CR-1999-209502

Report 11382
22 February 1999

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Integrated Advanced Microwave Sounding Unit-A (AMSU-A)

Engineering Test Report

SARR, SARP, DCS Receivers, Link Frequencies

EMI Sensitive Band Test Results

AMSU-A2, S/N 106

Contract No. NAS 5-32314
CDRL 207

Submitted to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Submitted by:

Aerojet
1100 West Hollyvale Street
Azusa, California 91702

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TABLE OF CONTENTS

Paragraph		Page
1	INTRODUCTION	1
1.1	General	1
1.2	Purpose	1
1.3	Scope	1
1.4	Summary of Test Results	1
2	TEST PROGRAM	2
2.1	Test Article	2
2.2	Test Starting and Completion Dates	2
2.3	Instrumentation	2
2.4	Test Frequencies	2
2.5	Operational Mode	4
2.6	Test Location	4
2.7	Test Procedure	4
2.8	Test Results	4
3	SUPPLEMENTARY INFORMATION	6
3.1	Supplementary Information	6

TABLE

Table		Page
I.	SARR, SARP, DCS Receiver, and Link Frequencies	3

FIGURES

Figure		Page
1	Test Data Sheet	7
2	Plot 1	10
3	Plot 2	11
4	Plot 3	12
5	Plot 4	13
6	Plot 5	14
7	Plot 6	15
8	Plot 7	16
9	Plot 8	17
10	Plot 9	18
11	Plot 10	19
12	Plot 11	20
13	Plot 12	21
14	Plot 13	22
15	Plot 14	23
16	Plot 15	24
17	Plot 16	25
18	Plot 17	26
19	Plot 18	27
20	Plot 19	28
21	Plot 20	29

Figures (Cont)

22 Plot 21 30
23 Plot 22 31
23 Plot 23 32
25 Plot 24 33
26 Plot 25 34
27 Plot 26 35
28 Plot 27 36
29 Plot 28 37
30 Plot 29 38
31 Plot 30 39
32 Plot 31 40
33 Plot 32 41
34 Plot 33 42
35 Plot 34 43
36 Plot 35 44
37 Plot 36 45
38 Plot 37 46
39 Plot 38 47
40 Plot 39 48
41 Plot 40 49
42 Plot 41 50
43 Plot 42 51
44 Plot 43 52
45 Plot 44 53
46 Plot 45 54
47 Plot 46 55
48 Plot 47 56
48 Plot 48 57
50 Plot 49 58
51 Plot 50 59
52 Plot 51 60
53 Plot 52 61
54 Plot 53 62
55 Plot 54 63

SECTION 1

INTRODUCTION

1.1 General

This document contains the procedures and test results of the discrete SARP EMI sensitive bands measurements performed on the AMSU-A2/METSAT instrument, part number 1331200-2, serial number 106. The test was performed as described in paragraph 3.4.6 of AE-26151/5D Test Procedure, Electromagnetic Interference (EMI)/Electromagnetic Radiation (EMR) and Electromagnetic Compatibility (EMC) for Advanced Microwave Sounding Unit-A (AMSU-A), dated 22 September 1998.

1.2 Purpose

The purpose of this report is to demonstrate that the frequency bands described in the Interface Specification, IS-3267415, paragraph 3.6.1.4.2 are not generated or present above the sensitivity level specified in the radiation requirements of the aforementioned specification.

1.3 Scope

This document describes the test performed by Aerojet, and it is presented in the following manner:

Section 1	Contains general introductory material and a summary of the test results.
Section 2	Contains a detailed description of the test plan, test procedure, and test results.
Section 3	Contains supplementary test information, pertinent test data, and the list of test equipment used.

1.4 Summary of Test Results

The test performed at each frequency band specified herein indicates that the AMSU-A2 instrument meets the requirements of the interface specification. No radiated emissions were detected in the measured frequency ranges above the sensitivity required.

SECTION 2

TEST PROGRAM

2.1 Test Article

The AMSU-A system passively monitors radiation from the earth's surface and atmosphere in the microwave portion of the spectrum. The instruments incorporate fifteen total-power super heterodyne type radiometers. The system is composed of two independent instruments. The module designated as AMSU-A2 contains the two lowest-frequency channels, i.e., Channel 1 has the 28.8 GHz frequency and Channel 2 has the 31.4 GHz frequency. The module designated as AMSU-A1 contains the thirteen remaining channels with frequencies from 50.8 GHz to 89 GHz.

Periodic on board calibration is accomplished by using an in-flight backbody calibration and cold space as energy reference sources. During each scan, the shrouded reflector observes 30 earth scene cells with one sample period each and two calibration target cells with two sample periods each. Complete end-to-end in-flight calibration from the antenna to the AMSU-A instrument output is provided for each channel. This will yield the maximum in-flight calibration accuracy that gives the radiometric data the required sensitivity and precision.

At each frequency, the half power antenna beamwidth is a constant 3.33°. Thirty contiguous scene resolution cells spaced 3.33° along the scan line are sampled in a stepped-scan fashion every eight seconds. The scan covers 50° on each side of the satellite path.

2.2 Test Starting and Completion Dates

The AMSU-A2 instrument, serial number 106, was tested between 24 November and 1 December 1998. No testing was performed during the period of 26 to 29 November 1998.

2.3 Instrumentation

All instrumentation was suitable for the purpose intended. Each instrument used was within its certification period. Instrumentation accuracy was verified by calibration in accordance with MIL-STD-45662 as implemented and controlled by Aerojet standard operating procedures. The attached Test Data Sheet 2, in Section 3, contains the list of the equipment with pertinent traceability information.

2.4 Test Frequencies

The test frequencies were selected from paragraph 3.6.1.4.2 of the interface specification, IS-3267415, as listed in Table I.

Table I. SARR, SARP, DCS Receiver, and Link Frequencies

Item No.	Frequency (MHz)	Level (dBm)
1	118.0 – 120.0	-100
2	120.0 – 121.45	-125
3	121.45 – 121.485	-145
4	121.5 MHz ±15 kHz	-150
5	121.515 – 121.550	-145
6	121.550 – 123.00	-125
7	123.00 – 125.00	-100
8	236.00 – 240.00	-100
9	240.00 – 242.925	-125
10	242.945 – 242.975	-145
11	243 MHz ±25 kHz	-150
12	243.025 – 243.075	-145
13	243.075 – 246.00	-125
14	246.00 – 250.00	-100
15	385.10 – 401.10	-100
16	401.10 – 405.90	-125
17	405.90 – 406.00	-145
18	406.05 MHz ±50 kHz	-150
19	406.10 – 406.20	-145
20	406.20 – 411.00	-125
21	411.00 – 425.00	-100
22	396.00 – 401.50	-125
23	401.50 – 401.60	-145
24	401.630 MHz ±50 kHz	-150
25	401.700 – 401.800	-145
26	401.800 – 406.00	-120
27	2010 – 2040	-120

2.5 Operational Mode

The AMSU-A2 instrument was tested in the IN-ORBIT mode of operation. In this mode, the antenna is rotating continuously and all the circuits are working. The maximum electric field radiated emissions are produced in this mode of operation.

2.6 Test Location

This test was conducted in the shielded enclosure located in Building 183 of the Aerojet test facility.

2.7 Test Procedure

The test procedure used for the performance of this test was extracted from the Process Specification, Test Procedure, Electromagnetic Interference (EMI)/Electromagnetic Radiation (EMR) and Electromagnetic Compatibility (EMC) for Advanced Microwave Sounding Unit-A (AMSU-A), document number AE-26151/5D paragraph 3.4.6.3.1, steps 14 through 23 changed as described below:

Step 14 – Activate the HP70004 with the HP70620 amplifier. Program the analyzer for noise averaging to a minimum of eight times. Verify that the minimum discernable signal level is below the required dBm level indicated in the list for the frequency band indicated.

Step 15 – Connect the equipment of step 14 to the biconical antenna and measure the radiated levels throughout the frequency bands from 118.0 MHz to 125.0 MHz. Performed the test in both polarities of the antenna.

Step 16 - Connect the equipment to the Log Periodic antenna and measure the radiated levels throughout the frequency bands from 236.0 MHz to 406.0 MHz. Performed the test in both polarities of the antenna.

Step 17 - Connect the equipment to the double ridged warm antenna and measure the radiated levels throughout the frequency band from 2010 MHz to 2040 MHz. Perform the test in both polarities of the antenna.

Step 18 - All of the measurements performed in steps 15, 16, and 17 shall be below the signal sensitivity. No narrow band signals shall be above the limit whether ambient or generated by the equipment.

Step 19 - The measurement of steps 14 through 18 shall be at the equipment minimum discernable signal and detected narrow bands are below or at the sensitivity requirement levels in Table I.

2.8 Test Results

No radiated emissions were recorded above the specified sensitivity levels in Table I. The emissions detected were ambient emissions produced by the Halon System. Some emissions were introduced into the shielded enclosure via the interconnect cables. In this case, the cables were moved to an area of minimum emissions, i.e., until the detected emissions were below the specified level.

The first complete scan of all the required frequency bands was conducted during the 24th and 25th of November. A retest of the marginal frequency bands was conducted on the 30th of November and the 1st of December.

The recorded data is presented in this order:

Plots 1 through 7	Covers the frequency range from 118.00 MHz to 125.00 MHz, with the antenna in the horizontal position.
Plots 8 through 14	Covers the above frequency range with the antenna in the vertical position. The detected emission that approximated the limit was a signal at 121.510 MHz, 2.07 dBm below the limit, with the antenna in the horizontal position.

Plots 15 through 21	Covers the frequency range from 236.00 MHz to 250.00 MHz, with the antenna in the horizontal position.
Plots 22 through 28	Covers the above frequency range with the antenna in the vertical position. The detected emission that approximated the limit was a signal 242.983 MHz, 1.02 dBm below the limit, with the antenna in the horizontal position.
Plots 29 through 35	Covers the frequency range from 385.10 MHz to 425.00 MHz, with the antenna in the horizontal position.
Plots 36 through 42	Covers the above frequency range with the antenna in the vertical position. The detected emission that approximated the limit was a signal at 406.021 MHz, 0.72 dBm below the limit, with the antenna in the vertical position.
Plots 43 through 47	Covers the frequency range from 396.00 MHz to 406.00 MHz, with the antenna in the horizontal position.
Plots 48 through 52	Covers the above frequency range with the antenna in the antenna in the vertical position. The detected emissions that approximated the limit was a signal at 401.601 MHz, 0.86 dBm below the limit with the antenna in the horizontal position.
Plots 53 and 54	Covers the frequency range from 2,010 MHz and 2,040 MHz, with the antenna in the horizontal and vertical position respectively. All emissions are at a minimum 10 dBm below the limit.

The referenced plots are presented in Section 3.

SECTION 3

SUPPLEMENTARY INFORMATION

3.1 Supplementary Information

This section contains the Test Data Sheet, Plots, and the equipment list.

AE-26151/5D
22 Sep 98

TEST DATA SHEET 2 (Sheet 1 of 3)
3.4.6: RE02 Test

Test Setup Verified: [signature] 11/24/98
Signature

3.4.6.3.1 Step 1: Test Equipment Log

Item	Manufacturer	Model/ Part No.	Aerojet Inventory No.	Calibration Date	Calibration Due Date
Spectrum Analyzer	HP	70004	C200044	11-12-98	11-12-99
with Amplifier	HP	70620	C200064	11-12-98	11-12-99
Plotter	HP	7475A	47417	CNR	CNR
Biconical Antenna	HP	11955A	C200224	1-16-98	1-16-99
Log Periodic Antenna	HP	11956A	C200225	1-16-98	1-16-99
Horn Antenna	Electrometrics	RGA-180	2508367	10-21-98	10-21-99

B-6

Figure 1. Test Data Sheet (Sheet 1 of 3)

AE-26151/5D
22 Sep 98

TEST DATA SHEET 2 (Sheet 2 of 3)
3.4.6: RE02 Test (Cont)

Test Setup Verified: Ken Shaver 12-1-98
Signature

3.4.6.3.2: Emission Measurements

Step	Antenna/Frequency	Band	Required	Emissions within limits?		Comments/ Observations
				Yes	No	
~~4~~	~~All except Horn 14 kHz to 1 GHz~~	Narrow	See Figure 3			
~~6~~	~~All except Horn 14 kHz to 1 GHz~~	~~Broad~~	~~See Figure 4~~	12-1-98	N/R	
~~12~~	~~Horn, RGA-180 1 to 2 GHz~~	Narrow	See Figure 3			
15	Biconical, EMCO 3104 121.5 MHz with Ampl	Narrow	No narrow-band freq. > -150 dBm	✓		
16	Log Conical, EMCO 3101 243 MHz, 401.65 MHz, & 406.05 MHz with Ampl	Narrow	No narrow-band freq. > -150 dBm	✓		
19	Horn, RGA-180 2010 to 2040 MHz with Ampl	Narrow	No narrow-band freq. > -120 dBm	✓		
~~21~~	~~Biconical/Log Conical 59.458 to 751.944 MHz~~	Narrow	No narrow-band freq. > -60 dBm			
21	400 to 500 MHz	Narrow	-107.1dBm			
~~21~~	~~2 to 18 GHz~~	~~Narrow~~	~~Figure 3~~			
21	1217 to 1227 MHz	Narrow	-111.8 dBm	12-1-98	N/R	
21	1565 to 1614 MHz	Narrow	-111.2 dBm			
21	2051.9 to 2055 MHz	Narrow	-126.7 dBm			
21	5254.7 to 5255.3 MHz	Narrow	-122.8 dBm			
~~21~~	5450 to 5825 MHz	Narrow	-80.7 dBm			

NOTE: Attach all backup data generated during the test (photos, printouts, plots, test logs, additional comments or observations, etc.) to this data sheet.

B-7

Figure 1. Test Data Sheet (Sheet 2 of 3)

AE-26151/5D
22 Sep 98

TEST DATA SHEET 2 (Sheet 3 of 3)
3.4.6: RE02 Test (Cont)

Test Setup Verified: Ken Shaw 12-1-98
Signature

3.4.6.3.2: Emission Measurements

Step	Antenna*/Frequency Range (MHz)	Band	Radiation Limit (dBm)	Emissions within limits?		Comments/ Observations
				Yes	No	
22	118.000 - 120.000	Narrow	-100 / Table IV	✓	✓	
22	120.000 -121.450	Narrow	-125 / Table IV	✓	✓	
22	121.450 - 121.485	Narrow	-145 / Table IV	✓	✓	
22	121.515 - 121.550	Narrow	-145 / Table IV	✓	✓	
22	121.550 - 123.000	Narrow	-125 / Table IV	✓	✓	
22	123.000 - 125.000	Narrow	-100 / Table IV	✓	✓	
23	236.000 - 240.000	Narrow	-100 / Table IV	✓	✓	
23	240.000 - 242.925	Narrow	-125 / Table IV	✓	✓	
23	242.925 - 242.975	Narrow	-145 / Table IV	✓	✓	
23	243.025 - 243.075	Narrow	-145 / Table IV	✓	✓	
23	243.075 - 246.000	Narrow	-125 / Table IV	✓	✓	
23	246.000 - 250.000	Narrow	-100 / Table IV	✓	✓	
23	385.100 - 401.100	Narrow	-100 / Table IV	✓	✓	
23	401.100 - 405.900	Narrow	-125 / Table IV	✓	✓	
23	405.900 - 406.000	Narrow	-145 / Table IV	✓	✓	
23	406.1 00 - 406.200	Narrow	-145 / Table IV	✓	✓	
23	406.200 - 411.00	Narrow	-125 / Table IV	✓	✓	
23	411.000 - 425.000	Narrow	-100 / Table IV	✓	✓	
23	396.000 - 401.500	Narrow	-125 / Table IV	✓	✓	
23	401.500 - 401.600	Narrow	-145 / Table IV	✓	✓	
23	401.700 - 401.800	Narrow	-145 / Table IV	✓	✓	
23	401.800 - 406.000	Narrow	-125 / Table IV	✓	✓	

* All frequency ranges are to be performed with antenna in both vertical and horizontal polarization.

Signature/Date

Unit AMSU-A2 METSAT/METOP

Serial No. 106

Shop Order 642843 Oper 0280000

Engineer: 1 Dec 98

Quality Control: 28 DEC 98

Customer Representative: 12/1/98

B-8

Figure 1. Test Data Sheet (Sheet 3 of 3)

