ITS Intertek Testing Services

APPLICATION FOR FCC PART 90 TYPE ACCEPTANCE

FURUNO ELECTRIC CO., LTD

Golf Range Finder
Model No.: GDM-10A

FCC ID: ADB9ZWGDM10A

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FCC Part 90 Type Acceptance

Intertek Testing Services NA Inc.
1365 Adams Court, Menlo Park, CA 94025
Telephone 650-463-2900 Fax 650-463-2910 Home Page www.worldlab.com

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David Chernomordik
Test Engineer

Date

1.2 Product Description

See attached pages.

1.2 Description of transmitter circuit

PLL circuit outputs 429.55 MHz signal according to basic oscillator (TX3) frequency 10.6 MHz (PLL IC controller is controlled by Microcomputer). This signal is modulated (variable reactance modulation, Q11/12, D3) by modulation signal (2400 b/S. +/- 2.5 kHz, Frequency modulation) and amplified up to 10 mW by TX output amplifier (Q9/10).

The modulation signal reaches TX-VCO (Q11/12, D3) through Low Pass filter and becomes SINE wave.

The amplified signal goes to antenna through TX/RX switch circuit composed of D5/6/7 and High frequency Band Pass filter (TX1 for suppression of spurious radiation).

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 100 kHz and 30 kHz respectively. The attenuator was included in spectrum analyzer OFFSET function.

Transmitter output was read off the spectrum analyzer in dBm.

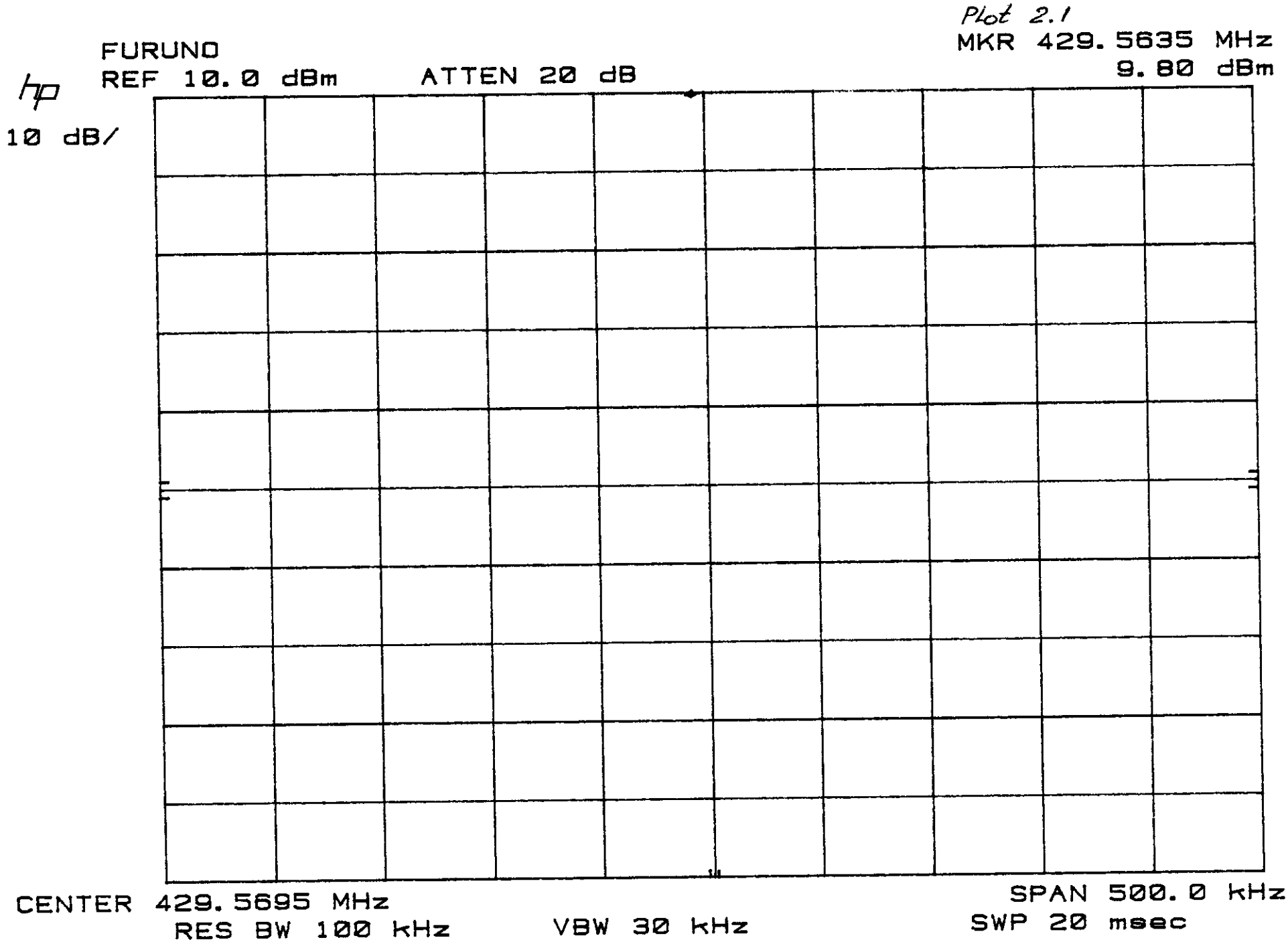
2.2 Test Equipment

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

Plot 2.1


FURUNO
REF 10.0 dBm
ATTEN 20 dB
MKR 429.5635 MHz
9.80 dBm
10 dB/
CENTER 429.5695 MHz
RES BW 100 kHz
VBW 30 kHz
SPAN 500.0 kHz
SWP 20 msec

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
429.55	83.8	22.2	1.0	107.0	9.6

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 then 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 was recorded. This spectrum was compared to the required emission mask.

The emission designator was defined as 11K25F1D, where 11.25 kHz is the Authorized Bandwidth.

