



APPLICATION FOR FCC PART 90 TYPE ACCEPTANCE

Teledesign Systems Inc.

**Radio Modem with 3412 Transceiver
Model No.: TS4000-05Bff**

FCC ID: JWFTS4000B

Report # J98033454

Date of Report: December 20, 1998

Total No. of Pages Contained in this Report: 72

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FCC Part 90 Type Acceptance

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Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

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1.0 Introduction

1.1 Test Summary

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
2.985(a)	RF Power Output	Pass	3
90.205	Effective Radiated Power	Pass	7
2.989(i), 90.209(b)(5), 90.210	Occupied Bandwidth, Bandwidth Limitation, Emission Masks	Pass	9
2.991, 90.210	Spurious Emissions at Antenna Terminals	Pass	31
2.993, 15.109, 90.210	Field Strength of Spurious Radiation	Pass	45
15.107	Line Conducted Emissions	Pass	50
2.995(a)	Frequency Stability vs. Temperature	Pass	54
2.995(d)(3)	Frequency Stability vs. Voltage	Pass	55
90.214	Transient Frequency Behavior	Pass	56



Xi-Ming Yang
Test Engineer

February 2, 1999
Date

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1.2 Product Description

The unit under test is a radio modem with 3412 transceiver.

1.3 Related Submittal(s) Grants

[X] Type acceptance granted for the radio transceiver used in this radio modem.

Applicant: Johnson Data Telemetry Corporation

FCC ID: ATH2423412-004

Date of Grant: December 10, 1996

File No.: 31010/EQU 17.9

[X] DOC for computer section, a separate DOC is prepared.

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2.0 RF Power Output, FCC §2.985(a)

2.1 Test Procedure

The transmitter output was connected to a calibrated coaxial attenuator, the other end of which was connected to a spectrum analyzer. The resolution bandwidth and the video bandwidth of the spectrum analyzer were set up to 300 kHz and 300 kHz respectively. The attenuator was included in spectrum analyzer OFFSET function.

Transmitter output was read off the spectrum analyzer in dBm.

2.2 Test Equipment

Hewlett Packard 8481A Power Sensor, 435B Power Meter

Hewlett Packard HP8566B Spectrum Analyzer, 100 Hz - 22 GHz

Tektronix 2782 Spectrum Analyzer, 100 Hz - 40 GHz

2.3 Test Results

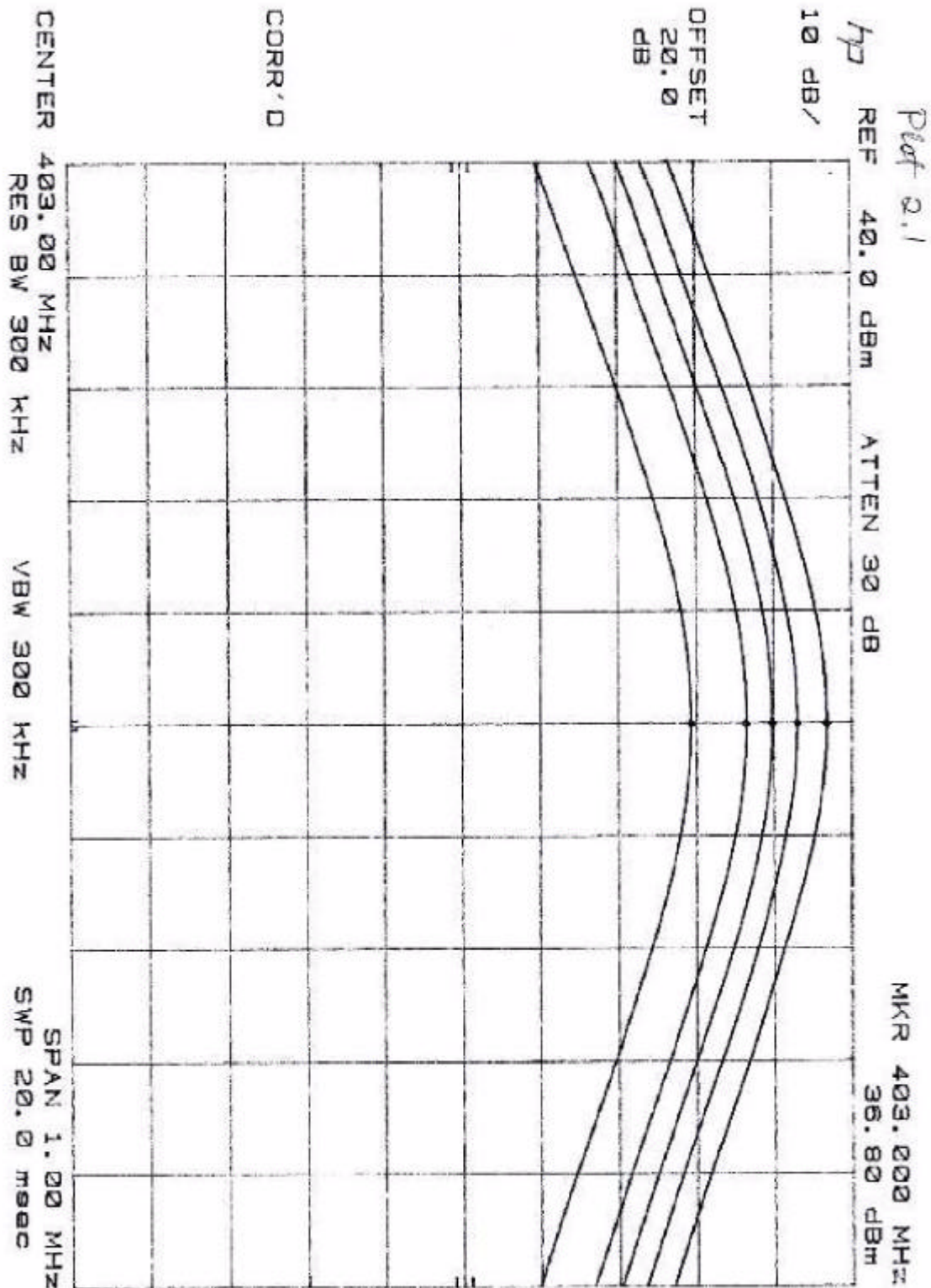
Refer to the attached plot #2.1-2.3 and table below:

Power Level (Watt)	Reading, dBm		
	512 MHz	458 MHz	403 MHz
5	37.3	37.4	36.8
2	33.7	33.2	33.0
1	30.5	30.6	29.7
0.5	27.5	27.3	26.4
0.1	18.9	19.0	19.3

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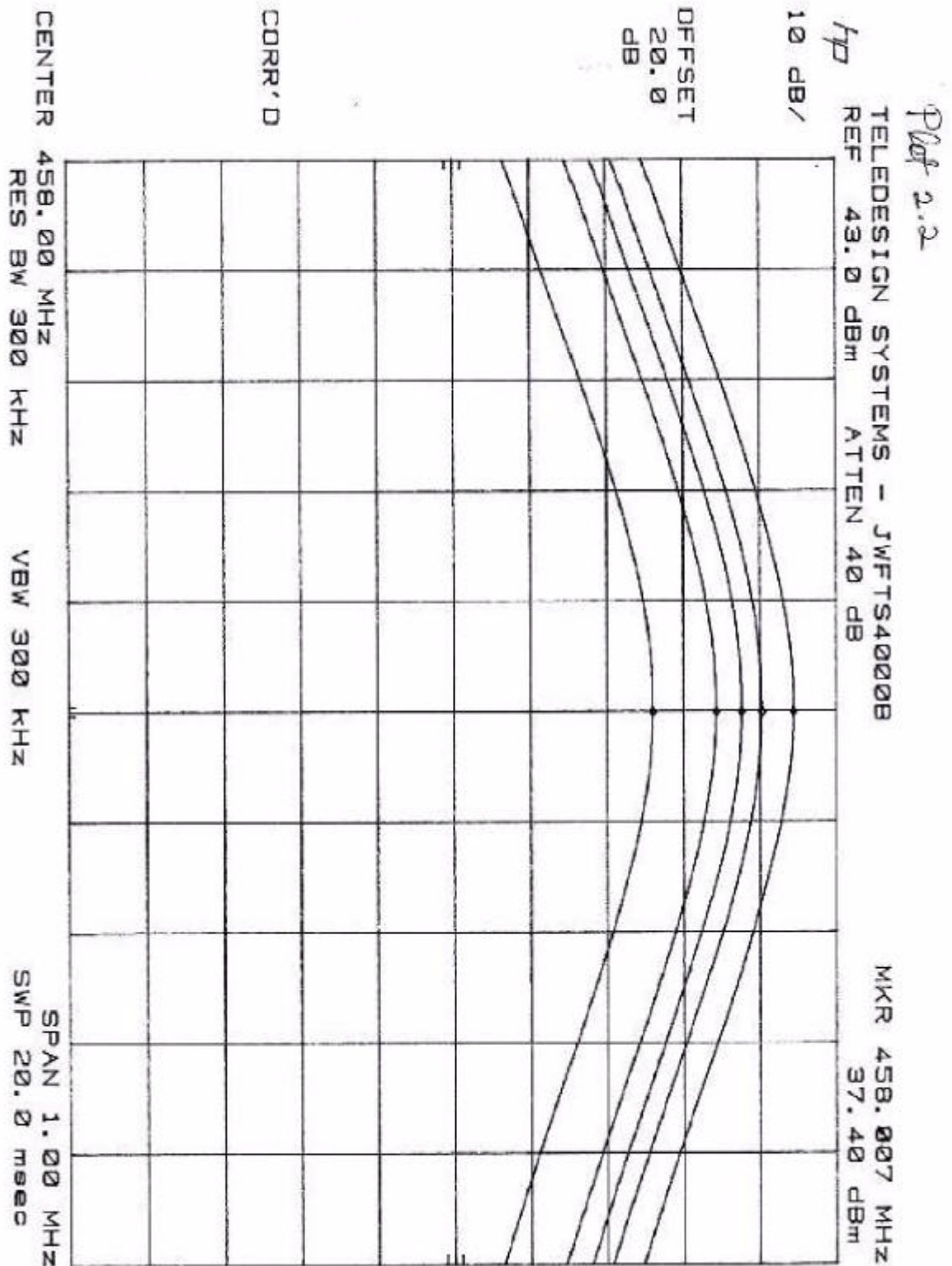
Date of Test: December 11, 1998



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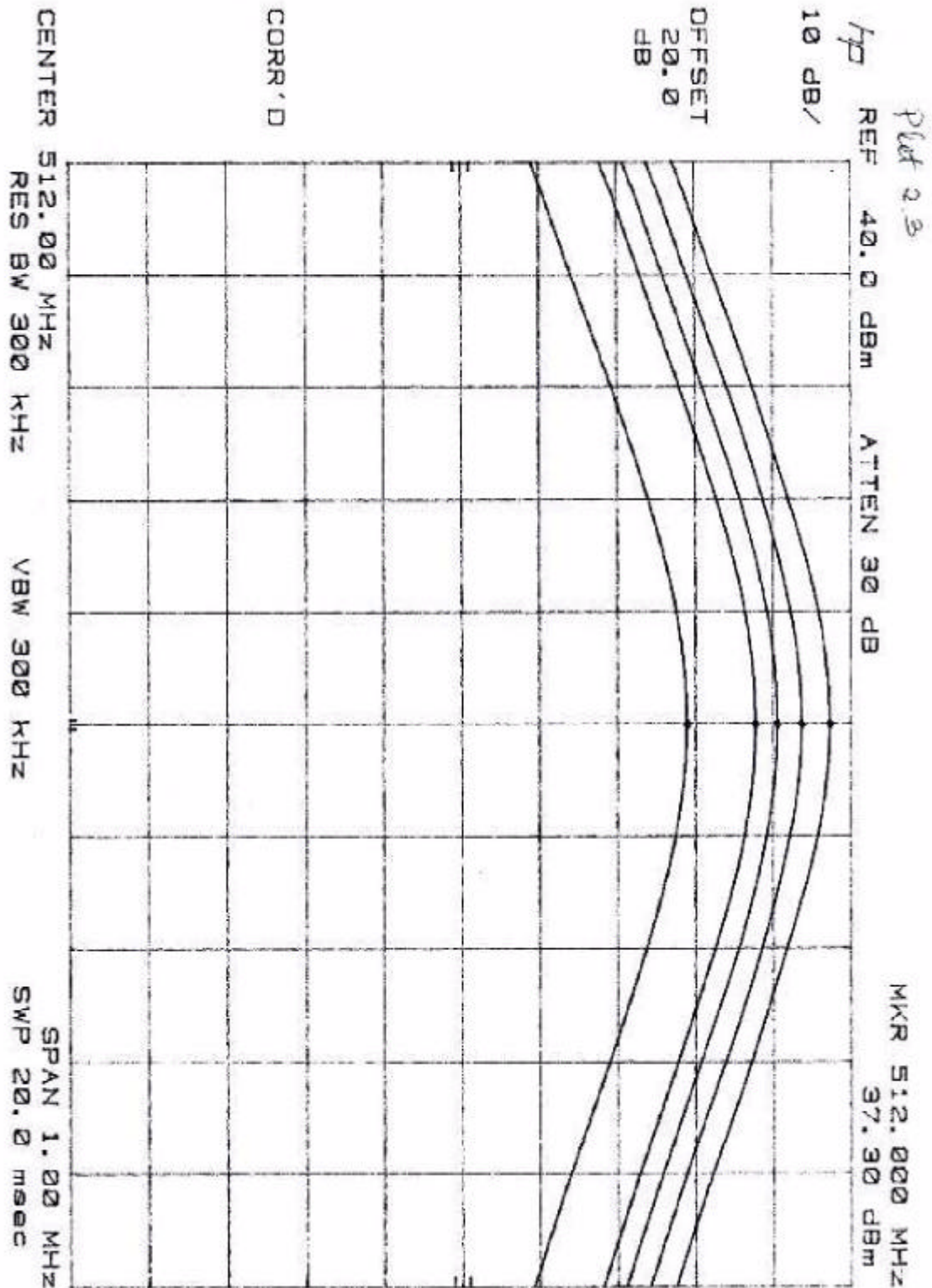
Date of Test: December 11, 1998



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3.0 Effective Radiated Power, FCC § 90.205

3.1 Test Procedure

The EUT was positioned on a non-conductive turntable, 0.8m above the ground plane on an open test site.

The radiated emission at the fundamental frequency was measured at 3m distance with a test antenna and spectrum analyzer. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set to 100 kHz. The maximum emission was recorded with the rotation of the turntable and the raising and lowering of the test antenna. The spectrum analyzer reading was recorded.

The ERP was calculated as follows:

$$ERP_{(dBm)} = E_{(dBuV/m)} + 20 \log D - 10 \log 30 - 10 \log G - 90$$

where D = 3m, distance

G = 1.64, gain of half-wave dipole

3.2 Test Equipment

Hewlett Packard HP8566B Spectrum Analyzer
CDI Biconical Antenna

3.3 Test Results

The maximum ERP is 12W.

Refer to the attached data.

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Teledesign Radio Modem with 3412 Transceiver

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Company: Teledesign System Inc.
Project #: J98033454
Model: JWFTS4000B
Engineer: Xi-Ming Yang
Date of test: Dec. 11, 1998

FCC 90 Radiated Emissions

Frequency	Antenna	Reading	Antenna	Pre-amp	Cable	Corrected	EIRP	ERP
MHz	Polarity		Factor		Loss	Reading		
	H/V	dB(uV)	dB(1/m)	dB	dB	dB(uV/m)	dB(pW)	dBm
403.0	V	121.7	16.0	0.0	0.4	138.1	132.9	40.7
458.0	V	117.6	16.6	0.0	0.4	134.6	129.4	37.2
512.0	V	116.3	18.7	0.0	0.5	135.5	130.3	38.1

Note: 1. All measurement were made at 3 meters

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4.0 Occupied Bandwidth, Bandwidth Limitation, Emission Masks. FCC §2.989(i), 90.209(b)(5), 90.210

4.1 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 sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set up at least 10 times higher than the authorized bandwidth of the transmitter. The spectrum analyzer reading was recorded and plotted. This reading is used as a reference for emission mask measurements.

The resolution bandwidth of the spectrum analyzer was set up to 100 Hz and the spectrum of the transmitting signal (random pattern) was recorded. This spectrum was compared to the required emission mask.

4.2 Test Equipment

HP 8566B Spectrum Analyzer, 100 Hz - 22 GHz

HP 7470A Plotter

4.3 Test Results

The EUT meets the requirements for the emission masks C and D for the Emission Designators:

20K0F1D

16K0F1D

11K2F1D

Refer to the attached plots 4.1 - 4.20.

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Occupied Bandwidth Plots:

Transmitting at 458 MHz				
Plot #	Emission Mask	Type of Modulation	Emission Designator	Description
4.1	C	4LFSK	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 100 kHz
4.2	C	4LFSK	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz
4.3	C	4LFSK	16KOF1D	B=24 kbps, M=3 kHz, D=5 kHz, Span 100 kHz
4.4	D	4LFSK	11K2F1D	B=15 kbps, M=1875 Hz, D=3750 Hz, Span 100 kHz
4.5	C	GMSK, BT=0.3	20KOF1D	B=19.2 kbps, M=6.4 kHz, D=3.6 kHz, Span 100 kHz
4.6	C	GMSK, BT=0.3	20KOF1D	B=19.2 kbps, M=6.4 kHz, D=3.6 kHz, Span 200 kHz
4.7	C	GMSK, BT=0.3	16KOF1D	B=19.2 kbps, M=6.4 kHz, D=1.6 kHz, Span 100 kHz
4.8	D	GMSK, BT=0.3	11K2F1D	B=9.6 kbps, M=3.2 Hz, D=2.4 kHz, Span 100 kHz
4.9	C	GMSK, BT=0.5	20KOF1D	B=14 kbps, M=7.2 kHz, D=3 kHz, Span 100 kHz
4.10	C	GMSK, BT=0.5	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 200 kHz
4.11	C	GMSK, BT=0.5	16KOF1D	B=10 kbps, M=5 kHz, D=3 kHz, Span 100 kHz
4.12	D	GMSK, BT=0.5	11K2F1D	B=7.2 kbps, M=3.6 kHz, D=2 kHz, Span 100 kHz
4.13	C	4LFSK	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz, Low Power
4.14	C	GMSK, BT=0.5	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 200 kHz, Low Power

B = Channel Baud Rate
M = Modulation Frequency
D = Peak Deviation

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Transmitting at 403 MHz				
Plot No.	Emission Mask	Type of Modulation	Emission Designator	Description
4.15	C	4FSK	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz
4.16	C	GMSK, BT=0.3	20KOF1D	B=19.2 kbps, M=6.4 kHz, D=3.6 kHz, Span 200 kHz
4.17	C	GMSK, BT=0.5	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 200 kHz

Transmitting at 512 MHz				
Plot No.	Emission Mask	Type of Modulation	Emission Designator	Description
4.18	C	4FSK	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz
4.19	C	GMSK, BT=0.3	20KOF1D	B=19.2 kbps, M=6.4 kHz, D=3.6 kHz, Span 200 kHz
4.20	C	GMSK, BT=0.5	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 200 kHz