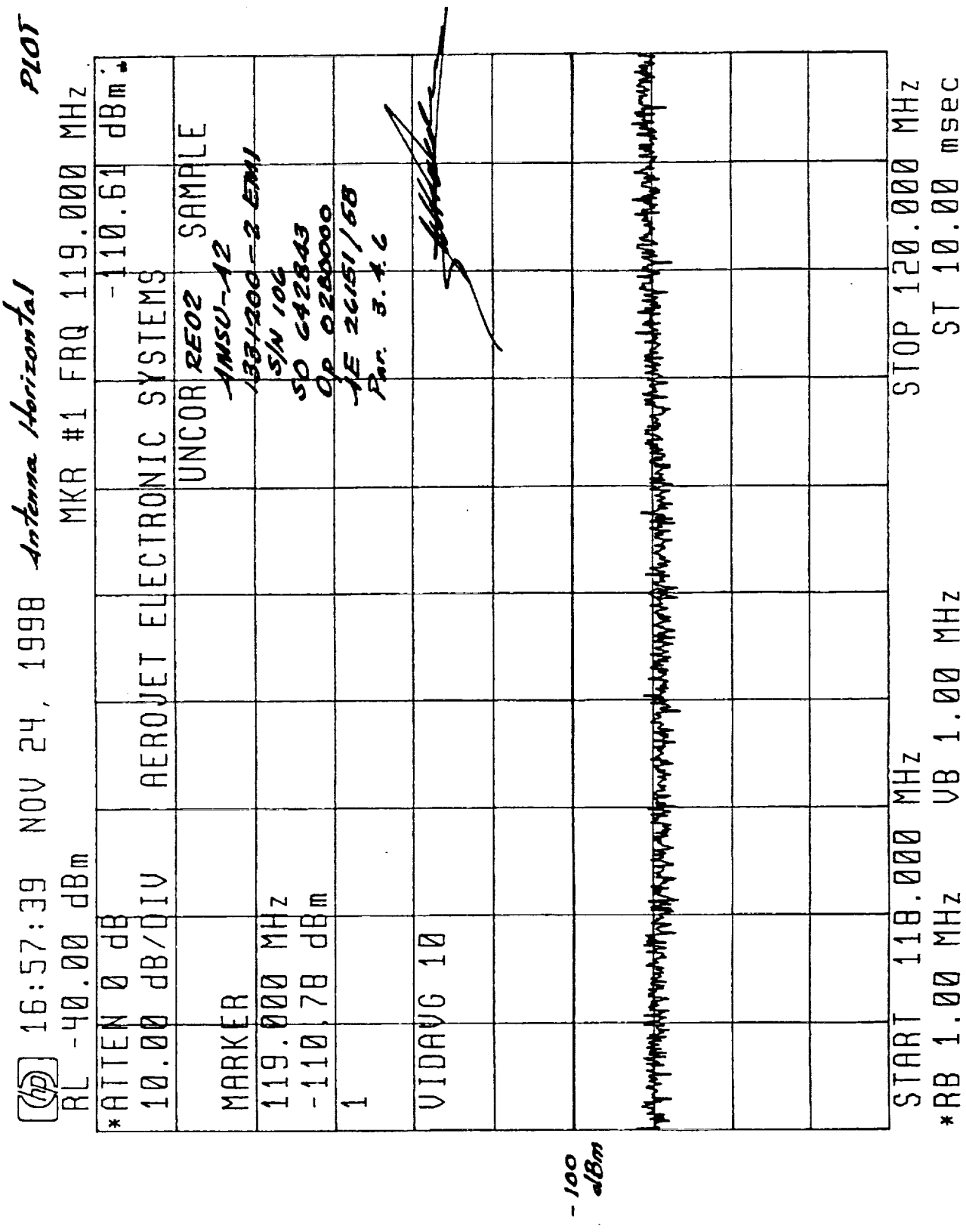


Figure 2. Plot 1

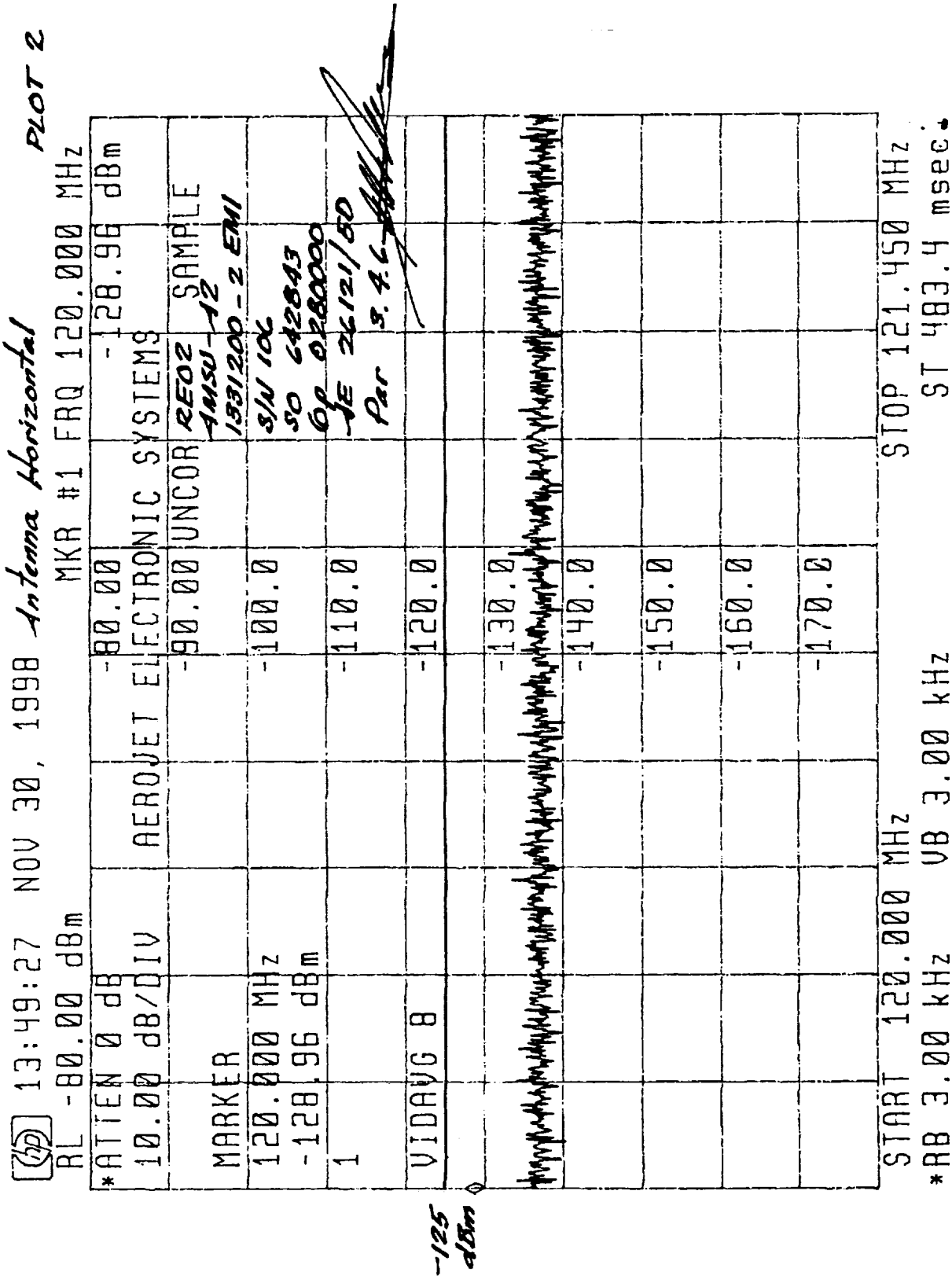


Figure 3. Plot 2

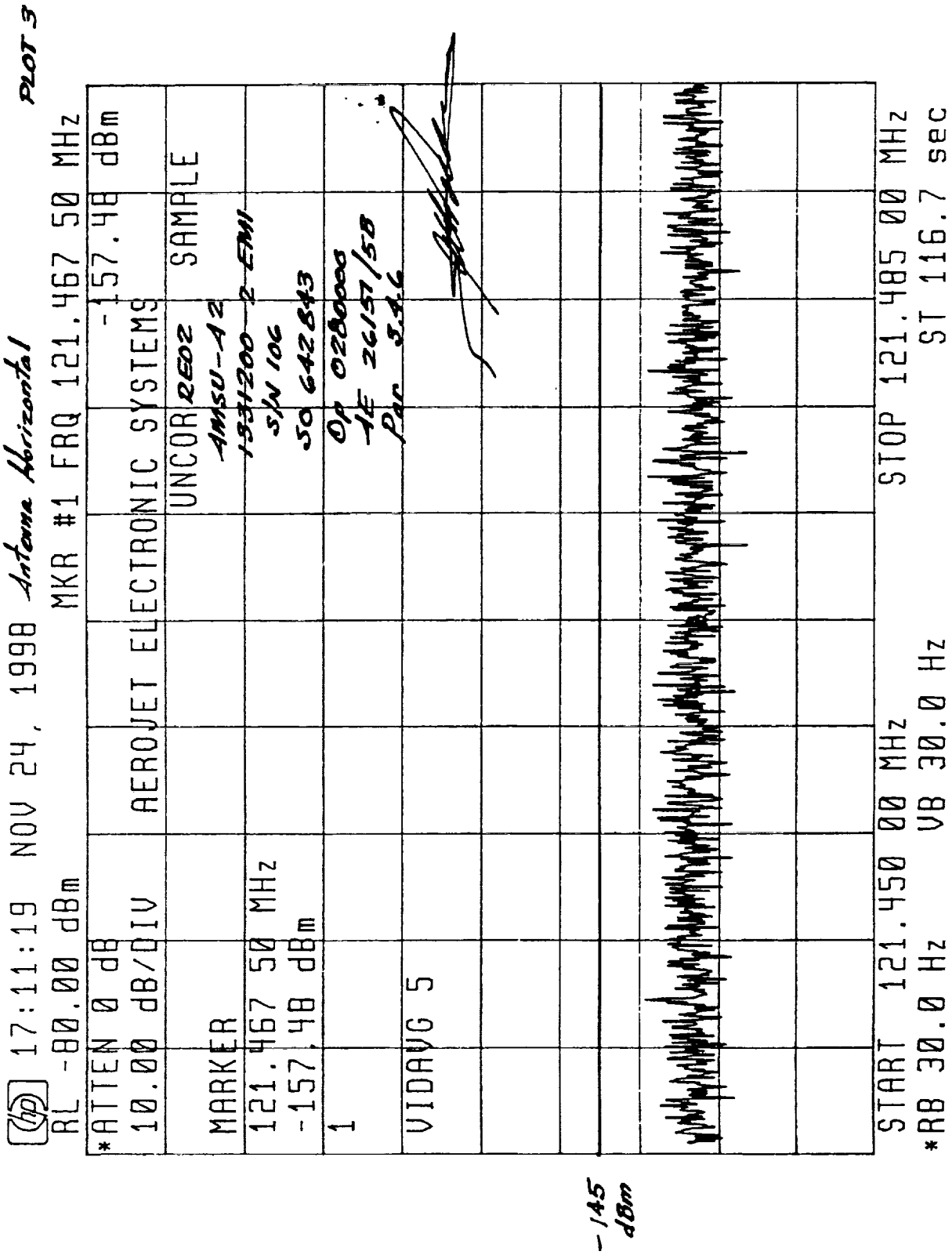


Figure 4. Plot 3

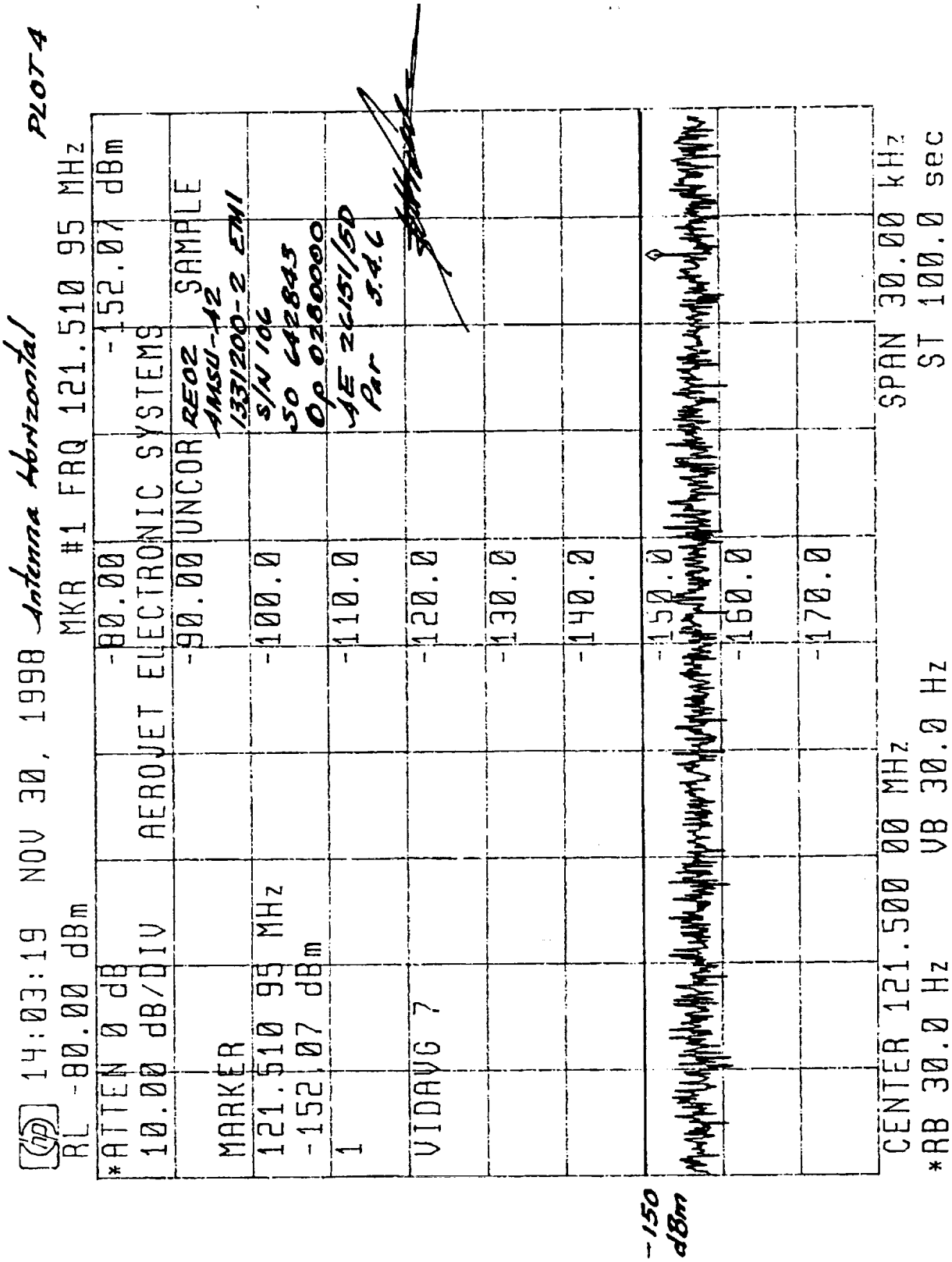


Figure 5. Plot 4

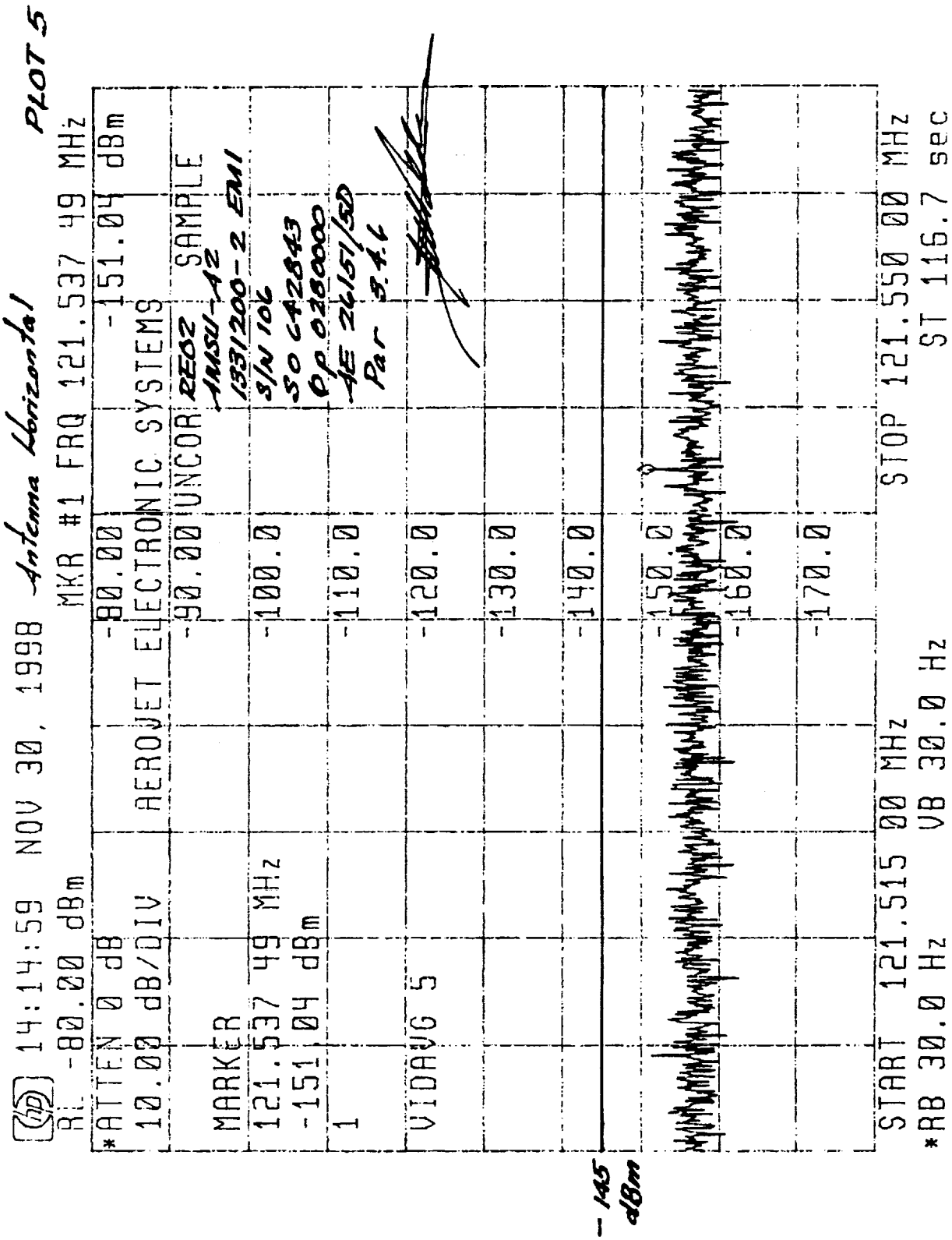


Figure 6. Plot 5

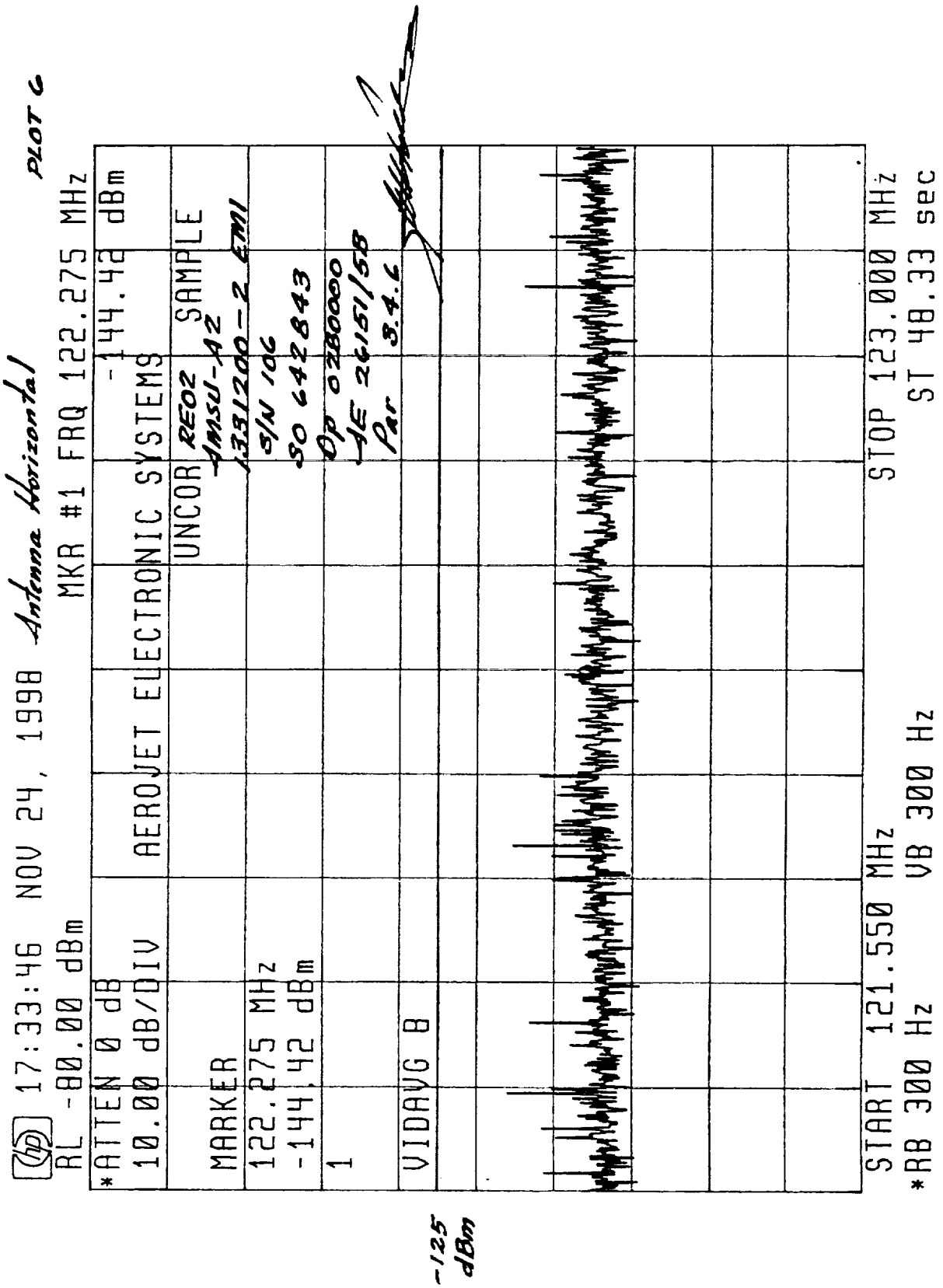


Figure 7. Plot 6

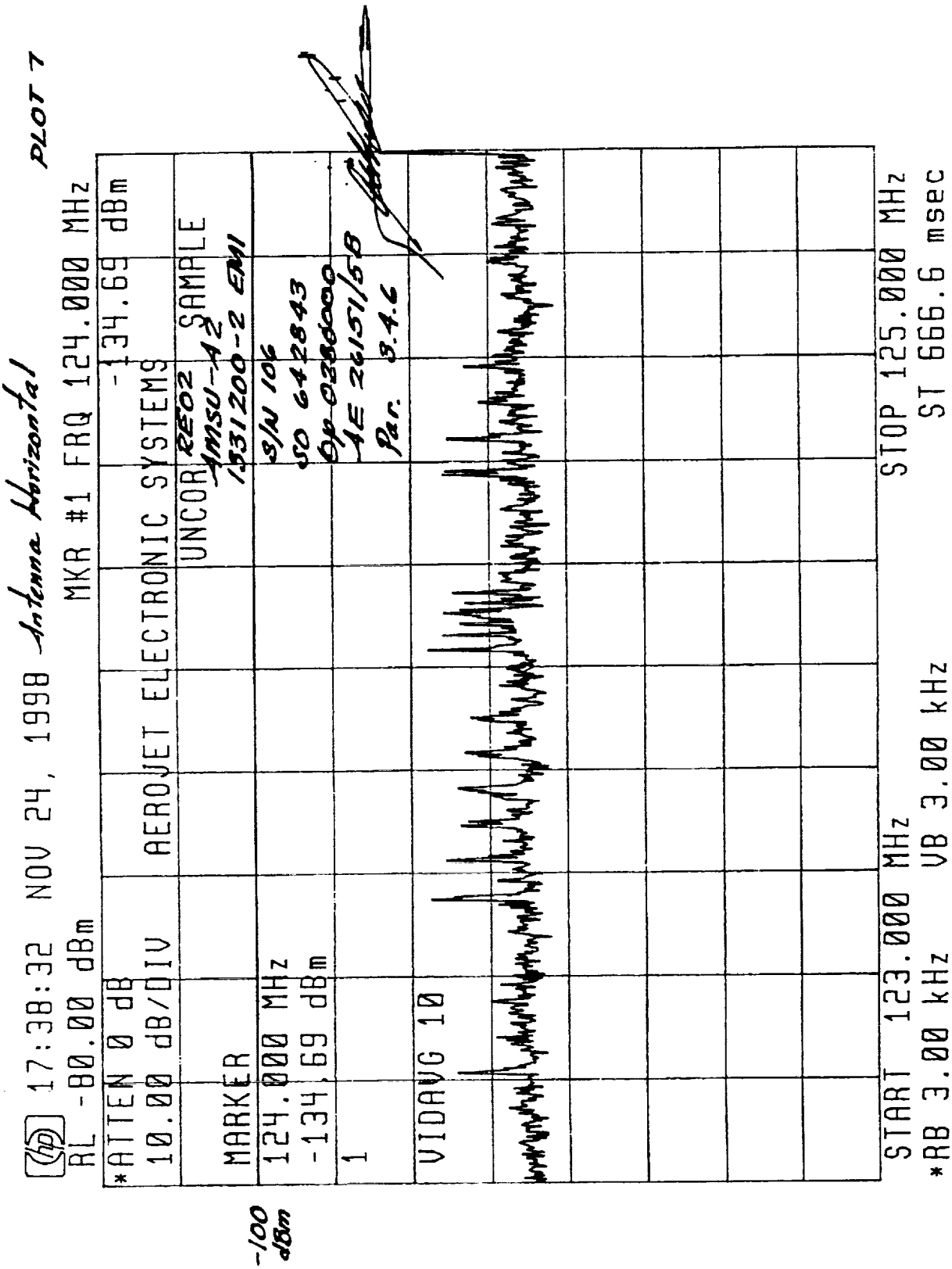


Figure 8. Plot 7

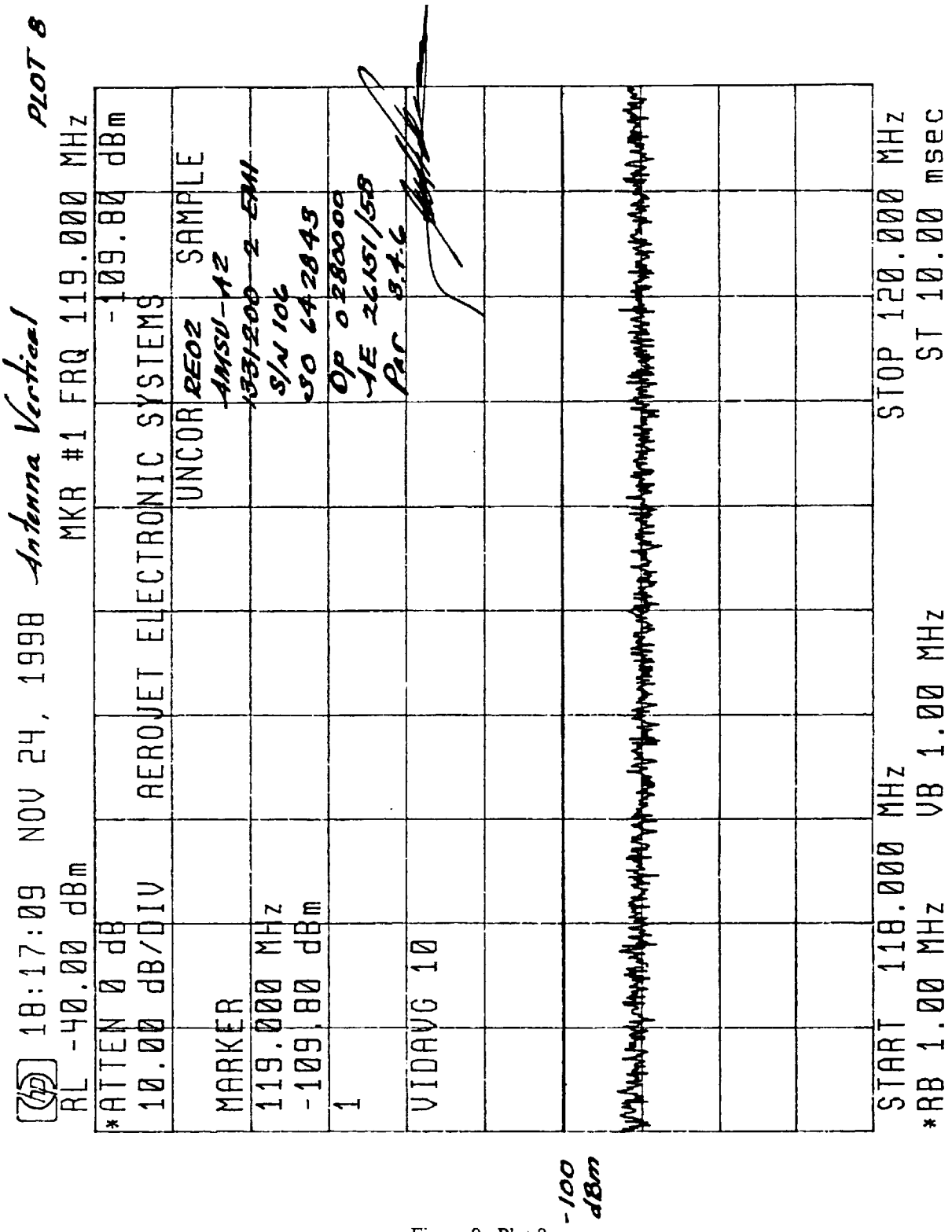


Figure 9. Plot 8

