

THE AUSTRALIA TELESCOPE NATIONAL FACILITY

Preliminary Interference Survey - No. 1 (Mopra)

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Introduction

A preliminary RFI survey across the band 500 MHz to 3000 MHz, was carried out during April 1993 at the Mopra antenna site. The purpose of this survey was to determine, if possible, what strong interfering signals were present in the SETI search band (i.e. 1000 MHz → 3000 MHz) and what strong signals were present in the bands below the search band, which might be a source of higher harmonic interference.

Method

The measurements were made using a very simple monitoring system consisting of a monopole antenna followed by a low noise broadband amplifier with approximately 30db of RF gain, the output of which was connected to a HP8569B spectrum analyser. The system arrangement is shown in Fig. 1.

To cover the SETI search band, three monopole antennas were used, the input return loss of which is shown in Fig. 2. In general, it was attempted to operate the monopoles where the VSWR was < 3:1 or -6db return loss. Thus, monopole #1 was operated from ~700 MHz to 1100 MHz, monopole #2 from 1100 MHz to 1700 MHz and monopole #3 from 1700 MHz to 3000 MHz.

The amplifier used to cover the lower part of the band up to 1500 MHz, was a Miteq AM-3A-000110 with a gain of ~30db and a noise figure of 2.5db max, whilst the upper part of the band, from 1500 → 3000 MHz, was covered by a Miteq AFD 2-010040 with ~ 23db gain and a maximum noise figure of ~ 3db.

In general the observations consisted of monitoring 100 MHz bands with the spectrum analyser set to maximum hold for periods of ~ 10 minutes or more. The resultant spectrum plots are shown in Fig. 3.

Finally, a recent (April 1994) spectrum analyser measurement was performed on the Mopra RF system at the input to the first conversion mixer and covering the band 1200 to 1800 MHz. The 22-m antenna was pointed to the zenith at the time.

Two plots are shown: the first, Fig. 4, is a logarithmic plot showing various interfering signals and their relative power levels. The second plot, Fig. 5, is on a voltage linear scale, and shows somewhat more clearly, the interfering signals in this band.

Results

1. April 1993

Apart from the numerous strong signals seen in the 500 → 1000 MHz range, (the strongest of these being UHF TV signals and cellular radio transmissions) the next band of concern to SETI investigations in general is the 1000 → 1200 MHz band. Here we have several strong intermittent transmissions around 1024, 1030, 1060, 1068, 1071 and 1090 MHz - keep in mind, however, that this band is not accessible to the Mopra feed system and these transmissions should not be a concern.

Of more immediate concern, however, is the band 1200 → 3000 MHz, and the transmissions seen in this band are listed in Table 1, with their approximate signal levels at the monopole antenna and their suspected origin. For simplicity, the monopole antenna gain was assumed to be 0 db, so that the signal levels listed in Table 1 will be somewhat higher by the actual monopole gain.

Table 1

<i>Frequency (MHz)</i>	<i>Approximate Level (dbm)</i>	<i>Origin</i>
1280	-104	10th harmonic of 128MHz
1382	-103	
1447	-104	
1532	-107	
1536	-107	12th harmonic of 128MHz
1587	-101	
1712	-105	
1738	-108	
1766	-106	
1782	-106	

It is interesting to note that at the time these measurements were made, the range from 1800 → 3000 MHz was clear of strong interfering signals (i.e. signals that could be detected with the equipment used in this experiment). A word of warning - the station microwave oven, when operating, produces very strong interference between 2400 and 2500 MHz and must be disabled when working at any frequency in the S-band region.

2. April 1994

These measurements were made with considerably more sensitivity - the L-band front end was used with the 22-metre antenna pointed at the zenith. In this case, we again assume 0 db gain for the antenna and 63 db gain for the RF system up to the point where the measurement was made.

The measurement shown covers 1000 → 2000 MHz and is a single sweep plot only. Therefore the intermittent transmissions that show up in a maximum hold plot may not be recorded in this measurement.

The following signals present in the receiver passband are recorded in Table 2.

Table 2

<i>Frequency (MHz)</i>	<i>Approximate Level (dbm)</i>	<i>Origin</i>
1024	-135	8th harmonic of 128MHz Sampler Clock
1099	-133	
1133	-135	
1199	-119	
1299	-110	
1408	-127	11th harmonic of 128MHz Sampler Clock
1500	-131	
1536	-127	12th harmonic of 128MHz
1557	-136	Mobilesat transmissions from Optus B1
1575	-139	GPS
1664	-129	13th harmonic of 128MHz
1704	-139	
1800	-132	

Discussion

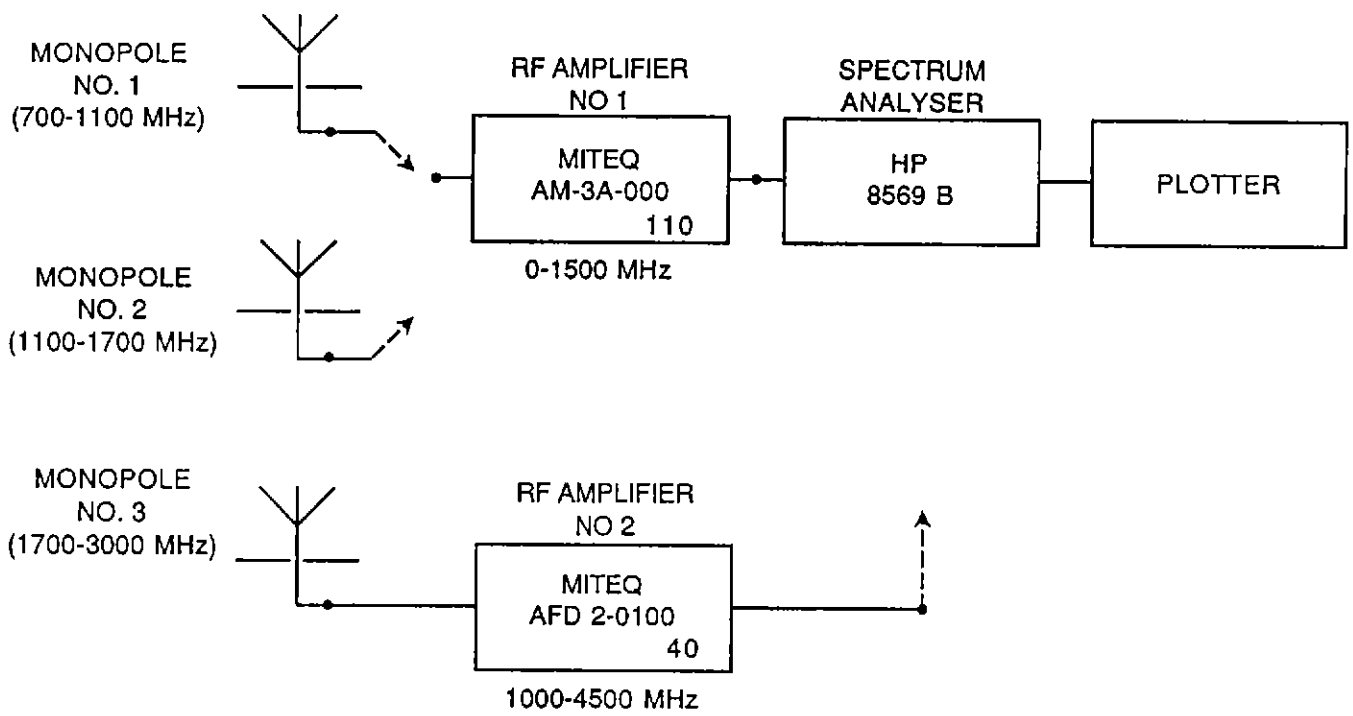
Apart from two harmonics of the 128 MHz sampler clock (1280 and 1536 MHz), the other signals seen in the early wideband survey of the 1200 → 3000 MHz range, would appear to be of terrestrial origin and are somewhat intermittent in nature. The polar pattern of the monopole antenna would tend to favour the reception of point to point microwave link transmissions and the absence of both GPS and Glonass emissions in the plots, would tend to bear this out. The fact that many minutes of searching, using the max hold function of the spectrum analyser is required to capture these signals, emphasises the intermittent nature of the transmissions and it is felt that these transmissions should be reobserved with a similar system to confirm their existence.

The signals seen in the April 1994 measurements, however, have much better signal-noise and at least half of them can be identified with sampler clock harmonics, GPS and Glonass transmissions, and Optus B1 mobilesats test transmissions. The rest are thought to be terrestrial microwave links.

It should be possible to deal with the sampler clock harmonic problem - the samplers can be removed from the sampler rack during the SETI observing period - this should apply to both Mopra and Parkes. However, the 128 MHz clock generator signal is supplied by the LO rack and may require special terminations.