B = Channel Baud Rate

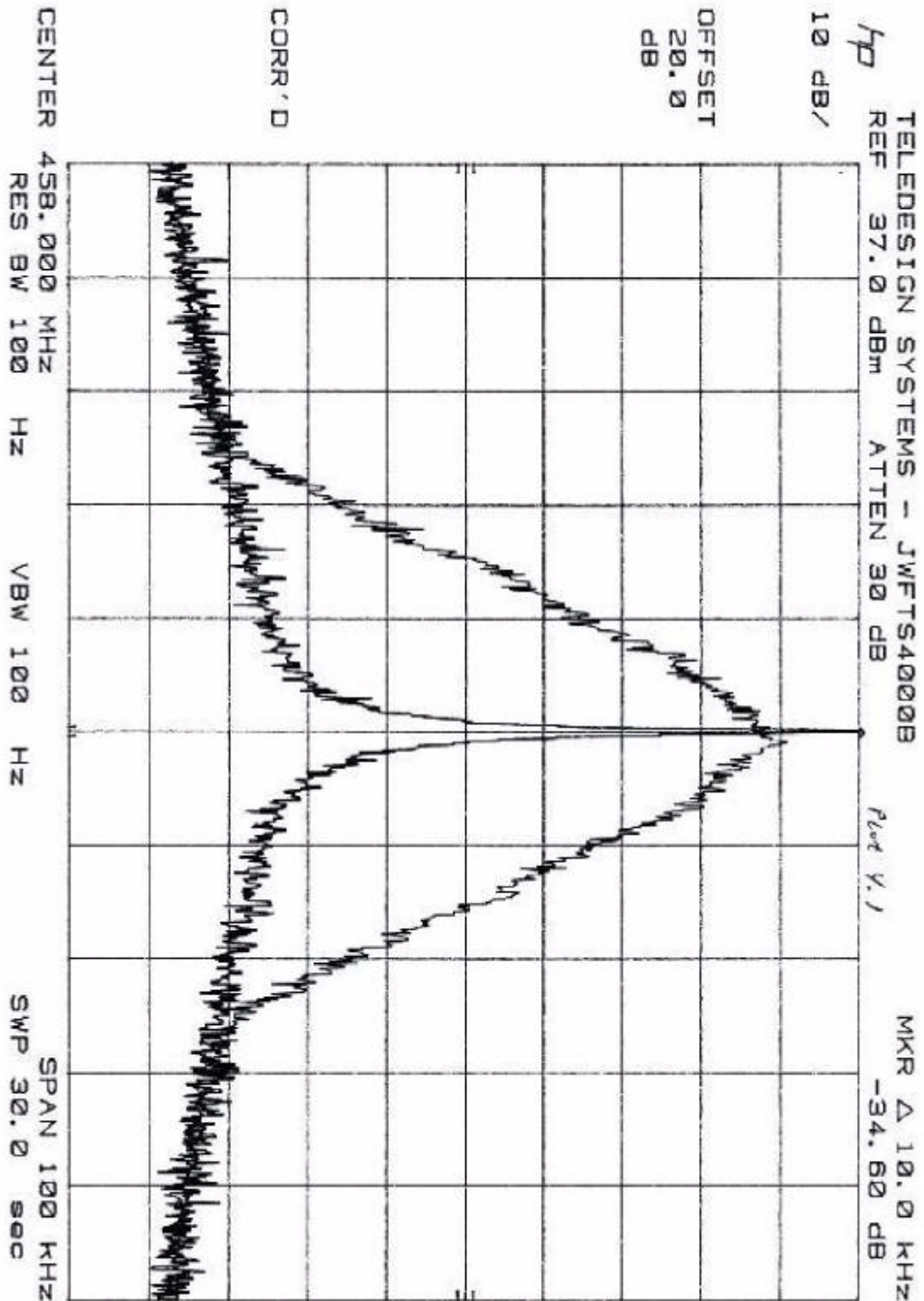
M = Modulation Frequency

D = Peak Deviation

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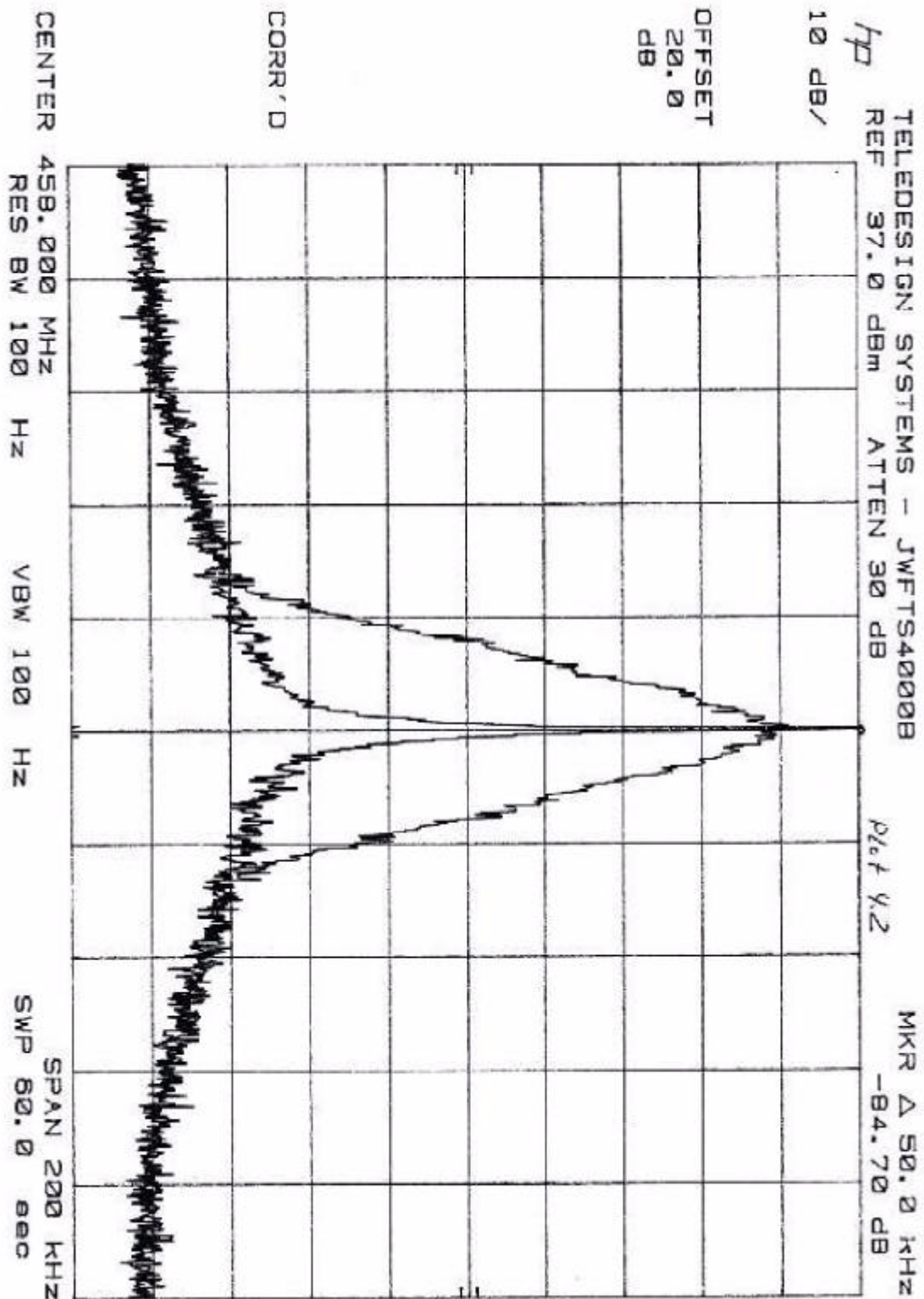
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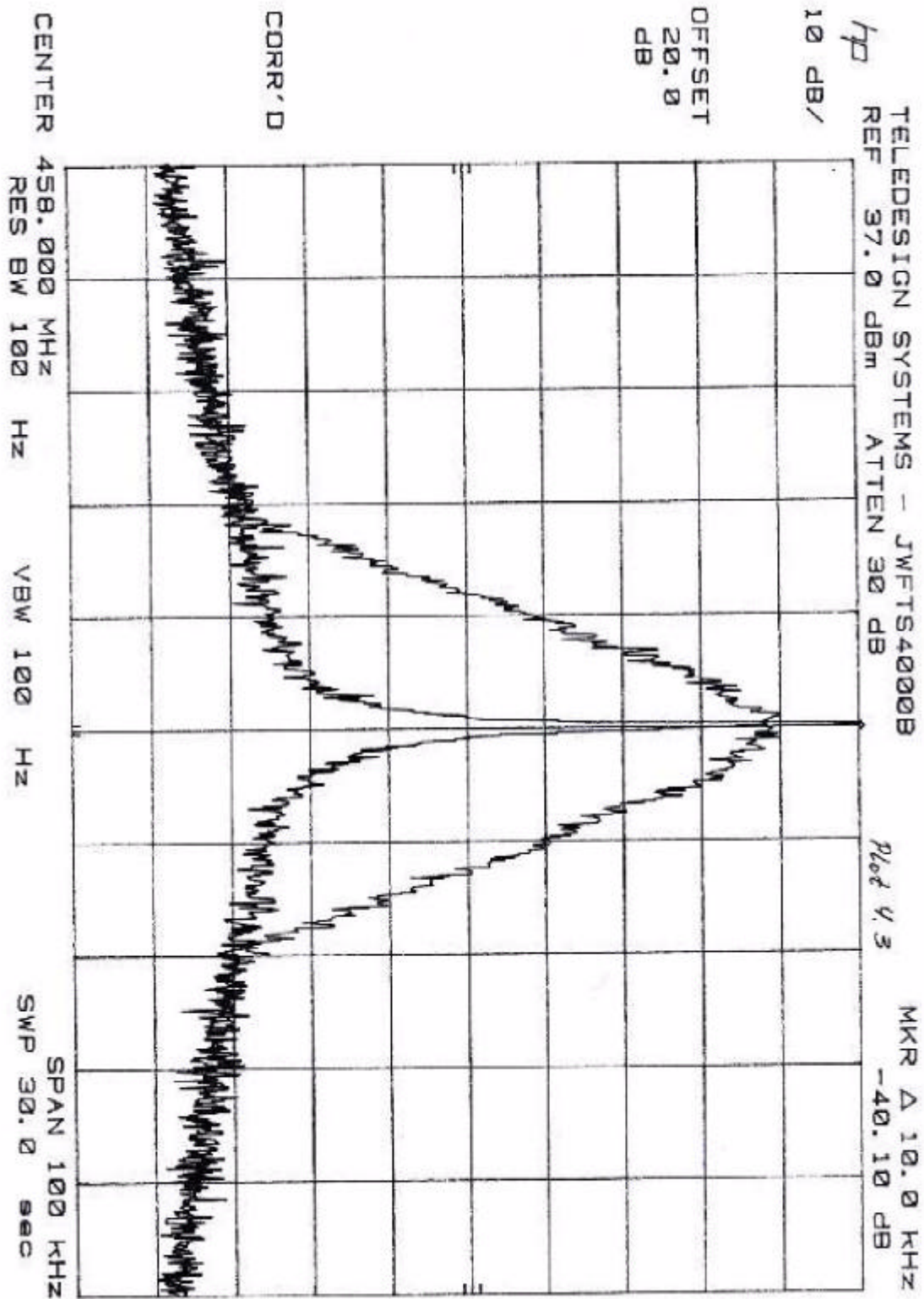
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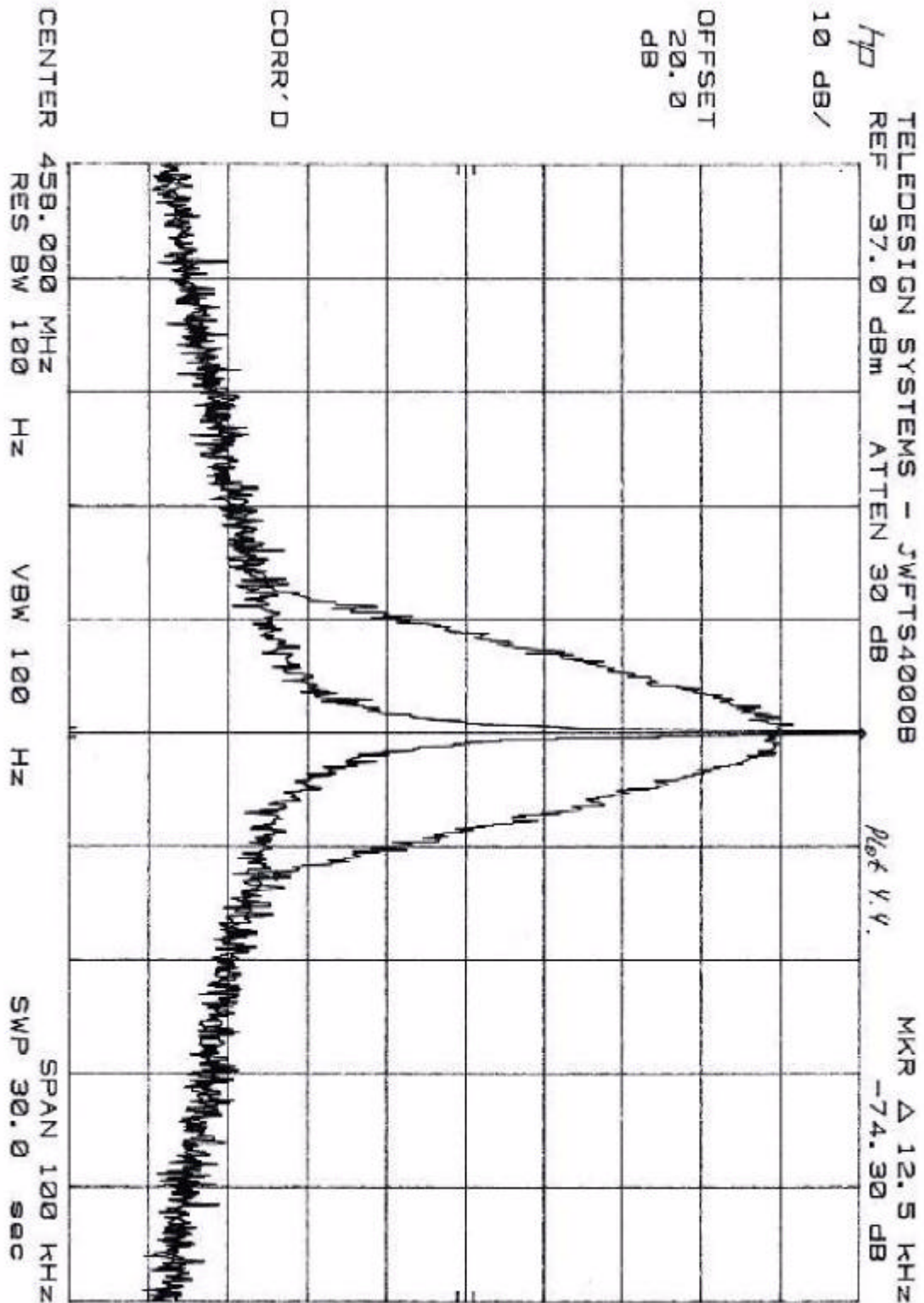
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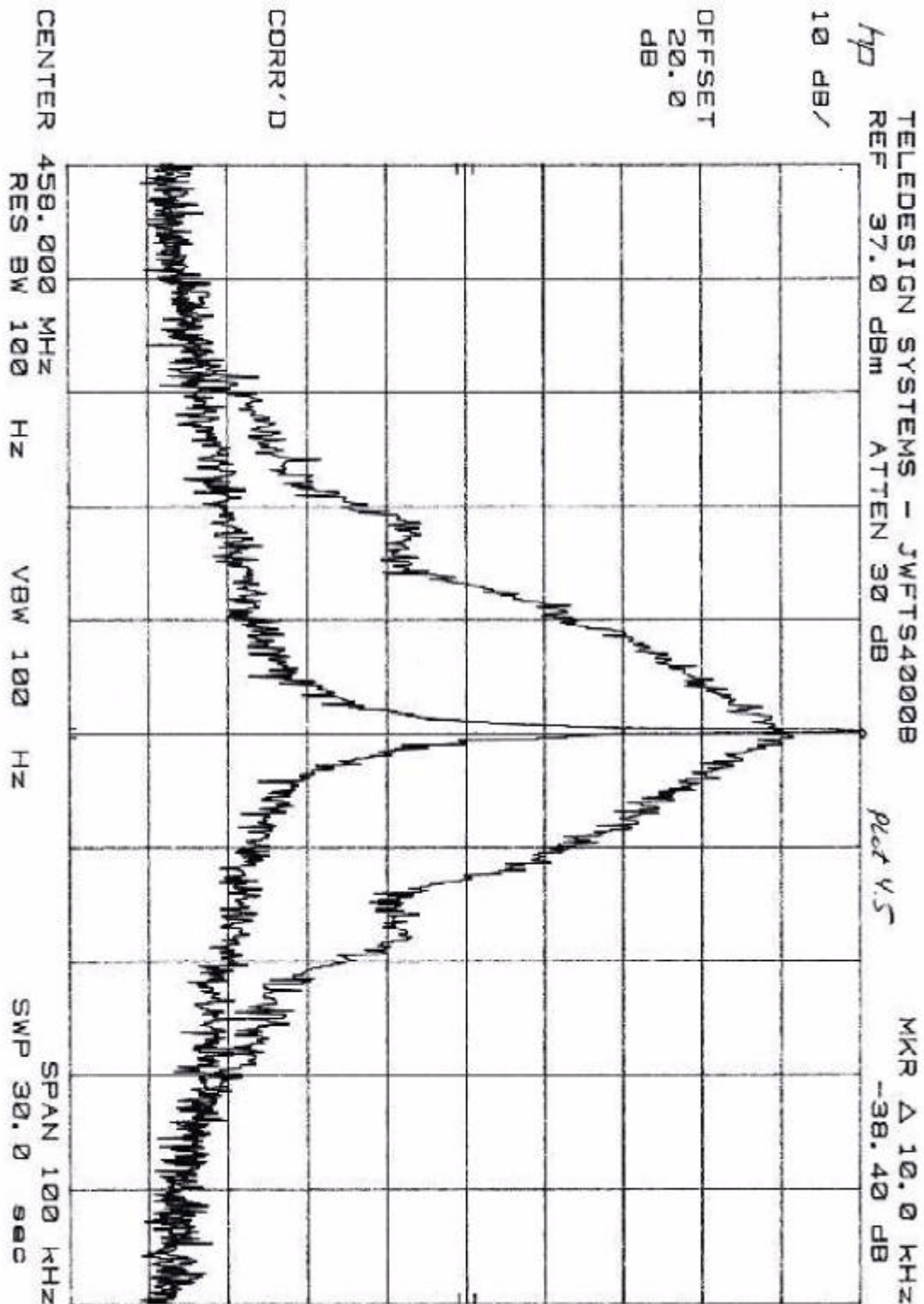
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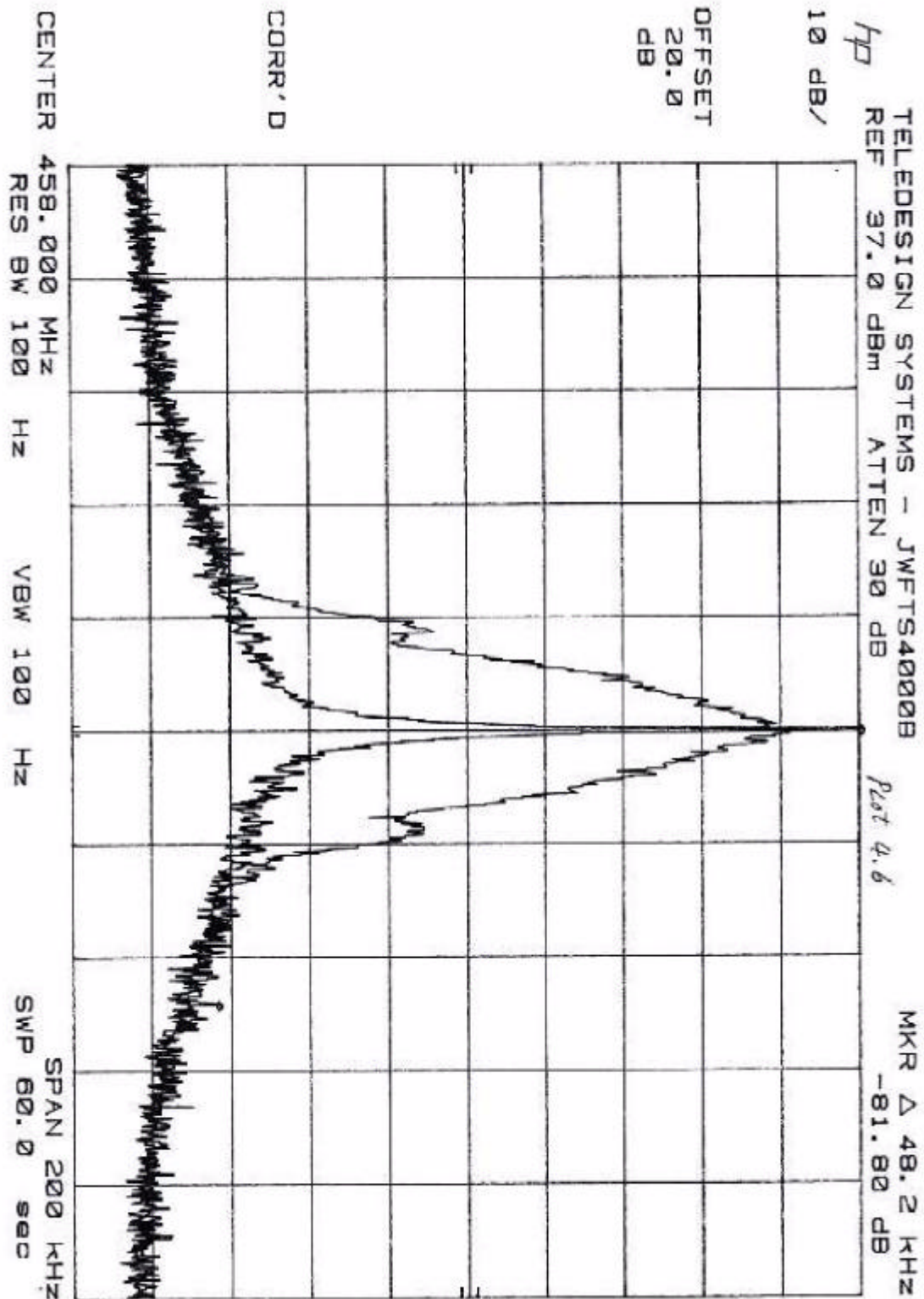
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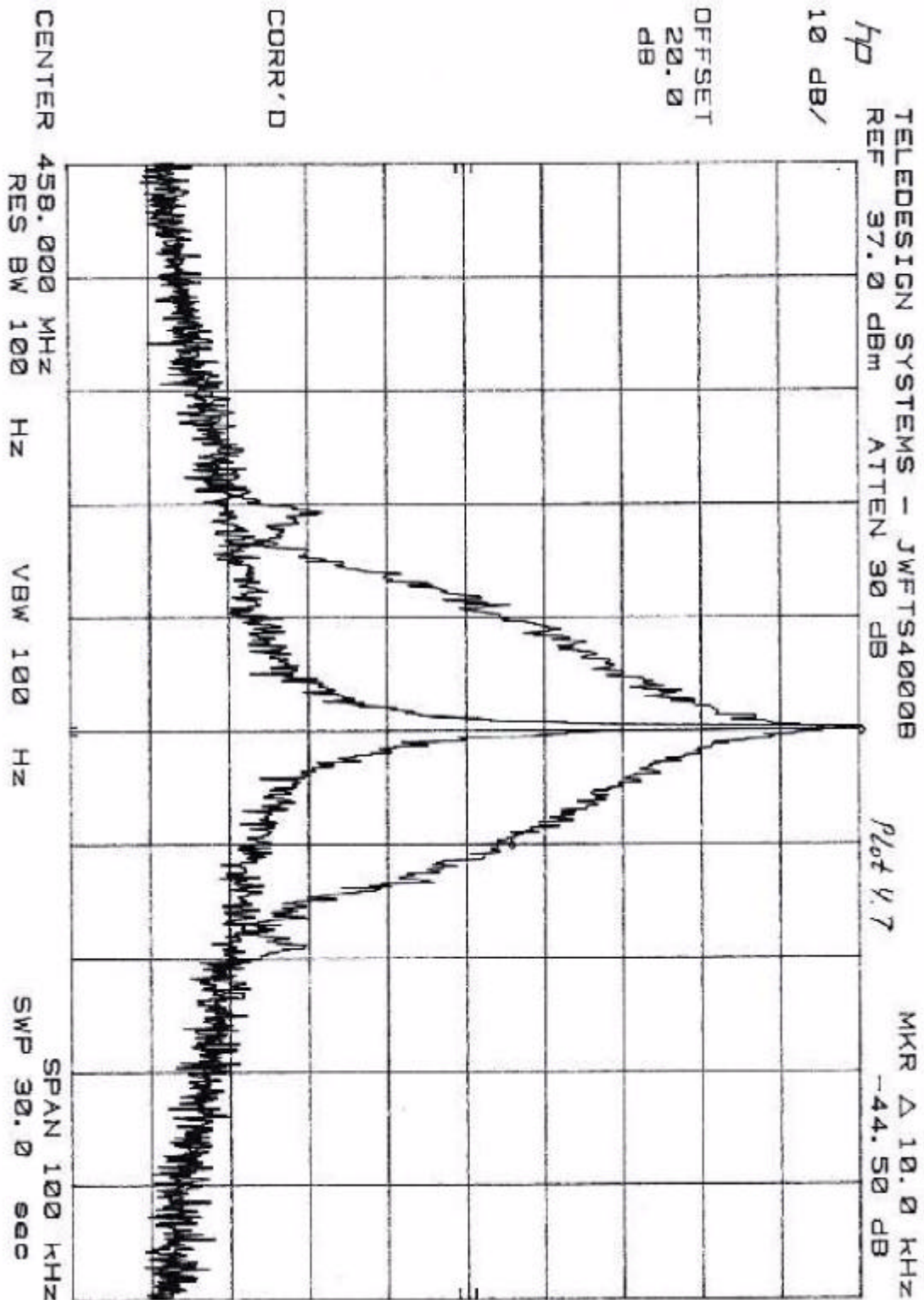
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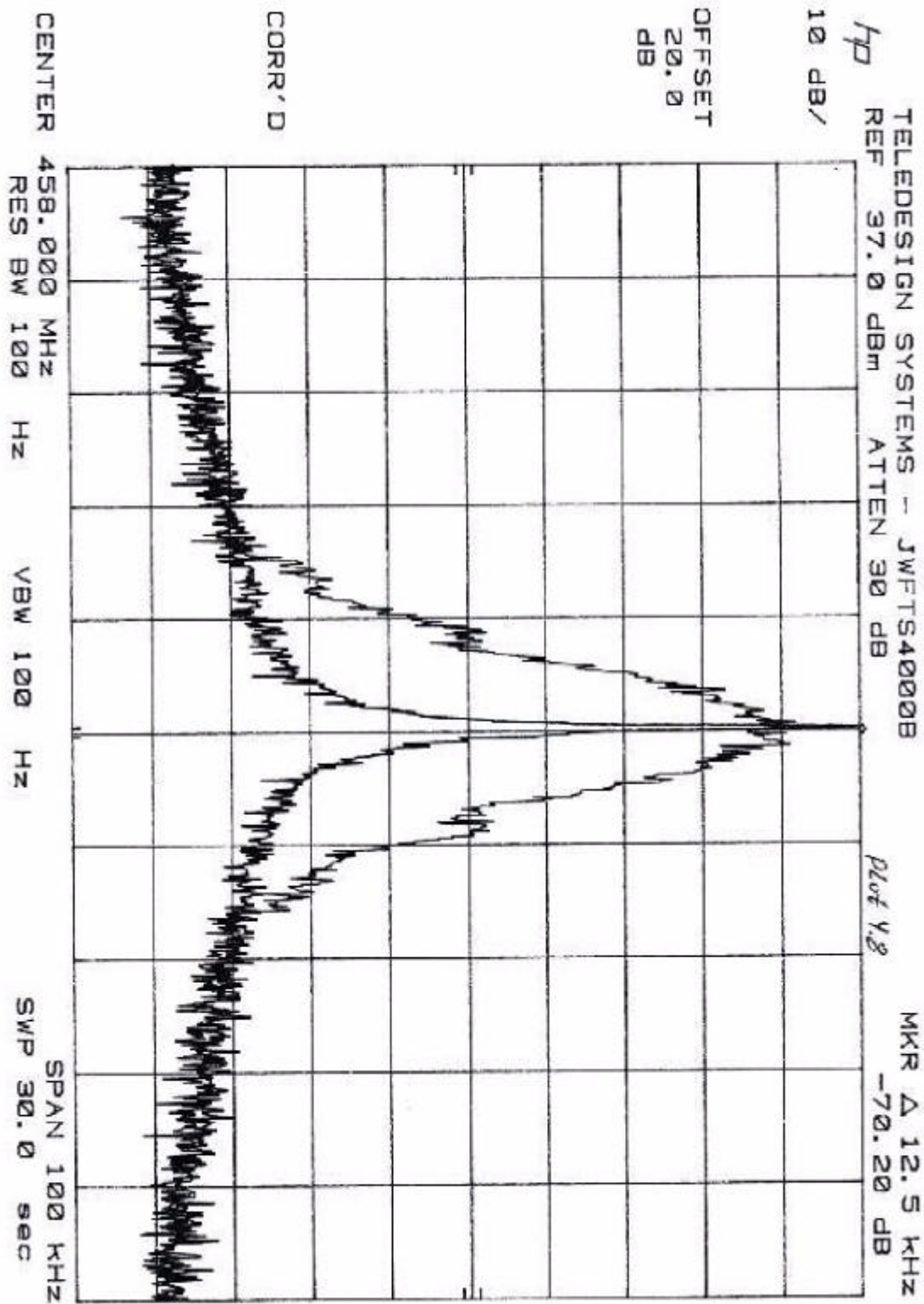
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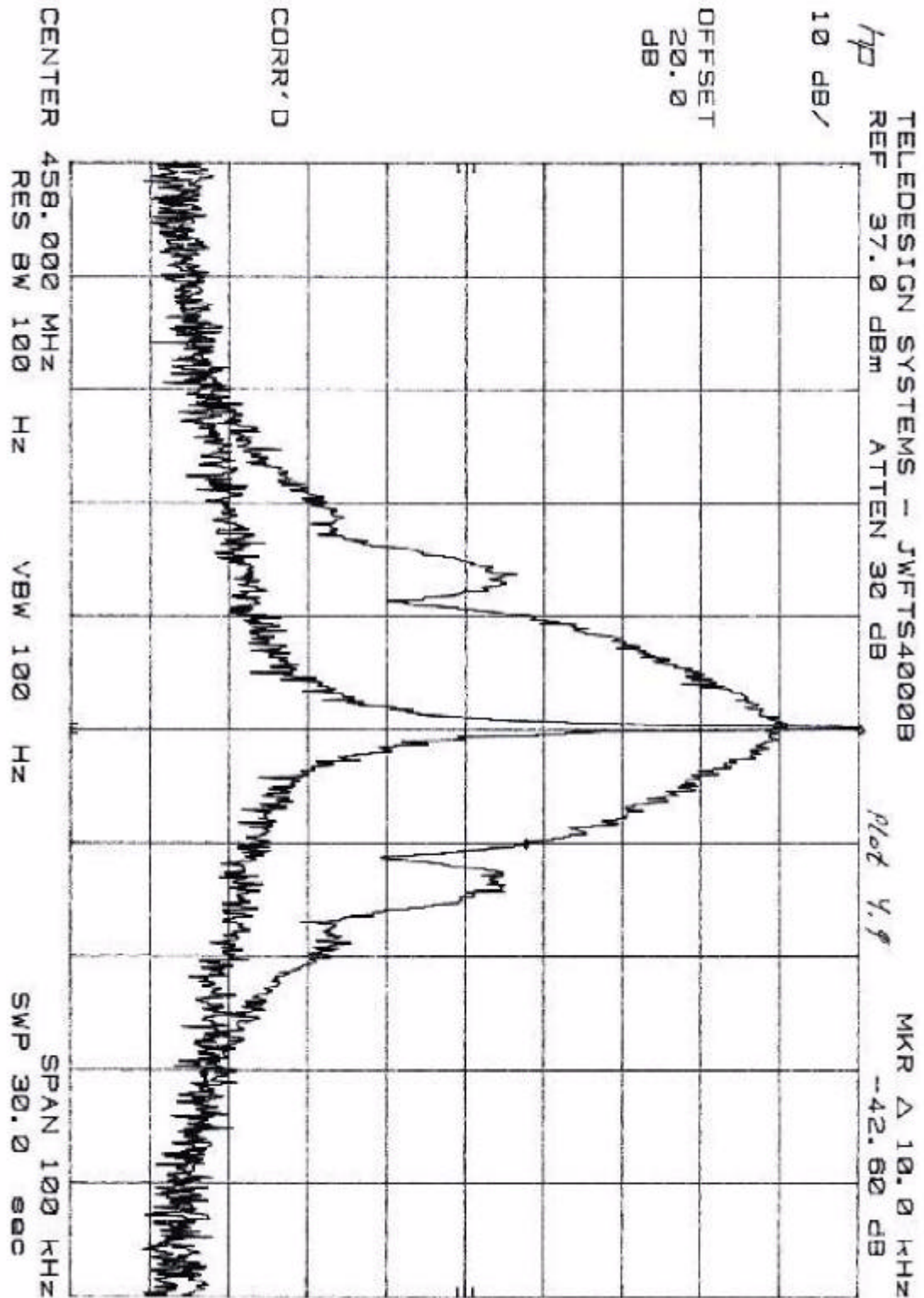
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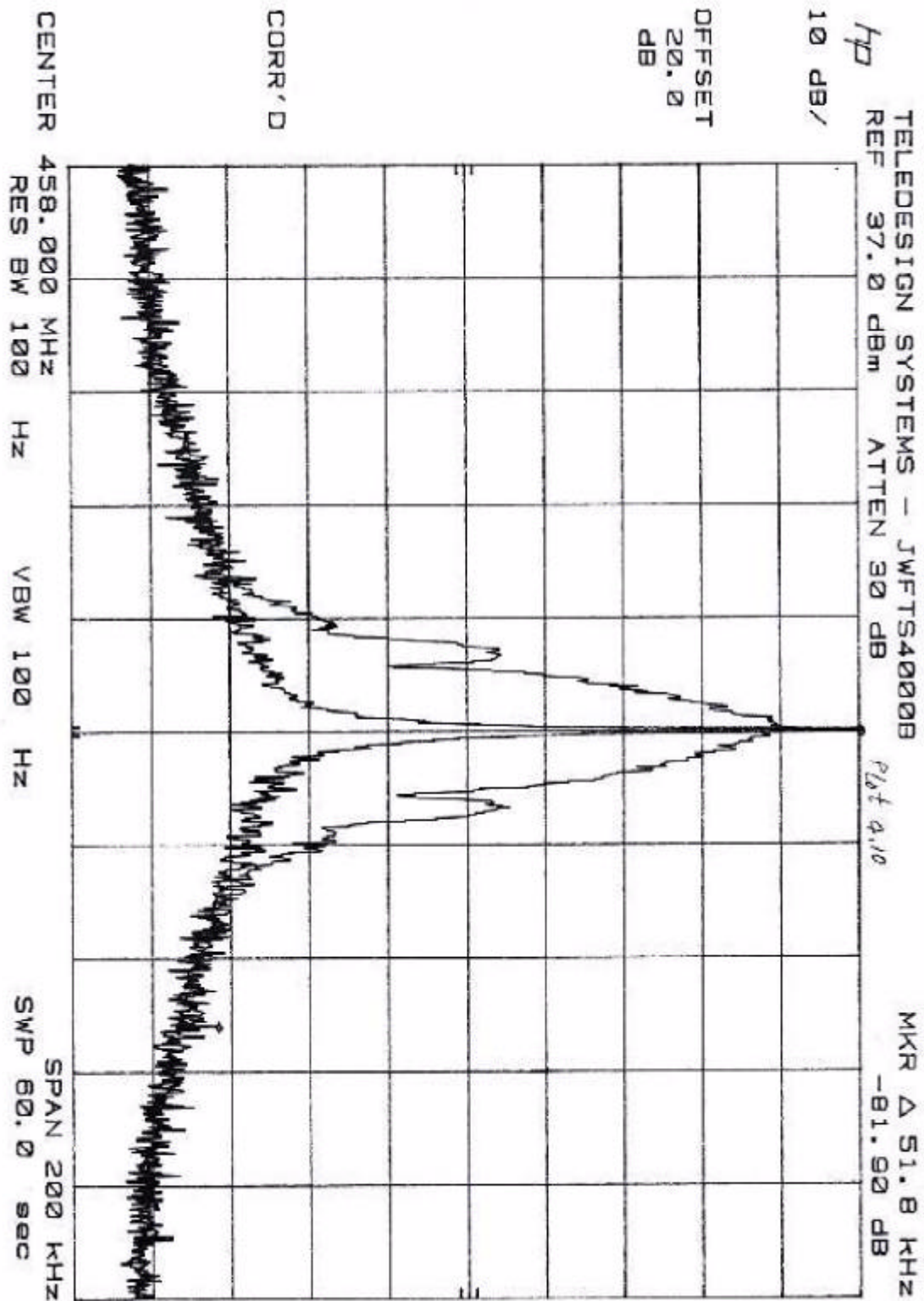
Date of Test: December 11, 1998