4.2 Test Equipment

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

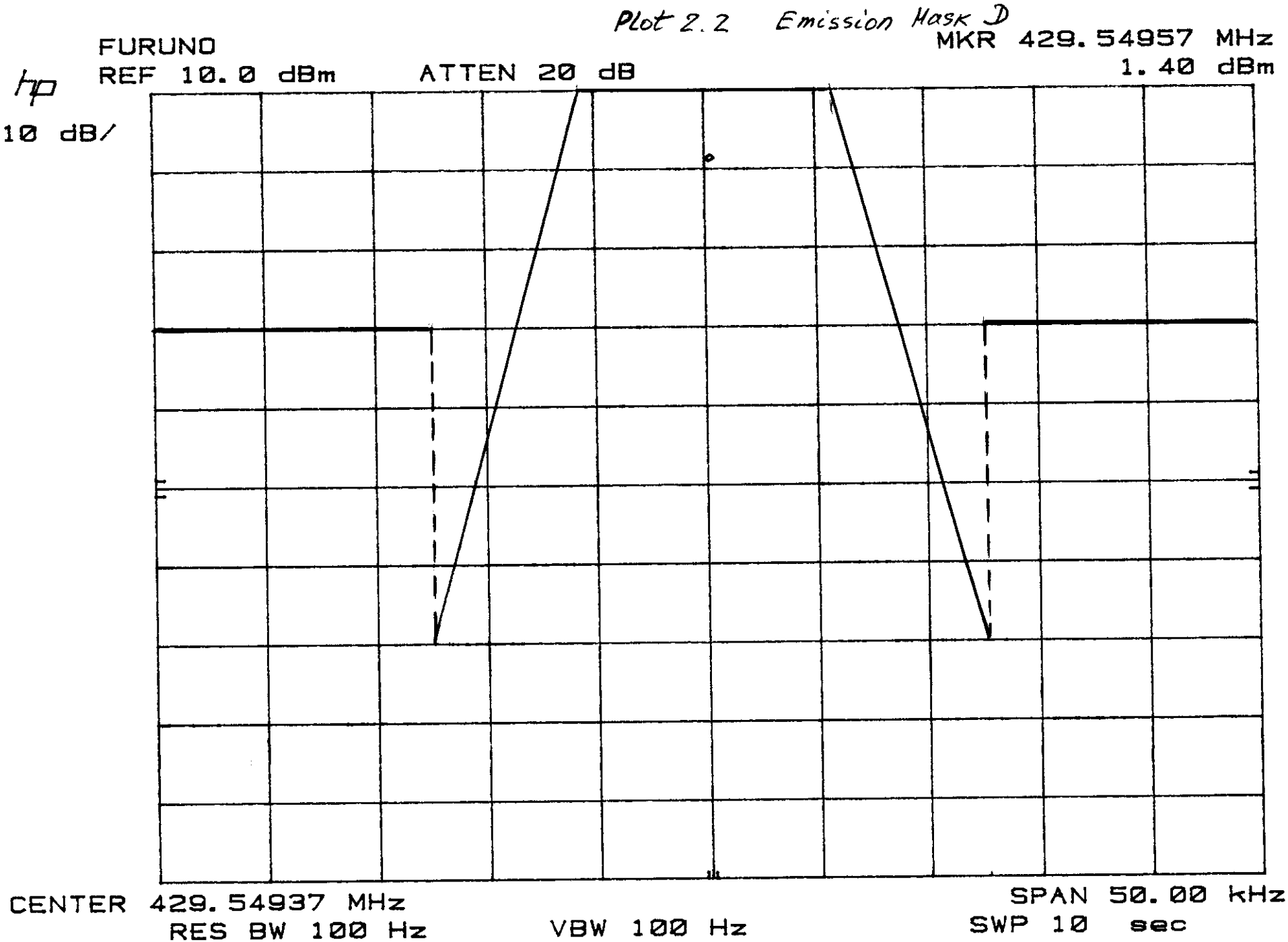
4.3 Test Results

The EUT meets the requirements for the emission mask D - 12.5 kHz channel bandwidth equipment. Refer to the attached plots 2.2 - 2.4.

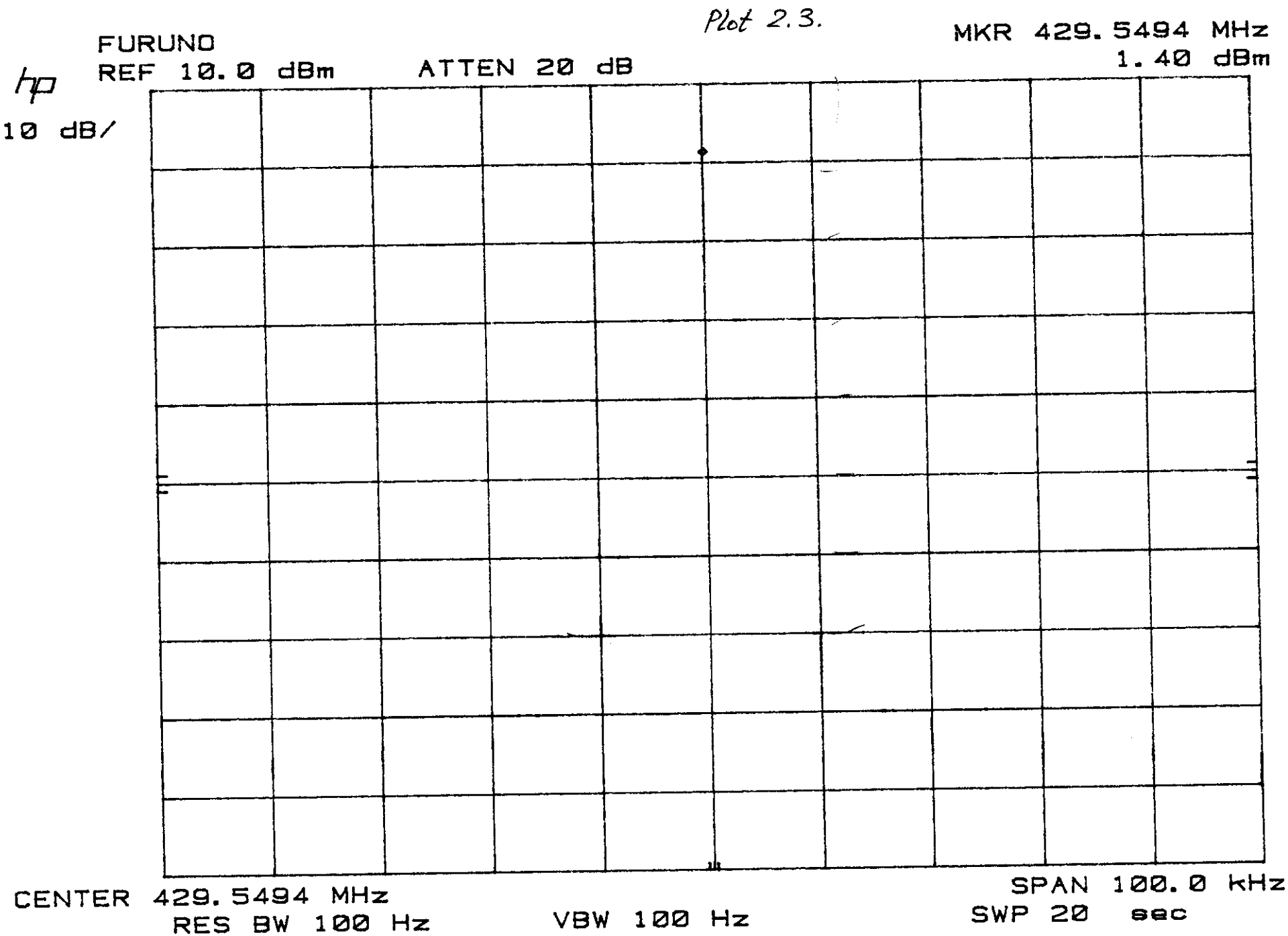
Emission Limitations, Occupied Bandwidth Plots:

Plot Number	Description
2.1	Full Power, reference level
2.2	Occupied bandwidth, scan 50 kHz
2.3	Occupied bandwidth, scan 100 kHz
2.4	Occupied bandwidth, scan 20 kHz

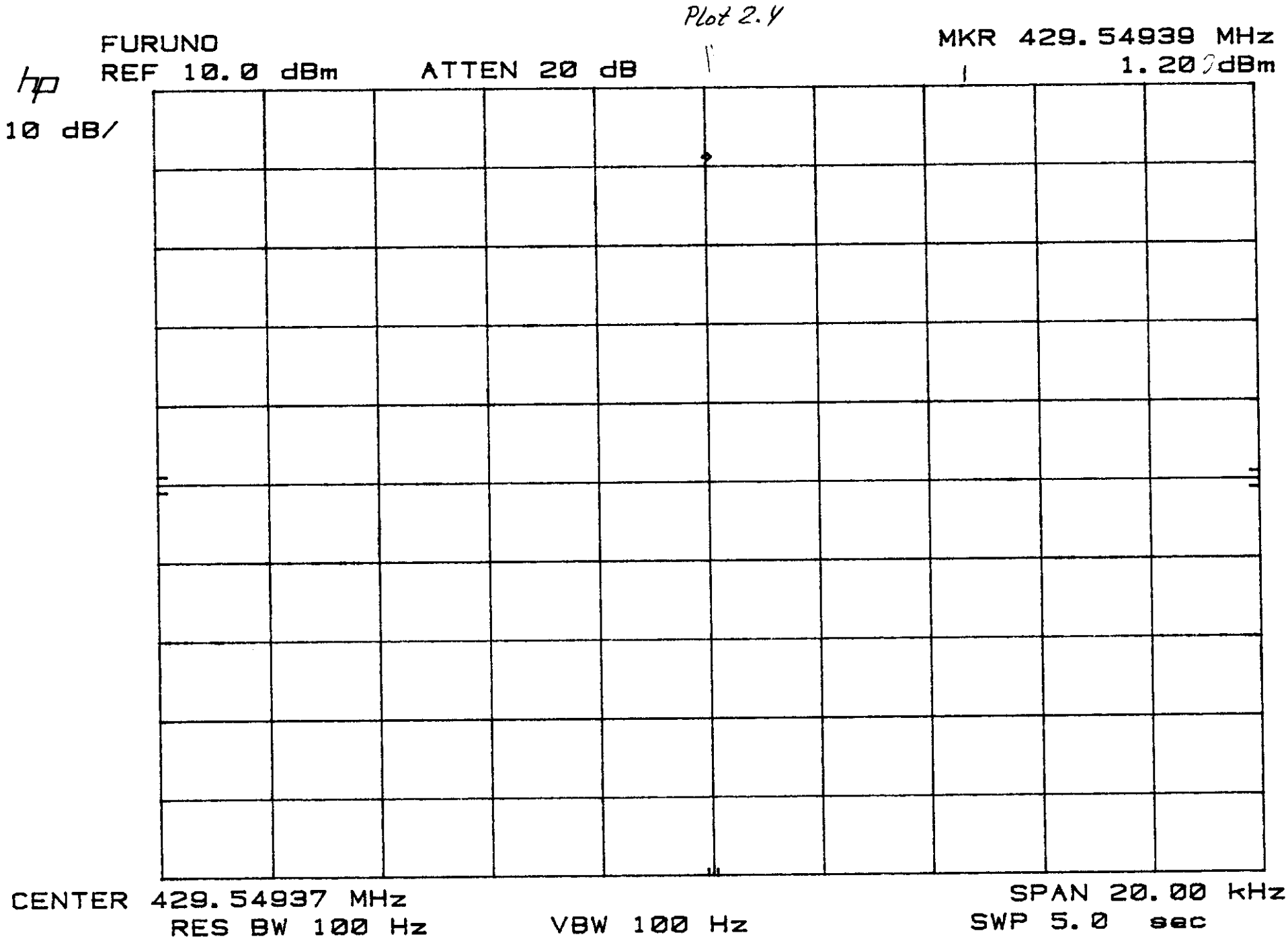
Plot 2.2 Emission Mask D



Plot 2.3.


FURUNO
REF 10.0 dBm
ATTEN 20 dB
MKR 429.5494 MHz
1.40 dBm
10 dB/
CENTER 429.5494 MHz
RES BW 100 Hz
VBW 100 Hz
SPAN 100.0 kHz
SWP 20 sec

Plot 2.4


FURUNO
REF 10.0 dBm
ATTEN 20 dB
MKR 429.54939 MHz
1.20 dBm
10 dB/
CENTER 429.54937 MHz
RES BW 100 Hz
VBW 100 Hz
SPAN 20.00 kHz
SWP 5.0 sec

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. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. 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

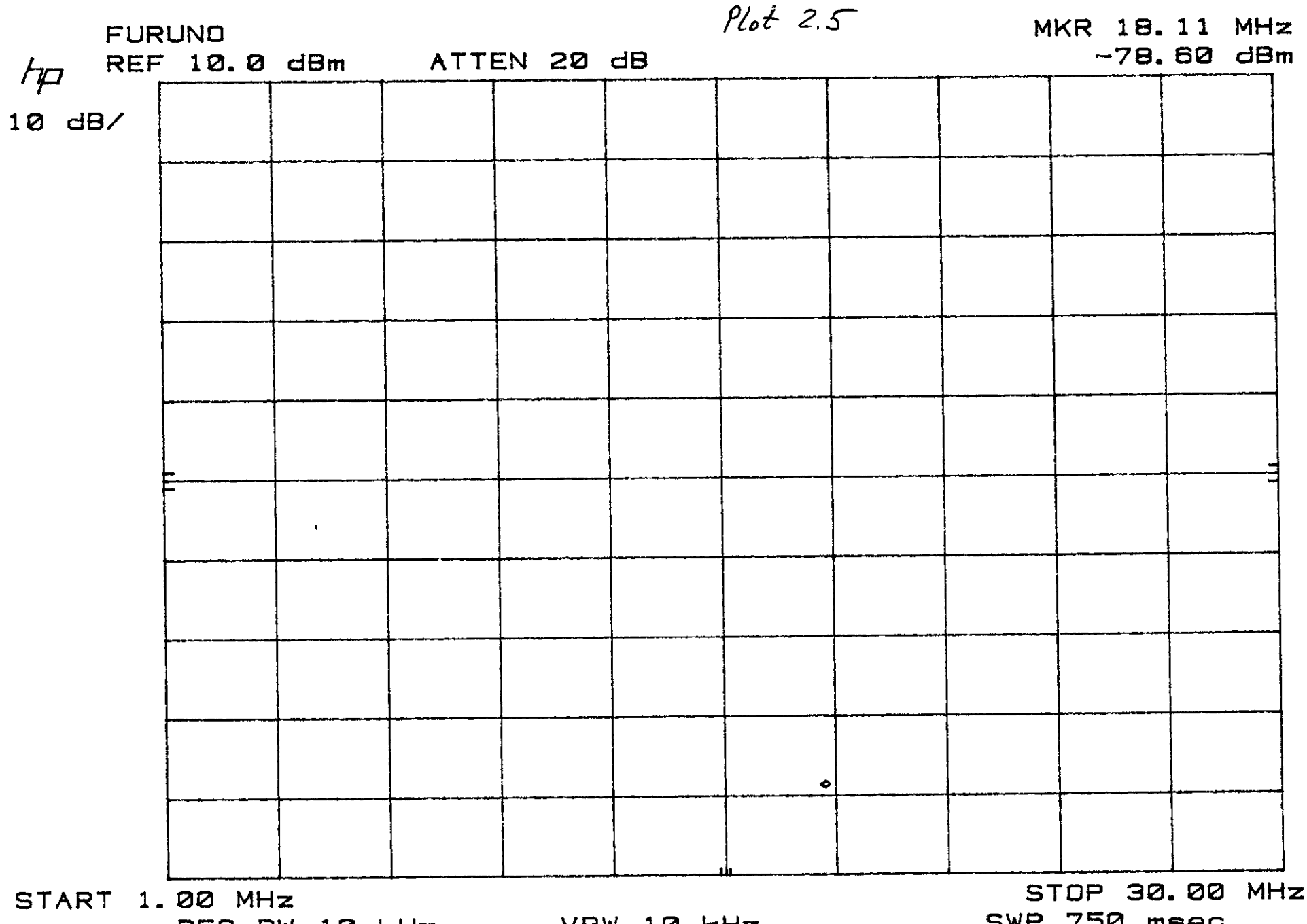
5.3 Test Results

Refer to the attached plots.

PLOT NUMBER	DESCRIPTION
2.5	1 - 30 MHz
2.6	30 - 500 MHz
2.7	0.5 - 1 GHz
2.8	1 - 2.5 GHz
2.9	2.5 - 5 GHz

The EUT passed the test.

Plot 2.5


FURUNO
REF 10.0 dBm
ATTEN 20 dB
MKR 18.11 MHz
-78.60 dBm
hp
10 dB/
START 1.00 MHz
RES BW 10 kHz
VBW 10 kHz
STOP 30.00 MHz
SWP 750 msec

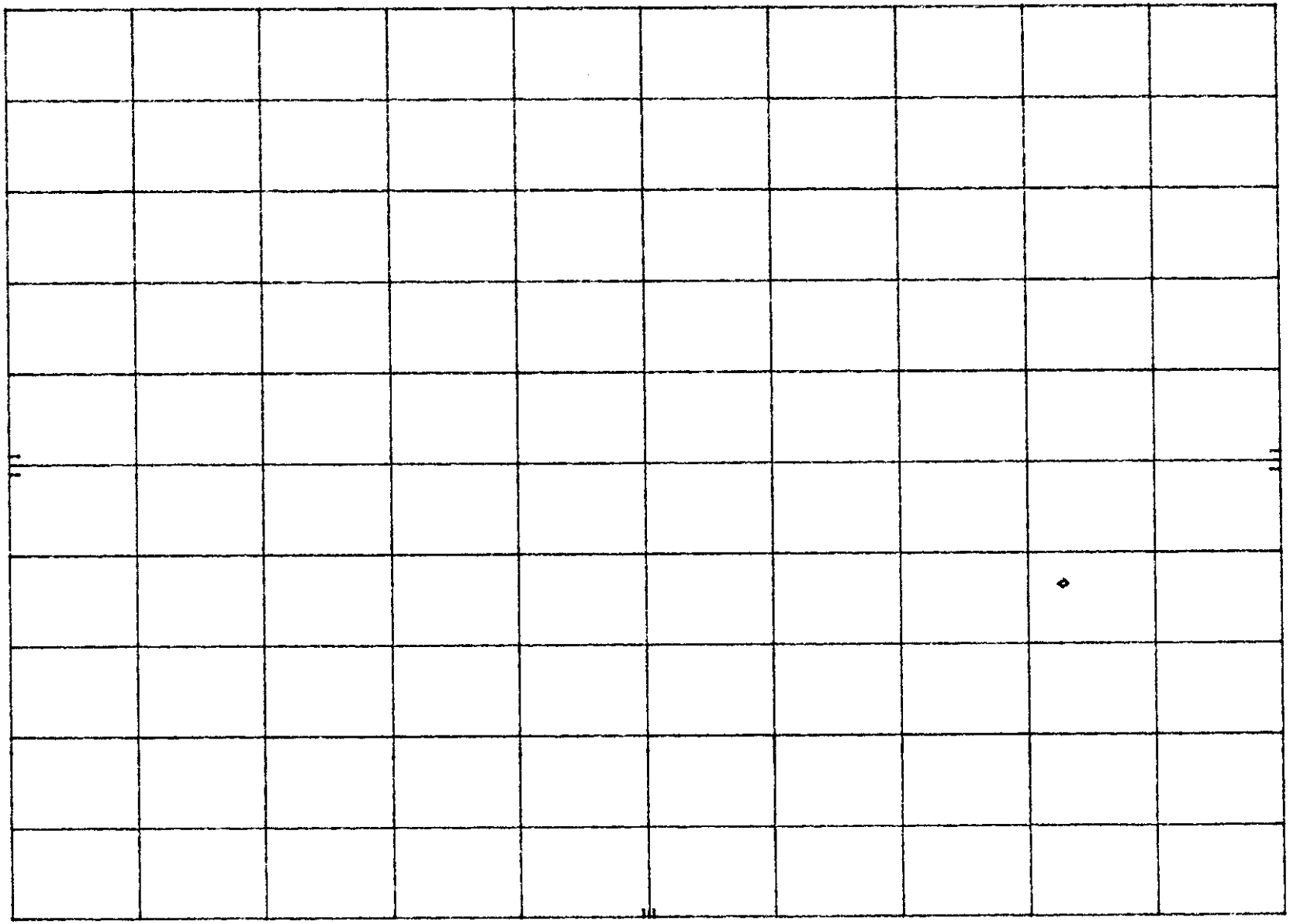
Plot 2.6

FURUNO

REF 10.0 dBm ATTEN 20 dB

MKR 418.7 MHz
-53.50 dBm

10 dB/



START 30.0 MHz

STOP 500.0 MHz

RES BW 100 kHz VBW 30 kHz SWP 300 msec

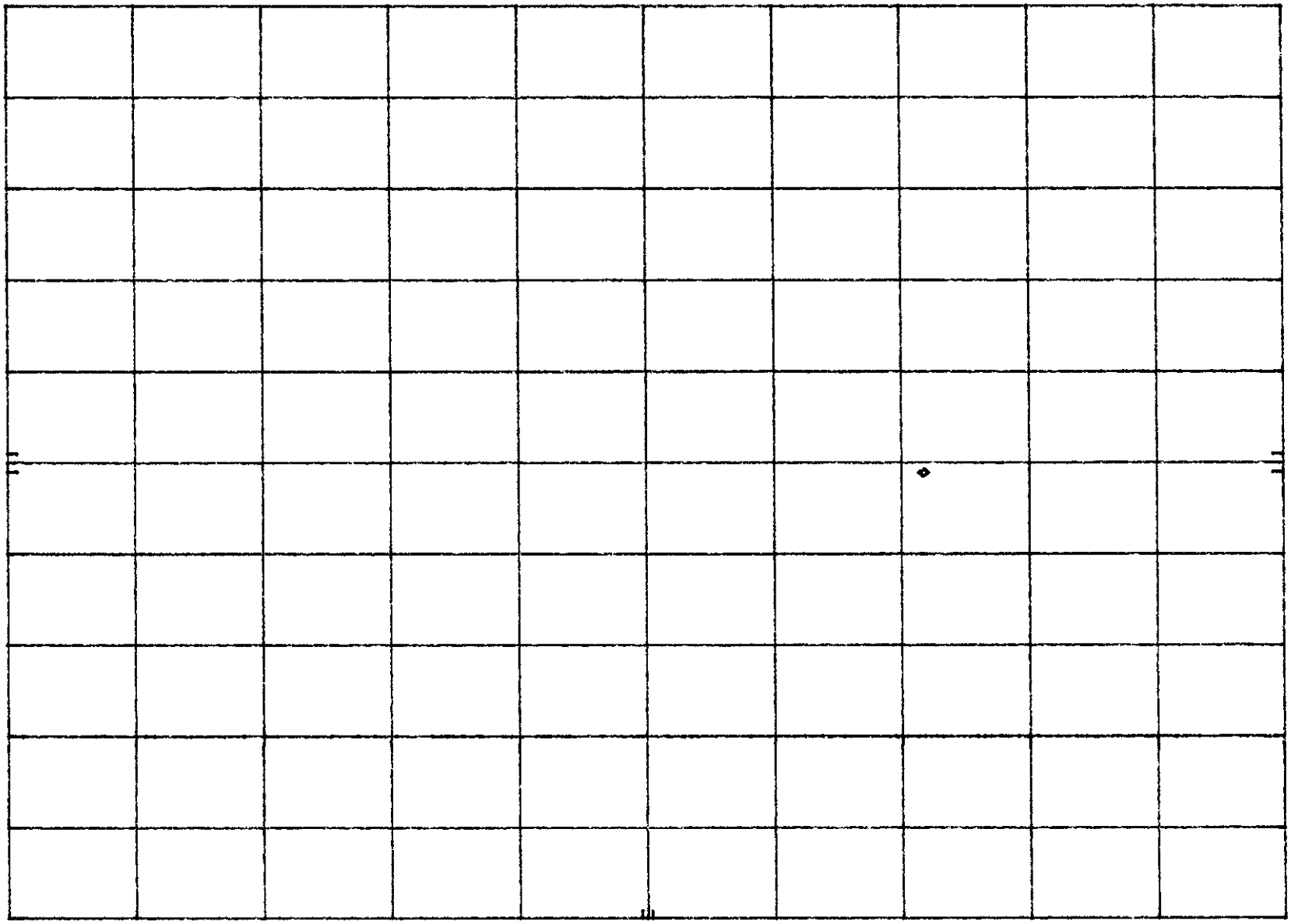
FURUNO

Plot 2.7

MKR 858.5 MHz
-41.10 dBm

hp
REF 10.0 dBm ATTEN 20 dB

10 dB/



START 500.0 MHz
STOP 1000.0 MHz
RES BW 100 kHz VBW 30 kHz SWP 300 msec

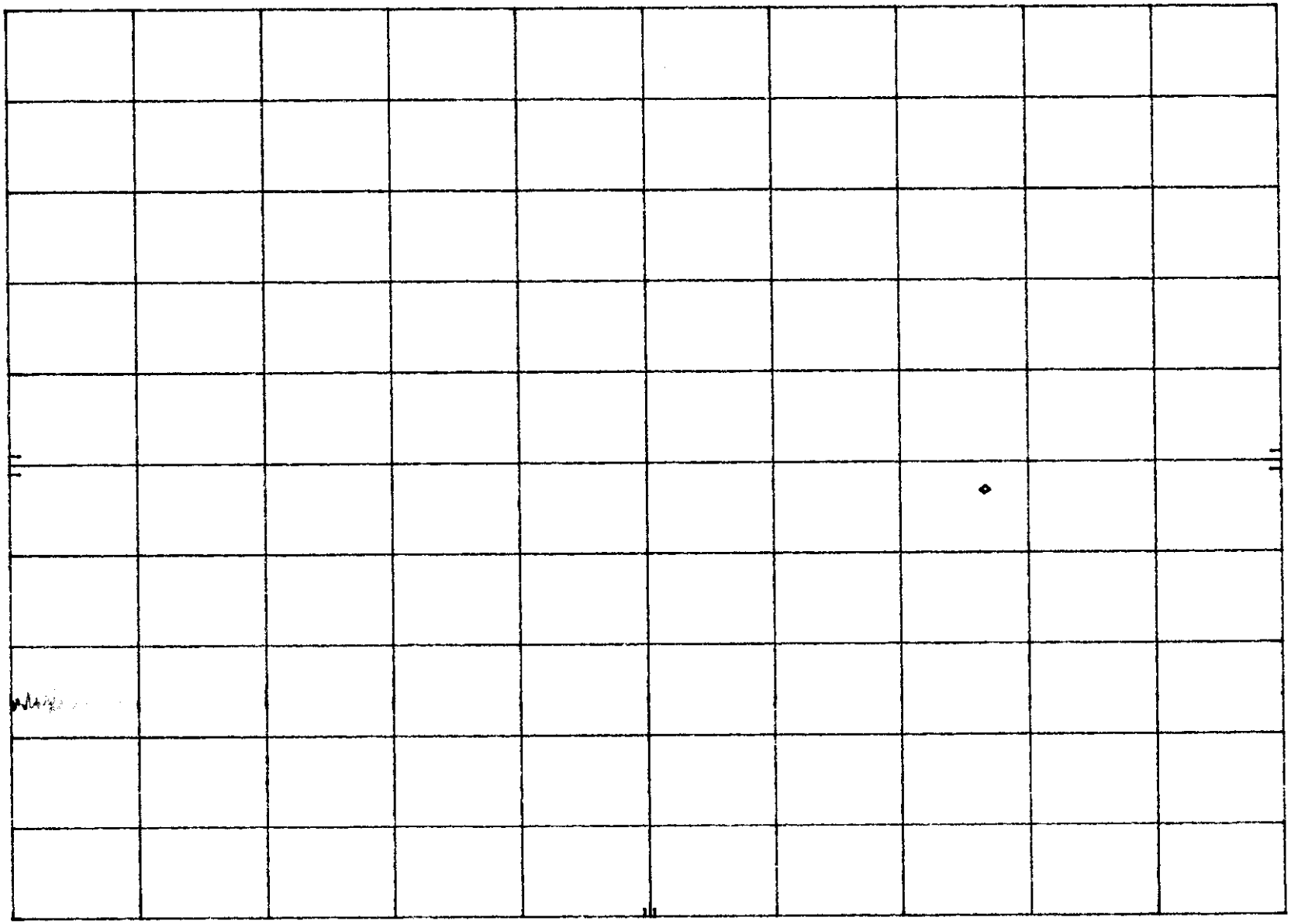
FURUNO

Plot 2.8

MKR 2.149 GHz
−43.10 dBm

REF 10.0 dBm ATTEN 20 dB

10 dB/

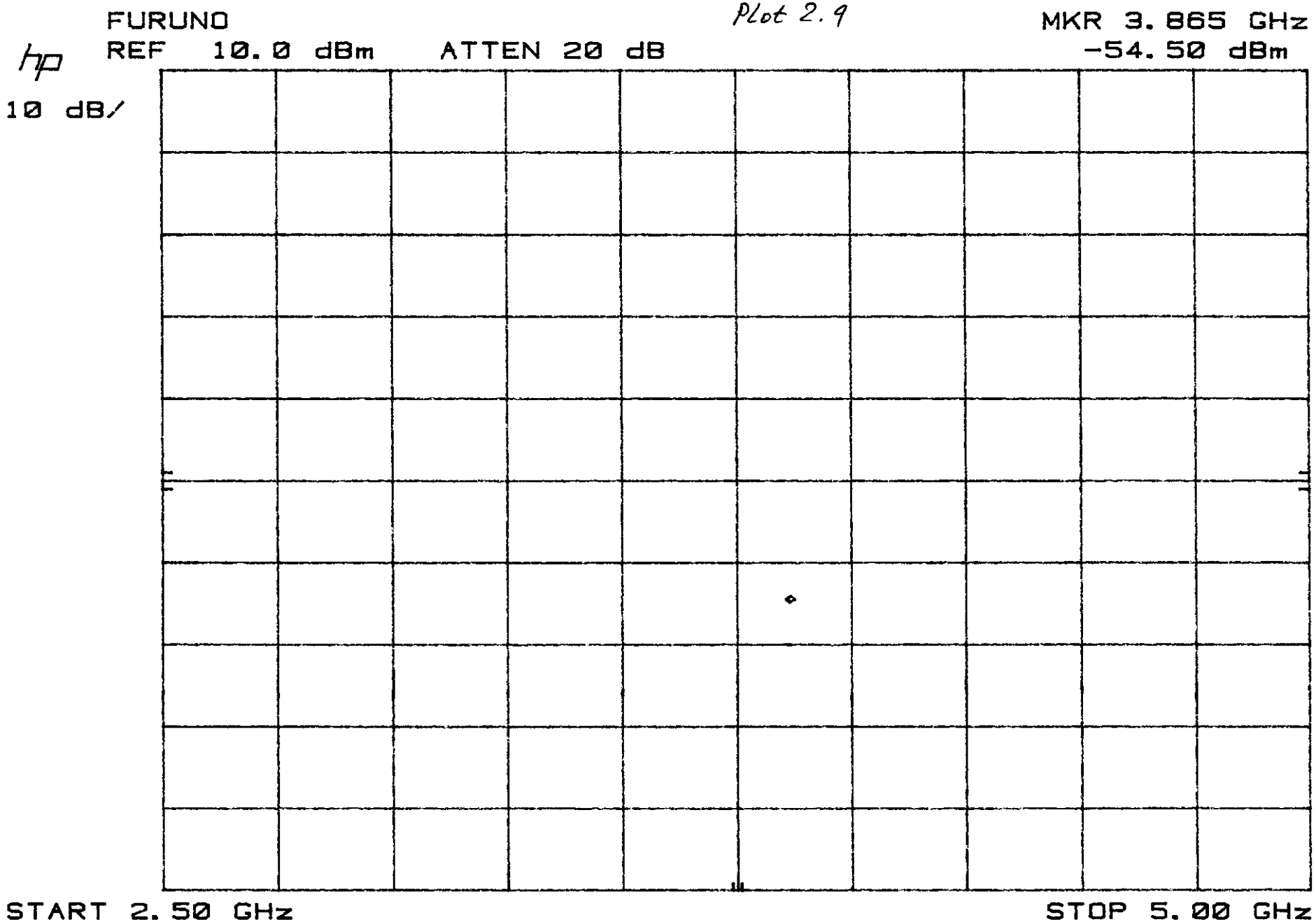


START 1.00 GHz

STOP 2.50 GHz

RES BW 100 kHz VBW 100 kHz SWP 450 msec

Plot 2.9


FURUNO
REF 10.0 dBm
ATTEN 20 dB
MKR 3.865 GHz
-54.50 dBm
10 dB/
START 2.50 GHz
STOP 5.00 GHz
RES BW 100 kHz
VBW 100 kHz
SWP 750 msec

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

CDI B100/200/300 Biconical Antennas
EMCO 3115 Horn Antenna
HP 8566B Spectrum Analyzer
Preamplifiers

6.4 Test Results

Refer to the data sheets below.

Spurious harmonic attenuation

Test site: #1
Test Engineer: D. Chernomordik
Operation Mode: Continuously transmitting at 429.55 MHZ

-30 req

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)	Spurious attenuat. dB	Margin dB
429.55	V	83.8	22.2	0	1.0	0	107.0	-	-
829.1	V	23.0	27.1	0	1.5	0	51.6	55.4	-32.6
1288.6	V	20.4	24.2	0	1.0	0	45.6	61.4	-38.6
1718.2	H	25.7	26.0	0	1.3	0	53.0	54.0	31.2
2147.7	H	36.4	27.6	0	1.6	0	65.6	41.4	-18.6
2577.3	H	29.8	28.1	0	2.0	0	59.9	47.1	-24.3
3006.8	H	29.7	30.2	0	2.4	0	62.3	44.7	-21.9
3436.4	H	20.0	31.3	0	2.8	0	54.1	52.9	-30.1
3865.9	H	15.0	32.2	0	3.3	0	50.5	56.5	-33.7
4295.5	H	14.0	32.4	0	4.0	0	50.4	56.6	-33.8

-25 etc

Note: Limit of spurious emission attenuation equals 43 +10Log(P) = 22.8 dB

50 - 20 = 30

Justification: Passed

FCC Part 15.109 Radiated Emission

Test site: #1
Test Engineer: D. Chernomordik
Operation Mode: Continuously transmitting at 429.55 MHz.

Frequency MHz	Antenna Pol.	SA Reading dB(uV)	Antenna Factor dB(1/m)	Pre-amp. Correct. dB	Cable loss dB	Field Strength dB(uV/m)	Limit dB(uV/m)	Margin dB
160.0	V	14.5	14.3	0	0.3	29.1	43.5	-14.4
180.0	V	21.4	17.0	0	0.5	38.9	43.5	-4.6
200.0	H	24.6	12.3	0	0.8	37.7	43.5	-5.8
220.0	H	23.0	11.8	0	1.0	35.8	46.0	-10.2
320.0	H	21.2	16.8	0	1.4	39.4	46.0	-6.6
340.0	H	21.5	16.6	0	1.6	39.7	46.0	-6.3
380.0	H	12.5	17.3	0	2.0	31.8	46.0	-14.2
420.0	H	11.5	19.2	0	2.5	33.2	46.0	-12.8
440.0	H	8.5	20.7	0	2.7	31.9	46.0	-14.1
480.0	H	16.3	19.0	0	3.0	38.3	46.0	-7.7
520.0	H	12.7	19.5	0	3.5	35.7	46.0	-10.3
560.0	H	13.2	19.7	0	4.0	36.9	46.0	-9.1

Note: All measurements were made at 3 m distance.
All other emissions not reported are at least 20 dB below the limit.
Frequency range investigated is from 30 to 1000 MHz.

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.

7.2 Test Configuration Setup - Line Conducted Emissions

Not applicable, the EUT is battery powered only.

7.3 Test Results

Not applicable, the EUT is battery powered only.

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)**
+50	429.548975	-1025
+40	429.549062	-938
+30	429.549495	-505
+20	429.549750	-250
+10	429.550275	275
0	429.550450	450
-10	429.550445	445
-20	429.550435	435
-30	429.550390	390

Justification: Passed

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: 429.55 MHz, Tolerance ±1074 Hz

Frequency Stability vs. Voltage		
Voltage	**Frequency (MHz)**	**Difference (Hz)**
5.52	429.550380	380
4.8	429.549750	-250
4.08	429.550355	355
3.8	429.550390	390

Justification: Passed

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 a modulated signal (FSK, 2400 bits/sec.). 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
2.10	Steady state. Transmitter OFF, RF generator ON (1 kHz tone, 12.5 kHz deviation),
2.11	Steady state. Transmitter ON (FSK, 2400 b/s), RF generator OFF.
2.12	Steady state. Transmitter ON (FSK, 2400 b/s), RF generator ON.*
2.13	RF generator ON, Transmitter was turned ON
2.14	The same as above
2.15	RF generator ON, Transmitter was turned ON, half scale
2.16	RF generator ON, Transmitter was turned OFF
2.17	RF generator ON, Transmitter was turned OFF, half scale
2.18	RF generator ON, Transmitter was turned OFF, 2 ms per division

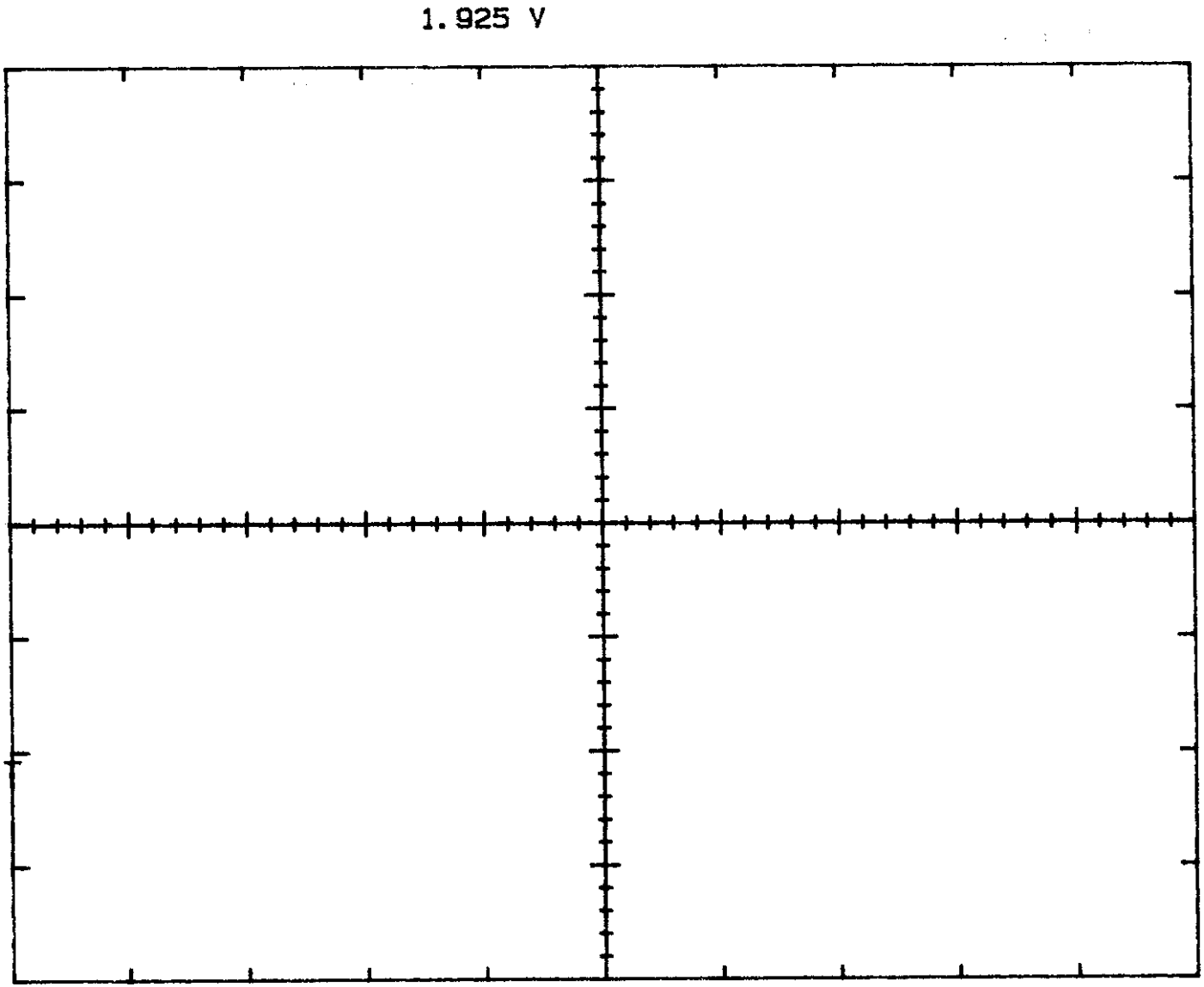
* As can be seen from plots 2.11 and 2.12 there is a smaal increment of the signal on the FM demodulator output caused by the generator's noise.

