ITS Intertek Testing Services
ETL SEMKO

FCC Part 95(F) Test Report

for

Gateway Communications Inc.

on the

VHF Data Transceiver
Model: DG200
FCC ID: NAUDG200

Test Report: 3041334
Date of Report: April 22, 2003

A2LA Certificate Number: 1755-01

Test Performed by:	Test Authorized by:
Intertek Testing Services 1365 Adams Court Menlo Park, CA 94025	Gateway Communications Inc. 904 S. Park Ave., Tucson, AZ 85719

Prepared by: Sergeiy Marker, EMC Manager **Date:** 4/25/03

Reviewed by: David Chernomordik, EMC Technical Manager **Date:** 4/25/03

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11.0 TEST EQUIPMENT 45

1.0 Job Description

1.1 Client Information

The EUT has been tested at the request of

Company: Gateway Communications Inc.
904 S. Park Ave.,
Tucson, AZ 85719

Name of contact: Tom Moore
Telephone: (520) 882-8730
Fax: (520) 624-2727

1.2 Equipment under test (EUT)

Equipment type: VHF Data Transceiver

Model number(s): DG200

Part or serial number: 000001

Manufacturer: SAME as above.

Use of Product: Data Transceiver, RTU in the 218-219 MHz Service.

Production is planned: [X] Yes, [ ] No

Technical Specifications:

Tx/Rx range	218.0125 to 218.4875 MHz- Seg.A 218.5125 to 218.9875 MHz-Seg.B
Modulation Type(M)	GFSK (BT = .3)
Deviation (D)	+/-3 kHz
Channel Spacing	12.5 kHz
Number of Channels	78 (39 in each segment A & B)
Frequency Stability	+/- 2.5 ppm (-30 to +80°C)
Data Rate	4800 bps synchronous
Tx Power (ERP)	0.5 to 4.0 W (27 dBm to 36 dBm with 3 dBm steps)
Antenna connector	Mini UHF
Detachable antenna ?	Yes
Power Supply	13.6 VDC @ 1.8 A max
RS-232 connector	DB-9 (full port), Modular connector (3 wire)

EUT receive date: 4/14/03

EUT received condition: Good condition prototype

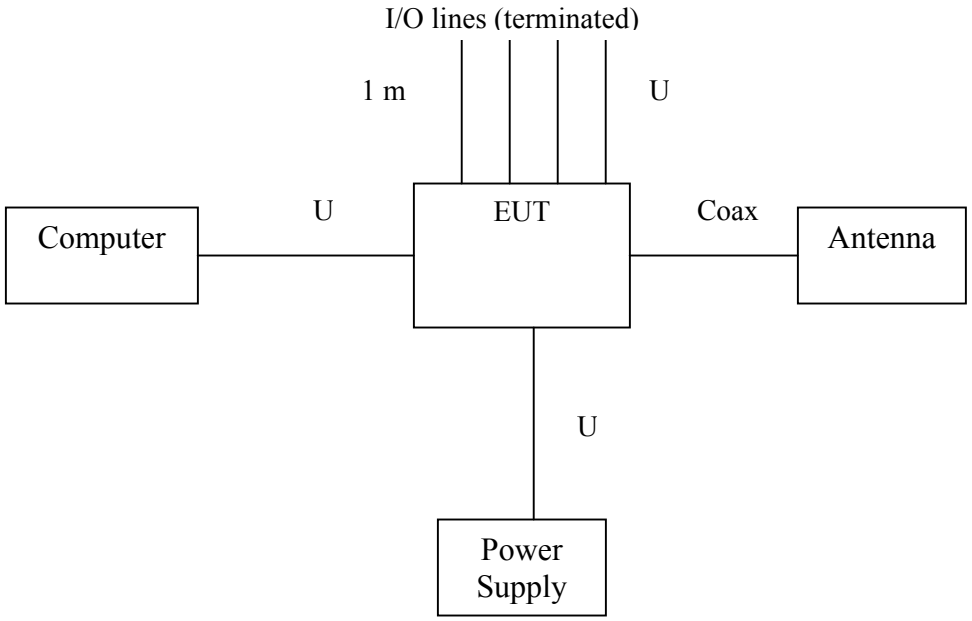
Test start date: 4/14/03

Test end date: 4/16/03

1.3 Test plan reference

FCC Part 2.1033, FCC Part 95 (F)

1.4 System test configuration
1.4.1 System block diagram & Support equipment



S:	Shielded	**U:**	Unshield	**F:**	With Ferrite Core

Support equipment					
Equp. #	**Equipment**	**Manufacturer**	**Model #**	**S/N #**	**FCC ID**
1	Computer	Compaq	Armada	Not labeled	N/A
2	Power Supply	BK Precision	1630	14602817	N/A
3	Antenna	Not labeled	Not labeled	Not labeled	N/A

Note: A quarter-wave antenna supplied for the testing is representative of the performance of a typical vehicular mounted antenna as recommended in the installation instructions

1.4.2 Justification

The system was configured for testing in a typical manner in accordance with ANSI C63.4 standard. During testing, the peripheral locations were varied with respect to the EUT.

1.4.3 Mode(s) of operation

The EUT was powered and fully operational. Several frequencies and different power levels were used in accordance with a test plane.

1.5 Modifications required for compliance

Intertek Testing Services implemented no modifications.

2.0 Test Summary

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
2.1046	Output Power	4.0 W	8
95.855	Effective Radiated Power	4.0 W	12
2.1051 95.857(b)	Spurious and Out-of-Band Emission at Antenna Terminals	Worst case Freq.: 436.1 MHz Margin: -17.0 dB	13
2.1053 95.857(b)	Spurious Radiated Emissions	Worst case Freq.: 476.975 MHz Margin: -2.6 dB	32
15.109(a)	Radiated Emissions from digital parts and receiver	Worst case Freq.: 78.0 MHz Margin: -4.9 dB	35
2.1049	Occupied Bandwidth	8.13 kHz	38
2.1055	Frequency Stability Vs. Temperature Vs. Voltage	 1.87 ppm 0.05 ppm	42
15.107(a)	AC Line conducted Emissions	N/A	

3.0 RF POWER OUTPUT

3.1 Test Description

Requirement:	FCC § 2.1046
Output Power:	

3.2 T est Procedure

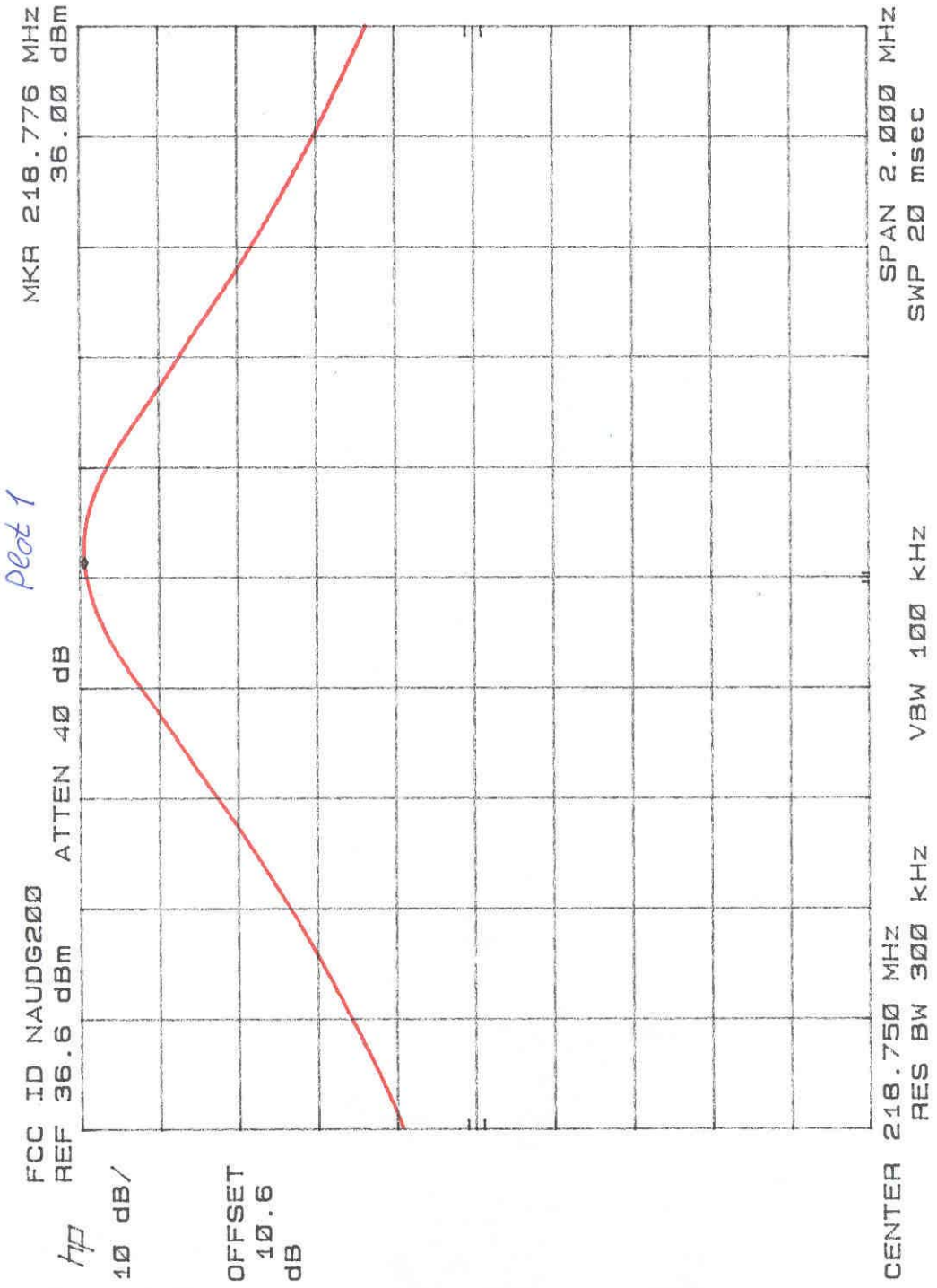
The EUT was positioned on a non-conductive table, 0.8m above the floor.
The output power at the middle frequencies of each frequency segments was measured at antenna terminals with a 10 dB attenuator and spectrum analyzer. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set to 300 and 100 kHz respectively.

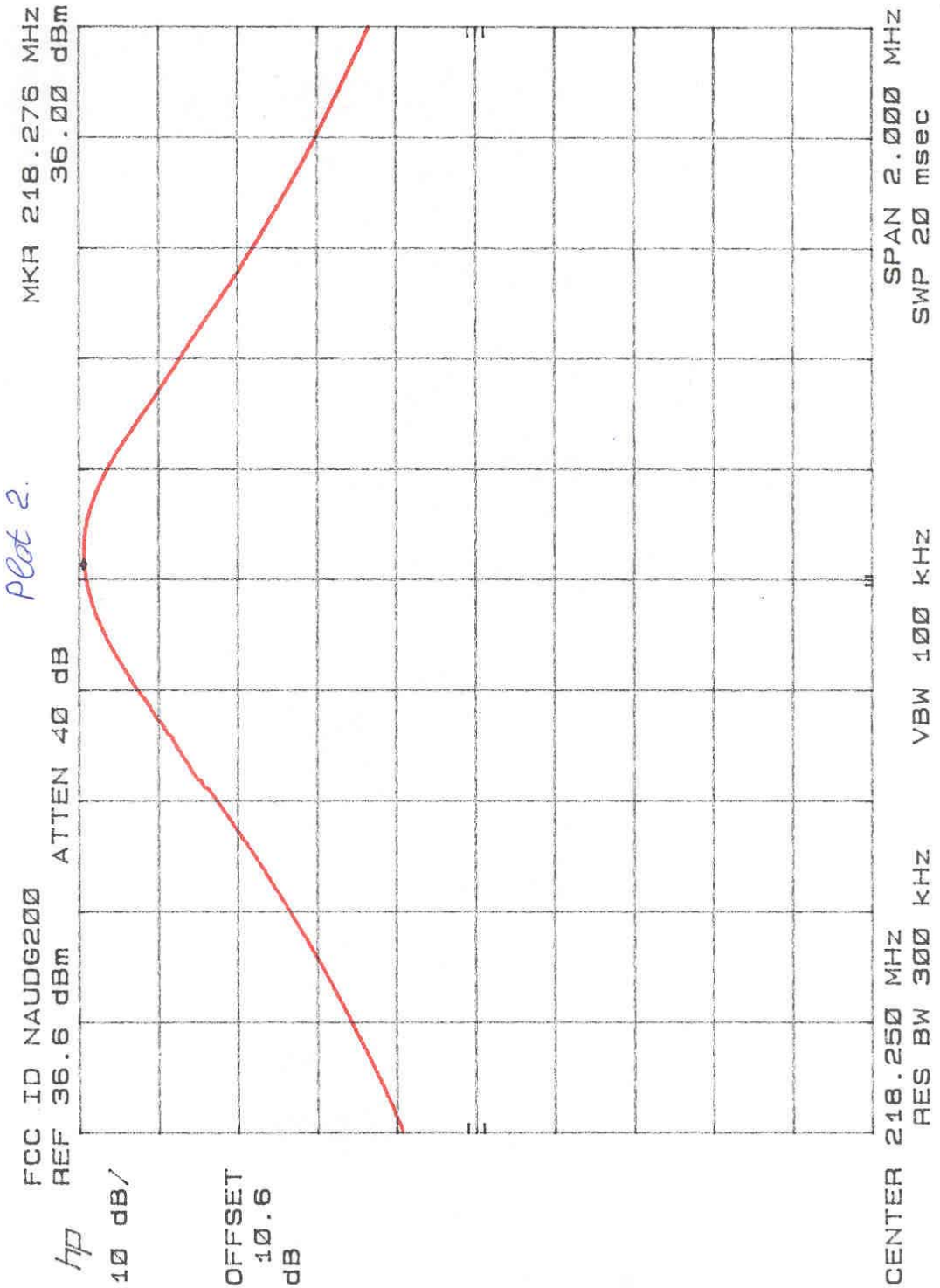
3.3 Test Results

Test Conditions:	***Offset = 10.6 dB***		***Test Result***
Frequency	**Attenuator**	**Cable Loss**	**Output Power Reading**
MHz	**dB**	**dB**	**dBm**
218.250	10.2	0.4	36.0
218.750	10.2	0.4	36.0

