FCC CERTIFICATION TEST REPORT

prepared for

Nomadic Communications PTY Ltd.
Level 3, 26-28 Prospect Street
Box Hill, Victoria
Australia 3128

FCC ID: OKKNMX920

February 14, 2000

WLL PROJECT #: 5633X

TABLE OF CONTENTS

Statement of Qualifications

1.0 INTRODUCTION **1**

1.1 SUMMARY 1

2.0 DESCRIPTION OF EQUIPMENT UNDER TEST (EUT) **2**

3.0 TEST CONFIGURATION **2**

3.1 RF OUTPUT POWER (FCC RULE PART 2.1046) 2
3.2 MODULATION CHARACTERISTICS (FCC RULE PART 2.1047) 3
3.3 OCCUPIED BANDWIDTH (FCC RULE PART 2.1049) 3
3.5 RADIATED EMISSIONS TESTING (FCC RULE PART 2.1053) 4
3.5.1 Radiated Data Reduction and Reporting *4*
3.6 FREQUENCY STABILITY (FCC RULE PART 2.1055) 6
3.6.1 Frequency Stability for Voltage Variation *7*
3.6.2 Frequency Stability for Temperature Variation *8*

TABLES

Table 1. Radiated Emissions Data
Table 2. Measurement Equipment Used

APPENDICES

Appendix A. Occupied Bandwidth Plot
Appendix B. Spurious Emissions at Antenna Terminals Plot
Appendix C. Statement of Measurement Uncertainty

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STATEMENT OF QUALIFICATIONS

for

Chad M. Beattie

Washington Laboratories, Ltd.

I am a NARTE-Accredited EMC Test Laboratory Engineer with an Associates in Electronic Systems Technology. I have nine years of electronics experience, the last three years being directly involved in EMI testing. I am qualified to perform EMC testing to the methods described in this test report. The measurements taken within this report are accurate within my ability to perform the tests and within the tolerance of the measuring instrumentation.

By: _____
Chad M. Beattie
Compliance Engineer

Date: February 14, 2000

FCC CERTIFICATION REPORT

for

Nomadic Communications PTY Ltd.

1.0 Introduction

This report has been prepared on behalf of Nomadic Communications PTY Ltd. in support of their application for FCC Certification under Part 90 of the FCC Rules and Regulations.

The Equipment Under Test was the Mobitex® RF Modem (Model NMX920).

All measurements were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code 200066-0) as an independent FCC test laboratory.

Measurements were made on the Equipment Under Test in accordance with FCC Rule Part 2, specifically the requirements stipulated in:

2.1046 RF Power Output
2.1047 Modulation Characteristics
2.1049 Occupied Bandwidth
2.1051 Spurious Emissions at Antenna Terminals
2.1053 Field Strength of Spurious Radiation
2.1055 Frequency Stability

All results reported herein relate only to the item tested. This report shall not be used to claim product endorsement by NVLAP or any agency of the US Government. The measurement uncertainty of the data contained herein is ±2.3 dB. Refer to Appendix C for Statement of Measurement Uncertainty.

1.1 Summary

The Nomadic Communications PTY Ltd. Mobitex® RF Modem complies with the technical requirements of Part 90 of the FCC Rules and Regulations.

2.0 Description of Equipment Under Test (EUT)

The Nomadic Communications PTY Ltd. Mobitex® RF Modem is a 900MHz Mobitex® radio packet modem designed for integration into third party (OEM) equipment. The EUT contains a MMCX Female antenna connector and power/data interface connector. The two watt radio uses GMSK modulation on 12.5kHz channels. The frequency range of operation is from 895 MHz to 905 MHz with up to 800 channels. Testing was performed at a low channel (896.0125 MHz), middle channel (898.375 MHz), and high channel (900.875 MHz).

Frequency Range:	895 MHz - 905 MHz
Modulation:	GMSK
Number of Channels:	800
Maximum Output Power:	2.04 watts

3.0 Test Configuration

3.1 RF Output Power (FCC Rule Part 2.1046)

Testing was performed on a low, middle and high transmit channel. Power to the EUT was supplied via a 7V AC/DC adapter through the interface board.

During testing, the EUT was connected to a DK2 Modem Regulator and Interface Board via the modem cable. The RS-232 port of the DK2 was connected to the PC serial port for software control. Specific Nomadic software program (NMXTOOL.EXE) was used to program the test frequency, power level, modulation (on/off), transmit time, and transmit control (on/off).

I/O Ports	I/O Cables
RS-232 Port/Modem Port	2 meter shielded/foil, Modem to Interface Board
RF Antenna Port	2 ft., shielded/ braided, Modem to 50Ω Load

The output from the transmitter was connected to a 20dB attenuator and then to the input of an HP 8564E RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the 20dB attenuator. The RF output power across a 50 ohm load termination was measured directly by the analyzer.

RESULTS: The measured RF output power at 896.0125MHz was 32.9 dBm, or 1.95 W.

RESULTS: The measured RF output power at 898.375MHz was 33.1 dBm, or 2.04 W.

RESULTS: The measured RF output power at 900.875MHz was 33.0 dBm, or 1.995 W.

3.2 Modulation Characteristics (FCC Rule Part 2.1047)

The transmitter module contains a gaussian filter and digitally controlled components to limit the modulation level. These components are adjusted only in manufacturing.

In order to confirm the modulation characteristics of the sample unit, the RF output from the EUT was connected to a Boonton Modulation Meter (M/N:82AD/01A/S10/S13).

RESULTS: The maximum deviation was 3.5 kHz.

3.3 Occupied Bandwidth (FCC Rule Part 2.1049)

The occupied bandwidth was measured by supplying the EUT with a maximum 8000 Hz data rate modulation signal. The RF output of the EUT was connected to the Hewlett Packard Spectrum Analyzer (M/N: HP 8564E) via a 20dB attenuator. The spectrum analyzer measurement resolution bandwidth and video bandwidth were set to 300 Hz.

Results of the testing are displayed in Appendix A of this report.

RESULTS: At 896.0125 MHz, OBW = 8 kHz

RESULTS: At 898.375 MHz, OBW = 8.16 kHz

RESULTS: At 900.875 MHz, OBW = 8.44 kHz

3.4 Spurious Emissions at Antenna Terminals (FCC Rule Part 2.1051)

Spurious emissions were measured by connecting the antenna terminals to the input of an HP 8564E spectrum analyzer via a 20dB attenuator. The unit was supplied with the maximum 8000 Hz pseudo-random data modulation signal. Per Section 90.210(j) of the FCC Rules, any emission shall be attenuated below the unmodulated carrier power by the following:

1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 2.5kHz, but no more than 6.25kHz: At least 53 log (f_d/2.5) dB.

2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 6.25kHz, but no more than 9.5kHz: At least 103 log (f_d/3.9) dB.

3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 9.5kHz: At least 157 log (f_d/5.3) dB or 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

For the EUT:

50 + 10 Log (2.04) W = 53.1 dB
(Unmodulated power = 32.2 dBm)

The emissions were checked up to the tenth harmonic of the carrier frequency (9.9 GHz); all emissions above 1GHz were suppressed at least 55 dB below the unmodulated carrier level. Appendix B shows plots of the spurious emissions up to a frequency of 9.9 GHz.

RESULTS: The EUT complies with the emission mask requirements of Section 90.210(j) of the FCC Rules for the three channels tested. Plots in Appendix B depict the emission mask, unmodulated signal power, and spurious emission level.

3.5 Radiated Emissions Testing (FCC Rule Part 2.1053)

The EUT was placed on an 80 cm high, 1 X 1.5 meters non-conductive motorized turntable for radiated testing on a 3 meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. Horizontal and vertical field components were measured.

The output from the antenna was connected, via a preselector or preamplifier, to the input of the spectrum analyzer. The detector function was set to peak. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

3.5.1 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limit, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are grouped into a composite antenna factor (AFc) and are supplied in the AFc column of Table 2. The AFc in dB/m is algebraically added to the Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Voltage: VdBµV

Composite Antenna Factor: AFcdB/m

Electric Field: EdBuV/m = VdBµV + AFcdB/m

To convert to linear units: EµV/m=antilog (EdBµV/m/20)

RESULTS: The EUT complies with the requirements. Data is recorded in Table 2.
LIMIT: 84.4 dBµV/m (16595.90 uV/m)

Table 1

FCC Part 90 Radiated Emissions Data - Site 2

CLIENT: Nomadic Communications PTY Ltd.
FCC ID: OKKNMX920
DATE: 4 Jan 00
BY: Chad M. Beattie
JOB #: 5633X

Freq	Polarity	Azimuth	Antenna Height	SA Level (QP)	AFc	E-Field	E-Field	Limit	Margin	
MHz	H/V	Degree	m	dBuV	dB/m	dBuV/m	uV/m	uV/m	dB	Channel
1792.03	V	135.00	1.0	71.7	-7.2	64.5	1673.7	16595.9	-19.9	L
1792.03	H	225.00	1.0	74.5	-7.2	67.3	2310.4	16595.9	-17.1	L
2688.04	V	270.00	1.0	65.7	-4.9	60.8	1092.7	16595.9	-23.6	L
2688.04	H	270.00	1.0	64.3	-4.9	59.4	930.0	16595.9	-25.0	L
3584.05	V	225.00	1.0	52.0	-3.7	48.3	258.7	16595.9	-36.1	L
3584.05	H	180.00	1.0	54.2	-3.7	50.5	333.3	16595.9	-33.9	L
4480.06	V	180.00	1.0	49.3	-2.8	46.5	211.5	16595.9	-37.9	L
4480.06	H	180.00	1.0	49.0	-2.8	46.2	203.6	16595.9	-38.2	L
5376.08	V	180.00	1.0	51.0	-2.1	48.9	279.6	16595.9	-35.5	L
6272.09	V	180.00	1.0	49.0	-0.5	48.5	266.1	16595.9	-35.9	L
6272.09	H	270.00	1.0	55.3	-0.5	54.8	551.6	16595.9	-29.6	L
1796.75	V	180.00	1.0	62.2	-7.2	55.0	562.3	16595.9	-29.4	M
1796.75	H	225.00	1.0	61.00	-7.2	53.8	489.7	16595.9	-30.6	M
2695.13	V	225.00	1.0	56.0	-4.9	51.1	358.1	16595.9	-33.3	M
2695.13	H	270.00	1.0	53.50	-4.9	48.6	268.6	16595.9	-35.8	M
1801.75	V	0.00	1.0	62.0	-7.2	54.8	551.1	16595.9	-29.6	H
1801.75	H	270.00	1.0	62.20	-7.2	55.0	564.0	16595.9	-29.4	H
2702.63	V	225.00	1.0	55.8	-4.9	50.9	350.4	16595.9	-33.5	H
2702.63	H	225.00	1.0	54.20	-4.9	49.3	291.5	16595.9	-35.1	H

3.6 Frequency Stability (FCC Rule Part 2.1055)

The requirements of Part 90 of the FCC Rules and Regulations call for the carrier frequency to be stable under different power supply voltages and over a wide temperature extreme.

The EUT is powered by DC voltage supplied via the DK2 Modem Regulator and Interface Board. The manufacturers power requirements for the EUT include the following:

Low DC Voltage of 6.5 VDC (manufacturer's specification)
High DC Voltage of 7.5 VDC (manufacturer's specifications)

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured with the Racal-Dana Model 1992 Frequency Counter while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter. The following are the reference frequencies at ambient for the Low, Middle, and High channels.

Low Channel: 896.01180 MHz

Mid Channel: 898.37412 MHz

High Channel: 900.87412 MHz

The limit is 1.5 ppm or

Limit = (896.013087×10^6 Hz) x (1.5×10^{-6}) = 1.344 kHz (Low Channel)

Limit = (898.375594×10^6 Hz) x (1.5×10^{-6}) = 1.347 kHz (Mid Channel)

Limit = (900.375599×10^6 Hz) x (1.5×10^{-6}) = 1.351 kHz (High Channel)

3.6.1 Frequency Stability for Voltage Variation

The carrier was measured while the transmitter was powered by 6.5 VDC and then 7.5 VDC. The unit was allowed to stabilize before the carrier frequency was taken.

The results are as follows:

Voltage (Volts DC)	Frequency (MHz)	Deviation (Hz)	Limit (1.5ppm) (kHz)
Low Channel			
6.5	896.01296450	122.5	1.344
7.5	896.01302200	65.0	1.344
Mid Channel			
6.5	898.37566870	-74.7	1.347
7.5	898.37548600	108.0	1.347
High Channel			
6.5	900.37556400	35.0	1.351
7.5	900.37545000	149.0	1.351

3.6.2 Frequency Stability for Temperature Variation

The carrier frequency was measured at 10 degree intervals as the temperature was increased from -30°C to +50°C over the course of 8 hours. The unit was brought to temperature and allowed to stabilize before the carrier frequency was taken.

The results are as follows:

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (kHz) 1.5 ppm
Low Channel			
Ambient	896.01308700	0.0	1.344
50	896.01290800	179.0	1.344
40	896.01311400	-206.0	1.344
30	896.01297900	135.0	1.344
20	896.01309300	-114.0	1.344
10	896.01319800	-105.0	1.344
0	896.01312300	75.0	1.344
-10	896.01306000	63.0	1.344
-20	896.01305300	7.0	1.344
-30	896.01308800	-35.0	1.344

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (kHz) 1.5 ppm
Mid Channel			
Ambient	898.37559400	0.0	1.347
50	898.37540800	186.0	1.347
40	898.37562100	-27.0	1.347
30	898.37547600	118.0	1.347
20	898.37559100	3.0	1.347
10	898.37569600	-102.0	1.347
0	898.37562500	-31.0	1.347
-10	898.37555800	36.0	1.347
-20	898.37555500	39.0	1.347
-30	898.37554600	48.0	1.347

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (kHz) 1.5 ppm
High Channel			
Ambient	900.37559900	0.0	1.351
50	900.37540100	198.0	1.351
40	900.37562500	-26.0	1.351
30	900.37547300	126.0	1.351
20	900.37558700	12.0	1.351
10	900.37569300	-94.0	1.351
0	900.37564000	-41.0	1.351
-10	900.37556000	39.0	1.351
-20	900.37555700	42.0	1.351
-30	900.37553500	64.0	1.351

Table 2

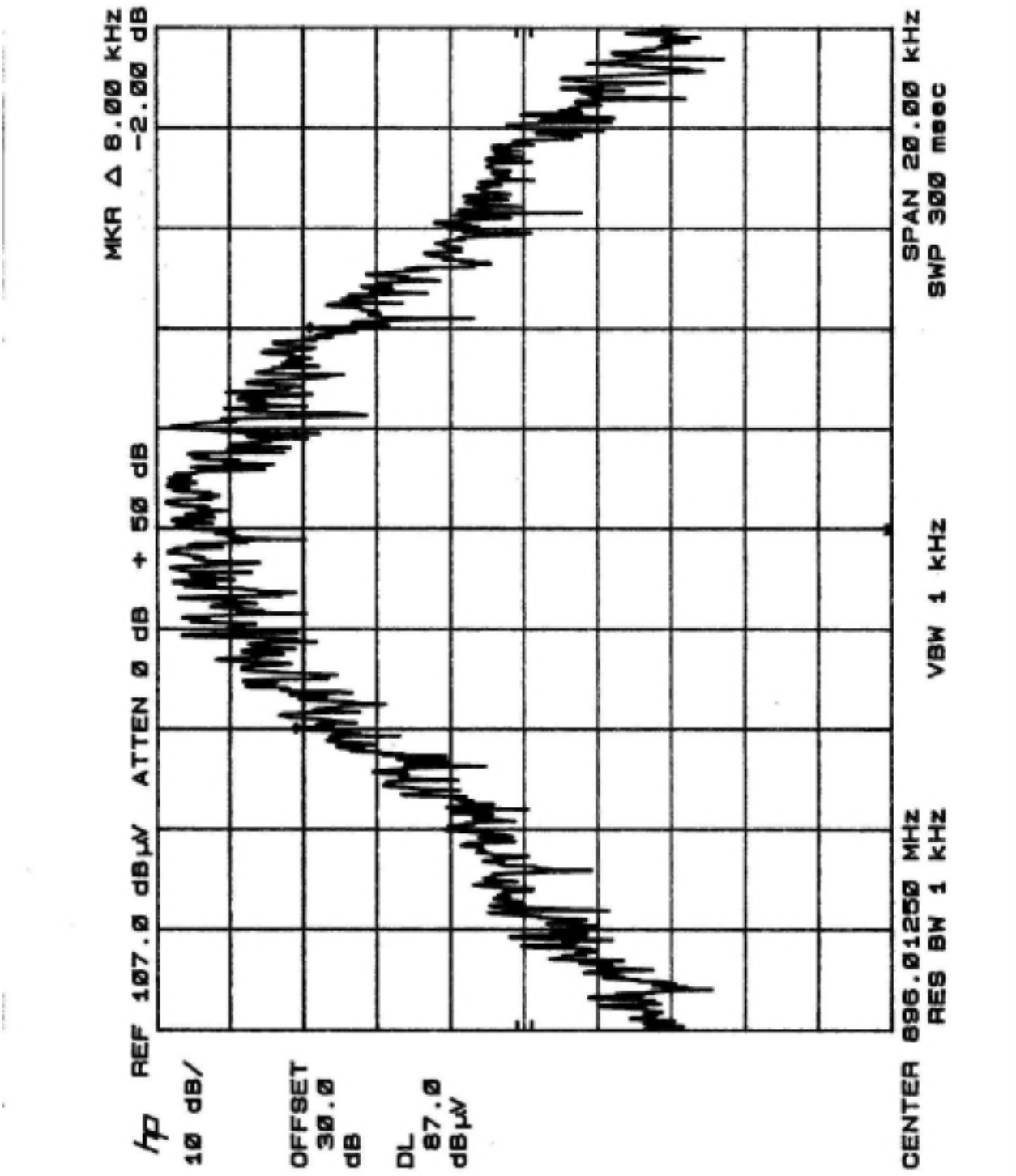
Measurement Equipment Used

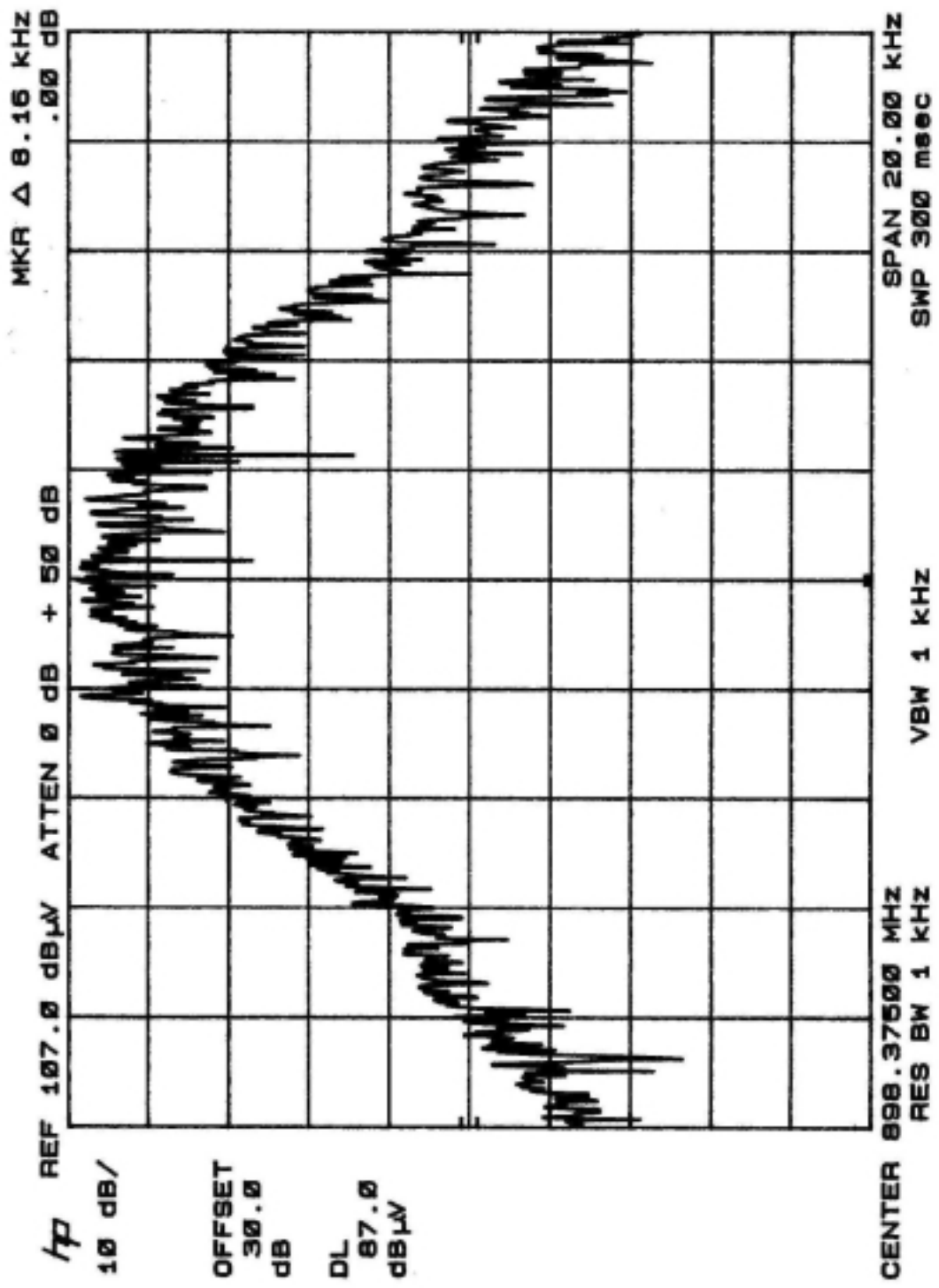
The following equipment is used to perform measurements:

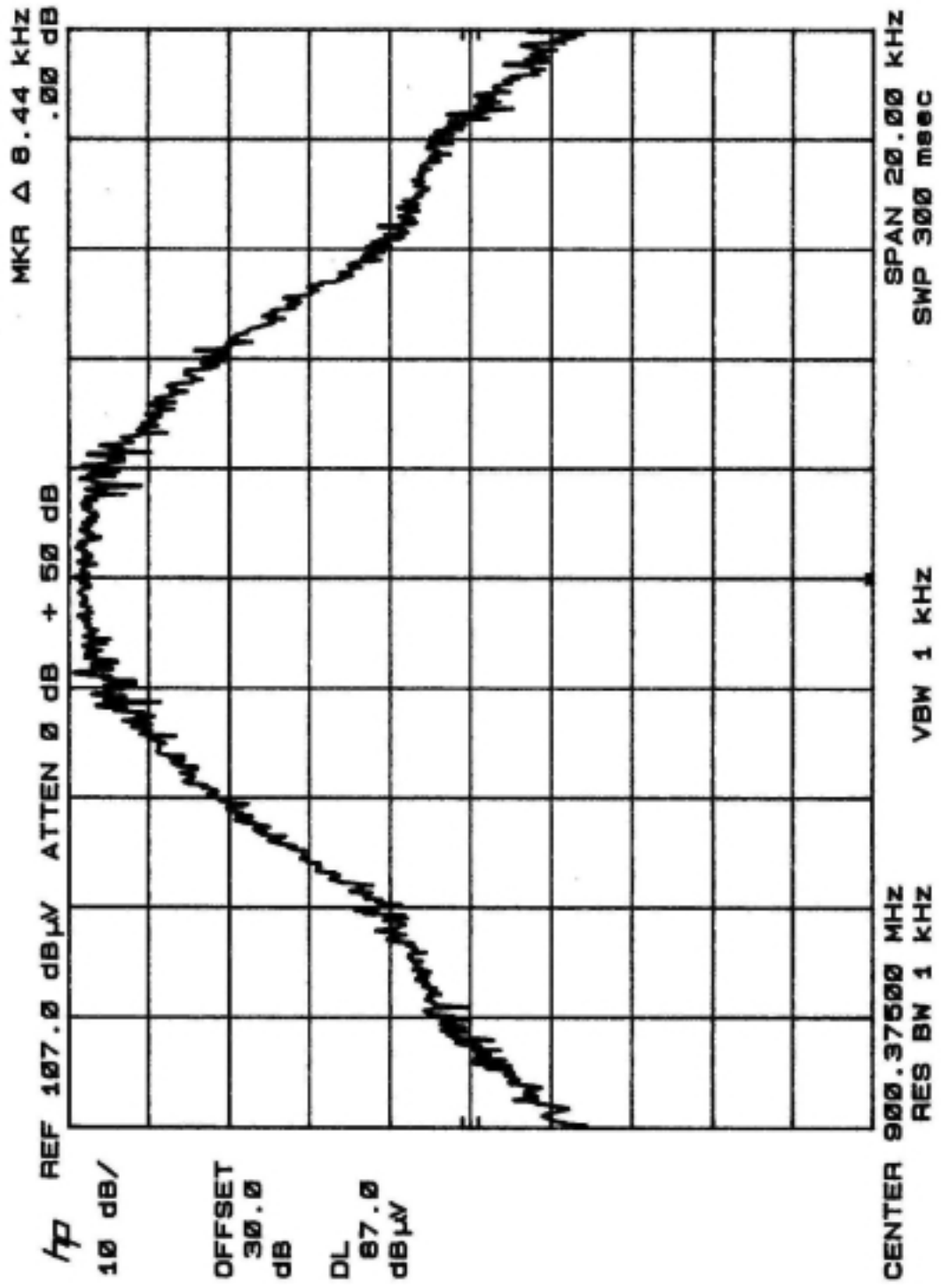
Hewlett-Packard Spectrum Analyzer: HP8564E
Hewlett-Packard Spectrum Analyzer: HP8568B
Hewlett-Packard Spectrum Analyzer: HP8593A
Hewlett-Packard Quasi-Peak Adapter: HP85650A
Hewlett-Packard Preselector: HP85685A
Hewlett-Packard Preamplifier: HP8449B
Antenna Research Associates, Inc. Biconical Log Periodic Antenna: LPB-2520A (Site 2)
Antenna Research Associates, Inc. Horn Antenna: DRG-118/A
Solar 50 Ω/50 µH Line Impedance Stabilization Network: 8012-50-R-24-BNC
Solar 50 Ω/50 µH Line Impedance Stabilization Network: 8028-50-TS-24-BNC
AH Systems, Inc. Portable Antenna Mast: AMS-4 (Site 2)
AH Systems, Inc. Motorized Turntable (Site 2)
RG-214 semi-rigid coaxial cable
RG-223 double-shielded coaxial cable

APPENDIX A

OCCUPIED BANDWIDTH PLOT

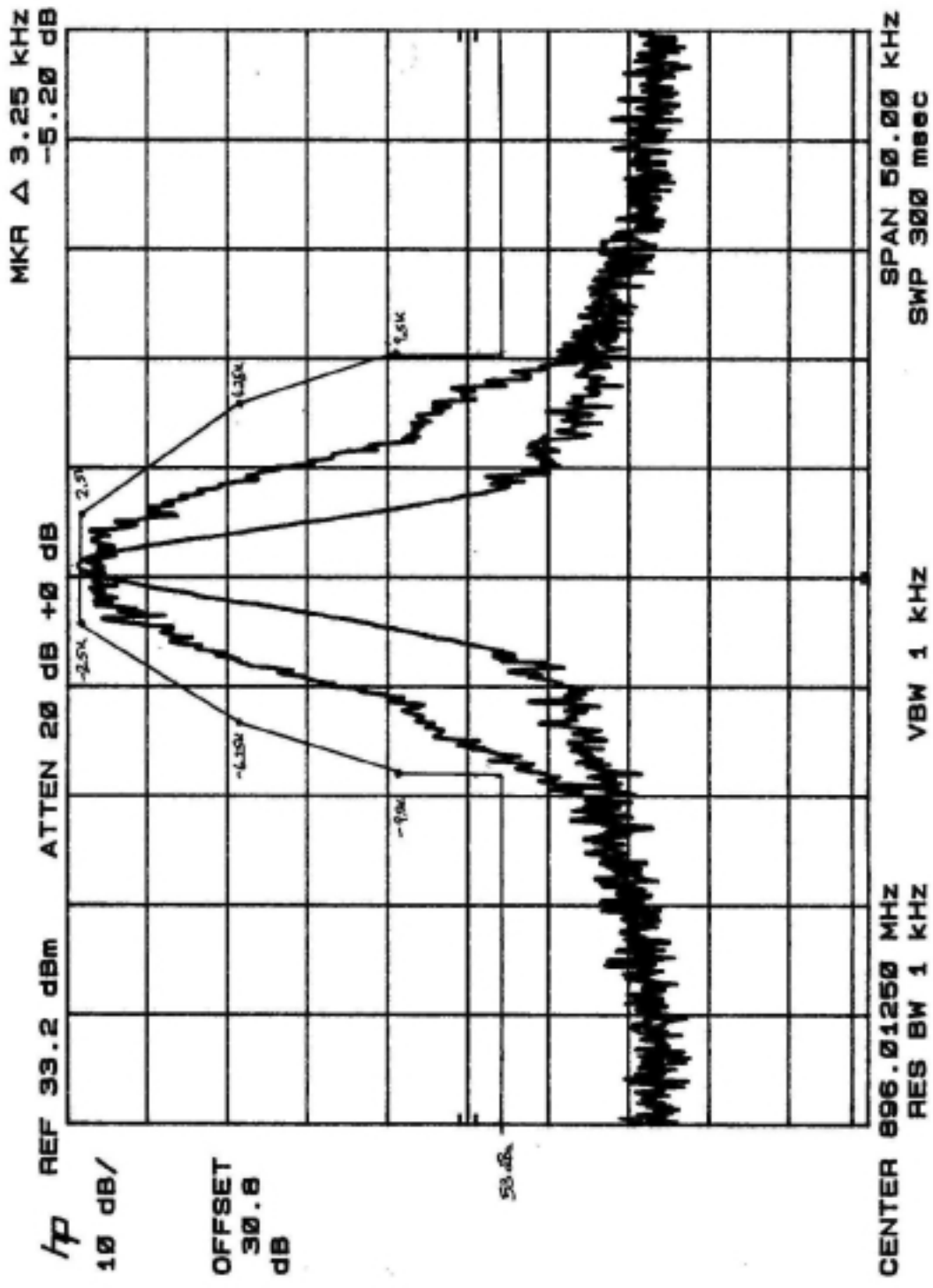

MKR Δ 8.00 kHz
-2.00 dB
REF 107.0 dBµV
ATTEN 0 dB + 50 dB
10 dB/
OFFSET
30.0
dB
DL
87.0
dBµV
SPAN 20.00 kHz
SWP 300 msec
VBW 1 kHz
CENTER 896.01250 MHz
RES BW 1 kHz

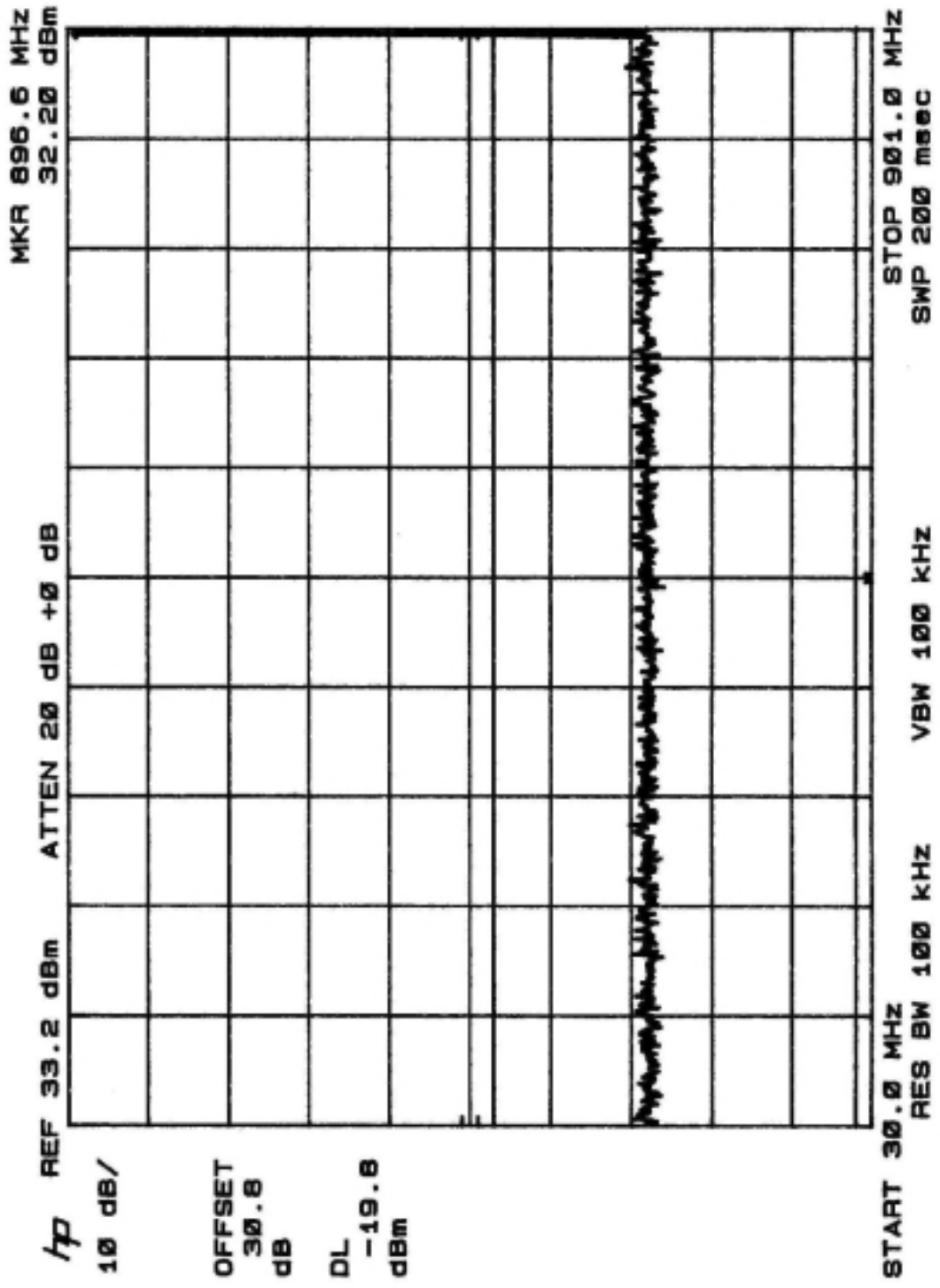

MKR Δ 8.16 kHz
.00 dB
REF 107.0 dBµV
ATTEN 0 dB + 50 dB
10 dB/
OFFSET
30.0
dB
DL
87.0
dBµV
CENTER 898.37500 MHz
RES BW 1 kHz
VBW 1 kHz
SPAN 20.00 kHz
SWP 300 msec

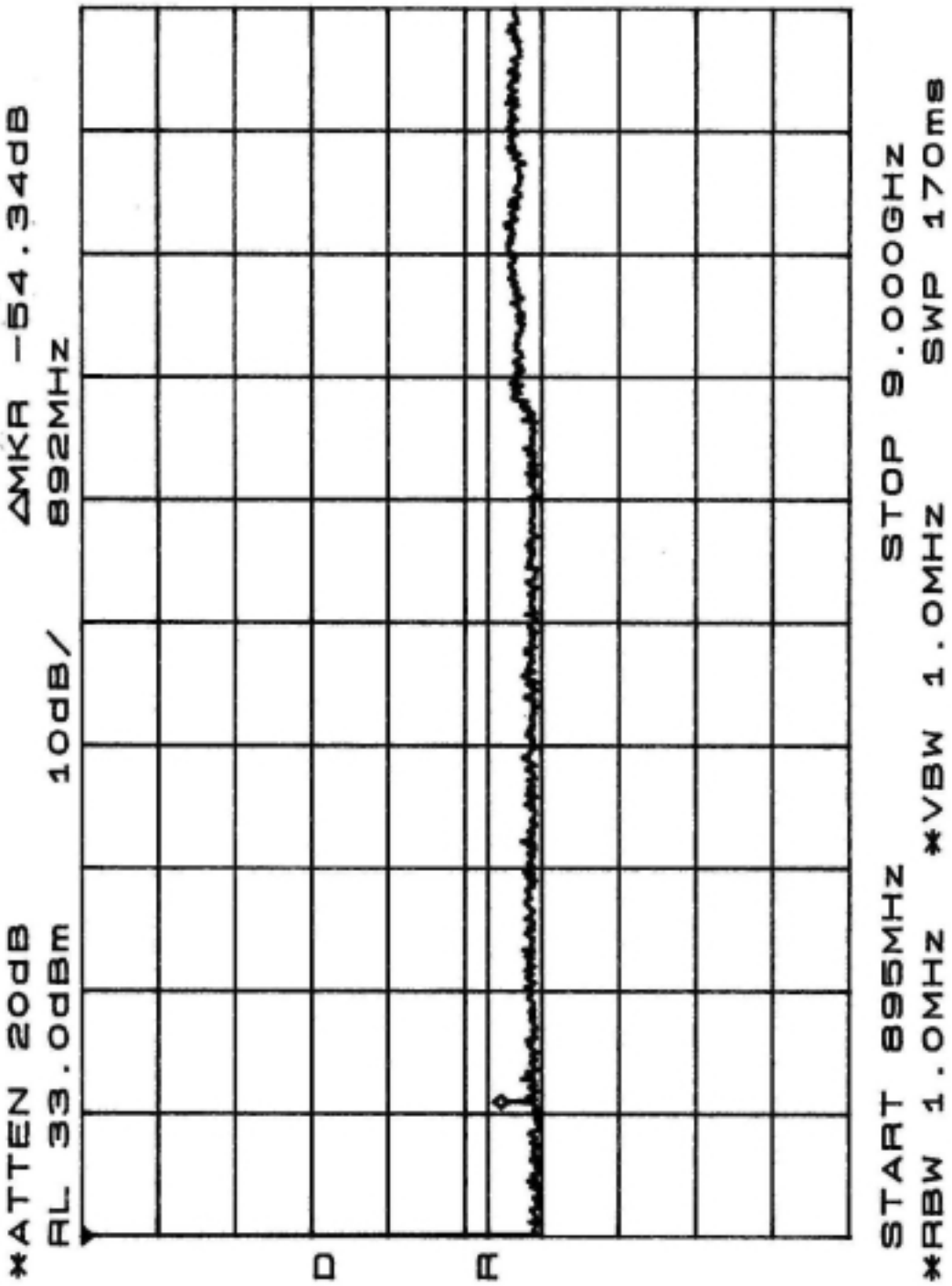

MKR Δ 8.44 kHz
.00 dB
REF 107.0 dBµV
ATTEN 0 dB + 50 dB
10 dB/
OFFSET
30.0
dB
DL
87.0
dBµV
SPAN 20.00 kHz
SWP 300 msec
CENTER 900.37500 MHz
RES BW 1 kHz
VBW 1 kHz

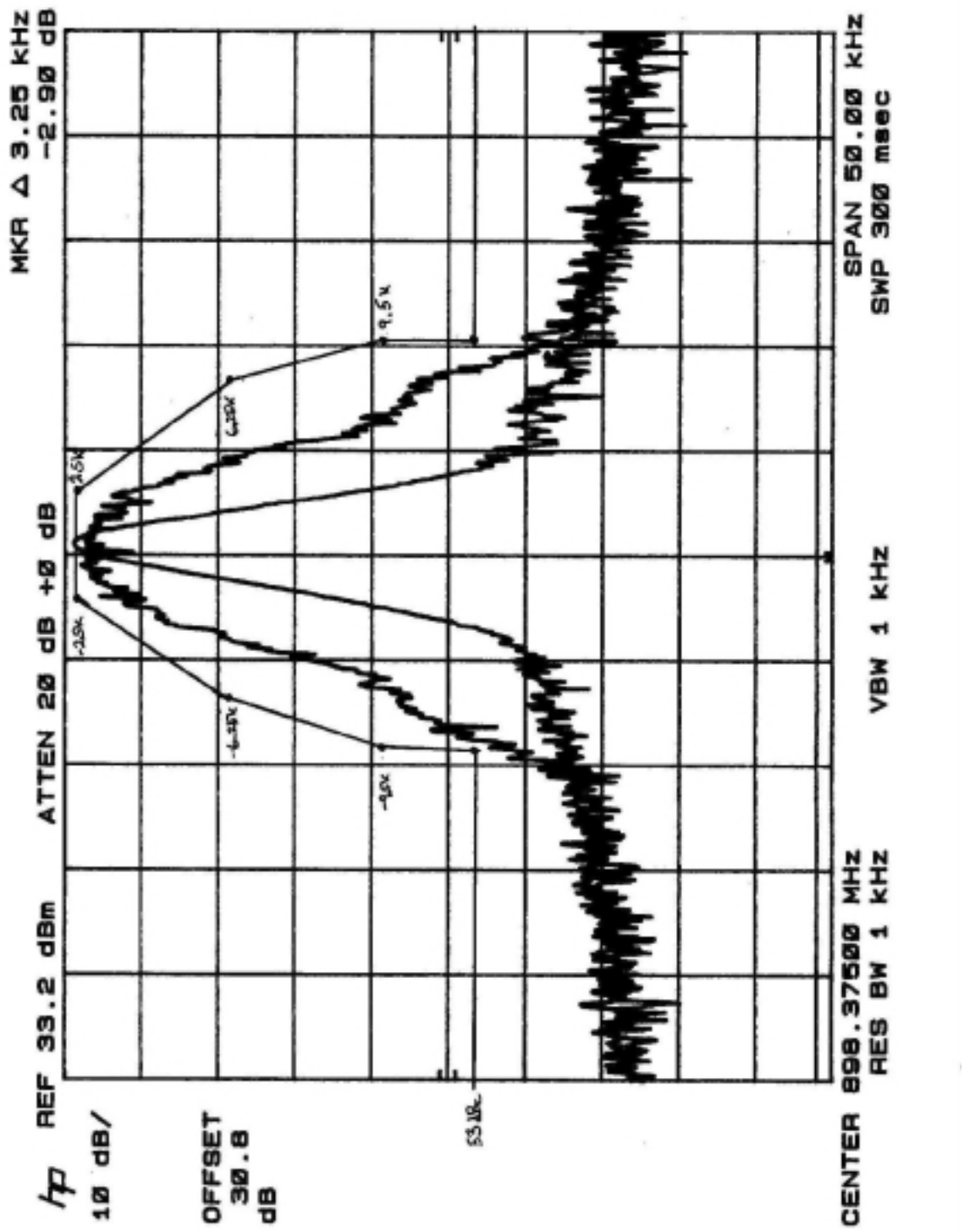
APPENDIX B

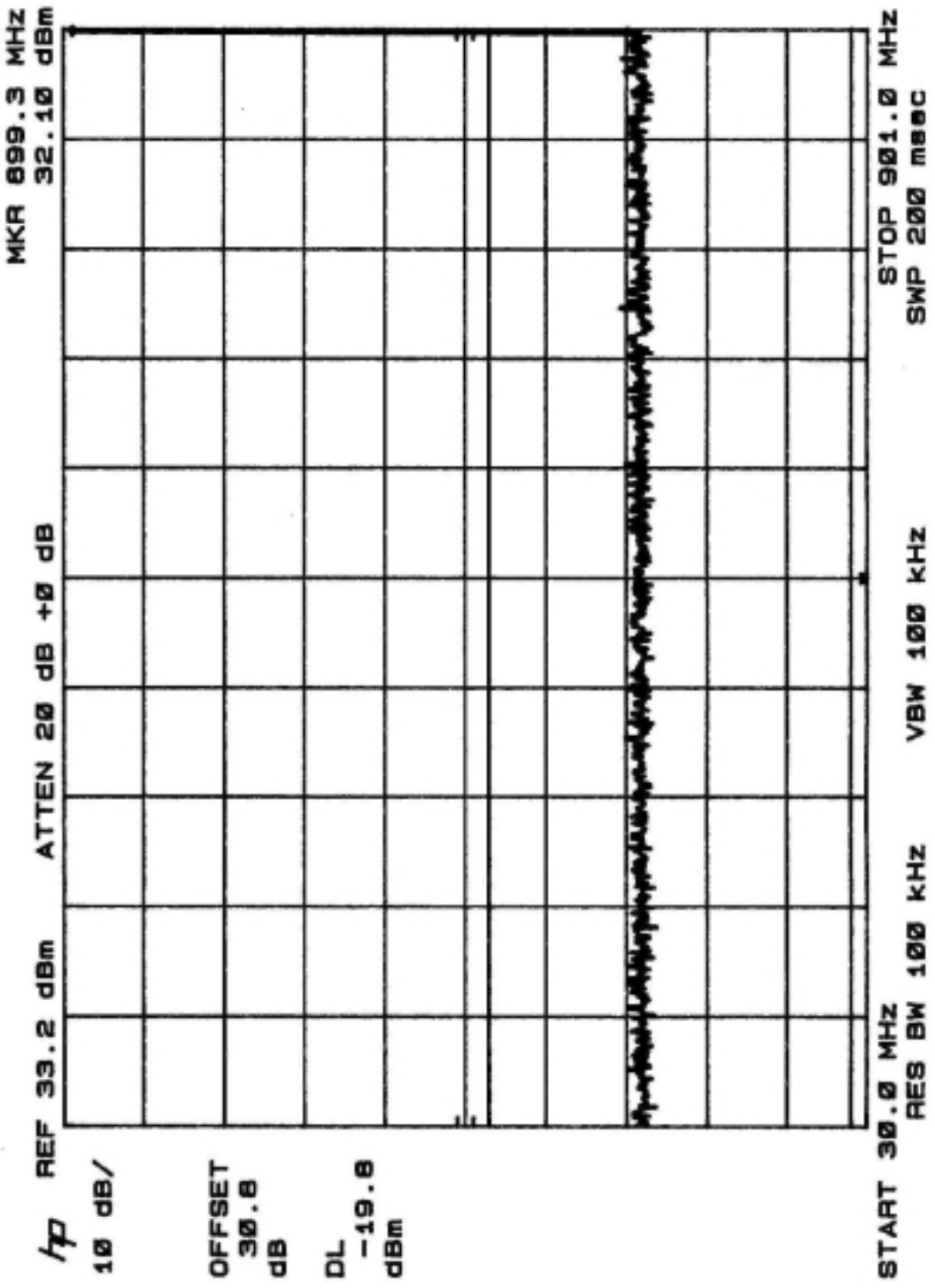
SPURIOUS EMISSIONS AT ANTENNA TERMINALS PLOT

