

APPLICATION FOR FCC PART 90 TYPE ACCEPTANCE

Teledesign Systems Inc.

**Radio Modem With 3474 Transceiver
Model No.: TS4000-02Aff**

FCC ID: JWFTS4000A

Report # J98019482

Date of Report: July 16, 1998

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FCC Part 90 Type Acceptance

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Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

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1.0 Introduction

1.1 Test Summary

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
2.985	RF Power Output	Pass	3
90.205	Effective Radiated Power	Pass	4
2.989(I), 90.209(b)(5), 90.210	Occupied Bandwidth, Bandwidth Limitation, Emission masks	Pass	5
2.991	Spurious emissions at antenna terminals	Pass	7
2.993, 15.109	Field Strength of Spurious Radiation	Pass	12
15.107	Line Conducted Emissions	Pass	15
2.995(a)	Frequency Stability vs. Temperature	Pass	16
2.995(d)(1)	Frequency Stability vs. Voltage	Pass	17
2.914	Transient frequency behavior	Pass	18

David Chernomordik

David Chernomordik
Test Engineer

8/6/98
Date

**Type Acceptance Information for TS4000 Radio Modem with 3474 Transceiver
Proposed FCC ID JWFTS4000A**

PURPOSE

The purpose of this document is to provide information in support of type acceptance testing and report generation in pursuit of a Grant of Equipment Authorization under FCC Parts 15 and 90 and Industry Canada RSS-119, RSS-210 and ICES-003 for Teledesign's TS4000 Radio Modem.

INTRODUCTION

The TS4000 is a high-speed radio modem that consists of a modem board, radio transceiver board and metal enclosure. The radio transceiver board connects to the modem board with a flexible printed circuit.

Radio Transceiver Board

The radio transceiver board for this application is an E.F. Johnson DL3474. This device is being used without any modifications. The DL3474 has received FCC type acceptance with an FCC ID of ATH2423474-001. All circuit descriptions and details for the radio transceiver can be found in the type acceptance document for the DL3474. A copy of this has been included with this application. The radio transceiver is available in a frequency range from 403-512 MHz and includes a temperature stable reference oscillator with a frequency stability of ± 1.5 PPM.

Modem Board

The modem board provides the serial data interfaces that the user's equipment interfaces to. The modem board also controls the operation of the radio transceiver. This control includes controlling the radio power and frequency and also controlling the modulation, data rate and frequency deviation of the transmit signal. Note that it is this transmit signal that defines the emission bandwidth and spectral efficiency.

Radio Flex Circuit

A flex circuit is used to interconnect the radio transceiver board to the modem board. This flex circuit is also used to interconnect the serial port 2 connector to the modem board. The J11 interconnecting diagram included with the modem board schematic provides the specific connections provided by the flex circuit for connecting the 3474 transceiver to the modem board.

Configuration Software

IBM compatible configuration software is used to control all aspects of configuration, tune up and test of the TS4000 radio modem.

General Information

Manufacturer:	Teledesign Systems Inc. 1710 Zanker Road San Jose, CA 95112 408-436-1024
Contact Person:	Mark Hubbard
Product Trade Name:	TS4000 Radio Modem
Product Model Number:	TS4000-02Aff where: ff - indicates frequency range
Proposed FCC ID:	FCC ID: JWFTS4000A
Production Plans:	Teledesign Systems Inc. plans to produce this product in quantity (greater than 1) production runs.

OPERATION DESCRIPTION

Radio Channel Programming and Switching

Up to 99 radio channels can be pre-programmed into the modem board's non-volatile memory with a PC based programming software. This software is only available to authorized dealers and service centers. The user can switch between pre-programmed channels by sending an ASCII control string through one of the modem board's serial ports. 

The frequency of the radio transceiver is controlled by the microcontroller using the SPI port. This port directly controls the PLL (Phase Lock Loop) on the radio transceiver board. The microcontroller monitors the lock condition of this PLL using the lock detect signal from the radio transceiver.

Radio Power Control

The transmit power is adjustable from 0.1 to 2 watts. The actual value is adjustable by the end user using the TS4000 configuration software but can never be set over the maximum value of 2 watts. The modem board sets the radio power using DAC U5A. The maximum value that this circuit can be set for is configured when the unit is tuned up. This prevents the user from setting the output power higher than the maximum allowed.

Data Rate and Emission Masks

The modulation data rate is controlled by the microcontroller using the clock circuitry (described above). The modulation data rate, combined with deviation, controls the occupied bandwidth of the transmitted signal. The allowed occupied bandwidth depends on the channel bandwidth and the corresponding emission mask of the signal. Please reference the emission designator calculations in the front of this document for the maximum modulation data rate and deviation allowed for each designated emission.

The maximum modulation rate that a unit can operate at is configured by Teledesign Systems when a unit is tuned up. The TS4000 configuration software allows the user to adjust the modulation data rate but can never set it above the maximum value that is configured when the unit is tuned up. The deviation is controlled by the modem board based on the modulation data rate that the unit is set for.

Spectral Efficiency

This equipment is capable of supporting a minimum of 4800 bits per second per 6.25 kHz of channel bandwidth. This allows this equipment to support the latest FCC spectral efficiency requirements. 

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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
2	33.1	33.0	33.0
1	30.1	30.1	29.9
0.5	27.3	27.4	27.0
0.1	19.8	19.7	19.5

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Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Occupied Bandwidth Plots:

Transmitting at 512 MHz			
Plot Number	Emission Mask	Emission Designator	Description
4.1	C	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 100 kHz
4.2	C	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz
4.3	C	16KOF1D	B=24 kbps, M=3 kHz, D=5 kHz, Span 100 kHz
4.4	D	11K2F1D	B=15 kbps, M=1875 Hz, D=3750 Hz, Span 100 kHz
4.5	C	20KOF1D	B=19.2 kbps, M=6 kHz, D=4 kHz, Span 100 kHz
4.6	C	16KOF1D	B=19.2 kbps, M=6 kHz, D=2 kHz, Span 100 kHz
4.7	D	11K2F1D	B=10 kbps, M=3125 Hz, D=2.5 kHz, Span 100 kHz
4.8	C	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 100 kHz
4.9	C	20KOF1D	B=14 kbps, M=7 kHz, D=3 kHz, Span 200 kHz
4.10	C	16KOF1D	B=10 kbps, M=5 kHz, D=3 kHz, Span 100 kHz
4.11	D	11K2F1D	B=7.2 kbps, M=3.6 kHz, D=2 kHz, Span 100 kHz
4.12	C	20KOF1D	B=32 kbps, M=4 kHz, D=6 kHz, Span 200 kHz, Low Power
4.13	C	11K2F1D	B=10 kbps, M=3125 Hz, D=2.5 kHz, Span 200 kHz, Low Power

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

PLOT# 2.1

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

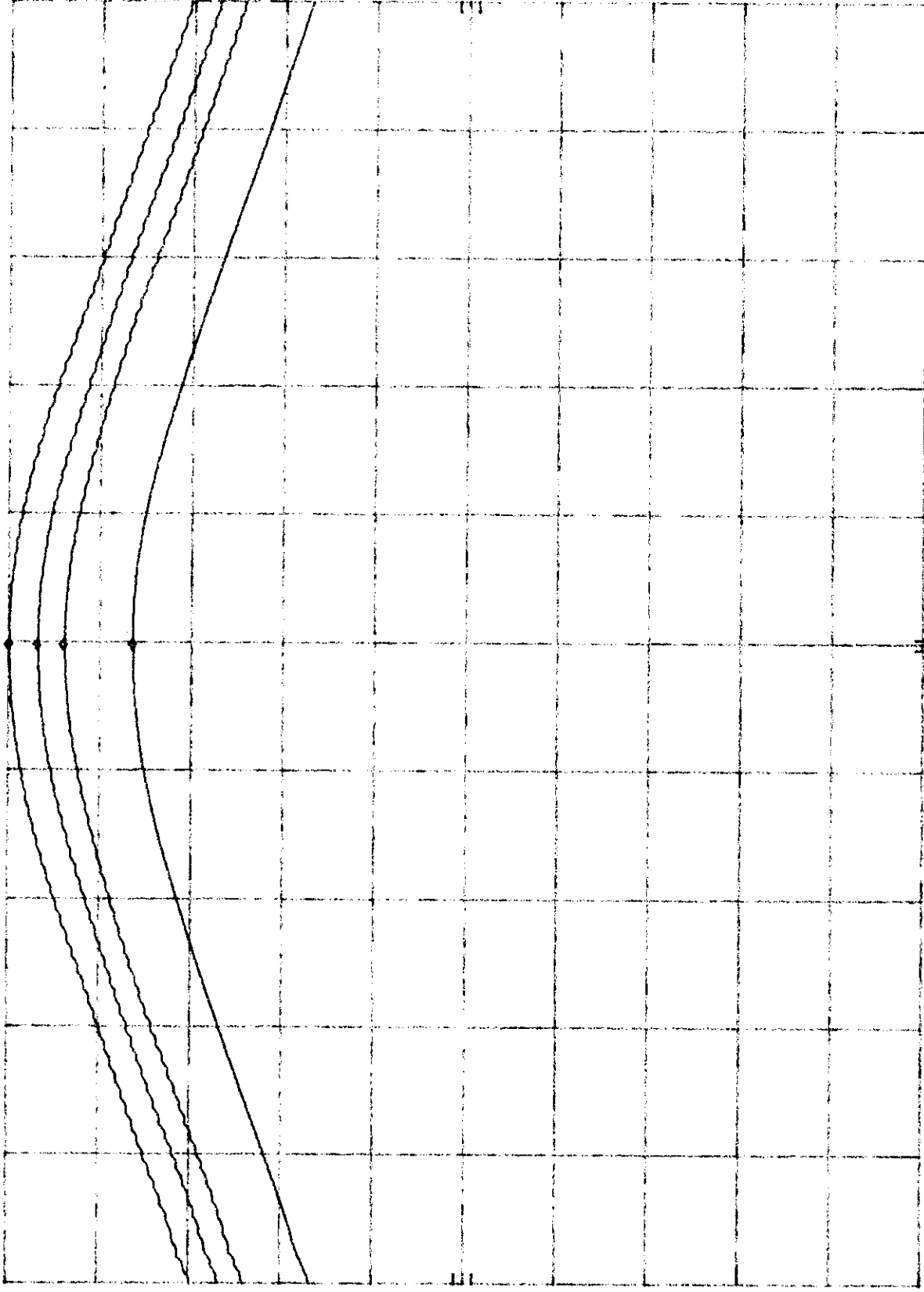
MKR 402.997 MHz
33.00 dBm

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 403.00 MHz

RES BW 300 kHz

VBW 300 kHz

SPAN 1.00 MHz
SWP 20.0 msec

PLOT# 2.2

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 457.998 MHz

REF 33.0 dBm

ATTEN 30 dB

33.00 dBm

hp

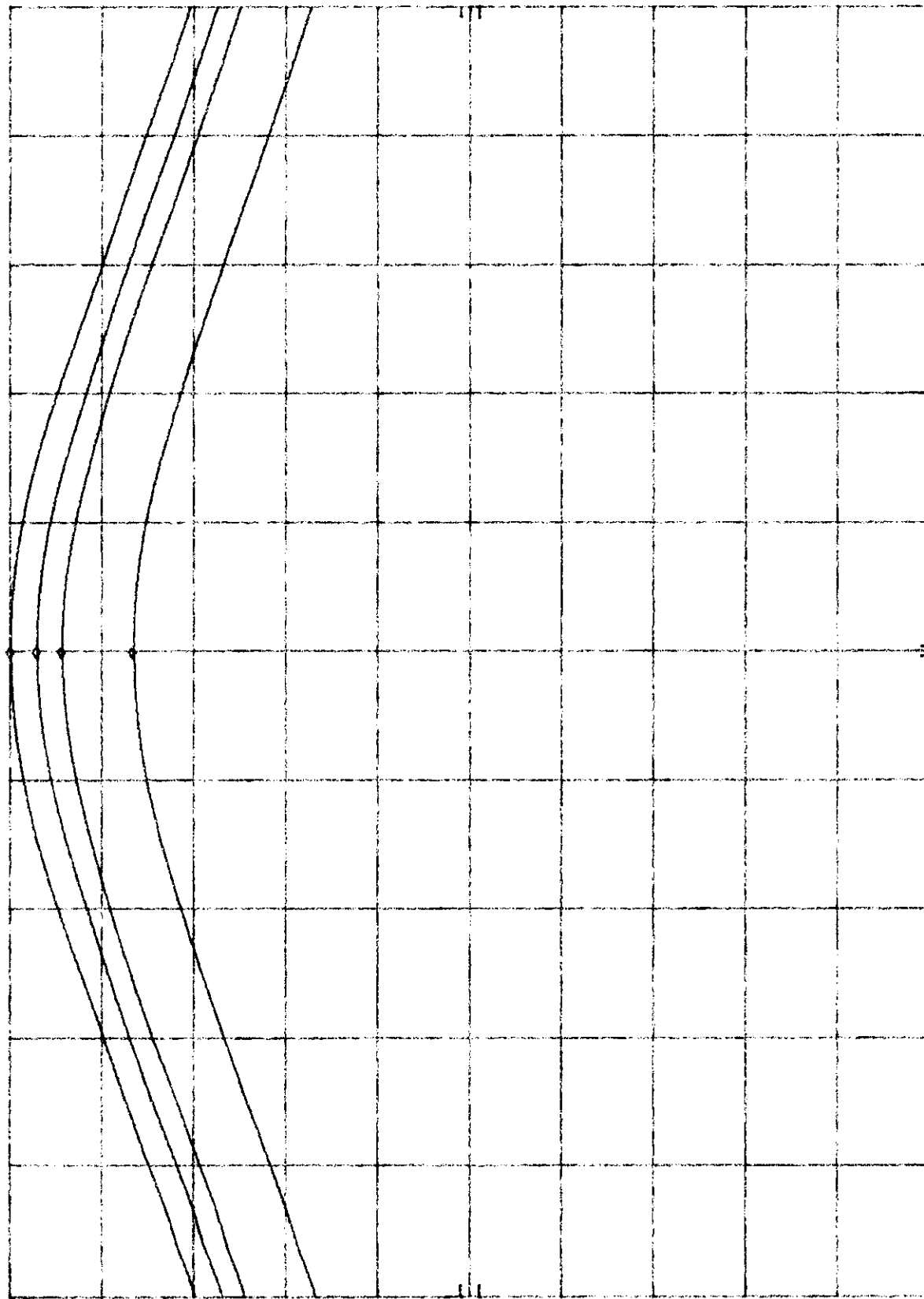
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 458.00 MHz

RES BW 300 kHz

VBW 300 Hz

SPAN 1.00 MHz

SWP 167 msec

PLOT# 2.3

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

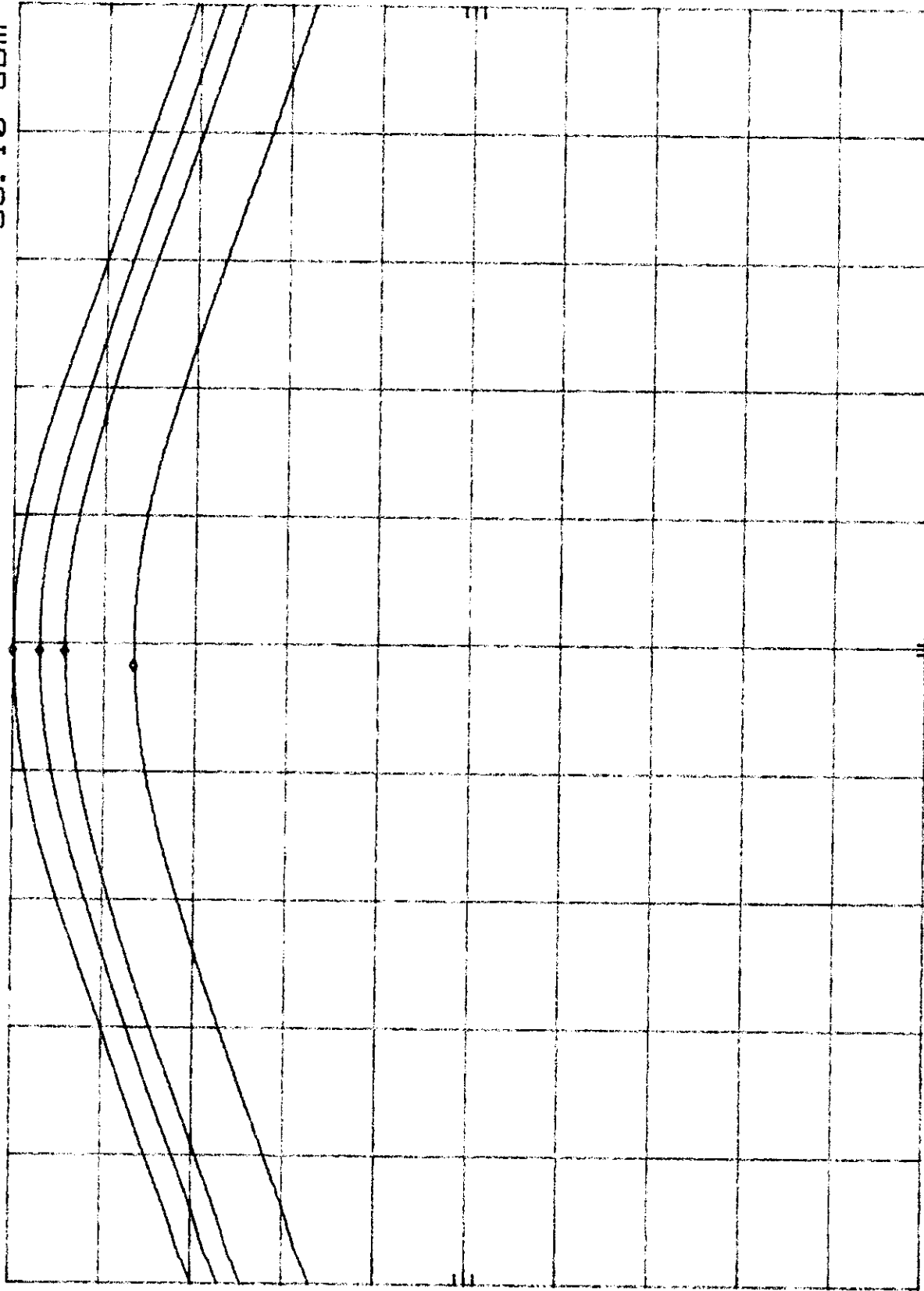
MKR 511.993 MHz
33.10 dBm

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.00 MHz
RES BW 300 KHz

VBW 300 KHz

SPAN 1.00 MHz
SWP 20.0 msec

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3.0 Effective Radiated Power, FCC § 90.205

Requirement: The Effective Radiated Power (ERP) must not exceed 20 Watts.

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

Refer to the table below. The EUT passed the test.

Frequency MHz	Spectrum Analyzer Reading dB(uV)	Antenna Factor dB(1/m)	Cable loss dB	Field Strength dB(uV/m)	ERP dBm
403.0	110.2	16.5	0.5	127.2	29,6
458.0	111.6	17.5	0.5	129.6	32.2
512.0	109.5	18.4	0.5	128.4	31.0

PLOT# 4.1

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

MKR Δ 9.9 KHz
-32.10 dB

hp

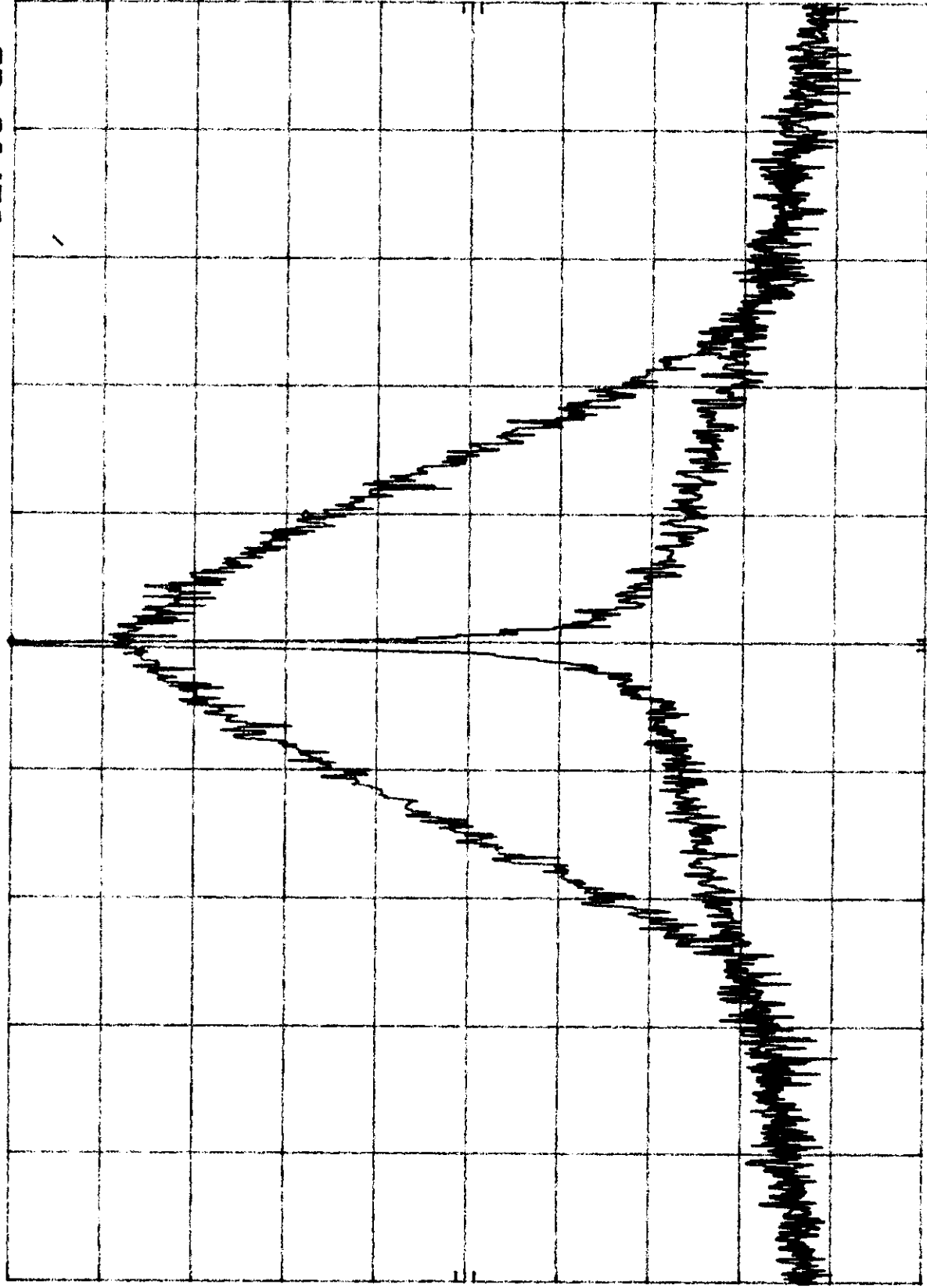
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100 KHz
SWP 30.0 sec

PLOT# 4.2

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

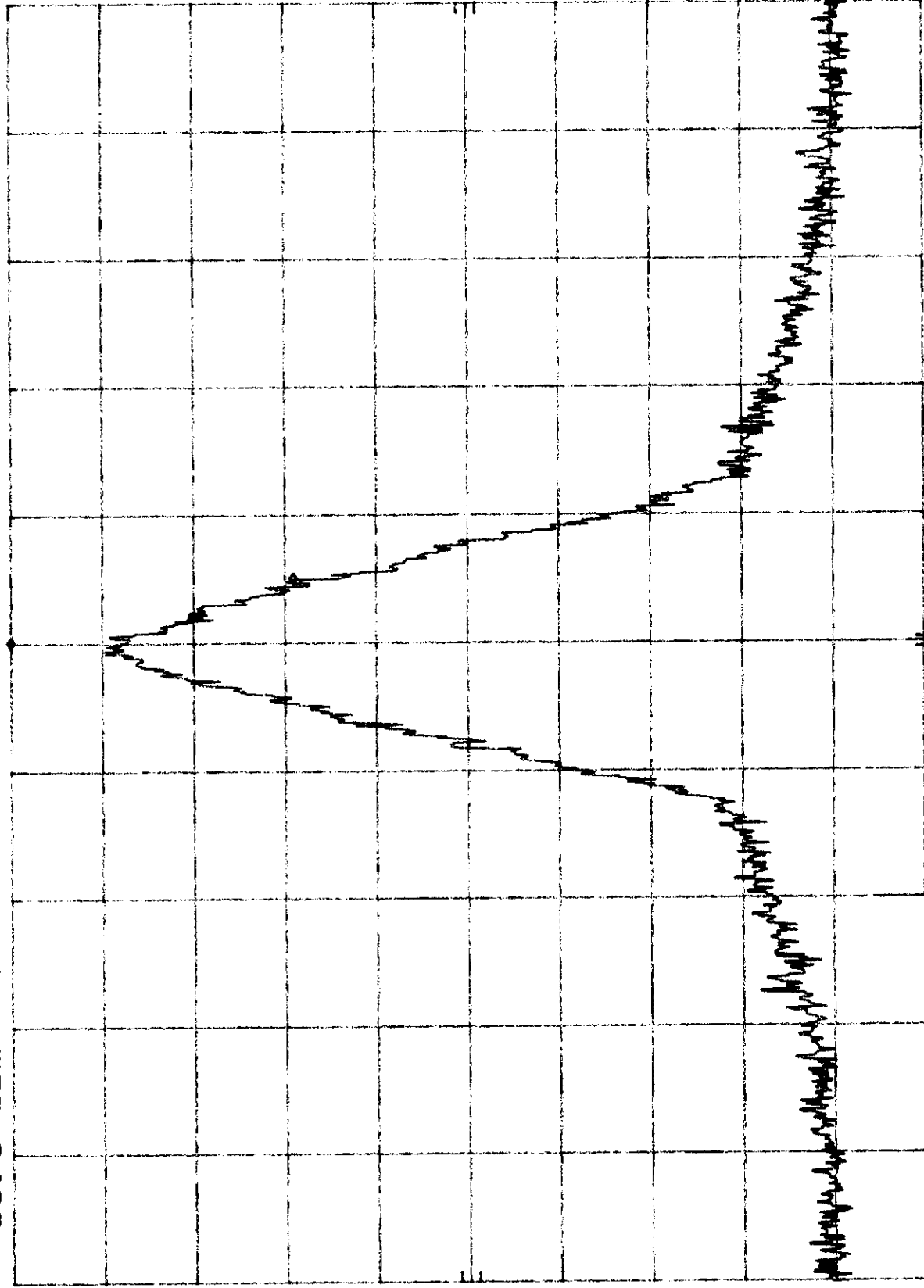
MKR Δ 10.0 KHz
-30.90 dB

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.000 MHz
RES BW 100 Hz

VBW 100 Hz

SPAN 200 KHz
SWP 60.0 sec

PLOT# 4.3

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR Δ 9.9 KHZ
-37.30 dB

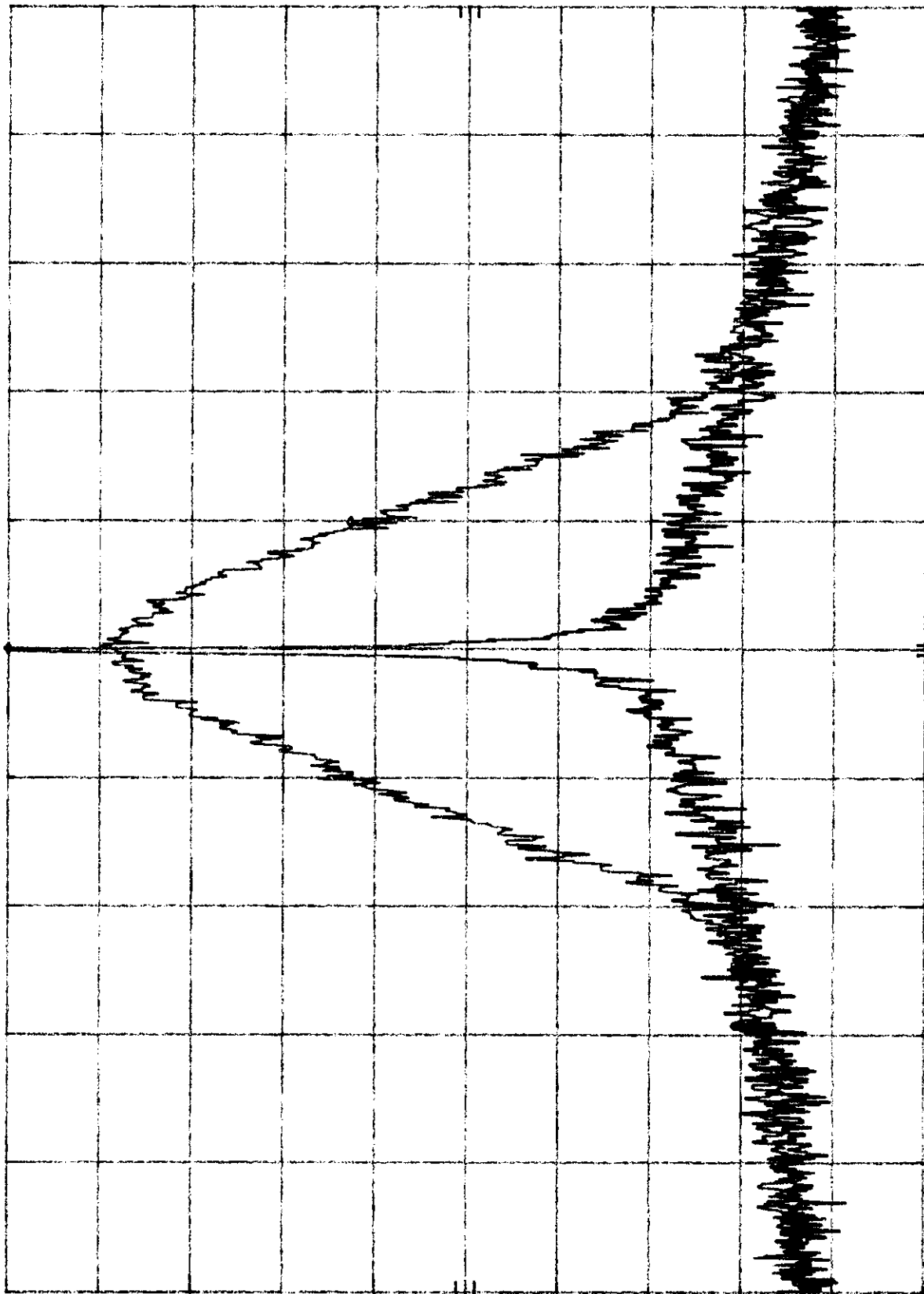
h₀

10 dB/

OFFSET

19.8
dB

CORR'D



CENTER 512.000 MHZ

RES BW 100 Hz

VBW 100 Hz

SPAN 100 KHZ

SWP 30.0 sec

PLOT# 4.4

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTN 30 dB

MKR Δ 12.3 KHz
-70.80 dB

hp

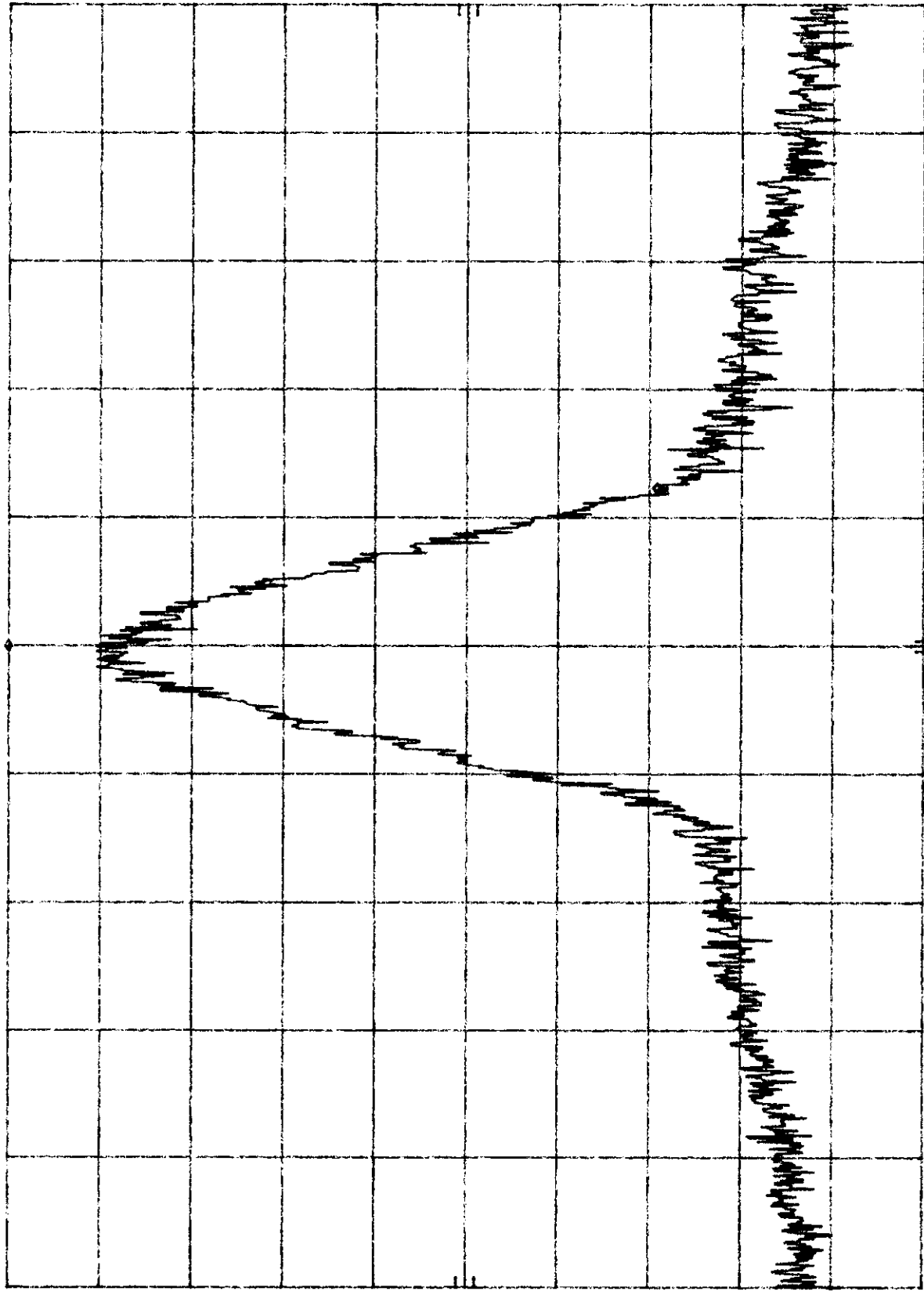
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100 KHz