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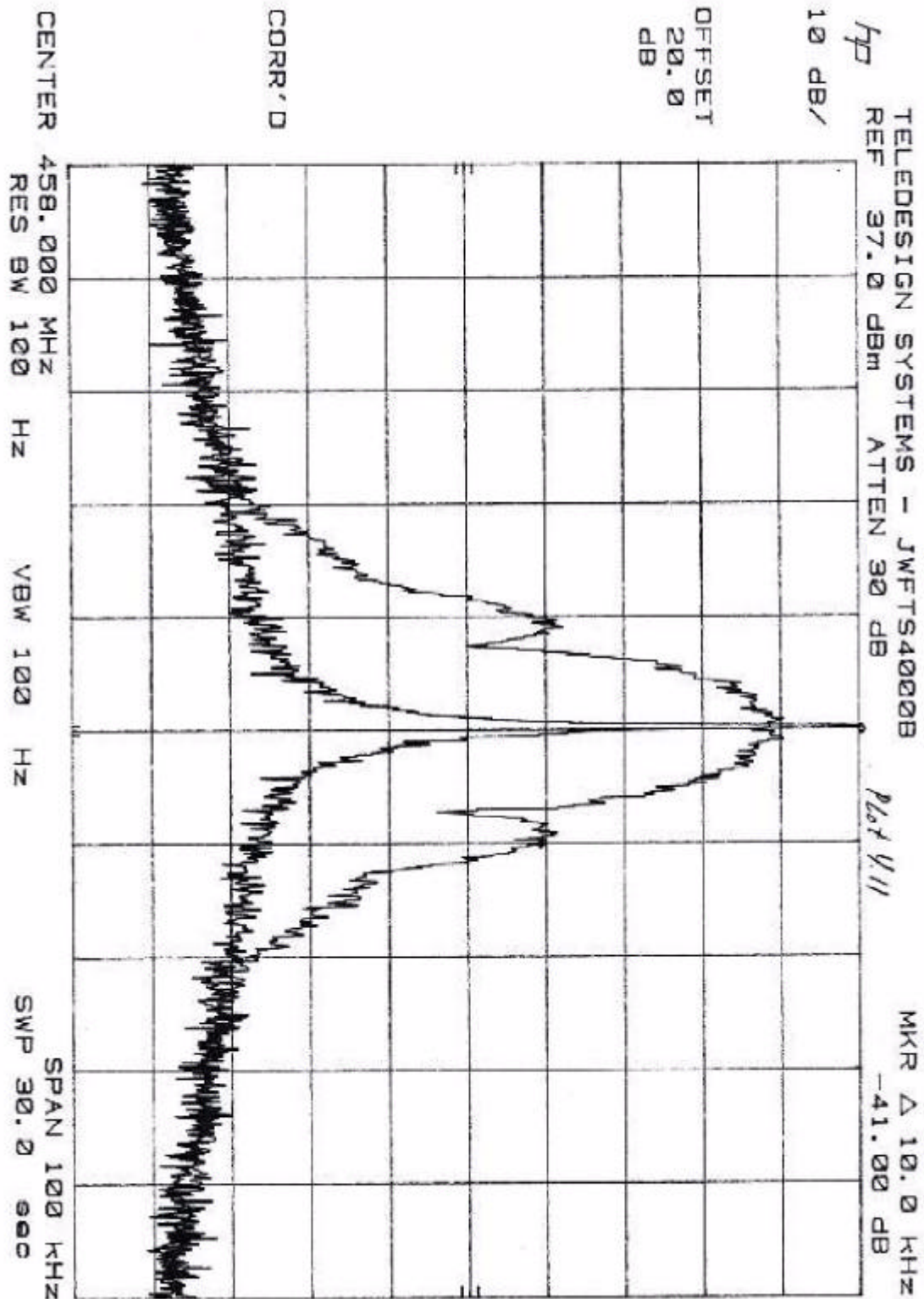
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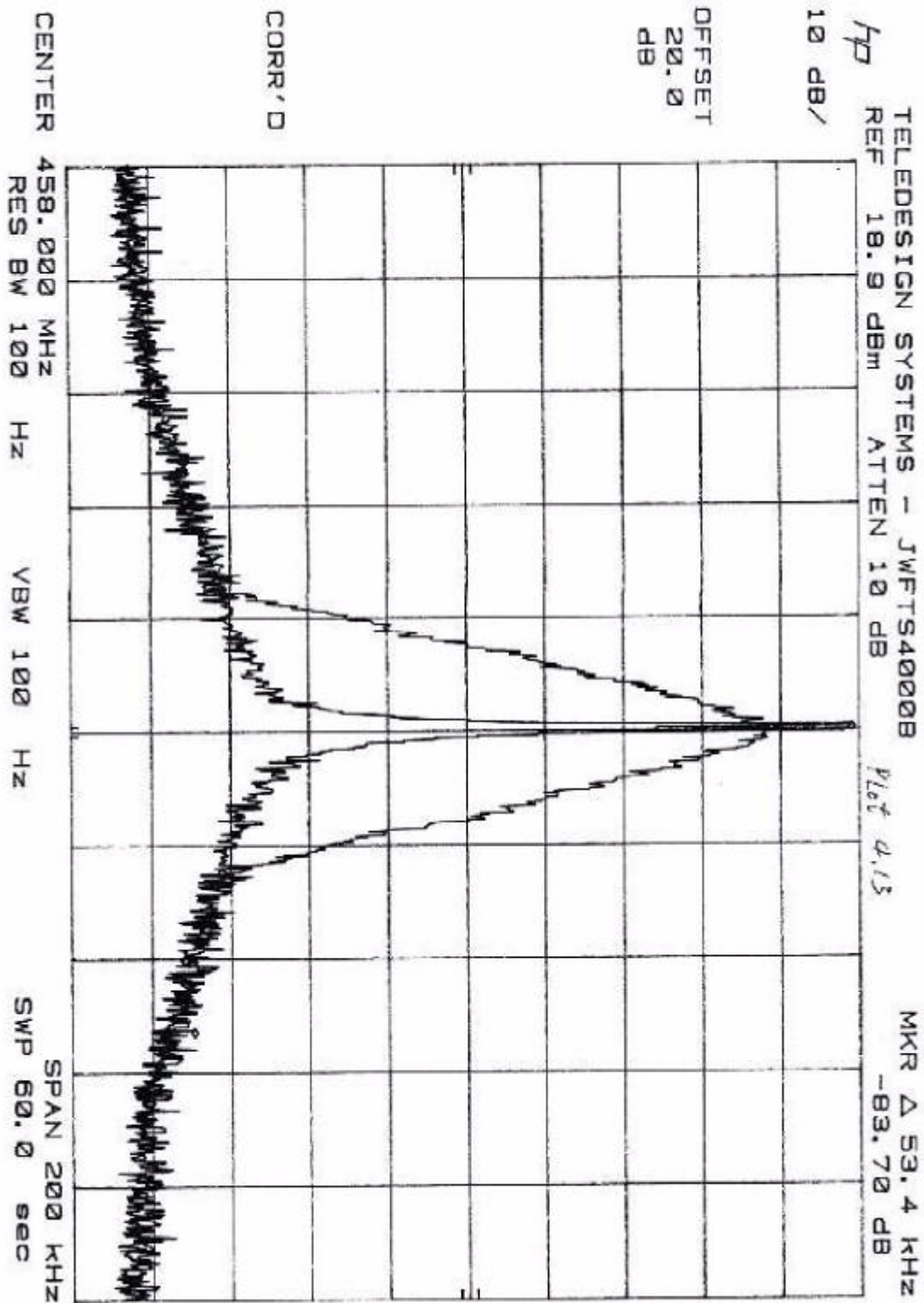
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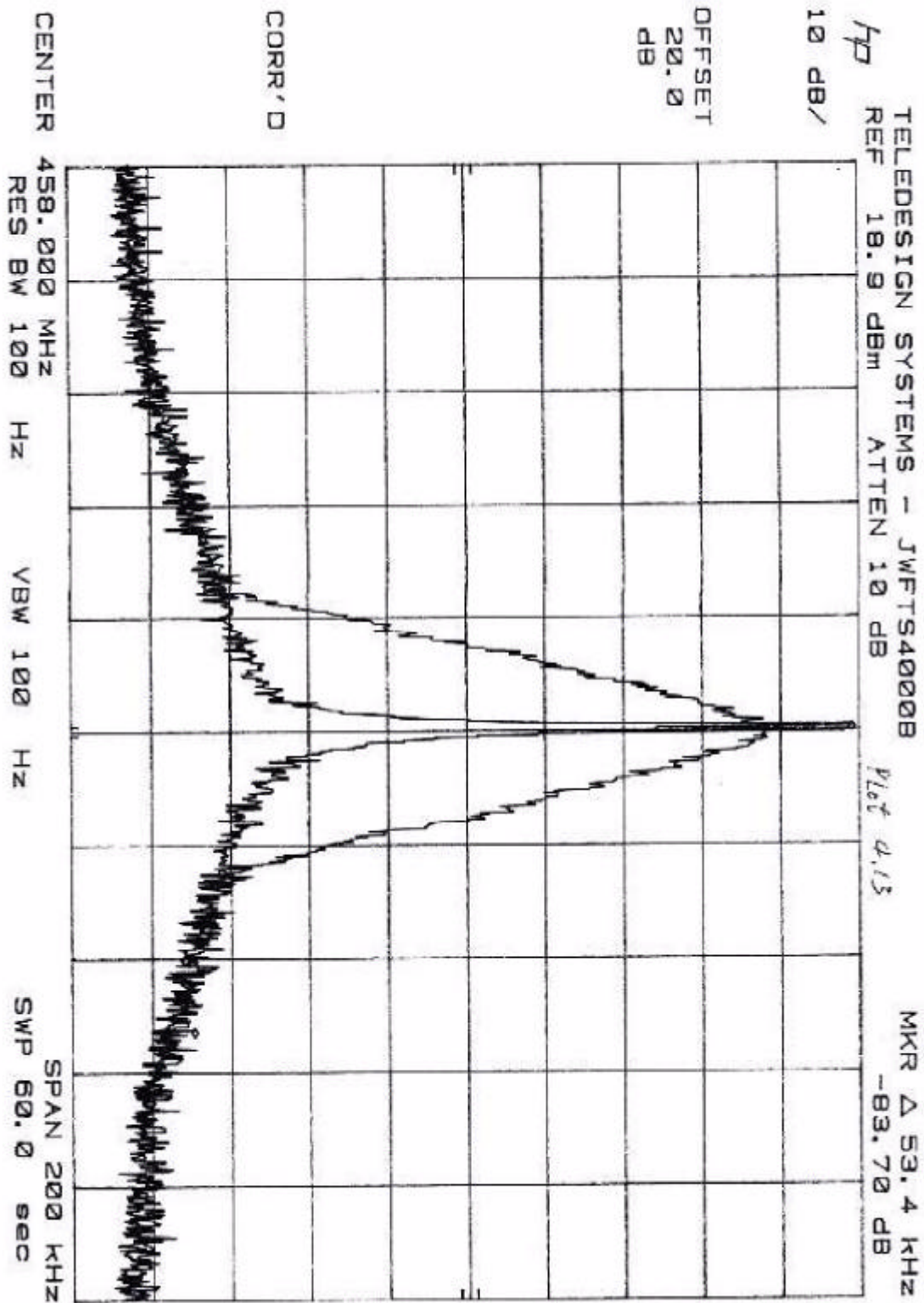
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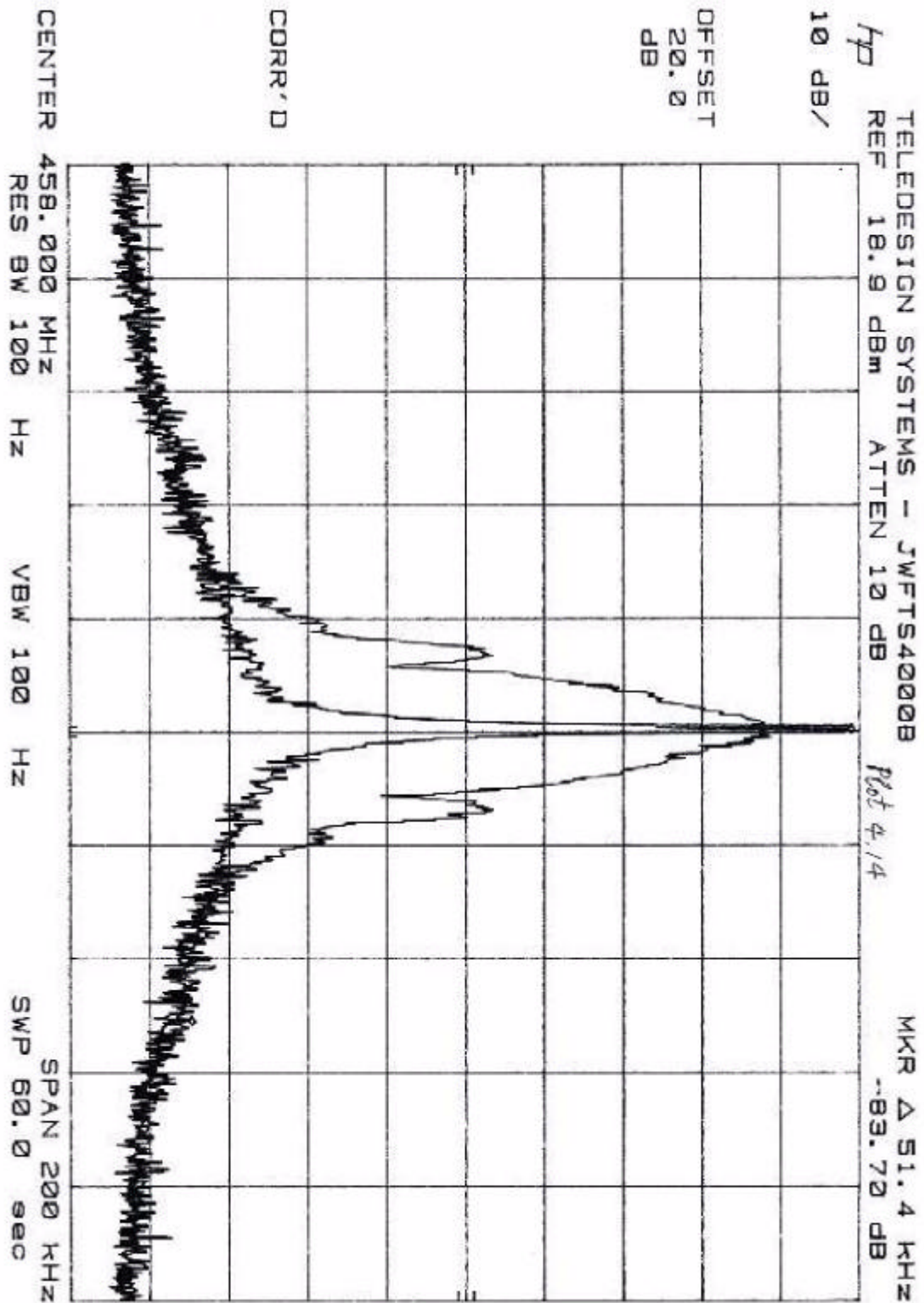
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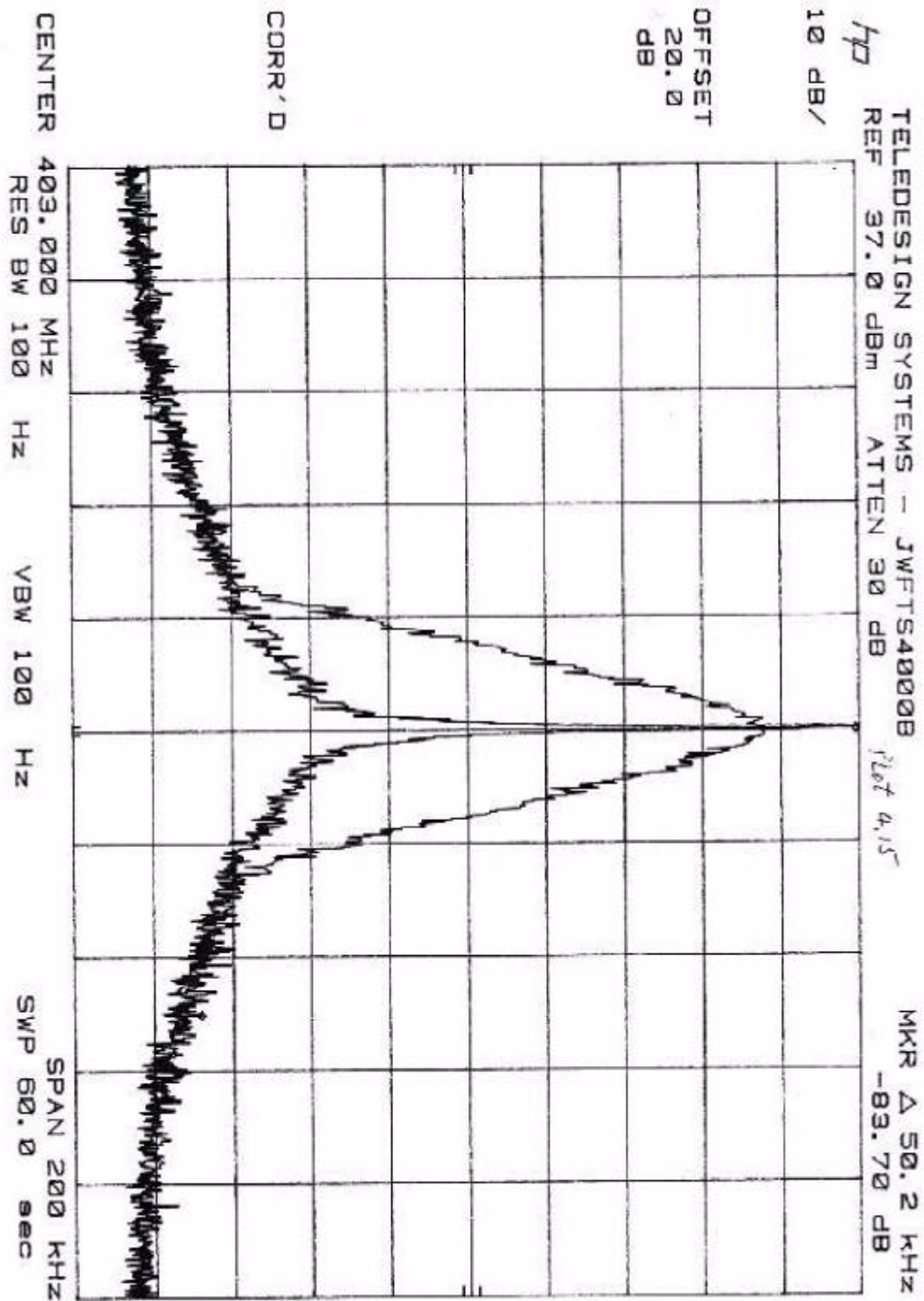
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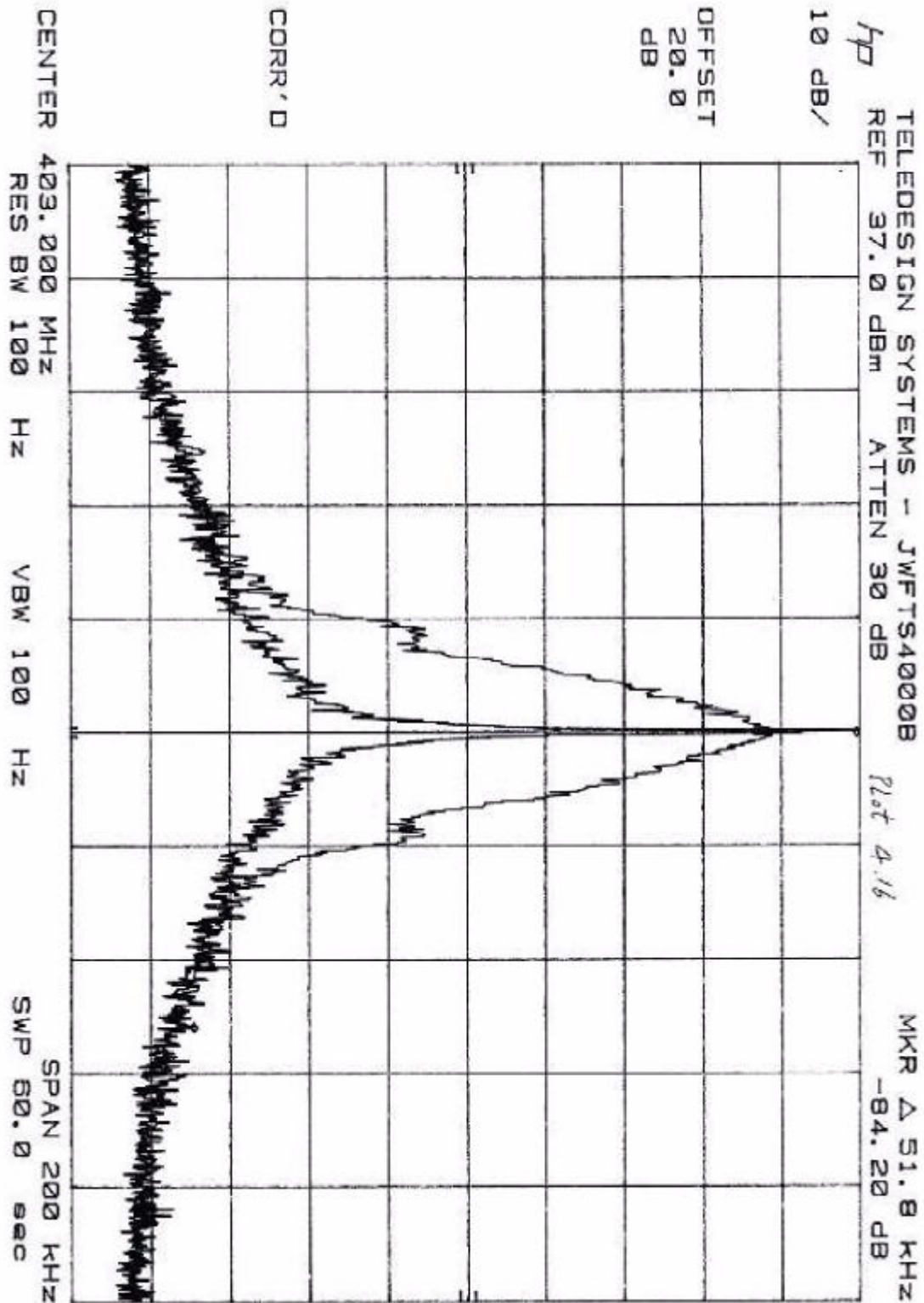
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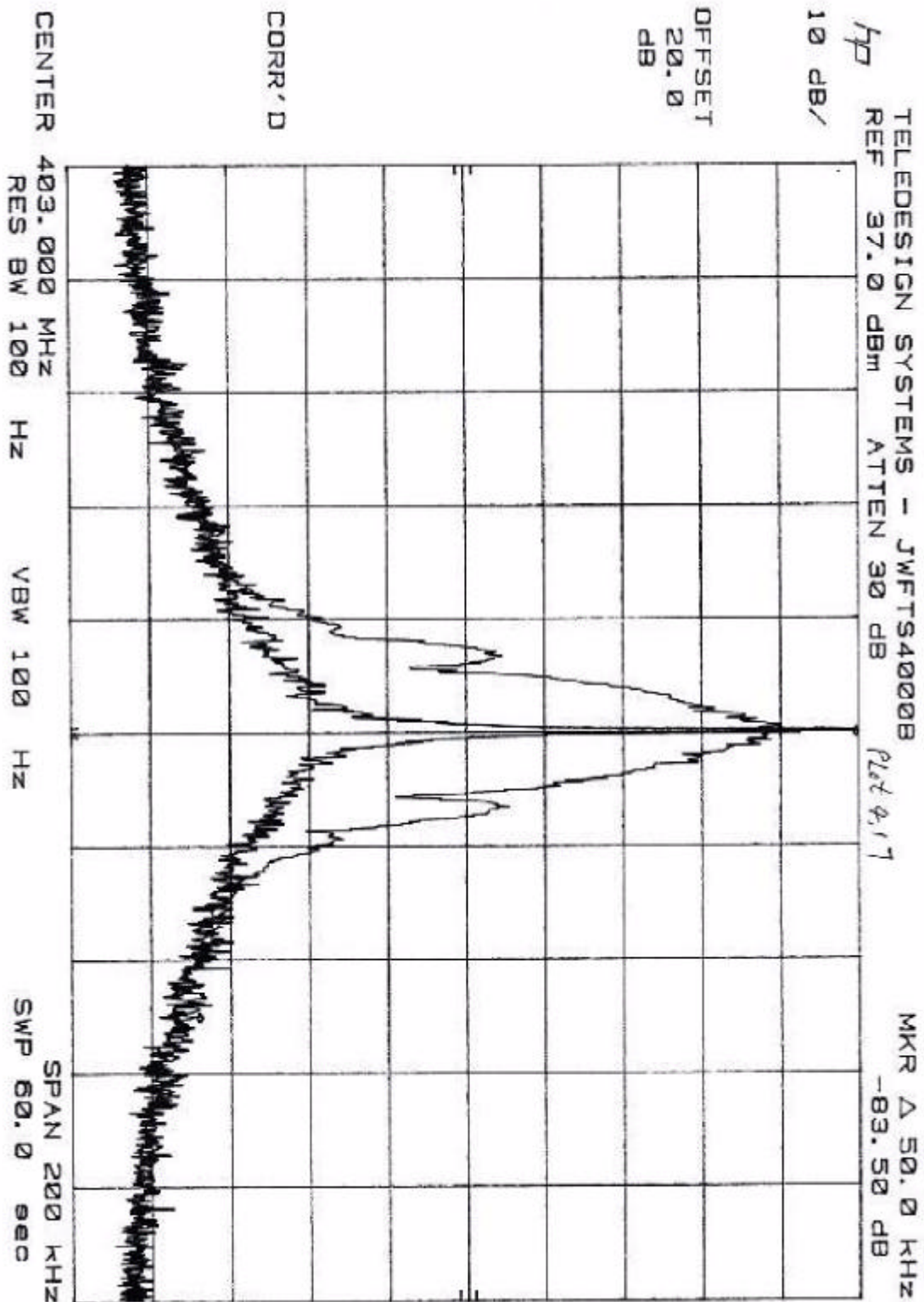
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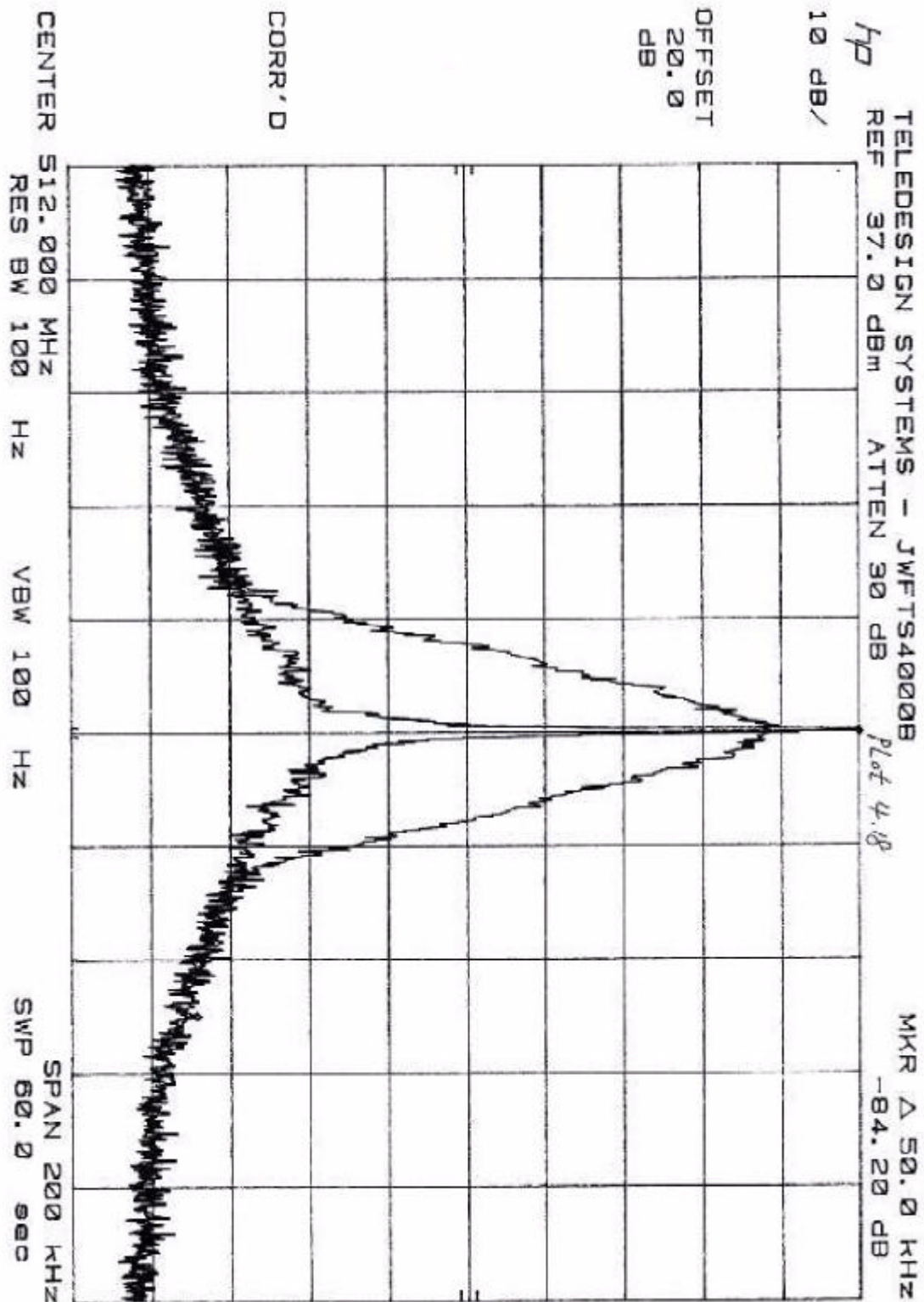
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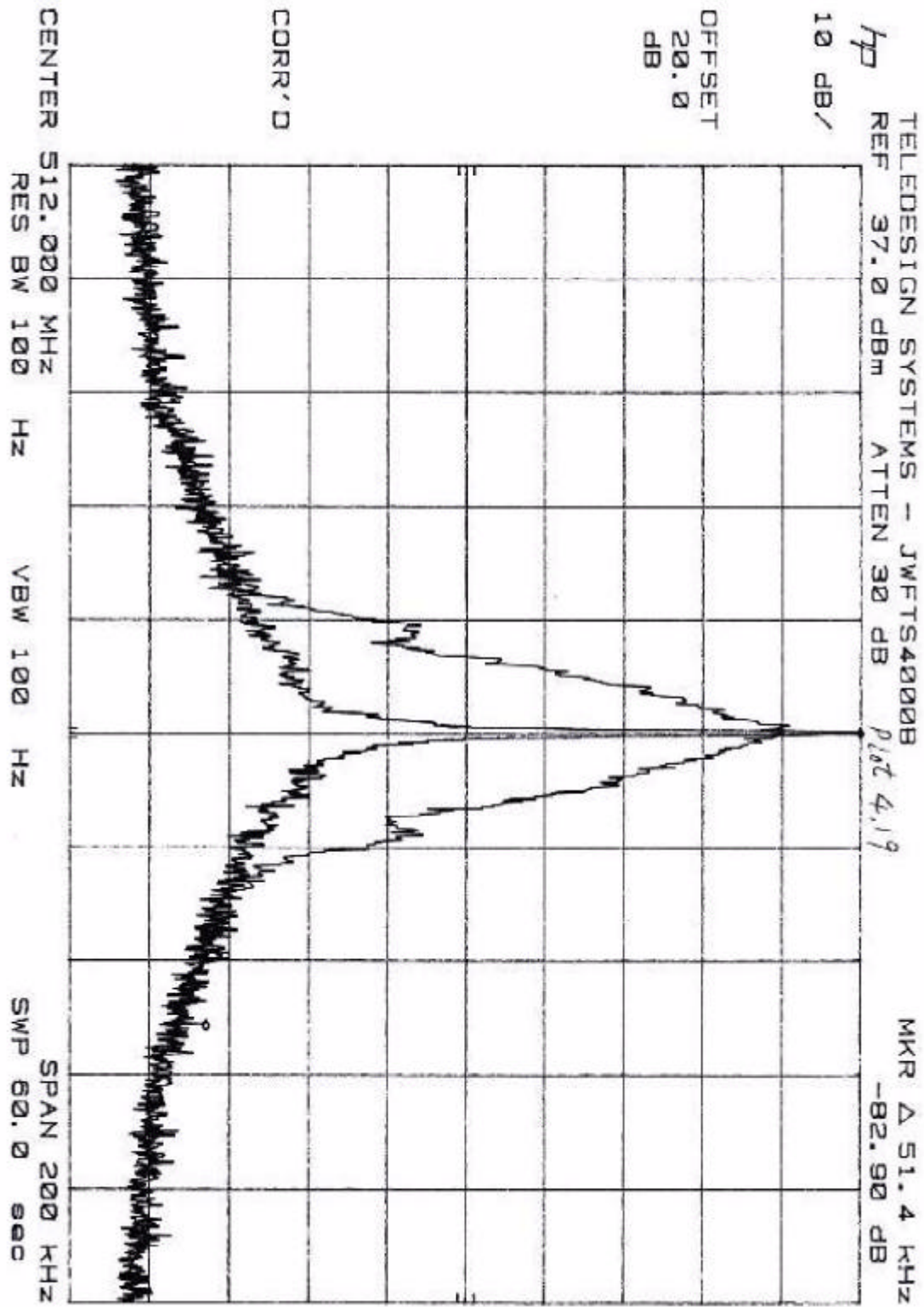
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5.0 Spurious Emissions at Antenna Terminals , FCC §2.991, §90.210