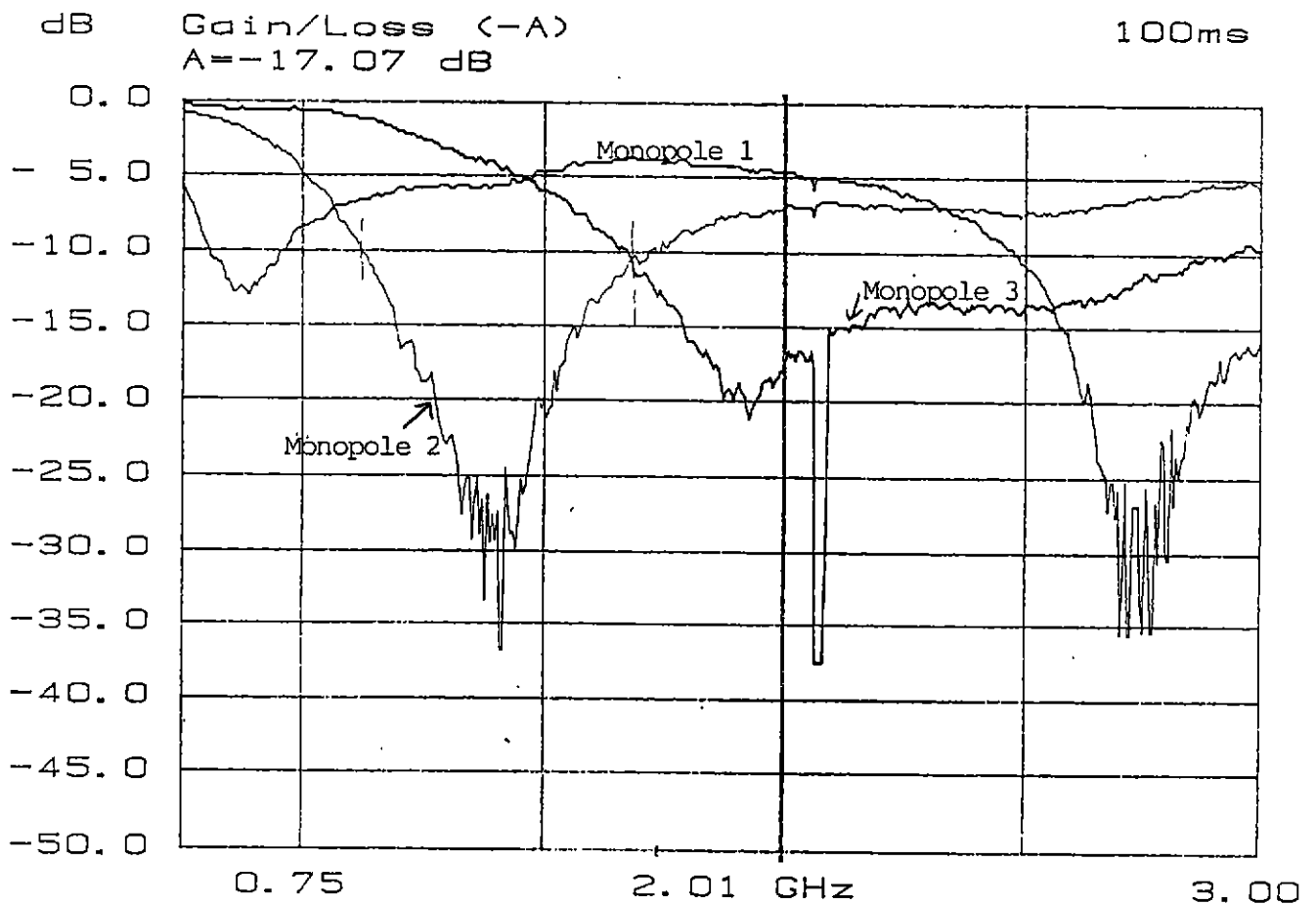
The Optus B1 mobilesats transmission will necessitate the need for some careful observational programming. These test transmissions, covering ~ 20 MHz near 1557 MHz are very strong, and will begin to approach input signal levels of -80 dbm when the antenna is pointed at the satellite. It is in a geostationary sky position (Az = 20.3° El = 51.7°), whereas the orbiting GPS and Glonass satellite transmissions which are of similar level, will tend to move fairly quickly to another part of the sky.

Figure 1.



MEASURING SYSTEM ARRANGEMENT
FIGURE:1

Figure 2.



7 April 93
17.30 East.

#3
700 - 800 MHz - Max Hold) $\frac{1}{4}$ Vertical Monopole

CTR 750.0 MHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
REF -51 dBm 5 dB/ ATTN 10 dB SWP AUTO

