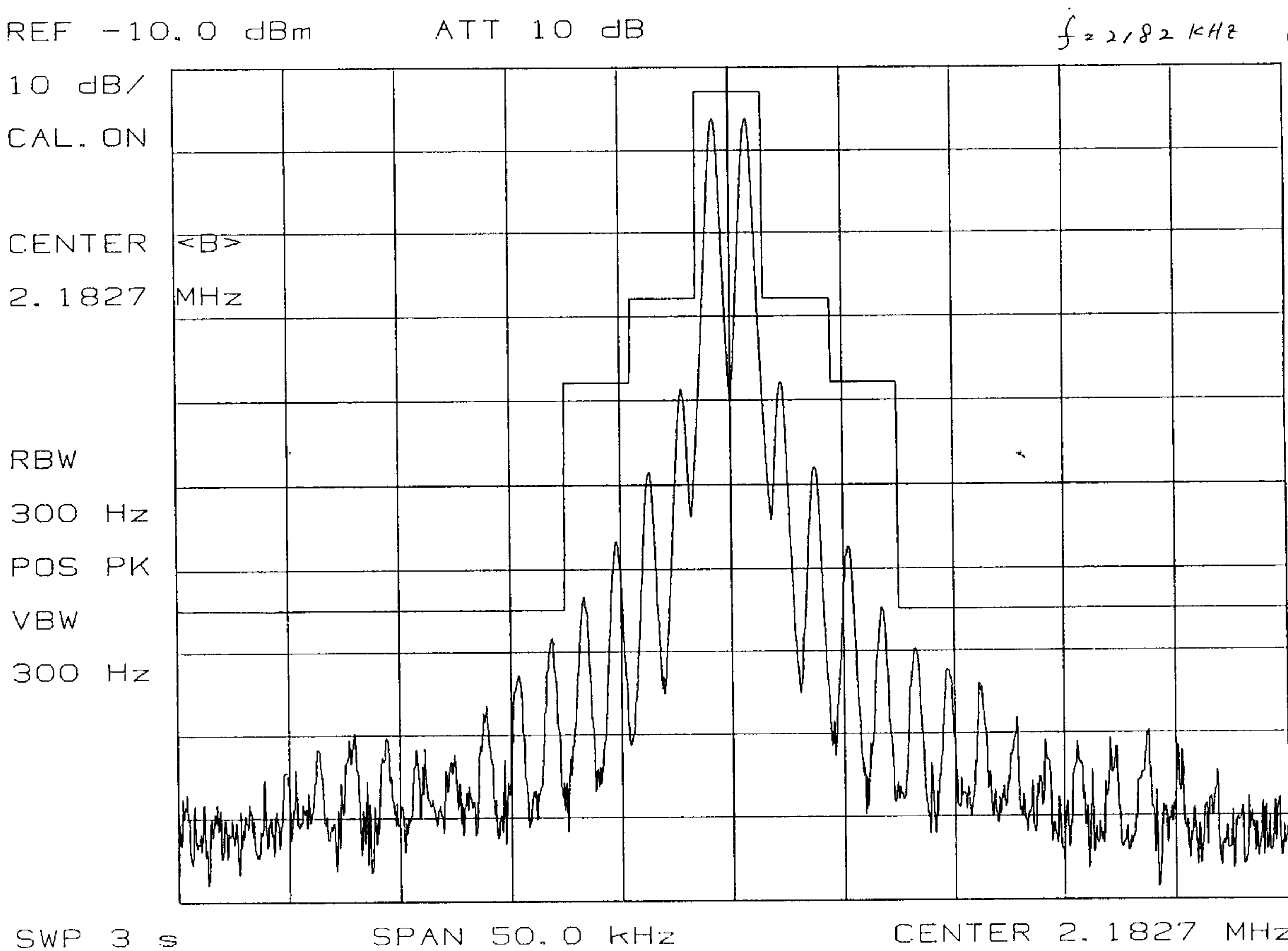
REF -10.0 dBm
ATT 10 dB
f = 2182 kHz H3E
10 dB/
CAL. ON
CENTER <B>
2. 1827 MHz
RBW
300 Hz
POS PK
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 2. 1827 MHz

Fig.5.4

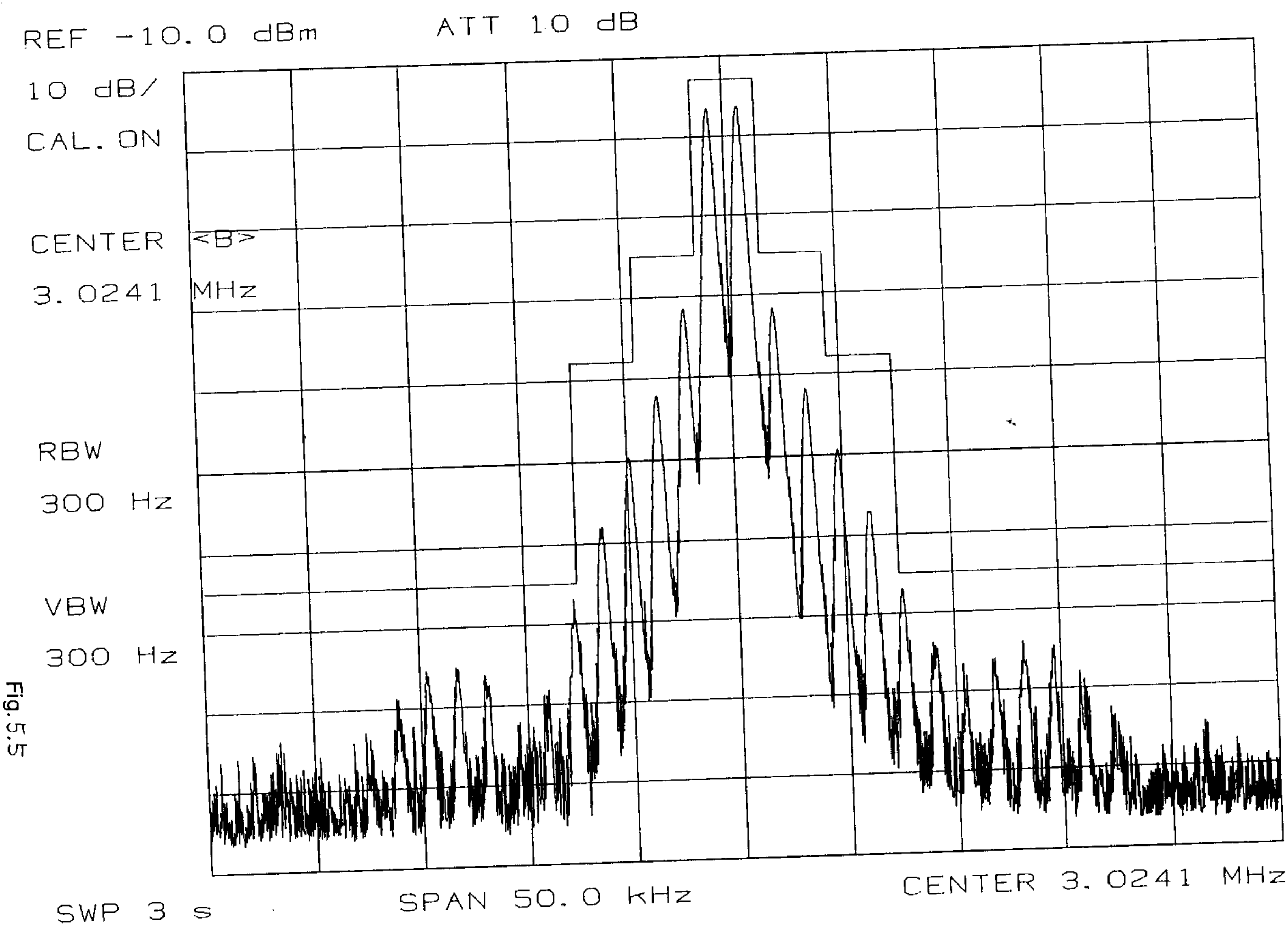
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
3.0241 MHz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 3.0241 MHz

Fig.5.5

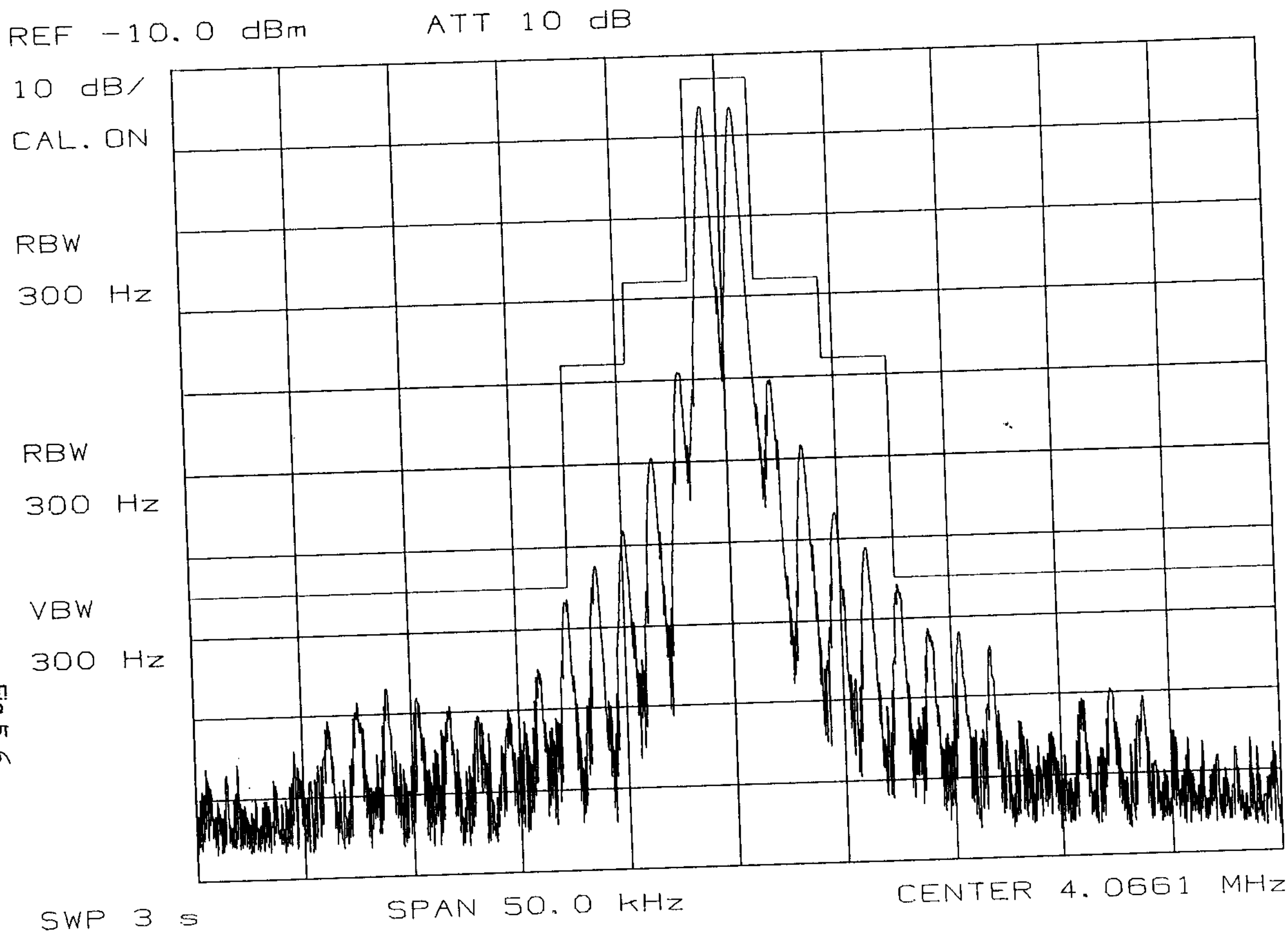
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
RBW
300 Hz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 4.0661 MHz

Fig.5.6

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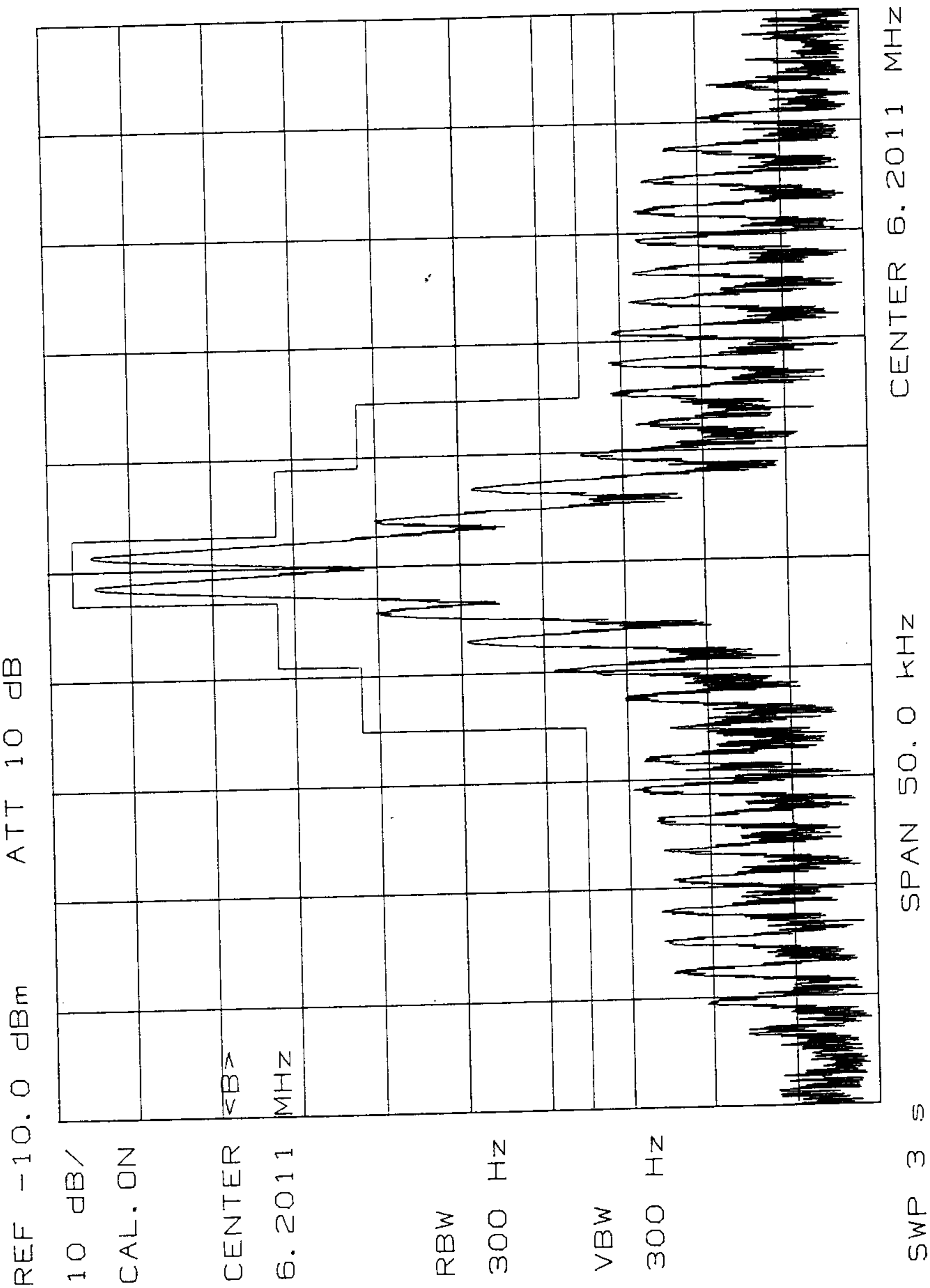

Fig. 5.7

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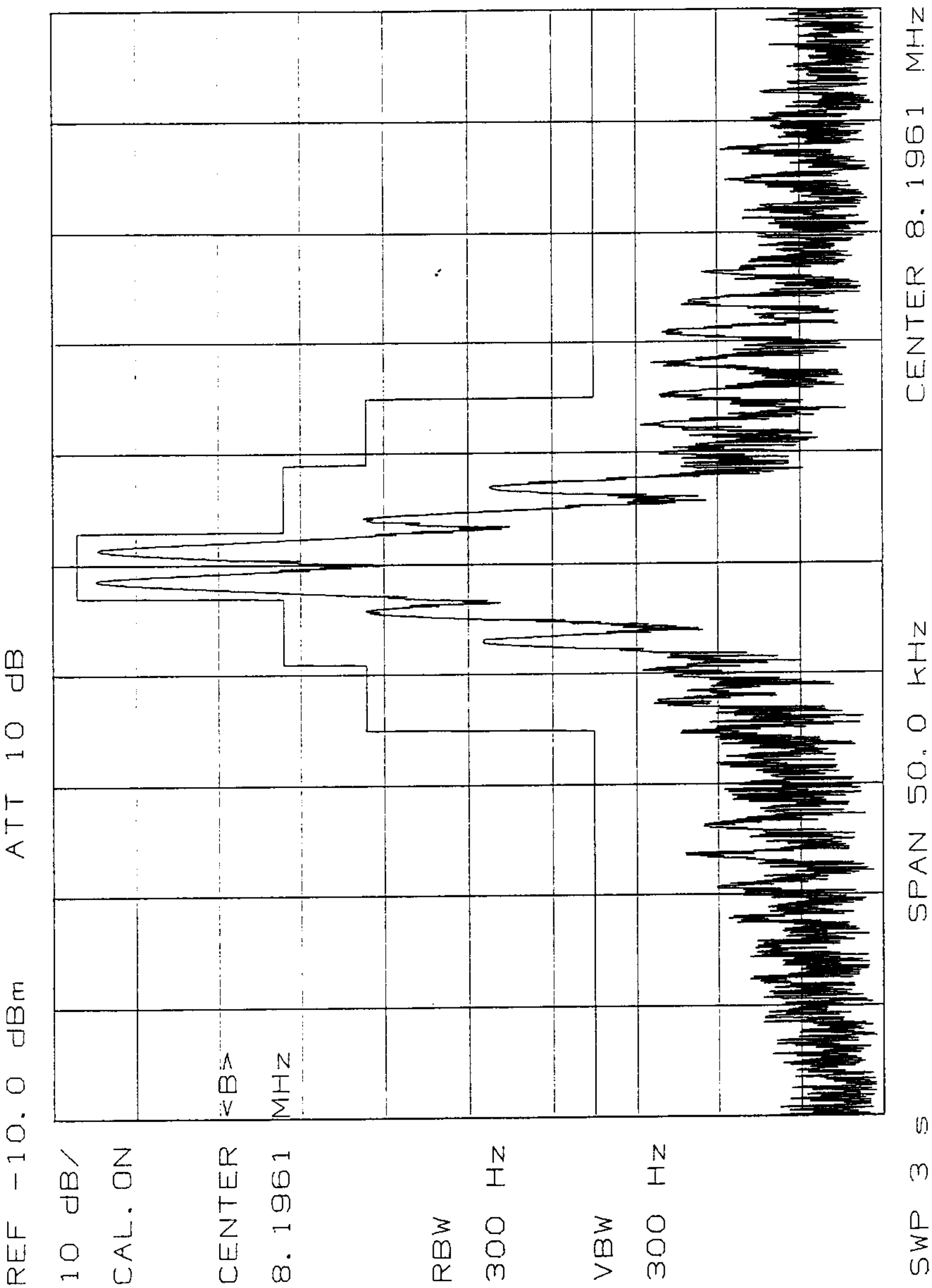

Fig. 5.8

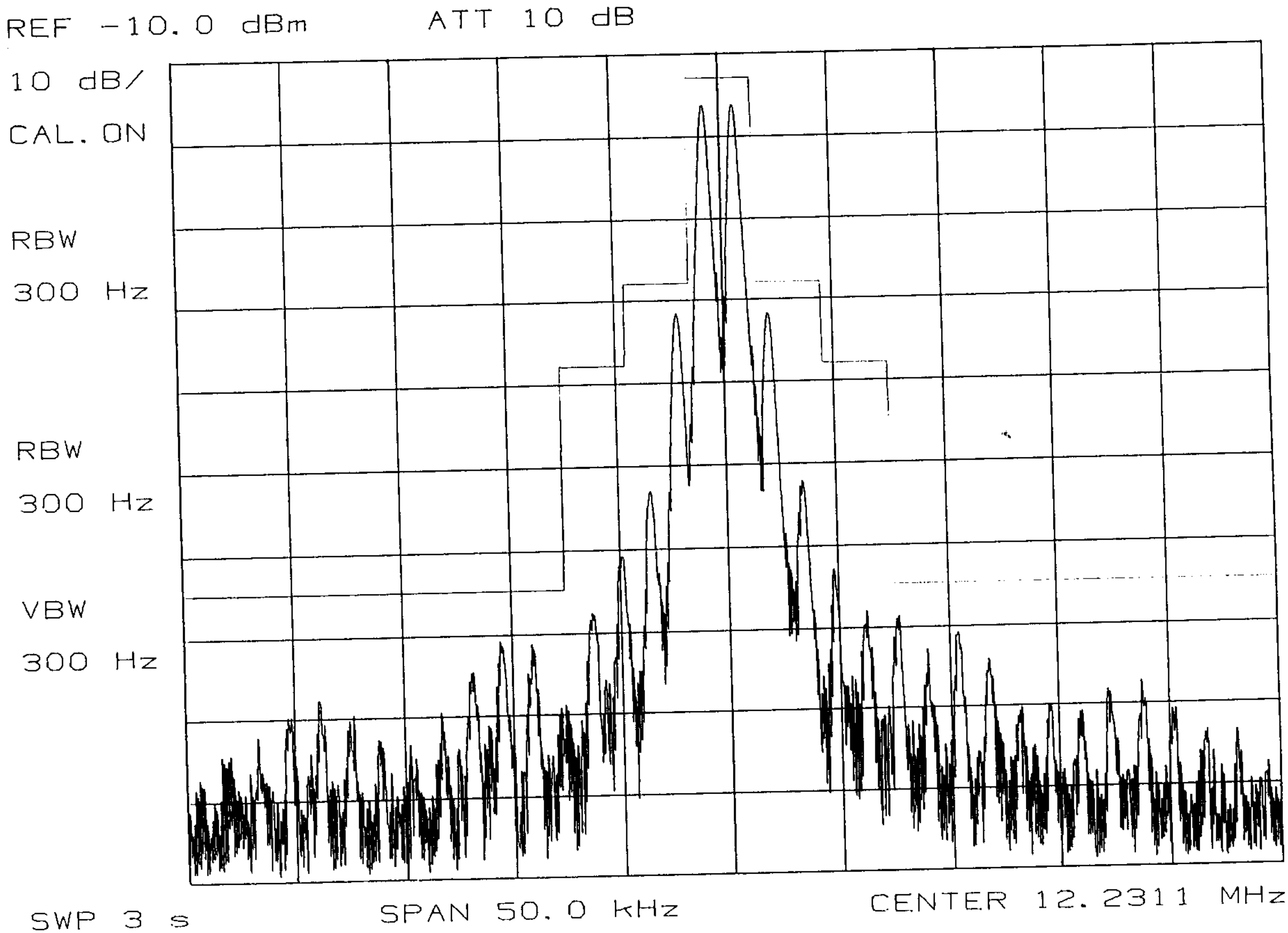
REF −10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
RBW
300 Hz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 12.2311 MHz

Fig. 5.9

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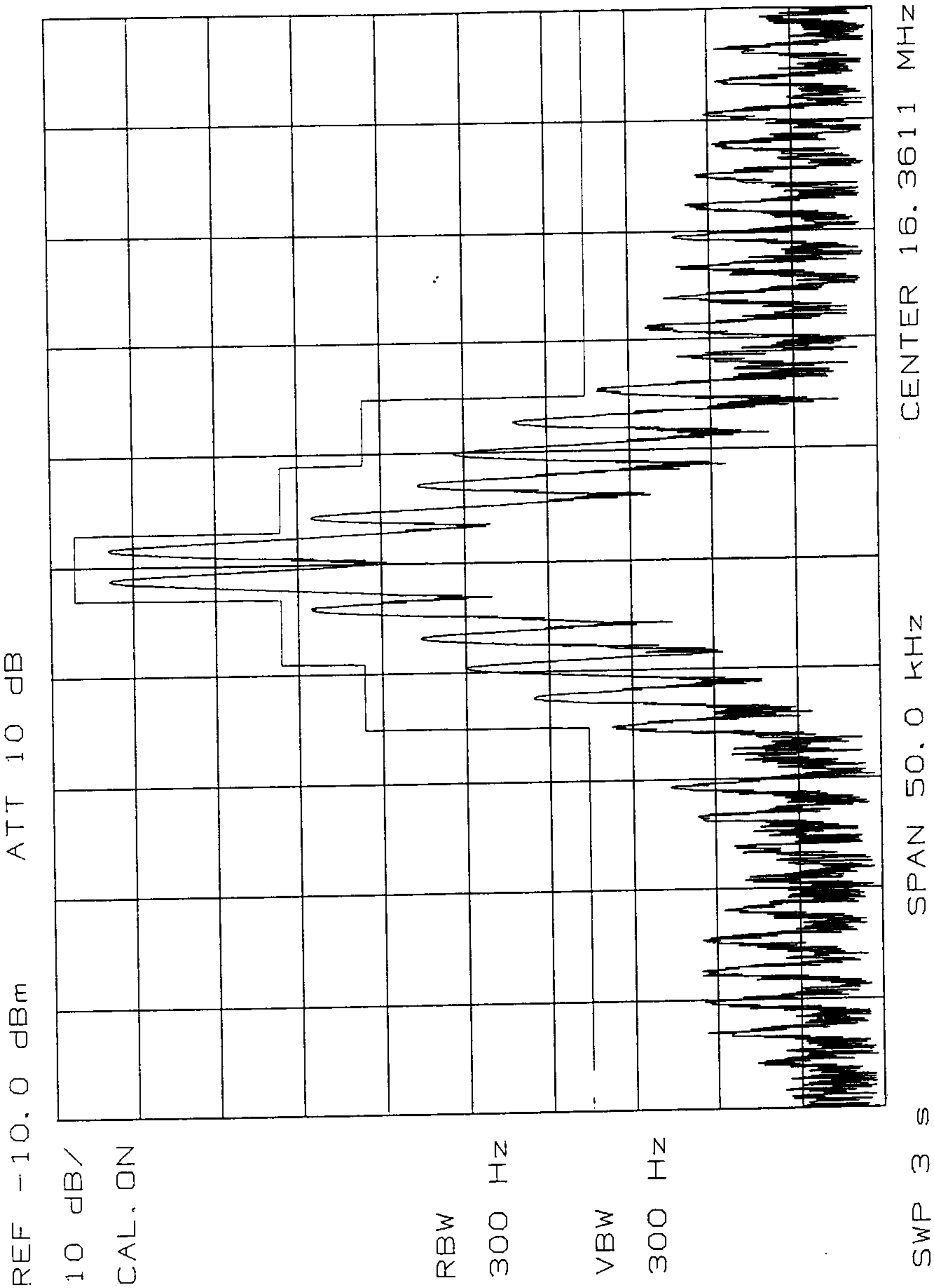

Fig. 5.10

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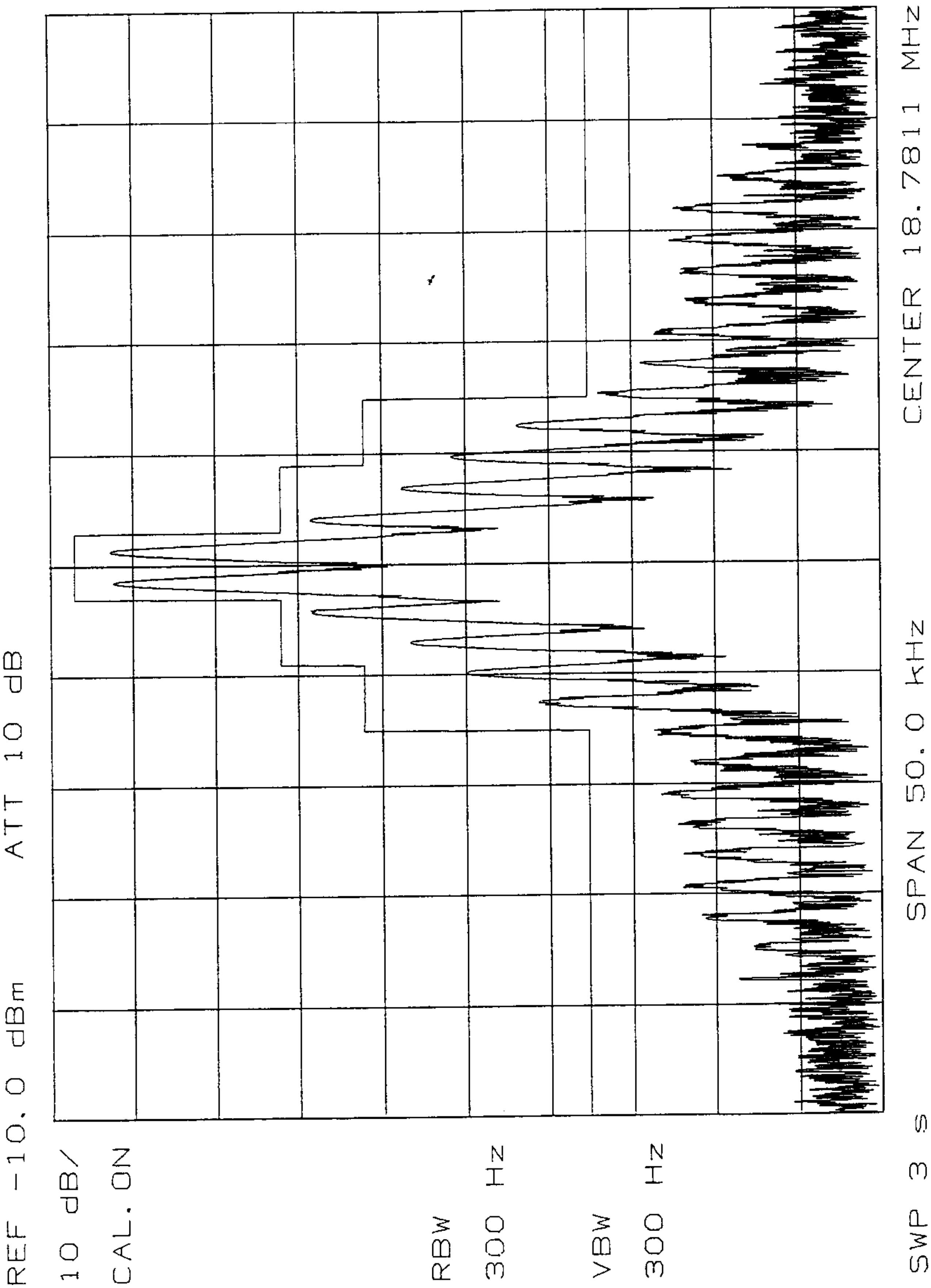

Fig. 5.11

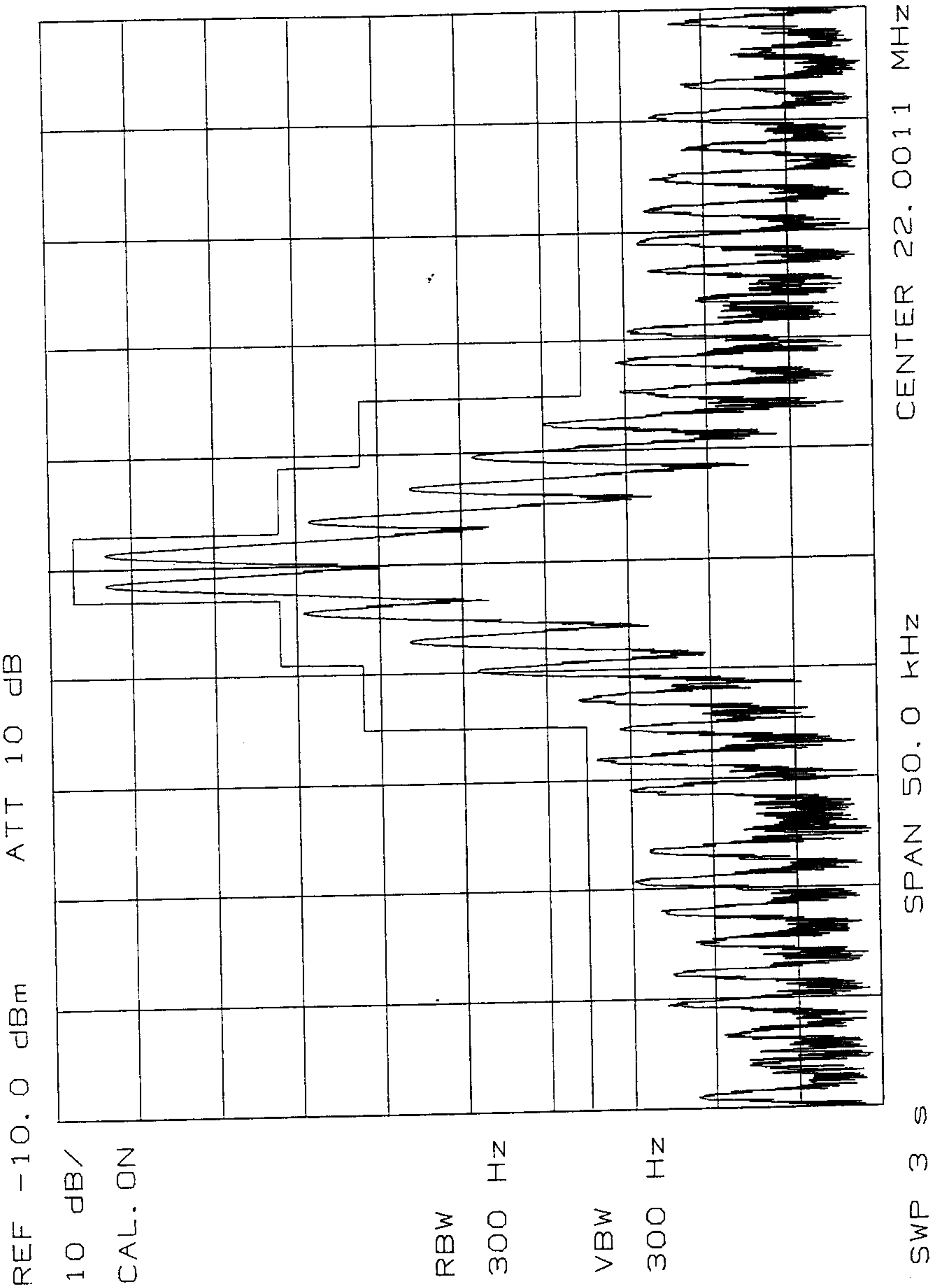
REF -10.0 dBm
10 dB/
CAL. ON
ATT 10 dB
RBW 300 Hz
VBW 300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 22.0011 MHz