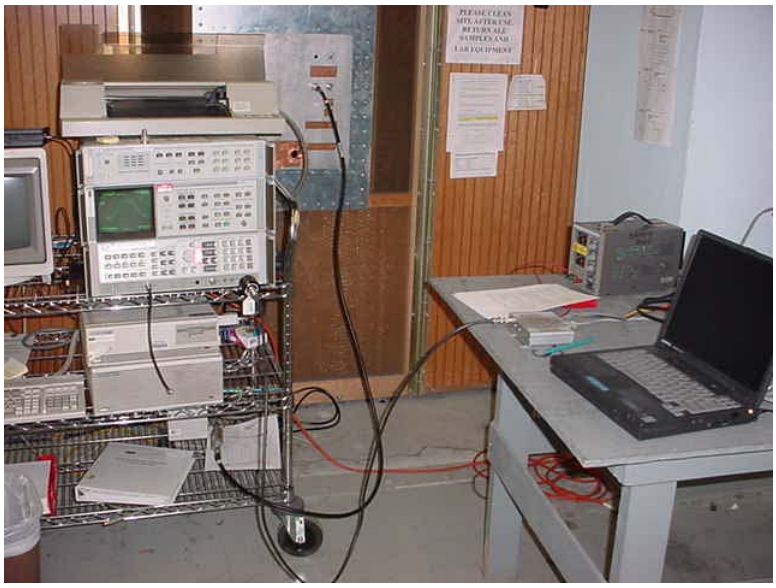
Note: Reading of SA includes 10.6 dB Offset(Attenuator + Cable loss)

Plots on the following two pages show the peak measurement scan made at the middle of frequency segments A & B


MKR 218.776 MHz
36.00 dBm
SPAN 2.000 MHz
SWP 20 msec
Plot 1
FCC ID NAUDG200
REF 36.6 dBm
ATTEN 40 dB
VBW 100 kHz
hp
10 dB/
OFFSET
10.6
dB
CENTER 218.750 MHz
RES BW 300 kHz


MKR 218.276 MHz
36.00 dBm
SPAN 2.000 MHz
SWP 20 msec
Plot 2.
FCC ID NAUDG200
REF 36.6 dBm
ATTEN 40 dB
VBW 100 kHz
hp
10 dB/
OFFSET
10.6
dB
CENTER 218.250 MHz
RES BW 300 kHz

3.5 Test Configuration Photograph



4.0 EFFECTIVE RADIATED POWER

4.1 Test Description

Requirement:	FCC § 95.855
Effective Radiated Power (ERP):	=< 4.0 watts (36 dBm)

4.2 Test Procedure

The ERP was calculated using equation:

$ERP_{dBm} = P_{dBm} + G_{dBd}$

Where: P = Output Power
G = Antenna Gain

4.3 Test Results

Transceiver output power is 4 watts. FCC § 95.855 limit for ERP of mobile RTU is 4 watts. Therefore, the maximum antenna gain allowed is 0 dBd.

5.0 SPURIOUS AND OUT-OF-BAND EMISSIONS AT ANTENNA TERMINAL

5.1 Test Description

Requirement:	FCC § 2.1051 & §95.857(b)
Spurious and out of bend emission at antenna terminals	1). 0 dB within authorized frequency segment 2). 28 dB on frequency removed from midpoint of the assigned frequency segment by more than 250 kHz up to and including 750 kHz. 3). 35 dB on frequency removed from midpoint of the assigned frequency segment by more than 750 kHz up to and including 1250 kHz. 4). 43 + 10logP(W) on frequency removed from midpoint of the assigned frequency segment by more than 1250 kHz.

5.2 Test Procedure

The EUT was positioned on a non-conductive table, 0.8m above the floor.
The measurements of unnecessary radiation are performed using the lowest and highest frequencies of each frequency segments with a 10 dB attenuator and spectrum analyzer. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set as follows:

1. 100 Hz for measuring emissions up to and including 250 kHz from the edge the authorized frequency segment.
2. 10 kHz for measuring emission more than 250 kHz from the edge of authorized frequency segment
3. Video bandwidth shall not be less than Resolution bandwidth

5.3 Test Results

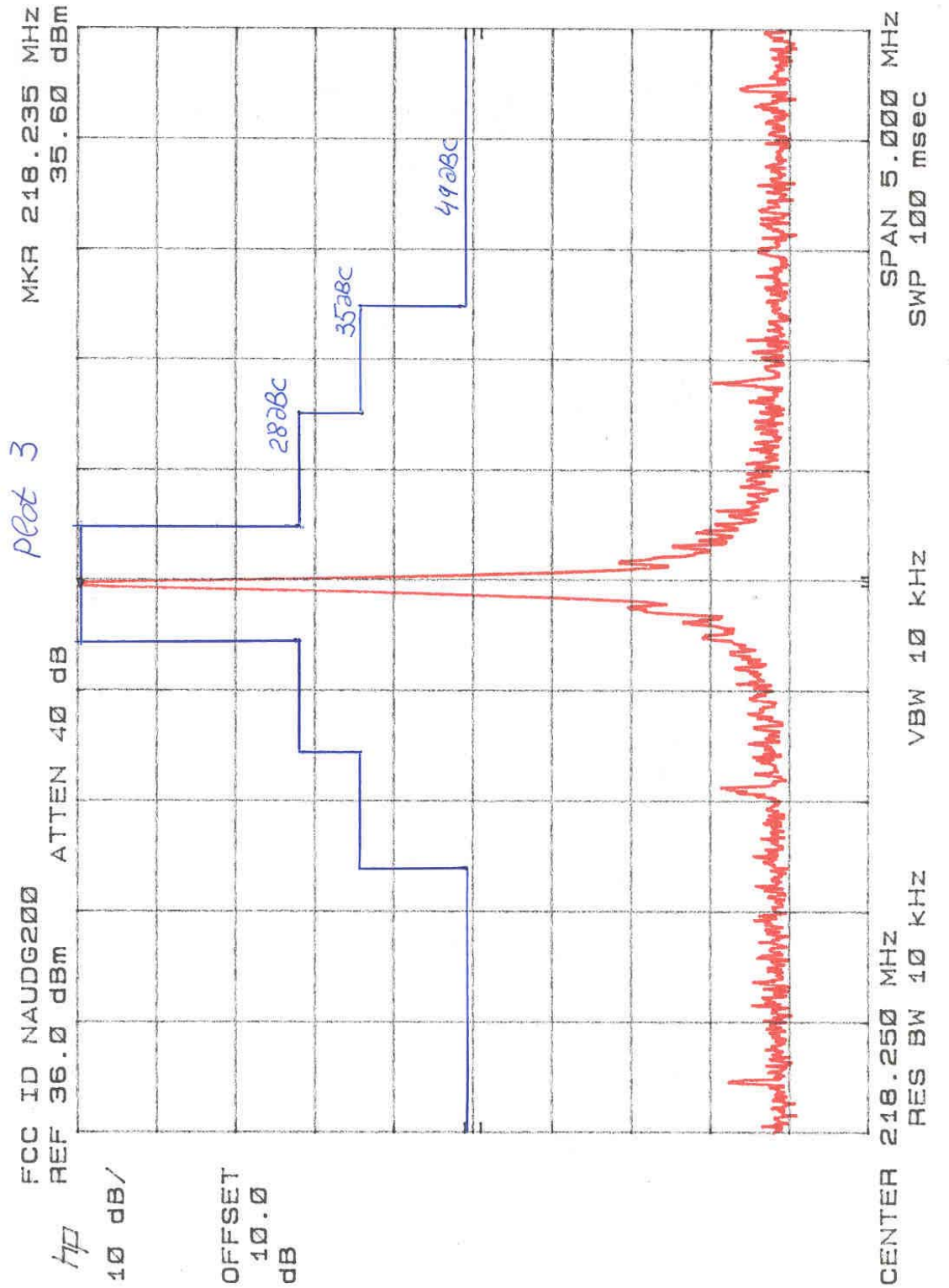
Maximum Power Level = 36 dBm

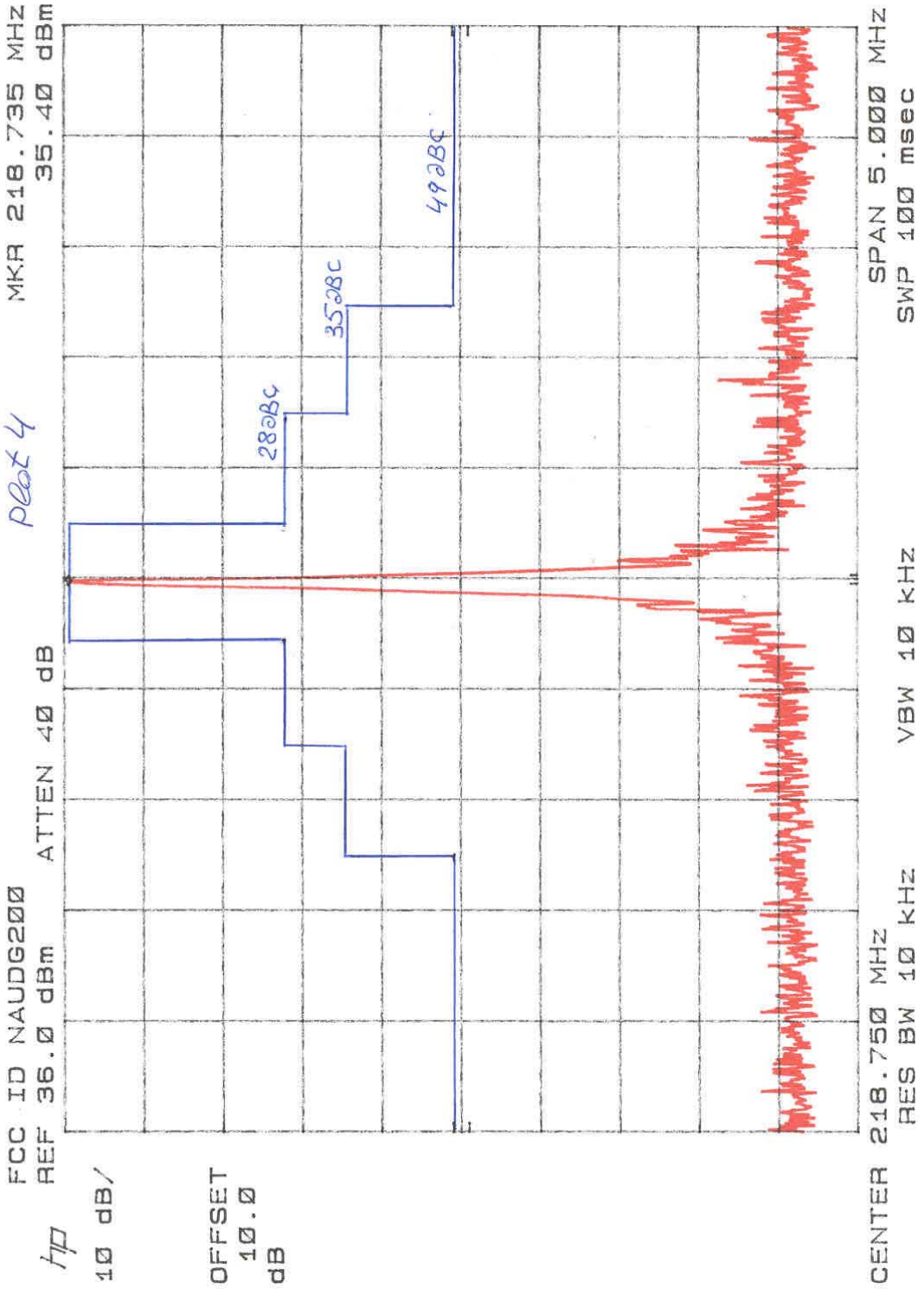
Plot No.	Plot Description	Comments
3	Emission mask for segment A	
4	Emission mask for segment B	
5	Emission from 30 to 217.75 MHz	Limit = P – (43+10logP(W) = -13 dBm
6	Emission from 217.750 to 218.000 MHz	Test result = - 22.8 dBm
7	Emission at lowest edge of seg. A (218.0125 MHz)	Test result (delta) = 64.4 dB
8	Emission at highest edge of seg. A (218.4875 MHz)	Test result (delta) = 69.2 dB
9	Emission from 218.500 to 218.750 MHz	Test result = - 22.6 dBm
10	Emission from 218.250 to 218.500	Test result = - 22.4 dBm
11	Emission at lowest edge of seg. B (218.5125 MHz)	Test result (delta) = 68.8 dB
12	Emission at highest edge of seg. B (218.9875 MHz)	Test result (delta) = 69.8 dB
13	Emission from 219.000 to 219.250 MHz	Test result = - 25.2 dBm
14	Emission from 219.250 to 1000 MHz	Limit = P – (43+10logP(W) = -13 dBm
15	Emission from 1000 to 2200 MHz	Limit = P – (43+10logP(W) = -13 dBm