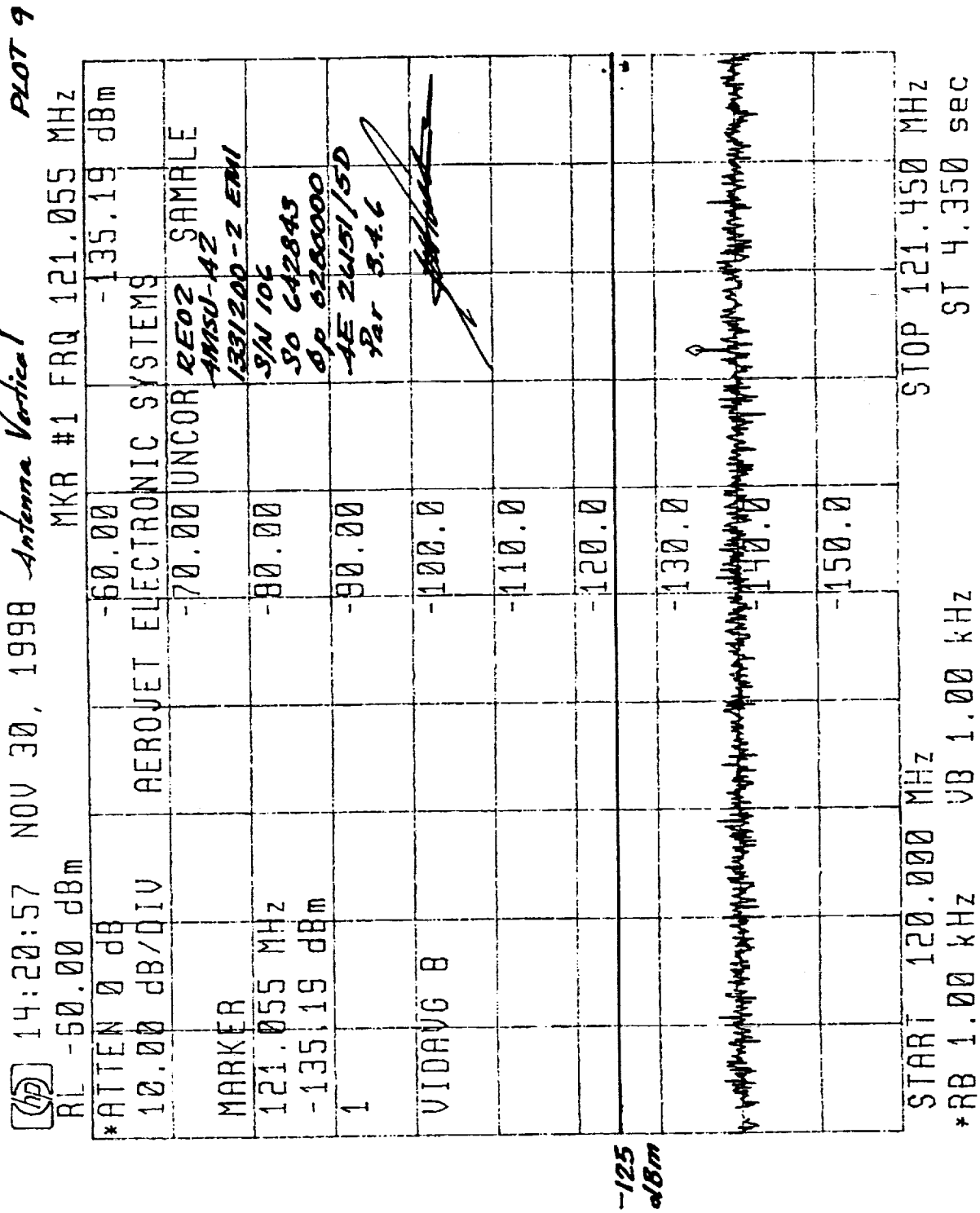


Figure 10. Plot 9

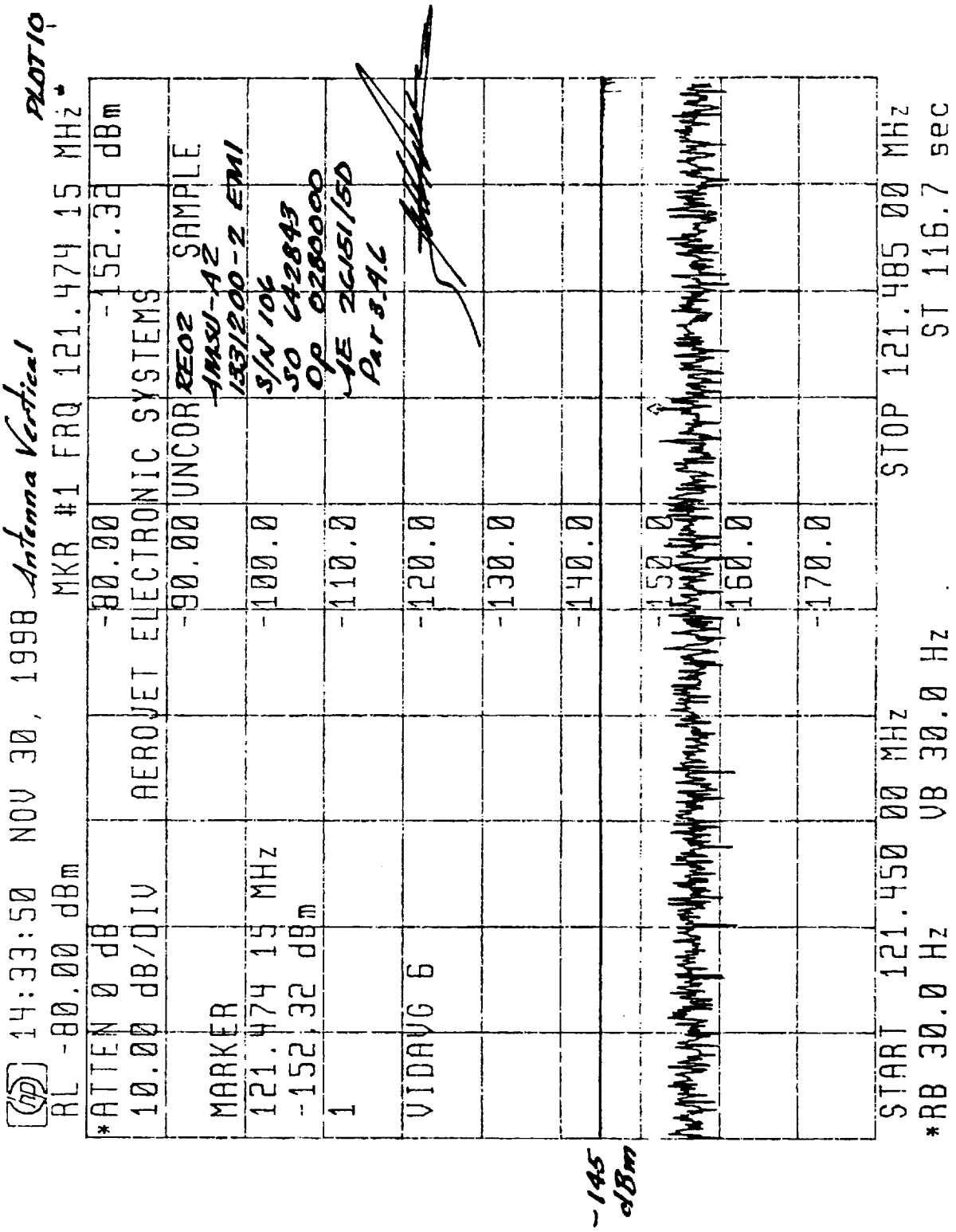


Figure 11. Plot 10

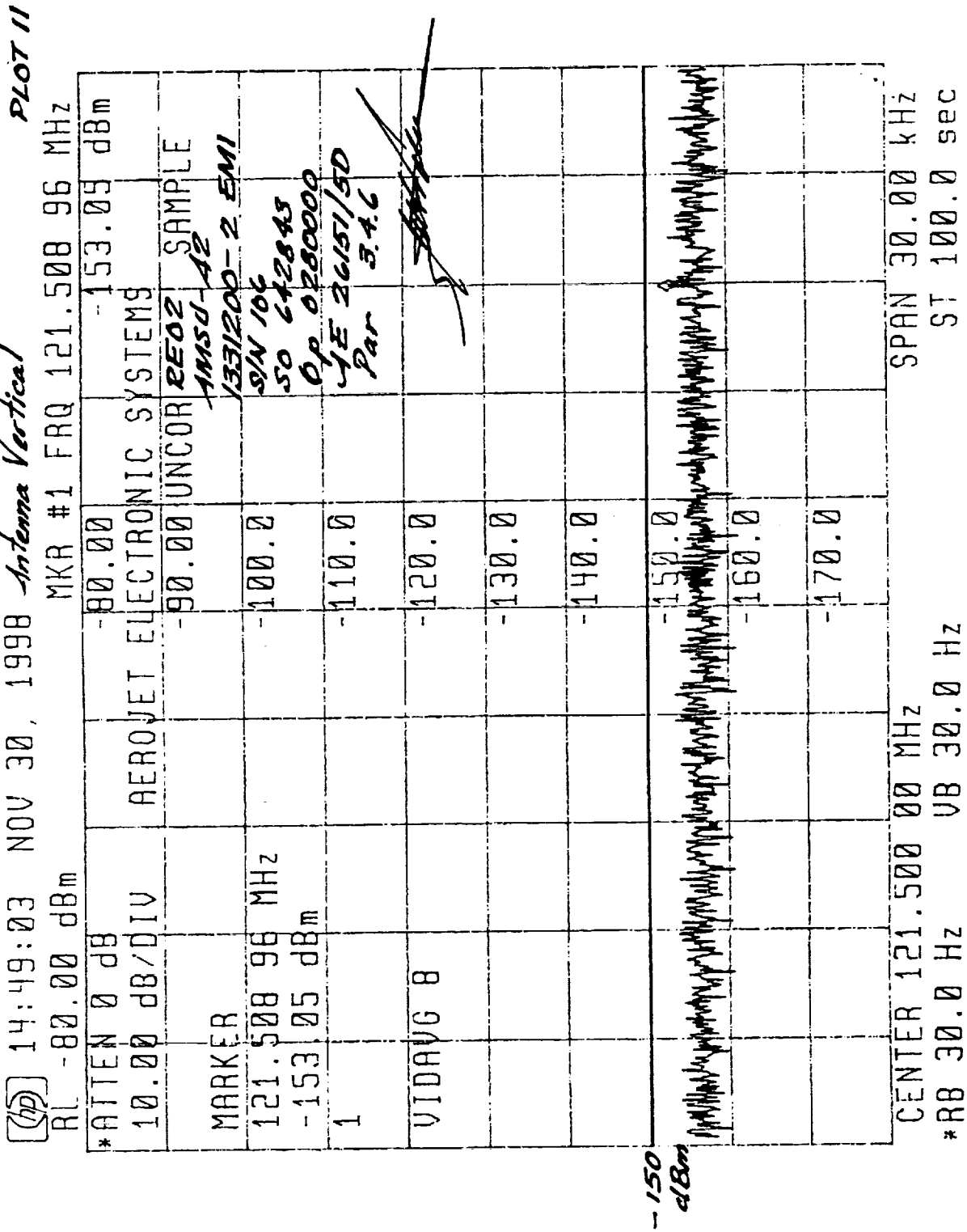


Figure 12. Plot 11

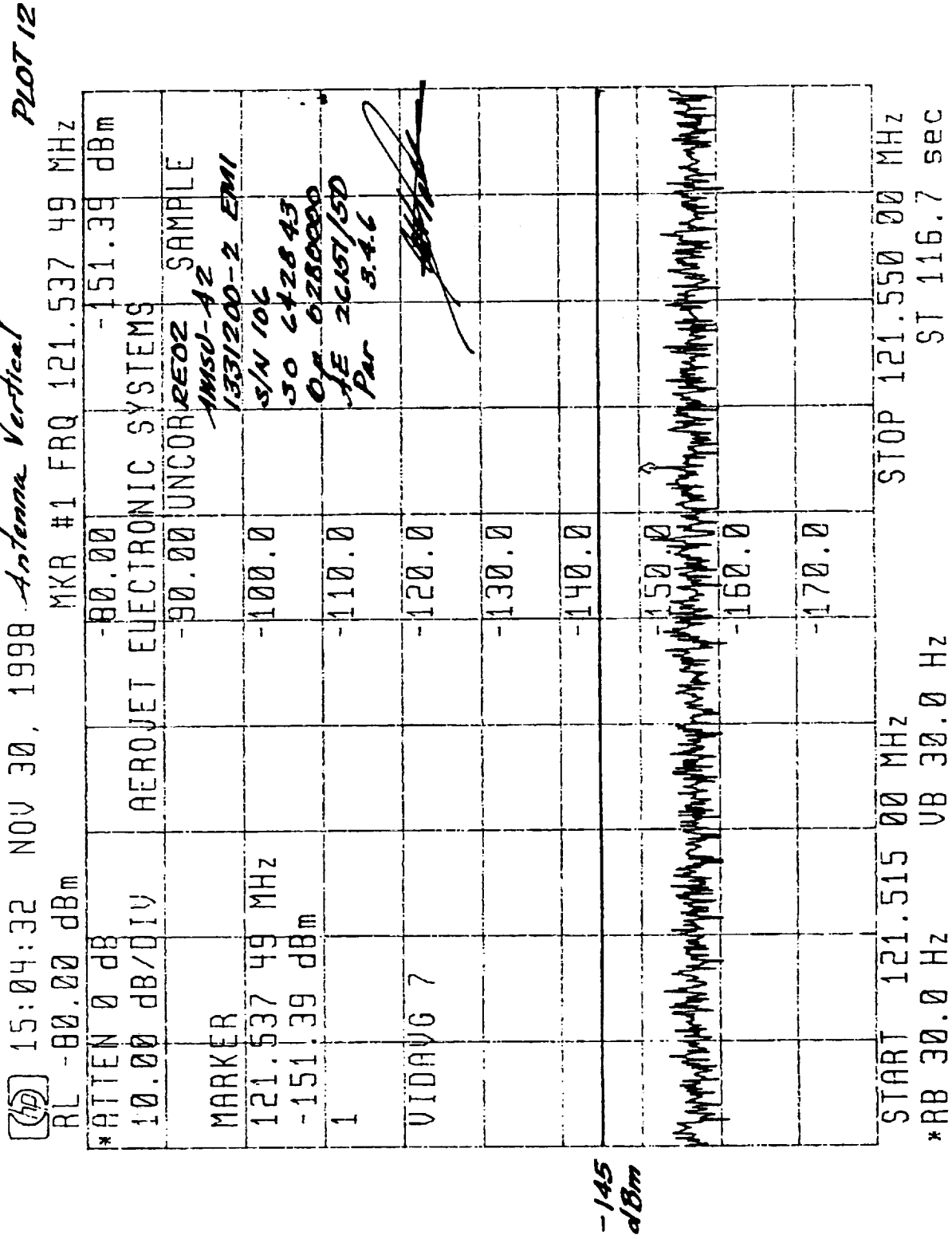


Figure 13. Plot 12

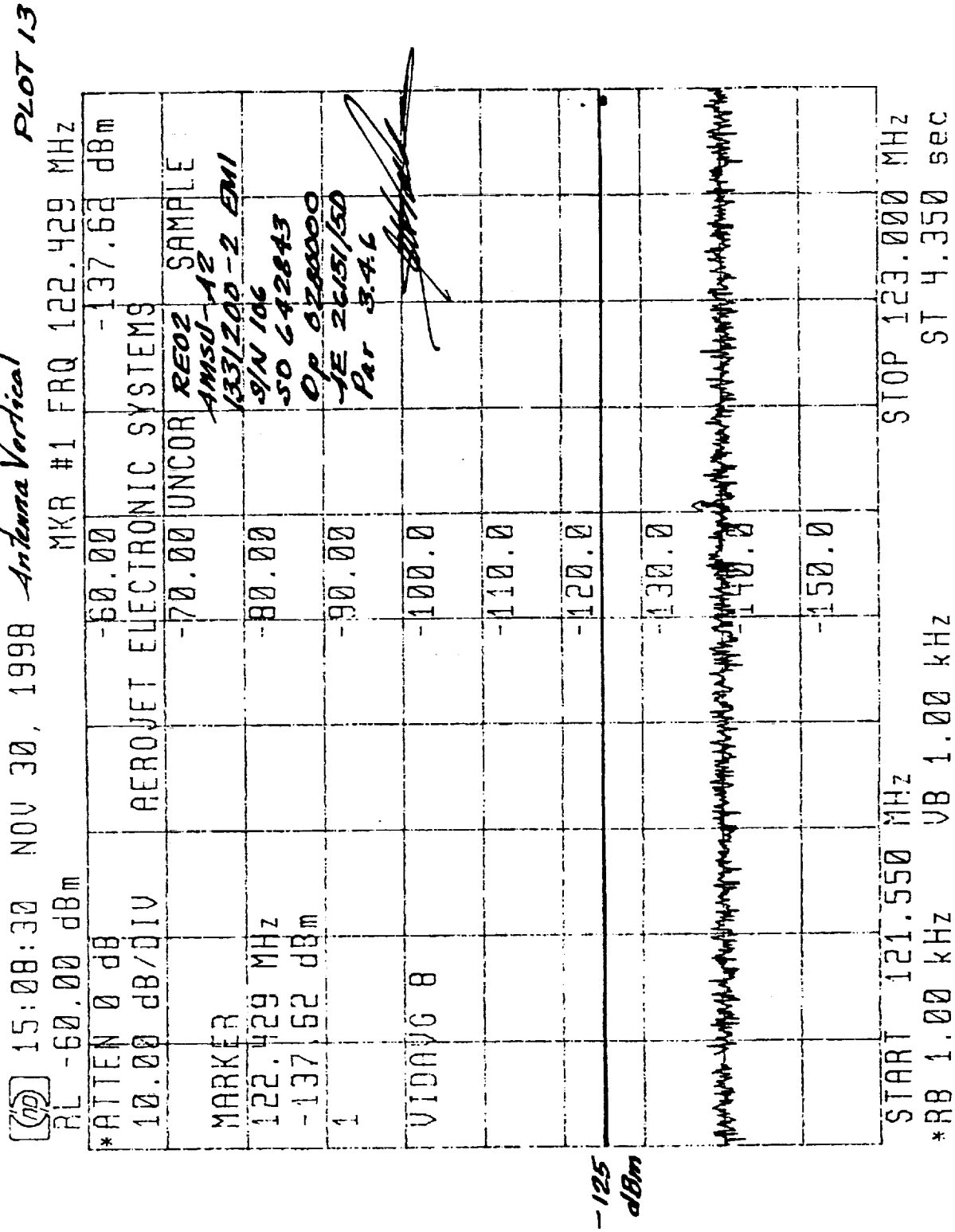


Figure 14. Plot 13

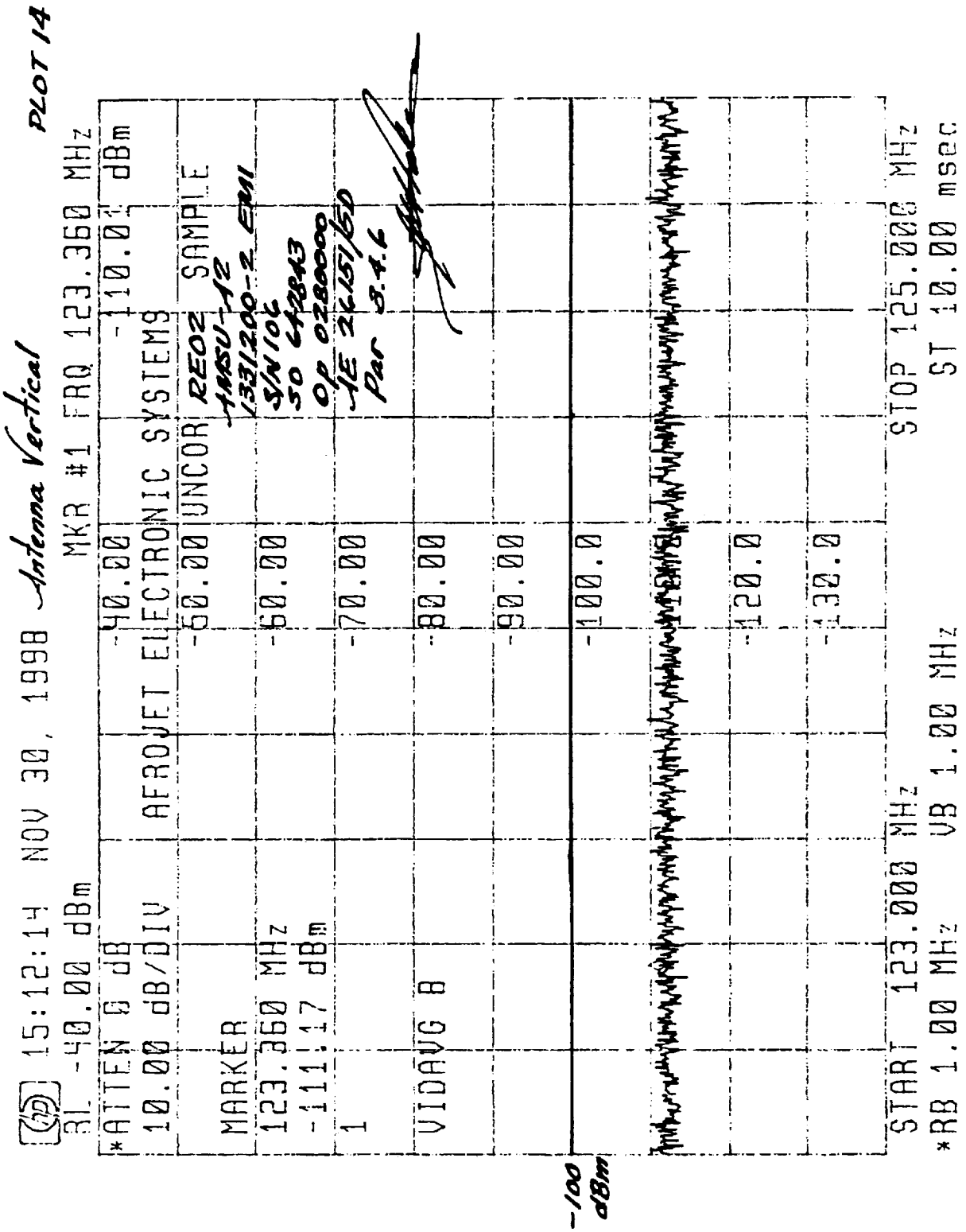


Figure 15. Plot 14

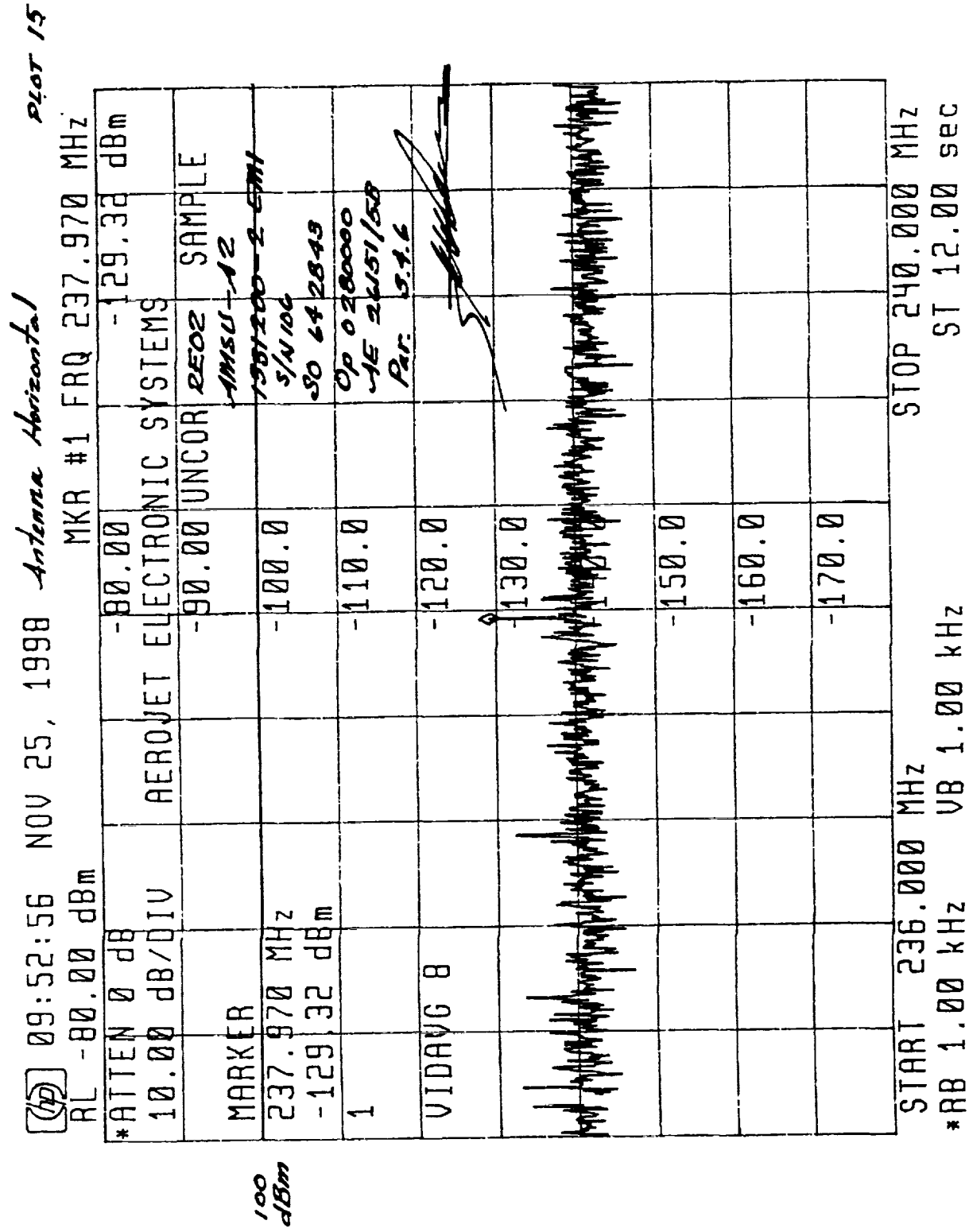


Figure 16. Plot 15

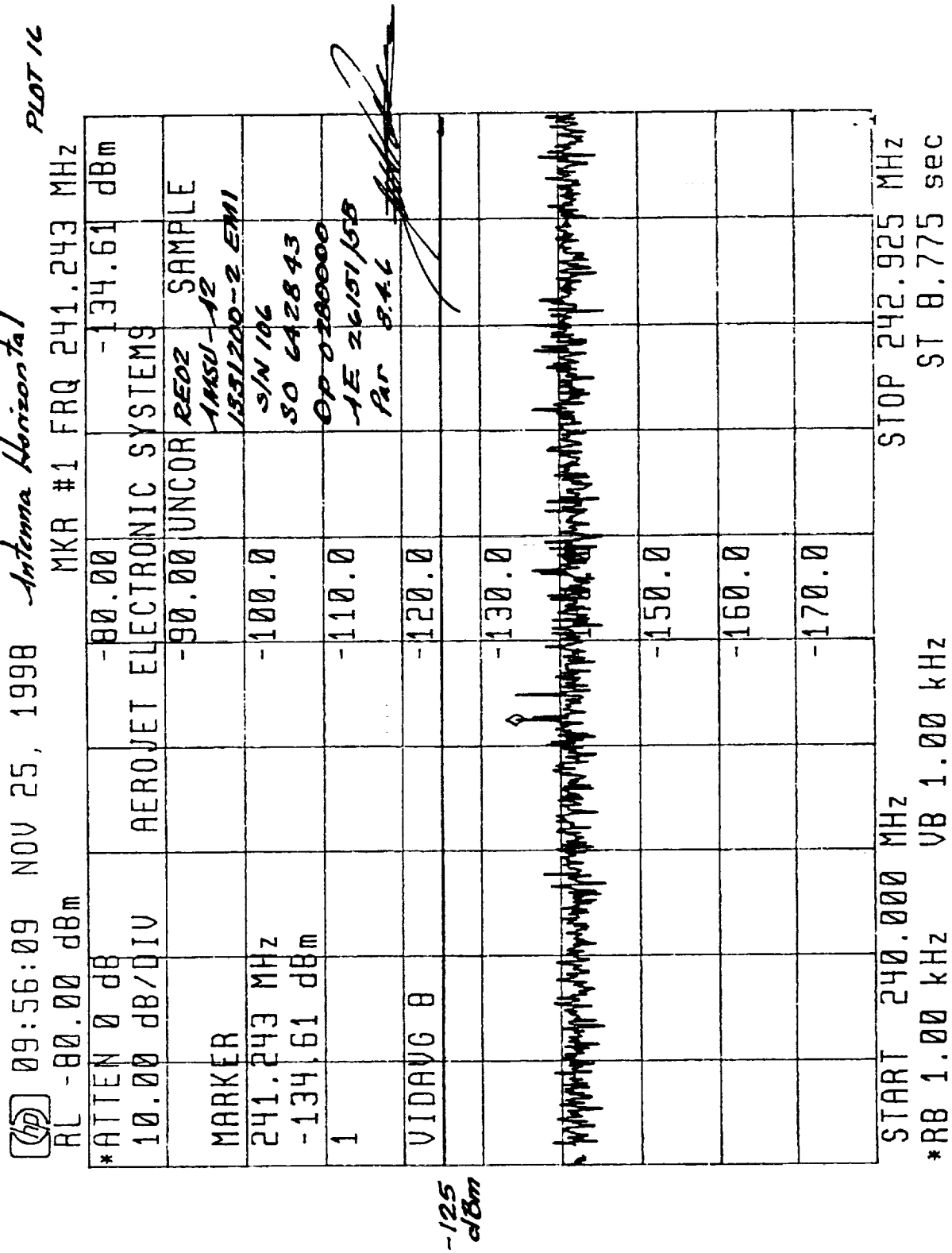


Figure 17. Plot 16