Fig. 5.12

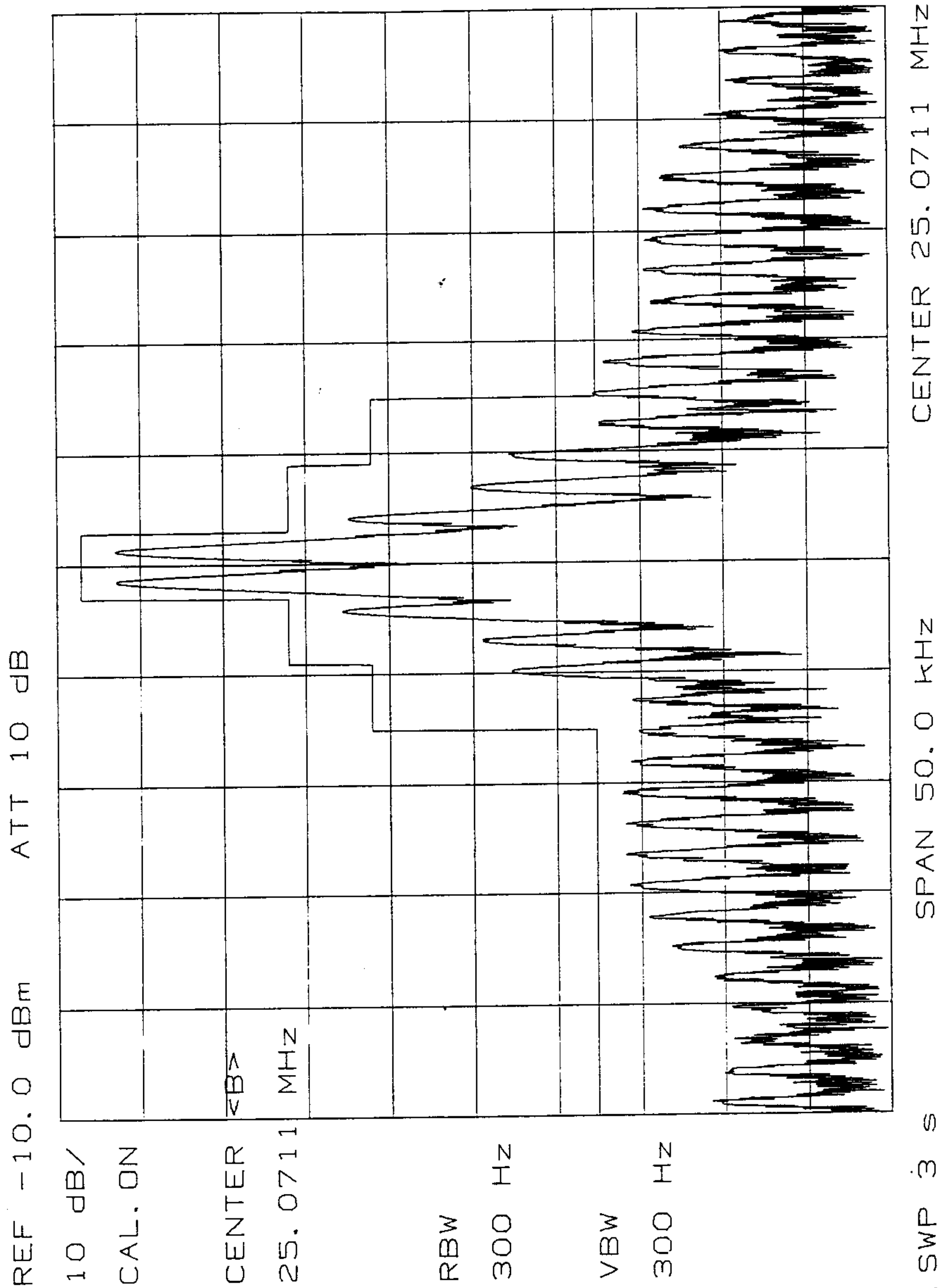
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
25.0711
<B>
MHz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 25.0711 MHz

Fig. 5.13

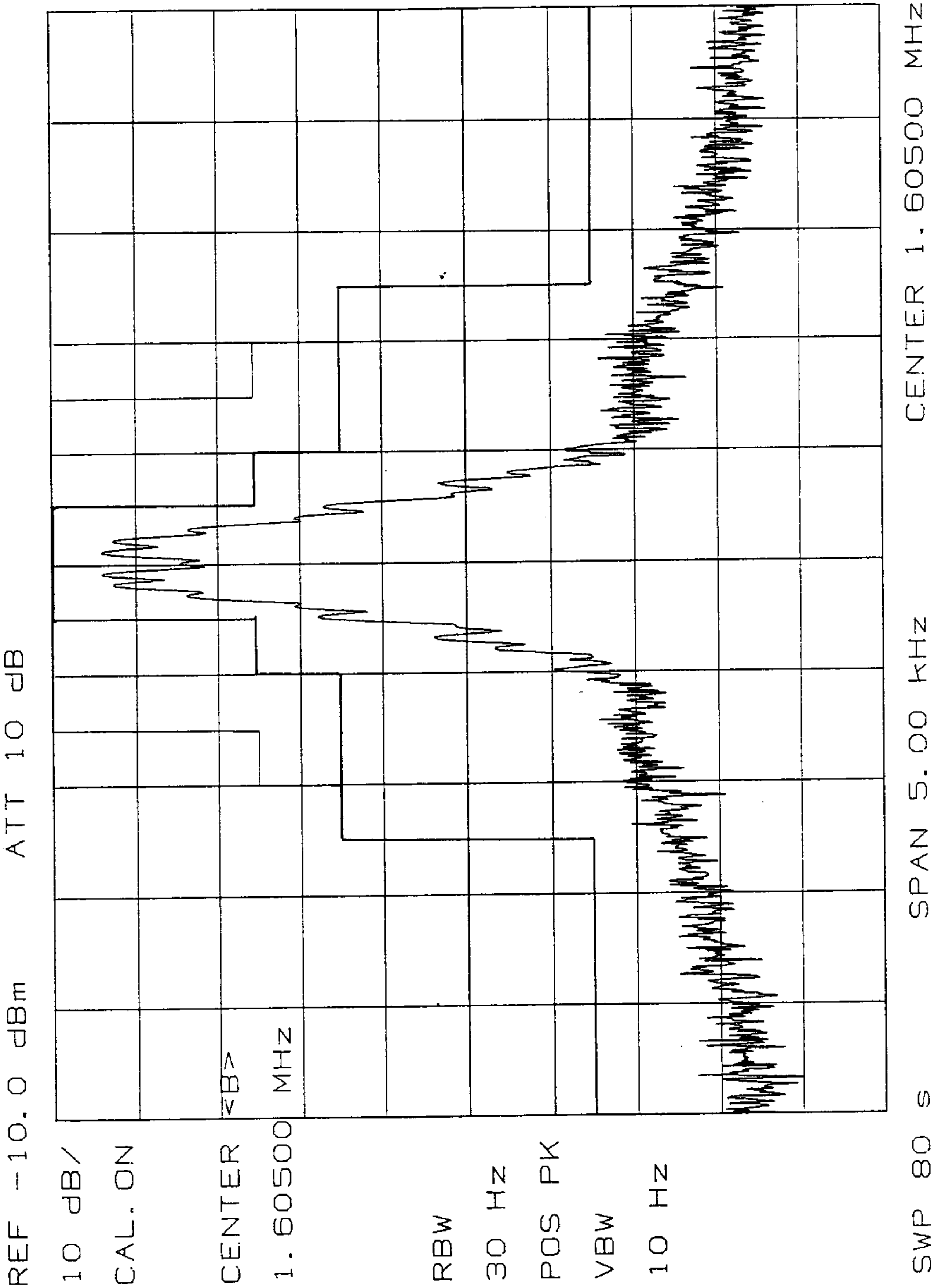
ATT 10 dB
REF -10.0 dBm
10 dB/
CAL. ON
CENTER <B>
1.60500 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 1.60500 MHz

Fig. 5.14

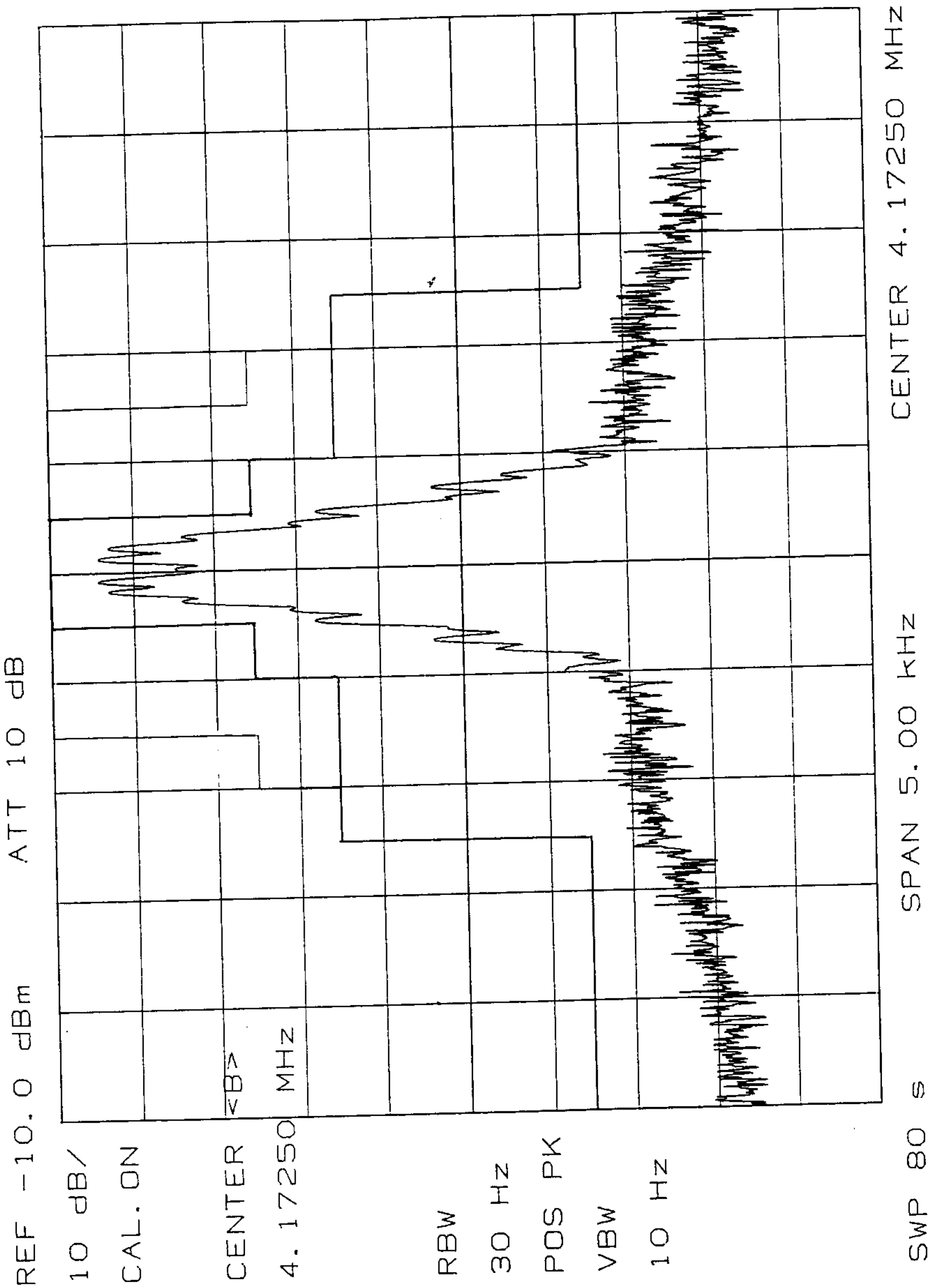
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
4.17250
<B>
MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 4.17250 MHz

Fig. 5.15

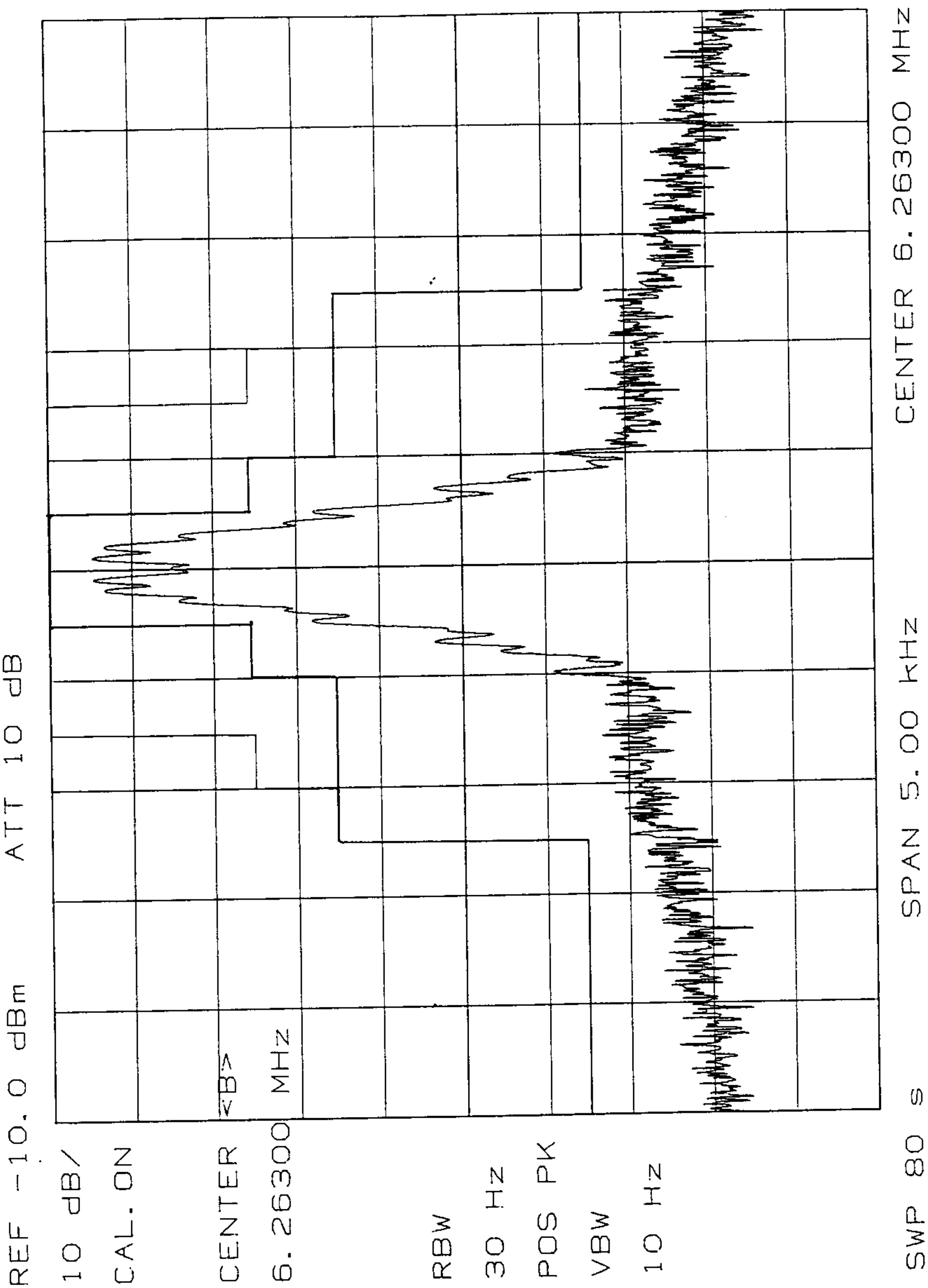
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
6. 26300
<B>
MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 6. 26300 MHz

Fig. 5.16

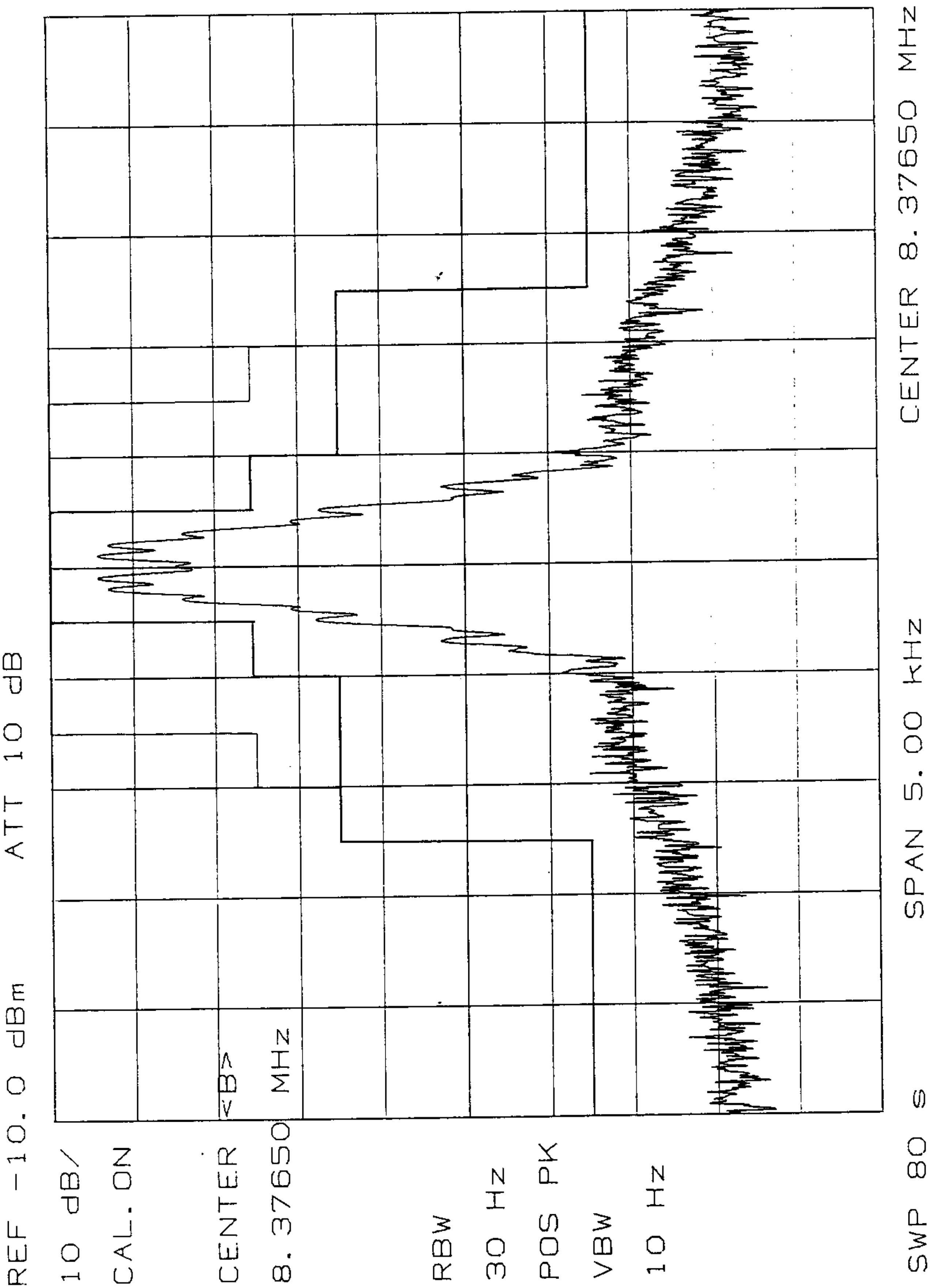
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
8.37650 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 8.37650 MHz

Fig. 5.17

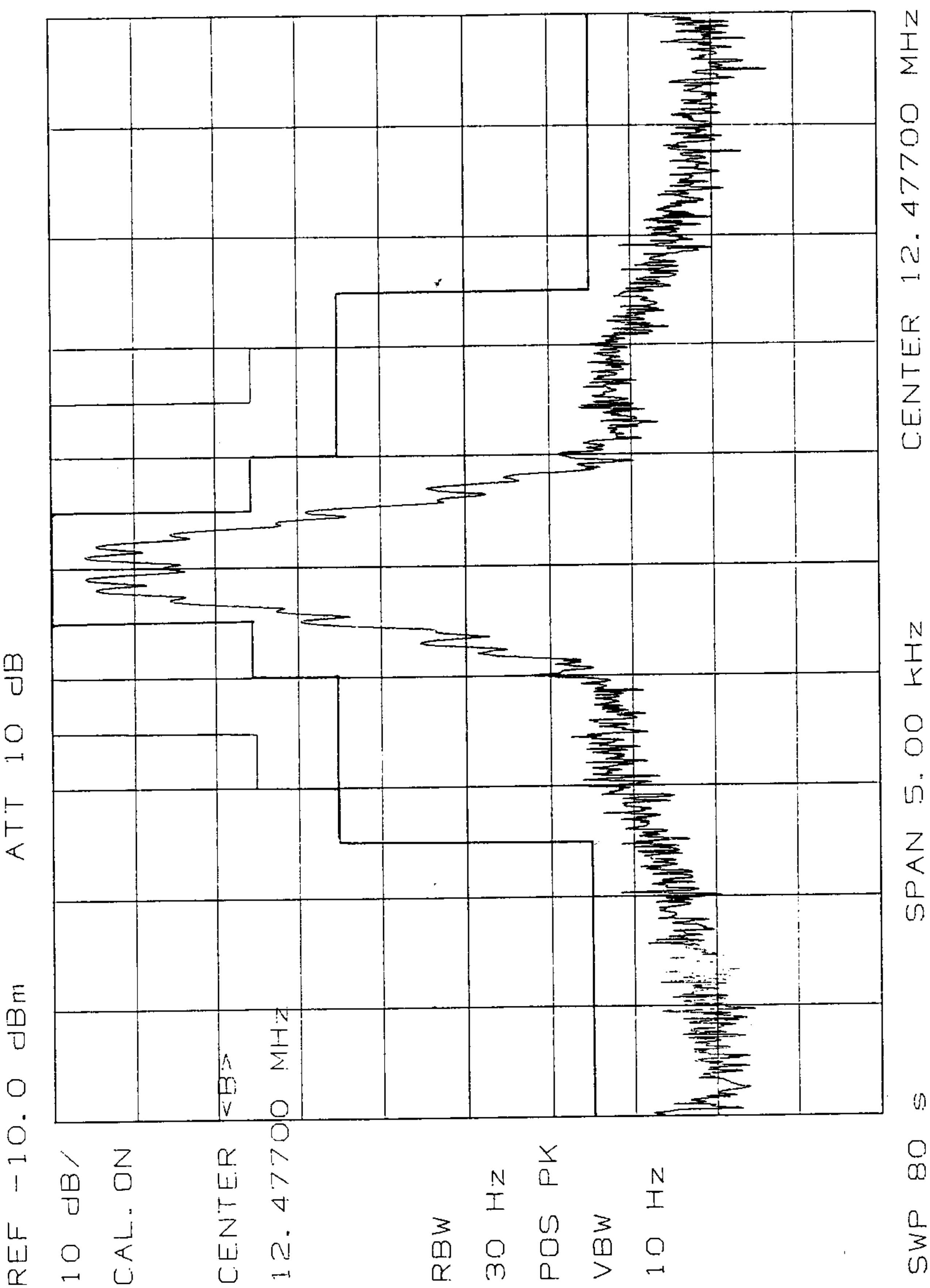
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
12. 47700
<B>
12. 47700 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 12. 47700 MHz

Fig. 5.18

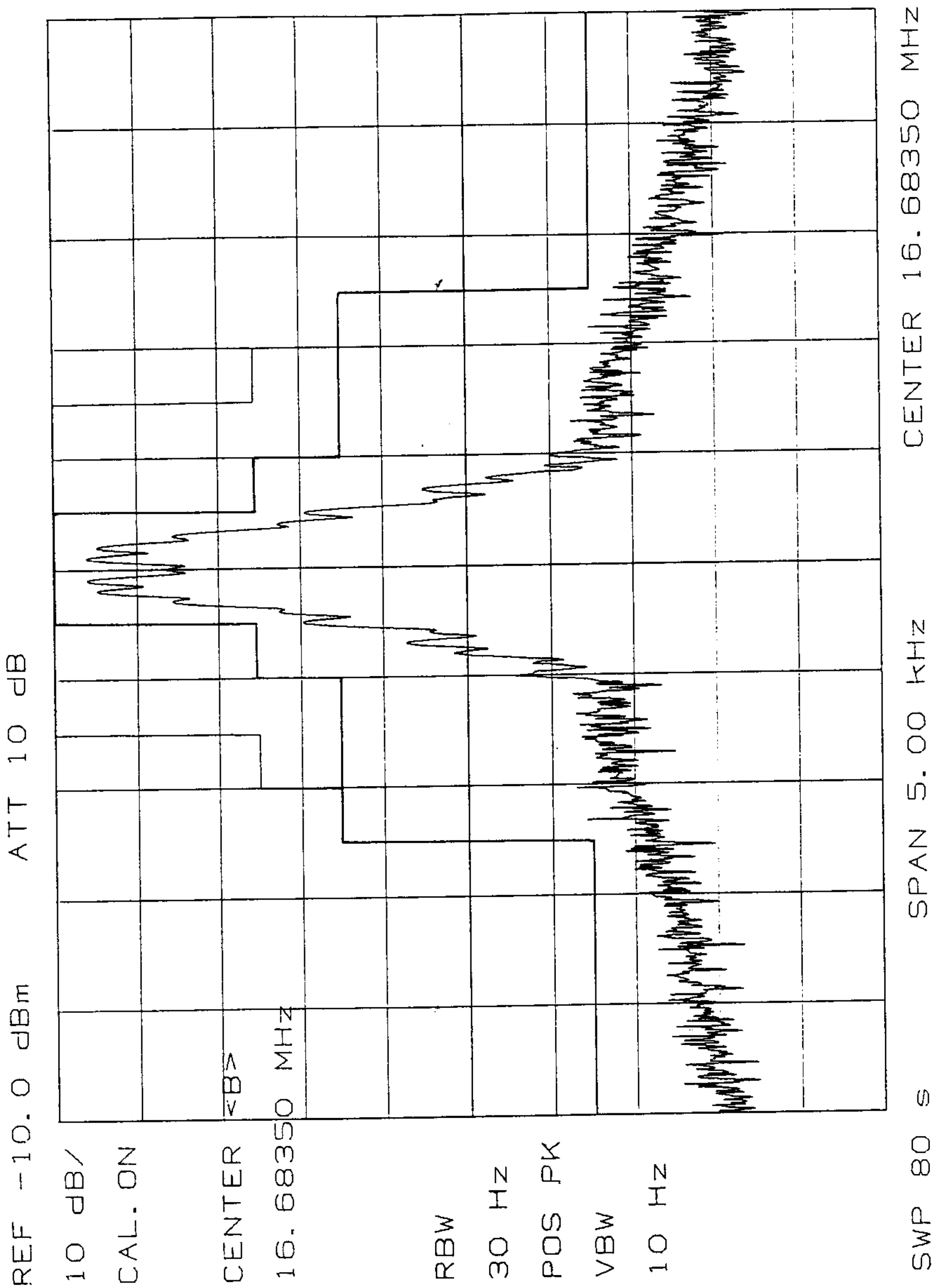
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
<B>
16.68350 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 16.68350 MHz

Fig. 5.19

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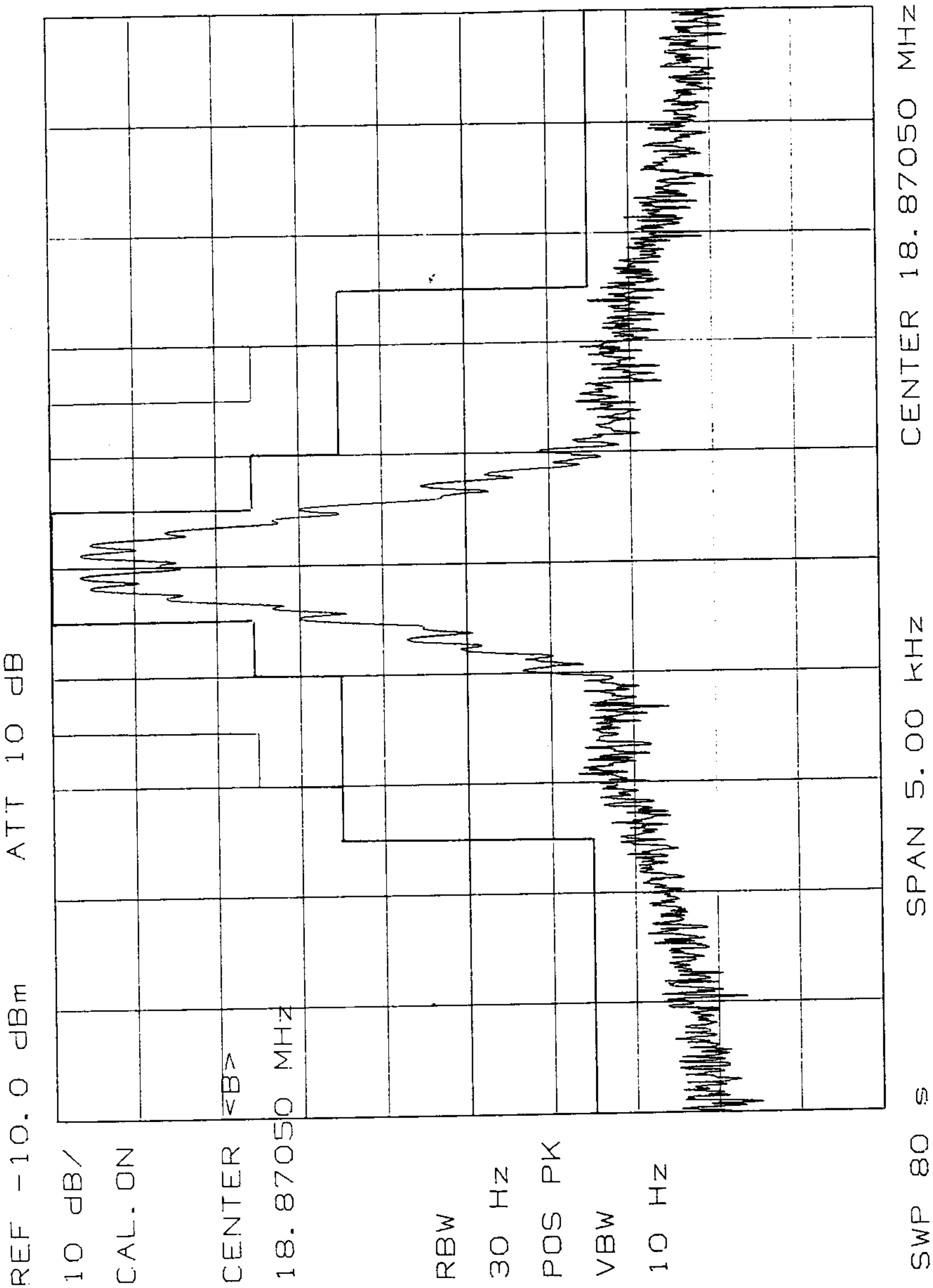

Fig. 5.20

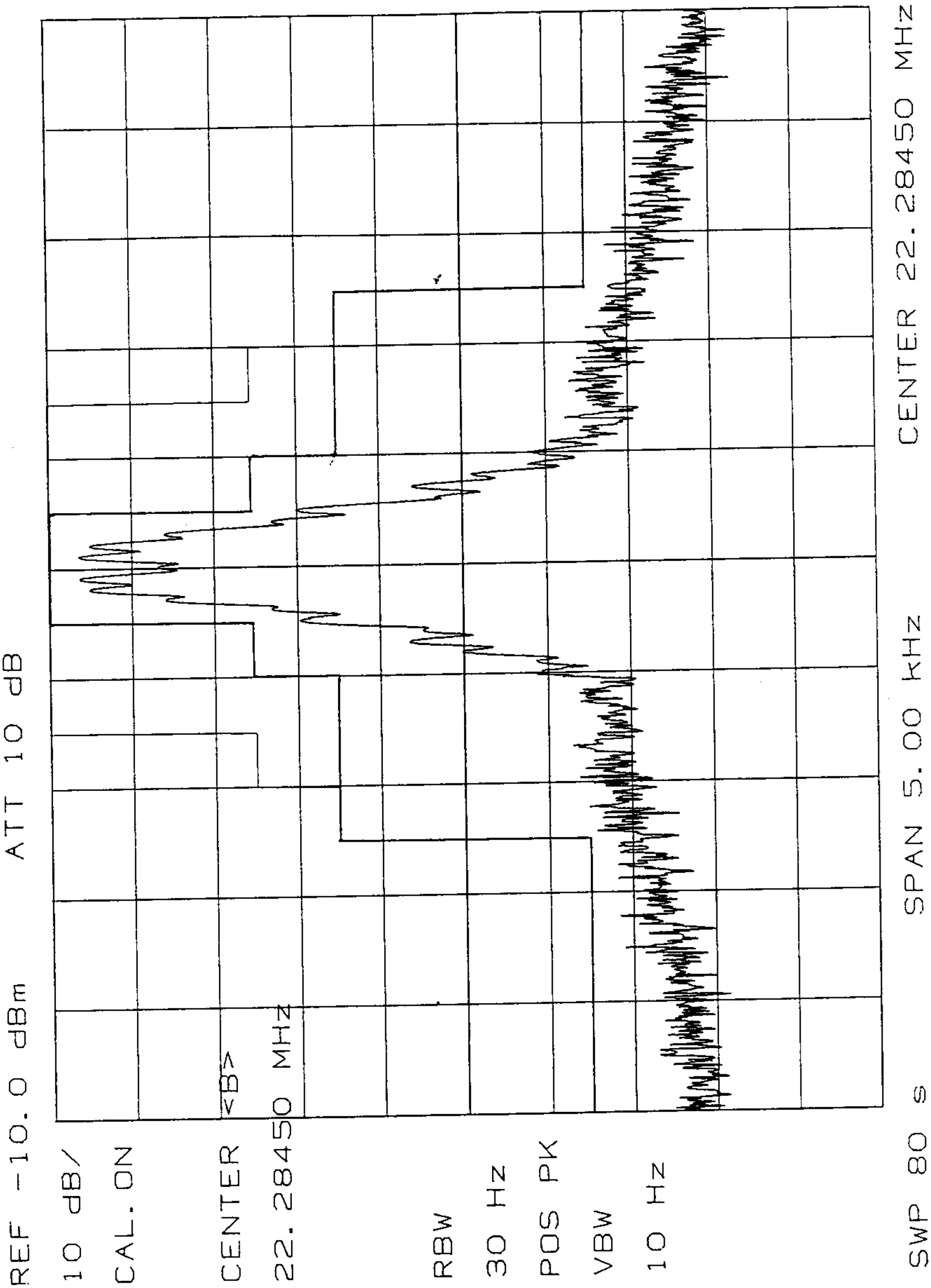
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
22. 28450 MHz
<B>
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5. 00 kHz
CENTER 22. 28450 MHz

Fig. 5.21

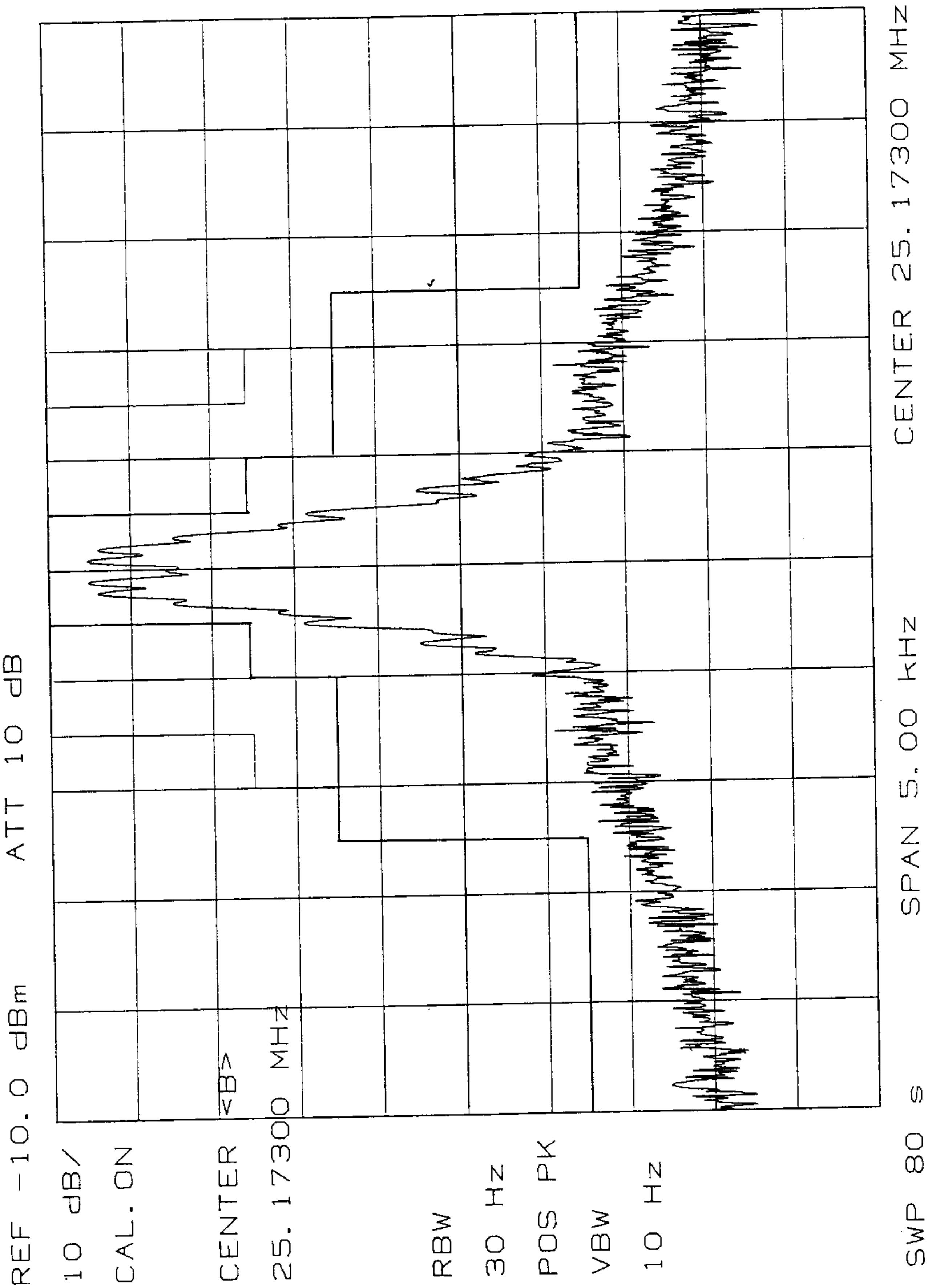
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
25.17300 MHz
<B>
25.17300 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 25.17300 MHz

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.