Out of Band Emissions:

The power of emissions must be attenuated below the power of the unmodulated carrier (P) on any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth - at least $50 + 10 \log P \text{ dB} = 50 + \text{LOG}(5) = 57$.

5.1 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. Sufficient scans were taken to show the out-of- band emissions if any up to 10th harmonic.

5.2 Test Equipment

HP 8566B Spectrum Analyzer, 100 Hz - 22 GHz
HP 7470A Plotter

5.3 Test Results

The EUT passed the test. Refer to the attached plots.

Transmitting at 403 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.1	GMSK, BT=0.5	20KOF1D	Scan 1-100 MHz
5.2	GMSK, BT=0.5	20KOF1D	Scan 100-1000 MHz
5.3	GMSK, BT=0.5	20KOF1D	Scan 1-2.5 GHz
5.4	GMSK, BT=0.5	20KOF1D	Scan 2.5-5.5 GHz

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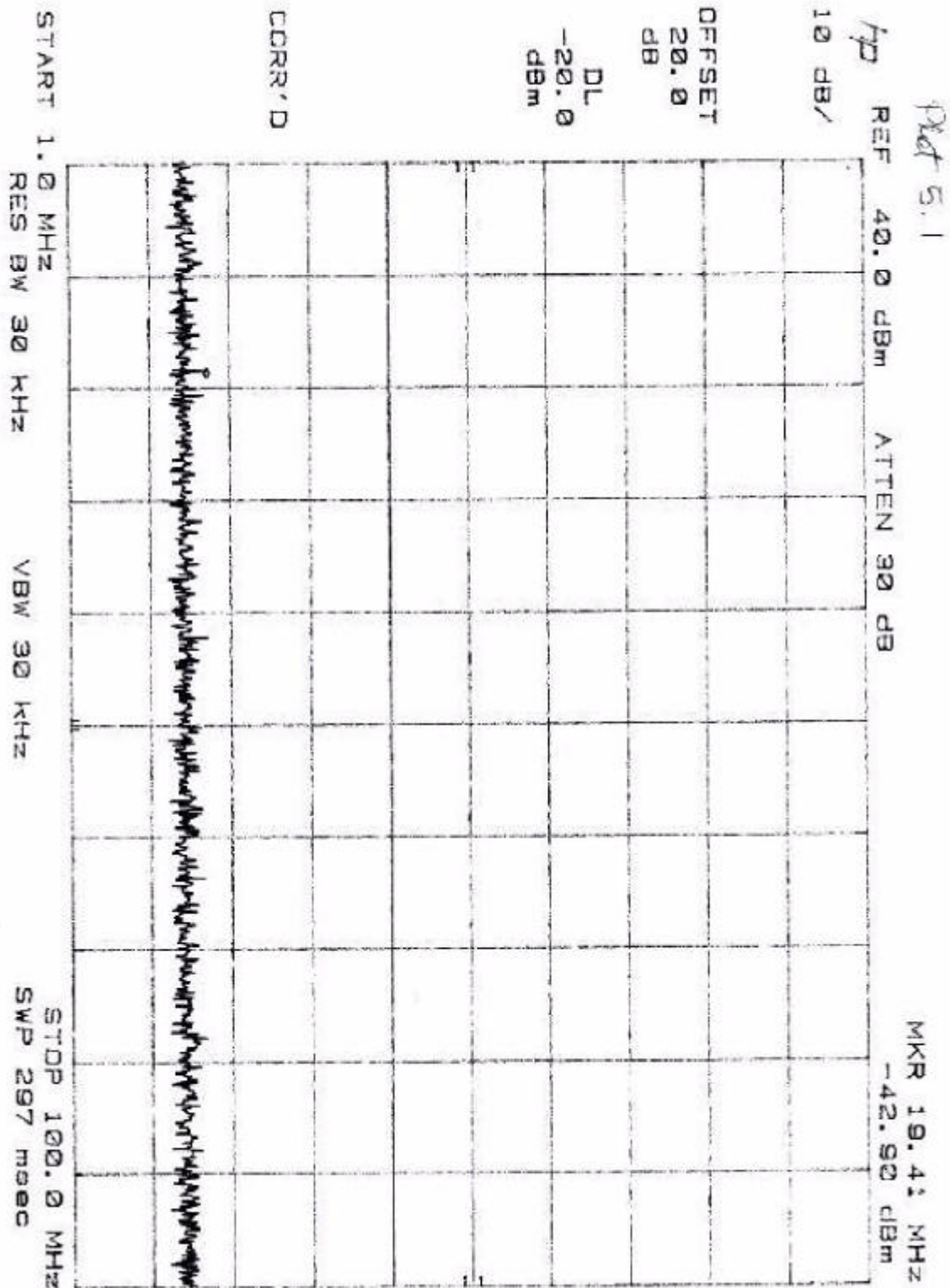
Transmitting at 458 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.5	GMSK, BT=0.5	20KOF1D	Scan 1-100 MHz
5.6	GMSK, BT=0.5	20KOF1D	Scan 100-1000 MHz
5.7	GMSK, BT=0.5	20KOF1D	Scan 1-2.5 GHz
5.8	GMSK, BT=0.5	20KOF1D	Scan 2.5-5.5 GHz

Transmitting at 512 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.9	GMSK, BT=0.5	20KOF1D	Scan 1-100 MHz
5.10	GMSK, BT=0.5	20KOF1D	Scan 100-1000 MHz
5.11	GMSK, BT=0.5	20KOF1D	Scan 1-2.5 GHz
5.12	GMSK, BT=0.5	20KOF1D	Scan 2.5-5.5 GHz