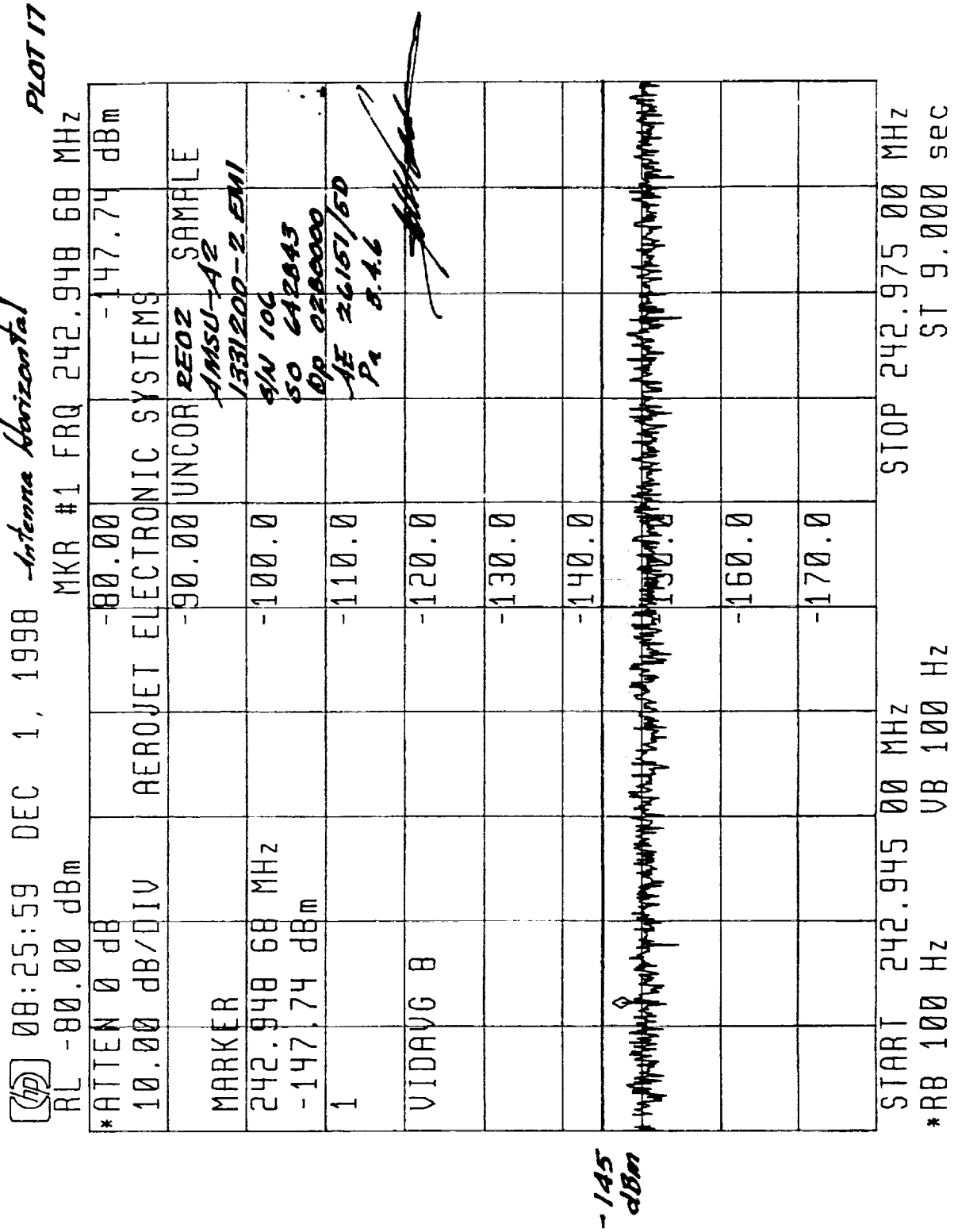


Figure 18. Plot 17

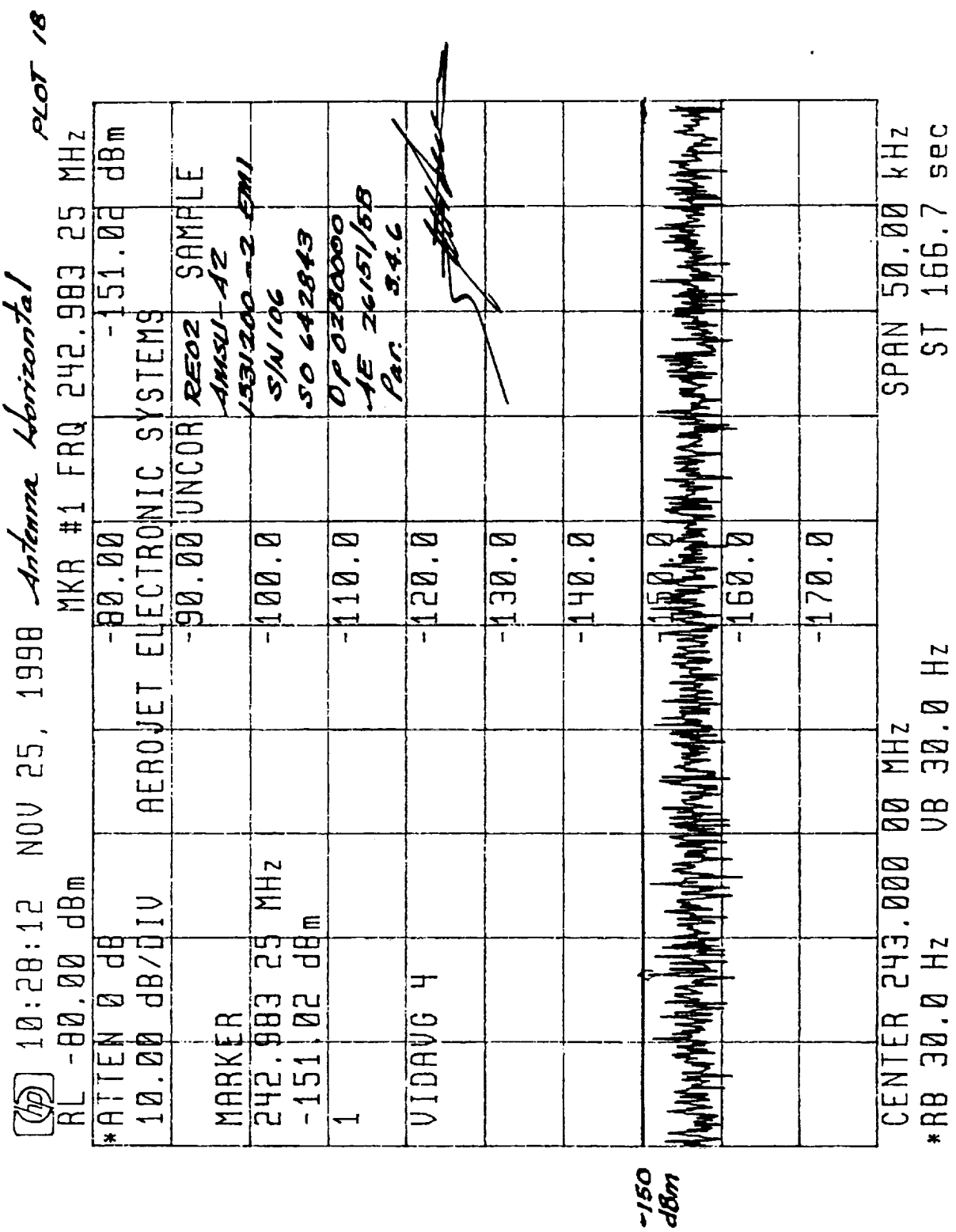


Figure 19. Plot 18

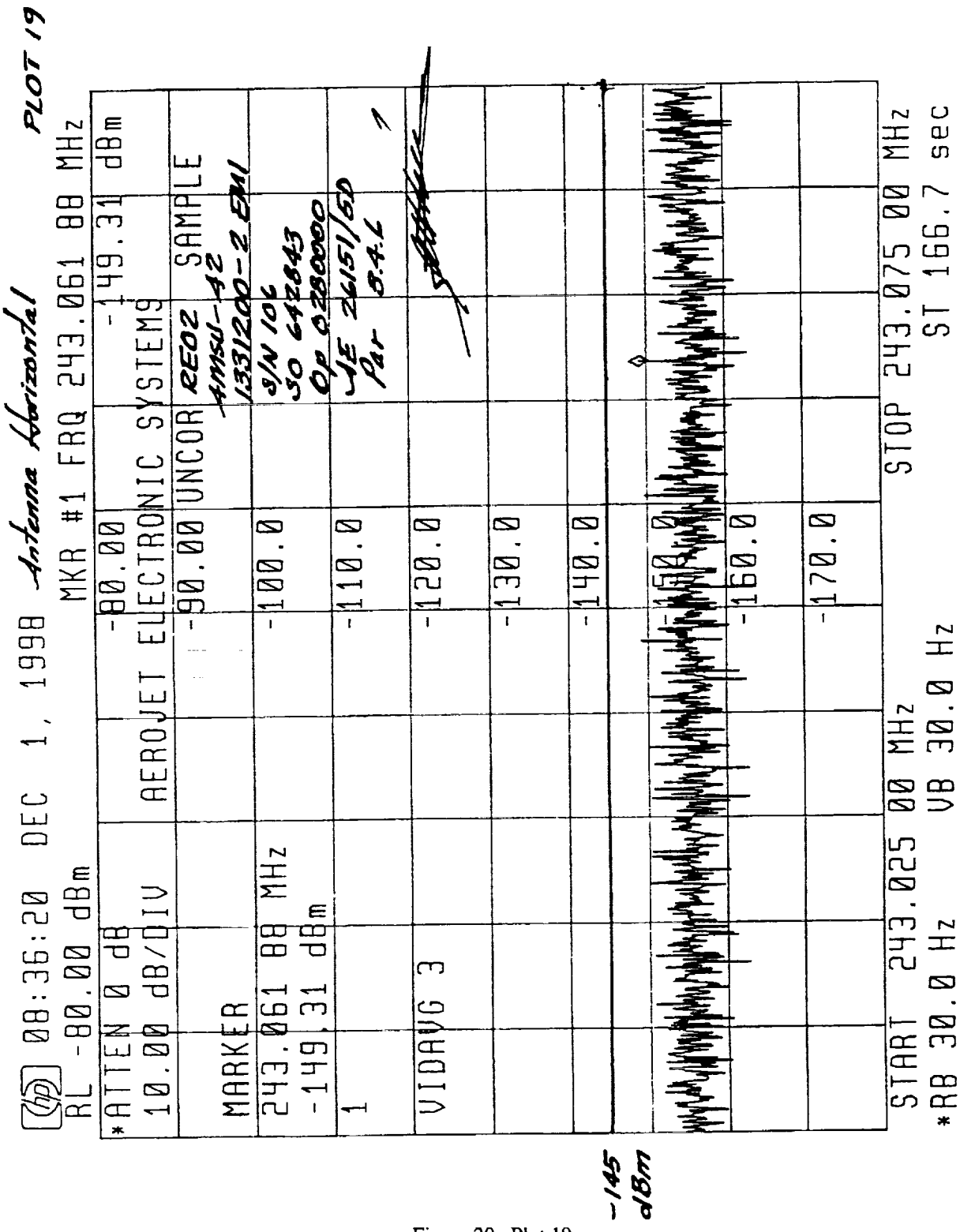


Figure 20. Plot 19

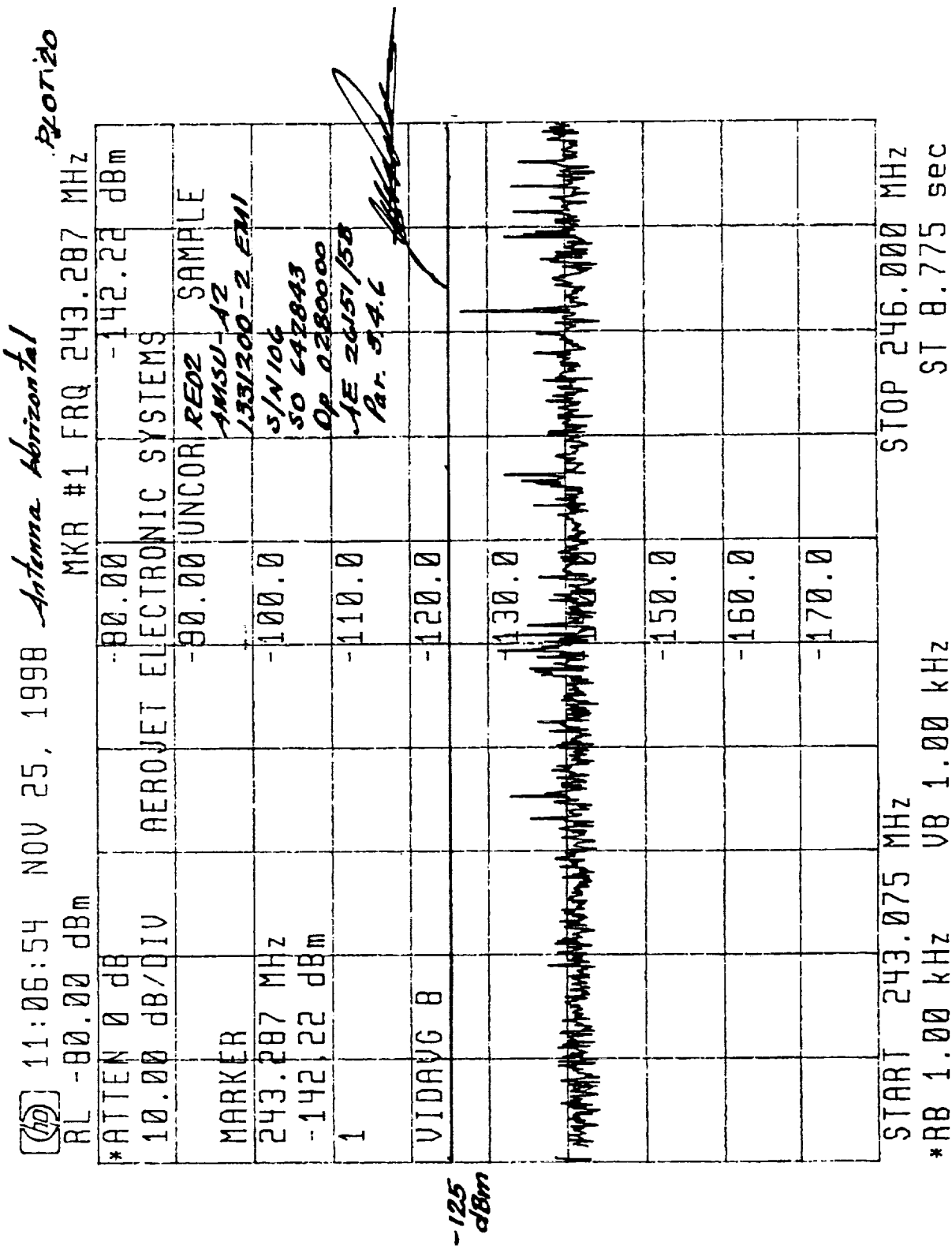


Figure 21. Plot 20

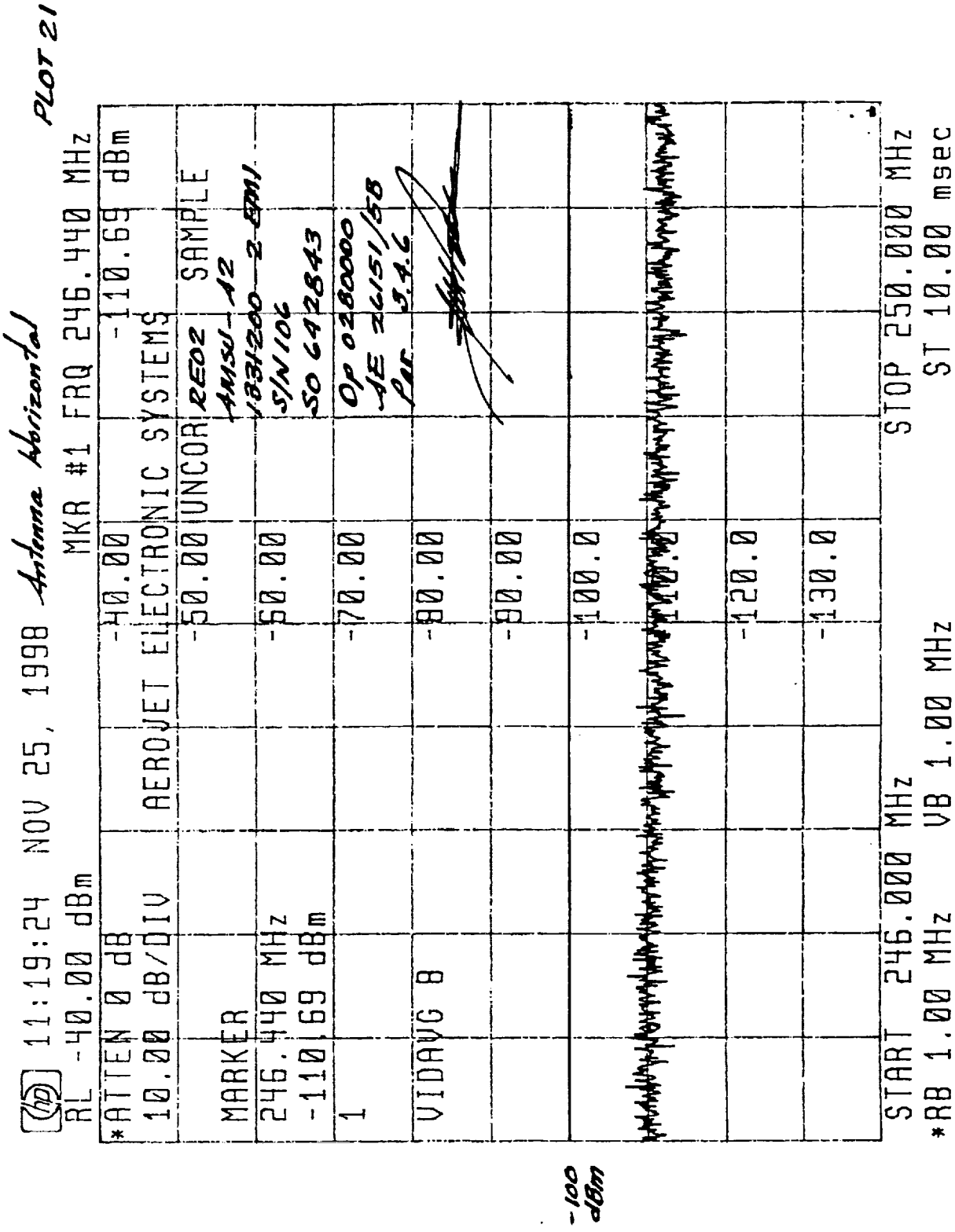


Figure 22. Plot 21

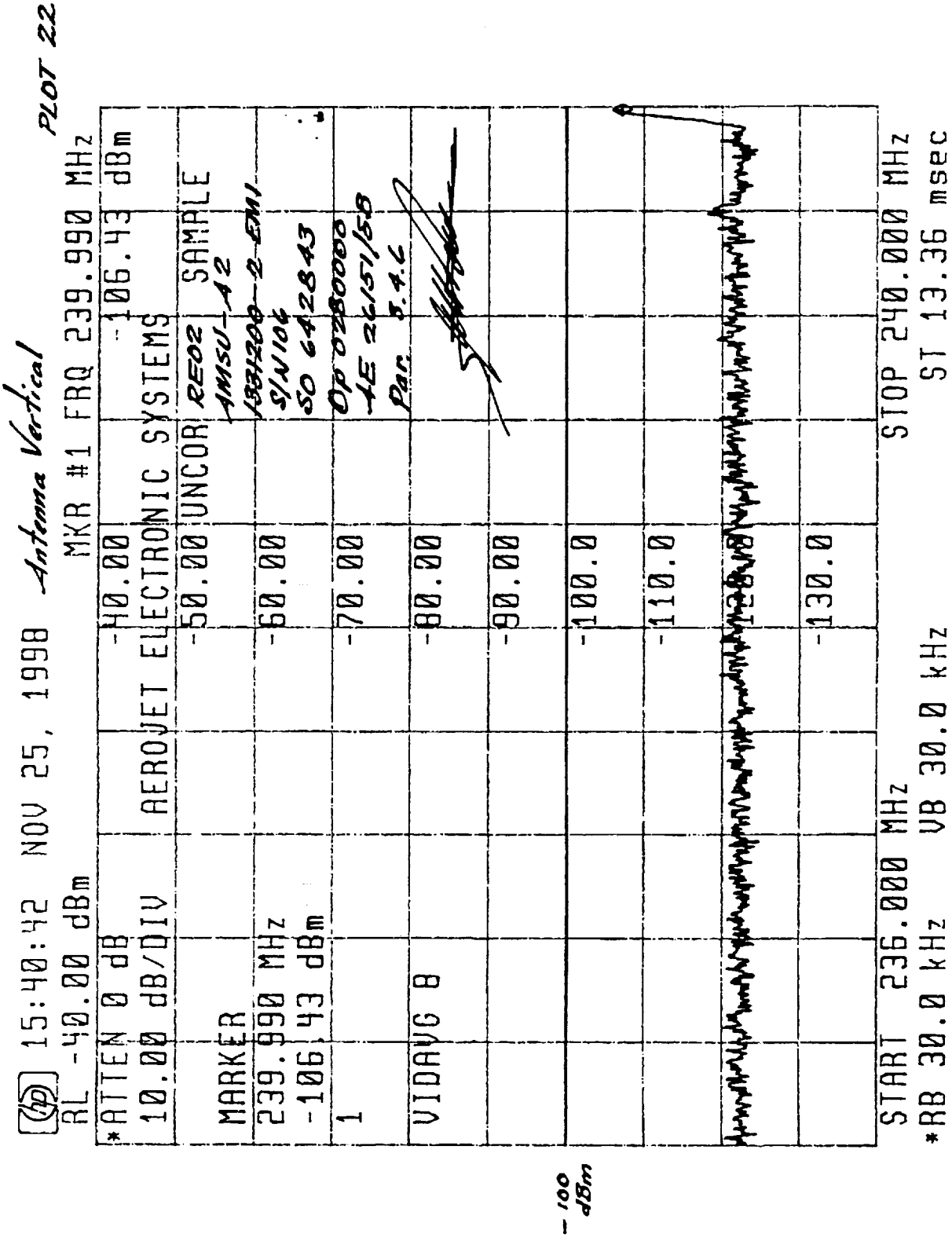


Figure 23. Plot 22

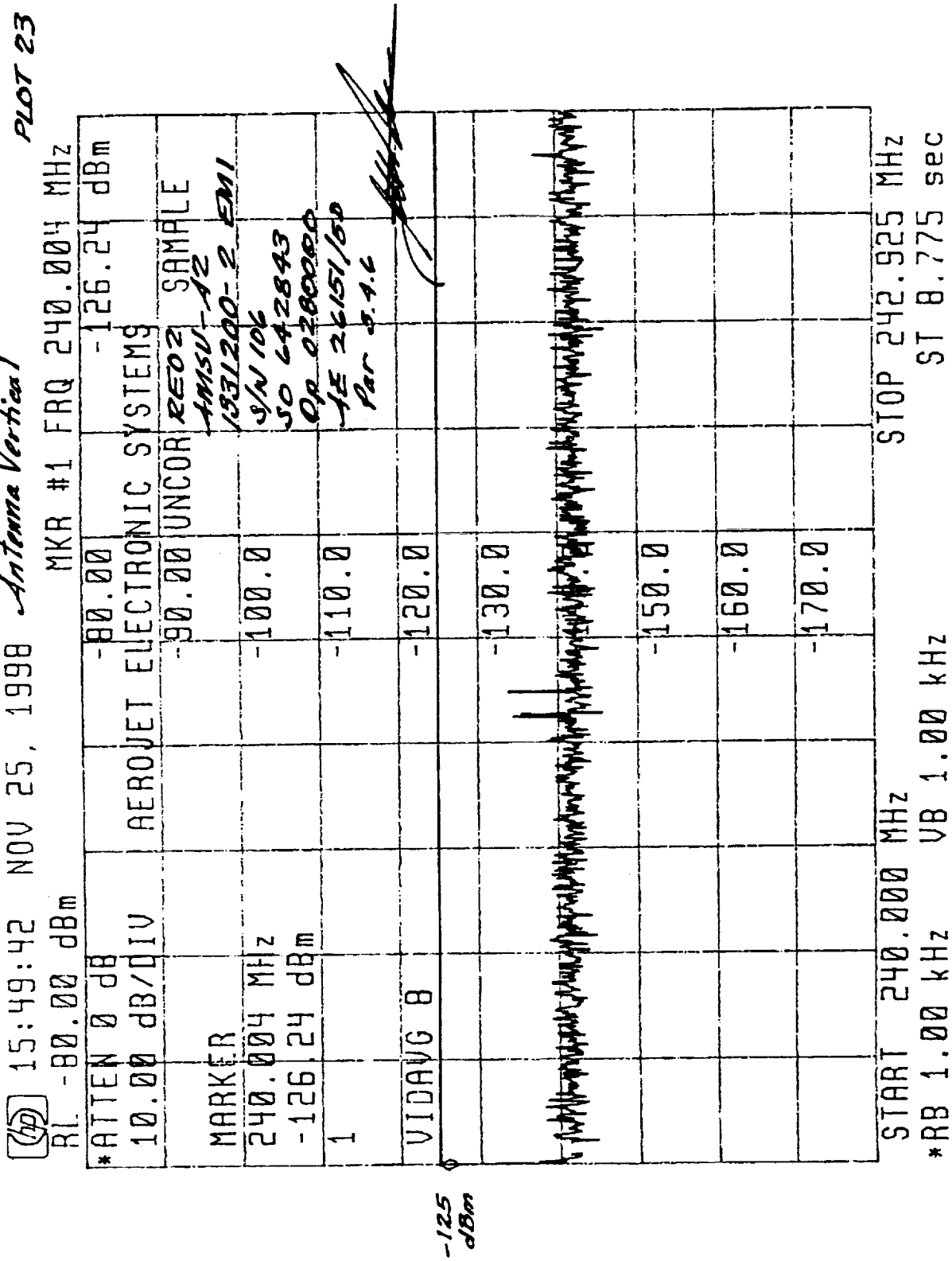


Figure 24. Plot 23

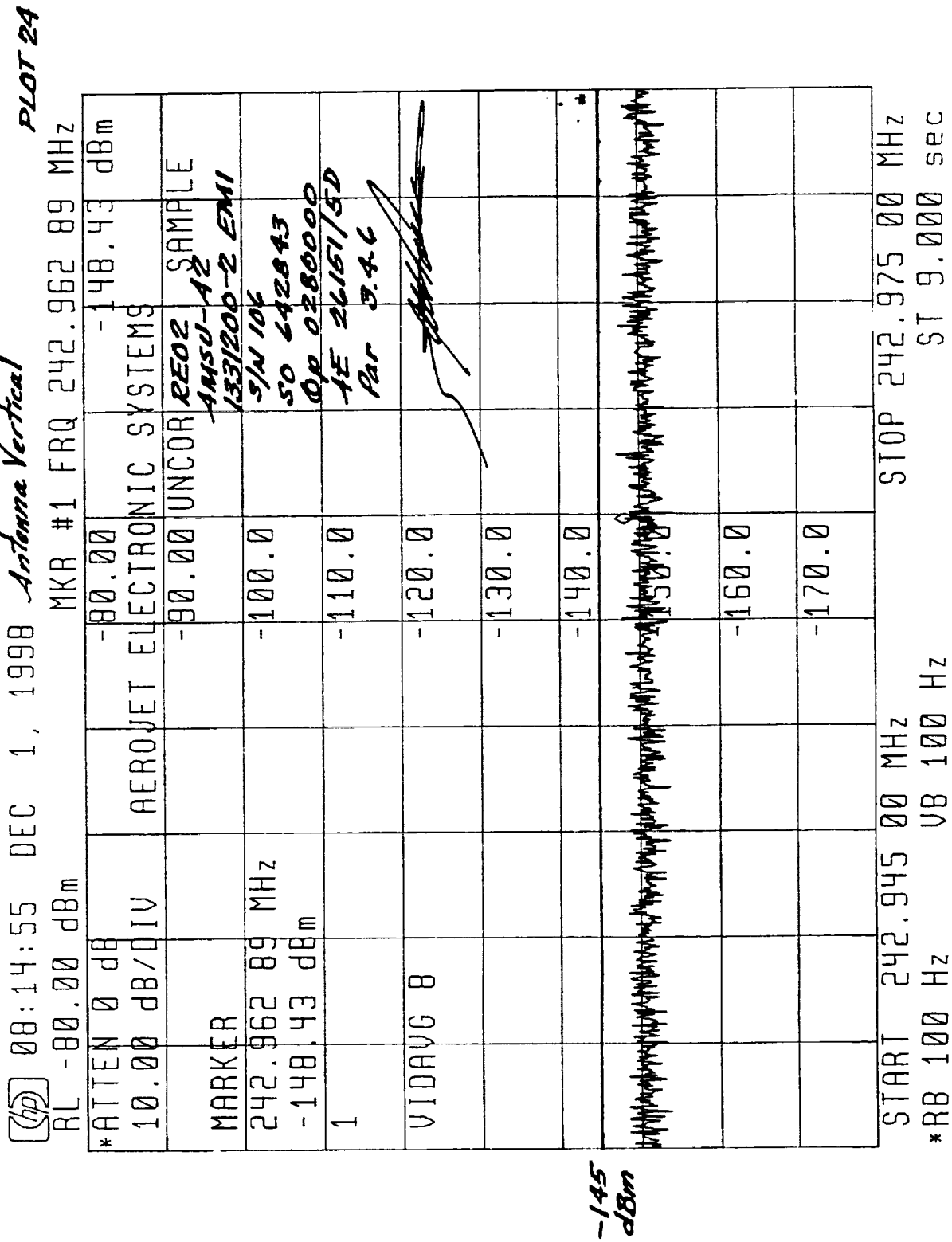
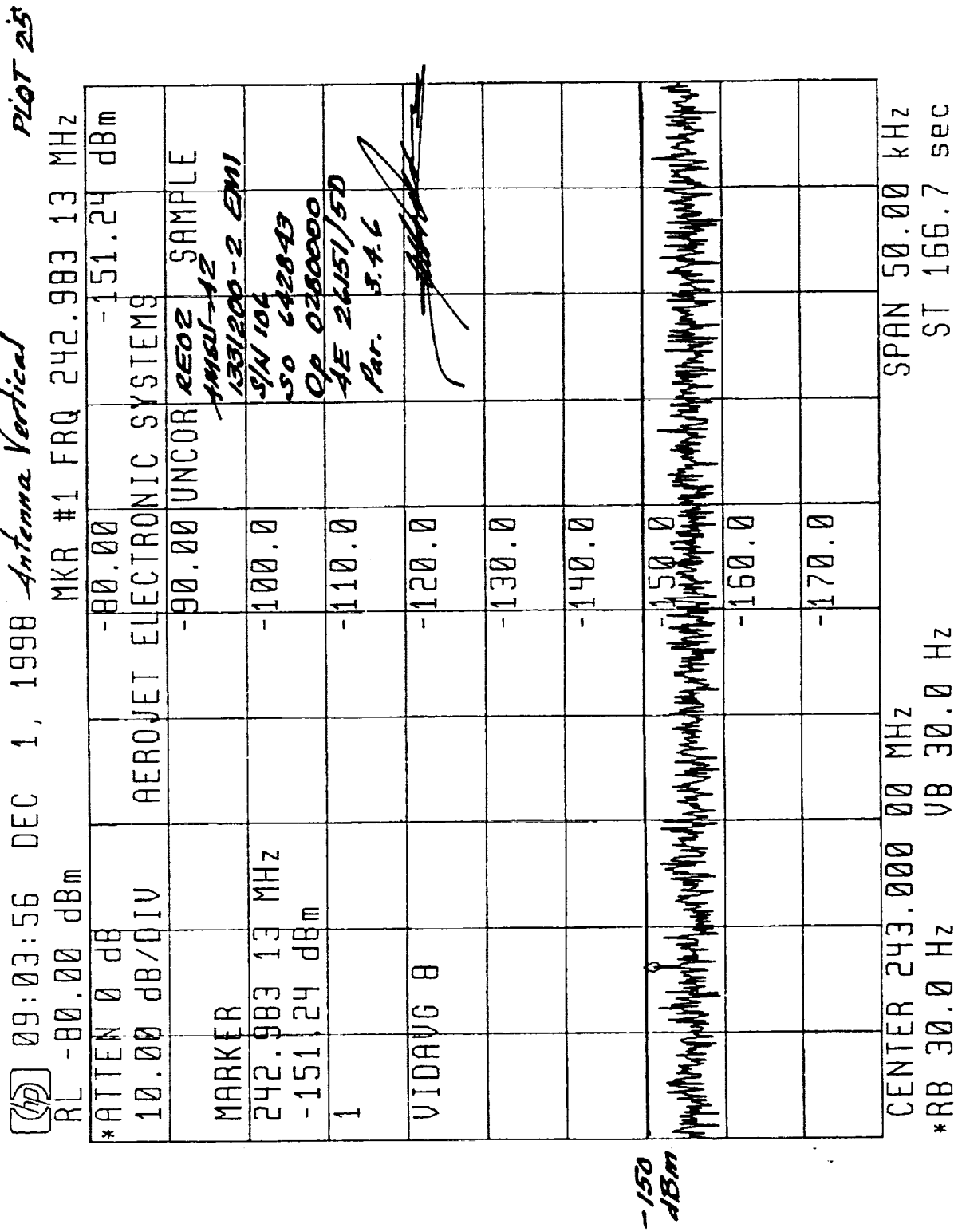