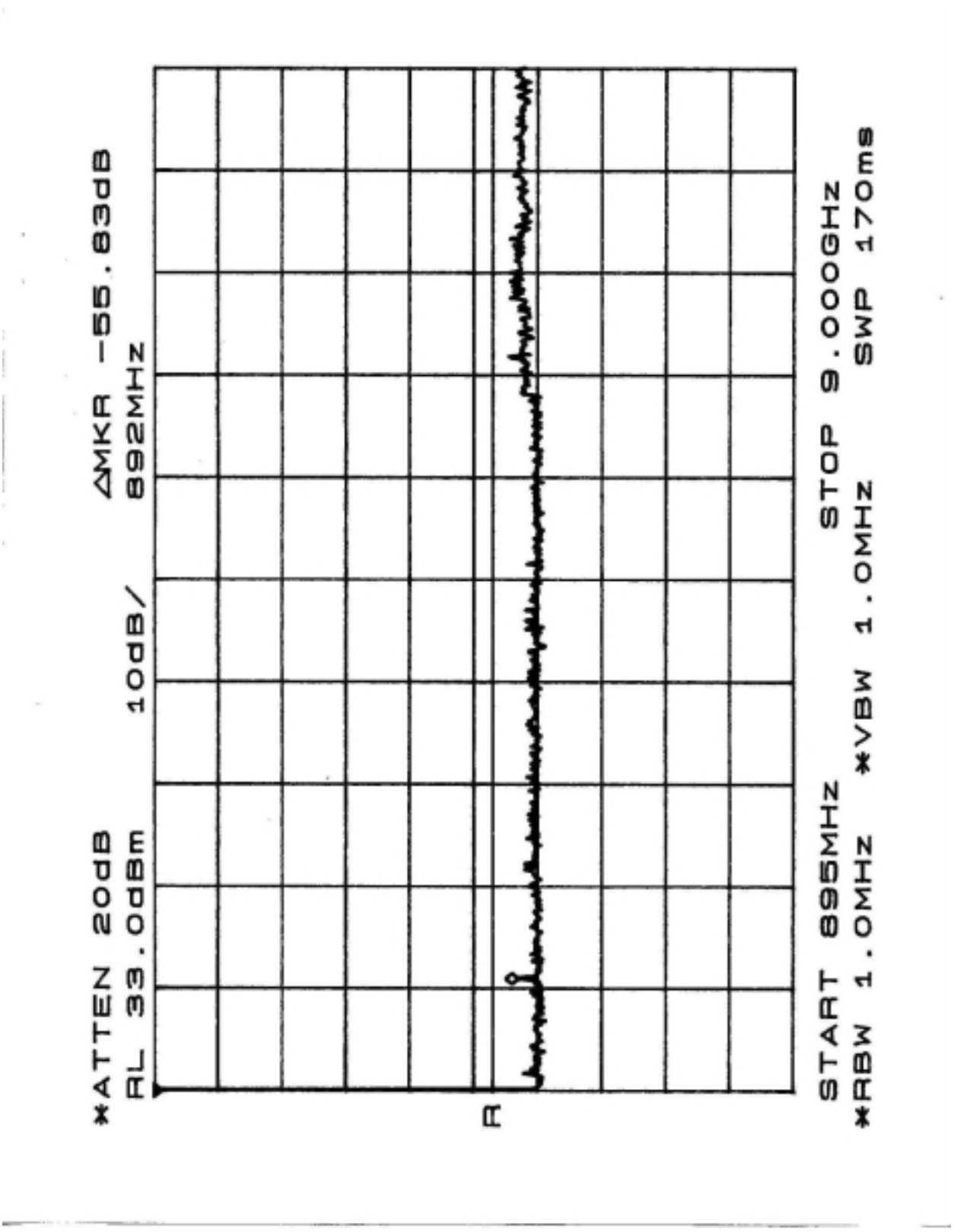

MKR Δ 3.25 kHz
-5.20 dB
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
CENTER 896.01250 MHz
RES BW 1 kHz
VBW 1 kHz
SPAN 50.00 kHz
SWP 300 msec

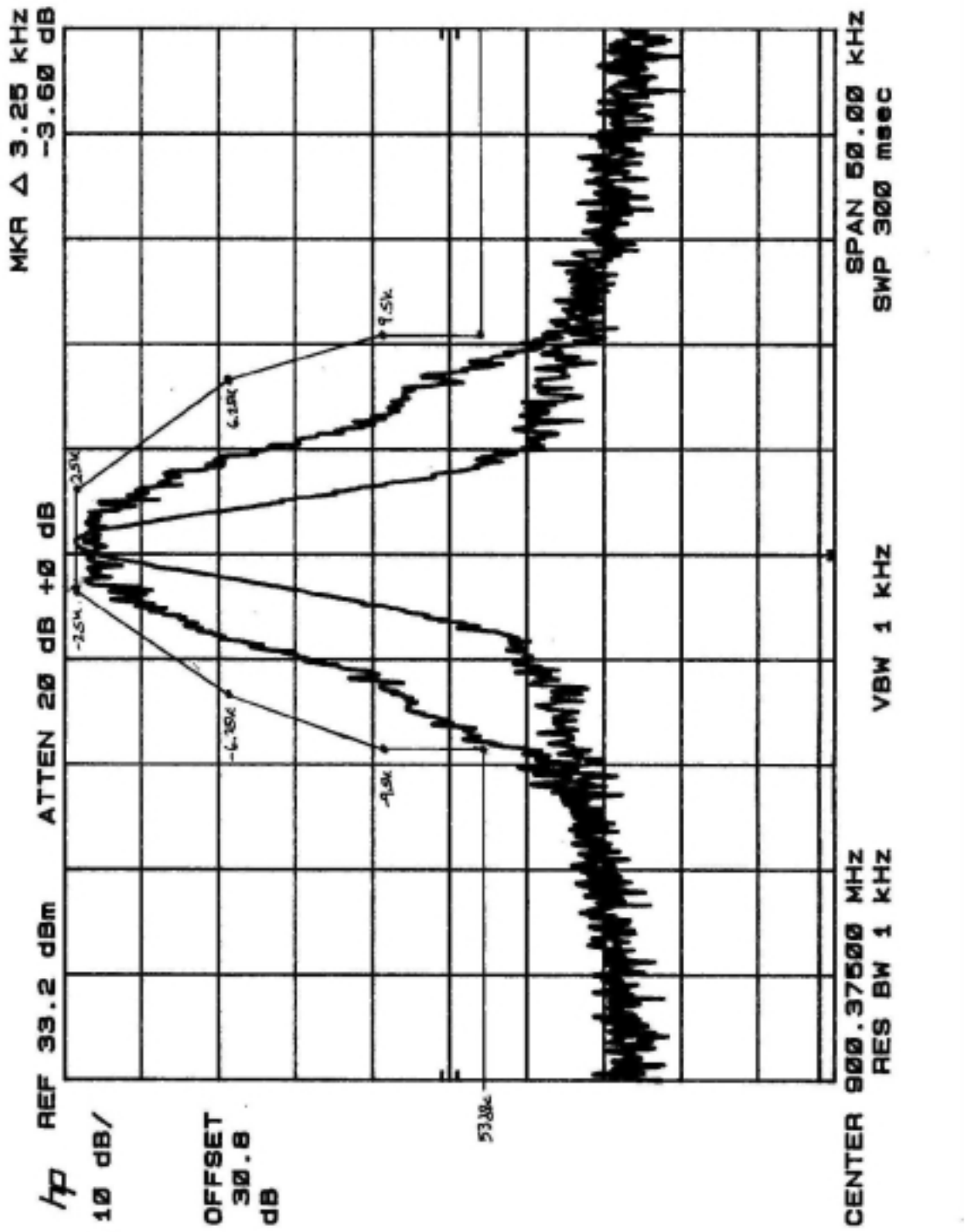

MKR 896.6 MHz
32.20 dBm
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
DL
-19.8
dBm
START 30.0 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 901.0 MHz
SWP 200 msec