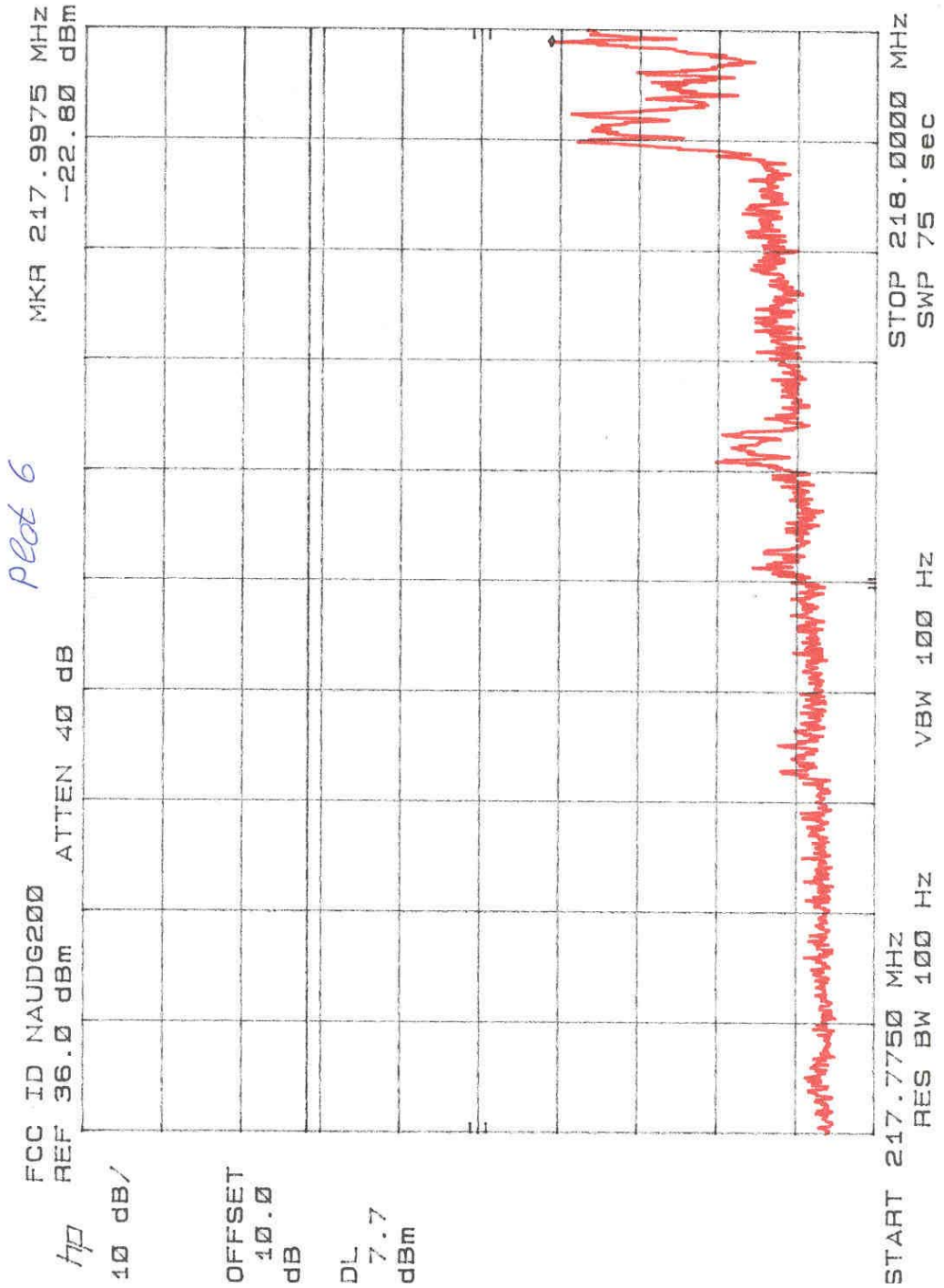
Minimum Power Level = 27 dB

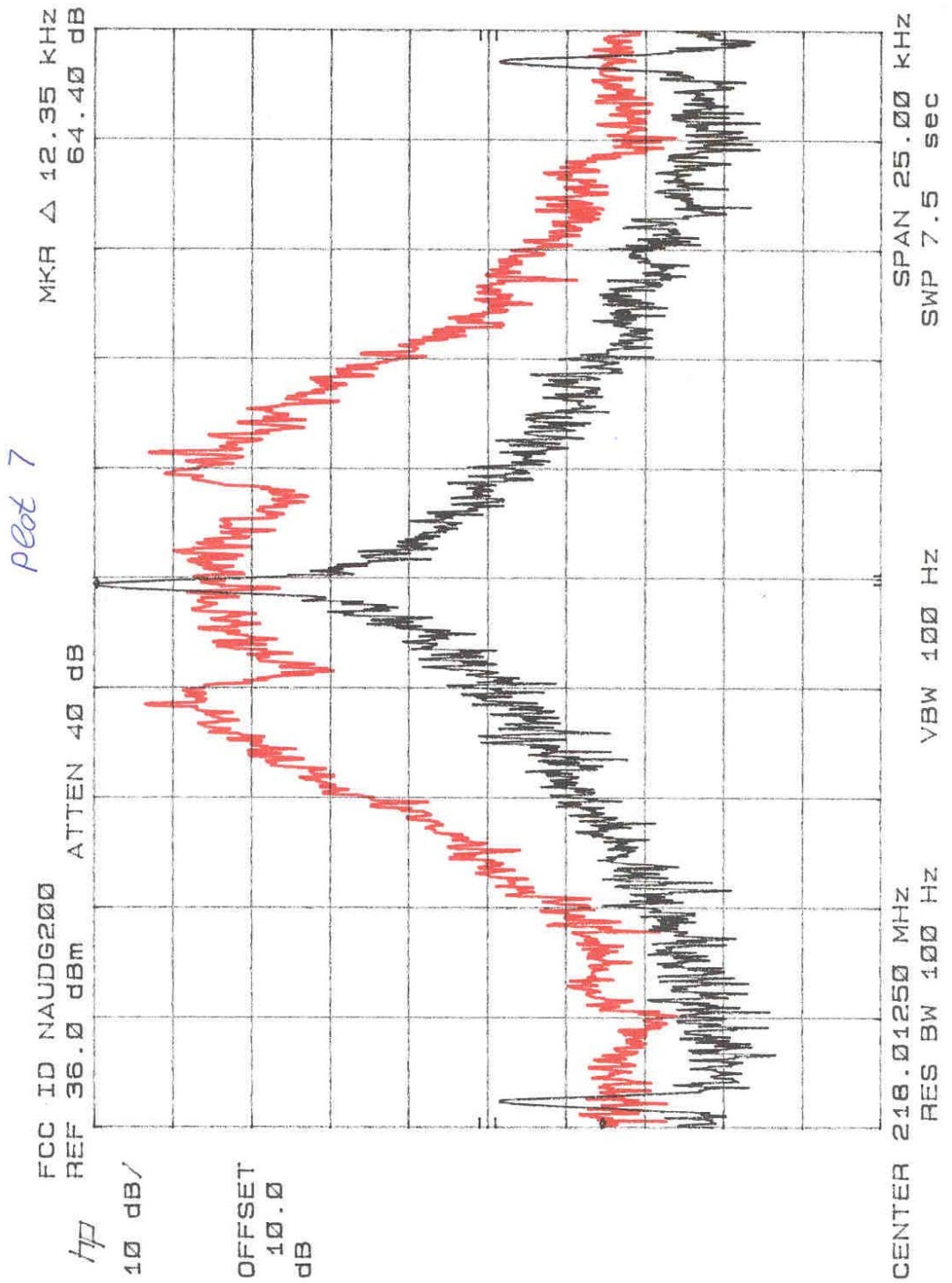
16	Emission at highest edge of seg. B (218.9875 MHz)	Test result (delta) = 69.8 dB
17	Emission from 219.000 to 219.250 MHz	Test result = - 32.6 dBm
18	Emission at lowest edge of seg. A (218.0125 MHz)	Test result (delta) = 69.4 dB
19	Emission from 217.750 to 218.000 MHz	Test result = - 39.6 dBm

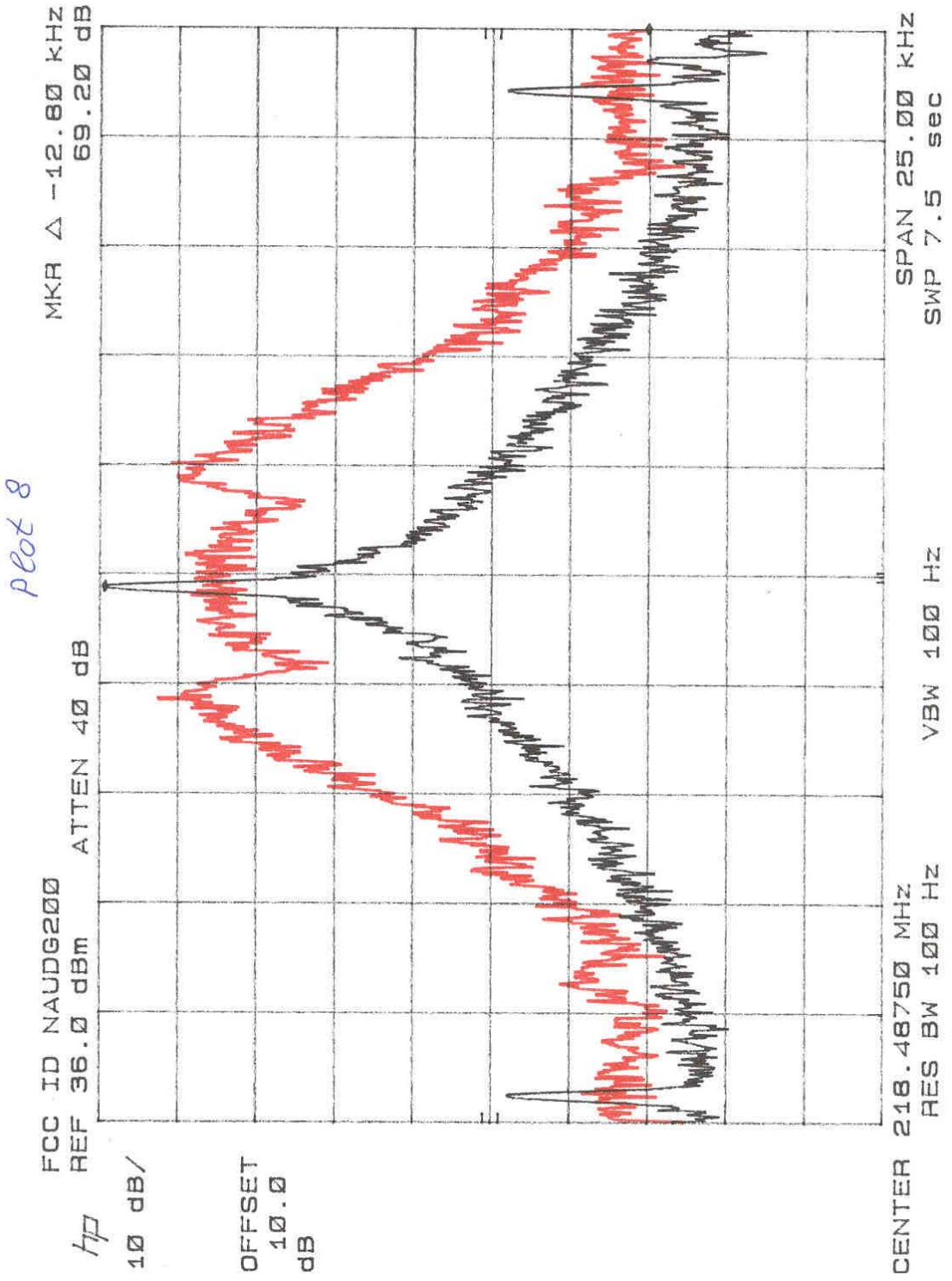
Please see the following pages for emission test result.


Plot 3
MKR 218.235 MHz
35.60 dBm
SPAN 5.000 MHz
SWP 100 msec
FCC ID NAUDG200
REF 36.0 dBm
ATTEN 40 dB
VBW 10 kHz
hp
10 dB/
OFFSET
10.0
dB
CENTER 218.250 MHz
RES BW 10 kHz
28dBc
35dBc
49dBc

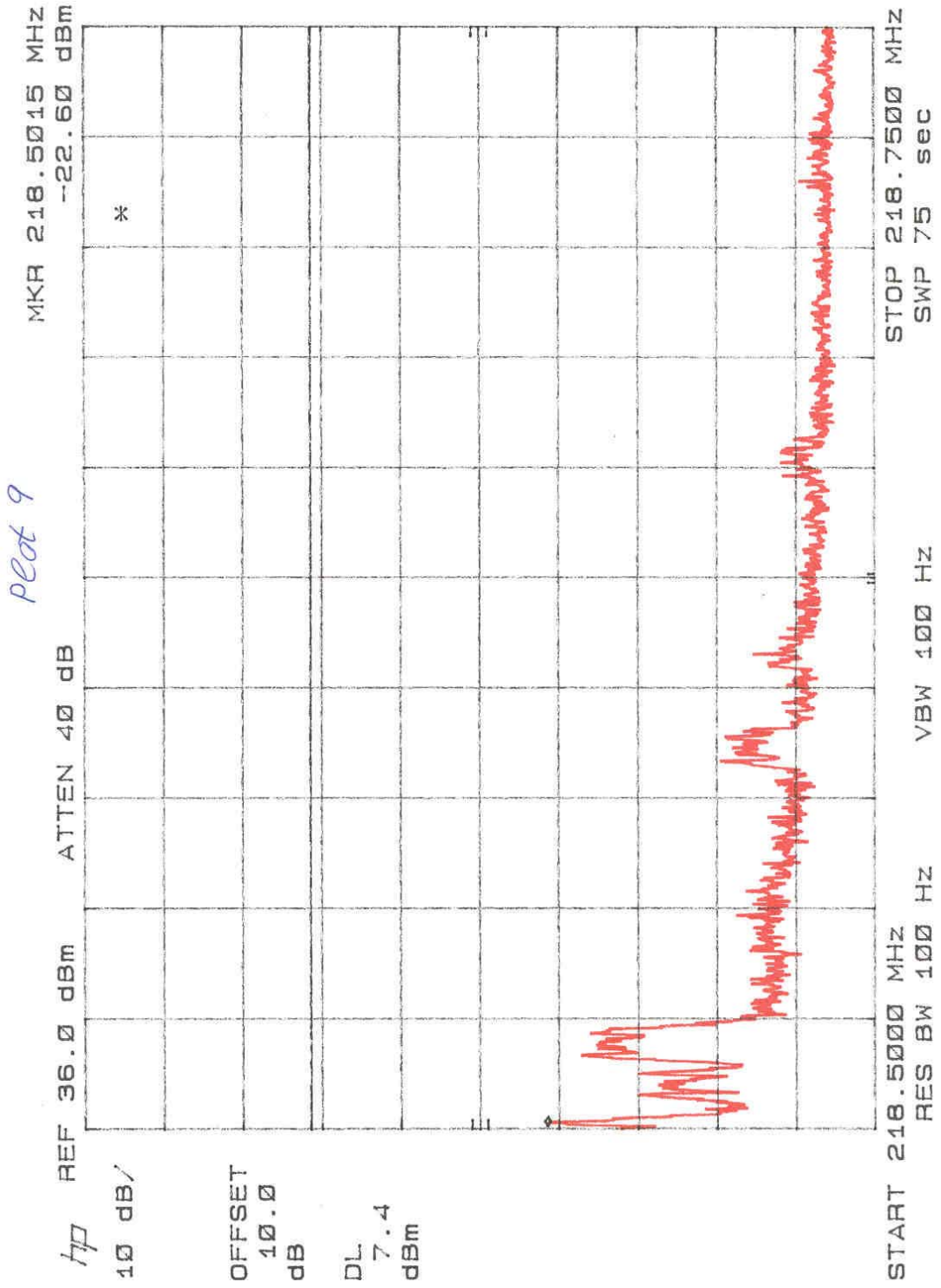

plot 4
MKR 218.735 MHz
35.40 dBm
SPAN 5.000 MHz
SWP 100 msec
FCC ID NAUDG200
ATTEN 40 dB
REF 36.0 dBm
VBW 10 kHz
hp
10 dB/
OFFSET
10.0
dB
CENTER 218.750 MHz
RES BW 10 kHz