Figure 25. Plot 24



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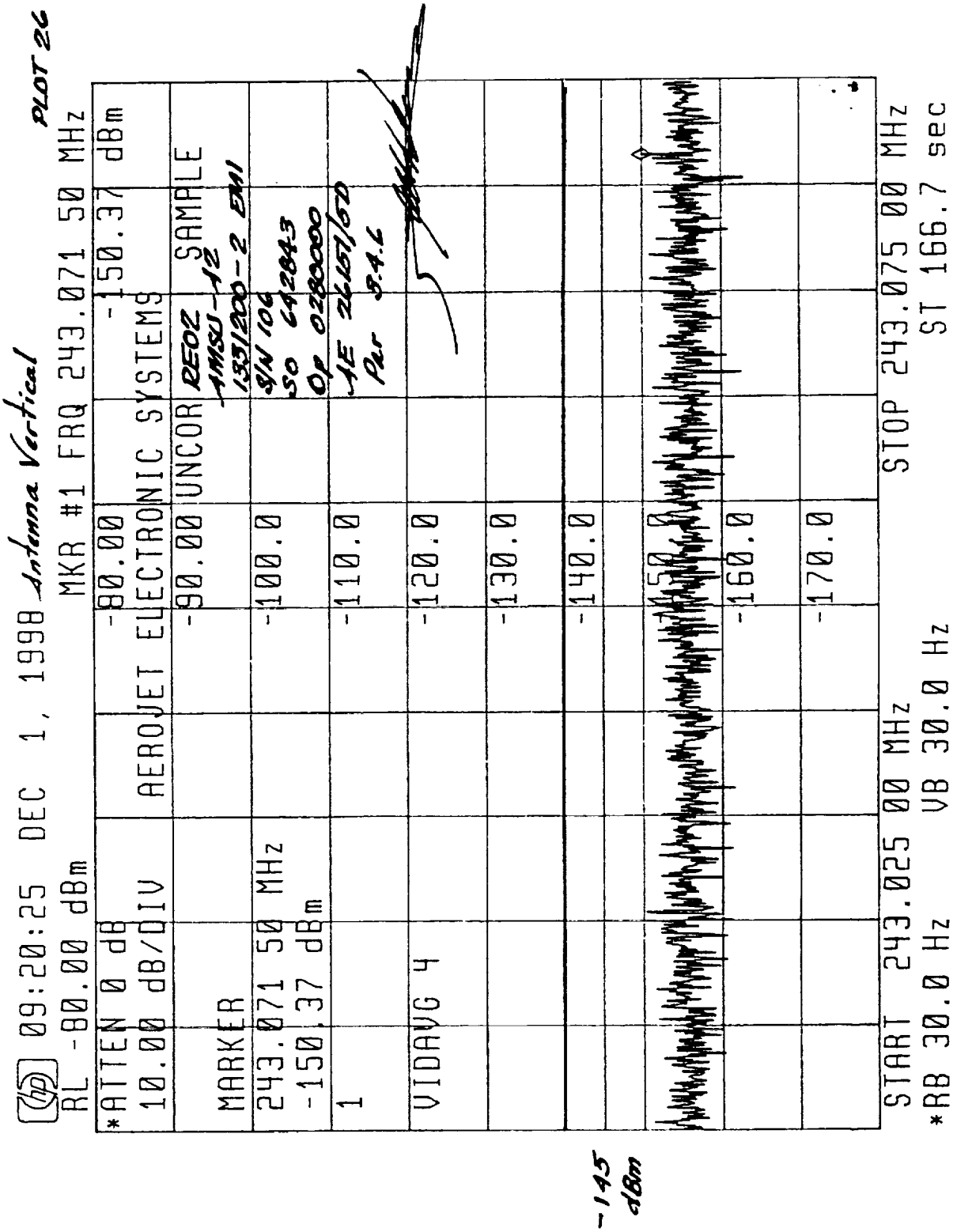

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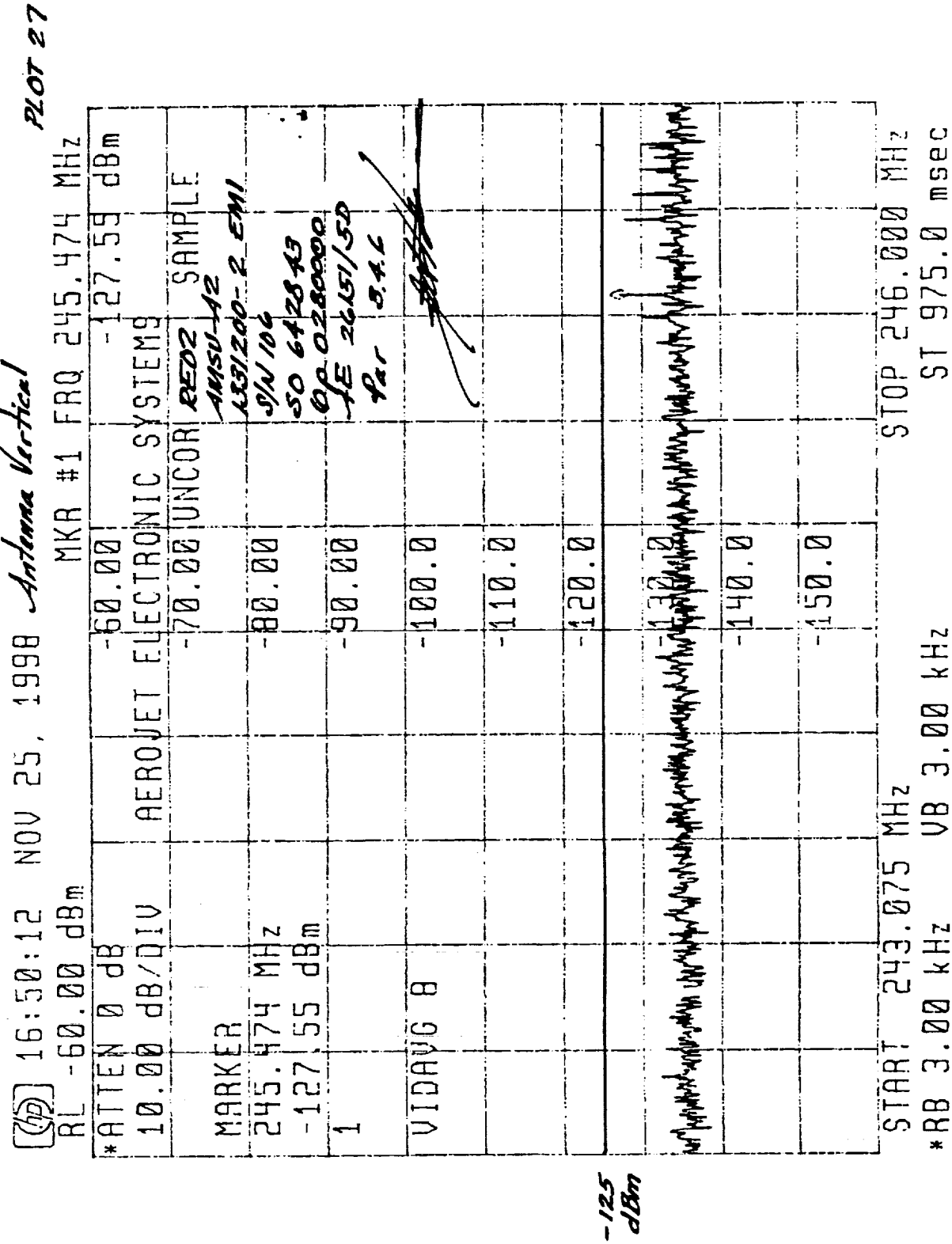

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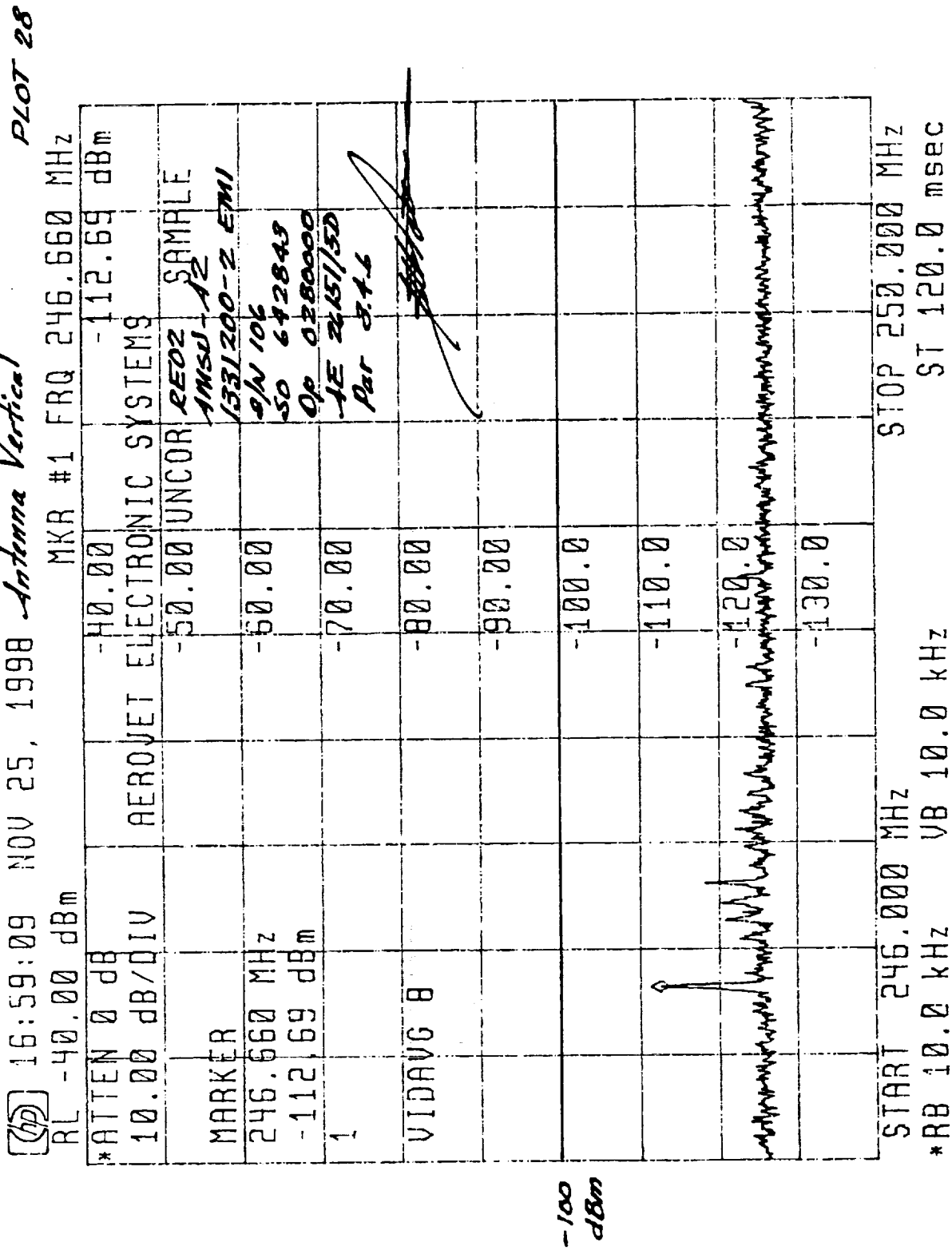

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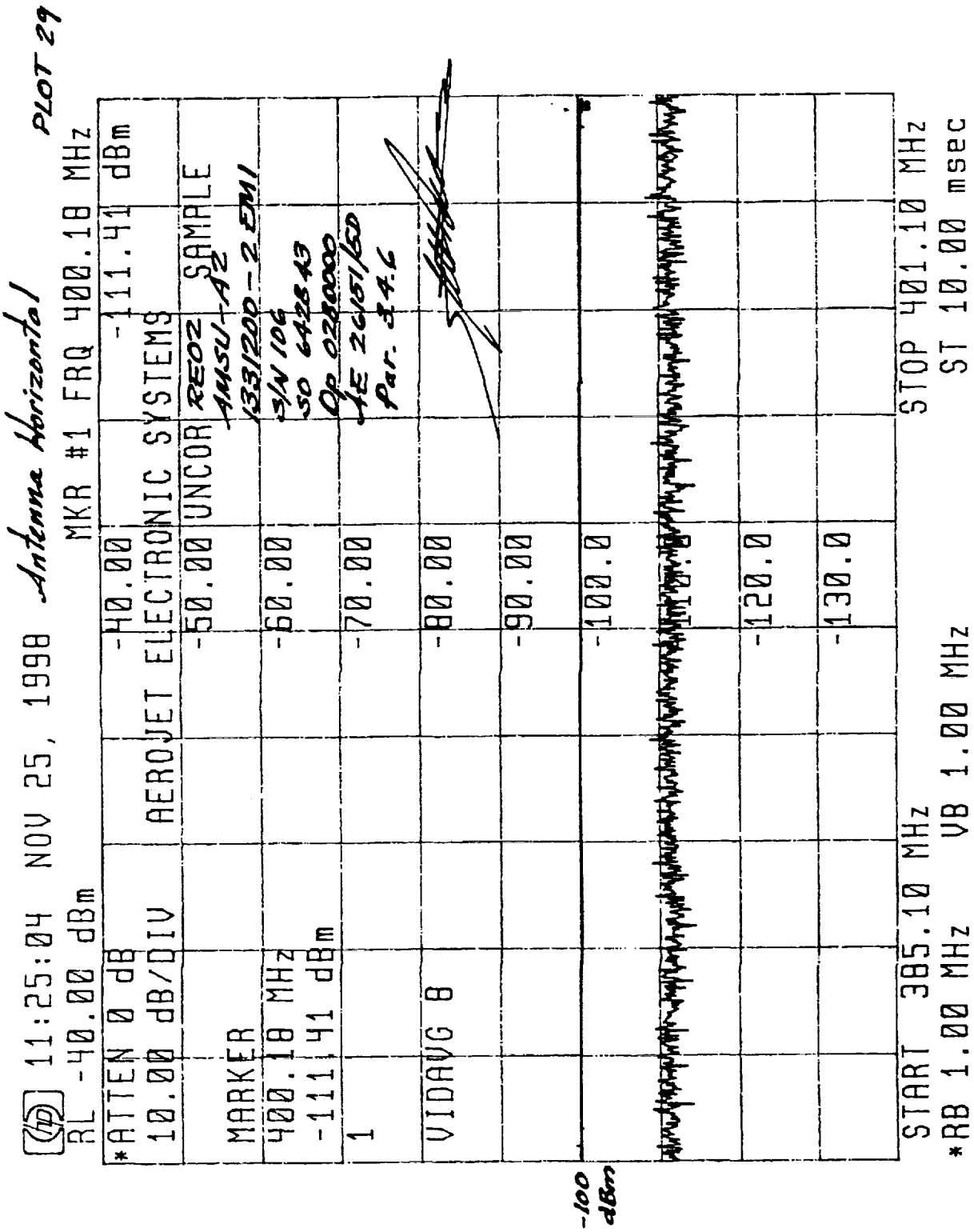

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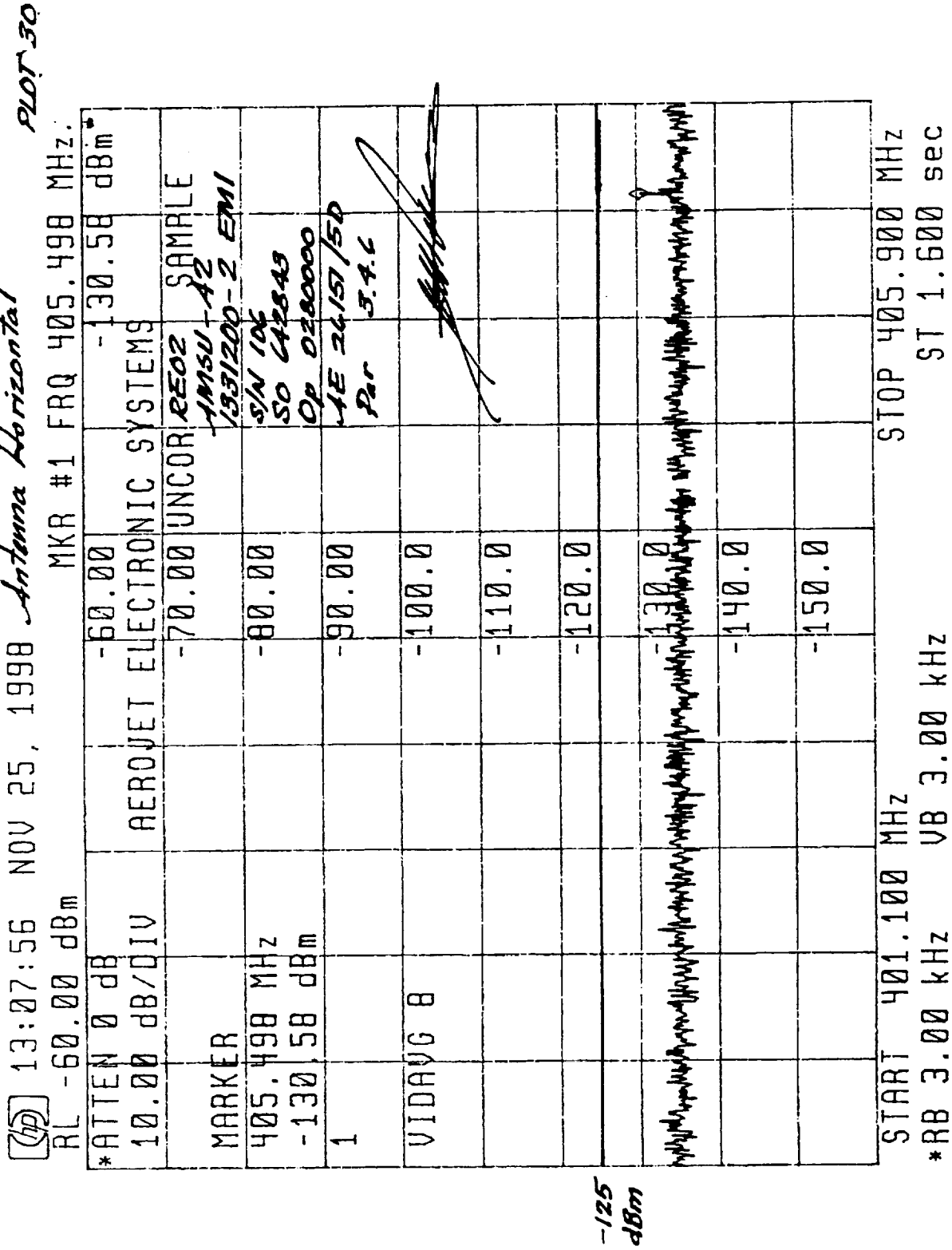

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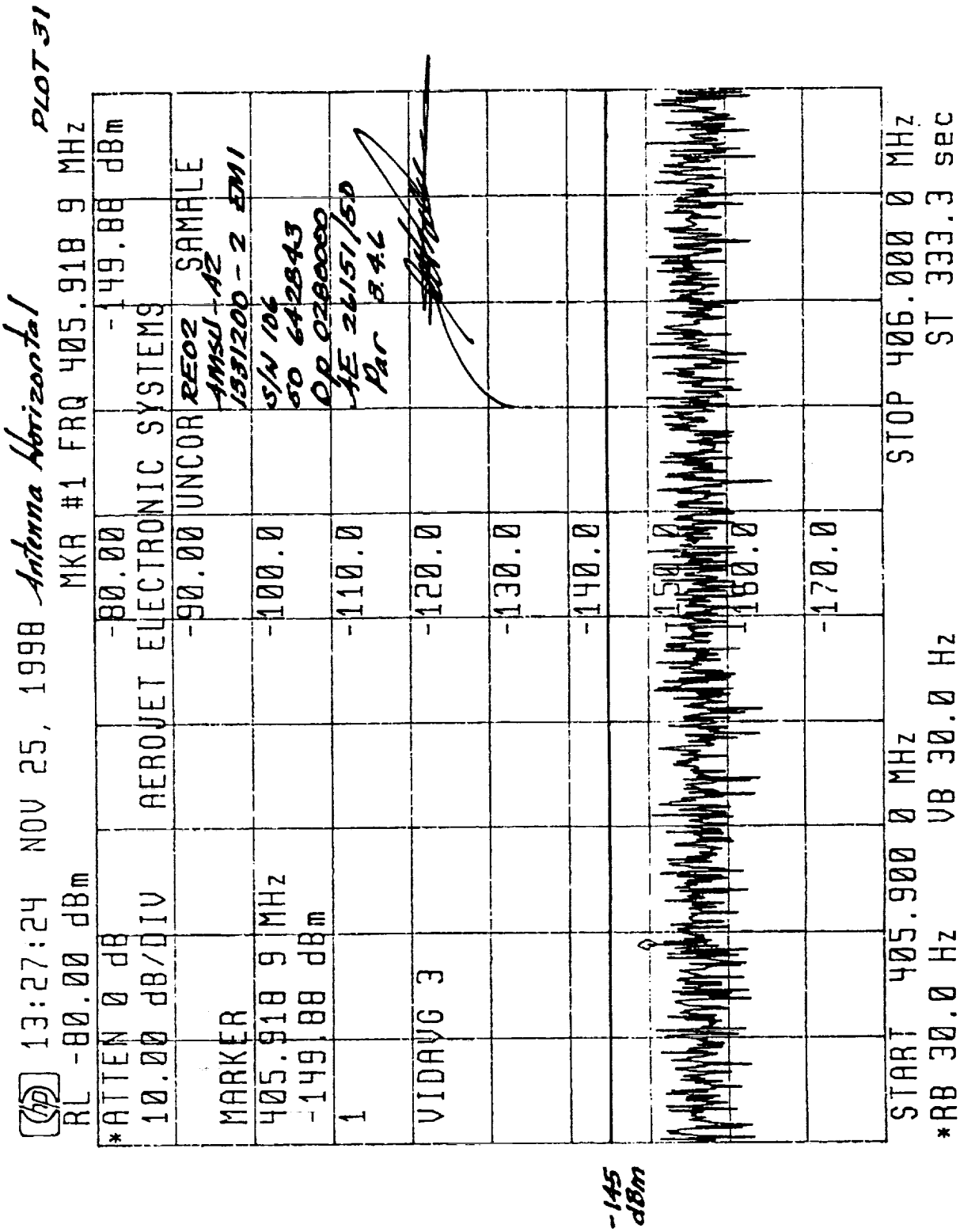

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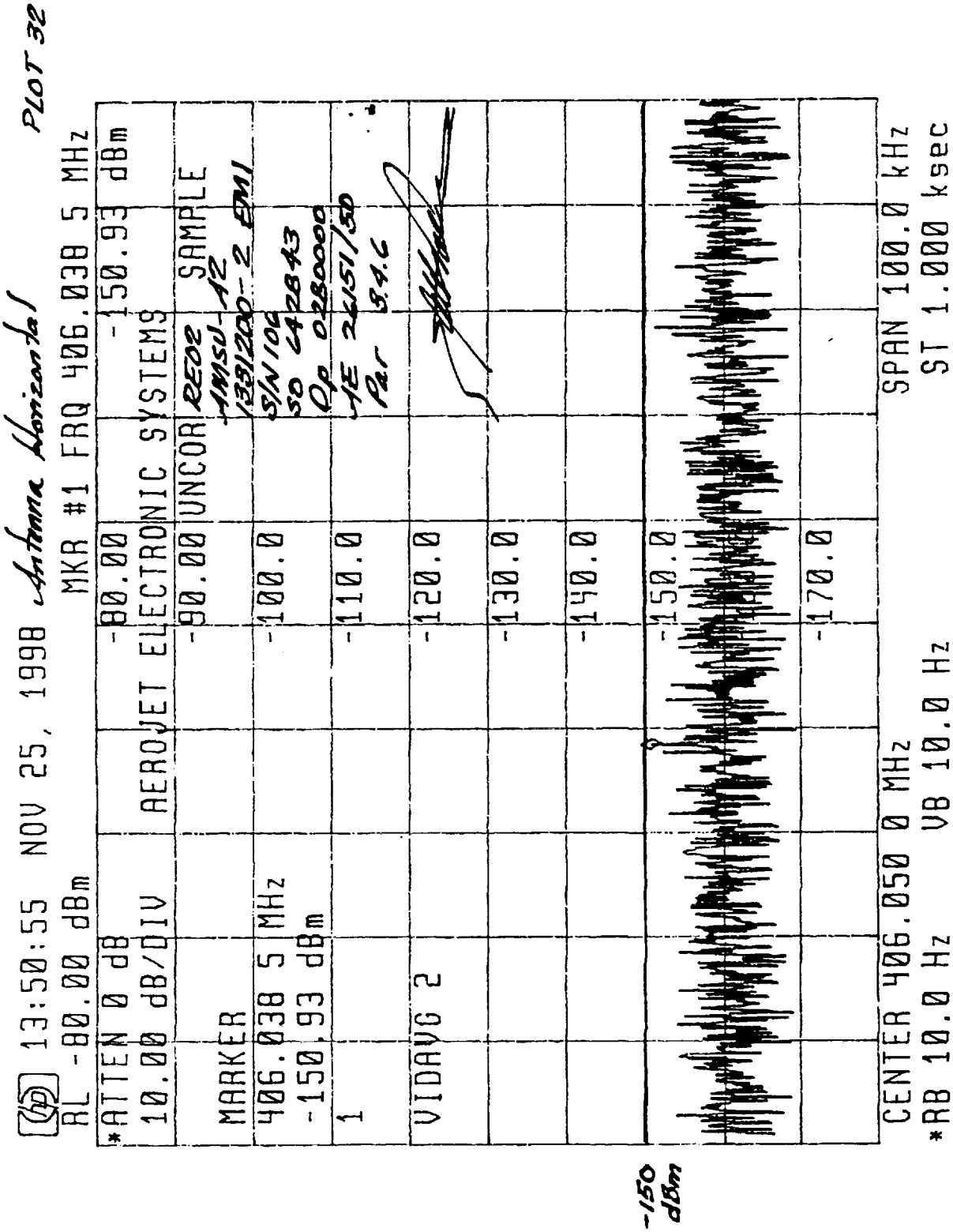

