FCC MEASUREMENT AND TECHNICAL REPORT ON THE AUTOMATIC POWER INCORPORATED PHALCON–2000 RADAR BEACON

Southwest Research Institute
6220 Culebra Road
San Antonio, Texas 78228-0510

Project 10-02192-202
Report Number EMCR 99/129

Prepared for:

Automatic Power, Inc.
213 Hutcheson Street
Houston, TX 77003

Prepared by:
David A. Carmony

November 1999

The results of this test report apply only to the specific samples tested. If the manufacturer extends the test results to apply to other samples of the same model, or from the same lot or batch, the manufacturer should ensure the additional samples are manufactured using identical electrical and mechanical components.

Reviewed by:

Ismael Martinez, Jr.
Sr. Engineering Technologist
Electromagnetic Compatibility Research Section

Approved:

James J. Polonis
Manager
Electromagnetic Compatibility Research Section

TABLE OF CONTENTS

Page

List of Tables 4

1.0 General Information 5

1.1 Product Description 5
1.2 Related Grants 5
1.3 Tested System Details 5
1.4 Test Methodology 6
1.5 Test Facility 6

2.0 Applicable Documents 7

2.1 FCC ID Label 7
2.2 Location of Label on EUT 7

3.0 System Test Configuration 8

3.1 Justification 8
3.2 EUT Exercise 8
3.3 Special Accessories 8
3.4 Equipment Modification 8
3.5 Configuration of Tested System 8

4.0 EMC Tests 9

4.1 Power Output 9
4.1.1 Test Procedures 9
4.1.2 Test Results 9
4.2 Occupied Bandwidth 9
4.2.1 Test Procedures 9
4.2.2 Test Results 10
4.3 Spurious Emissions at Antenna Terminals 10
4.3.1 Test Procedures 10
4.3.2 Test Results 10
4.4 Field Strength of Spurious Radiation 11
4.4.1 Test Procedures 11
4.4.2 Test Results 11
4.5 Frequency Stability 11
4.5.1 Test Procedures 11
4.5.2 Test Results 11

APPENDIX

A: RF Power Output 12
B: Occupied Bandwidth 15
C: Spurious Emissions at Antenna Terminals..... 24
D: Field Strength of Spurious Radiation..... 39
E: Frequency Stability 63

Attachment 1: Technical Description and Block Diagram
Attachment 2: Schematics
Attachment 3: Installation Guide
Attachment 4: Photographs of Tested EUT

LIST OF TABLES

Table		Page
1.1	Phalcon-2000 Components	5
1.2	List of EMC Tests Performed	6
4.1	Power Output Test Results	9
4.2	Occupied Bandwidth Measurements	10

1.0 GENERAL INFORMATION

1.1 Product Description

The equipment under test (EUT) was an Automatic Power Model Phalcon-2000 Radar Beacon (RACON). The Phalcon-2000 is a radar transponder that responds to marine radar interrogation in either X-Band (9300-9500 MHz) and S-Band (2900-3100) by transmitting a coded signal that is shown as a definable "paint" on the interrogating radar display. The Phalcon-2000 can be mounted on lighthouses, buoys, bridges, offshore platforms, breakwaters, and other structures that need to be identified as an aid to navigation. Attachment 1 contains a detailed technical description of the Phalcon-2000 Radar Beacon. The tests described in this document were performed on the Phalcon-2000 Radar Beacon to determine compliance to FCC CFR 47 Part 2 and Part 80 (80.213, h) rules.

1.2 Related Grants

There are no related grants.

1.3 Tested System Details

The Automatic Power Model Phalcon-2000 RACON tested was serial number 104. The Phalcon-2000 was operated from 12 Vdc during testing. The operating voltage was input via a 6-pin circular connector. A 9-pin circular connector provides access for an external terminal (e.g., laptop) for setting response code, service period, sensitivity, and other parameters. An external modem may also be connected to the 9-pin circular connector for remote setting of performance parameters and control. Power and data cables were provided to access the 6-pin and 9-pin connectors. The 12 Vdc was supplied by an external power supply or battery during testing, which was not provided by Automatic Power.

The Model Phalcon-2000 equipment description, functionality, and block diagrams are provided in Attachment 1. Schematic diagrams of the Model Phalcon-2000 are provided in Attachment 2. Attachment 3 contains the Phalcon-2000 Installation Guide.

Testing was performed for both the X-Band (9300-9500 MHz) and S-Band (2900-3100) of the Model Phalcon-2000. Table 1.1 lists the components of the Phalcon-2000.

TABLE 1.1
PHALCON-2000 COMPONENTS

Component Description	Model No.	Serial Number
Automatic Power Radar Beacon	Phalcon-2000	104
Power Cable; length: 8 ft.; 6-pin circular connector on one end	Carol C-1206	none
Data Cable; length: 9 ft.; 9-pin circular connector on one end; 9-pin "D' (modem) and 25-pin "D" (RS-232) on other end	Carol C-3610	none

1.4 Test Methodology

Testing was performed by the Electromagnetic Compatibility Research (EMCR) Section at Southwest Research Institute (SwRI) from October 20 to November 10, 1999. Test requirements were taken from FCC CFR 47 Part 2 and Part 80 (80.213, h). Table 1.2 lists the specific tests performed.

TABLE 1.2
LIST OF EMC TESTS PERFORMED

FCC Test Requirement	Code of Federal Regulations, Title 47, Paragraph
RF Power Output	2.1046
Occupied Bandwidth	2.1049
Spurious Emissions at Antenna Terminals	2.1051
Field Strength of Spurious Radiation	2.1053
Frequency Stability	2.1055

1.5 Test Facility

The Open Area Test Site (OATS) used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning these test sites are found in the report entitled, "Description of Measurement Facility," dated 28 April 1997, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 12, 1997, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

2.0 APPLICABLE DOCUMENTS

2.1 FCC ID Label

The FCC ID label for the Automatic Power Model Phalcon-2000 Radar Beacon is shown in Attachment 3.

2.2 Location of Label on EUT

The location of the label is shown in Attachment 3.

3.0 SYSTEM TEST CONFIGURATION

3.1 Justification

FCC Part 2 and Part 80 tests were performed in either a shielded anechoic chamber, on the open area test site, or on a test bench. Tests performed were for power output, modulation characteristics, occupied bandwidth, spurious emissions at antenna terminals, field strength of spurious radiation, and frequency stability. Frequency stability temperature tests were performed in a temperature chamber.

3.2 EUT Exercise

The Automatic Power Model Phalcon-2000 Radar Beacon was powered by an external 12 Vdc supply or battery, (not supplied with the RACON). During testing, a simulated radar signal was transmitted at the Phalcon-2000 to induce a response signal.

3.3 Special Accessories

No special accessories are required.

3.4 Equipment Modification

No equipment modifications were made during testing.

3.5 Configuration of Tested System

Refer to Appendix A through F for photographs of the EUT test configuration.

4.0 EMC TESTS

4.1 Power Output

4.1.1 Test Procedures

RF power output was measured on both the S and X bands of the Phalcon-2000 to determine compliance with FCC Title 47, Chapter I, Part 2, Section 2.1046. The RF output power was measured at a low, middle, and high frequency across the S band and the X band. The output power was measured at the antenna terminals using a 30-dB attenuator and a spectrum analyzer.

The output of the Phalcon-2000 is a pulsed signal whose width is dependent upon the radar signal that triggers the unit. The maximum pulse width and response rate the Phalcon-2000 is capable of producing was used to determine the maximum on time for the pulsed signal over a 100 ms period. The Phalcon-2000 maximum pulse width of 48 μs and maximum response rate of 100 μs results in a maximum on time of 48 ms over a 100 ms time period. Therefore, the average factor would be as follows:

$$20 \log (48/100) \text{ dB} = -6.4 \text{ dB}$$

The average factor was applied to the measured RF output levels from the Phalcon-2000.

4.1.2 Test Results

The measured levels of the RF output power from the Phalcon-2000 at the antenna terminals are shown in Table 4.1. The calculated average factor was applied to each level. Refer to Appendix A for test setup photos and a test equipment list.

Table 4.1
Power Output Test Results

Band	Frequency (MHz)	Peak Power		Power with average factor applied	
		dBm	Power	dBm	Power
S	2905	+27	501 mW	+20.6	115 mW
	3000	+28	631 mW	+21.6	145 mW
	3095	+27.1	513 mW	+20.7	117 mW
X	9305	+28.3	676 mW	+21.9	155 mW
	9400	+29.7	933 mW	+23.3	214 mW
	9495	+28.5	708 mW	+22.1	162 mW

4.2 Occupied Bandwidth

4.2.1 Test Procedures

Occupied Bandwidth was measured both the S and X bands of the Phalcon-2000 to determine compliance with FCC Title 47, Chapter I, Part 2, Section 2.1049. The occupied bandwidth was measured at the points below its lower and above its upper frequency limit where the power equaled 0.5% of the total power.

4.2.2 Test Results

Measurements of the occupied bandwidth are listed in the table below. See Appendix B for data plots, test setup photos and a test equipment list.

Table 4.2
Occupied Bandwidth Measurements

Band	Frequency	Occupied Bandwidth
S	2910 MHz	16 MHz
	3000 MHz	14 MHz
	3090 MHz	24 MHz
X	9310 MHz	19 MHz
	9400 MHz	17 MHz
	9510 MHz	17 MHz

4.3 Spurious Emissions at Antenna Terminals

4.3.1 Test Procedures

Spurious emissions at the antenna terminals were measured to verify compliance to FCC Title 47, Chapter I, Part 2, Section 2.1051. Tests were performed on both the S band and X band of the Phalcon-2000 over the frequency range of 30 MHz to 22 GHz. A spectrum analyzer was attached to the Phalcon-2000 antenna terminals while a simulated radar signal was transmitting at the Phalcon-2000 to induce a response. The harmonics and spurious emissions were required to be 43 plus 10 log (mean power in watts) dB below the fundamental emission:

Band		Limit
S	43 + 10 log (.145) dB =	34.6 dB (below fundamental)
X	43 + 10 log (.214) dB =	36.3 dB (below fundamental)

4.3.2 Test Results

Testing showed that the spurious emissions at the antenna terminals were below required levels. The worst case emissions was the second harmonic of the 9.4 GHz X band fundamental, which was 37.2 dB below the fundamental frequency. See Appendix C for data plots, test setup photos, and a test equipment list.

4.4 Field Strength of Spurious Radiation

4.4.1 Test Procedures

The field strength of spurious radiation was measured on the Phalco-2000 to verify compliance to FCC Title 47, Chapter I, Part 2, Section 2.1053. Tests were performed in a 3-meter anechoic chamber from 1000 MHz to 40 GHz on both the S band and X band. The Phalcon-2000 was set up in a 3-meter anechoic chamber and triggered by a simulated radar signal generated by a signal generator and antenna. The harmonics and spurious emissions were required to be 43 plus 10 log (mean power in watts) dB below the fundamental emission:

Band		Limit
S	43 + 10 log (.145) dB =	34.6 dB (below fundamental)
X	43 + 10 log (.214) dB =	36.3 dB (below fundamental)

4.4.2 Test Results

The data plots in Appendix D show the field strength of the spurious emissions were below the FCC limits. Both horizontal and vertical S band emissions were at least 10 dB below the limit. Horizontal X band emissions were also at least 10 dB below the limit, with the exception of two frequencies. A signal at 34.99 GHz was measured 6.7 dB under the limit. A signal at 25.93 GHz was measured 0.5 dB under the limit. The X band antenna is horizontally polarized. Vertical scans were also performed on the X band which showed emissions well under the limit. However, the vertical X band data plots are not included in the test report. See Appendix D for data plots, photographs of the test setup, and a test equipment list.

4.5 Frequency Stability

4.5.1 Test Procedures

The frequency stability of the Phalcon-2000 was performed to verify compliance to FCC Title 47, Chapter I, Part 2, Section 2.1055. Tests were performed for frequency stability for both the S and X bands with variations in both temperature and primary supply voltage. Since the Phalcon-2000 normally operates at either 12 Vdc or 24 Vdc, the voltage variation test was performed using both 12 Vdc and 24 Vdc as the nominal supply voltages as specified in Section 2.1055, (d), (1).

During the voltage variation frequency stability test, Phalcon-2000 was initially supplied with 12 Vdc. An S band signal of 2997.7 MHz was transmitted at the Phalcon-2000, and a receive antenna and spectrum analyzer was set to receive and display the response frequency. After the response frequency was recorded, the supply voltage was decreased to 85 % of the nominal 12 Vdc voltage, or 10.2 volts. The response frequency was again recorded, and the supply voltage was increased to 115 % of the nominal 12 Vdc voltage, or 13.8 volts. The response frequency was again recorded. This test was repeated using 24 Vdc as the nominal supply voltage. The test was also performed at an X band frequency of 9400 MHz.

During the temperature variation frequency stability test, the temperature was varied from –20 to +50 degrees Celsius in 10-degree increments. Tests were performed on both the S and X bands.

4.5.2 Test Results

The voltage variation frequency stability test revealed the frequency varied by a maximum of 1.64 MHz on the S band and 600 kHz on the X band. The temperature variation frequency stability test revealed the frequency varied by a maximum of 910 kHz on the S band and 1.08 MHz on the X band. However, some of this variation was due to the input frequency which varied by 170 kHz on the S band and 590 kHz on the X band. See Appendix F for test data, test setup photographs, and a test equipment list.

APPENDIX A

RF POWER OUTPUT

EQUIPMENT USE REPORT

Date:	Oct 21, 1999		
Project #	10-2192-202	**Project Manager**	D. Carmony
Test Location :	Open Area at SE9	**Technician:**	D. Smith

RF Power Output Test Equipment				
Manufacturer	**Description**	**Model No.**	**Serial No.**	**Cal. Due**
HP	Spectrum Analyzer	8566B	2152A0312	12 Feb 00
Narda	30 dB Attenuator	4779-30	8711	Verified
HP	Microwave cable	5061-5458	---	Verified

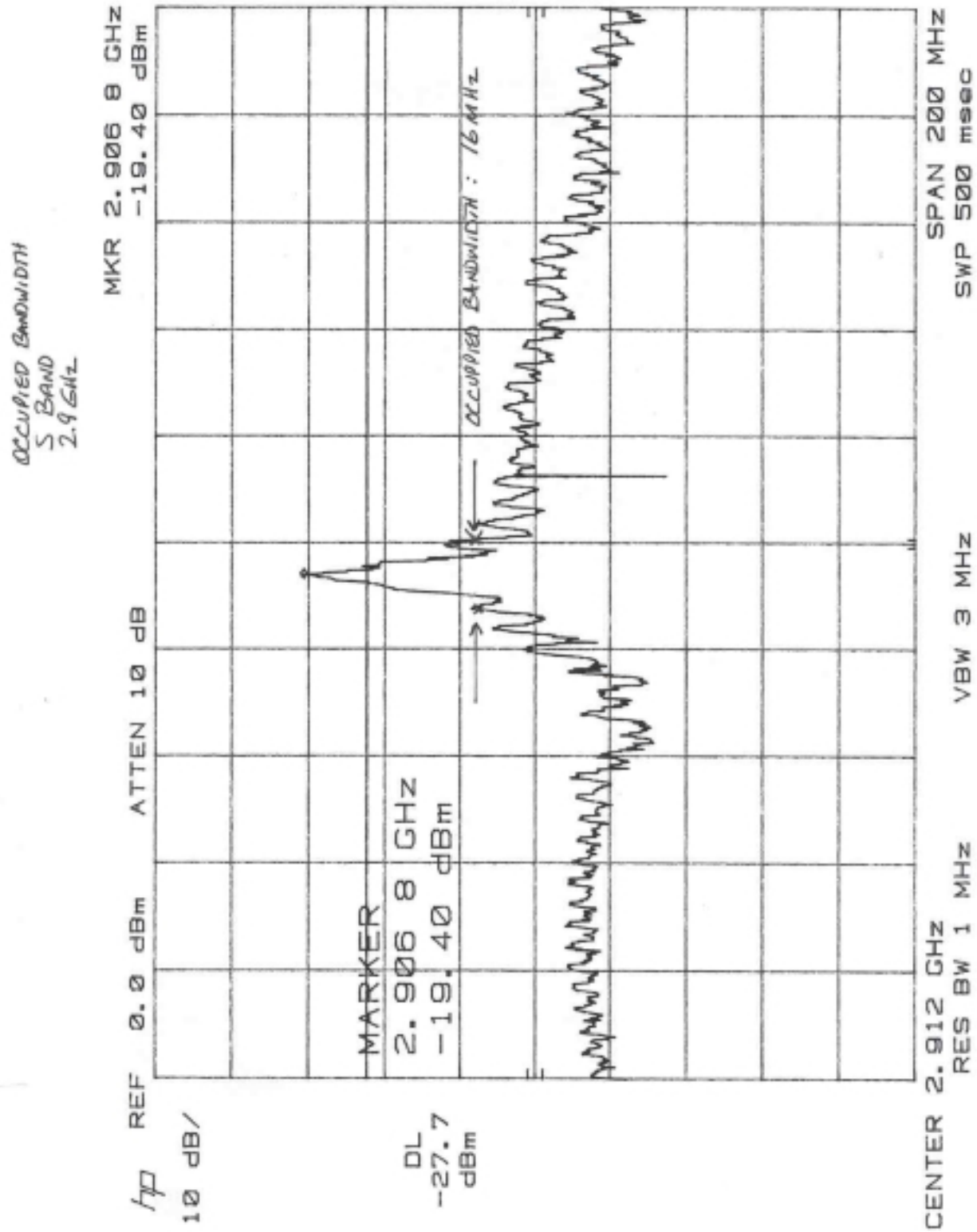
PHOTO DOCUMENTATION WORKSHEET

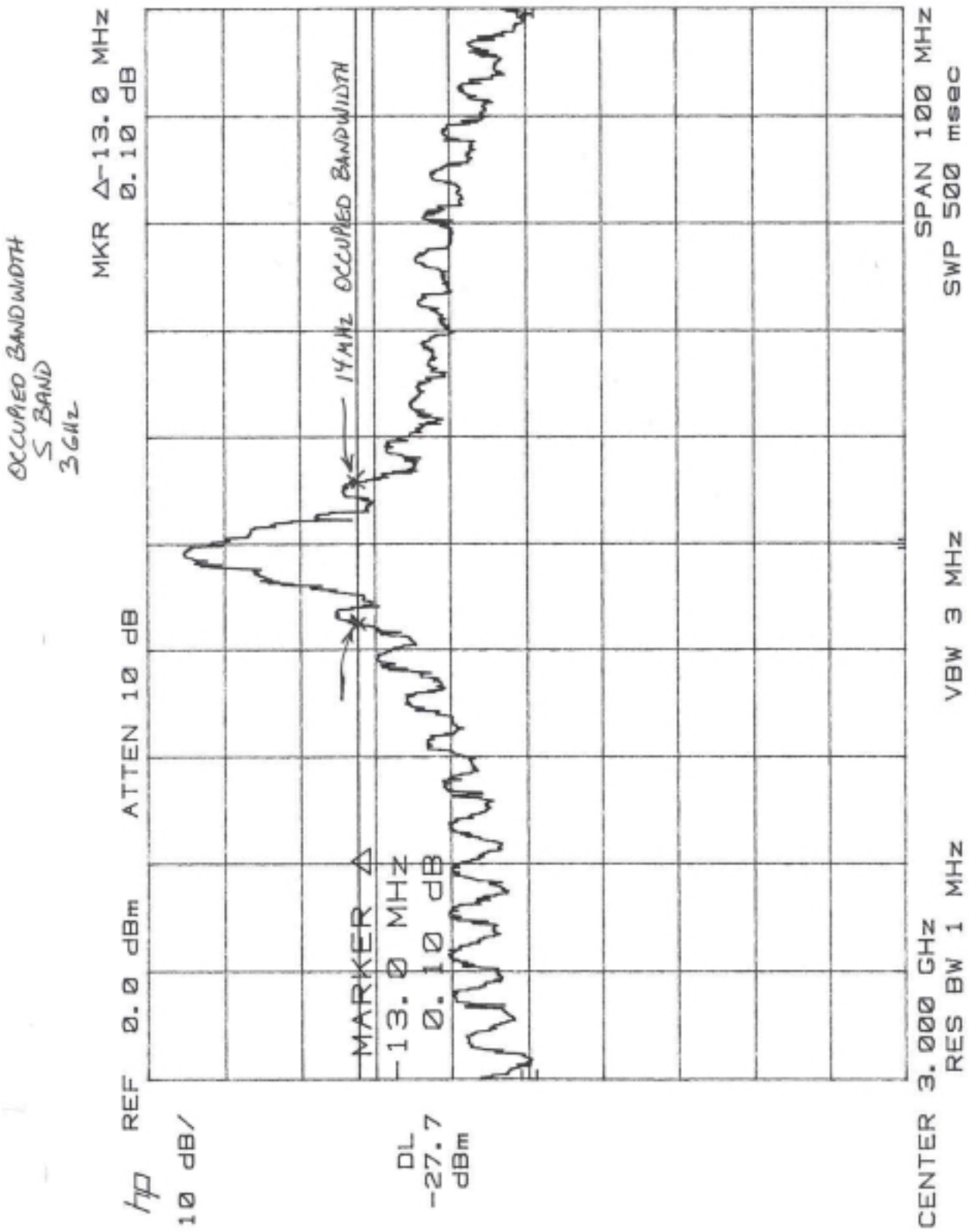
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202

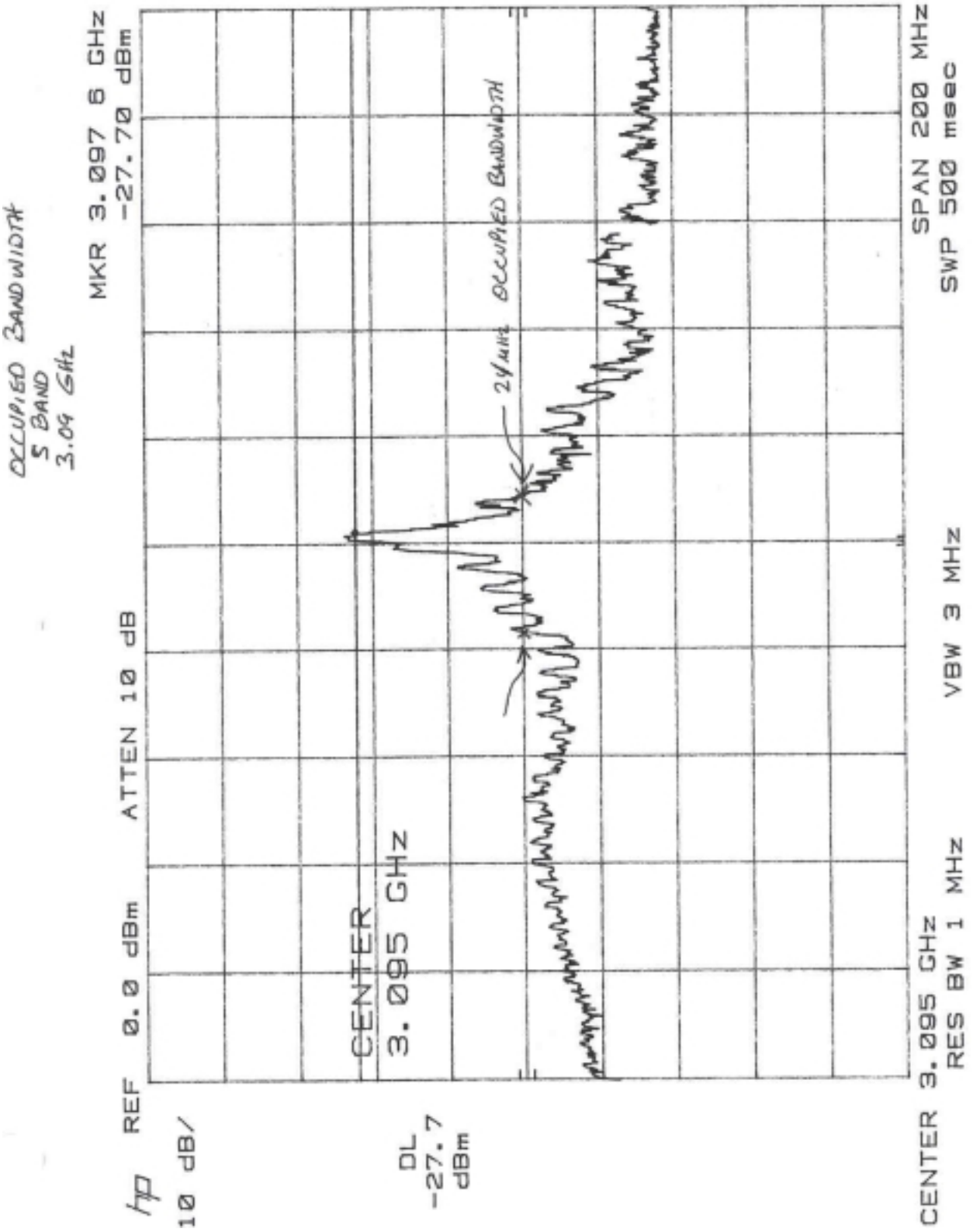
RF POWER OUTPUT MEASUREMENT TEST CONFIGURATION

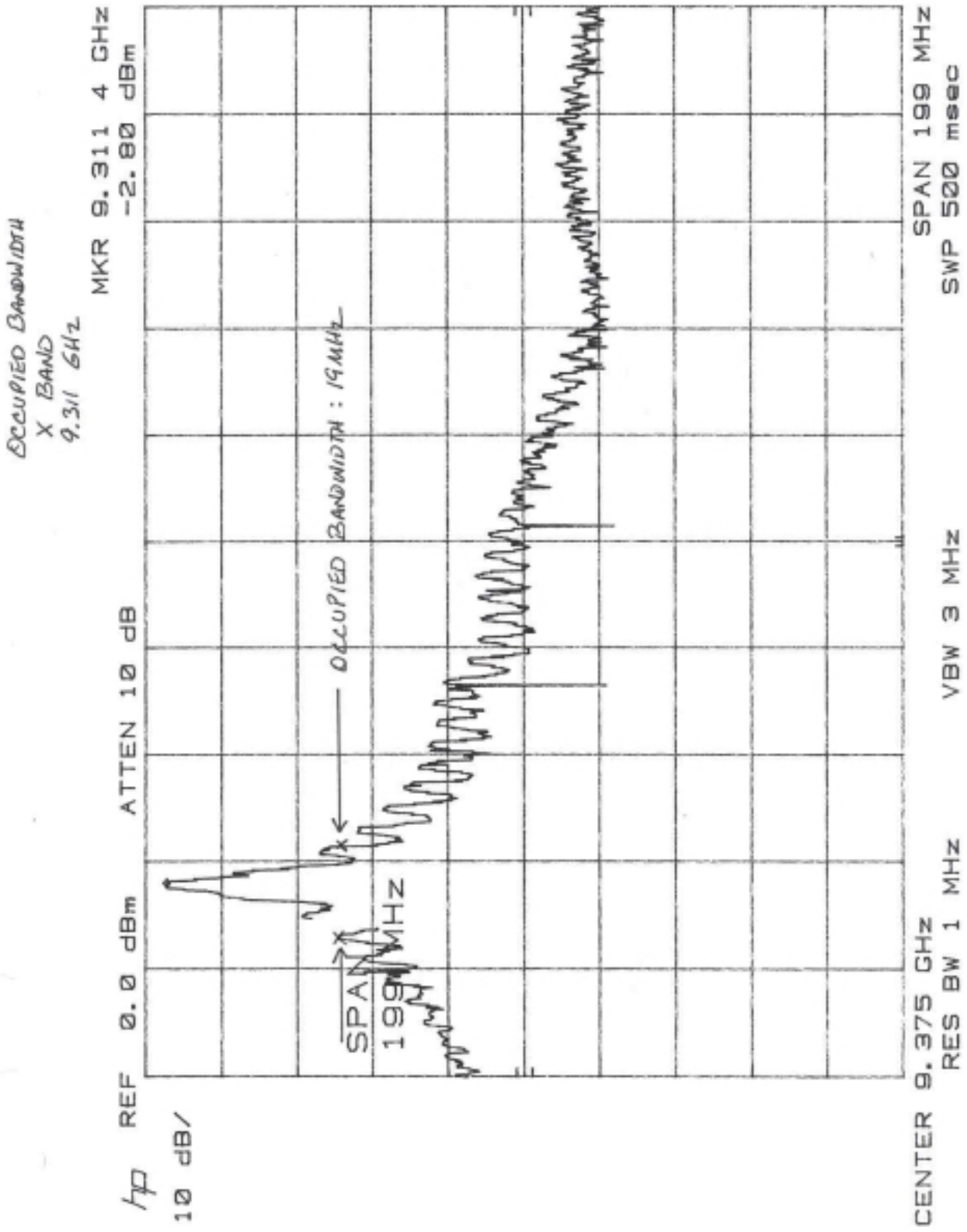
APPENDIX B

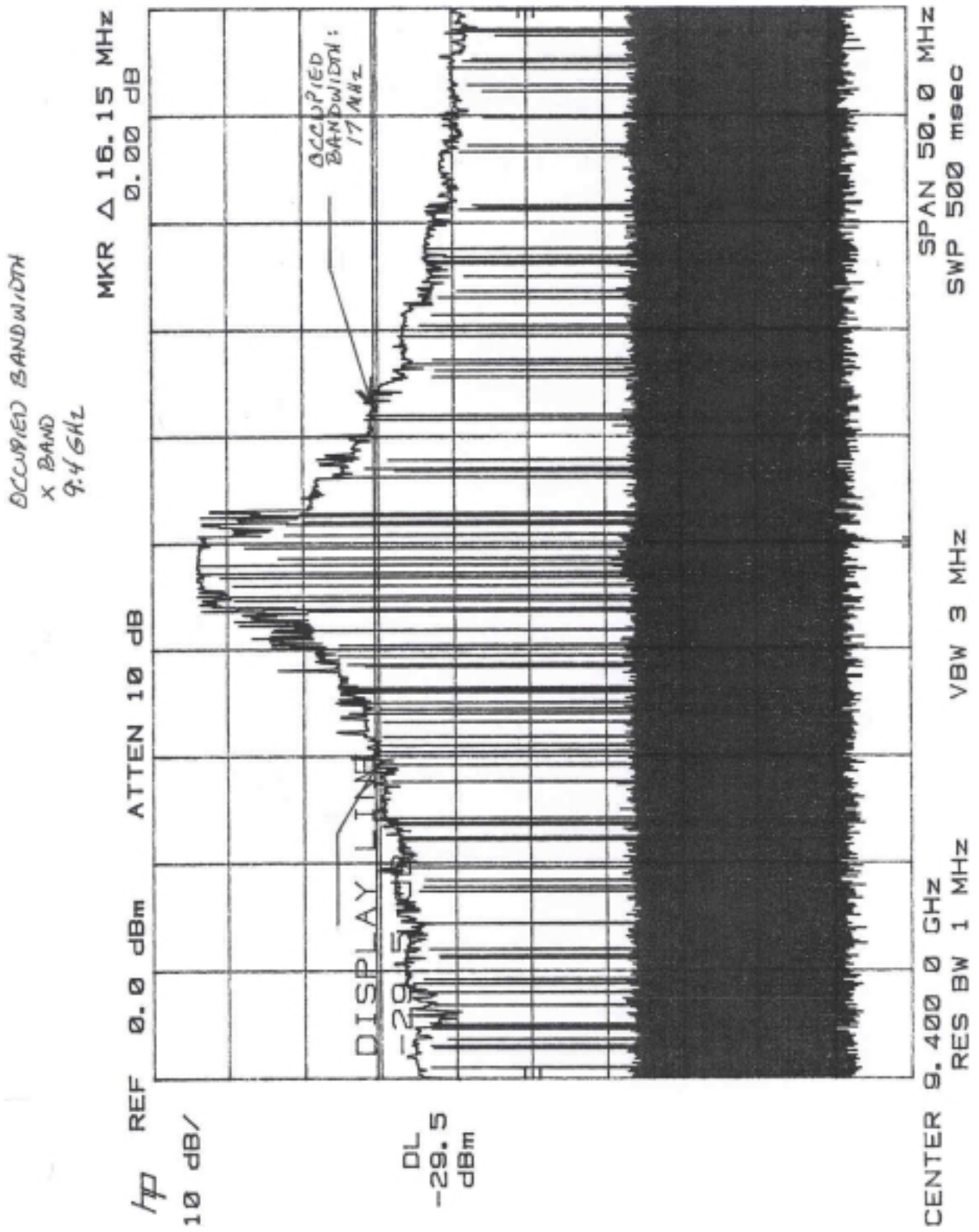
OCCUPIED BANDWIDTH

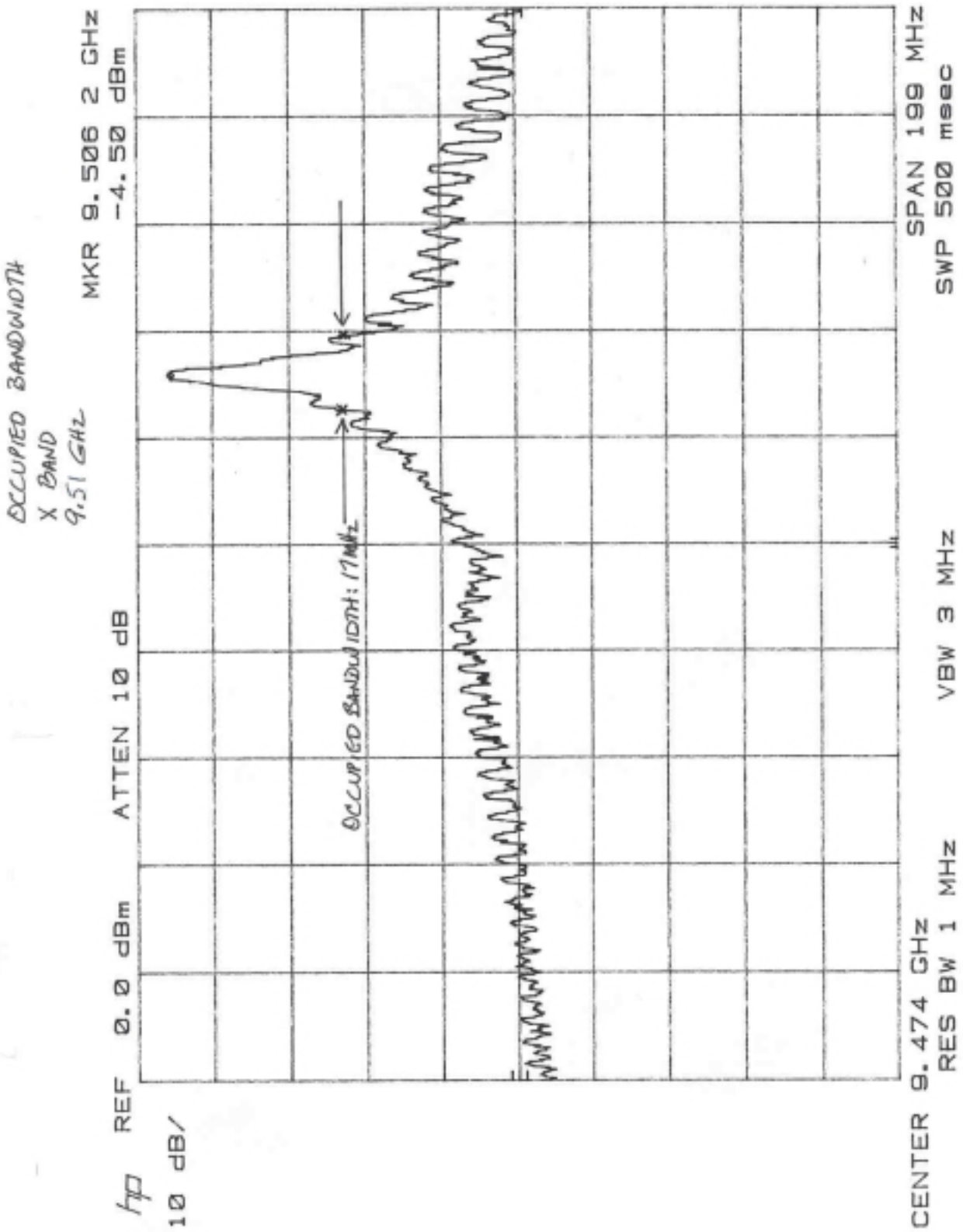

OCCUPIED BANDWIDTH
S BAND
2.9 GHz
MKR 2.906 8 GHz
-19.40 dBm
REF 0.0 dBm
ATTEN 10 dB
10 dB/
DL
-27.7
dBm
MARKER
2.906 8 GHz
-19.40 dBm
OCCUPIED BANDWIDTH : 16 MHz
CENTER 2.912 GHz
RES BW 1 MHz
VBW 3 MHz
SPAN 200 MHz
SWP 500 msec


OCCUPIED BANDWIDTH
≤ BAND
3GHz
MKR Δ-13.0 MHz
0.10 dB
14MHz OCCUPIED BANDWIDTH
REF 0.0 dBm
ATTEN 10 dB
10 dB/
MARKER Δ
-13.0 MHz
0.10 dB
DL
-27.7
dBm
CENTER 3.000 GHz
RES BW 1 MHz
VBW 3 MHz
SPAN 100 MHz
SWP 500 msec


OCCUPIED BANDWIDTH
S BAND
3.09 GHz
MKR 3.097 6 GHz
-27.70 dBm
REF 0.0 dBm
ATTEN 10 dB
10 dB/
DL
-27.7
dBm
CENTER
3.095 GHz
24 kHz OCCUPIED BANDWIDTH
SPAN 200 MHz
SWP 500 msec
CENTER 3.095 GHz
RES BW 1 MHz
VBW 3 MHz


OCCUPIED BANDWIDTH
X BAND
9.311 GHz
MKR 9.311 4 GHz
-2.80 dBm
REF 0.0 dBm
ATTEN 10 dB
10 dB/
OCCUPIED BANDWIDTH : 19 MHz
SPAN 199 MHz
CENTER 9.375 GHz
RES BW 1 MHz
VBW 3 MHz
SPAN 199 MHz
SWP 500 msec


OCCUPIED BANDWIDTH
X BAND
9.4 GHz
MKR Δ 16.15 MHz
0.00 dB
OCCUPIED BANDWIDTH: 17 MHz
DISPLAY LINE
-29.5 dBm
REF 0.0 dBm
ATTEN 10 dB
10 dB/
DL -29.5 dBm
CENTER 9.400 0 GHz
RES BW 1 MHz
VBW 3 MHz
SPAN 50.0 MHz
SWP 500 msec


OCCUPIED BANDWIDTH
X BAND
9.51 GHz
MKR 9.506 2 GHz
-4.50 dBm
REF 0.0 dBm
ATTEN 10 dB
10 dB/
OCCUPIED BANDWIDTH: 1.1 MHz
CENTER 9.474 GHz
RES BW 1 MHz
VBW 3 MHz
SPAN 199 MHz
SWP 500 msec

EQUIPMENT USE REPORT

Date:	October 29, 1999		
Project #	10-2192-202	**Project Manager**	D. Carmony
Test Location :	Area next to SE9	**Technician:**	D.Smith

Occupied Bandwidth Measurement Test Equipment				
Manufacturer	**Description**	**Model No.**	**Serial No.**	**Cal. Due**
HP	Signal Generator	8350A	2120A00685	19 Mar 00
HP	RF Plug In	83592A	2125A00179	19 Mar 00
HP	Spectrum Analyzer	8566B	2152A0312	12 Feb 00
HP	Microwave cable	5061-5458	---	Verified
EMCO	Double Ridge Horn	3115	0501	2 Dec 99
EMCO	Double Ridge Horn	3115	2043	6 Jan 00

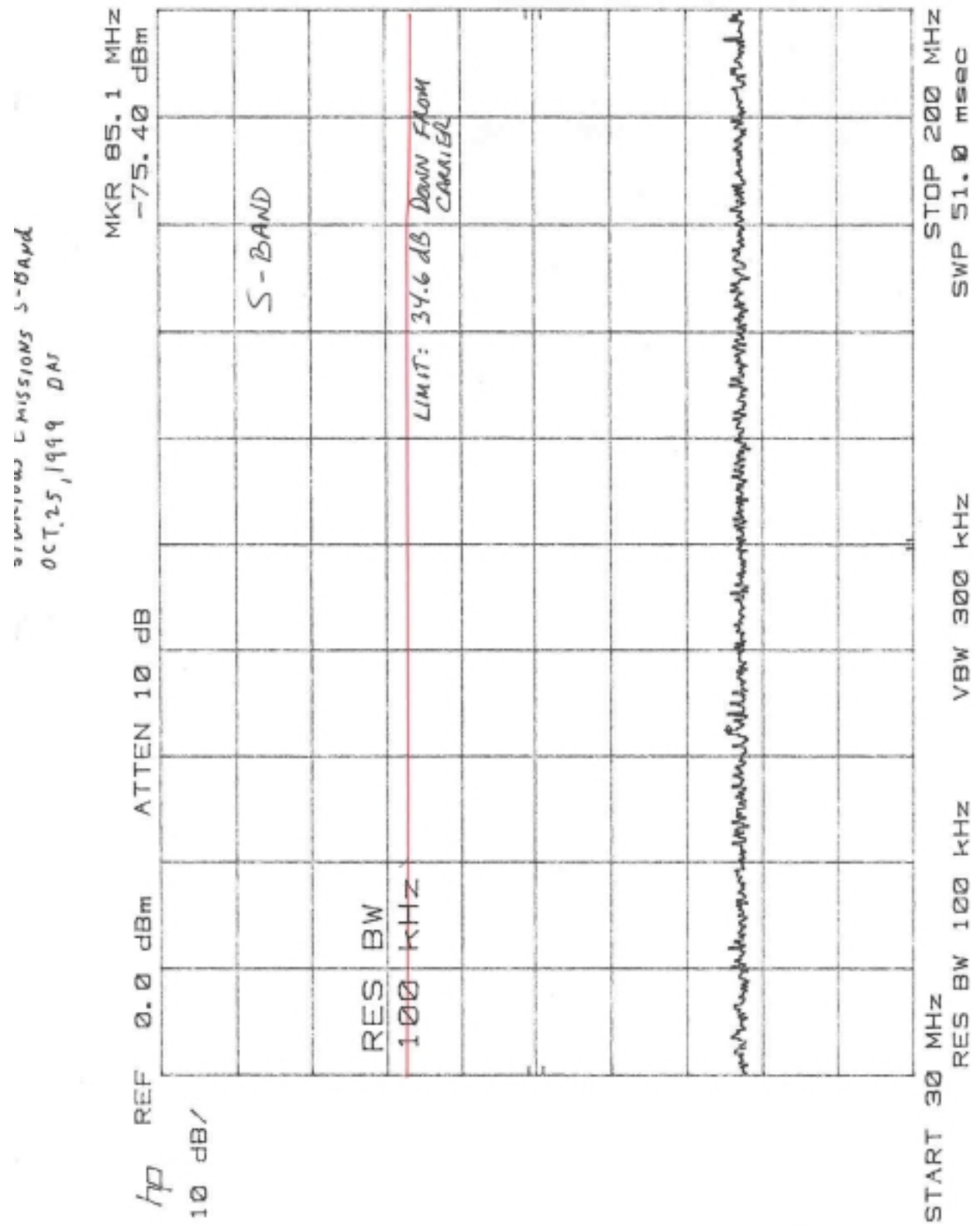
PHOTO DOCUMENTATION WORKSHEET	
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202

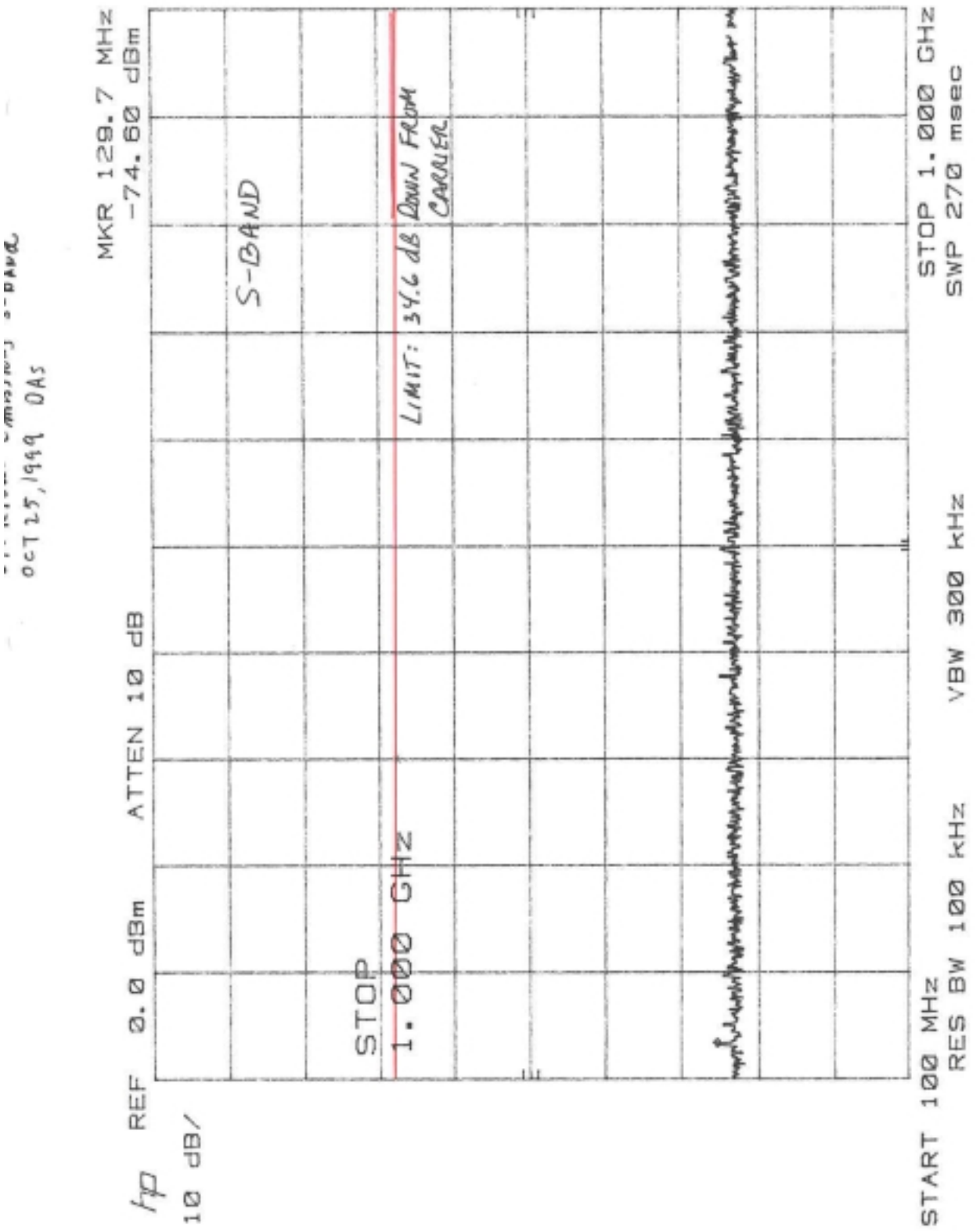
OCCUPIED BANDWIDTH TEST CONFIGURATION

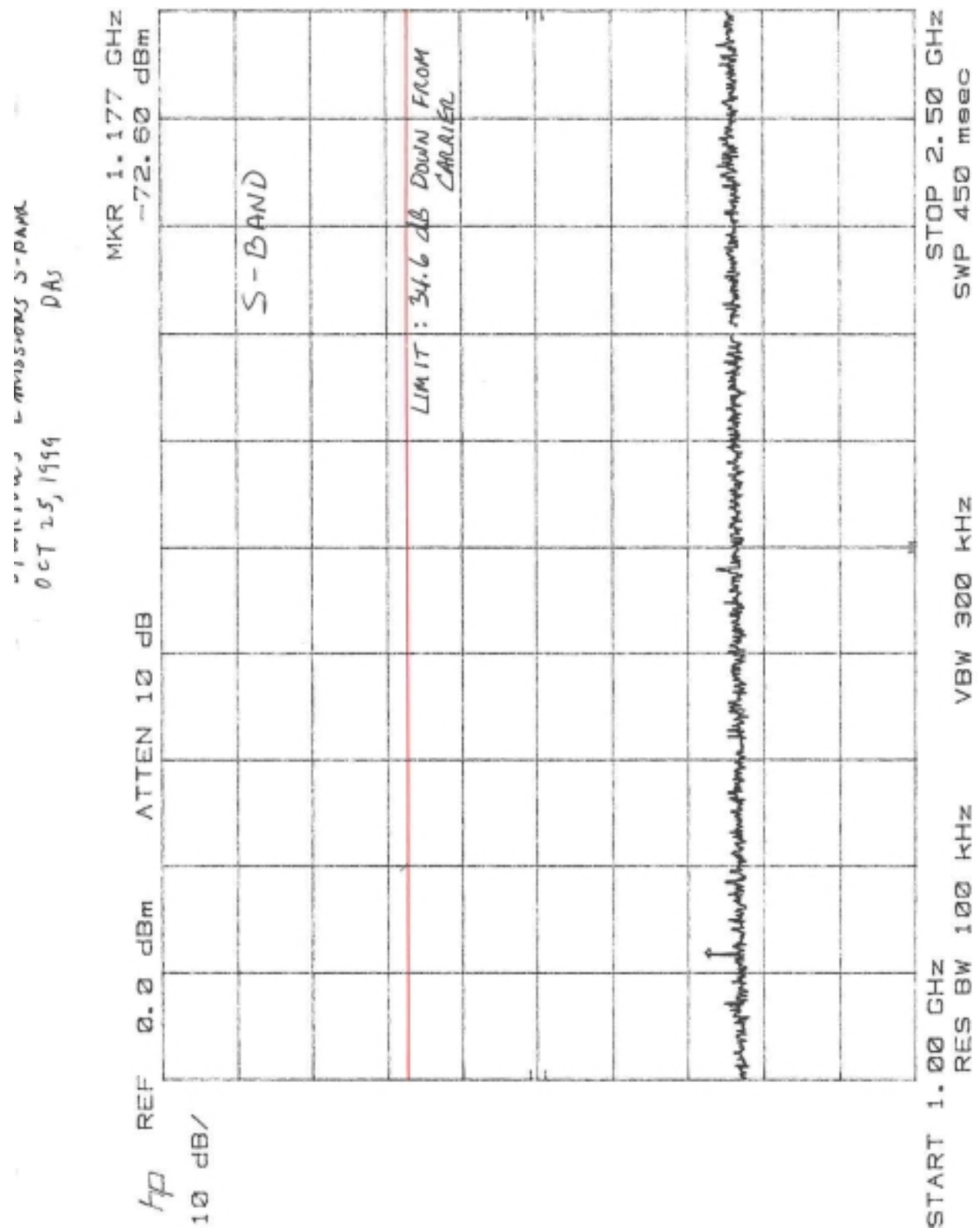
OCCUPIED BANDWIDTH TEST CONFIGURATION

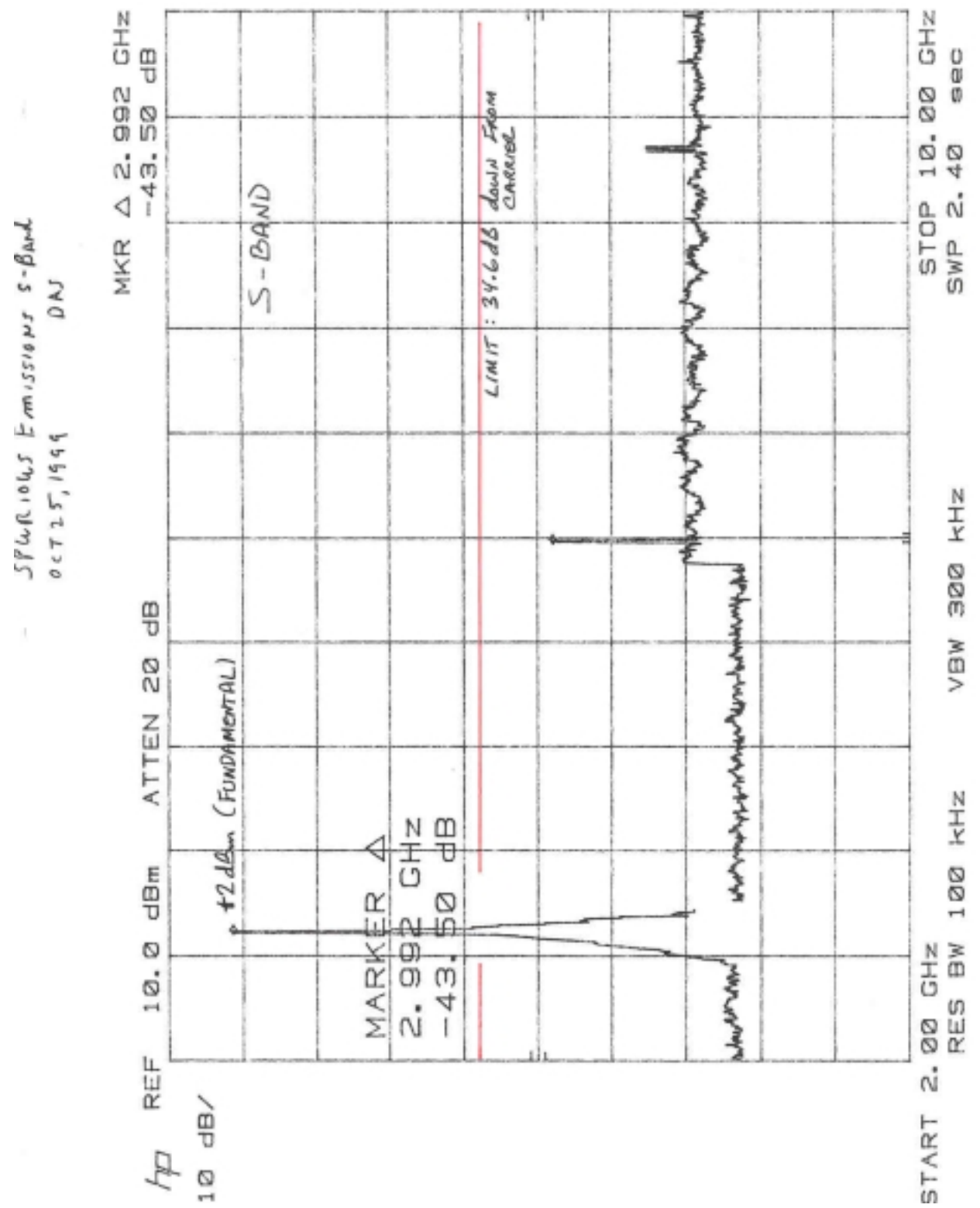
APPENDIX C

SPURIOUS EMISSIONS AT ANTENNA TERMINALS

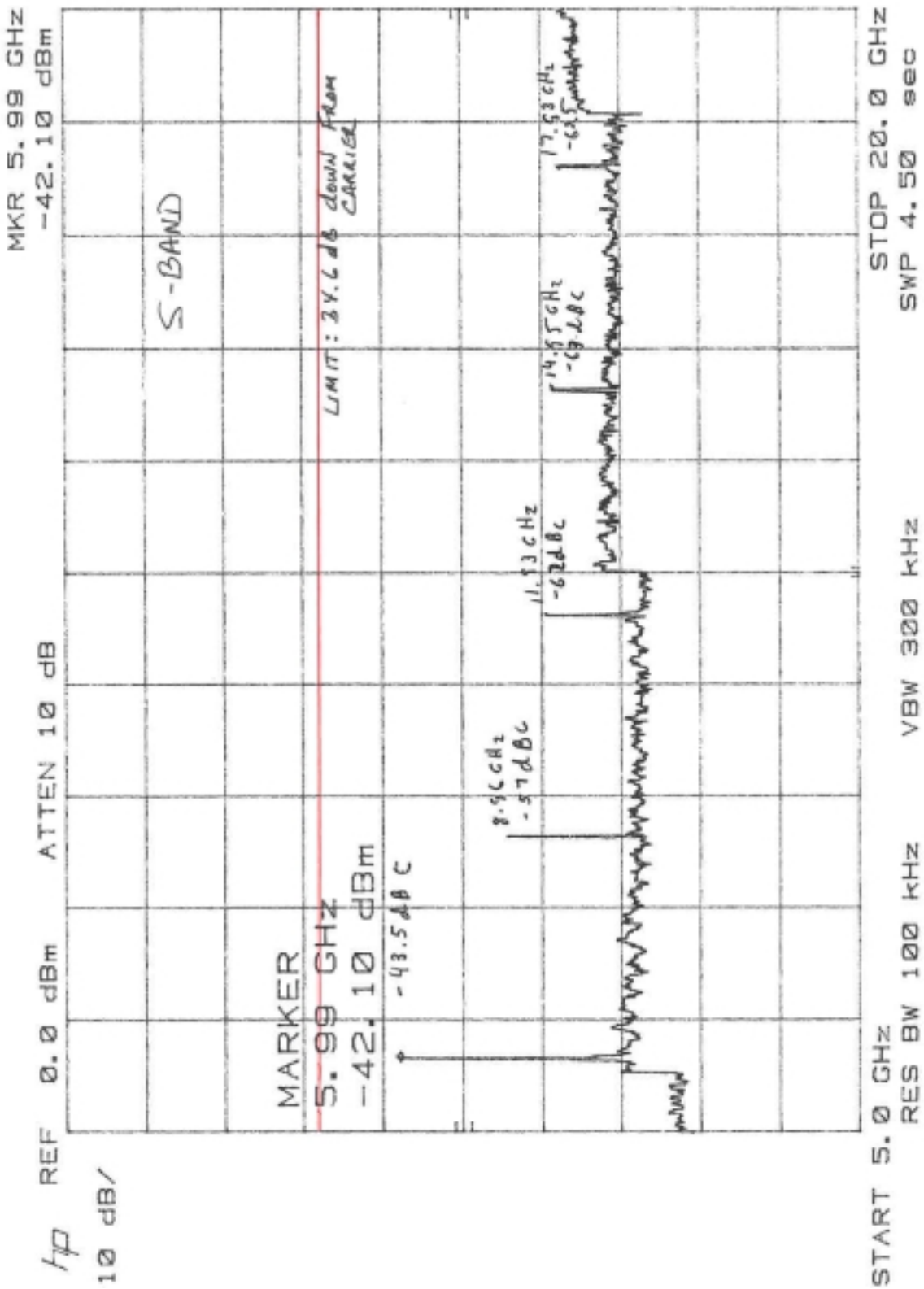

Spurious Emissions S-Band
OCT.25,1999 DAS
MKR 85.1 MHz
-75.40 dBm
S-BAND
LIMIT: 34.6 dB Down From Carrier
RES BW
100 kHz
hp
REF 0.0 dBm
ATTEN 10 dB
10 dB/
START 30 MHz
RES BW 100 kHz
VBW 300 kHz
STOP 200 MHz
SWP 51.0 msec

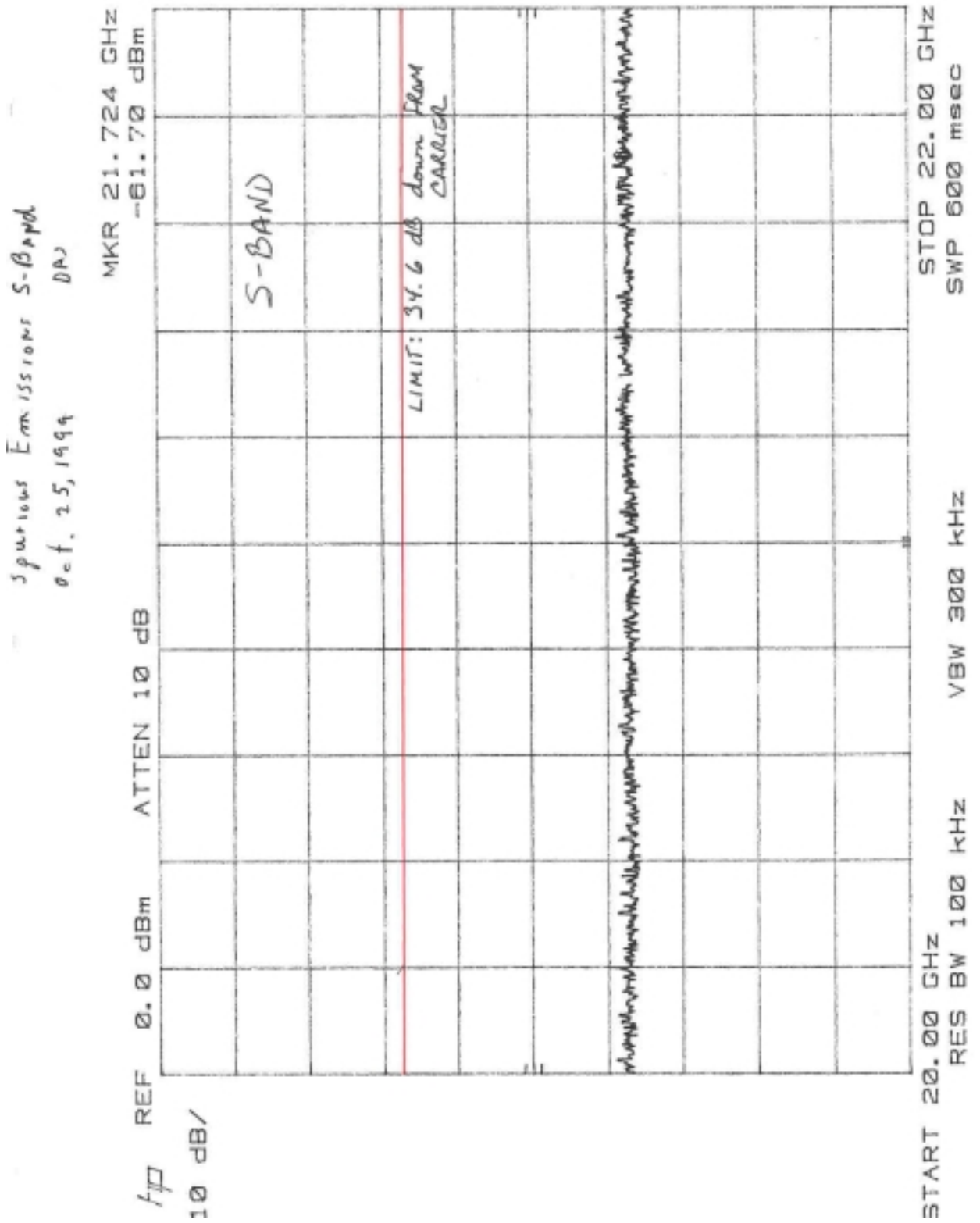

Oct 25, 1999 OAS
MKR 129.7 MHz
-74.60 dBm
S-BAND
LIMIT: 34.6 dB Down From Carrier
STOP
1.000 GHz
REF 0.0 dBm
ATTEN 10 dB
10 dB/
START 100 MHz
RES BW 100 kHz
VBW 300 kHz
STOP 1.000 GHz
SWP 270 msec


MKR 1.177 GHz
-72.60 dBm
S-BAND
LIMIT : 34.6 dB DOWN FROM CARRIER
REF 0.0 dBm
ATTEN 10 dB
10 dB/
START 1.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 2.50 GHz
SWP 450 msec
OCT 25, 1999
DAS


Spurious Emissions S-Band
OCT 25, 1999
DNJ
MKR Δ 2.992 GHz
-43.50 dB
S-BAND
LIMIT: 34.6dB down from carrier
REF 10.0 dBm
ATTEN 20 dB
+2 dBm (FUNDAMENTAL)
MARKER Δ
2.992 GHz
-43.50 dB
10 dB/
START 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 10.00 GHz
SWP 2.40 sec

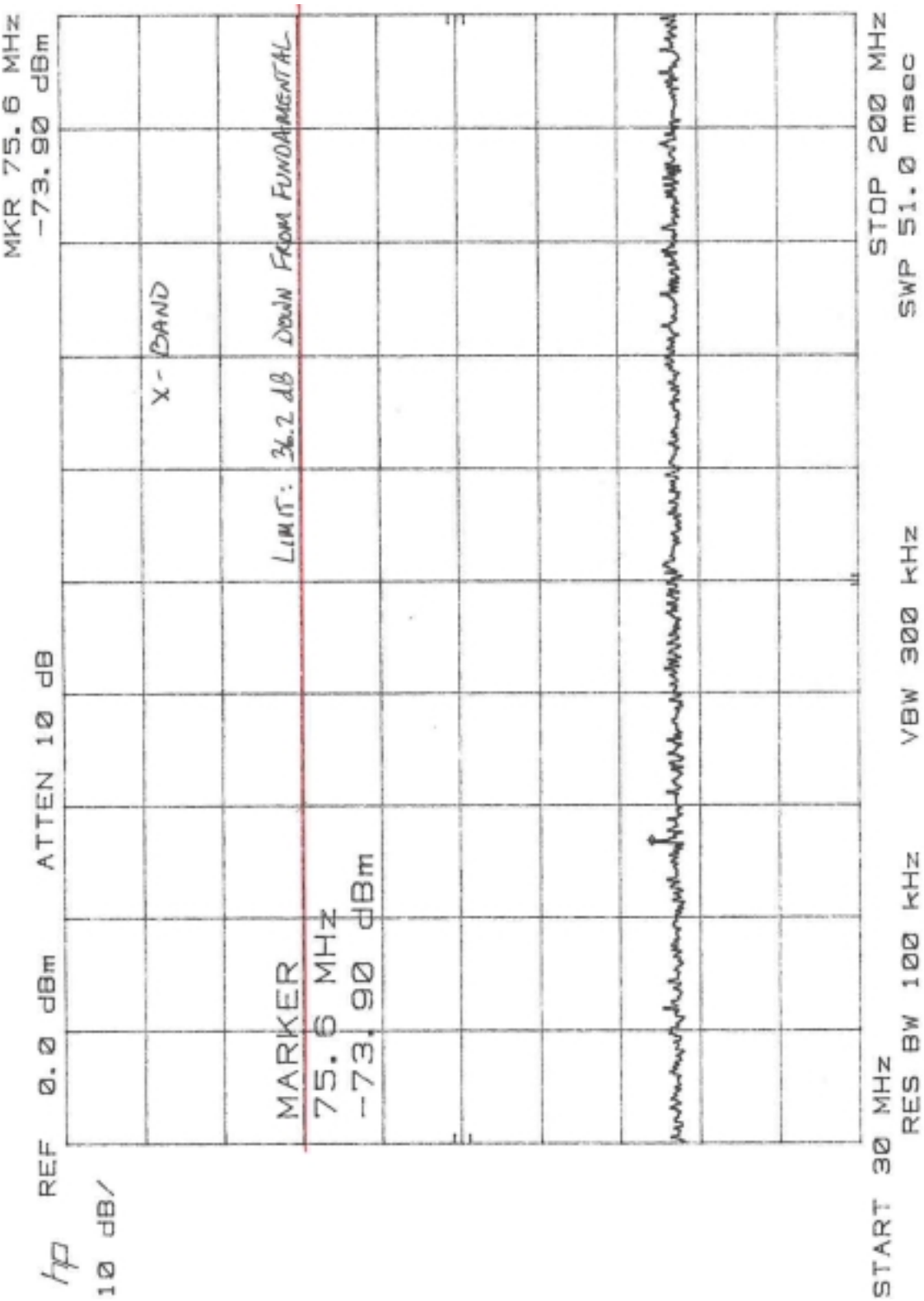
SPURIOUS EMISSIONS S-BAND
OCT. 25, 1999

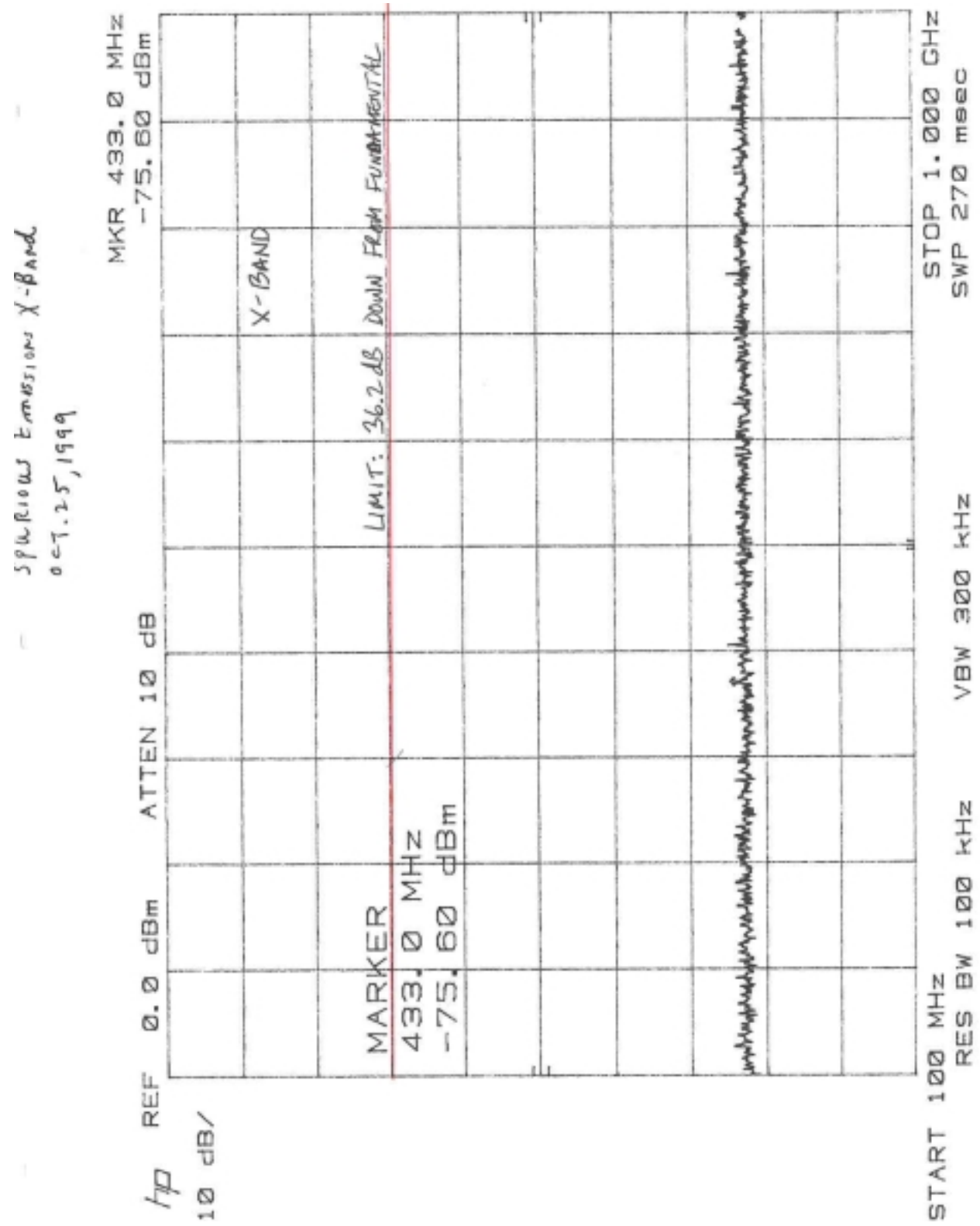


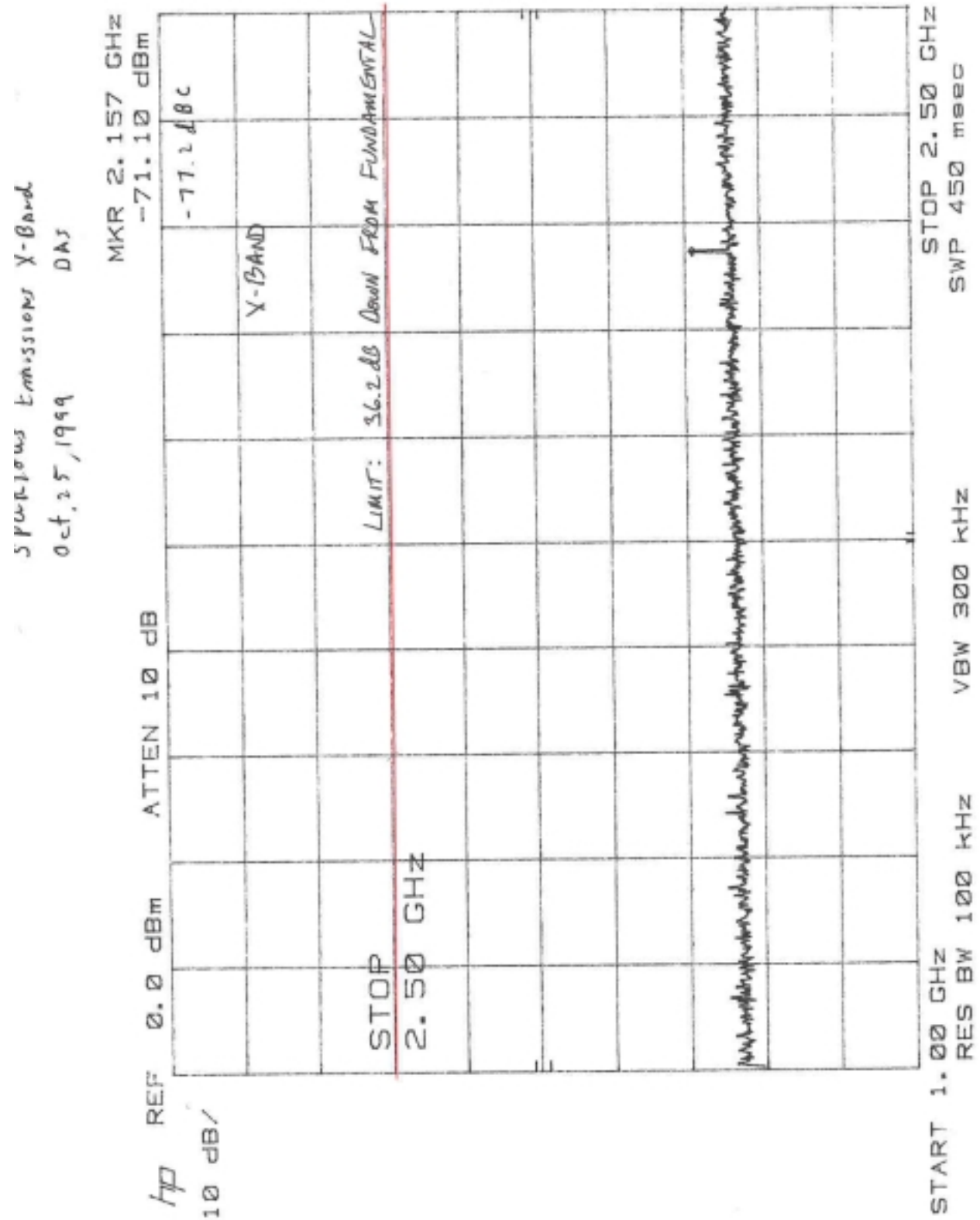

Spurious Emissions S-Band
Ref. 25, 1999
DAJ
MKR 21.724 GHz
-61.70 dBm
S-BAND
LIMIT: 34.6 dB down from carrier
REF 0.0 dBm
ATTEN 10 dB
10 dB/
START 20.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 22.00 GHz
SWP 600 msec

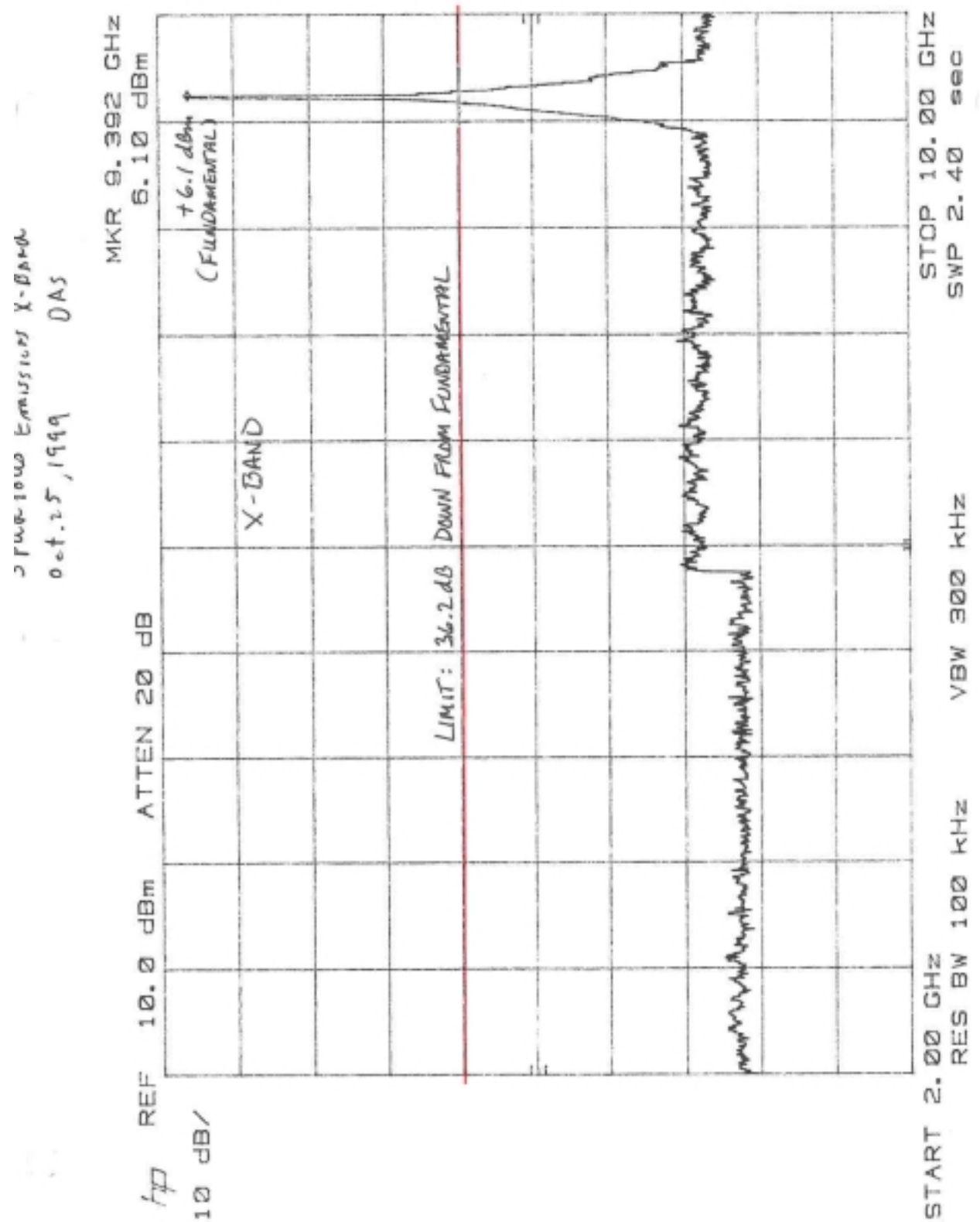
SPURIOUS EMISSIONS X-BAND

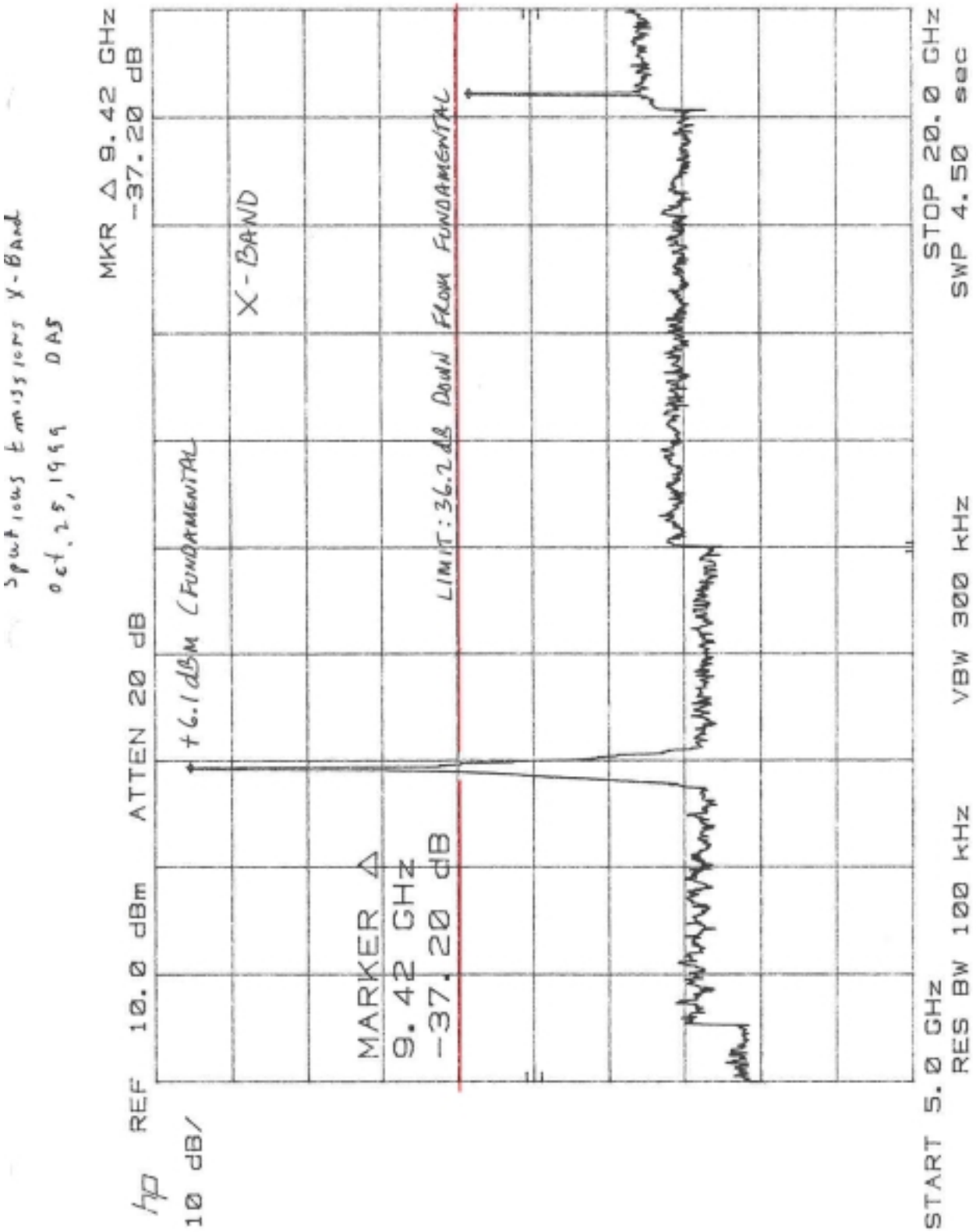
OCT. 25, 1999 DAS

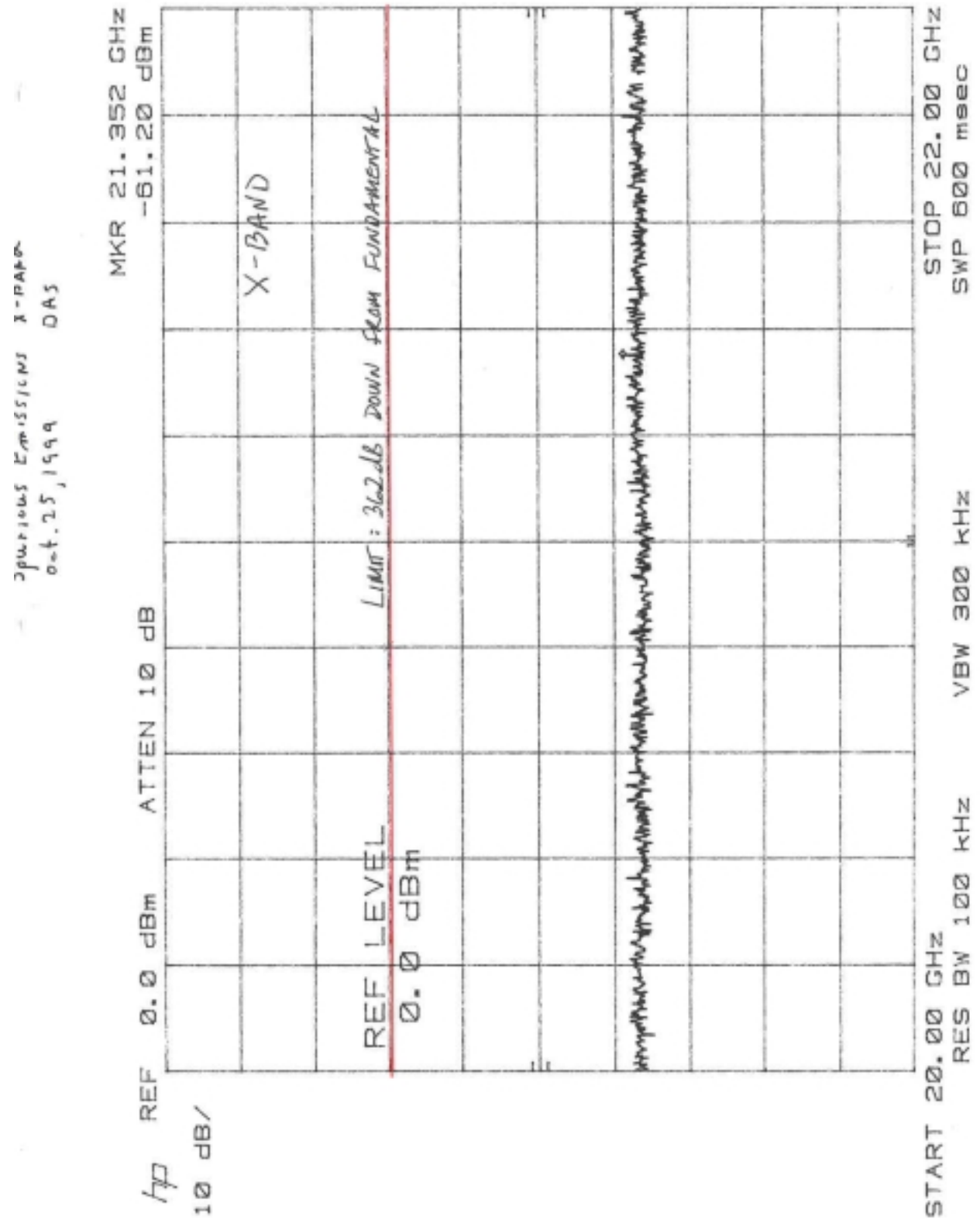



SPURIOUS EMISSIONS X-BAND
OCT. 25, 1999
hp
REF 0.0 dBm
ATTEN 10 dB
10 dB/
MKR 433.0 MHz
-75.60 dBm
X-BAND
LIMIT: 36.2 dB DOWN FROM FUNDAMENTAL
MARKER
433.0 MHz
-75.60 dBm
START 100 MHz
RES BW 100 kHz
VBW 300 kHz
STOP 1.000 GHz
SWP 270 msec


Spurious Emissions X-Band
Oct. 25, 1999
DAS
MKR 2.157 GHz
-71.10 dBm
-77.2 dBc
X-BAND
LIMIT: 36.2 dB Down From Fundamental
STOP
2.50 GHz
REF 0.0 dBm
ATTEN 10 dB
10 dB/
START 1.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 2.50 GHz
SWP 450 msec


Transmitter Emissions X-Band
Oct. 25, 1999 DAS
MKR 9.392 GHz
6.10 dBm
+6.1 dBm
(FUNDAMENTAL)
X-BAND
LIMIT: 36.2 dB DOWN FROM FUNDAMENTAL
REF 10.0 dBm ATTEN 20 dB
10 dB/
START 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 10.00 GHz
SWP 2.40 sec


Spurious Emissions X-Band
Oct. 25, 1999 DAS
MKR Δ 9.42 GHz
-37.20 dB
X-BAND
REF 10.0 dBm ATTEN 20 dB
10 dB/
+6.1 dBM (FUNDAMENTAL
LIMIT: 36.2 dB DOWN FROM FUNDAMENTAL
MARKER Δ
9.42 GHz
-37.20 dB
START 5.0 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 20.0 GHz
SWP 4.50 sec


Spurious Emissions X-PAPER
Oct. 25, 1999 DAS
MKR 21.352 GHz
-61.20 dBm
X-BAND
LIMIT: 36.2dB DOWN FROM FUNDAMENTAL
REF LEVEL
0.0 dBm
REF 0.0 dBm ATTEN 10 dB
10 dB/
START 20.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 22.00 GHz
SWP 600 msec

EQUIPMENT USE REPORT

Date:	October 25, 1999		
Project #	10-2192-202	**Project Manager**	D. Carmony
Test Location :	SE9 room	**Technician:**	D.Smith

Spurious Emissions at Antenna Terminals Test Equipment				**Cal. Due**
Manufacturer	**Description**	**Model No.**	**Serial No.**	
HP	Signal Generator	8350A	2120A00685	19 Mar 00
HP	RF Plug In	83592A	2125A00179	19 Mar 00
HP	Spectrum Analyzer	8566B	2152A0312	12 Feb 00
Narda	6 dB Attenuator	4779-6	8709	Verified
HP	Microwave cable	5061-5458	---	Verified

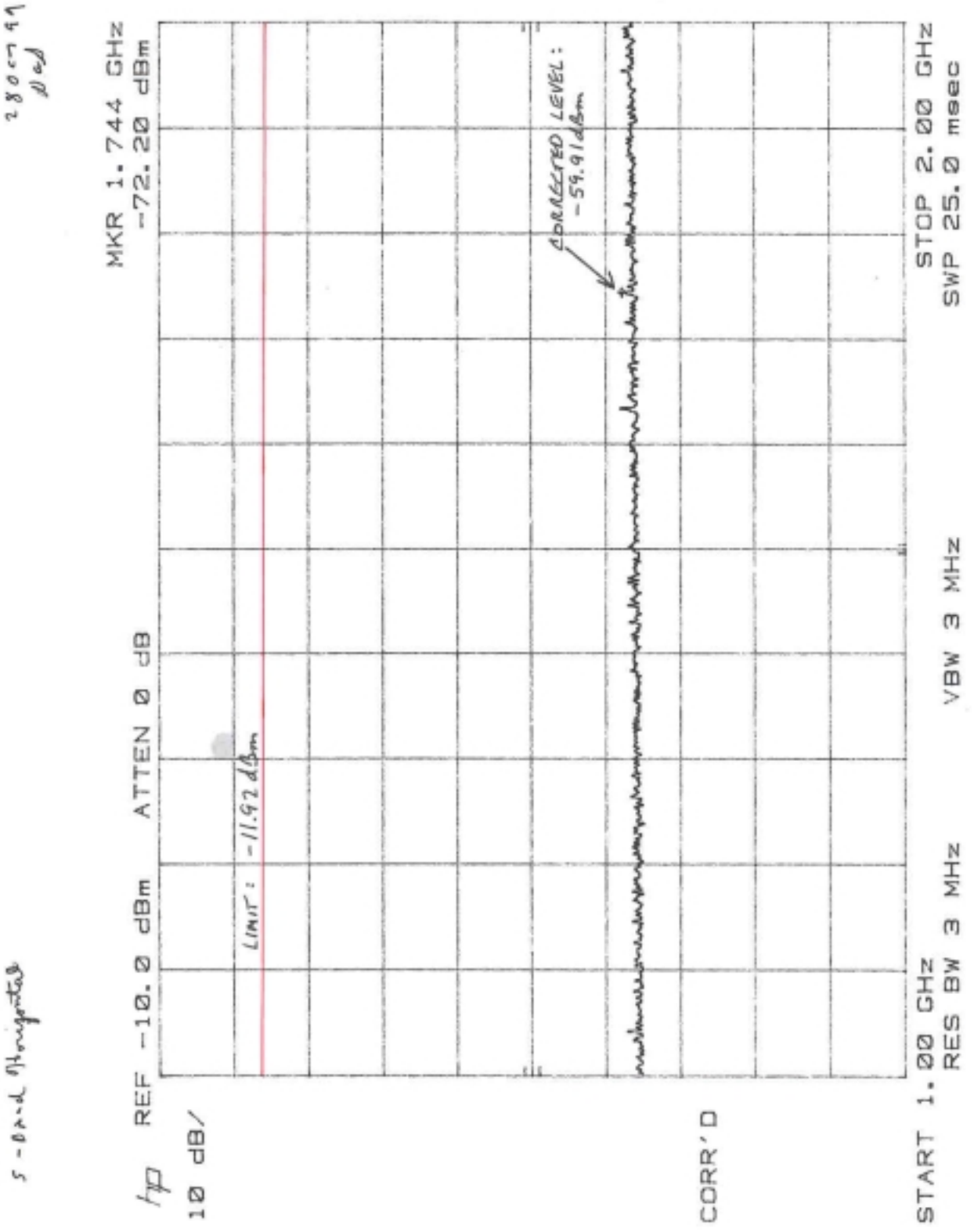
PHOTO DOCUMENTATION WORKSHEET

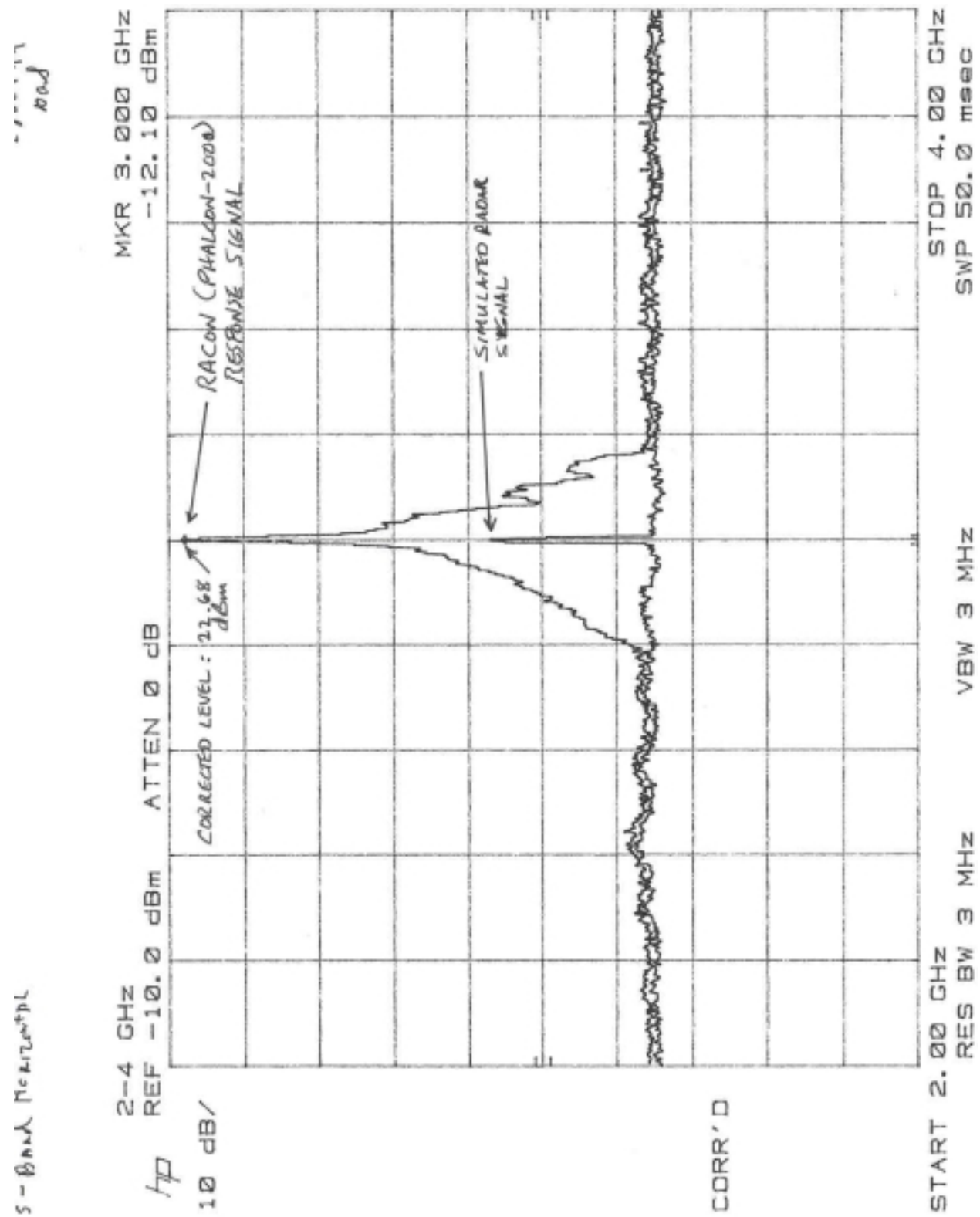
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202

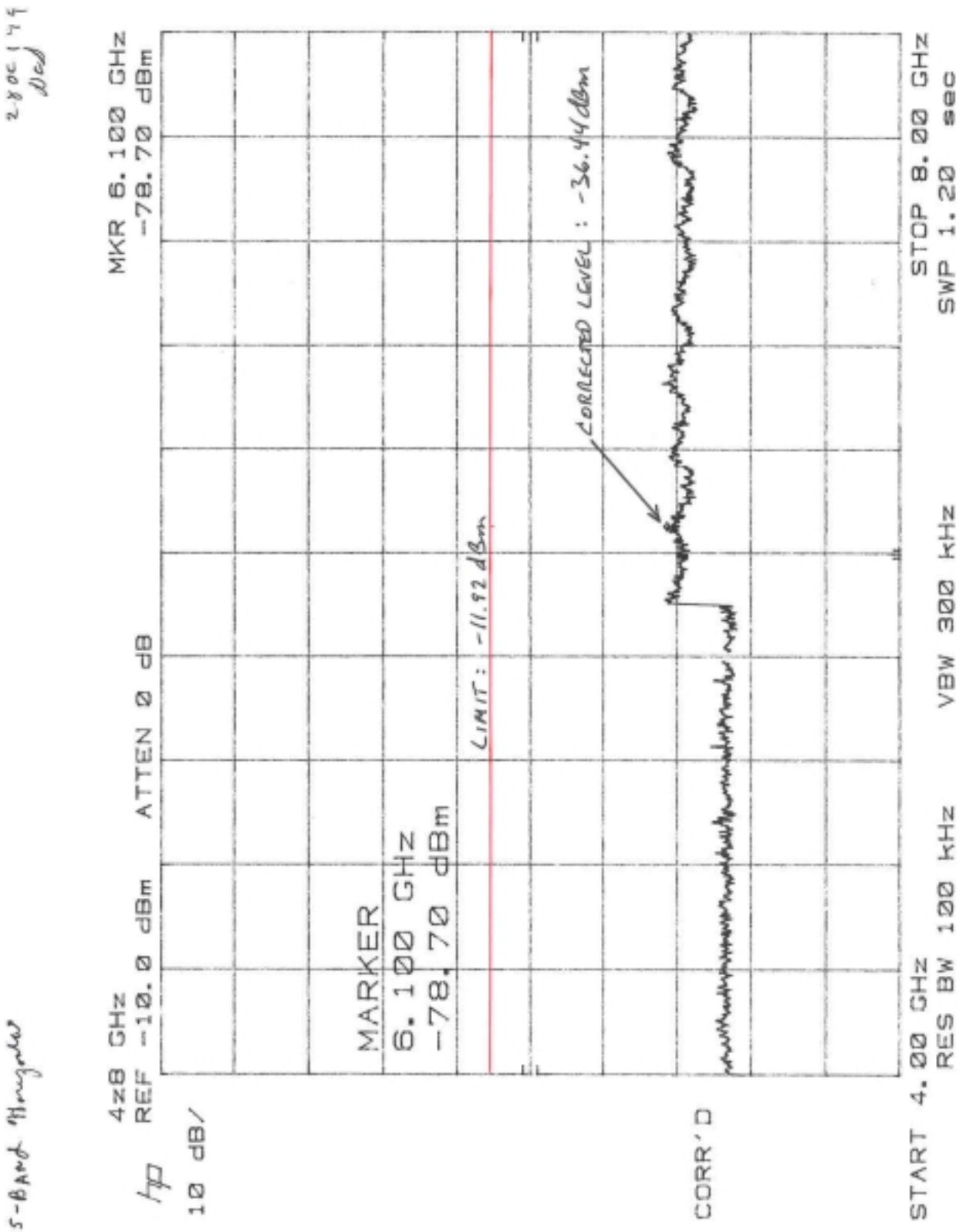
SPURIOUS EMISSIONS AT ANTENNA TERMINALS TEST CONFIGURATION

APPENDIX D

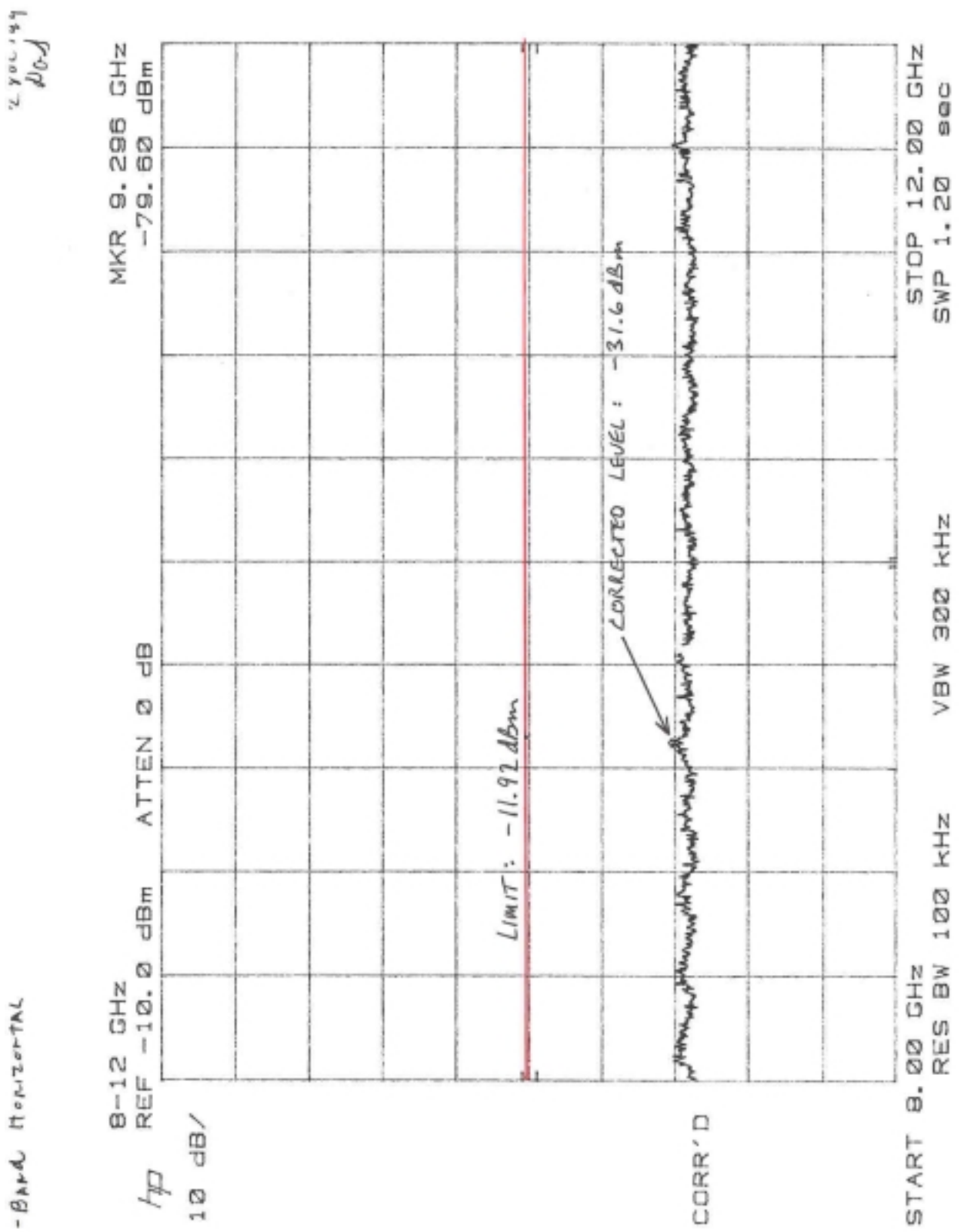
FIELD STRENGTH OF SPURIOUS RADIATION

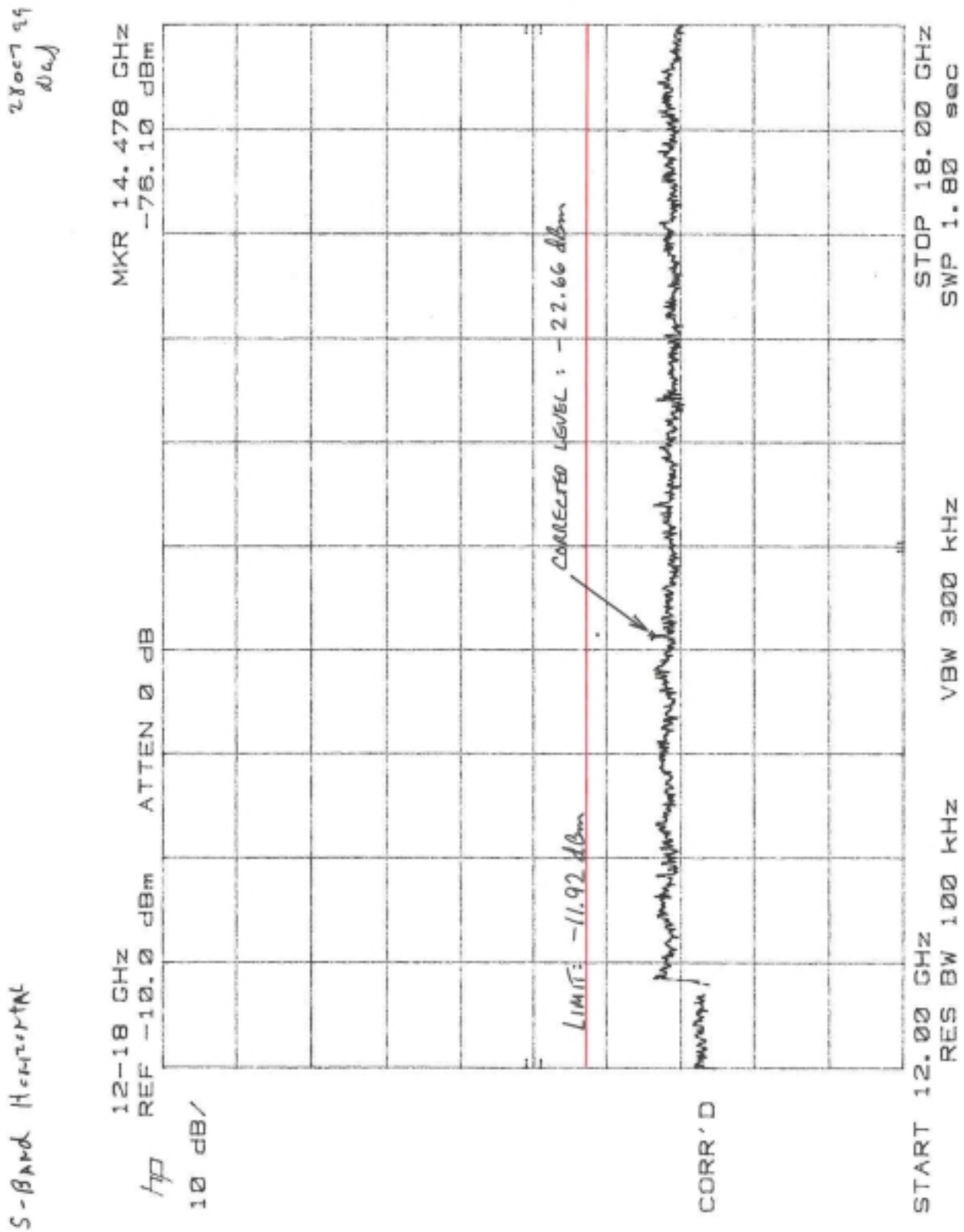

5 - Band Magenta
2807 99
Mod
MKR 1.744 GHz
-72.20 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
LIMIT: -11.92 dBm
ADJUSTED LEVEL:
-59.91 dBm
CORR'D
START 1.00 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 2.00 GHz
SWP 25.0 msec

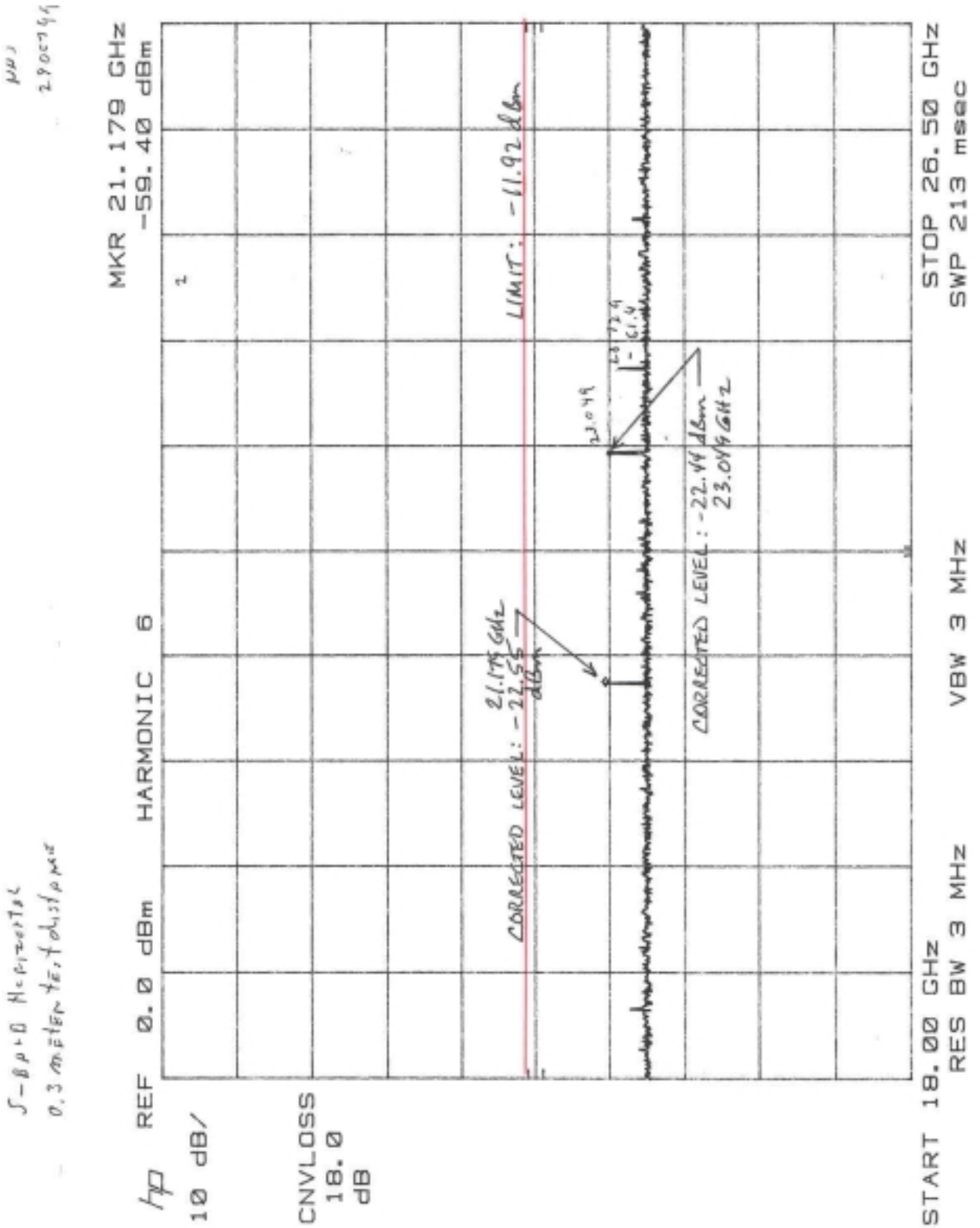

MKR 3.000 GHz
-12.10 dBm
RACON (PHALCON-2000) RESPONSE SIGNAL
SIMULATED RADAR SIGNAL
2-4 GHz
REF -10.0 dBm
ATTEN 0 dB
CORRECTED LEVEL: 11.68 dBm
10 dB/
CORR'D
START 2.00 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 4.00 GHz
SWP 50.0 msec

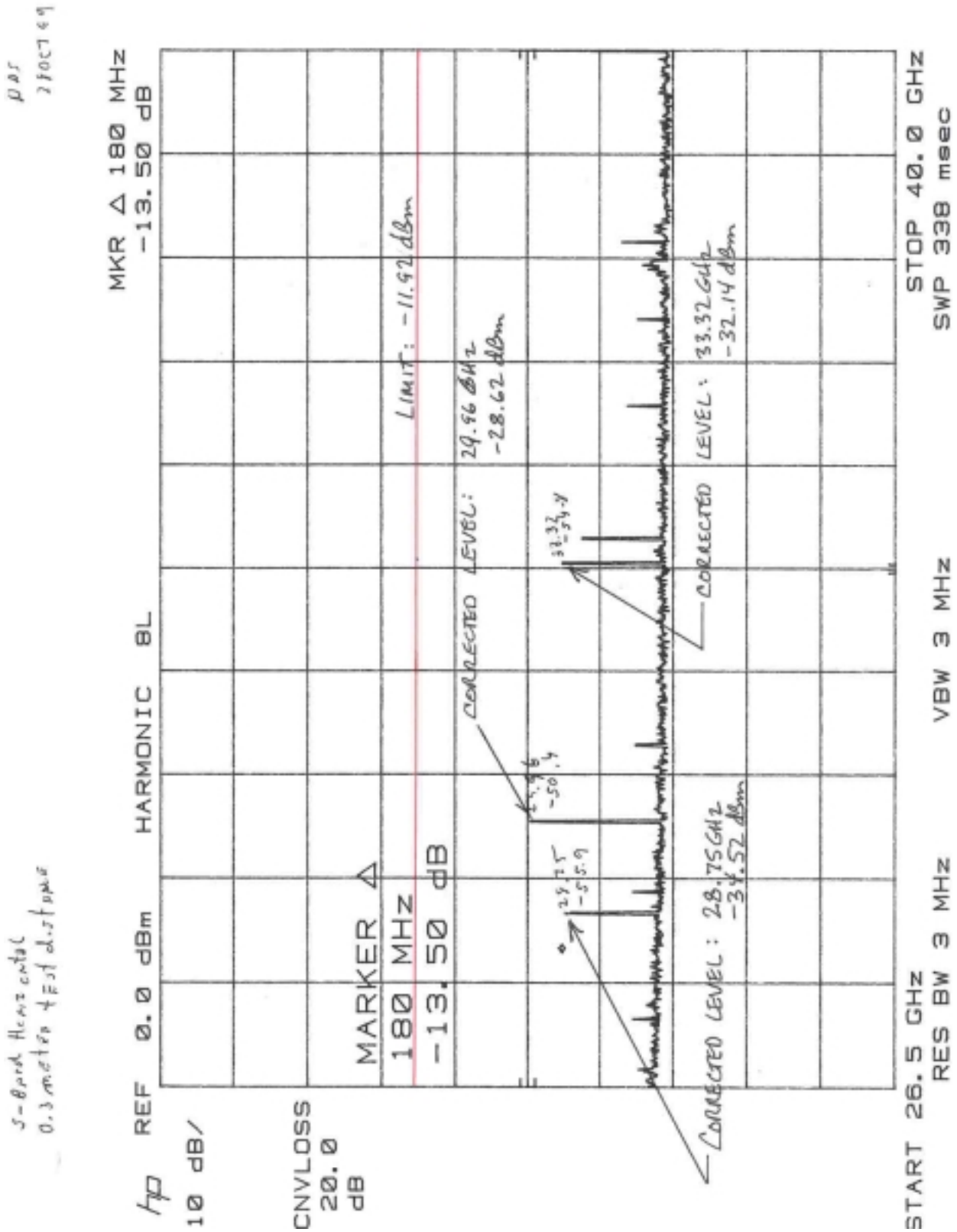

5-Band Harmonics
2.4 GHz Low
4x8 GHz
REF -10.0 dBm
ATTEN 0 dB
10 dB/
MKR 6.100 GHz
-78.70 dBm
MARKER
6.100 GHz
-78.70 dBm
LIMIT: -11.92 dBm
CORRECTED LEVEL: -36.94 dBm
CORR'D
START 4.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 8.00 GHz
SWP 1.20 sec

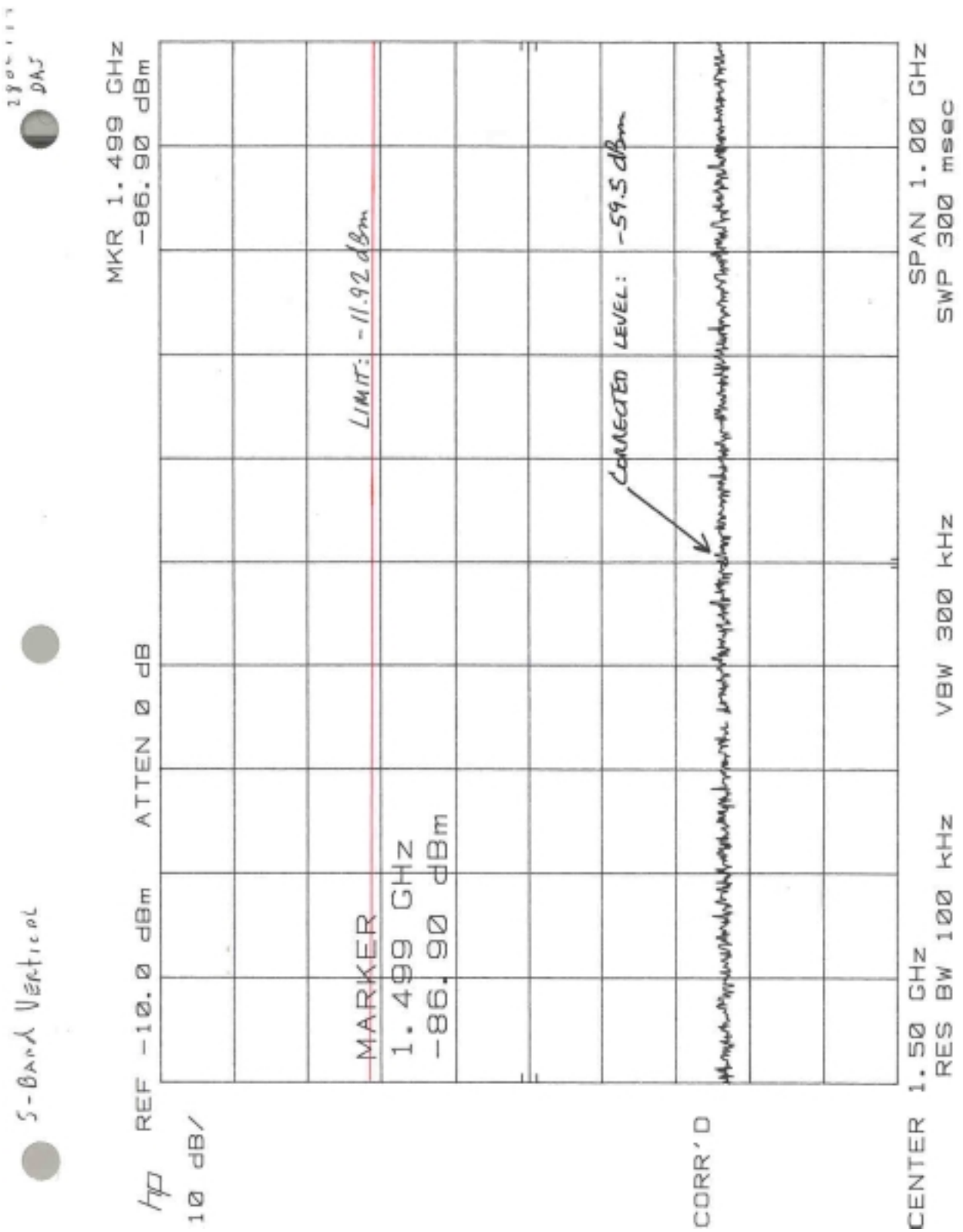
S-BAND HORIZONTAL

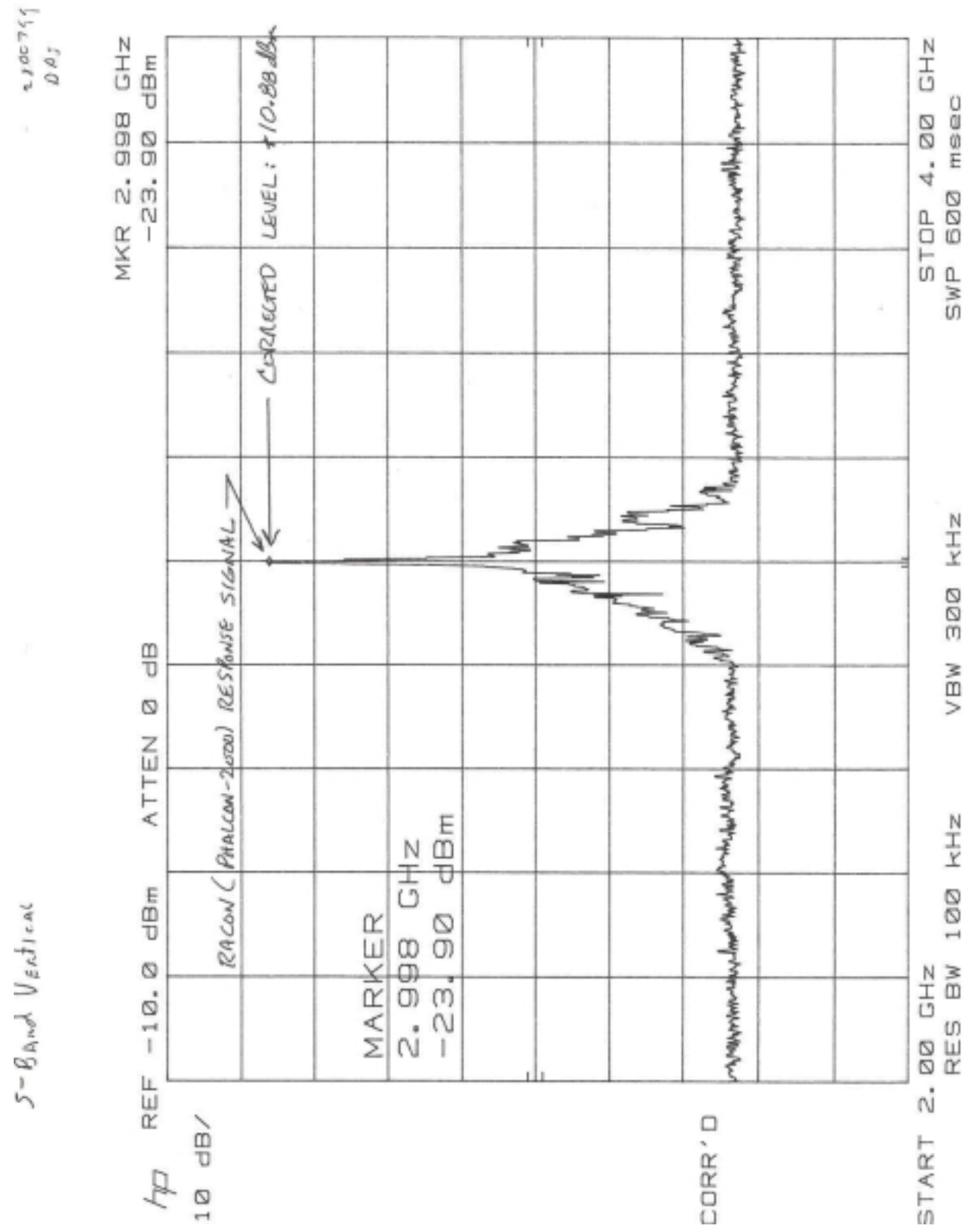


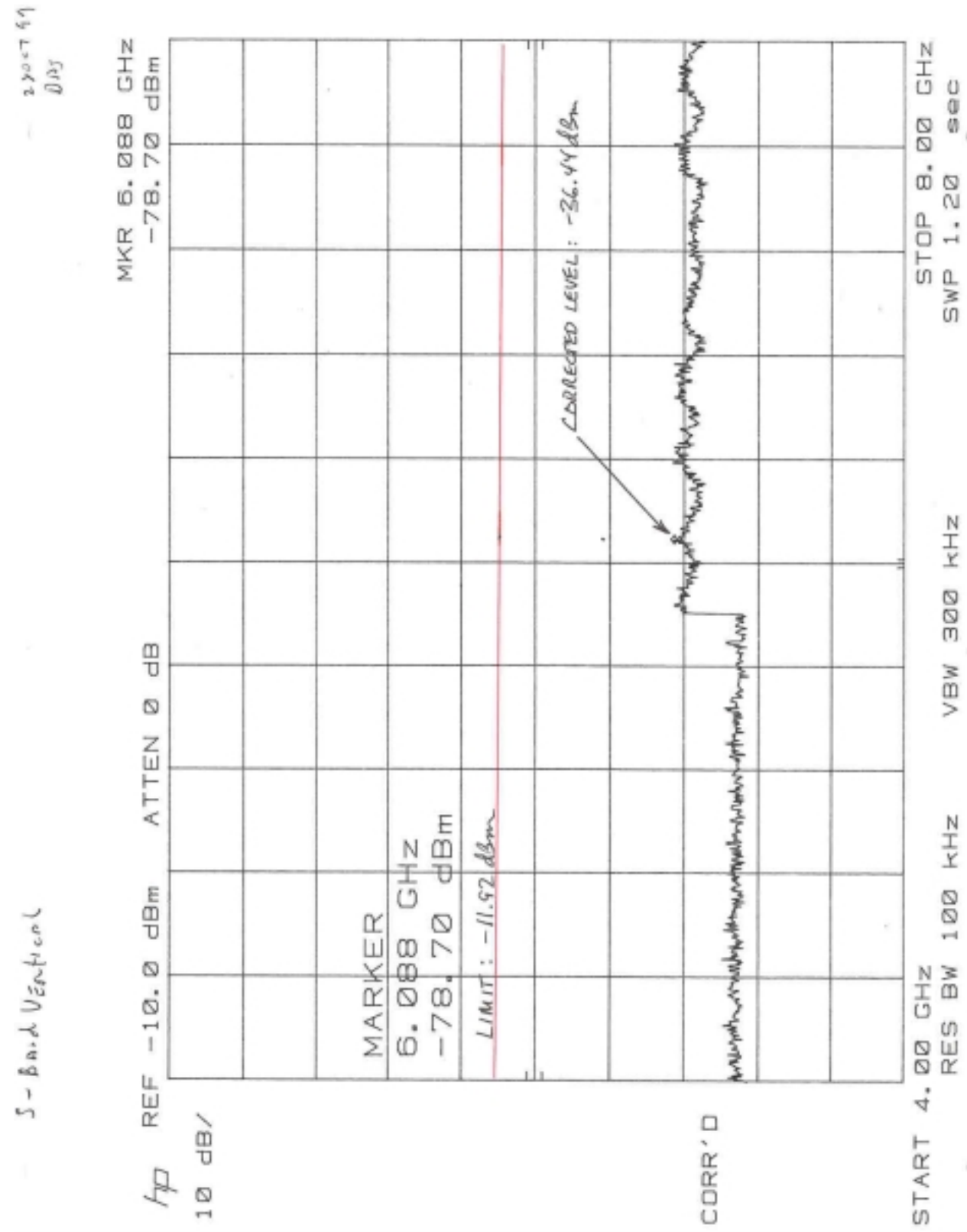

S-Band Horizontal
23oct 99
dwj
12-18 GHz
REF -10.0 dBm
ATTEN 0 dB
MKR 14.478 GHz
-76.10 dBm
10 dB/
CORR'D
CORRECTED LEVEL : -22.66 dBm
LIMIT: -11.92 dBm
START 12.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 18.00 GHz
SWP 1.80 sec

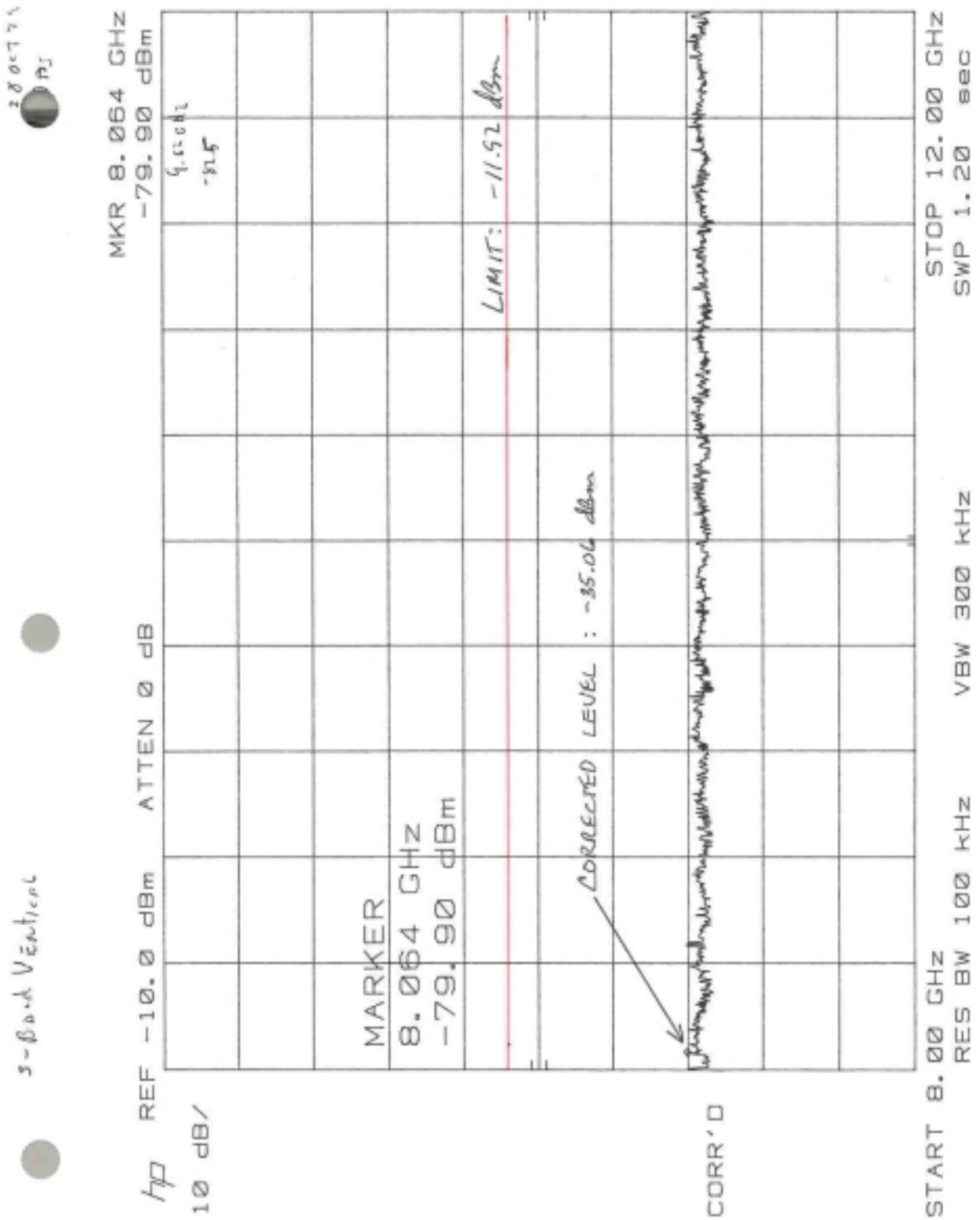

MKR 21.179 GHz
-59.40 dBm
REF 0.0 dBm
HARMONIC 6
10 dB/
CNVLOSS
18.0
dB
LIMIT: -11.92 dBm
CORRECTED LEVEL: -22.55 dBm
21.179 GHz
CORRECTED LEVEL: -22.94 dBm
23.019 GHz
START 18.00 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 26.50 GHz
SWP 213 msec

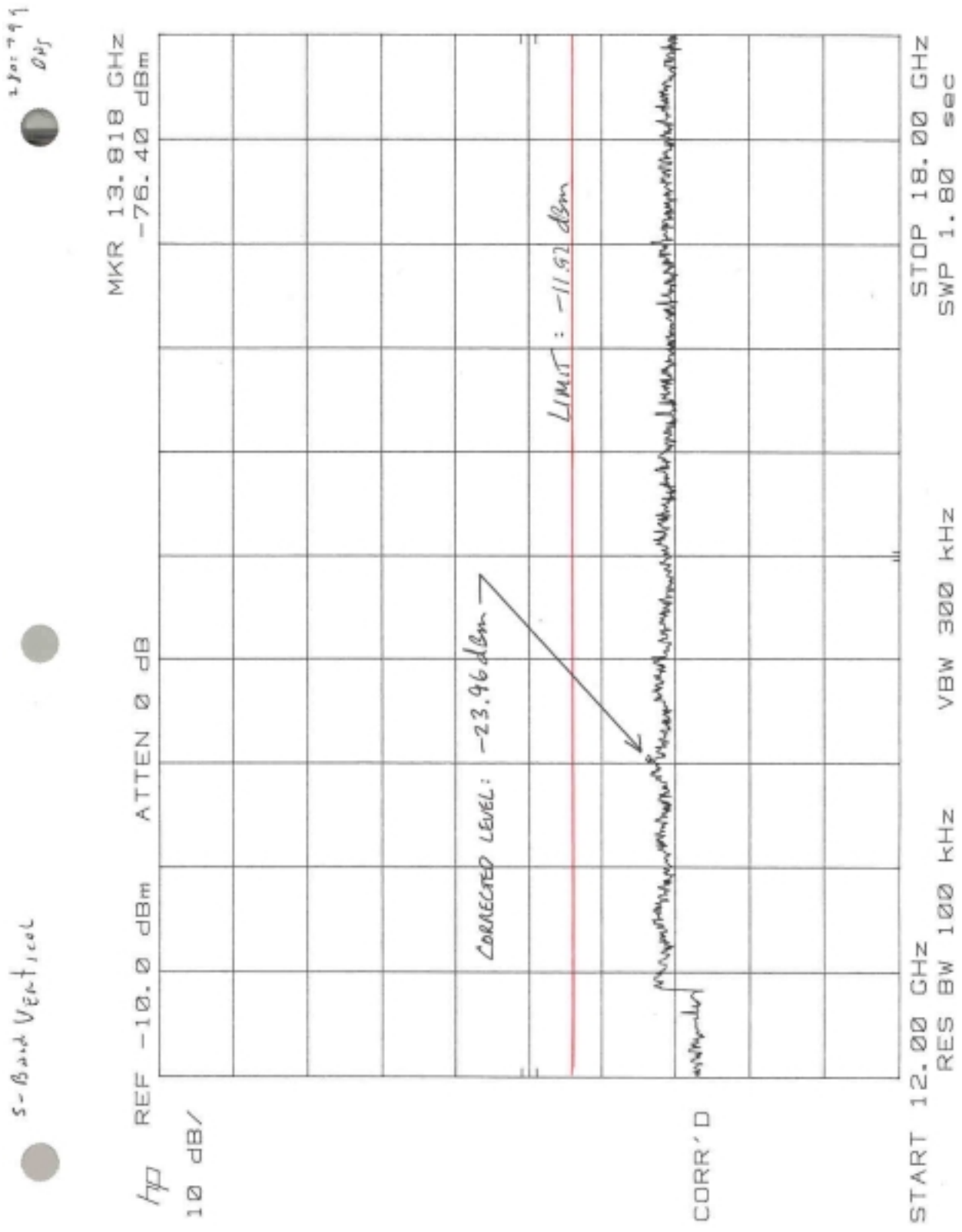

REF 0.0 dBm
10 dB/
CNVLOSS
20.0
dB
HARMONIC BL
MKR Δ 180 MHz
-13.50 dB
MARKER Δ
180 MHz
-13.50 dB
LIMIT: -11.92 dBm
CORRECTED LEVEL: 29.66 GHz
-28.62 dBm
CORRECTED LEVEL: 28.75GHz
-34.52 dBm
CORRECTED LEVEL: 33.32GHz
-32.14 dBm
START 26.5 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 40.0 GHz
SWP 338 msec

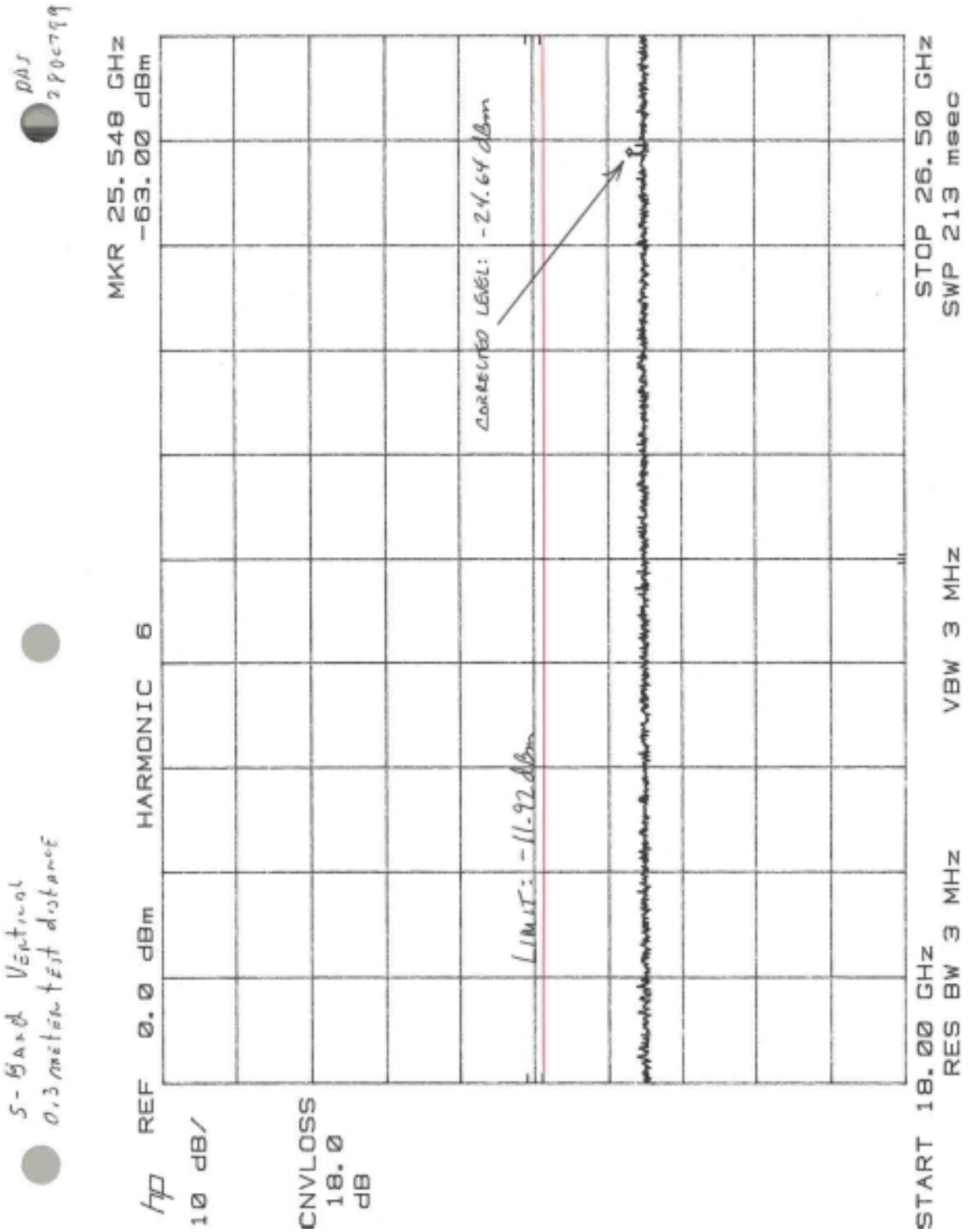

S-Band Vertical
MKR 1.499 GHz
-86.90 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
LIMIT: -11.92 dBm
MARKER
1.499 GHz
-86.90 dBm
CORRECTED LEVEL: -59.5 dBm
CORR'D
CENTER 1.50 GHz
RES BW 100 kHz
VBW 300 kHz
SPAN 1.00 GHz
SWP 300 msec

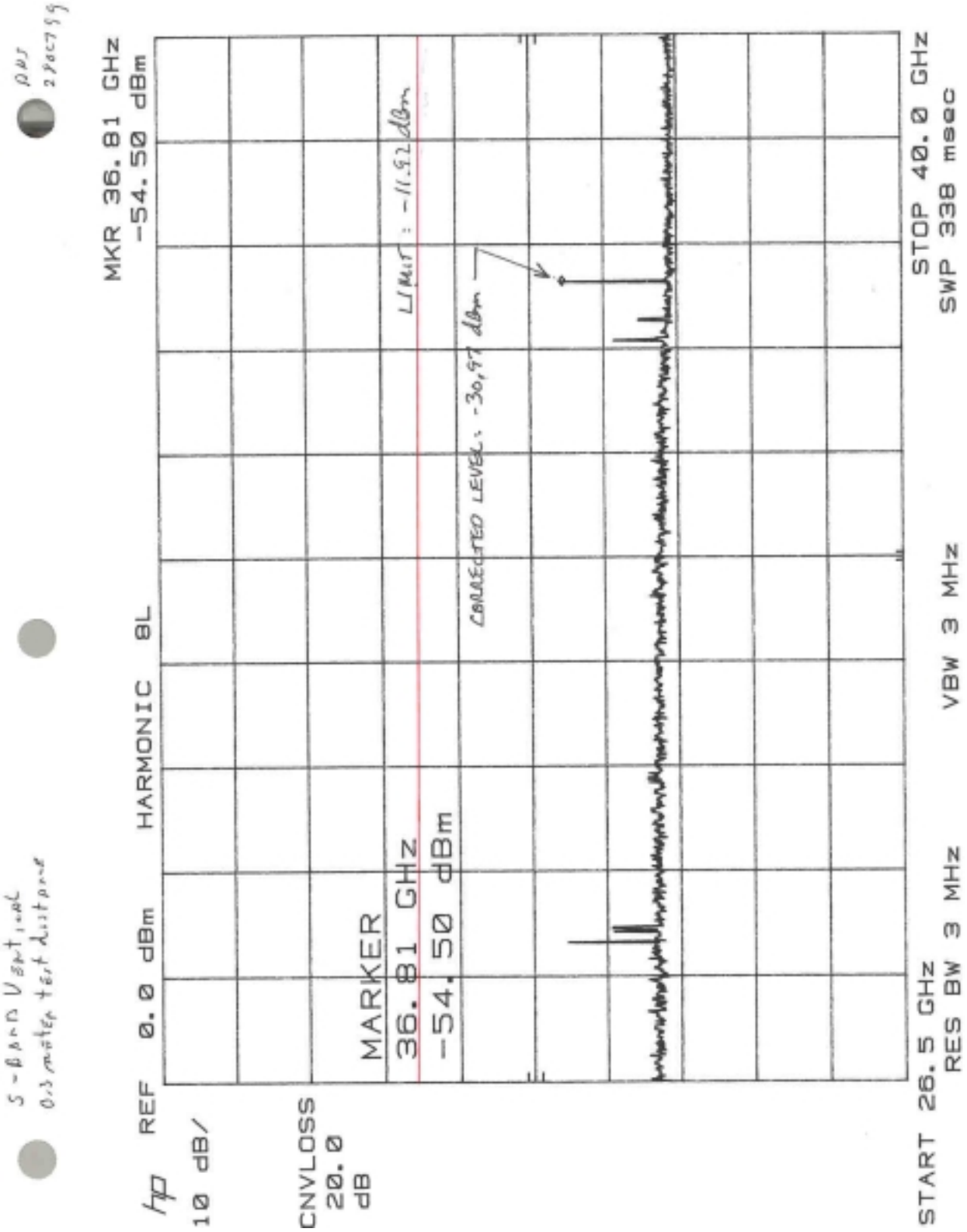

S-Band Vertical
REF -10.0 dBm
ATTEN 0 dB
10 dB/
RACOM (PHALCOM-2000) RESPONSE SIGNAL
CORRECTED LEVEL: +10.00 dBm
MKR 2.998 GHz
-23.90 dBm
MARKER
2.998 GHz
-23.90 dBm
CORR'D
START 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 4.00 GHz
SWP 600 msec

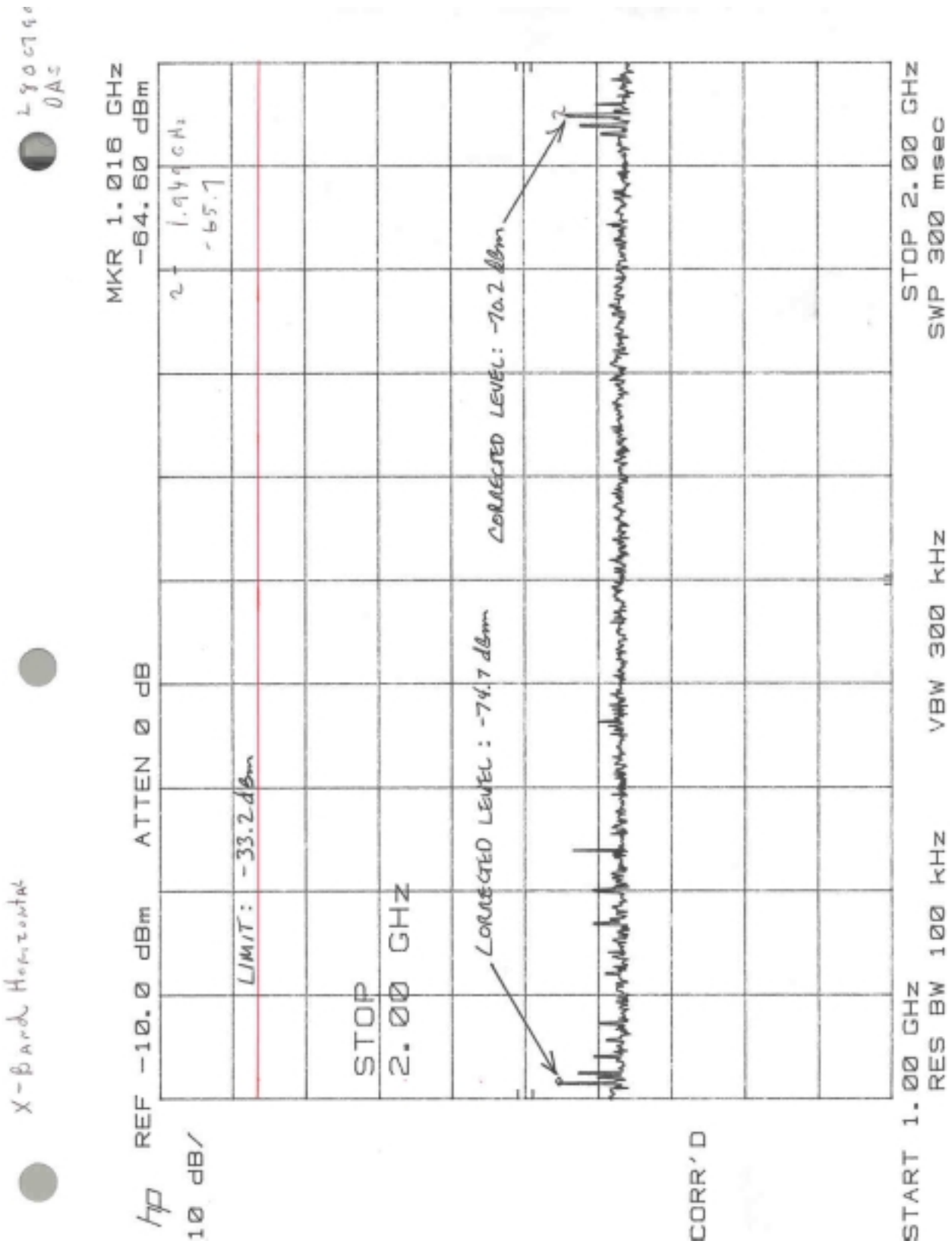

5 - Band Vertical
2 Oct 99
MKR 6.088 GHz
-78.70 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
MARKER
6.088 GHz
-78.70 dBm
LIMIT: -11.92 dBm
CORRECTED LEVEL: -36.44 dBm
CORR'D
START 4.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 8.00 GHz
SWP 1.20 sec

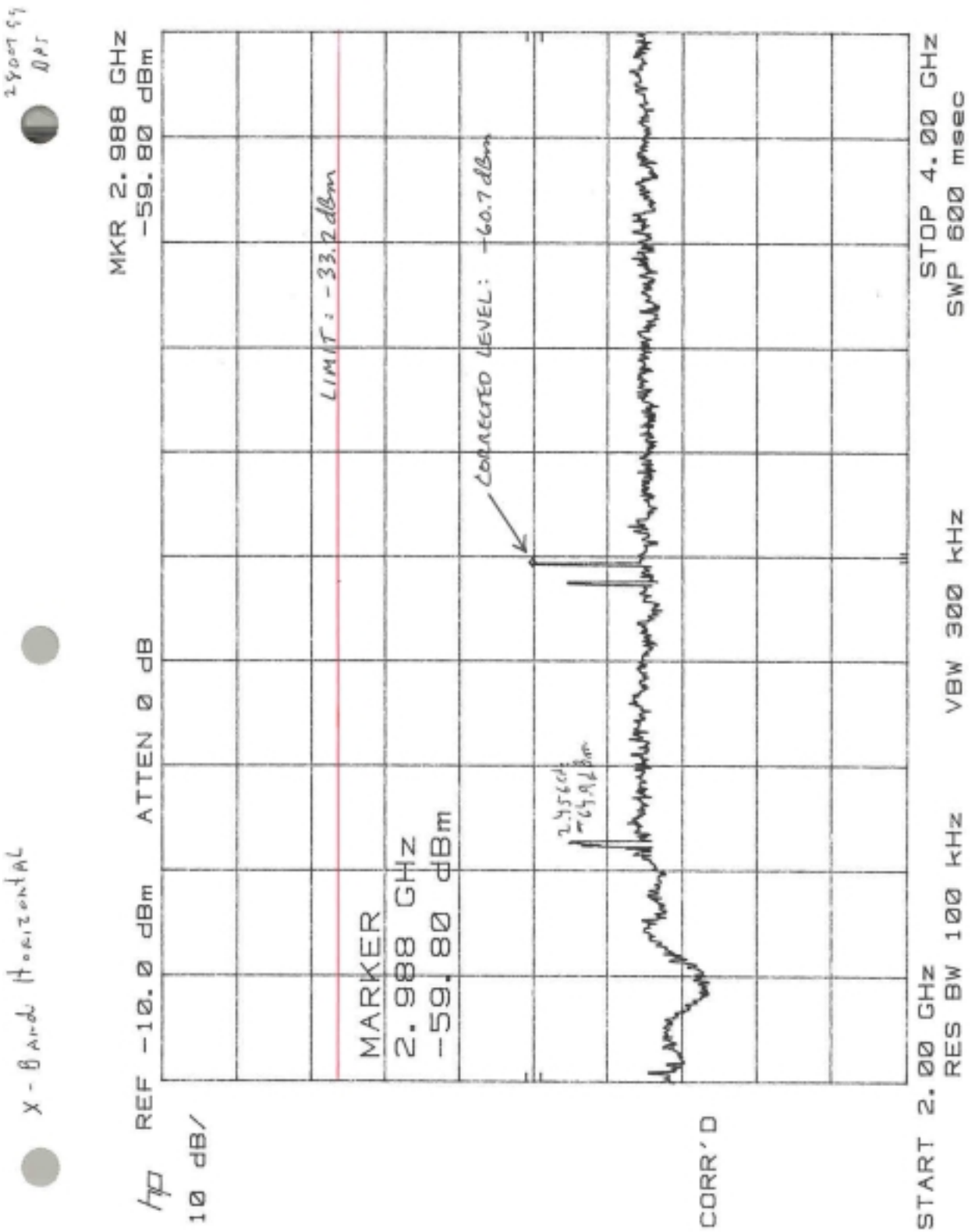

MKR 8.064 GHz
-79.90 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
MARKER
8.064 GHz
-79.90 dBm
LIMIT: -11.52 dBm
CORRECTED LEVEL : -35.06 dBm
CORR'D
START 8.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 12.00 GHz
SWP 1.20 sec

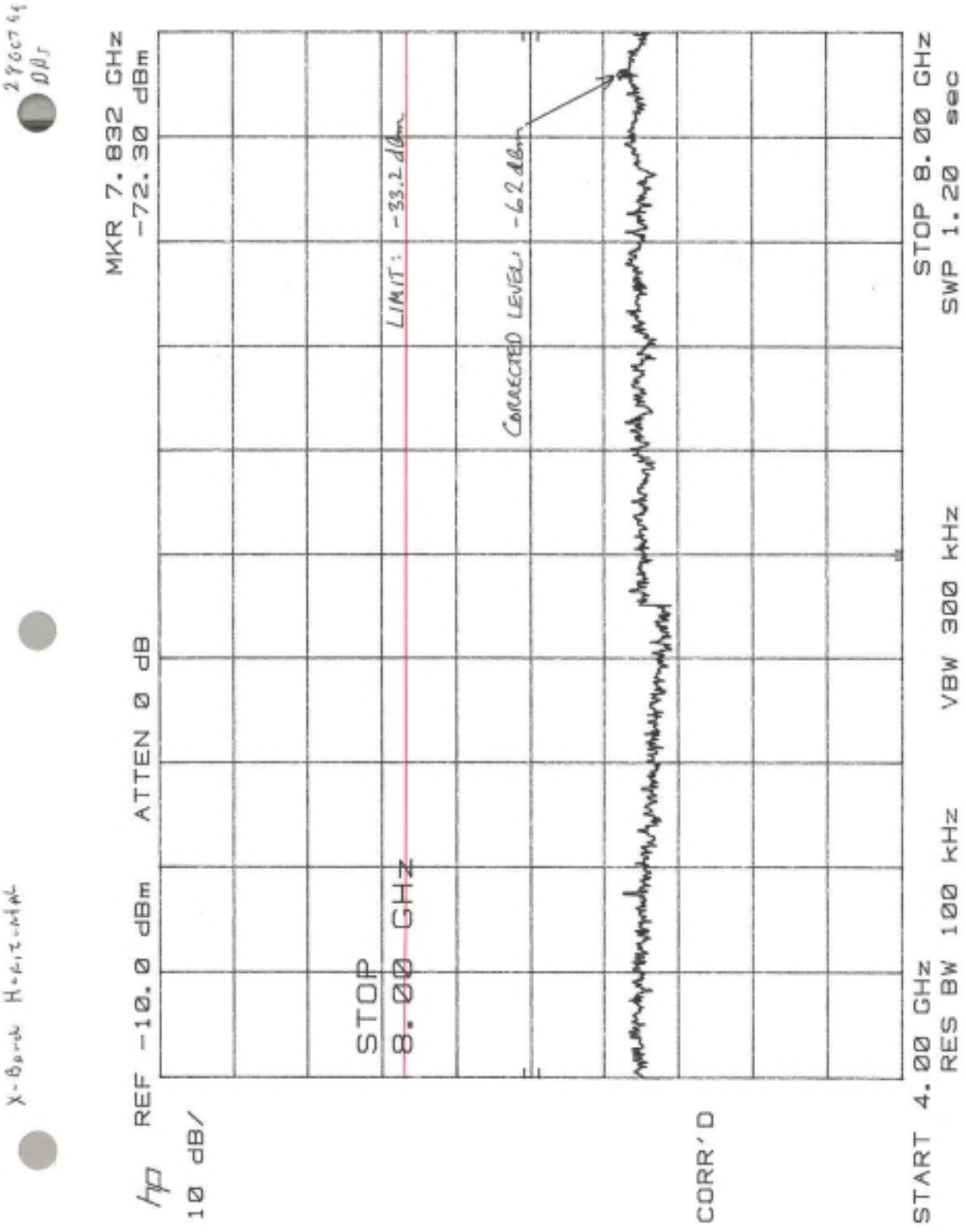

MKR 13.818 GHz
-76.40 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
CORR'D
CORRECTED LEVEL: -23.96 dBm
LIMIT: -11.92 dBm
START 12.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 18.00 GHz
SWP 1.80 sec

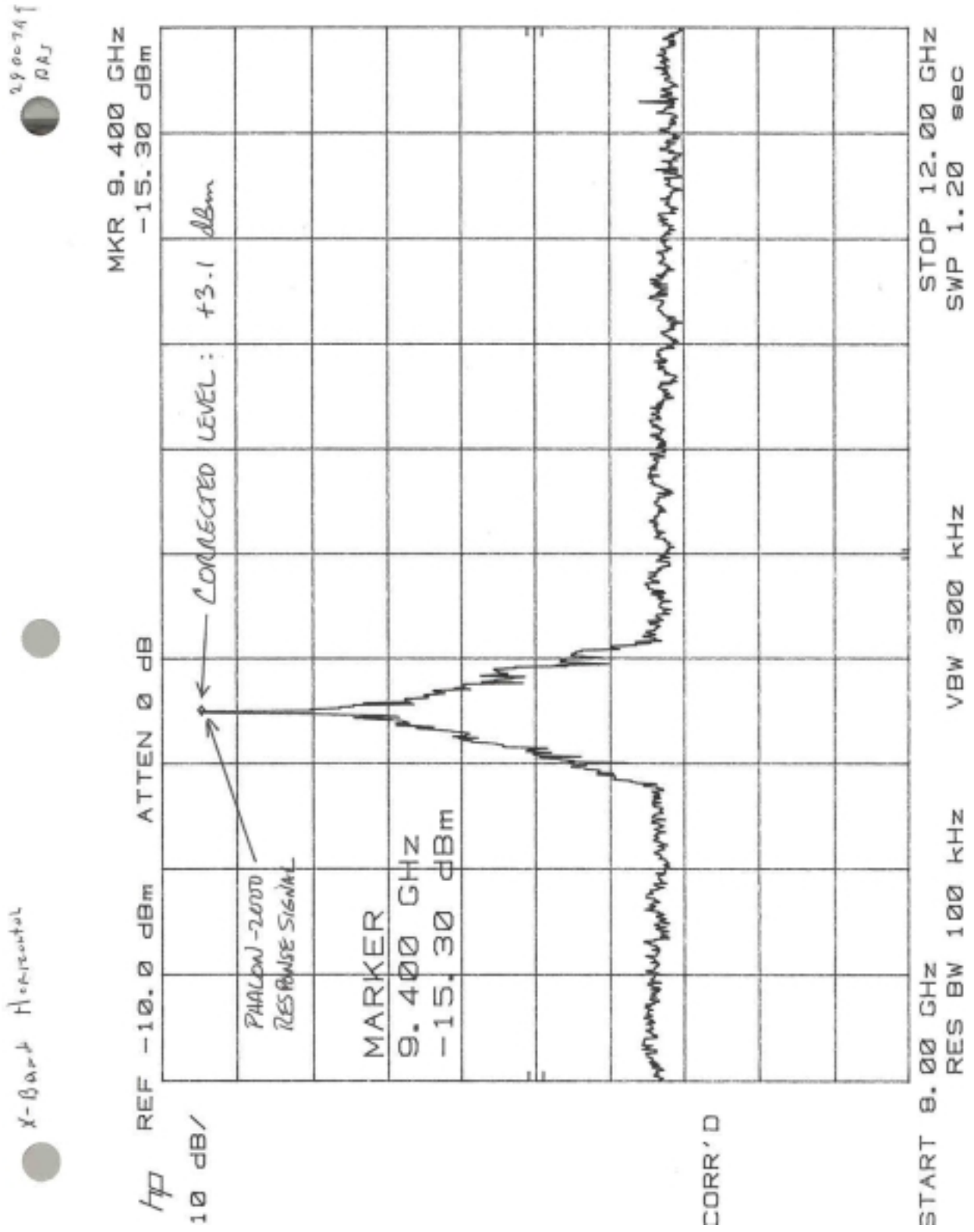

S-Band Vertical
0.3 meter test distance
DAS
2 Pol 799
MKR 25.548 GHz
-63.00 dBm
REF 0.0 dBm
HARMONIC 6
10 dB/
CNVLOSS
18.0
dB
CORRECTED LEVEL: -24.64 dBm
LIMIT: -11.92 dBm
START 18.00 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 26.50 GHz
SWP 213 msec

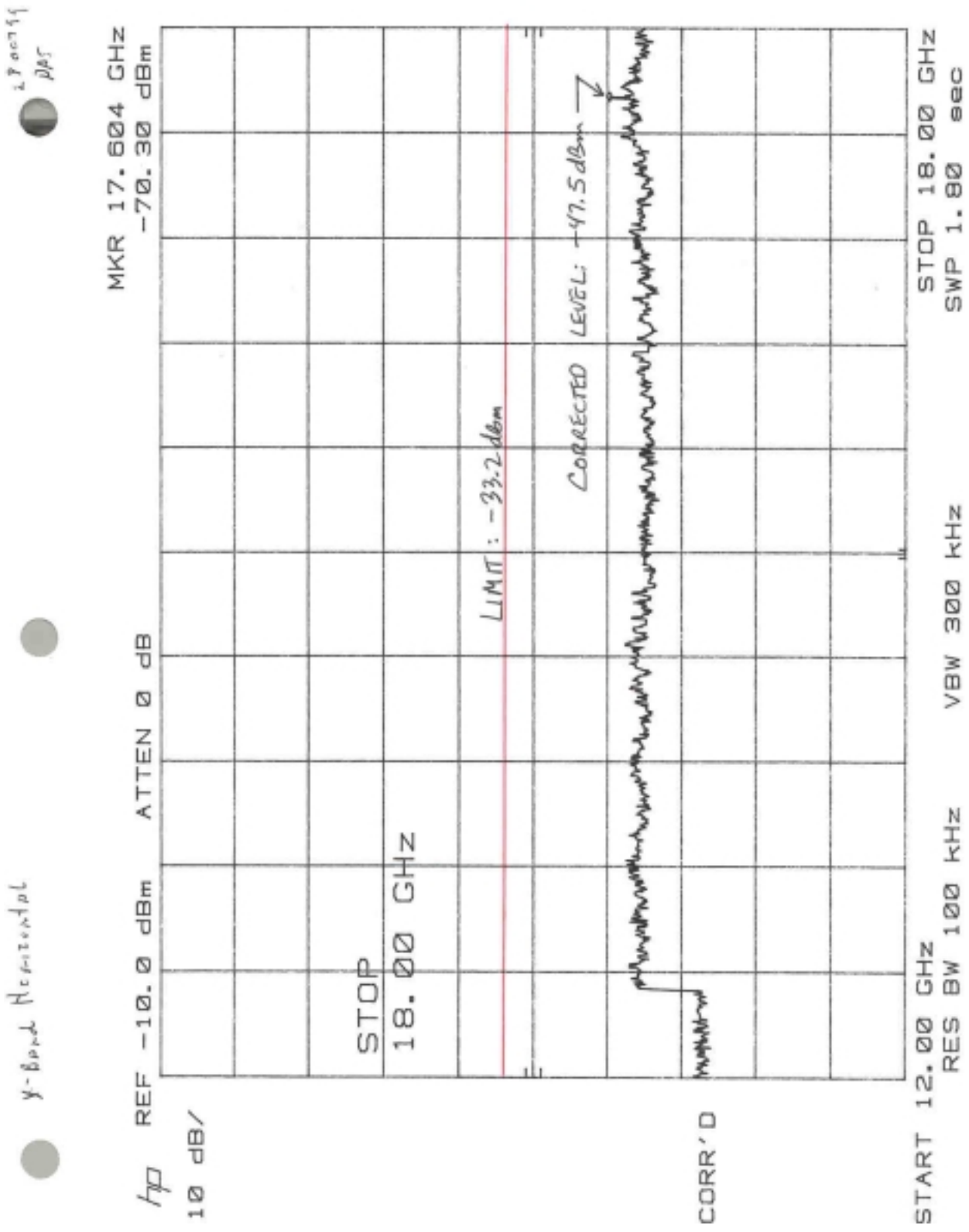

MKR 36.81 GHz
-54.50 dBm
REF 0.0 dBm
HARMONIC 8L
10 dB/
CNVLOSS
20.0
dB
MARKER
36.81 GHz
-54.50 dBm
CORRECTED LEVEL: -30.97 dBm
LIMIT: -11.52 dBm
START 26.5 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 40.0 GHz
SWP 338 msec

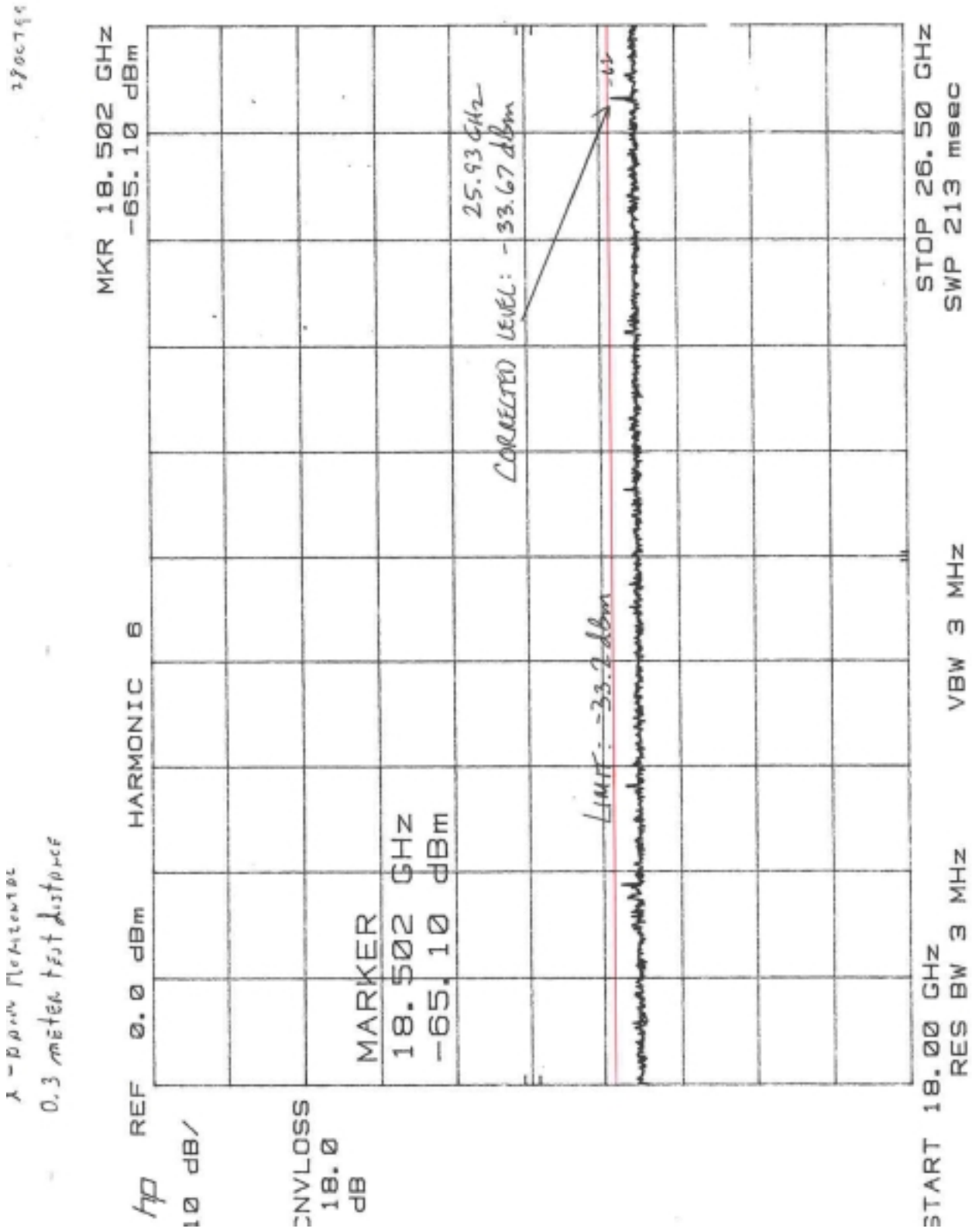

X-Band Horizontal
Log
dB
MKR 1.016 GHz
-64.60 dBm
2 1.994 GHz
-65.1
REF -10.0 dBm
ATTEN 0 dB
10 dB/
LIMIT: -33.2 dBm
STOP
2.00 GHz
CORRECTED LEVEL: -74.7 dBm
CORRECTED LEVEL: -70.2 dBm
CORR'D
START 1.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 2.00 GHz
SWP 300 msec

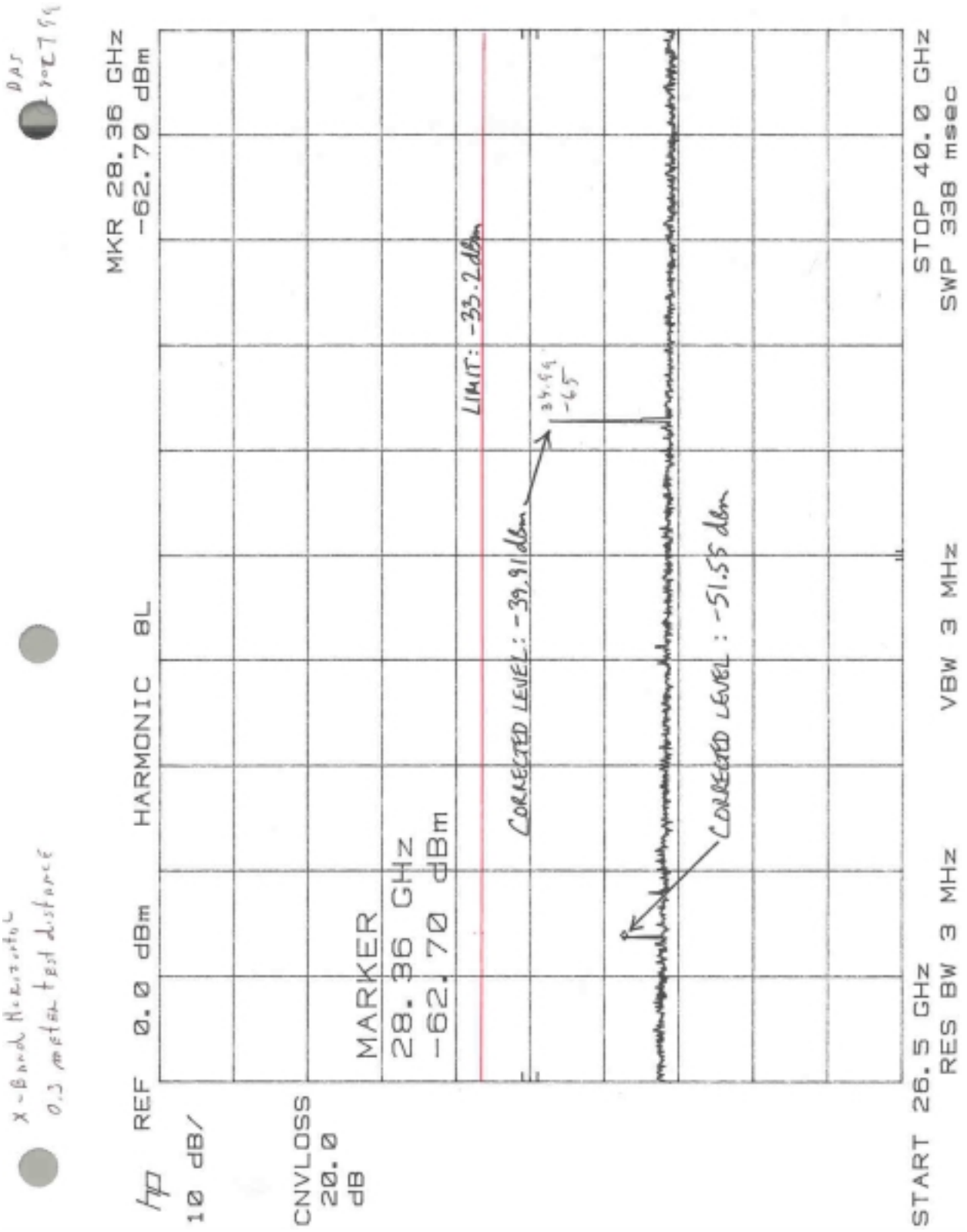

X - Band Horizontal
Report #1
Date
MKR 2.988 GHz
-59.80 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
LIMIT: -33.2 dBm
CORRECTED LEVEL: +60.7 dBm
MARKER
2.988 GHz
-59.80 dBm
2.456 GHz
-69.4 dBm
CORR'D
START 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 4.00 GHz
SWP 600 msec


MKR 7.832 GHz
-72.30 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
STOP
8.00 GHz
LIMIT: -33.2 dBm
CORRECTED LEVEL -6.2 dBm
CORR'D
START 4.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 8.00 GHz
SWP 1.20 sec


MKR 9.400 GHz
-15.30 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
CONNECTED
LEVEL : +3.1 dBm
PHALON -2000
RESPONSE SIGNAL
MARKER
9.400 GHz
-15.30 dBm
CORR'D
START 8.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 12.00 GHz
SWP 1.20 sec


MKR 17.604 GHz
-70.30 dBm
REF -10.0 dBm
ATTEN 0 dB
10 dB/
STOP
18.00 GHz
LIMIT: -33.2 dBm
CORRECTED LEVEL: -47.5 dBm
CORR'D
START 12.00 GHz
RES BW 100 kHz
VBW 300 kHz
STOP 18.00 GHz
SWP 1.80 sec


MKR 18.502 GHz
-65.10 dBm
REF 0.0 dBm
HARMONIC 6
10 dB/
CNVLOSS
18.0
dB
MARKER
18.502 GHz
-65.10 dBm
25.93 GHz
CORRECTED LEVEL: -33.67 dBm
LIMIT: -33.2 dBm
START 18.00 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 26.50 GHz
SWP 213 msec

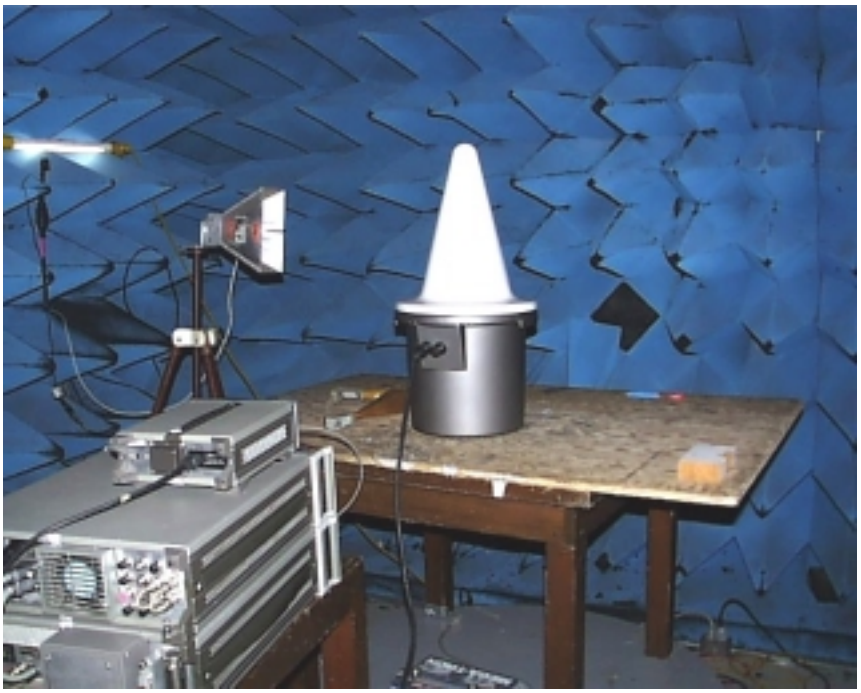

X-Band Horizontal
0.3 meter test distance
DAS
REF 0.0 dBm
HARMONIC 8L
10 dB/
CNVLOSS
20.0
dB
MARKER
28.36 GHz
-62.70 dBm
MKR 28.36 GHz
-62.70 dBm
LIMIT: -33.2 dBm
CORRECTED LEVEL: -39.91 dBm
34.64
-4.5
CORRECTED LEVEL: -51.55 dBm
START 26.5 GHz
RES BW 3 MHz
VBW 3 MHz
STOP 40.0 GHz
SWP 338 msec

EQUIPMENT USE REPORT

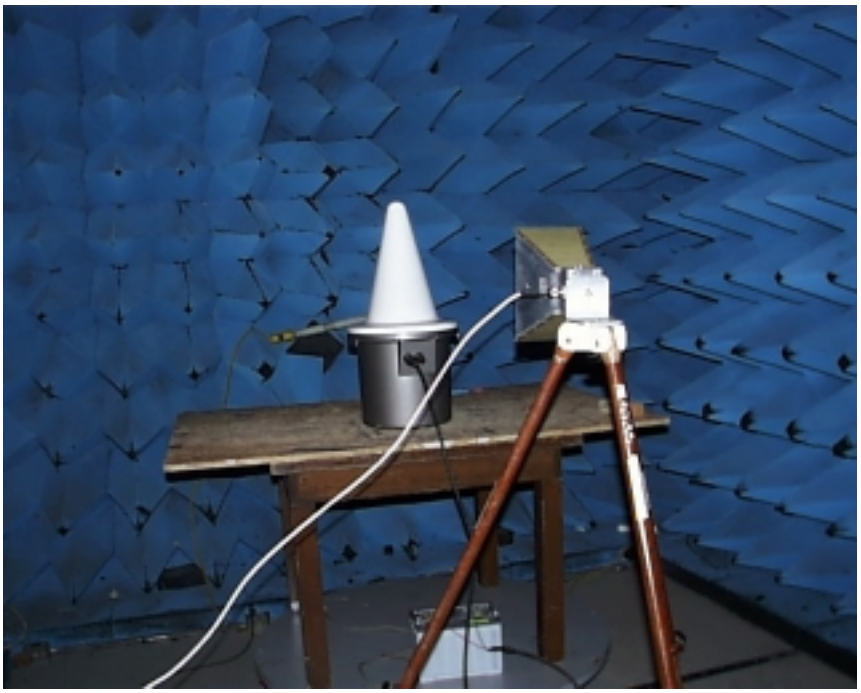
Date:	October 28, 1999		
Project #	10-2192-202	**Project Manager**	D. Carmony
Test Location :	SE9 room	**Technician:**	D.Smith

Field Strength of Spurious Radiation Test Equipment				**Cal. Due**
Manufacturer	**Description**	**Model No.**	**Serial No.**	
HP	Signal Generator	8350A	2120A00685	19 Mar 00
HP	RF Plug In	83592A	2125A00179	19 Mar 00
HP	Spectrum Analyzer	8566B	2152A0312	12 Feb 00
EMCO	Double Ridge Horn	3115	501	02 Dec 99
EMCO	Double Ridge Horn	3115	2043	06 Jan 00
SWRI	1-18 GHz Preamp	JCA018-505	101	Verified
HP	2-8 GHz Amp	11975A	2517A01089	05 Nov 99
HP	Harmonic Mixer	11970K	3003A05727	14 Dec 01
HP	Harmonic Mixer	11970A	2332A01252	16 Oct 01
Ma/com	26.5– 40 GHz Antenna	3-28-725	L-001021	Manufacturer data
Systron-Donner	18-26.5 GHz Antenna	DBE 520 20	010	Manufacturer data

PHOTO DOCUMENTATION WORKSHEET	
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202



FIELD STRENGTH OF SPURIOUS RADIATION TEST CONFIGURATION



FIELD STRENGTH OF SPURIOUS RADIATION TEST CONFIGURATION

APPENDIX E

FREQUENCY STABILITY

Date: 25-26 October 1999
Test Technician: David Smith

Frequency Stability: Supply Voltage

S Band

Input Voltage (Vdc)	% of Nominal	Input Frequency (MHz)	Phalcon-2000 Response Frequency (MHz)	Response frequency change from nominal voltage (MHz)
10.2	85	2997.65	2997.92	0.28
12	100	2997.70	2997.64	-
13.8	115	2997.68	2999.28	1.64
20.4	85	2997.62	2998.58	-0.6
24	100	2997.73	2999.18	-
27.6	115	2997.68	2998.88	-0.3

Ambient: 71 Degrees, 44 % Humidity

X Band

Input Voltage (Vdc)	% of Nominal	Input Frequency (MHz)	Phalcon-2000 Response Frequency (MHz)	Response frequency change from nominal voltage (MHz)
10.2	85	9400.02	9399.70	0.18
12	100	9400.01	9399.52	-
13.8	115	9400.11	9399.72	0.2
20.4	85	9400.17	9399.46	-0.6
24	100	9400.03	9400.06	-
27.6	115	9400.08	9399.86	-0.2

Date: 26 October 1999
Test Technician: David Smith

Frequency Stability: Temperature

S Band

Temperature Degrees C	Time	Input Frequency (MHz)	Input Frequency Drift (MHz)	Phalcon-2000 response frequency (MHz)	Response frequency change (MHz)
50	11:30	2997.67	2997.84 MHz (max) 2997.67 MHz (min) 170 kHz drift	2997.56	2997.83 MHz (max) 2996.92 MHz (min) 910 kHz drift
40	12:15	2997.67		2996.92	
30	13:00	2997.78		2997.83	
20	13:50	2997.82		2997.82	
10	14:20	2997.70		2997.47	
0	14:50	2997.82		2997.58	
-10	15:20	2997.84		2997.62	
-20	15:50	2997.78		2997.46	

X Band

Temperature Degrees C	Time	Input Frequency (MHz)	Input Frequency Drift (MHz)	Phalcon-2000 response frequency (MHz)	Response frequency change (MHz)
50	11:30	9398.44	9399.05 MHz (max) 9398.44 MHz (min) 590 kHz drift	9397.74	9398.82 MHz (max) 9397.74 MHz (min) 1.08 MHz drift
40	12:15	9398.48		9398.00	
30	13:00	9399.05		9398.22	
20	13:50	9398.79		9398.46	
10	14:20	9398.99		9398.82	
0	14:50	9398.72		9398.48	
-10	15:20	9398.70		9398.32	
-20	15:50	9398.48		9398.70	

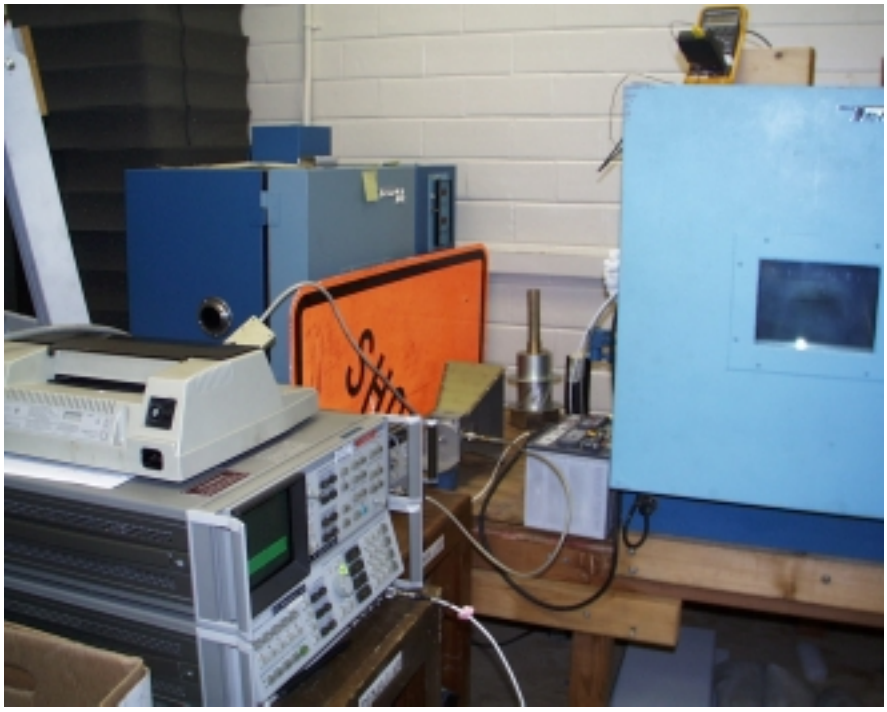
EQUIPMENT USE REPORT

Date:	October 20, 25-26, 1999		
Project #	10-2192-202	**Project Manager**	D. Carmony
Test Location :	SE9 room/ B68 Thermal Chamber	**Technician:**	D.Smith

Frequency Stability Test Equipment				**Cal. Due**
Manufacturer	**Description**	**Model No.**	**Serial No.**	
HP	Signal Generator	8350A	2120A00685	19 Aug 00
HP	RF Plug In	83592A	2125A00179	19 Aug 00
HP	Spectrum Analyzer	8566B	2152A03129	12 Feb 00
EMCO	Horn Antenna	3115	0501	2 DEC 99
HP	Power Supply	6291A	2240A-07844	Verified
---	12 Volt Automotive Battery	----	----	Verified
Narda	Directional Coupler	3045-20	110	Not Required
Narda	Directional Coupler	3003-20	09013	Not Required
Fluke	Thermocouple Module	80TK	4090	1 Aug 00
Fluke	DVM	87	64330494	29 Sept 00
EMCO	Horn Antenna	3115	0501	2 DEC 99
Fluke	DVM	89	74330134	18 OCT 00
Cole Palmer	Temperature / Humidity	3310-40	13939	02 FEB 00
Tenny	Benchtop Temperature Chamber	Temp Guard III	---	Verified

PHOTO DOCUMENTATION WORKSHEET	
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202

FREQUENCY STABILITY (TEMPERATURE) TEST CONFIGURATION



FREQUENCY STABILITY (TEMPERATURE) TEST CONFIGURATION

PHOTO DOCUMENTATION WORKSHEET	
EUT: Phalcon-2000	Tested By: D.Smith
Client: Automatic Power	Project #: 10-2192.202

FREQUENCY STABILITY (VOLTAGE) TEST CONFIGURATION