FCC ID NAUDG200
REF 36.0 dBm
ATTEN 40 dB
MKR 217.9975 MHz
-22.80 dBm
10 dB/
OFFSET
10.0
dB
DL
7.7
dBm
START 217.7750 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 218.0000 MHz
SWP 75 sec
peak 6

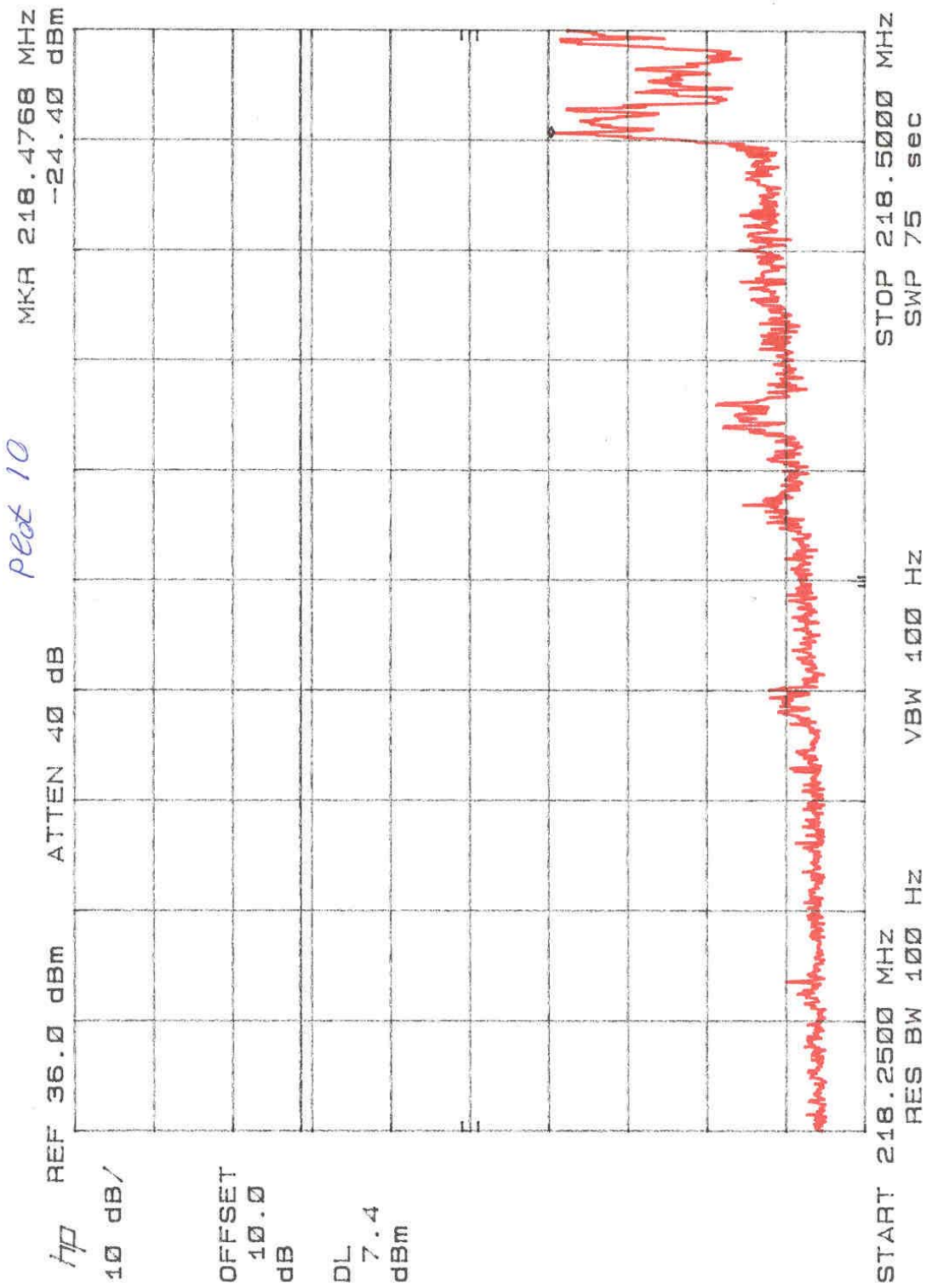

Plot 7
FCC ID NAUDG200
REF 36.0 dBm
ATTEN 40 dB
MKR Δ 12.35 kHz
64.40 dB
10 dB/
OFFSET
10.0
dB
CENTER 218.01250 MHz
RES BW 100 Hz
VBW 100 Hz
SPAN 25.00 kHz
SWP 7.5 sec

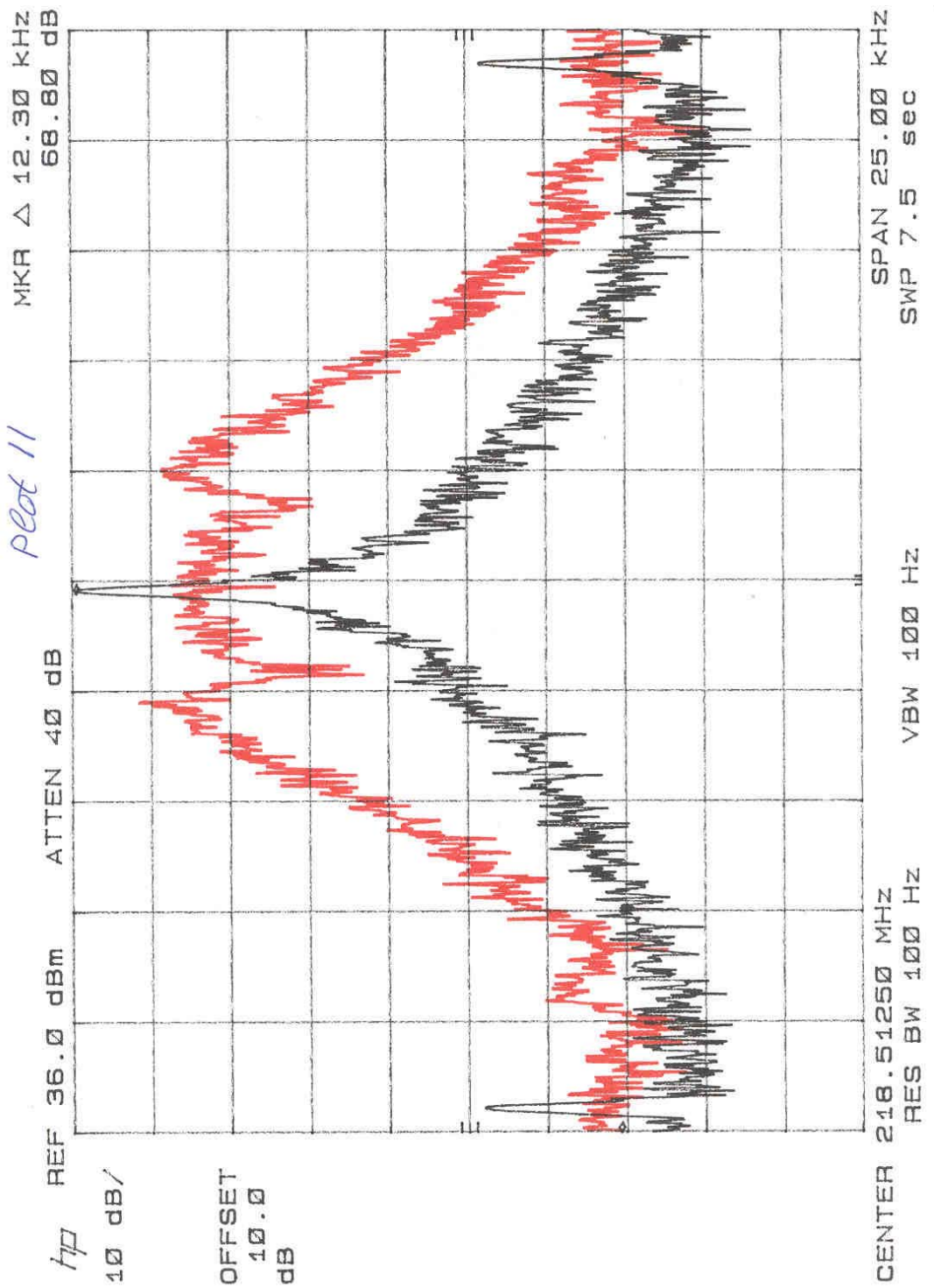

MKR Δ -12.80 kHz
69.20 dB
SPAN 25.00 kHz
SWP 7.5 sec
FCC ID NAUDG200
REF 36.0 dBm
ATTEN 40 dB
VBW 100 Hz
hp
10 dB/
OFFSET
10.0
dB
CENTER 218.48750 MHz
RES BW 100 Hz

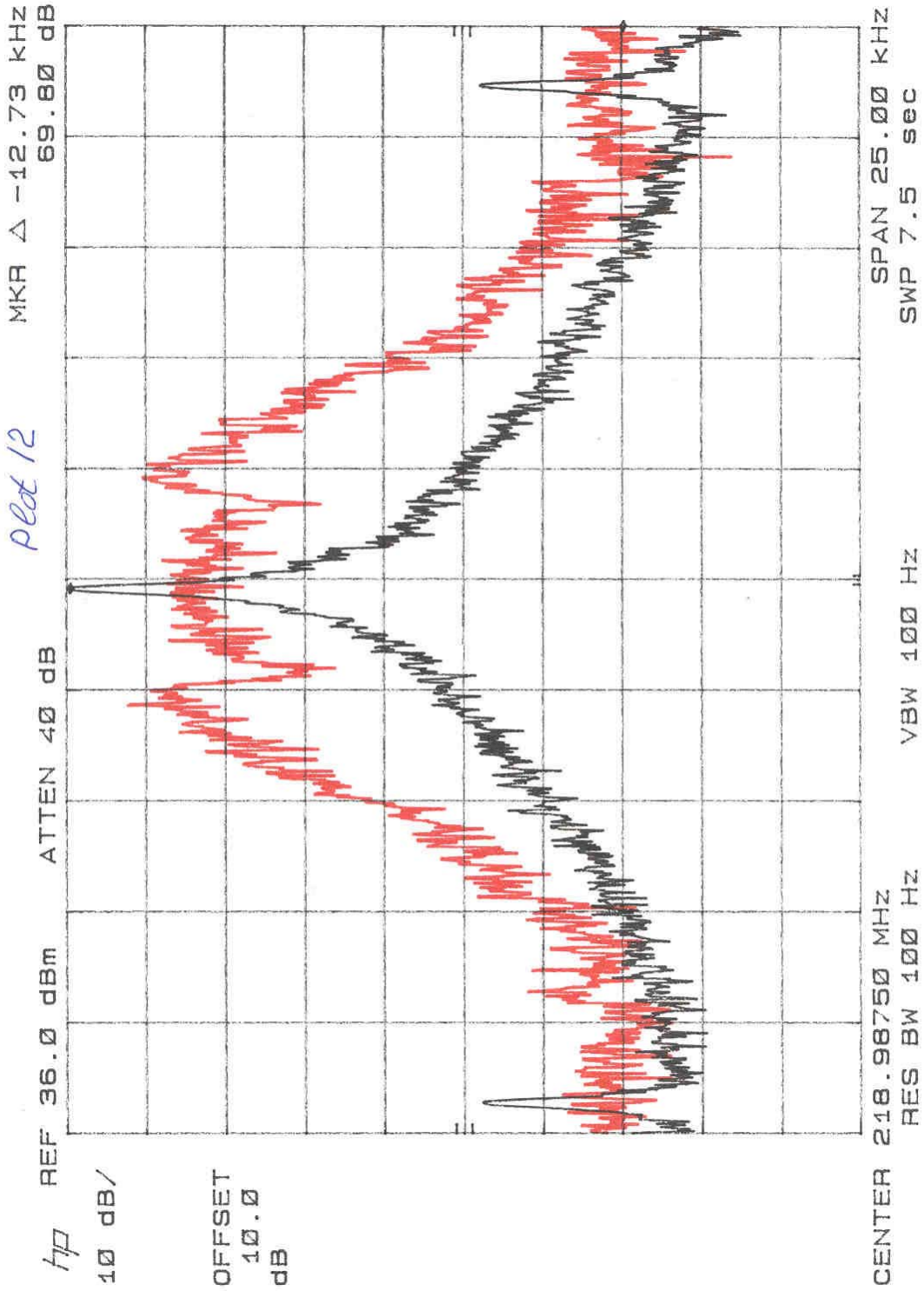
Plot 8

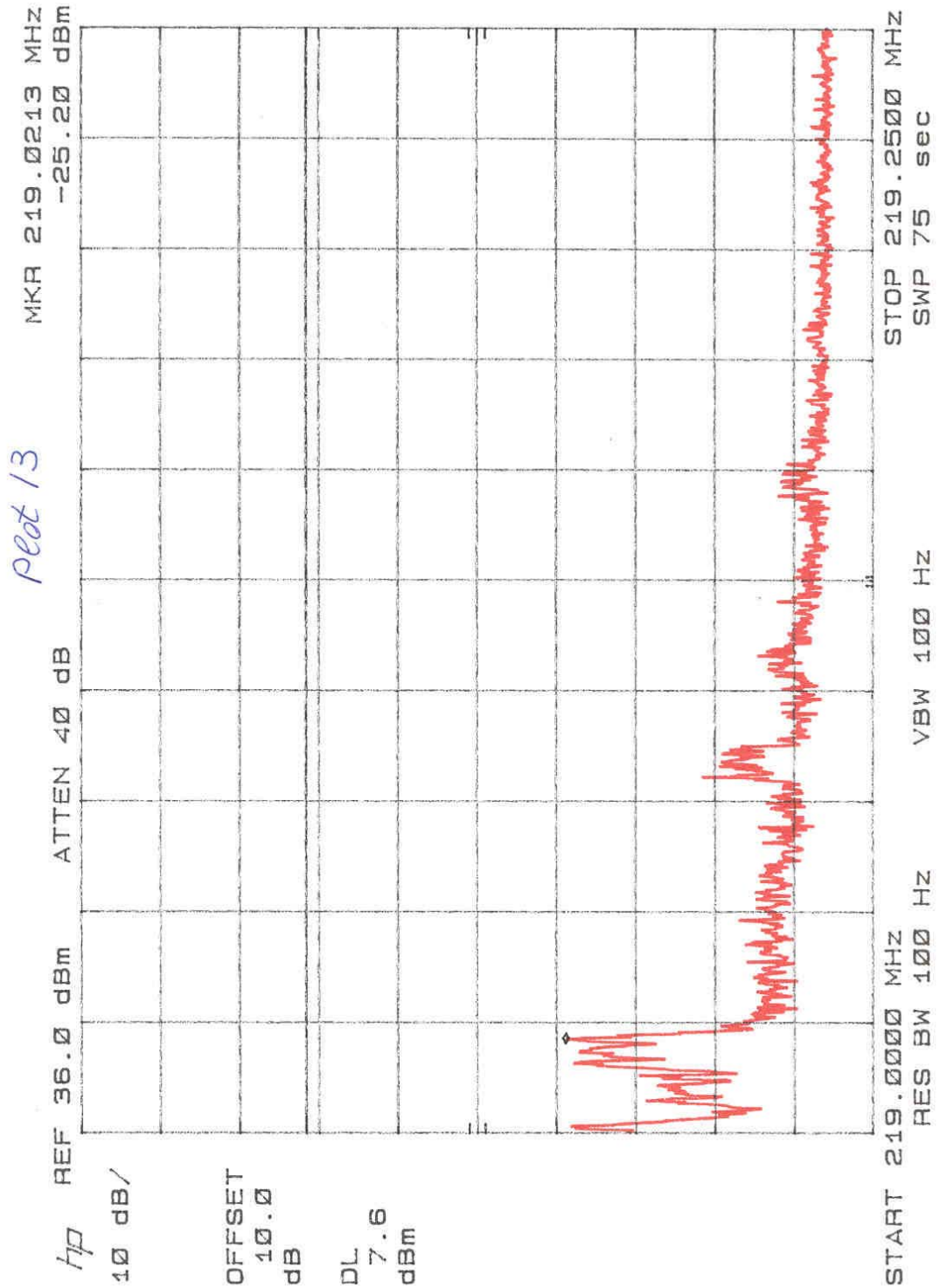

MKR 218.5015 MHz
-22.60 dBm
*
REF 36.0 dBm
ATTEN 40 dB
10 dB/
OFFSET
10.0
dB
DL
7.4
dBm
START 218.5000 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 218.7500 MHz
SWP 75 sec

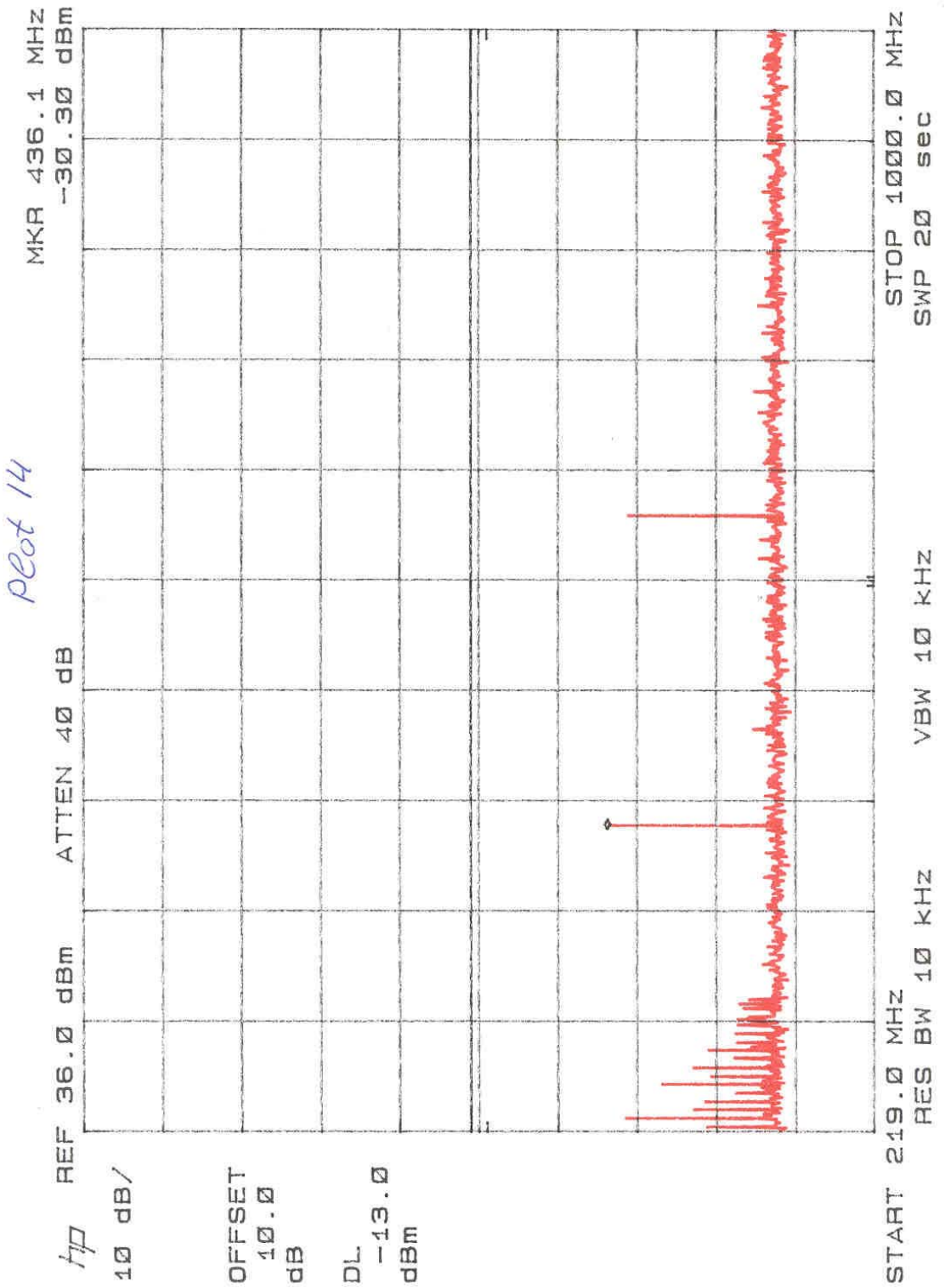
Peak 9


MKR 218.4768 MHz
-24.40 dBm
peak 10
REF 36.0 dBm
ATTEN 40 dB
hp
10 dB/
OFFSET
10.0
dB
DL
7.4
dBm
START 218.2500 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 218.5000 MHz
SWP 75 sec

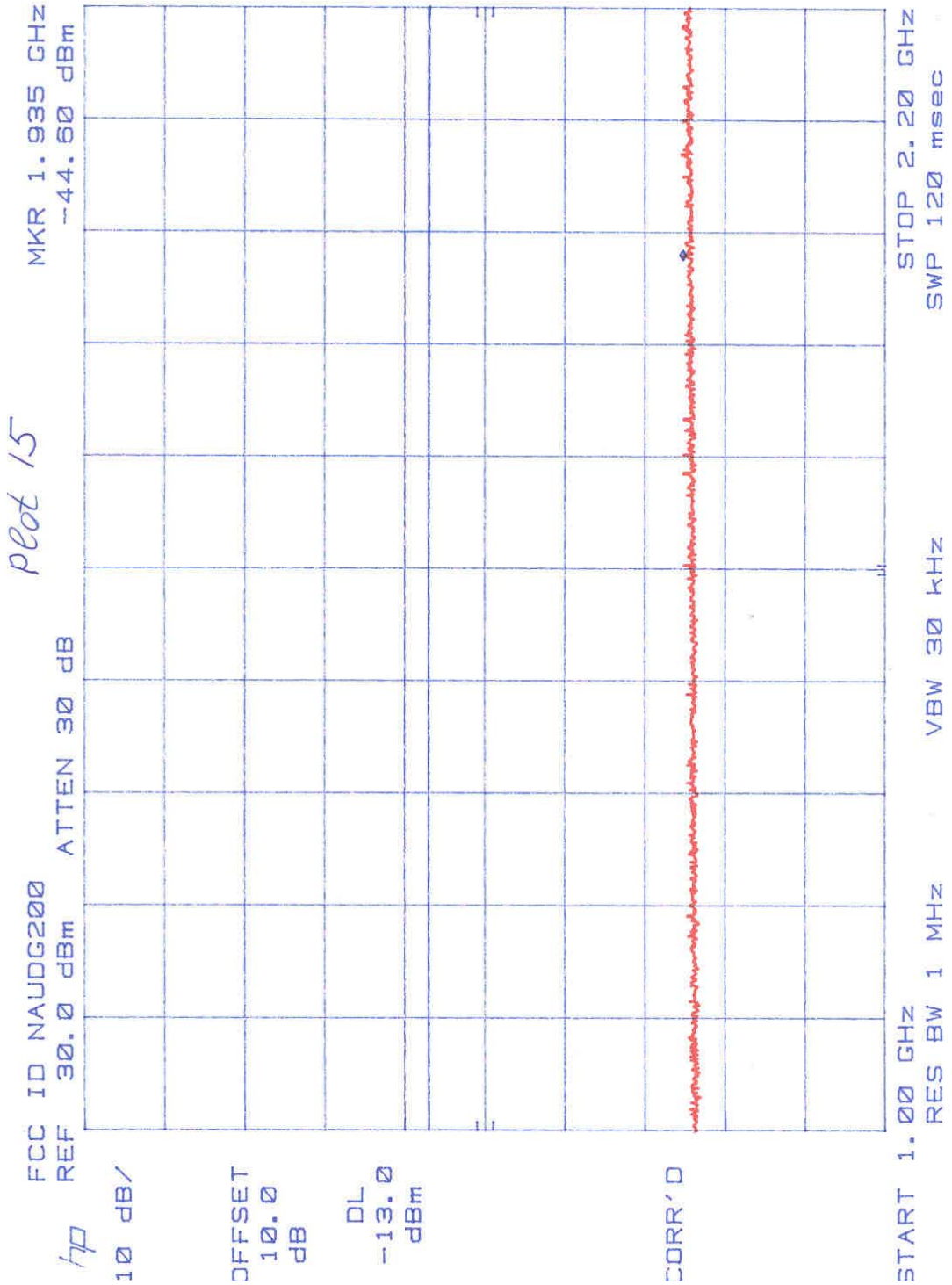

MKR Δ 12.30 kHz
68.80 dB
plot 11
REF 36.0 dBm
ATTEN 40 dB
10 dB/
OFFSET
10.0
dB
SPAN 25.00 kHz
SWP 7.5 sec
VBW 100 Hz
CENTER 218.51250 MHz
RES BW 100 Hz