10.2 Test Result

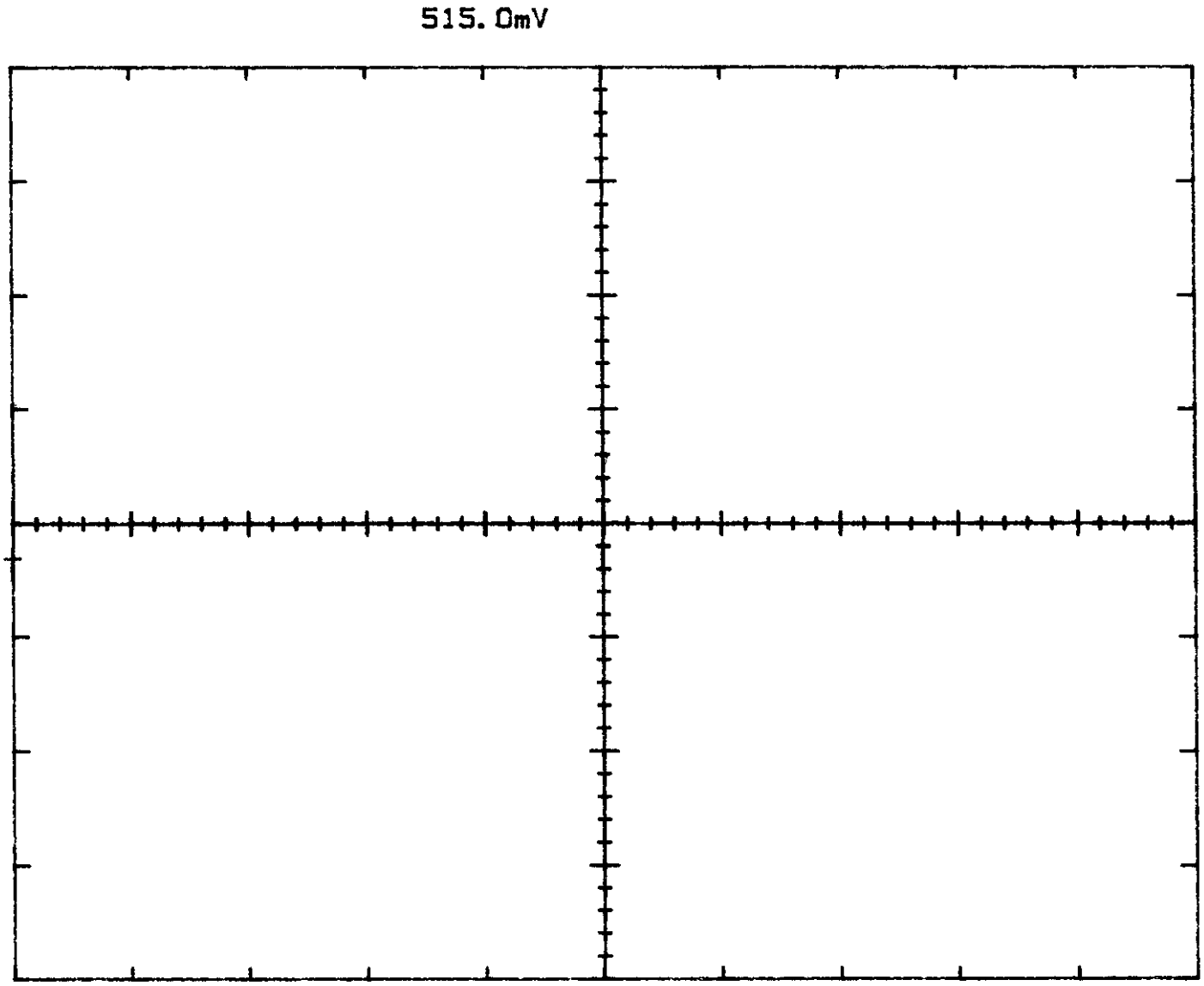
For the test result, see attached plots.

Note: The modulating signal of the transmitter and additional generator's noise (see plots 2.11 and 2.12) does not allow to show compliance with the requirement of the frequency tolerance ($\pm$2.5 ppm, $\pm$1074 Hz) during the time from the end of t_2 to the beginning of t_3 (see plots 2.13, 2.16). However, there is no difference between frequency behavior in transient mode and in steady state mode (compare plots 2.12 and 2.13) for above mentioned time. In this case, it can be considered that EUT passed the test.