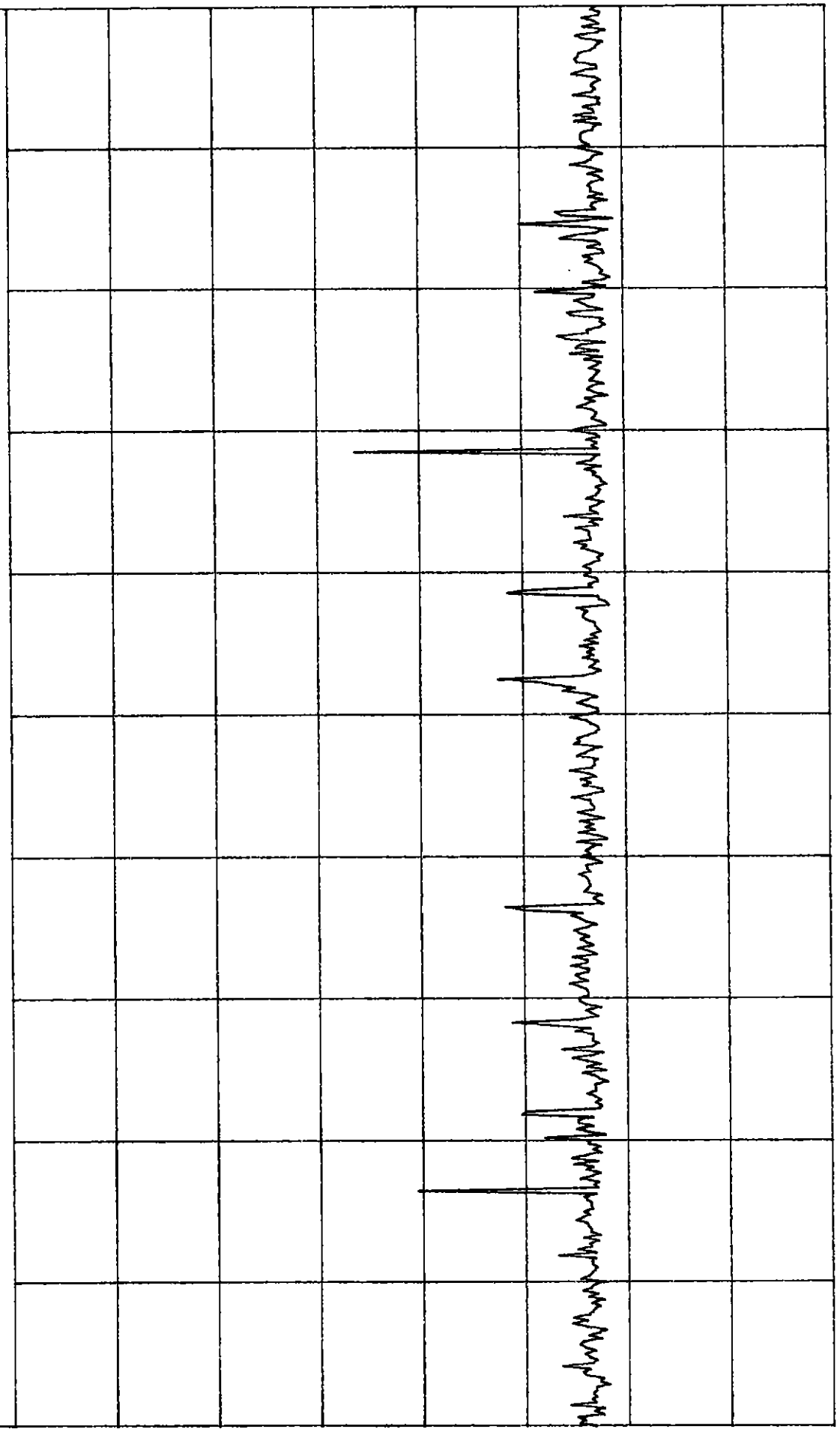


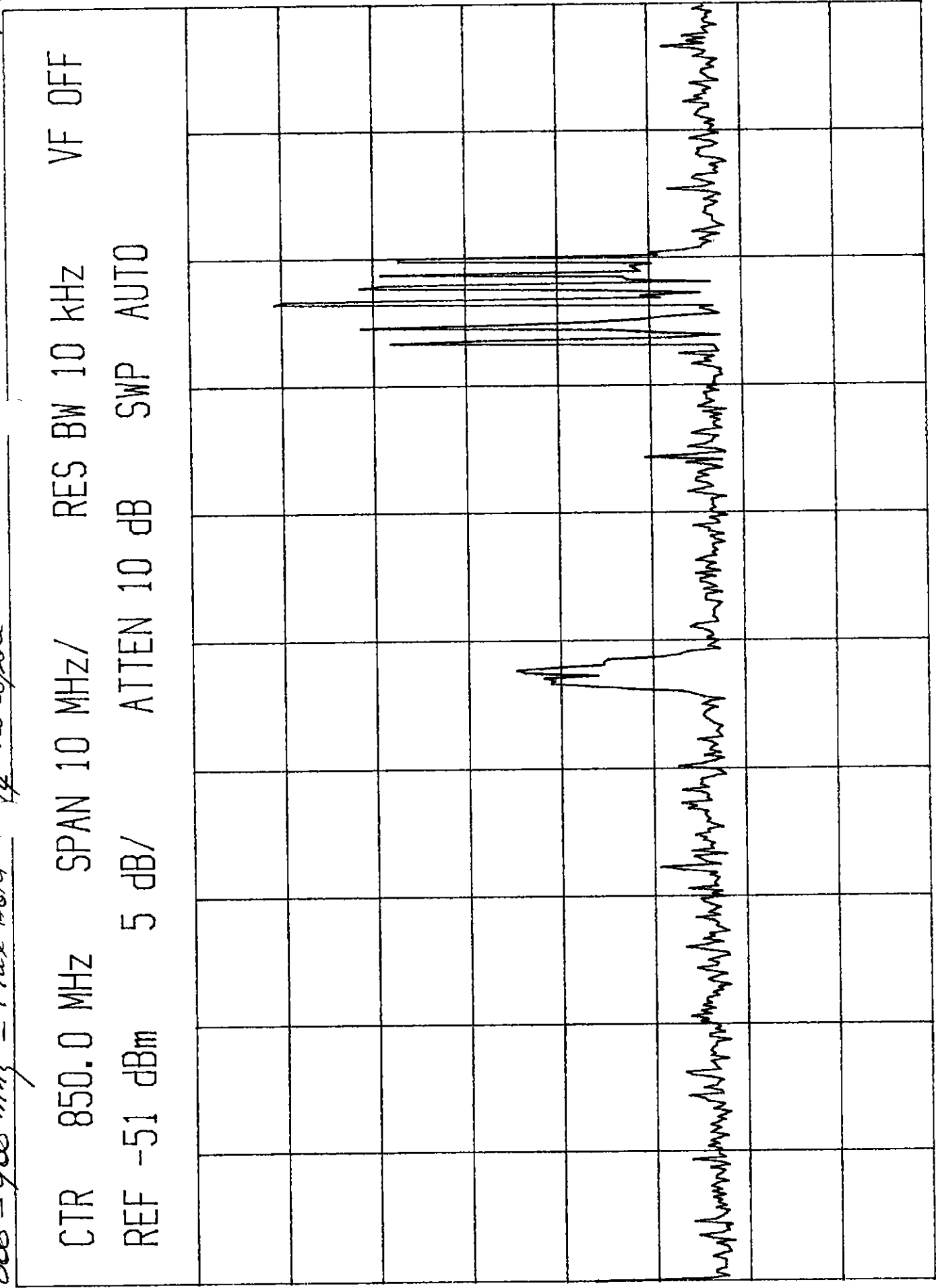
Figure 3.