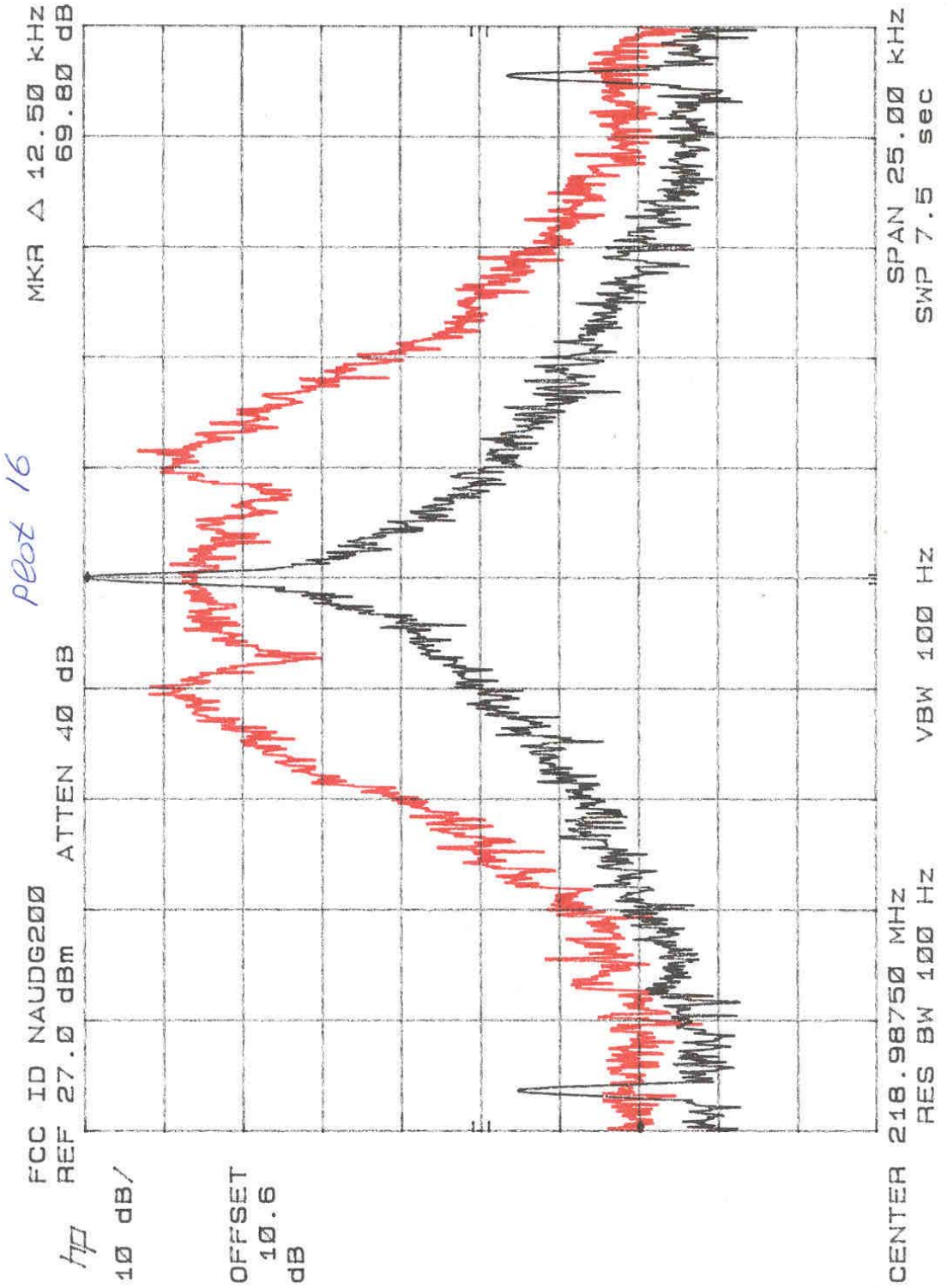

MKR Δ -12.73 kHz
69.80 dB
SPAN 25.00 kHz
SWP 7.5 sec
Plot 12
REF 36.0 dBm
ATTEN 40 dB
VBW 100 Hz
10 dB/
OFFSET
10.0
dB
CENTER 218.98750 MHz
RES BW 100 Hz

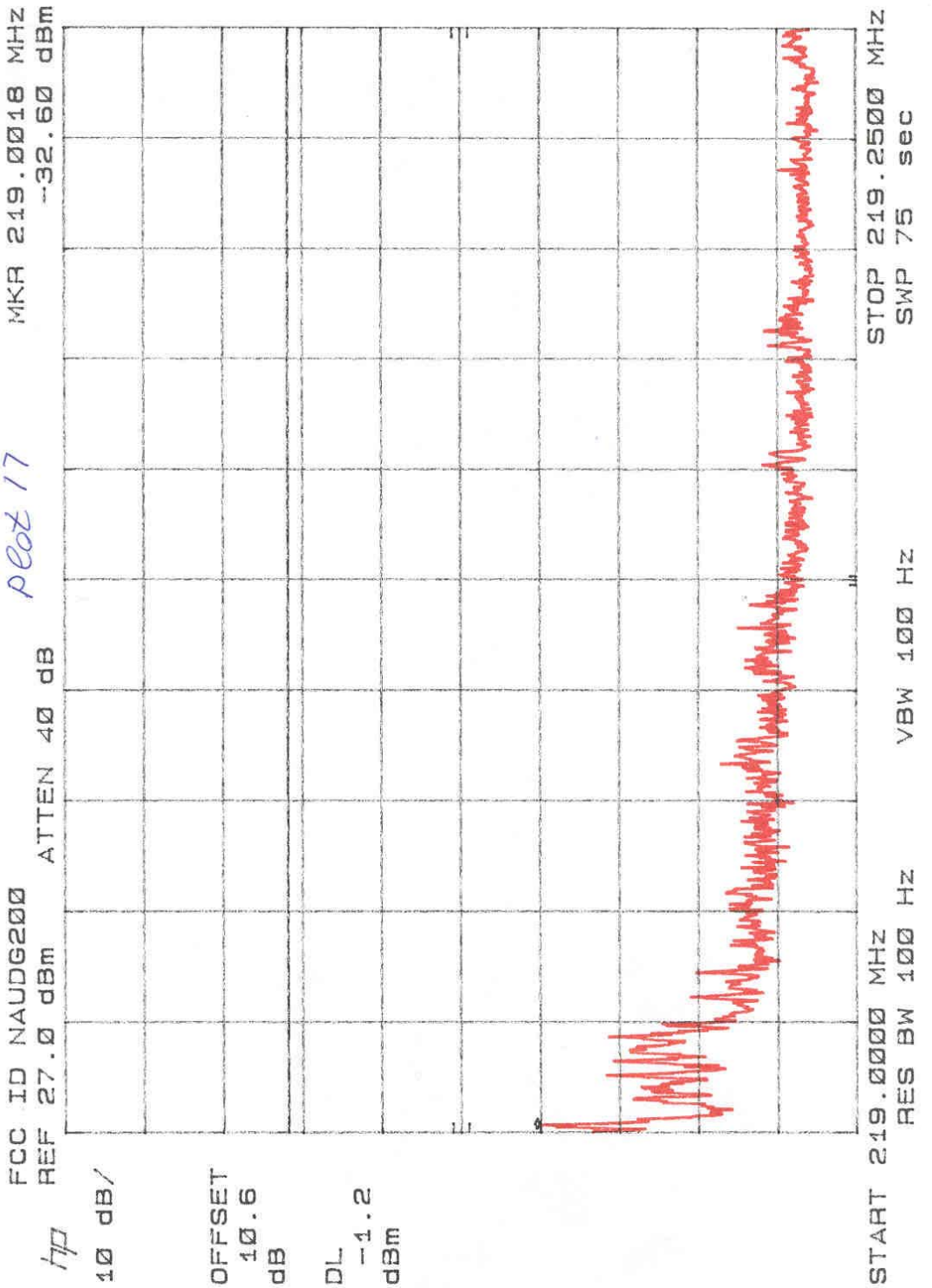

Plot 13
MKR 219.0213 MHz
-25.20 dBm
REF 36.0 dBm
ATTEN 40 dB
10 dB/
OFFSET
10.0
dB
DL
7.6
dBm
START 219.0000 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 219.2500 MHz
SWP 75 sec

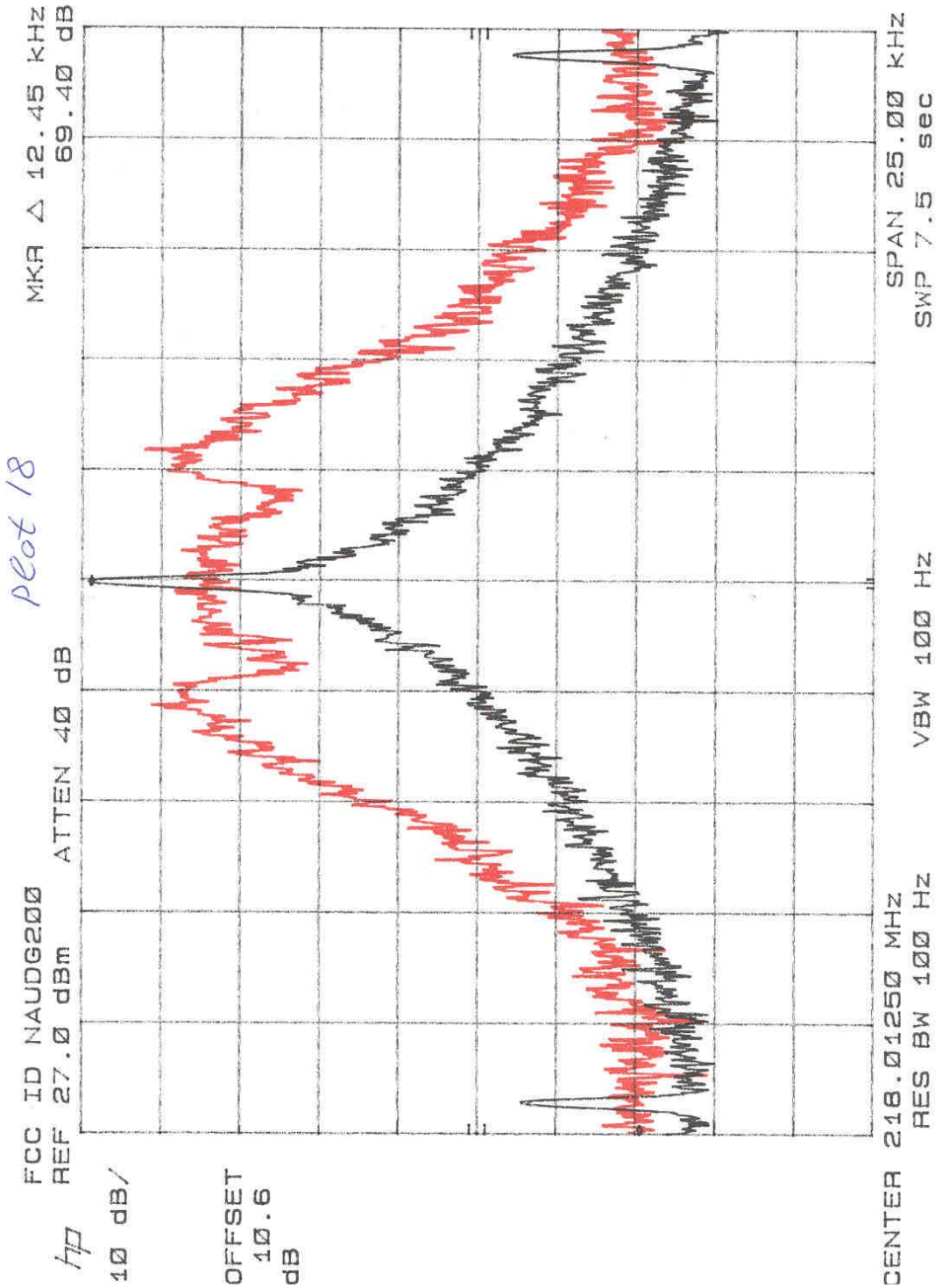

MKR 436.1 MHz
-30.30 dBm
REF 36.0 dBm
ATTEN 40 dB
10 dB/
OFFSET
10.0
dB
DL
-13.0
dBm
START 219.0 MHz
RES BW 10 kHz
VBW 10 kHz
STOP 1000.0 MHz
SWP 20 sec

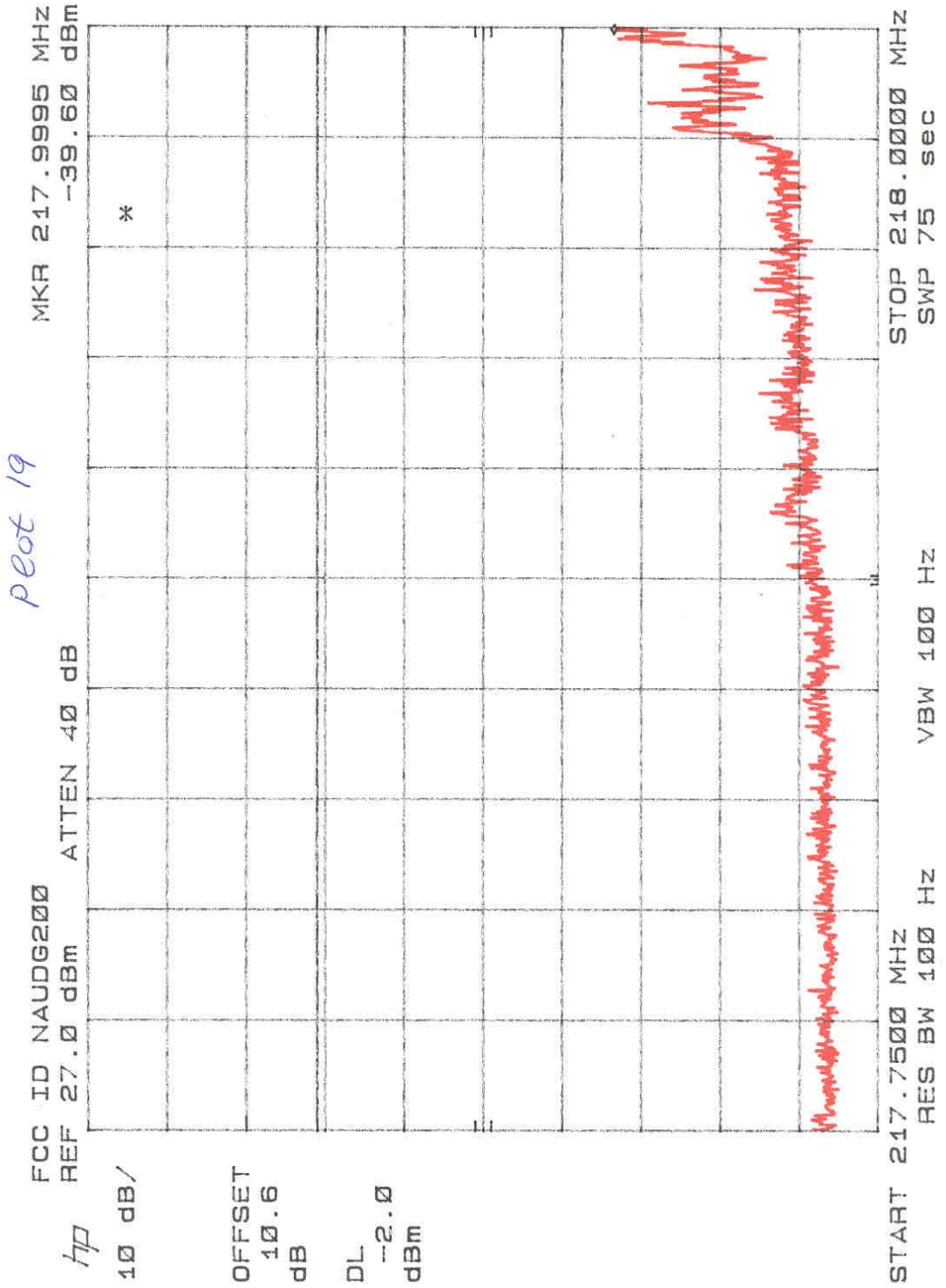
Plot 14


plot 15
FCC ID NAUDG200
REF 30.0 dBm
10 dB/
ATTEN 30 dB
OFFSET
10.0
dB
DL
-13.0
dBm
MKR 1.935 GHz
-44.60 dBm
CORR'D
START 1.00 GHz
RES BW 1 MHz
VBW 30 kHz
STOP 2.20 GHz
SWP 120 msec

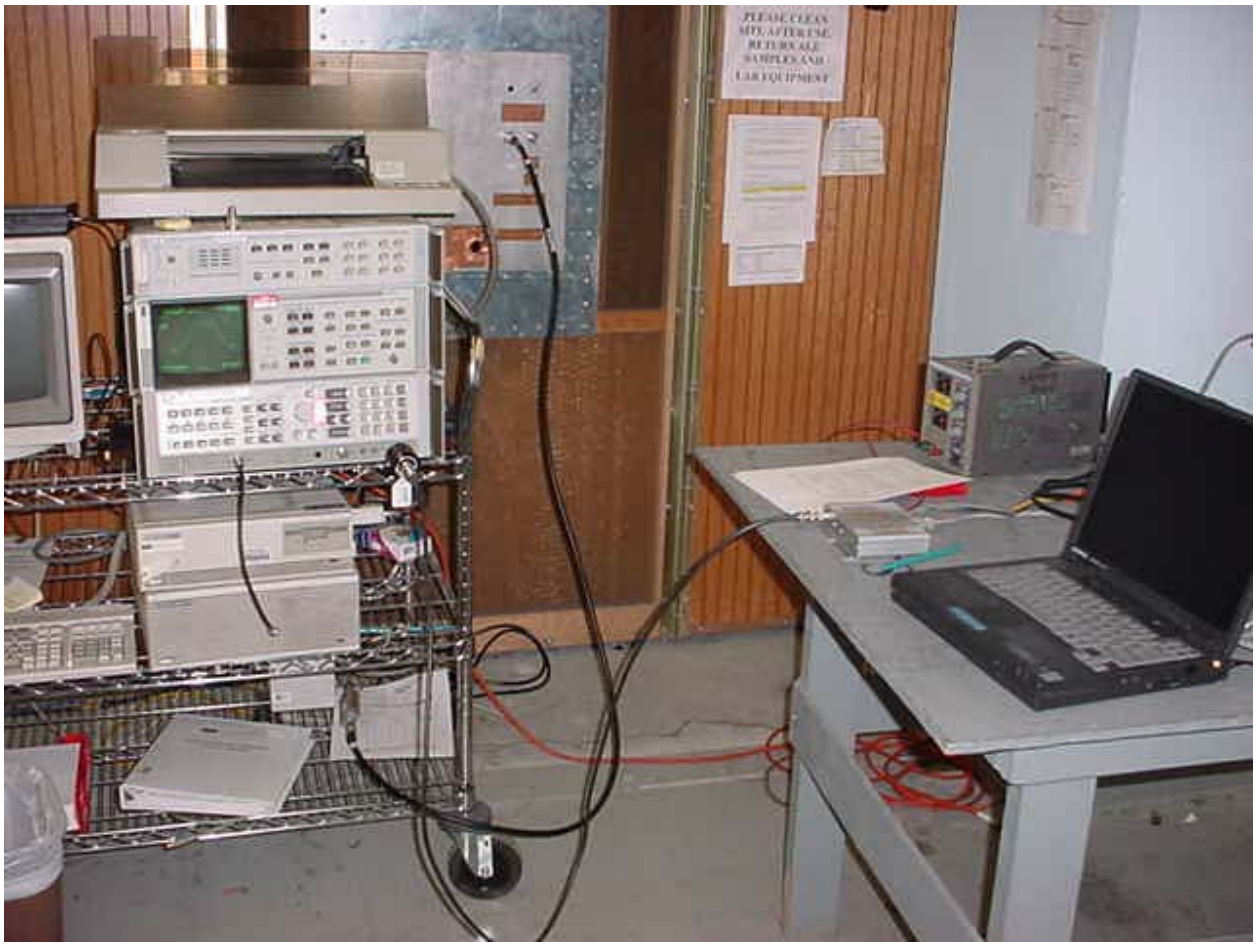

MKR Δ 12.50 kHz
69.80 dB
SPAN 25.00 kHz
SWP 7.5 sec
Peak 16
FCC ID NAUDG200
REF 27.0 dBm
ATTEN 40 dB
VBW 100 Hz
10 dB/
OFFSET
10.6
dB
CENTER 218.98750 MHz
RES BW 100 Hz


FCC ID NAUDG200
REF 27.0 dBm
ATTEN 40 dB
MKR 219.0018 MHz
-32.60 dBm
Plot 17
hp
10 dB/
OFFSET
10.6
dB
DL
-1.2
dBm
START 219.0000 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 219.2500 MHz
SWP 75 sec


FCC ID NAUDG200
REF 27.0 dBm
ATTEN 40 dB
MKR Δ 12.45 kHz
69.40 dB
SPAN 25.00 kHz
SWP 7.5 sec
VBW 100 Hz
RES BW 100 Hz
CENTER 218.01250 MHz
10 dB/
OFFSET
10.6
dB
peak 18


Plot 19
FCC ID NAUDG200
REF 27.0 dBm
ATTEN 40 dB
MKR 217.9995 MHz
-39.60 dBm
10 dB/
OFFSET
10.6
dB
DL
-2.0
dBm
START 217.7500 MHz
RES BW 100 Hz
VBW 100 Hz
STOP 218.0000 MHz
SWP 75 sec

5.4 Test Configuration Photograph



6.0 SPURIOUS RADIATED EMISSIONS

6.1 Test Description

Requirement:	FCC § 2.1053, § 95.857(b)
Spurious Radiated Emission:	Spurious Radiated Emission attenuation must be more than 43 + 10logP(W)

6.2 Test Procedure

A) The transmitter was placed on a wooden turntable. Antenna terminals were connected to the 50 Ohm Dummy load.

B) The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height was varied from 1 to 4 m, antenna polarization was varied and turn table was rotated 360° in order to identify the maximum level of emissions from the EUT (Veut).

C) The frequency range up to tenth harmonic of the fundamental frequency was investigated.

D) Then EUT was replaced with Substitution Antenna:
a) Half-wave Dipole up to 1 GHz
b) Horn antenna above 1 GHz
and a Signal generator

E) Step B and C were repeated

F) Output power (Vg) of the signal generator (input signal to the substitution antenna) was adjusted to receive the same signal on the spectrum analyzer as with EUT

G) Radiated power of the spurious emissions was calculated as power supplied to the substitution antenna plus substitution antenna gain in dBd. Result was compared against the limit.

Note: Limit for spurious emission radiated power is
P(dBm) – [43 + 10LogP(Watts)] = -13 dBm

6.3 Test Results:

Test Result:	EUT PASSED Spurious Radiation test with margin 2.8 dB @ 436.975 MHz

See the following page for test data

Spurious Radiated Emissions

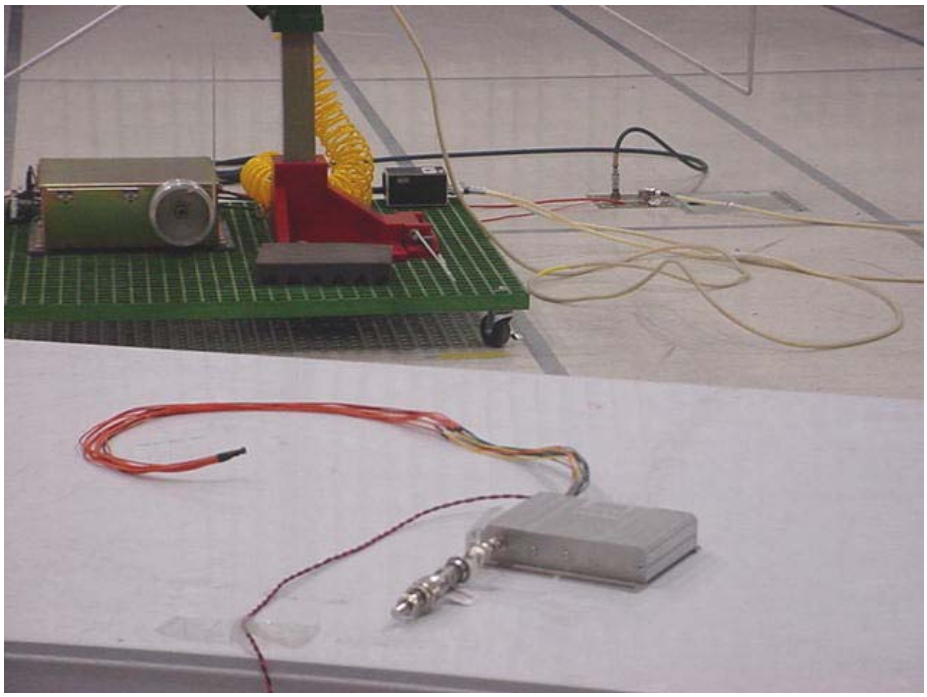
Company: Gateway Communication
Project #: 3041334
Model: DG200
Engineer: Sergey Marker
Date of test: April 15,2003
Test Condition: Continue transmitting

Harmonics Frequency	Antenna Pol	Reading Veut	Signal Gener. Vg	Antenna Gain	Spurious ERP	Limit	Margin
MHz	H/V	dBµV	dBm	dBd	dBm	dBm	dB
436.975	H	95.3	-15.8	0	-15.8	-13.0	-2.8
655.45	H	76.4	-27.8	0	-27.8	-13.0	-14.8
873.925	H	70.7	-28.0	0	-28.0	-13.0	-15.0
1092.4	H	84.1	-22.8	3.5	-19.3	-13.0	-6.3
1310.875	H	73.8	-34.7	4.5	-30.2	-13.0	-17.2
1529.35	V	66.0	-43.5	5.0	-38.5	-13.0	-25.5
1747.825	V	68.7	-37.6	5.3	-32.3	-13.0	-19.3
1966.3	V	63.1	-43.3	5.7	-37.6	-13.0	-24.6
2184.75	H	54.4	-52.7	6.3	-46.4	-13.0	-33.4

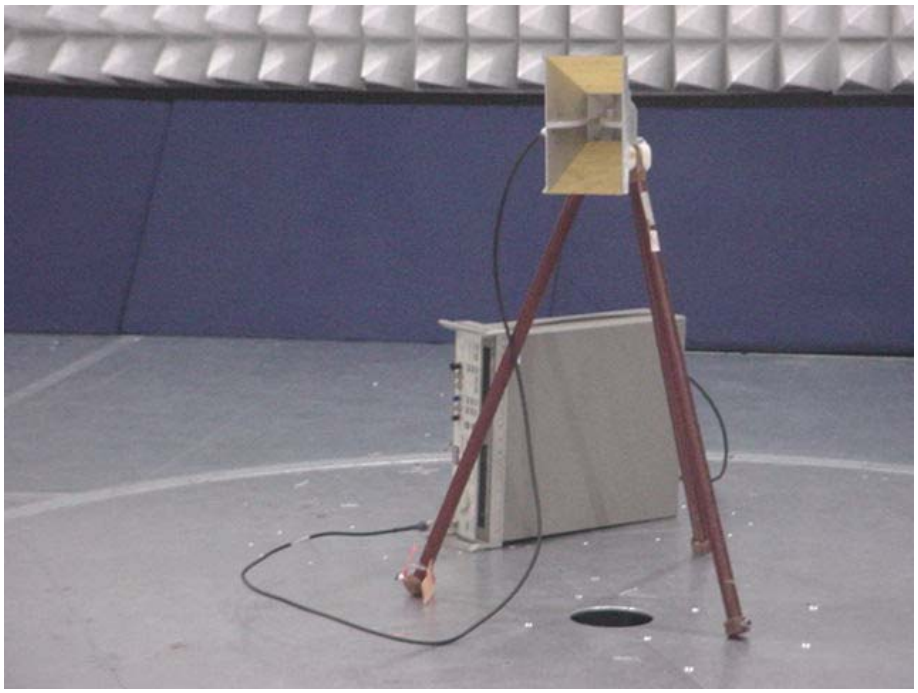
Notes: a) Numbers with a minus sign in margin column are below the limit.

b) Spurious ERP = Vg + G(dBd)

6.4 Test Configuration Photographs



Direct Measurements from EUT



Substitution Antenna above 1 GHz

7.0 RADIATED EMISSION FROM DIGITAL PARTS AND RECEIVER

7.1 Test description

Requirement:	FCC § 15.109(a)
Radiated Emission:	Class B Limit

7.2 Test Procedure

The transmitter was placed on a wooden turntable and antenna terminal was connected to the ¼ wave antenna.
The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height was varied from 1 to 4 m, antenna polarization was changed, and turn table was rotated 360° in order to identify the maximum level of emissions from the EUT.

7.3 Test Results:

Test Result:	EUT PASSED Radiated Emission test with margin 4.9 dB @ 394.7 MHz

See the following page for test data

Gateway Communications Inc. Model: DG200 Date of Test: April 15 to 17, 2003
FCC ID: NAUDG200

Standard: FCC 15.109(a)
Test: Radiated Emissions
Frequency Range: 30 MHz to 1000 MHz
Limit: Class B
Measurement Distance: 3 meters

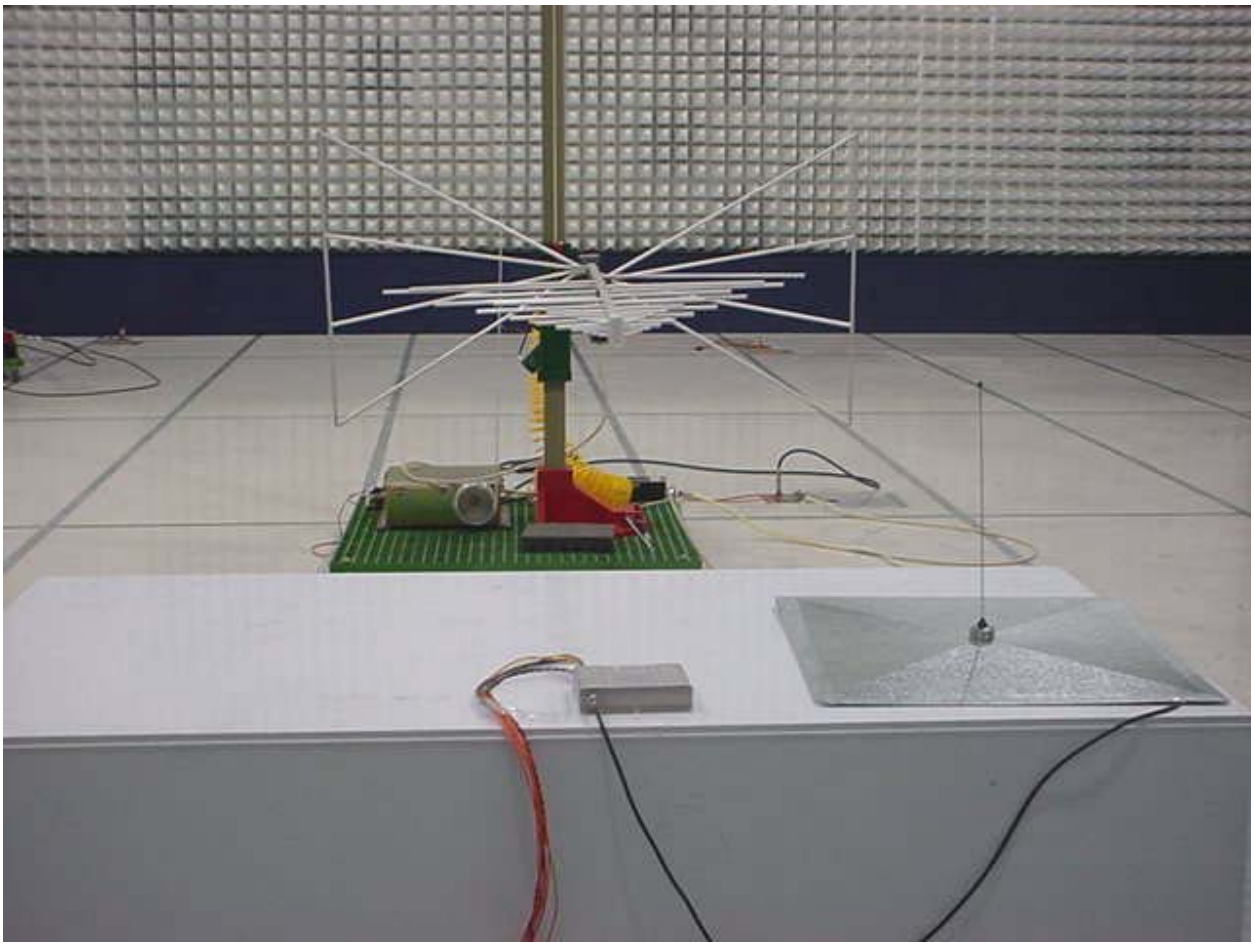
Measurement Uncertainty: 3.92 dB
Temperature: 24˚C
Relative Humidity: 58%

Quasi peak measurements were made at the highest points and found to be as below:

Frequency	Antenna Polariz.	Quasi Pk FS	Limit	Margin	RA	AG	CF	AF	Ext. Atten.
MHz	V/H	dBµV/m	dBµV/m	dB	dBµV	dB	dB	dB(1/m)	dB
78.0	H	35.2	40.0	-13.5	49.0	32.3	0.8	6.0	3.0
84.0	V	31.4	40.0	-8.6	52.8	32.3	0.8	7.1	3.0
96.0	V	25.7	43.5	-17.8	46.8	32.3	0.9	7.4	3.0
120.0	V	34.1	43.5	-9.4	55.2	32.3	1.0	7.1	3.0
394.7	H	41.1	46.0	-4.9	52.6	32.3	1.9	15.9	3.0
592.1	H	36.0	46.0	-10.0	43.7	32.5	2.3	19.5	3.0

Note: a) A complete scan from 30-2200 MHz was made with antenna oriented horizontally and vertically.
b) All emissions not reported are at least 10 dB below the limits
c) Analyzer setting: below 1 GHz RBW ≥100 kHz, VBW ≥100 kHz
above 1 GHz RBW ≥ 1 MHz, VBW ≥ 1 MHz
Detector mode: below 1 GHz Quasi-peak
Above 1 MHz Average
d) Numbers with a minus sign in margin column are below the limit.

7.4 Test Configuration Photograph



8.0 OCCUPIED BANDWIDTH

8.1 Test description

Requirement:	FCC §2.1049

8.2 Test Procedure

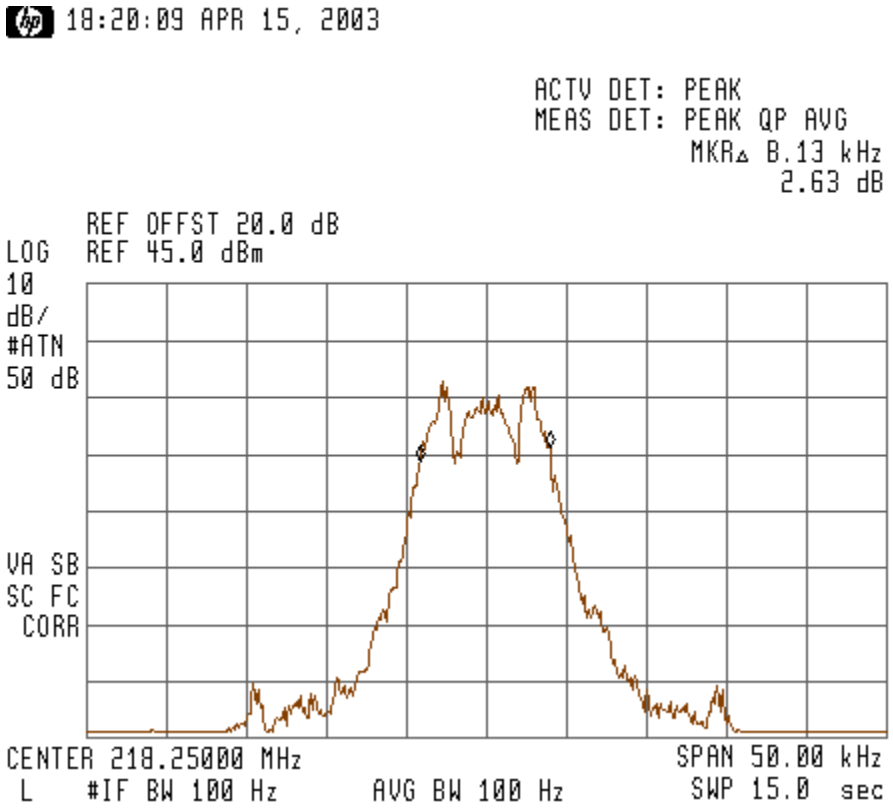
The antenna was disconnected from the transmitter and the short cable was connected to the transmitter RF output. The RF output was connected to the input of the spectrum analyzer through 10 dB attenuator.

The resolution bandwidth of the spectrum analyzer was set approximately 1% of the authorized bandwidth of the transmitter.

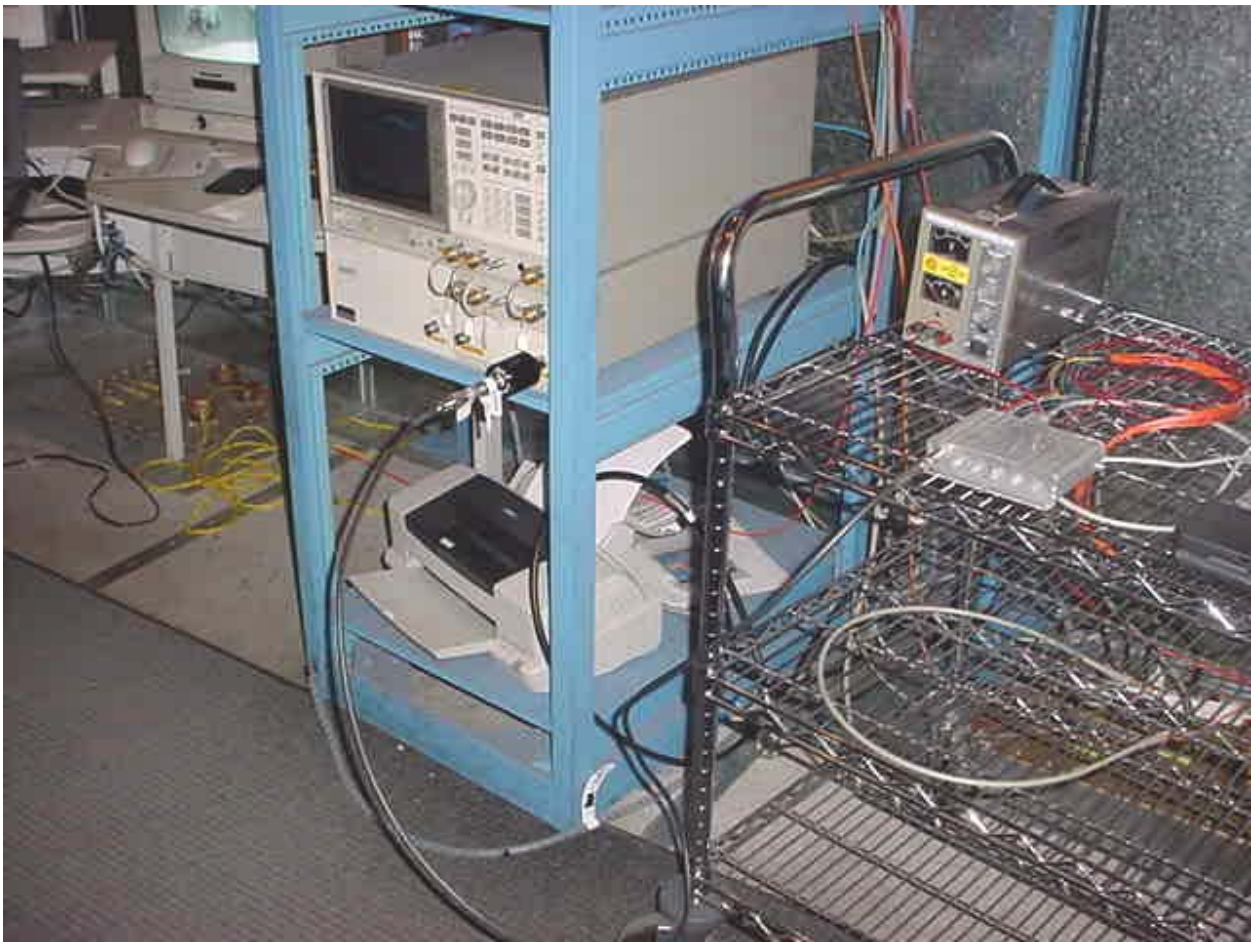
The 99% Power bandwidth was measured and found equal 8.13 kHz.

8.3 Test Results

Test Result:	The Occupied Bandwidth is 8.13 kHz



8.4 Test Configuration Photograph



9.0 AC LINE CONDUCTED EMISSIONS

9.1 Test Description

Parameter:	ANSI C63.4
Requirement:	FCC § 15.107

9.2 Test Procedure

The EUT was connected to the DC power supply.

9.3 Test Results

Not applicable, the EUT is battery powered only.

10.0 FREQUENCY STABILITY

10.1 Test description

Requirement:	FCC § 1.1055
Frequency Tolerance:	Within 0.00025% (2.5ppm)

10.2 Test Procedure

The ppm frequency error of the transmitter was calculated by:

$$ppm\ error = \left(\frac{MCF}{ACF} - 1\right) \cdot 10^6$$

Where MCF is the Measured Carrier Frequency in MHz
ACF is the Assigned Carrier Frequency in MHz

10.2.1 Frequency Stability vs. Temperature

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed through attenuators. The EUT was placed inside the temperature chamber.
The temperature stability was measured with variation of ambient temperature as follows:
a) From -30°C to +50°C with intervals of 10°C
b) After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the counter.

10.2.2 Frequency Stability vs. Voltage

At room temperature (25 ±5°C), an external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115%, 100% and 85% of the nominal operating input voltage.

10.3 Test Results

Frequency Stability vs Temperature		
ACF (MHz):	218.75	Limit: 2.5ppm
Temperature, C	MCF (MHz)	PPM Error
50	218.74968	-1.462857143
40	218.74978	-1.005714286
30	218.74992	-0.365714286
20	218.75001	0.045714286
10	218.75016	0.731428571
0	218.75023	1.051428571
-10	218.75033	1.508571428
-20	218.75036	1.645714286
-30	218.75041	1.874285714

Frequency Stability vs Voltage			
ACF (MHz): 218.75			Limit: 2.5 ppm
%	Voltage	MCF (MHz)	PPM Error
115	15.64	218.75001	0.05
100	13.60	218.75001	0.05
85	11.56	218.75001	0.05

10.4 Test Configuration Photograph

11.0 TEST EQUIPMENT

Measurement equipment used for compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Serial #	Cal Int	Cal Due
BI-Log Antenna	EMCO	3143	9509-1160	12	9/19/03
Dipole Antenna	CDI	Roberts	331	12	9/10/03
Horn Antenna	EMCO	3115	9170-3712	12	6/02/03
Horn Antenna	EMCO	3115	8812-3049	12	4/03/04
Pre-Amplifier	Sonoma Inst.	310	185634	12	4/30/03
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	4/30/03
RF Filter Section	Hewlett Packard	85460A	3448A00267	12	7/16/03
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	7/16/03
Spectrum Analyzer w/8650 QP Adapter	Hewlett Packard	8568B	1912A0053 2521A01021	12	11/20/03
Spectrum Analyzer w/85650 QP Adapter	Hewlett Packard	8566B	2416A00317 2043A00251	12	4/30/03
Signal Generator	Hewlett Packard	83732A	3222A00119	12	5/04/03
Digital Counter	Leader	LDC-825	1010046	12	9/03/03
Environmental Chamber	B-M-A Inc.	TH-64	2287	12	5/22/03