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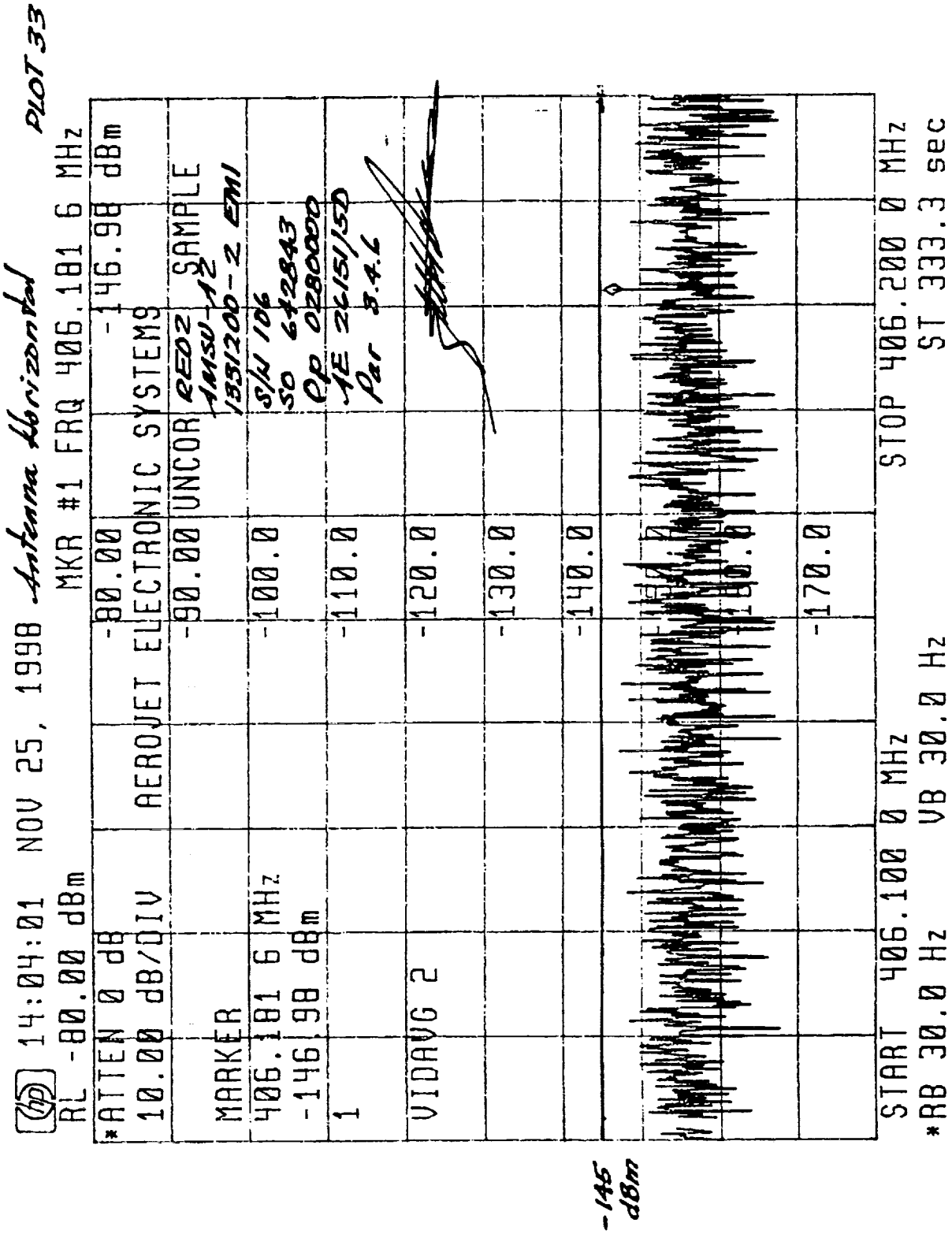

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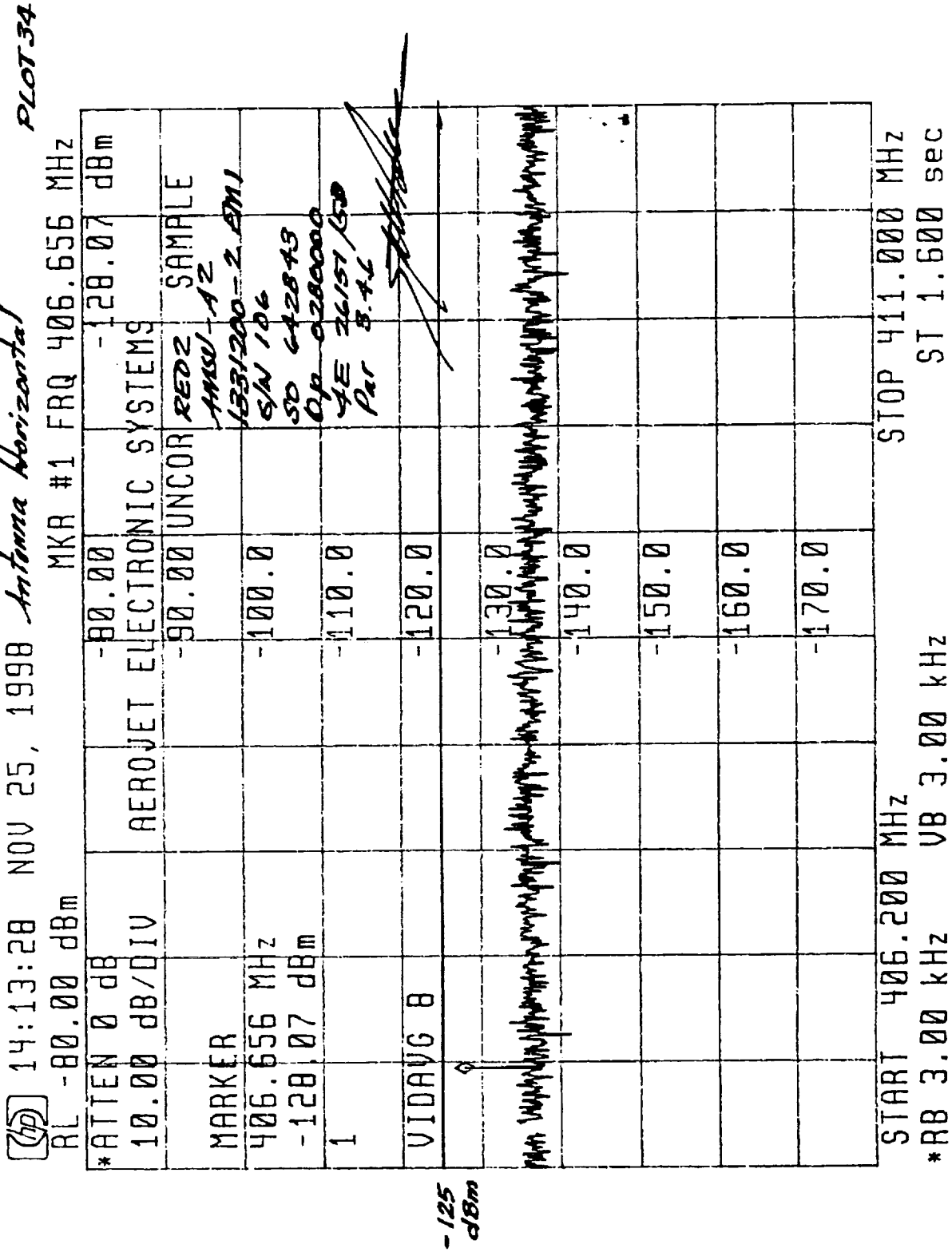

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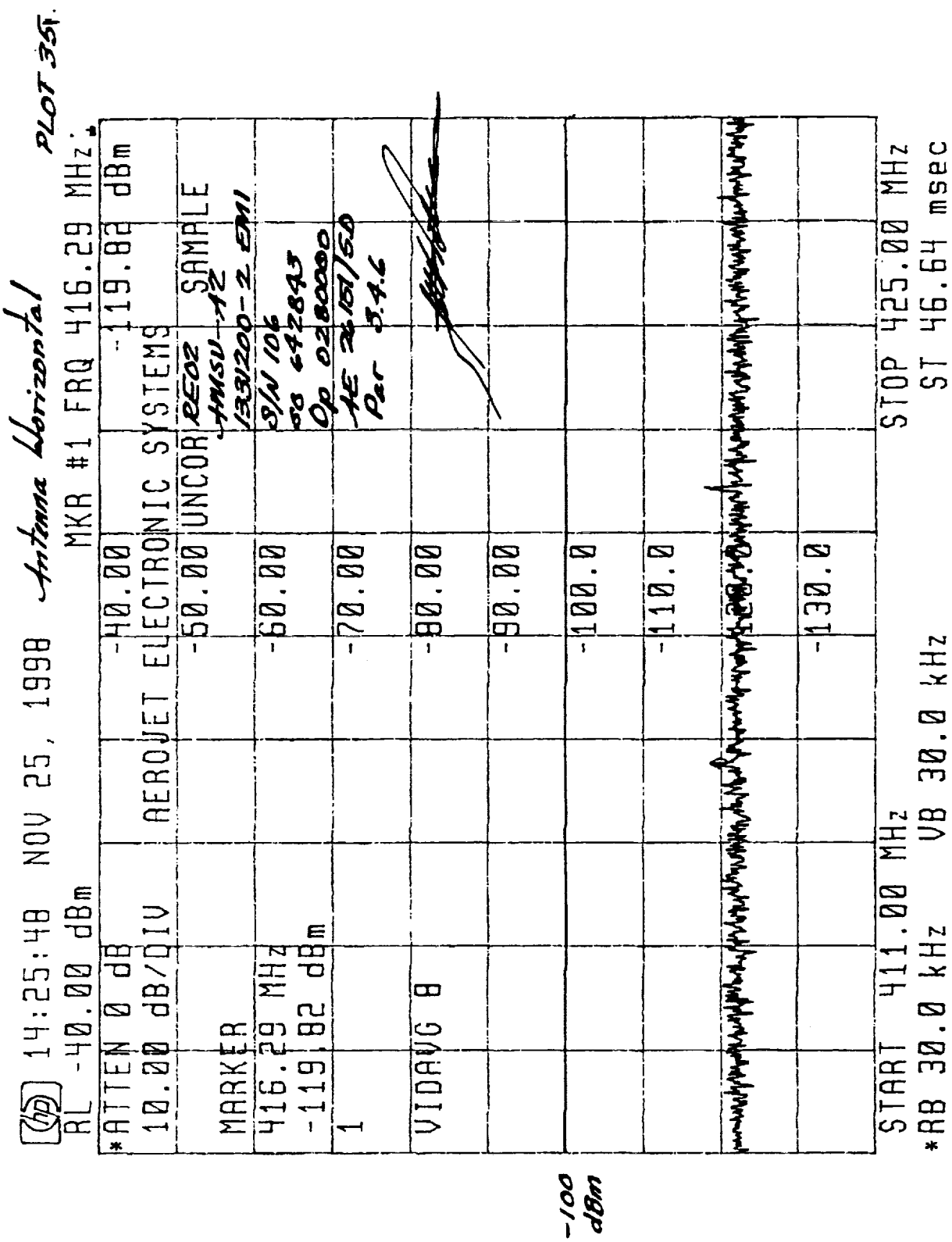

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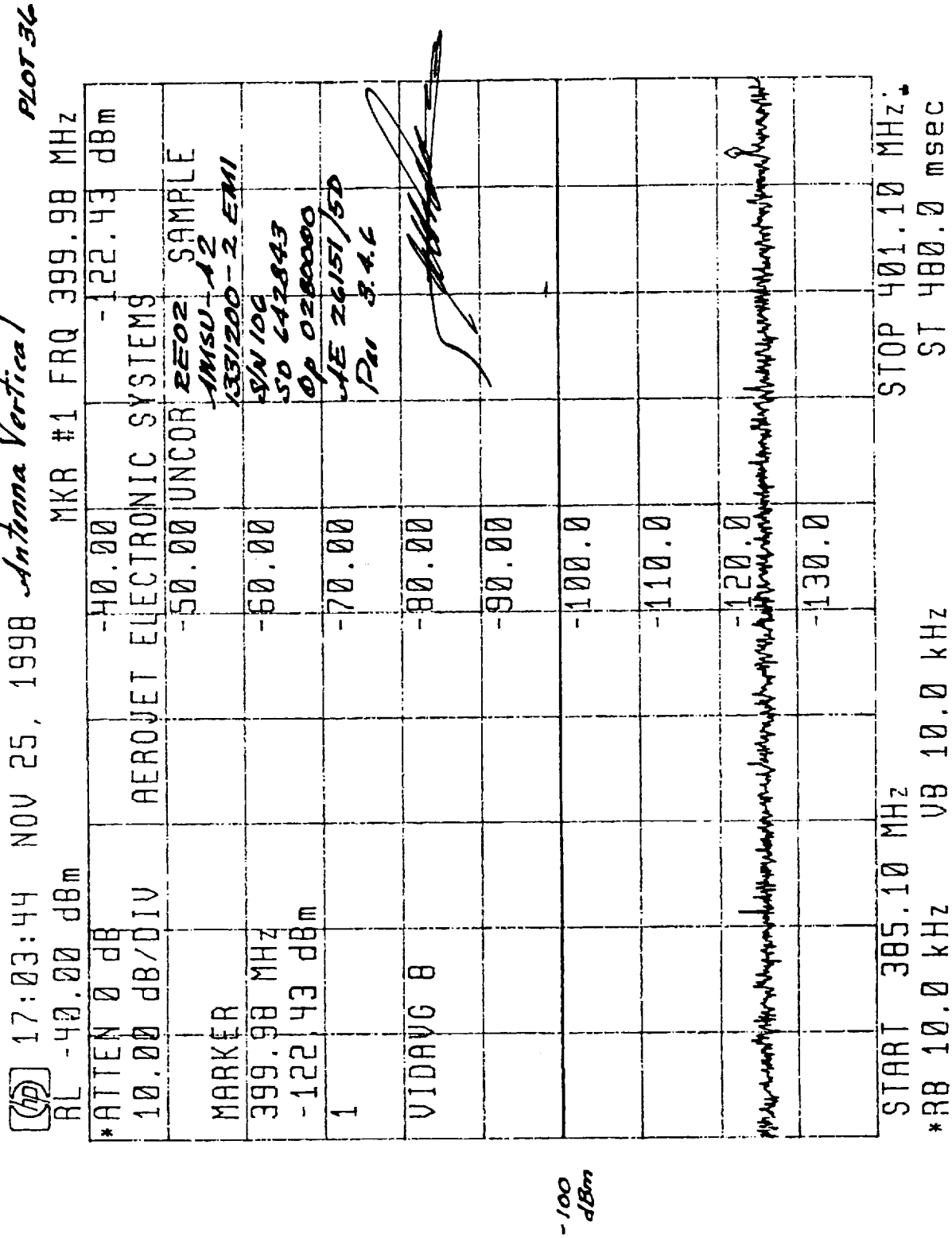

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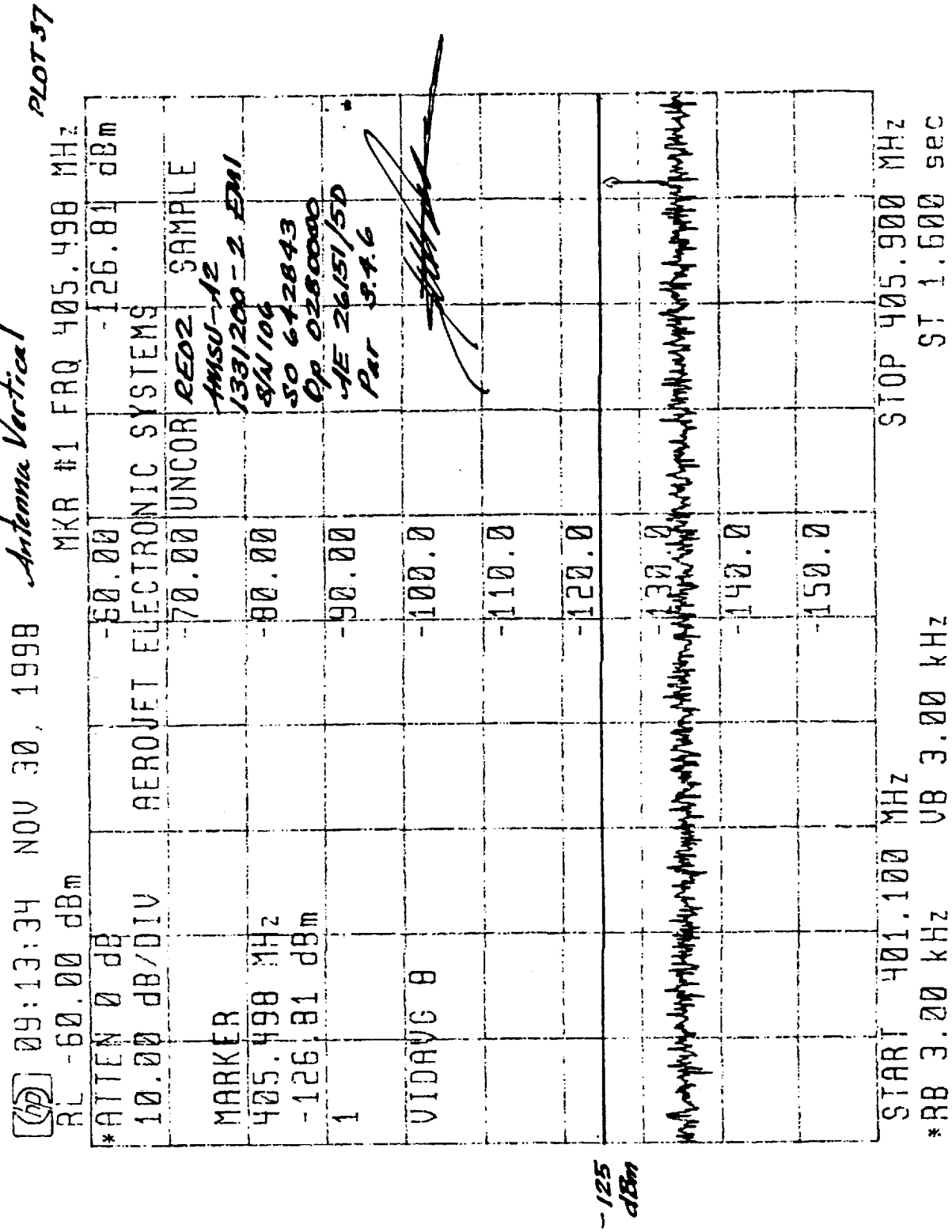

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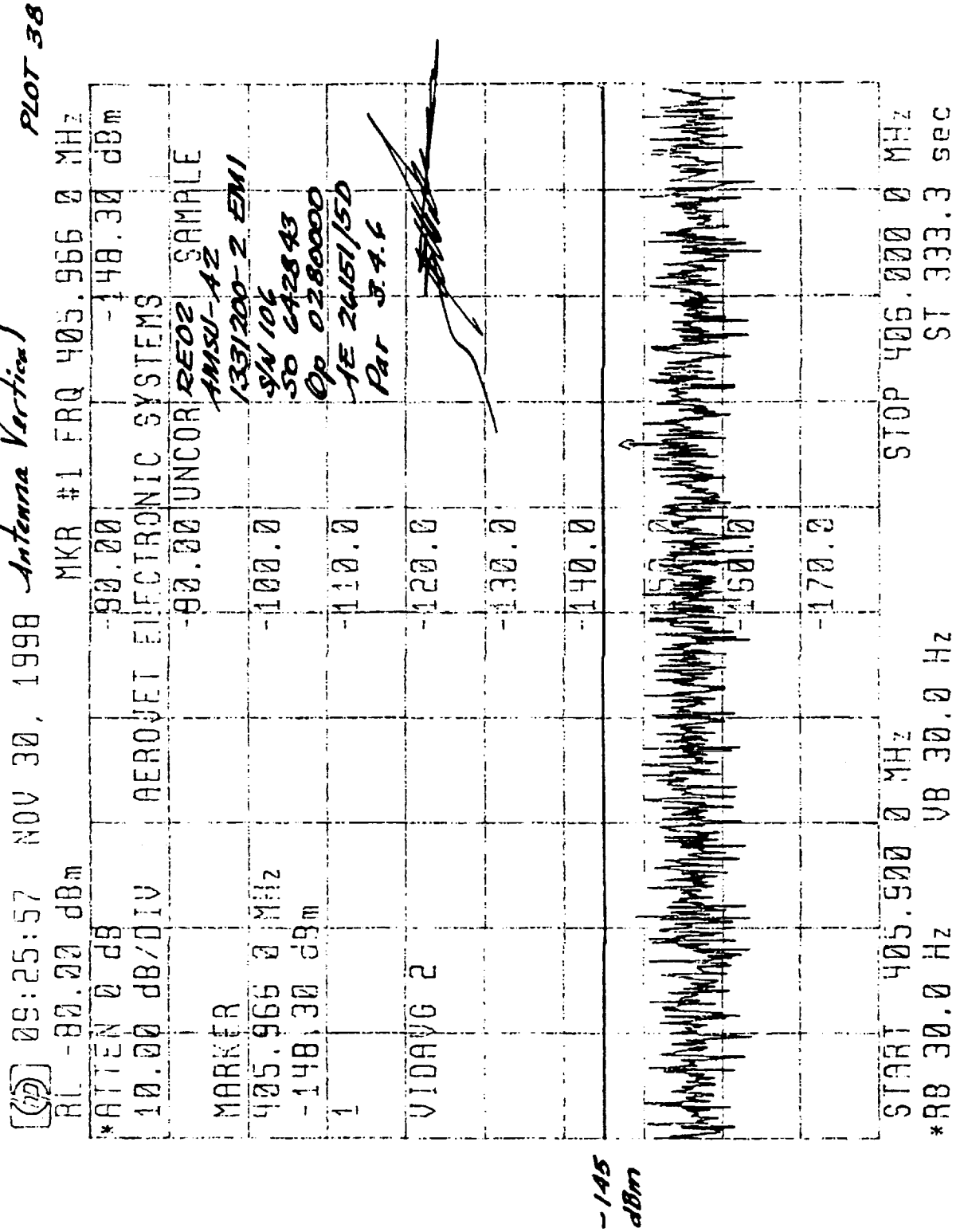

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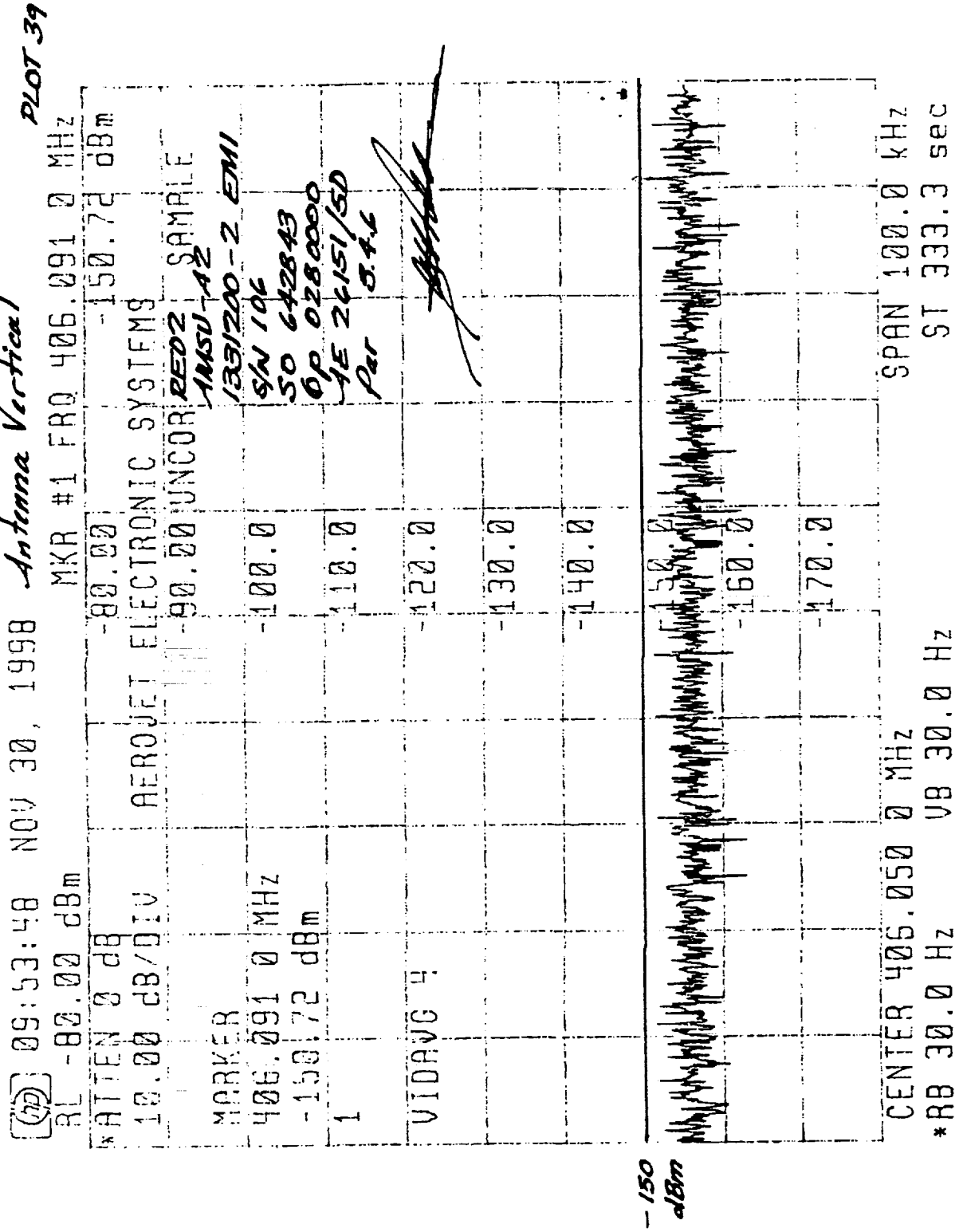

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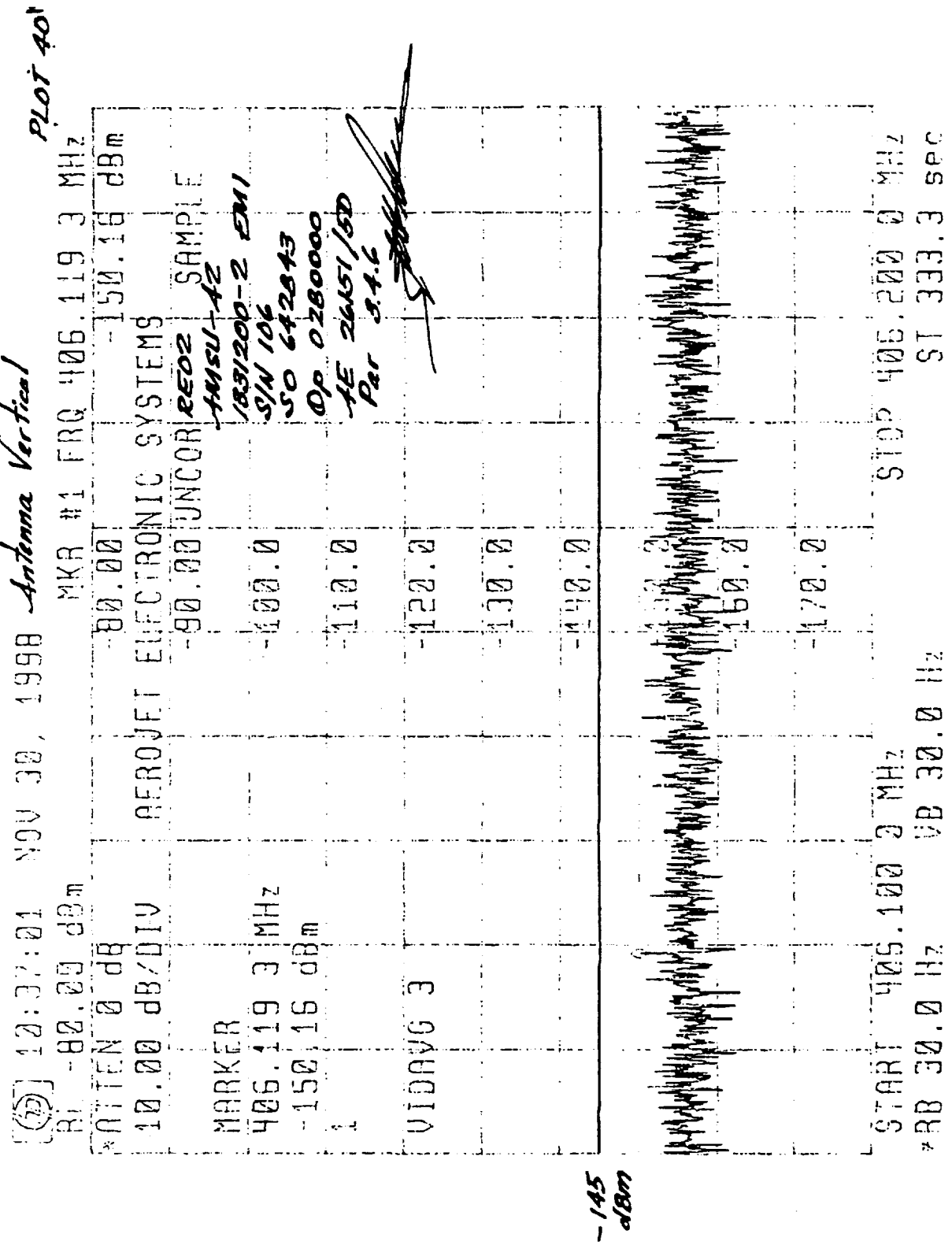