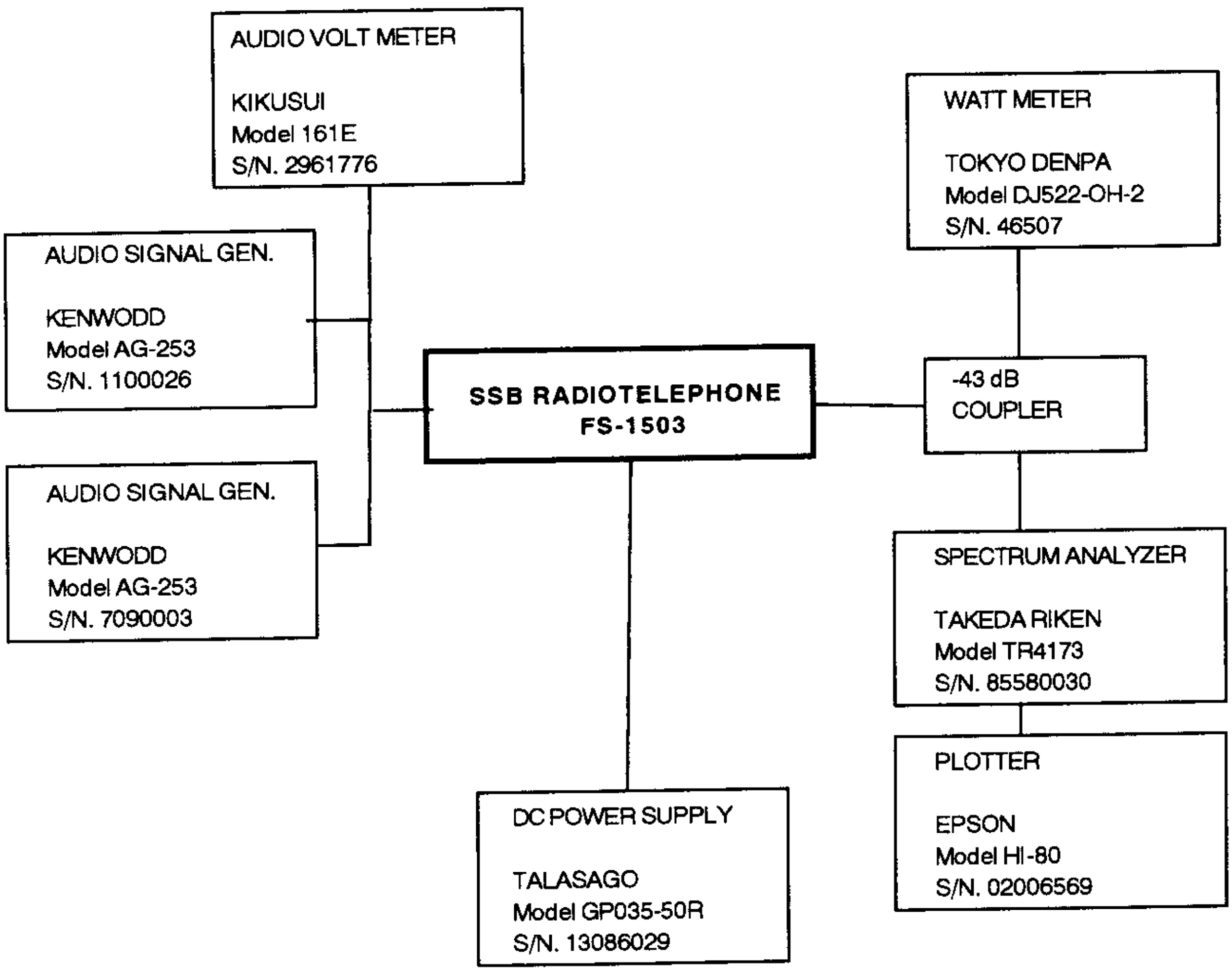

Fig. 6.1

6.2 Test Result

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

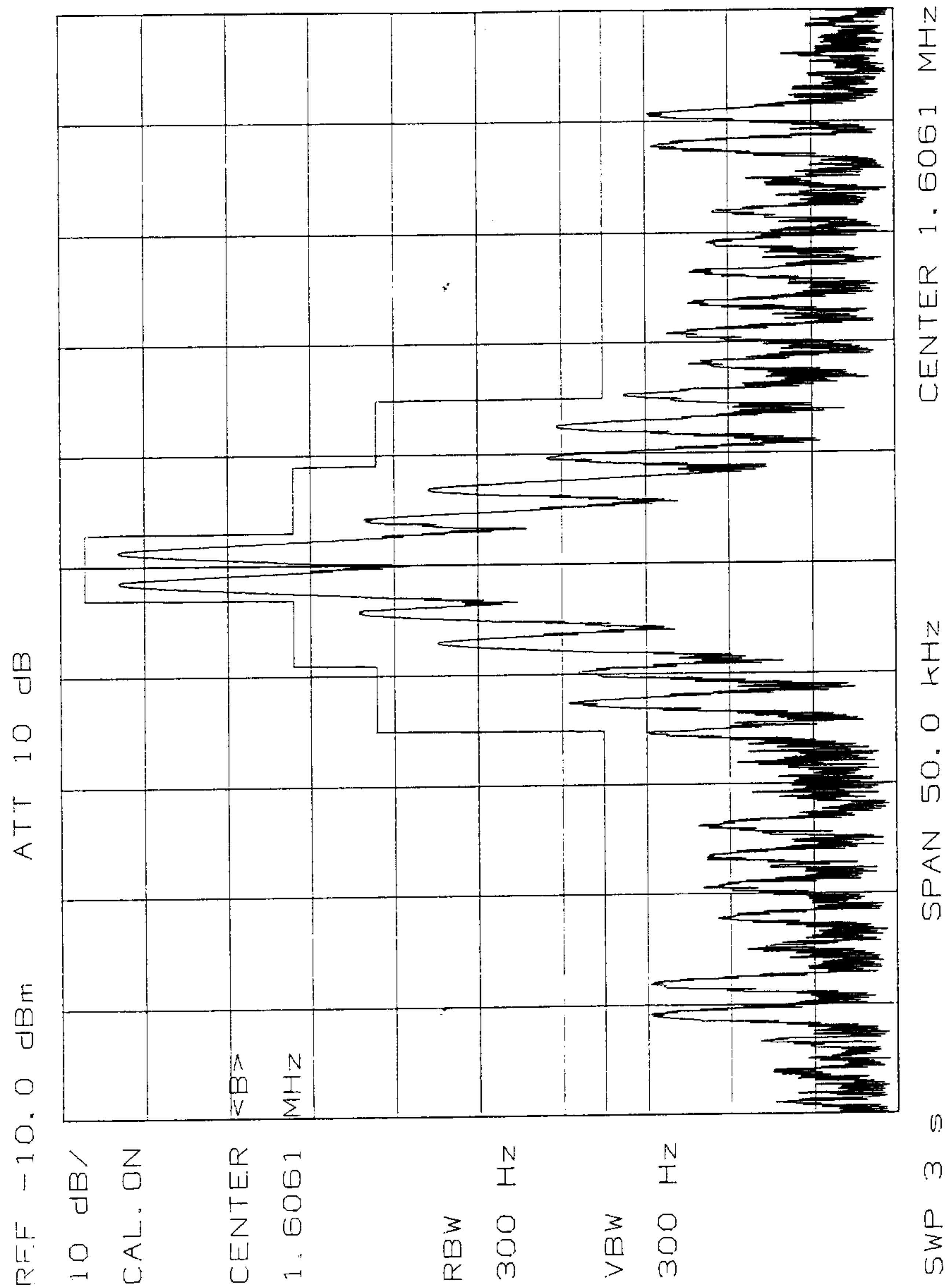
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
<B>
1.6061
MHz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 1.6061 MHz

Fig. 6.2

Pub. No. : TI- 1681

Date : May. 1998

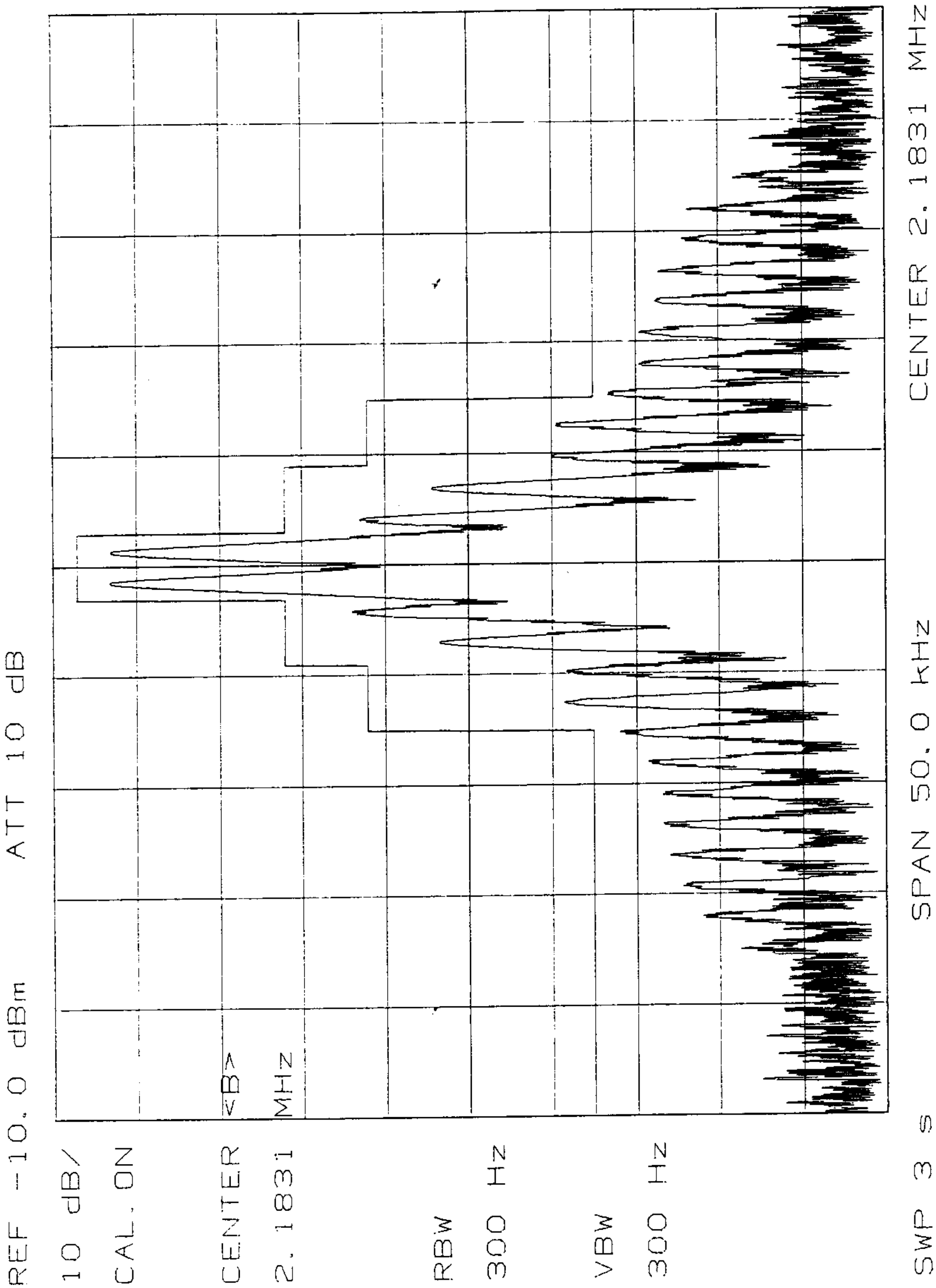

Fig. 6.3

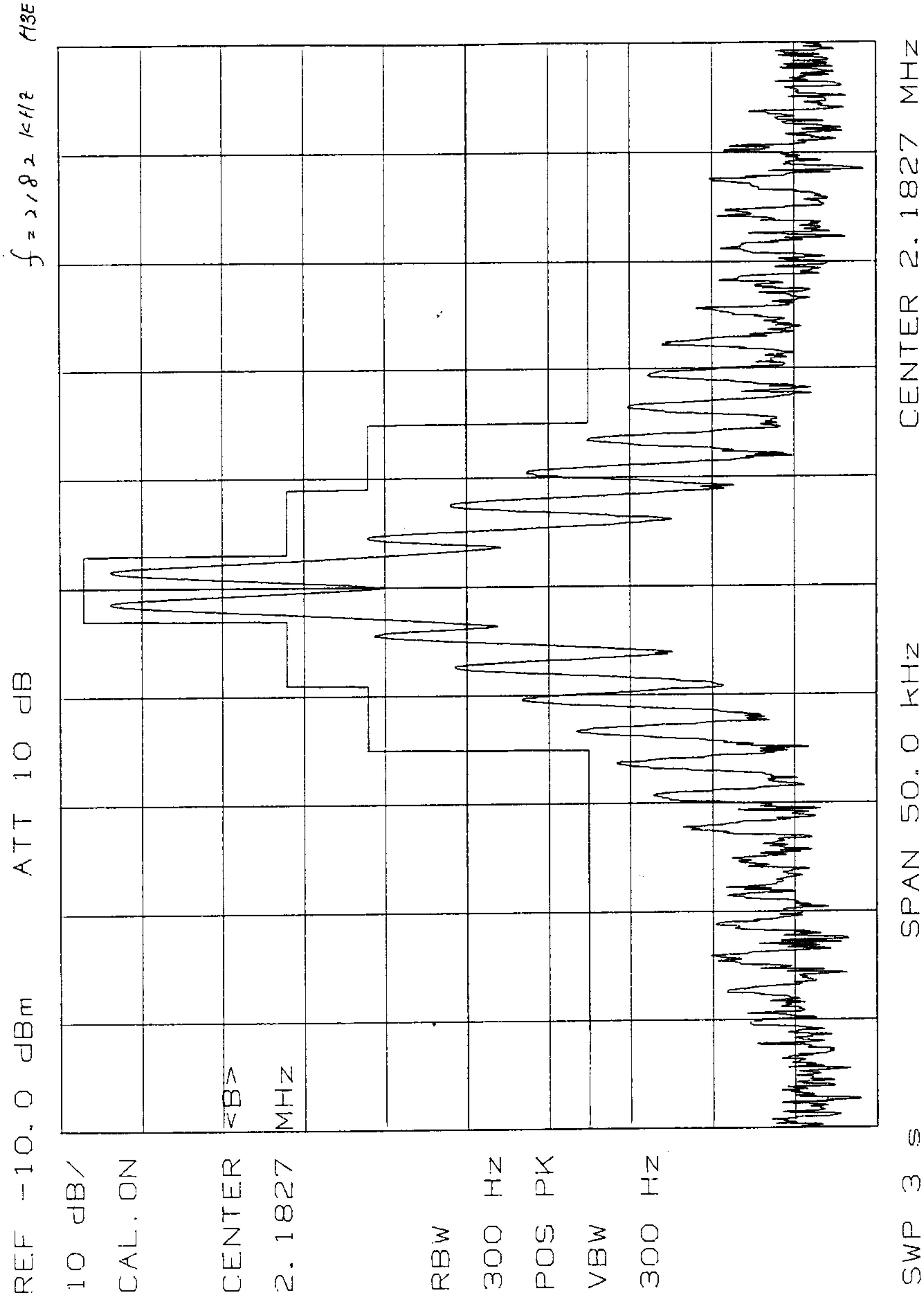
H3E
f = 2182 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL.ON
CENTER
2.1827
<B>
MHz
RBW
300 Hz
POS PK
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 2.1827 MHz

Fig. 6.4

Pub. No.: TI- 1681

Date : May. 1998

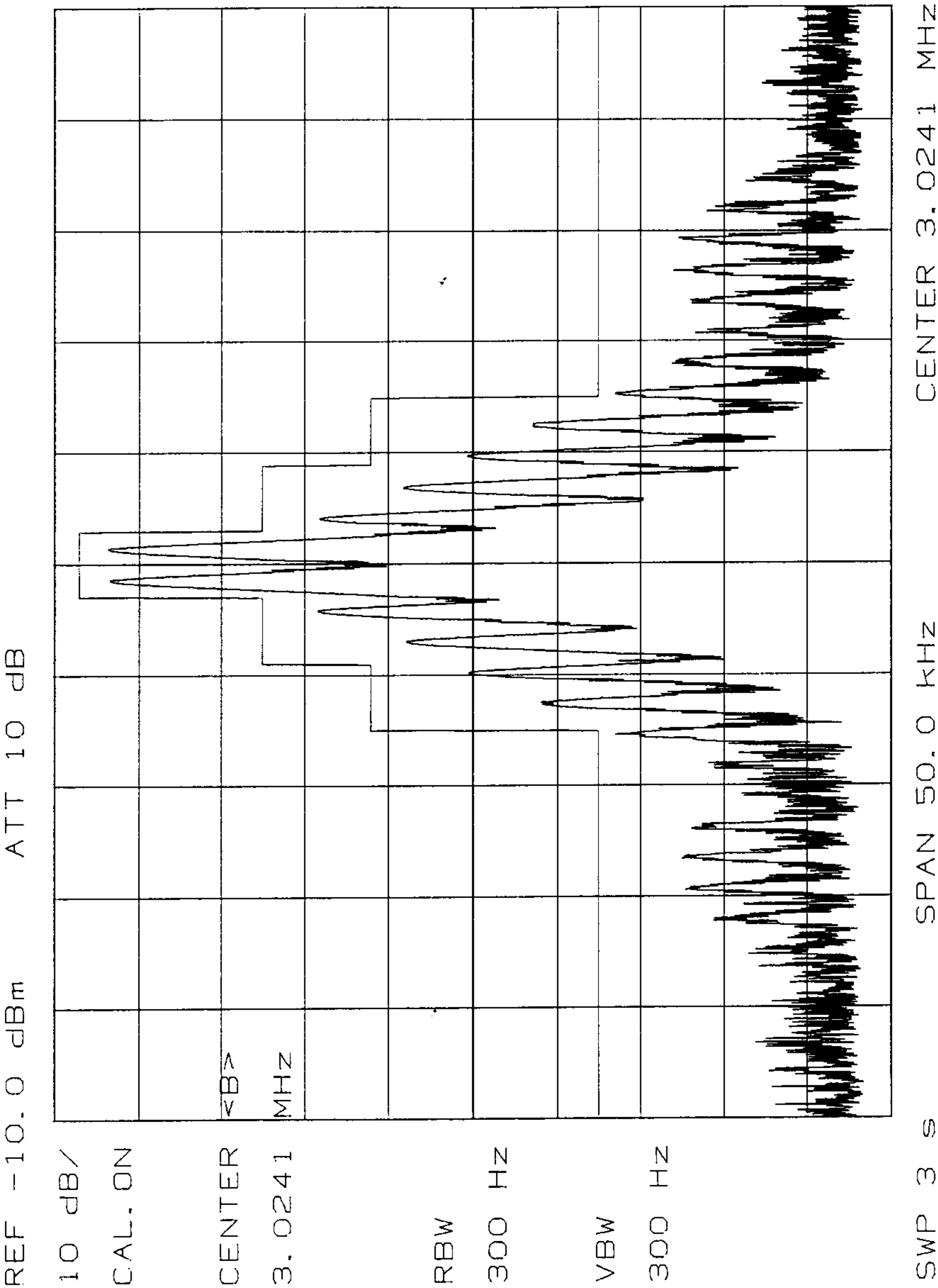

Fig. 6.5

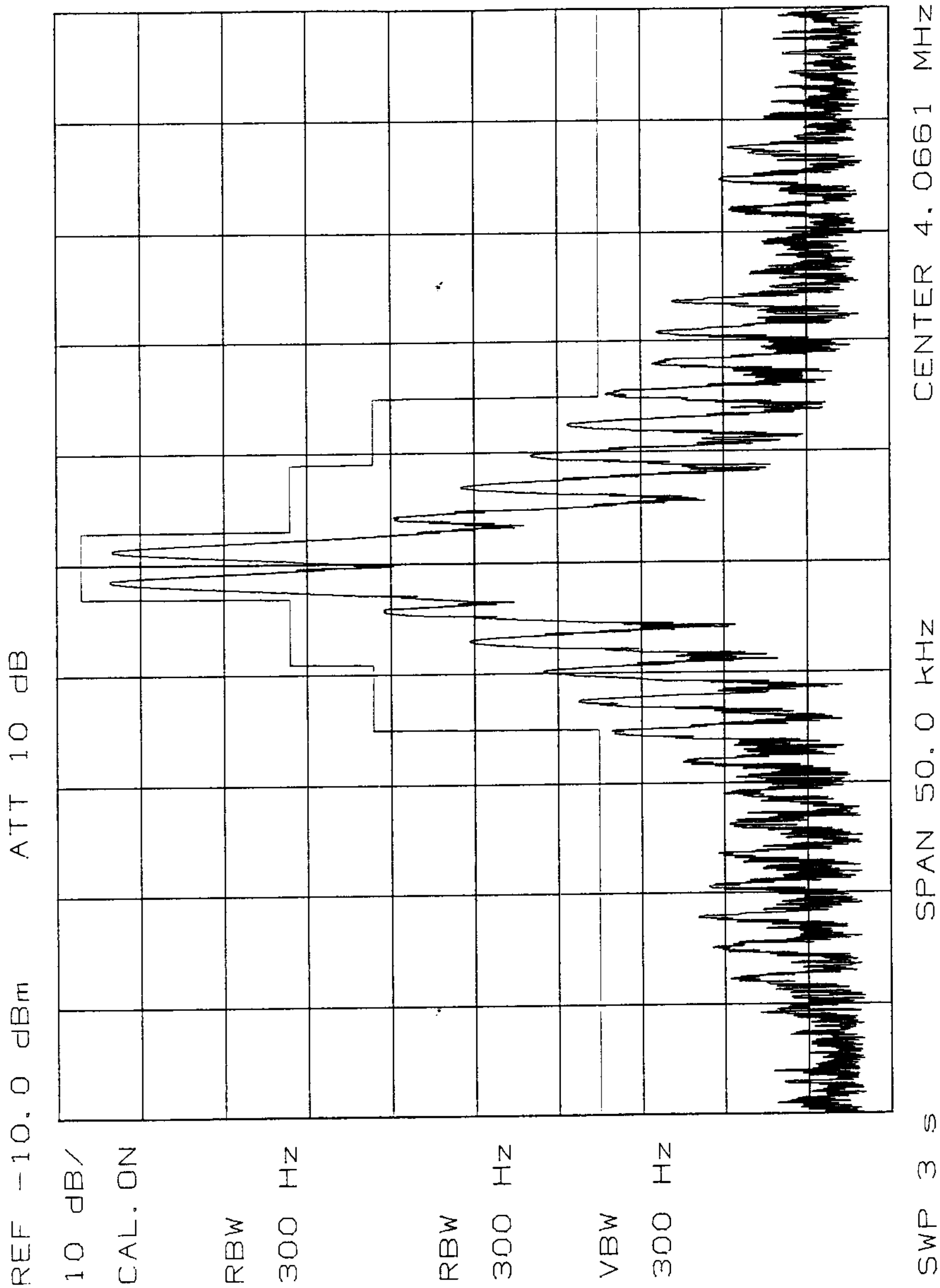
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
RBW
300 Hz
RBW
300 Hz
VBW
300 Hz
CENTER 4.0661 MHz
SPAN 50.0 kHz
SWP 3 s

Fig. 6.6

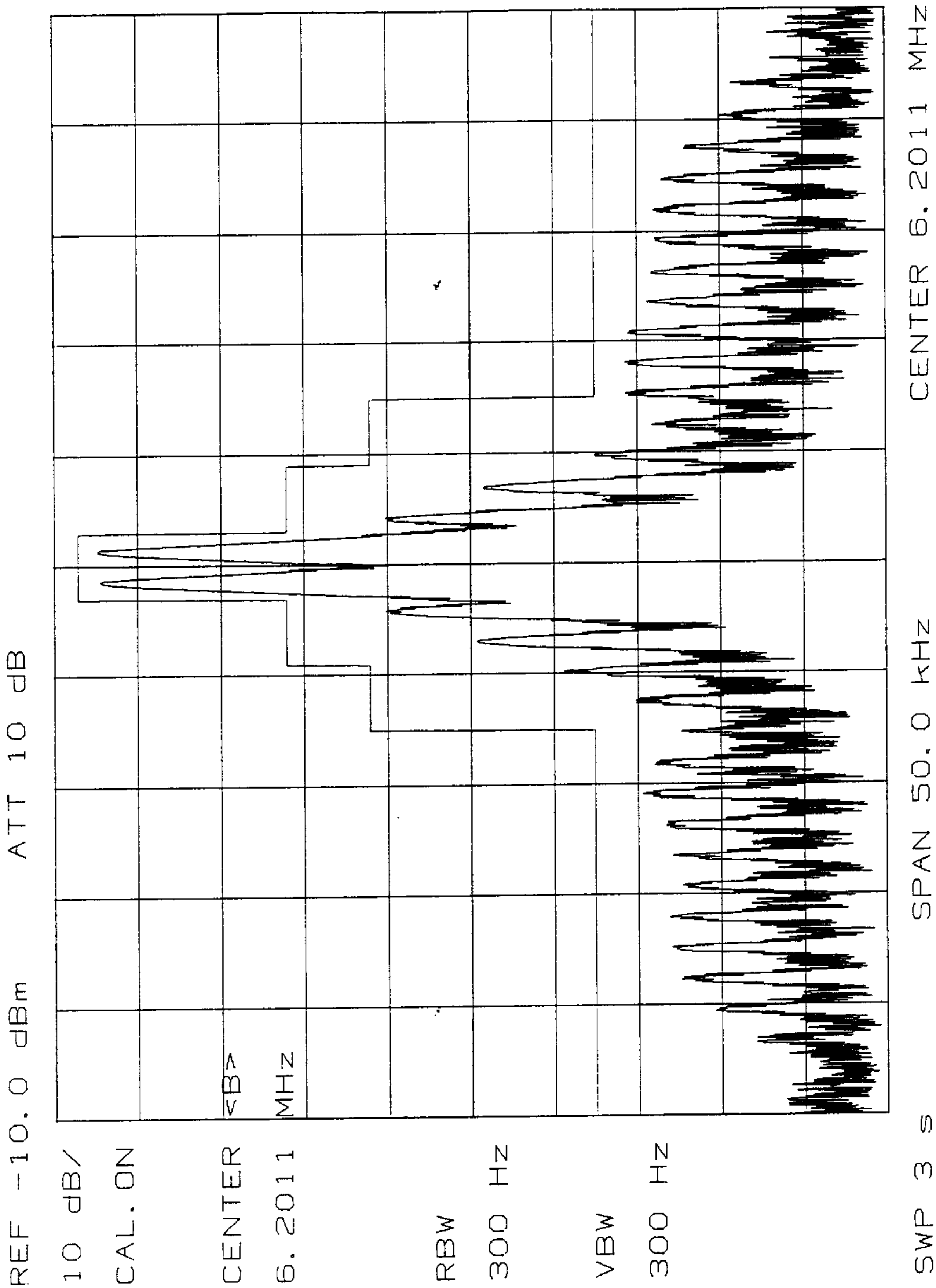
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL.ON
CENTER
6.2011
<B>
MHz
RBW
300 Hz
VBW
300 Hz
SWP 3 s
SPAN 50.0 kHz
CENTER 6.2011 MHz

Fig. 67

Pub. No. : TI- 1681

Date : May. 1998

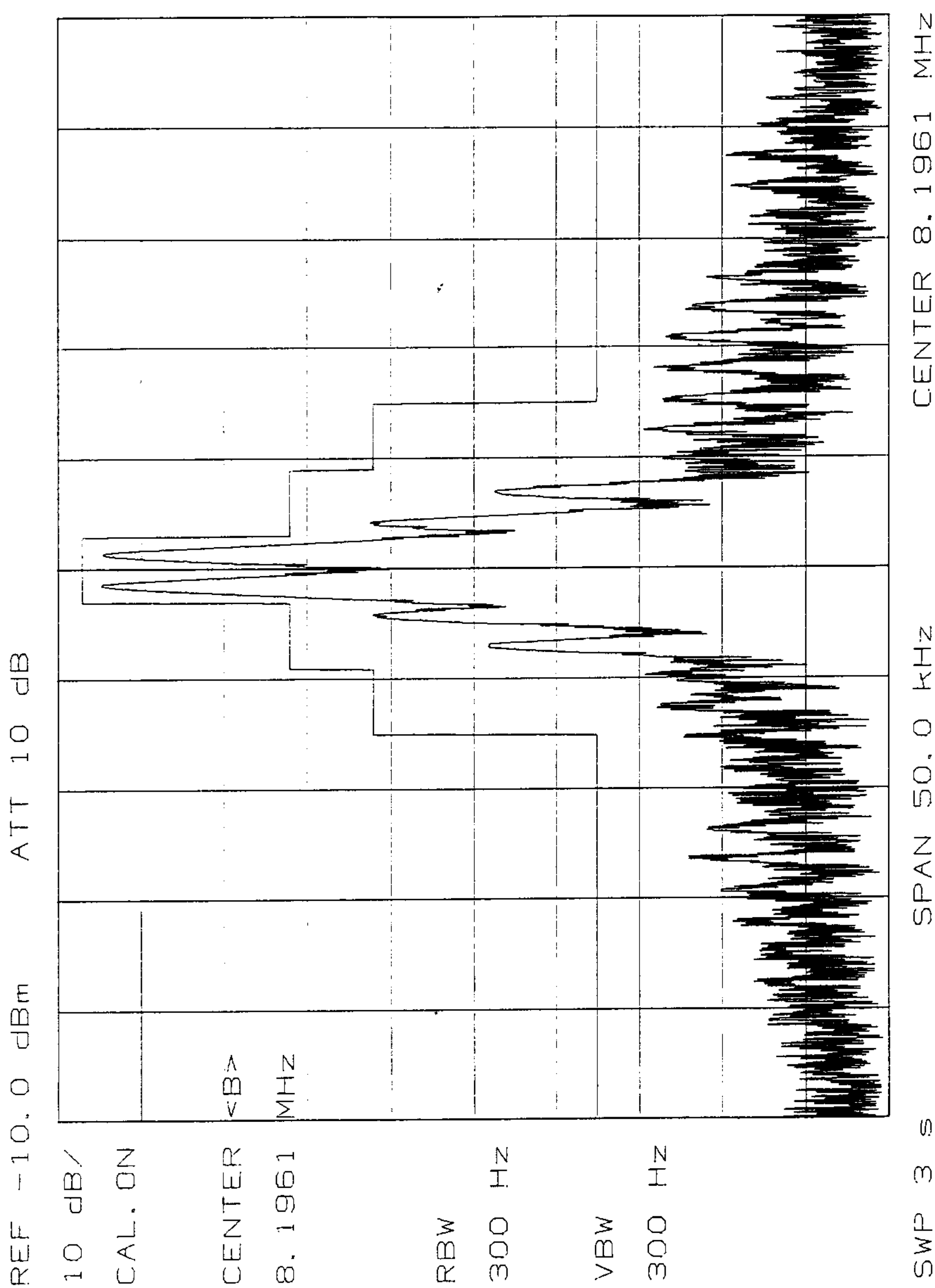

Fig. 6.8

Pub. No. : TI- 1681

Date : May. 1998

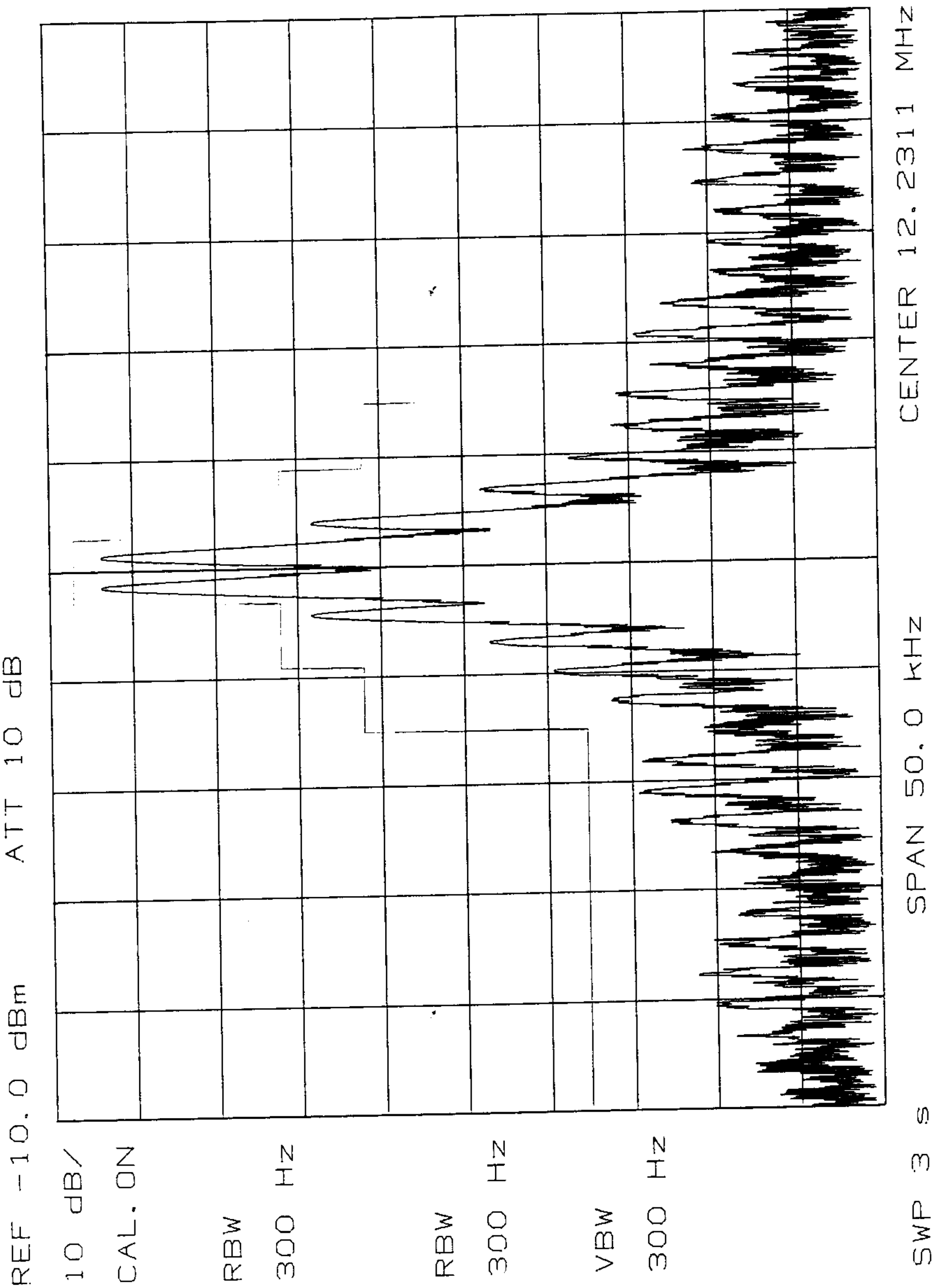

Fig. 6.9

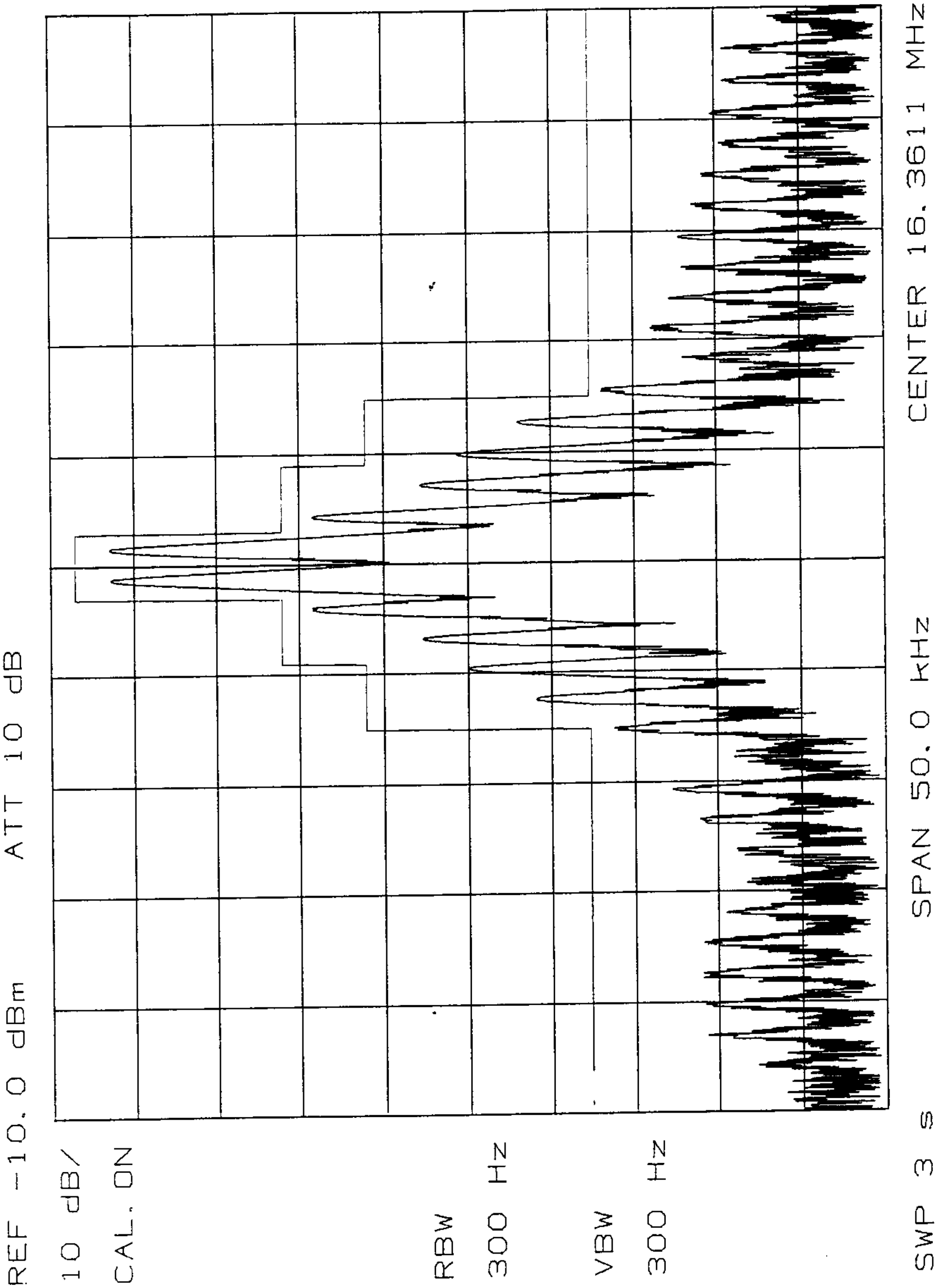
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
RBW 300 Hz
VBW 300 Hz
CENTER 16.3611 MHz
SPAN 50.0 kHz
SWP 3 s