800 - 900 MHz - Max Hold

7/4 Monopole

1.4 GHz 7.2

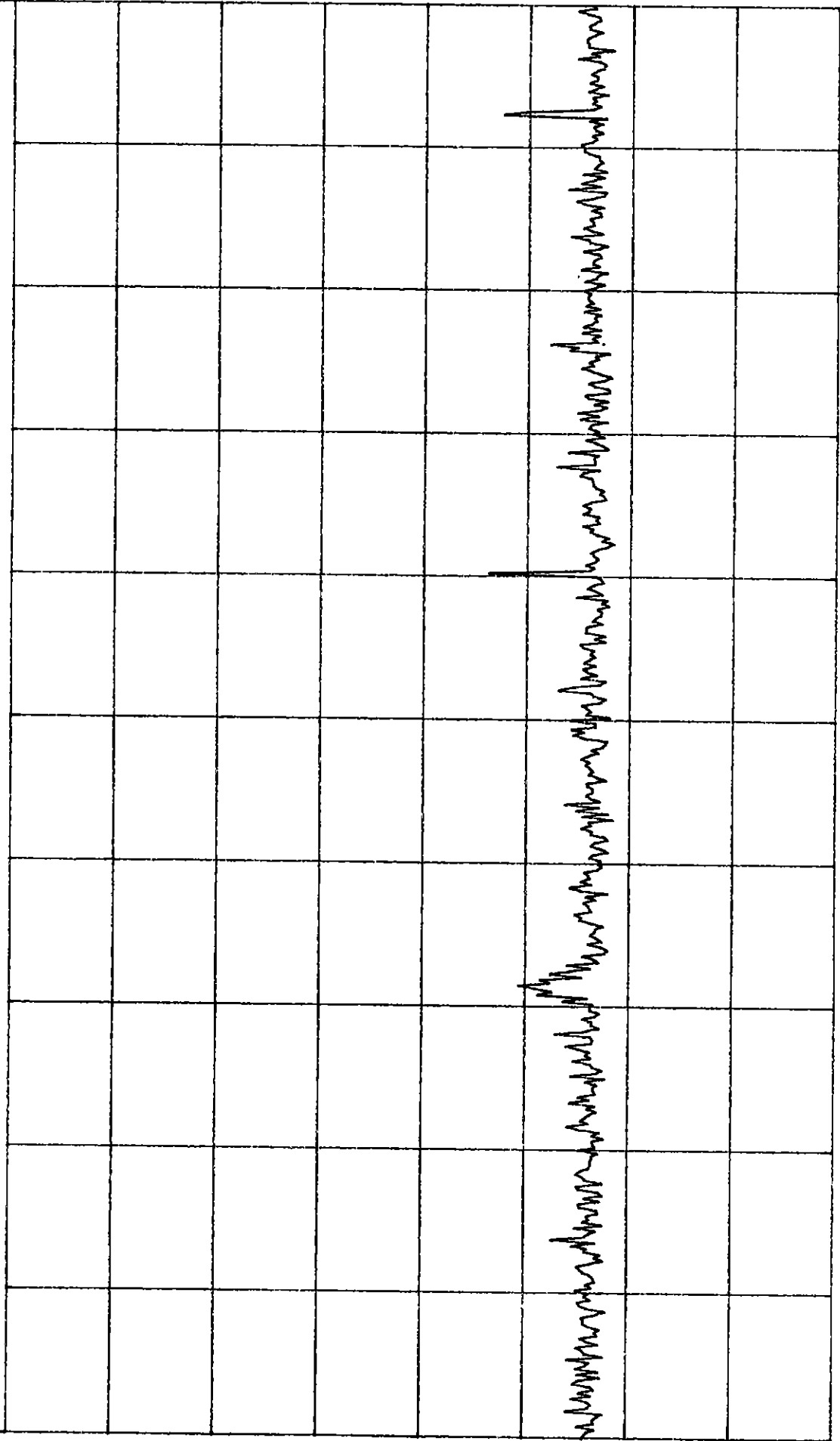
17.40 EARX



7 April 93
17.50 East

900 - 1000 Mhz - Max Hold. $\frac{1}{4}$ Monopole

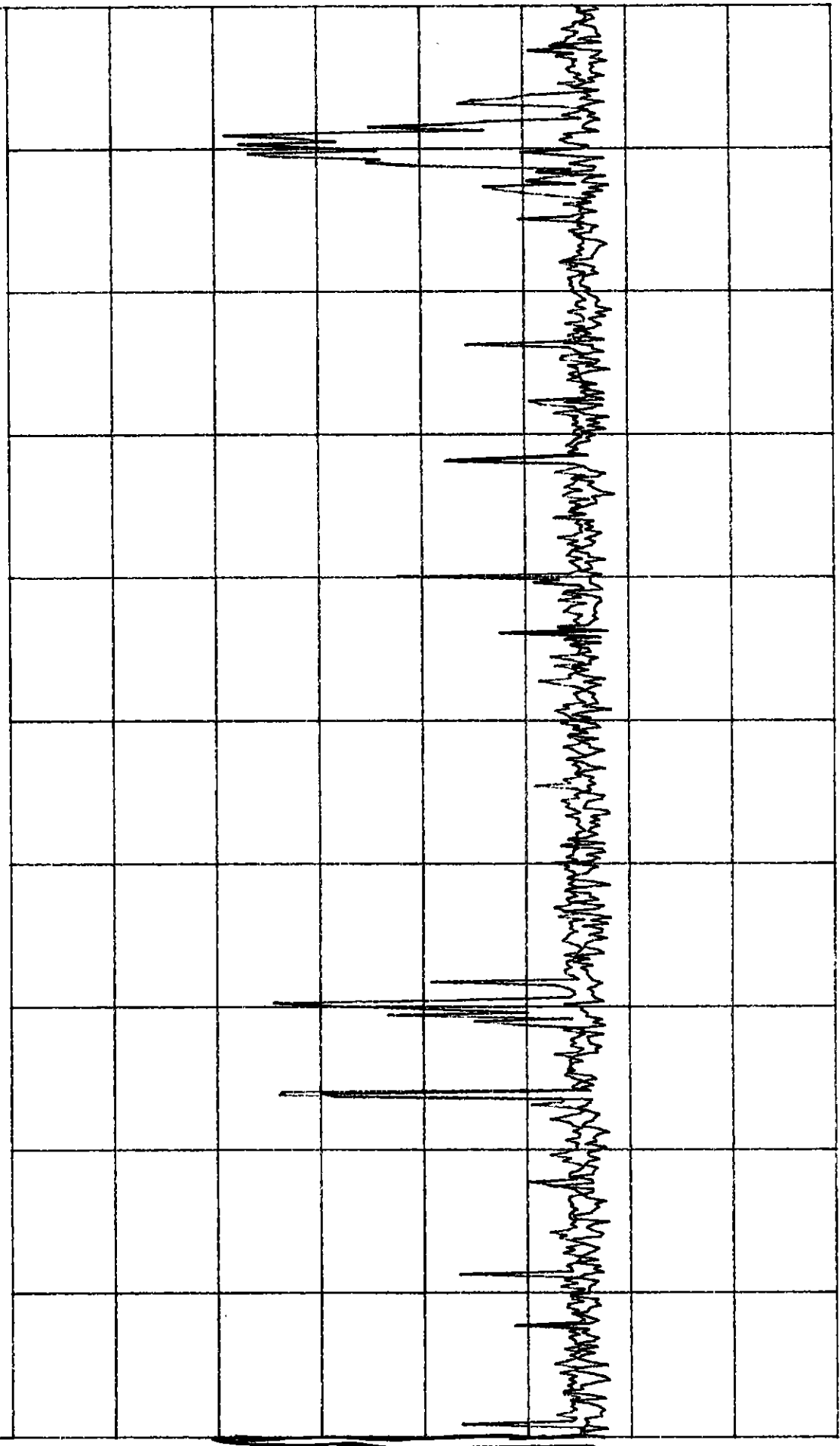
CTR 950.0 MHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
REF -51 dBm 5 dB/ ATTN 10 dB SWP AUTO



7 April 1993.
18.00 East.
18.28 East.

1000-1100 MHz. - Max Hold. - $\frac{1}{4}$ monopole.

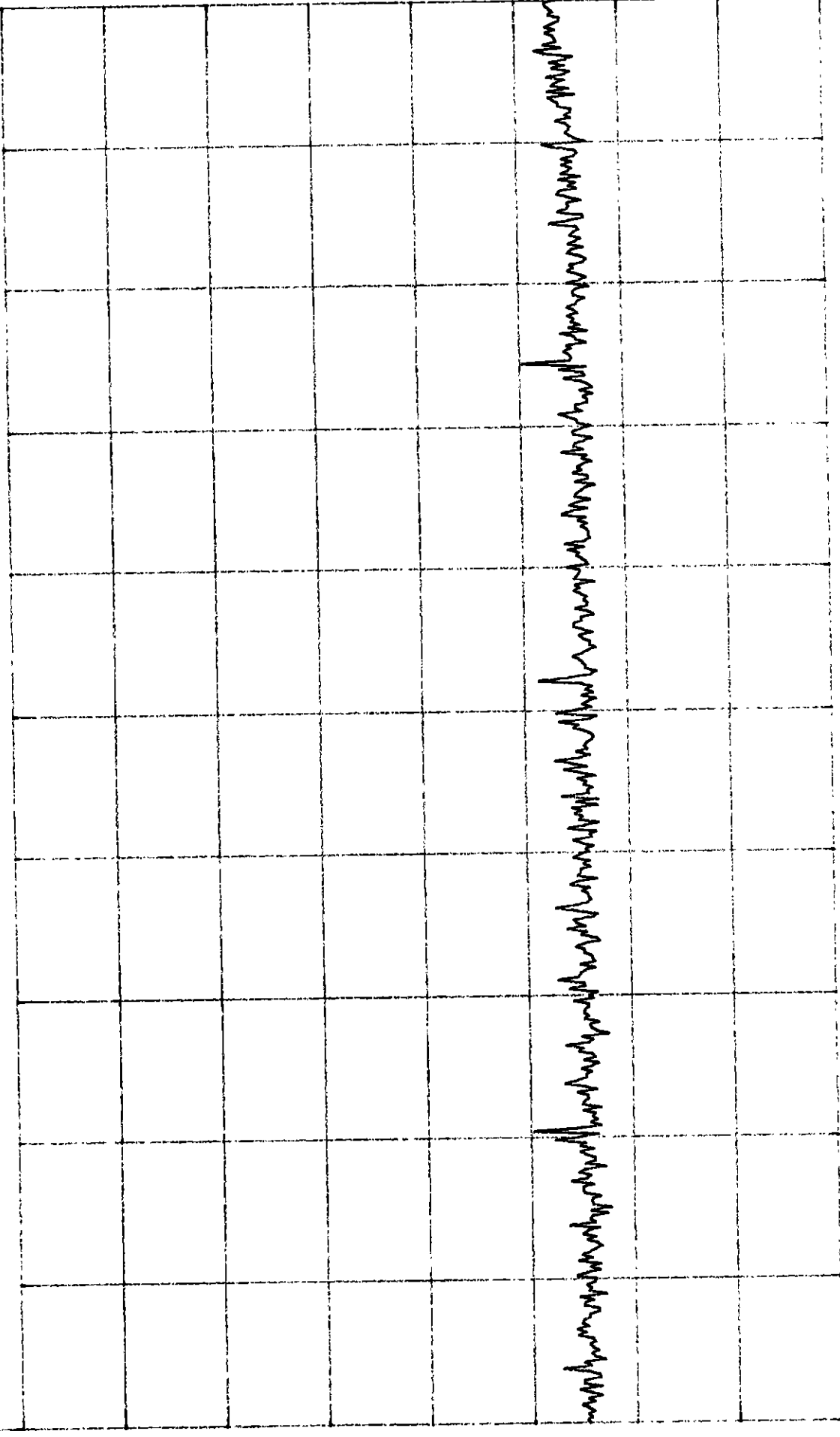
CTR 1.0500 GHz SPAN 10 MHz/ RES BW 10 KHZ VF OFF
REF -51 dBm 5 dB/ ATTN 10 dB SWP AUTO



7 April 1993
18:40 EST

1100 - 1200 MHz - Max Hold. - $\frac{1}{2}$ Monopole.

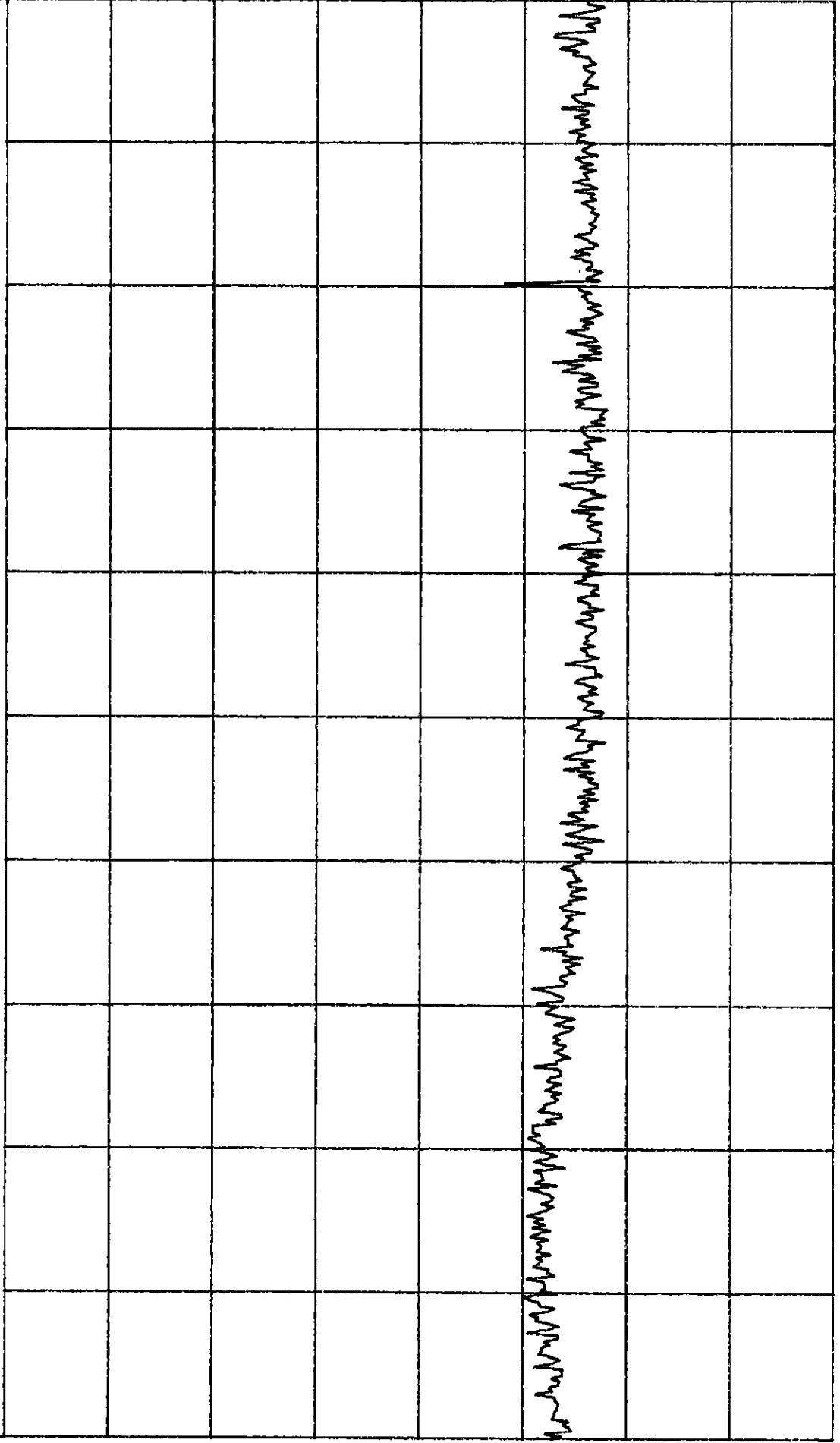
CTR 1.1500 GHz SPAN 10 MHz/ RES BW 10 KHZ VF OFF
REF -51 dBm 5 dB/ ATTEN 10 dB SWP AUTO



7 April 1993
1850
EAST.

1-200 - 1-300 GHz - Max H 'Y' - 1/4 Monopole

CTR 1.2500 GHZ SPAN 10 MHZ/ RES BW 10 KHZ VF OFF
REF -51 dBm 5 dB/ ATTEN 10 dB SWP AUTO



7 April 93
22.40
EAST

~~1.40-1.50 GHz~~: Max Heli. - 1/4 Monopole. #3

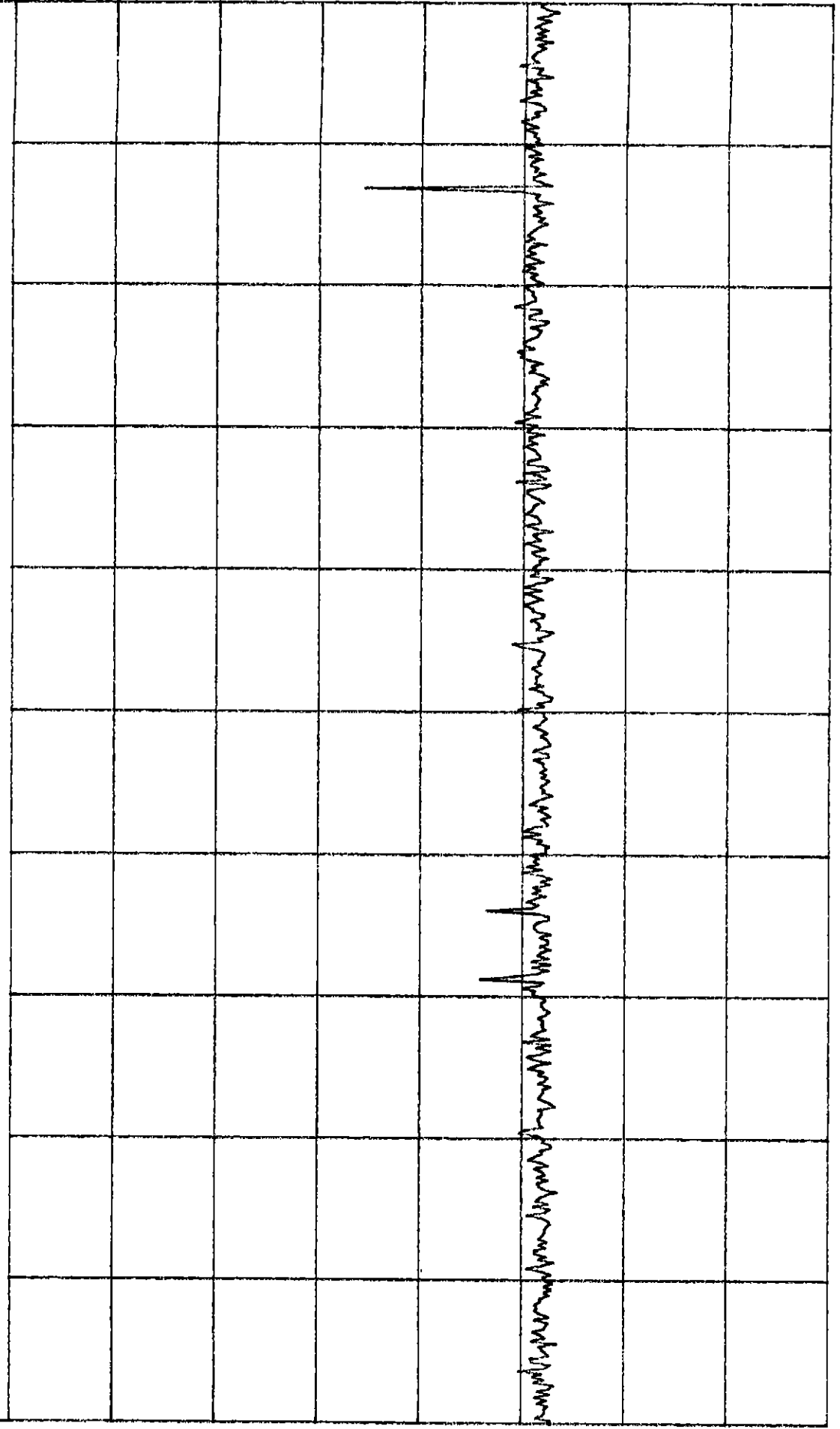
CTR 1.4500 GHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
REF -51 dBm 5 dB/ ATTEN 10 dB SWP AUTO

Start of spectrum at 1.4500 GHz. Max Heli. - 1/4 Monopole. #3. The plot shows a series of peaks and troughs, indicating signal activity across the frequency range.

8th April: 93
10.30 EST.

1.5 → 1.6 GHz : Max Calc) - 74 Monopole #3

CTR 1.5500 GHz SPAN 10 MHz/ RES BW 10 KHZ VF OFF
REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO

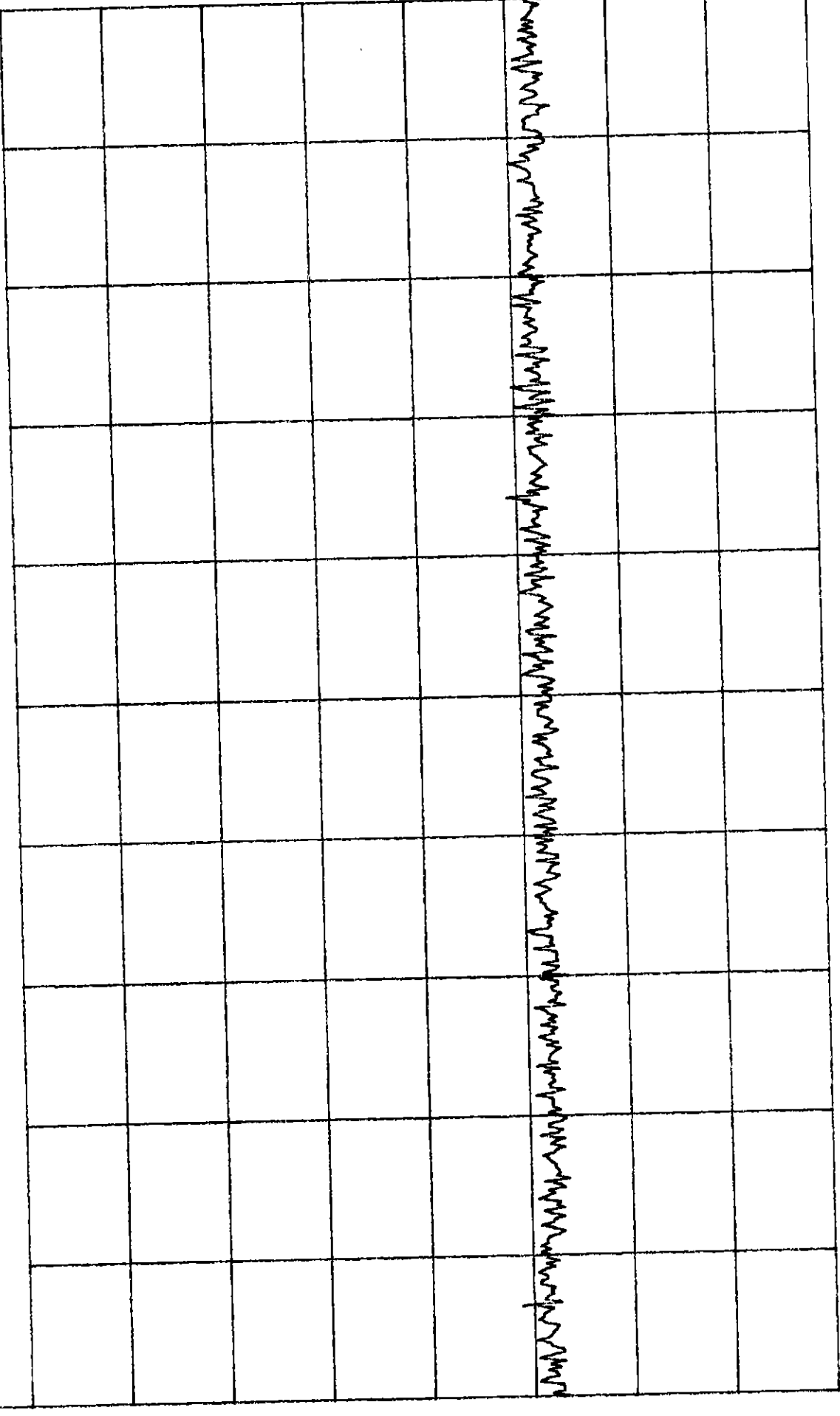


Handwritten notes in the right margin: *Handwritten notes, possibly describing the measurement setup or results.*

8-Sept 93
11.00
EPR

1.6-1.7 GHz : Max Hold) 1/4 Monopole #3

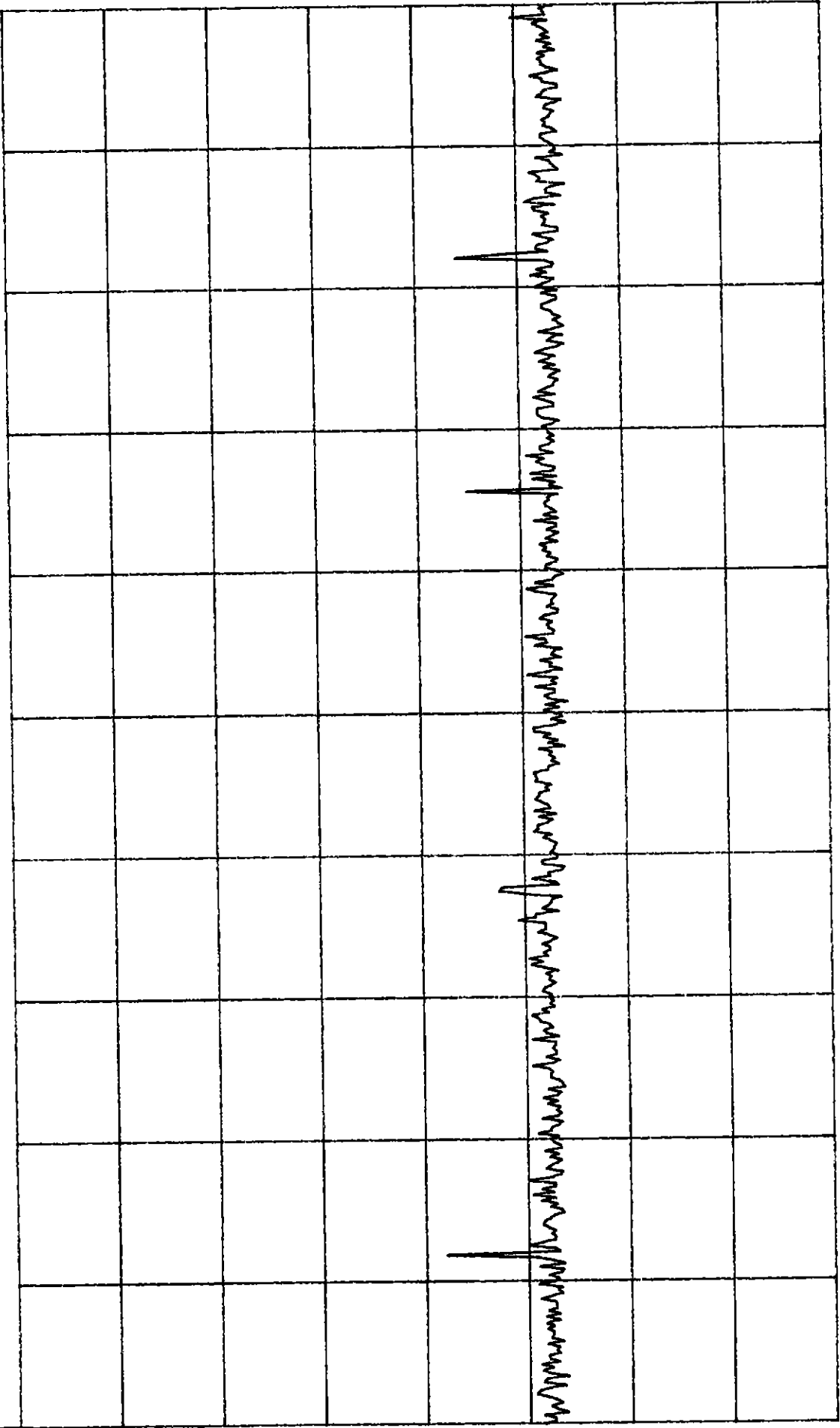
CTR 1.6500 GHZ SPAN 10 MHz/ RES BW 10 KHZ VF OFF
REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO



8th April 93
11.15
East.

1.7-1.8 GHz : Max hold) $\frac{1}{4}$ Monopole #3

CTR 1.7500 GHz SPAN 10 MHz/ RES BW 10 KHz VF OFF
REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO



Shafiq 93
11-25-
EASR

1.8 - 1.9 GHz : Max Hold) 1/4 Monopole #3.

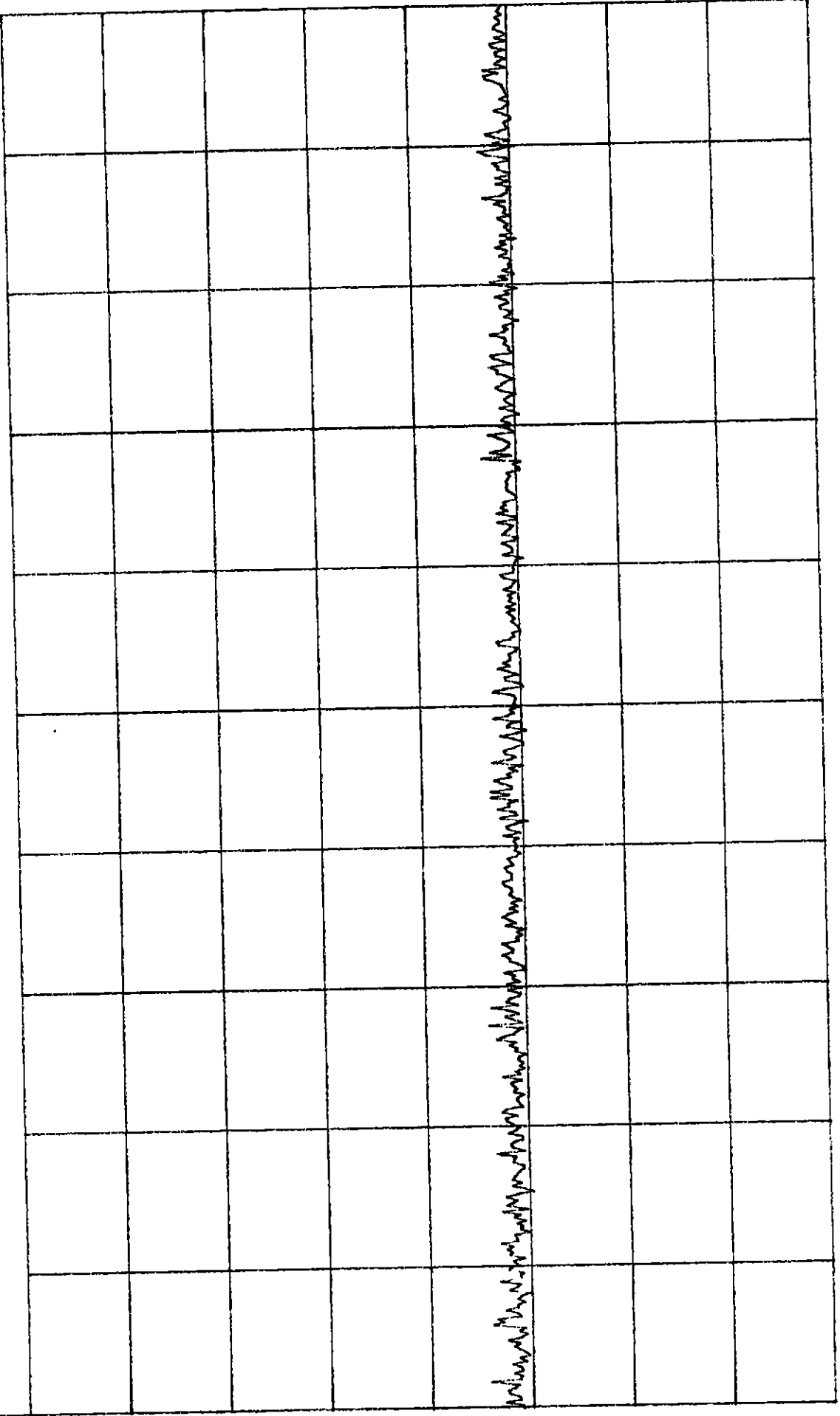
CTR 1.8500 GHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
REF -61 dBm 5 dB/ ATTN 0 dB SWP AUTO

Handwritten scribbles and illegible text in the lower portion of the grid.