SWP 30.0 sec

PLOT# 4.5

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

MKR Δ 10.0 kHz
-37.80 dB

hp

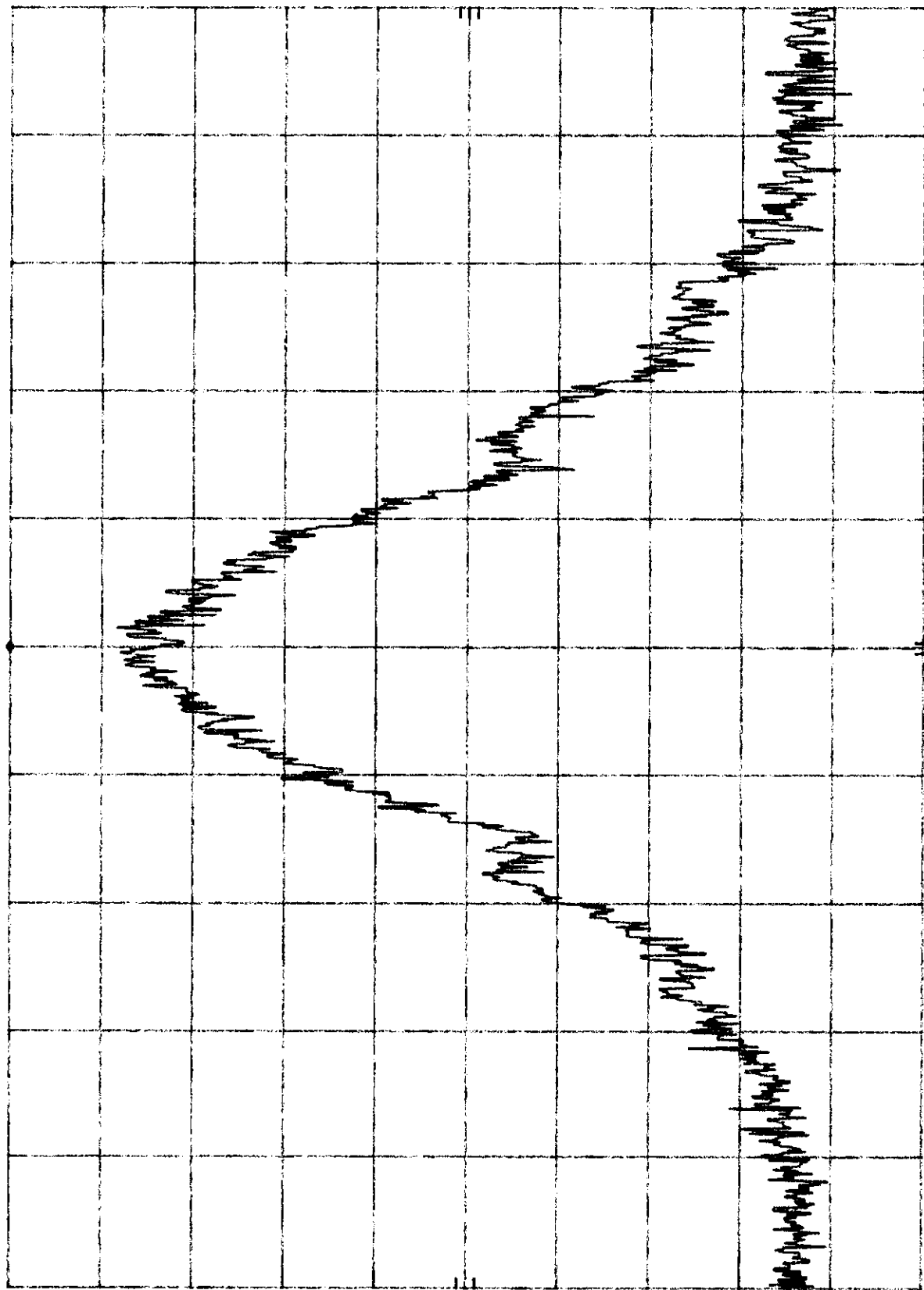
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

Hz

VBW 100 Hz

Hz

SPAN 100 kHz

SWP 30.0 sec

PLOT# 4.6

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTEN 30 dB

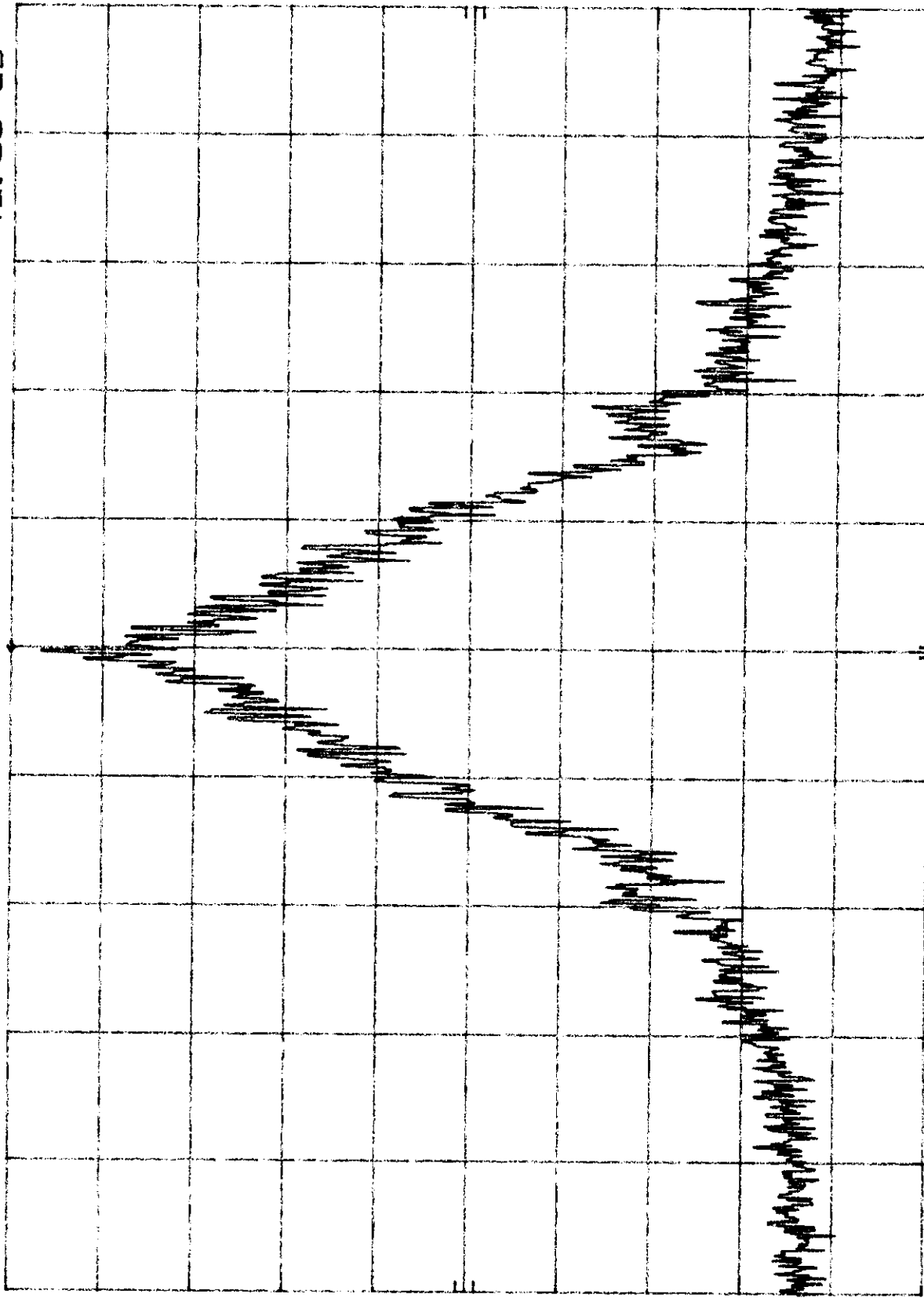
MKR Δ 9.9 kHz
-42.50 dB

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.000 MHz
RES BW 100 Hz

VBW 100 Hz

SPAN 100 kHz
SWP 30.0 sec

PLOT# 4.7

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTEN 30 dB

MKR Δ 12.5 kHz

-72.90 dB

HP

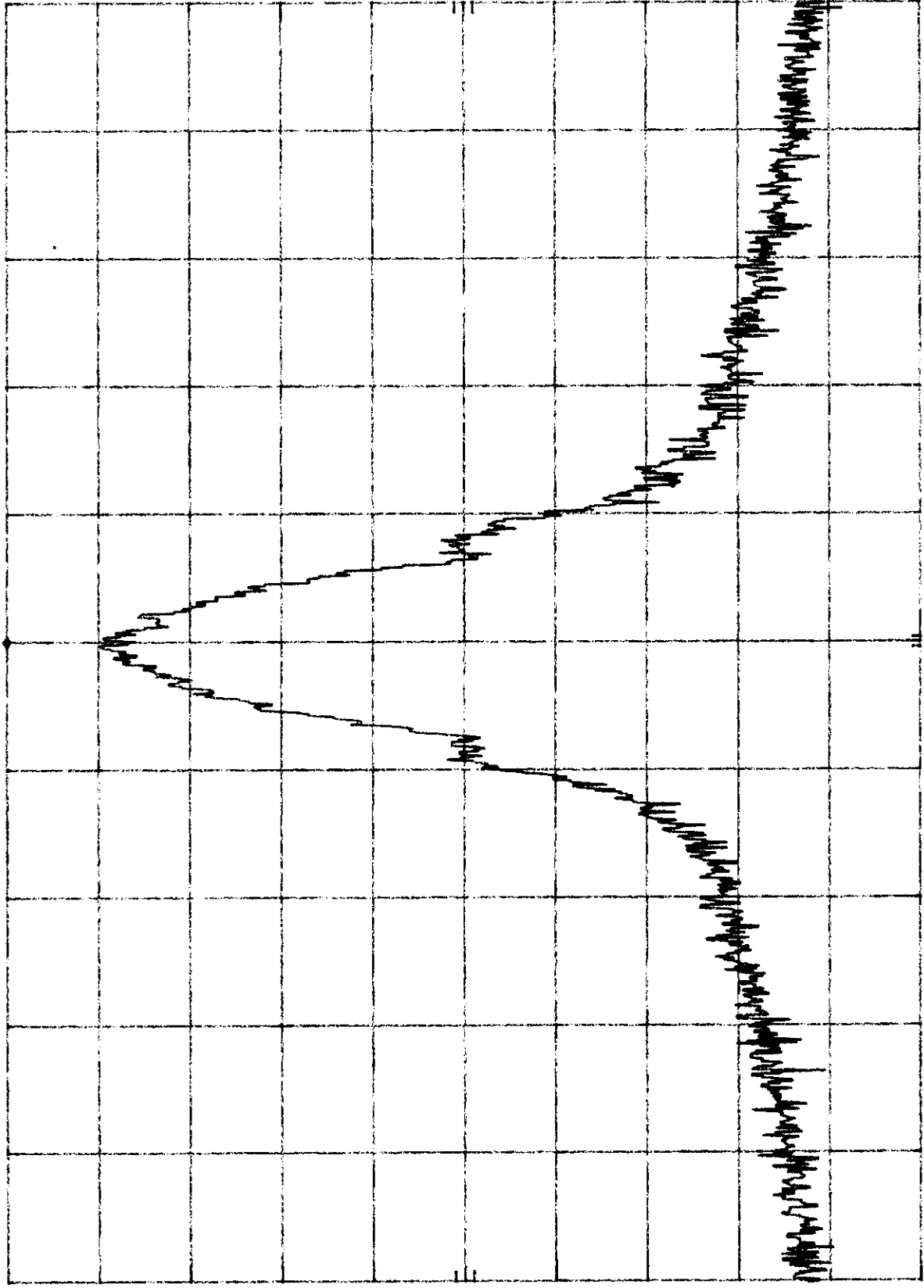
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

Hz

VBW 100 Hz

Hz

SPAN 100 kHz

SWP 30.0 sec

PLOT# 4.8

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTEN 30 dB

MKR Δ 13.0 KHz
-45.30 dB

hp

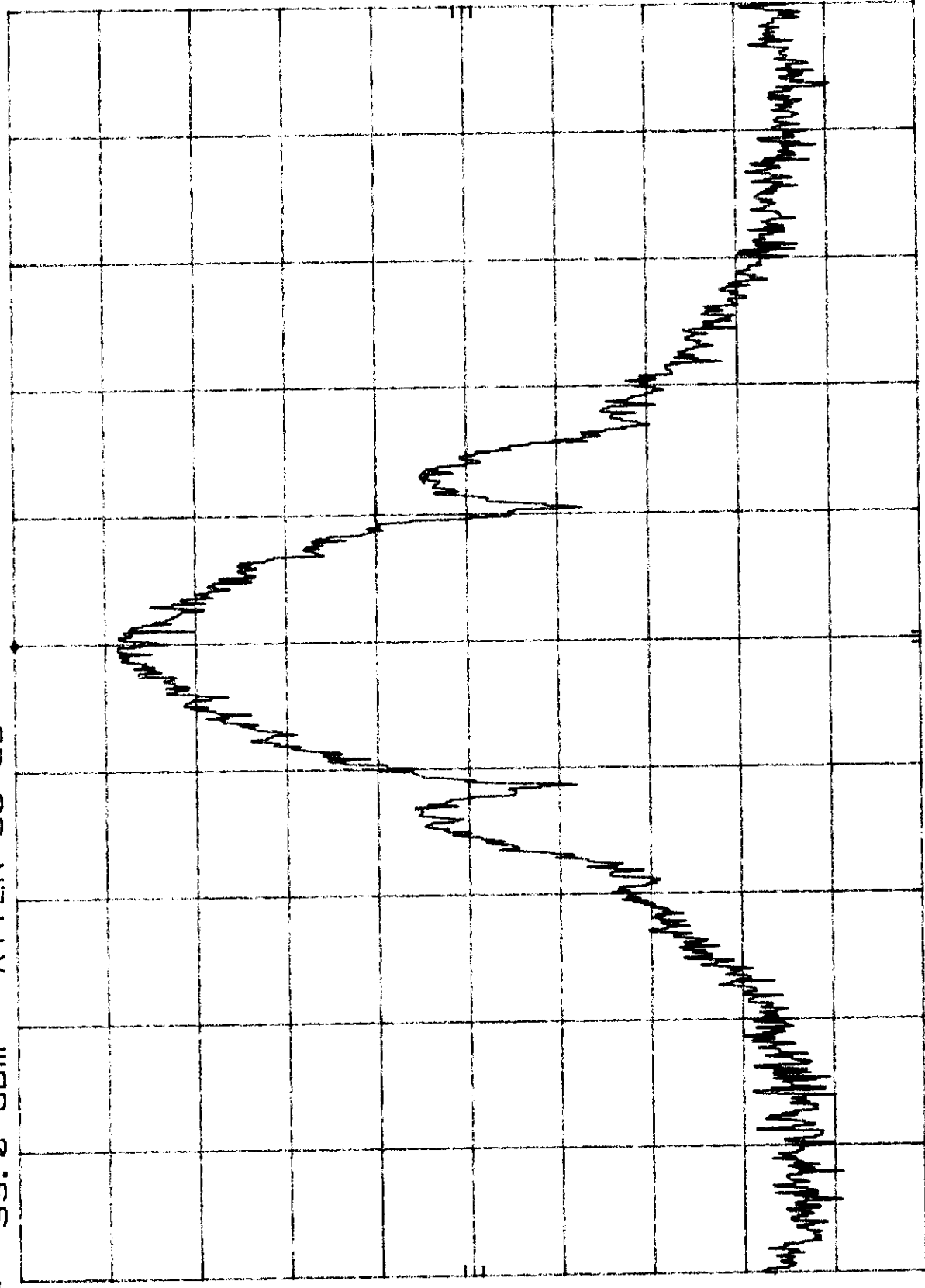
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

Hz

VBW 100

Hz

SPAN 100 KHz

SWP 30.0 sec

PLOT# 4.9

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTEN 30 dB

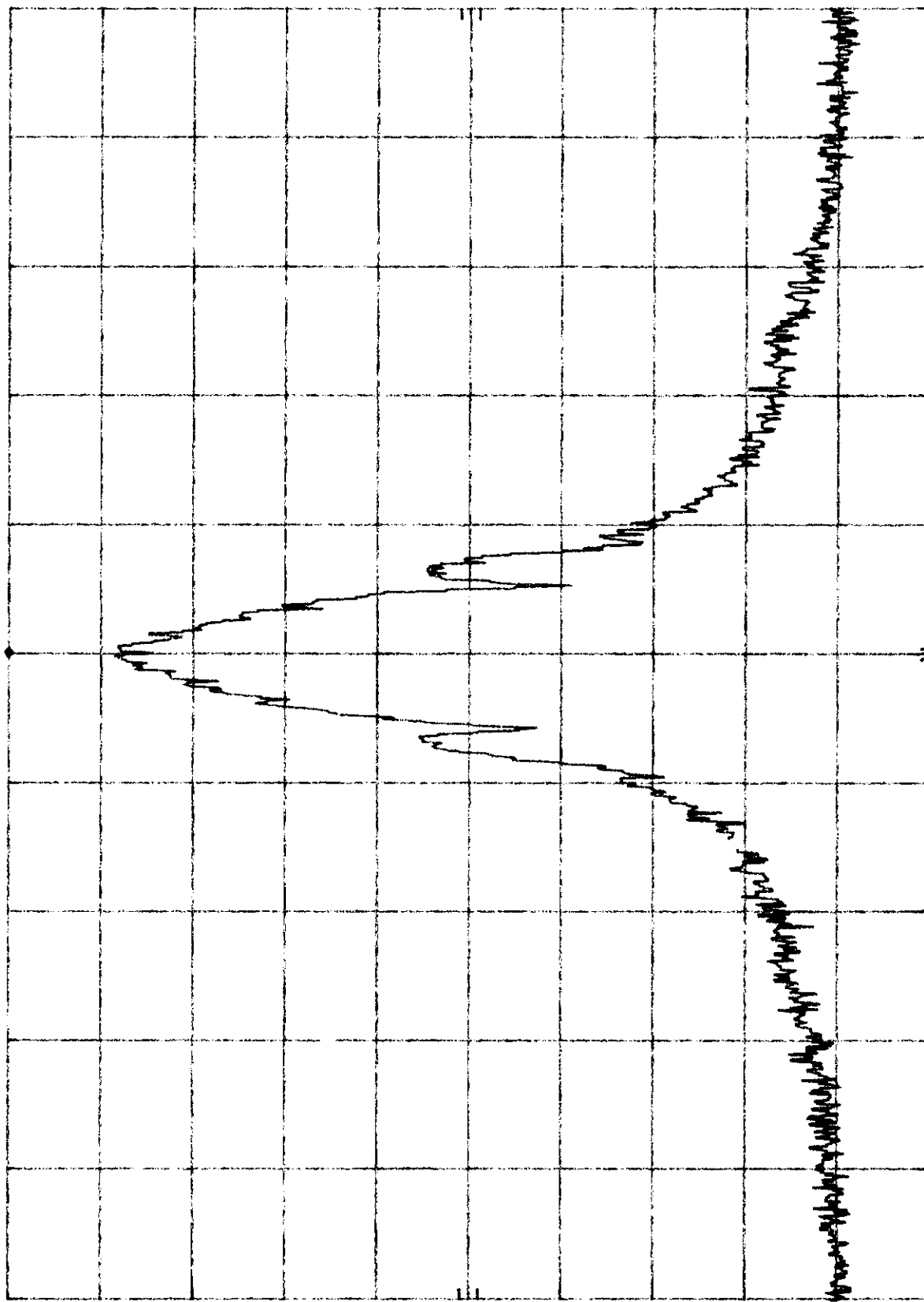
MKR Δ 12.8 KHz
-45.80 dB

HP

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.000 MHz
RES BW 100 Hz

Hz

VBW 100 Hz

Hz

SPAN 200 KHz
SWP 60.0 sec

PLOT# 4.10

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

MKR Δ 9.9 KHz
-40.30 dB

hp

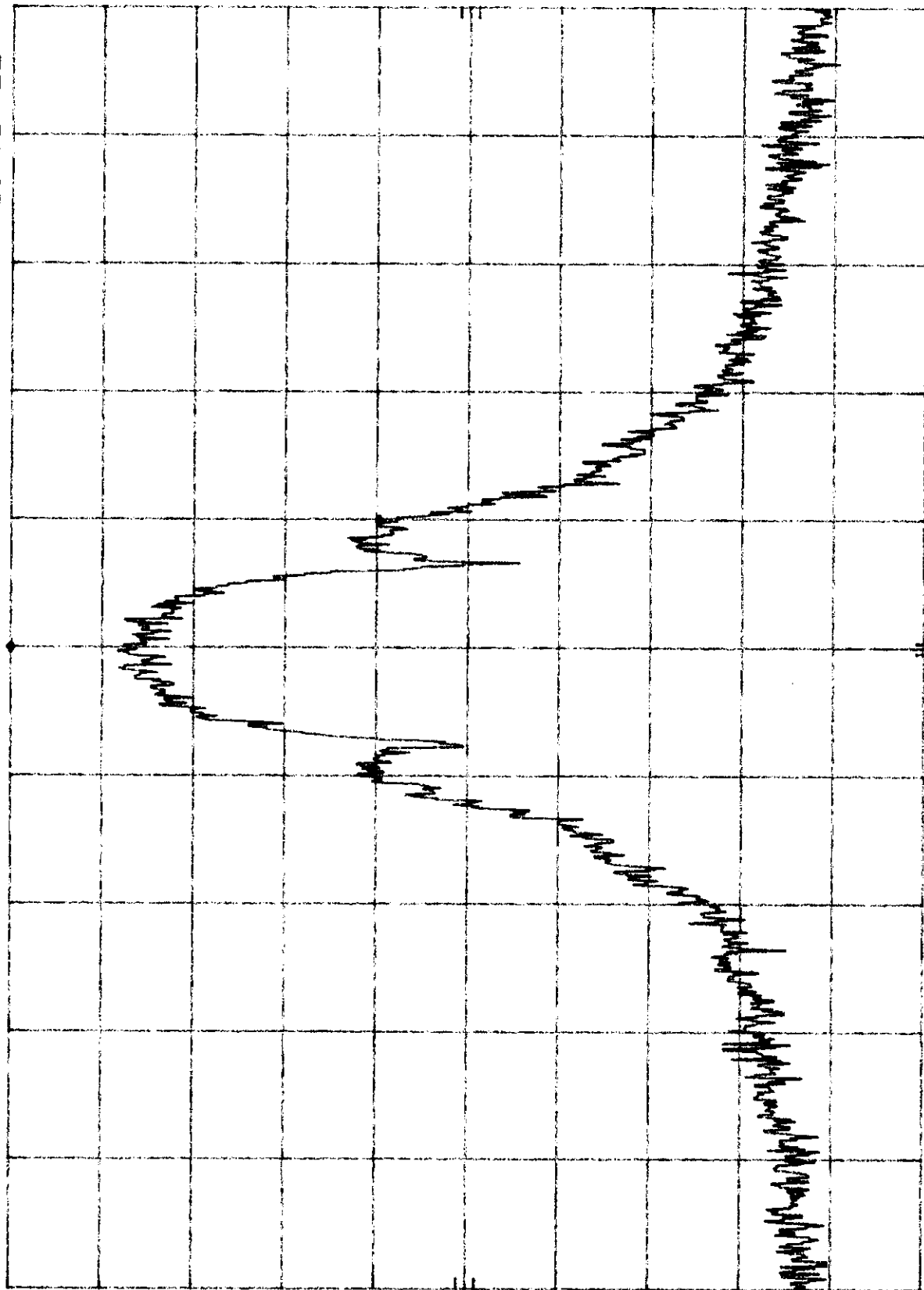
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100 KHz

SWP 30.0 sec

PLOT# 4.11

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTEN 30 dB

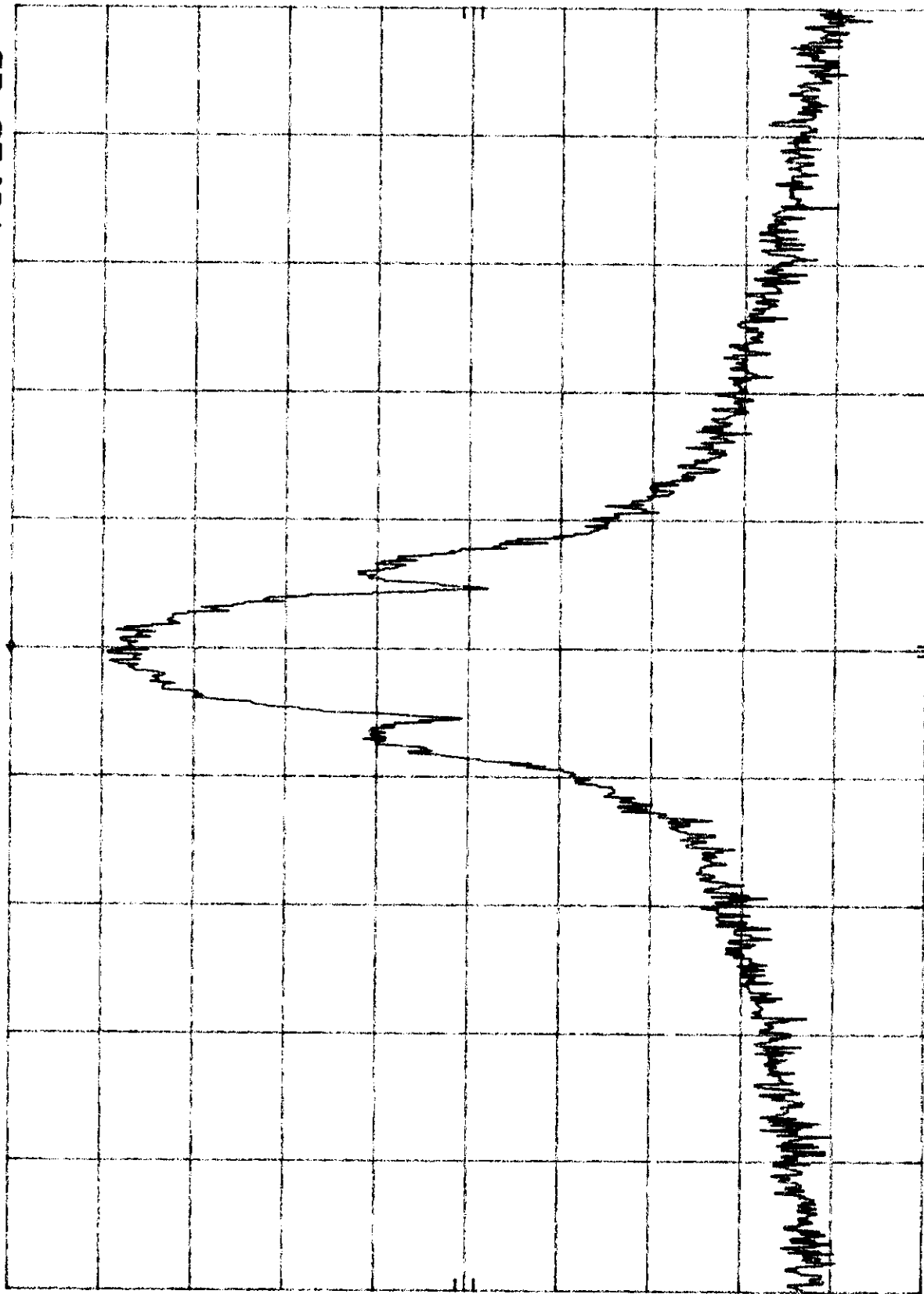
MKR Δ 12.5 KHz
-70.20 dB

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.000 MHz
RES BW 100 Hz

VBW 100 Hz

SPAN 100 KHz
SWP 30.0 sec

PLOT# 4.12

TELEDESIGN SYSTEMS - JWFTS4000A
REF 19.8 dBm ATTN 10 dB

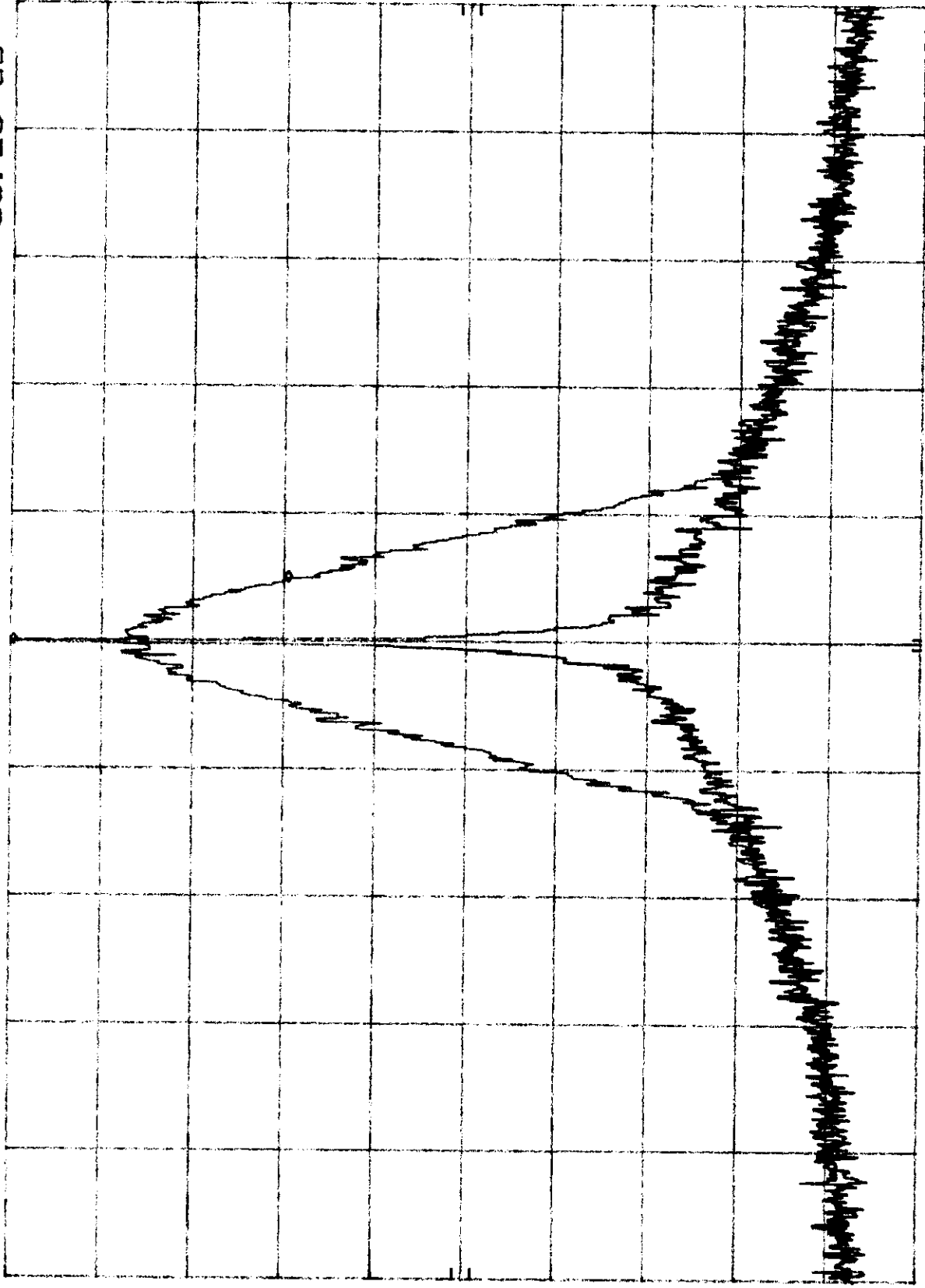
MKR Δ -10.0 KHz
30.20 dB

10 dB/

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 200 KHz
SWP 60.0 sec

PLOT# 4.13

TELEDESIGN SYSTEMS - JWFTS4000A

REF 19.8 dBm

ATTEN 10 dB

MKR Δ -12.4 kHz
43.50 dB

hp

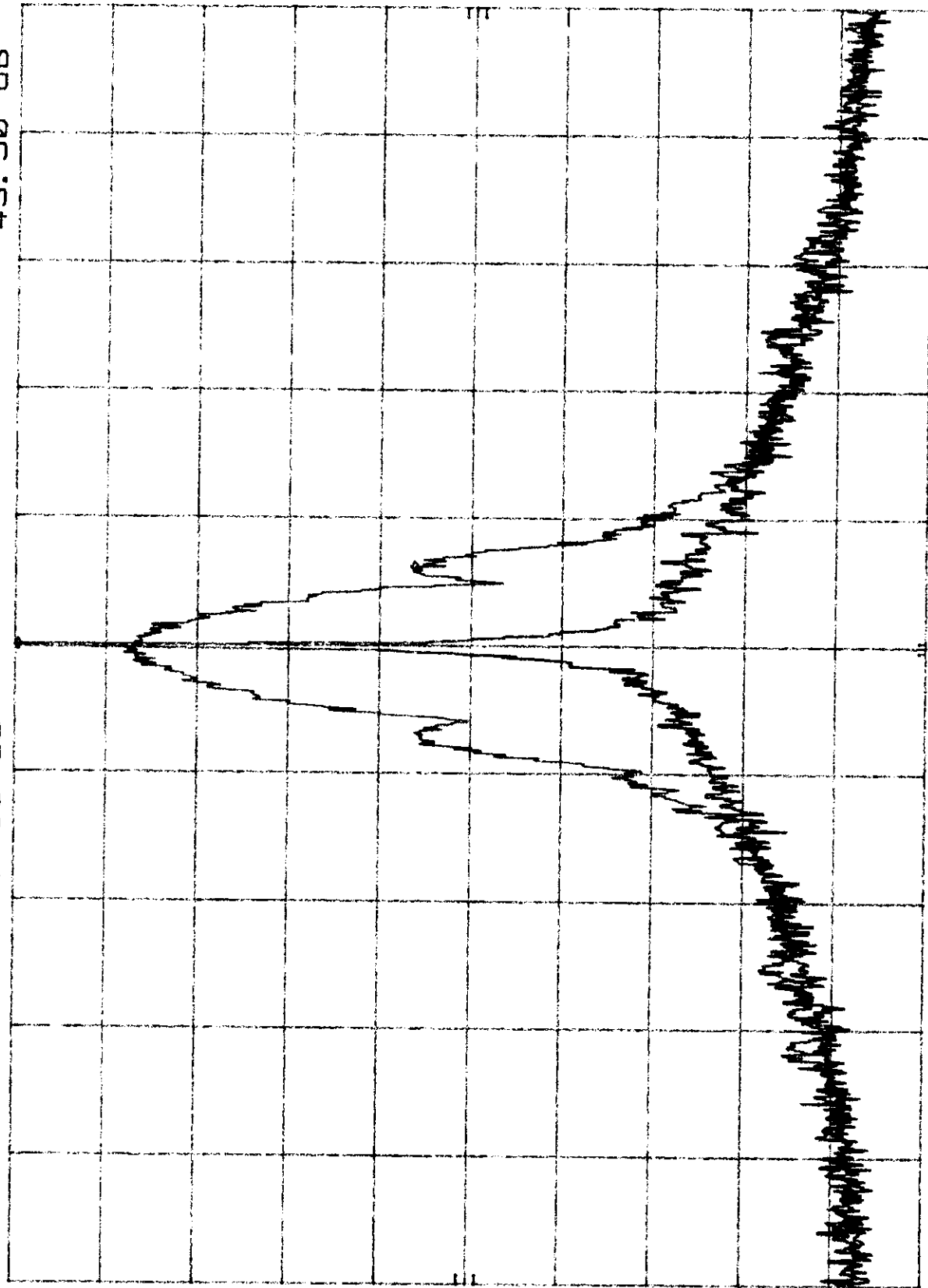
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 512.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 200 kHz
SWP 50.0 sec

PLOT# 4.14

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

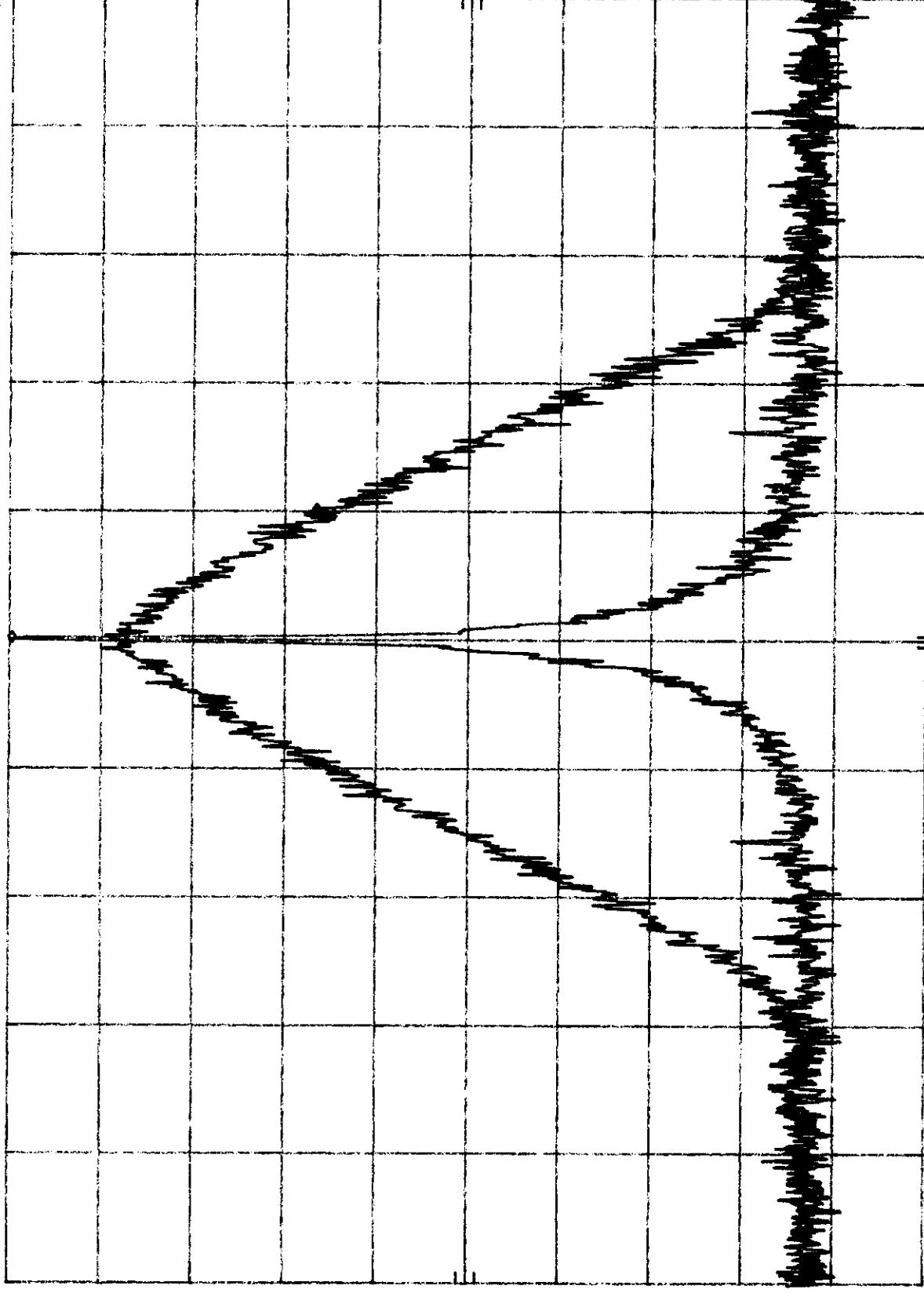
MKR Δ 10.0 KHz
-33.20 dB

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz
SWP 20 sec

PLOT# 4.15

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

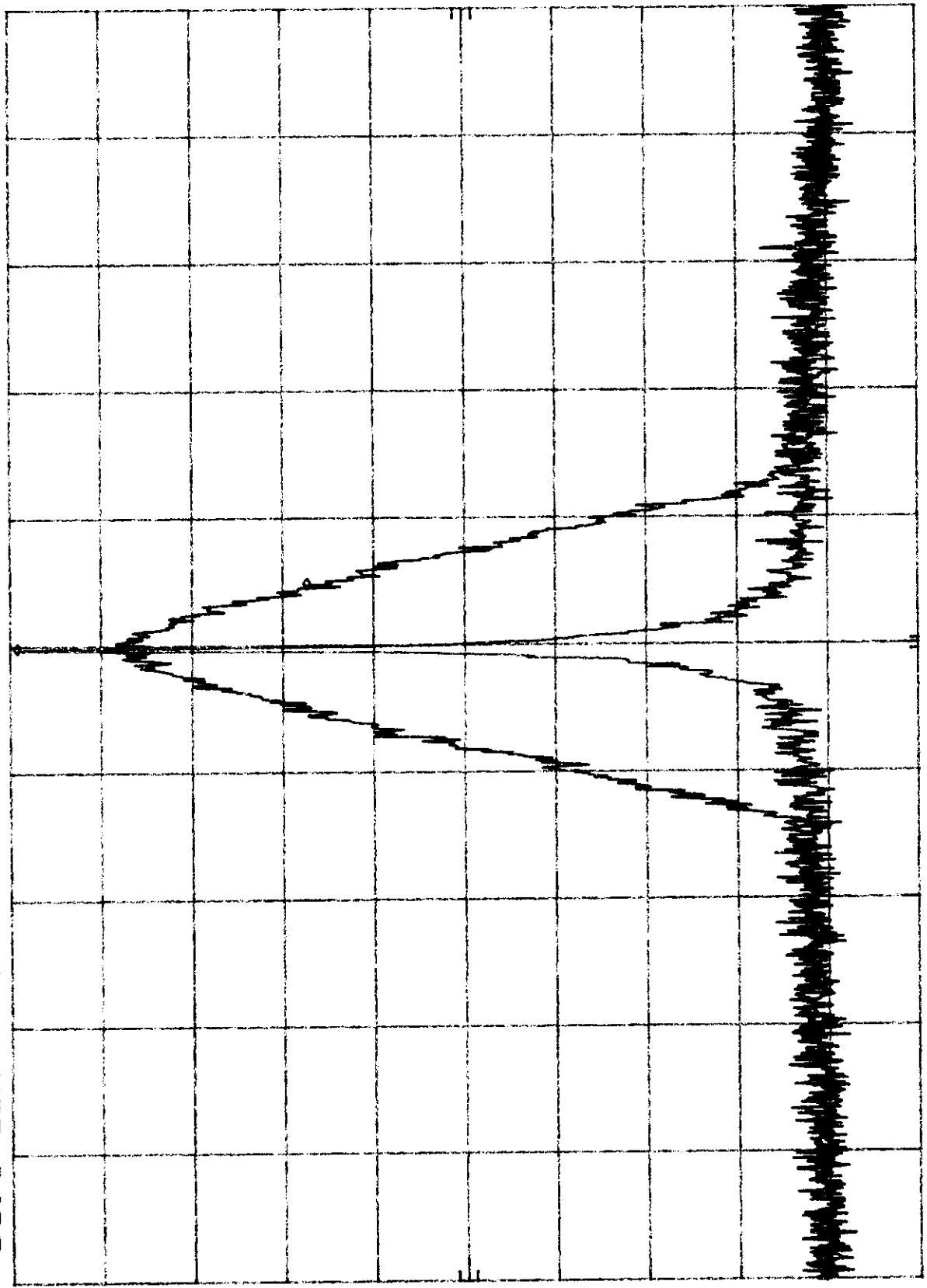
MKR Δ 10.0 kHz

-31.90 dB

hp

10 dB/

OFFSET
19.8
dB



CENTER 403.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 200.0 kHz

SWP 50 sec

PLOT# 4.16

TELEDESIGN SYSTEM - JWFTS4000A

MKR Δ 10.0 KHz
-41.50 dB

REF 33.0 dBm ATTEN 30 dB

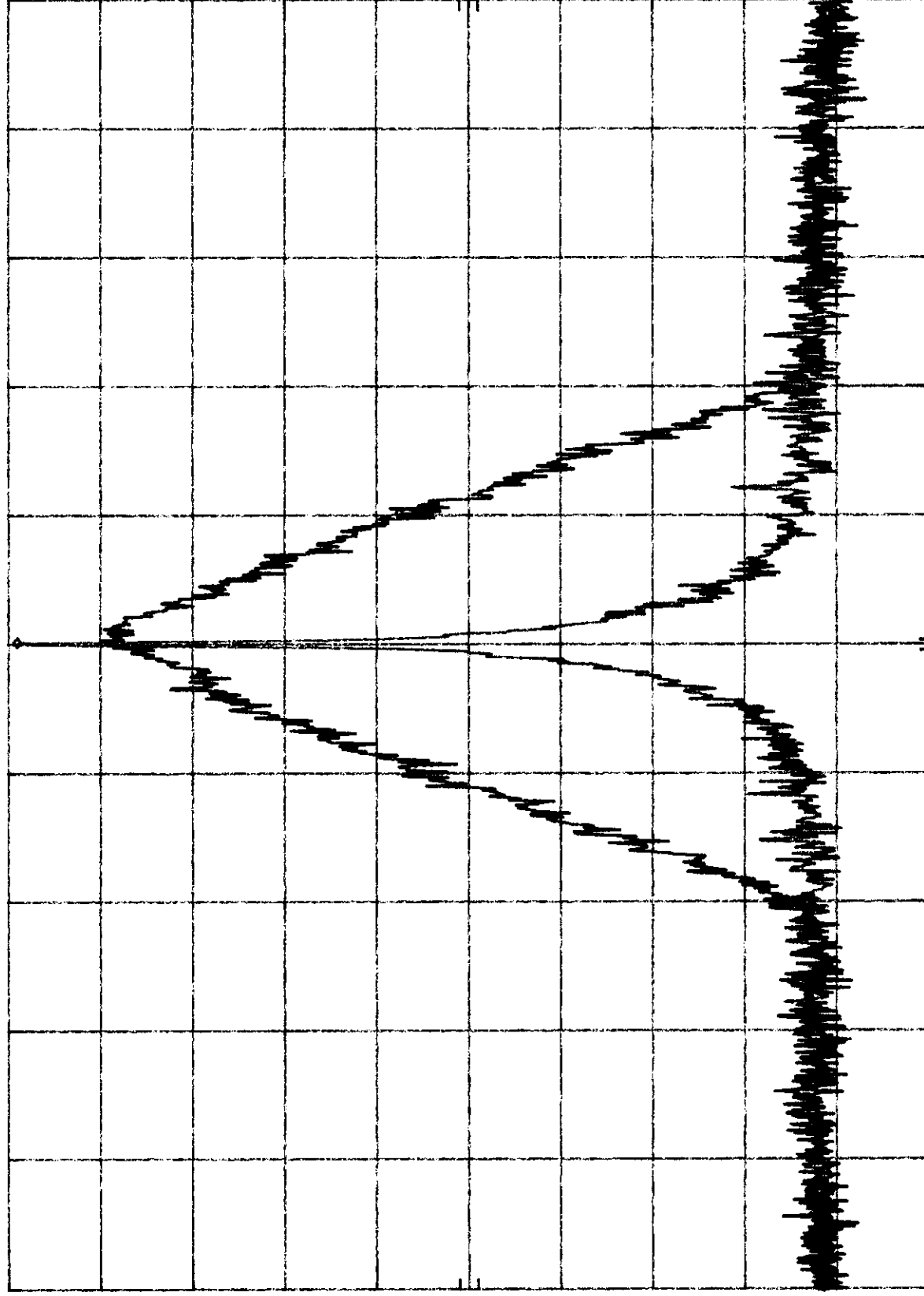
hp

10 dB/

OFFSET

19.8

dB



CENTER 403.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz
SWP 20 sec

PLOT# 4.17

TELEDESIGN SYSTEM - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

MKR Δ 11.6 KHz
-69.30 dB

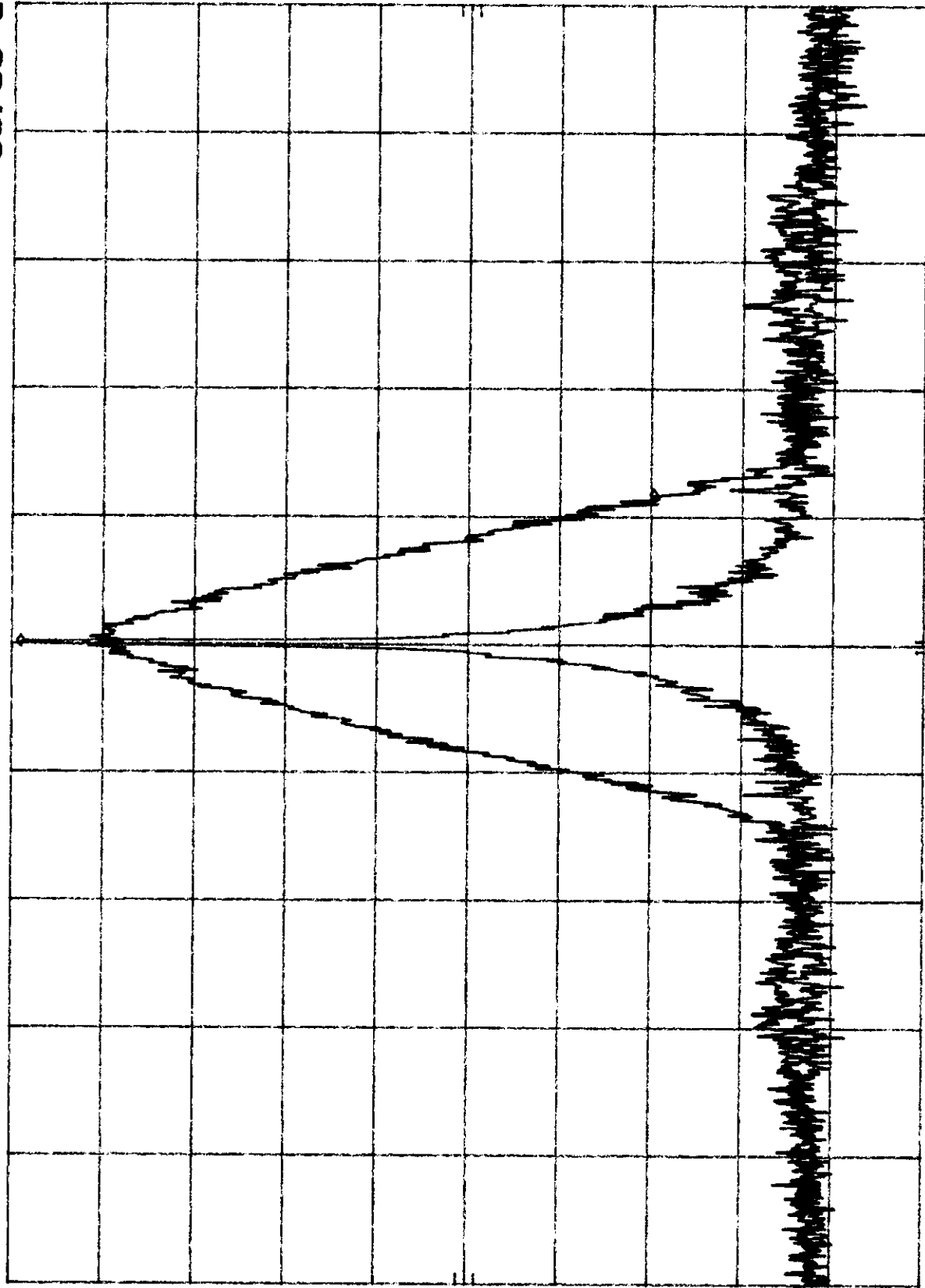
hp

10 dB/

OFFSET

19.8

dB



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz

SWP 20 sec

PLOT# 4.18

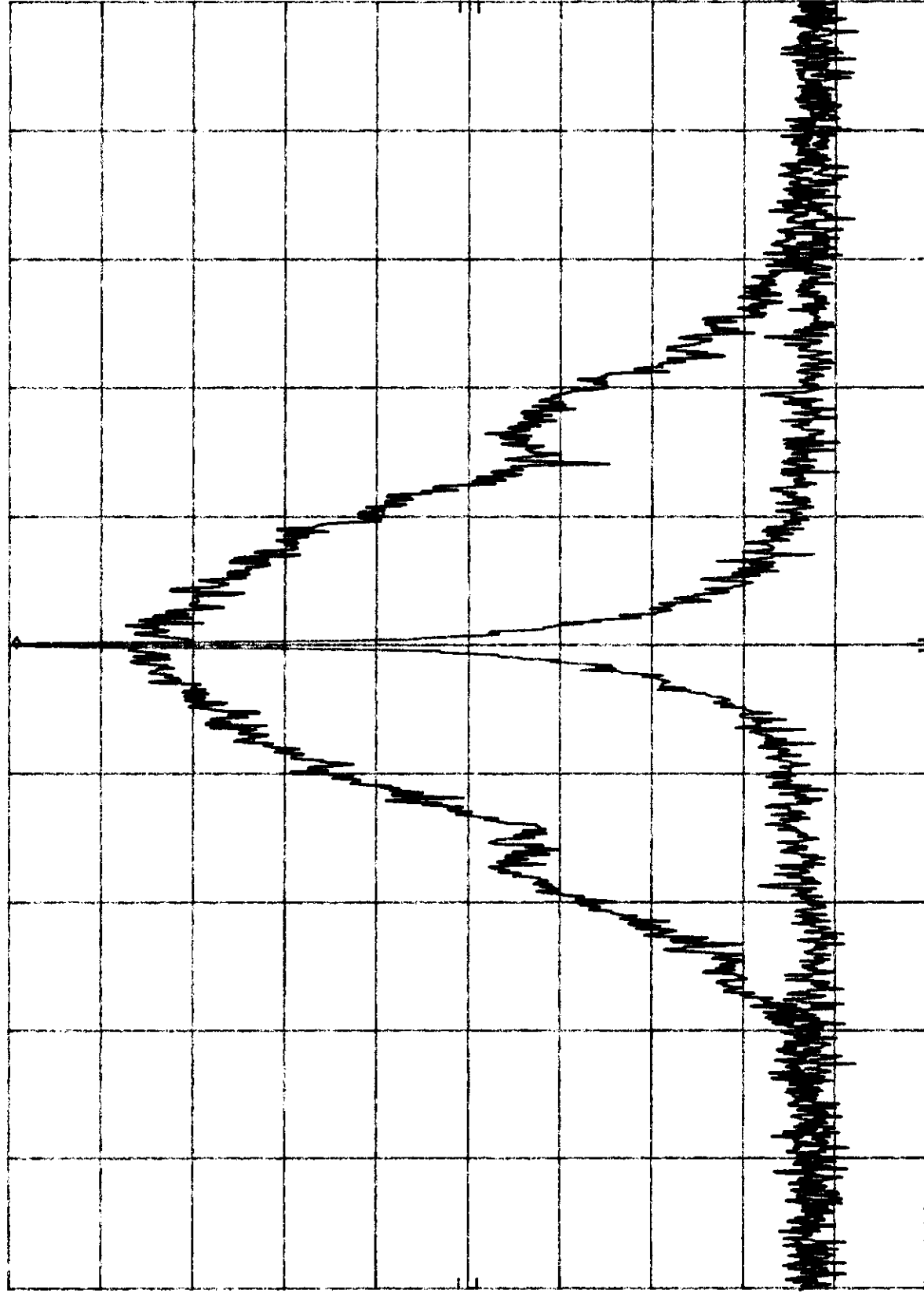
TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTEN 30 dB

MKR Δ 10.0 KHz
-39.60 dB

hp

10 dB/

OFFSET
19.8
dB



CENTER 403.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz
SWP 20 sec

PLOT# 4.19

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

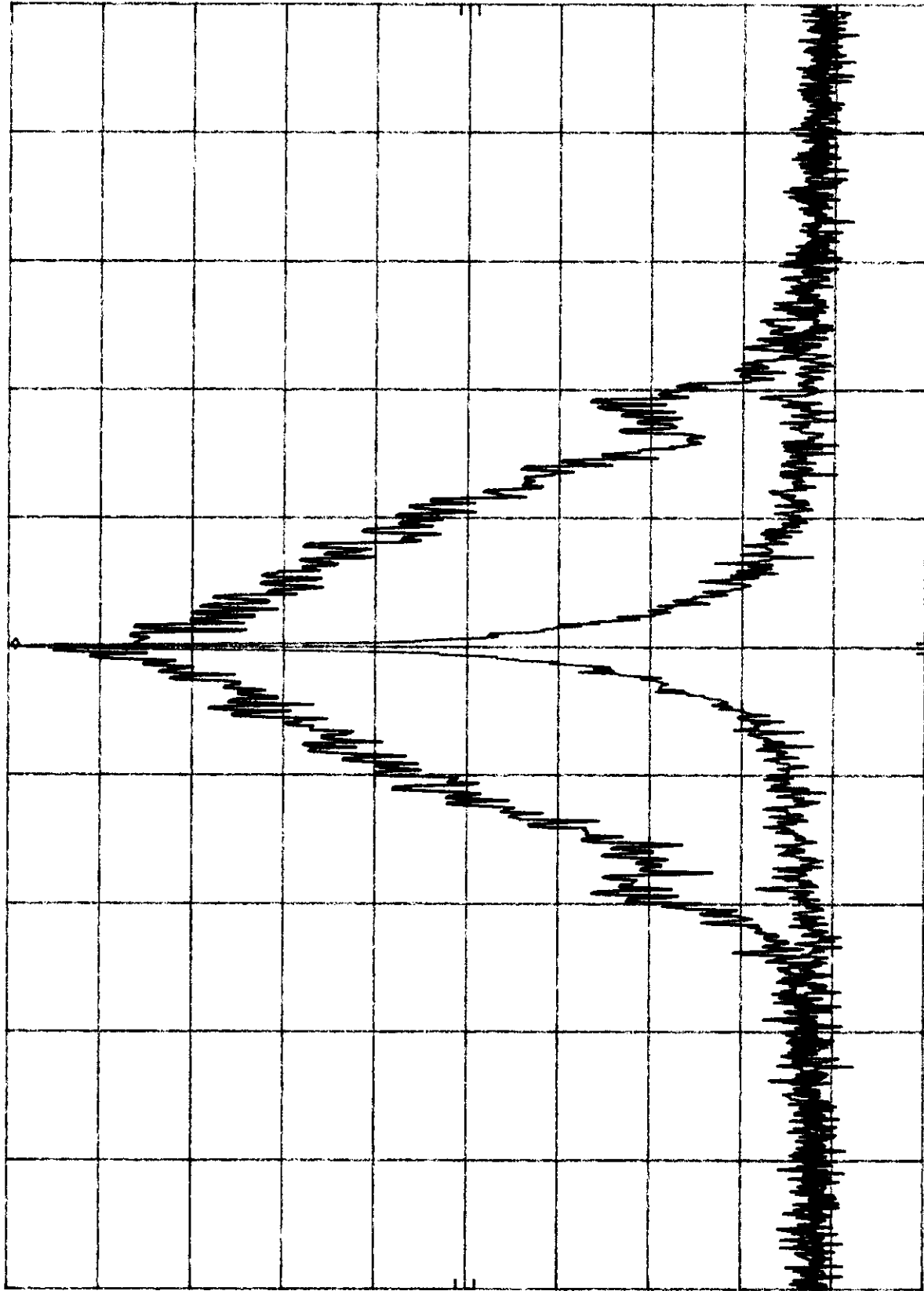
ATTEN 30 dB

MKR Δ 10.0 KHz
-45.60 dB

h₀

10 dB/

OFFSET
19.8
dB



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz
SWP 20 sec

PLOT# 4.20

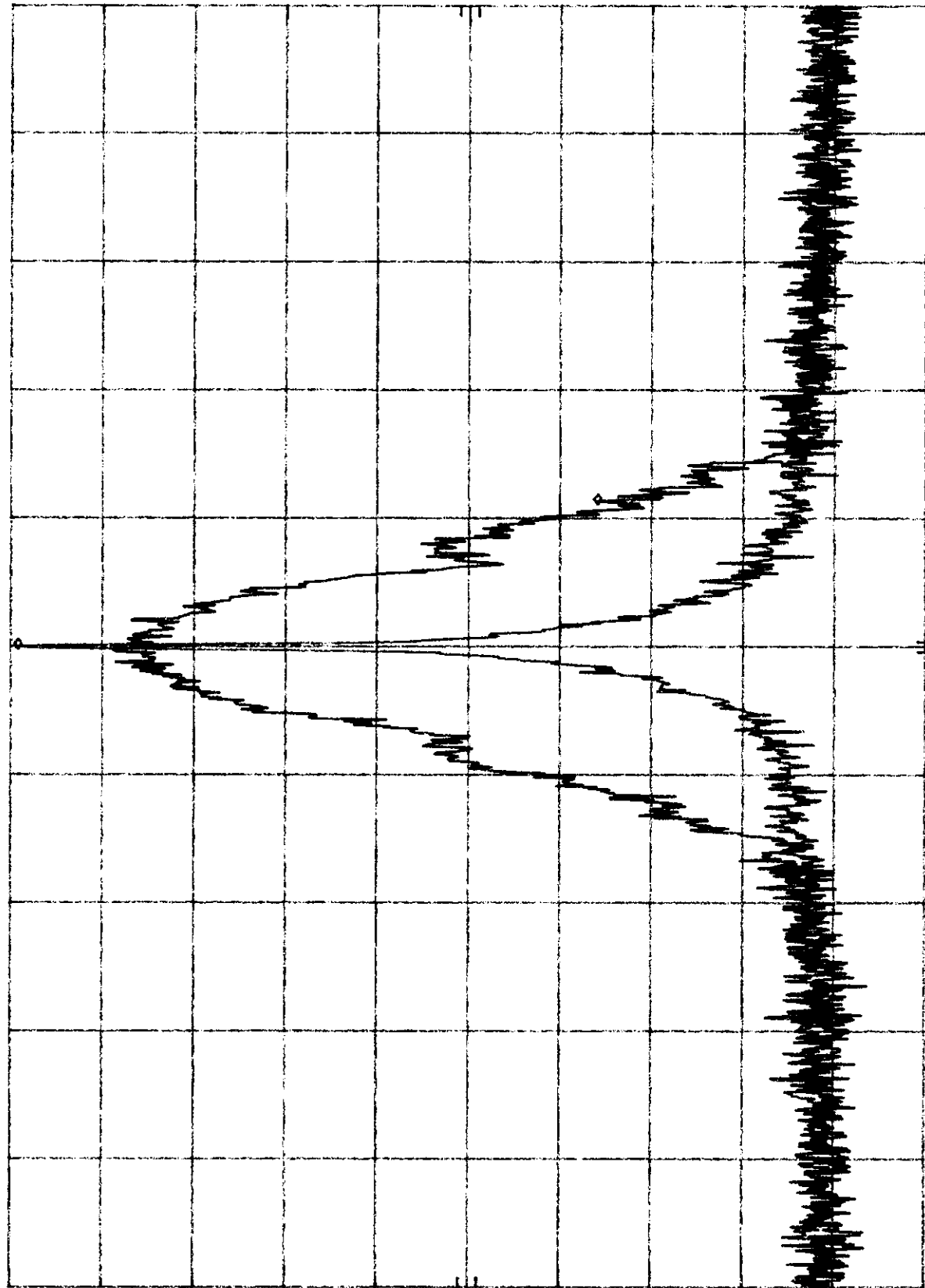
TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR Δ 11.3 KHz
-63.30 dB

h₁₀

10 dB/

OFFSET
19.8
dB



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz

SWP 20 sec

PLOT# 4.21

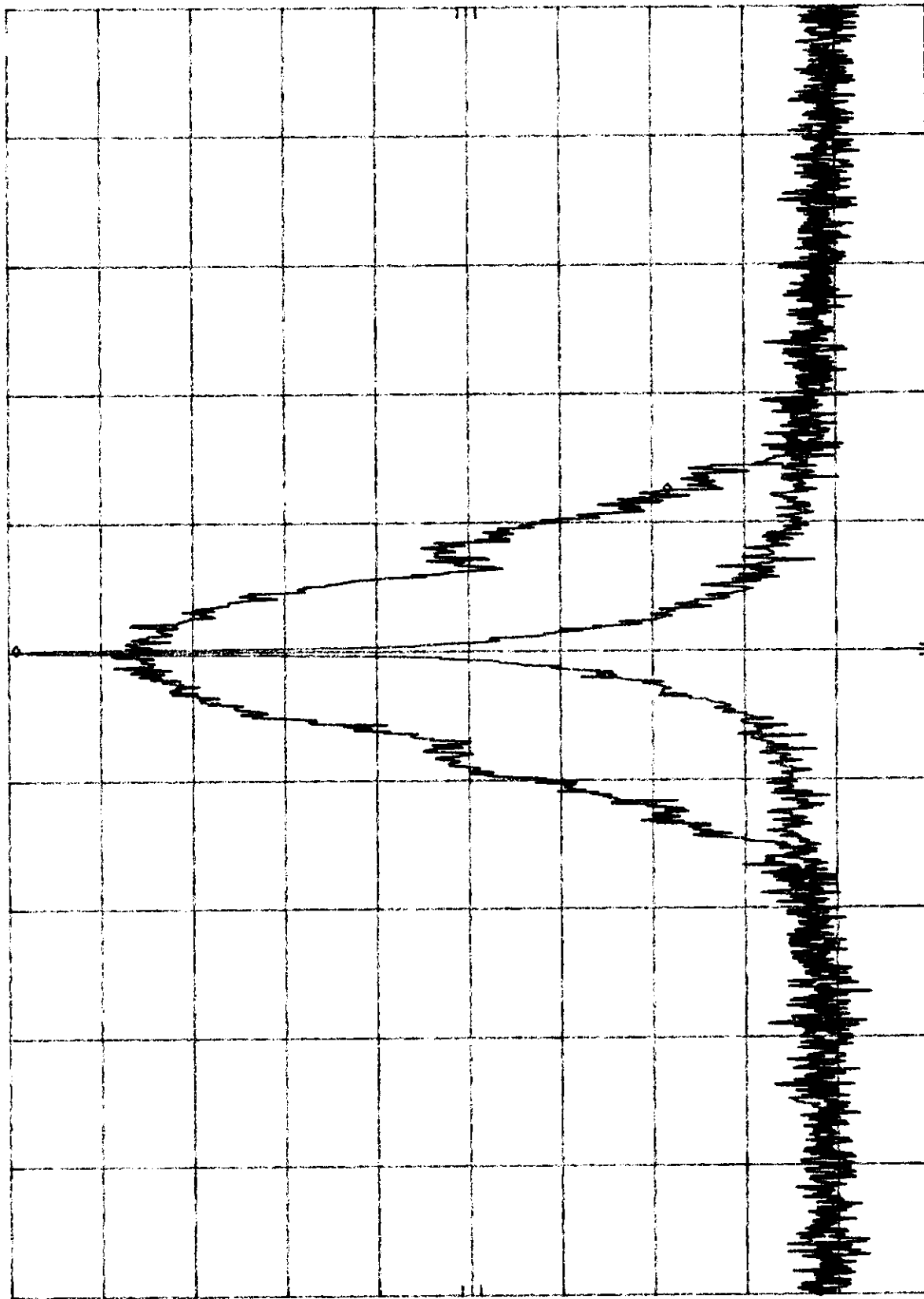
TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR Δ 12.4 KHz
--70.90 dB

hp

10 dB/

OFFSET
19.8
dB



CENTER 403.000 MHz
RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz
SWP 20 sec

PLOT# 4.22

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTN 30 dB

MKR Δ 13.0 KHz

--45.30 dB

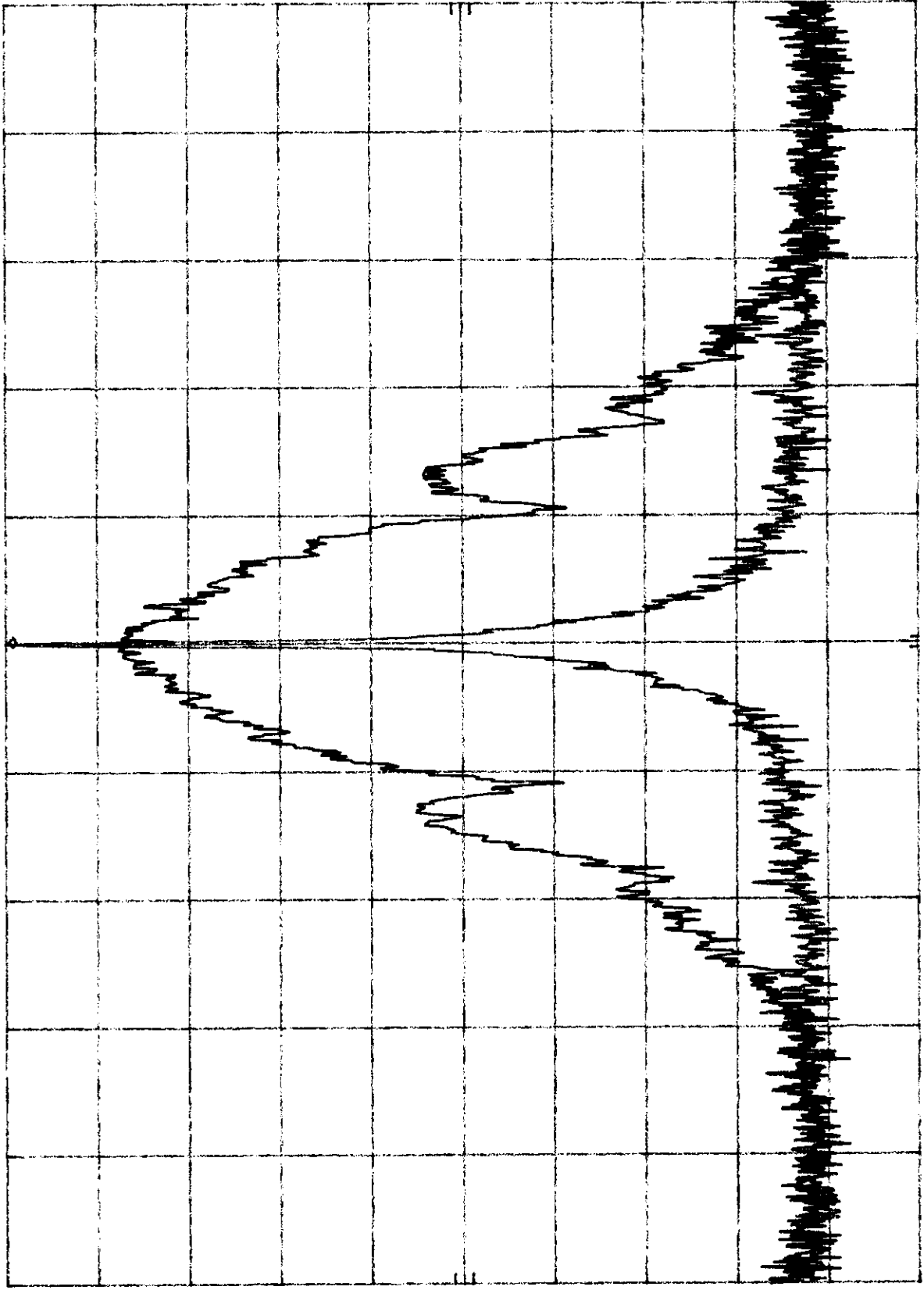
h₀

10 dB/

OFFSET

19.8

dB



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz

SWP 20 sec

PLOT# 4.23

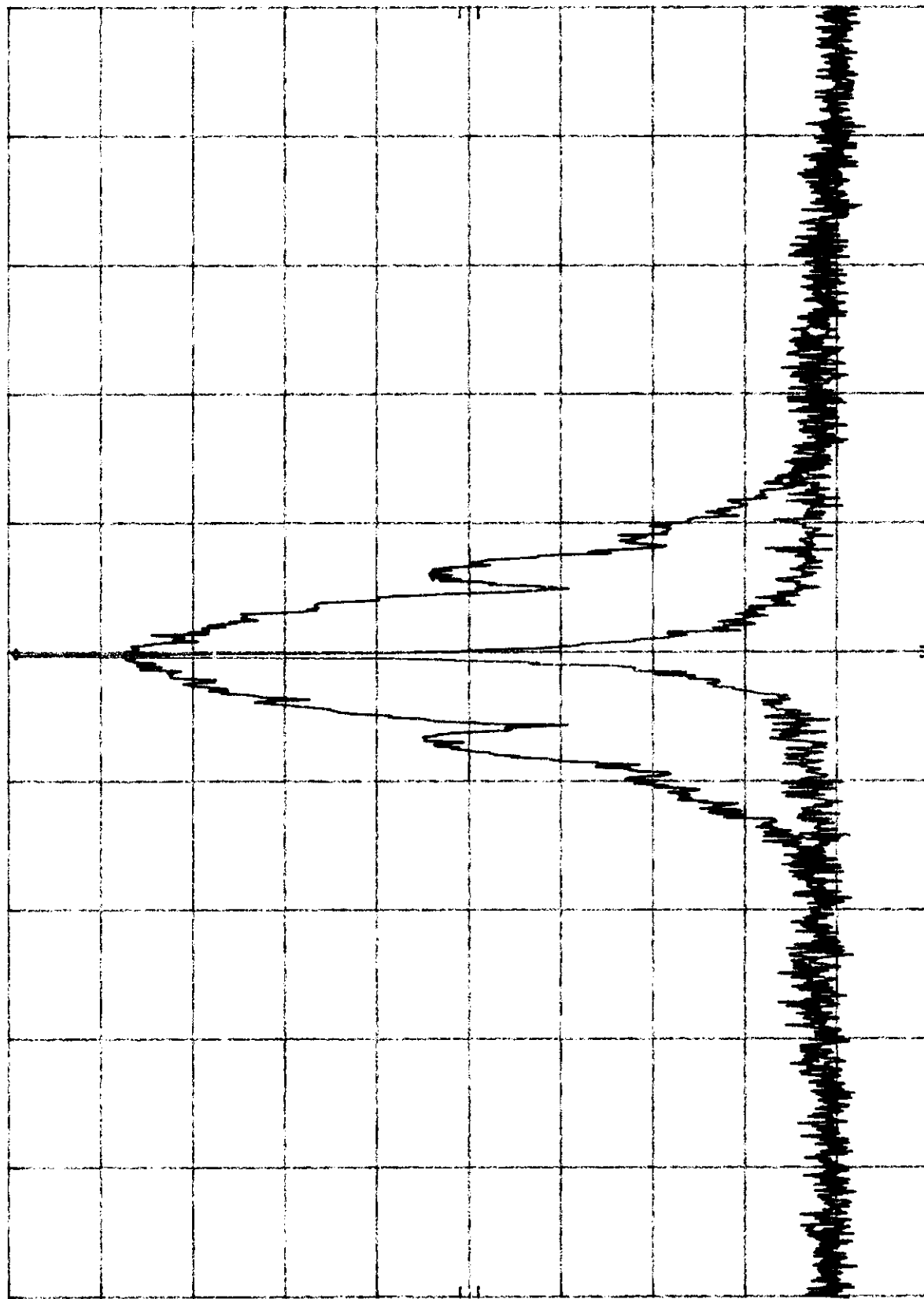
TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR Δ 12.2 kHz
-45.30 dB

hp

10 dB/

OFFSET
19.8
dB



CENTER 403.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 200.0 kHz

SWP 50 sec

PLOT# 4.24

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTEN 30 dB

MKR Δ 10.0 KHz

-41.50 dB

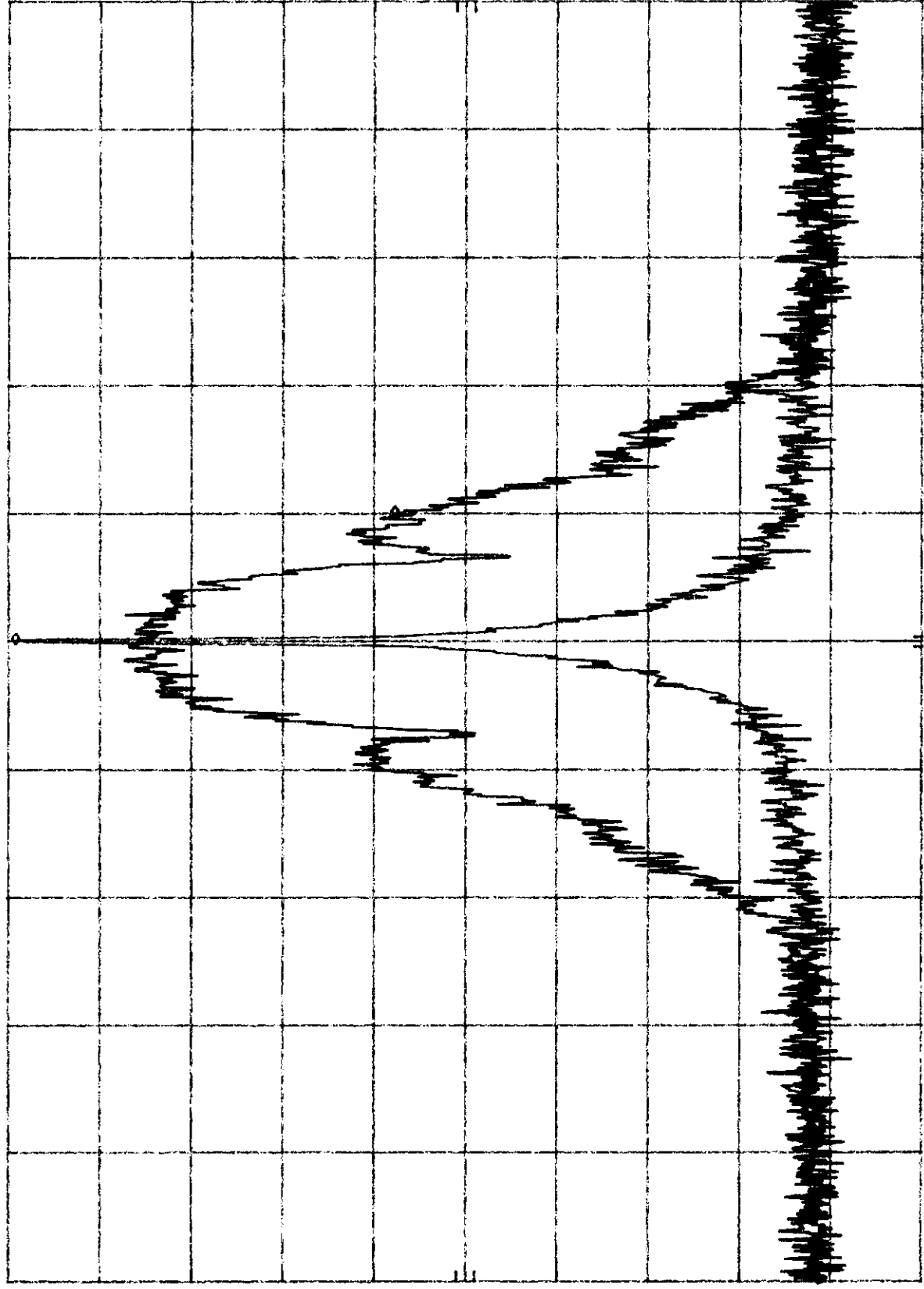
hp

10 dB/

OFFSET

19.8

dB



CENTER 403.0000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz

SWP 20 sec

PLOT# 4.25

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm

ATTEN 30 dB

MKR Δ 12.5 KHz

-71.70 dB

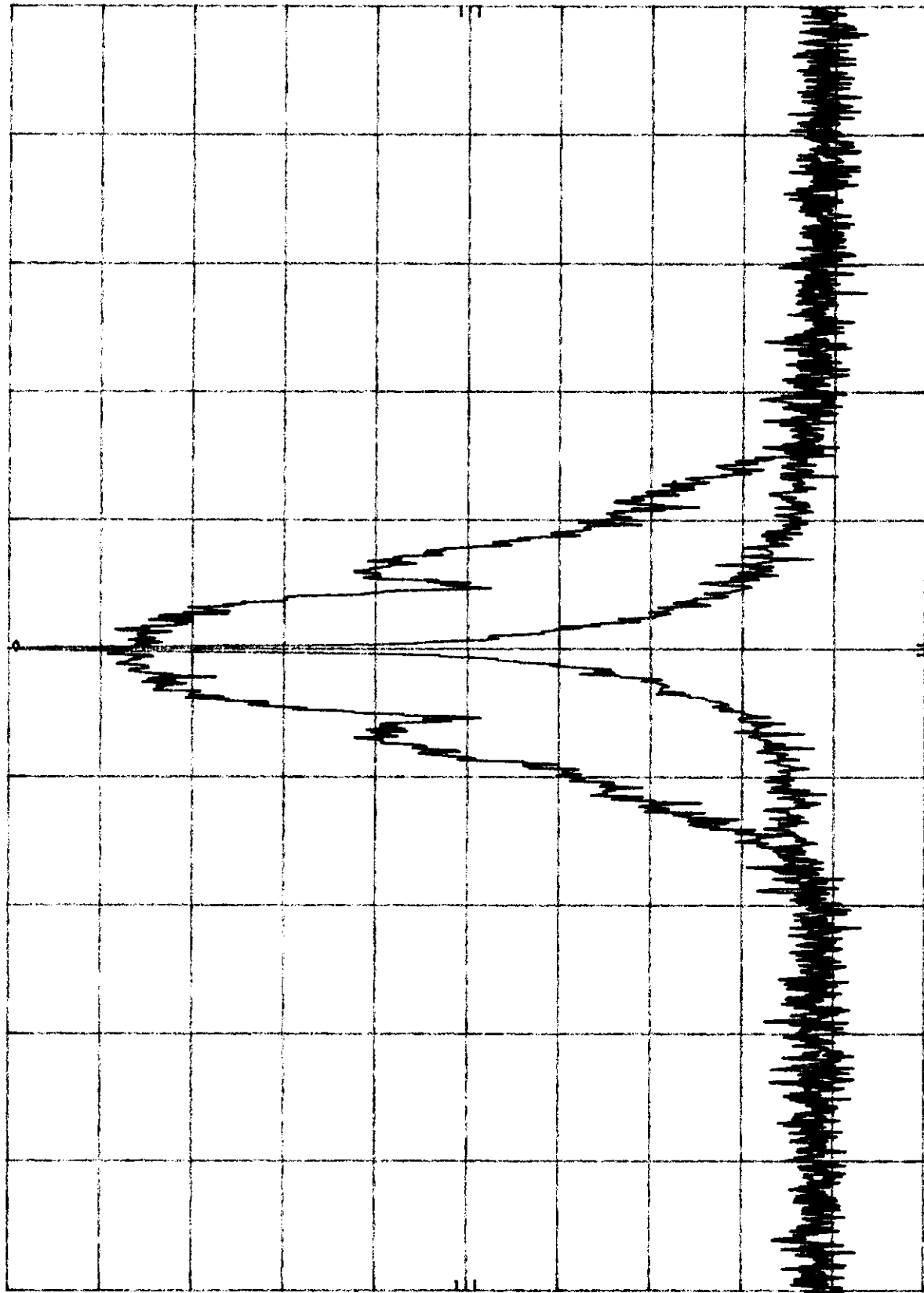
h₁₀

10 dB/

OFFSET

19.8

dB



CENTER 403.000 MHz

RES BW 100 Hz

VBW 100 Hz

SPAN 100.0 KHz

SWP 20 sec

PLOT# 4.26

TELEDESIGN SYSTEMS - JWFTS4000A

MKR Δ 10.0 KHz
-33.80 dB

REF 33.0 dBm ATTN 30 dB

h₁₀

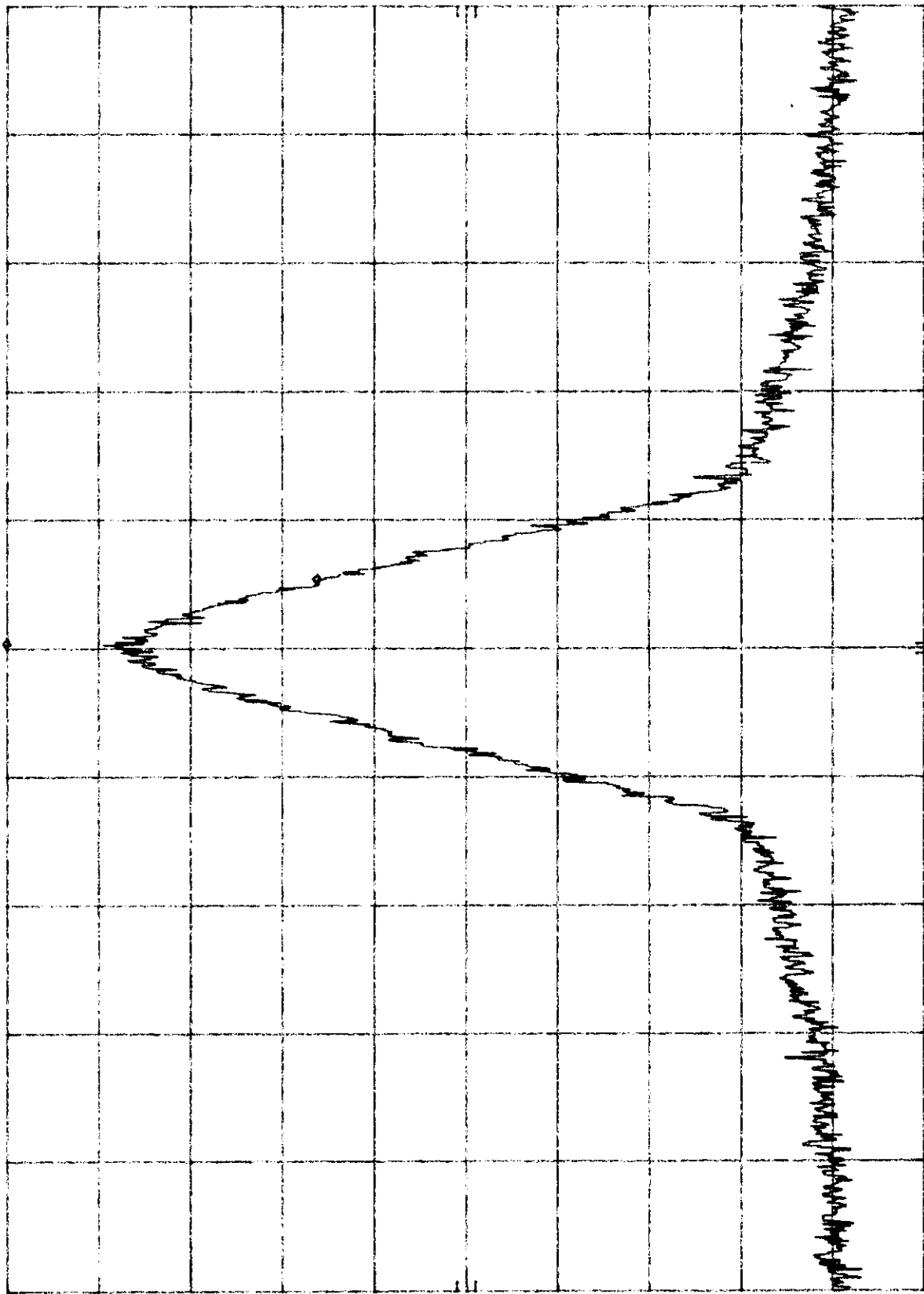
10 dB/

OFFSET

19.8

dB

CORR'D



CENTER 458.000 MHz

RES BW 100 Hz

Hz

VBW 100

Hz

SPAN 200 KHz

SWP 60.0 sec

PLOT# 4.27

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

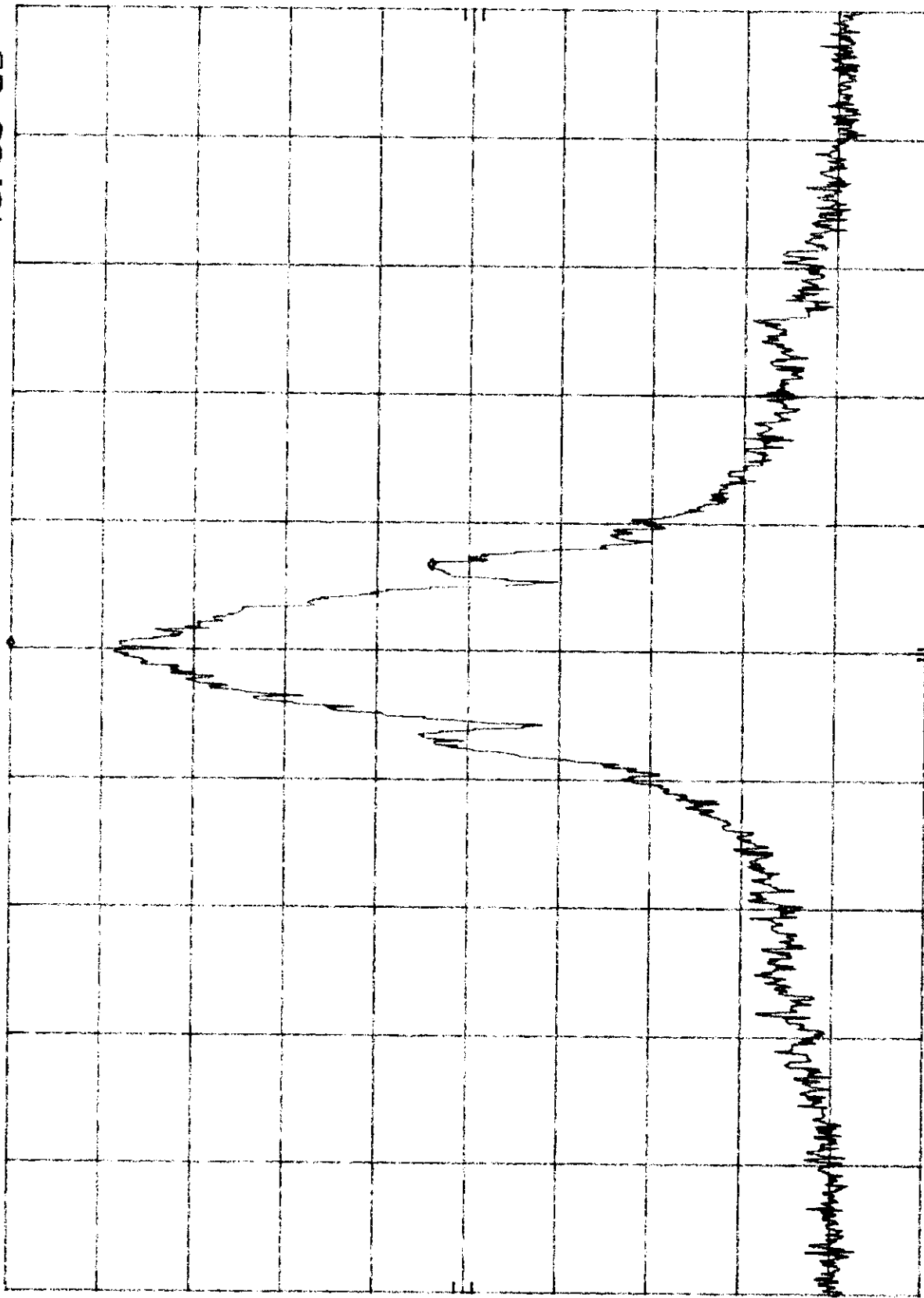
MKR Δ 12.8 KHz
--45.90 dB

hp

10 dB/

OFFSET
19.8
dB

CORR'D



CENTER 458.000 MHz
RES BW 100 Hz

VBW 100 Hz

SPAN 200 KHz
SWP 60.0 sec

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

5.0 Out of Band Emissions at Antenna Terminals , FCC §2.991

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 $43 + 10 \log P$ dB.

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 512 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.1	4 Level FSK	20KOF1D	Scan 1-100 MHz
5.2	4 Level FSK	20KOF1D	Scan 100-1000 MHz
5.3	4 Level FSK	20KOF1D	Scan 1-2.5 GHz
5.4	4 Level FSK	20KOF1D	Scan 2.5-5.5 GHz
5.5	GMSK, BT=0.3	11K2F1D	Scan 1-100 MHz
5.6	GMSK, BT=0.3	11K2F1D	Scan 100-1000 MHz
5.7	GMSK, BT=0.3	11K2F1D	Scan 1-2.5 GHz
5.8	GMSK, BT=0.3	11K2F1D	2.5-5.5 GHz

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Transmitting at 403 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.9	4 Level FSK	20KOF1D	Scan 1-100 MHz
5.10	4 Level FSK	20KOF1D	Scan 100-1000 MHz
5.11	4 Level FSK	20KOF1D	Scan 1-2.5 GHz
5.12	4 Level FSK	20KOF1D	Scan 2.5-5.5 GHz
5.13	GMSK, BT=0.3	11K2F1D	Scan 1-100 MHz
5.14	GMSK, BT=0.3	11K2F1D	Scan 100-1000 MHz
5.15	GMSK, BT=0.3	11K2F1D	Scan 1-2.5 GHz
5.16	GMSK, BT=0.3	11K2F1D	2.5-5.5 GHz

Transmitting at 458 MHz			
Plot Number	Type of Modulation	Emission Designator	Description
5.17	4 Level FSK	20KOF1D	Scan 1-100 MHz
5.18	4 Level FSK	20KOF1D	Scan 100-1000 MHz
5.19	4 Level FSK	20KOF1D	Scan 1-2.5 GHz
5.20	4 Level FSK	20KOF1D	Scan 2.5-5.5 GHz

PLOT# 5.1

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTEN 30 dB

MKR 67.33 MHz
-47.10 dBm

hp

10 dB/

OFFSET

19.8

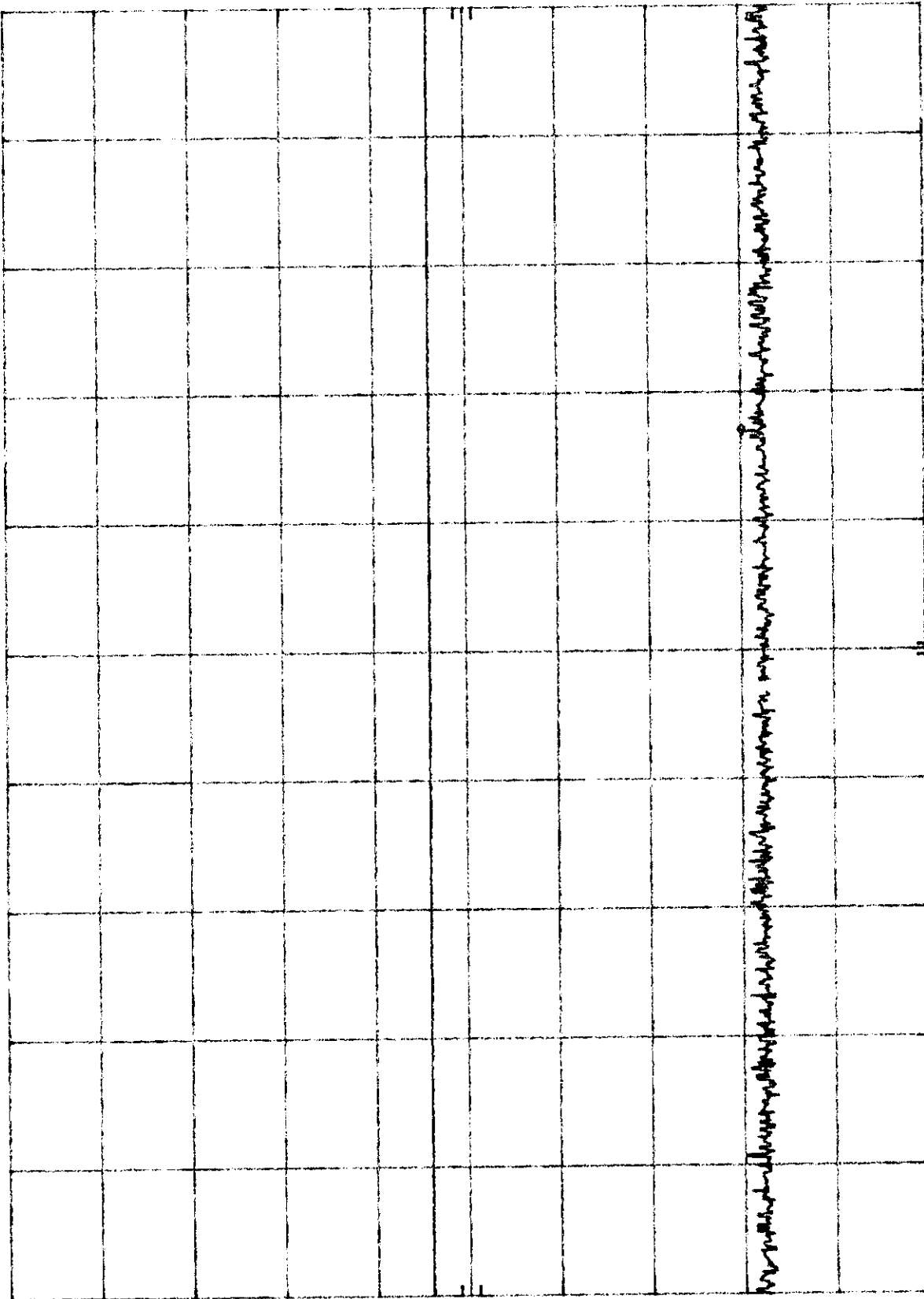
dB

DL

-13.0

dBm

CORR'D



START 1.0 MHz

RES BW 10 kHz

VBW 10 kHz

STOP 100.0 MHz

SWP 2.97 sec

PLOT# 5.2

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTEN 30 dB

MKR 667.0 MHz
-42.50 dBm

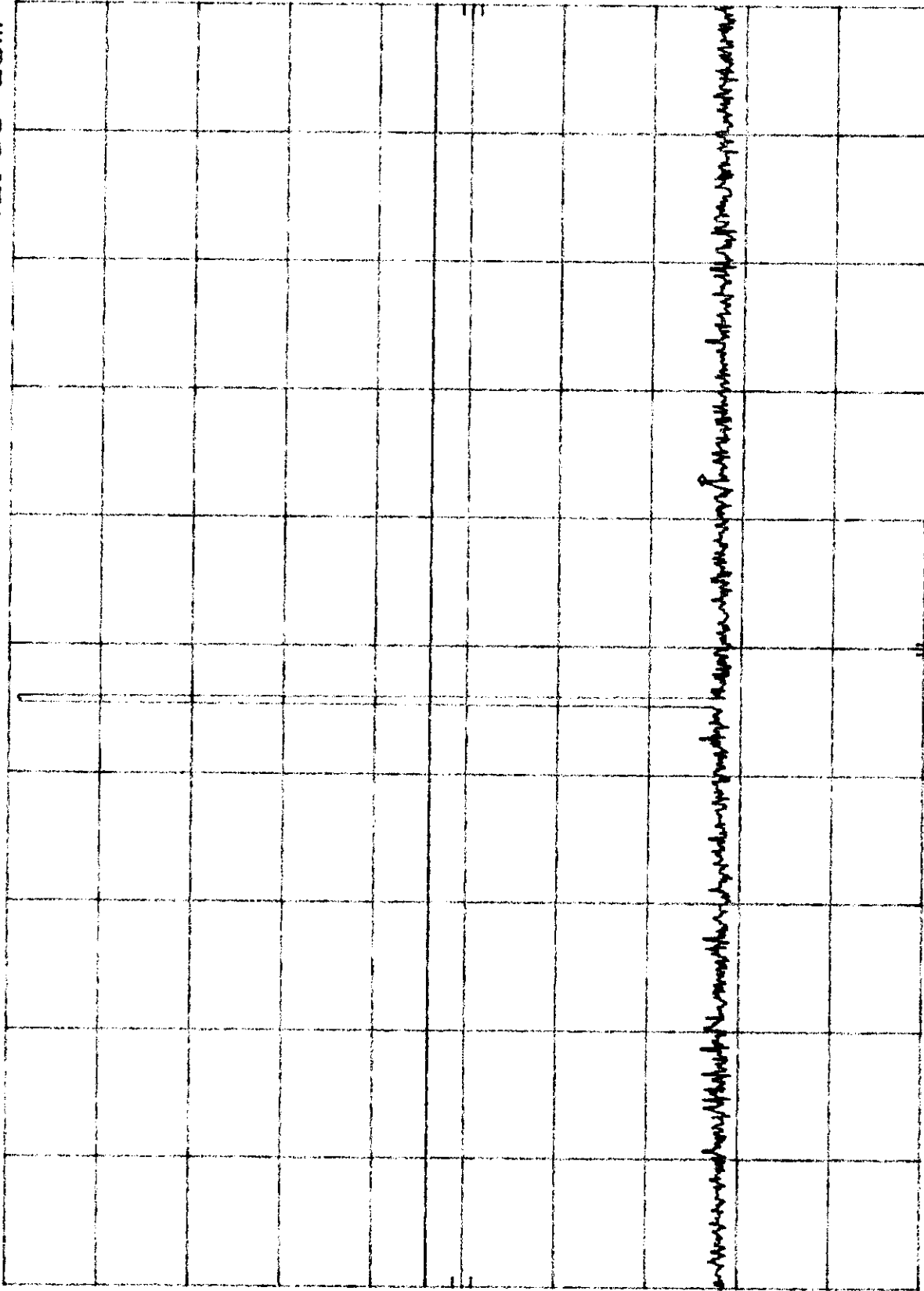
hp

10 dB/

OFFSET
19.8
dB

DL
-13.0
dBm

CORR'D



START 100 MHz

RES BW 30 KHz

VBW 30 KHz

STOP 1.000 GHz
SWP 2.70 sec

PLOT# 5.3

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR 1.023 GHz
-35.20 dBm

h₀

10 dB/

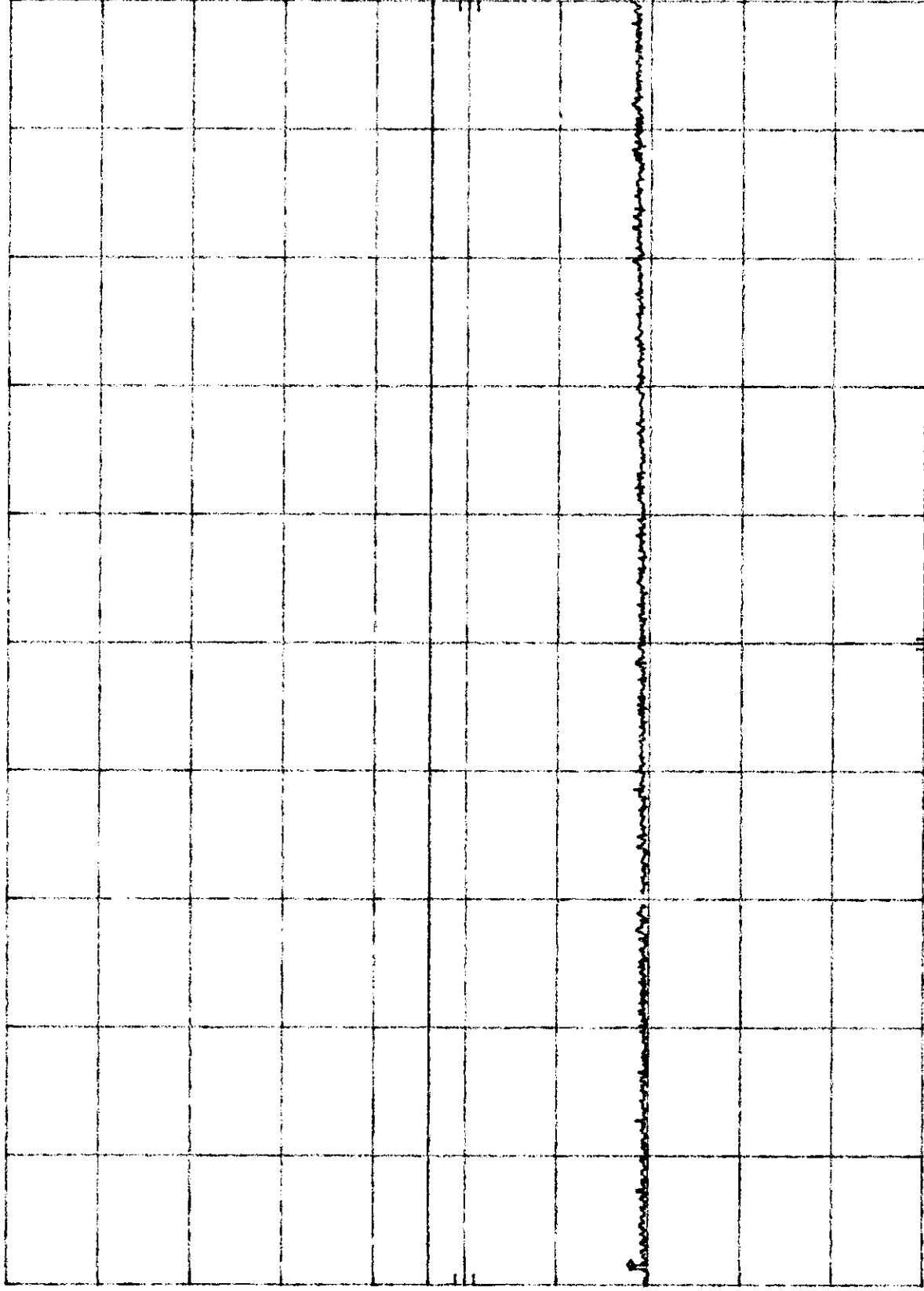
OFFSET

19.8
dB

DL

-13.0
dBm

CORR'D



START 1.00 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 2.50 GHz
SWP 150 msec

PLOT# 5.4

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR 2.845 GHz
-35.30 dBm

hp

10 dB/

OFFSET

19.8

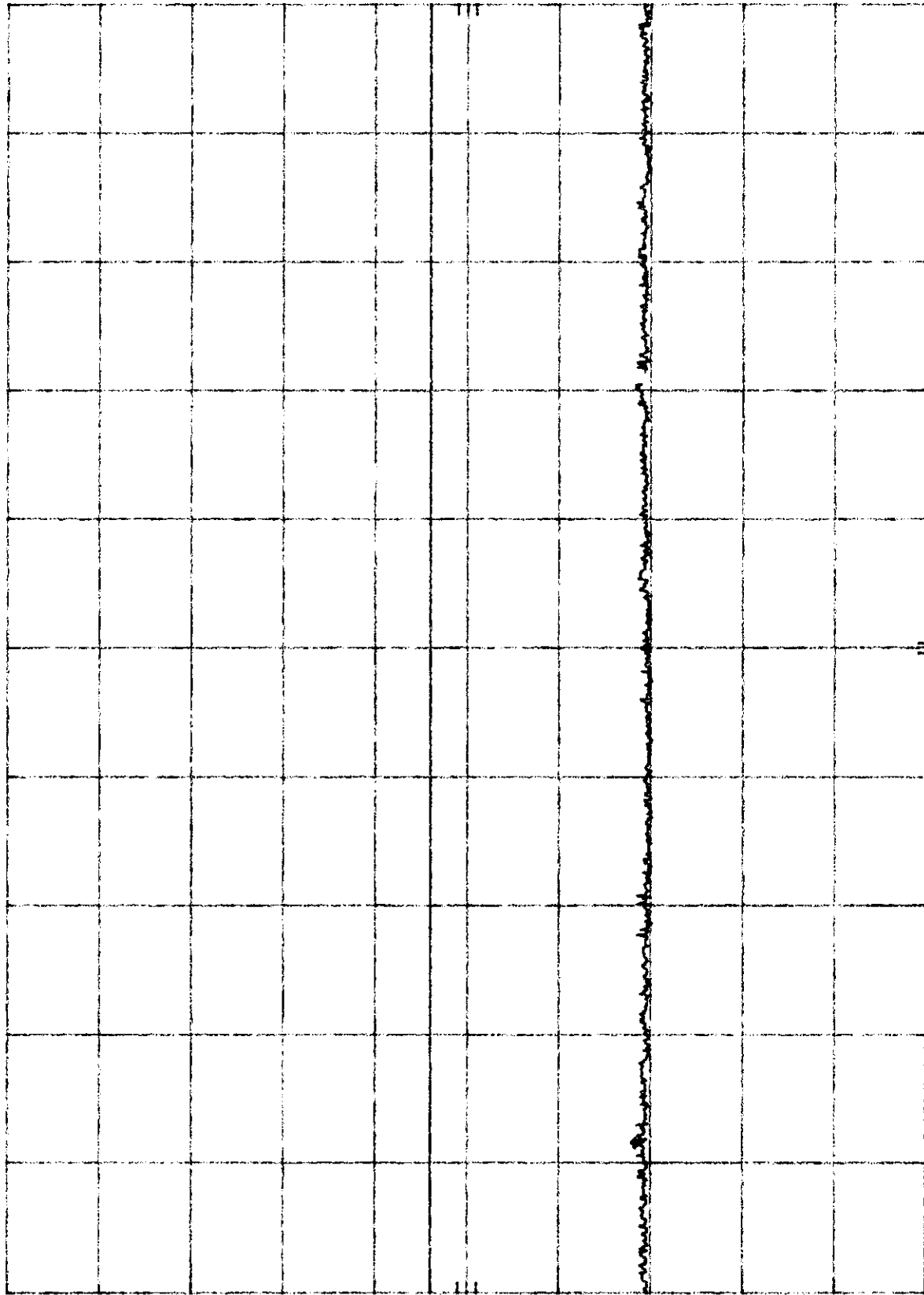
dB

DL

-13.0

dBm

CORR'D



START 2.50 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 5.50 GHz

SWP 300 msec

PLOT# 5.5

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 65.85 MHz
-46.80 dBm

REF 33.0 dBm ATTN 30 dB

hp

10 dB/

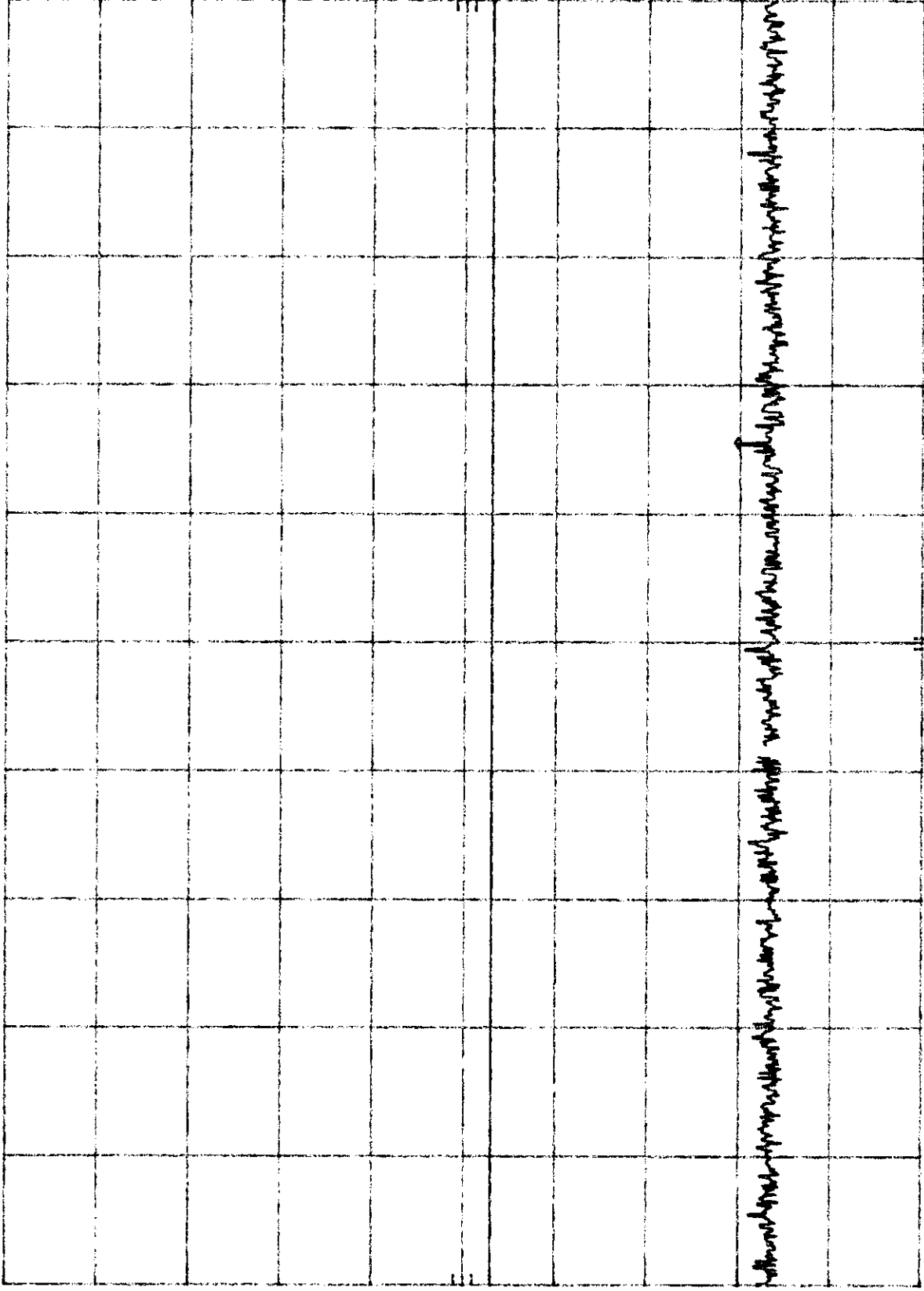
OFFSET

19.8
dB

DL

-20.0
dBm

CORR'D



START 1.0 MHz

RES BW 10 kHz

VBW 10 kHz

STOP 100.0 MHz
SWP 2.97 sec

PLOT# 5.6

TELEDESIGN SYSTEMS -- JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR 947.8 MHz
--42.40 dBm

10 dB

10 dB/

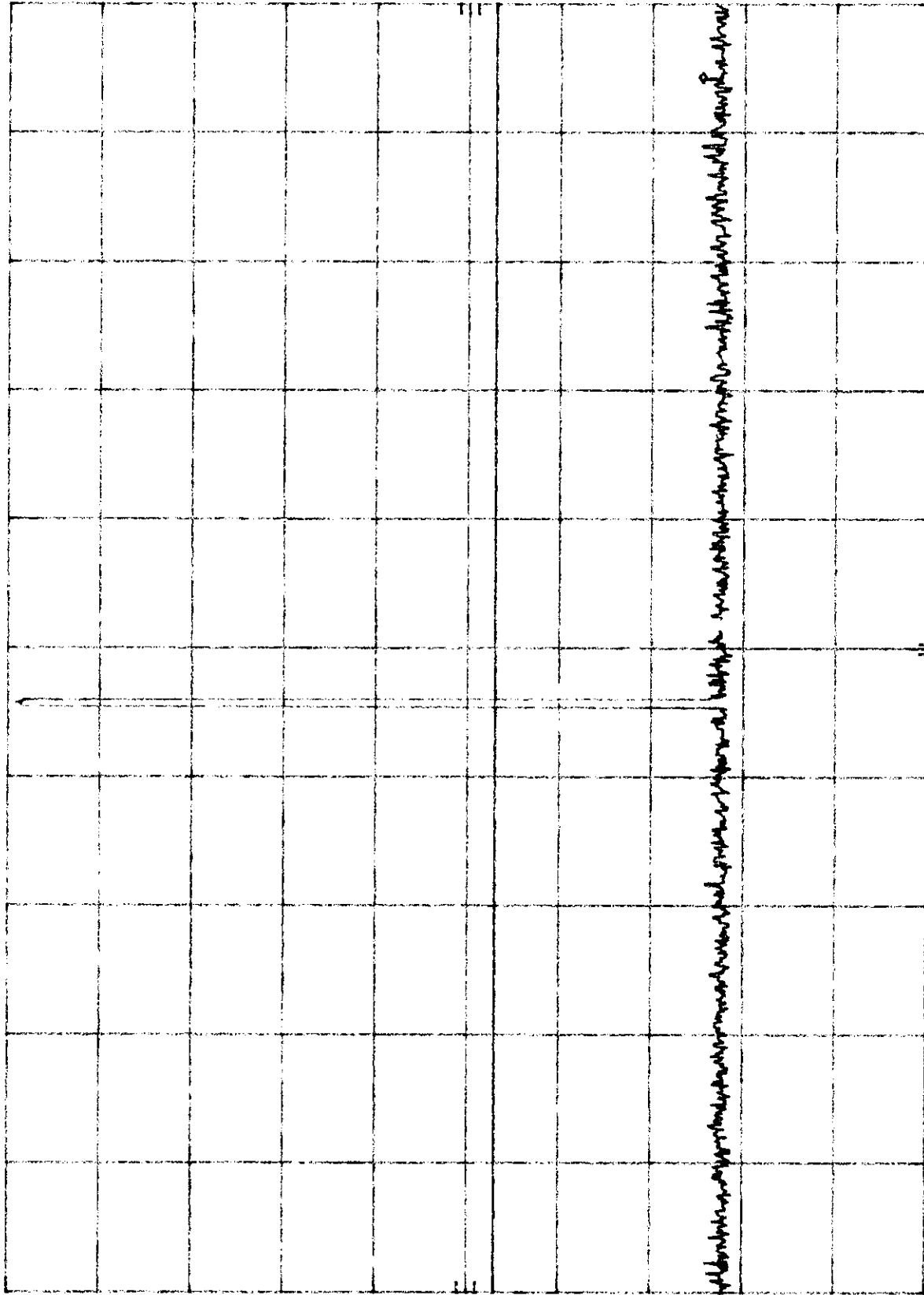
OFFSET

19.8
dB

DL

-20.0
dBm

CORR'D



START 100 MHz

RES BW 30 kHz

VBW 30 kHz

STOP 1.000 GHz
SWP 2.70 sec

PLOT# 5.7

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 2.371 GHz
-34.30 dBm

REF 33.0 dBm ATTN 30 dB

hp

10 dB/

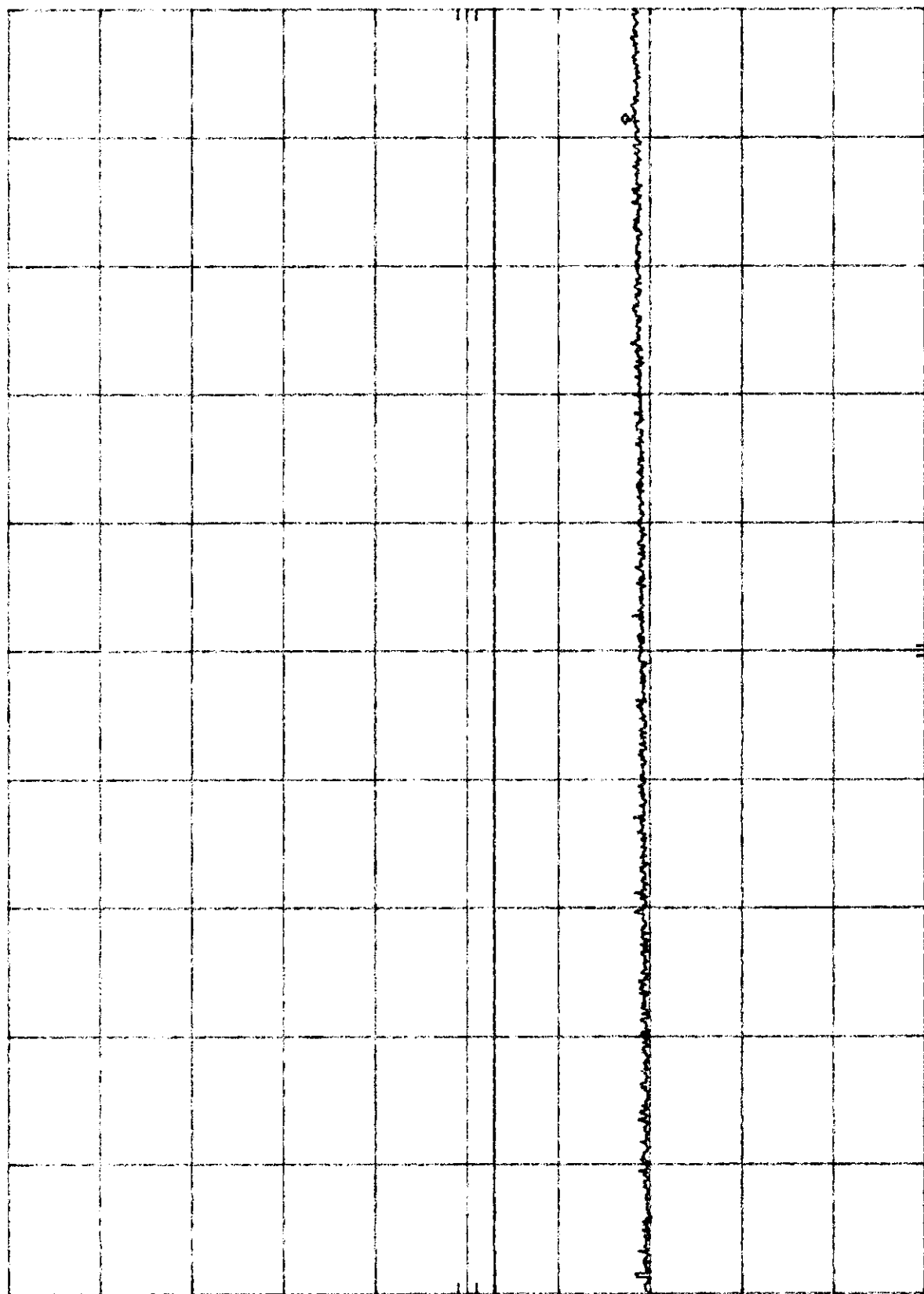
OFFSET

19.8
dB

DL

-20.0
dBm

CORR'D



STOP 2.50 GHz
SWP 150 msec

VBW 30 KHz

START 1.00 GHz
RES BW 1 MHz

PLOT# 5.8

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 2.743 GHz
-35.30 dBm

REF 33.0 dBm ATTN 30 dB

h₁₀

10 dB/

OFFSET

19.8

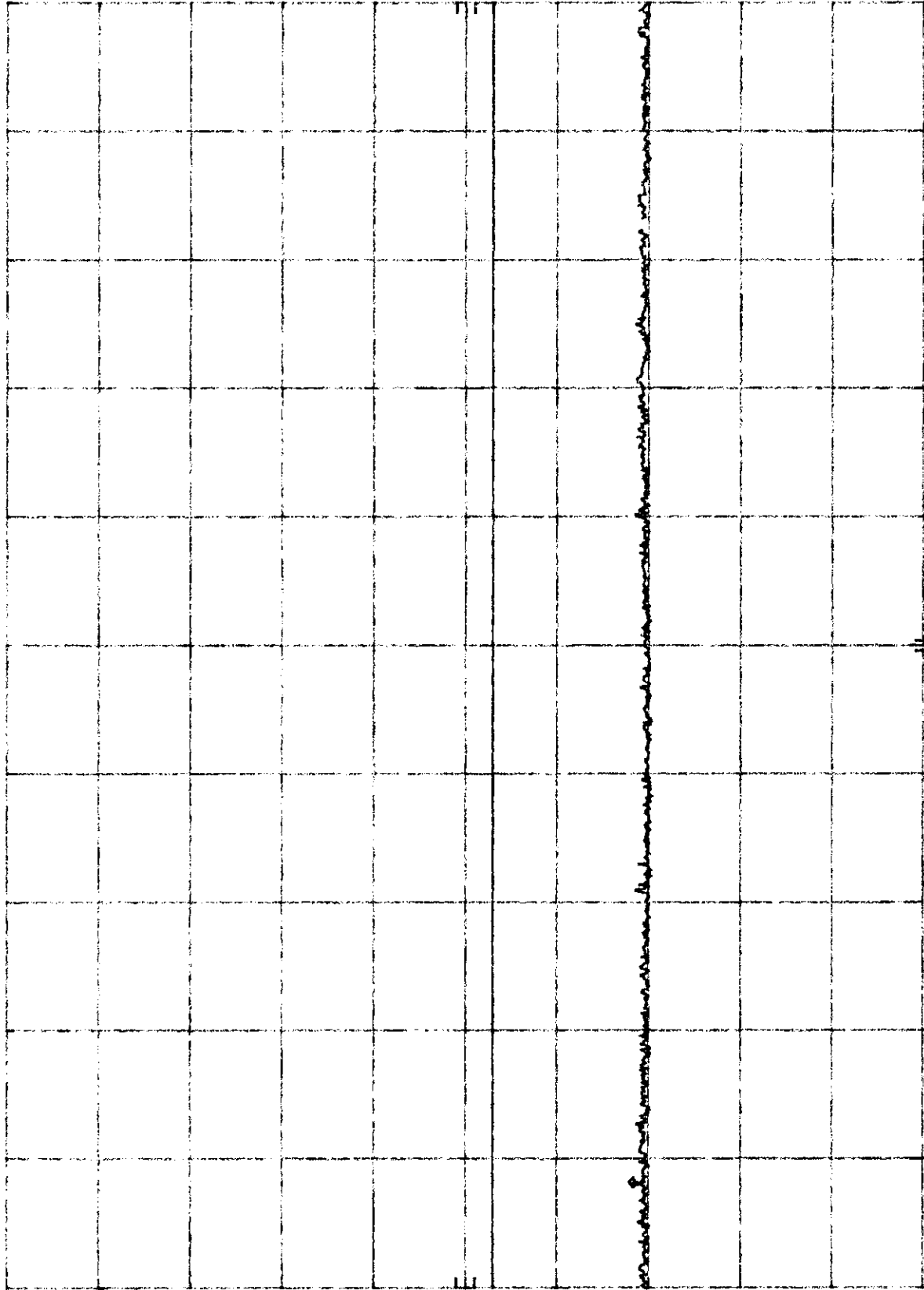
dB

DL

-20.0

dBm

CORR'D



START 2.50 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 5.50 GHz

SWP 300 msec

PLOT# 5.9

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 61.69 MHz
-47.60 dBm

REF 33.0 dBm ATTN 30 dB

hp

10 dB/

OFFSET

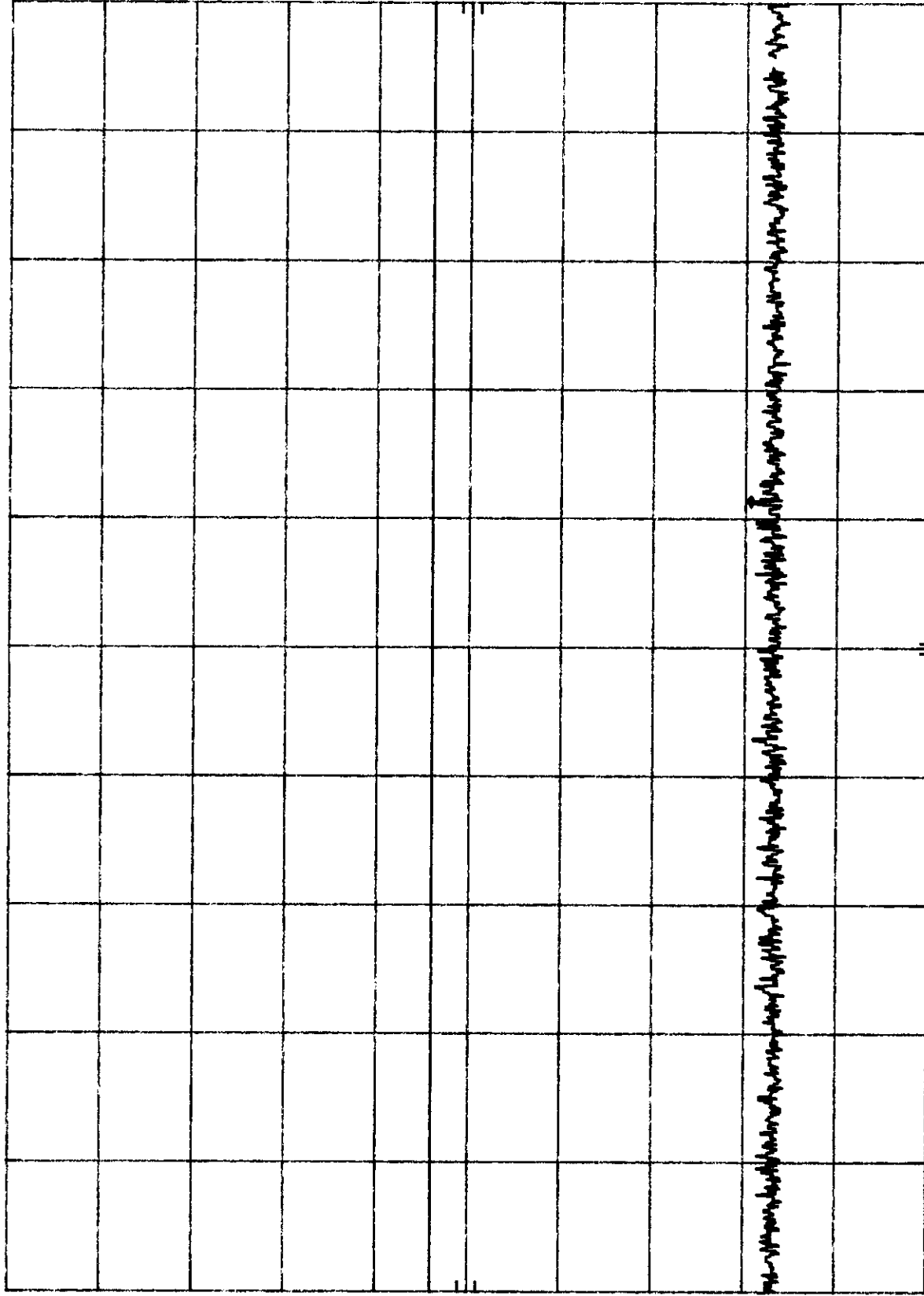
19.8

dB

DL

-13.0

dBm



START 1.0 MHz

RES BW 10 kHz

VBW 10 kHz

STOP 100.0 MHz

SWP 2.97 sec

PLOT# 5.10

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 807.4 MHz
-39.00 dBm

REF 33.0 dBm ATTEN 30 dB

HP

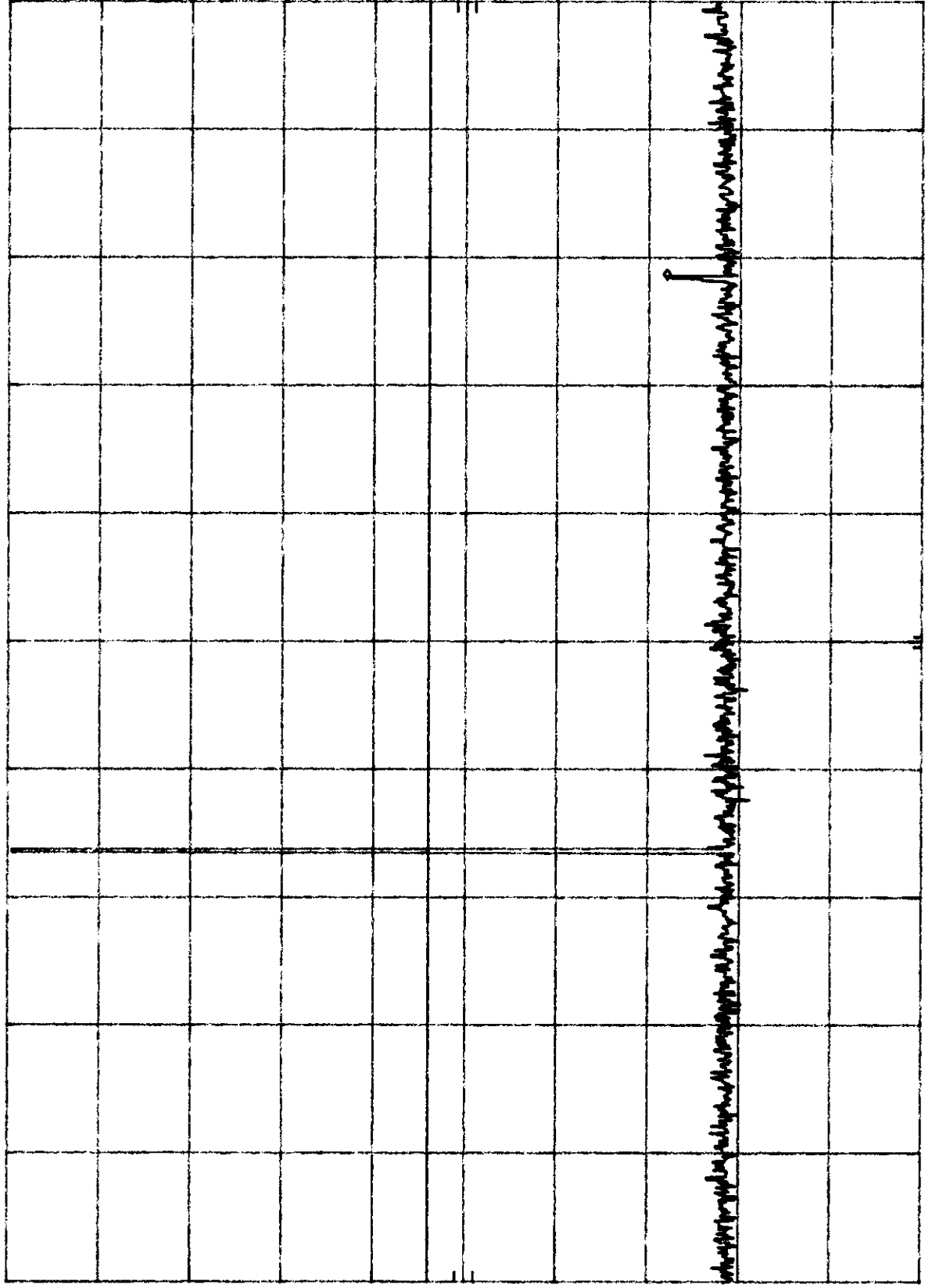
10 dB/

OFFSET

19.8
dB

DL

-13.0
dBm



START 100 MHz

RES BW 30 KHz

VBW 30 KHz

STOP 1.000 GHz

SWP 2.70 sec

PLOT# 5.11

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 1.207 GHz
-31.80 dBm

REF 33.0 dBm ATTN 30 dB

hp

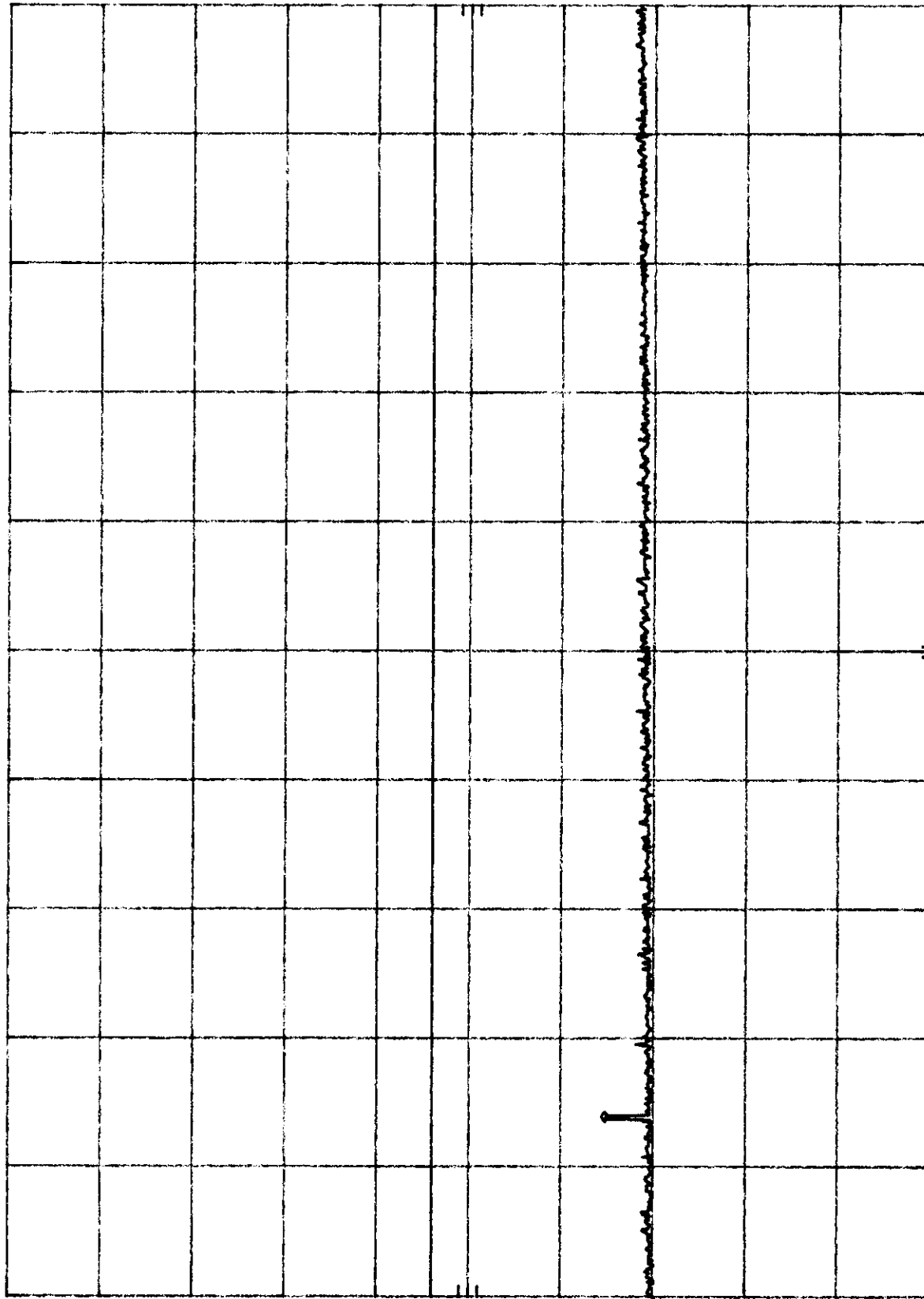
10 dB/

OFFSET

19.8
dB

DL

-13.0
dBm



START 1.00 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 2.50 GHz

SWP 150 msec

PLOT# 5.12

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 2.872 GHz
-35.60 dBm

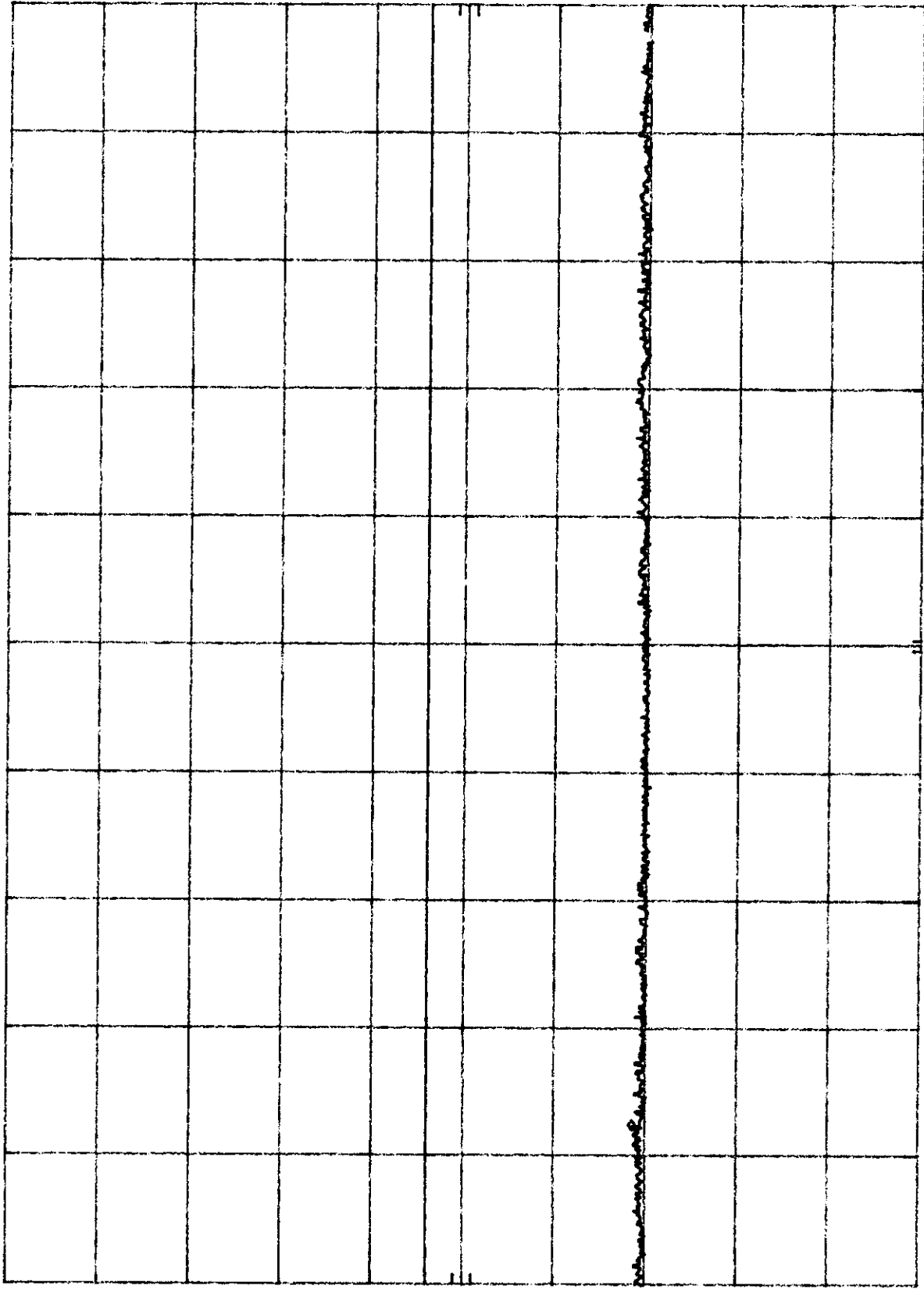
REF 33.0 dBm ATTN 30 dB

hp

10 dB/

OFFSET
19.8
dB

DL
-13.0
dBm



START 2.50 GHz RES BW 1 MHz STOP 5.50 GHz
VBW 30 kHz SWP 300 msec

PLOT# 5.13

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 51.49 MHz
-48.10 dBm

REF 33.0 dBm ATTEN 30 dB

hp

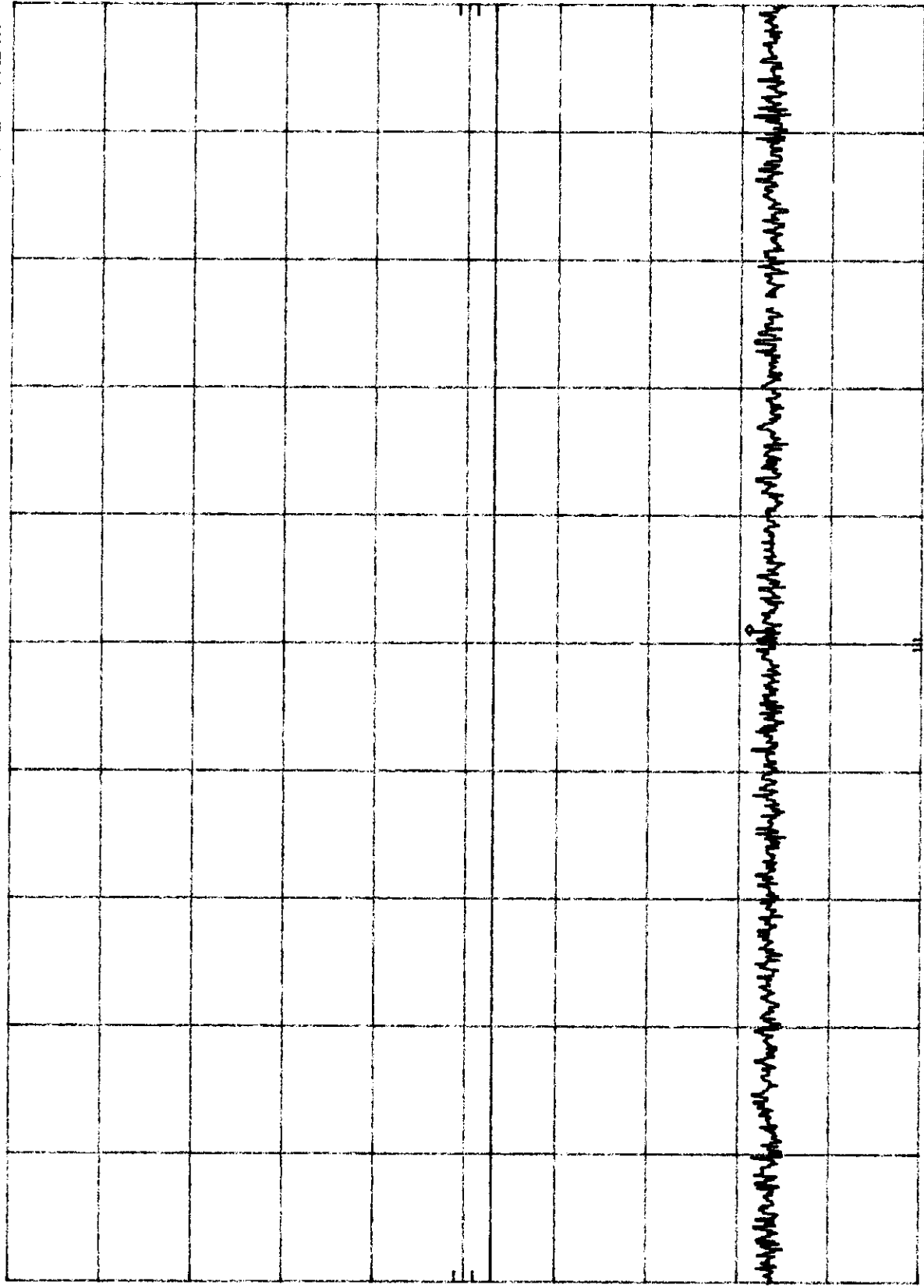
10 dB/

OFFSET

19.8
dB

DL

-20.0
dBm



START 1.0 MHz

RES BW 10 KHz

VBW 10 KHz

STOP 100.0 MHz

SWP 2.97 sec

PLOT# 5.14

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 807.4 MHz
-37.50 dBm

REF 33.0 dBm ATTN 30 dB

hp

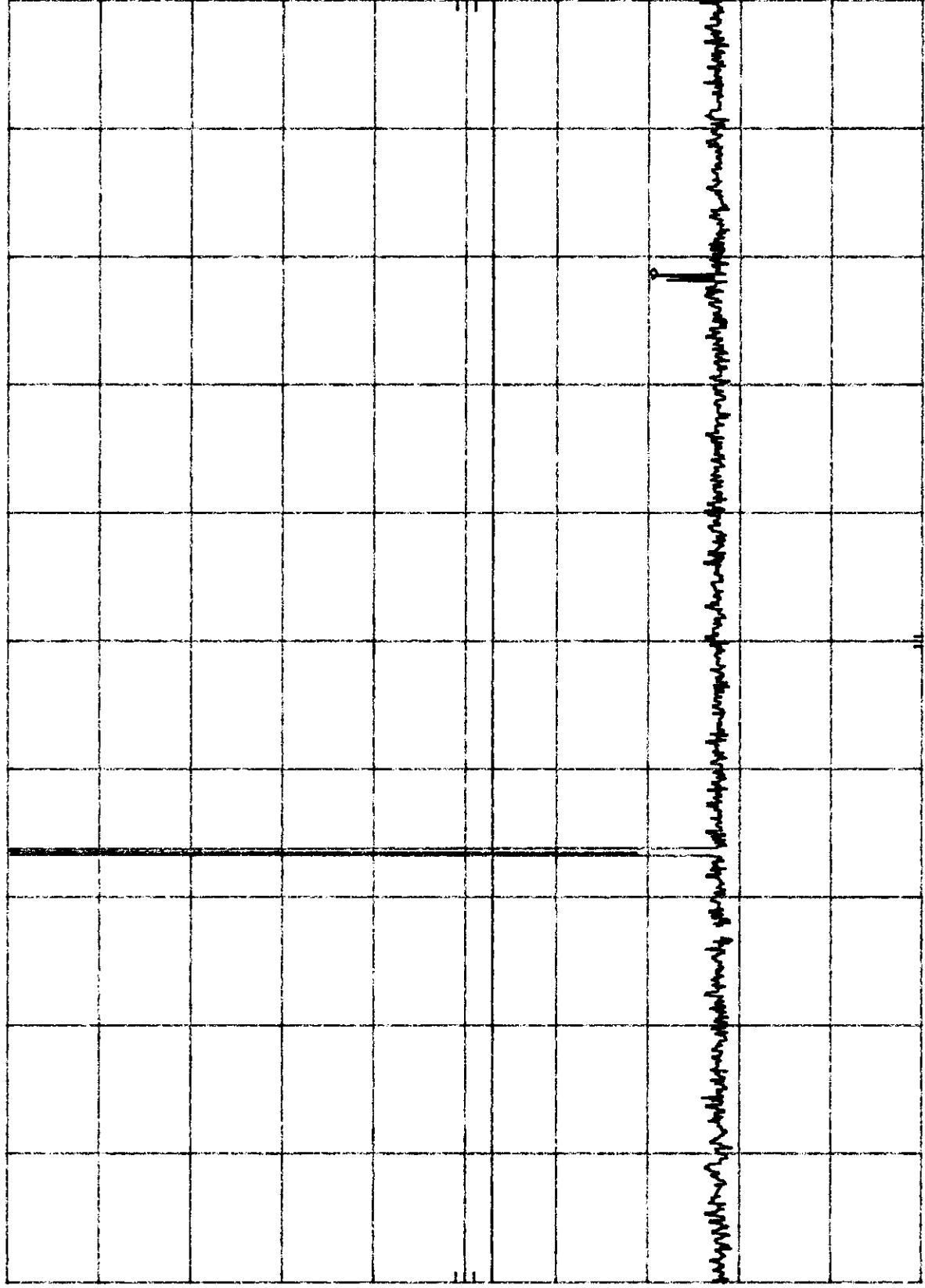
10 dB/

OFFSET

19.8
dB

DL

-20.0
dBm



START 100 MHz

RES BW 30 KHz

VBW 30 KHz

STOP 1.000 GHz

SWP 2.70 sec

PLOT# 5.15

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 1.209 GHz
-32.60 dBm

REF 33.0 dBm ATTN 30 dB

hp

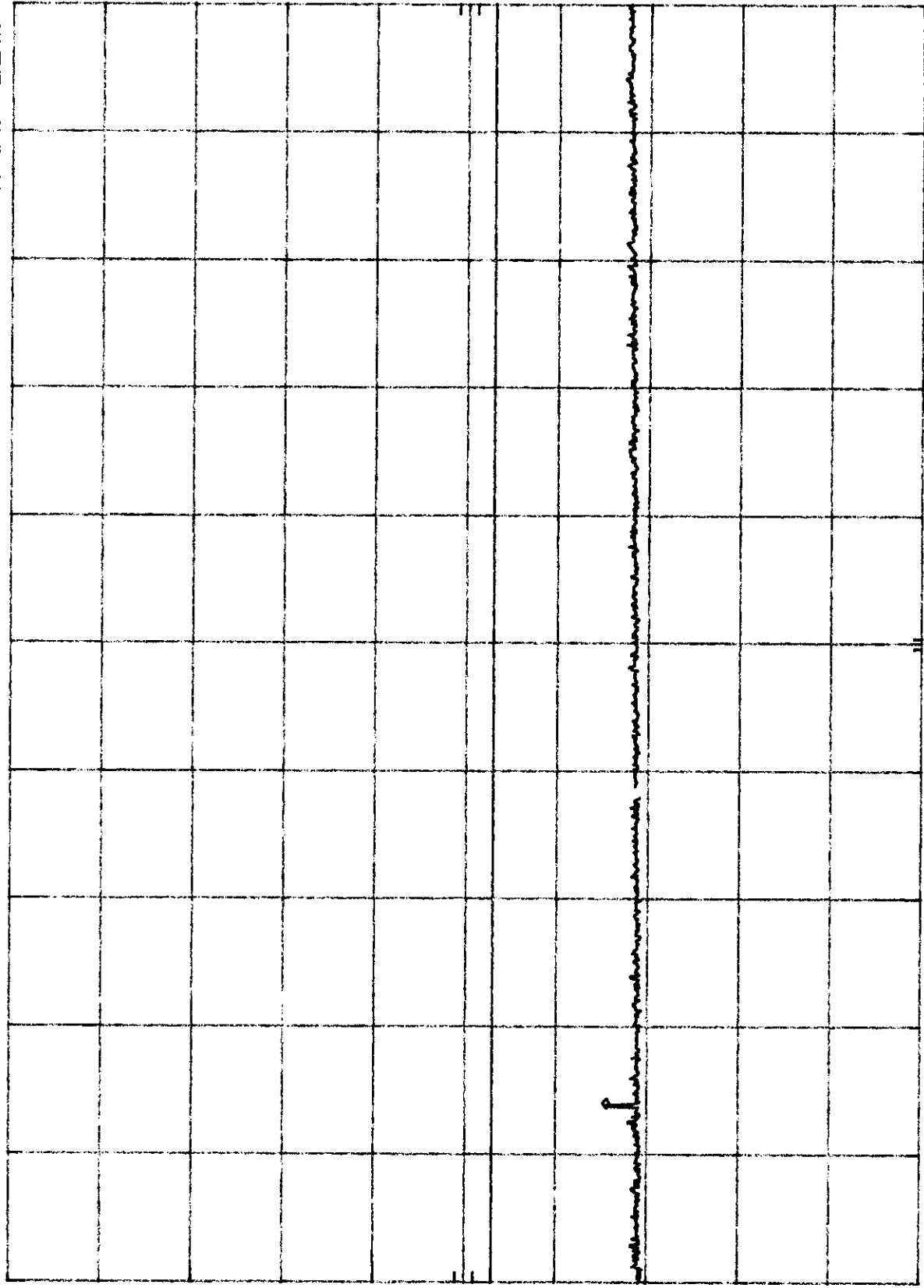
10 dB/

OFFSET

19.8
dB

DL

-20.0
dBm



START 1.00 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 2.50 GHz
SWP 150 msec

PLOT# 5.16

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 5.014 GHz
-35.30 dBm

REF 33.0 dBm ATTN 30 dB

HP

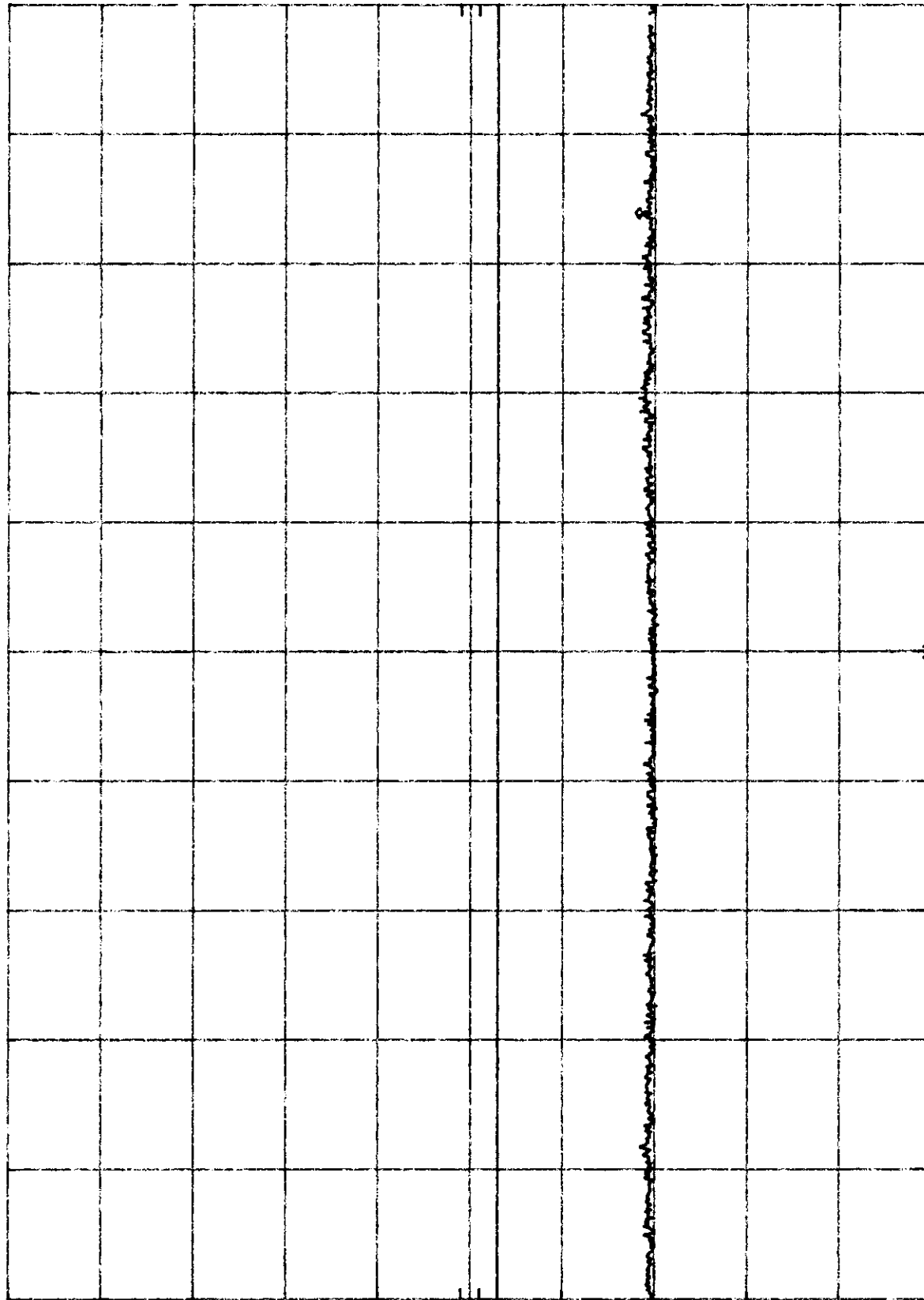
10 dB/

OFFSET

19.8
dB

DL

-20.0
dBm



START 2.50 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 5.50 GHz
SWP 300 msec

TELEDESIGN SYSTEMS -- JWFTS4000A

MKR 9.42 MHz
 -47.70 dBm

72

REF 33.0 dBm ATTEN 30 dB

100-1087

OFFSET
19.8
PB

DL
-20.0
dBm

CORR. D

START 1.0 MHZ

RES BW 10 KHZ

VBW 10 KHZ

STOP 100.0 MHZ
SWP 2.97 sec

PLOT# 5.18

TELEDESIGN SYSTEMS - JWFTS4000A
REF 33.0 dBm ATTN 30 dB

MKR 917.2 MHz
-33.10 dBm

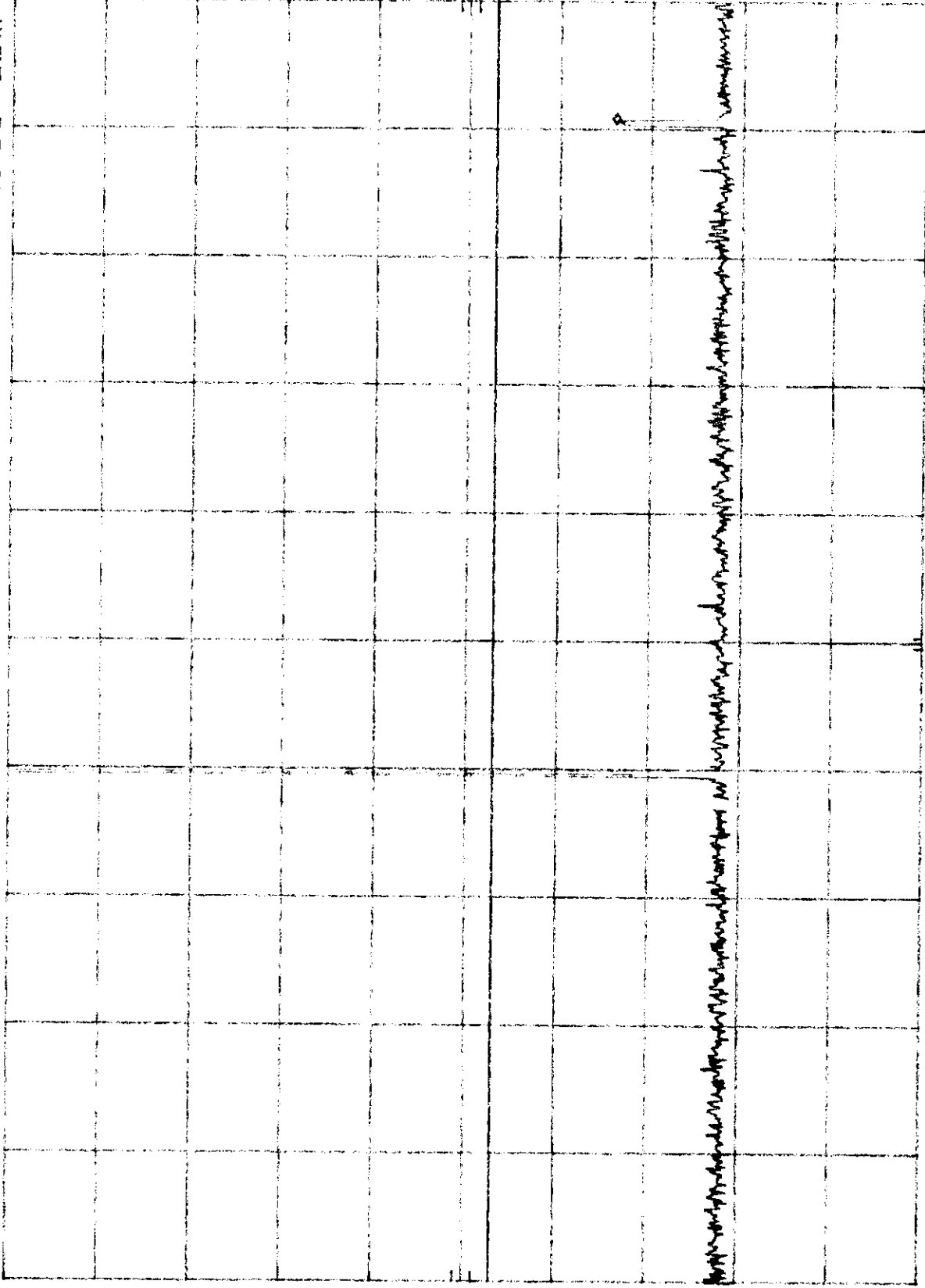
hp

10 dB/

OFFSET
19.8
dB

DL
-20.0
dBm

CORR'D



START 100 MHz

RES BW 30 KHz

VBW 30 KHz

STOP 1.000 GHz
SWP 2.70 sec

PLOT# 5.19

TELEDESIGN SYSTEMS - JWFTS4000A

MKR 2.442 GHz
-34.80 dBm

REF 33.0 dBm ATTN 30 dB

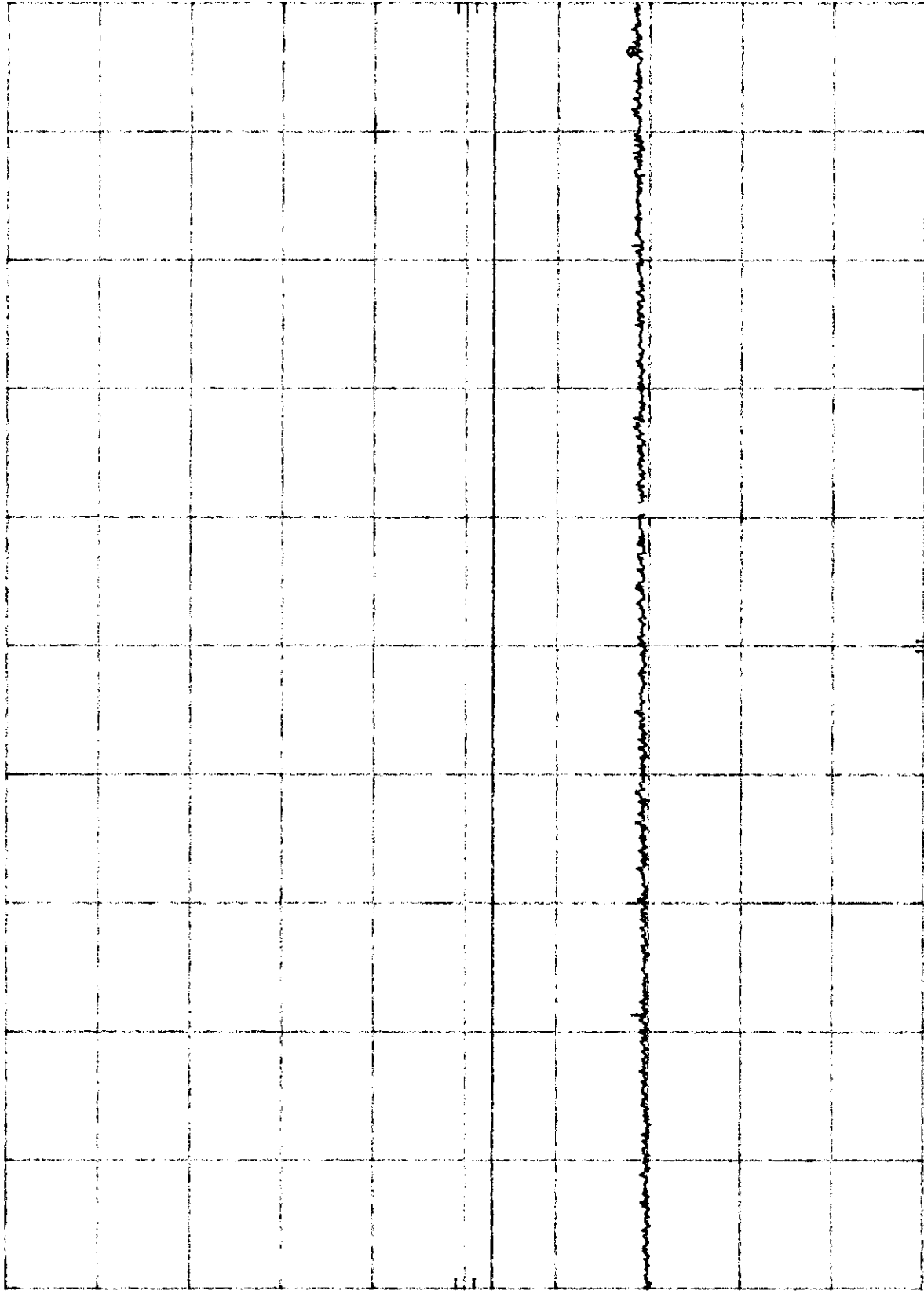
h_p

10 dB/

OFFSET
19.8
dB

DL
-20.0
dBm

CORR'D



START 1.00 GHz RES BW 1 MHz STOP 2.50 GHz
VBW 30 kHz SWP 150 msec

PLOT# 5.20

TELEDESIGN SYSTEMS - JWFTS4000A

REF 33.0 dBm ATTN 30 dB

MKR 3.394 GHz
-35.10 dBm

h₁₀

10 dB/

OFFSET

19.8
dB

DL

-20.0
dBm

CORR'D



START 2.50 GHz

RES BW 1 MHz

VBW 30 kHz

STOP 5.50 GHz
SWP 300 msec

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

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

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 W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

6.4 Test Results

Refer to the attached data sheets.

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Test Site: #1

Test Engineer: D. Chernomordik

Operation Mode: Transmitting at 403 MHz, Output Power 2 W

Spurious Harmonic Attenuation

Frequency MHz	Antenna Pol. V/H	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Distance Correct. dB	Field Strength dB(uV/m)	Spurious attenuat. dB	Margin dB
403.0	V	110.2	16.5	0	0.5	0	127.2	-	-
806.0	V	30.0	21.9	0	1.0	0	52.9	74.3	-28.3
1209.0	V	20.9	24.0	0	1.2	0	46.1	81.1	-35.1
1612.0	V	27.0	25.5	0	1.5	0	54.0	73.2	-27.2
2015.0	V	19.0	27.5	0	2.3	0	48.8	78.4	-32.4
2418.0	V	35.8	27.9	-26.0	2.4	0	40.1	87.1	-41.1
2821.0	V	40.2	29.5	-26.0	2.5	0	46.2	81.0	-35.0
3224.0	V	33.8	30.5	-26.0	2.8	0	41.1	86.1	-40.1
3627.0	V	29.2	31.8	-26.0	3.0	0	38.0	89.2	-43.2
4030.0	V	28.4	32.5	-26.0	3.2	0	38.1	89.1	-43.1

Note: Limit of spurious emission attenuation equals $43 + 10\log(P) = 46$ dB

At the fundamental frequency, an antenna was connected to the transmitter output,
at the harmonic frequencies, a dummy load (50 Ohm) was connected to the transmitter
output.

Justification: Passed

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Test Site: #1

Test Engineer: D. Chernomordik

Operation Mode: Transmitting at 458 MHz, Output Power 2 W

Spurious Harmonic Attenuation

Frequency MHz	Antenna Pol. V/H	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Distance Correct. dB	Field Strength dB(uV/m)	Spurious attenuat. dB	Margin dB
458.0	V	111.6	17.5	0	0.5	0	129.6	--	--
916.0	V	27.3	23.4	0	1.0	0	51.7	77.9	-31.0
1374.0	V	19.6	24.2	.0	1.2	0	45.0	84.6	-38.6
1832.0	H	20.0	27.2	.0	1.5	0	48.7	80.9	-34.9
2290.0	H	46.0	27.6	-26.0	2.3	0	49.9	79.7	-33.7
2748.0	H	41.7	29.0	-26.0	2.4	0	47.1	82.5	-36.5
3286.0	H	31.0	30.7	-26.0	2.5	0	38.2	91.4	-45.4
3664.0	V	39.2	31.4	-26.0	2.8	0	47.4	82.2	-36.2
4121.0	V	26.5	32.4	-26.0	3.0	0	35.9	93.7	-47.7
4580.0	V	31.8	32.1	-26.0	3.2	0	41.1	88.5	-42.5

Note: Limit of spurious emission attenuation equals $43 + 10\log(P) = 46$ dB

At the fundamental frequency, an antenna was connected to the transmitter output,
at the harmonic frequencies, a dummy load (50 Ohm) was connected to the transmitter
output.

Justification: Passed

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Test site: #1

Test Engineer: D. Chernomordik

Operation Mode: Transmitting at 512 MHz. Output Power 2 W.

Spurious Harmonic Attenuation

Frequency MHz	Antenna Pol. V/H	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Distance Correct. dB	Field Strength dB(uV/m)	Spurious attenuat. dB	Margin dB
512.0	V	109.5	18.4	0	0.5	0	128.4	--	--
1024.0	V	21.5	23.5	0	1.0	0	46.0	82.4	-36.4
1536.0	V	20.5	24.9	0	1.2	0	46.6	81.8	-35.8
2048.0	H	19.6	27.6	0	1.5	0	48.7	79.7	-33.7
2560.0	H	36.6	28.2	-26.0	2.3	0	41.1	87.3	-41.3
3072.0	H	31.4	30.3	-26.0	2.4	0	38.1	90.3	-44.3
3584.0	H	35.9	31.3	-26.0	2.5	0	43.7	84.7	-38.7
4096.0	V	27.9	32.5	-26.0	2.8	0	37.2	91.2	-45.2
4608.0	V	26.6	32.6	-26.0	3.0	0	36.2	92.2	-46.2
5120.0	V	32.7	33.5	-26.0	3.2	0	43.4	85.0	-39.0

Note: Limit of spurious emission attenuation equals $43 + 10\log(P) = 46$ dB

At the fundamental frequency, an antenna was connected to the transmitter output,
at the harmonic frequencies, a dummy load (50 Ohm) was connected to the transmitter
output.

Justification: Passed

INTERTEK TESTING SERVICES - Menlo Park

Teledesign Radio Modem W/ 3474 Transceiver

Date of Test: 7/2&3/98 & 7/6-8/98

Test site: #1

Test Engineer: D. Chernomordik

Operation Mode: Receiving

FCC Pt 15 Radiated Emission from Receiver (LO frequency)

Frequency MHz	Antenna Pol.	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Distance Correct. dB	Field Strength dB(uV/m)	Limit dB(uV/m)	Margin dB
456.0	H	36.2	17.4	-16.0	0.6	0	38.2	46.0	-7.8
911.9	H	24.6	22.8	-16.0	0.9	0	32.3	46.0	-13.7
1367.9	V	29.4	24.2	-26.0	1.1	0	28.7	54.0	-25.3
511.0	V	32.9	18.3	-16.0	0.7	0	35.9	46.0	-10.1
1021.9	V	38.0	23.1	-26.0	1.0	0	36.1	54.0	-17.9
1532.9	V	29.7	24.9	-26.0	1.2	0	29.8	54.0	-24.2
565.0	H	30.7	19.2	-16.0	0.7	0	34.6	46.0	-11.4
1129.9	V	40.8	23.8	-26.0	1.1	0	39.7	54.0	-14.3
1694.9	V	29.9	25.5	-26.0	1.3	0	30.7	54.0	-23.3

Measurements were made at 3 meters.

Judgement: Passed

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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.

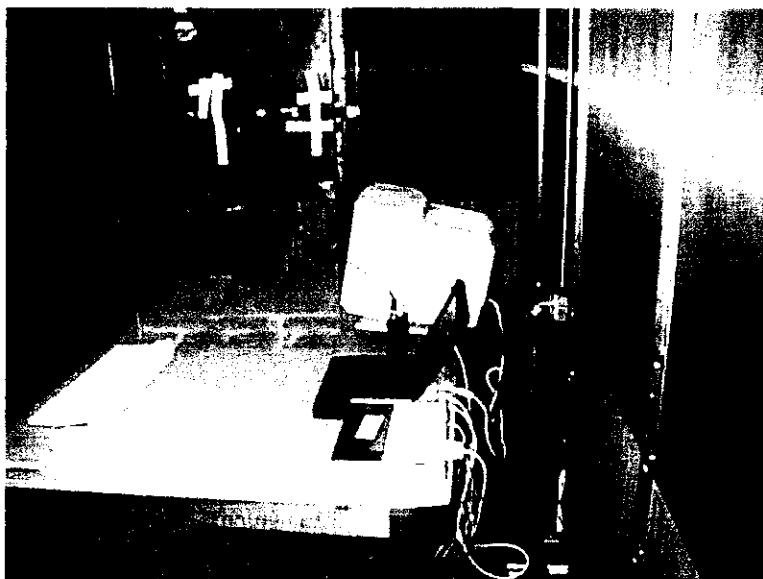
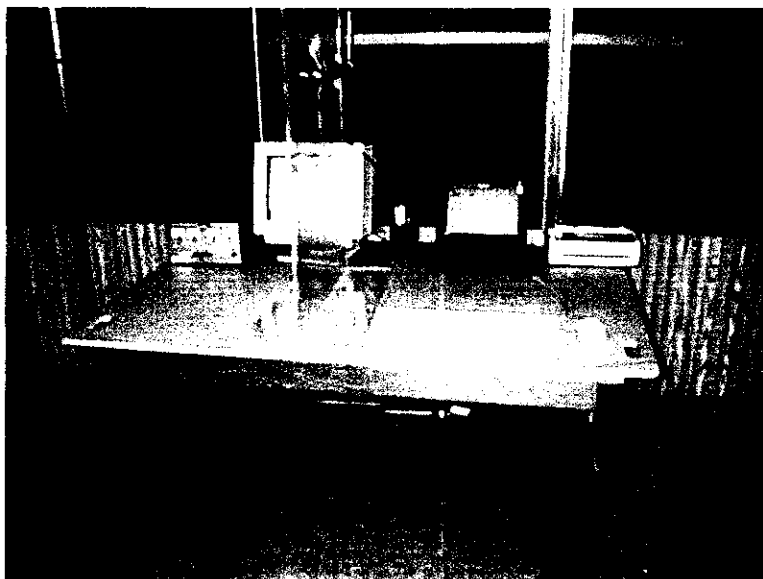
Both HOT and NEUTRAL leads were tested.

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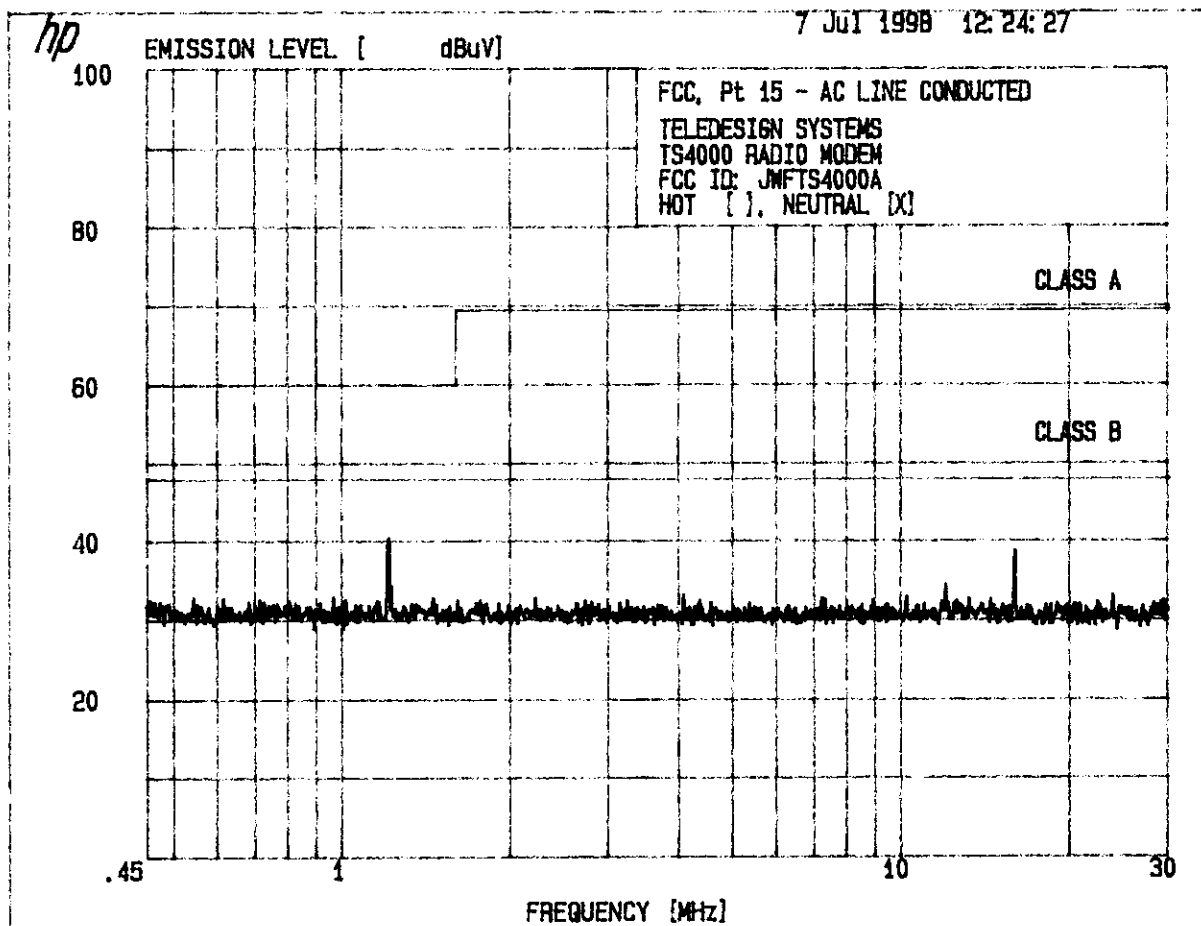
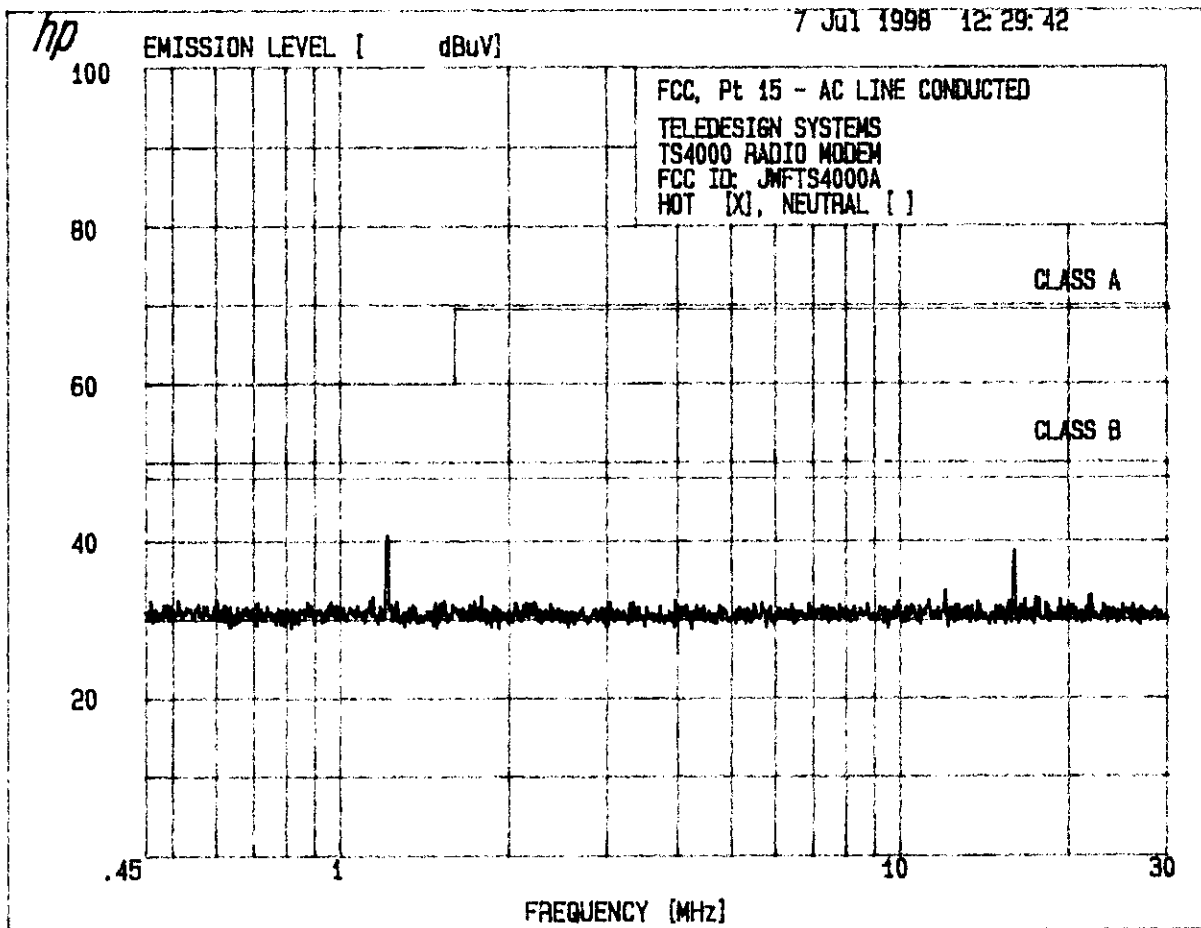
Date of Test: 7/2&3/98 & 7/6-8/98

7.2 Test Configuration Setup - Line Conducted Emissions



7.3 Test Results

See attached pages.



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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: 429.55MHz, Tolerance ± 1074 Hz

Frequency Stability vs Temperature		
Temperature, C	Frequency (MHz)	Difference (Hz)
+00	512.000300	+300
+50	512.000263	+253
+40	512.000263	+263
+30	512.000333	+333
+20	512.999984	-16
+10	511.999705	-295
0	511.999742	-258
-10	512.000076	+76
-20	512.000047	+47
-30	512.000385	+385

Justification: Passed

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9.0 Frequency Stability vs Voltage, FCC 2.995(d)(2)

9.1 Test Procedure

An external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115% of the DC nominal value and for 85% of the nominal value.