Fig. 6.10

Pub. No. : TI- 1681

Date : May, 1998

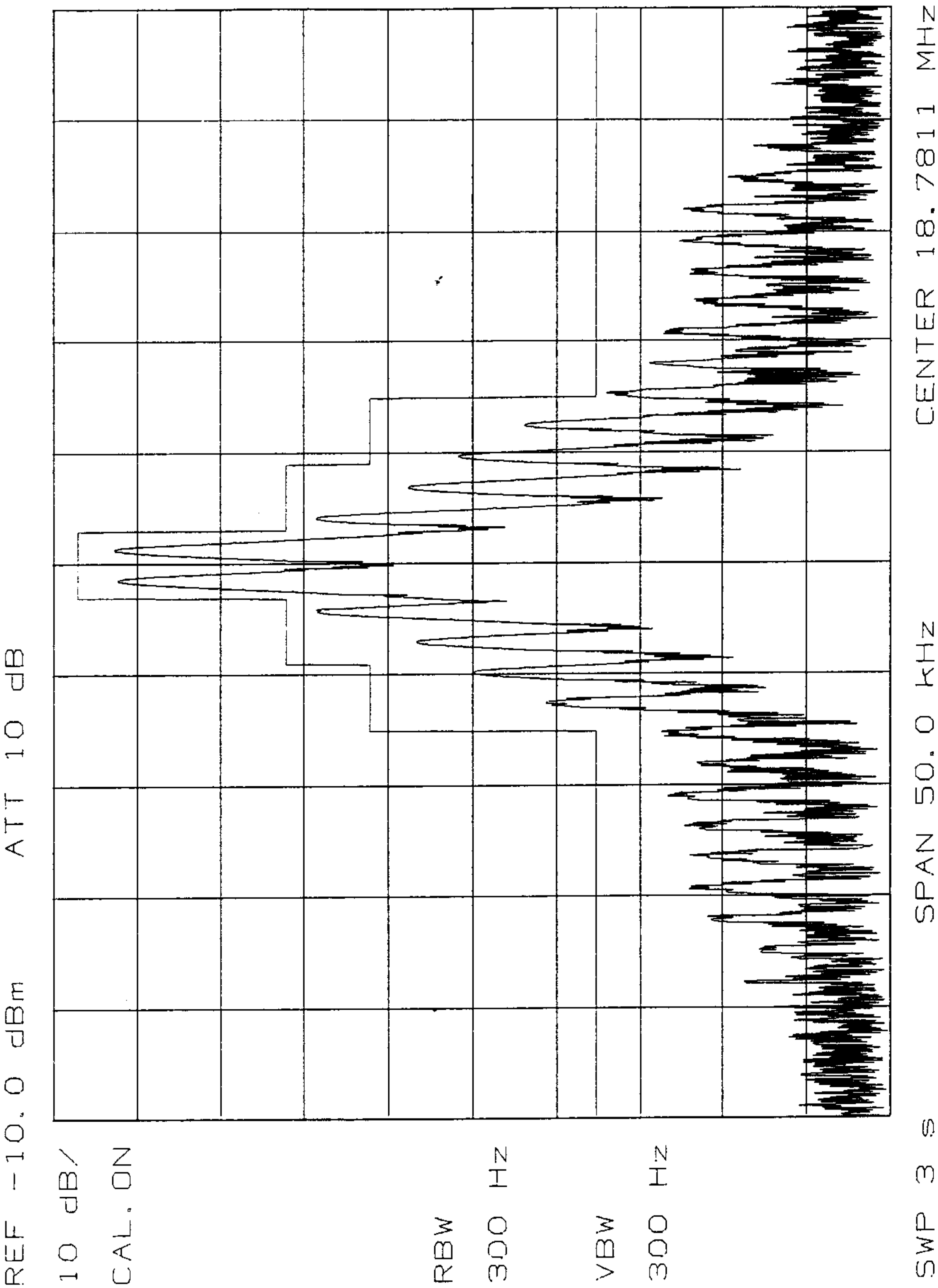

Fig. 6.11

Pub. No.: TI- 1681

Date : May, 1998

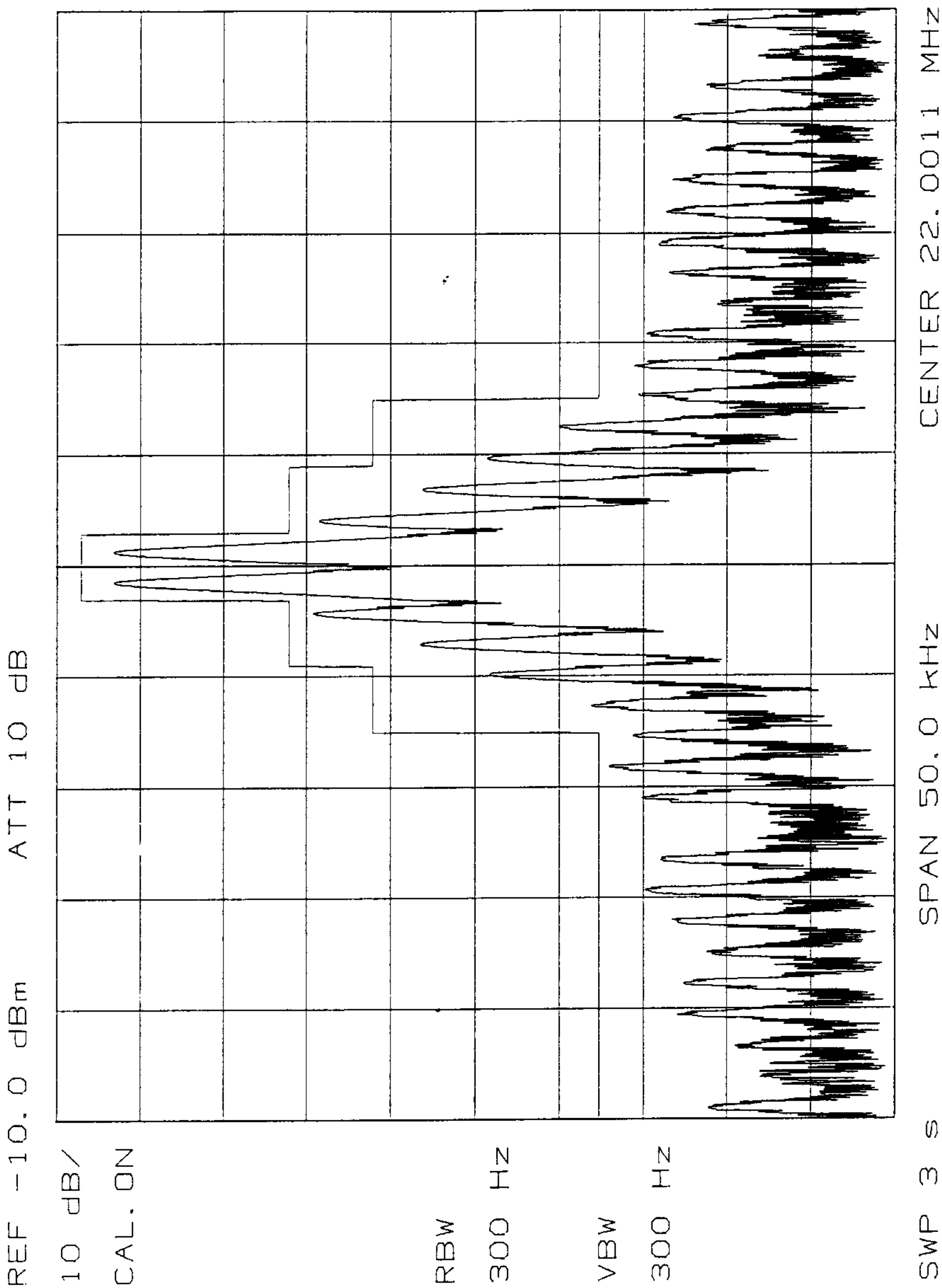

Fig. 6.12

Pub. No. : TI- 1681

Date : May, 1998

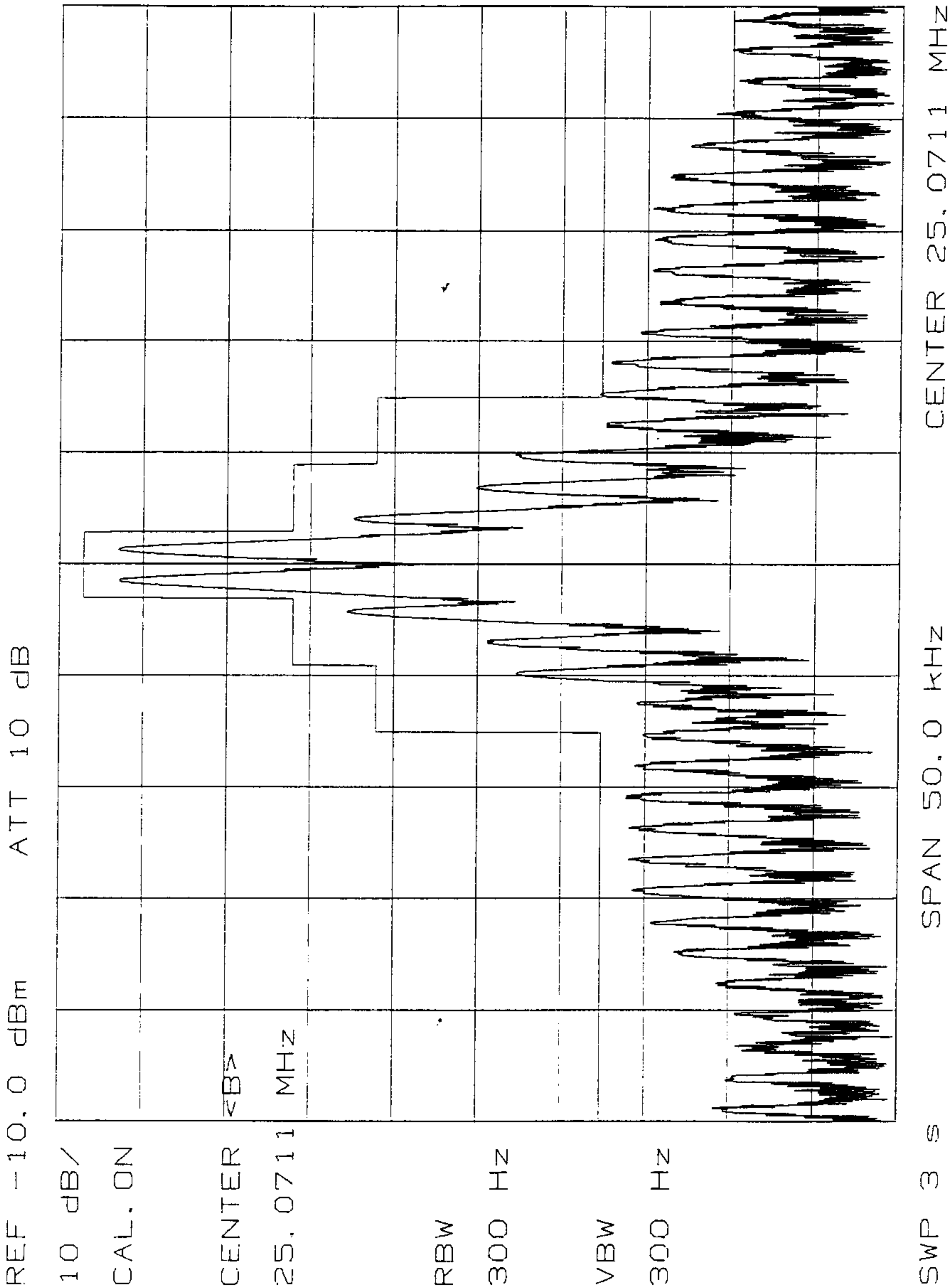

Fig. 6.13

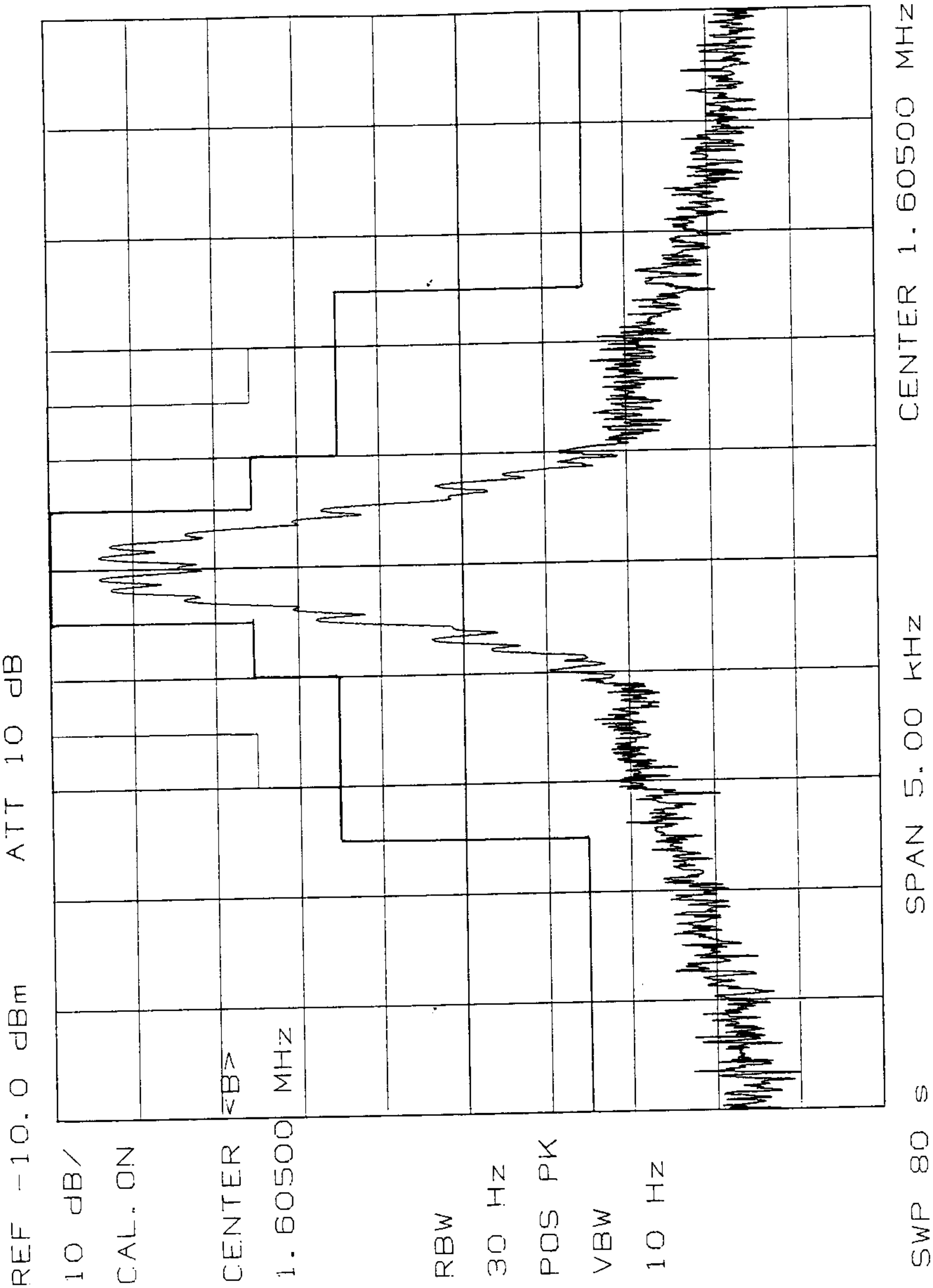
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
<B>
1.60500 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 1.60500 MHz

Fig. 6.14

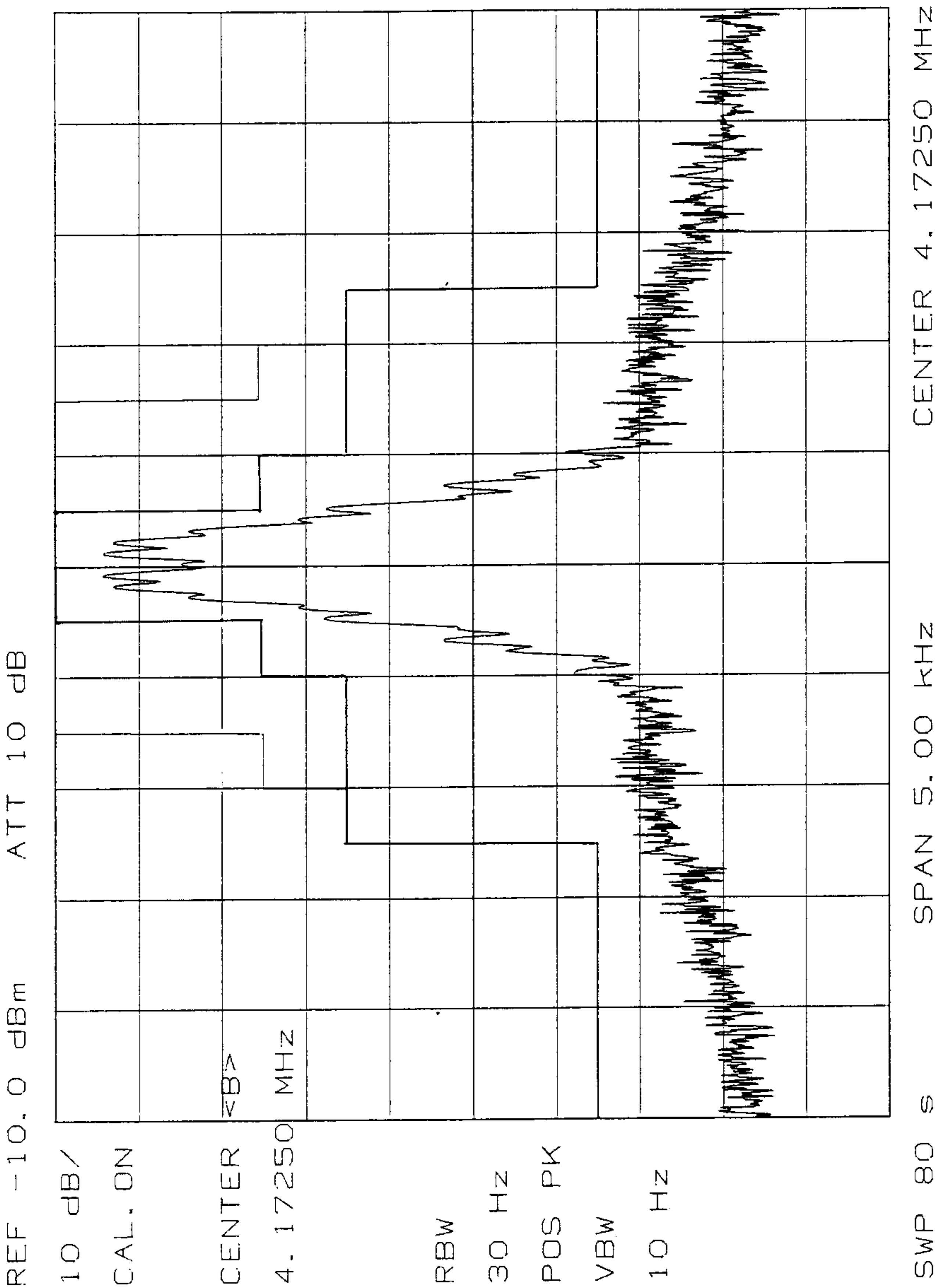
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
4.17250 MHz
RBW 30 Hz
POS PK
VBW 10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 4.17250 MHz

Fig. 6.15

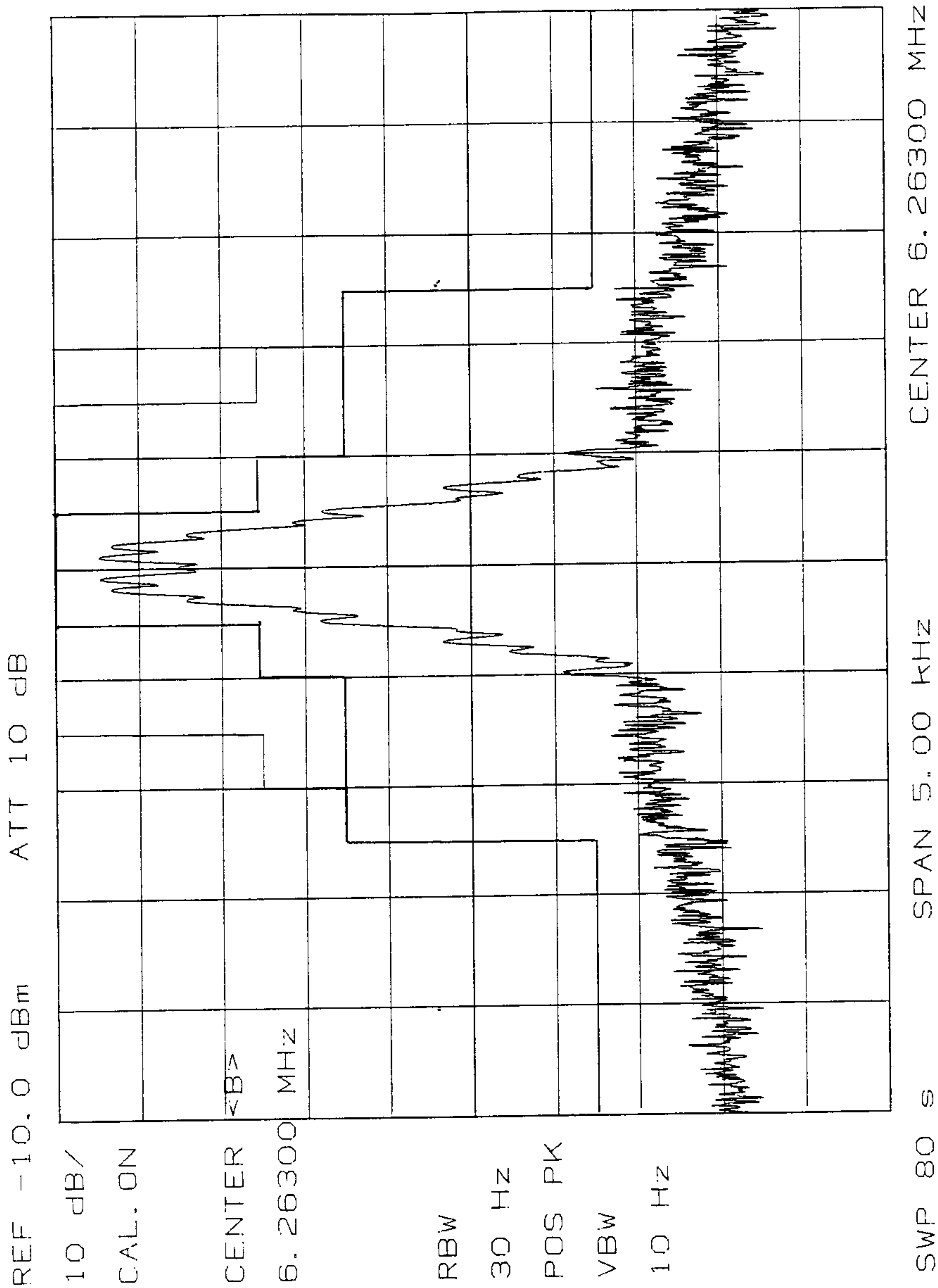
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
6.26300
<B>
MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 6.26300 MHz

Fig. 6.16

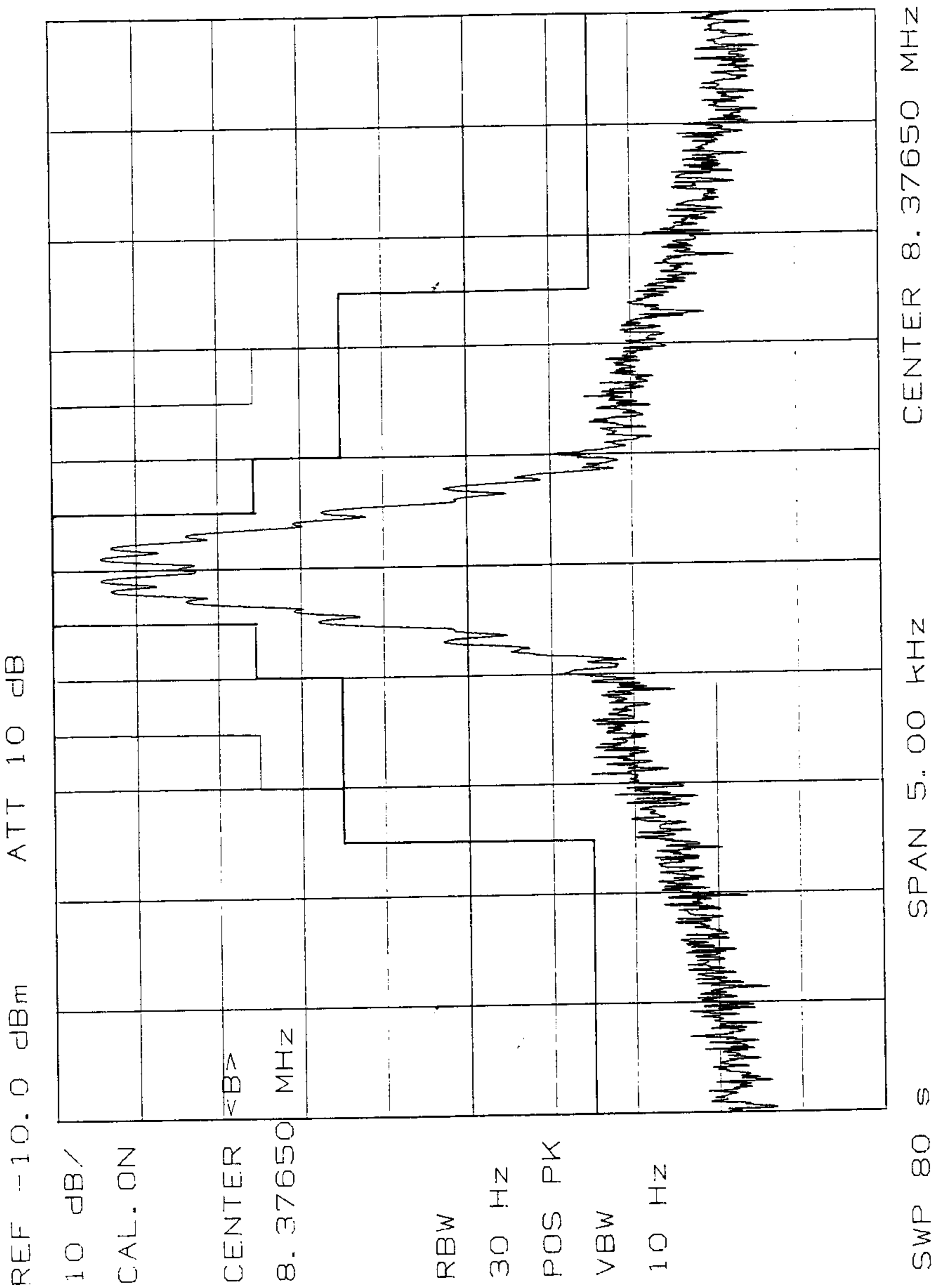
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
8.37650 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
CENTER 8.37650 MHz
SPAN 5.00 kHz

Fig. 6.17

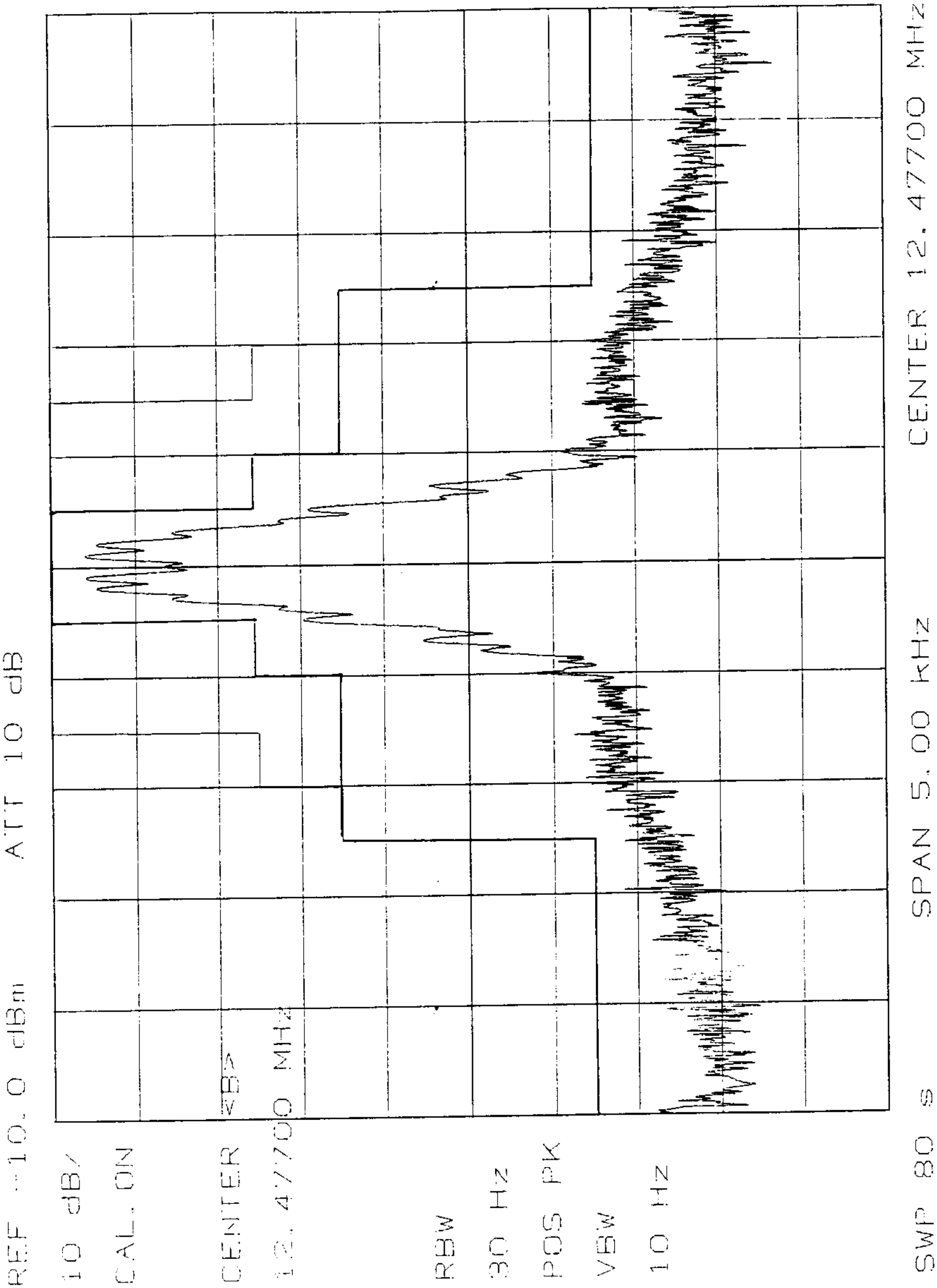
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER
12.47700 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 12.47700 MHz

Fig. 6.18

Pub. No.: TI- 1681

Date : May. 1998

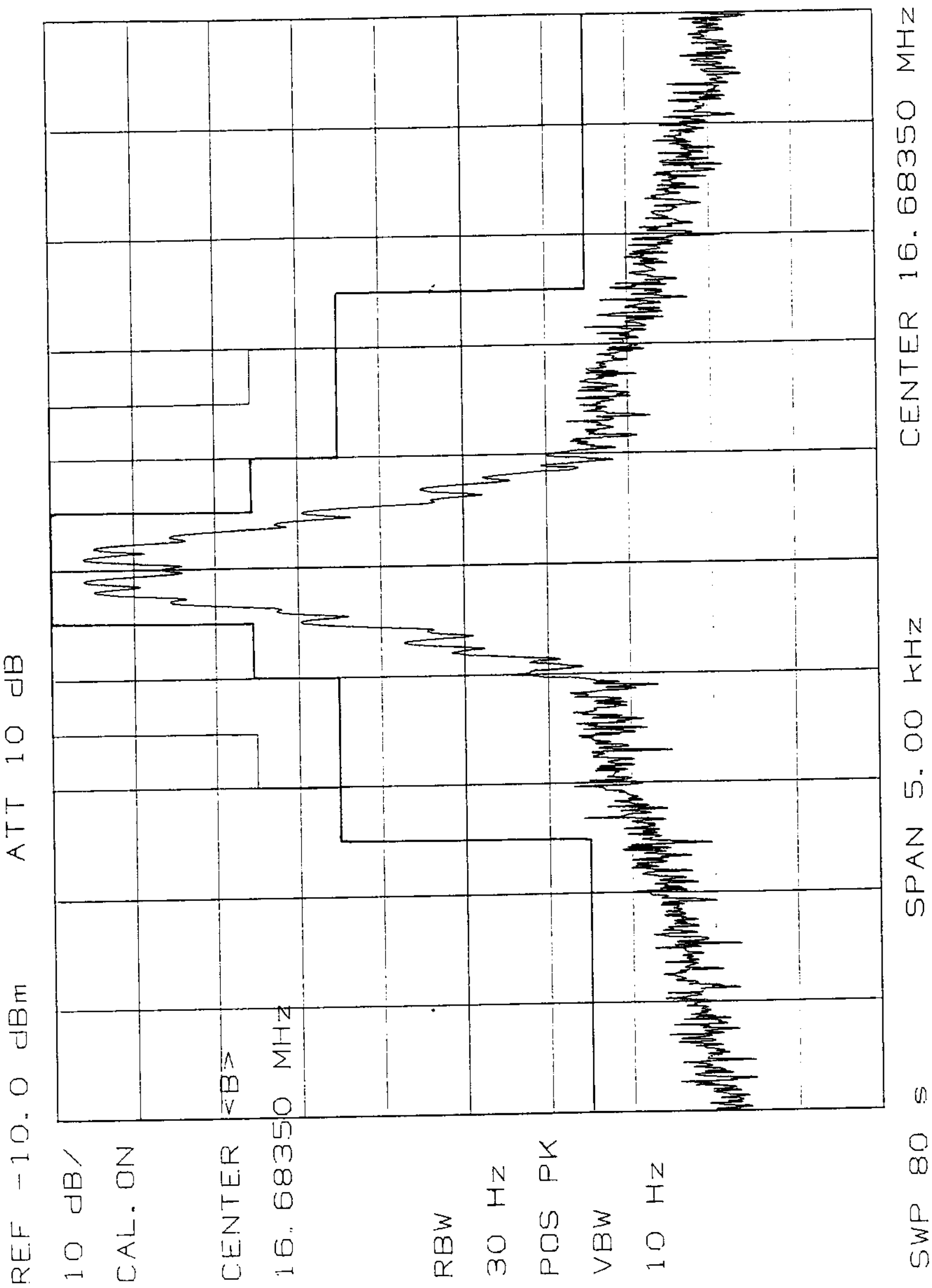

Fig. 6.19

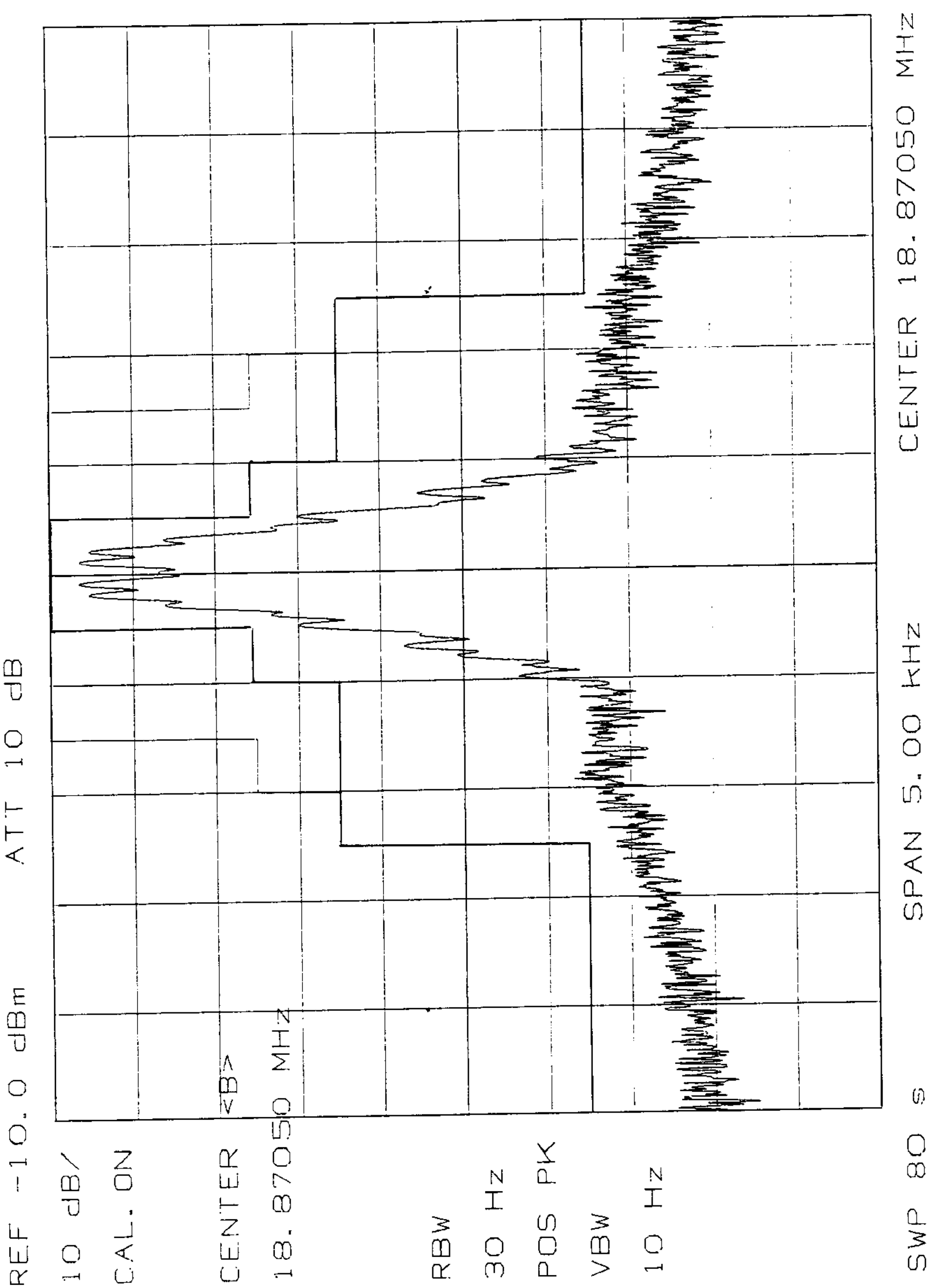
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
CENTER <B>
18.87050 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 18.87050 MHz

Fig. 6.20

Pub. No. : TI- 1681

Date : May. 1998

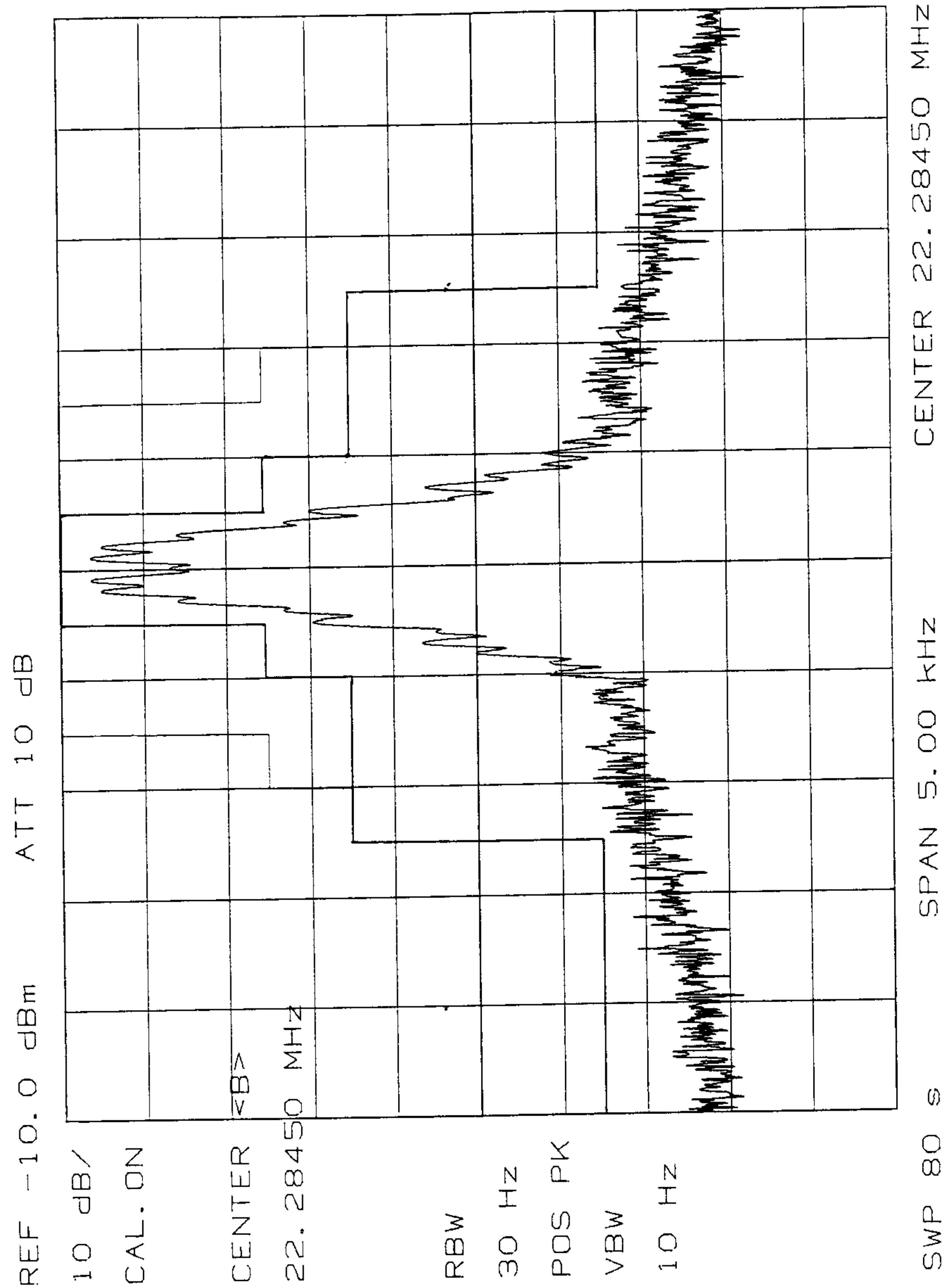

Fig. 6.21

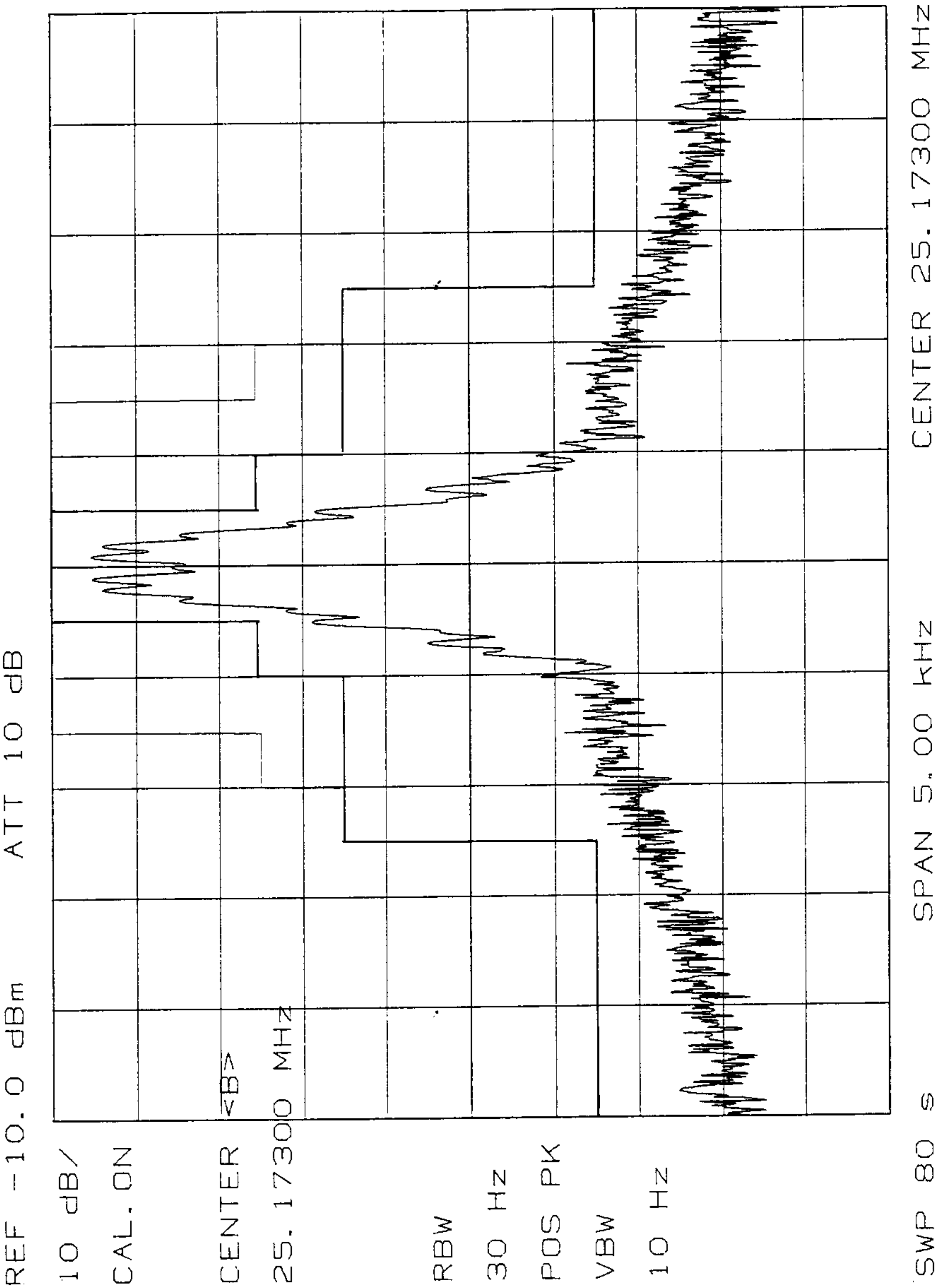
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL.ON
CENTER <B>
25.17300 MHz
RBW
30 Hz
POS PK
VBW
10 Hz
SWP 80 s
SPAN 5.00 kHz
CENTER 25.17300 MHz

Fig. 6.22

Pub. No. : TI- 1681

Date : May. 1998

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 l800 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.

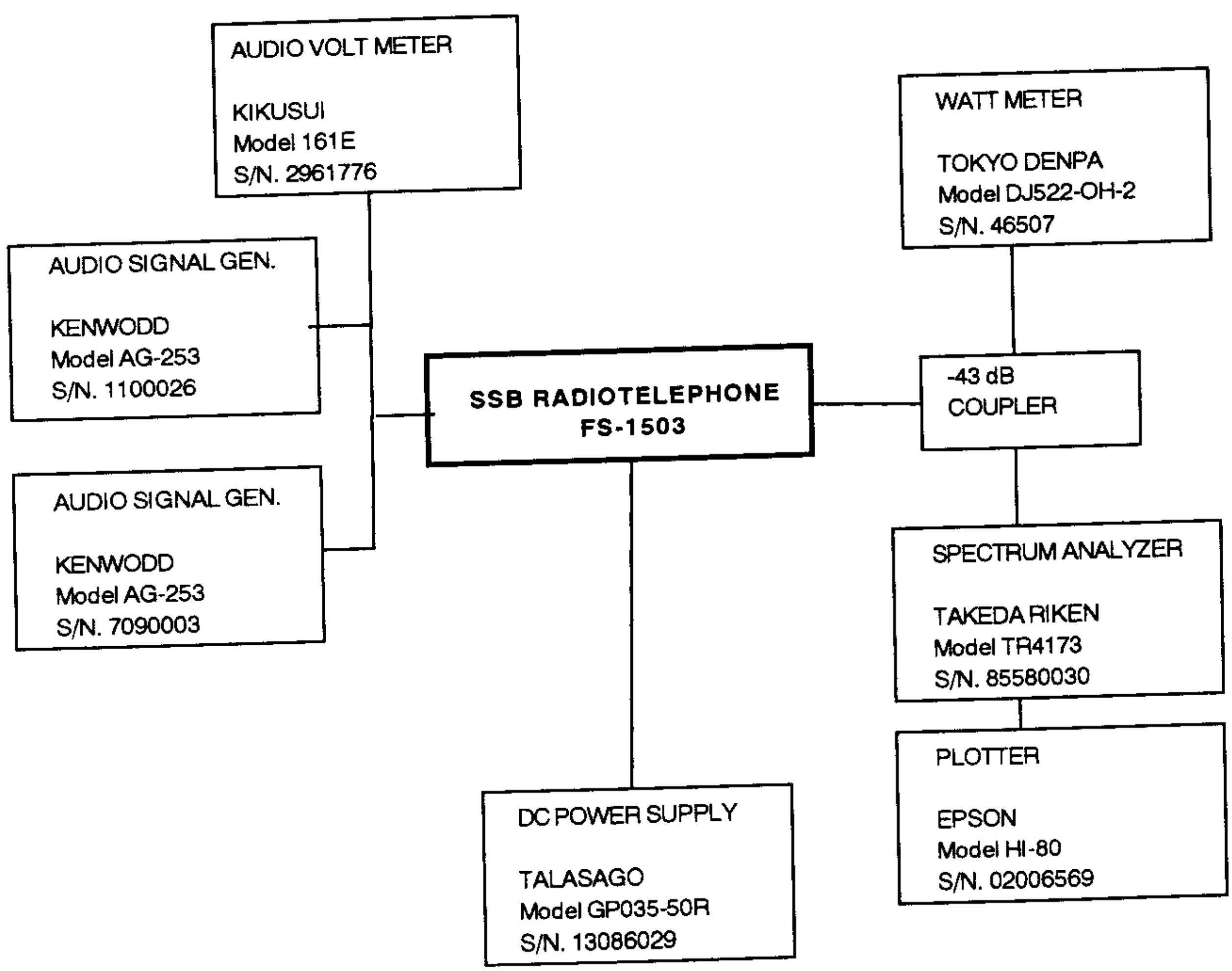

Fig. 7.1

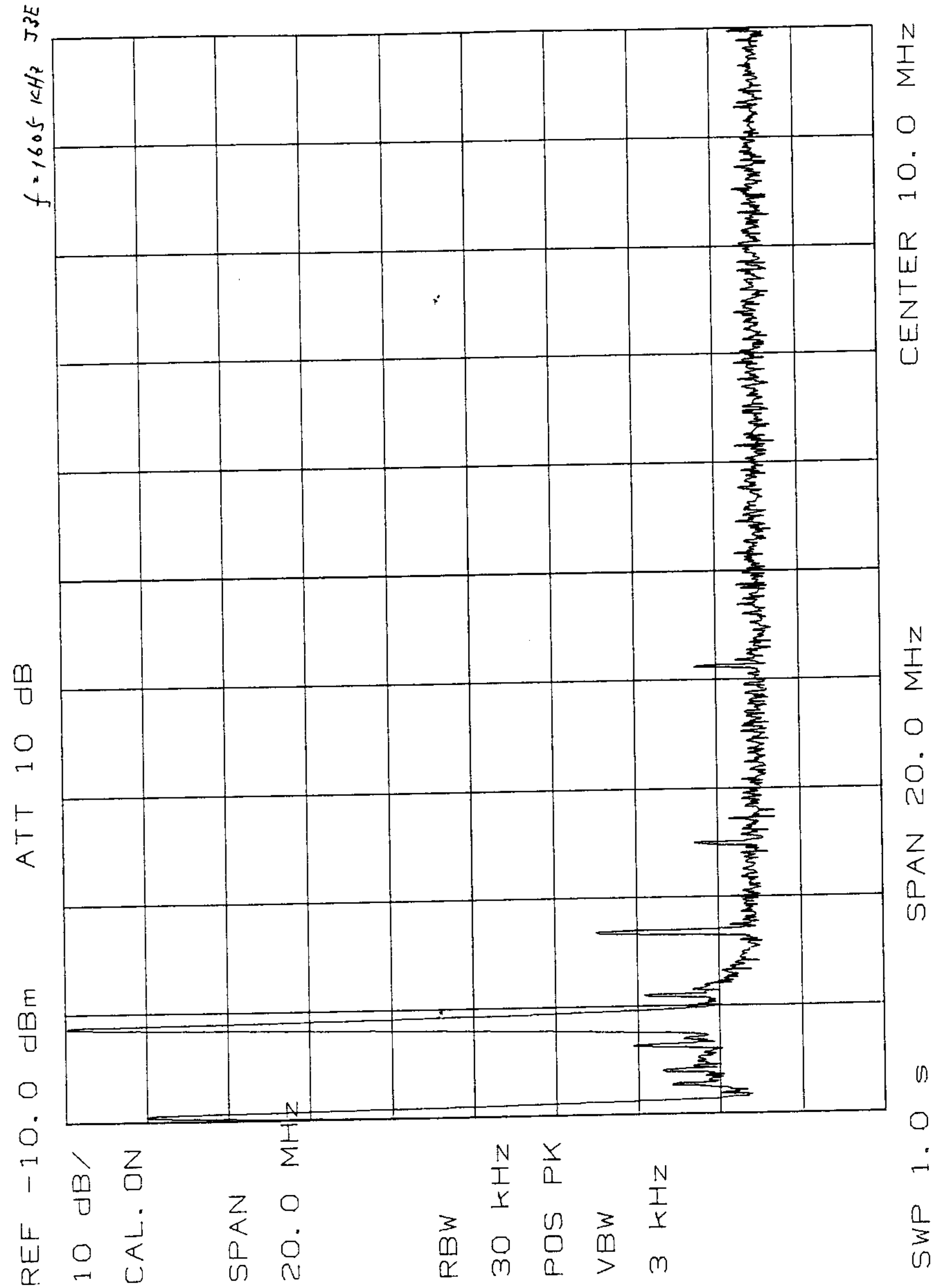
f = 1605 kHz J3E
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
20.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 1.0 s
SPAN 20.0 MHz
CENTER 10.0 MHz

Fig. 7.2

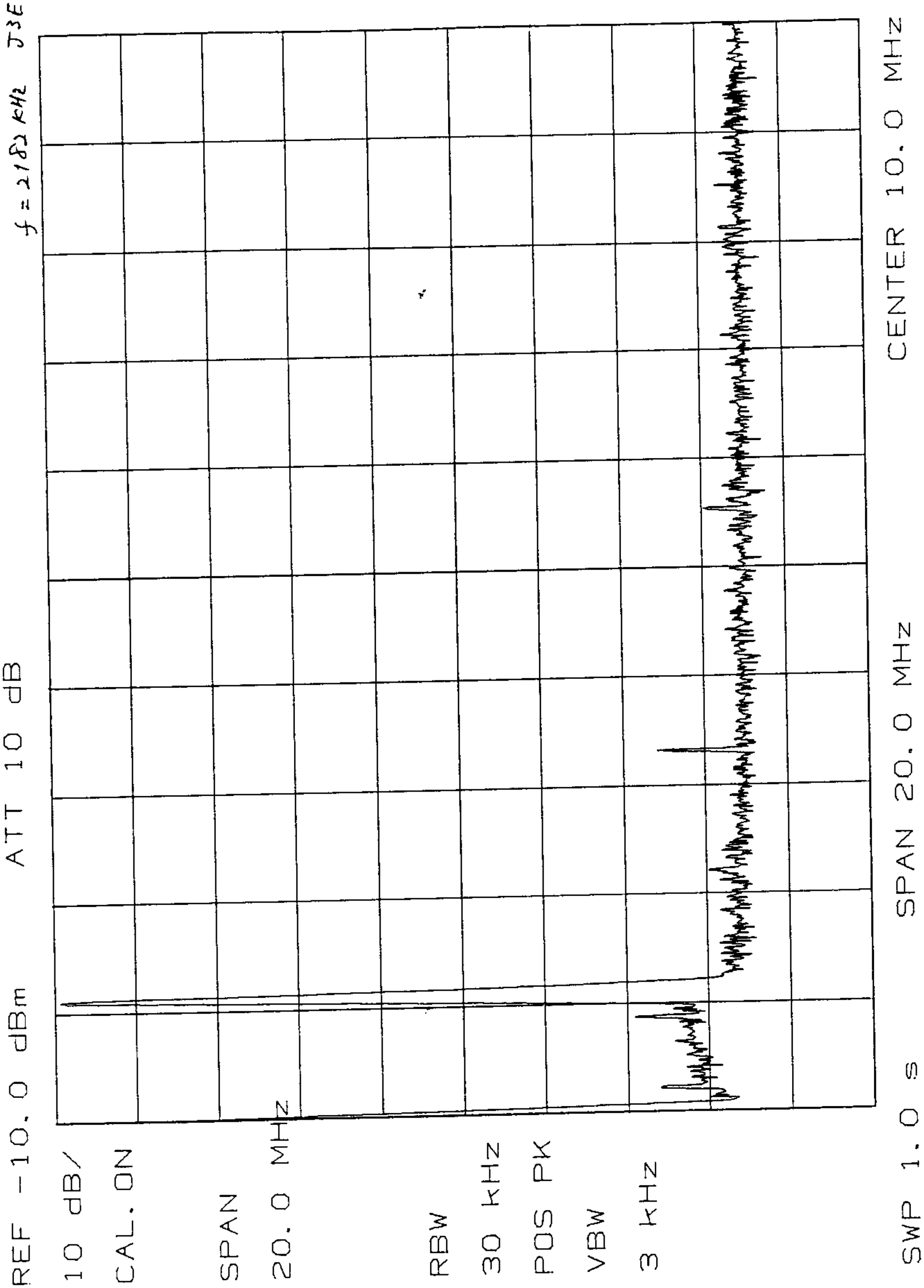
f = 2182 kHz J3E
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
20.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 1.0 s
SPAN 20.0 MHz
CENTER 10.0 MHz

Fig. 7.3

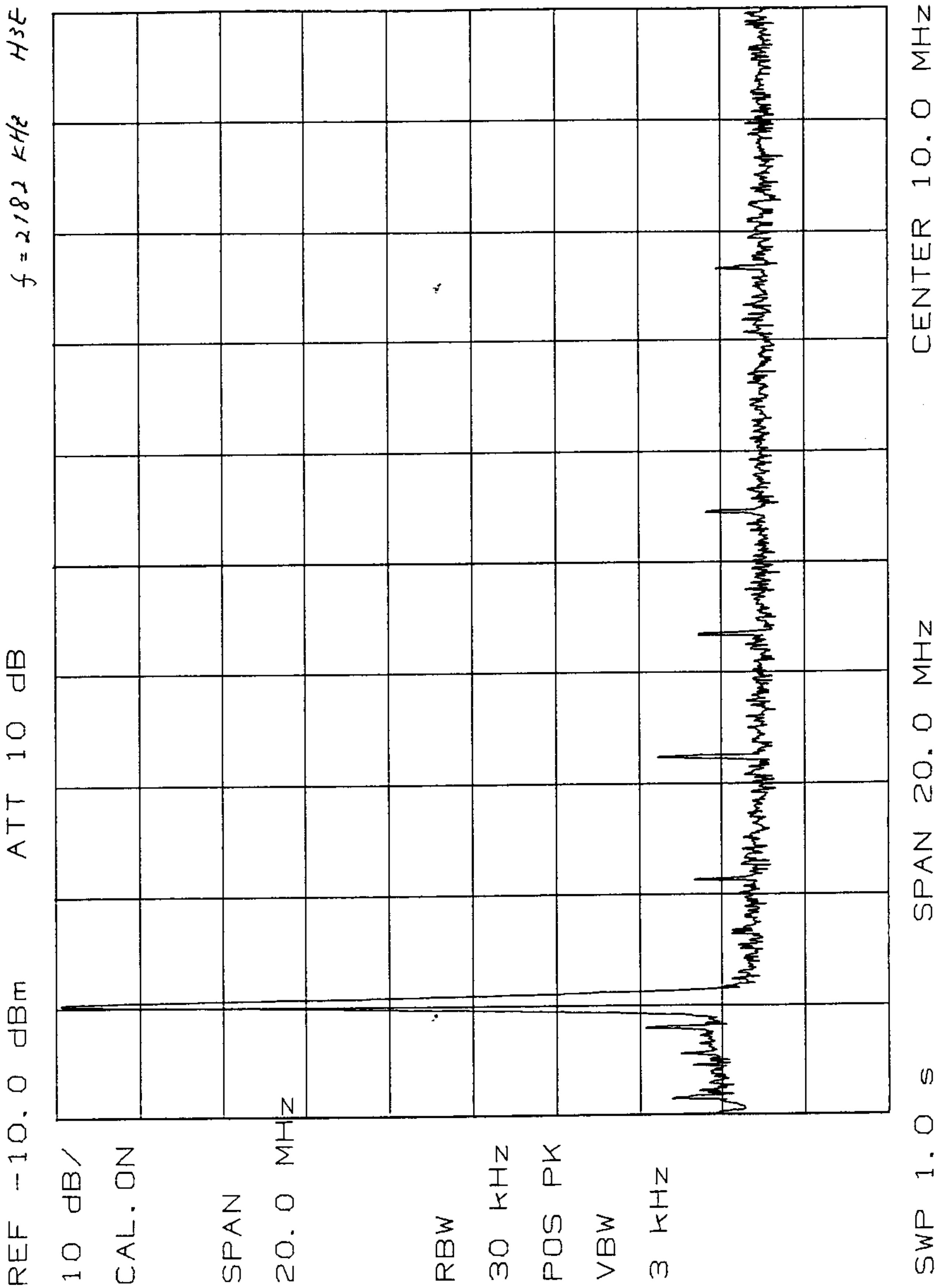
REF -10.0 dBm
ATT 10 dB
f = 2182 kHz
H3E
10 dB/
CAL. ON
SPAN
20.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 1.0 s
SPAN 20.0 MHz
CENTER 10.0 MHz

Fig. 7.4

Pub. No.: TI-1681

Date: May. 1998

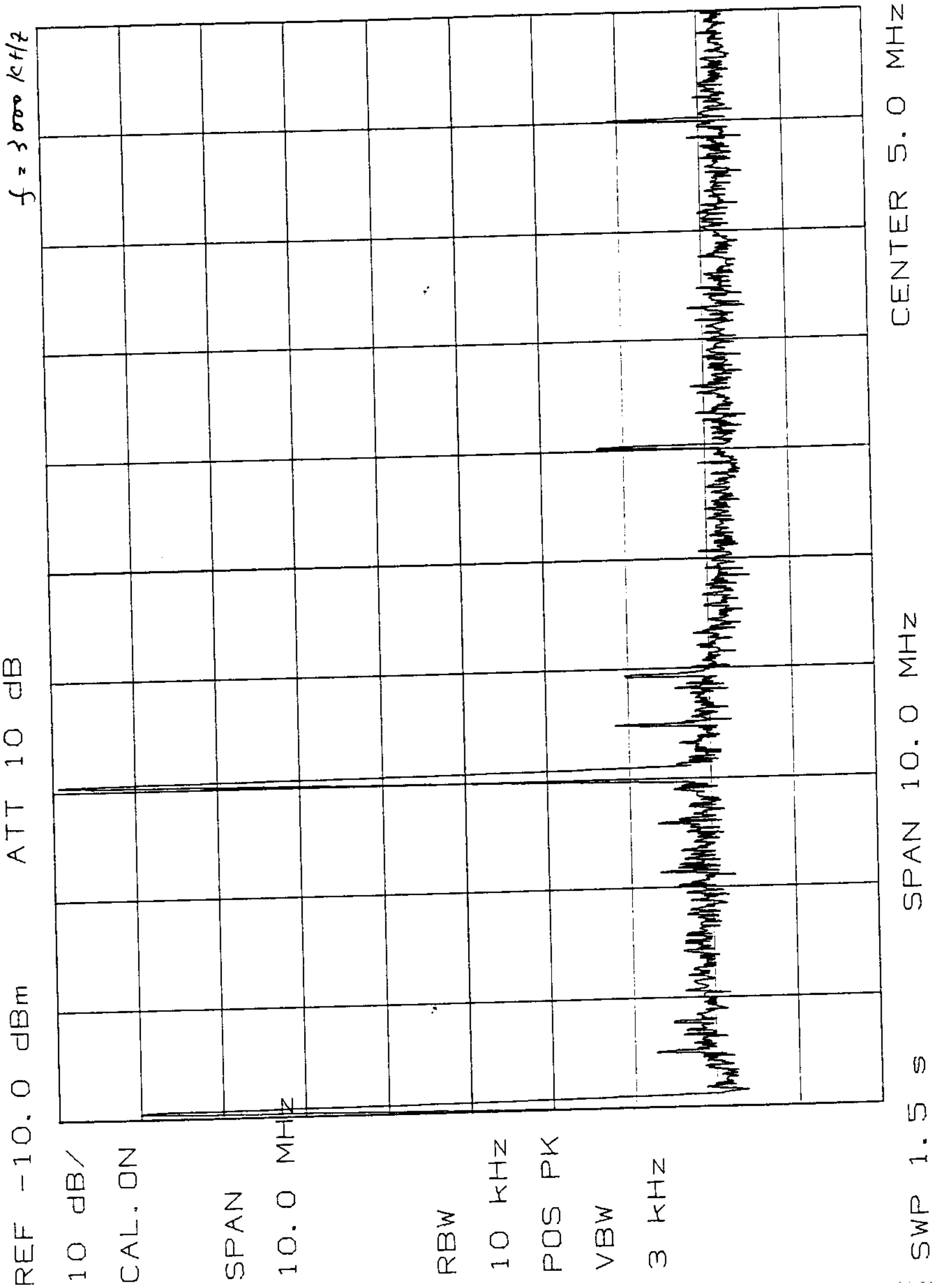

Fig. 7.5

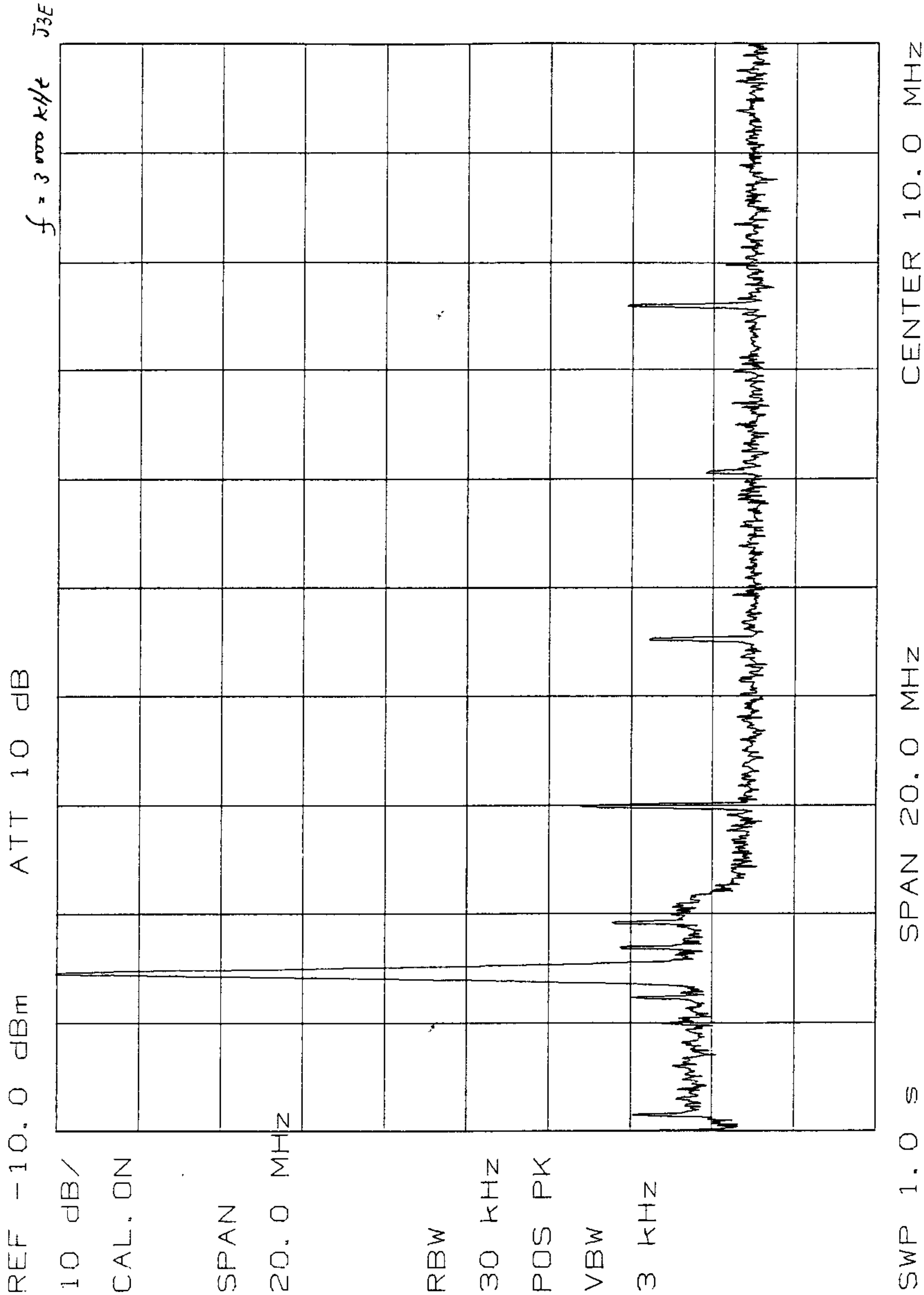
J3E
f = 3000 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
20.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 1.0 s
SPAN 20.0 MHz
CENTER 10.0 MHz

Fig. 7.6

Pub. No. : TI- 1681

Date : May. 1998

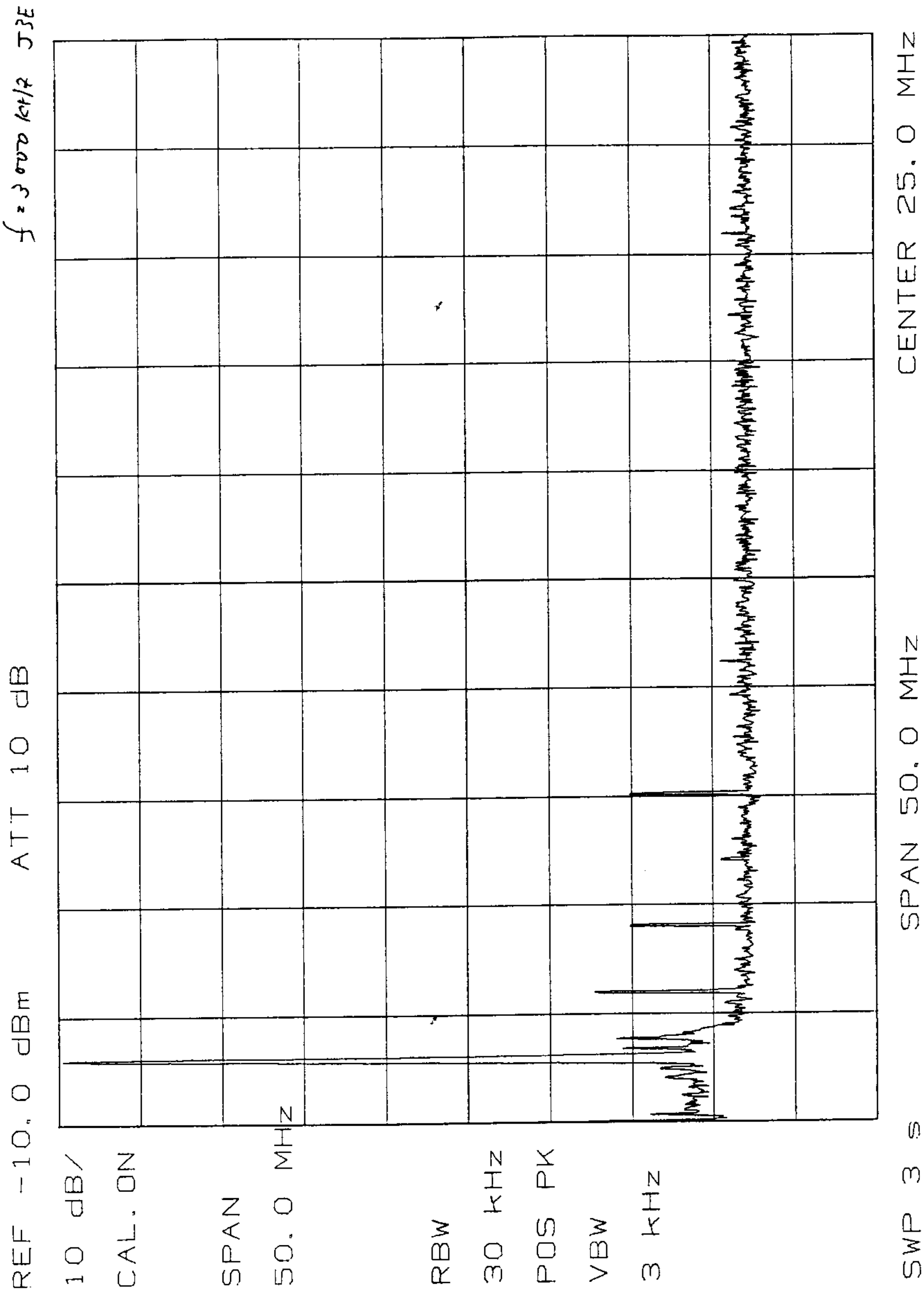

Fig. 7. 7

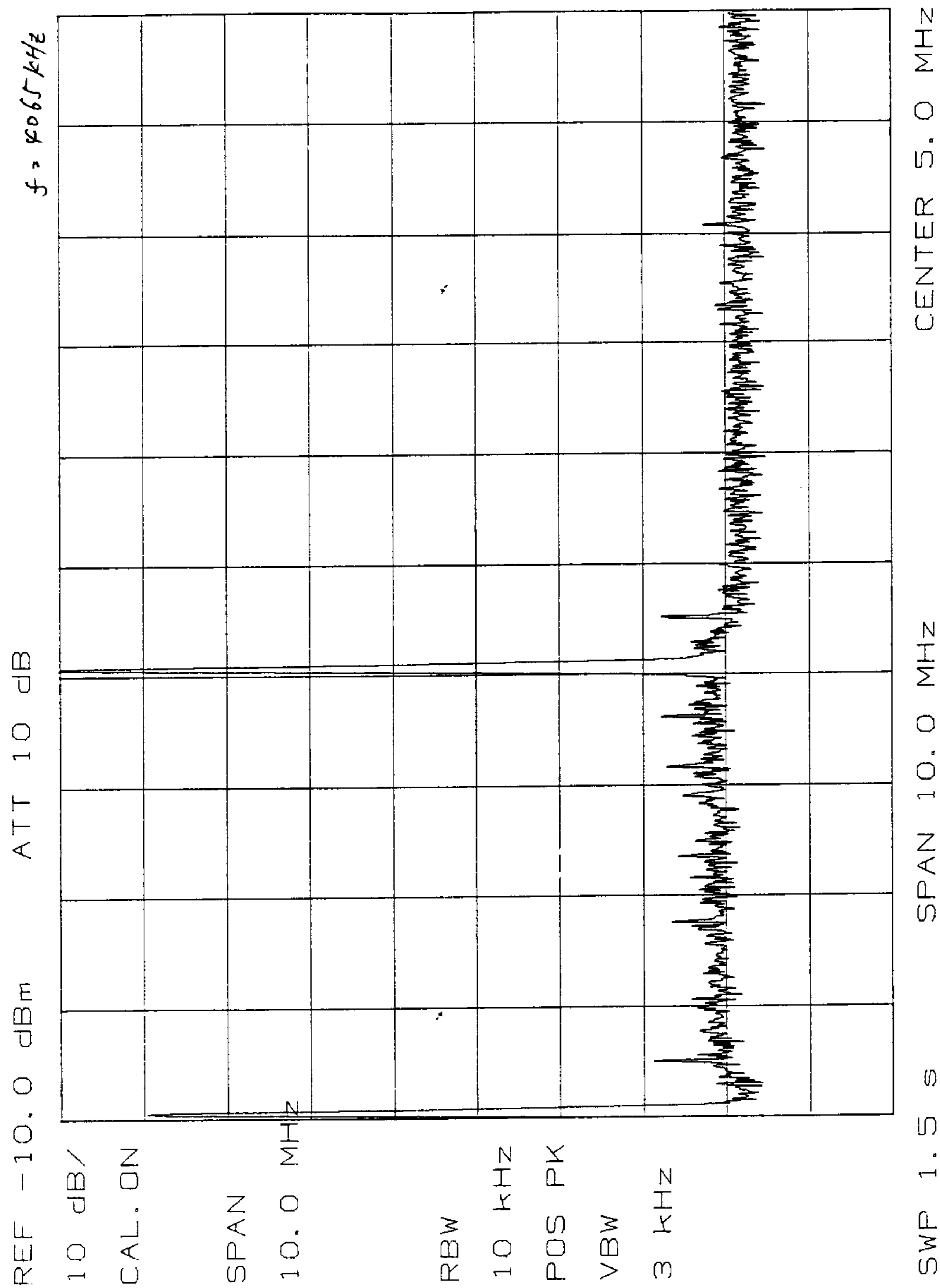
f = 4065 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
10.0 MHz
RBW
10 kHz
POS PK
VBW
3 kHz
SWP 1.5 s
SPAN 10.0 MHz
CENTER 5.0 MHz

Fig. 7.8

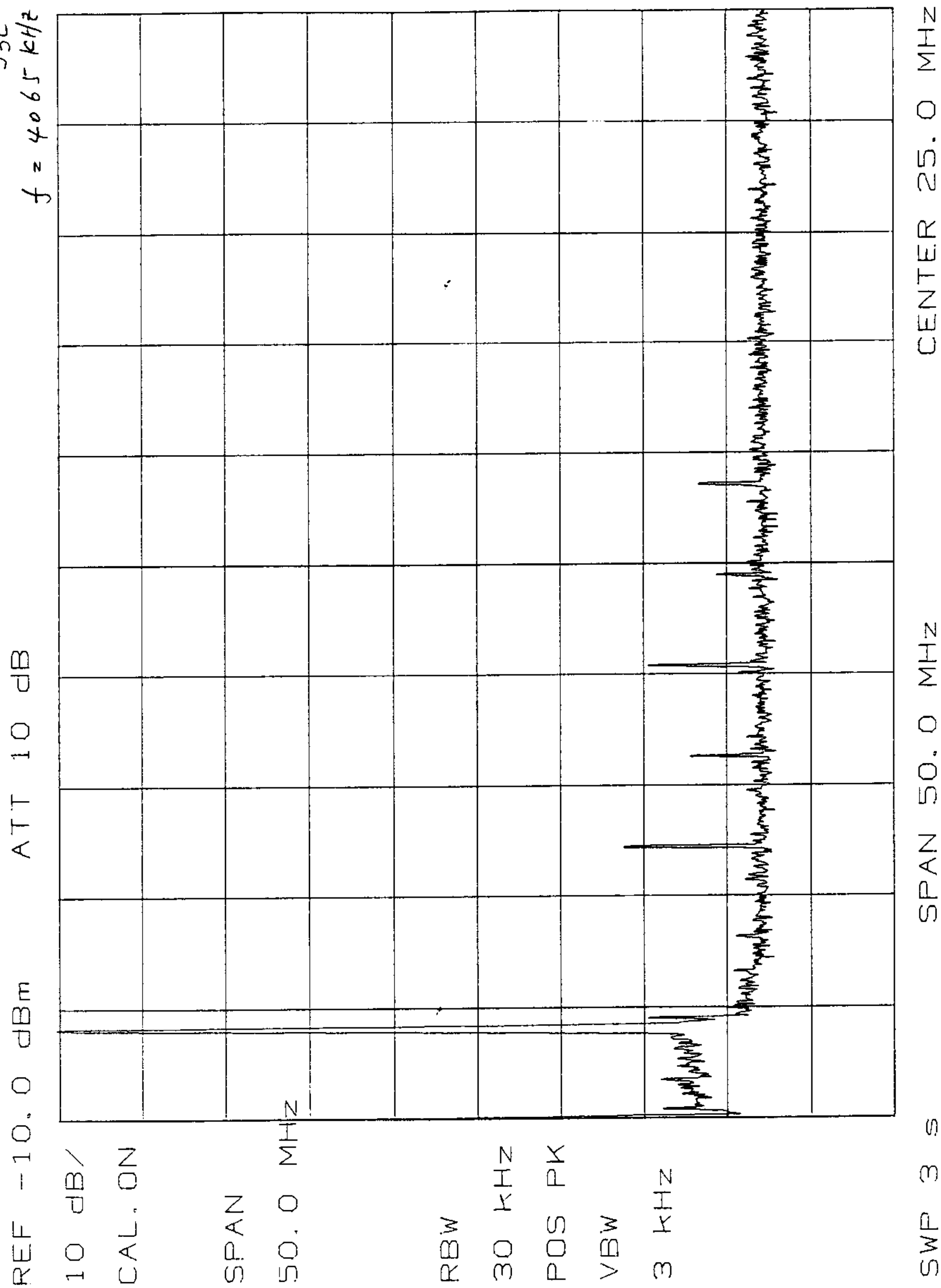
f = 4065 kHz
J3E
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
50.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 3 s
SPAN 50.0 MHz
CENTER 25.0 MHz

Fig. 7.9

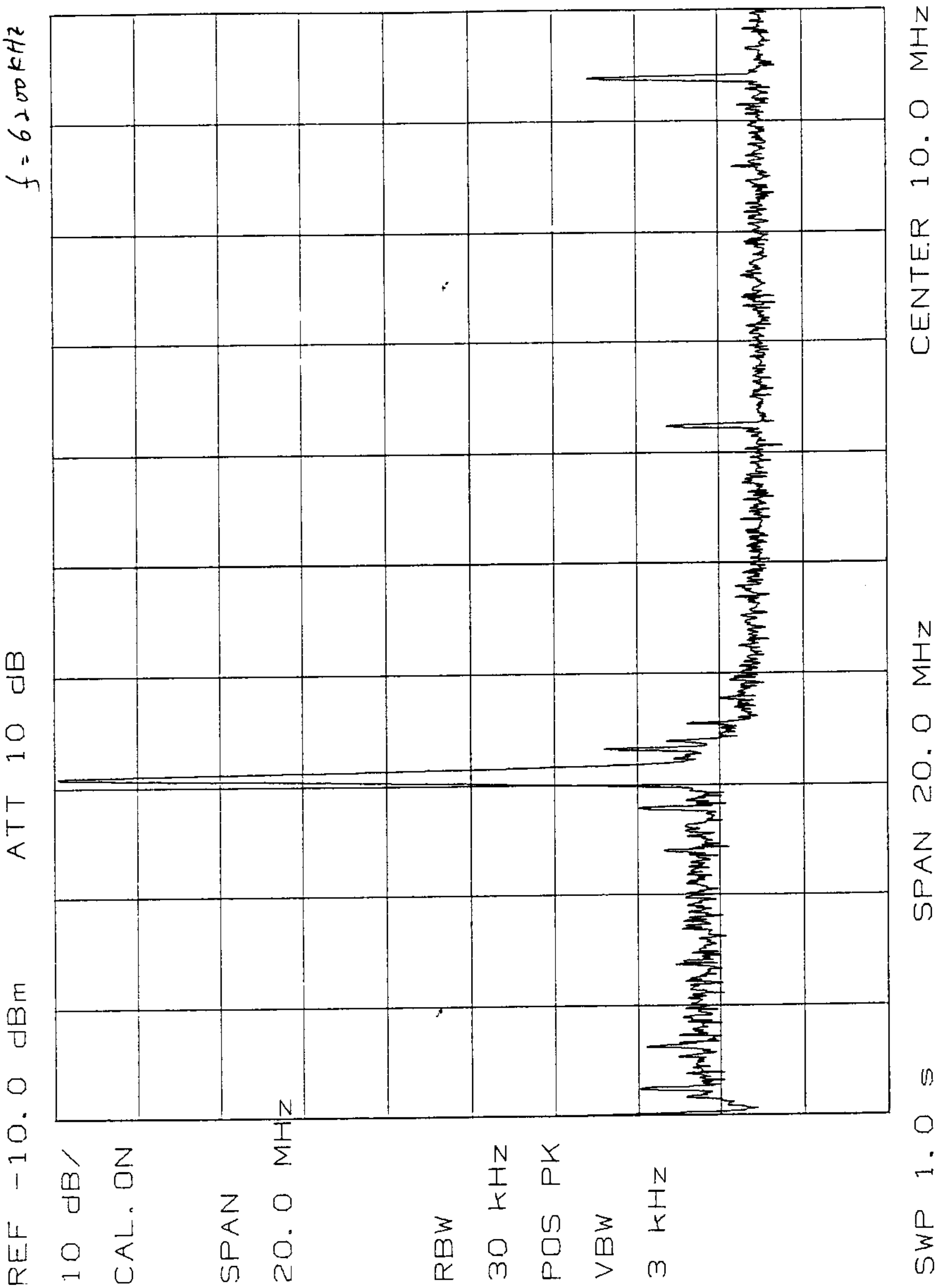
f = 6200 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
20.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
CENTER 10.0 MHz
SPAN 20.0 MHz
SWP 1.0 s

Fig. 7.10

Pub. No.: TI-1681

Date: May, 1998

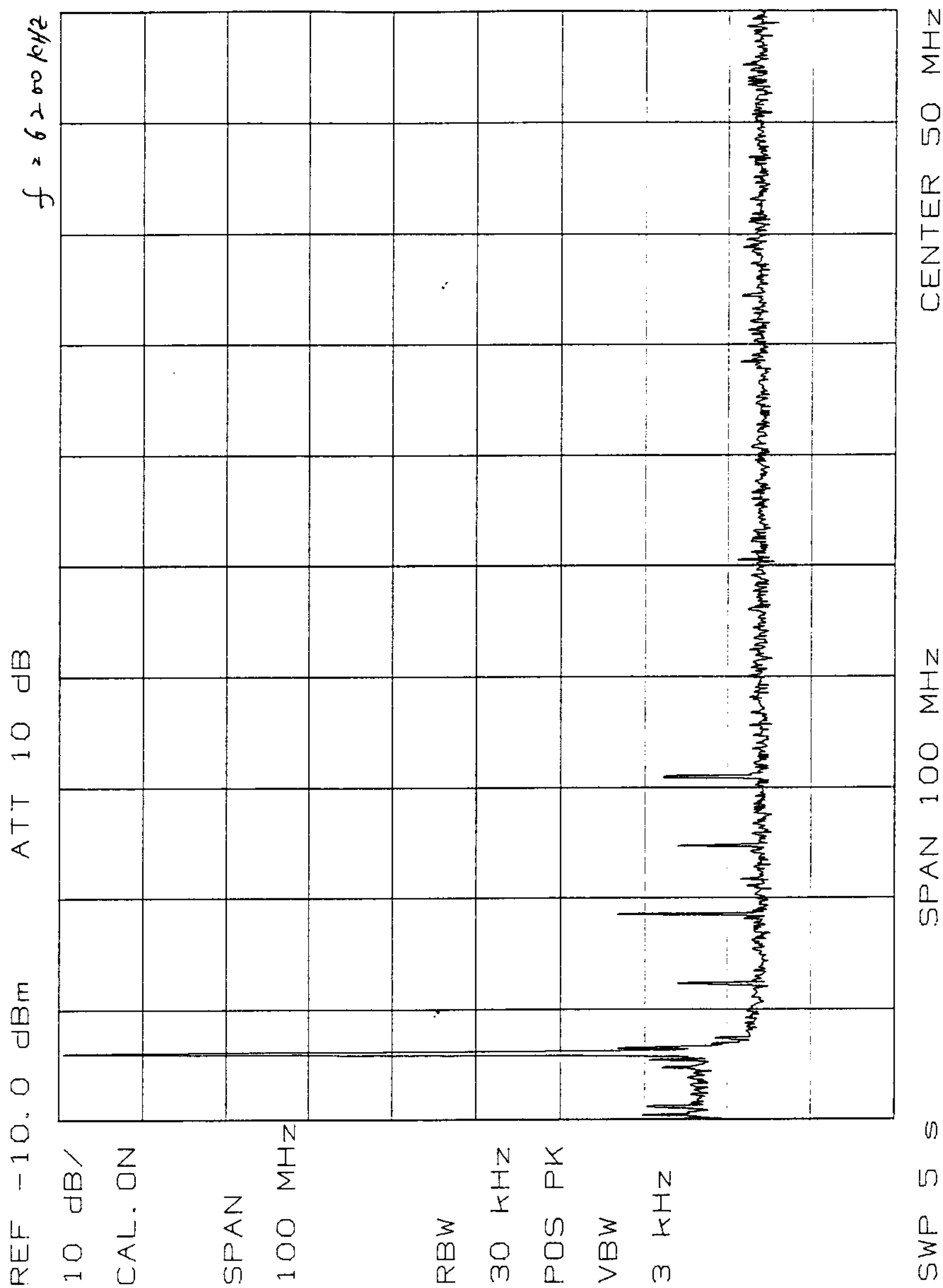

Fig. 7.11

Pub. No. : TI- 1681

Date : May. 1998

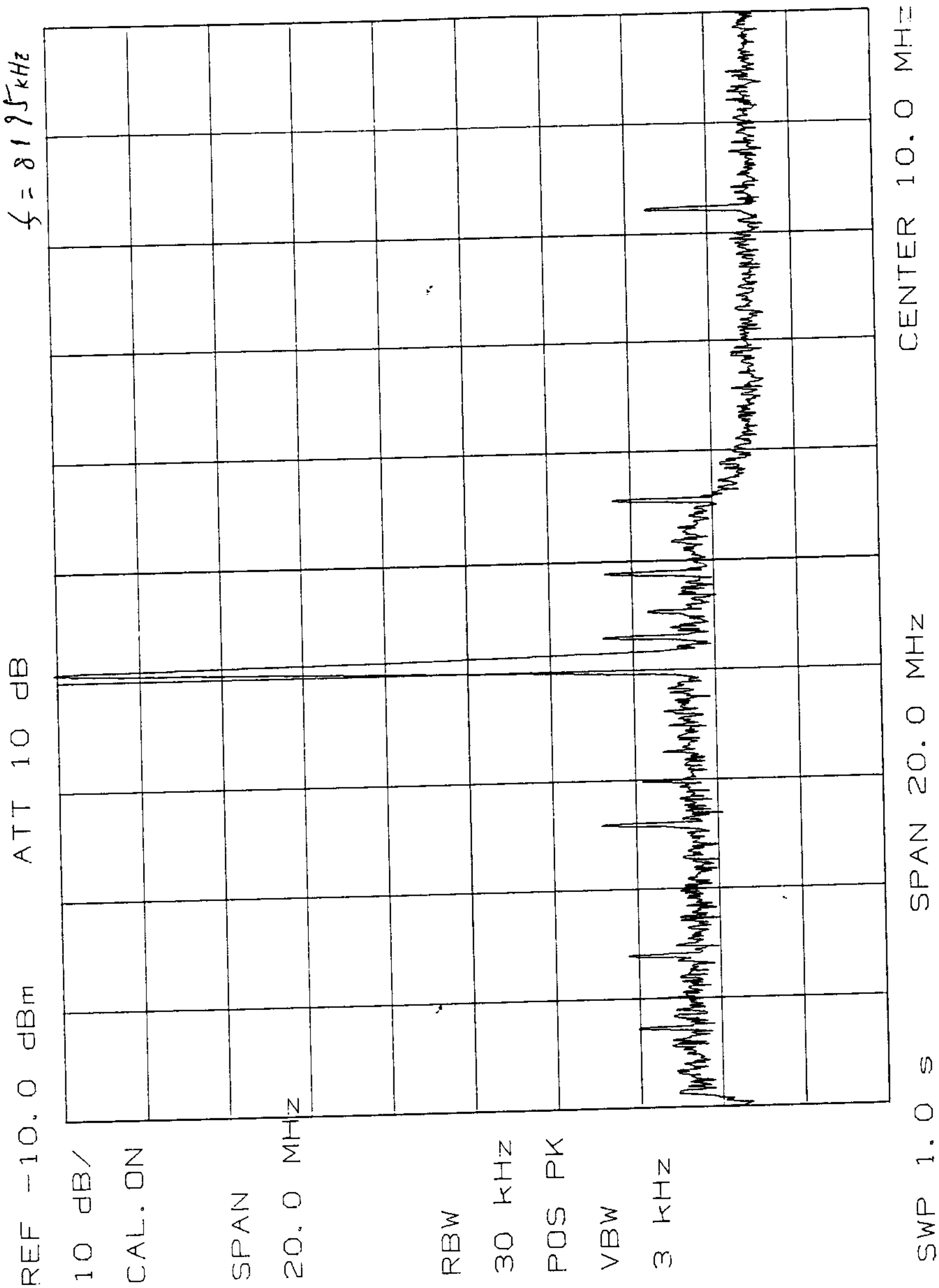

Fig. 7.12

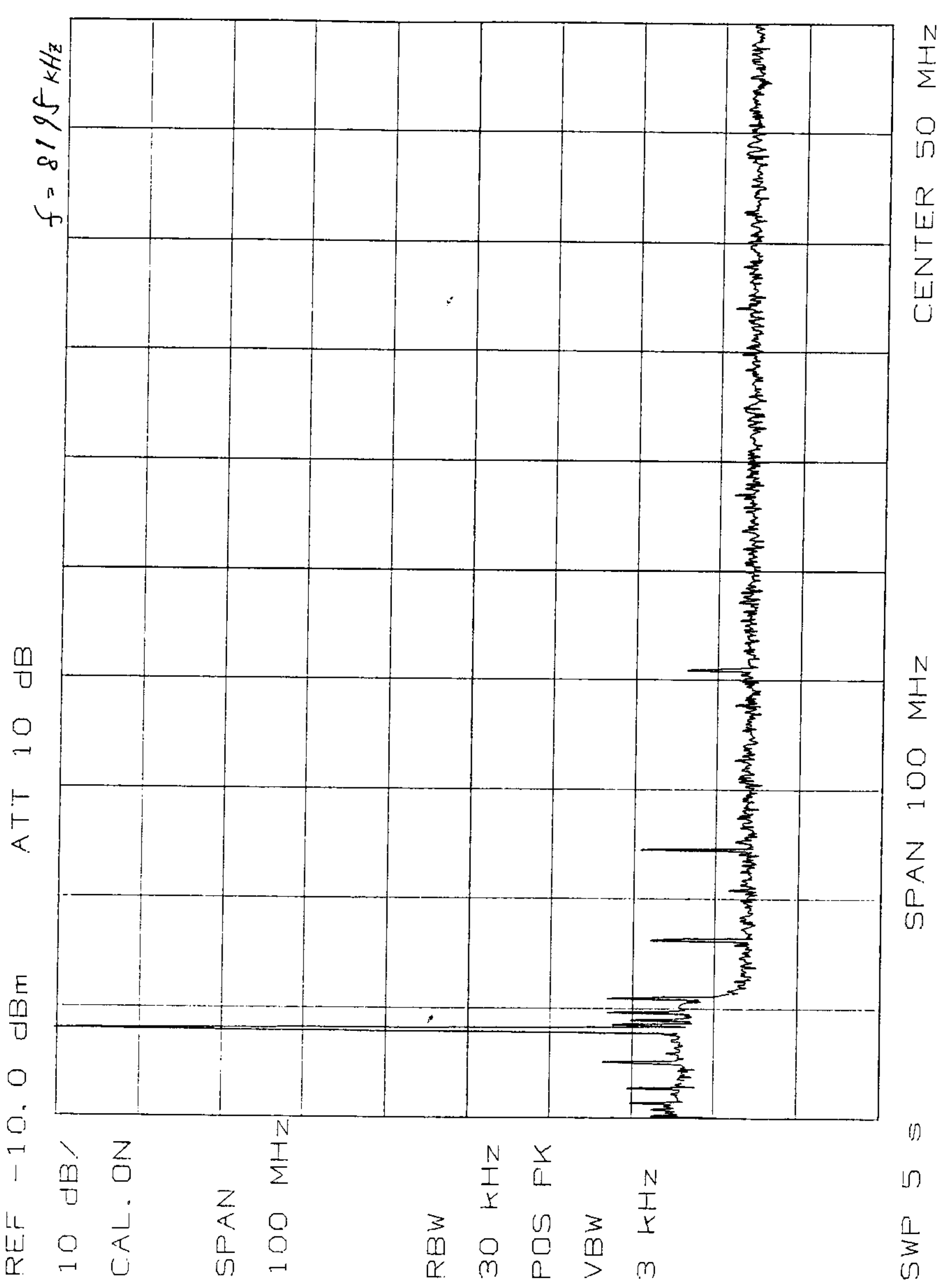
f = 8195 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
100 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 5 s
CENTER 50 MHz
SPAN 100 MHz

Fig. 7.13

Pub. No. : TI- 1681

Date : May, 1998

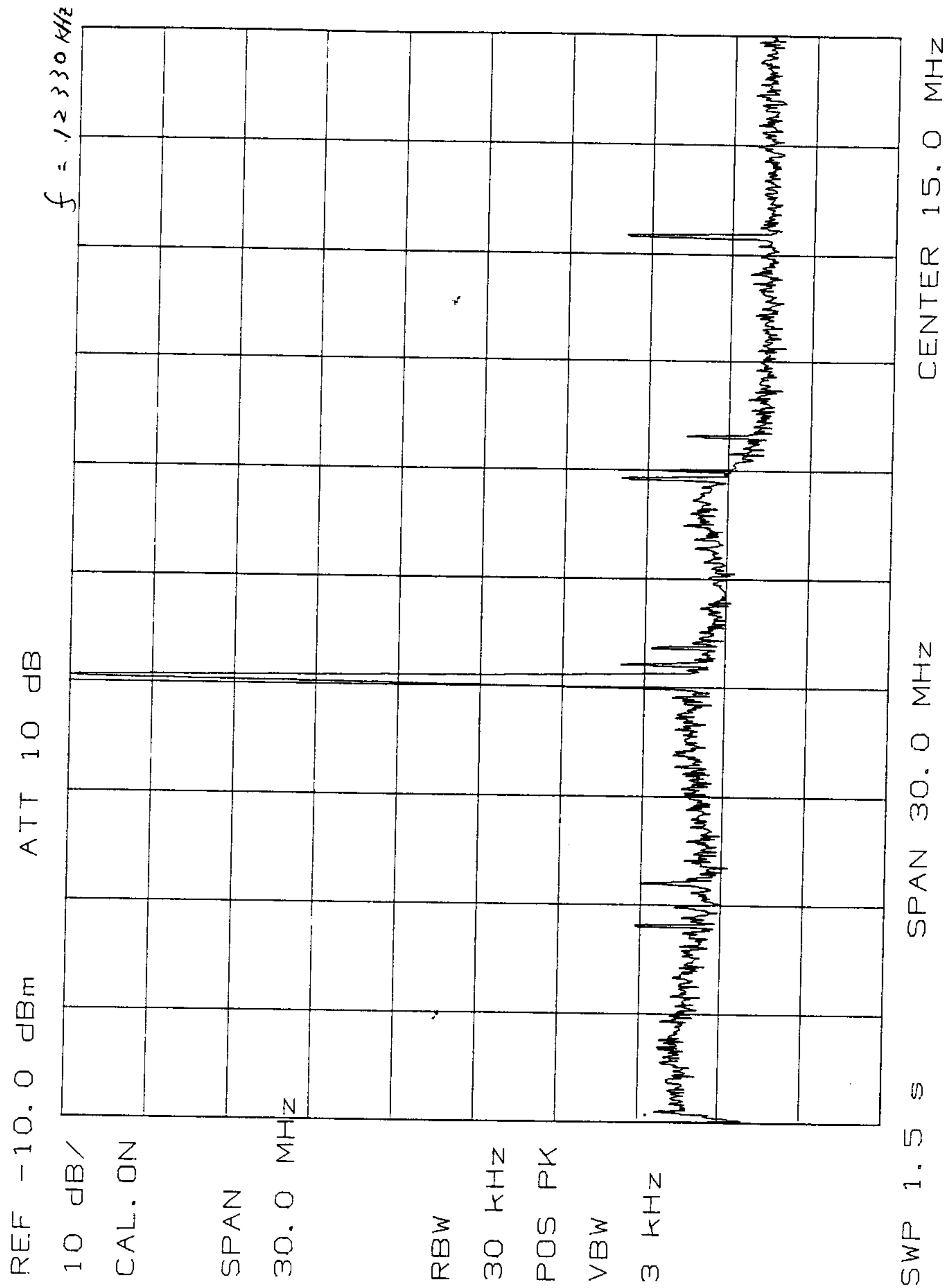

Fig. 7.14

Pub. No. : TI- 1681

Date : May, 1998

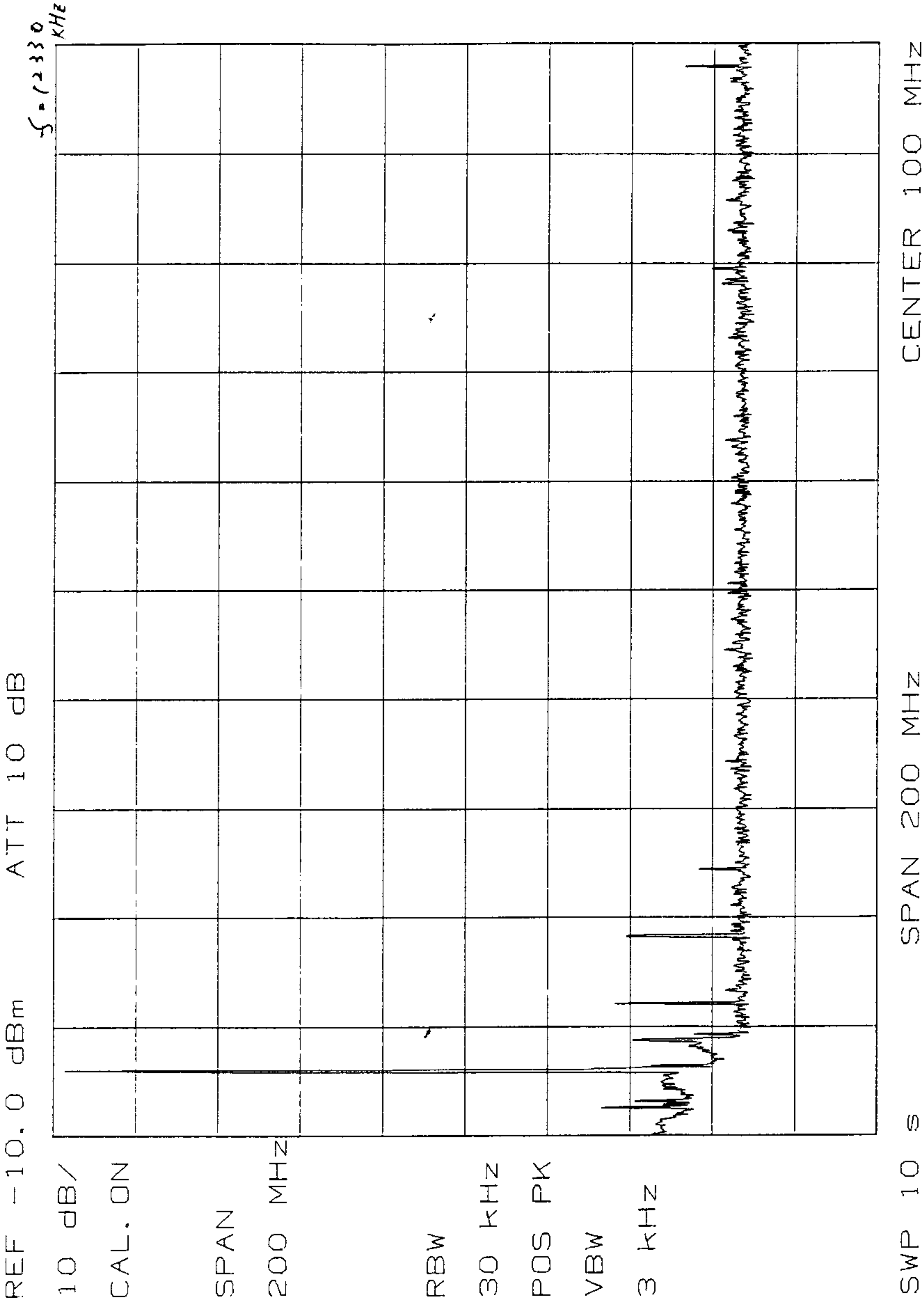

Fig. 7.15

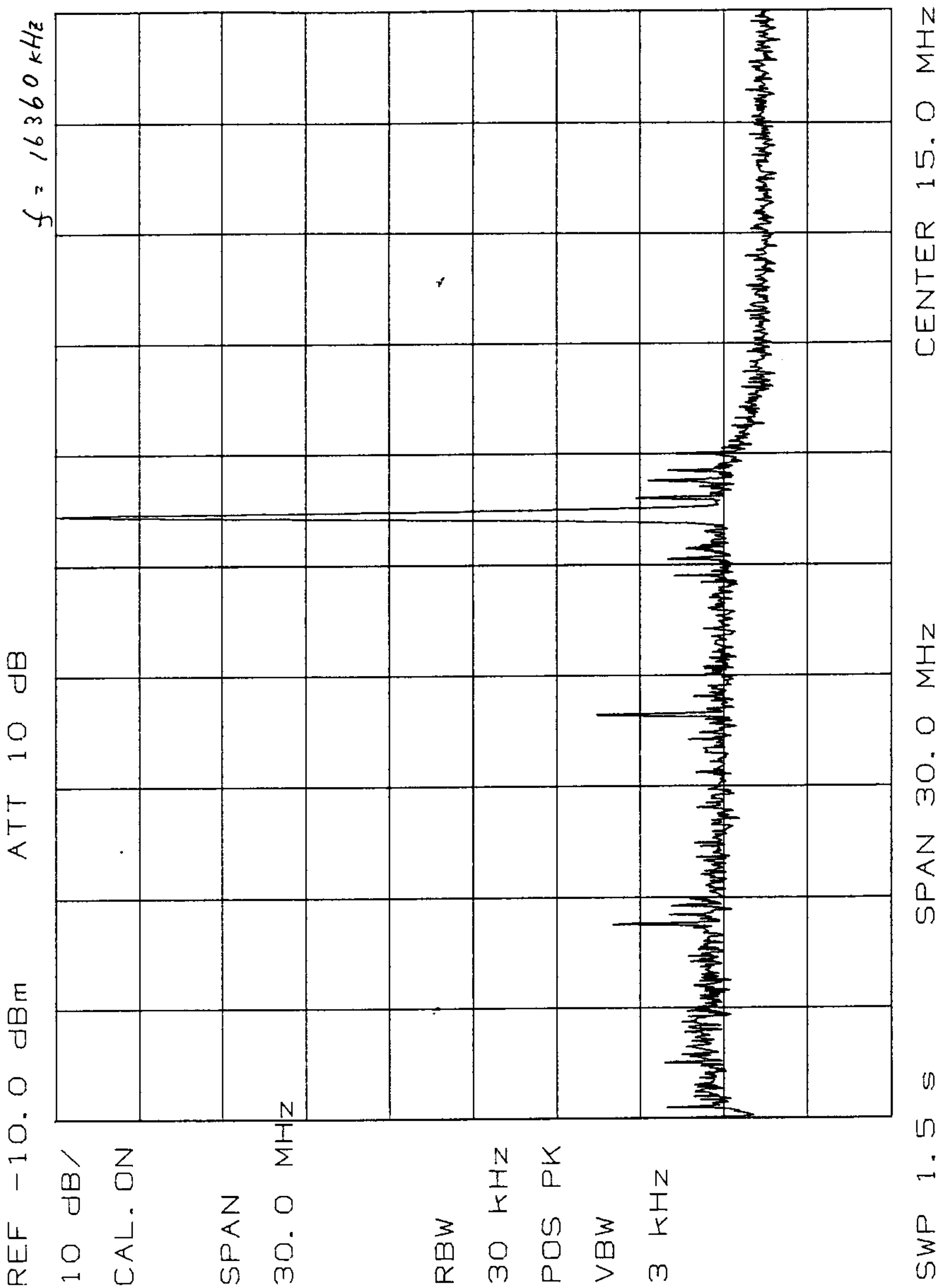
f = 16360 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
30.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
CENTER 15.0 MHz
SPAN 30.0 MHz
SWP 1.5 s