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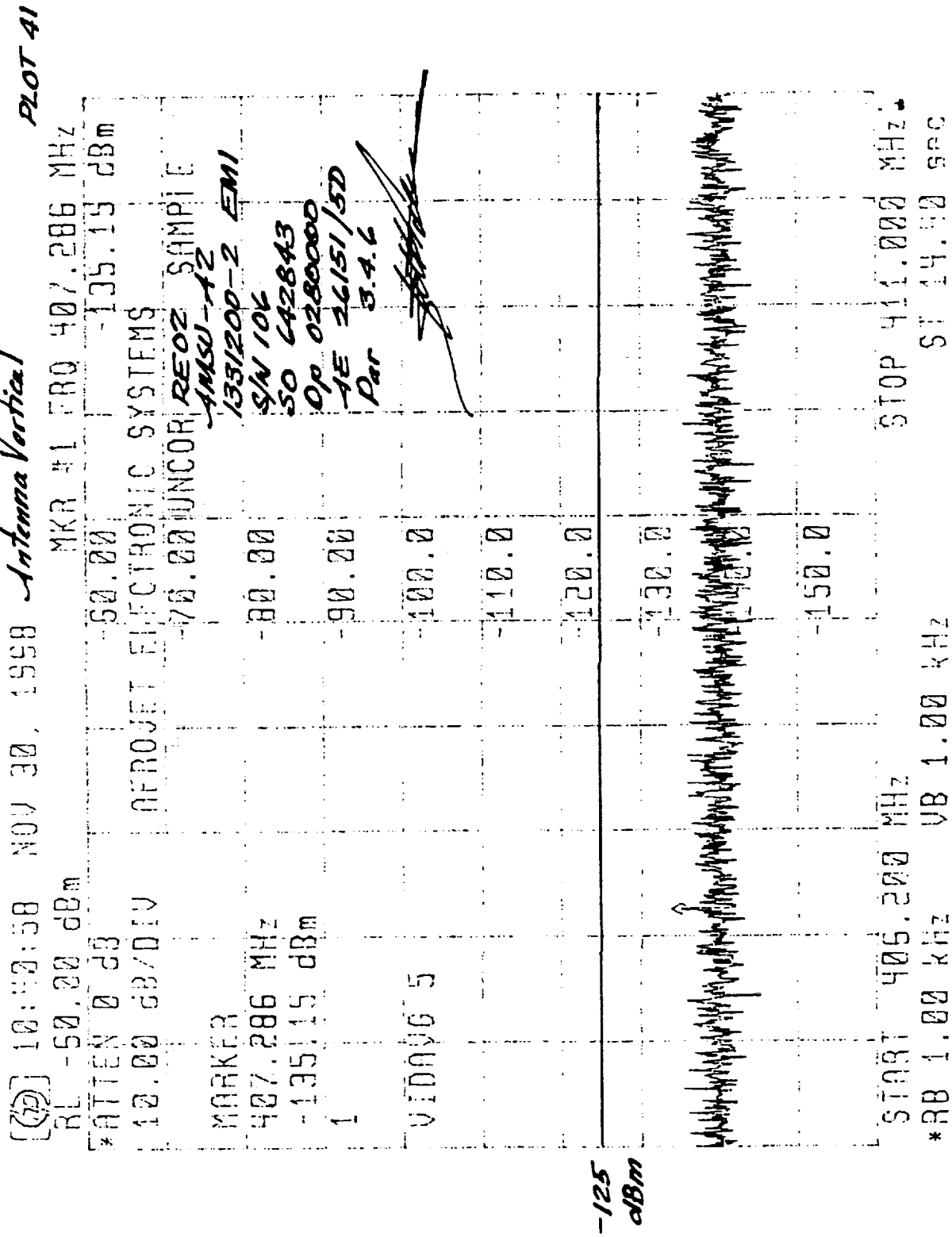

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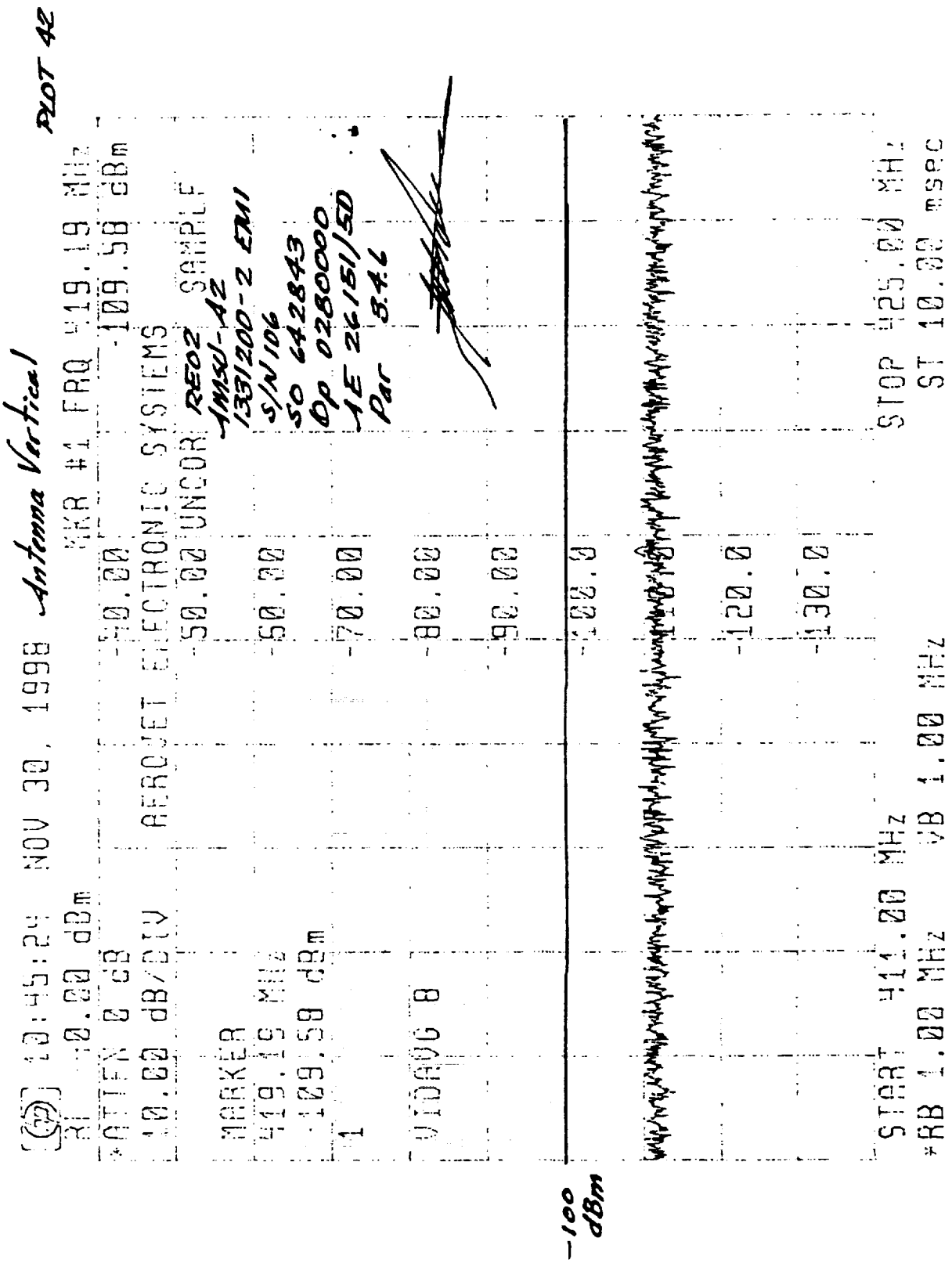

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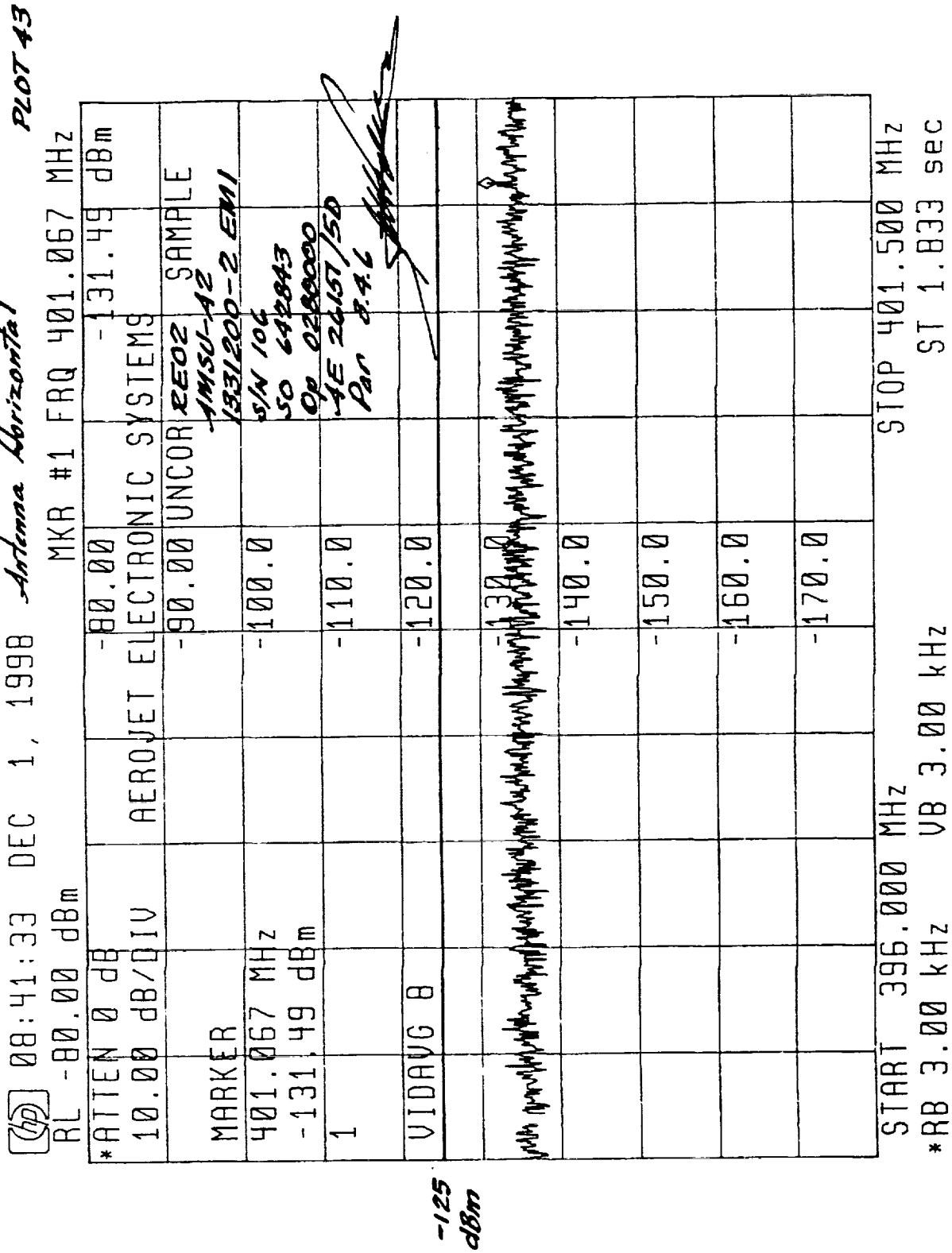

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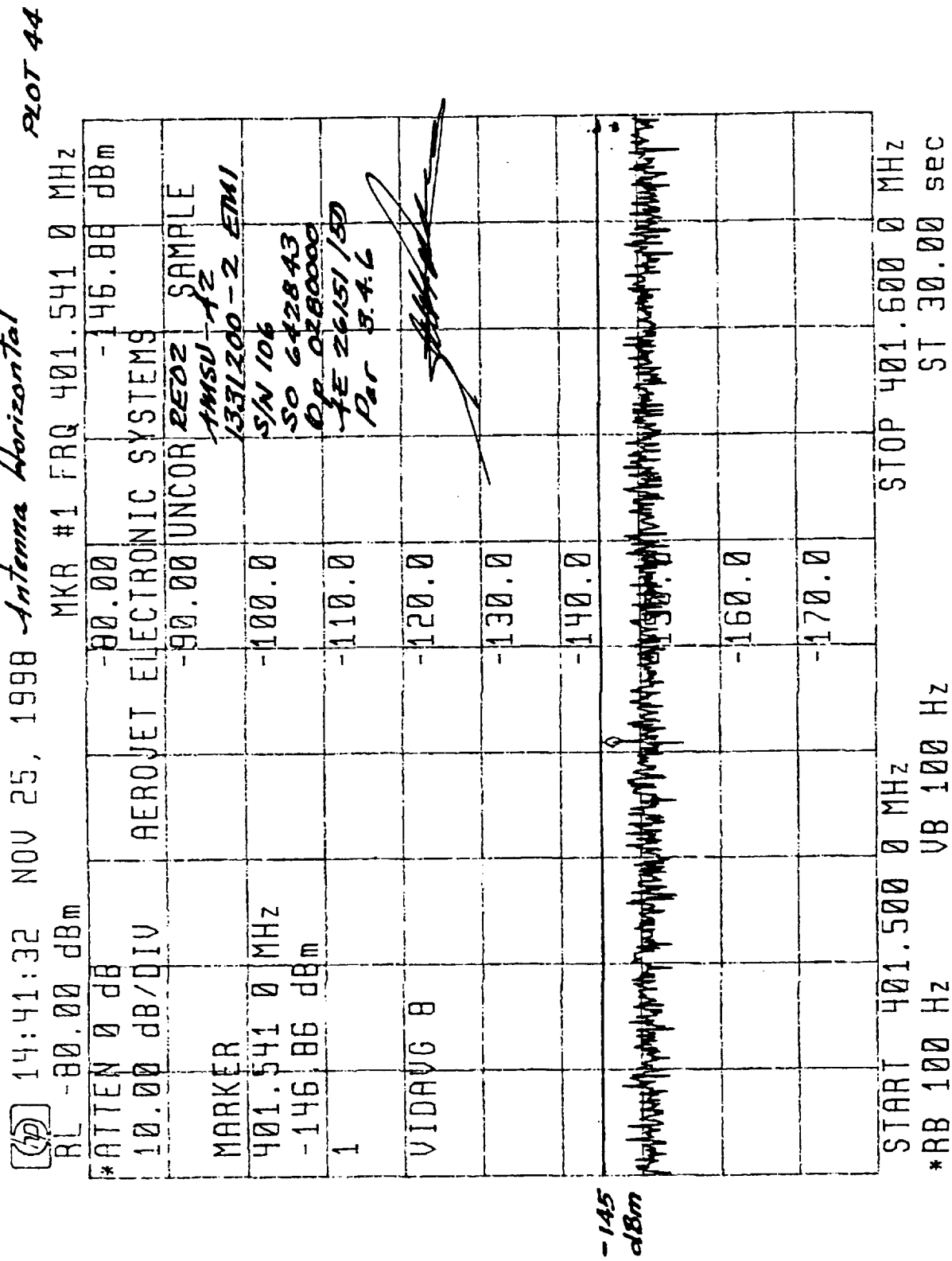

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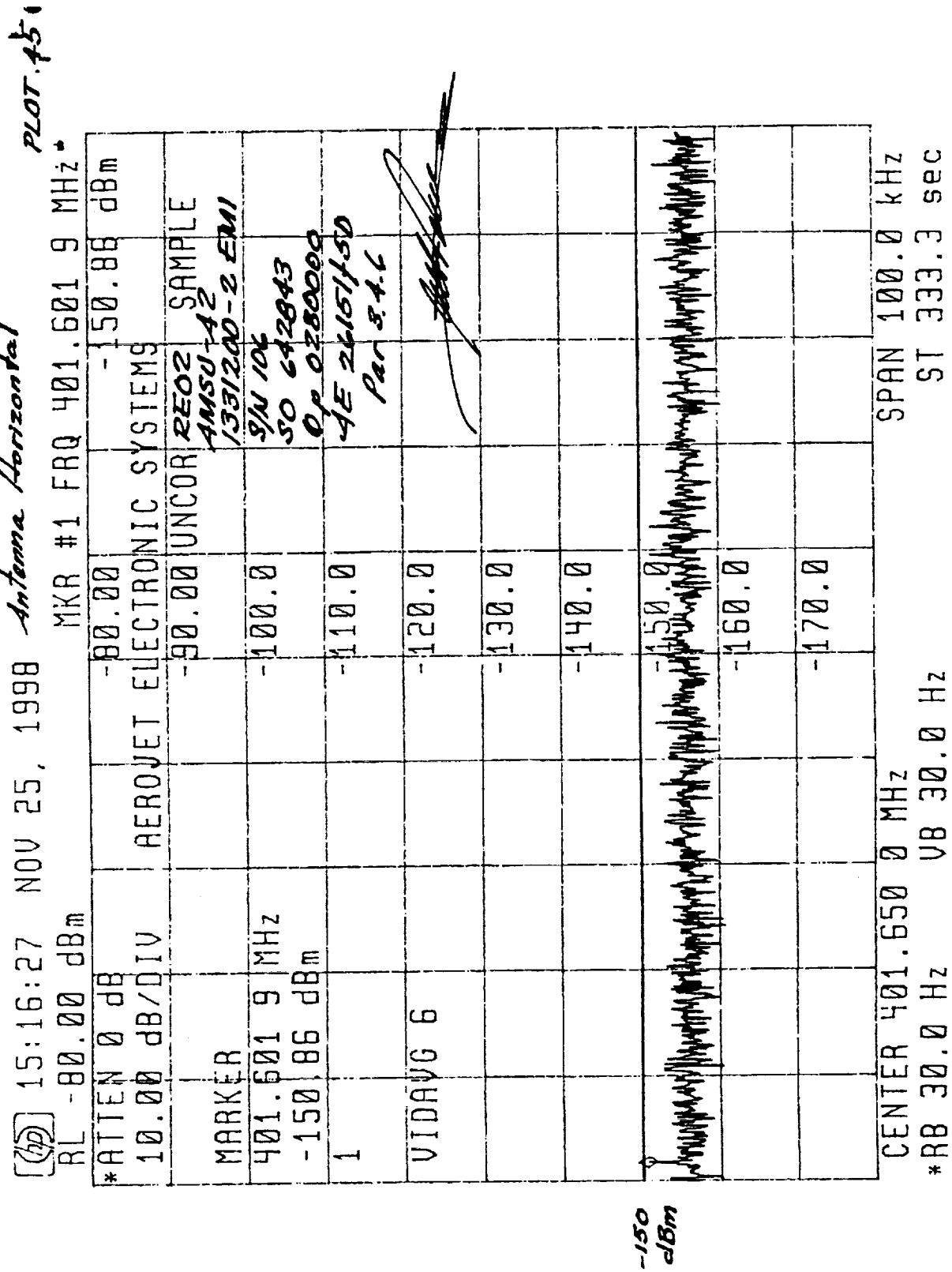

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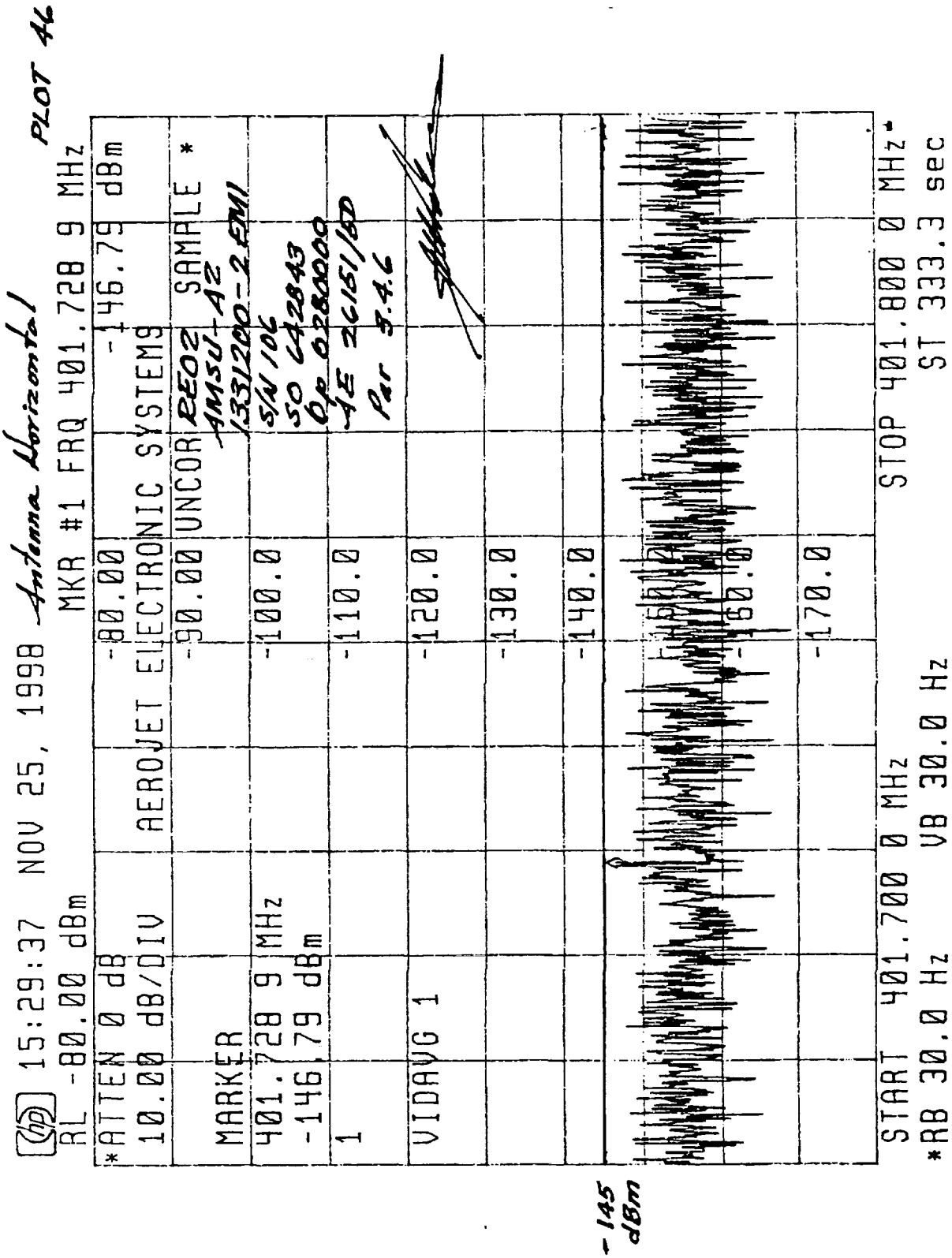

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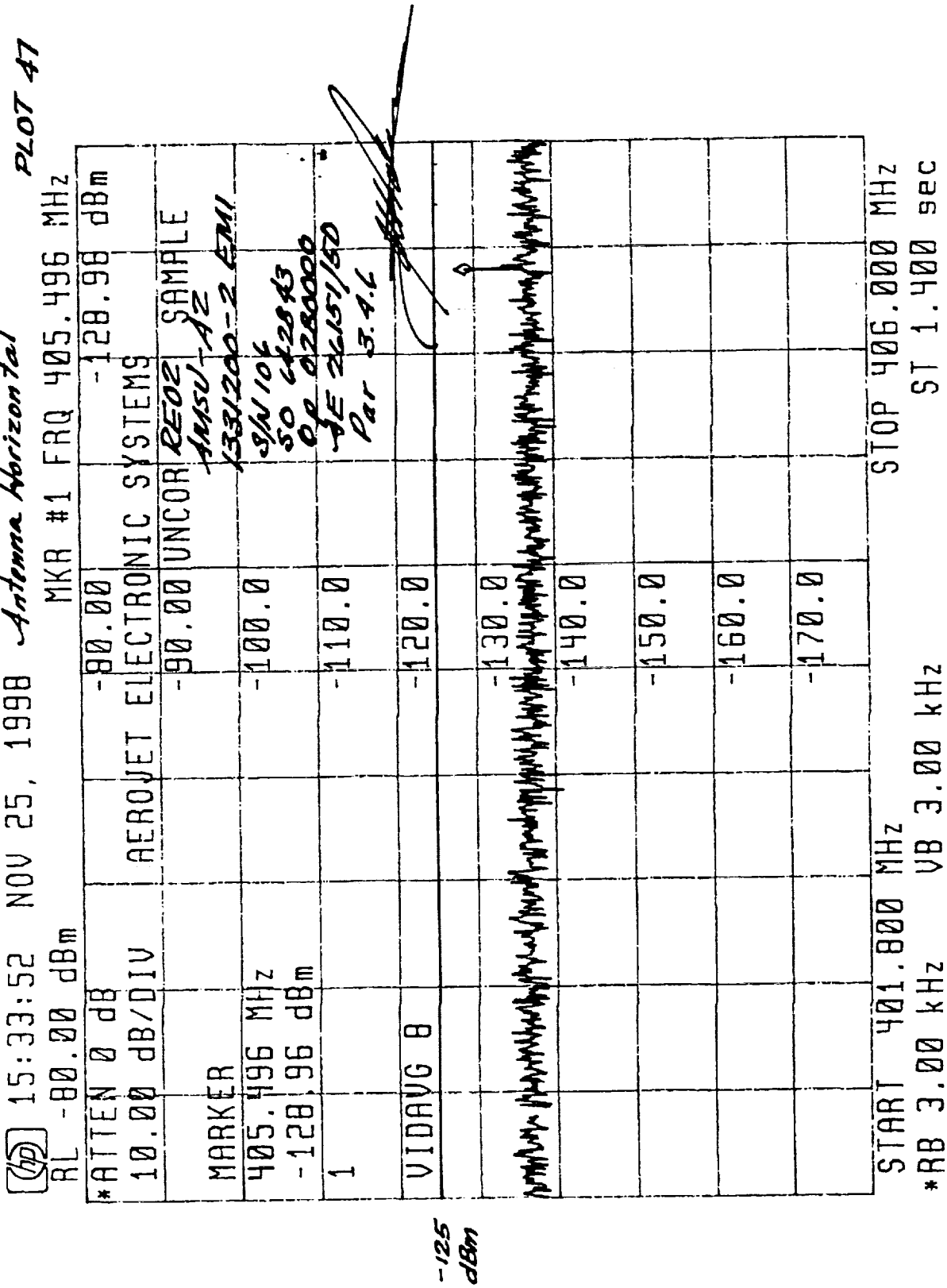