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: 512.00 MHz, Tolerance ± 768 Hz

Frequency Stability vs. Voltage		
Voltage	Frequency (MHz)	Difference (Hz)
10.2	512.000062	62
12.0	512.000064	64
24.0	512.000066	66
28.0	512.000077	77
9.0	512.000059	59

Justification: Passed

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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 NUMBER	DESCRIPTION
10.1	458 MHz, Transmitter On
10.2	458 MHz, Transmitter On
10.3	458 MHz, Transmitter On
10.4	458 MHz, Transmitter Off
10.5	458 MHz, Transmitter Off
10.6	403 MHz, Transmitter On
10.7	403 MHz, Transmitter Off
10.8	512 MHz, Transmitter On
10.9	512 MHz, Transmitter Off

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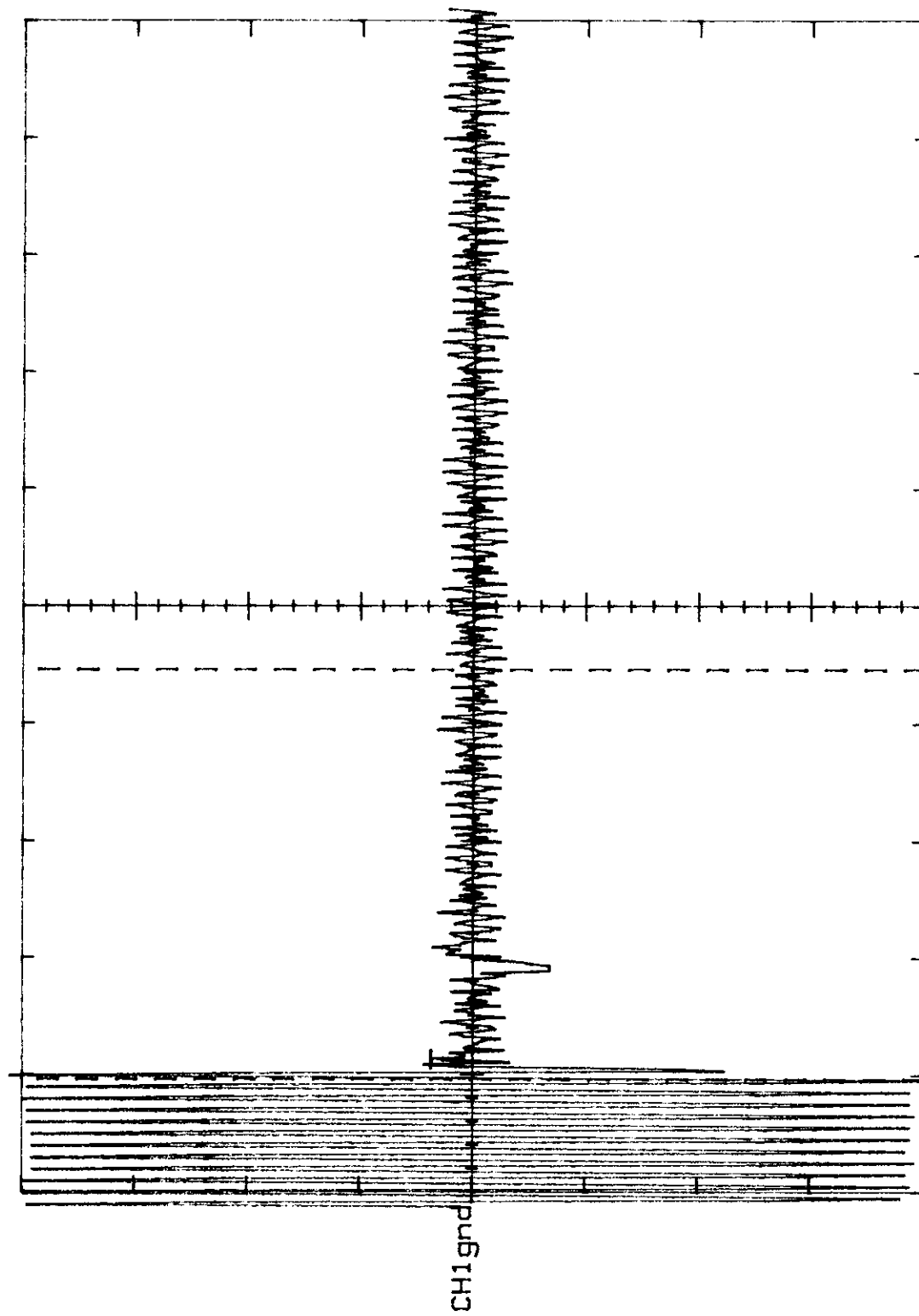
10.2 Test Result

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

458 MHz Plot # 10.1

CH1↕>500mV A 10ms -59.4mV EXT1

35.000ms

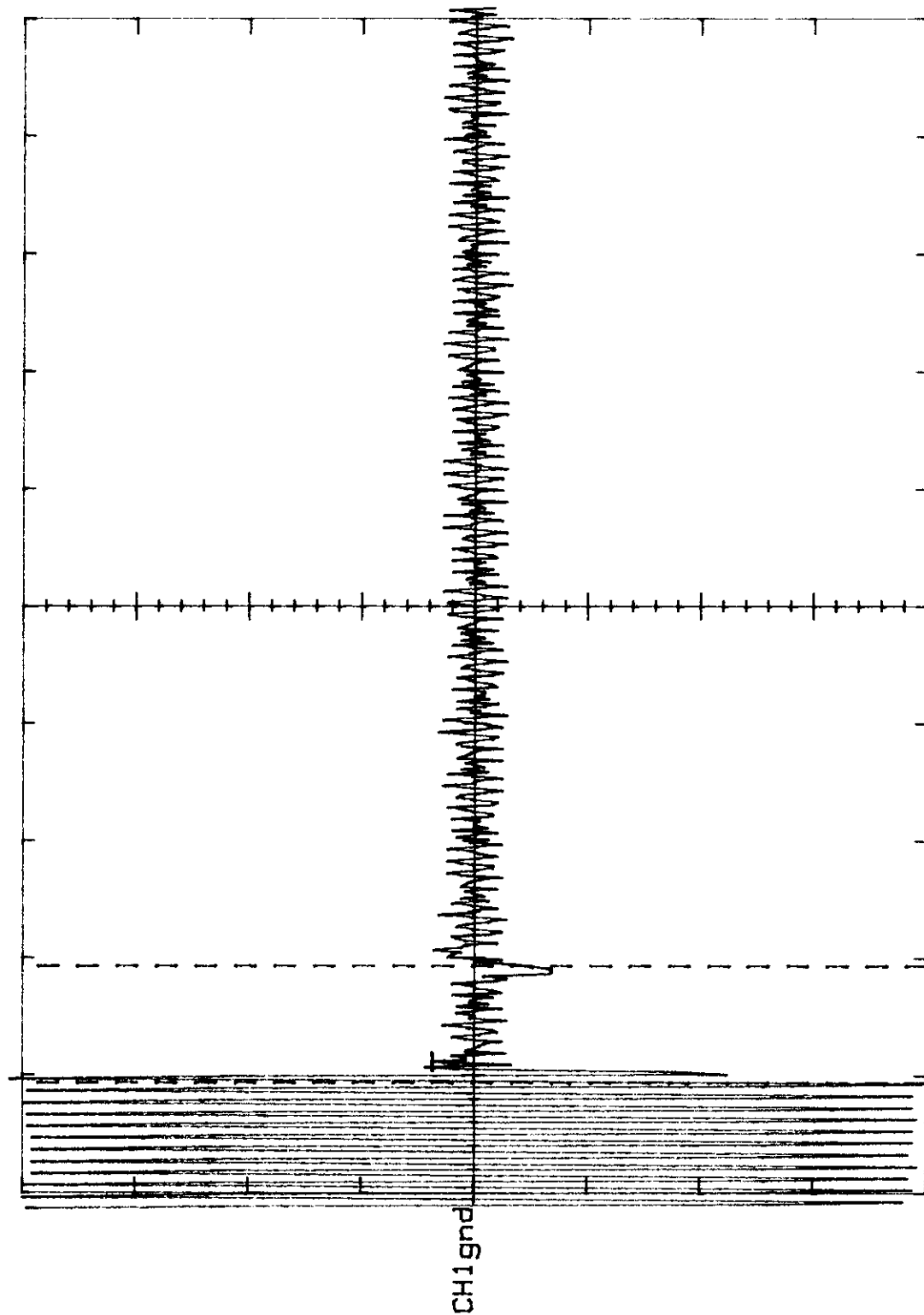


458 MHz Plot # 10.2

CH1↓>500mV

A 10ms -59.4mV EXT1

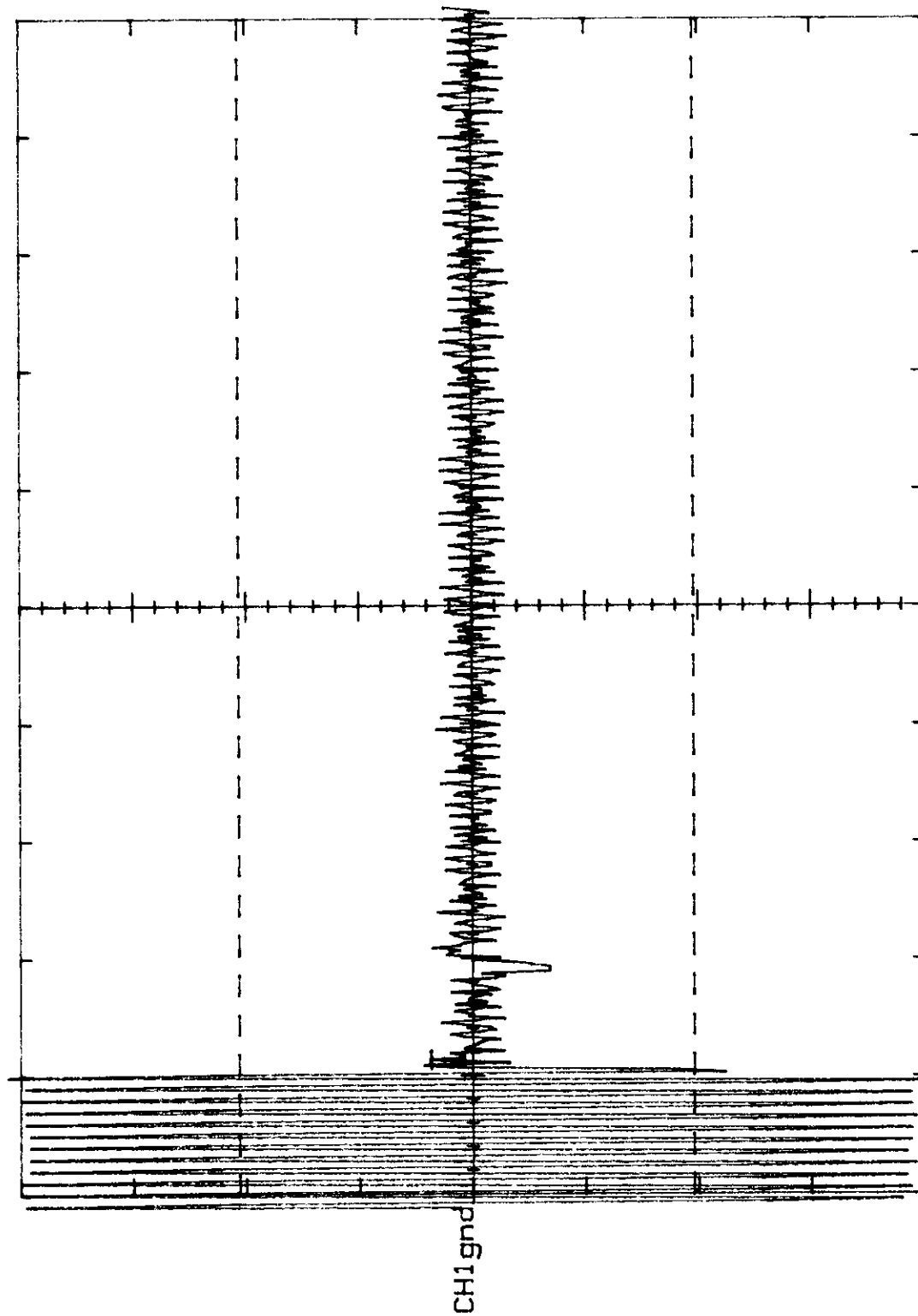
10.000ms



458 MHz Plot # 10.3

CH1↕>500mV A 10ms -59.4mV EXT1

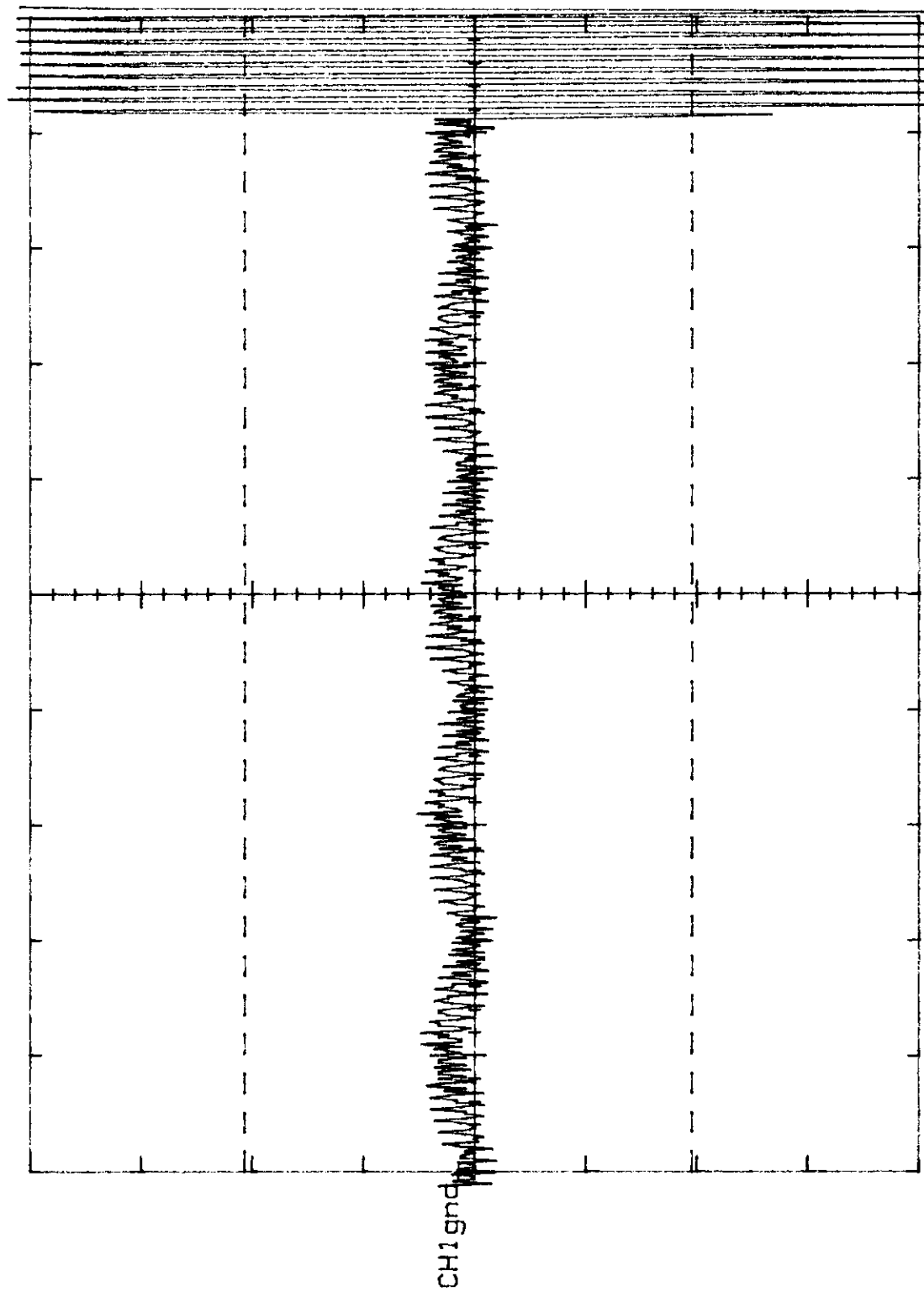
4.030 DIV



458 MHz Plot # 10.4

CH1↕>500mV A 10ms -59.4mV EXT1

4.030 DIV

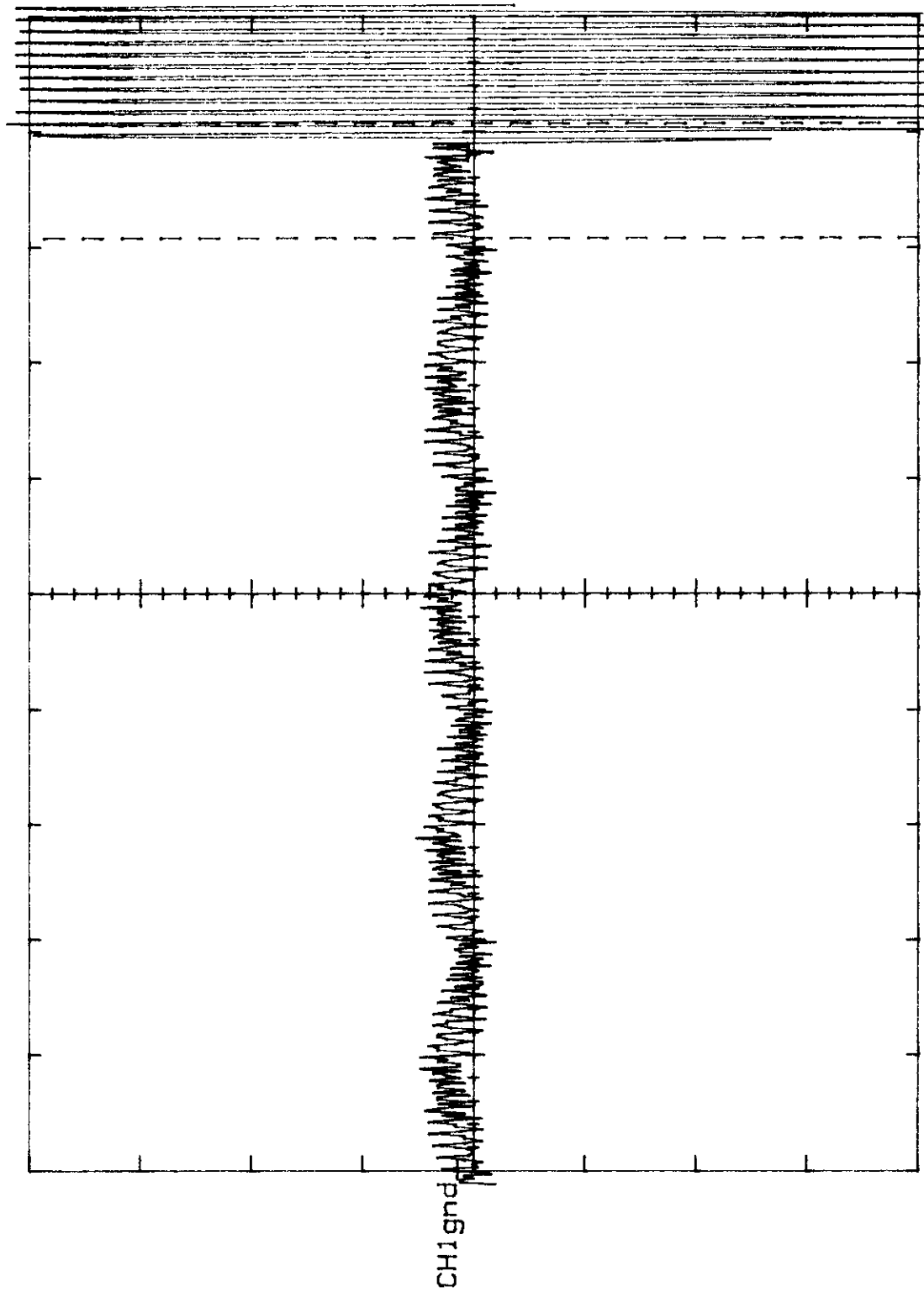


458 MHz Plot # 10.5

CH1↓>500mV

A 10ms -59.4mV EXT1

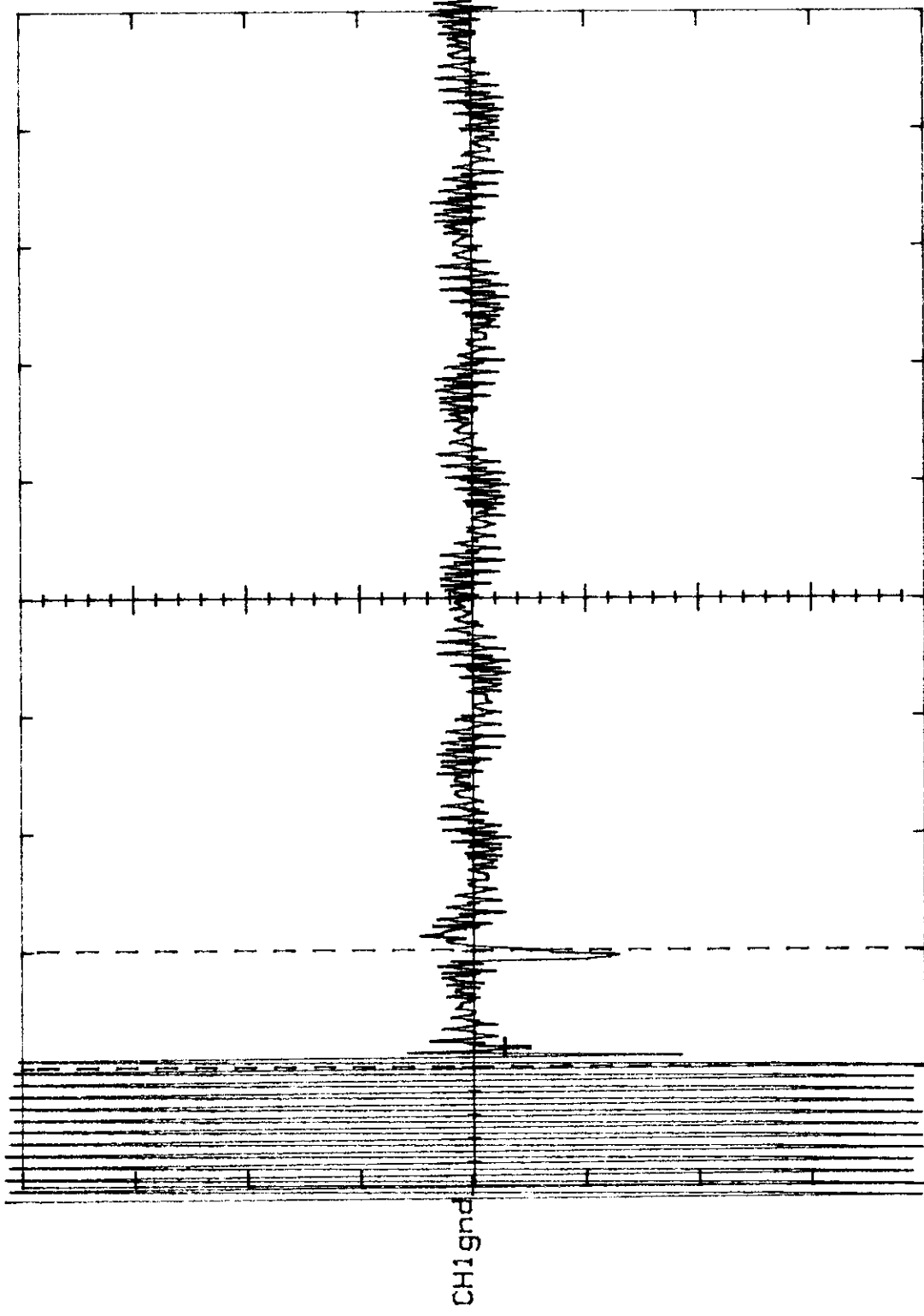
10.000ms



403 MHz Plot # 10.6

CH1↕>500mV A 10ms -59.4mV EXT1

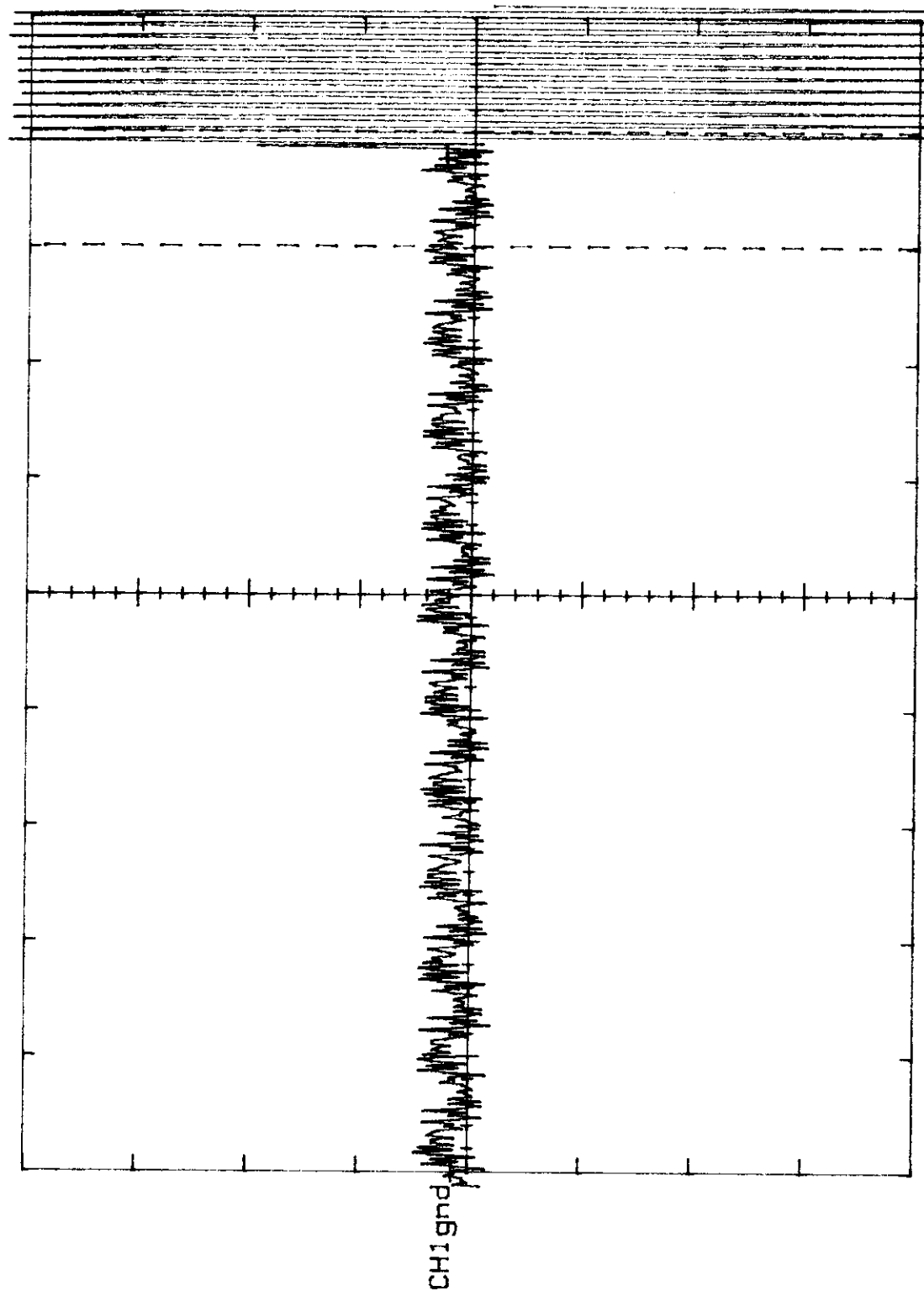
10.100ms



403 MHz Plot # 10.7

CH1↓>500mV A 10ms -59.4mV EXT1

10.000ms

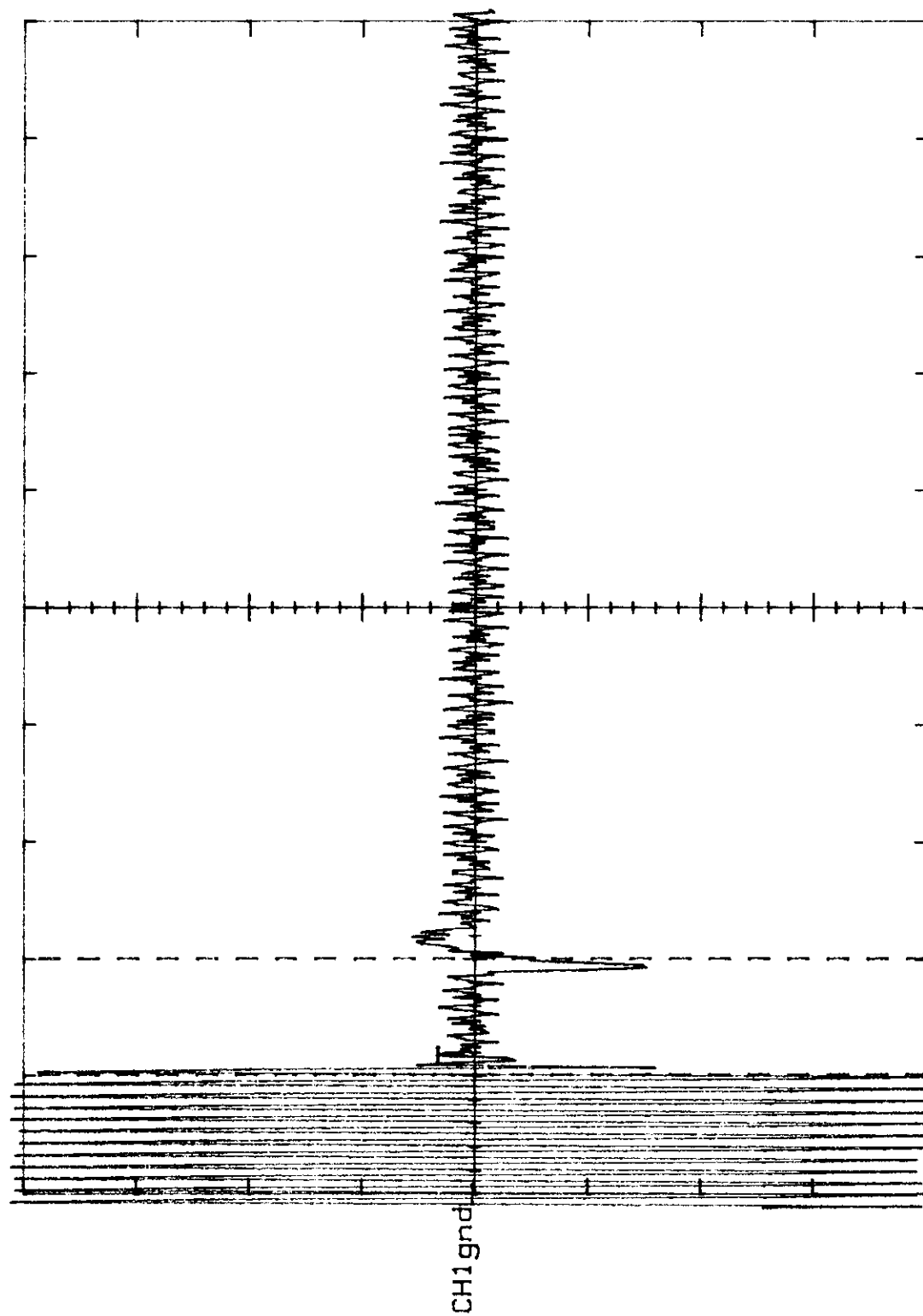


512 MHz Plot # 10.8

CH1↓>500mV

A 10ms -59.4mV EXT1

10.000ms

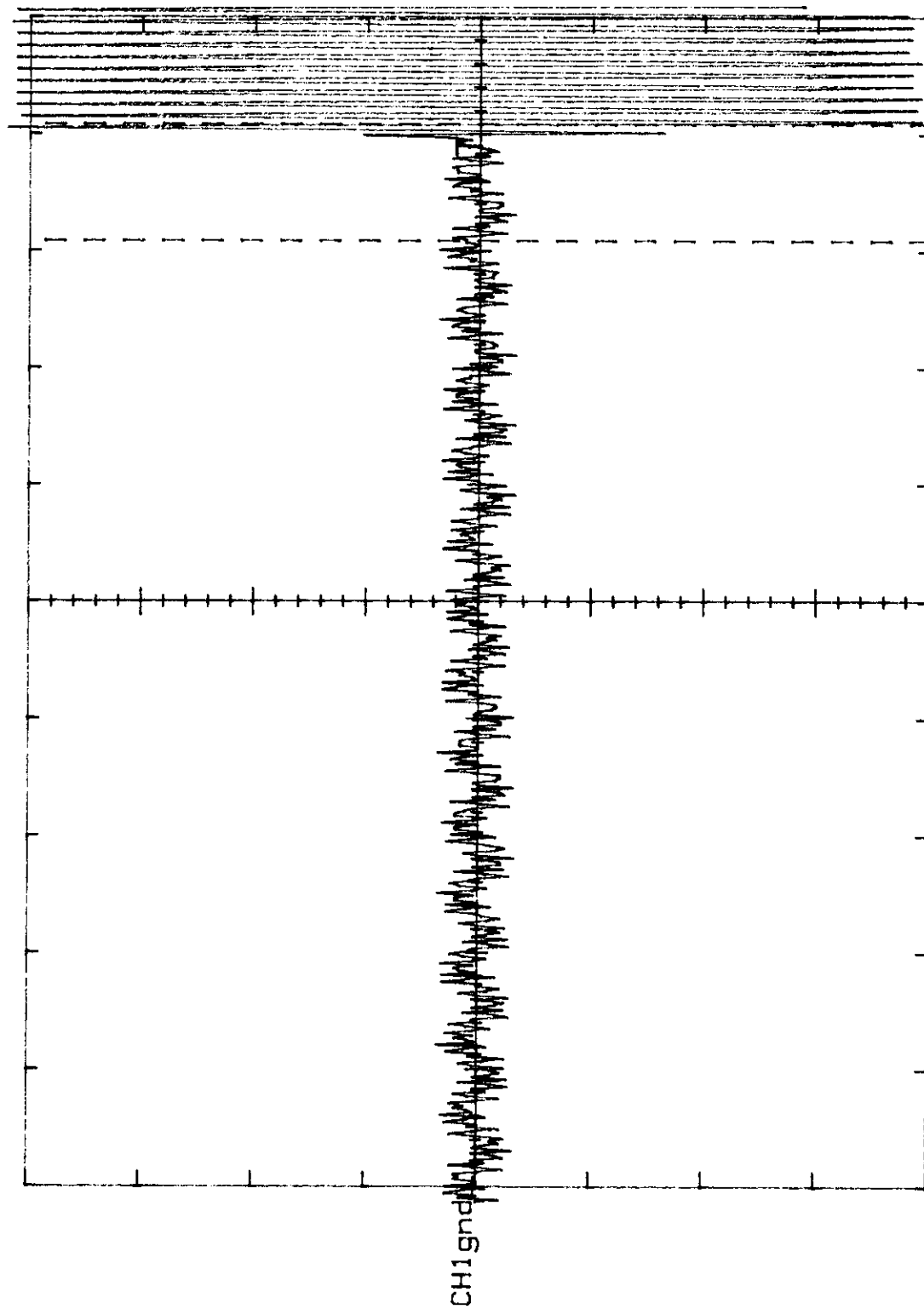


512 MHz Plot # 10.9

CH1 $\downarrow \rightarrow$ 500mV

A 10ms -59.4mV EXT1

10.000ms



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Appendix A - Photographs

See attached.