Fig. 7.16

Pub. No.: TI-1681

Date: May, 1998

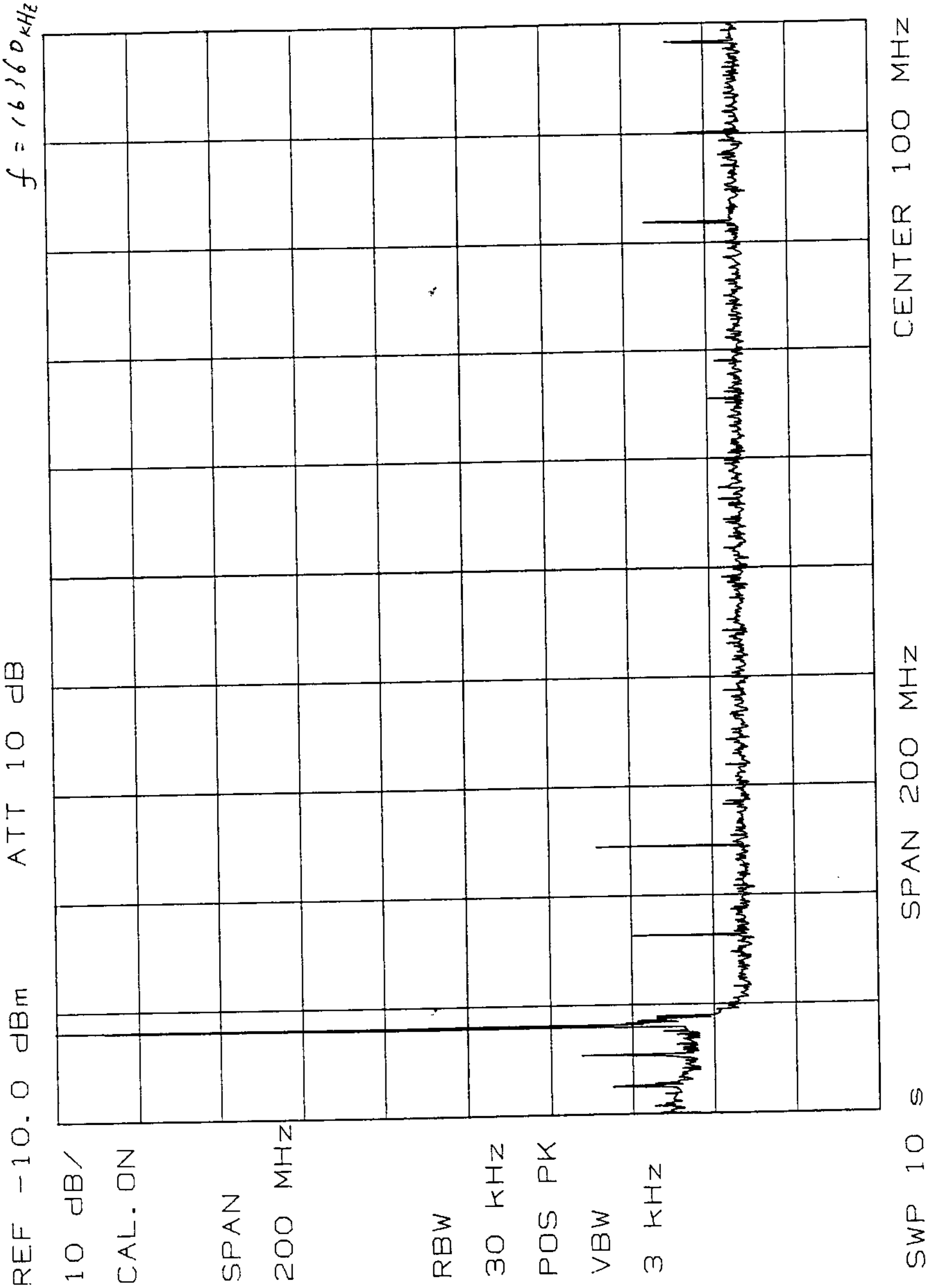

Fig. 7.17

Pub. No. : TI- 1681

Date : May. 1998

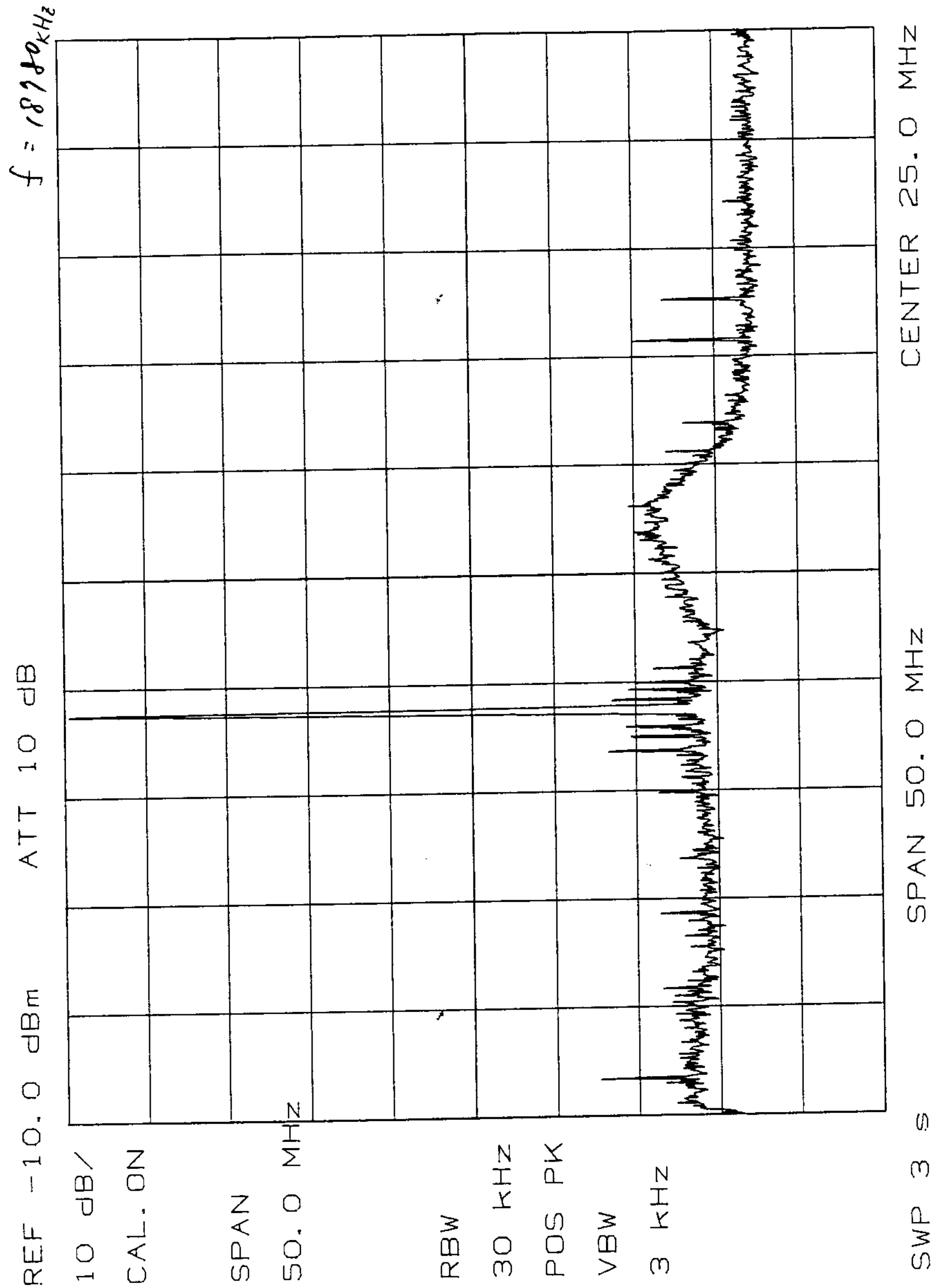

Fig. 7.18

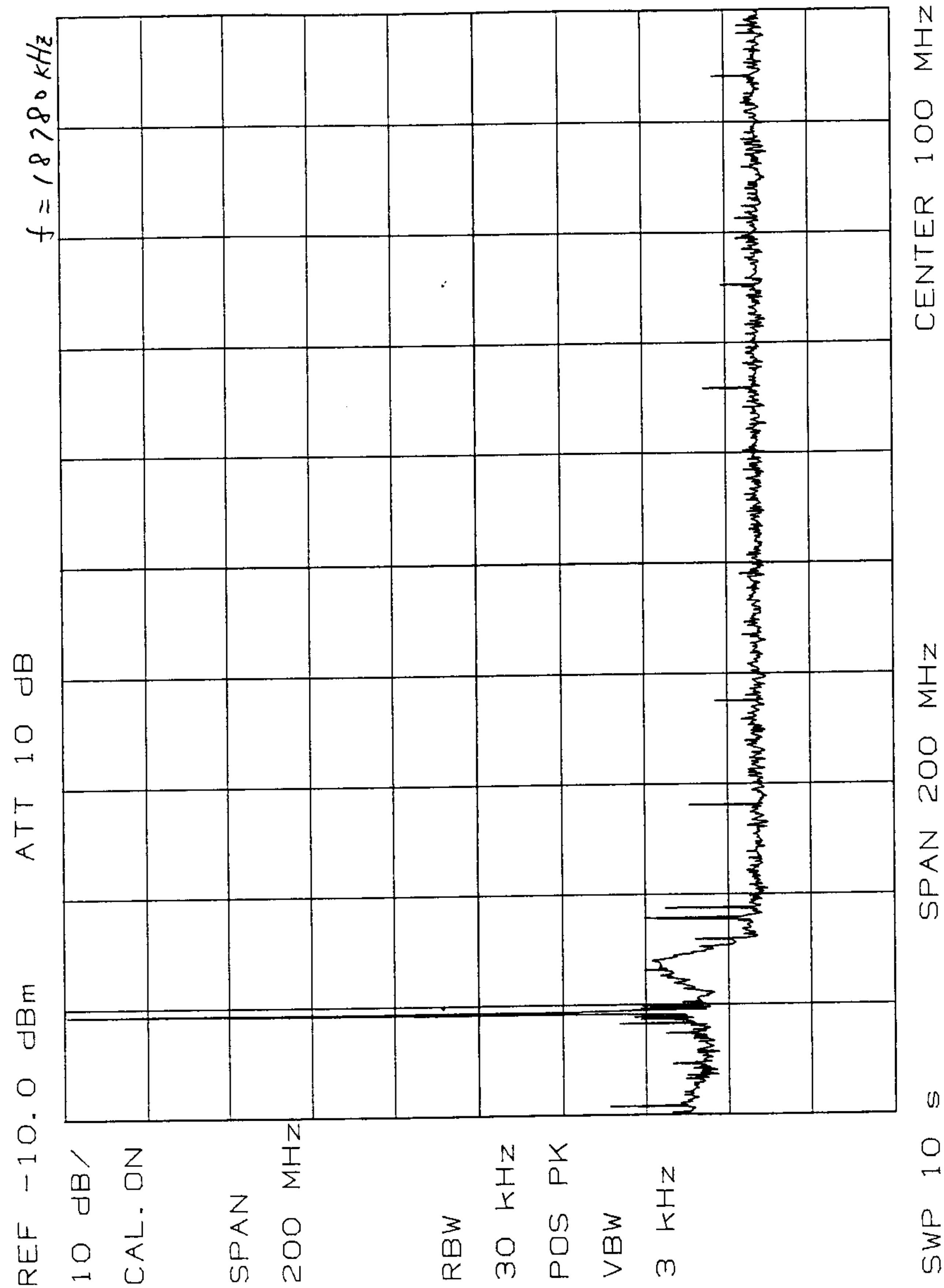
f = 18780 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
200 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
CENTER 100 MHz
SPAN 200 MHz
SWP 10 s

Fig. 7.19

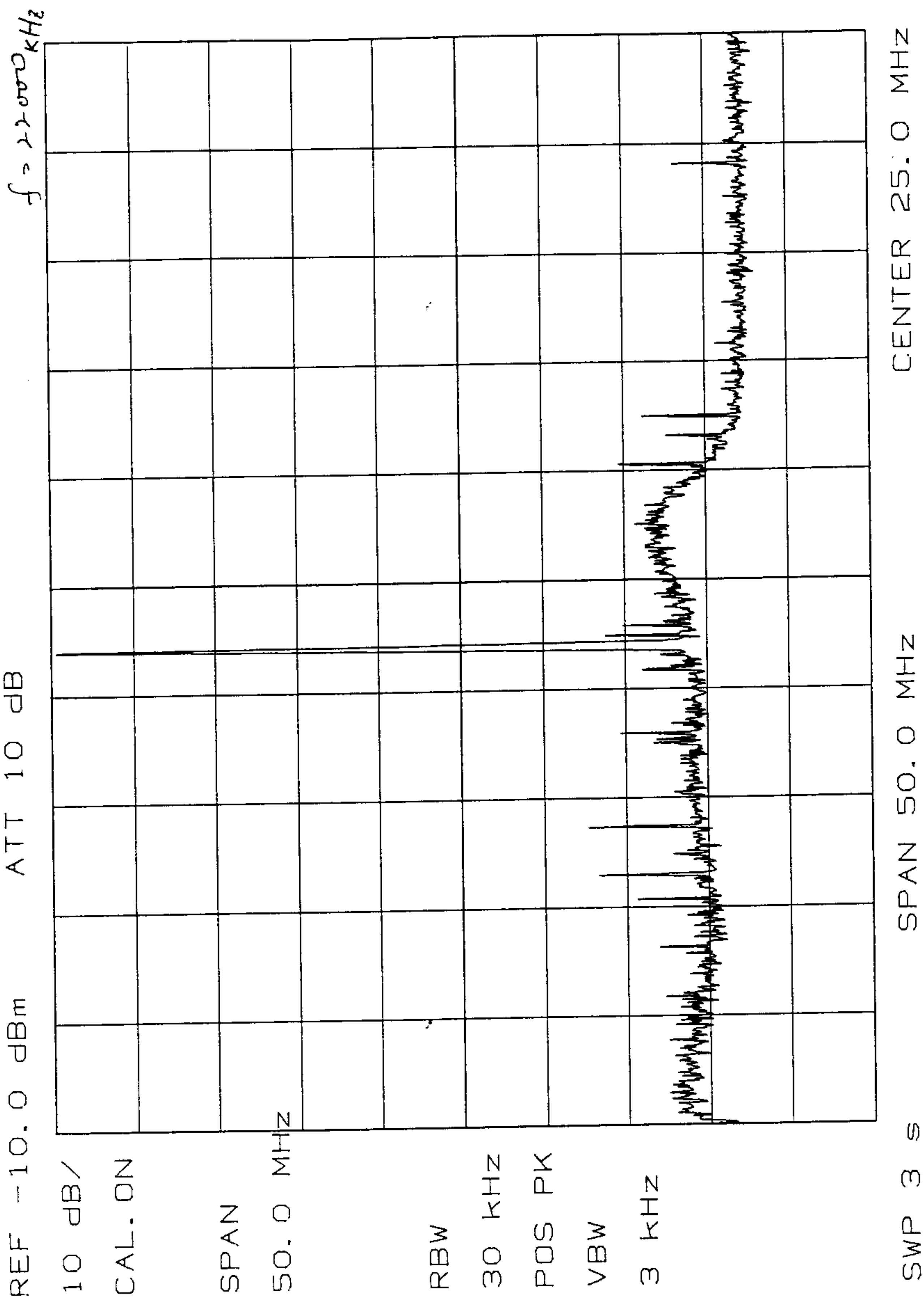
REF −10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
50.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 3 s
SPAN 50.0 MHz
CENTER 25.0 MHz

Fig. 7.20

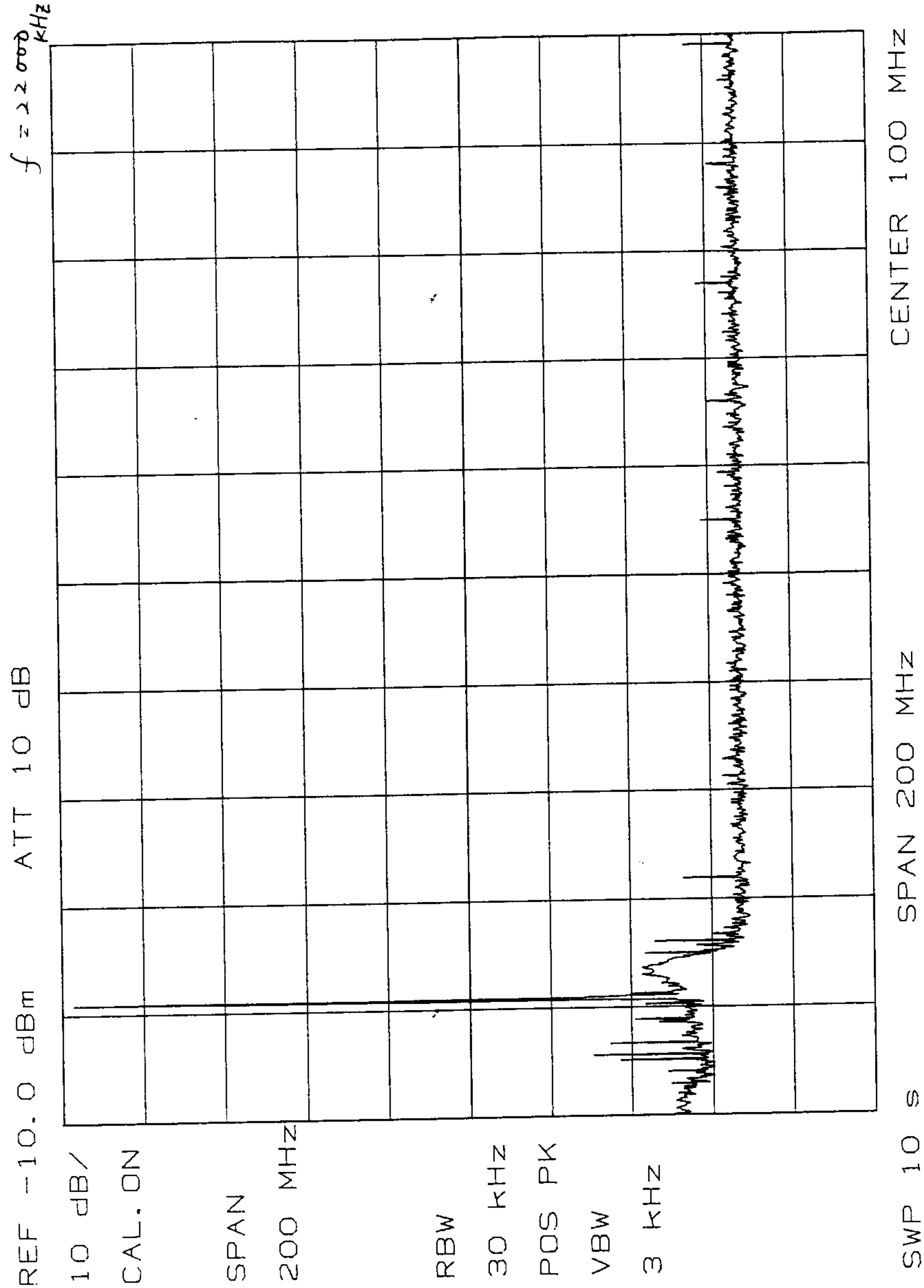
f = 22 000 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
200 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 10 s
SPAN 200 MHz
CENTER 100 MHz

Fig. 7.21

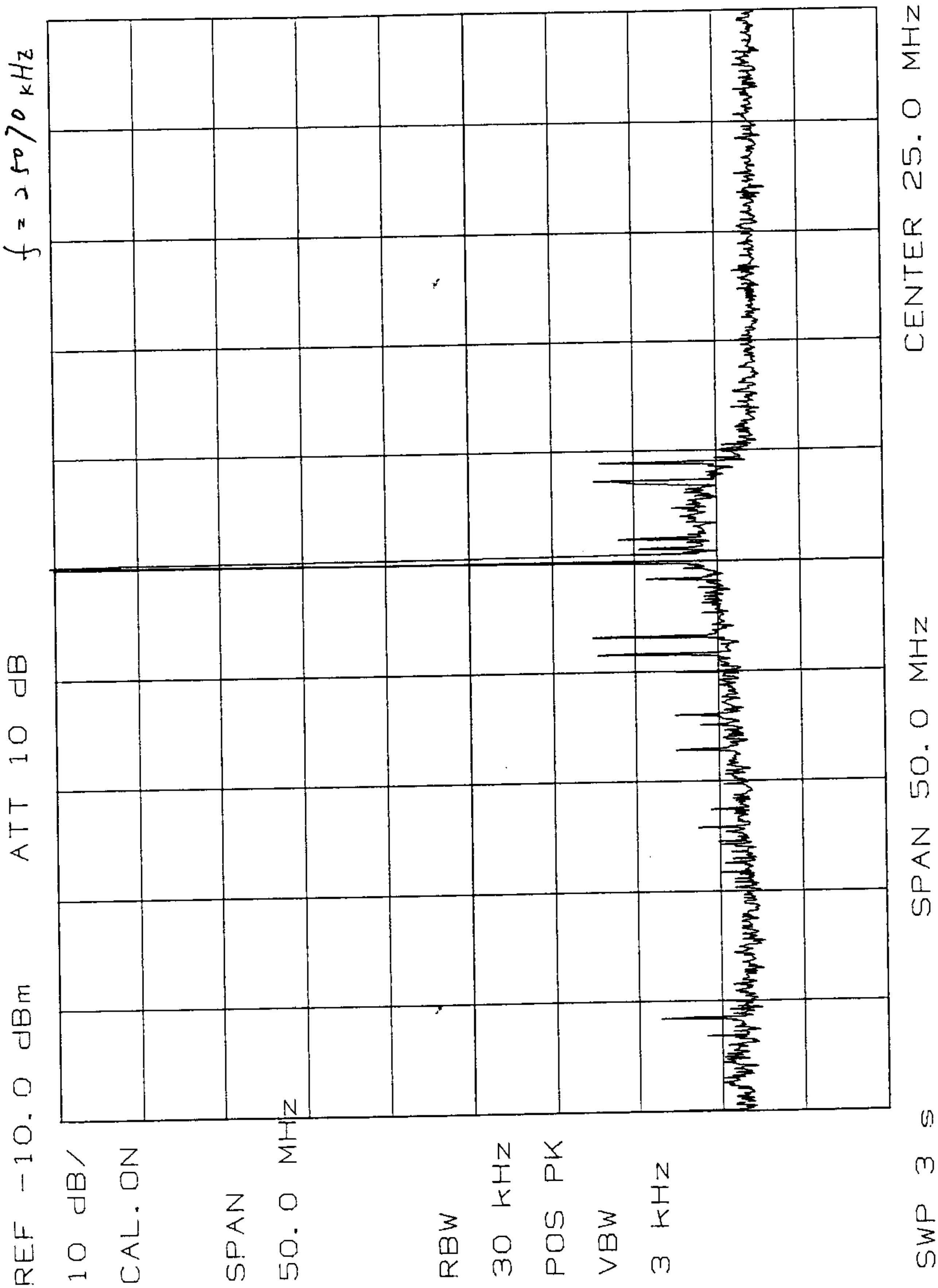
f = 2570 kHz
REF -10.0 dBm
ATT 10 dB
10 dB/
CAL. ON
SPAN
50.0 MHz
RBW
30 kHz
POS PK
VBW
3 kHz
SWP 3 s
CENTER 25.0 MHz
SPAN 50.0 MHz

Fig. 7.22

Pub. No. : TI- 1681

Date : May, 1998

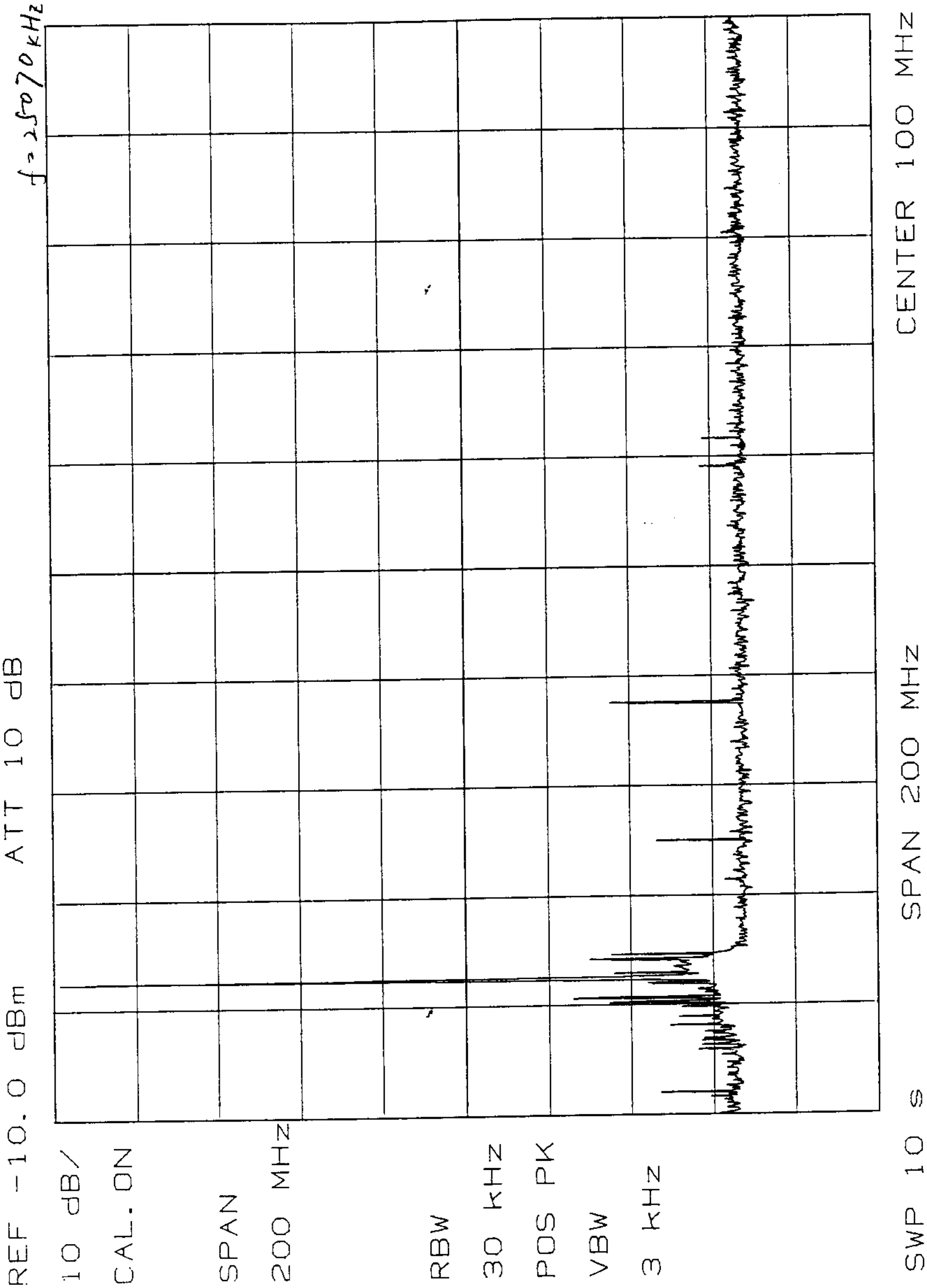

Fig. 7.23

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 Pt emitted from an isotropic antenna in free space is expressed:

$P = Pt/4R^2$ (W/m^2)

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,

$$E = (120\,P)^{1/2}$$
$$= (120\,Pt/4R^2)^{1/2}$$
$$= (30\,Pt)^{1/2}/R$$

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

$$E = \sqrt{30 \times 150}\,/10$$
$$= 6.7\ (V/m)$$

Put 1 μV/m = 0 dBμ
6.7 V/m = 134 dBμ (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 Fc, 456.5 kHz (Intermediate Frequency) and its harmonics, 54.4565 MHz (2nd LO frequency) and (54.4565 + Fc) 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.

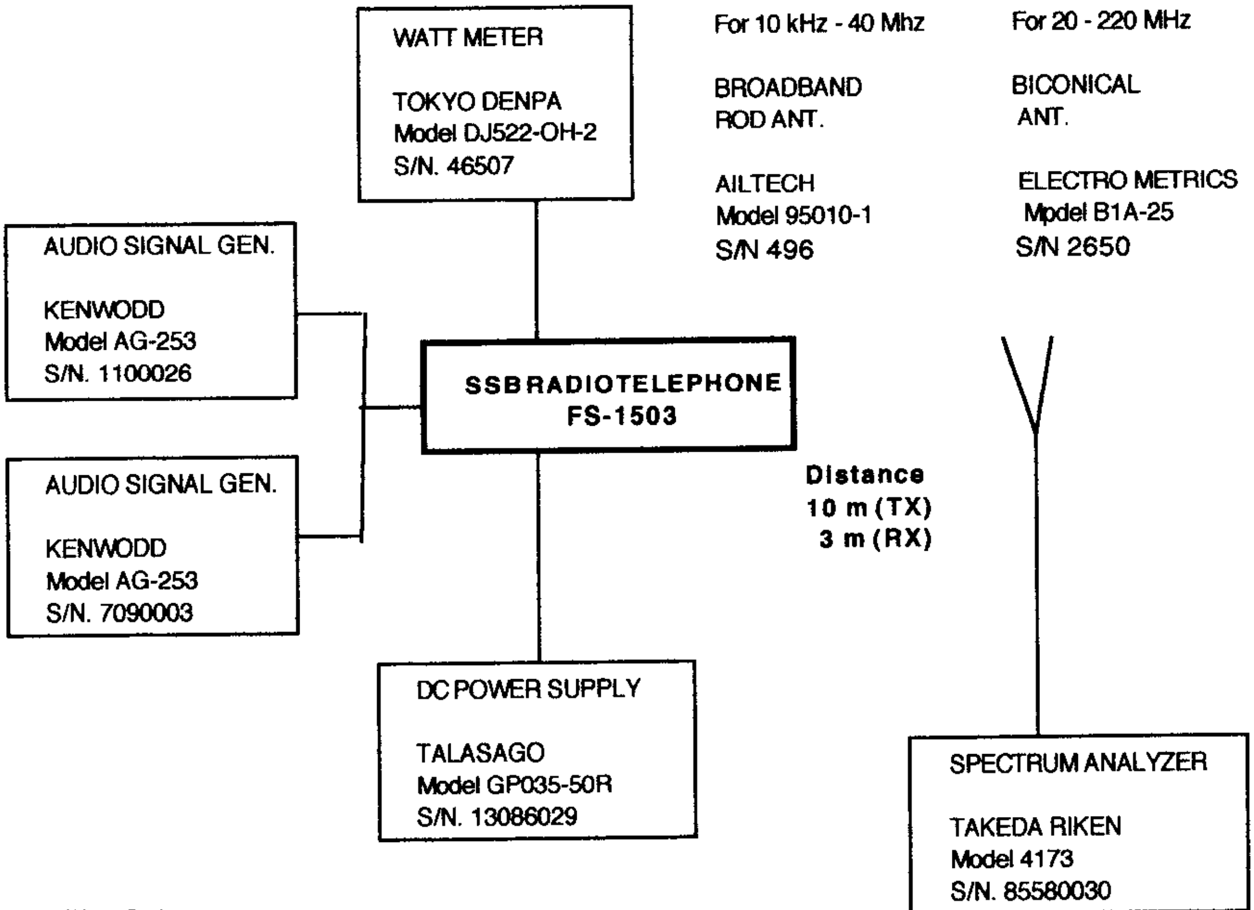

Fig. 8.1

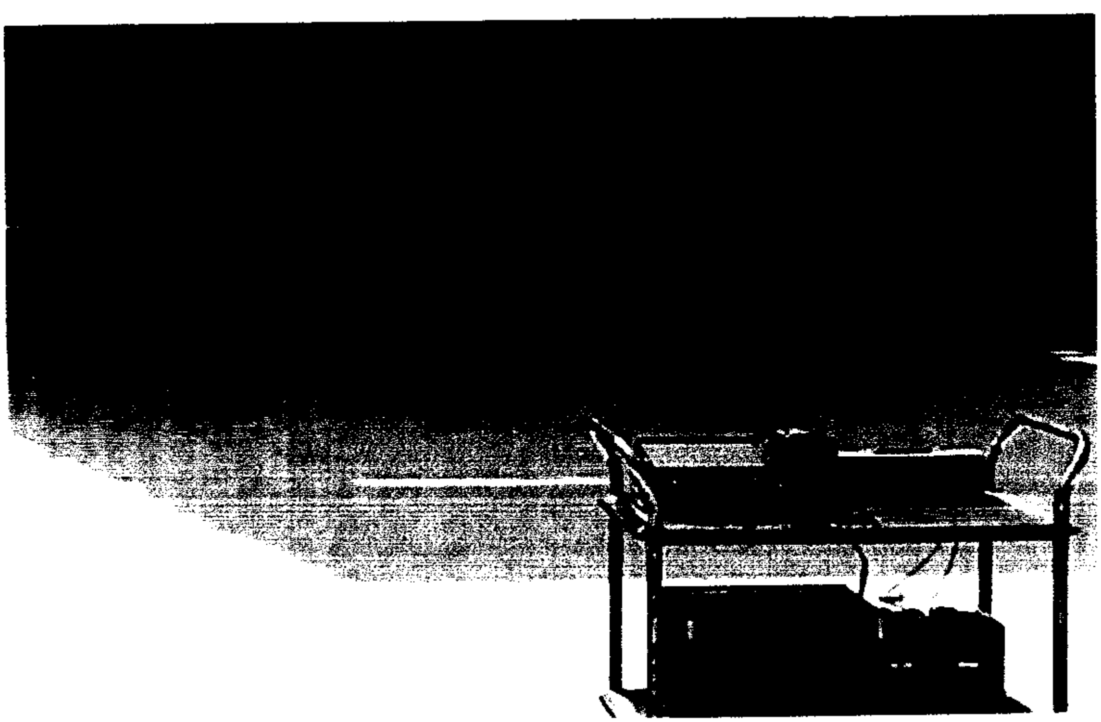

Photo showing the Test Site:
Roof of 6 story building as always done for Marine Radar Measurements

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×Fc		None detected to 120 dB
3×Fc		
4×Fc		
5×Fc		
6×Fc		
7×Fc		
8×Fc		
9×Fc		
10×Fc		
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 8.2

Fc: 2182.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc		None detected to 120 dB
3×Fc		
4×Fc		
5×Fc		
6×Fc		
7×Fc		
8×Fc		
9×Fc		
10×Fc		
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 8.3

Fc: 3023.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc		None detected to 120 dB
3×Fc		
4×Fc		
5×Fc		
6×Fc		
7×Fc		
8×Fc		
9×Fc		
10×Fc		
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×Fc		None detected to 120 dB
3×Fc		
4×Fc		
5×Fc		
6×Fc		
7×Fc		
8×Fc		
9×Fc		
10×Fc		
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×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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 8.6

Fc: 12230.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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 8.7

Fc: 16360.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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 8.8

Fc: 18780.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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 8.9

Fc: 22000.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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 8.10

Fc: 25070.0 kHz

Spurious Frequency		Cabinet Radiation below Reference Level
2×Fc, 3×Fc, 4×Fc, 5×Fc, 6×Fc, 7×Fc, 8×Fc, 9×Fc, and 10×Fc		None detected to 120 dB
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)	

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.