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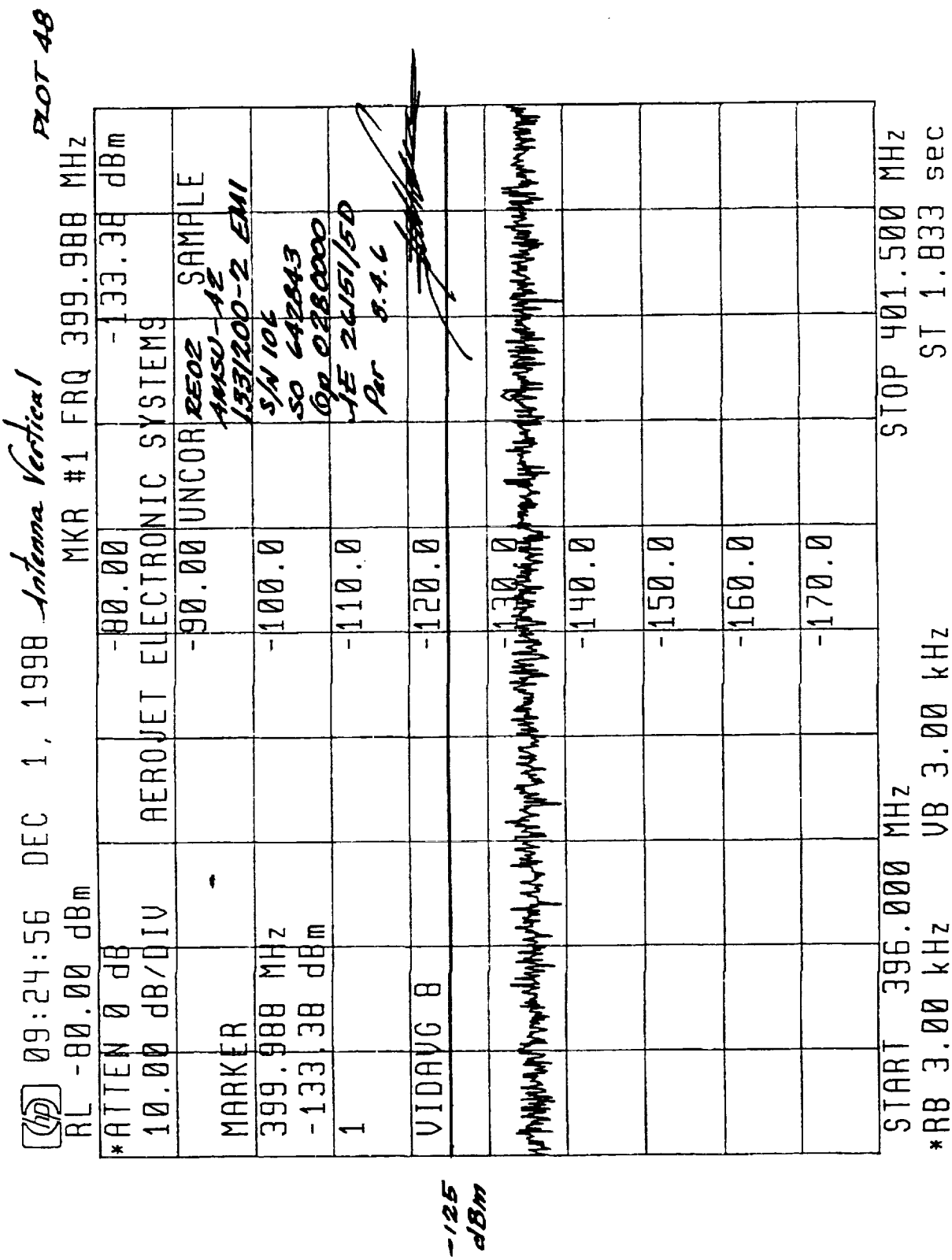

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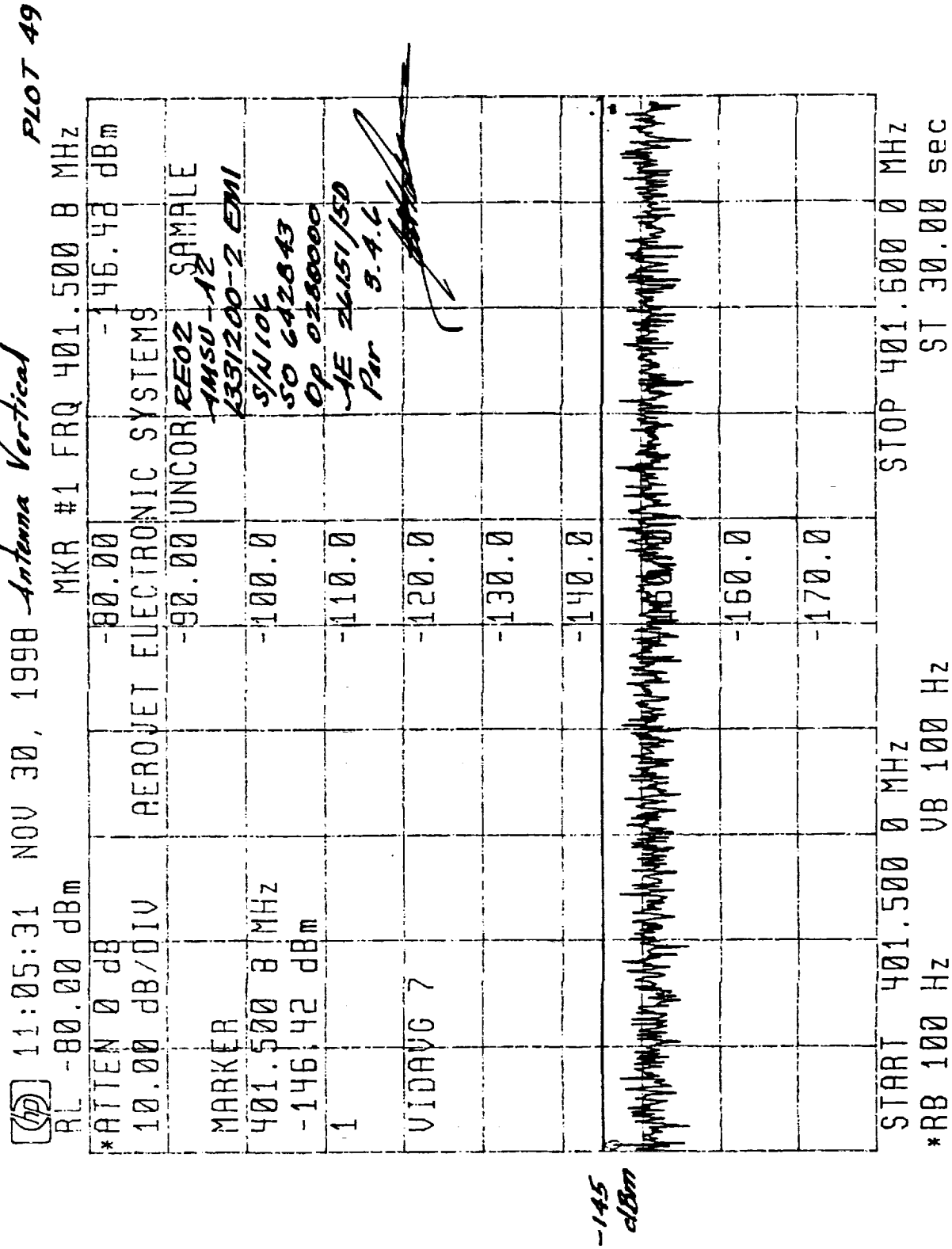

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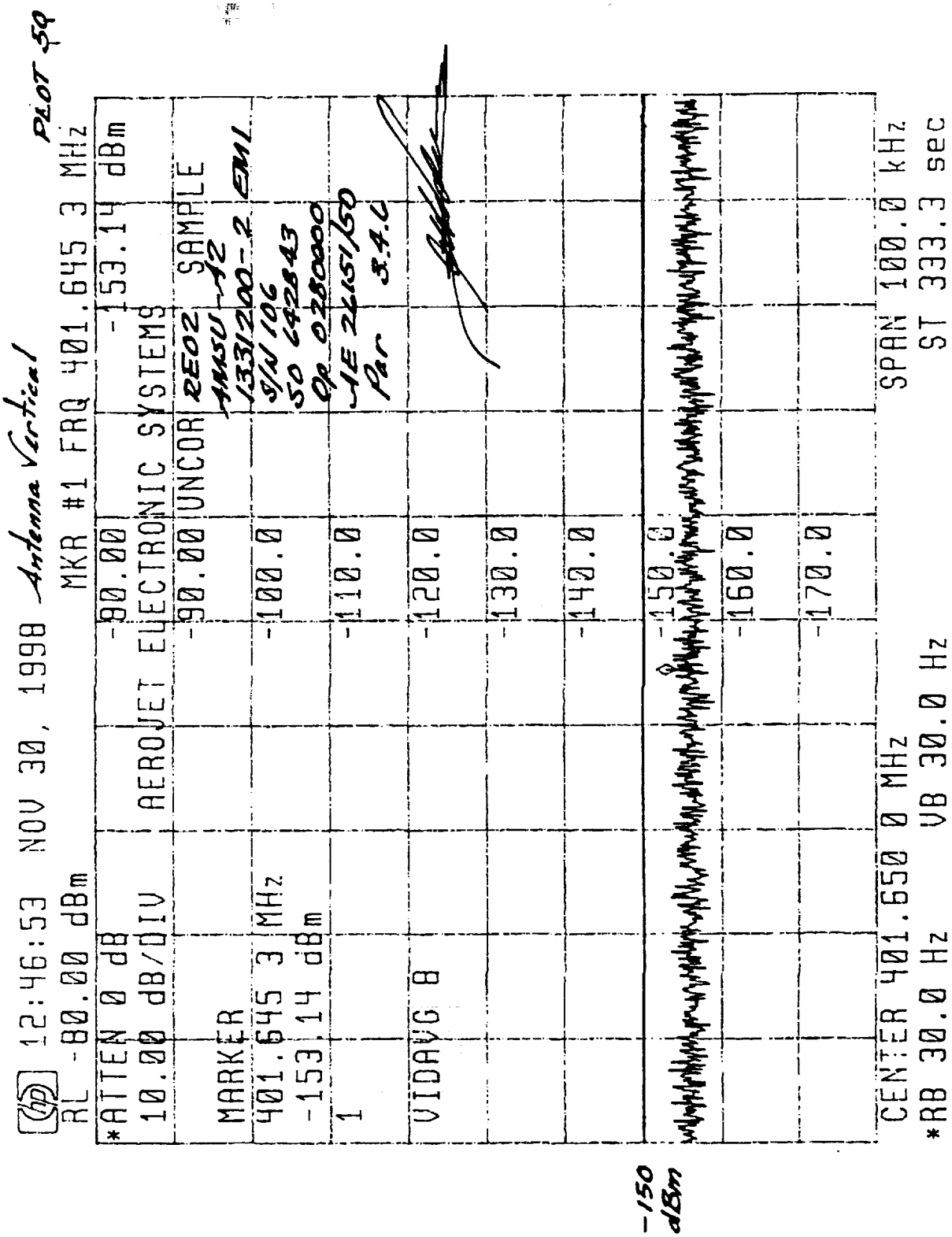

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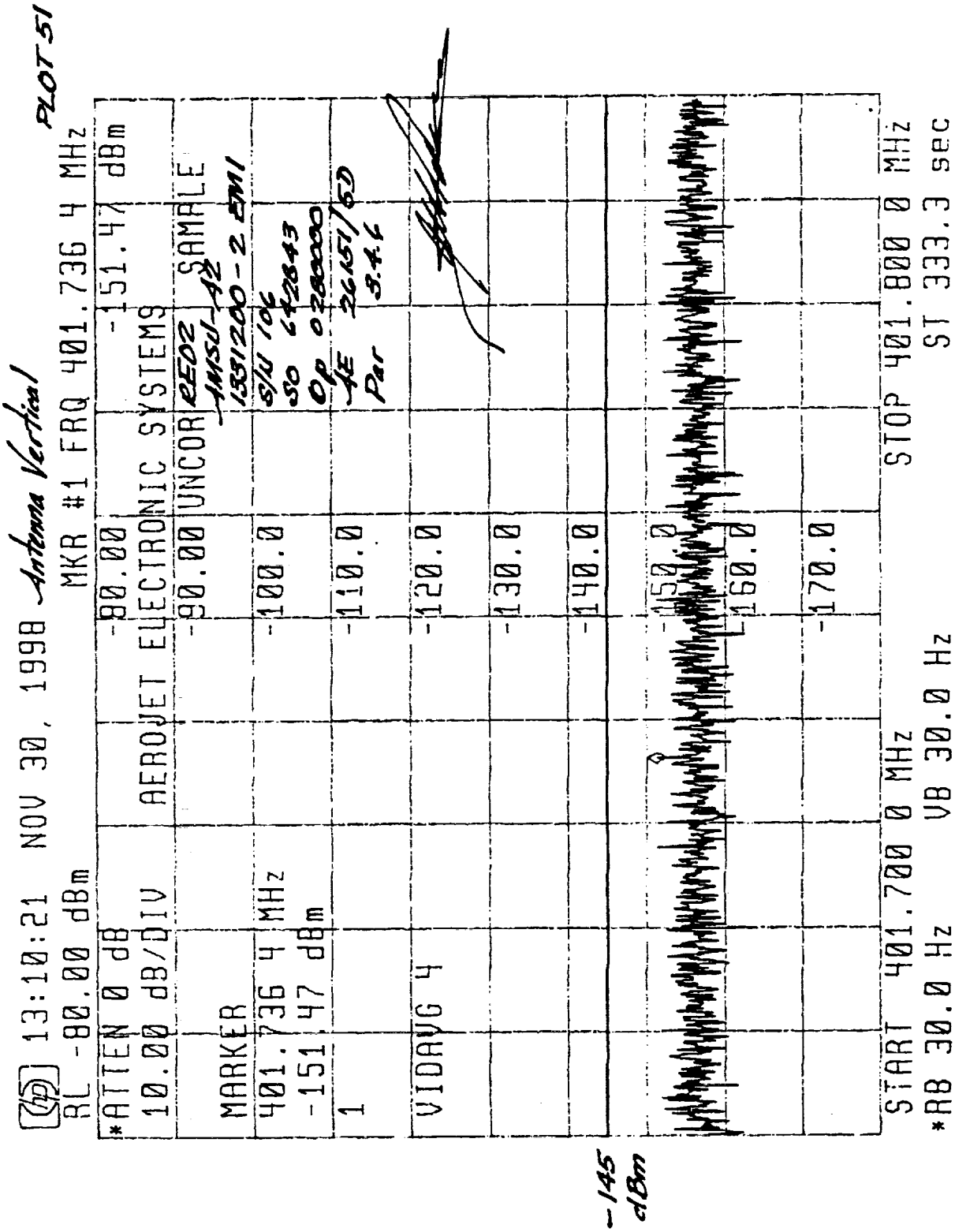

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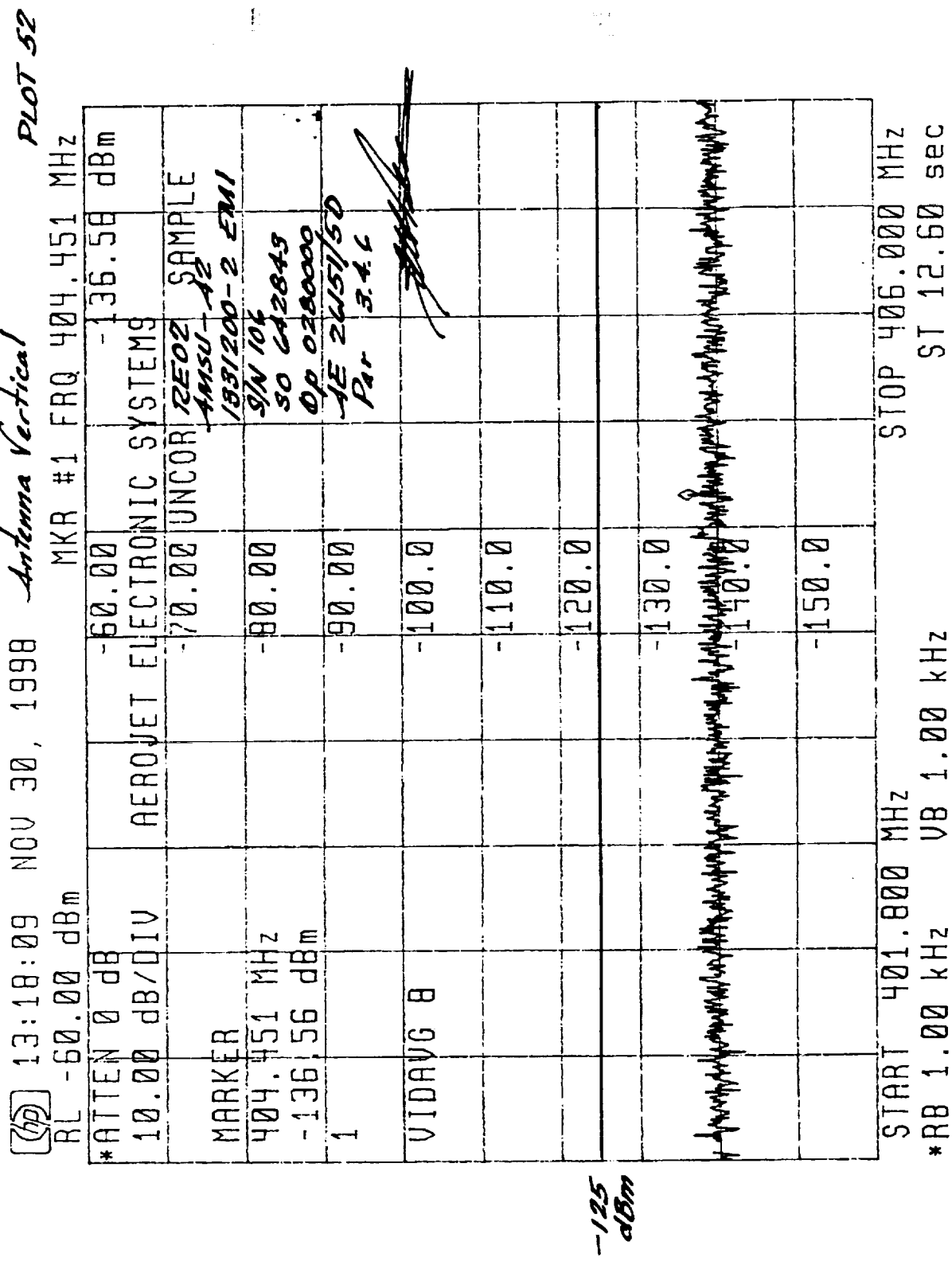

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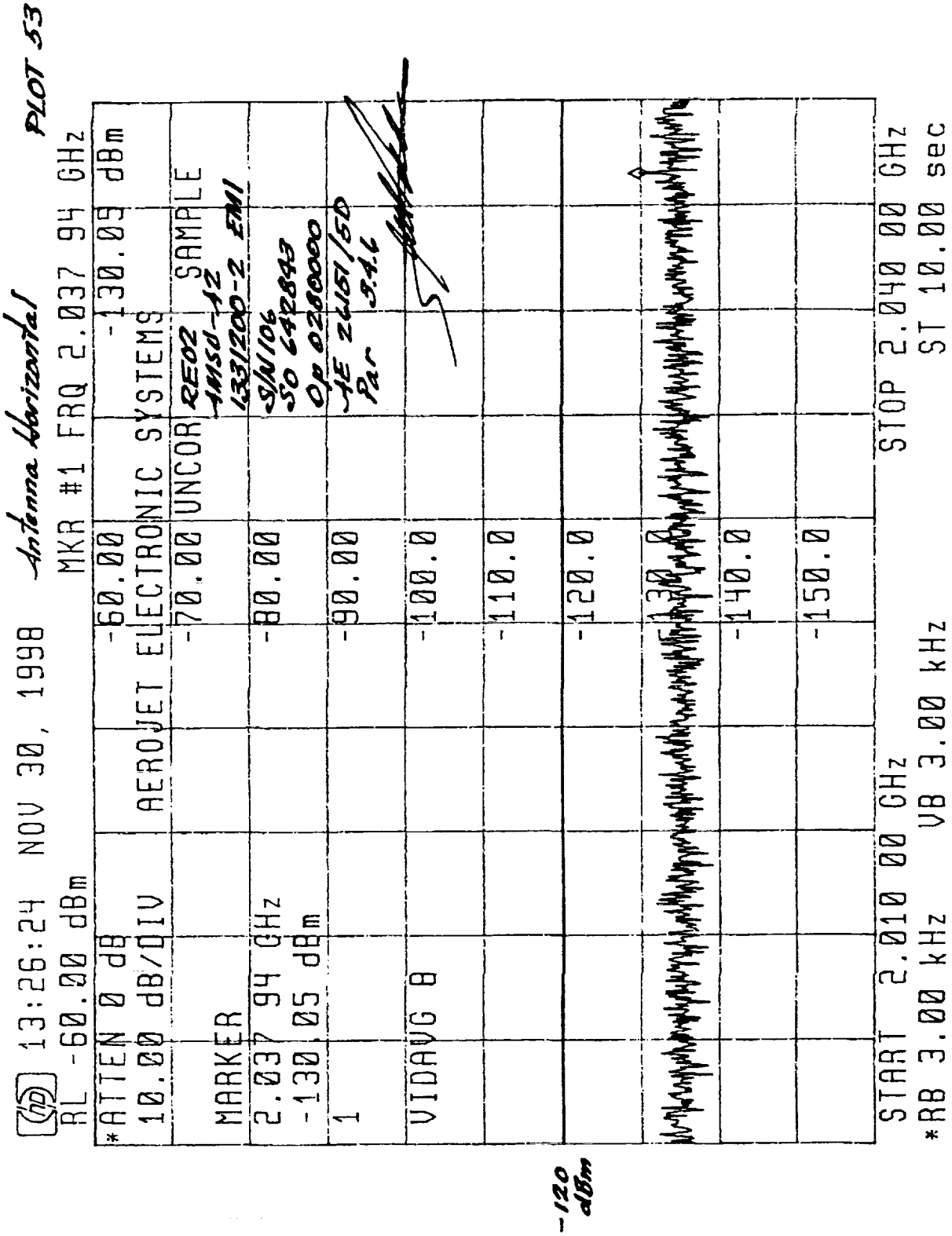

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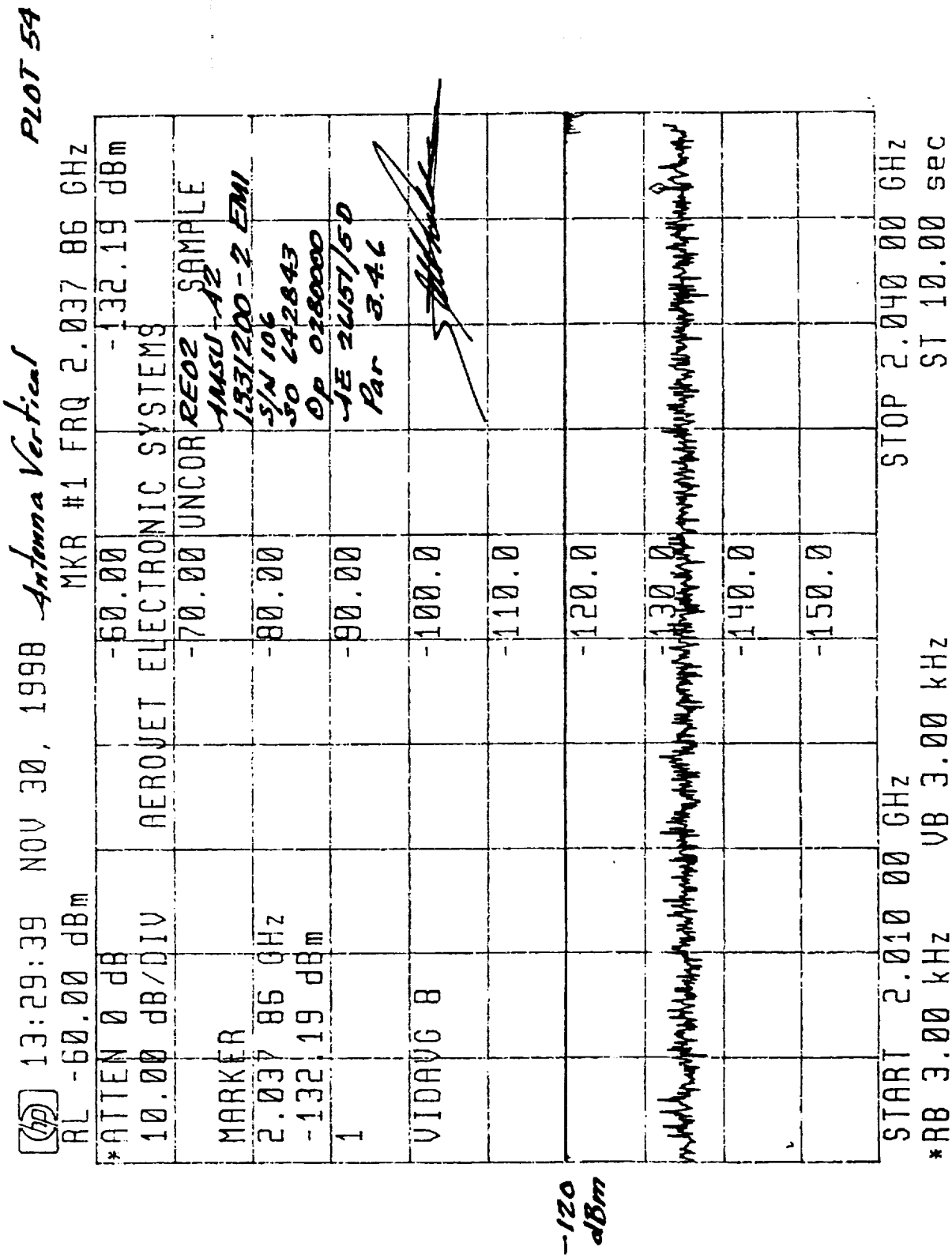

Figure 55. Plot 54

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Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
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4. Title and Subtitle	5. Report Date
Integrated Advanced Microwave Sounding Unit-A (AMSU-A), Engineering Test Report	22 February 1999
	6. Performing Organization Code: ---
7. Author(s): A. Valdez	8. Performing Organization Report No: 11382
	10. Work Unit No.: ---
9. Performing Organization Name and Address: Aerojet, 1100 W. Hollyvale, Azusa, CA 91702	11. Contract or Grant No.: NAS 5-32314
12. Sponsoring Agency Name and Address: NASA, Goddard Space Flight Center, Greenbelt, Maryland 20771	13. Type of Report and Period Covered: Final
	14. Sponsoring Agency Code: ---

15. Supplementary Notes: ---

16. ABSTRACT (*Maximum 200 words*)

This is the Engineering Test Report, SARR, SARP, DCS Receivers, Link Frequencies EMI Sensitive Band Test Results, AMSU-A2, S/N 107, for the Integrated Advanced Microwave Sounding Unit-A (AMSU-A).

17. Key Words (Suggested by Author(s))	18. Distribution Statement
EOS Microwave System	Unclassified --- Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified		---

NASA FORM 1626 OCT 86

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Block 10. Work Unit No. Provide Research and Technology Objectives and Plants (RTOP) number.

Block 11. Contract or Grant No. Provide when applicable.

Block 12. Sponsoring Agency Name and Address. National Aeronautics and Space Administration, Washington, D.C. 20546-0001. If contractor report, add NASA installation or HQ program office.

Block 13. Type of Report and Period Covered. NASA formal report series; for Contractor Report also list type (interim, final) and period covered when applicable.

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REPORT DOCUMENTATION PAGE

Form Approved
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1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
February 1999

3. REPORT TYPE AND DATES COVERED
Contractor Report

4. TITLE AND SUBTITLE
Integrated Advanced Microwave Sounding Unit–A (AMSU-A) Engineering Test Report

5. FUNDING NUMBERS
NAS5-32314

6. AUTHOR(S)
A. Valdez

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS (ES)
Aerojet
1100 W. Hollyvale
Azusa, CA 91702

8. PEFORMING ORGANIZATION REPORT NUMBER
11382
February 1999

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS (ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
NASA/CR-1999-209502

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unclassified–Unlimited
Subject Category:19
Report available from the NASA Center for AeroSpace Information,
7121 Standard Drive, Hanover, MD 21076-1320. (301) 621-0390.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

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14. SUBJECT TERMS
EOS, Microwave System

15. NUMBER OF PAGES
63

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL