

INTERTEK TESTING SERVICES - Menlo Park

GWCOM, Inc., Base Station, Model: GWBASE2000URCS

Date of Test: June 2-8, 1998

1.0 Test Summary

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
2.985	RF Power Output	Pass	3
90.205, 24.132(c)	Effective Radiated Power	Pass	4
2.989(I), 90.209(b)(5), 90.210, 24.133(a)(1)	Occupied Bandwidth, Bandwidth Limitation, Emission masks	Pass	5
2.991	Spurious emissions at antenna terminals	Pass	7
2.993, 15.109	Field Strength of Spurious Radiation	Pass	12
15.107	Line Conducted Emissions	Pass	15
2.995(a), 24.135(a)	Frequency Stability vs. Temperature	Pass	16
2.995(d)(1), 24.135(a)	Frequency Stability vs. Voltage	Pass	17

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7/10/98

Date

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1.2 Product Description

The GWCom Inc. Model No.: GWBASE2000URCS is a base station that provides two-way access for personal messaging units with both receive and transmit capability.

For more details, refer to the attached users manual.

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2.0 RF Power Output, FCC §2.985(a)

2.1 Test Procedure

The transmitter output was connected to a calibrated coaxial attenuator, the other end of which was connected to a spectrum analyzer. The resolution bandwidth and the video bandwidth of the spectrum analyzer were set up to 100 kHz and 300 kHz. The attenuator was included in spectrum analyzer OFFSET function.

Transmitter output was read off the spectrum analyzer in dBm.

2.2 Test Equipment

Hewlett Packard 8481A Power Sensor, 435B Power Meter

Hewlett Packard HP8566B Spectrum Analyzer, 100 Hz - 22 GHz

Tektronix 2782 Spectrum Analyzer, 100 Hz - 40 GHz

2.3 Test Results

Refer to the attached plots #2.3.a, 2.3.b, & 2.3.c for low, middle, and high channels.

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3.0 Effective Radiated Power, FCC § 90.205, § 24.132(a)

Requirement: The Effective Radiated Power (ERP) must not exceed 3500 Watts.

3.1 Test Procedure

The Duplexer "Wacom WP-678/794" and antenna "Scala OGB3-900" (5 dBi) were connected to the transmitter.

The EUT was positioned on a non-conductive turntable, 0.8m above the ground plane on an open test site.

The radiated emission at the fundamental frequency was measured at 3m distance with a test antenna and spectrum analyzer. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set to 100 kHz. The maximum emission was recorded with the rotation of the turntable and the raising and lowering of the test antenna. The spectrum analyzer reading was recorded.

The ERP was calculated as follows:

$$\text{ERP}_{(\text{dBm})} = E_{(\text{dBuV/m})} + 20 \log D - 10 \log 30 - 10 \log G - 90$$

where D = 3m, distance

G = 1.64, gain of half-wave dipole

3.2 Test Equipment

Hewlett Packard HP8566B Spectrum Analyzer
EMCO Horn antenna

3.3 Test Results

Refer to the table below.

Frequency MHz	Spectrum Analyzer Reading dB(uV)	Antenna Factor dB(1/m)	Cable loss dB	Field Strength dB(uV/m)	ERP dBm
930.4	101.0	23.0	3.0	127.0	29.6

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4.0 Occupied Bandwidth, Bandwidth Limitation, Emission masks. FCC §2.989(I), 90.209(b)(5), 90.210, 24.133(a)(1)

4.1 Test Procedure

The RF output of the transceiver was connected to the input of the spectrum analyzer through sufficient attenuation.

The spectrum with no modulation was plotted.

The transmitter was set up to transmit pseudo-random pattern of 9.6 kb/s and the spectrum with modulation was plotted. The plots also were made for wideband data such as 0,1,0,1...and 1,1,0,0,1,1,0,0.....

4.2 Test Equipment

HP 8566B Spectrum Analyzer, 100 Hz - 22 GHz
Tektronix 2784 Spectrum Analyzer, 100 Hz - 40 GHz
HP 7470A Plotter

4.3 Test Results

For test results refer to the attached plots 4.3.a - 4.3.d

The EUT passed the emission mask tests for 20 kHz authorized bandwidth (for Part 90) and 45 kHz authorized bandwidth (for Part 24).

Therefore the emission designator is as follows: 20K0F1D
45K0F1D

The necessary bandwidth (BW) is calculated as follows:

$$BW = 2(M+D) = 10.8 \text{ kHz}$$

Where a modulation frequency M = 3 kHz, and
a deviation D = 2.4 kHz

The modulation frequency for GMSK modulation with BT = 0.3 for 9.6 kb/s is approximately equals $9.6/3.2 = 3 \text{ kHz}$

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Emission Limitations, Occupied Bandwidth Plots:

Plot Number	Description of Modulation
4.3.a	Random pattern, span 50 kHz
4.3.b	0,1,0,1....data, span 50 kHz
4.3.c	1,1,0,0,1,1....data, span 50 kHz
4.3.d	Random pattern, span 100 kHz
4.3.e	0,1,0,1....data, span 100 kHz
4.3.f	1,1,0,0,1,1...data, span 100 kHz
4.3.g	Random pattern, span 200 kHz
4.3.h	0,1,0,1....data, span 200 MHz
4.3.i	1,1,0,0,1,1...data, span 200 kHz

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5.0 Out of Band Emissions at Antenna Terminals , FCC §2.991

Out of Band Emissions:

The power of emissions must be attenuated below the power of the unmodulated carrier (P) on any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth - at least $43 + 10 \log P$ dB.

5.1 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The pseudo-random modulating signals was set up. The several plots were made to show compliance with the emissions attenuation at the edges of the assigned frequency bands: 928 - 930 MHz for Part 24, 930 - 931 MHz for Part 90. Sufficient scans were also taken to show the out of band emissions if any up to 10th harmonic.

5.2 Test Equipment

HP 8566B Spectrum Analyzer, 100 Hz - 22 GHz
Tektronix 2784 Spectrum Analyzer, 100 Hz - 40 GHz

5.3 Test Results

Refer to the attached plots.

The EUT passed the test.

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Plots of Out of Band Emissions at Antenna Terminal are attached.

PLOT NUMBER	DESCRIPTION
5.3.a	Part 24, scan 930 - 931 MHz, High Channel
5.3.b	Part 24, scan 930 - 931.1 MHz, High Channel
5.3.c	Part 24, scan 930.4 - 931 MHz, Low Channel
5.3.d	Part 24, scan 930.3 - 931 MHz, Low Channel
5.3.e	Part 90, scan 929 - 930 MHz, High Channel
5.3.f	Part 90, scan 929 - 930.5 MHz, High Channel
5.3.g	Part 90, scan 929 - 930 MHz, Low Channel
5.3.h	Part 90, scan 928.5 - 930 MHz, Low Channel
5.3.i - 5.3.l	Scan 1 MHz - 10 GHz, transmitter only
5.3.m - 5.3.p	Scan 1 MHz - 10 GHz, transmitter with duplexer

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6.0 Field Strength of Spurious Radiation, FCC § 2.993, §15.109

6.1 Test Procedure

For radiated emission measurement below 1GHz, an antenna was connected to the transmitted output. For radiated emission measurement above 1GHz, a 50 Ohm coaxial load was connected to the transmitter output. The transmitter was placed on a wooden turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

The spurious harmonic attenuation was calculated as the difference between E in dB(uV/m) at the fundamental frequency and at the spurious emission frequency.

6.2 Test Equipment

EMCO 3115 Horn Antenna

HP 8566B Spectrum Analyzer

Tektronix 2784 Spectrum Analyzer

High Pass Filter

Preamplifier

INTERTEK TESTING SERVICES - Menlo Park

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6.4 Test Results

Spurious Harmonic Attenuation

Test site: #1
Test Engineer: D. Chernomordik
Operation Mode: Transmitting at 930.425 MHZ
For harmonic measurements, the Output is terminated with dummy load

Frequency MHz	Antenna Pol.	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Distance Correct. dB	Field Strength dB(uV/m)	Spurious attenuat. dB	Margin dB
930.4	V	101.0	23.0	0	3.0	0	127.0	-	-
1860.8	V	30.4	24.7	0	1.0	0	56.1	70.9	-31.9
2791.3	V	43.5	28.1	-28.4	2.3	0	45.5	81.5	-42.5
3721.7	V	25.6	31.5	-27.8	2.7	0	32.0	95.0	-56.0
4652.1	V	23.8	32.2	-28.0	3.2	0	31.2	95.8	-56.8
5582.6	V	23.2	34.4	-28.3	3.7	0	33.0	94.0	-55.0
6513.0	V	25.1	34.0	-28.0	4.2	0	35.3	91.7	-52.7
7443.4	V	26.3	35.8	-28.0	4.3	0	38.4	88.6	-49.6
8373.8	V	26.2	37.0	-27.2	4.8	0	40.8	86.2	-47.2
9304.3	V	27.0	37.8	-27.0	5.0	0	42.8	84.2	-45.2

Note: Measurements were made at 3 m distance

Limit of spurious emission attenuation equals $43 + 10 \log P = 39$ dB

Justification: Passed

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FCC Part 15.109 Radiated Emission

Frequency MHz	Antenna Pol.	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Field Strength dB(uV/m)	Limit dB(uV/m)	Margin dB
50.2	V	15.8	6.5	0	0.6	22.9	40.0	-17.1
75.2	V	14.0	5.6	0	0.7	20.3	40.0	-19.7
125.3	H	9.5	7.7	0	0.9	18.1	43.5	-25.4
150.3	H	8.5	9.3	0	1.0	18.8	43.5	-24.7
200.5	V	14.8	10.1	0	1.1	26.0	43.5	-17.5
225.5	V	11.0	10.9	0	1.1	23.0	46.0	-23.0
250.6	V	16.4	11.6	0	1.2	29.2	46.0	-16.8
275.6	H	11.5	12.5	0	1.3	25.3	46.0	-20.7
300.7	V	27.4	13.2	0	1.4	42.0	46.0	-4.0
350.8	V	25.6	14.6	0	1.5	41.7	46.0	-4.3
375.9	H	12.0	15.2	0	1.6	28.8	46.0	-17.2
400.9	H	23.4	16.0	0	1.7	40.5	46.0	-5.5
856.8 *	V	15.4	20.5	0	2.1	38.0	46.0	-8.0
1713.6	V	6.9	24.5	0	2.3	33.7	54.0	-20.3

Note: All measurements were made at 3 m distance.

All other emissions not reported are at least 20 dB below the limit.

Frequency range investigated is from 30 to 5000 MHz.

* Local Oscillator frequency

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7.0 Line Conducted Emissions, FCC § 15.107

7.1 Test Procedure

Test procedure described in the ANSI C63.4 Standard was employed.

The EUT was connected to an AC line through the LISNs.

Both HOT and NEUTRAL leads were tested.

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7.3 Test Results

Refer to the attached plots. The EUT passed the test.

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8.0 Frequency Stability vs Temperature, FCC § 2.995(a), 24.135(a)

8.1 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer via feedthrough attenuators. The EUT was placed inside the temperature chamber. The RF output cable exited the chamber through an opening.

After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the spectrum analyzer.

8.2 Test Equipment

Thermotron Ind. Temperature Chamber, Model S-8C

Hewlett Packard 8591E Spectrum Analyzer

AC Power Source, Model 1501L-1M

8.3 Test Results

Refer to the test data below.

Frequency: 930.425 MHz, Tolerance ± 930 Hz

Frequency Stability vs Temperature		
Temperature, C	Frequency (MHz)	Difference (Hz)
+ 60	930.424833	-167
+ 50	930.425113	+ 113
+ 40	930.425143	+ 143
+ 30	930.425223	+ 223
+ 20	930.425178	+ 178
+ 10	930.424978	-22
0	930.424893	-107
-10	930.424753	-247
-20	930.425053	+ 53
-30	930.425103	+ 103

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9.0 Frequency Stability vs Voltage, FCC 2.995(d)(2), 24.135(a)

9.1 Test Procedure

An external variable AC power source was connected to the EUT. The frequency of the transmitter was measured for 115% of the AC nominal value and for 85% of the nominal value.

9.2 Test Equipment

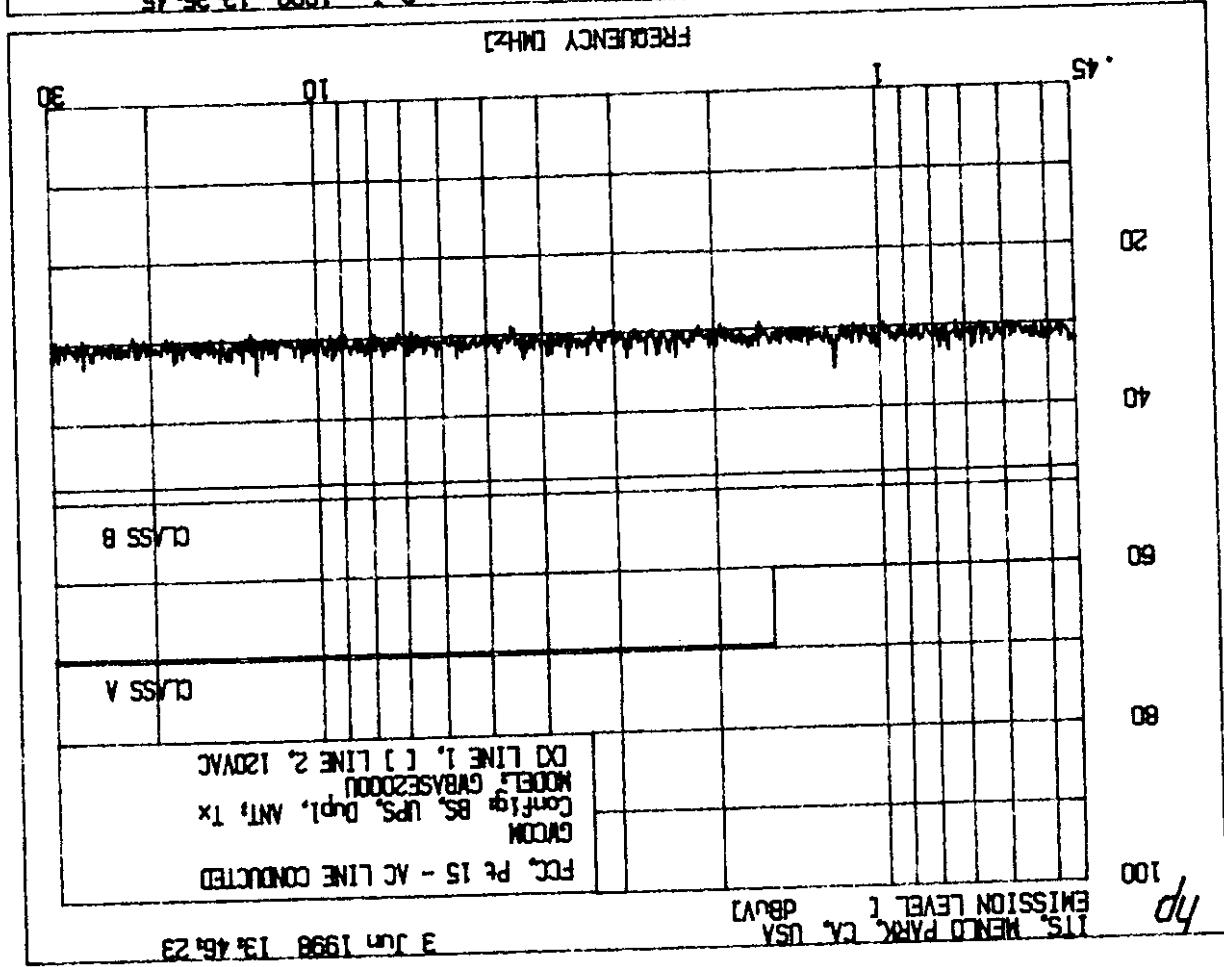
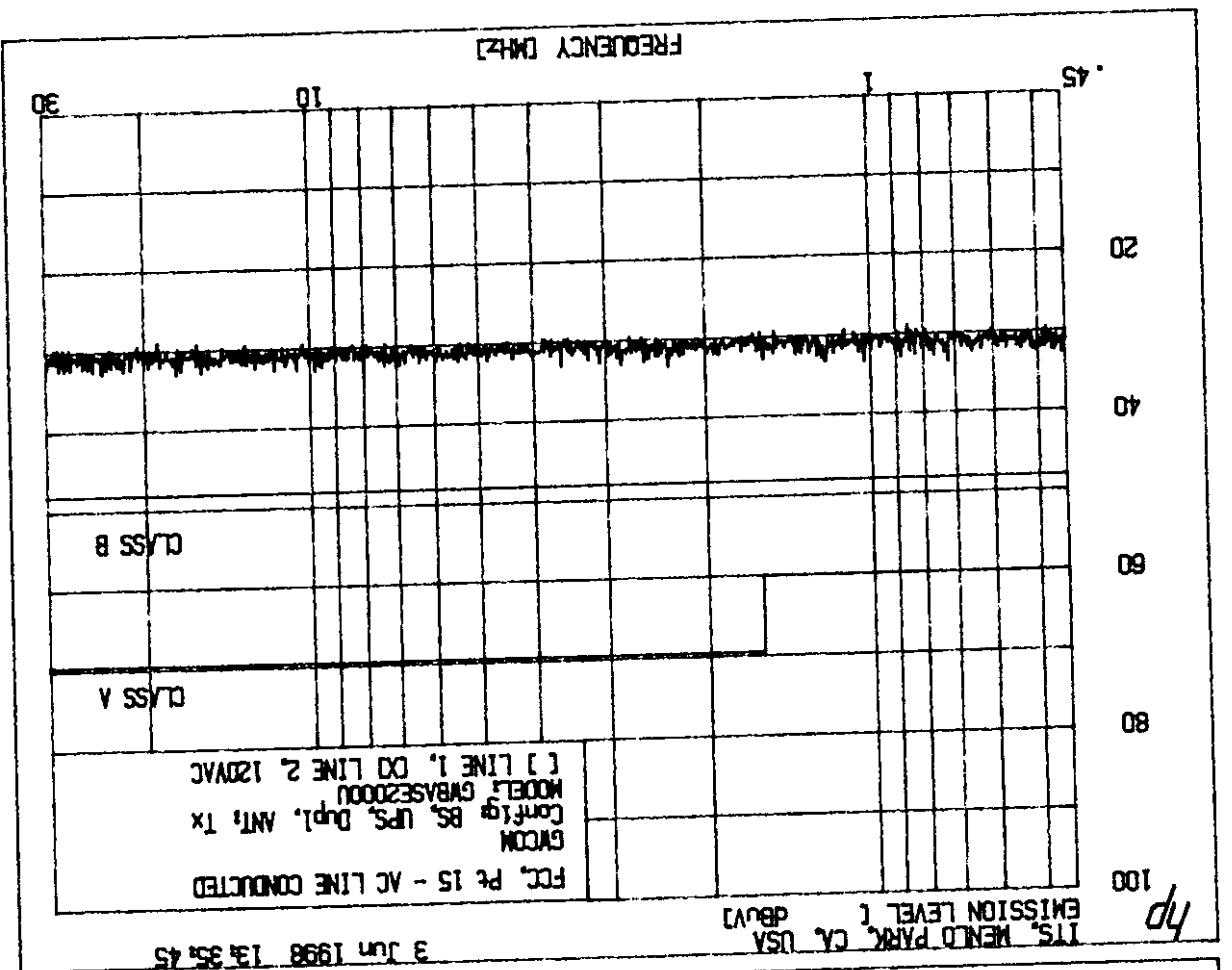
Hewlett Packard 8591E Spectrum Analyzer
AC Power Source, Model 1501L-1M

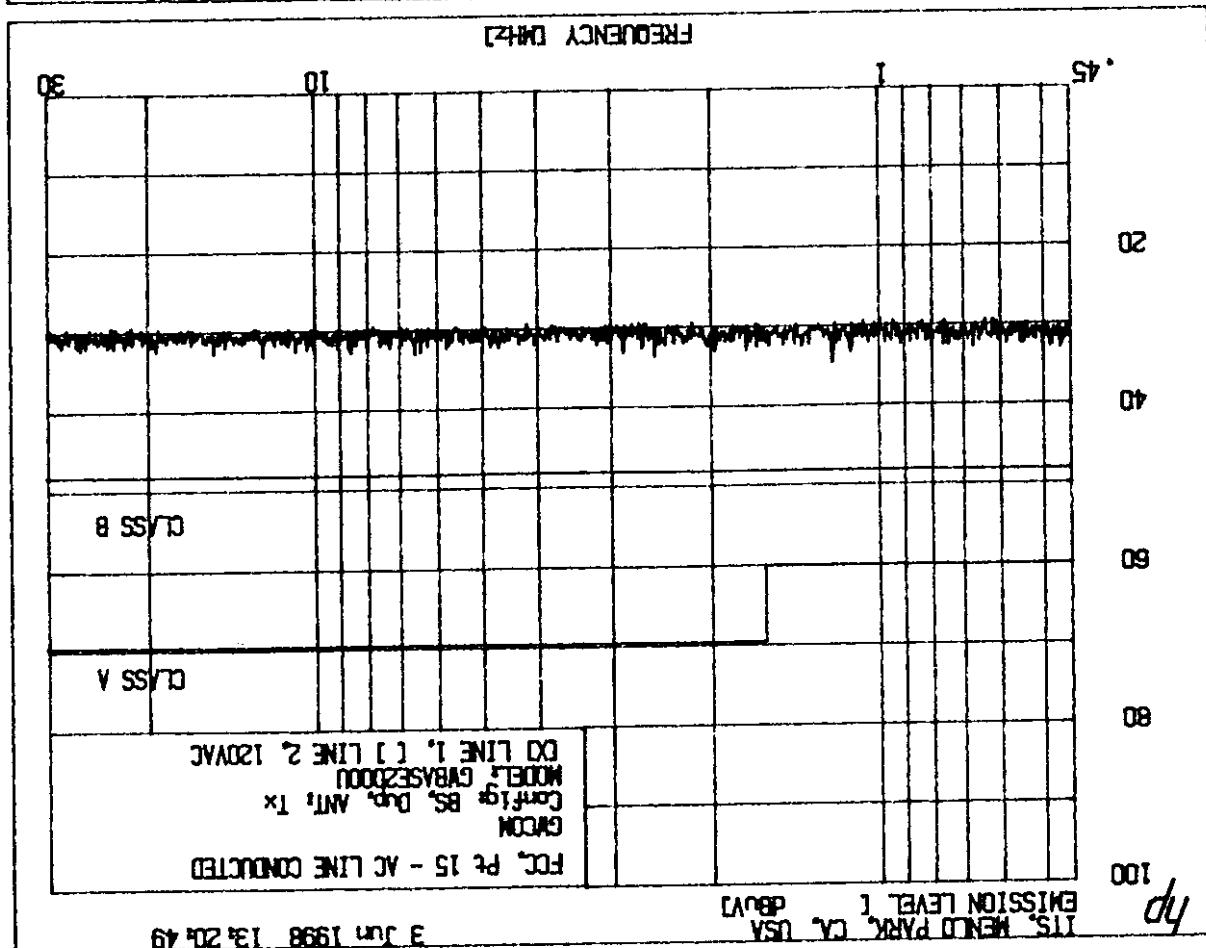
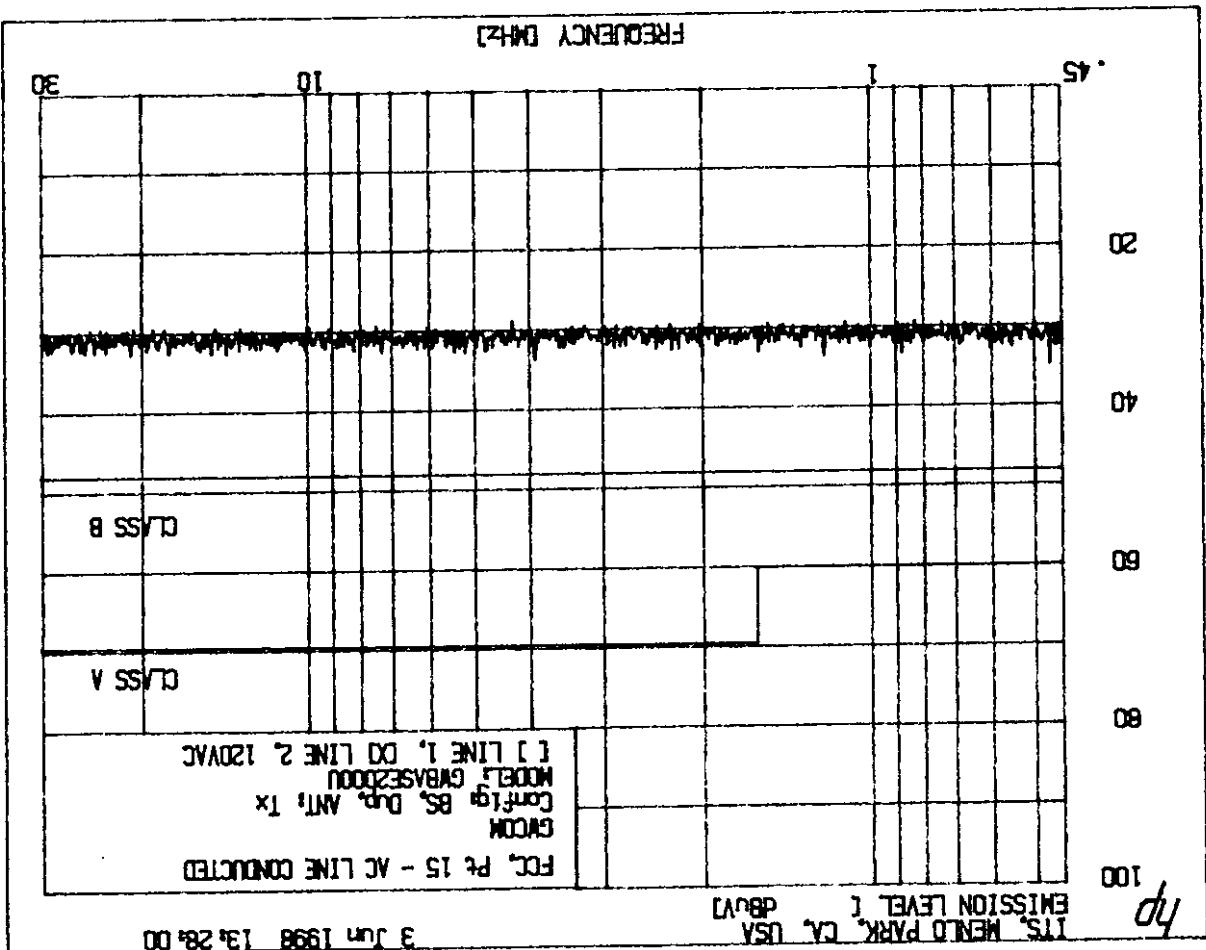
9.3 Test Results.

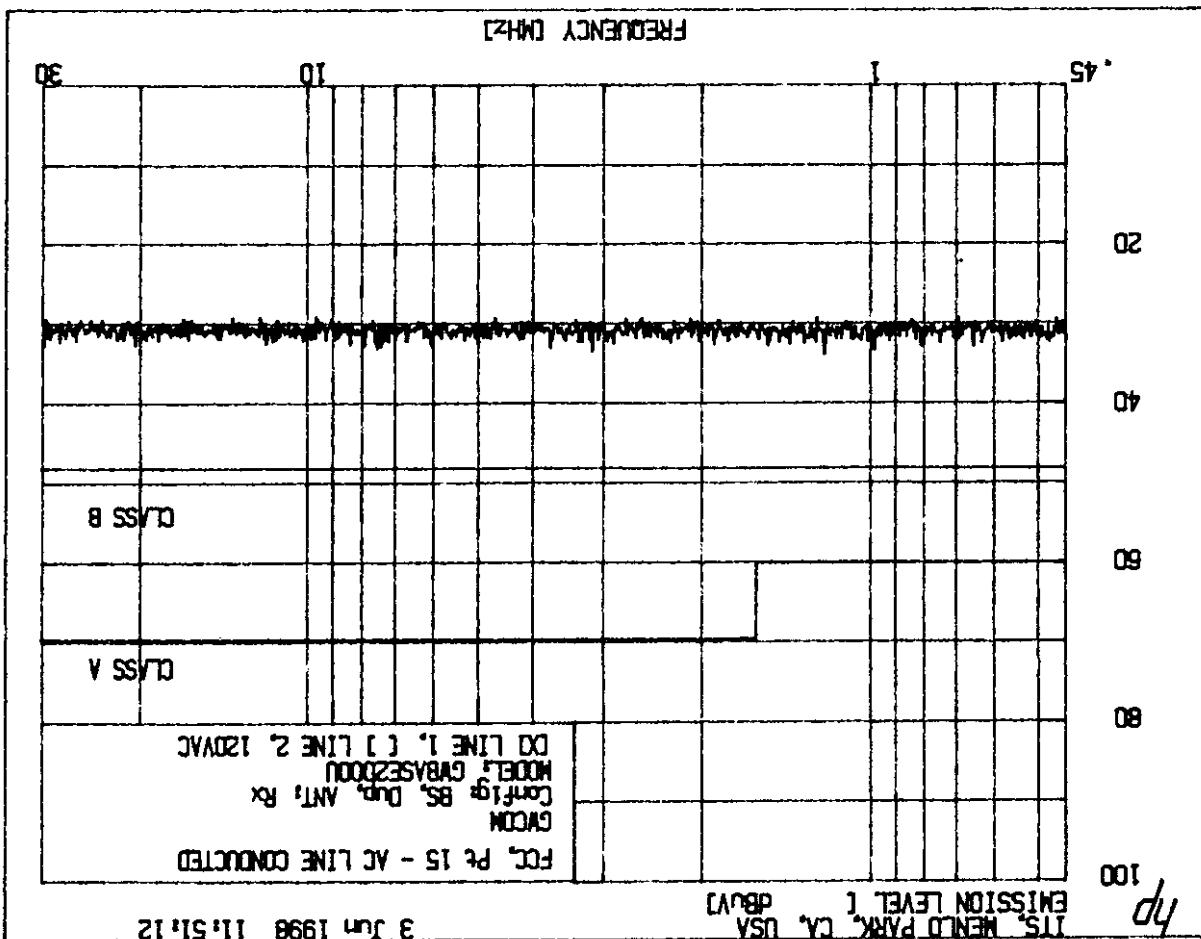
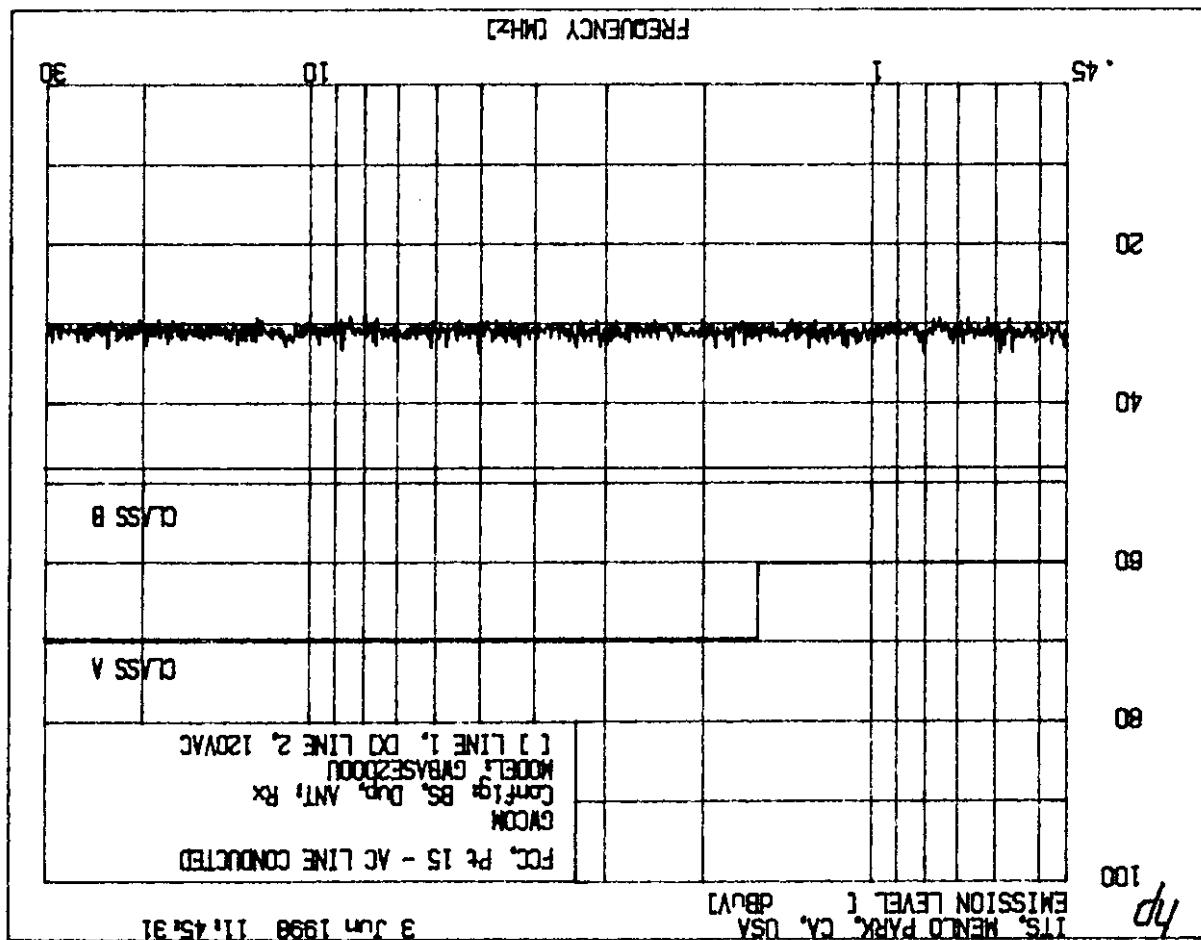
Refer to the test data below.

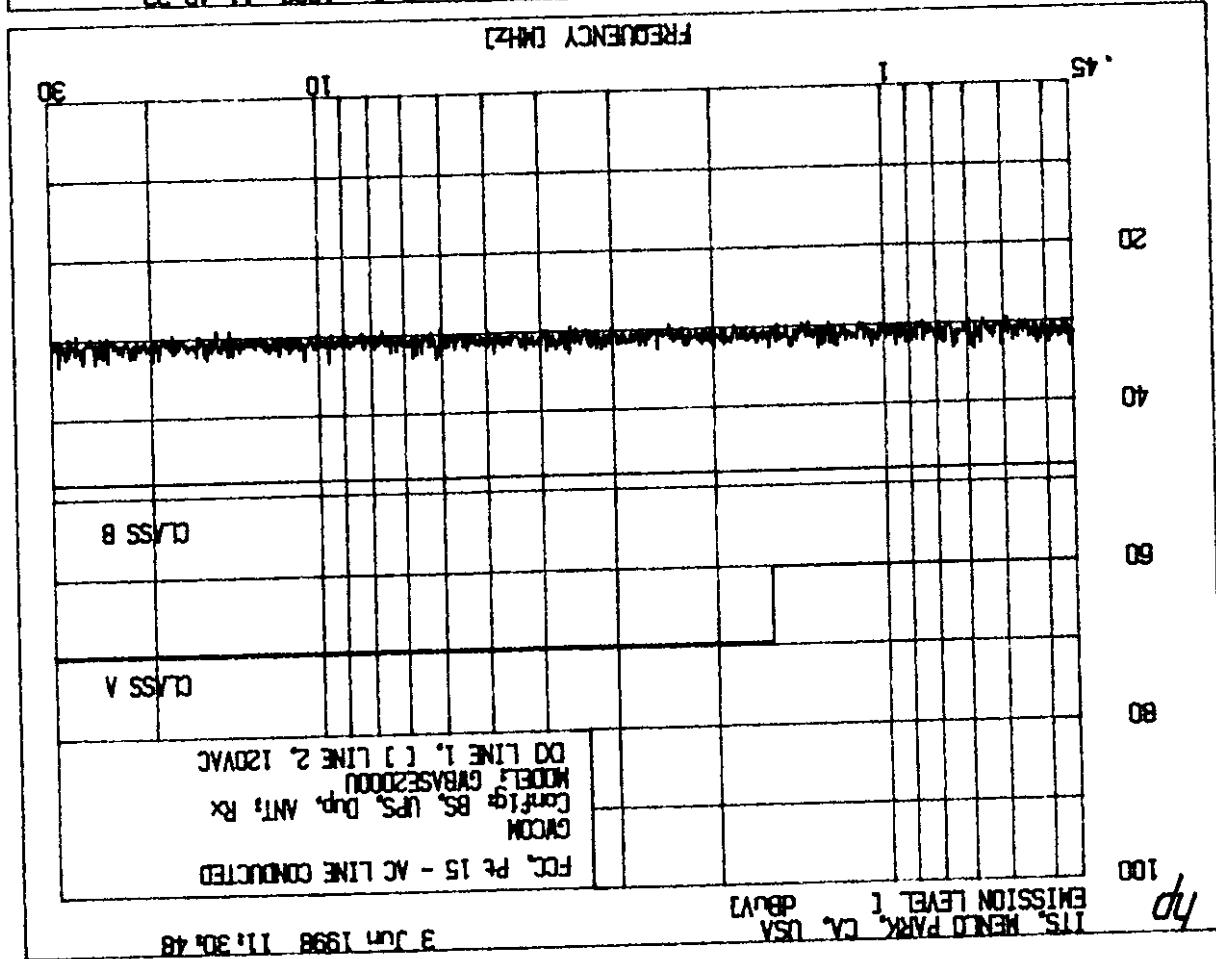
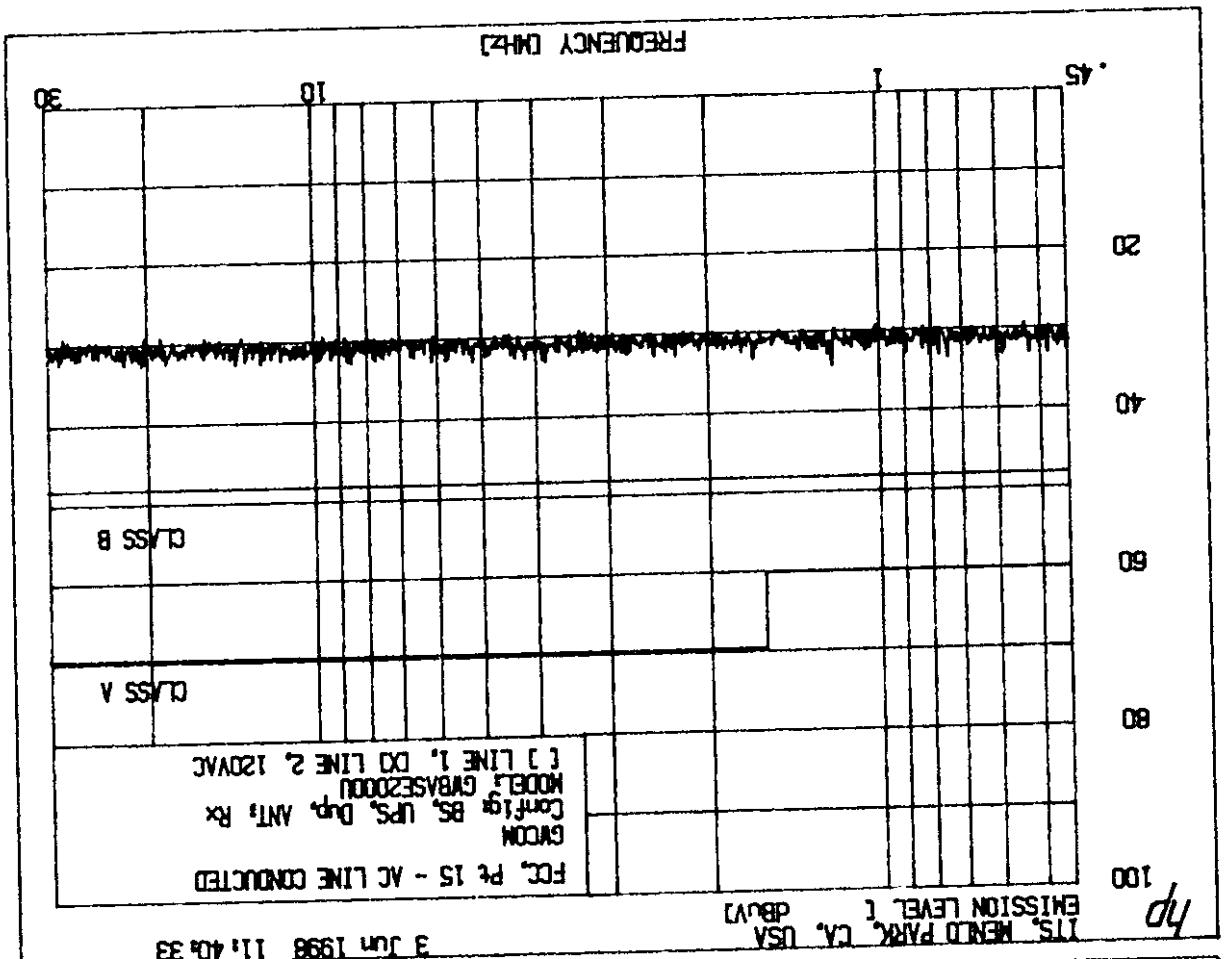
Frequency: 930.425 MHz, Tolerance ± 930 Hz

Frequency Stability vs. Voltage		
Voltage, V	Frequency (MHz)	Difference (Hz)
97	930.424943	-57
115	930.424943	-57
133	930.424933	-67







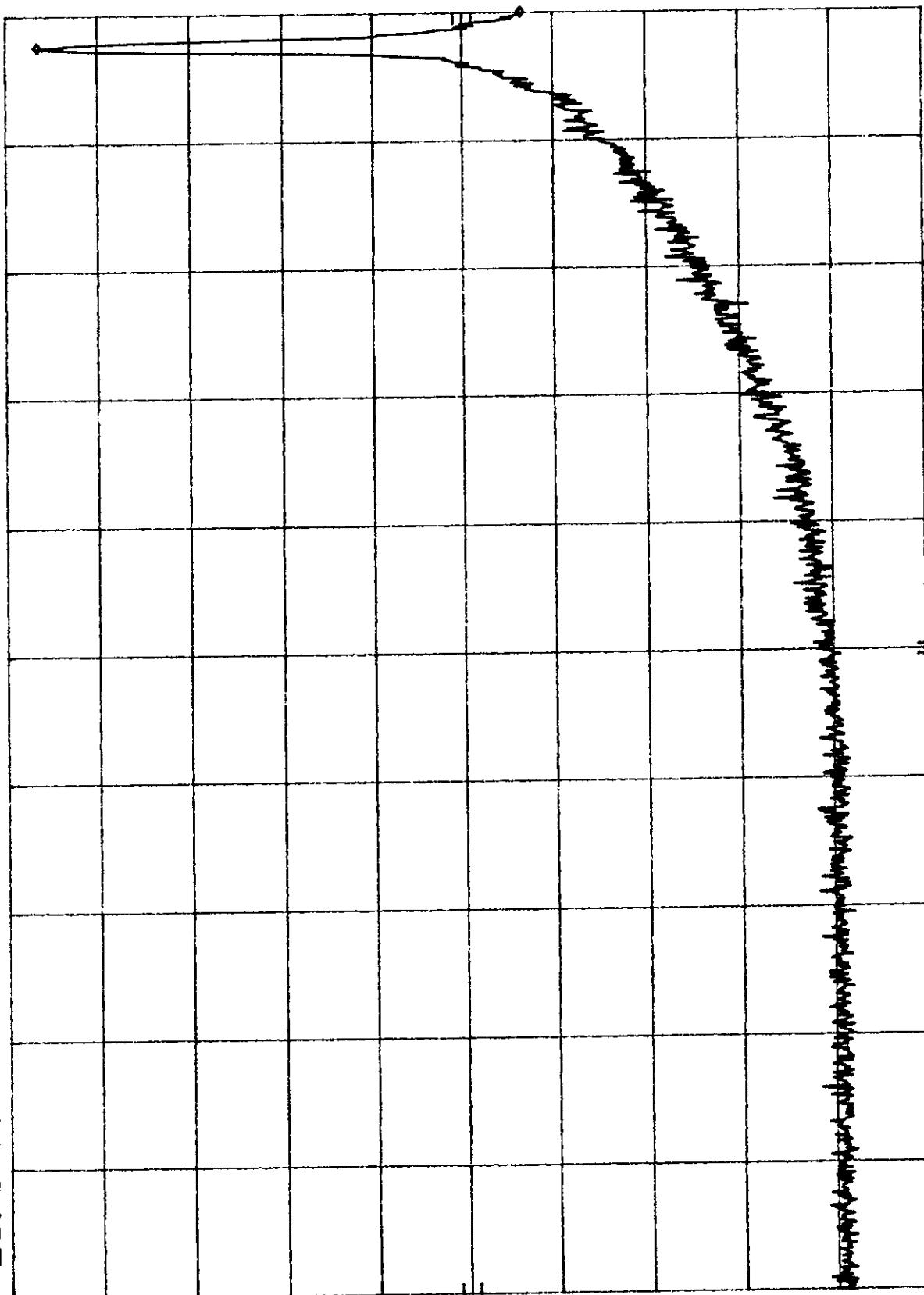


PLOT# 5.3.a

GWCOM. GBASE2000U
REF 26.0 dBm

f_{pp}

10 dB/



START 930.000 MHz
RES BW 300 Hz
STOP 931.000 MHz
SWP 20 sec

VBW 300 Hz

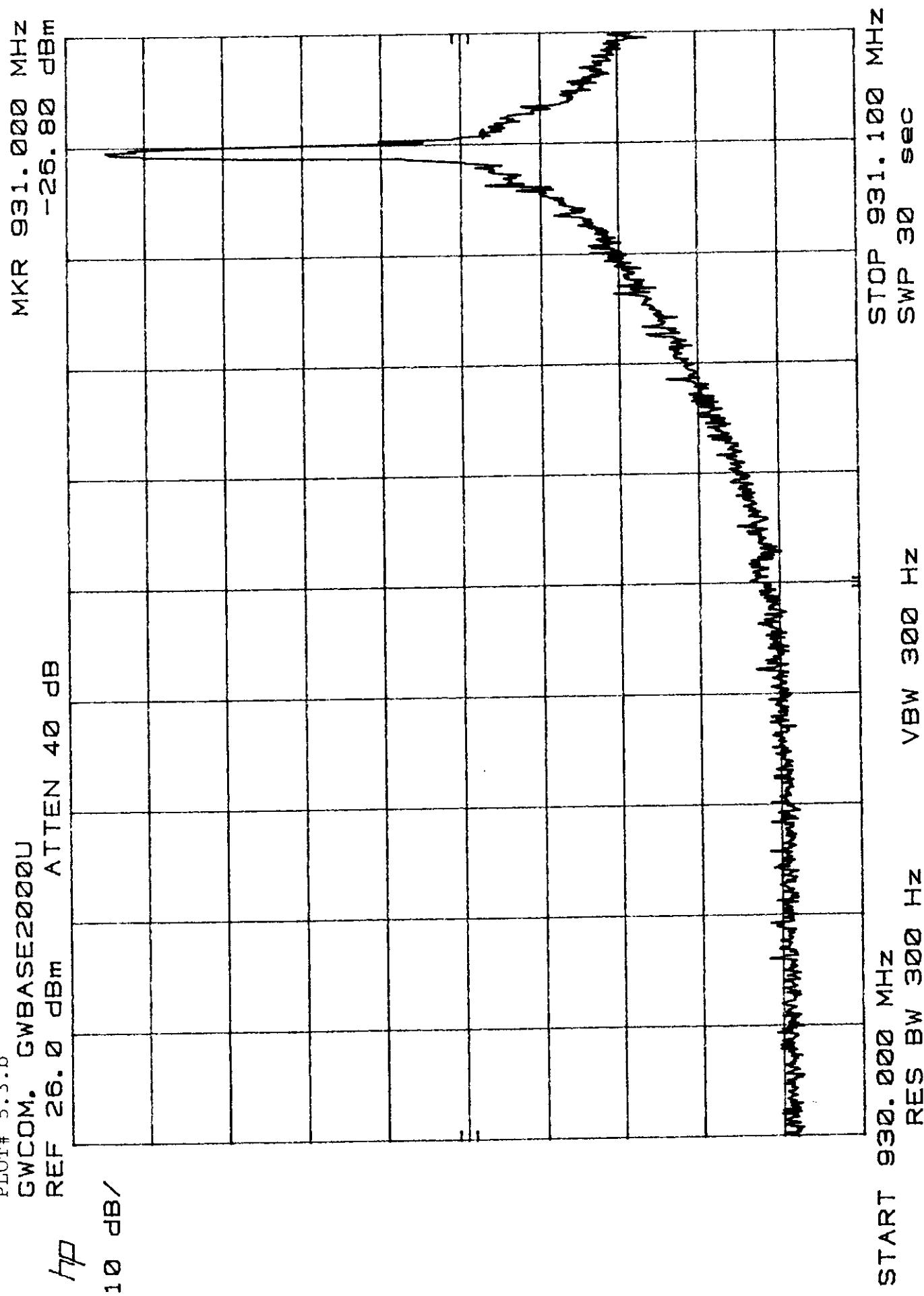
PLOT# 5.3.b

GWCOM. GBASE2000U

REF 26.0 dBm ATTEN 40 dB

$\frac{1}{f^2}$

10 dB/

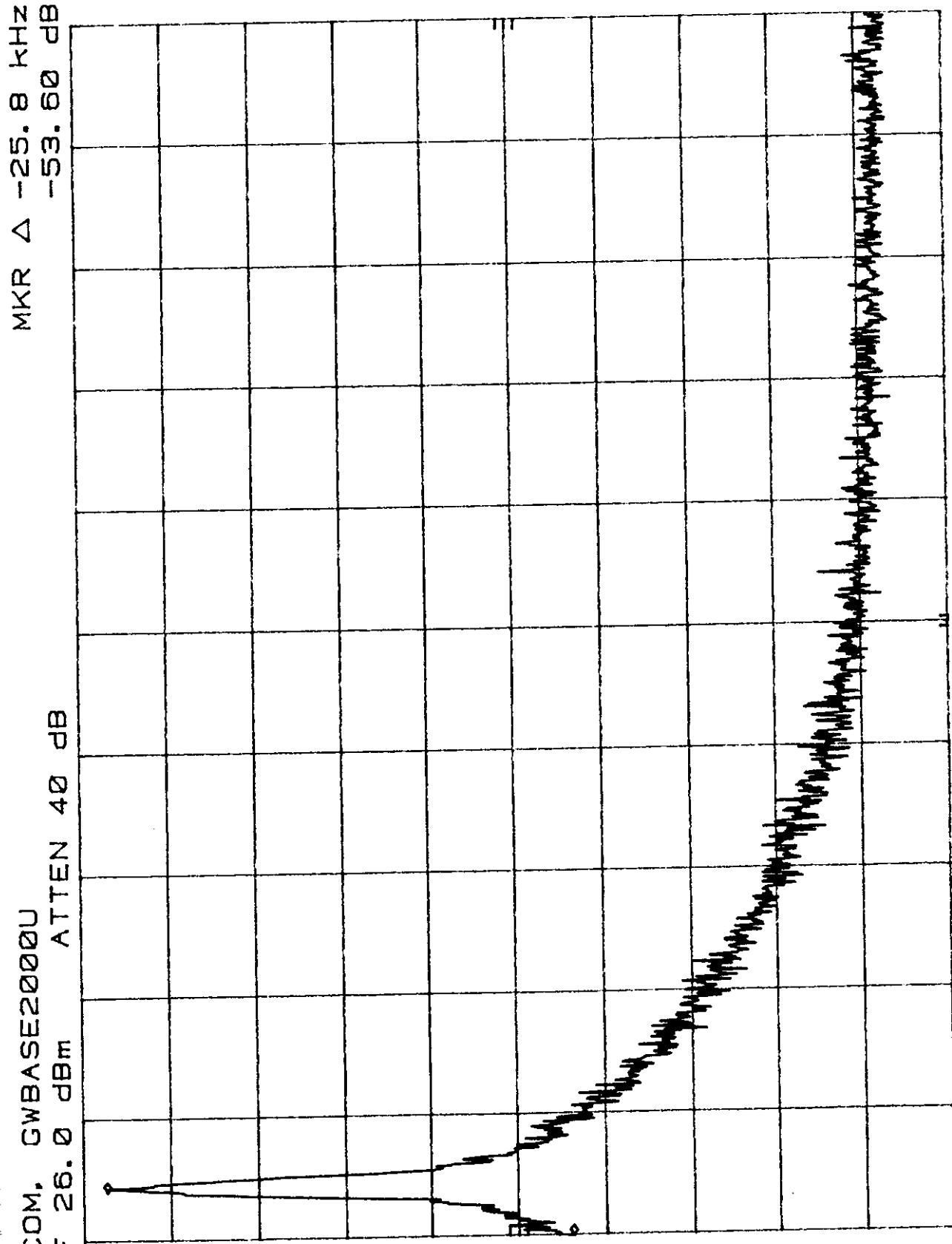


PLOT# 5.3.c

GWCOM, GwBASE20000U

REF 26.0 dBm ATTEN 40 dB

10 dB/



START 4000 MHz
RES BW 300 Hz

VBW 300 Hz

STOP 931.0000 MHz
SWP 15 sec

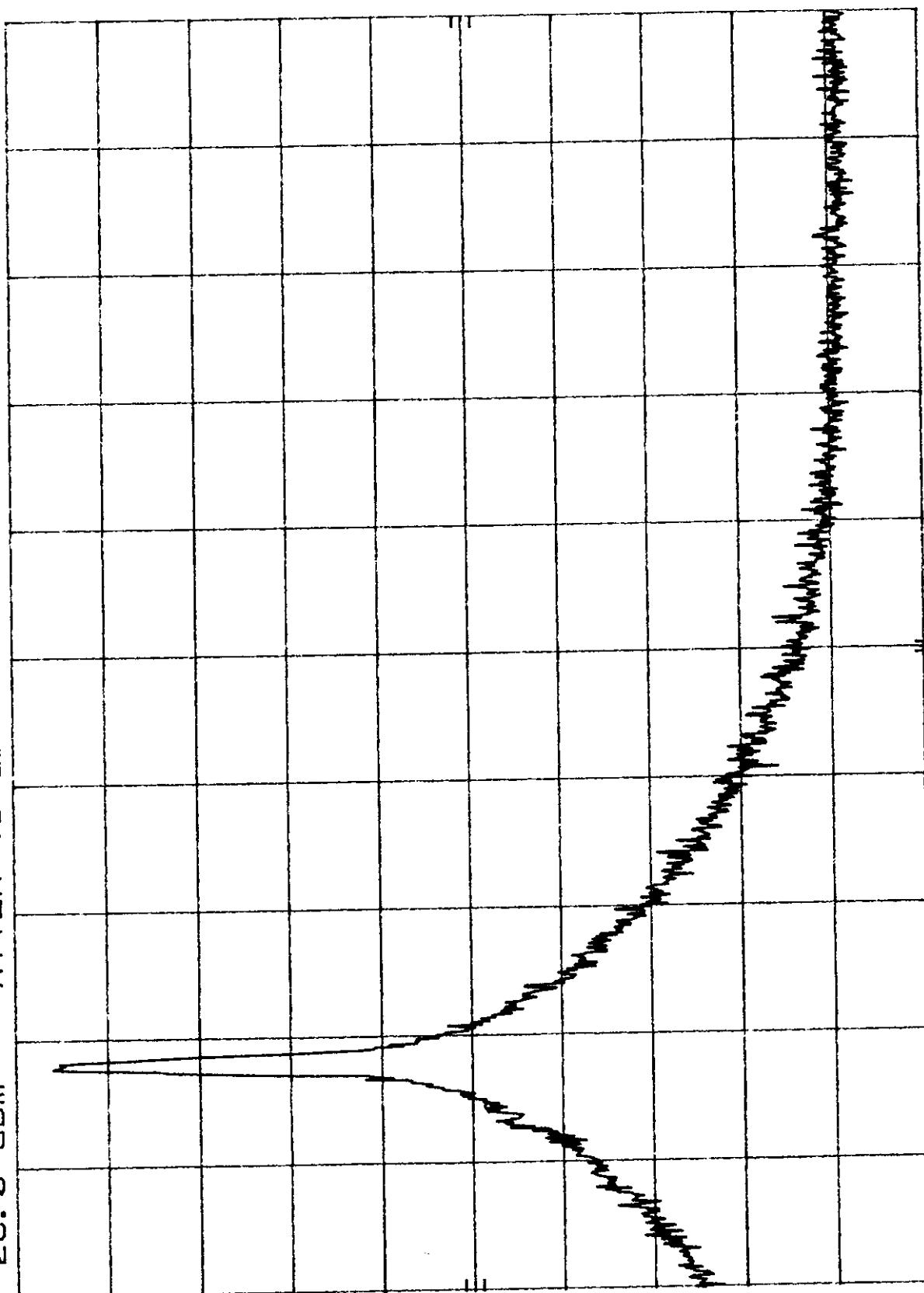
MKR Δ -25.8 kHz
-53.60 dB

PLOT# 5.3.d

GWCOM, GBASE2000U
REF 26.0 dBm ATTEN 40 dB

MKR 930.4001 MHz
-25.70 dBm

10 dB/



START 930.3000 MHz
RES BW 300 Hz
STOP 931.0000 MHz
SWP 15 sec

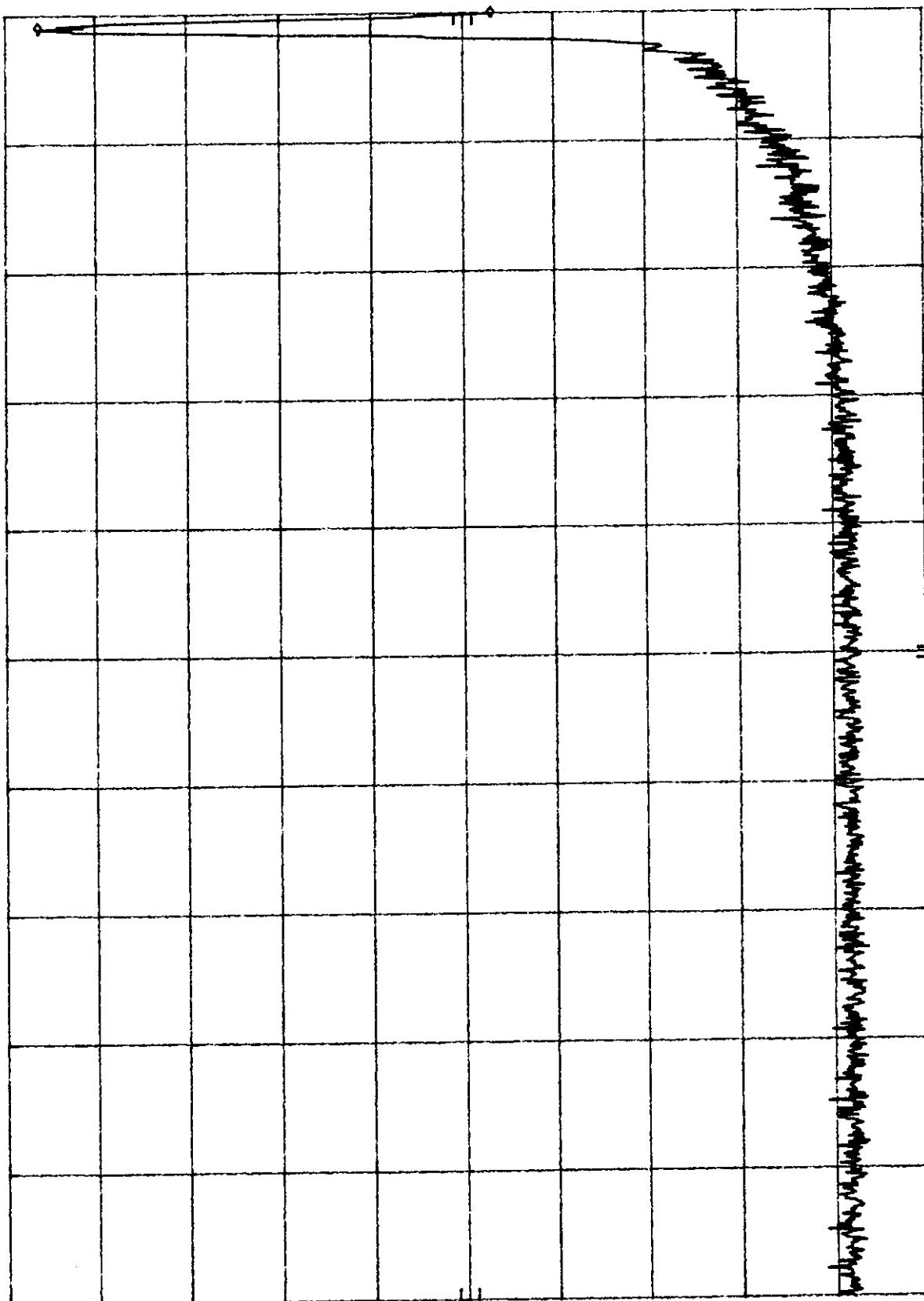
PLOT# 5.3.e

GWCOM. GBASE2000U
REF 26.0 dBm

Hz

10 dB/

MKR Δ 10 kHz
-49.40 dB



START 929.000 MHz
RES BW 300 Hz

VBW 300 Hz

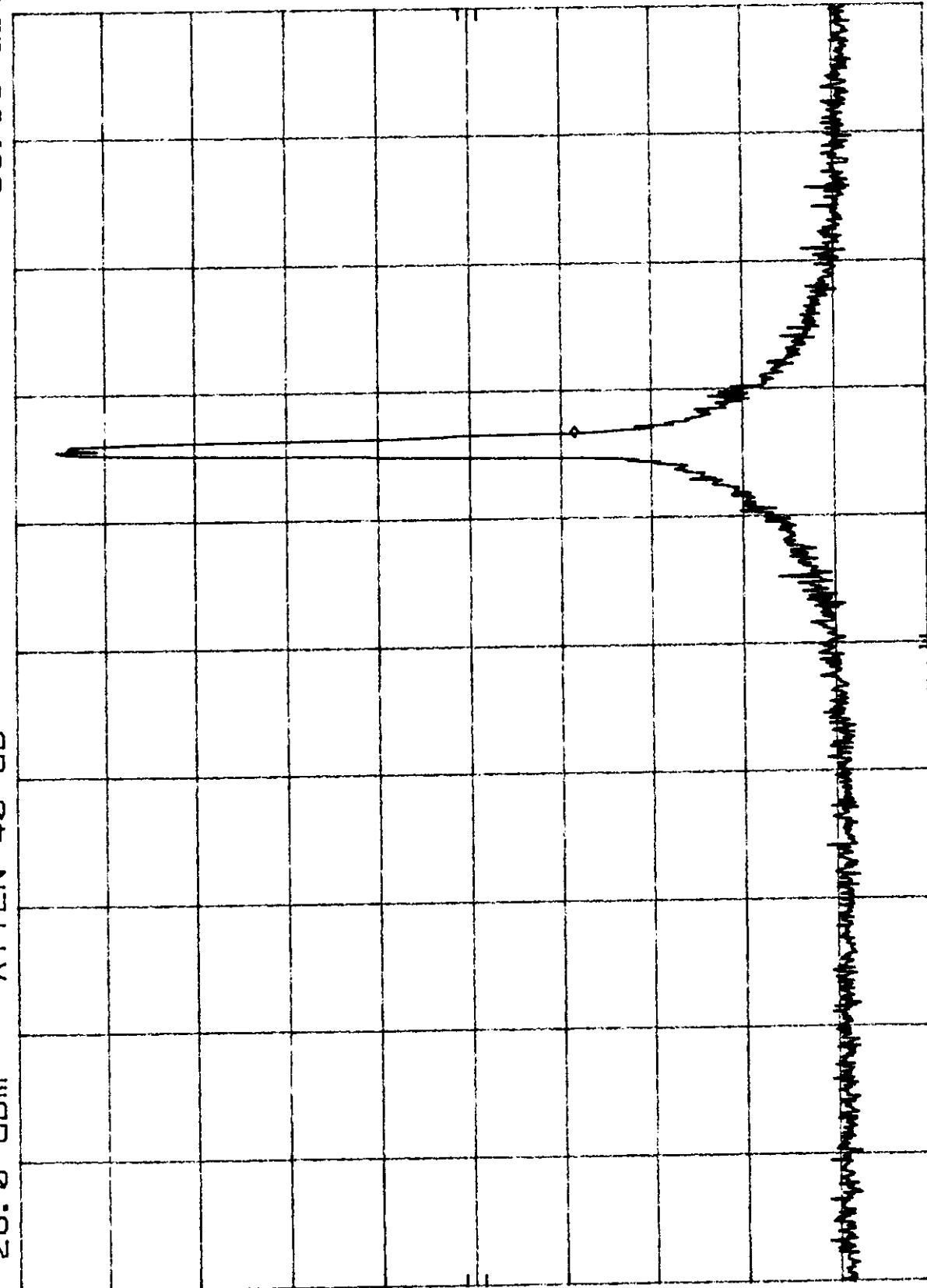
STOP 930.000 MHz
SWP 20 sec

PILOT# 5.3.f

GWCOM. GBASE2000U

REF 26.0 dBm ATTEM 40 dB

10 dB/



START 929.000 MHz
RES BW 300 Hz

VBW 300 Hz

STOP 930.500 MHz
SWP 30 sec

MKRF 930.000 MHz
-35.50 dBm

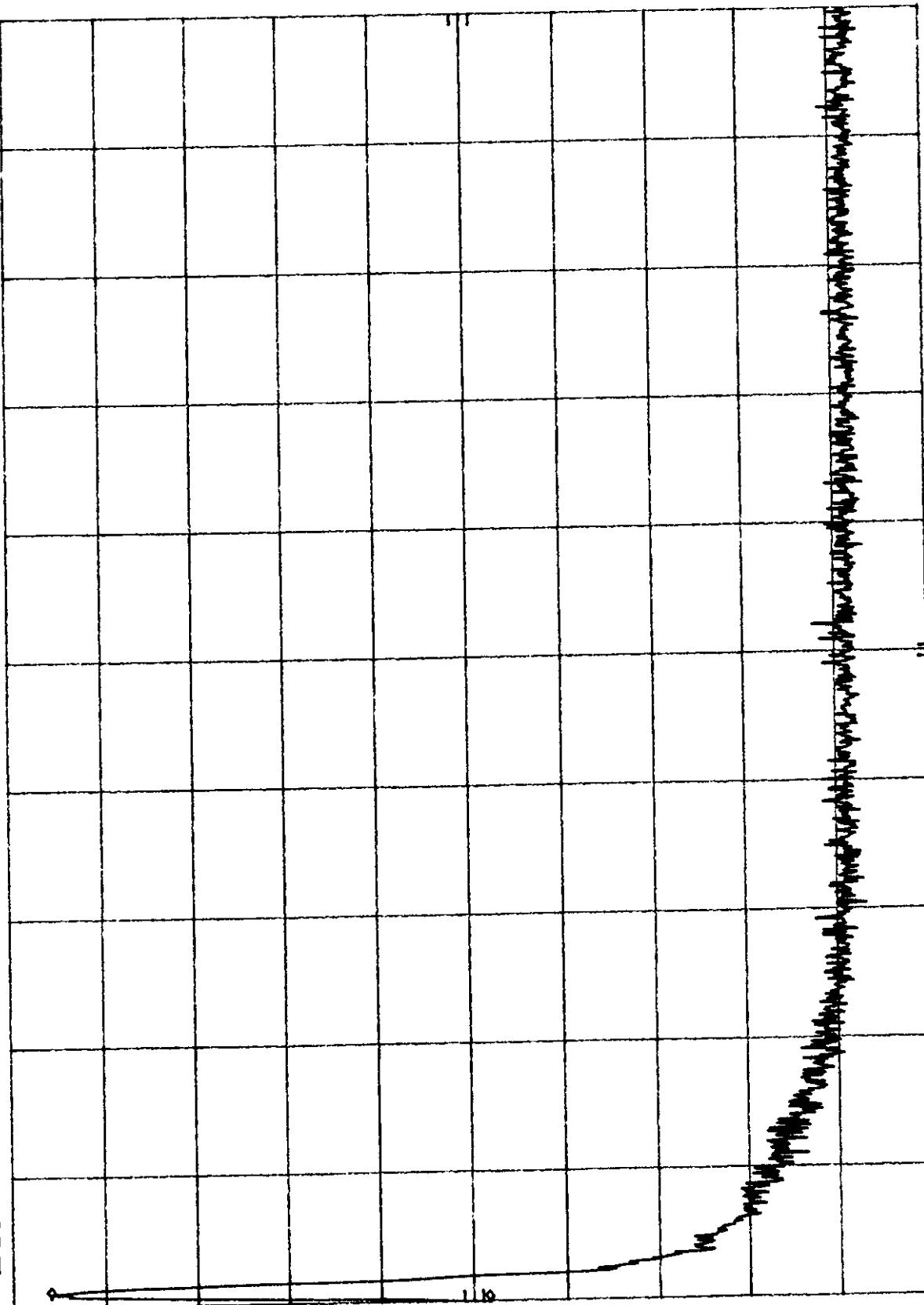
PLOT# 5..3..9

GWCOM. GBASE2000U
REF 26.0 dBm

10 dB/
Hz

ATTEN 40 dB

MKR Δ -10 kHz
-47.60 dB



START 929.000 MHz
RES BW 300 Hz

VBW 300 Hz
SWP 20 sec

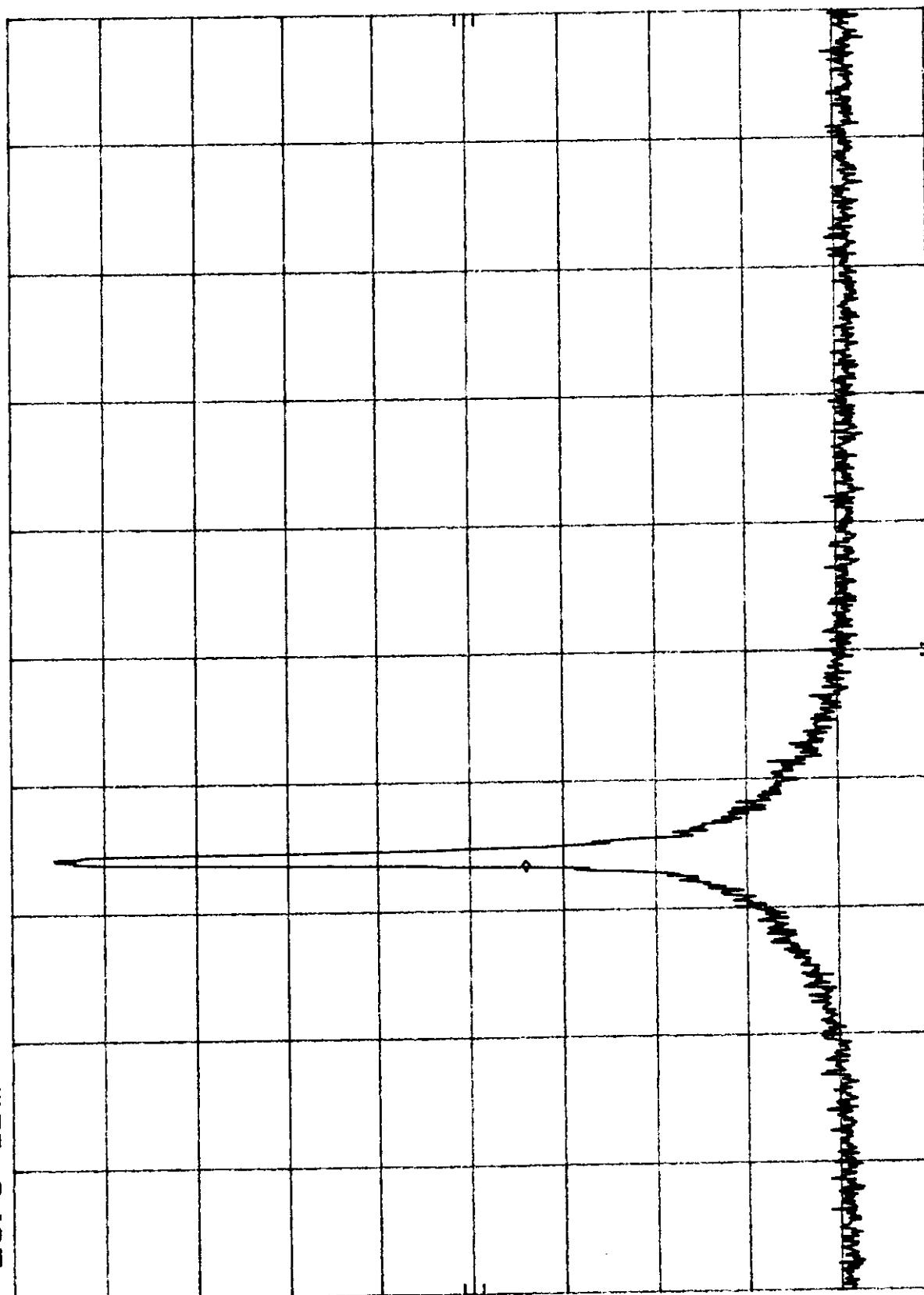
STOP 930.000 MHz
SWP 20 sec

PLOT# 5.3.h

GWCOM, GBASE2000U
REF 26.0 dBm ATTN 40 dB

10 dB/
Hz

MKR 929.001 MHz
-30.00 dBm



STOP 930.000 MHz
SWP 30 sec

START 928.500 MHz
RES BW 300 Hz
VBW 300 Hz

PLOT# 5.3.1

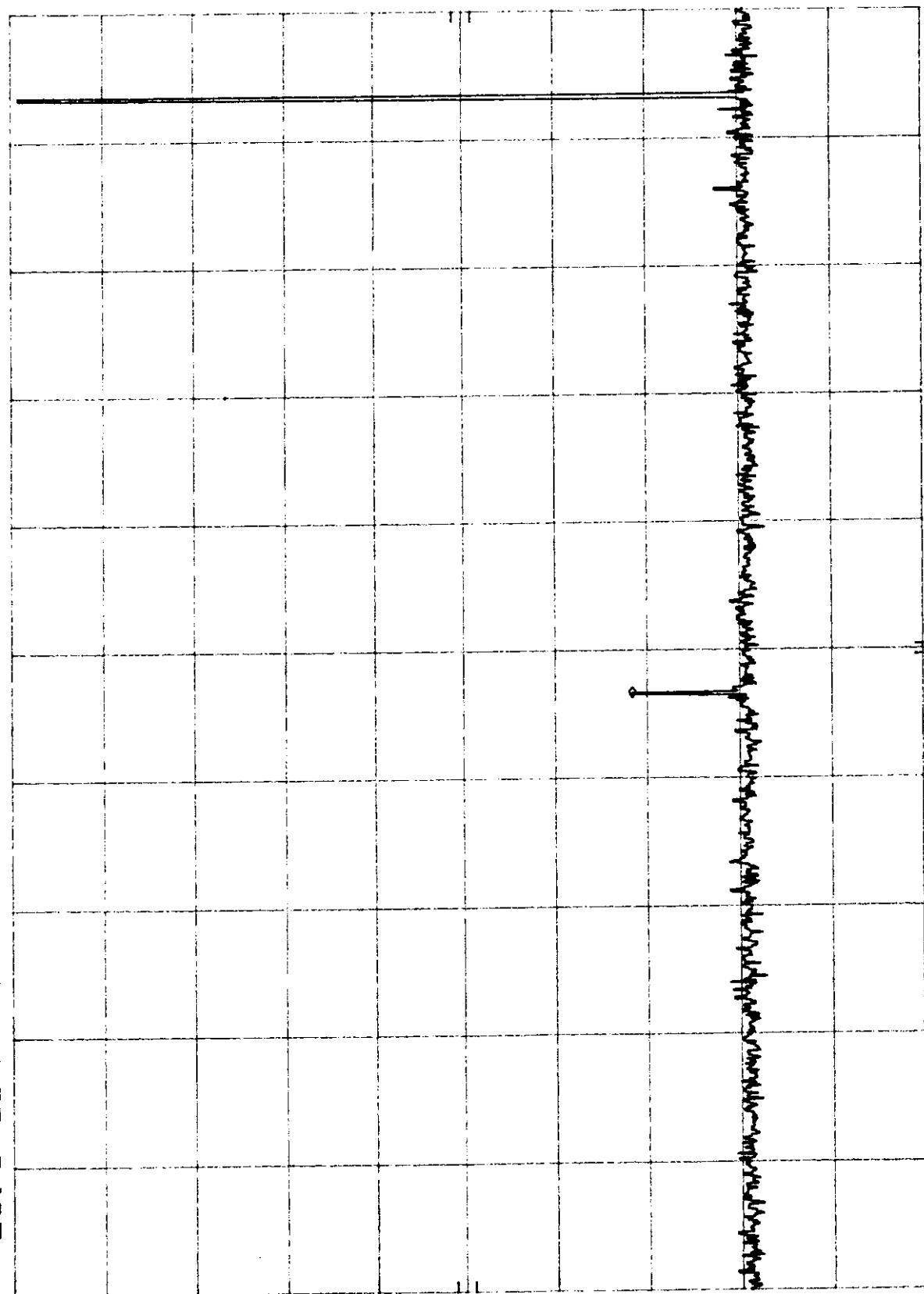
GWCOM. GBASE 2000U

REF 26.0 dBm

ATTEN 40 dB

MKR 467 MHz
-42.40 dBm

10 dB/



START 1 MHz
RES BW 30 kHz
VBW 30 kHz

STOP 1.00 GHz
SWP 3.00 sec

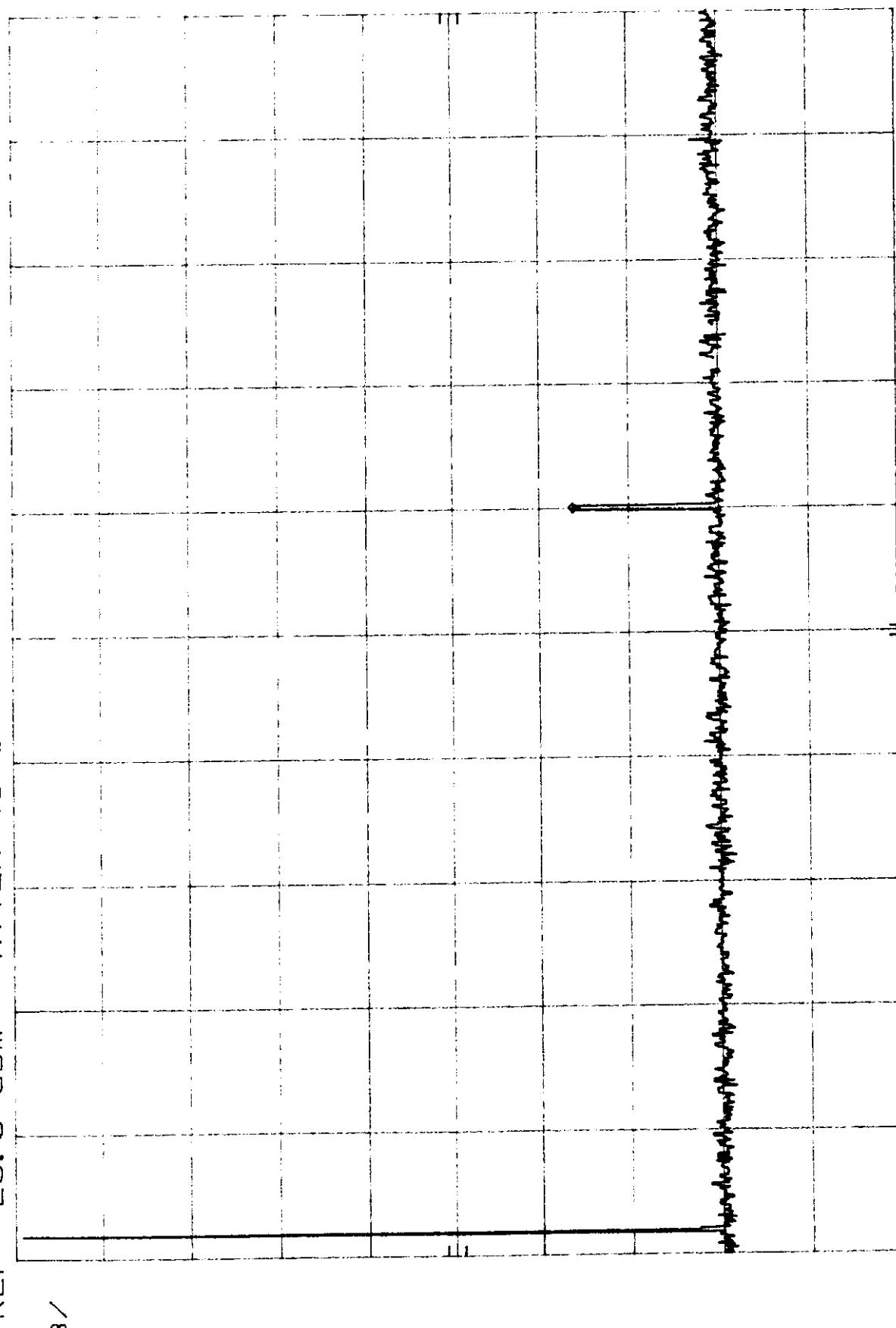
PLOT# 5.3.j

GWCOM. GBASE 2000U

REF 26.0 dBm

ATTEN 40 dB

H_p dB/



START 900 MHz
RES BW 30 kHz
VBW 30 kHz

STOP 2. 50 GHz
SWP 4. 80 sec

MKR 1. 860 GHz
-37.70 dBm

PLT# 5.3.k

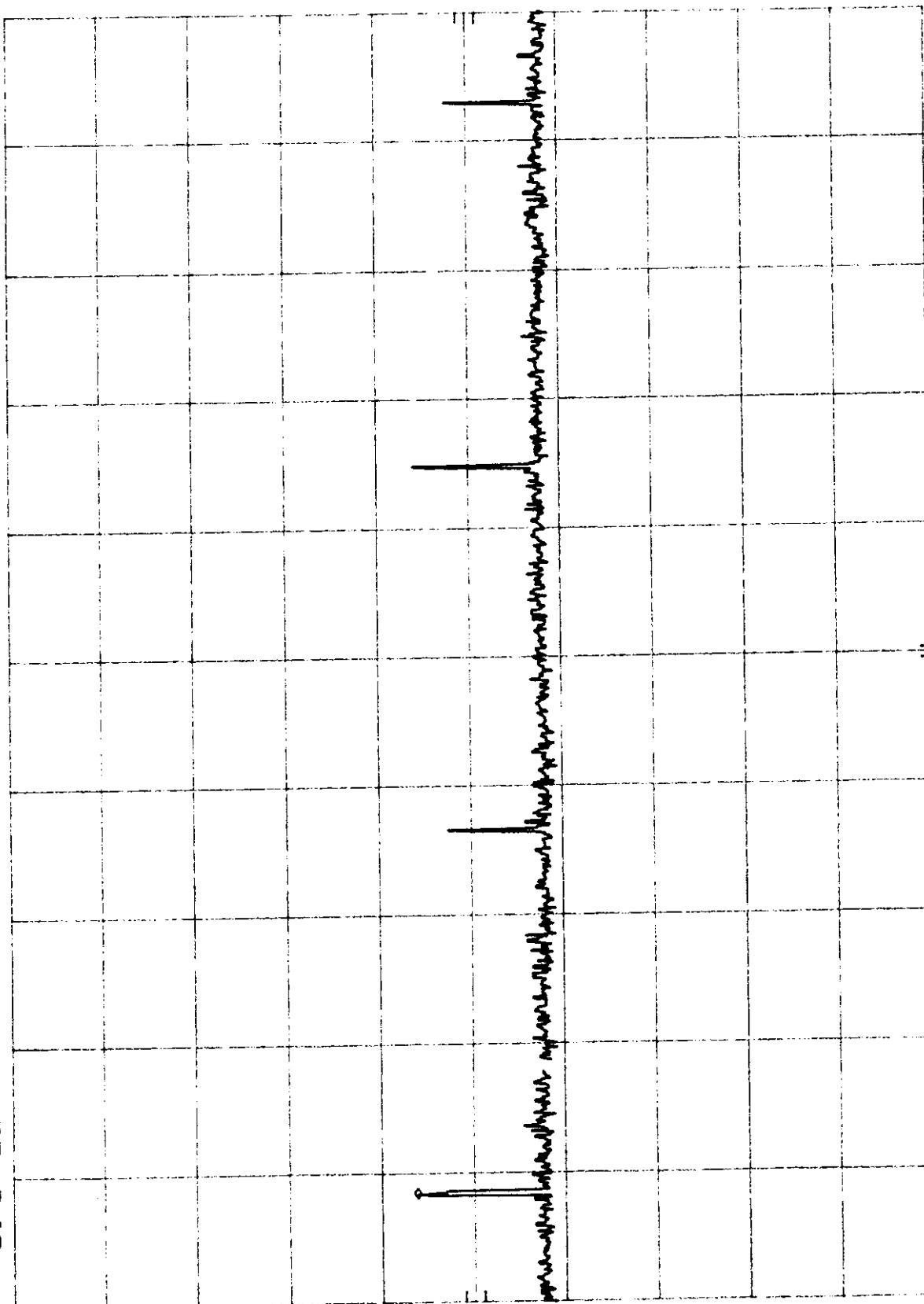
GWCOM, GBASE 2000

40

10 dB /

REF 0.0 dBm ATTEN 30 dB

MKR 2.777 GH
-43.90 dBm

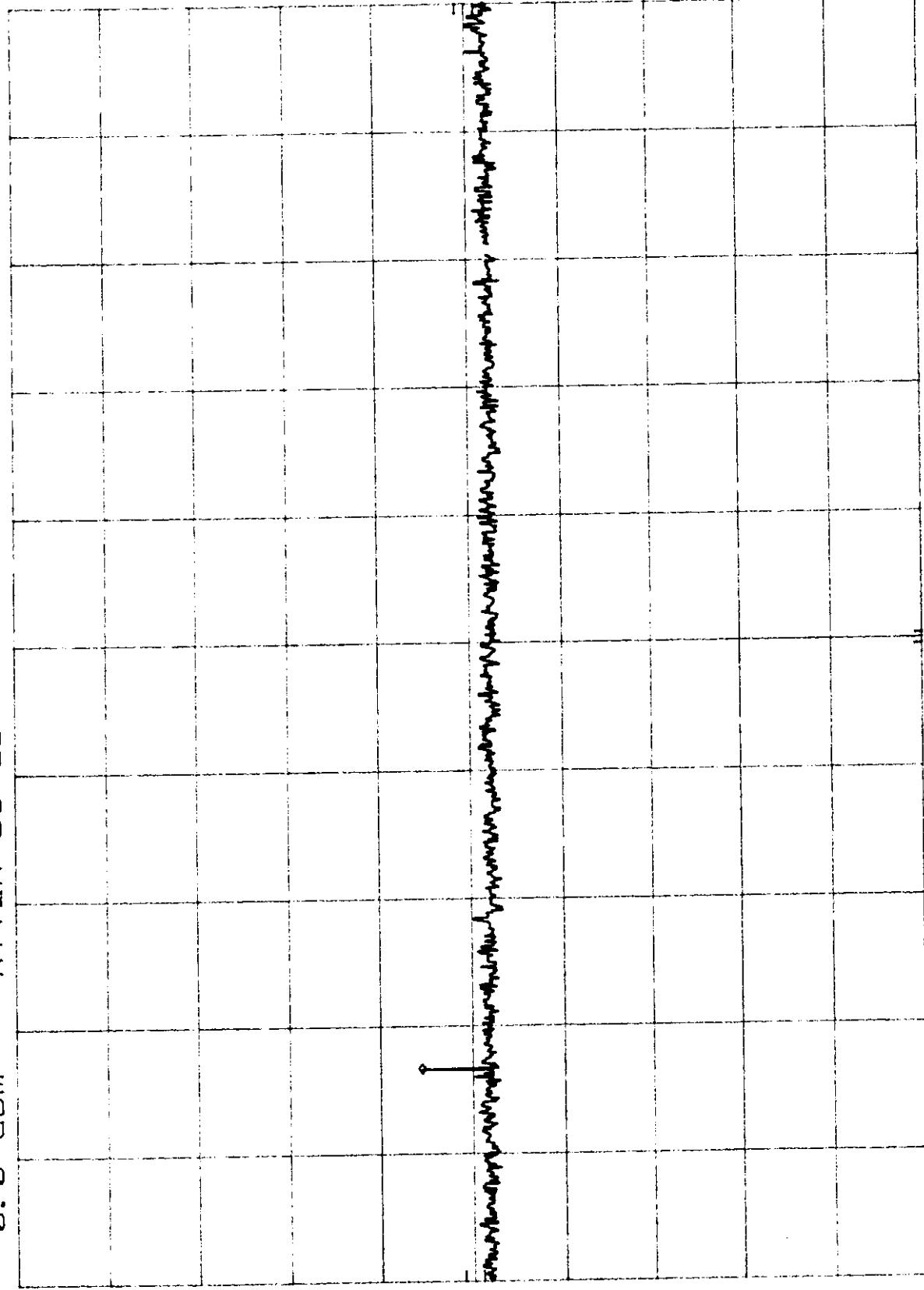


START 2.50 GHz RES BW 100 kHz VBW 100 kHz

PLOT# 5.3.1

GWCOM. GBASE 2000U

REF 0.0 dBm



100

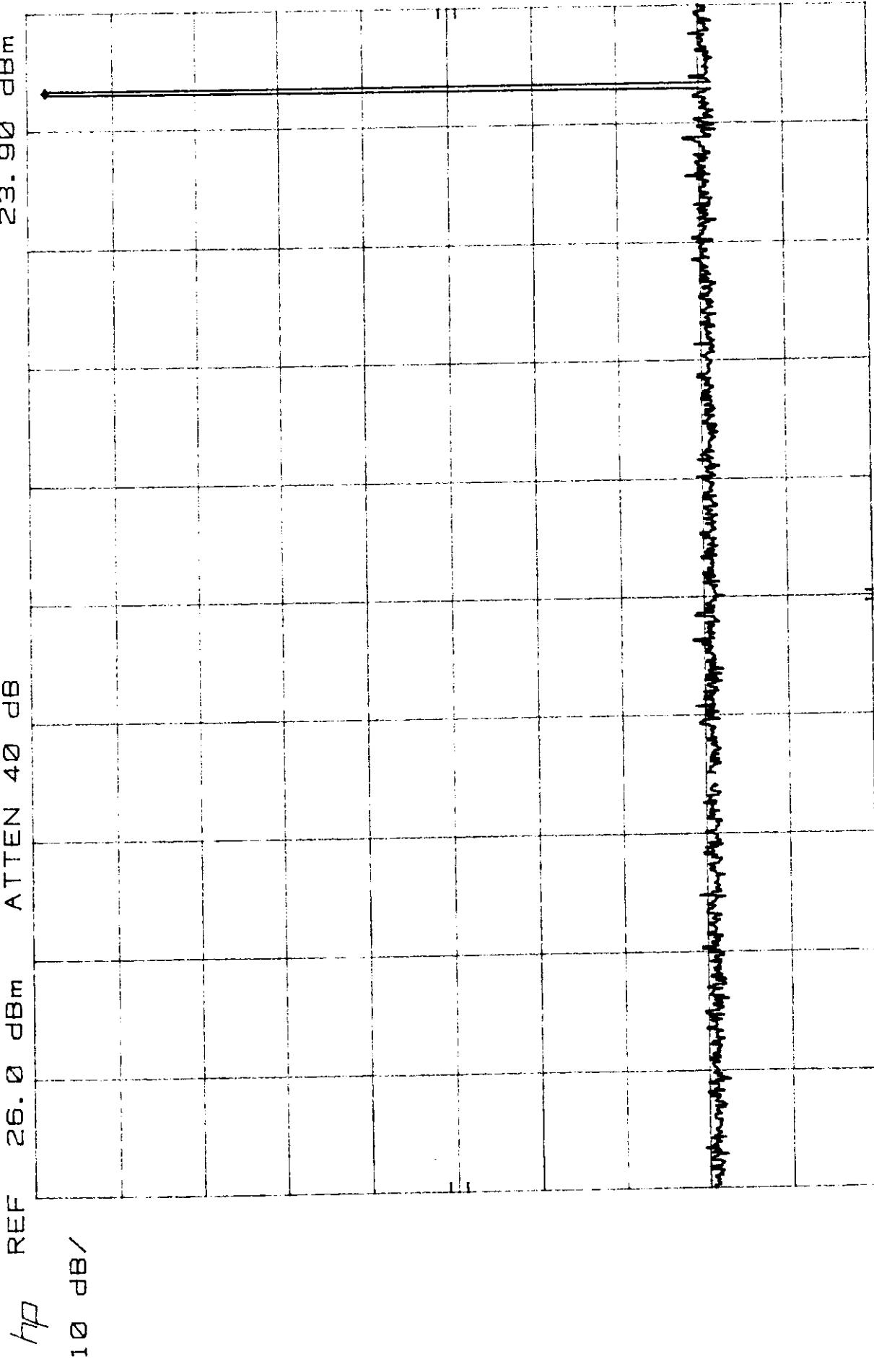
100

START 5.80 GHz
RES BW 100 kHz
VBW 100 kHz

PLOT# 5.3.m

GWCOM. GBASE 2000U
REF 26.0 dBm ATTN 40 dB

MKR 932 MHz
23.90 dBm



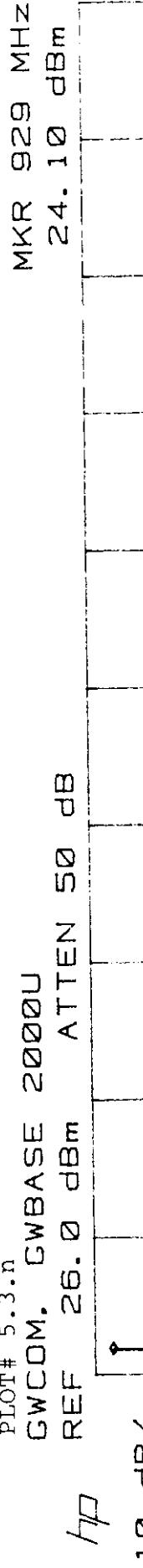
START 1 MHz

RES BW 30 kHz

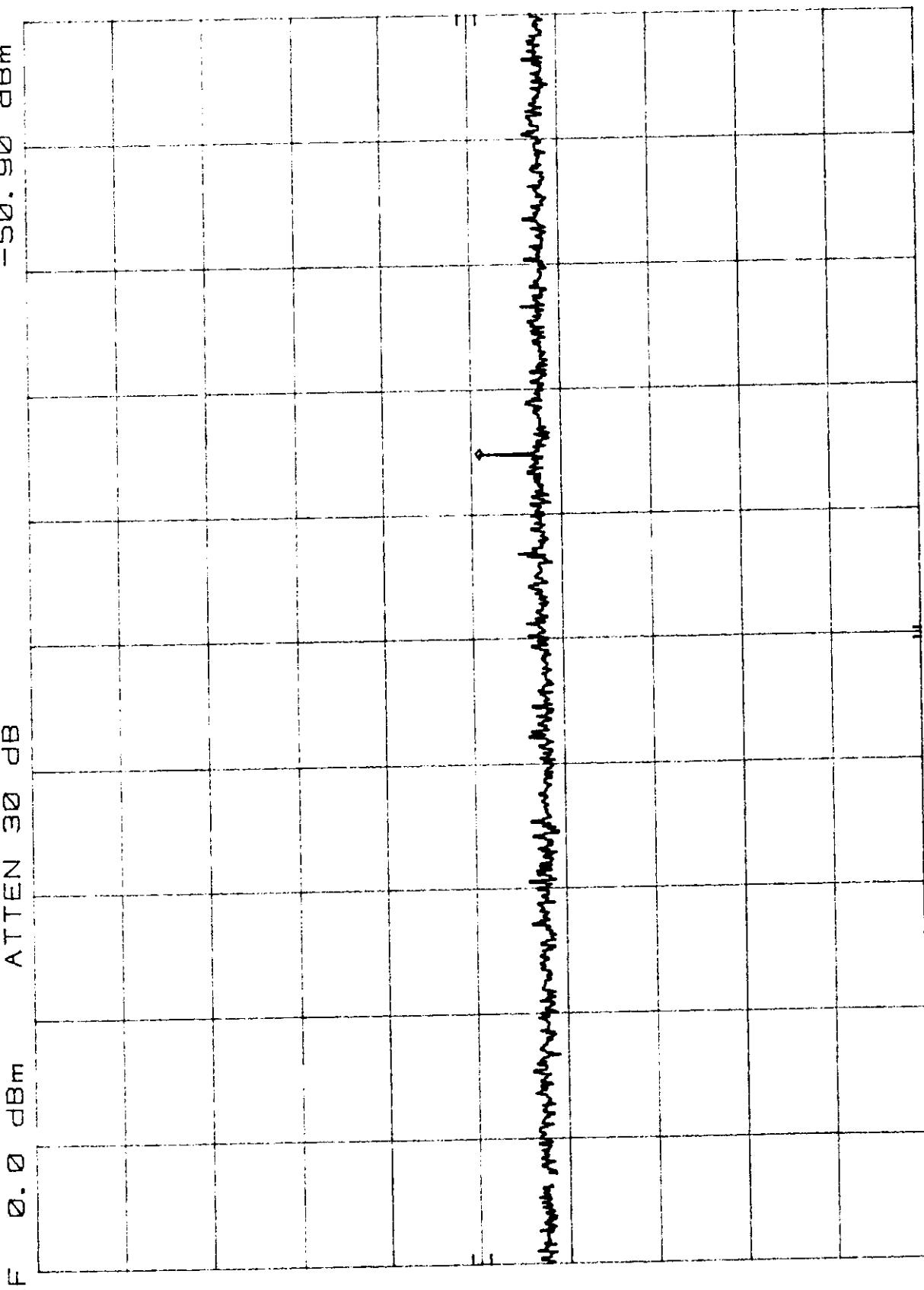
VBW 30 kHz

STOP 1.00 GHz
SWP 3.00 sec

PLOT# 5.3.n
GWCOM. GBASE 2000U
REF 26.0 dBm ATTN 50 dB



PLOT# 5.3.0
GWC0M. GBASE 2000U
REF 0.0 dBm ATTEN 30 dB



START 2. 50 GHz
RES 8W 100 kHz
VBW 100 kHz

MKR 4. 638 GHz
-50. 90 dBm

PILOT# 5.3.p

GWCOM. GBASE 2000U

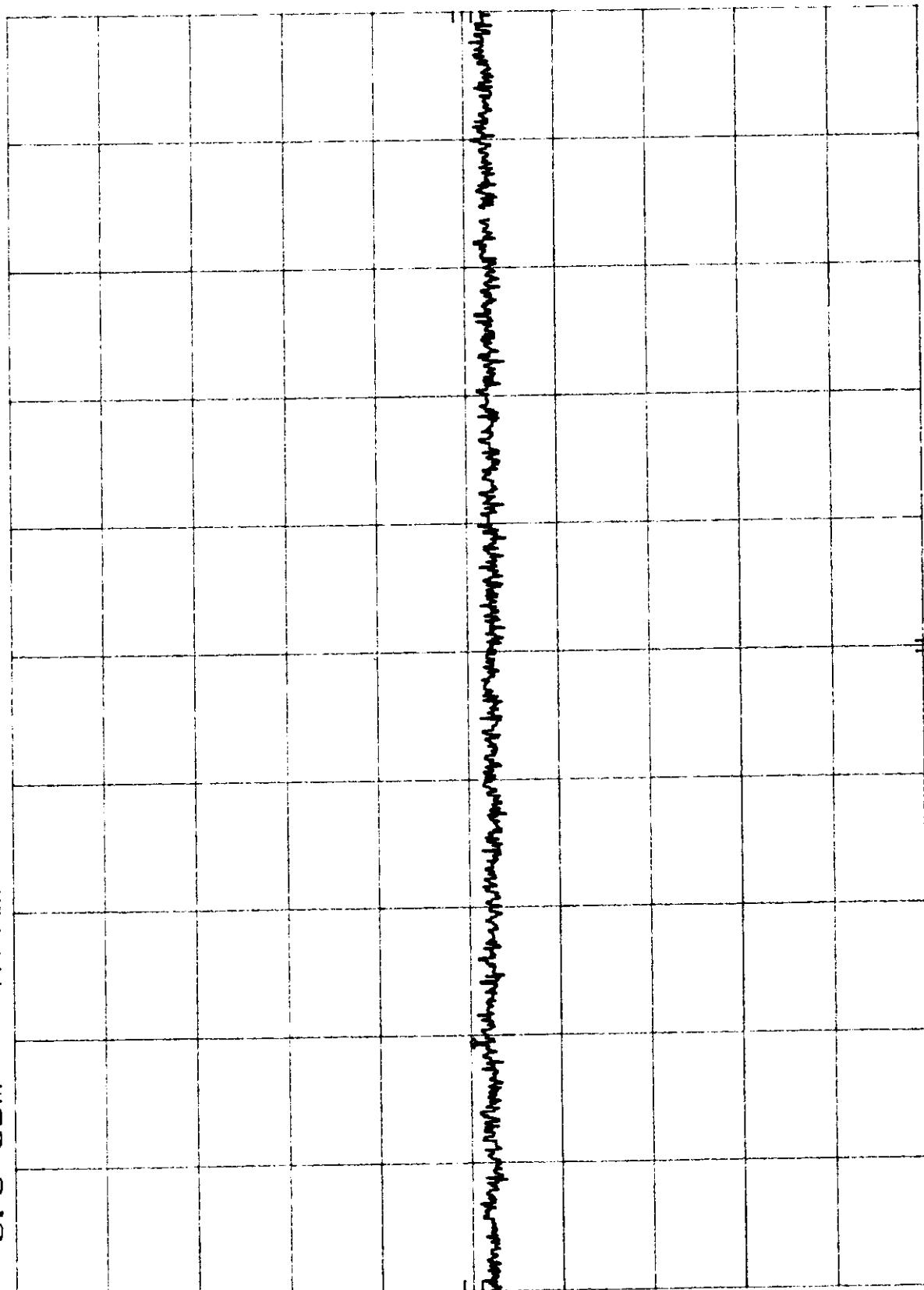
REF 0. 0 dBm

MKR 6. 611 GHz

-50. 30 dBm

100

10 dB/



START 5. 80 GHz
RES BW 100 kHz

VBW 100 kHz

STOP 10. 00 GHz
SWP 1. 26 sec

PLOT# 4.3.a

GWCOM. GWBASE 20000U

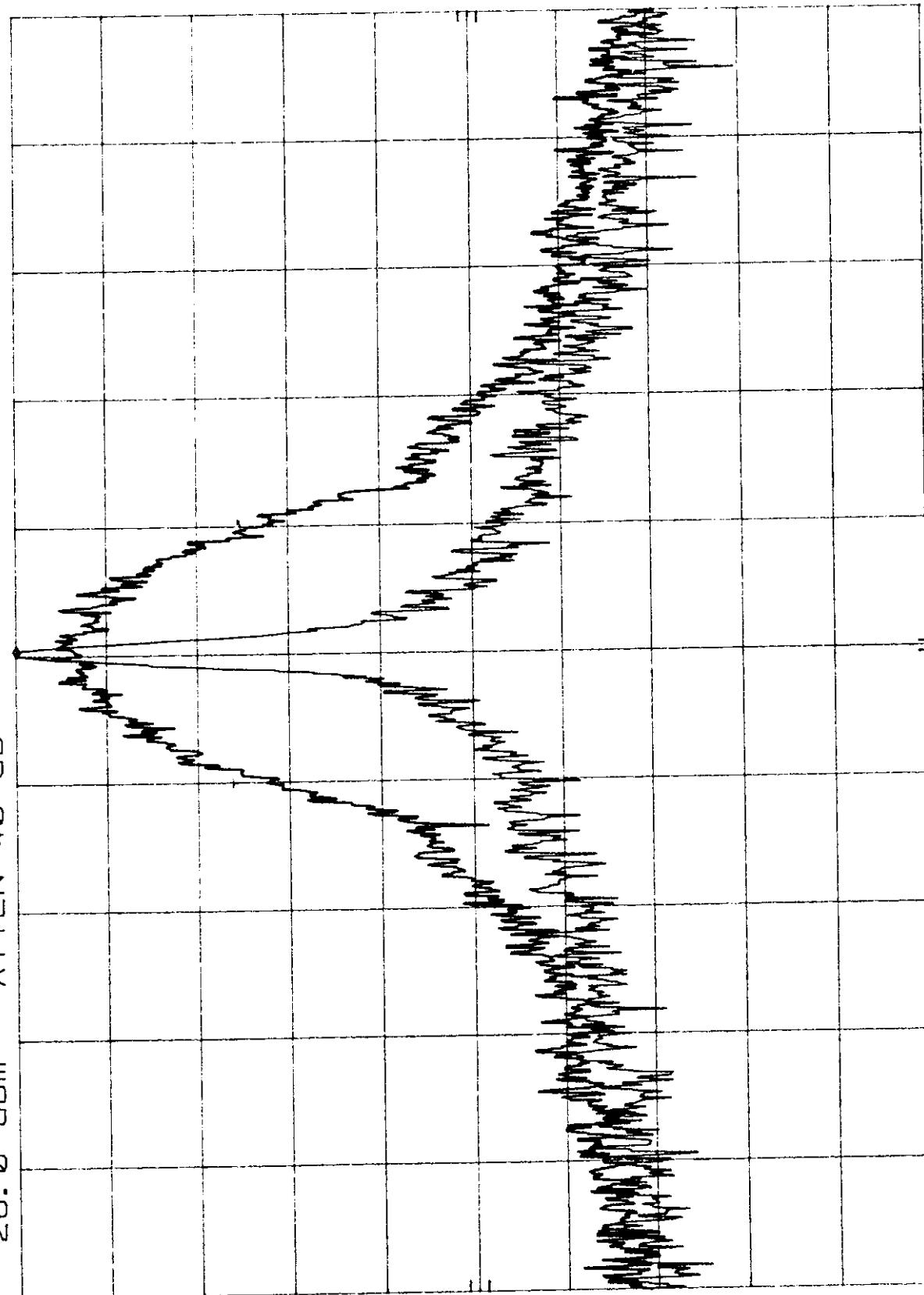
REF 26. 0 dBm

ATTEN 40 dB

MKR 930. 424 55 MHz

25. 90 dBm

10 dB/



CENTER 930. 424 4 MHz

RES BW 300 Hz

VBW 300 Hz

SPAN 50. 0 kHz

SWP 1. 50 sec

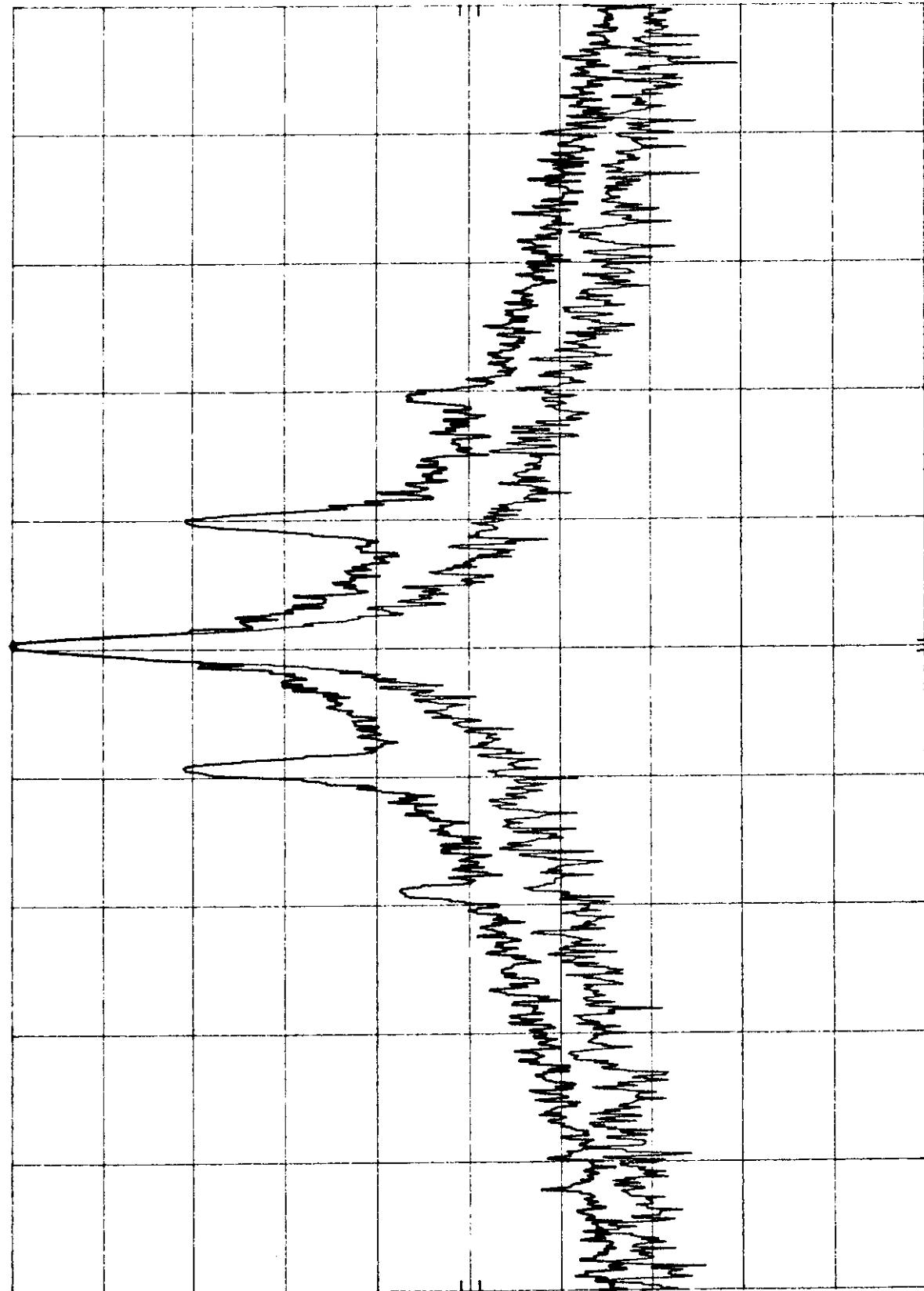
PLOT# 4.3.b

GWCOM. GWBASE 2000U
REF 26. 0 dBm ATTEM 40 dB

$\frac{dP}{dt}$

10 dB/

MKRF 930. 424 55 MHz
25. 90 dBm



SPAN 50. 0 kHz
SWP 1. 50 sec

CENTER 930. 424 4 MHz
RES BW 300 Hz VBW 300 Hz

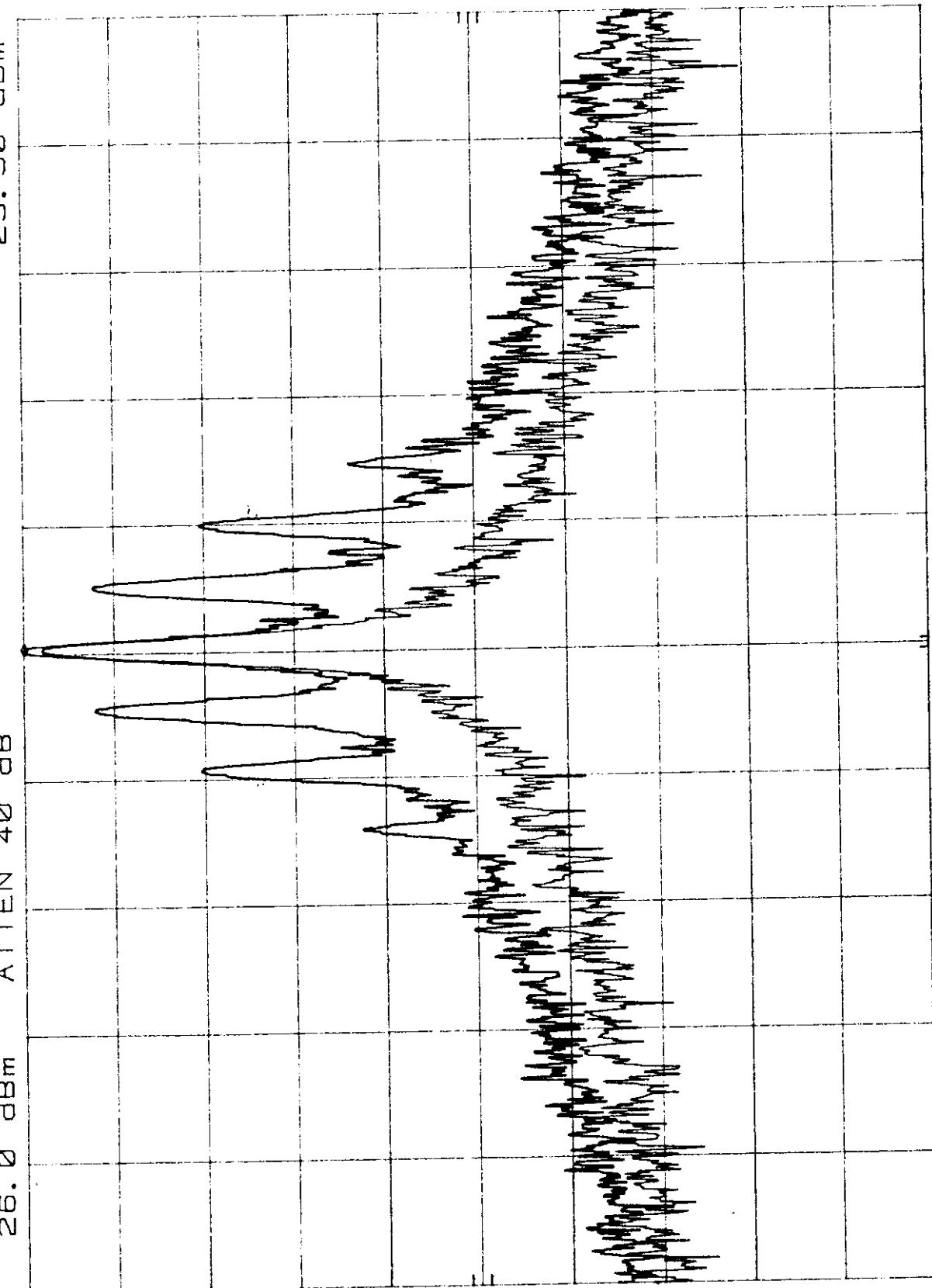
CENTER

PLOT# 4.3.c
GWCOM. G
REF 26.

PLOT# 4.3.c
GWCOM. Gwbase 20000U

R

10 dB/



CENTER

930.424 4 MHz
RES BW 300 Hz

VBW 300 Hz

SPAN 50.0 kHz
SWP 1:50 sec

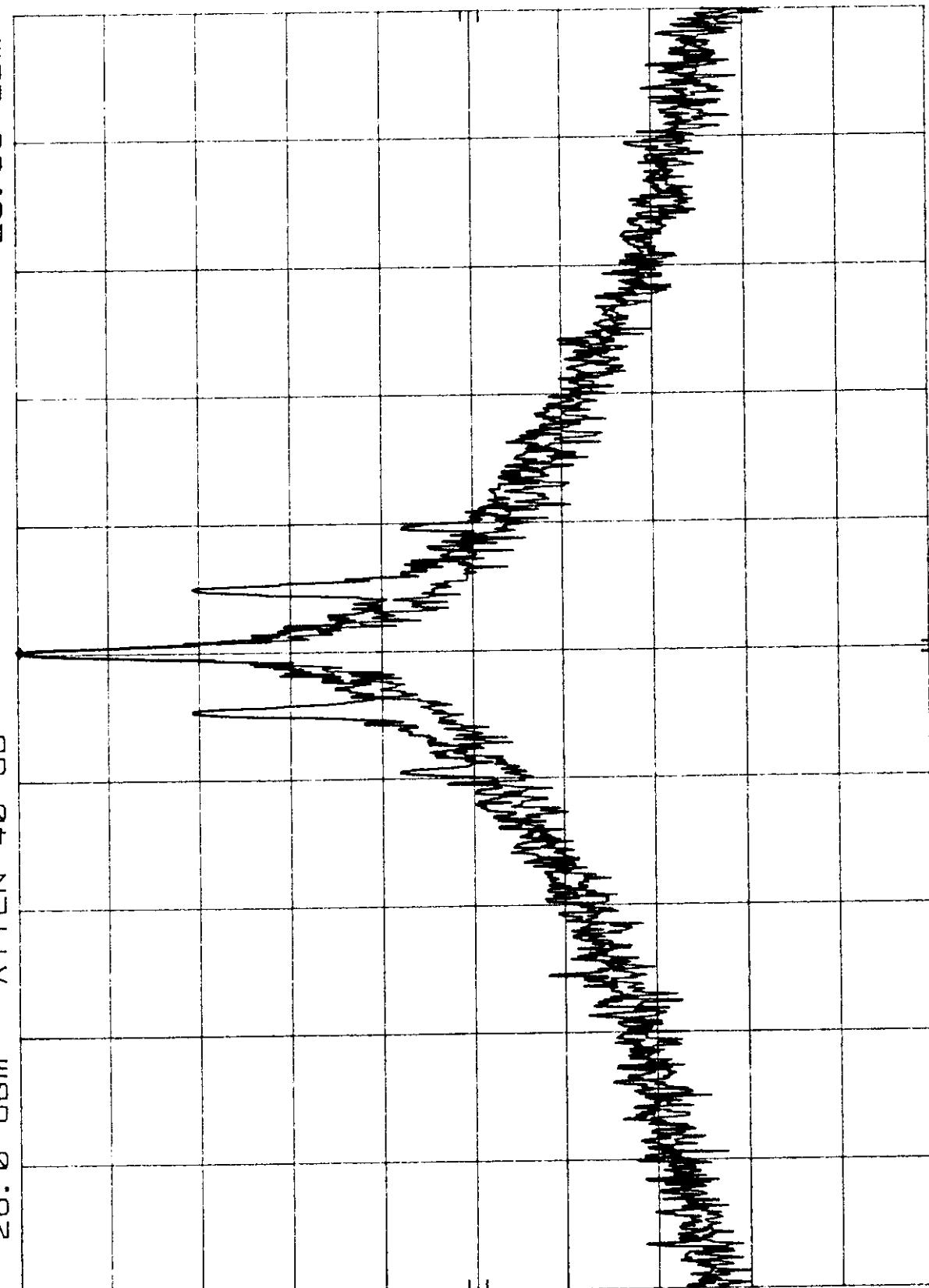
PLOT# 4.3.e

GWCOM. GWBASE 2000U

REF 26. 0 dBm

ATTEN 40 dB

10 dB/

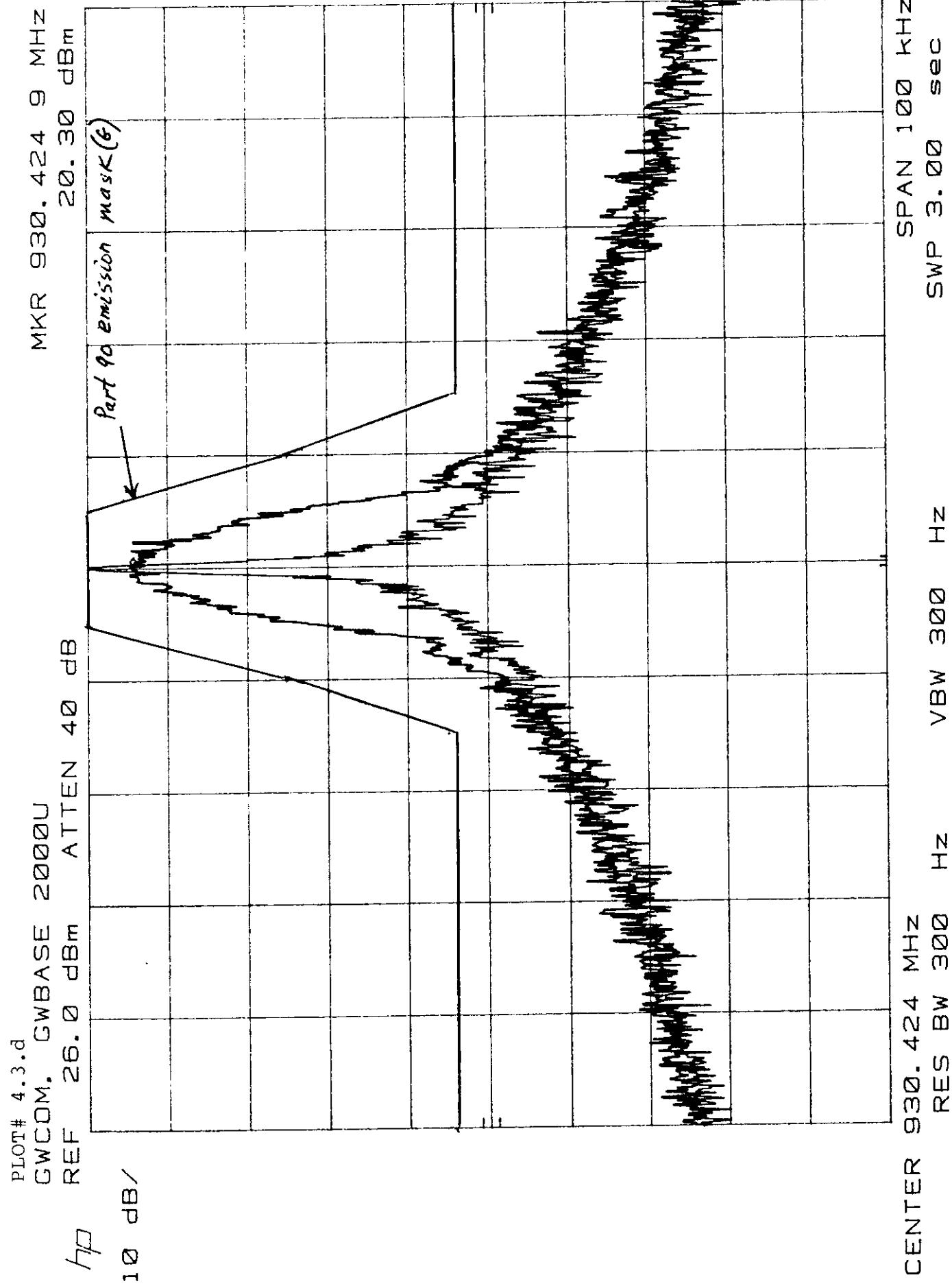


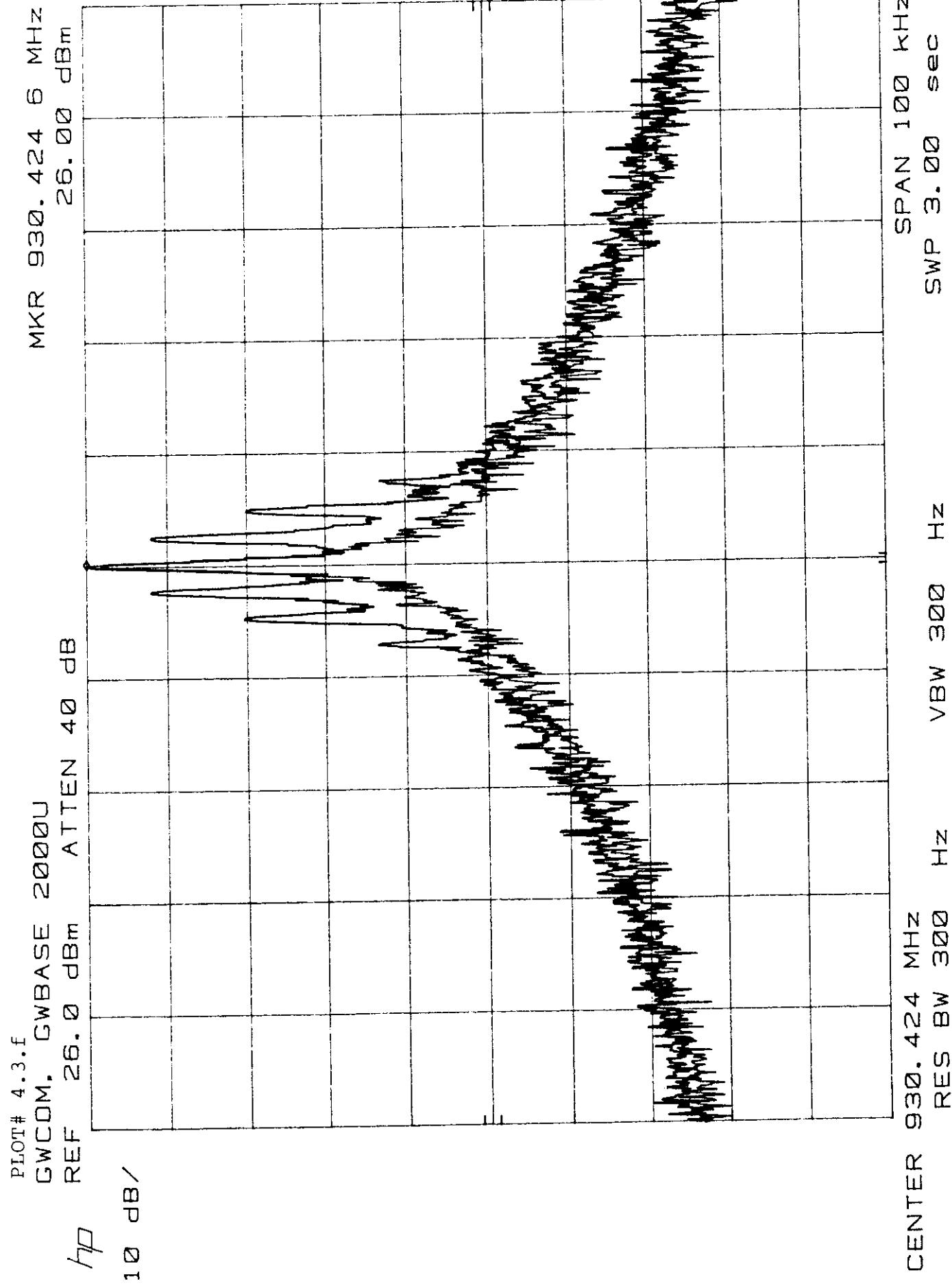
CENTER 930.424 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 100 kHz
SWP 3.00 sec

MKR 930.424 5 MHz
25. 80 dBm

PLOT# 4.3.d
GWCOM. GBASE 2000U
REF 26.0 dBm

10 dB/
Hz





PLOT# 4.3.g

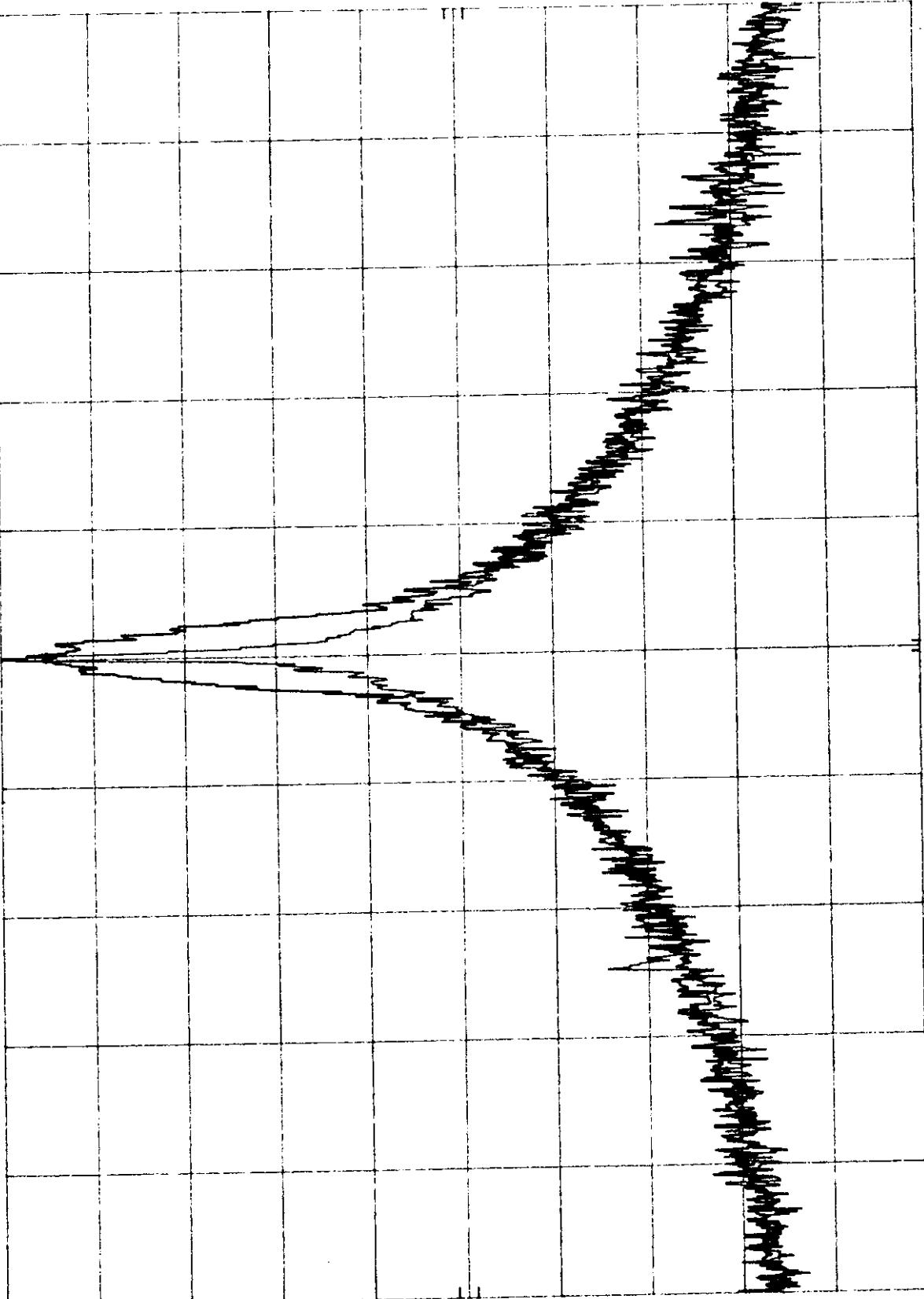
GWCOM. GWBASE 2000U

REF 26. 0 dBm

10 dB/

MKR 930.424 6 MHz
21.10 dBm

ATTEN 40 dB



SPAN 201 kHz
SWP 6.00 sec

CENTER 930.424 MHz
RES BW 300 Hz

VBW 300 Hz

CENTER 930.424 MHz
RES BW 300 Hz

PLOT# 4.3.h

GWCOM. GBASE 2000U

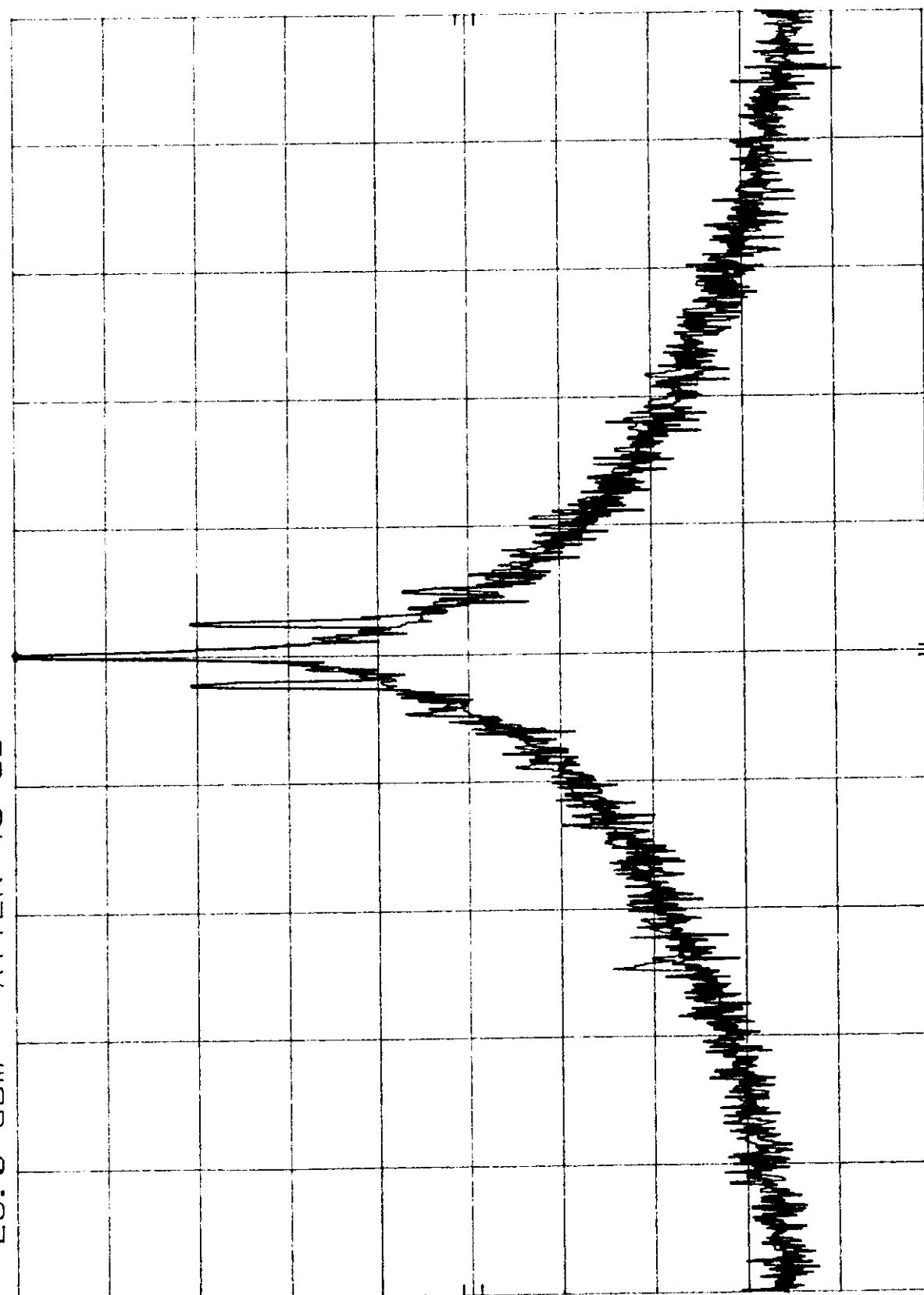
REF 26.0 dBm

ATTEN 40 dB

MKR 930.424 6 MHz

25.90 dBm

$\frac{10}{\text{dB}}$



CENTER 930.424 MHz

RES BW 300 Hz

VBW 300 Hz

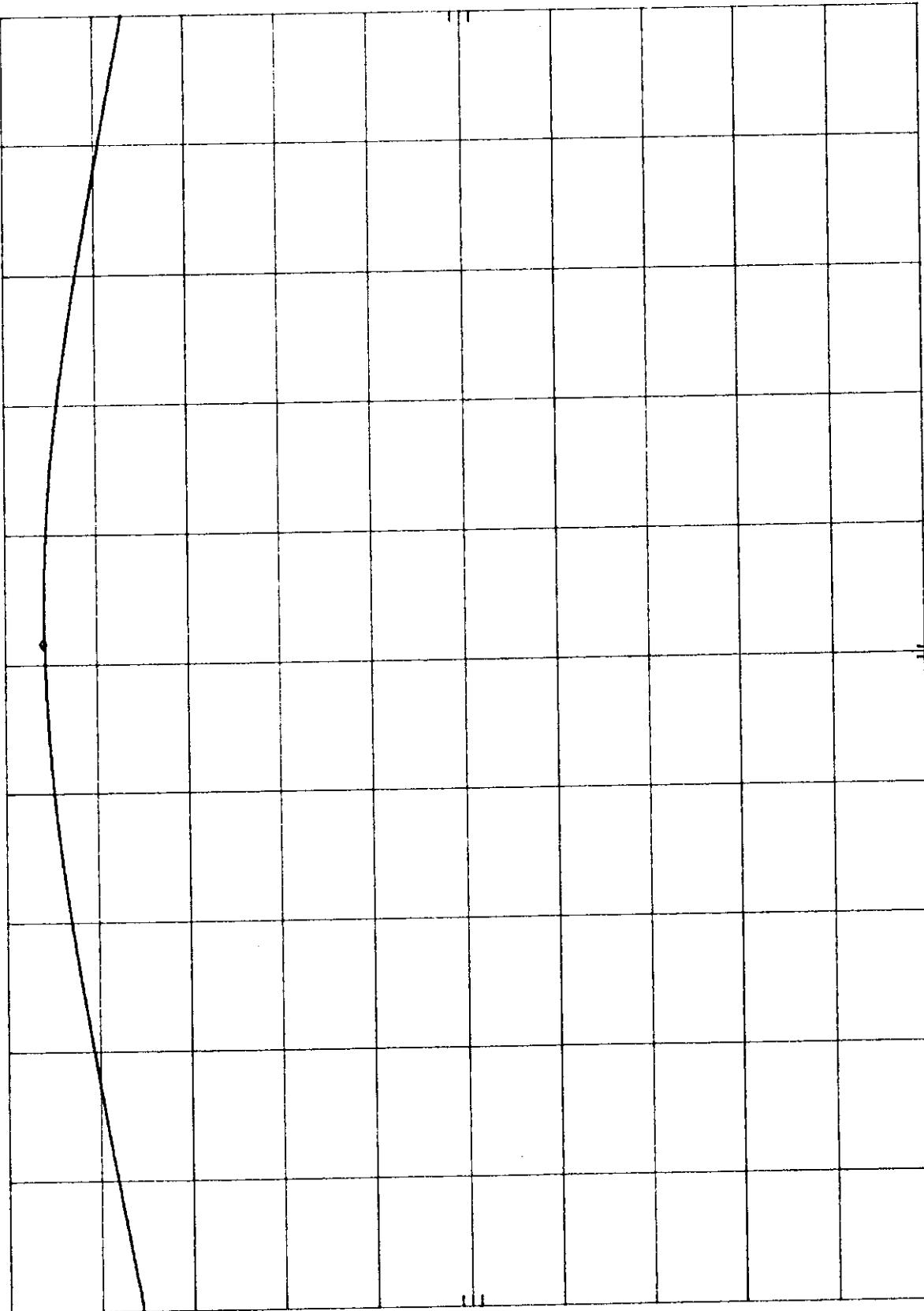
SPAN 201 kHz

SWP 6.00 sec

PLOT# 2.3.a

GWCOM, GBASE 2000U
REF 30. 0 dBm ATTEN 40 dB
MKR 930. 013 2 MHz
25. 90 dBm

h_p
10 dB/



CENTER 930. 010 MHz
RES BW 100 kHz VBW 300 kHz
SPAN 200 kHz SWP 20. 0 msec

PLOT# 4.3.i

GWCOM. GBASE 2000U

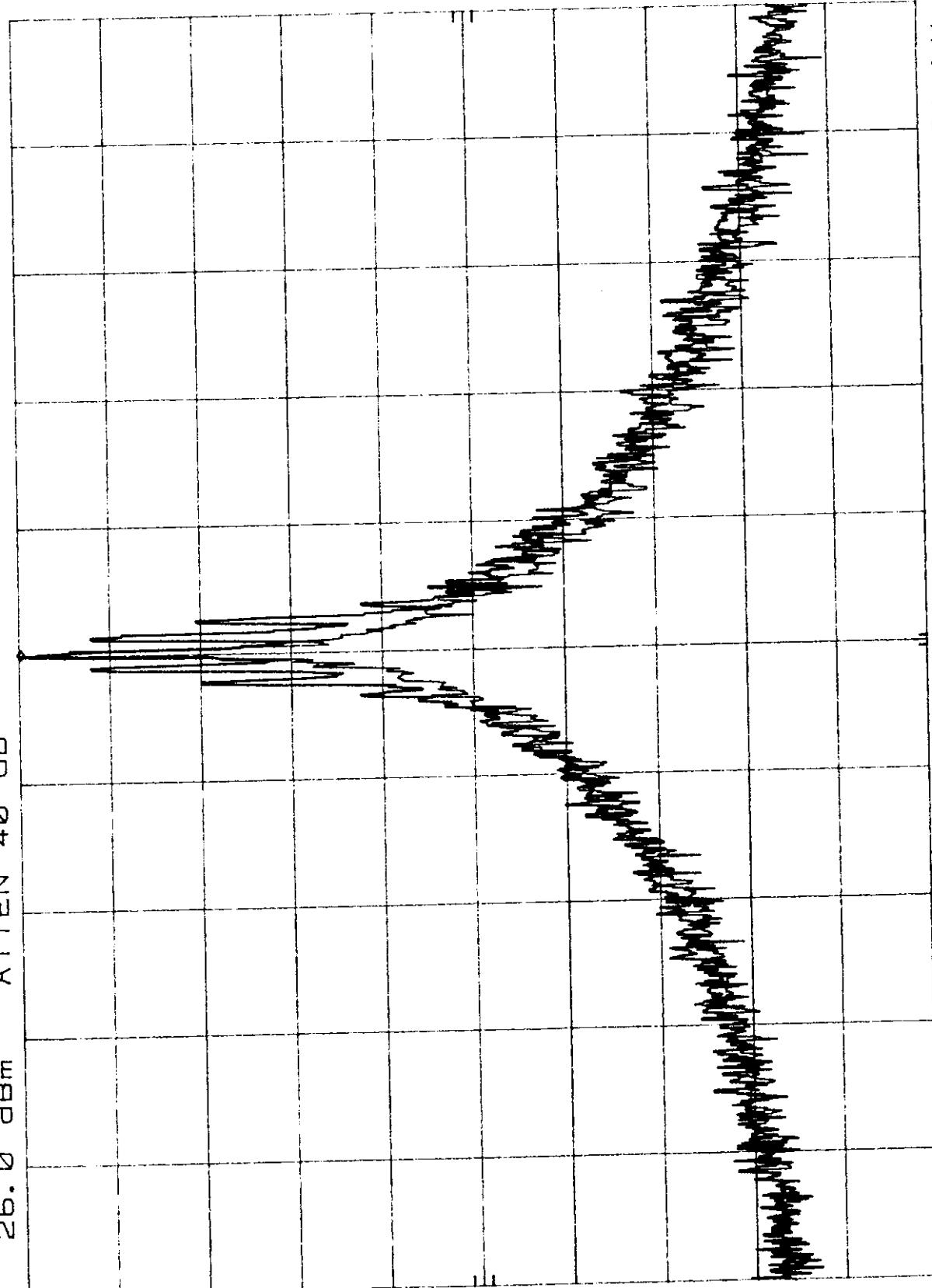
REF 26.0 dBm

ATTEN 40 dB

$\frac{dP}{dt}$

10 dB/

MKR 930.424 6 MHz
25.80 dBm



CENTER

930.424 MHz
RES BW 300 Hz

VBW 300 Hz
SPAN 201 kHz

SWP 6.00 sec

PILOT# 2.3.b

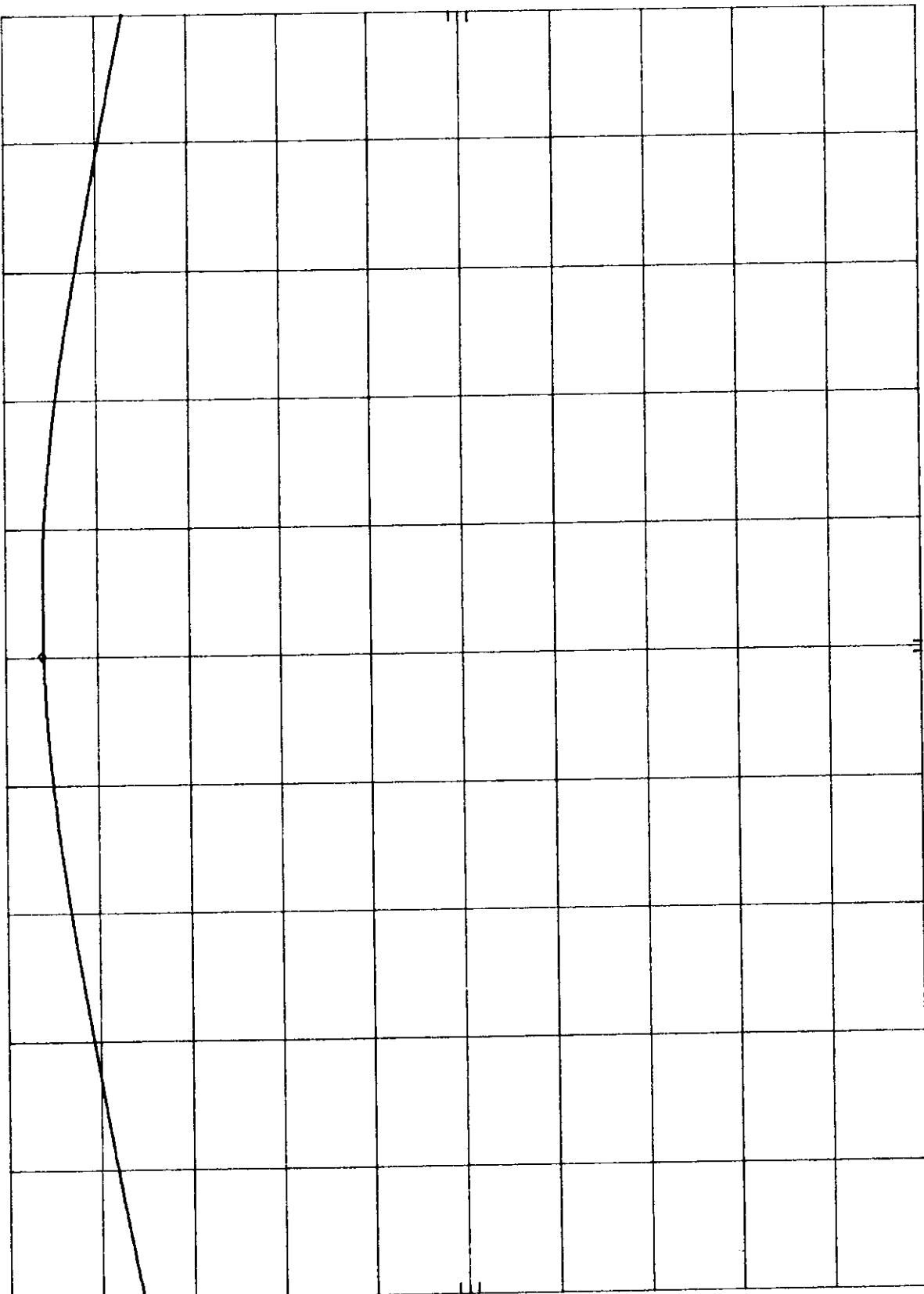
GWCOM. GWBASE 2000U
REF 30.0 dBm ATT

10

REF 30.0 dBm ATTEN 40 dB

GW.COM GWBASE 20000

MKR 930.409 4 MHz 26.00 dBm



SPAN 201 kHz
SWP 20.0 msec

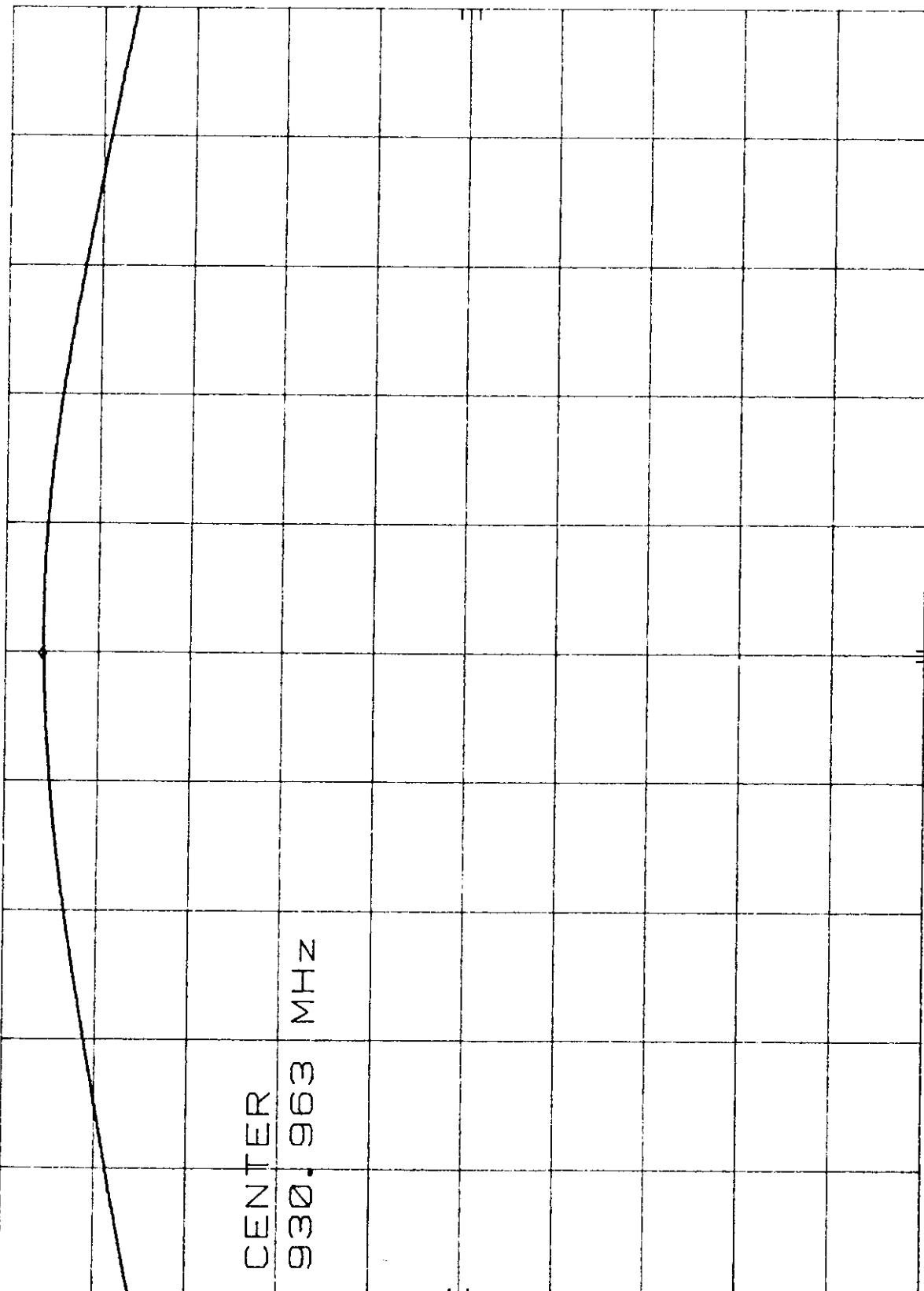
VBW 300 kHz

CENTER 930.409 MHz
RES BW 100 kHz

PLOT# 2.3.C

GWCOM. GWBASE 2000U
REF 30.0 dBm ATTEM 40 dB

10 dB/



CENTER 930.963 MHz

RES BW 1000 kHz

VBW 300 kHz

SPAN 201 kHz
SWP 20.0 msec