



Intertek Testing Services

APPLICATION FOR FCC CERTIFICATION

Symbol Technologies Inc.

2.4 GHz 500mW Radio

Model: LA3021-500

FCC ID: H9PLA3021-500

Job# J99013298

Report# J99013298d

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Date of Report: June 22, 1999

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Symbol Technologies Inc.

Date of Test: May 13 - June 9, 1999

FCC ID: H9PLA3021-500

1 . 0 Summary of Tests

Symbol Technologies Inc. - Model No.: LA-3021400
FCC ID: H9PLA3021-500

TEST	REFERENCE	RESULTS
Max. Output power	15.247(b)(3)	Pass
20 dB Bandwidth	15.247(a)(l)	Pass
Min. Hopping Channels	15.247(a)(l)	Pass
Average Channel Occupancy Time	15.247(a)(l)	Pass
Out of Band Antenna Conducted Emission	15.247 (c)	Pass
Out of Band Radiated Emission	15.247(c)	Not Applicable
Radiated Emission in Restricted Bands	15.247(c), 15.209(a)	Pass
AC Conducted Emission	15.207	Pass
Radiated Emission from Digital Part	15.109	Pass
Radiated Emission from Receiver L.O.	15.109	Not Applicable
Antenna Requirement	15.203	Pass

Test Engineer:

Xi-Ming Yang
XI-Ming YangDate: July 1, 1999

EMC Site Mgr. :

David Chernomordik
David Chernomordik, Ph.D.Date: 1/7/99

Symbol Technologies Inc.
FCC ID: H9PLA3021-500

Date of Test: May 13 - June 9, 1999

2.0 General Description

2.1 Product Description

The Symbol Technologies Inc. Model LA3021-500 is a 2.4 GHz frequency hopping spread spectrum device.

Overview of the EUT

Applicant	Symbol Technologies Inc.
Trade Name & Model No.	Symbol Technologies, Model No. LA3021-500
FCC Identifier	H9PLA3021-500
Use of Product	
Manufacturer & Model of Spread Spectrum Module	
Type of Transmission	Frequency Hopping Spread Spectrum
Rated RF Output (mW)	500
Frequency Range (MHz)	2402 - 2480
Number of Channel(s)	79
Antenna(s) & Gain, dBi	21 antennas; see antenna data sheet
Processing Gain Measurements	[X] Will be provided directly to the FCC reviewing engineer by the client or manufacturer of the spread spectrum module
Antenna Requirement	☐ The EUT uses a permanently connected antenna. ☒ The antenna is affixed to the EUT using a unique connector which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector. ☐ The EUT requires professional installation (attach supporting documentation if using this option).
Manufacturer name & address	Symbol Technologies 2145 Hamilton Avenue San Jose, CA 95125

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Data Sheet**" of this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

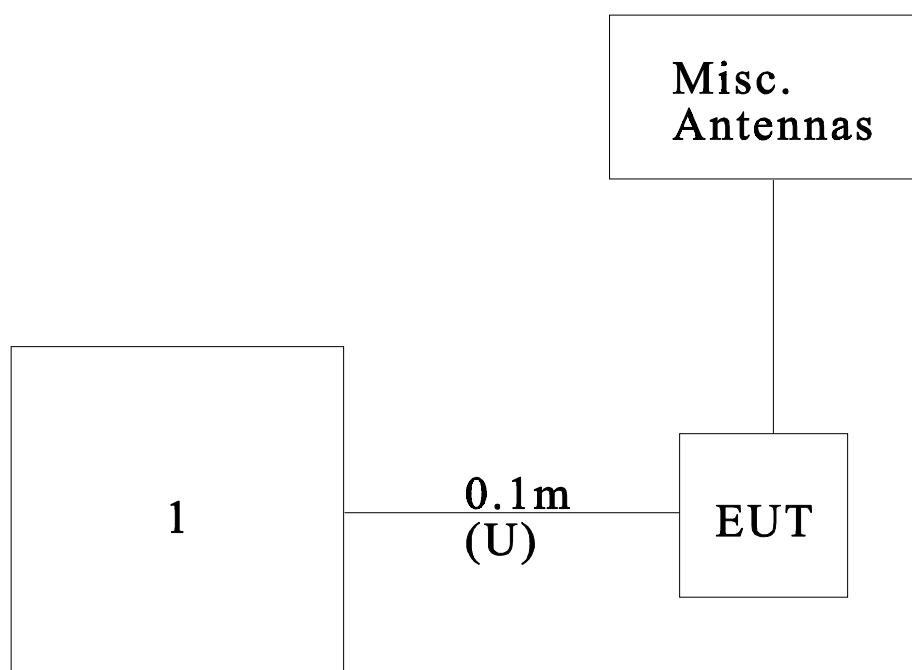
The open area test site and conducted measurement facility used to collect the radiated data is located at 1365 Adams Court, Menlo Park, CA 94025. This test facility and site measurement data have been fully placed on file with the FCC.

3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No.	Serial No.	FCC ID
1	Dell Computer	POS3410-N500	F999999	DoC

3.2 Block Diagram of Test Setup



m: Length in meters

U: Unshielded

3.3 Justification

For emission testing, the equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). During testing, all cables were manipulated to produce worst case emissions.

For radiated emission measurements, the EUT is attached to a cardboard box (if necessary) and placed on the wooden turntable. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). The EUT is wired to transmit full power.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use.

3.5 Mode of Operation During Test

For emissions testing, the units were setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing.

3.6 Modifications Required for Compliance

The following modifications were installed during compliance testing in order to bring the product into compliance (Please note that this list does not include changes made specifically by Symbol Technologies Inc. prior to compliance testing):

No modifications were made to the EUT by Intertek Testing Services.

4.0 Measurement Results

4.1 Maximum Conducted Output Power at Antenna Terminals , FCC Ref: 15.247(b):

With the hopping function turned OFF:

☐ The antenna port of the EUT was connected to the input of a power meter. Power was read directly and cable loss correction was added to the reading to obtain power at the EUT antenna terminals.

☒ The antenna port of the EUT was connected to the input of a spectrum analyzer. The analyzer was set for maximum RES BW and power was read directly in dBm.

For antennas with gains of 6 dBi or less , maximum allowed transmitter output is 1 watt (+30 dBm).

For antennas with gains greater than 6 dBi, transmitter output level must be decreased by an amount equal to (GAIN - 6)/3 dBm.

NOTE: Hopping function disabled during test

Frequency (MHz)	Output in dBm	Output in mWatt
2402	25.2	331
2440	24.9	309
2480	24.5	281

Cable loss: 0.2 dB

External Attenuation: 3.0 dB

Cable loss, external attenuation:

☒ included in OFFSET function

☐ added to SA raw reading

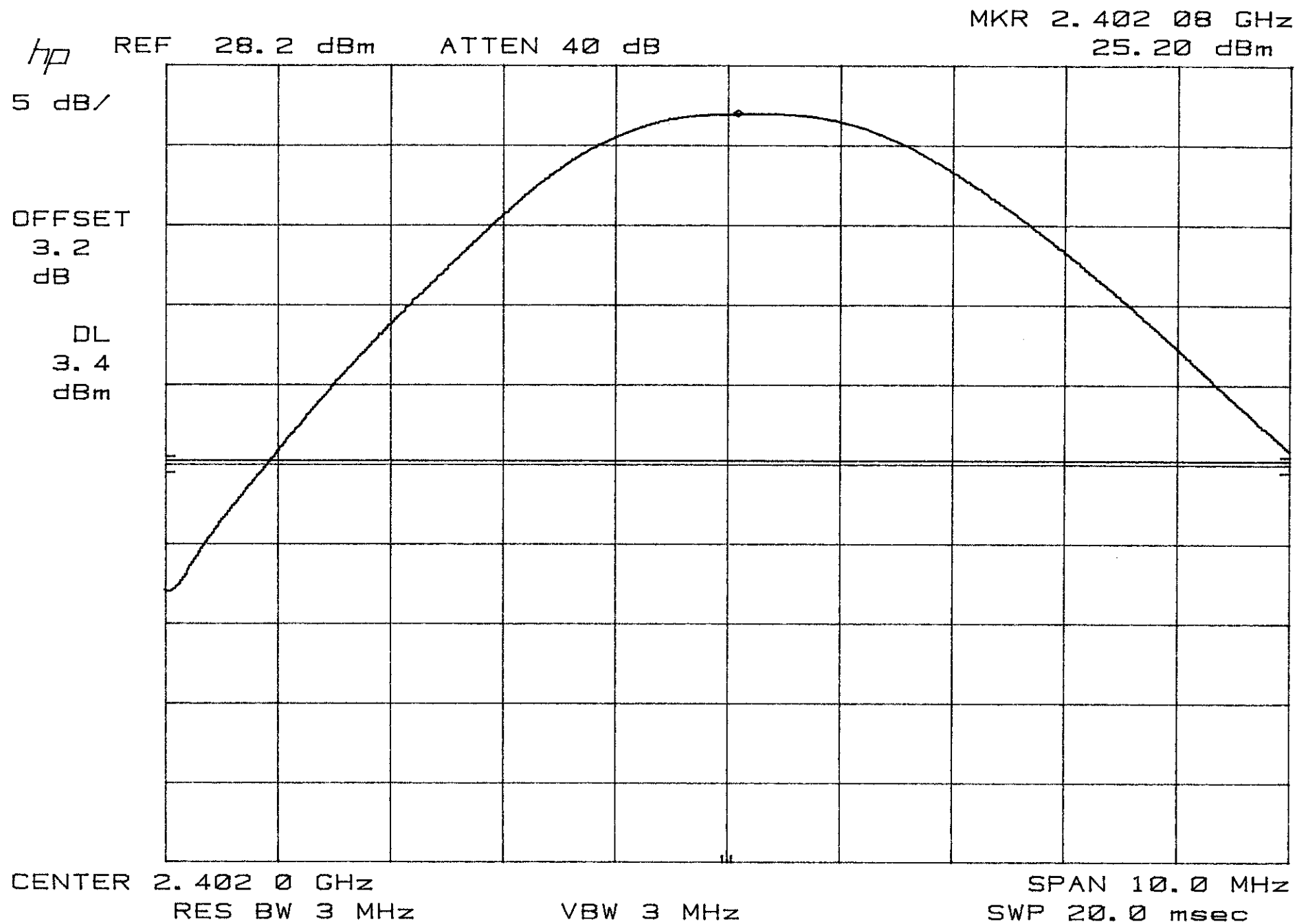
EUT Transmit Antenna Gain (0 dBi) +20.3 dBm max. output level =20.3 dBm.

Please refer to the attached plots for details:

Plot 1.a: Low Channel Output Power

Plot 1.b: Middle Channel Output Power

Plot 1.c: High Channel Output Power



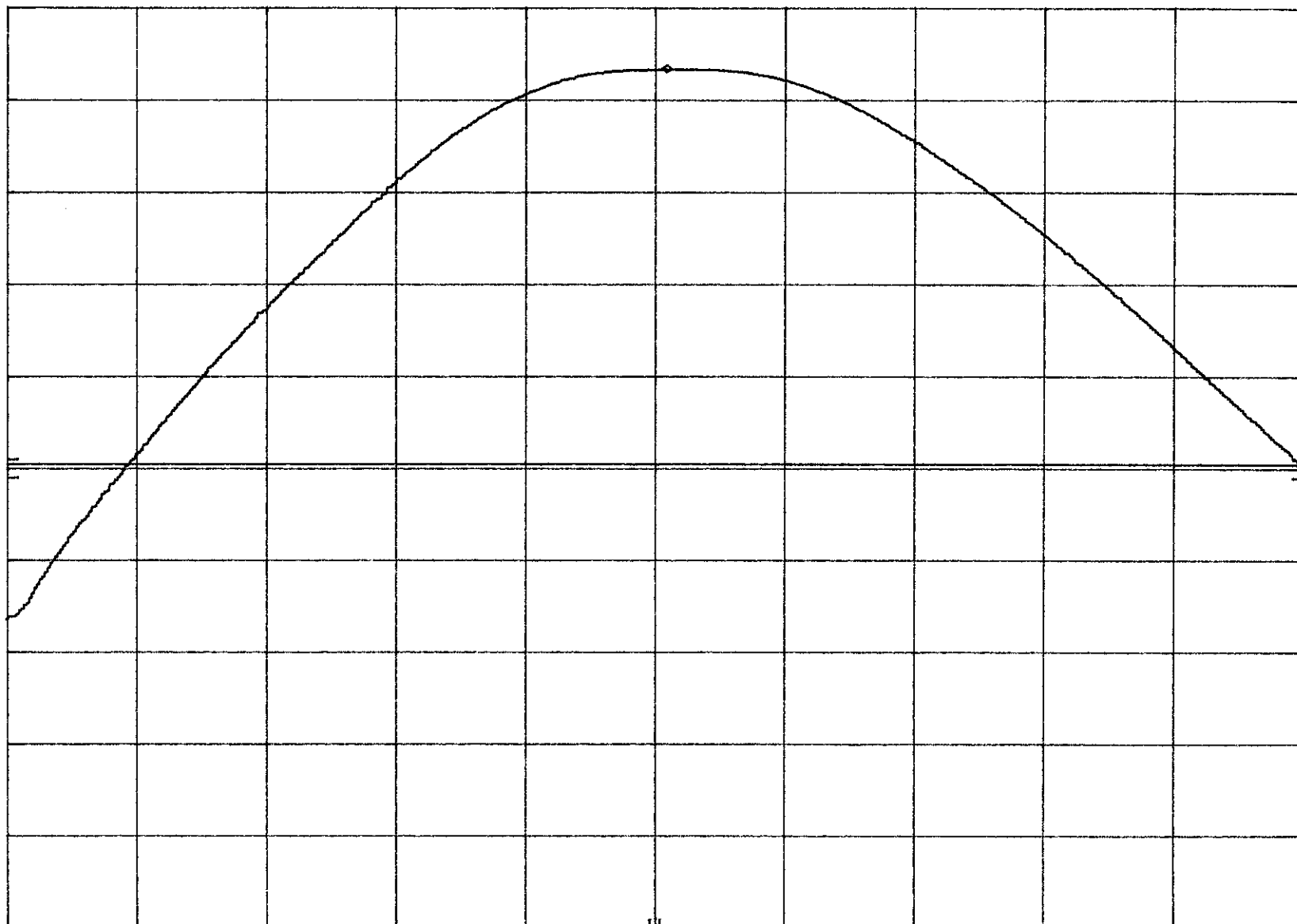
MKR 2.440 08 GHz
24.90 dBm

hp REF 28.2 dBm ATTN 40 dB

5 dB/

OFFSET
3.2
dB

DL
3.4
dBm



CENTER 2.440 0 GHz

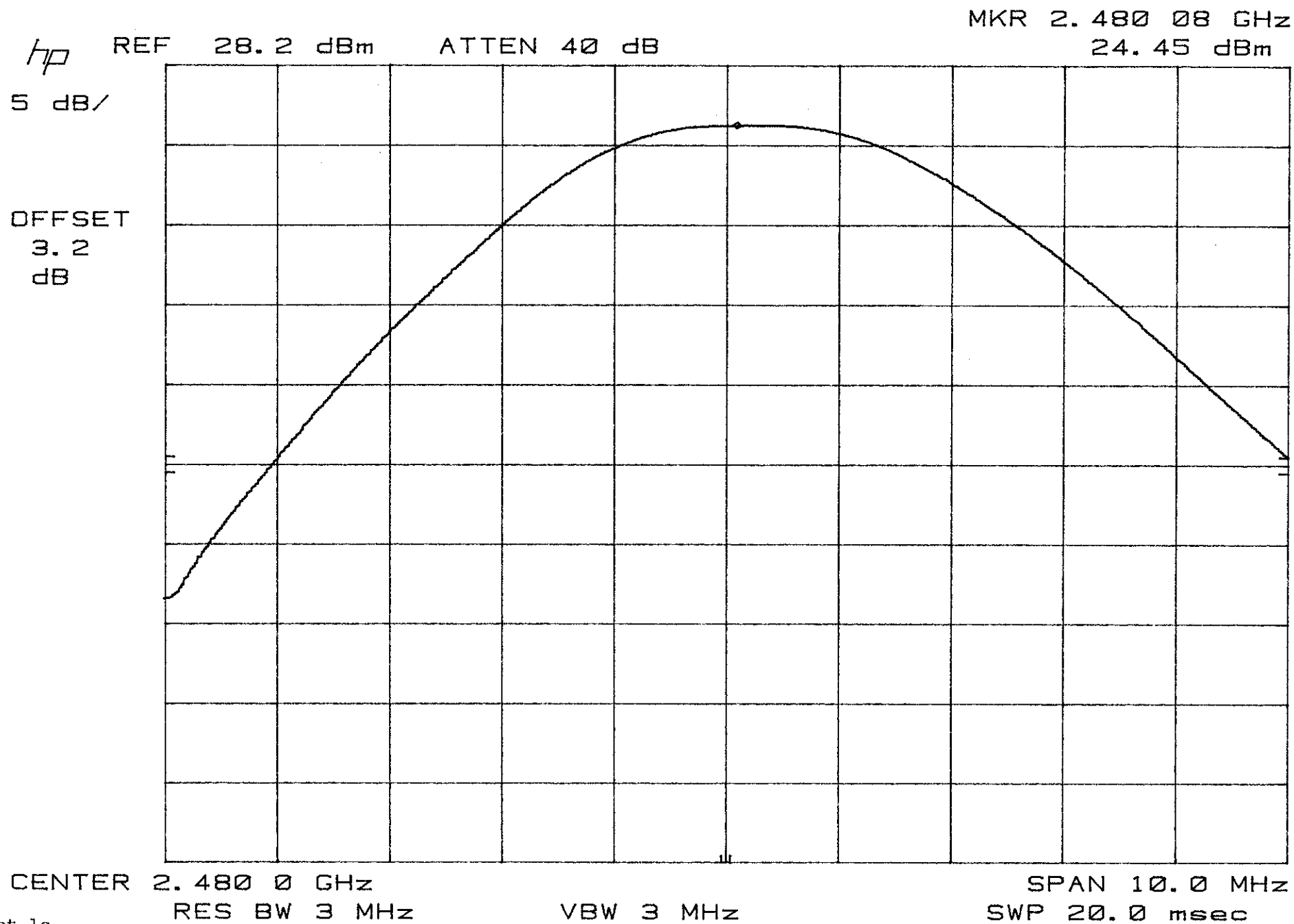
SPAN 10.0 MHz

Plot 1b

RES BW 3 MHz

VBW 3 MHz

SWP 20.0 msec



4.2 Hopping Channel 20 dB RF Bandwidth, FCC Ref: 15.247(a)(1)

Test results:

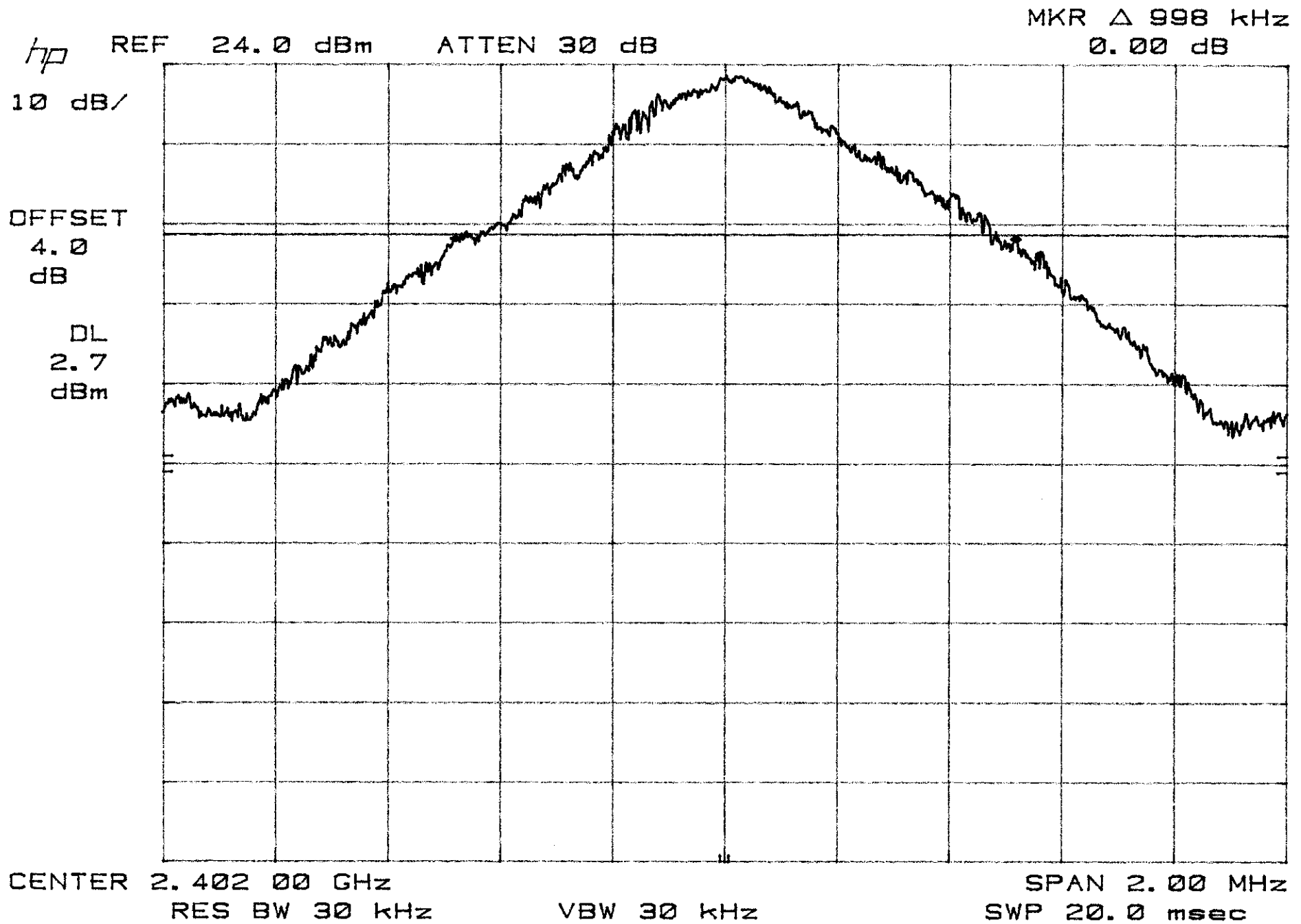
Channel (Frequency, MHz)	20 dB Bandwidth (kHz)
Low, 2402	998
Middle, 2440	994
High, 2480	996

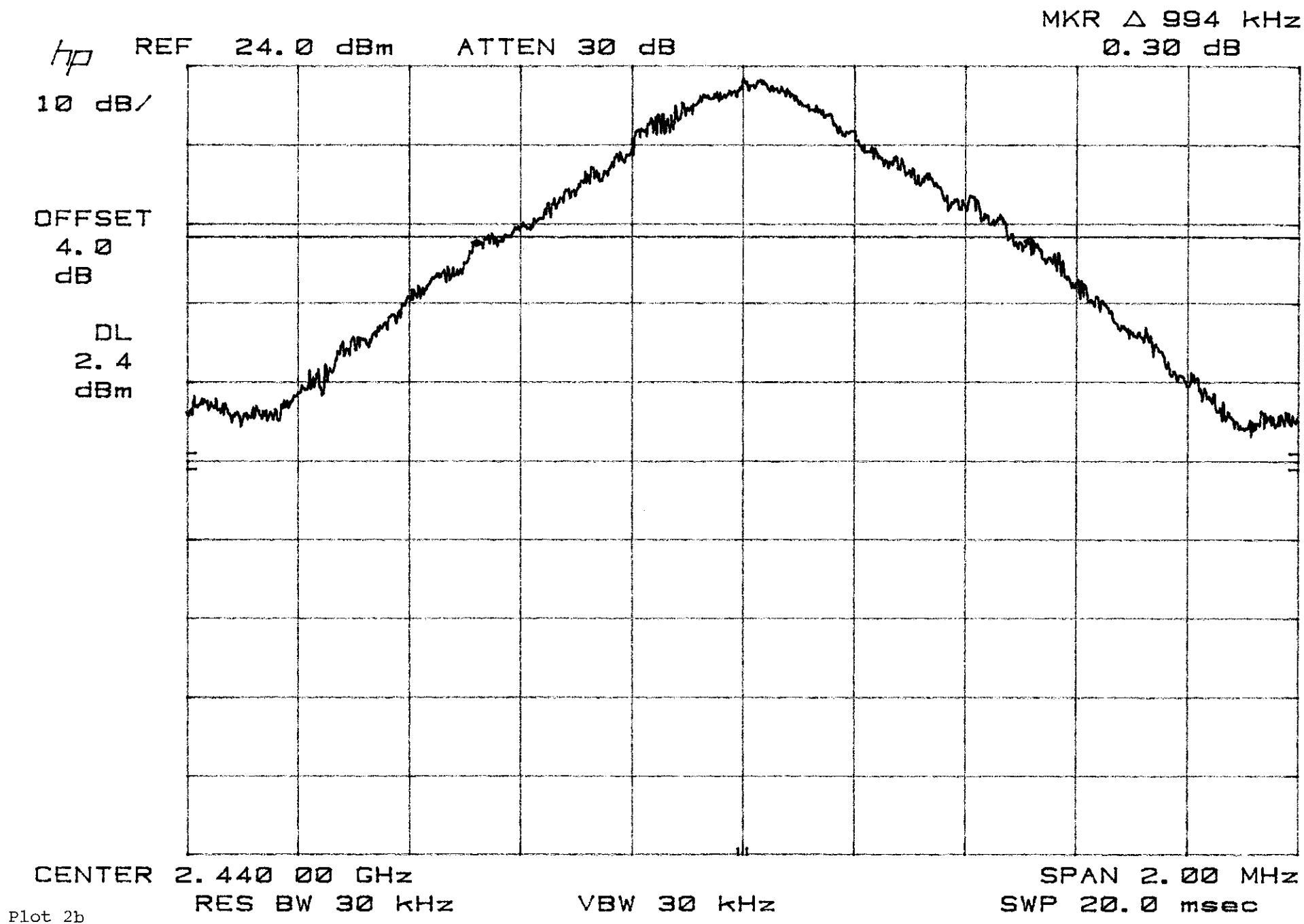
Please refer to the attached plots for details:

Plot 2.a: Low Channel

Plot 2.b: Middle Channel

Plot 2.c: High Channel





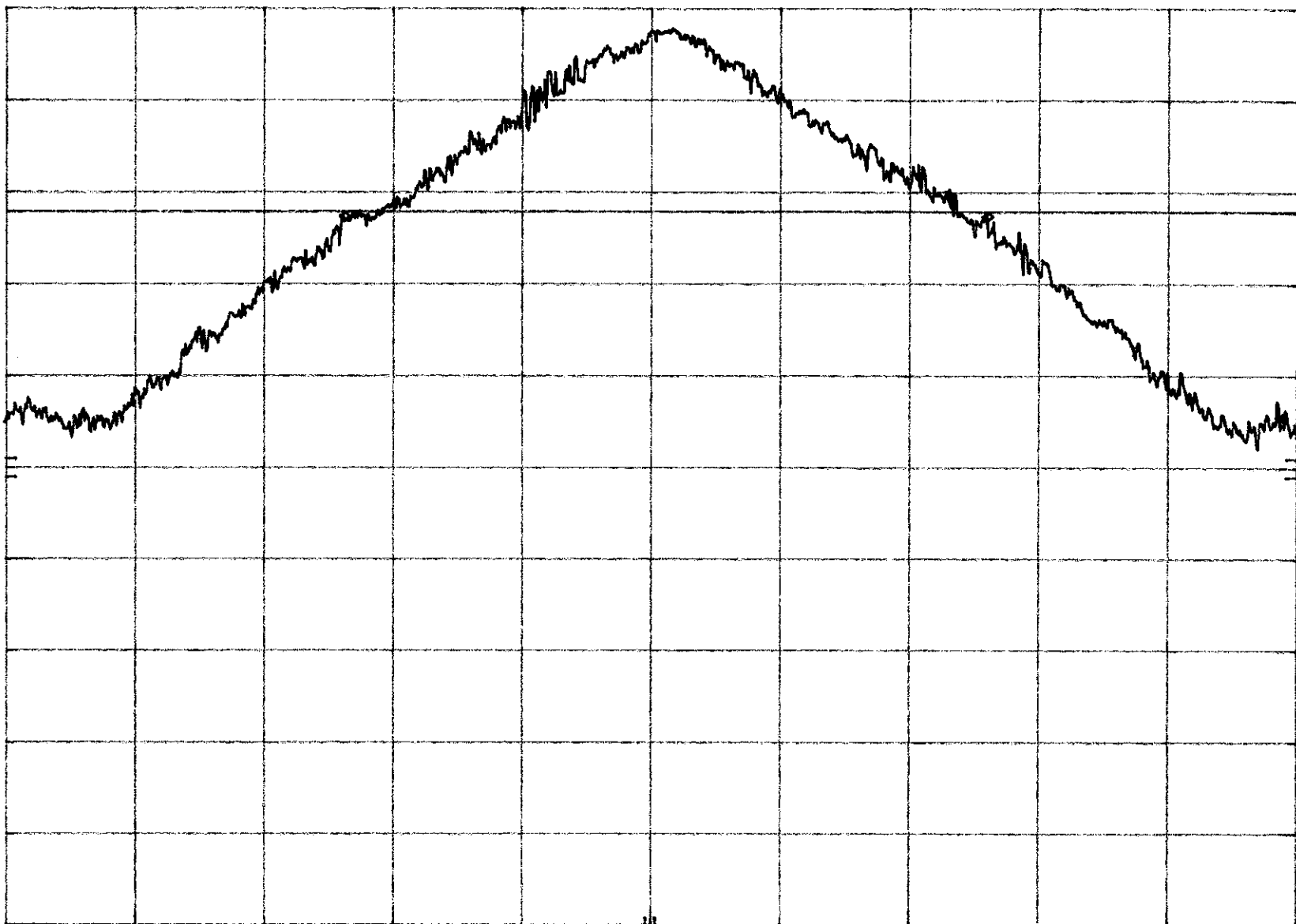
MKR Δ 996 kHz
0.00 dB

hp REF 24.0 dBm ATTN 30 dB

10 dB/

OFFSET
4.0
dB

DL
1.9
dBm



CENTER 2.480 00 GHz

RES BW 30 kHz

VBW 30 kHz

SPAN 2.00 MHz

SWP 20.0 msec

4.3 Minimum Number of Hopping Frequencies, FCC Ref: 15.247(a)(1)(I&ii)

The RF passband of the EUT was divided into 2 approximately equal bands. With the analyzer set to MAX HOLD readings were taken for 2 - 3 minutes in each band. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

Number of hopping channels	79
----------------------------	----

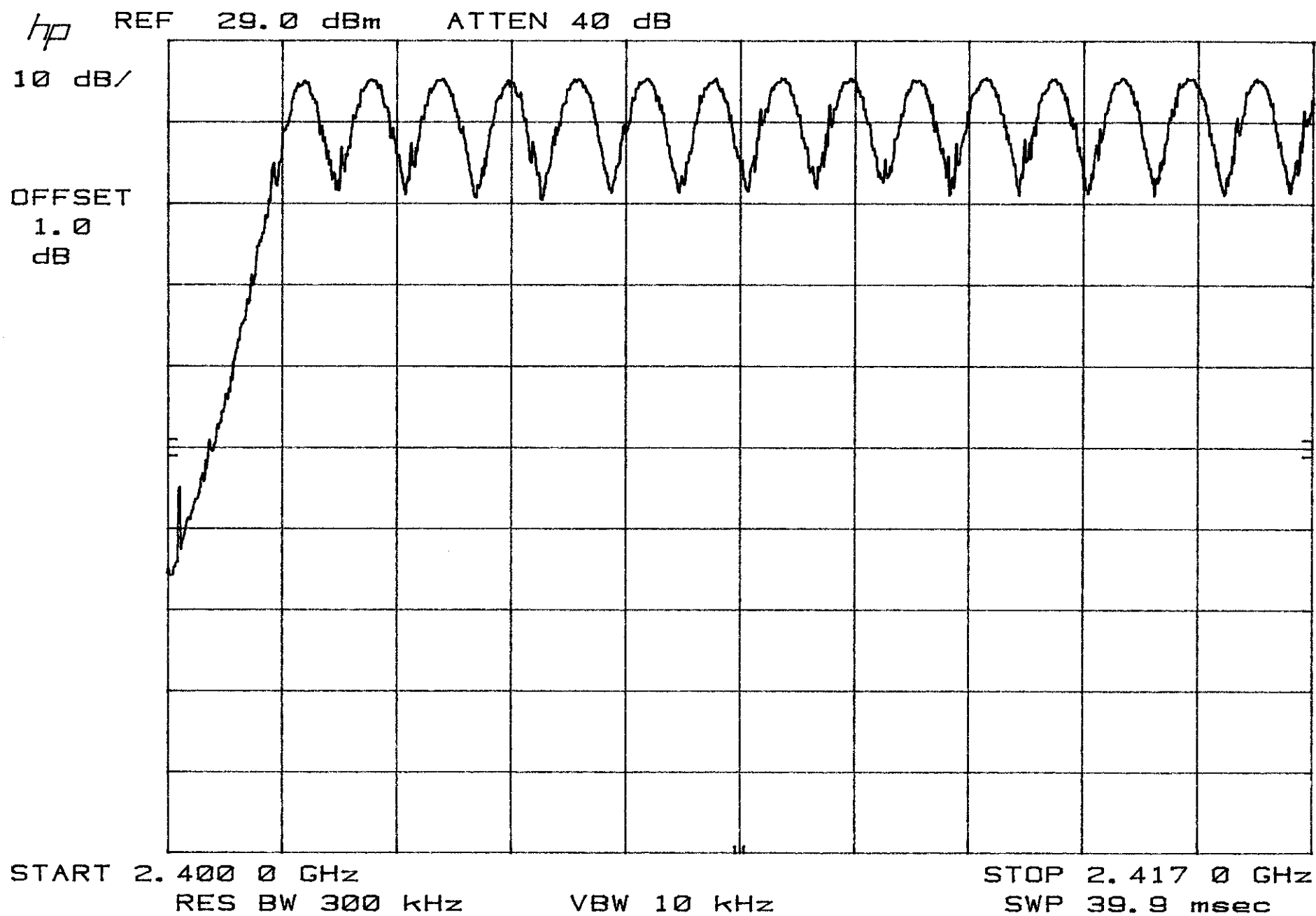
Minimum Requirements:

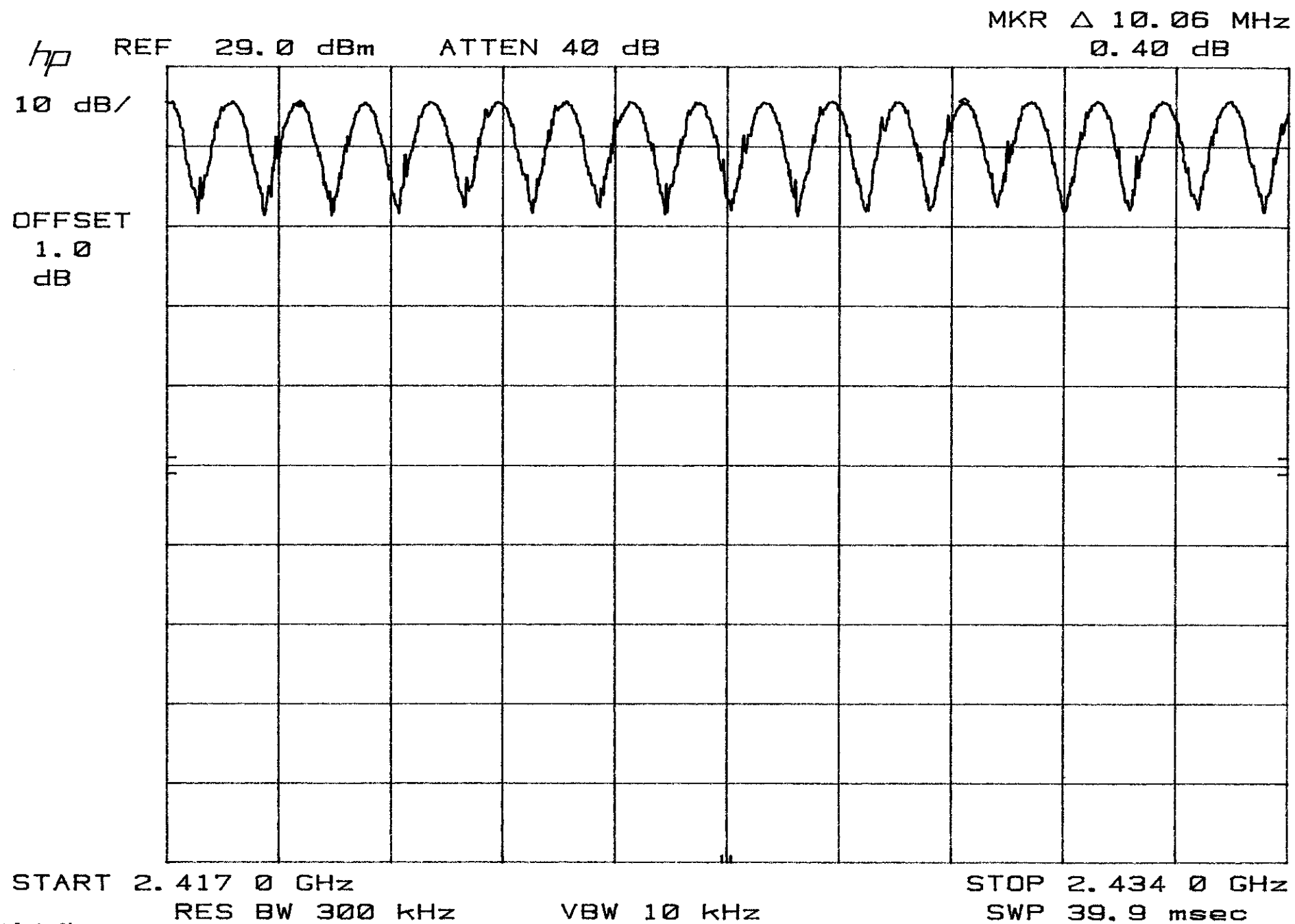
at least 50 channels for 902 - 928 MHz band;

at least 75 channels for 2400 - 2483.5 and 5725 - 5850 MHz systems

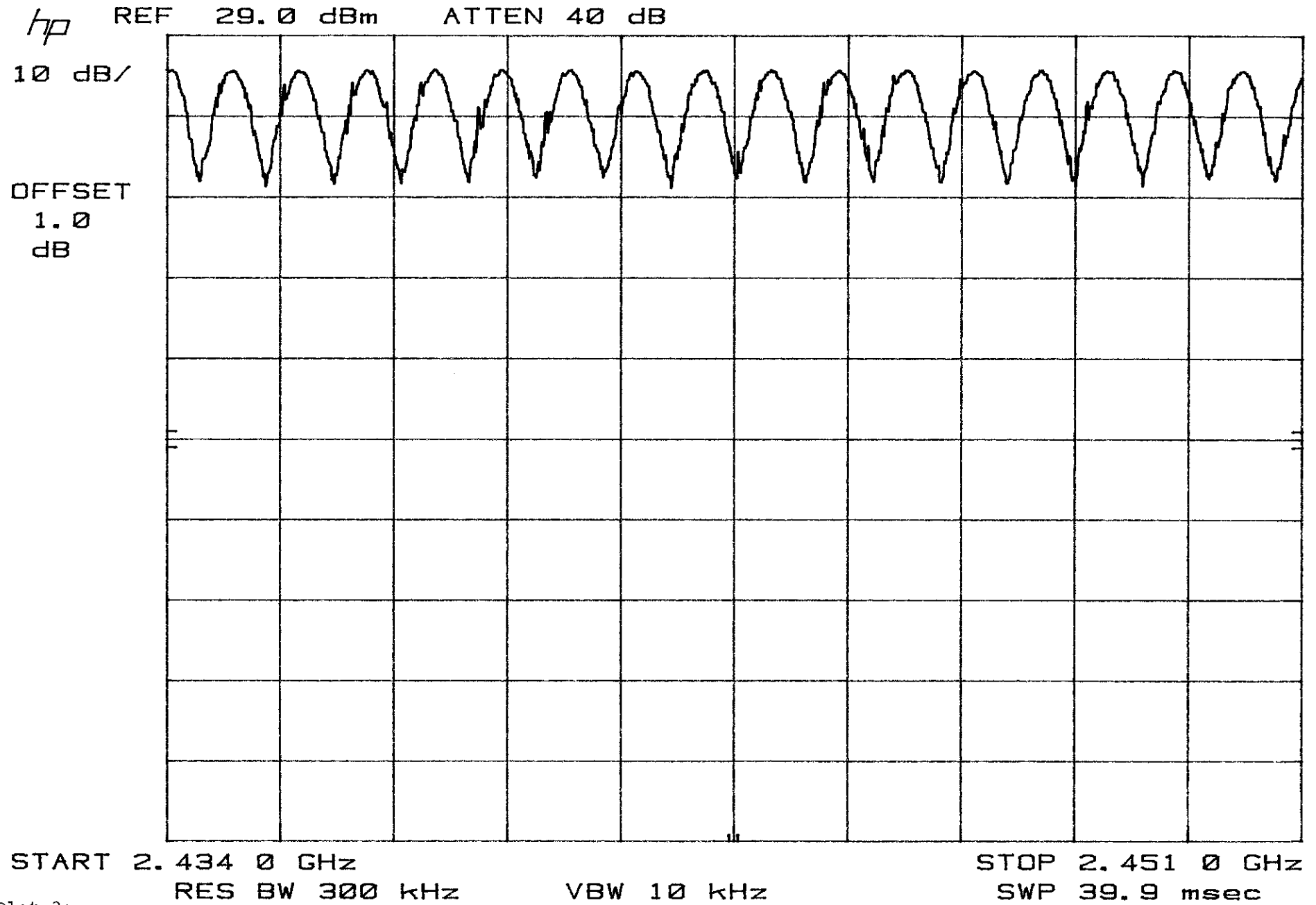
Please refer to the attached plots for details:

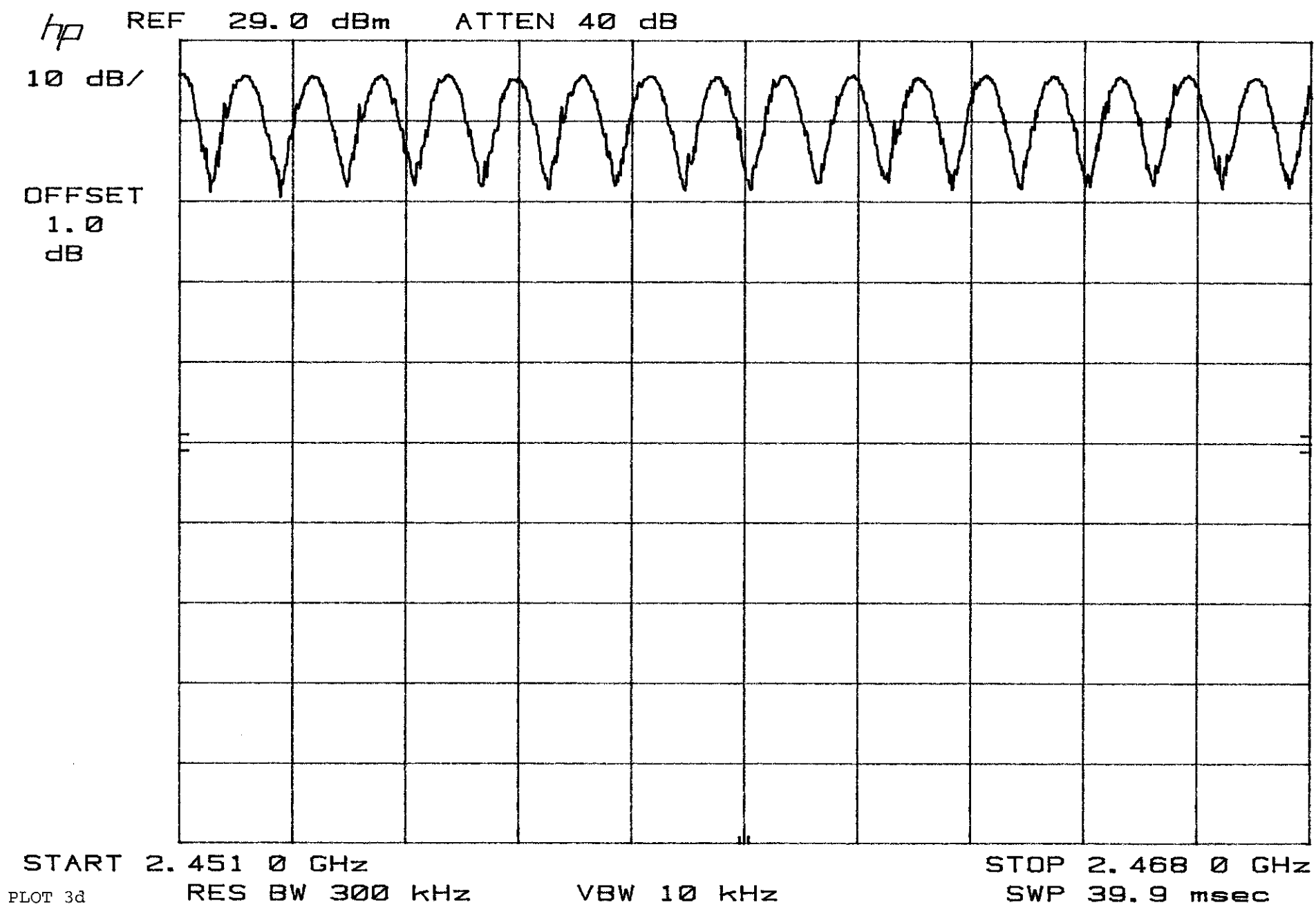
Plots 3.a - 3.e

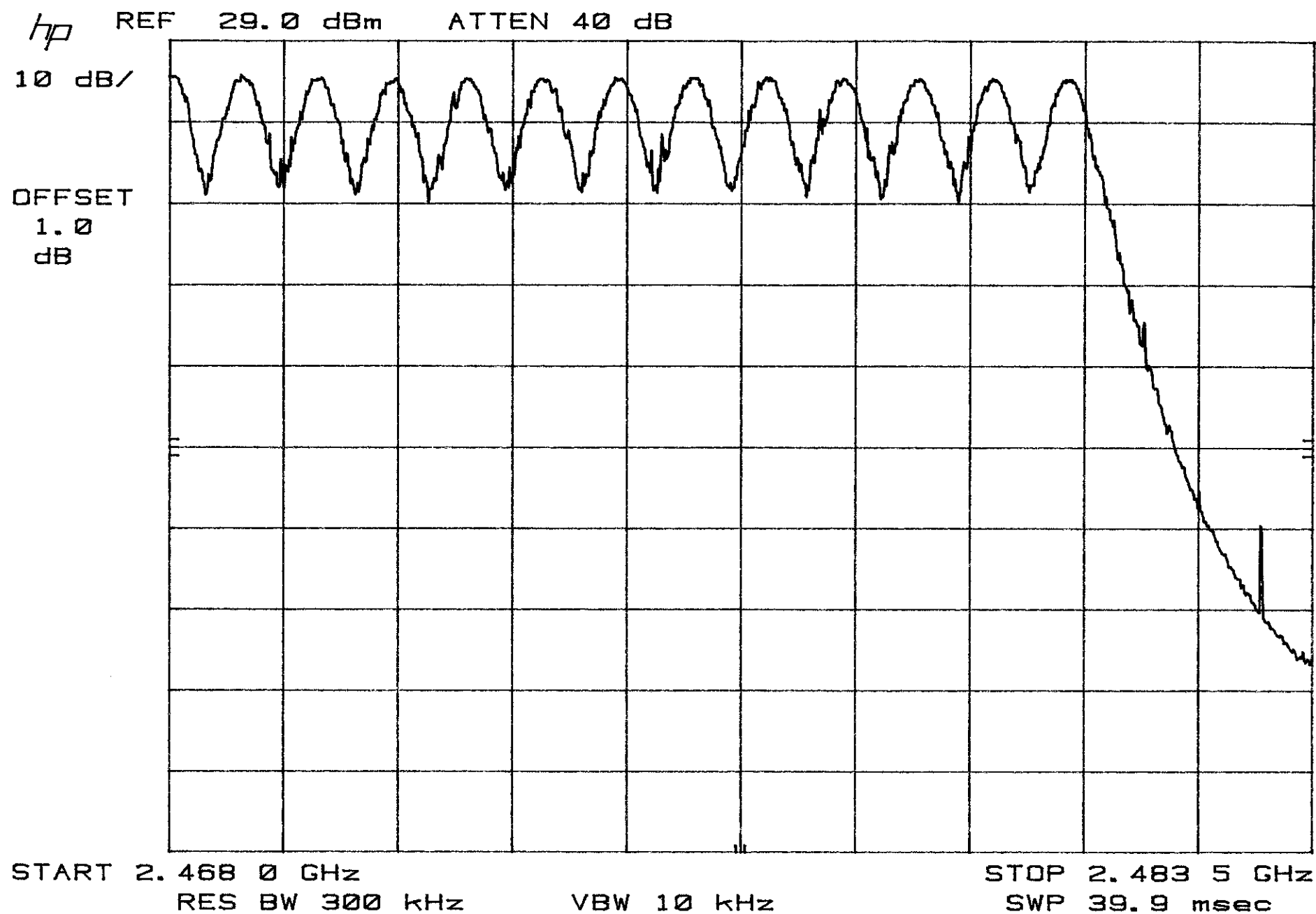




Plot 3b







4.4 Average Channel Occupancy Time, FCC Ref: 15.247(a)(1)(I&ii)

Requirement:

Average 0.4 seconds maximum occupancy in 20 seconds, 902-928 MHz

Average 0.4 seconds maximum occupancy in 30 seconds, 2400-2483.5/5725-5850 MHz

The spectrum analyzer center frequency was set to one of the known hopping channels. The SWEEP was set to 0.4 second, the SPAN was set to ZERO SPAN, and the TRIGGER was set to VIDEO. The time duration of the transmission so captured was measured with the MARKER DELTA function.

The SWEEP was then set to the time required by the regulation (20 seconds for 902-928 MHz devices, 30 seconds for all other bands). The analyzer was set to SINGLE SWEEP, the total ON time was added and compared against the limit (0.4 seconds).

The average time occupancy is:

$$39 \times 9.9 \text{ (ms)} = 386.1 \text{ ms}$$

Please refer to the attached plots for details:

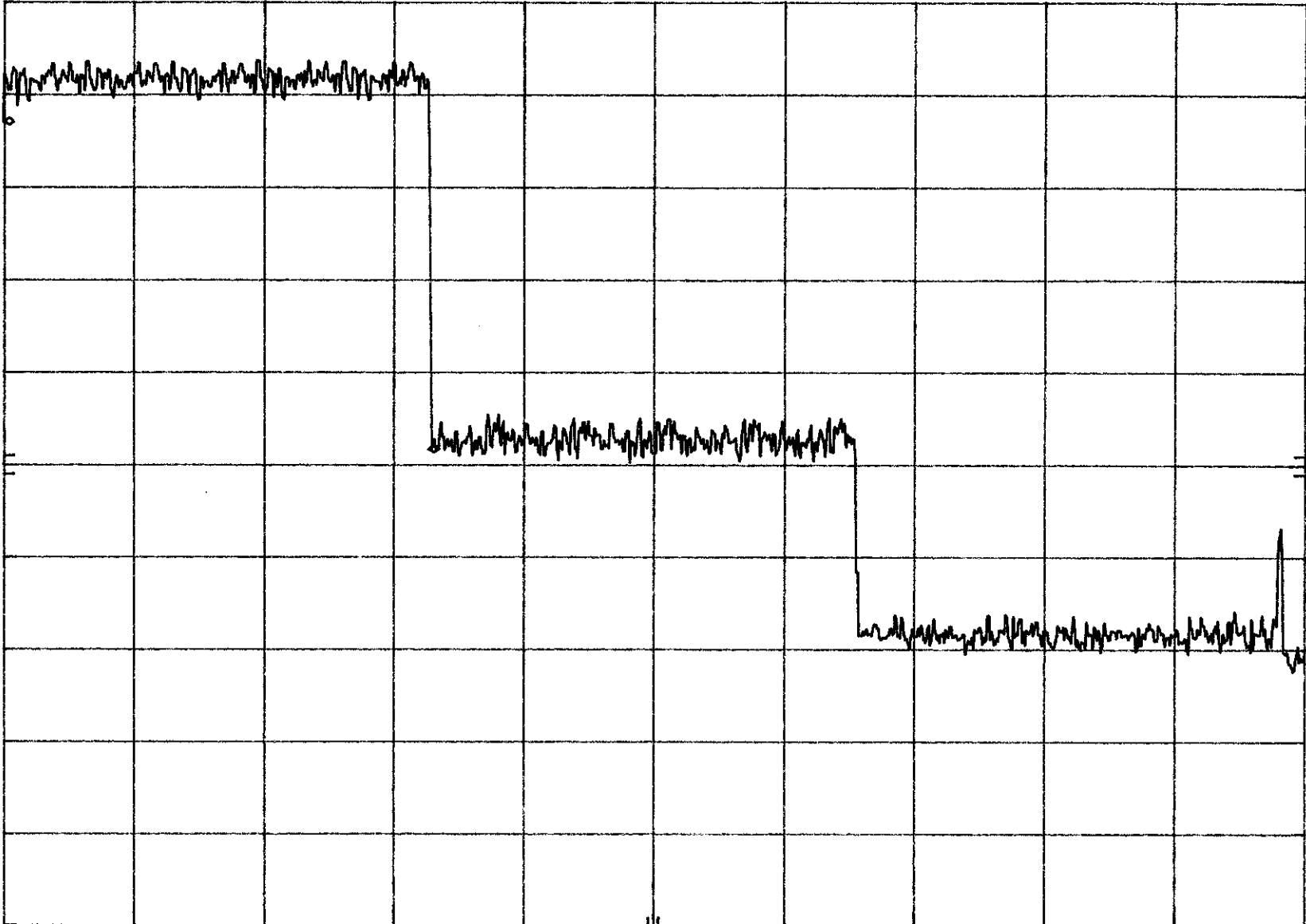
Plots 4.a - 4.b

MKR Δ 9.900 msec
-35.40 dB

hp REF 28.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



CENTER 2.440 000 000 GHz

RES BW 30 kHz

VBW 30 kHz

SPAN 0 Hz

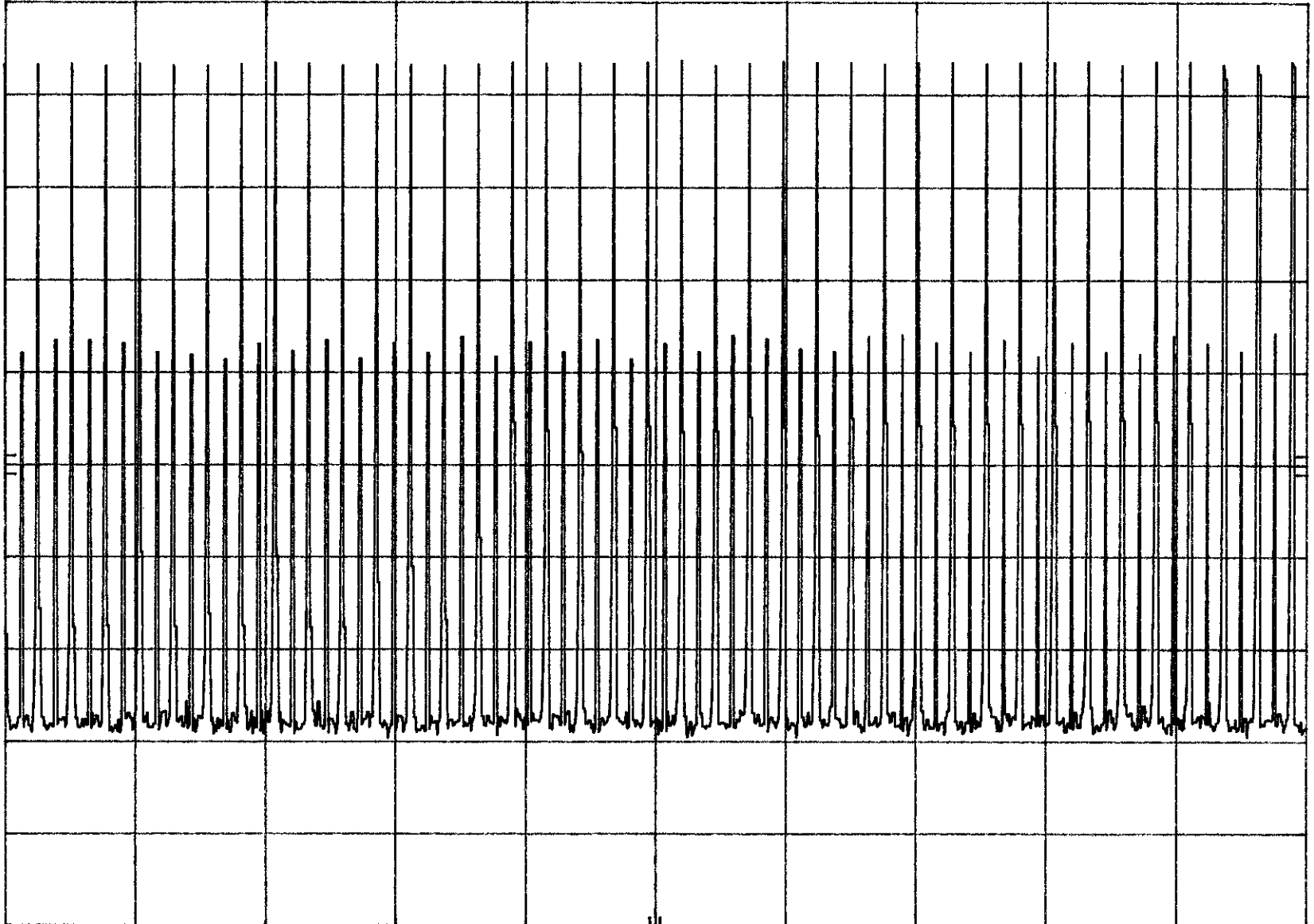
SWP 30.0 msec

Plot 4a

hp REF 28.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



CENTER 2.440 000 000 GHz

SPAN 0 Hz

RES BW 30 kHz

VBW 30 kHz

SWP 30.0 sec

Plot 4b

4.5 Out of Band Conducted Emissions, FCC Ref: 15.247 (c)**Requirements:**

In any 100 kHz bandwidth outside the EUT passband, the RF power produced by the modulation products of the spreading sequence, the information sequence, and the carrier frequency shall be at least 20 dB below that of the maximum in-band 100 kHz emission.

Result:

Please refer to the attached Plots for details:

Low Channel	Plots 5.a.1 - 5.a.6
Middle Channel	Plots 5.b.1 - 5.b.5
High Channel	Plots 5.c.1 - 5.c.7

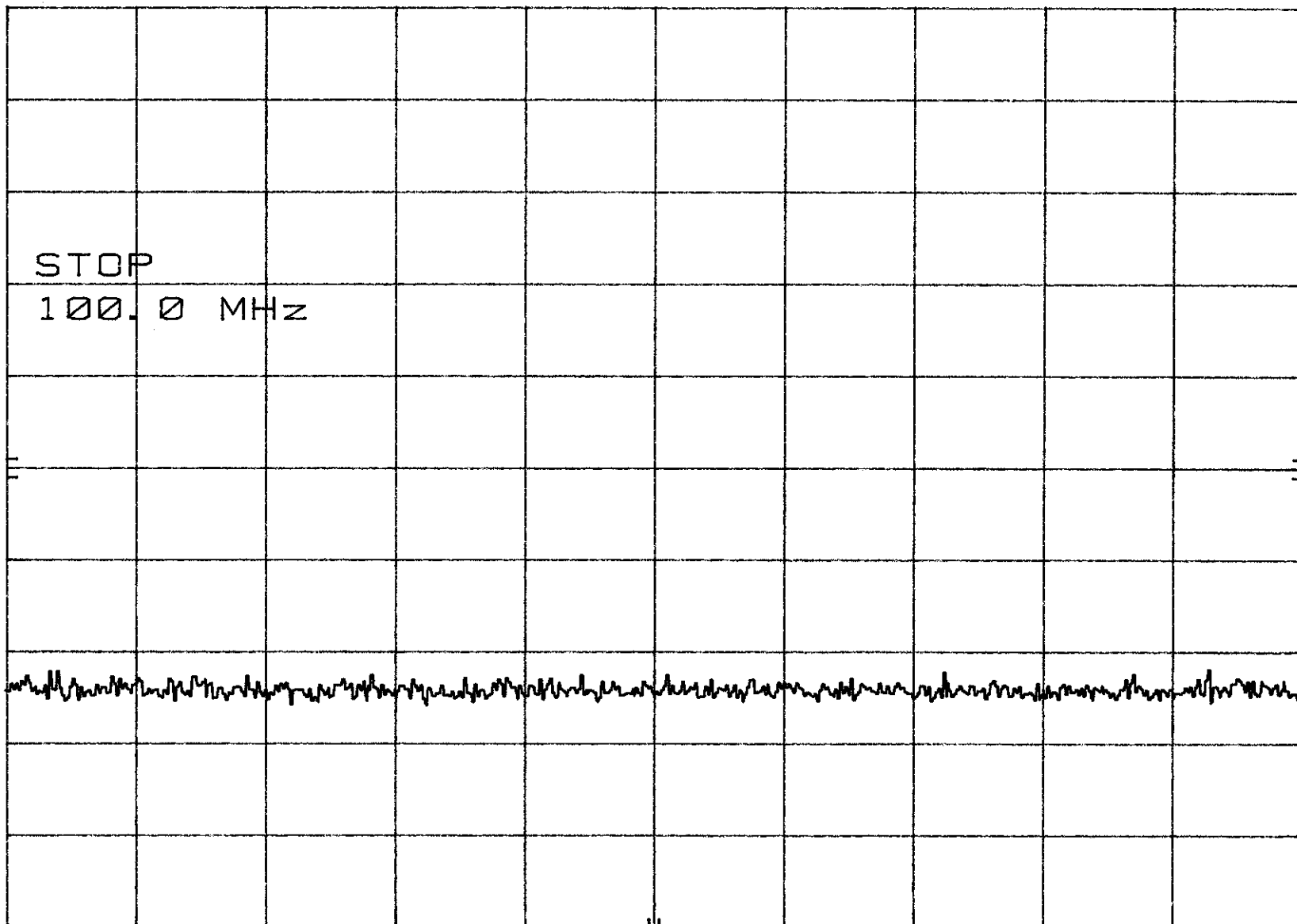
hp REF 28.2 dBm ATTEN 40 dB

10 dB/

OFFSET
3.2
dB

STOP

100.0 MHz



START 1.0 MHz

STOP 100.0 MHz

Plot 5a,1

RES BW 100 kHz

VBW 100 kHz

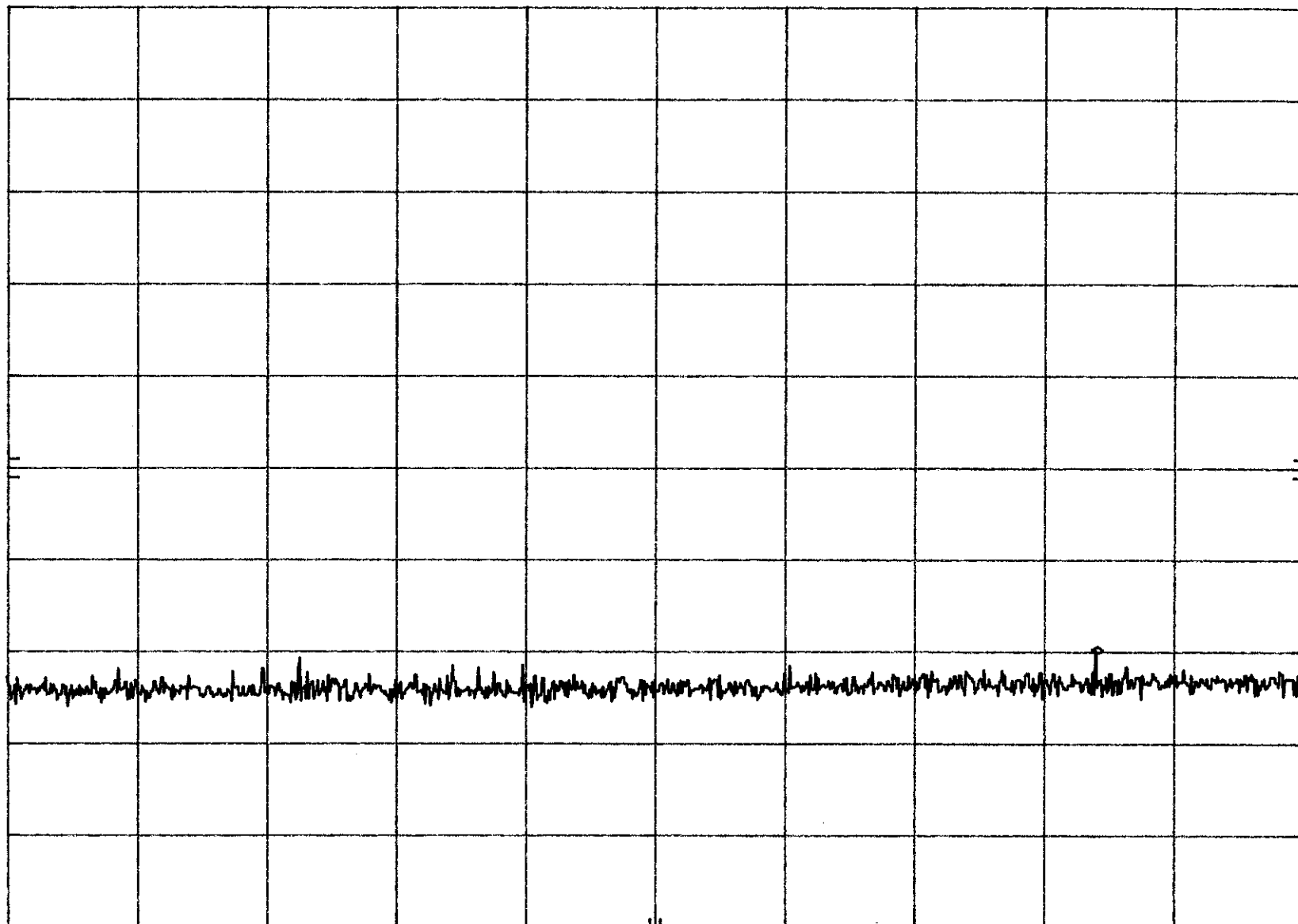
SWP 30.0 msec

MKR 2.024 GHz
-41.60 dBm

hp REF 28.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



START 100 MHz
Plot 5a,2

RES BW 100 kHz

VBW 100 kHz

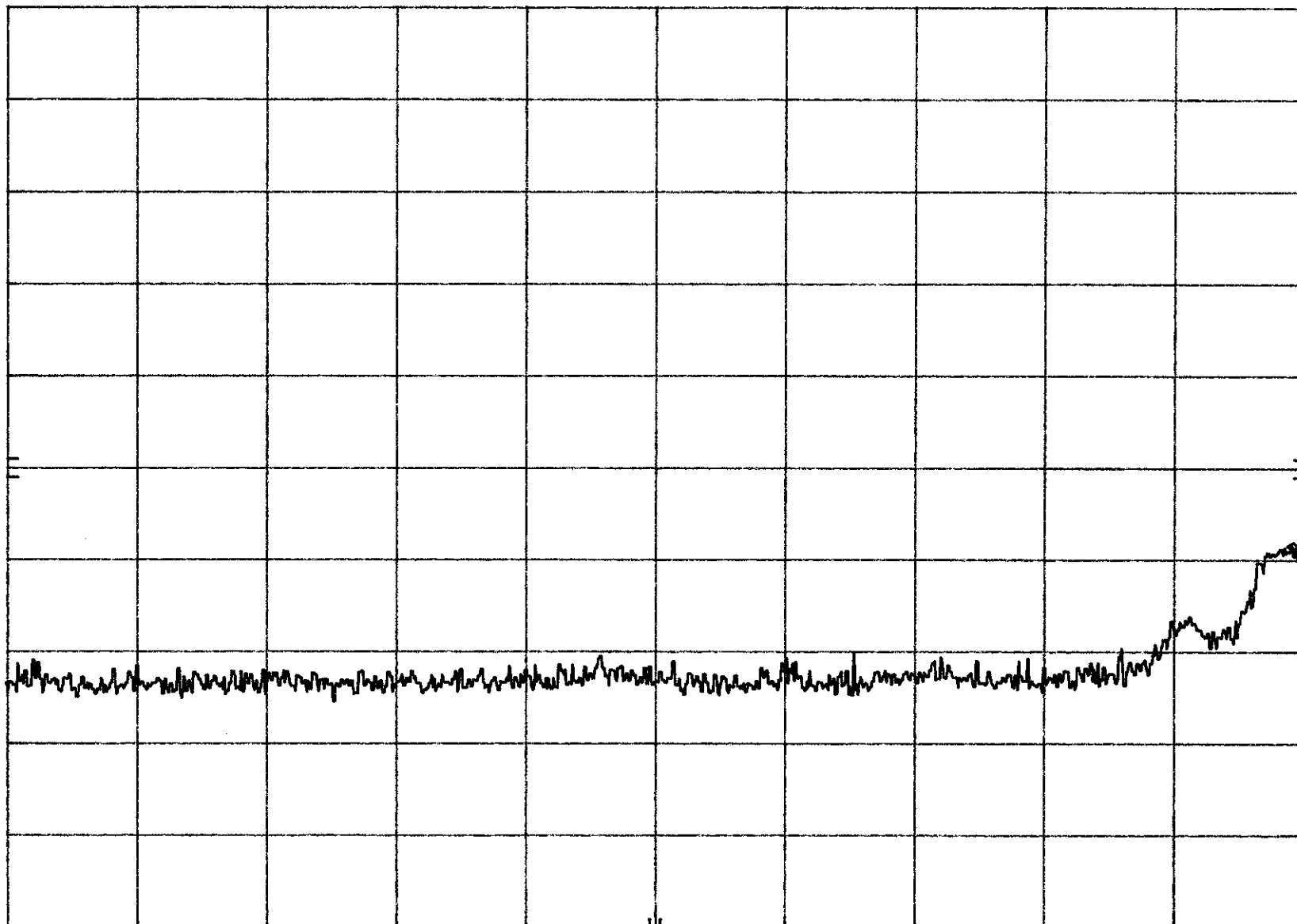
STOP 2.39 GHz
SWP 687 msec

MKR 2.399 90 GHz
-30.30 dBm

hp REF 28.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



START 2.390 0 GHz

RES BW 100 kHz

VBW 100 kHz

STOP 2.400 0 GHz

SWP 20.0 msec

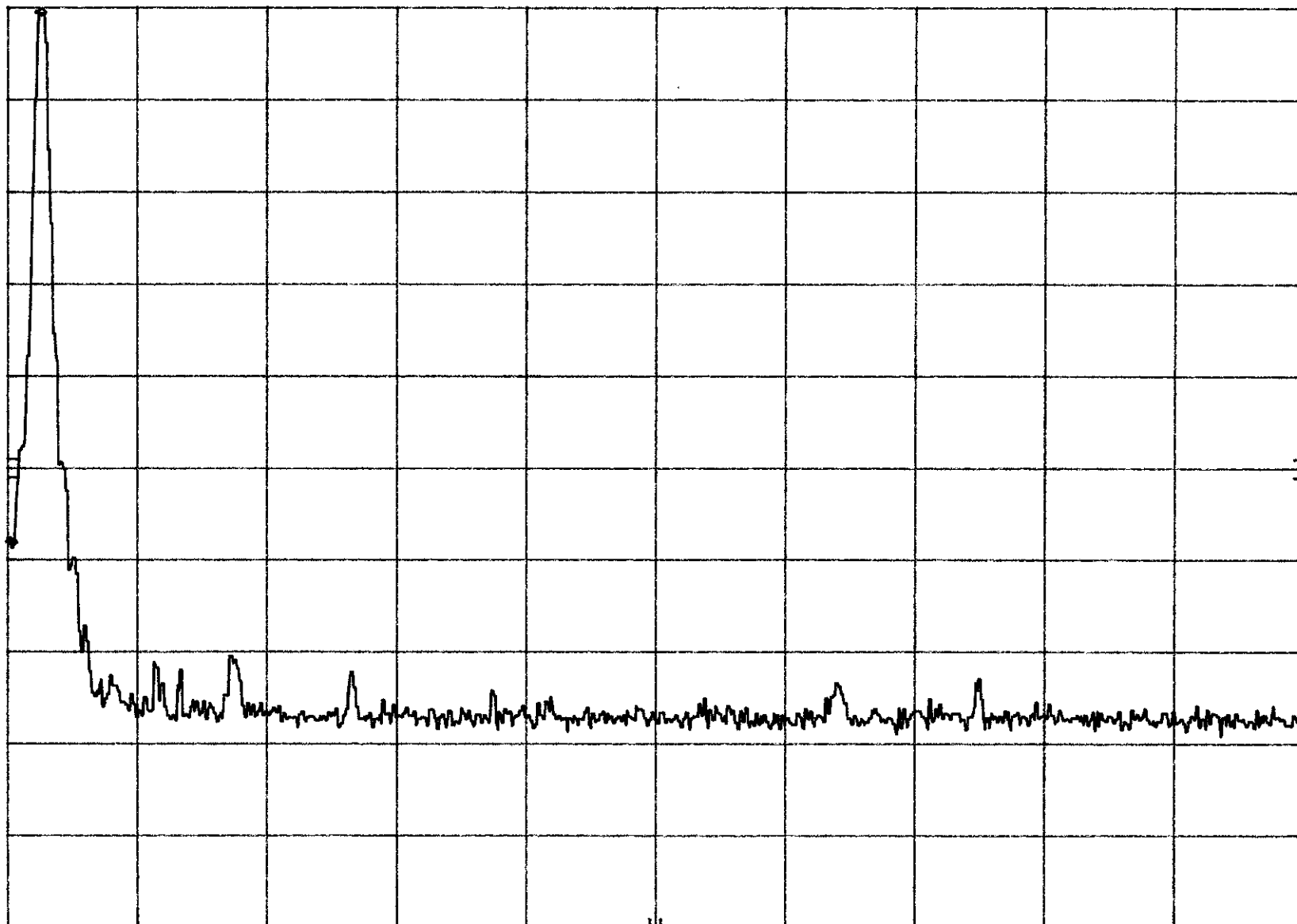
Plot 5a,3

MKR Δ -2.09 MHz
-57.60 dB

hp REF 23.2 dBm ATTN 30 dB

10 dB/

OFFSET
3.2
dB



START 2.400 0 GHz

STOP 2.483 5 GHz

Plot 5a, 4 RES BW 100 kHz

VBW 100 kHz

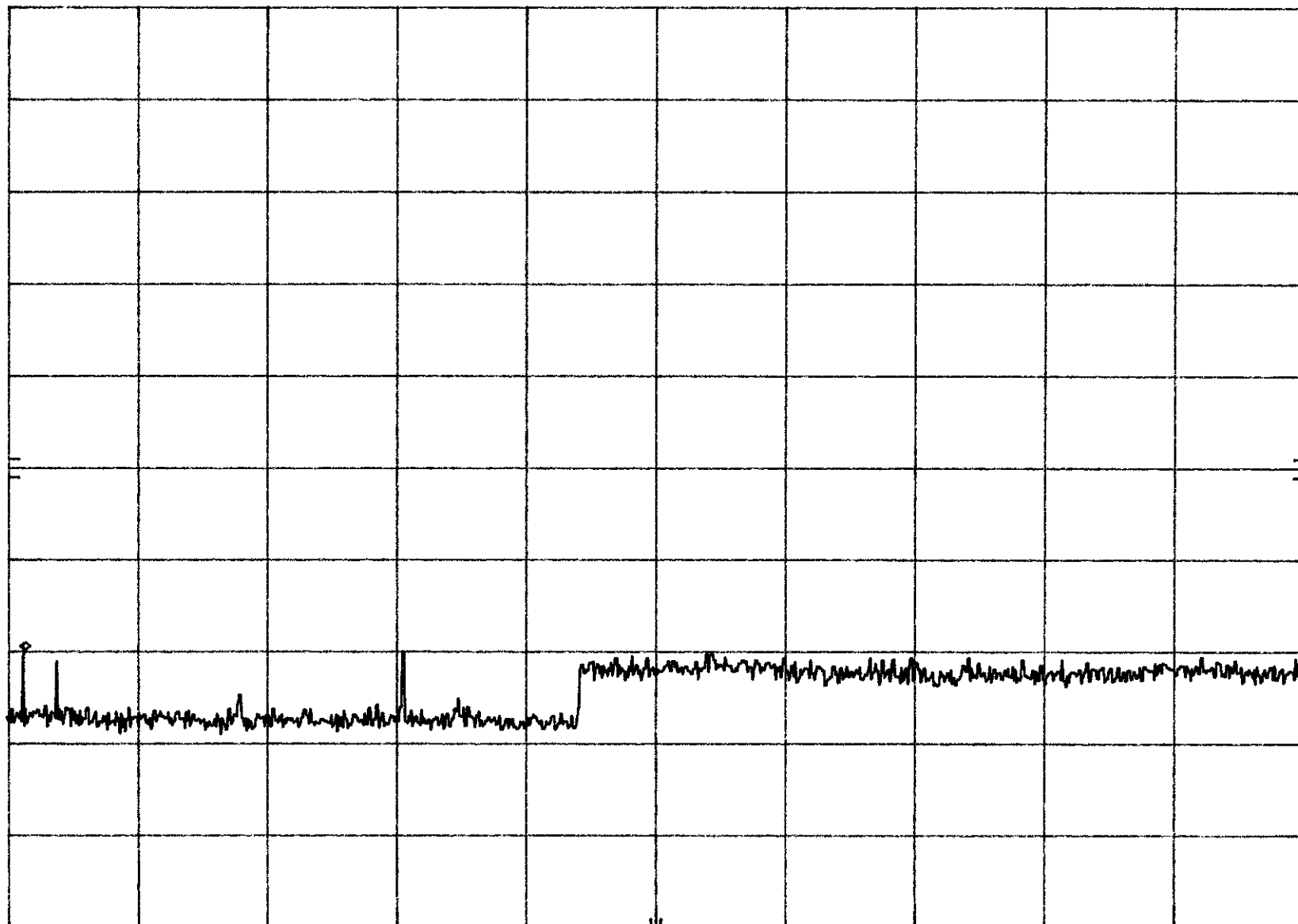
SWP 25.1 msec

MKR 2.574 GHz
-46.20 dBm

hp REF 23.2 dBm ATTN 30 dB

10 dB/

OFFSET
3.2
dB



START 2.48 GHz

STOP 10.00 GHz

Plot 5a, 5

RES BW 100 kHz

VBW 100 kHz

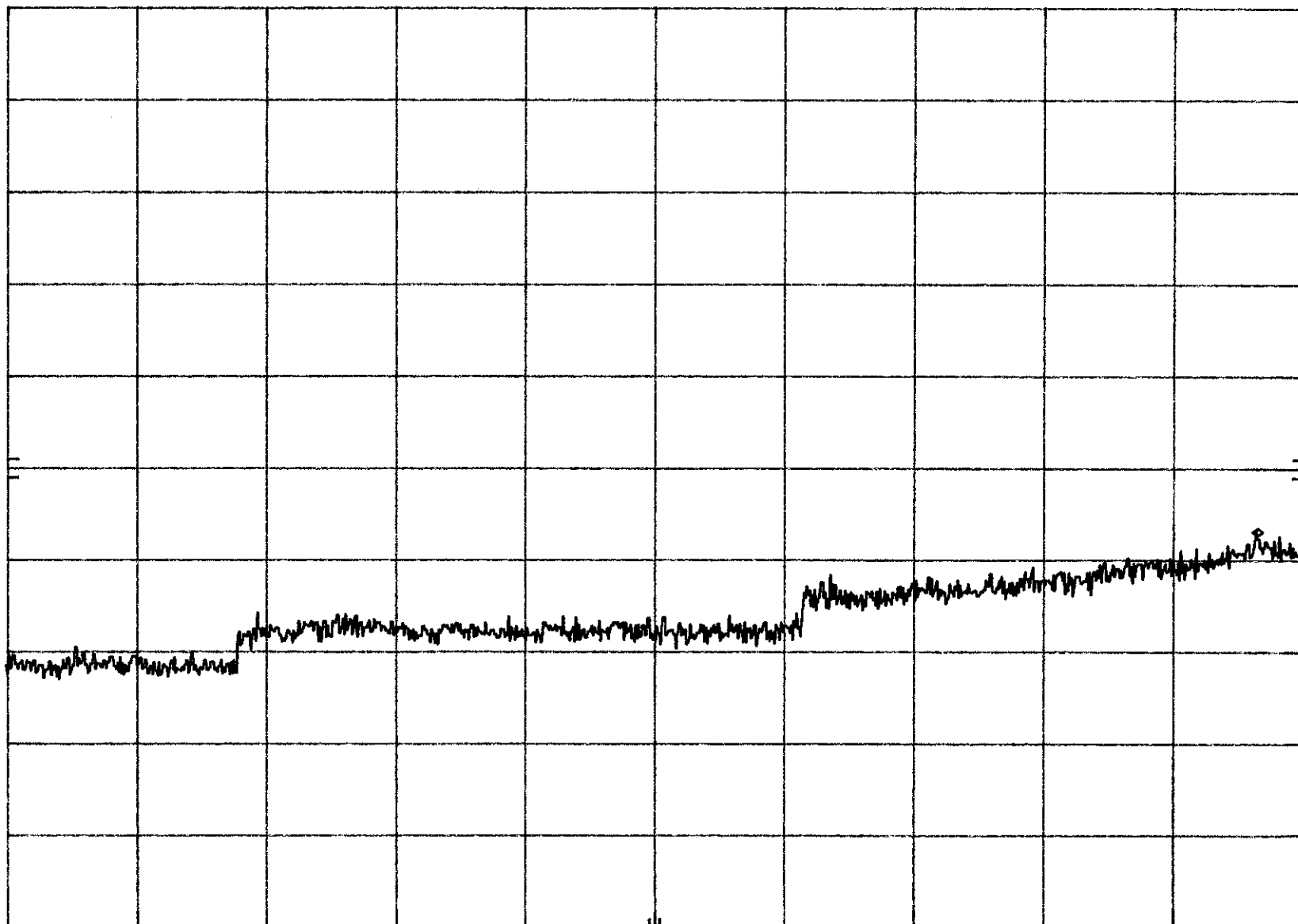
SWP 2.25 sec

MKR 23.50 GHz
-33.70 dBm

hp REF 23.2 dBm ATTN 30 dB

10 dB/

OFFSET
3.2
dB



START 10.0 GHz

STOP 24.0 GHz

PLOT 5a,6

RES BW 100 kHz

VBW 100 kHz

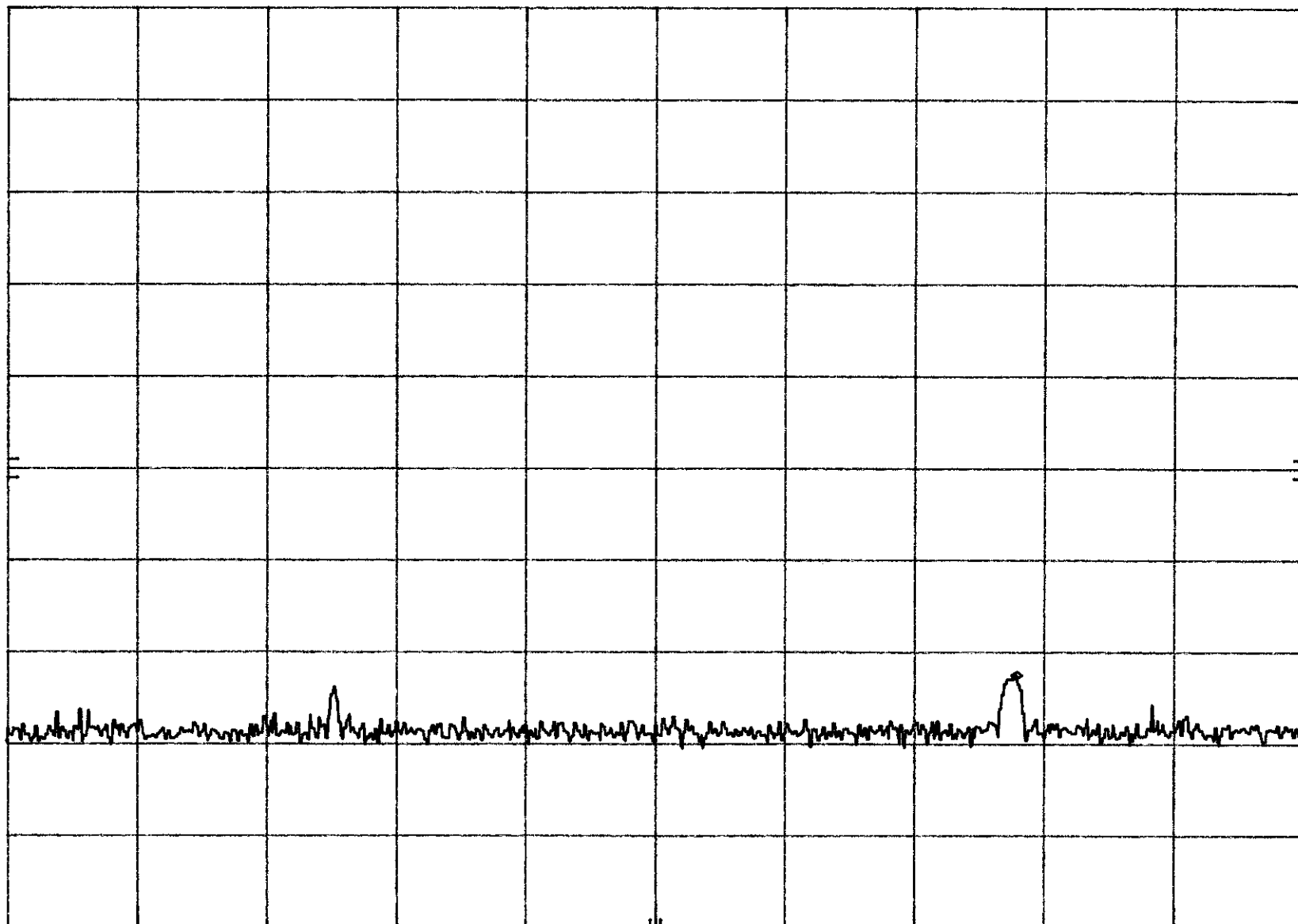
SWP 4.20 sec

MKR 78.02 MHz
-49.30 dBm

hp REF 23.2 dBm ATTEN 30 dB

10 dB/

OFFSET
3.2
dB



START 1.0 MHz

RES BW 100 kHz

VBW 100 kHz

STOP 100.0 MHz

SWP 29.7 msec

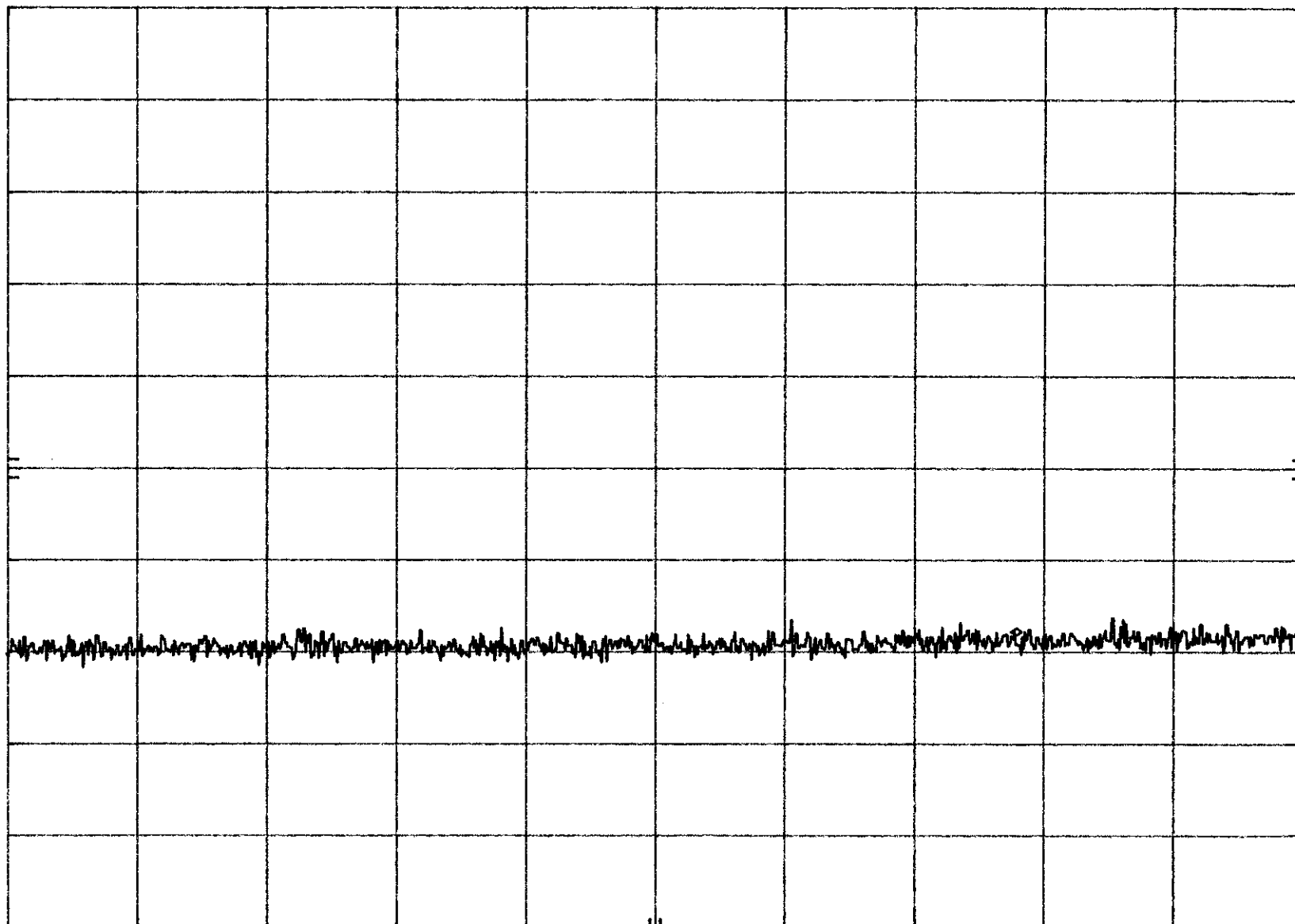
Plot05b,1

MKR 1.889 GHz
-44.60 dBm

hp REF 23.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



START 100 MHz

STOP 2.40 GHz

Plot 5b, 2

RES BW 100 kHz

VBW 100 kHz

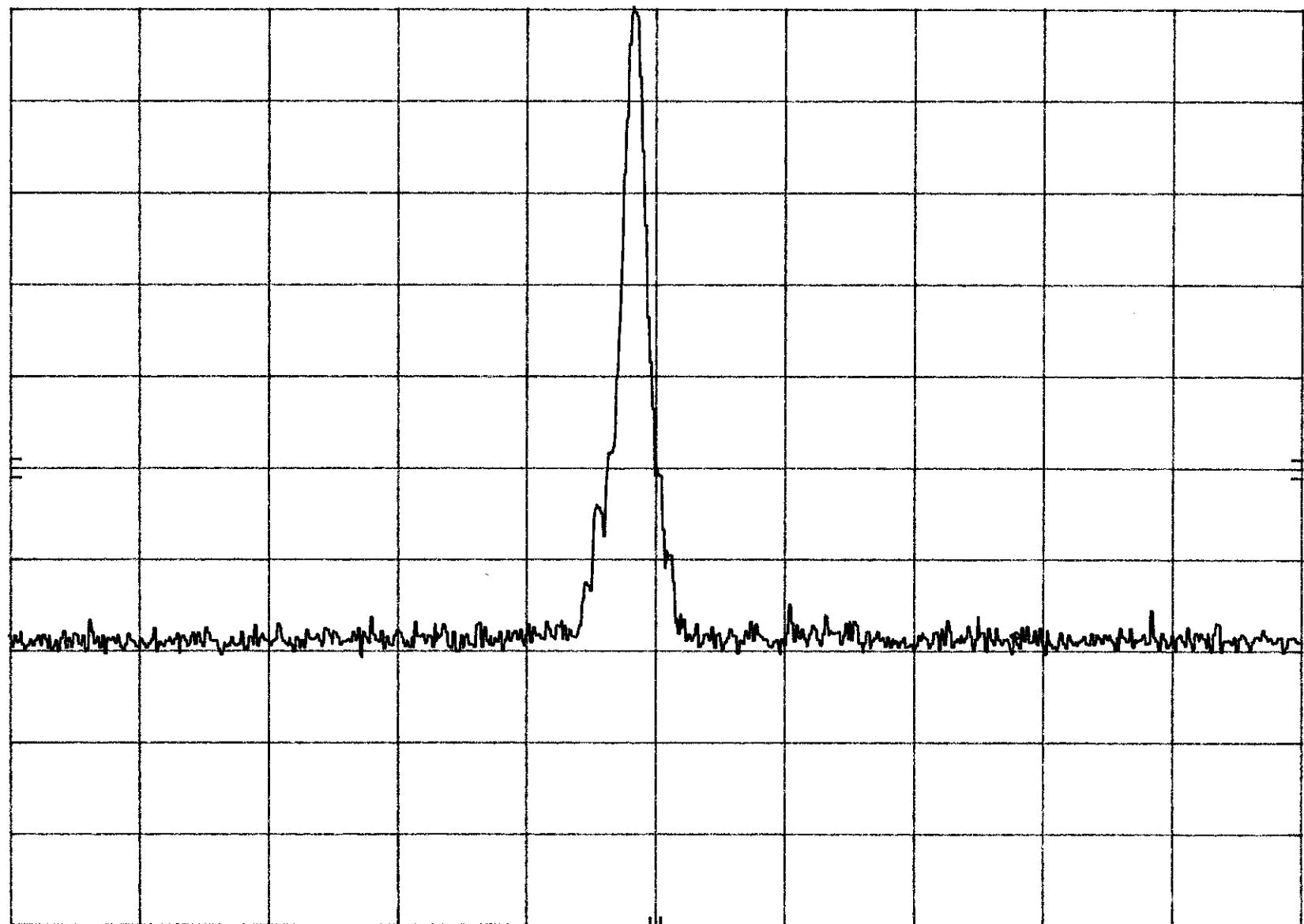
SWP 690 msec

MKR 2.464 96 GHz
-45.10 dBm

hp REF 23.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



START 2.400 0 GHz

STOP 2.483 5 GHz

RES BW 100 kHz

VBW 100 kHz

SWP 25.1 msec

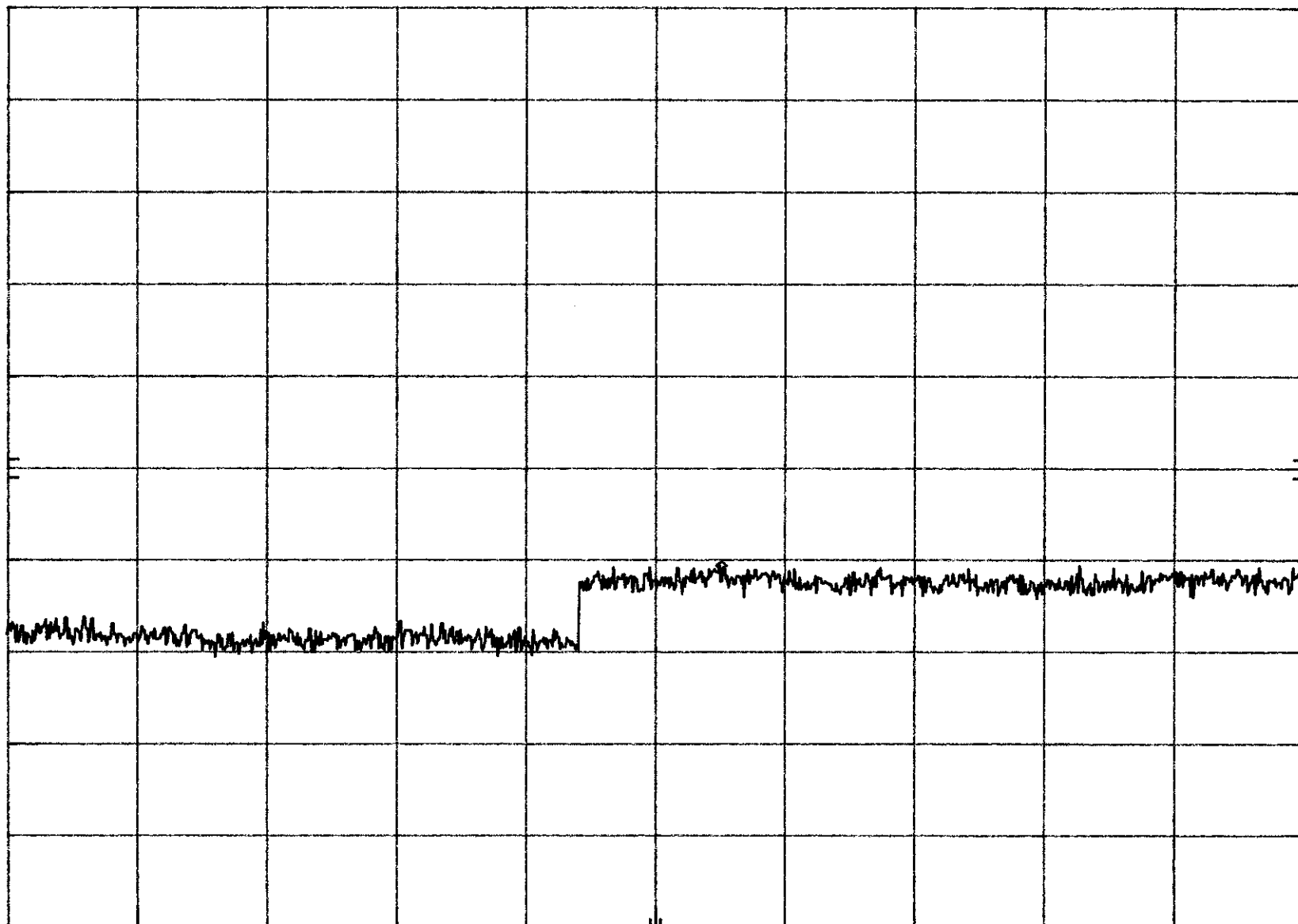
Plot 5b,3

MKR 6.617 GHz
-37.40 dBm

hp REF 23.2 dBm ATTN 40 dB

10 dB/

OFFSET
3.2
dB



START 2.48 GHz

STOP 10.00 GHz

Plot 5b,4

RES BW 100 kHz

VBW 100 kHz

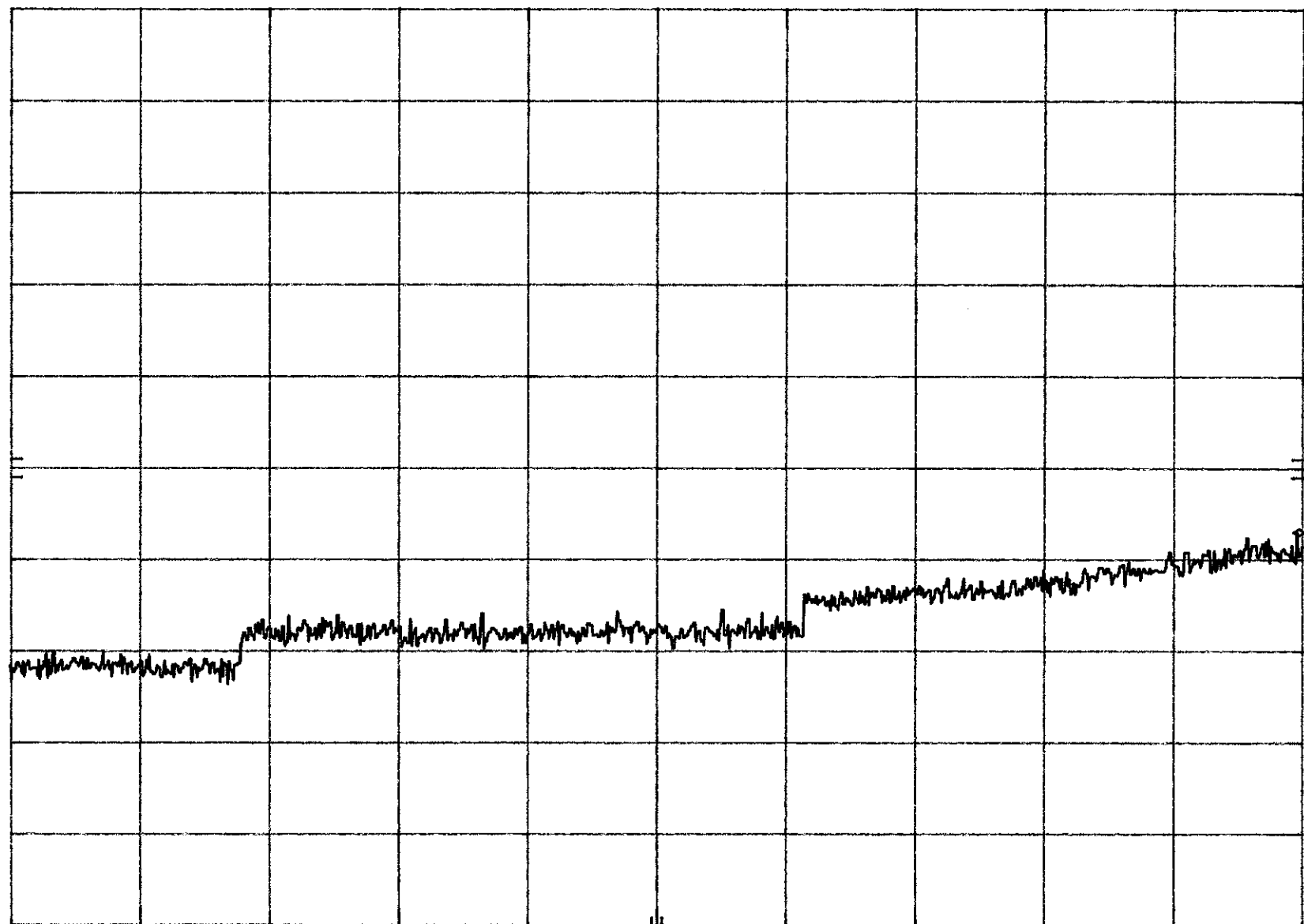
SWP 2.25 sec

MKR 23.94 GHz
-33.80 dBm

hp REF 23.2 dBm ATTN 30 dB

10 dB/

OFFSET
3.2
dB



START 10.0 GHz

STOP 24.0 GHz

Plot 5b,5

RES BW 100 kHz

VBW 100 kHz

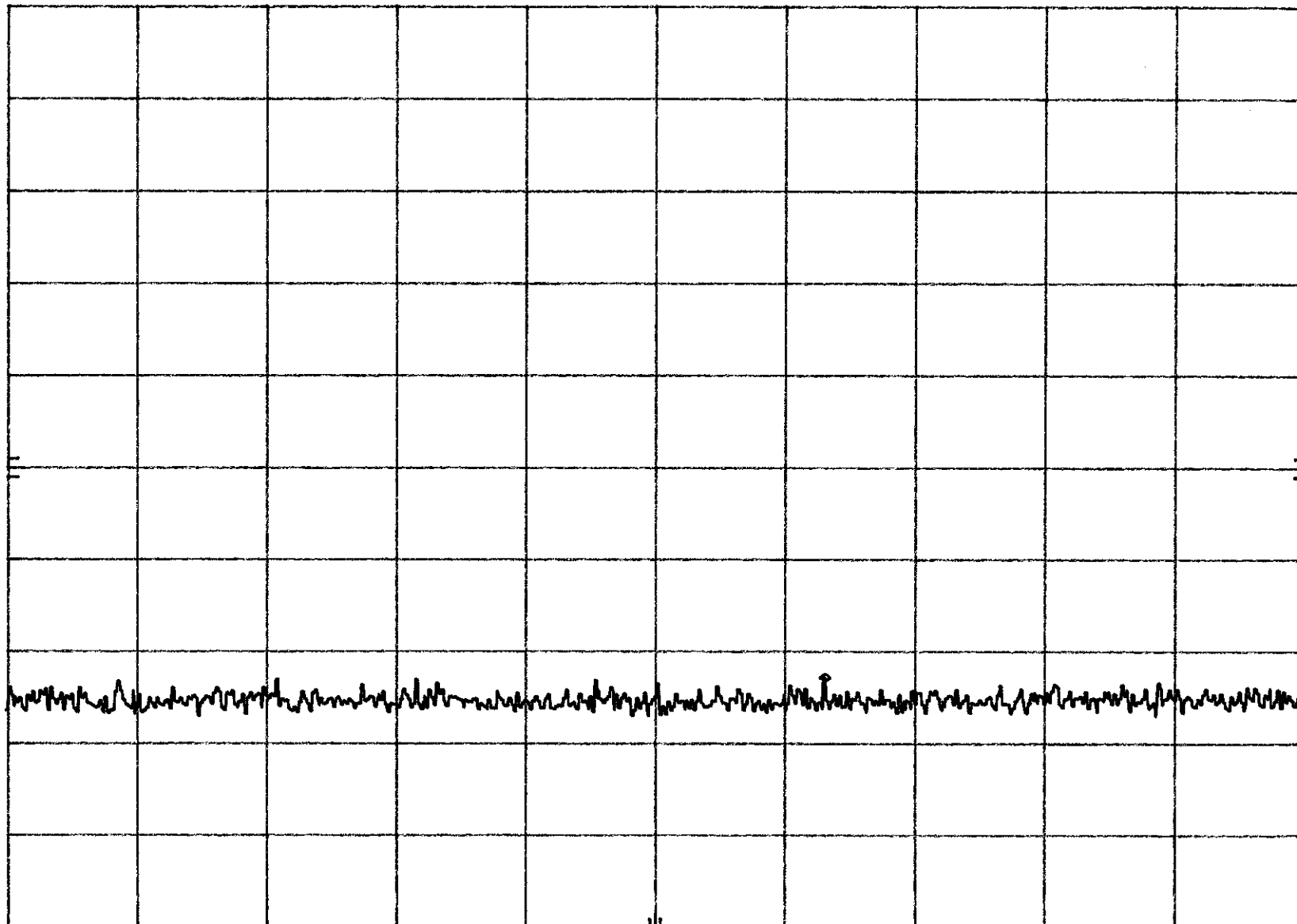
SWP 4.20 sec

MKR 63.37 MHz
-46.10 dBm

hp REF 26.7 dBm ATTN 40 dB

10 dB/

OFFSET
1.0
dB



START 1.0 MHz

STOP 100.0 MHz

Plot 5c,1

RES BW 100 kHz

VBW 100 kHz

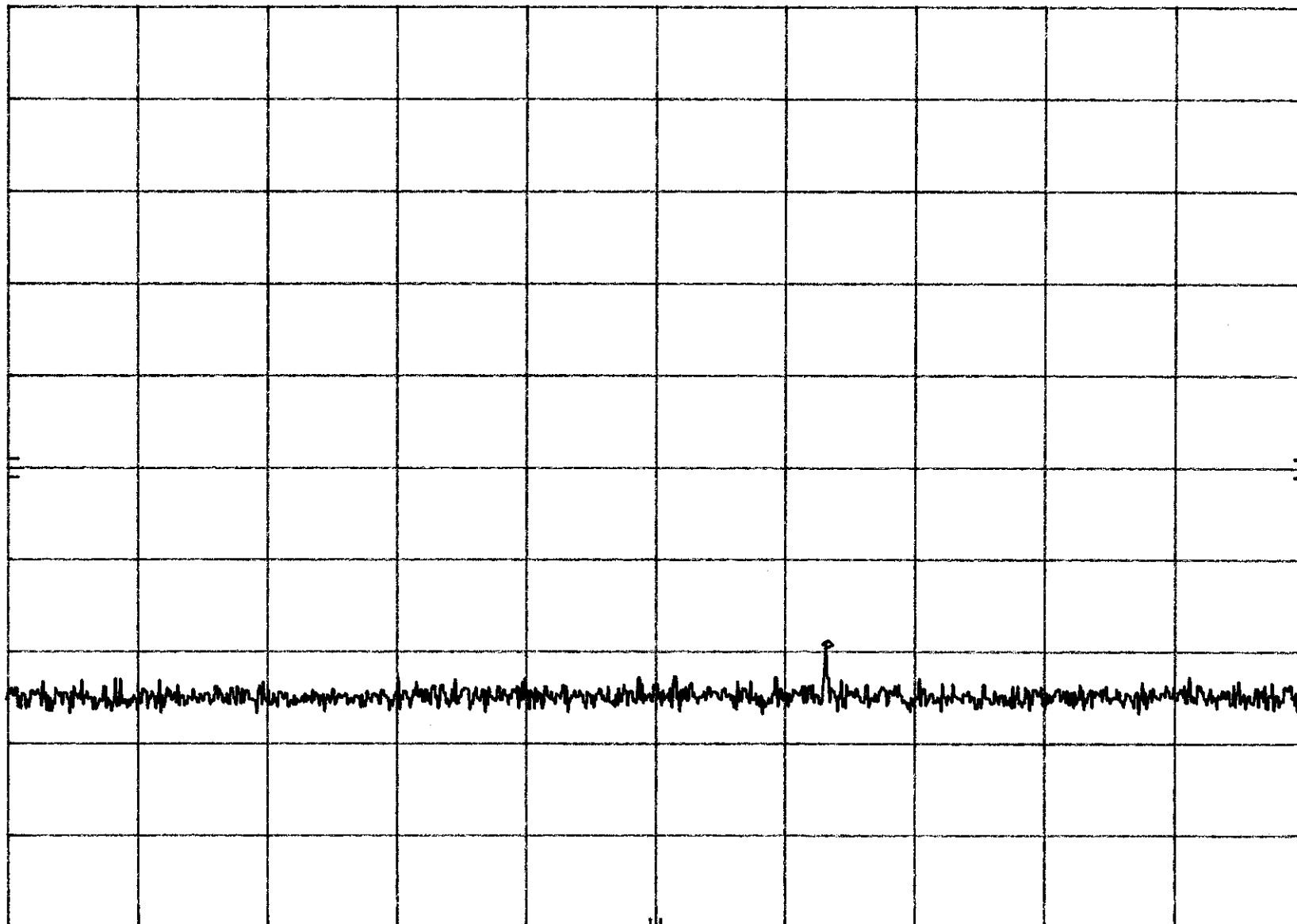
SWP 29.7 msec

MKR 668.8 MHz
-42.50 dBm

hp REF 26.7 dBm ATTN 40 dB

10 dB/

OFFSET
1.0
dB



START 100 MHz

RES BW 100 kHz

VBW 100 kHz

STOP 1.000 GHz

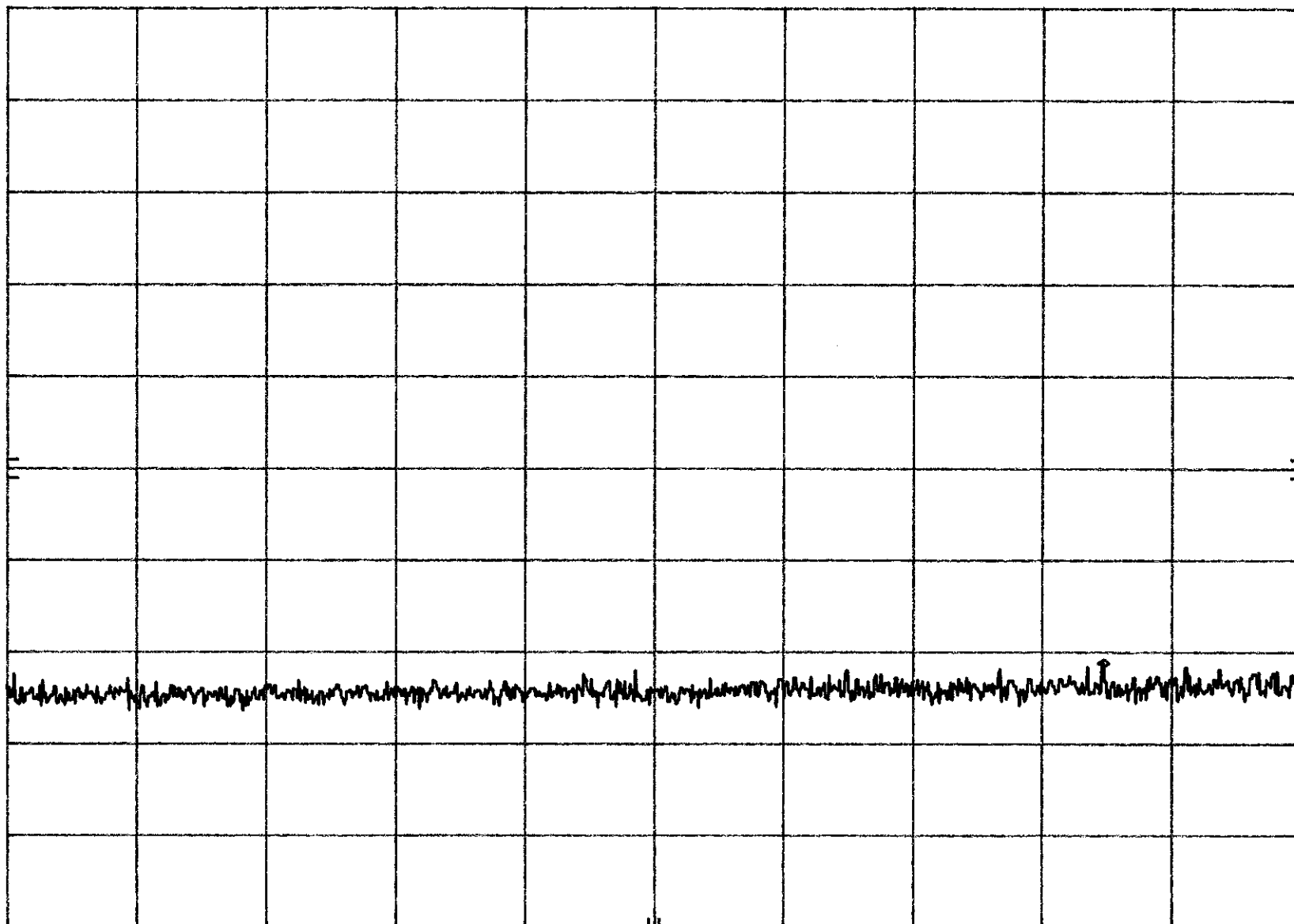
SWP 270 msec

MKR 2.186 GHz
-44.50 dBm

hp REF 26.7 dBm ATTEN 40 dB

10 dB/

OFFSET
1.0
dB



START 1.00 GHz

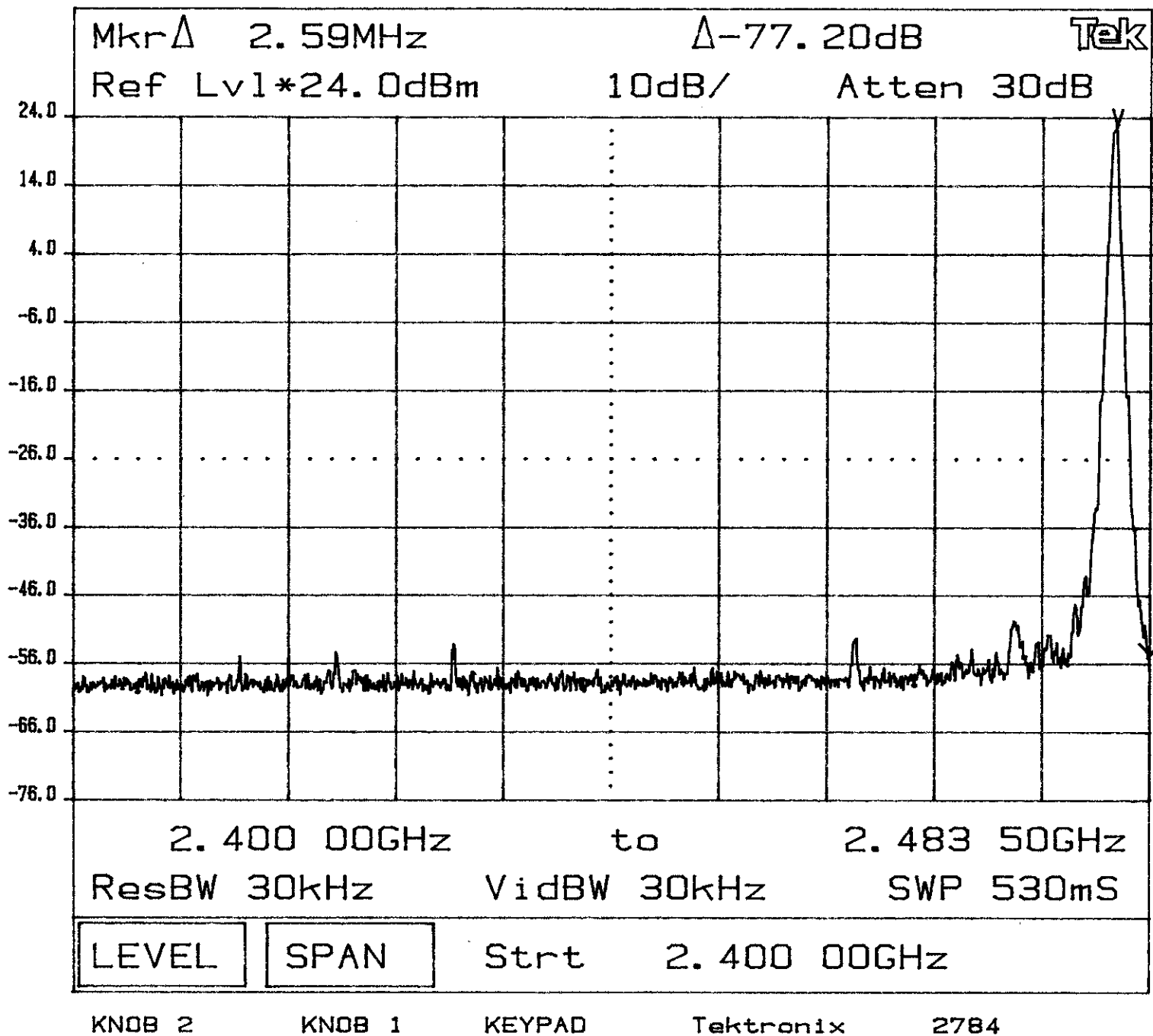
STOP 2.40 GHz

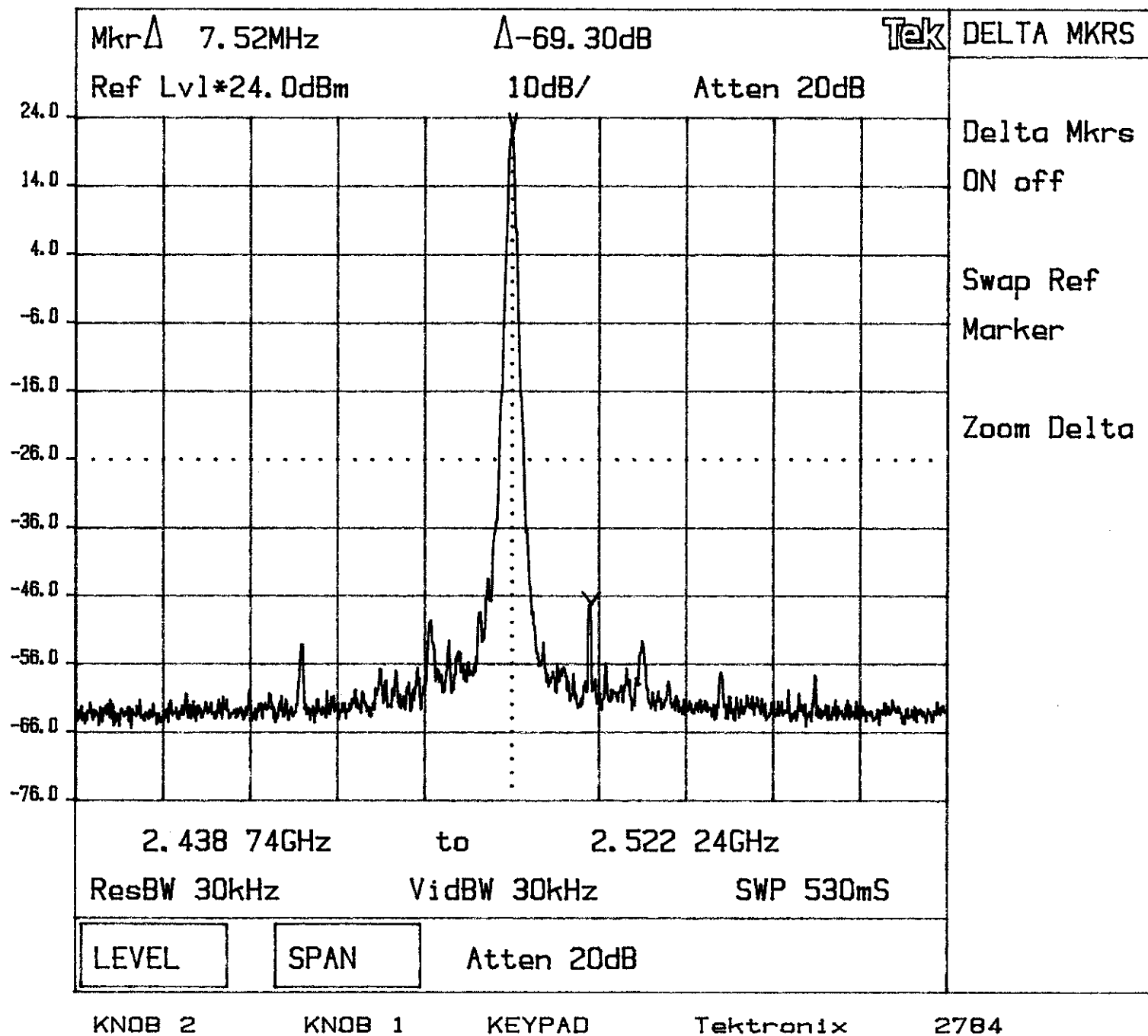
RES BW 100 kHz

VBW 100 kHz

SWP 420 msec

Plot 5c,3



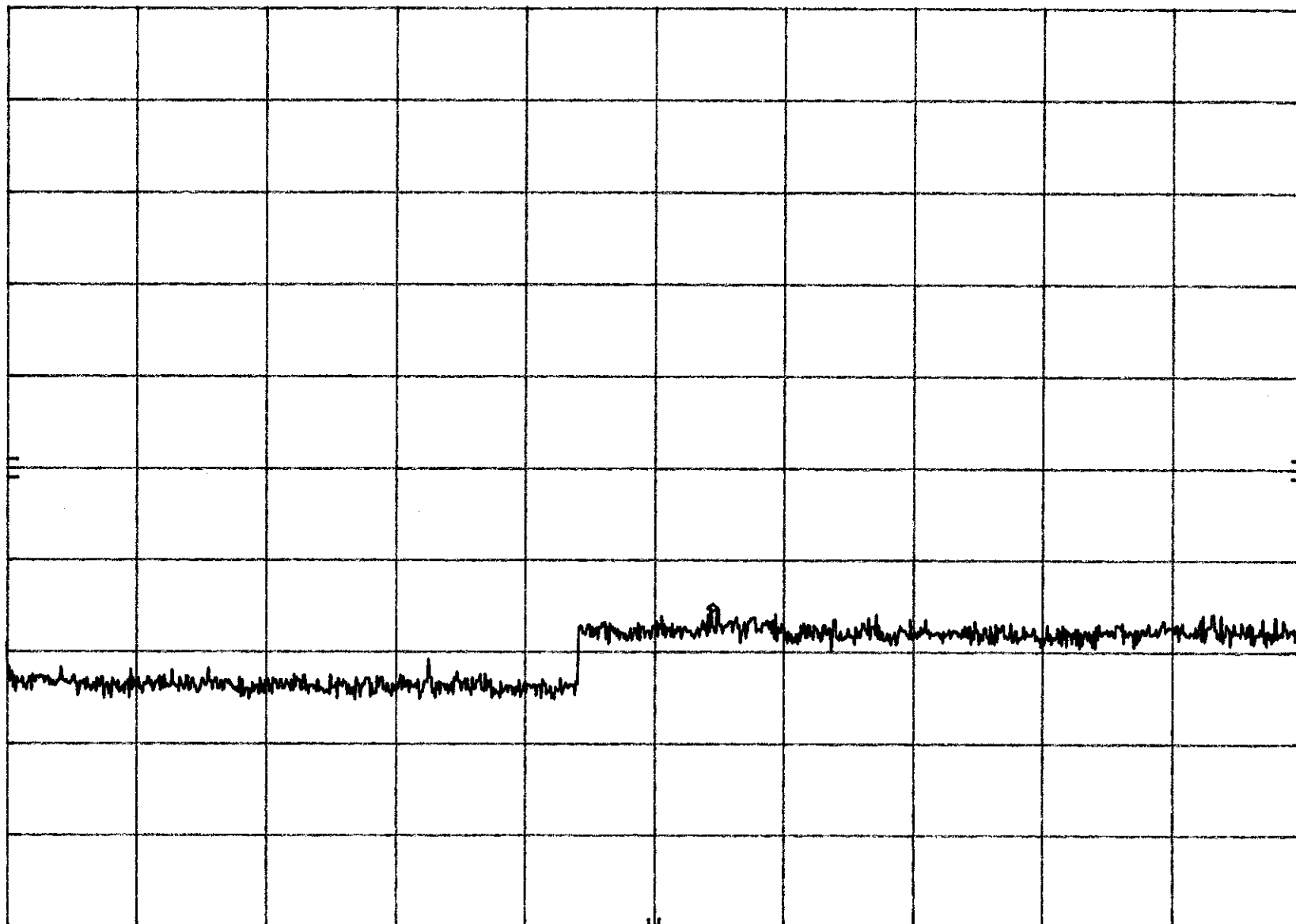


MKR 6.572 GHz
-38.50 dBm

hp REF 26.7 dBm ATTN 40 dB

10 dB/

OFFSET
1.0
dB



START 2.48 GHz

RES BW 100 kHz

VBW 100 kHz

STOP 10.00 GHz

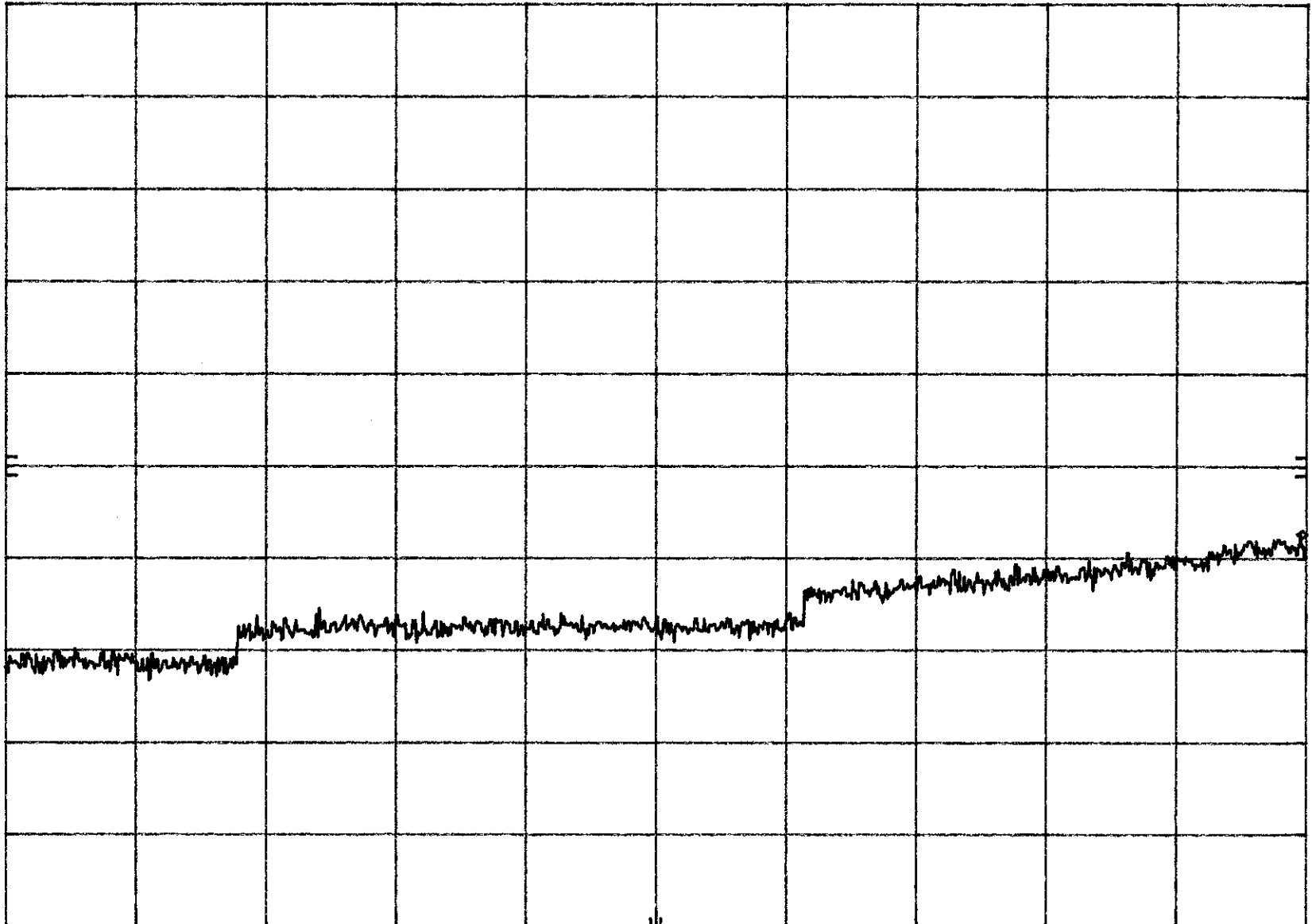
SWP 2.25 sec

MKR 23.94 GHz
-36.40 dBm

hp REF 21.0 dBm ATTN 30 dB

10 dB/

OFFSET
1.0
dB



START 10.0 GHz

RES BW 100 kHz

VBW 100 kHz

STOP 24.0 GHz

SWP 4.20 sec

4.6 Out of Band Radiated Emissions (for emissions in § 4.6 above that are less than 26 dB below carrier), FCC Ref: 15.247 (c)

For out of band emissions that are close to or that exceed the 20 dB attenuation requirement described in the specification, radiated measurements were performed at a 3 m separation distance to determine whether these emissions complied with the general radiated emission requirement.

☐ Test results are attached.

☒ Not required, all emissions more than 26 dB below fundamental

4.7 Transmitter Radiated Emissions in Restricted Bands, FCC Ref: 15.247(c),

Radiated emission measurements were performed from 30 MHz to 25000 MHz. Analyzer resolution is 100 kHz or greater for frequencies from 30 MHz to 1000 MHz and 1 MHz for frequencies above 1000 MHz.

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included. All measurements were performed with peak detection and average detection (above 1 GHz) unless otherwise specified.

On the following pages, the emissions on the harmonics frequencies, the limits, and the margin of compliance are presented. These tests were made when the transmitter is in full radiated power.

The additional test was performed to show compliance with the requirement at the band-edge frequency 2483.5 MHz and up to 2500 MHz.

The transmitter was setup to transmit at the highest channel. The spectrum analyzer with resolution bandwidth 1 MHz was connected to the antenna terminal of the transmitter. The antenna conducted emissions in the band 2400 - 2483.5 MHz were measured and plotted. The difference (delta) between the levels on fundamental frequency and on the frequency 2483.5 MHz was determined. Then the field strength (E_0 in dBuV/m) of radiated emission at the fundamental frequency at 3 m was measured.

The radiated emission (E_1 in dBuV/m) at 2483.5 MHz was calculated as follows:

$$E_1 = E_0 - \text{delta.}$$

The same procedure was used to measure the radiated emissions at the frequency 2390 MHz and down to 2310 MHz.

For the test results, refer to plot numbers 5.a.4, 5.c.4, and 5.c.5 in section 4.5.

For transmitters with hopping channel ON times < 100 msec, DUTY CYCLE CORRECTION is permitted for emissions above 1000 MHz: Duty Cycle of 0 dB was used.

4.9 Radiated Emissions from Digital Section of Transceiver, FCC Ref: 15.109

☐ Not Applicable - No digital part

☒ Test results are attached



Company: Symbol Technologies
Project #: 599013298
Model: LA 3021-500-US
Engineer: Xi-Ming Yang
Date of test: June 9,1999

FCC 15 Class B Radiated Emissions

Frequency	Antenna Polarity	Reading	Antenna Factor	Cable Loss	Pre-amp	Distance Factor	Corrected Reading	Limit	Margin
MHz	H N	dB(uV)	dB/m	dB	dB	dB	dB(uV/m)	dB(uV/m)	dB
60.0	H	31.5	4.7	0.0	0.0	0.0	36.2	40.0	-3.8
140.0	H	27.7	8.4	0.0	0.0	0.0	36.1	43.5	-7.4
160.0	H	31.0	8.8	0.0	0.0	0.0	39.8	43.5	-3.7
200.0	H	29.9	10.2	0.0	0.0	0.0	40.1	43.5	-3.4
240.0	H	30.0	11.0	0.0	0.0	0.0	41.0	46.0	-5.0
260.0	H	31.0	12.0	0.0	0.0	0.0	43.0	46.0	-3.0
280.0	H	30.0	12.1	0.0	0.0	0.0	42.1	46.0	-3.9
300.0	H	26.8	13.1	0.0	0.0	0.0	41.9	46.0	-4.1
380.0	H	26.0	15.0	0.0	0.0	0.0	41.0	46.0	-5.0
450.0	H	25.0	16.0	0.0	0.0	0.0	41.0	46.0	-5.0
720.0	H	10.8	20.4	0.0	0.0	0.0	31.2	46.0	-14.8

- Note:
1. All measurement were made at 3 meters
 2. Negative signs (-) in the margin column signify levels below the limit.

4.10 Radiated Emissions from Receiver Section of Transceiver (L.O. Radiation), FCC Ref:
15.109, 15.111

☒ [X] Not required - EUT operation above 960 MHz only

☐ [] Not Applicable - EUT is transmitter only

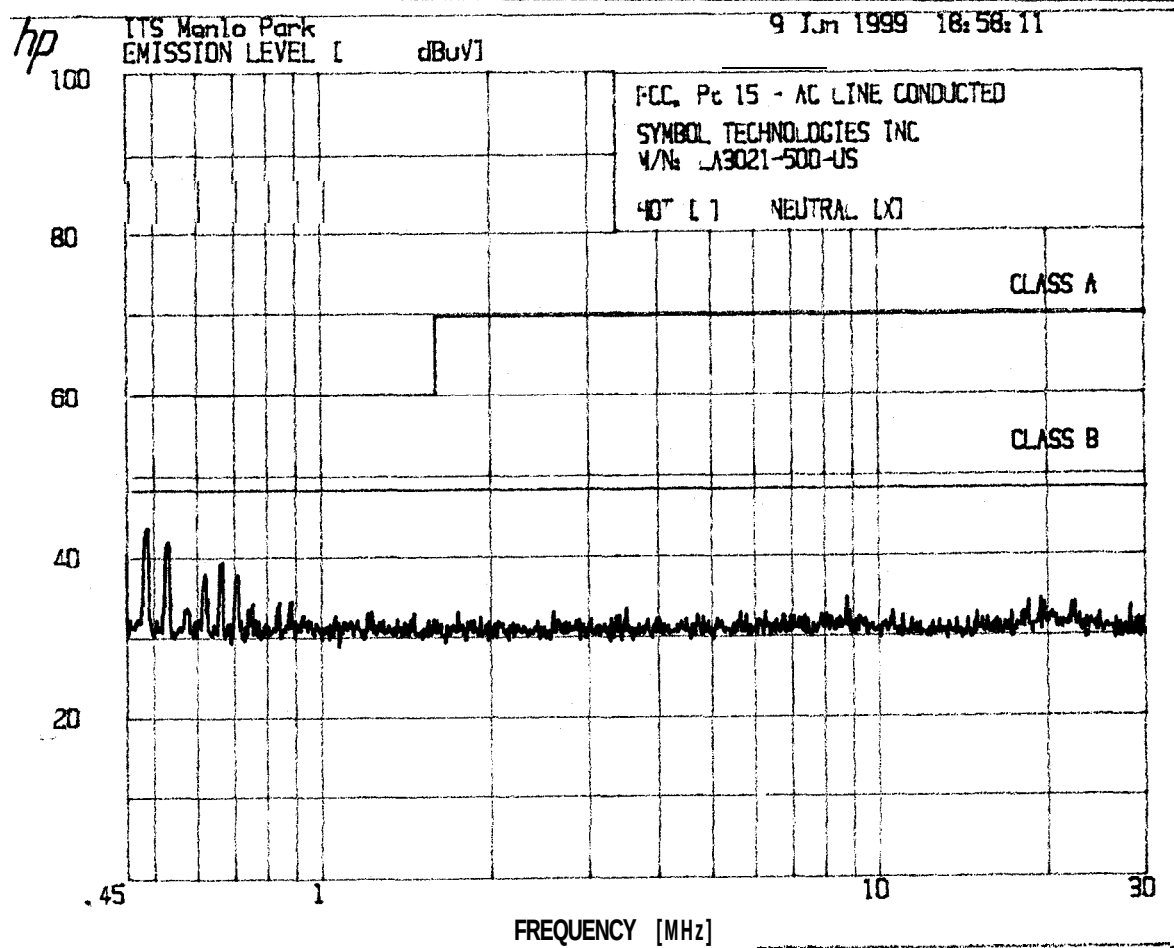
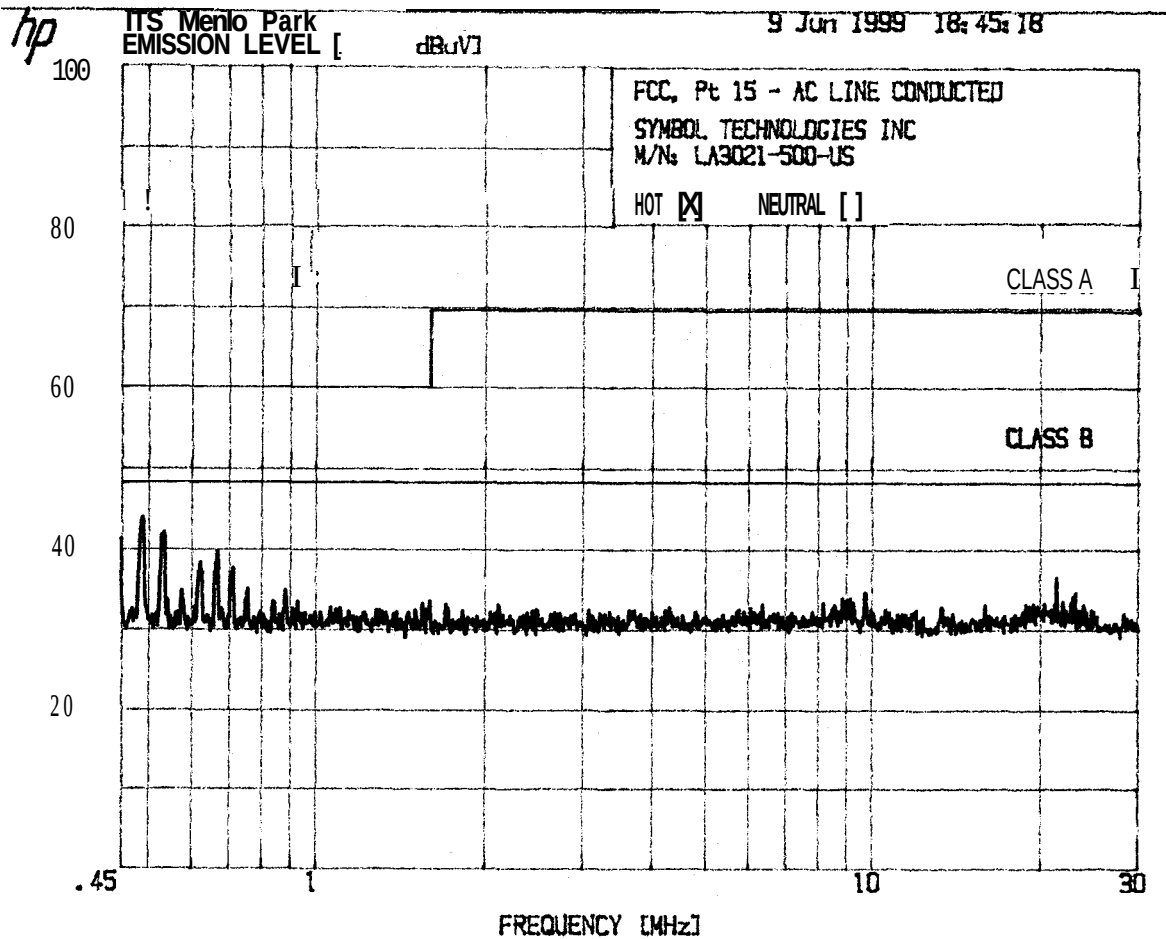
☐ [] Not performed; exempt until June 1999

☐ [] Test results are attached

4.11 AC Line Conducted Emission, FCC Rule 15.207:

☐ Not required; battery operation only

☒ Test data attached



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3. FCC CFR 47, Pt 15
3.1 FCC, Pt 15 - AC LINE CONDUCTED

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SYMBOL TECHNOLOGIES INC
M/N: LA3021-500-US

HOT [X] NEUTRAL []

PEAKS FOUND ABOVE 35 dBuV

PEAK#	FREQ (MHz)	AMPL (dBuV)
1	.4935	43.8
2	.5390	42.0
3	.6268	38.2
4	.6732	39.7
5	.7169	37.6
6	21.54	36.6

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ITS Menlo Park 9 Jun 1999 18:58:11

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3. FCC CFR 47, Pt 15

3.1 FCC, Pt 15 - AC LINE CONDUCTED

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SYMBOL TECHNOLOGIES INC

M/N: LA3021-500-US

HOT [] NEUTRAL [X]

PEAKS FOUND ABOVE 38 dBuV

PEAK#	FREQ (MHz)	AMPL (dBuV)
1	.4914	43.4
2	.5367	41.8
3	.6704	39.3

4.12 AC Line Conducted Configuration Photograph



5.0 **Equipment Photographs**

Photographs of the EUT are attached.

6.0 **Product Labeling**

6.1 Label Artwork

6.2 Label Location

See attached pages.

7.0 **Technical Specifications**

7.1 Circuit Diagram

See attached pages.

7.2 Block Diagram

See attached pages.

7.3 Antenna gain and Mounting Information

See attached pages.

8.0 **Instruction Manual**

Attached is a preliminary copy of the Instruction Manual.

Please note that the required FCC Information to the User can be found on Page ____ of this manual.

This manual will be provided to the end-user with each unit sold/leased in the United States.