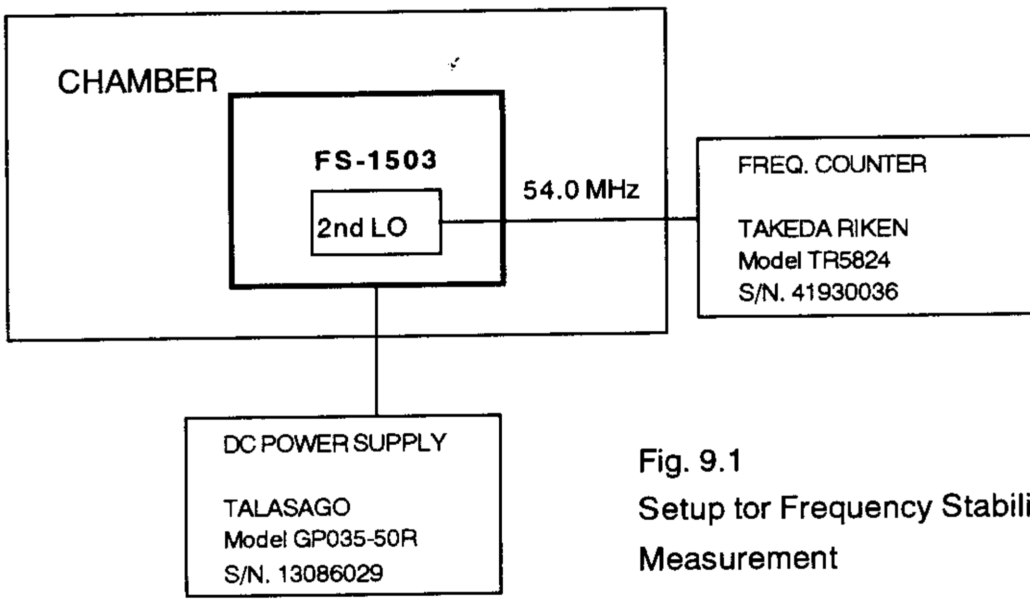

Fig. 9.1
Setup tor Frequency Stability Measurement

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 ℃ to + 50 ℃ at 10 ℃ 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 ℃, -20 ℃, 0 ℃ and + 30 ℃.

9.2 Test Result

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

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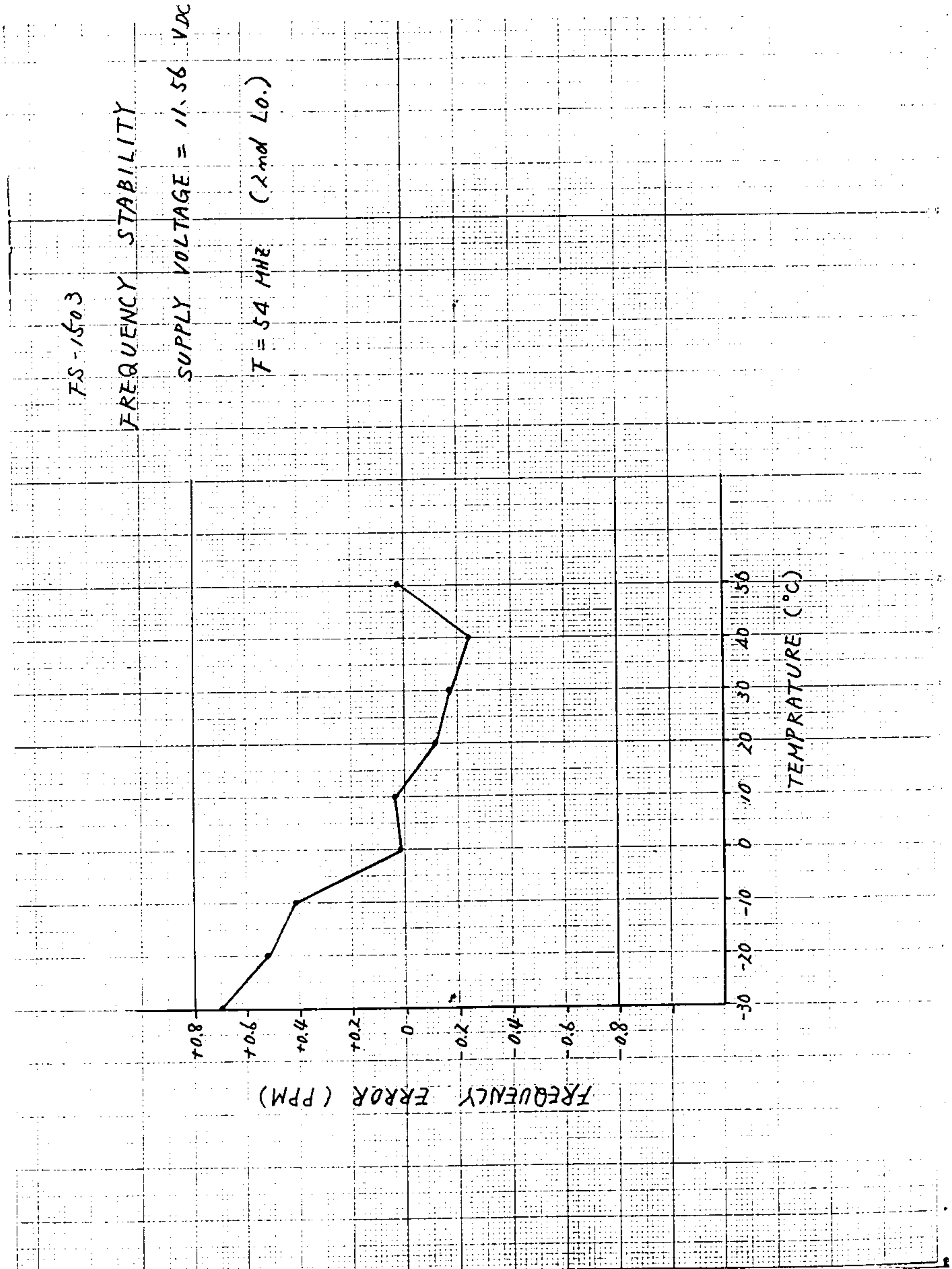

Fig. 9.2

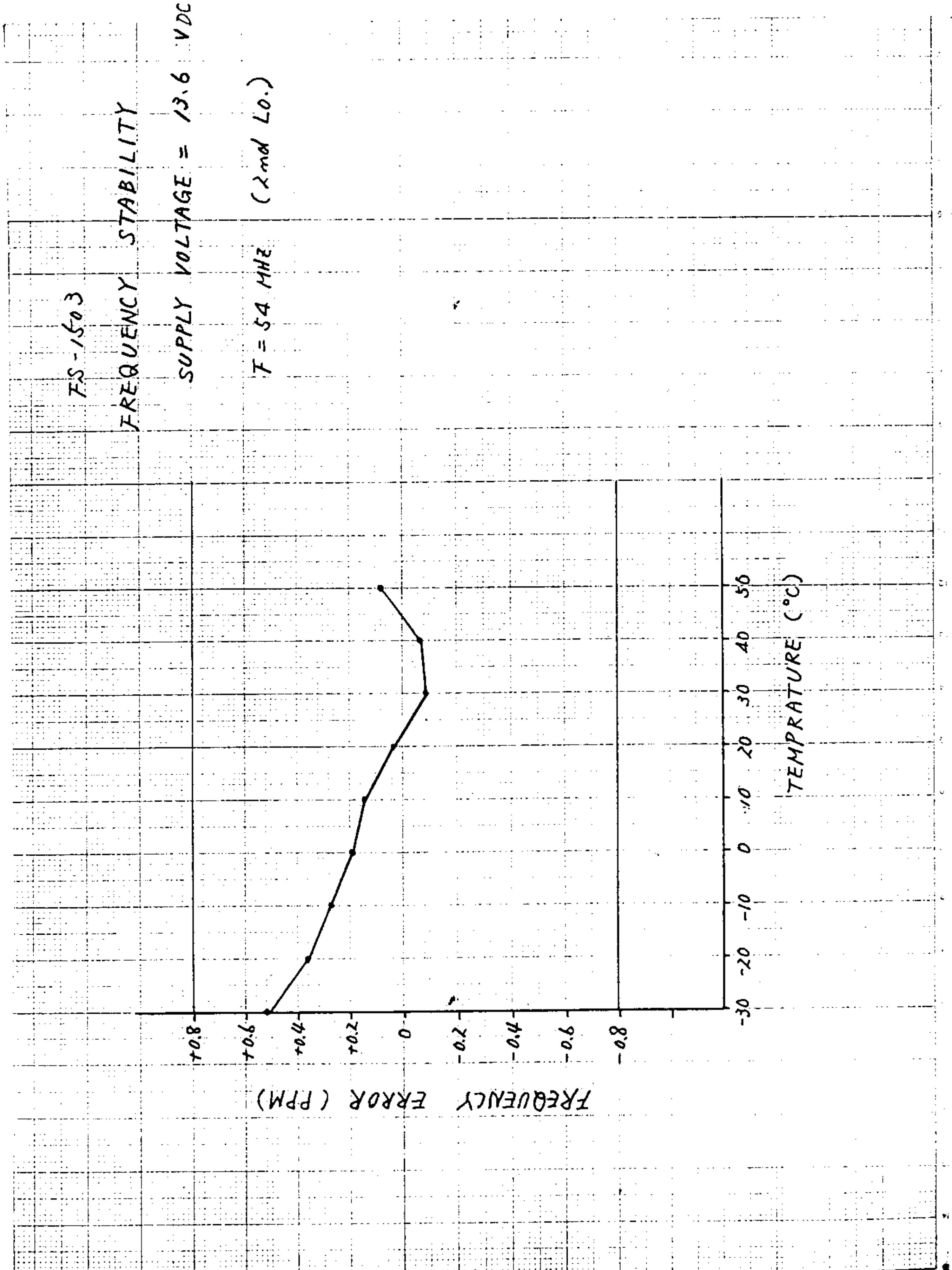
FS-1503
FREQUENCY STABILITY
SUPPLY VOLTAGE = 13.6 VDC
F = 54 MHz (2nd LO.)
TEMPRATURE (°C)
-30 -20 -10 0 10 20 30 40 50
FREQUENCY ERROR (PPM)
+0.8 +0.6 +0.4 +0.2 0 -0.2 -0.4 -0.6 -0.8

Fig. 9.3

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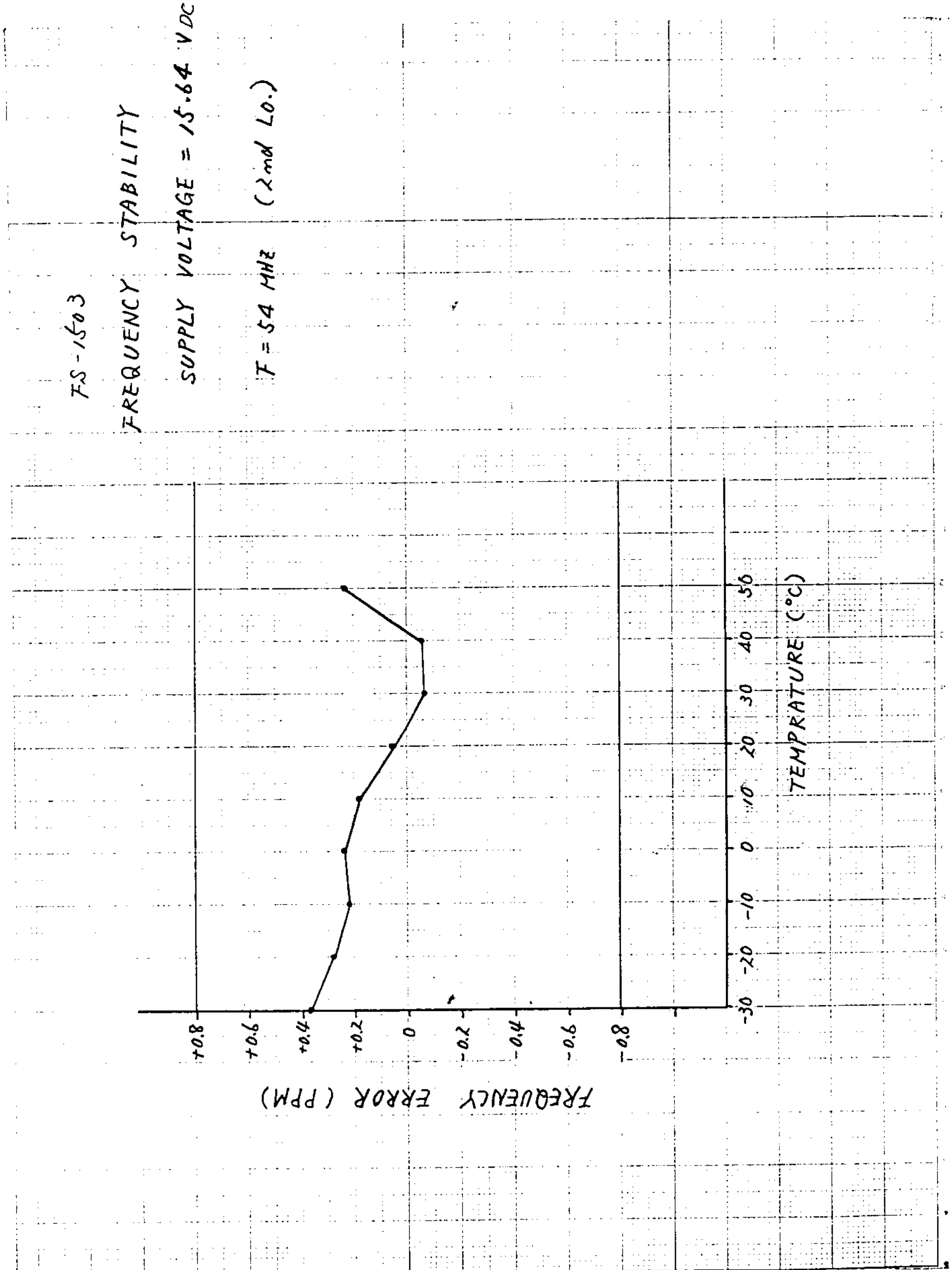

Fig. 9.4

Pub. No.: TI-1681

Date: May. 1998

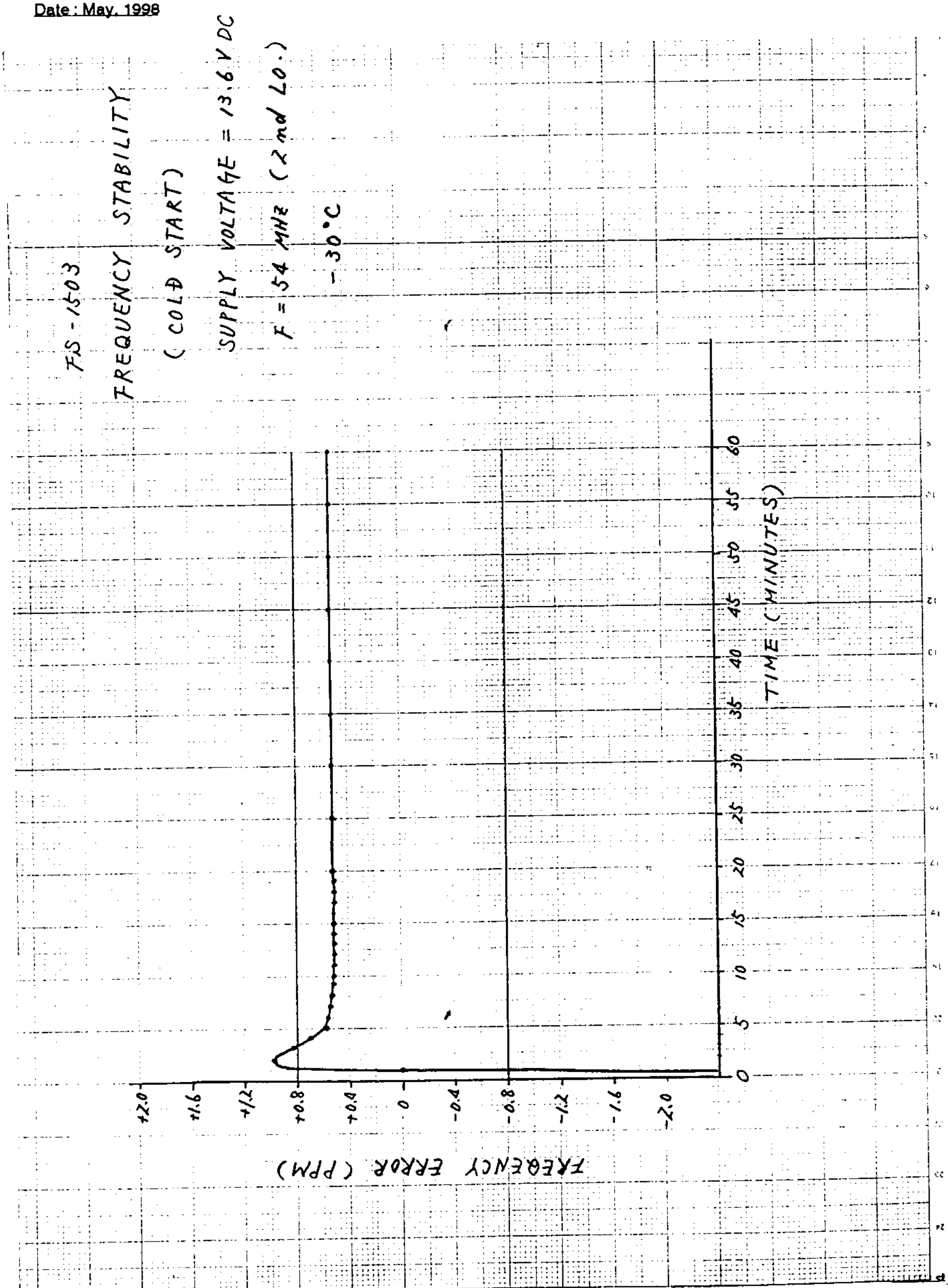

Fig. 9.5

Pub. No.: TI-1681

Date: May, 1998

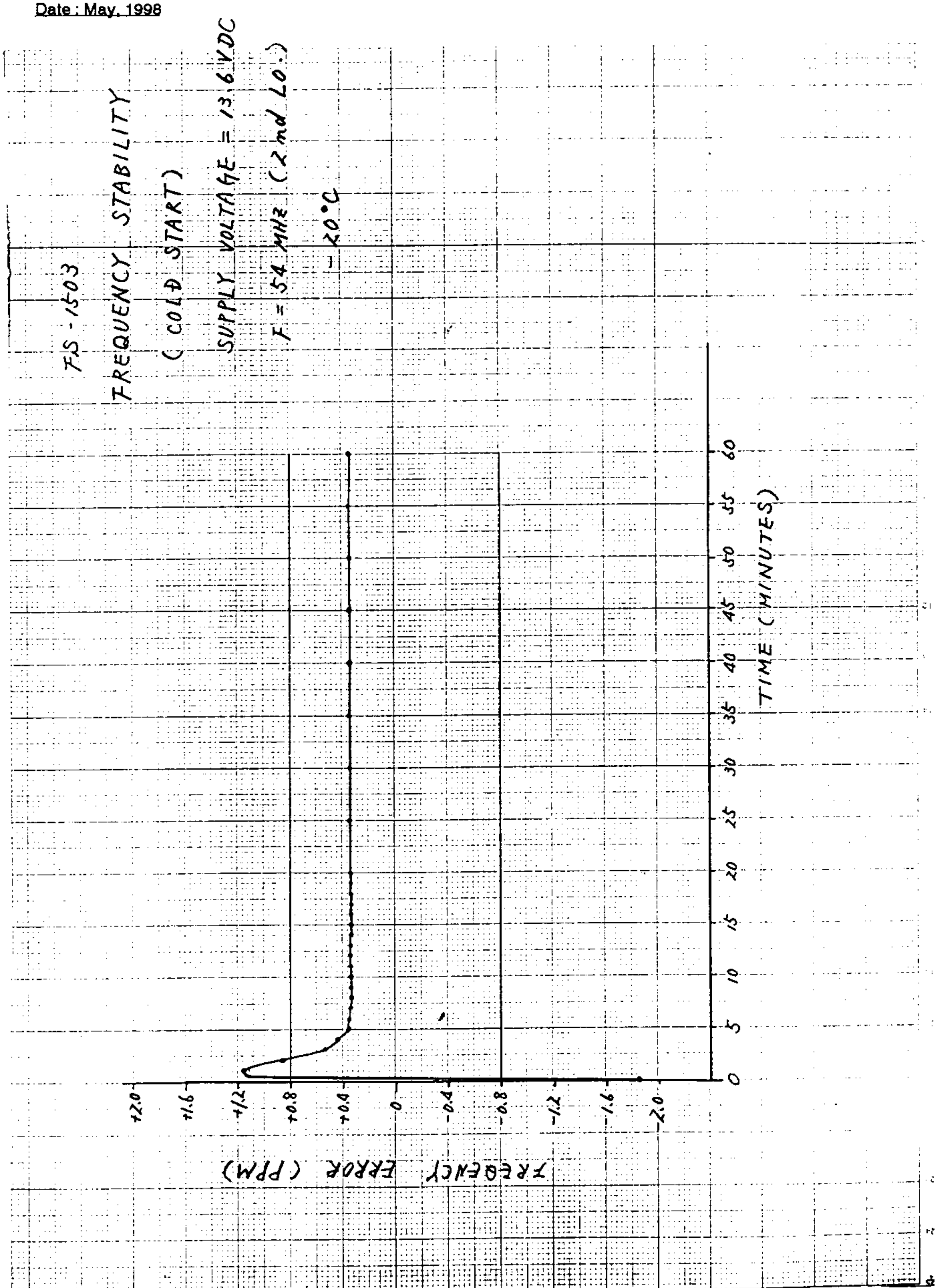

Fig. 9.6

Pub. No. : TI- 1681

Date : May. 1998

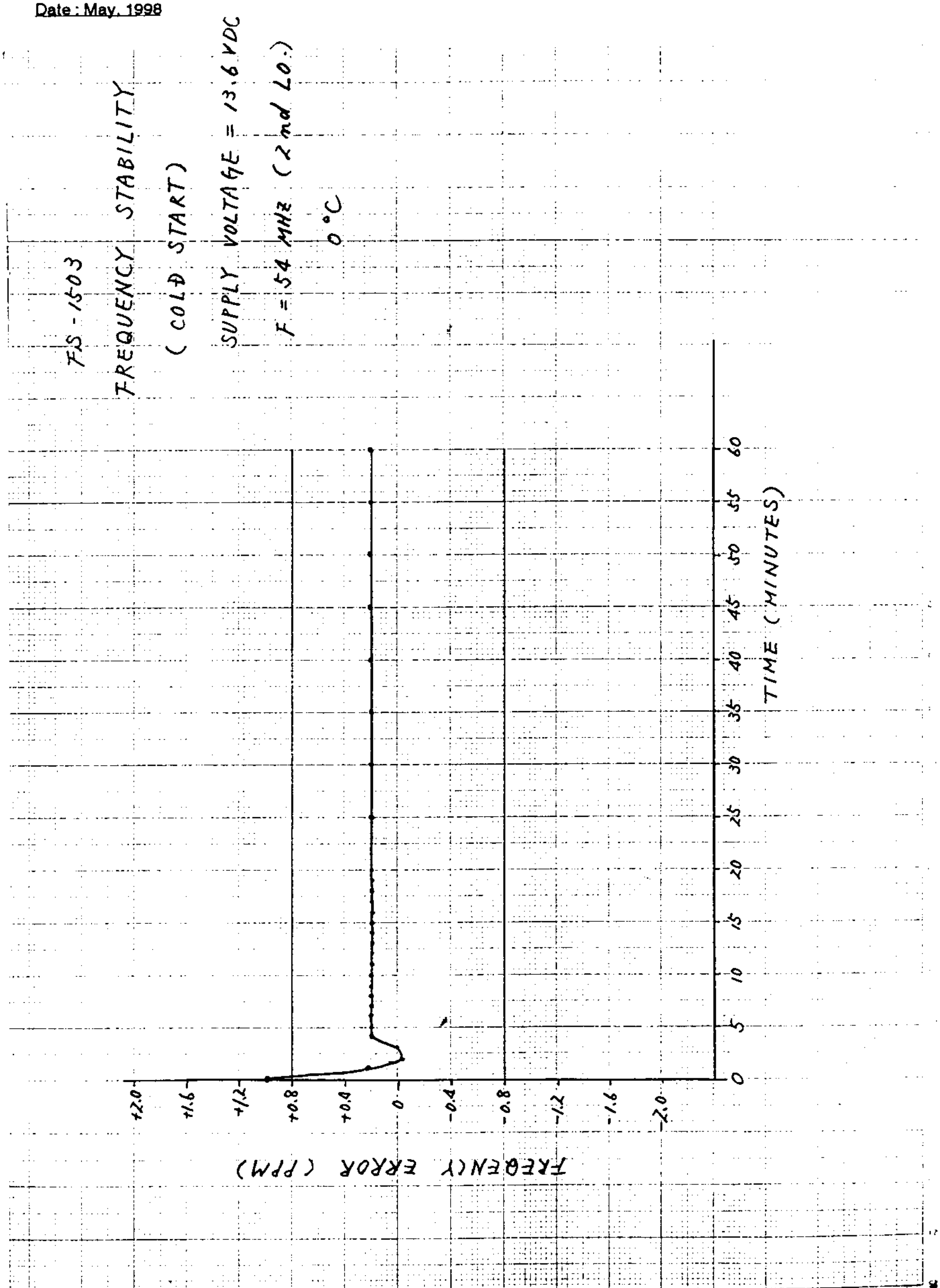

Fig. 9.7

Pub. No. : TI- 1681

Date : May. 1998

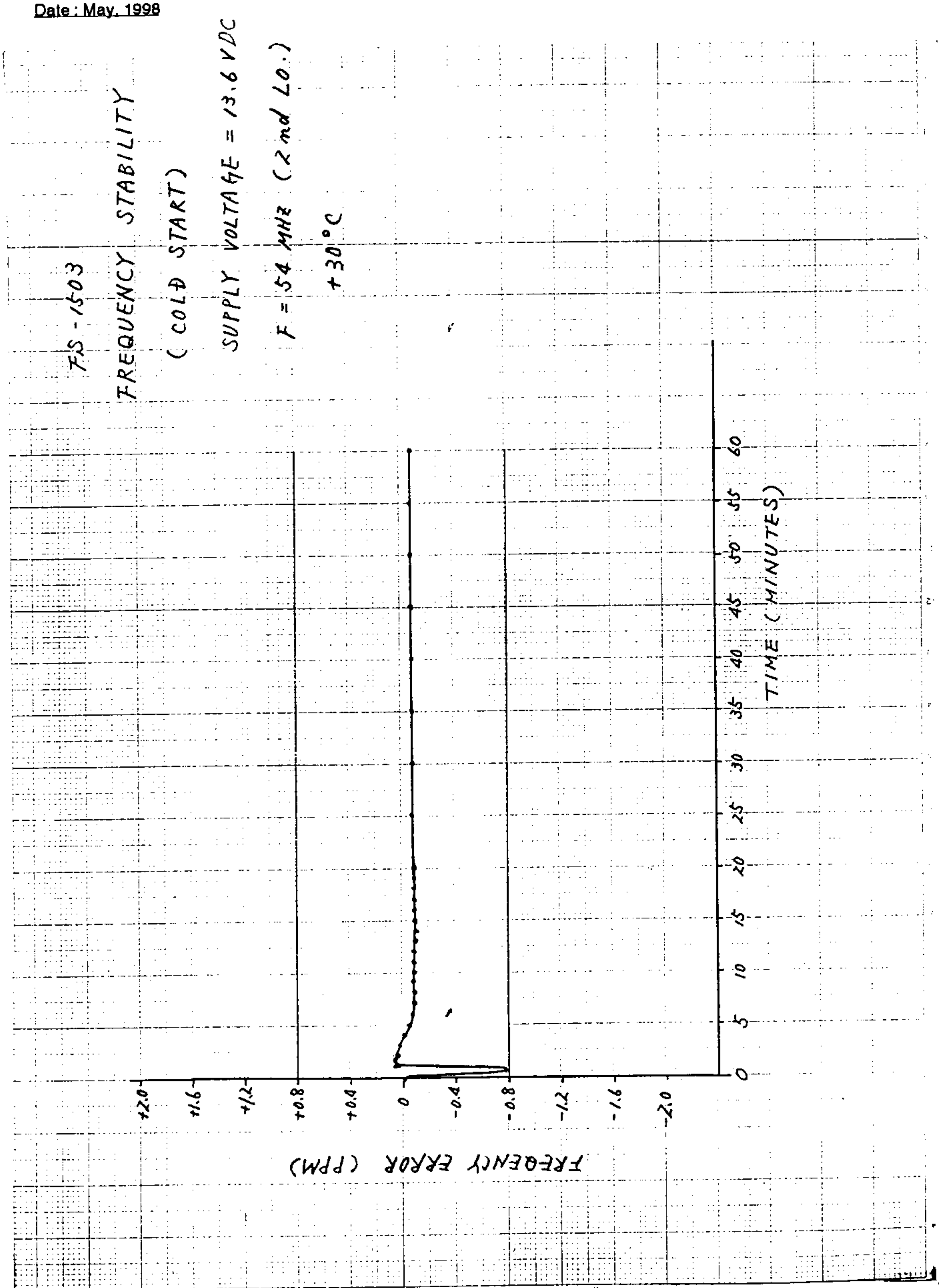

Fig. 9.8

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 dBμ(6 μV/m)	Less than 0.01 μV/m
30 - 100 MHz	Instrument's noise level: Less than 35 dBμ (56 μV/m)	Less than 0.09 μV/m
100 - 220 MHz	Instrument's noise level: Less than 35 dBμ (56 μV/m)	Less than 0.09 μV/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

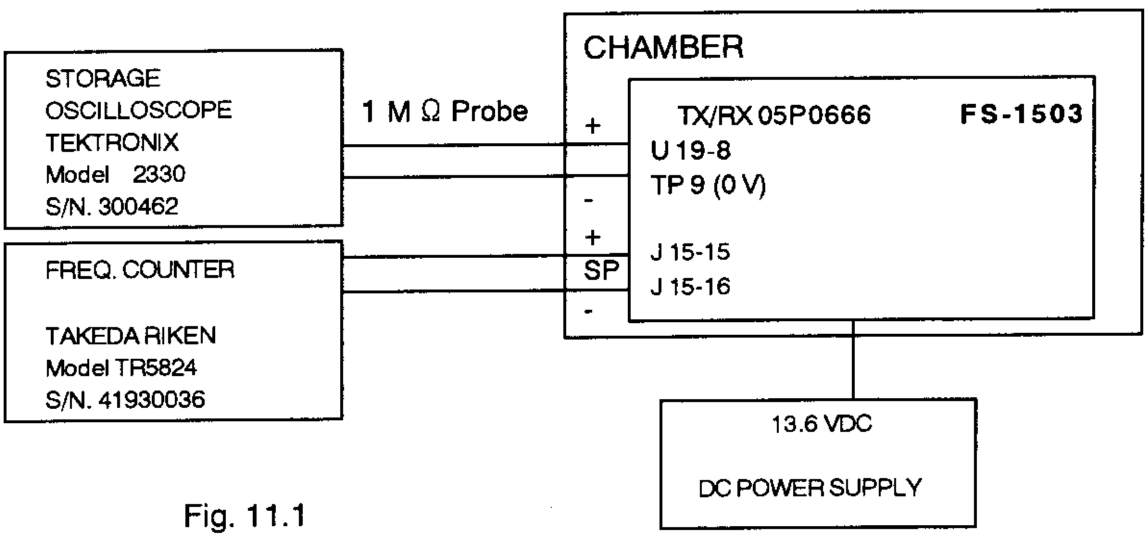

Fig. 11.1

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

11.3 MEASUREMENT/TEST RESULTS

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

(1) Frequency tolerance of each tone:

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

(2) Duration tolerance of each tone:

		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

(3) Interval between successive tones:

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
INTERVAL BETWEEN TONES		4 ms or less	0	0	0	0	0	0	0	0	0

(4) Amplitude ratio of the tones:

		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

(5) Output of the device:

		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

(6) Light from the device must not interfere with the safe navigation of the ship:

Dimmable to fully extinguished.

(7) Alarm period:

		FCC STD	-30 °C	-20 °C	-10 °C	0 °C	+10 °C	+20 °C	+30 °C	+40 °C	+50 °C
ALARM PERIOD		30 - 60 s	45	45	45	45	45	45	45	45	45

(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.

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12 TRANSMITTER POWER ADJUSTMENT PROCEDURE

SSB RADIO TELEPHONE

Model FS-1503

12.1 Set-up

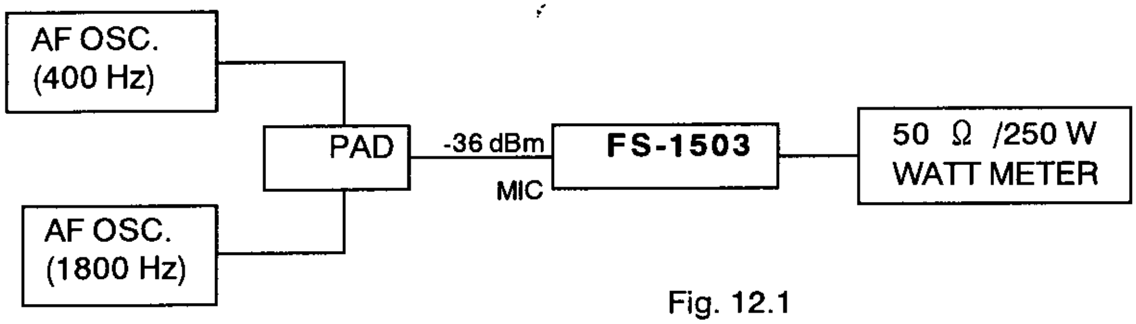

Fig. 12.1

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.