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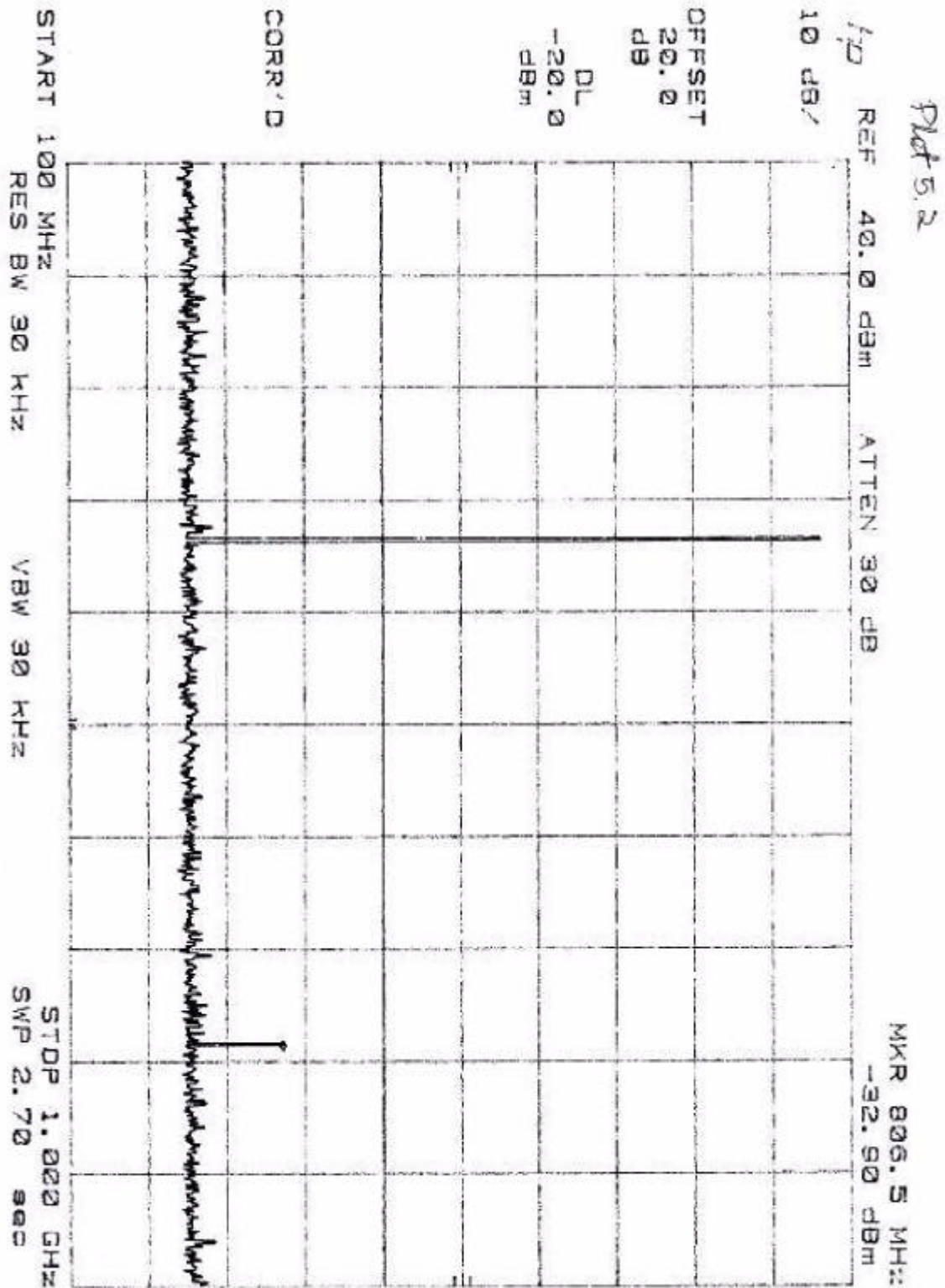
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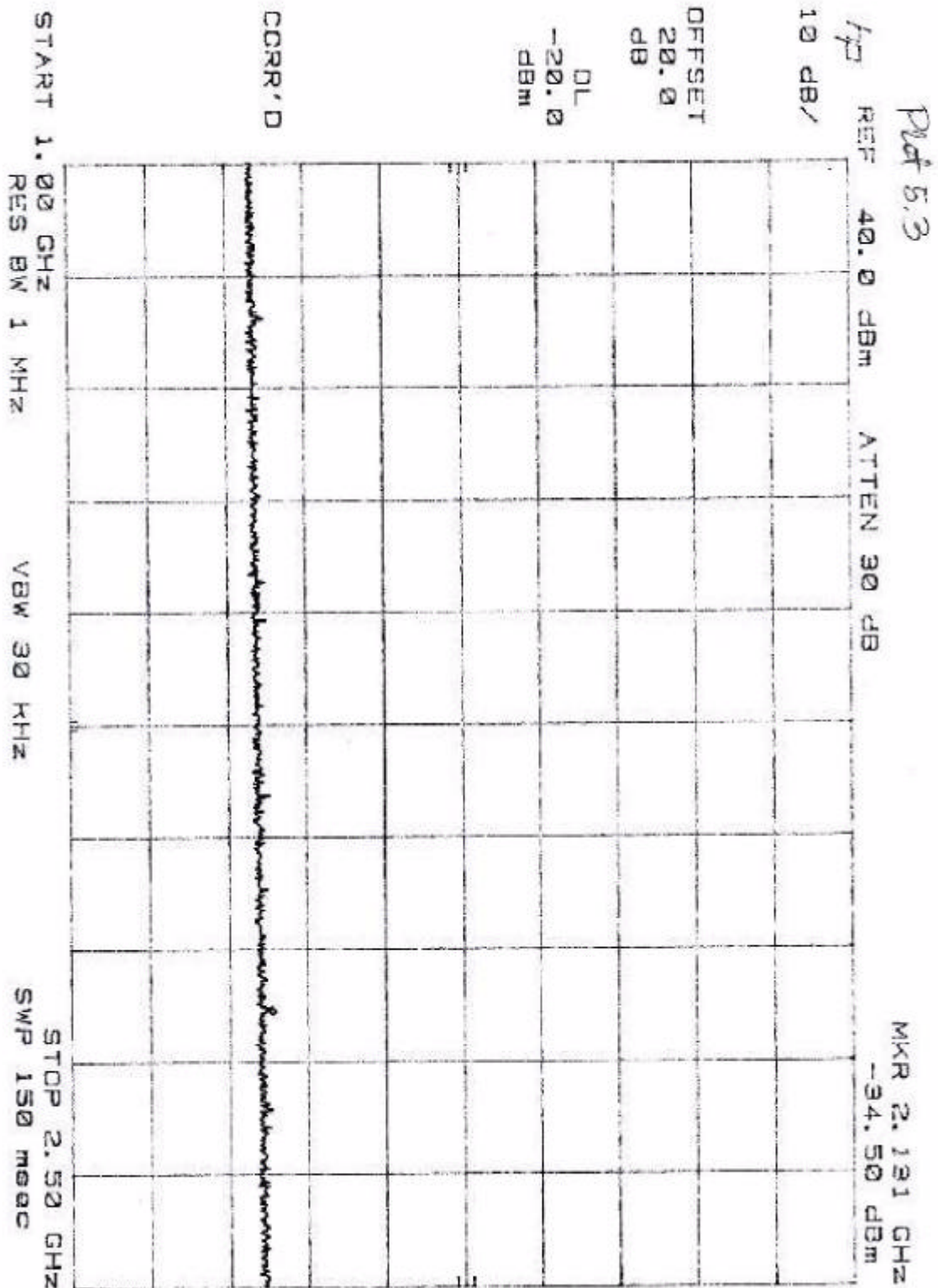
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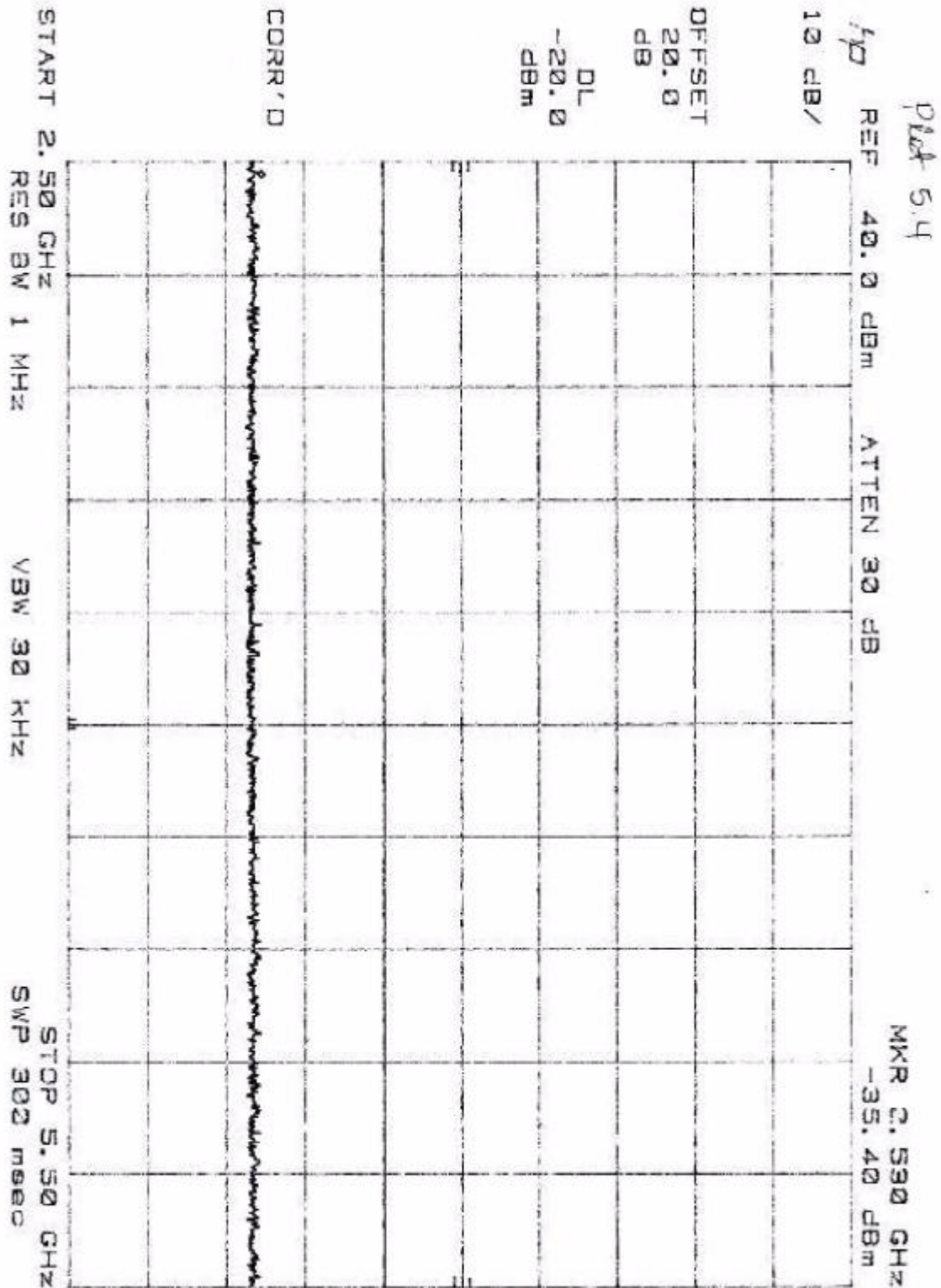
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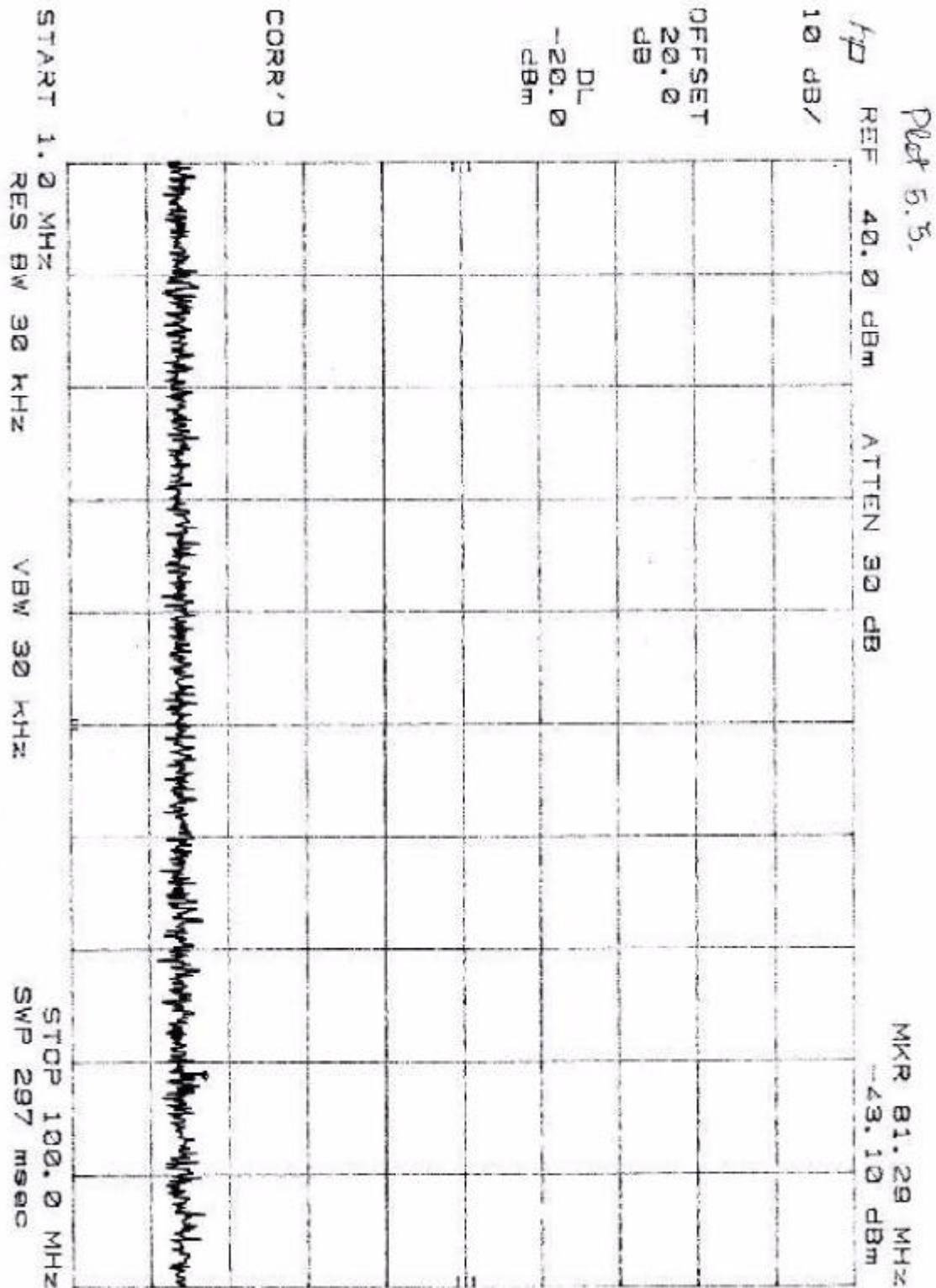
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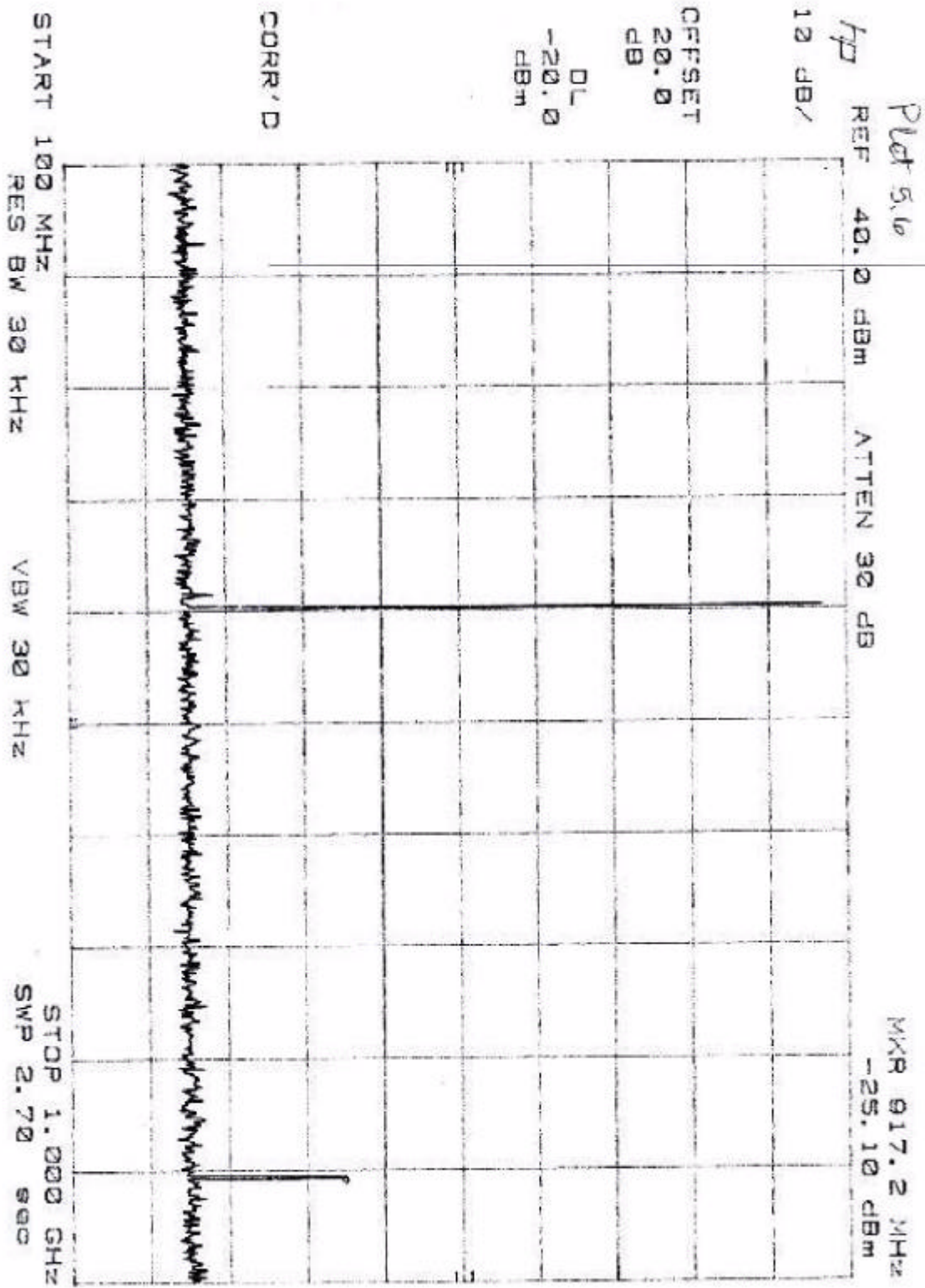
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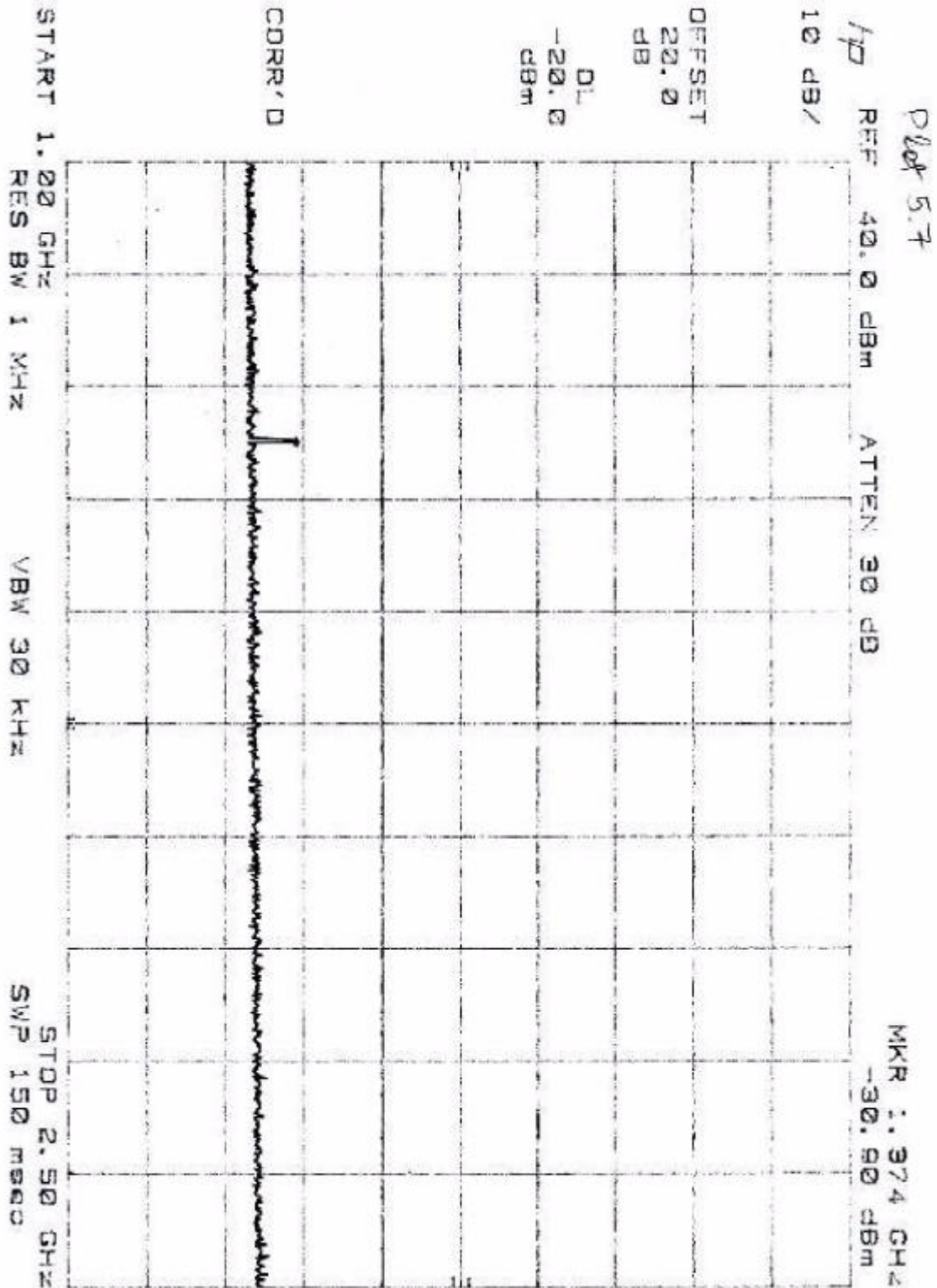
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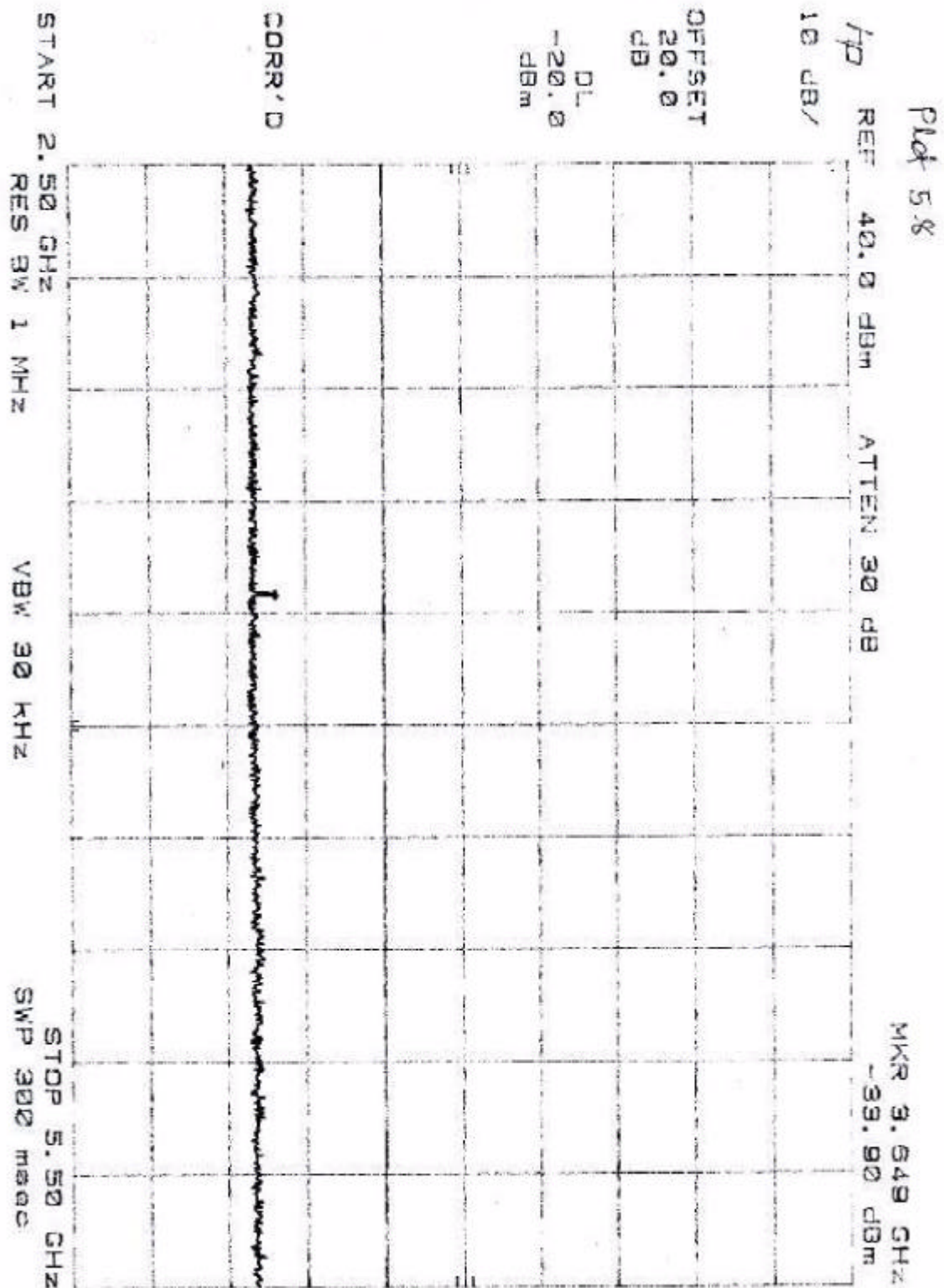
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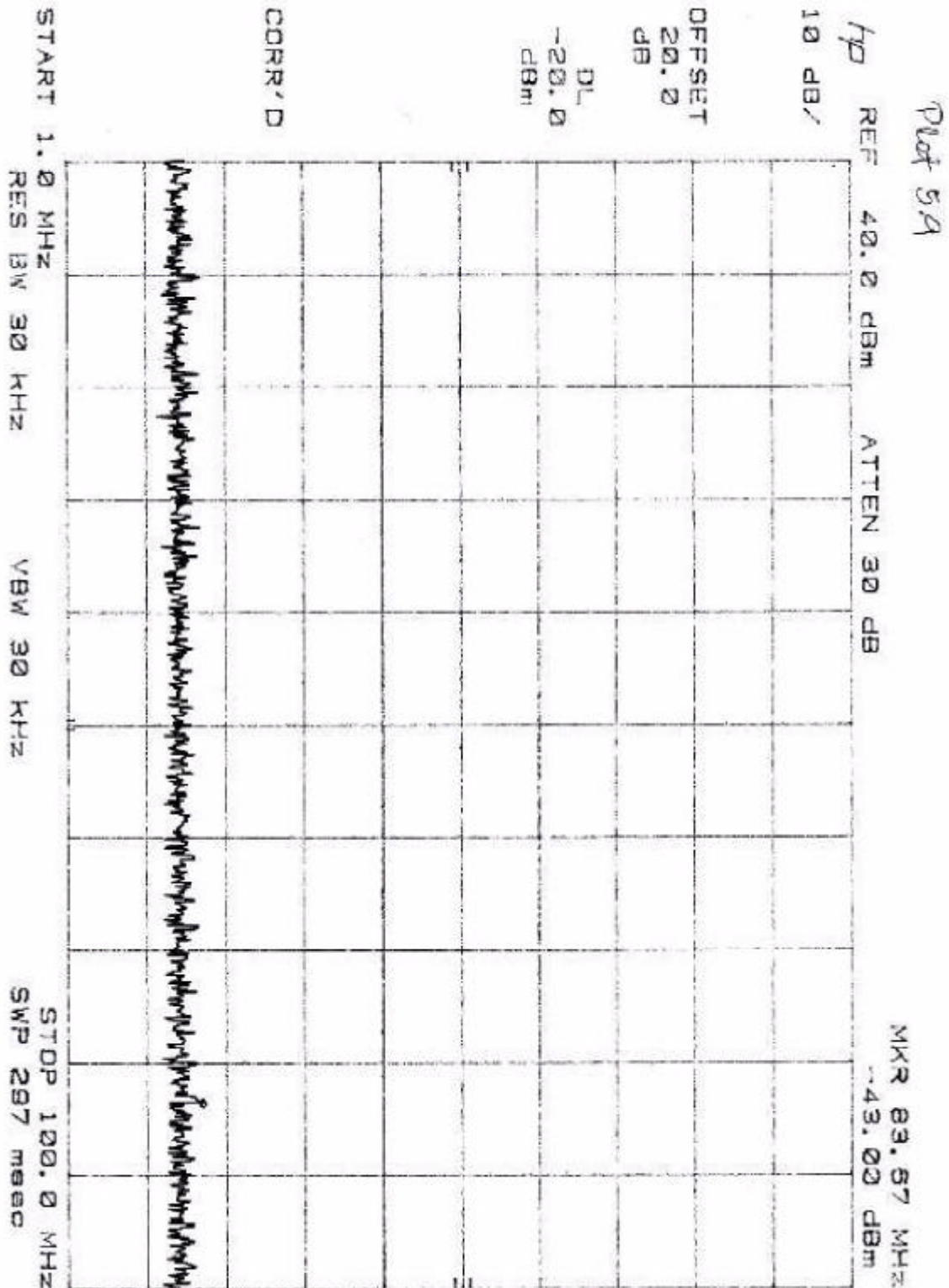
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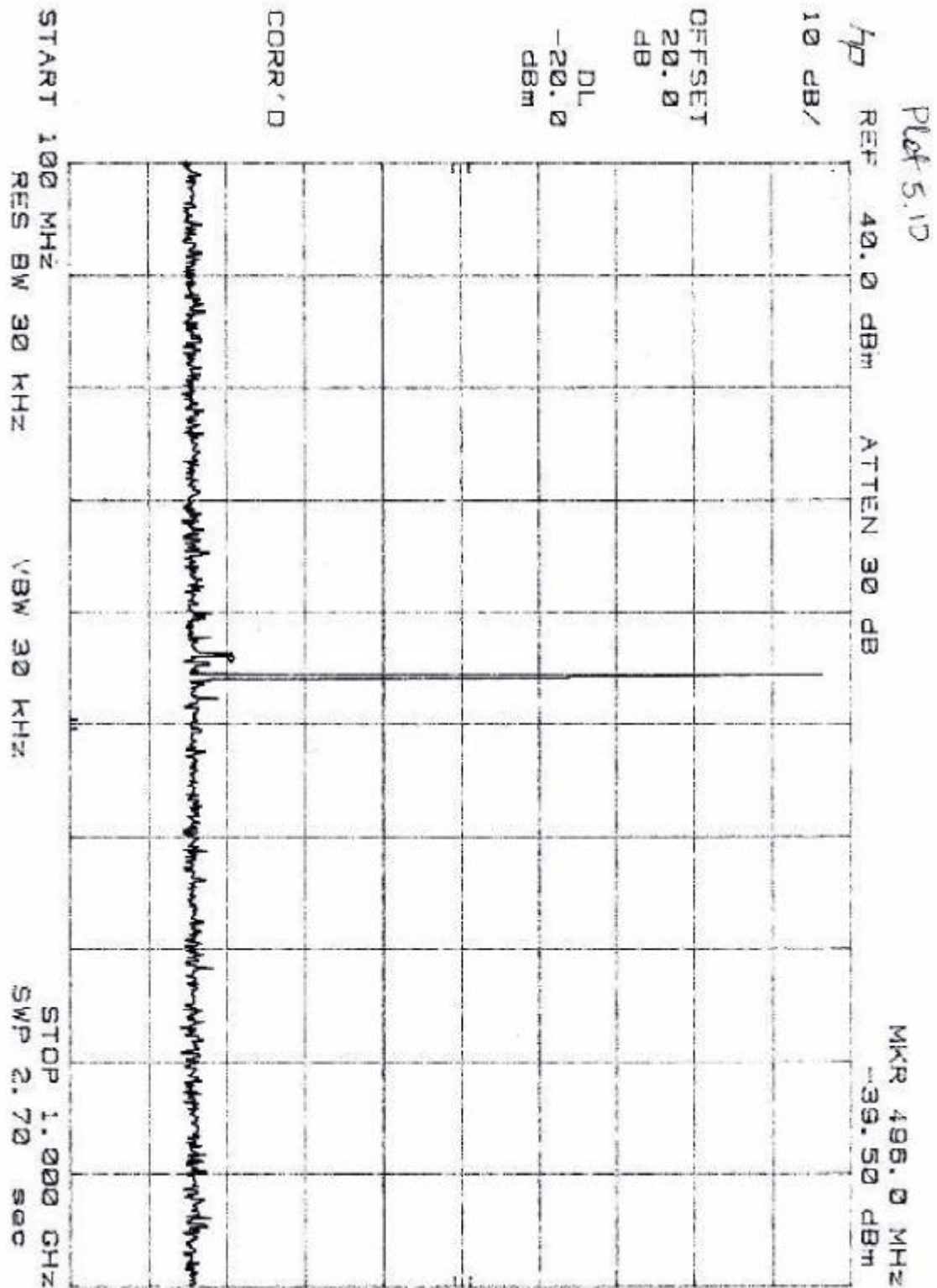
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Teledesign Radio Modem with 3412 Transceiver

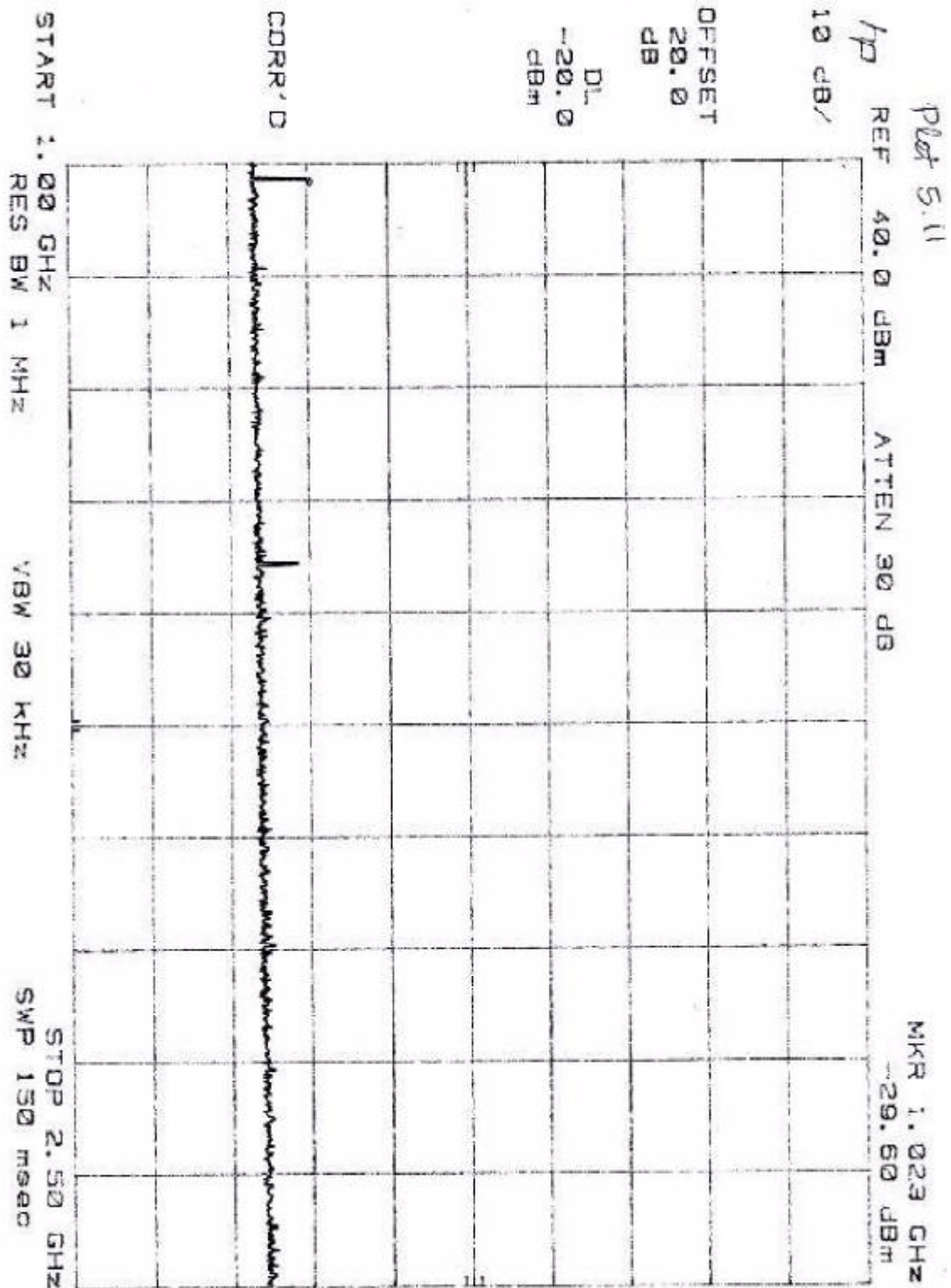
Date of Test: December 11, 1998



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Teledesign Radio Modem with 3412 Transceiver

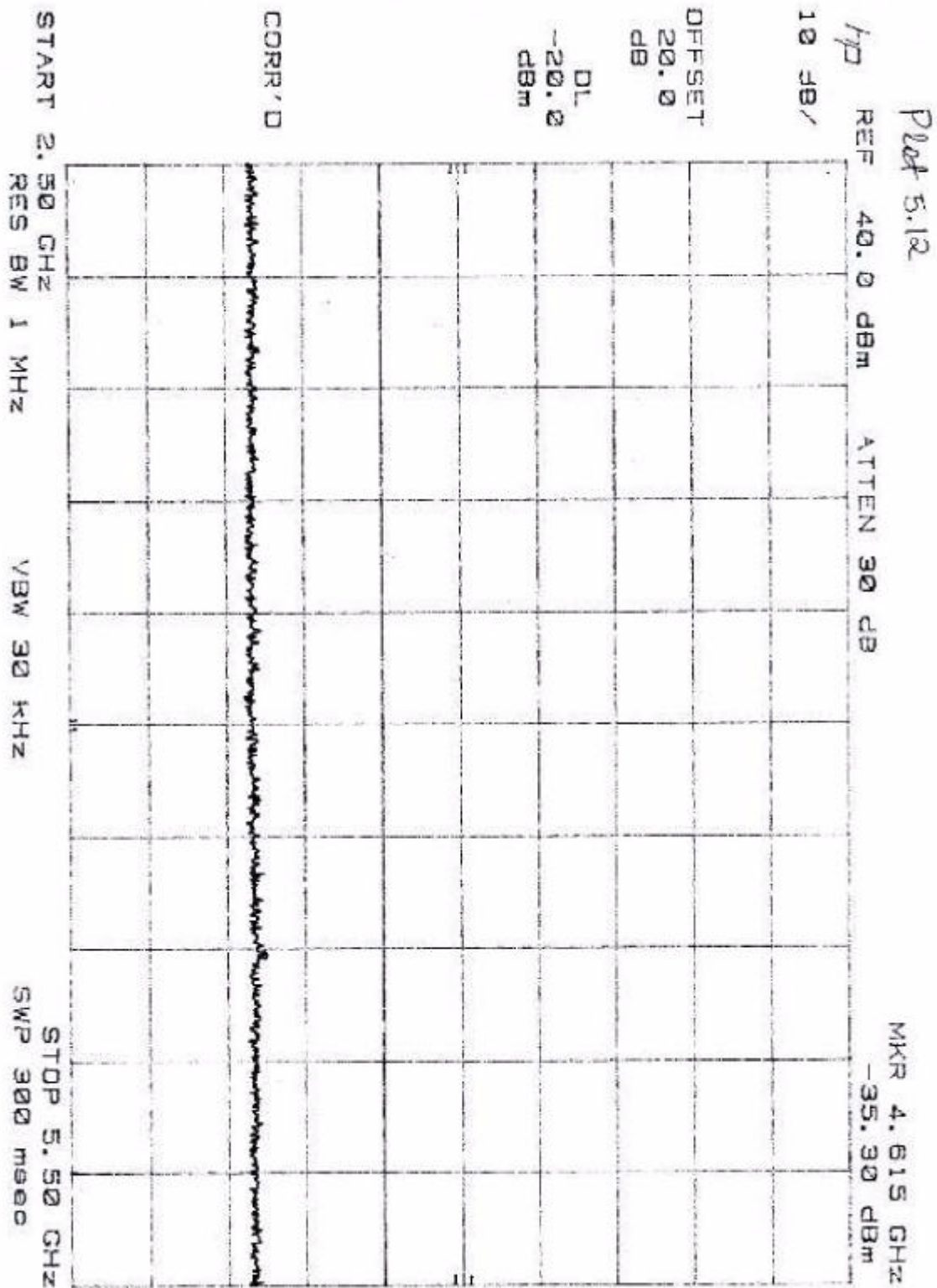
Date of Test: December 11, 1998



INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998



INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

6.0 Field Strength of Spurious Radiation, FCC § 2.993, §15.109, §90.210

6.1 Test Procedure

The transmitter was placed on a wooden turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3 orthogonal axis.

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

The spurious harmonic attenuation was calculated as the difference between E in dB(uV/m) at the fundamental frequency and at the spurious emission frequency.

6.2 Test Equipment

EMCO 3143 Bilog antenna

EMCO 3115 Horn Antenna

HP 8566B Spectrum Analyzer

Preamplifiers: CDI P950, 10 - 1000 MHz

CDI P1000+, 1 - 10 GHz

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

6.3 Test Results

Refer to the attached data sheets.

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998



Company: Teledesign System Inc.
Project #: J98033454
Model: JWFTS4000B (Tx @ 403.0 MHz)
Engineer: Xi-Ming Yang
Date of test: Dec. 11, 1998

FCC 90 Radiated Emissions

Frequency	Antenna	Reading	Antenna	Pre-amp	Cable	Field	Spurious	Margin
MHz	Polarity		Factor		Loss	Strength	Attenuation	
	H/V	dB(uV)	dB(1/m)	dB	dB	dB(uV/m)	dB	dB
806.0	V	33.0	22.2	0.0	0.8	56.0	82.1	-25.1
1209.0	H	31.8	23.8	0.0	1.2	56.8	81.3	-24.3
1612.0	H	43.2	25.5	0.0	1.6	70.3	67.8	-10.8
2015.0	V	27.0	27.5	0.0	2.1	56.6	81.5	-24.5
2418.0	H	30.0	27.9	0.0	2.1	60.0	78.1	-21.1
2821.0	H	20.0	29.0	0.0	2.5	51.5	86.6	-29.6
3224.0	H	16.0	30.8	0.0	2.8	49.6	88.5	-31.5
3627.0	H	17.0	31.3	0.0	3.0	51.3	86.8	-29.8
4030.0	V	18.0	32.5	0.0	3.3	53.8	84.3	-27.3

- Note:
1. All measurement were made at 3 meters
 2. Field Strength at the fundamental frequency equals 138.1 dBuV/m
 3. Spurious emissions attenuation limit equals $50 + 10\log P = 57.0$ dB

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998



Company: Teledesign System Inc.
Project #: J98033454
Model: JWFTS4000B (Tx @ 458.0 MHz)
Engineer: Xi-Ming Yang
Date of test: Dec. 11, 1998

FCC 90 Radiated Emissions

Frequency	Antenna	Reading	Antenna	Pre-amp	Cable	Field	Spurious	Margin
MHz	Polarity	dB(uV)	Factor	dB	Loss	Strength	Attenuation	dB
916.0	V	29.6	22.9	0.0	0.9	53.4	81.2	-24.2
1374.0	H	32.0	24.0	0.0	1.3	57.3	77.3	-20.3
1832.0	H	33.0	26.3	0.0	1.8	61.1	73.5	-16.5
2290.0	V	28.0	27.5	0.0	2.1	57.6	77.0	-20.0
2748.0	V	29.8	29.0	0.0	2.5	61.3	73.3	-16.3
3206.0	V	21.0	30.8	0.0	2.7	54.5	80.1	-23.1
3664.0	V	18.0	31.5	0.0	3.0	52.5	82.1	-25.1
4122.0	H	20.0	32.3	0.0	3.1	55.4	79.2	-22.2
4580.0	V	18.0	32.1	0.0	3.4	53.5	81.1	-24.1

- Note:
1. All measurement were made at 3 meters
 2. Field Strength at the fundamental frequency equals 134.6 dBuV/m
 3. Spurious emissions attenuation limit equals $50 + 10 \log P = 57.0$ dB

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998



Company: Teledesign System Inc.
Project #: J98033454
Model: JWFTS4000B (Tx @ 512.0 MHz)
Engineer: Xi-Ming Yang
Date of test: Dec. 11, 1998

FCC 90 Radiated Emissions

Frequency	Antenna	Reading	Antenna	Pre-amp	Cable	Field	Spurious	Margin
MHz	Polarity	dB(uV)	Factor	dB	Loss	Strength	Attenuation	dB
1024.0	H	30.0	23.1	0.0	1.0	54.1	81.4	-24.4
1536.0	V	43.4	24.9	0.0	1.5	69.8	65.7	-8.7
2048.0	V	42.5	27.5	0.0	2.1	72.1	63.4	-6.4
2560.0	H	30.0	27.9	0.0	2.1	60.0	75.5	-18.5
3072.0	V	20.0	30.2	0.0	2.5	52.7	82.8	-25.8
3584.0	V	28.0	31.3	0.0	2.8	62.1	73.4	-16.4
4096.0	H	19.0	32.5	0.0	3.0	54.5	81.0	-24.0
4608.0	V	27.0	32.1	0.0	3.4	62.5	73.0	-16.0
5120.0	H	19.0	33.1	0.0	4.0	56.1	79.4	-22.4

- Note: 1. All measurement were made at 3 meters
2. Field Strength at the fundamental frequency equals 135.5 dBuV/m
3. Spurious emissions attenuation limit equals $50 + 10\log P = 57.0$ dB

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

7.0 Line Conducted Emissions, FCC § 15.107

7.1 Test Procedure

Test procedure described in the ANSI C63.4 Standard was employed.

The EUT was connected to the DC power supply, that was connected to the AC line through the LISNs.

Both HOT and NEUTRAL leads were tested.

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

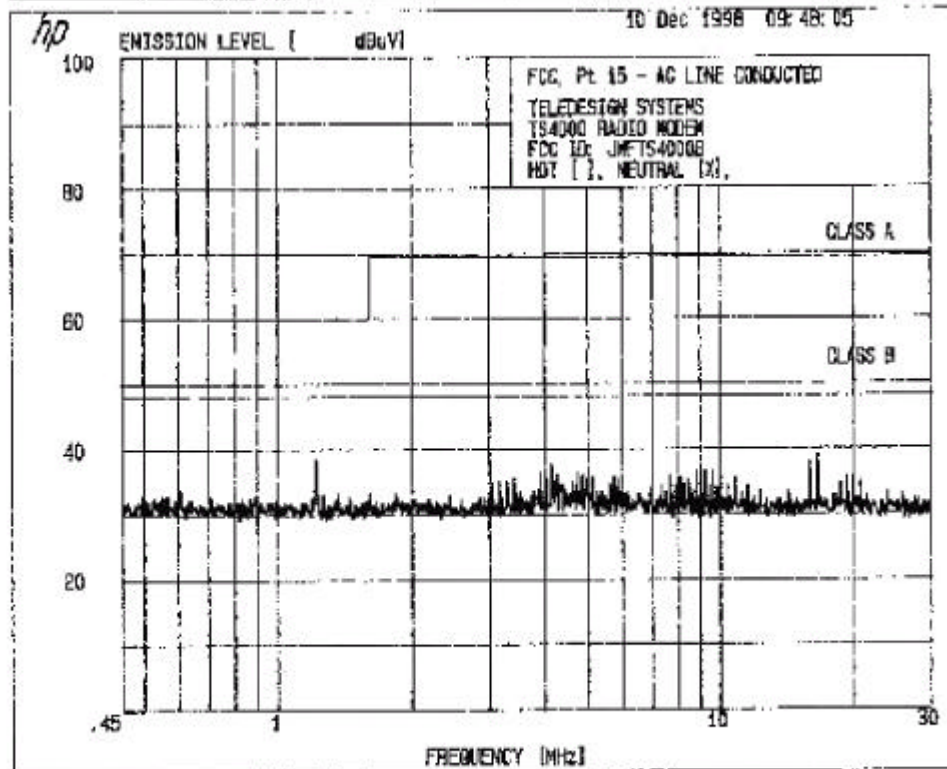
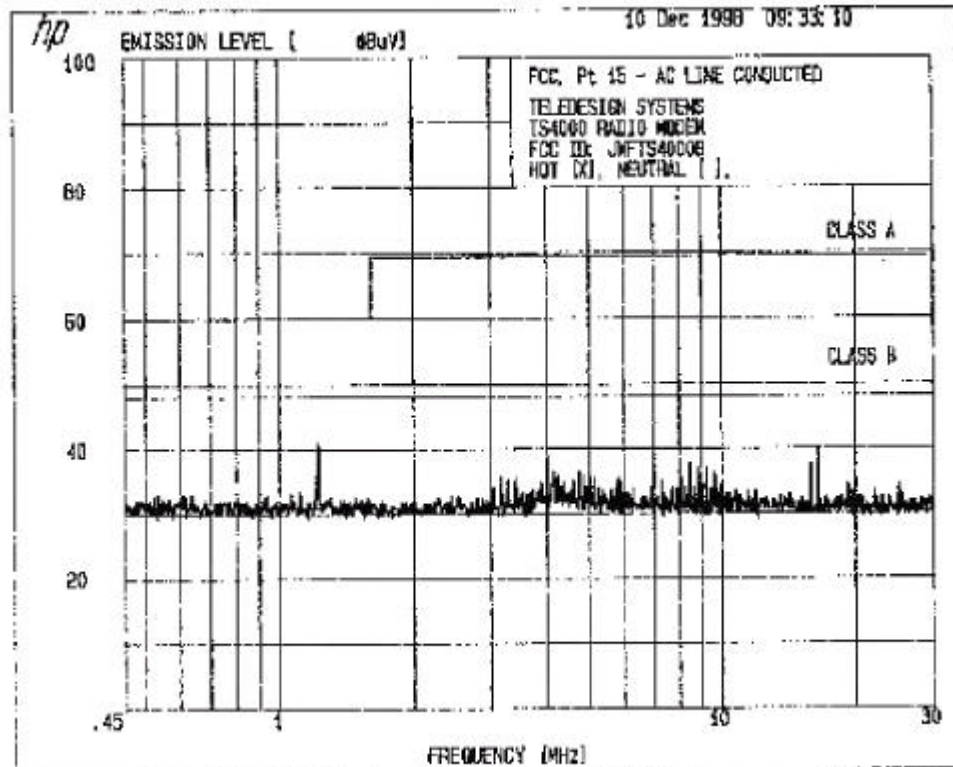
7.2 Test Results

See attached pages.

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998



INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

10 Dec 1998 09:48:05		
3. FCC CFR 47, Pt 15 3.1 FCC, Pt 15 - AC LINE CONDUCTED		
TELEDESIGNSYSTEMS, TS 4000 RADIO MODEM FCC ID: JWFTS4000B (Neutral), Peaks Found Above 38 dBuV		
PEAK #	FREQUENCY (MHz)	AMPL (dBuV)
1	1.221	38.6
2	15.92	38.1
3	16.53	39.1

10 Dec 1998 09:33:10		
3. FCC CFR 47, Pt 15 3.1 FCC, Pt 15 - AC LINE CONDUCTED		
TELEDESIGNSYSTEMS, TS 4000 RADIO MODEM FCC ID: JWFTS4000B (Hot), Peaks Found Above 38 dBuV		
PEAK #	FREQUENCY (MHz)	AMPL (dBuV)
1	1.227	41.0
2	4.038	38.7
3	16.53	40.1

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

8.0 Frequency Stability vs Temperature, FCC § 2.995(a)

8.1 Test Procedure

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feedthrough attenuators. The EUT was placed inside the temperature chamber. The DC leads, RF output cable, exited the chamber through an opening. After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the counter.

8.2 Test Equipment

Temperature Chamber, -50C to +100C
Hewlett Packard 5383A Frequency Counter
Tektronix 2784 Spectrum Analyzer
Goldstar DC Power Supply, GR303

8.3 Test Results

Refer to the test data below.

Frequency: 458 MHz, Tolerance ± 687 Hz

Frequency Stability vs Temperature	
Temperature, C	Difference (Hz)
+60	- 25
+50	75
+40	135
+30	155
+20	155
+10	110
0	30
-10	-160
-20	- 30
-30	300

Justification: Passed

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

9.0 Frequency Stability vs Voltage, FCC 2.995(d)(3)

9.1 Test Procedure

An external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for the nominal supply voltage and at each extreme of the supply voltage range.

9.2 Test Equipment

Hewlett Packard 5383A Frequency Counter

Tektronix 2784 Spectrum Analyzer

Goldstar DC Power Supply, GR303

9.3 Test Results.

Refer to the test data below.

Frequency: 458.00 MHz, Tolerance ± 687 Hz

Frequency Stability vs. Voltage	
Voltage	Difference (Hz)
11	155
14	185
20	200
24	200
28	200

Justification: Passed

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

10.0 Transient Frequency Behavior, FCC 90.214

10.1 Test Procedure

Test was performed according the TIA/EIA/IS-102.CAAA, Section 2.2.18. The transmitter was continuously transmitting an unmodulated signal. The generator was generating FM signal (1 kHz tone, 12.5 kHz deviation). Several plots were made on the FM demodulator output with the EUT turned ON and OFF.

PLOT #	FREQ. MHz	TRANSMIT MODULATION	DESCRIPTION
10.1	403	Low	Transmitter On, T1
10.2	403	Low	Transmitter On, T2
10.3	403	Low	Transmitter Off, T3
10.4	403	High	Transmitter On, T1, T2
10.5	403	High	Transmitter Off, T3
10.6	458	Low	Transmitter On, T1
10.7	458	Low	Transmitter On, T2
10.8	458	Low	Transmitter Off, T3
10.9	458	High	Transmitter On, T1, T2
10.10	458	High	Transmitter Off, T3
10.11	512	Low	Transmitter On, T1
10.12	512	Low	Transmitter On, T2
10.13	512	Low	Transmitter Off, T3
10.14	512	High	Transmitter On, T1, T2
10.15	512	High	Transmitter Off, T3

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Teledesign Radio Modem with 3412 Transceiver

Date of Test: December 11, 1998

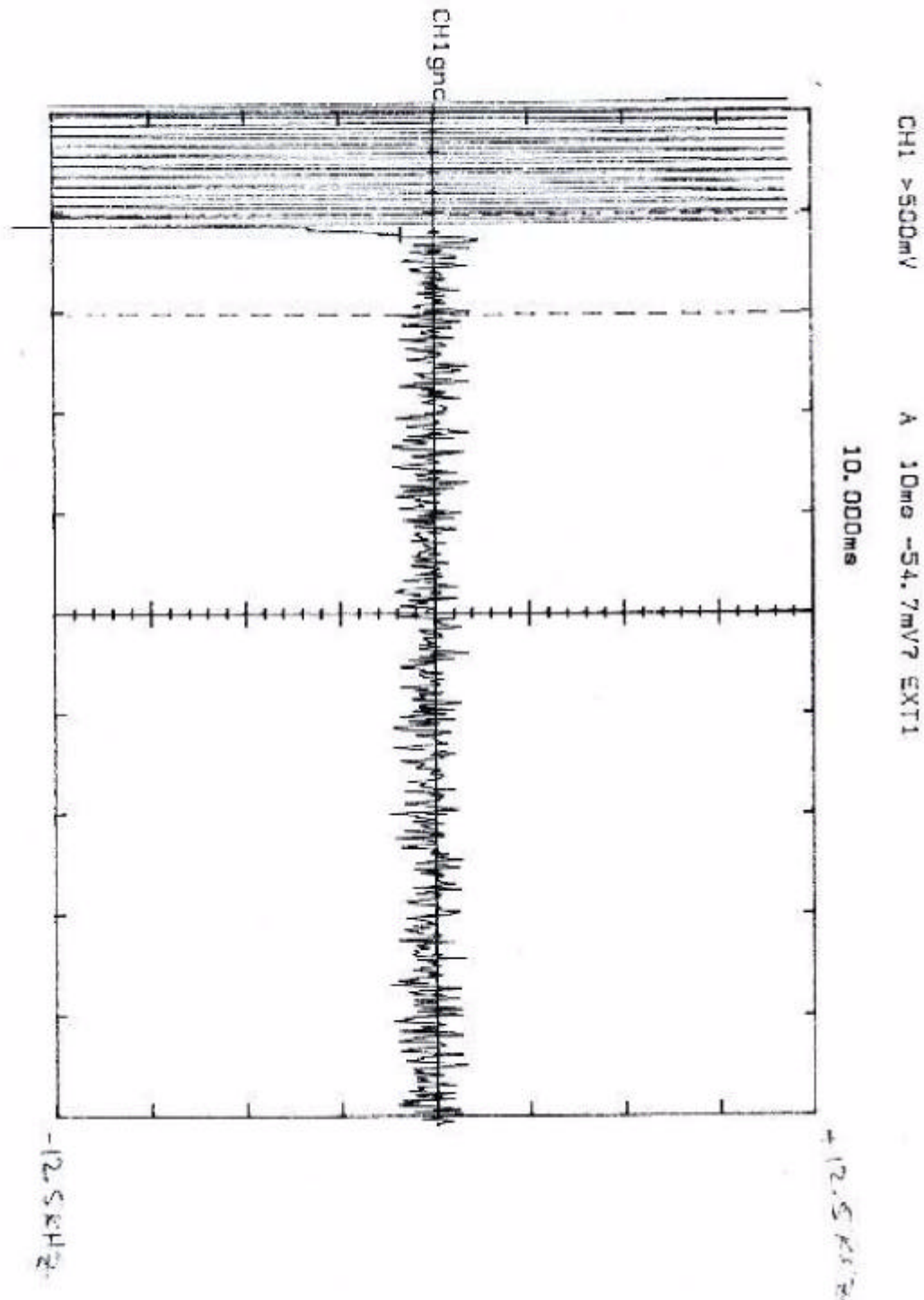
10.2 Test Result

For the test result, see attached plots. The EUT passed the test.