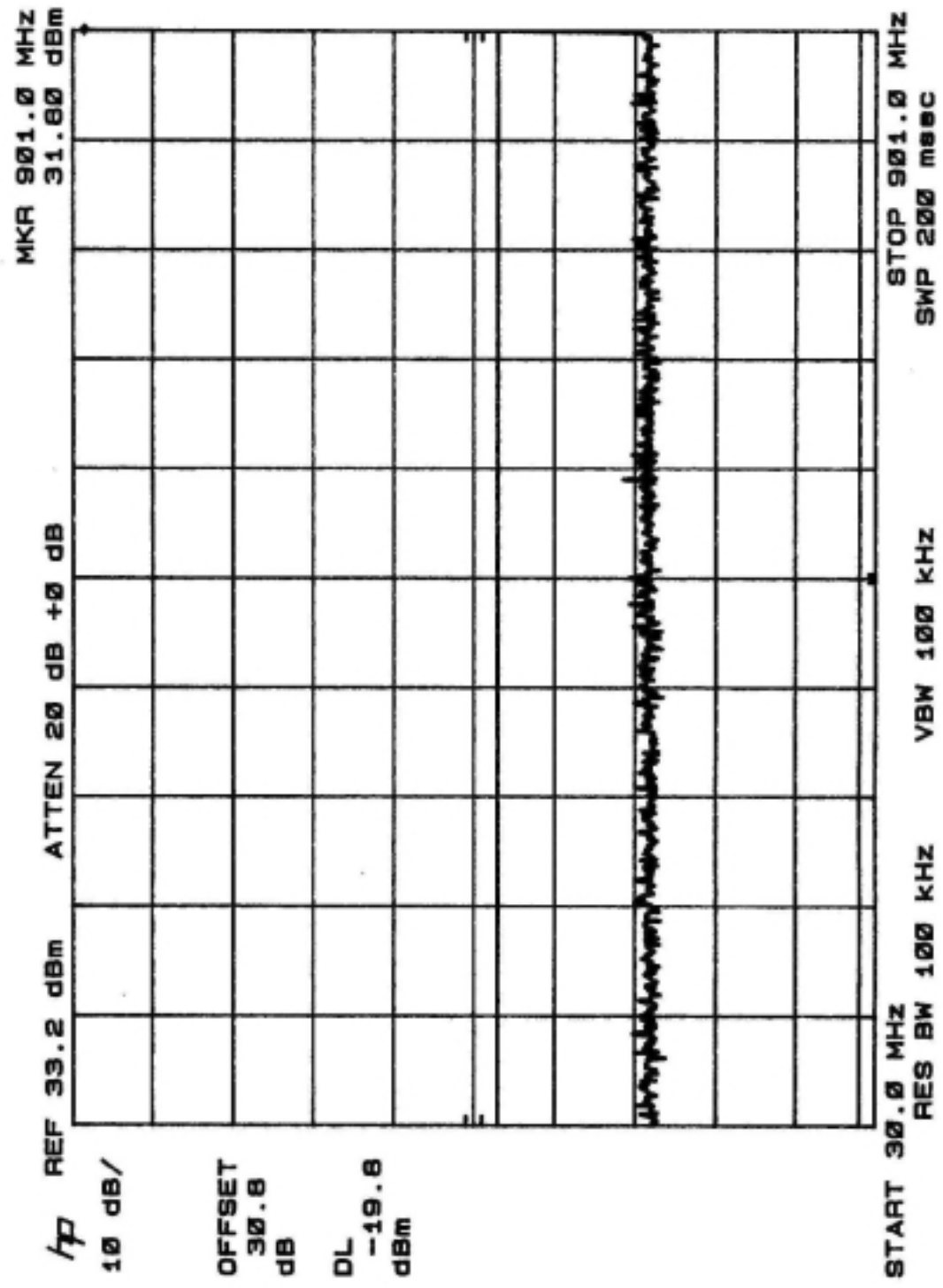

*ATTEN 20dB
RL 33.0dBm
10dB/
ΔMKR -54.34dB
892MHz
D
R
START 895MHz
*RBW 1.0MHz
*VBW 1.0MHz
STOP 9.000GHz
SWP 170ms

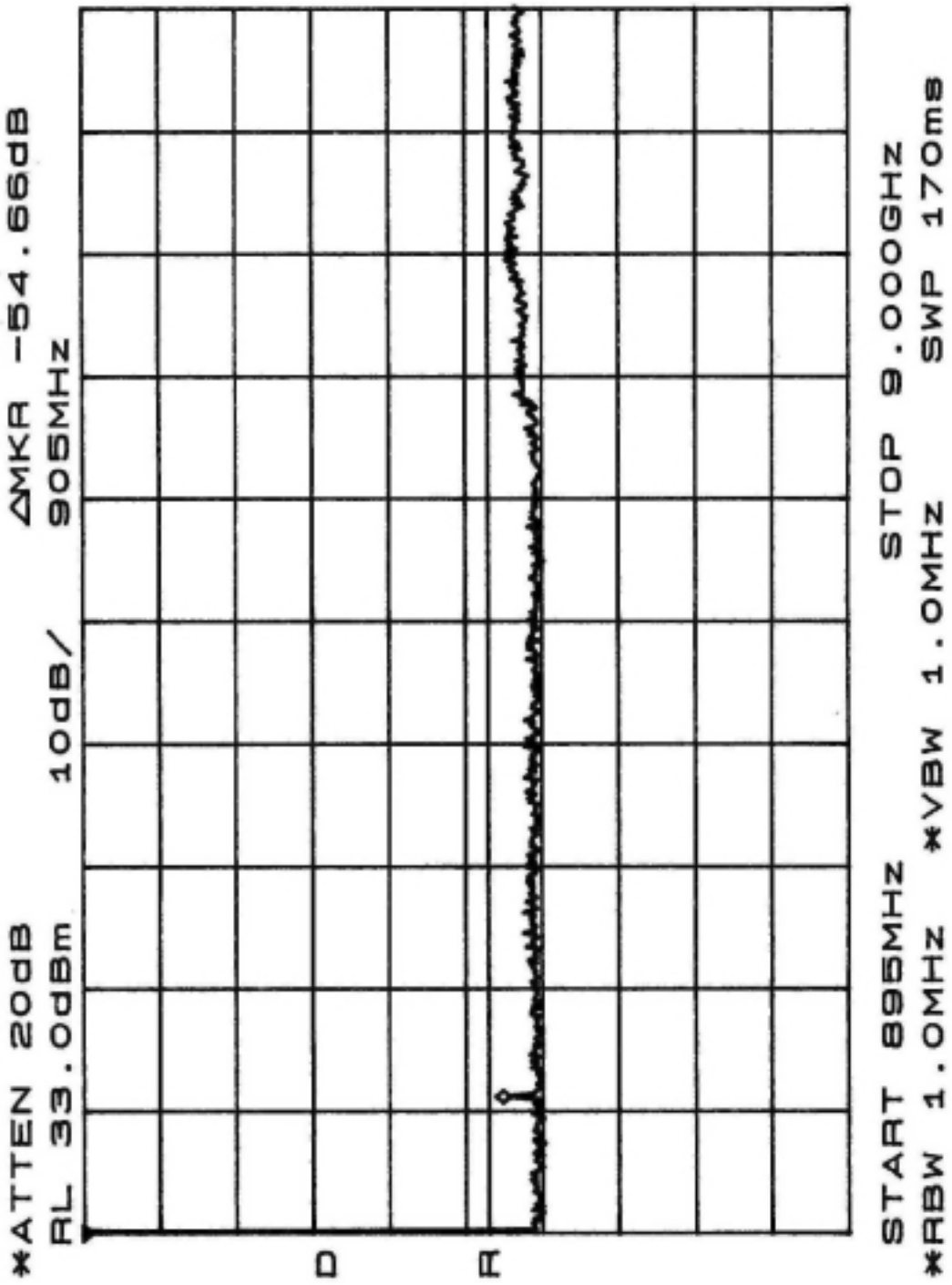

MKR Δ 3.25 kHz
-2.90 dB
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
SPAN 50.00 kHz
SWP 300 msec
CENTER 898.37500 MHz
RES BW 1 kHz
VBW 1 kHz


MKR 899.3 MHz
32.10 dBm
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
DL
-19.8
dBm
START 30.0 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 901.0 MHz
SWP 200 msec


*ATTEN 20dB
RL 33.0dBm
10dB/
ΔMKR -55.83dB
892MHz
A
START 895MHz
*RBW 1.0MHz
*VBW 1.0MHz
STOP 9.000GHz
SWP 170ms


MKR Δ 3.25 kHz
-3.60 dB
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
CENTER 900.37500 MHz
RES BW 1 kHz
VBW 1 kHz
SPAN 50.00 kHz
SWP 300 msec


MKR 901.0 MHz
31.80 dBm
REF 33.2 dBm
ATTEN 20 dB +0 dB
10 dB/
OFFSET
30.8
dB
DL
-19.8
dBm
START 30.0 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 901.0 MHz
SWP 200 msec


*ATTEN 20dB
RL 33.0dBm
10dB/
ΔMKR -54.66dB
905MHz
D
R
START 895MHz
*RBW 1.0MHz
*VBW 1.0MHz
STOP 9.000GHz
SWP 170ms

APPENDIX C

STATEMENT OF MEASUREMENT UNCERTAINTY

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:
A = Antenna calibration uncertainty, in dB = 2 dB
B = Spectrum Analyzer uncertainty, in dB = 1 dB
C = Site uncertainty, in dB = 4 dB
n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.