8-4-93
11:45 am.

2.0 → 2.1 GHz : Max Hold : $\frac{1}{4}$ Noise #3.

CTR 2.0500 GHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
REF -61 dBm 5 dB/ ATTN 0 dB SWP AUTO



~~When the signal is present, the spectrum analyzer will show a peak at the center of the span.~~

B-4-93

2.1 → 2.2 GHz : Max Hold : 1/2 Mono #3.

12.00
EAST.

CTR 2.1500 GHz SPAN 10 MHz/ RES BW 10 kHz VF OFF

REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO

[Handwritten notes or scribbles in the grid area]

8-4-93
1215
East.

2.3 Ghz → 2.4 Ghz : Max He ' : 1/4 Mono #3.

CTR 2.3500 GHZ SPAN 10 MHZ/ RES BW 10 KHZ VF OFF
REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO

[Handwritten scribbles and markings across the grid, including a diagonal line in the middle row.]

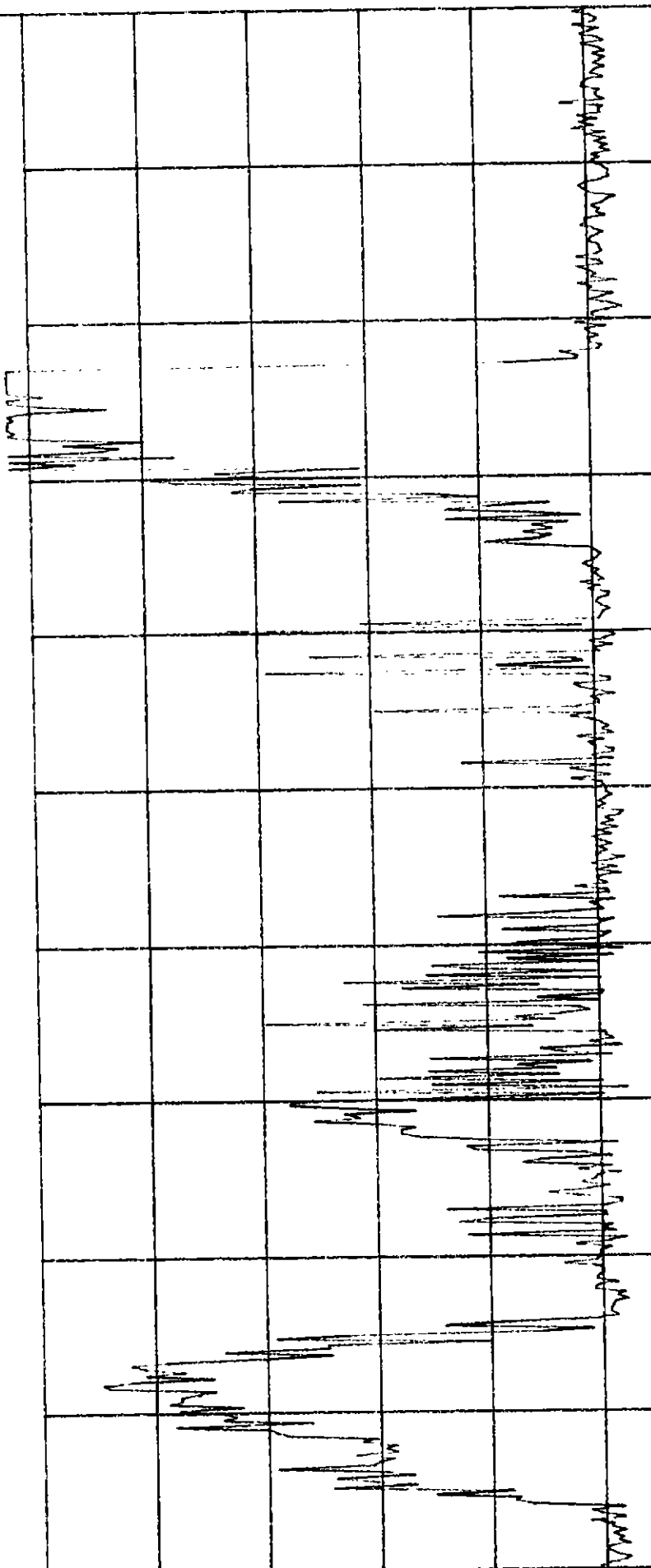
8-4-93

12-20 EAST.

2.4-2.5 GHz : Max Hold 1/4 Mono #3

CTR 2.4500 GHZ SPAN 10 MHZ/ RES BW 10 KHZ VF OFF

REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO



Mopra Lodge Microwave Oven in Operation.

B-4-93

12-30

2.4 - 2.5 GHz : Max Hold) 1/4 Mono #3.

CTR 2.4500 GHZ SPAN 10 MHz/ RES BW 10 KHZ VF OFF

REF -61 dBm 5 dB/ ATTN 0 dB SWP AUTO

Spectrum Analyzer Setup: 2.45 GHz, 10 MHz Span, 10 kHz Res BW, 5 dB Attn, -61 dBm Ref

B-4-93
1303
ENST.

2.8 - 2.9 GHz: Max Hold, 1/4 Monopole #3.

CTR 2.8500 GHZ SPAN 10 MHZ/ RES BW 10 KHZ VF OFF
REF -61 dBm 5 dB/ ATTEN 0 dB SWP AUTO

[Faint handwritten notes, possibly "Max Hold", are visible across the grid.]

B-4-93
13-12
EAST

2.9-3.0 GHz : Max Hold : $\frac{1}{4}$ Mono pole #3

CTR 2.9500 GHz SPAN 10 MHz/ RES BW 10 kHz VF OFF
 REF -61 dBm 5 dB/ ATTN 0 dB SWP AUTO

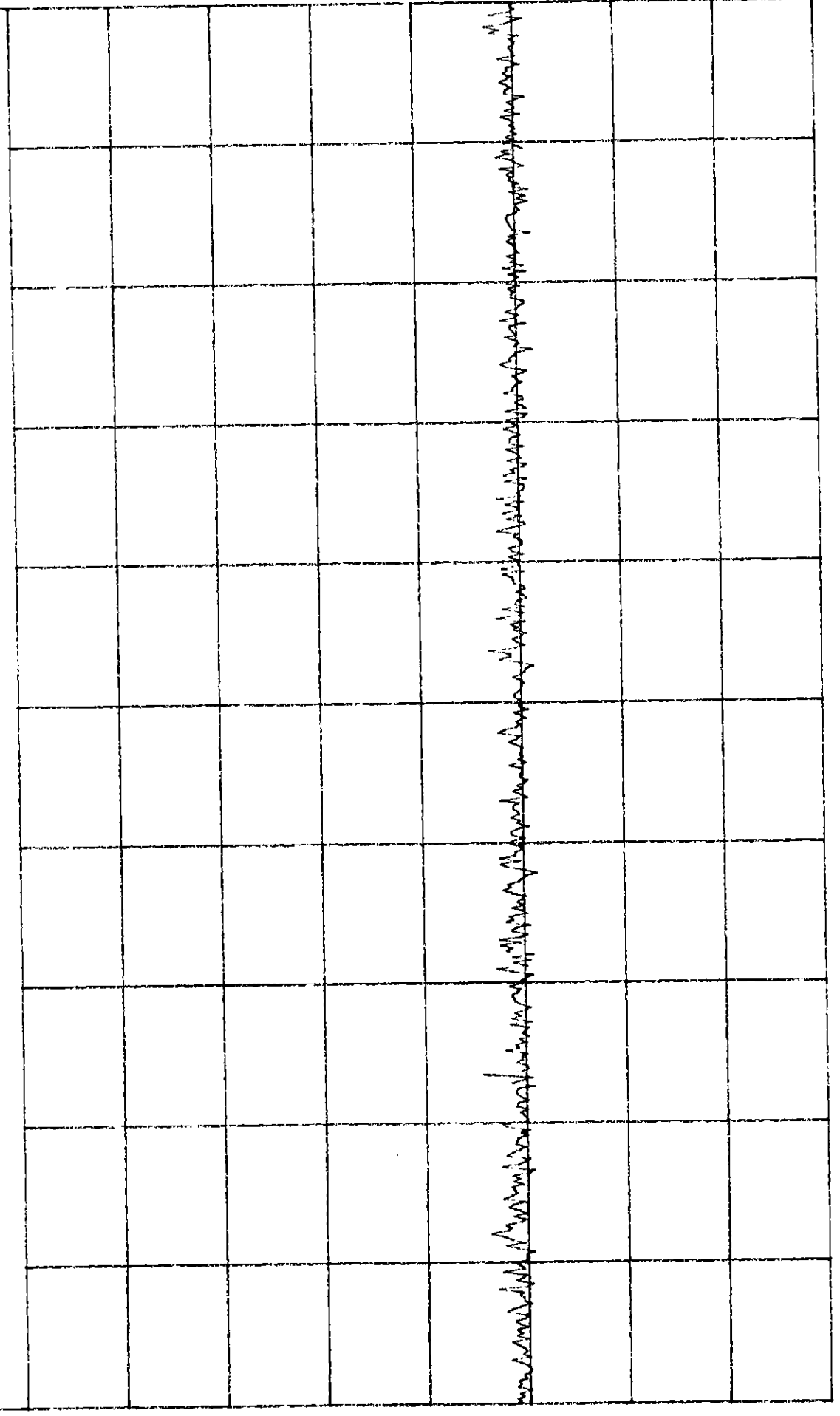
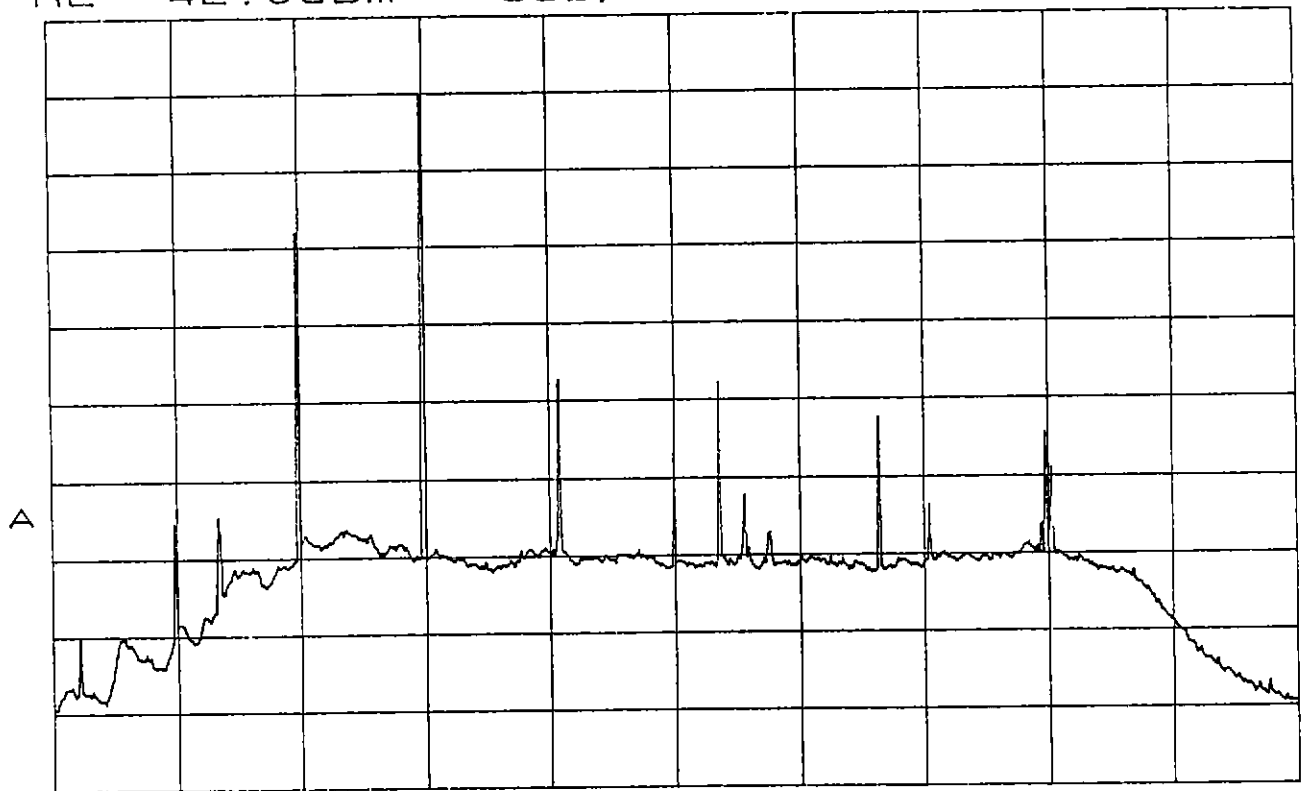


Figure 4.

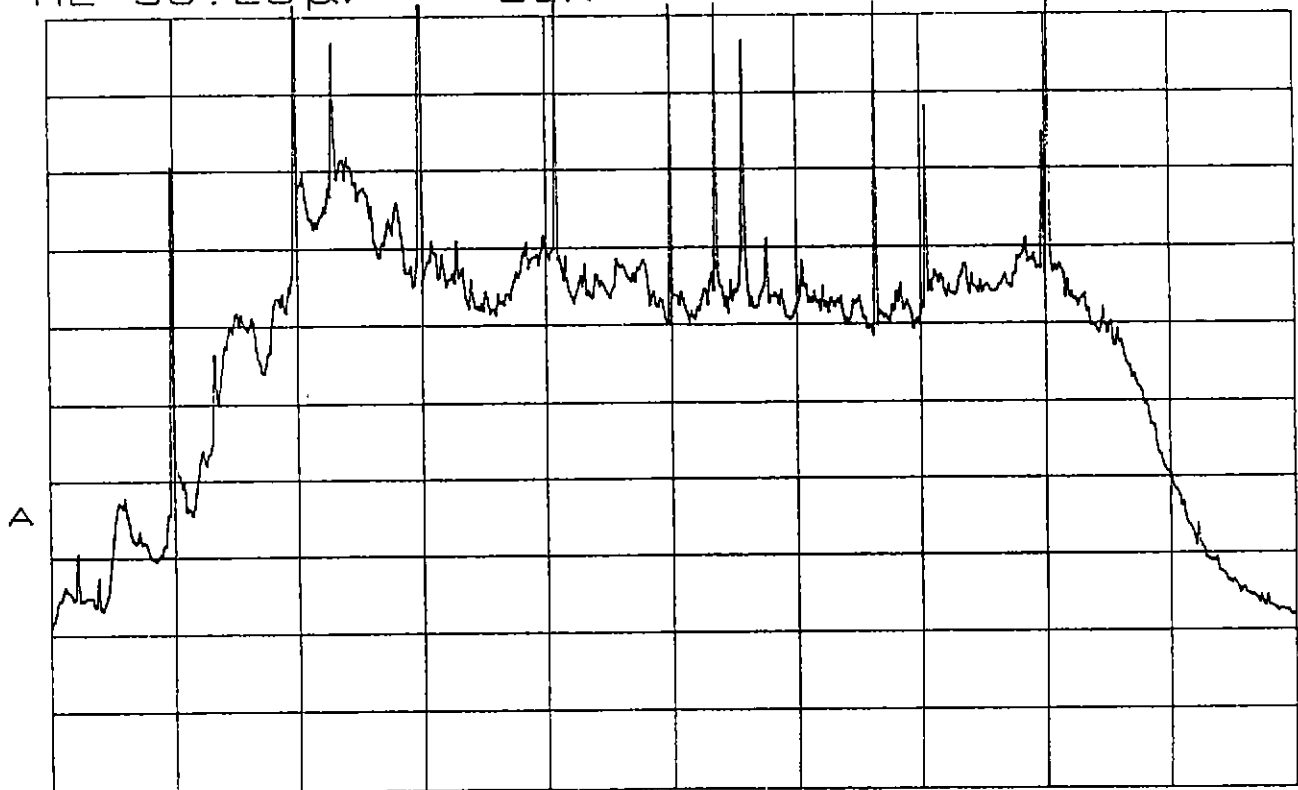
ATTEN 10dB
RL -42.0dBm 5dB/



CENTER 1.500GHZ SPAN 1.000GHZ
*RBW 100KHZ *VBW 300HZ *SWP 100sec

Figure 5.

ATTEN 10dB
RL 56.23μV LIN



CENTER 1.500GHZ SPAN 1.000GHZ
*RBW 100KHZ *VBW 300HZ *SWP 100sec