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Teledesign Radio Modem with 3412 Transceiver

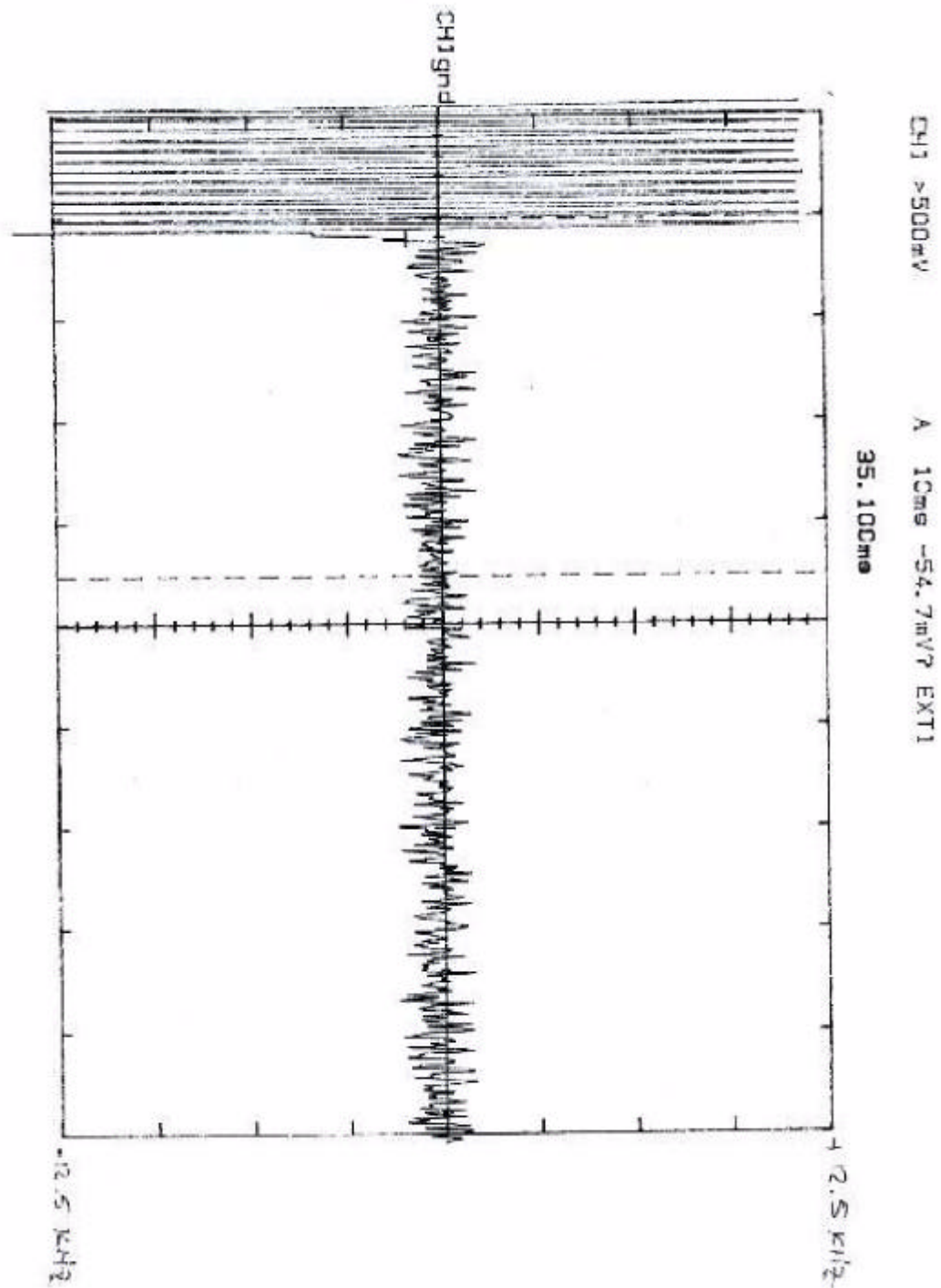
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Teledesign Radio Modem with 3412 Transceiver

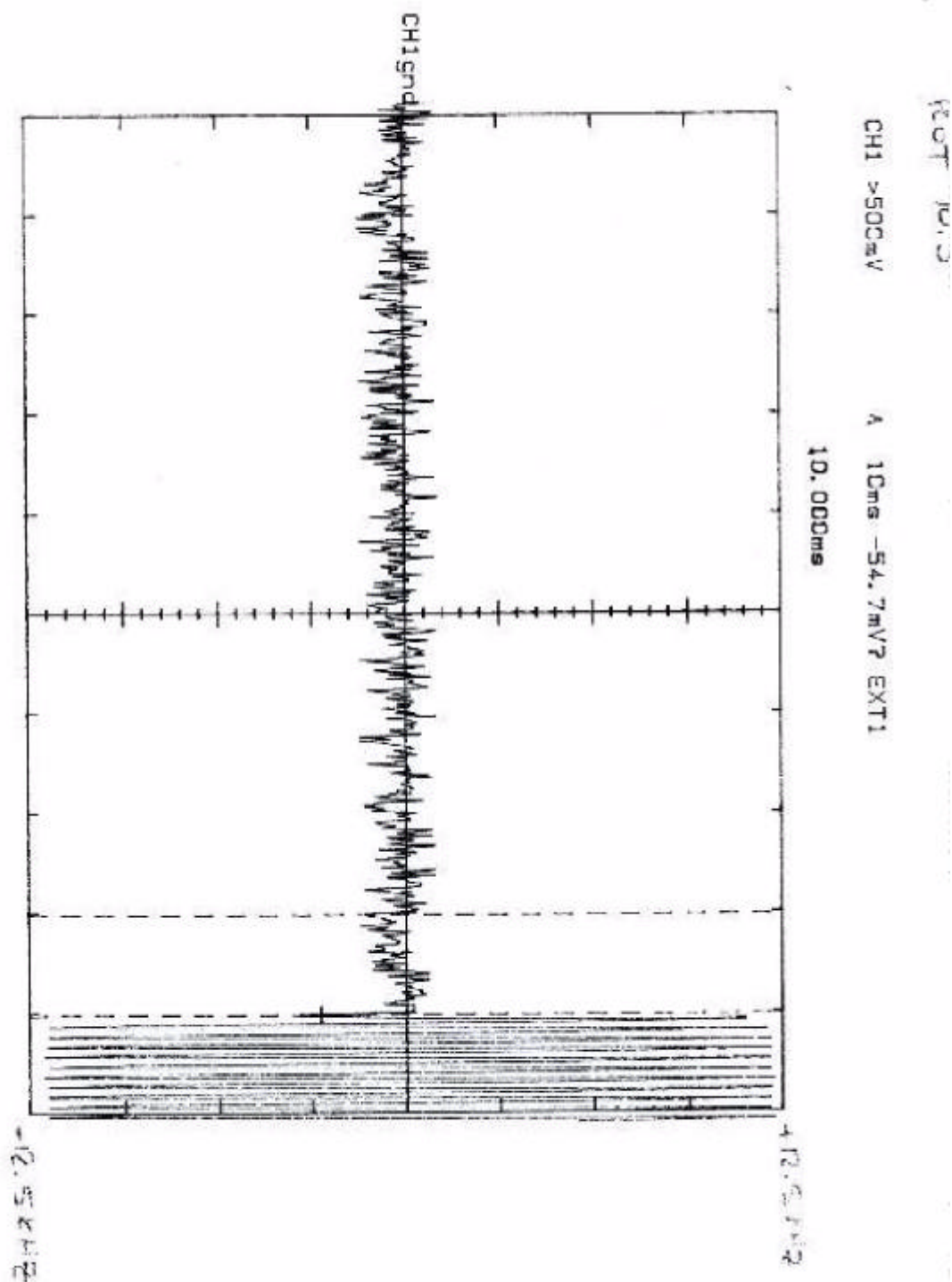
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Teledesign Radio Modem with 3412 Transceiver

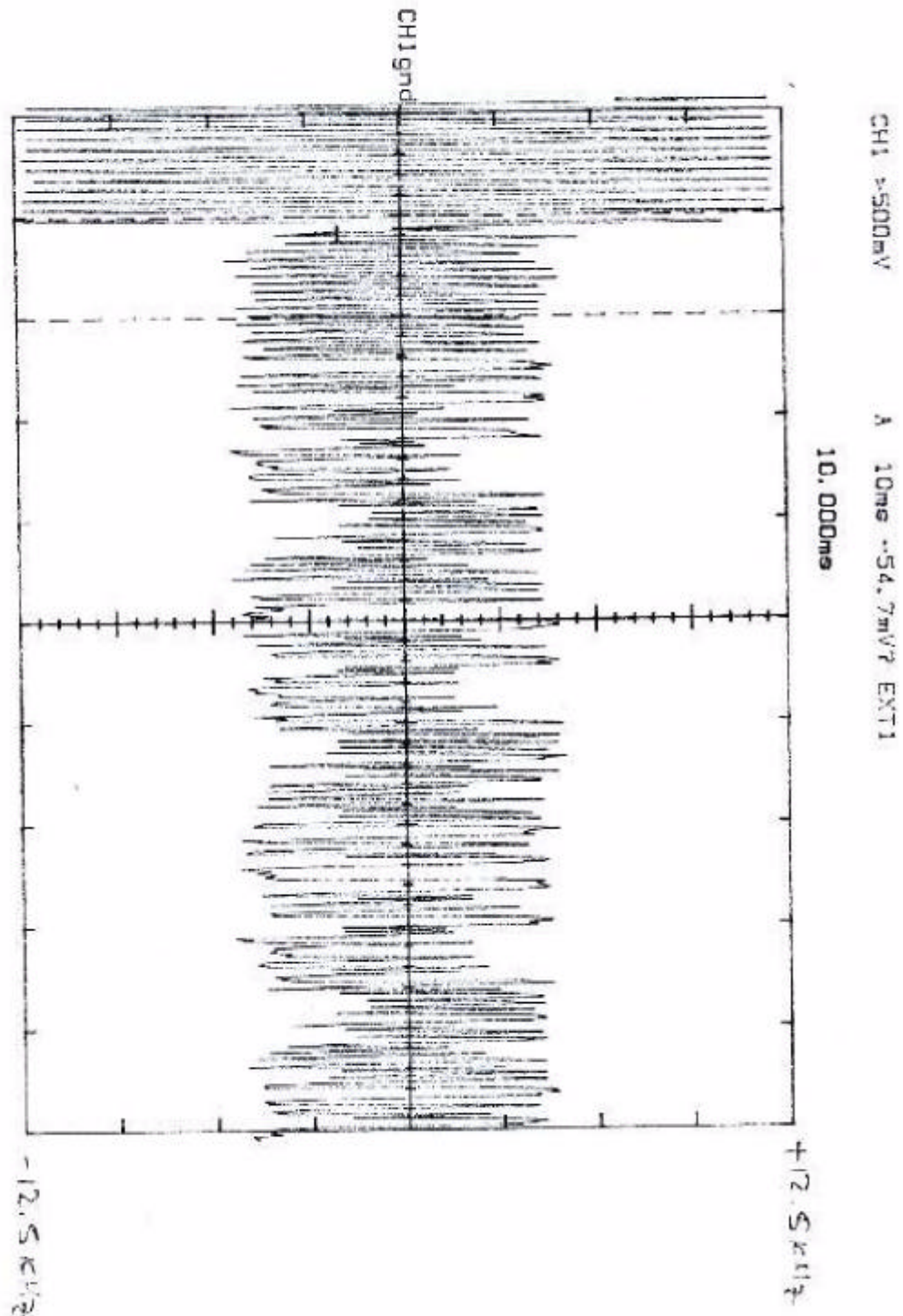
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Teledesign Radio Modem with 3412 Transceiver

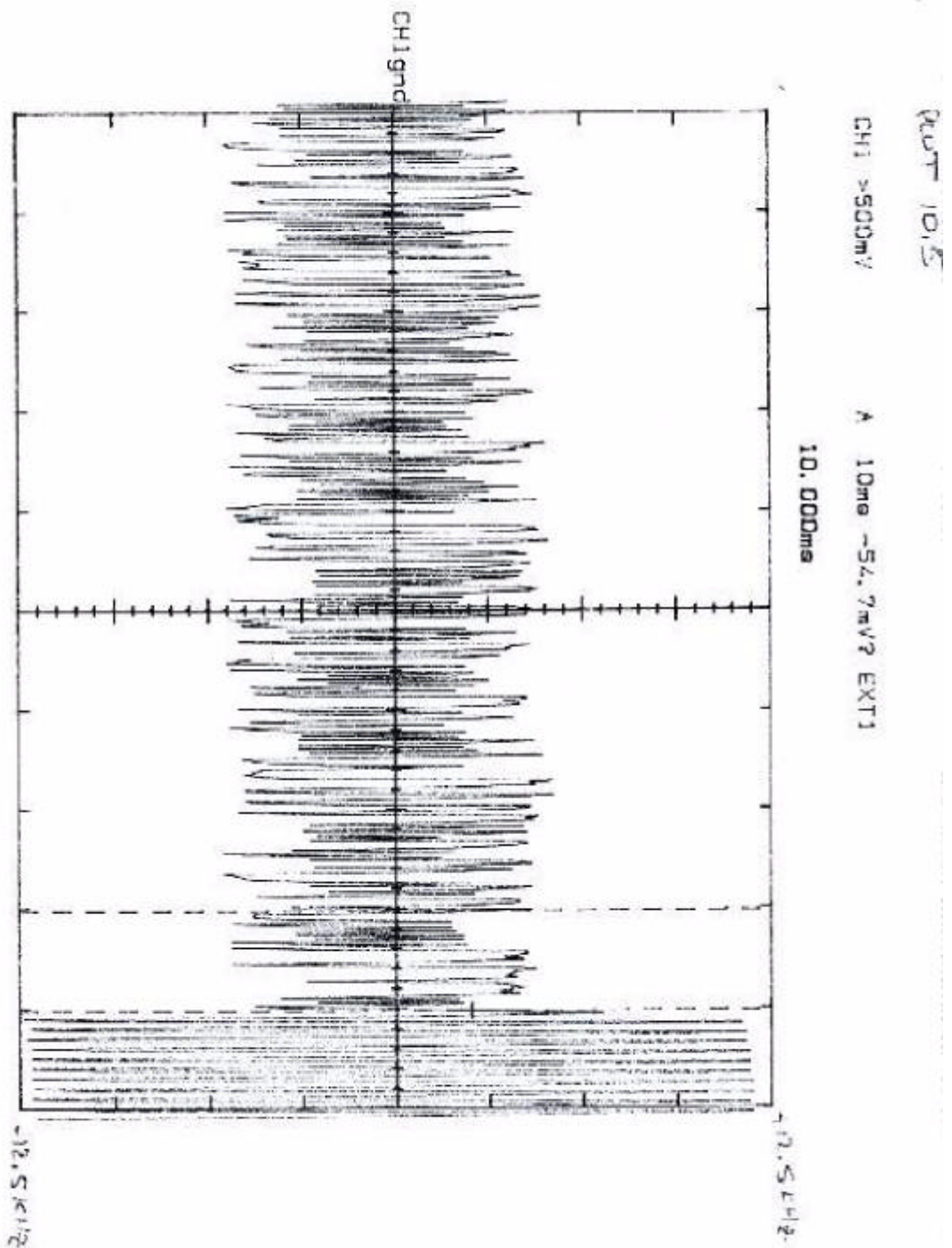
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Teledesign Radio Modem with 3412 Transceiver

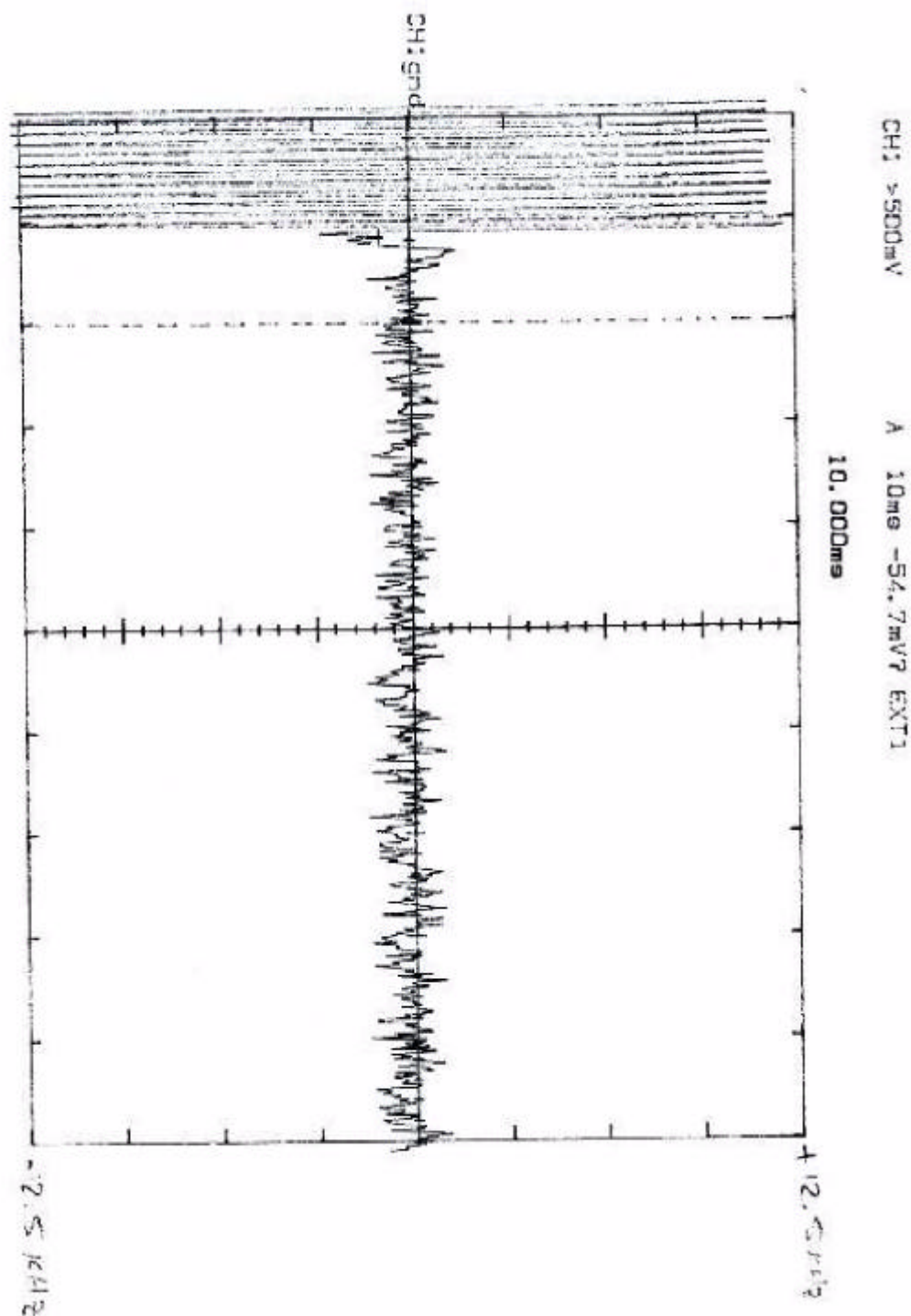
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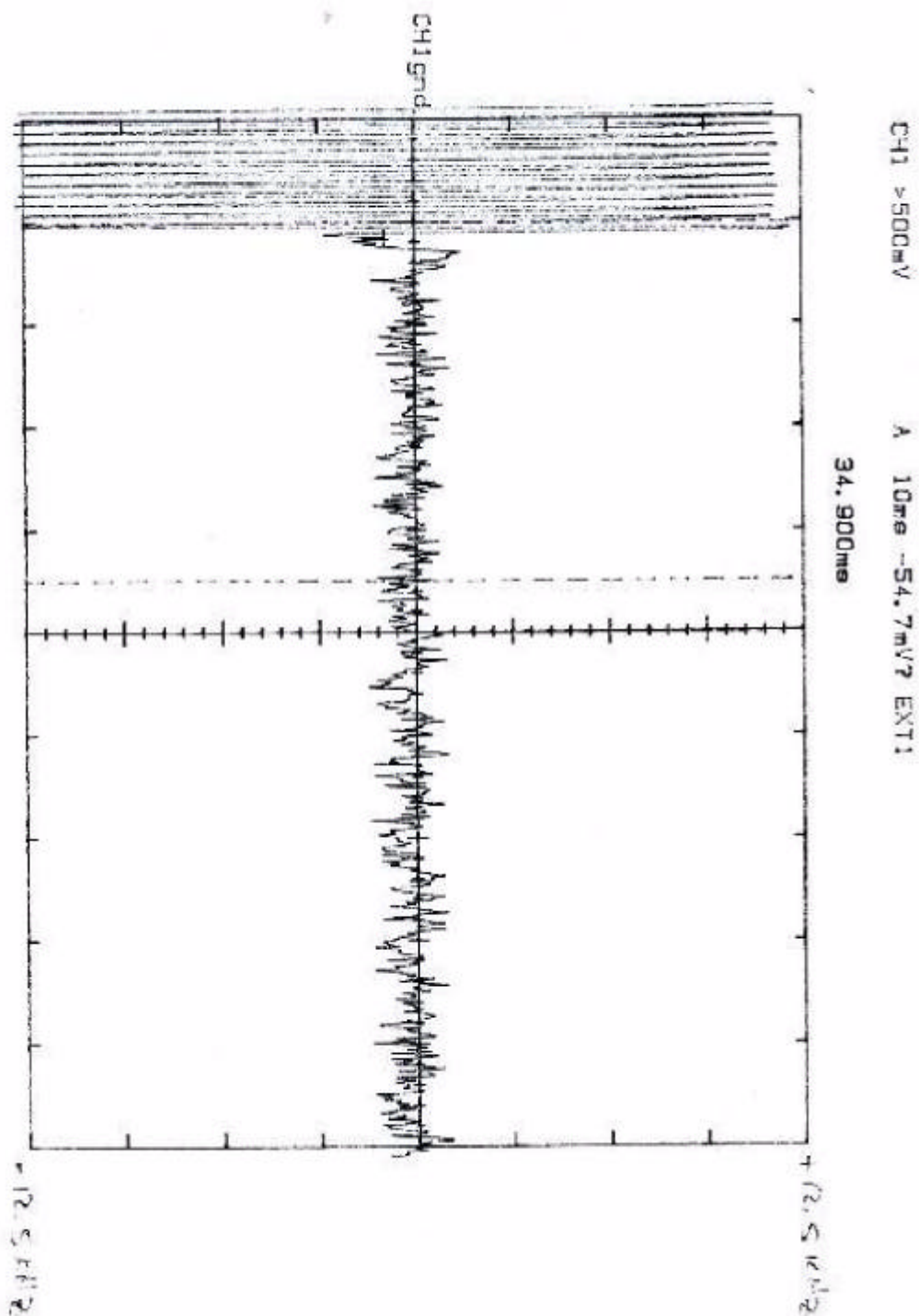
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Teledesign Radio Modem with 3412 Transceiver

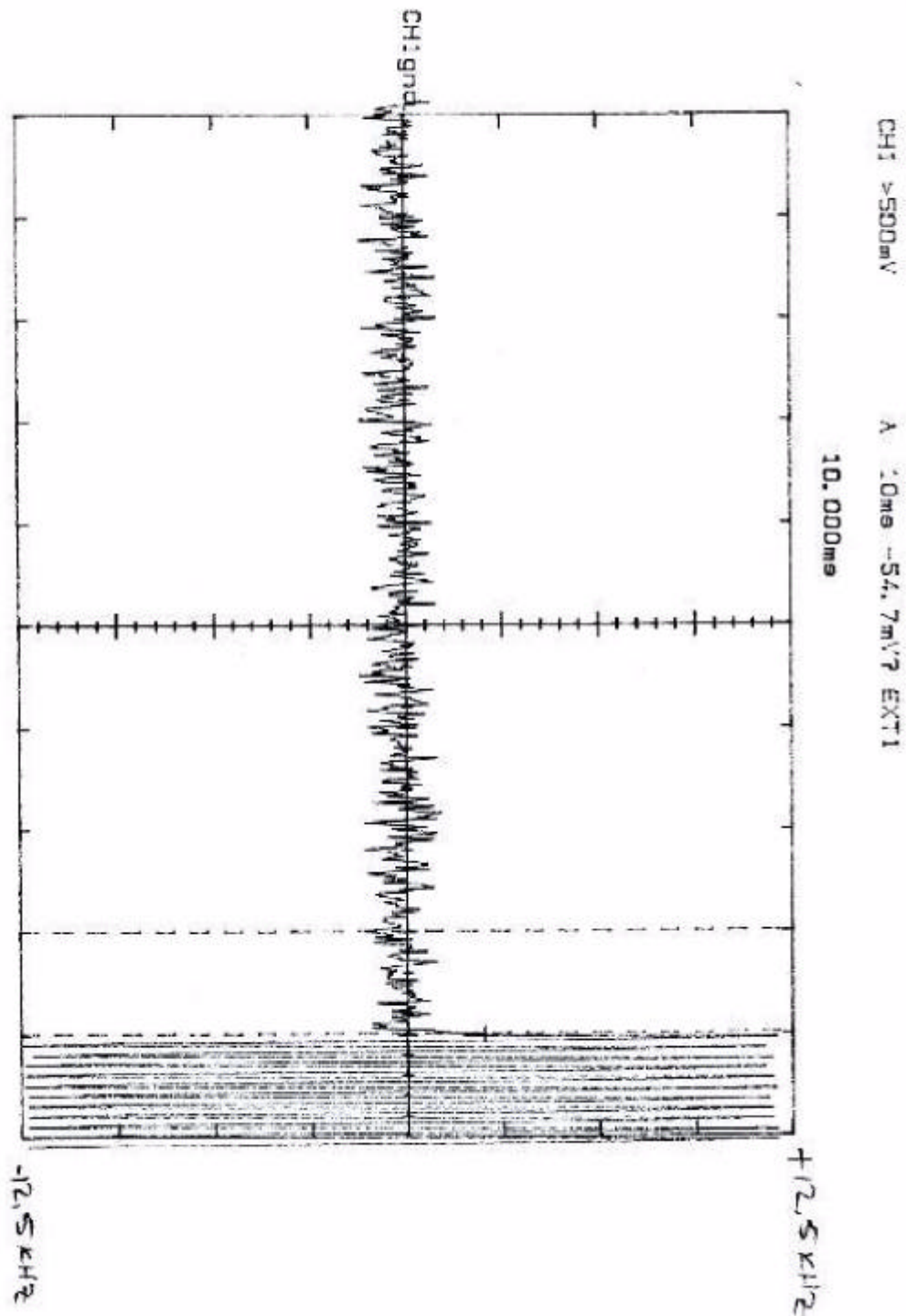
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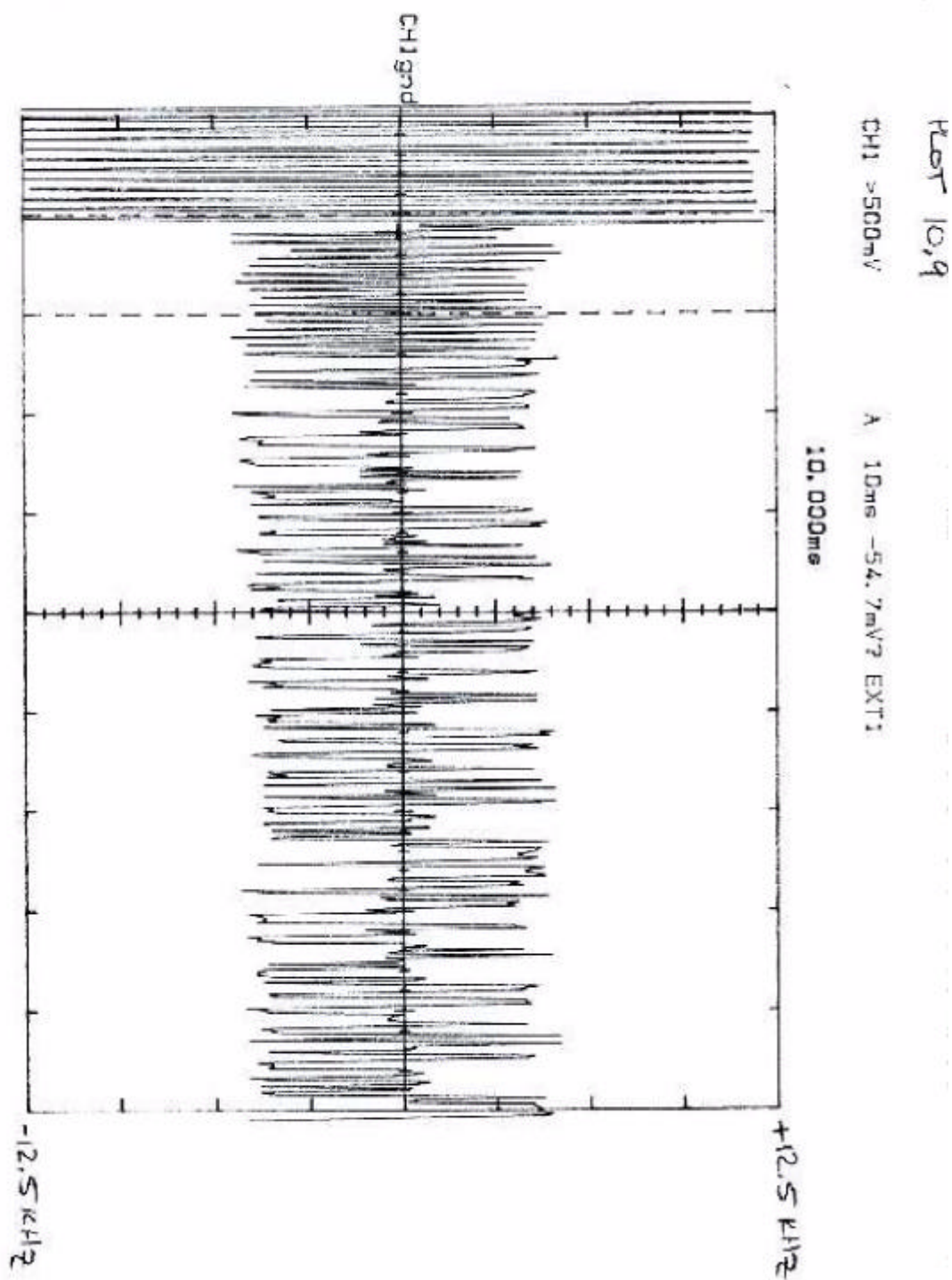
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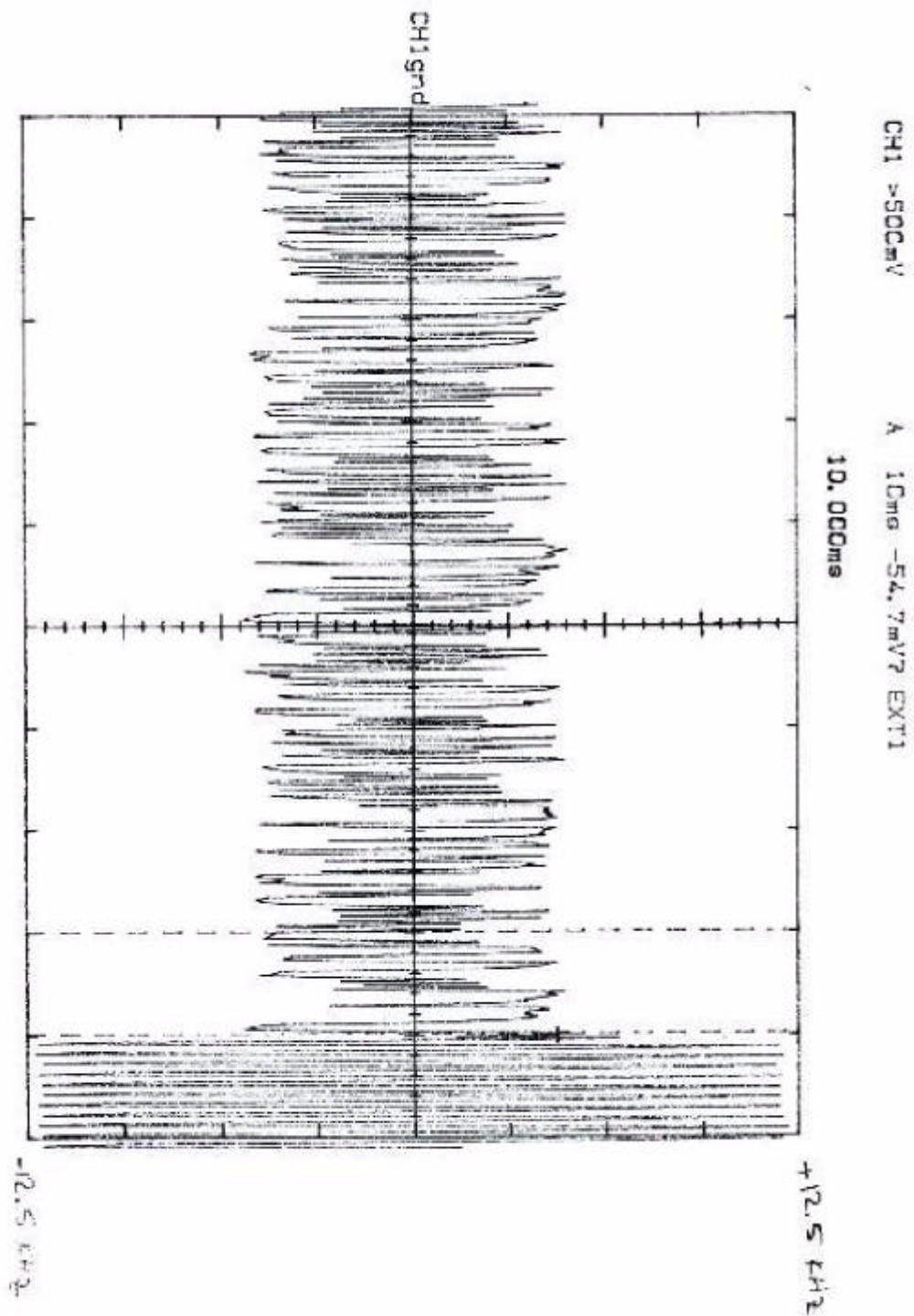
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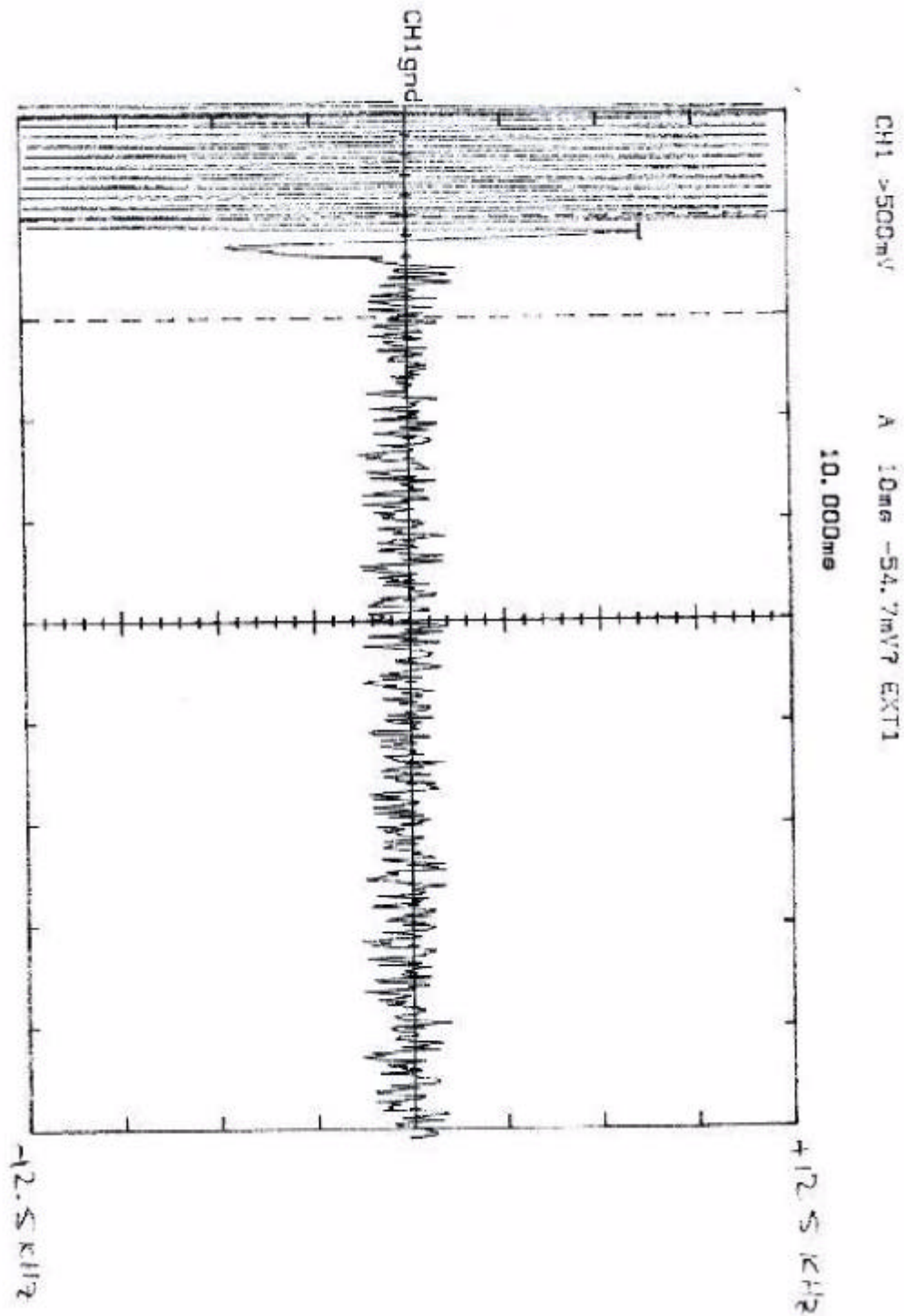
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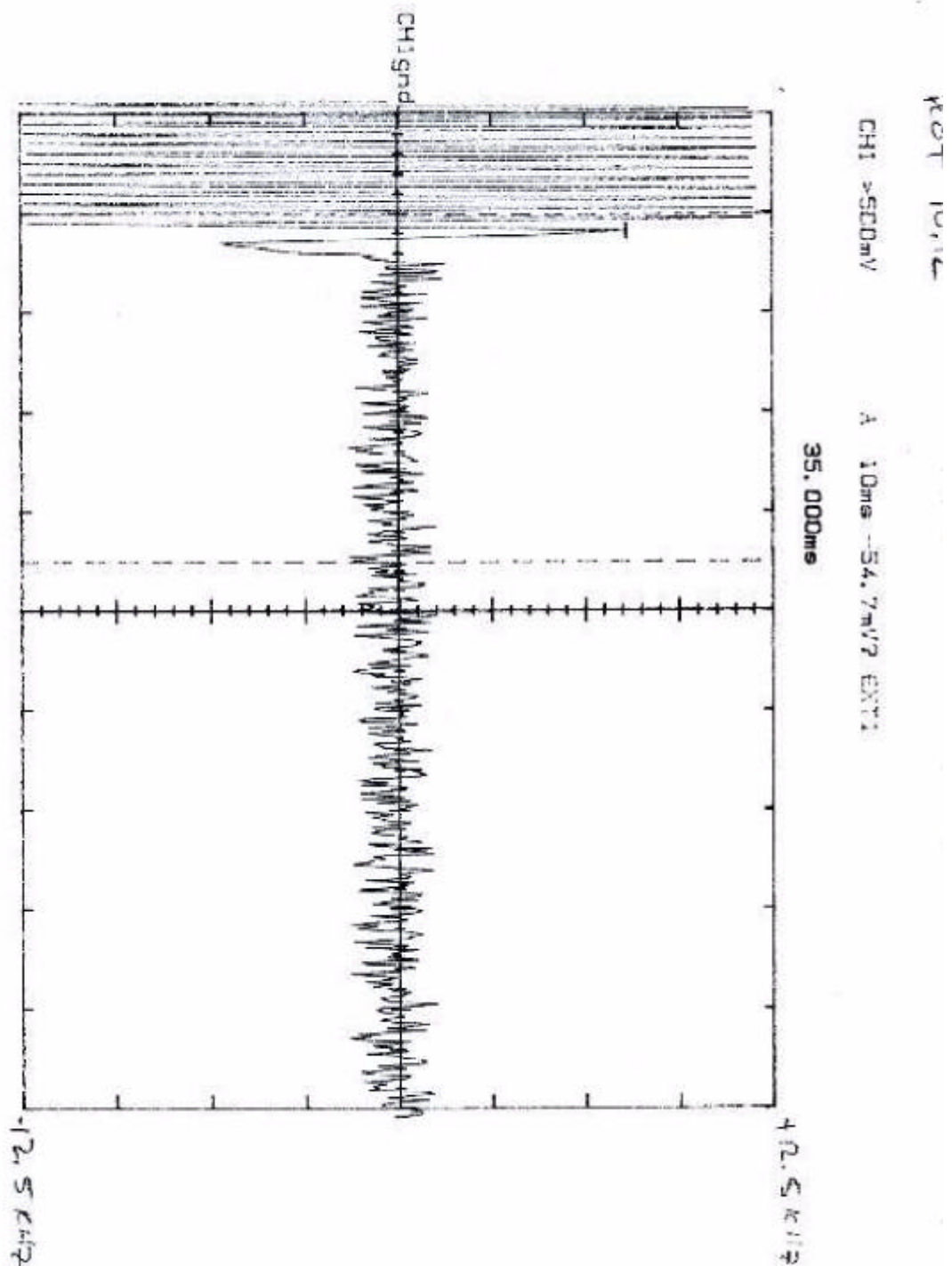
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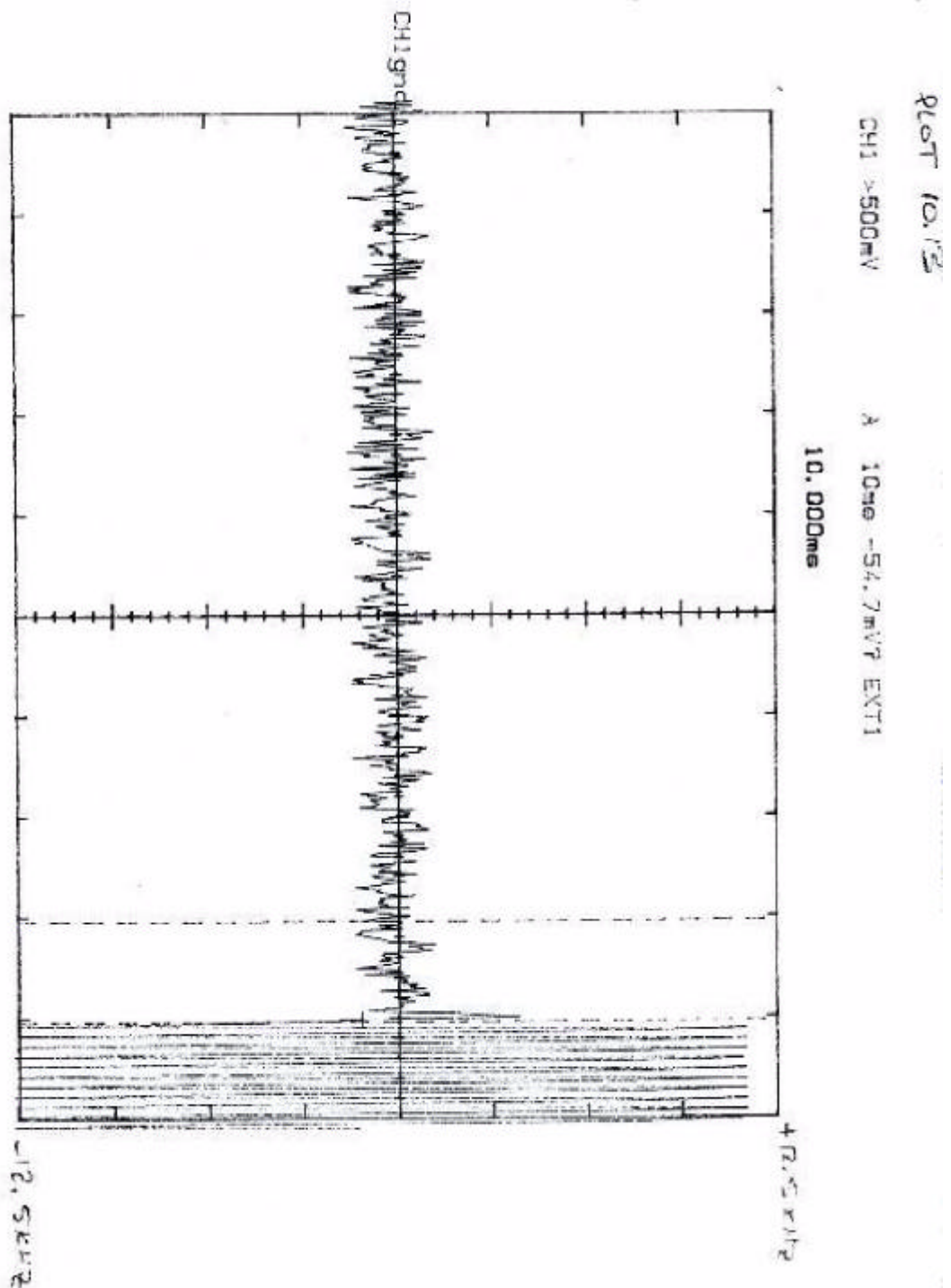
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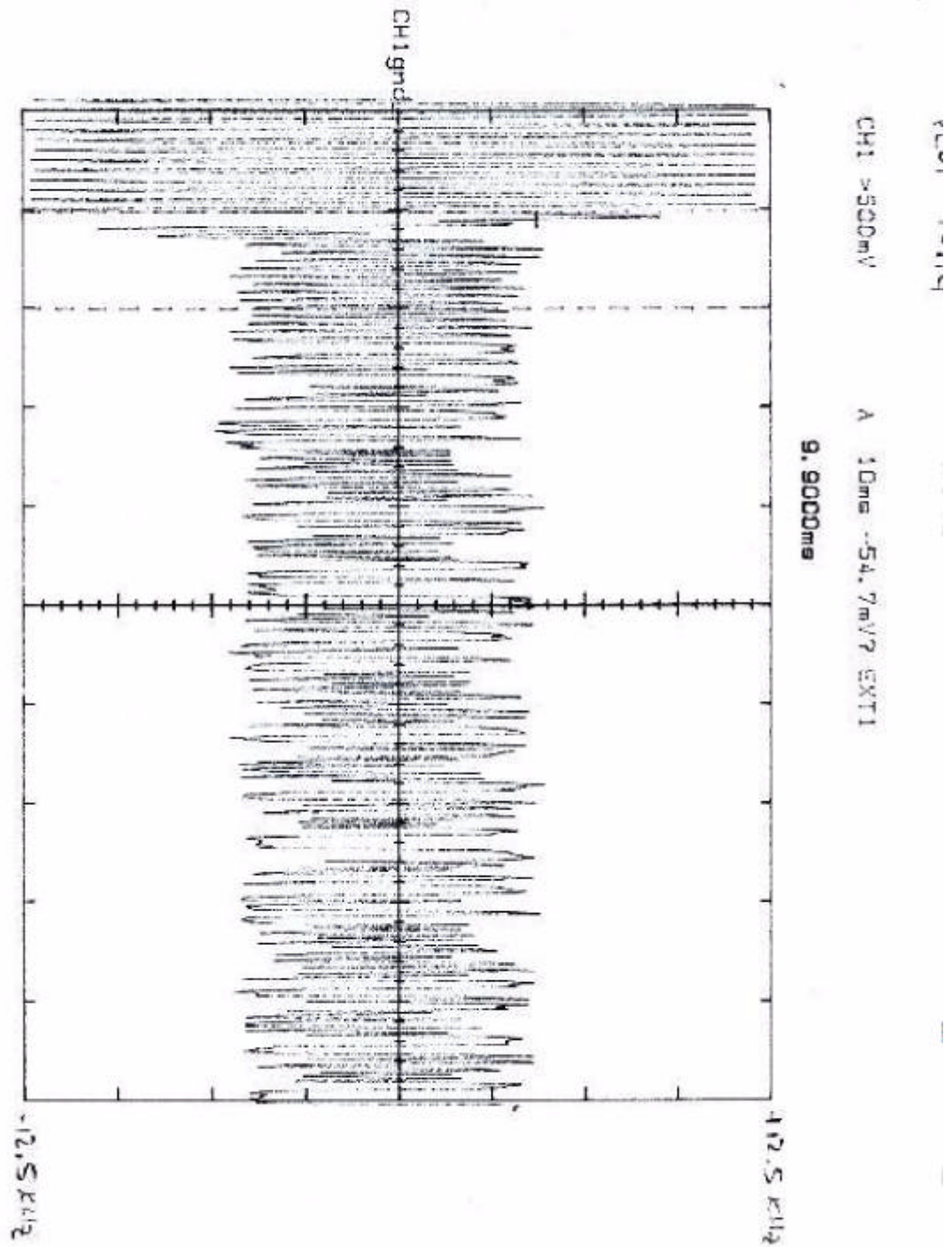
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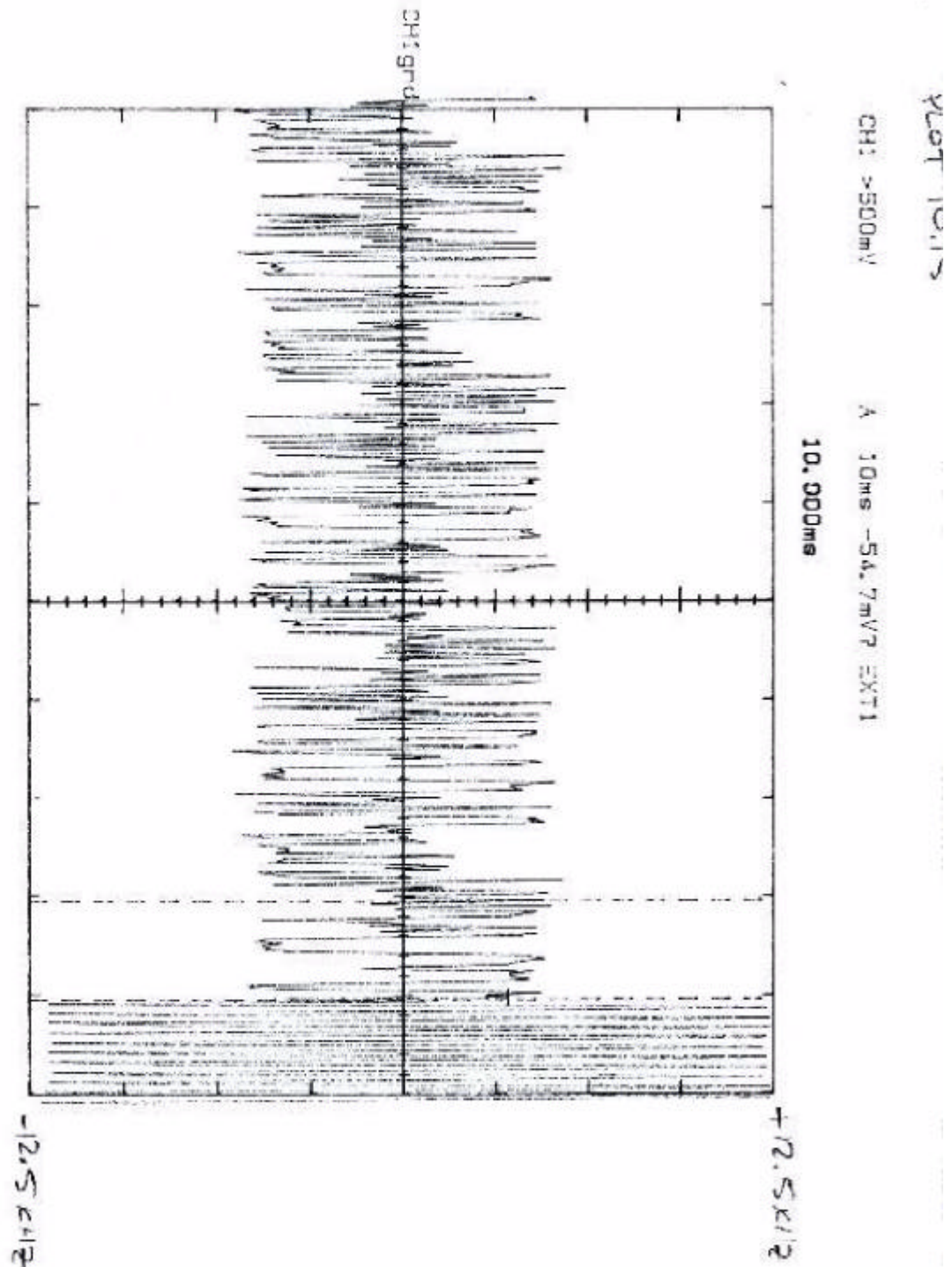
Date of Test: December 11, 1998



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