Plot 2.10

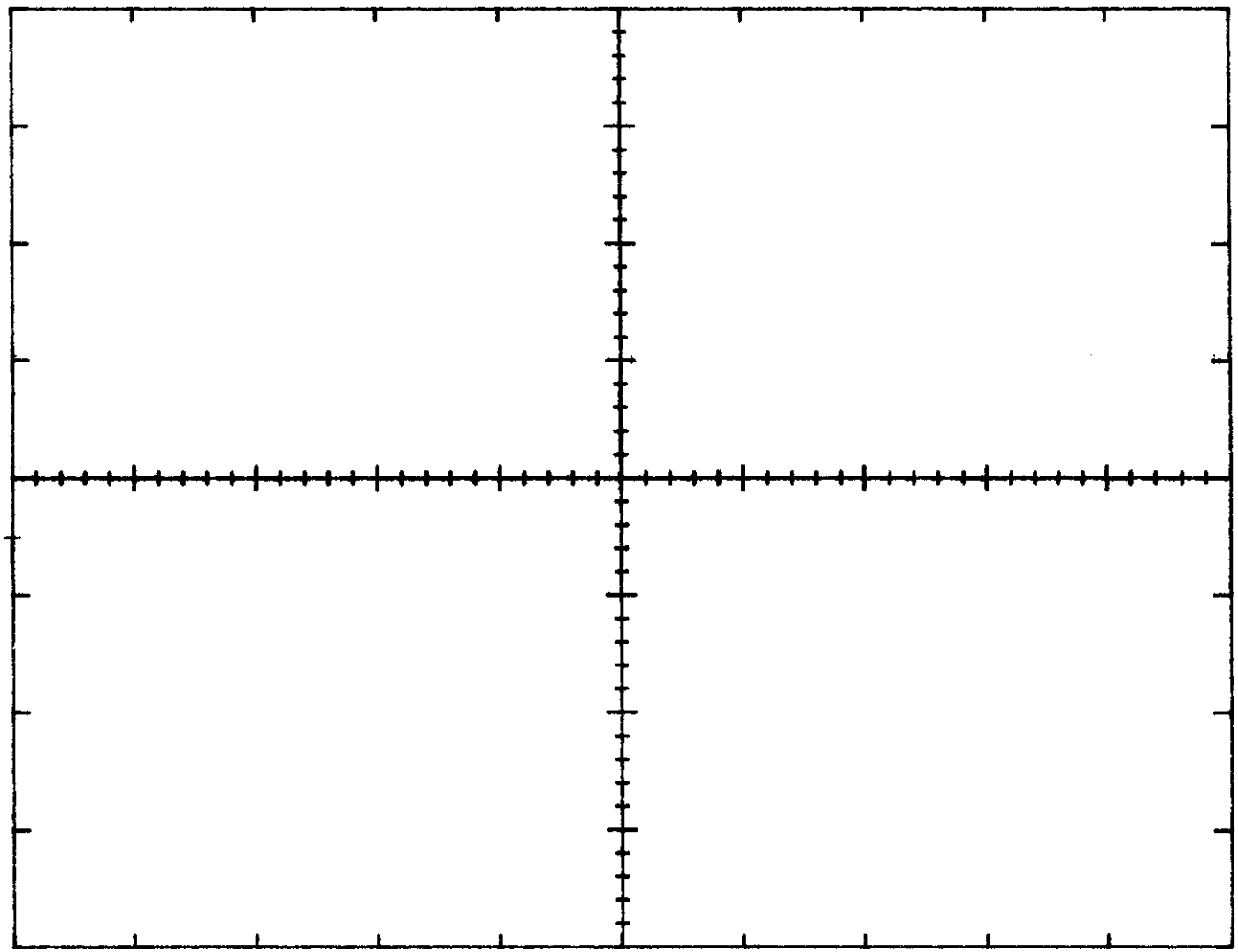


Plot 2.11

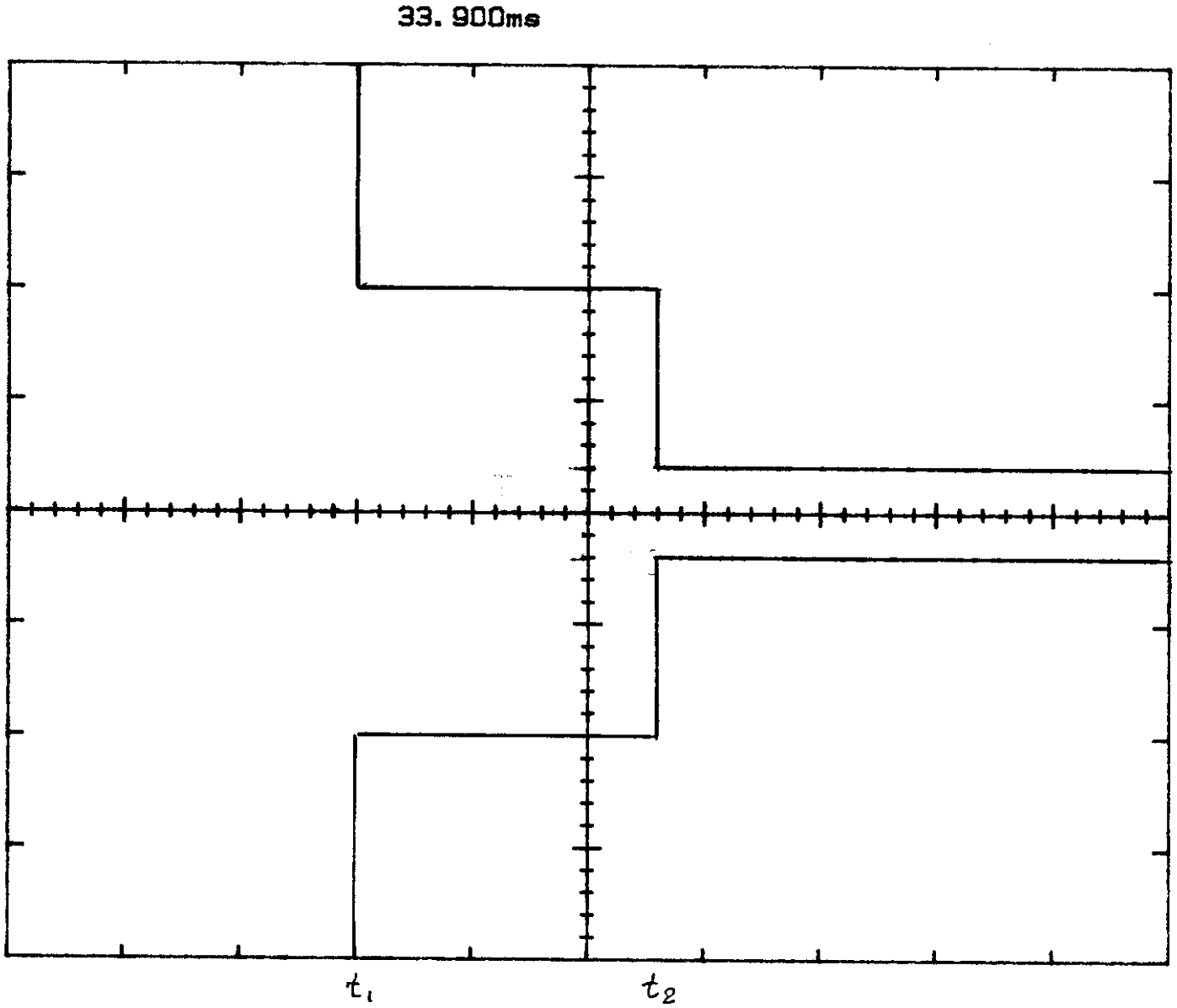


Plot 2.12

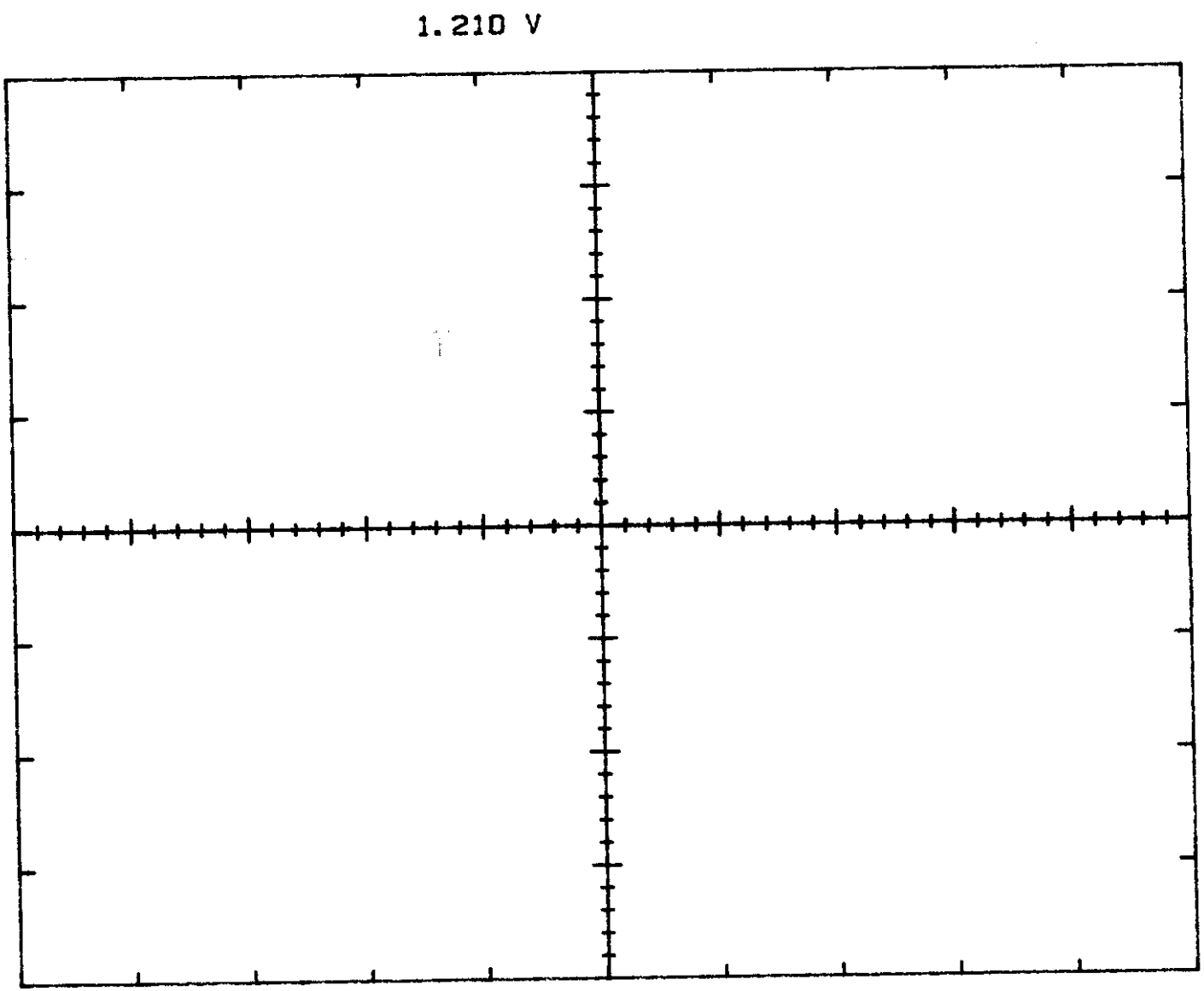
515.0mV



Plot 2.13

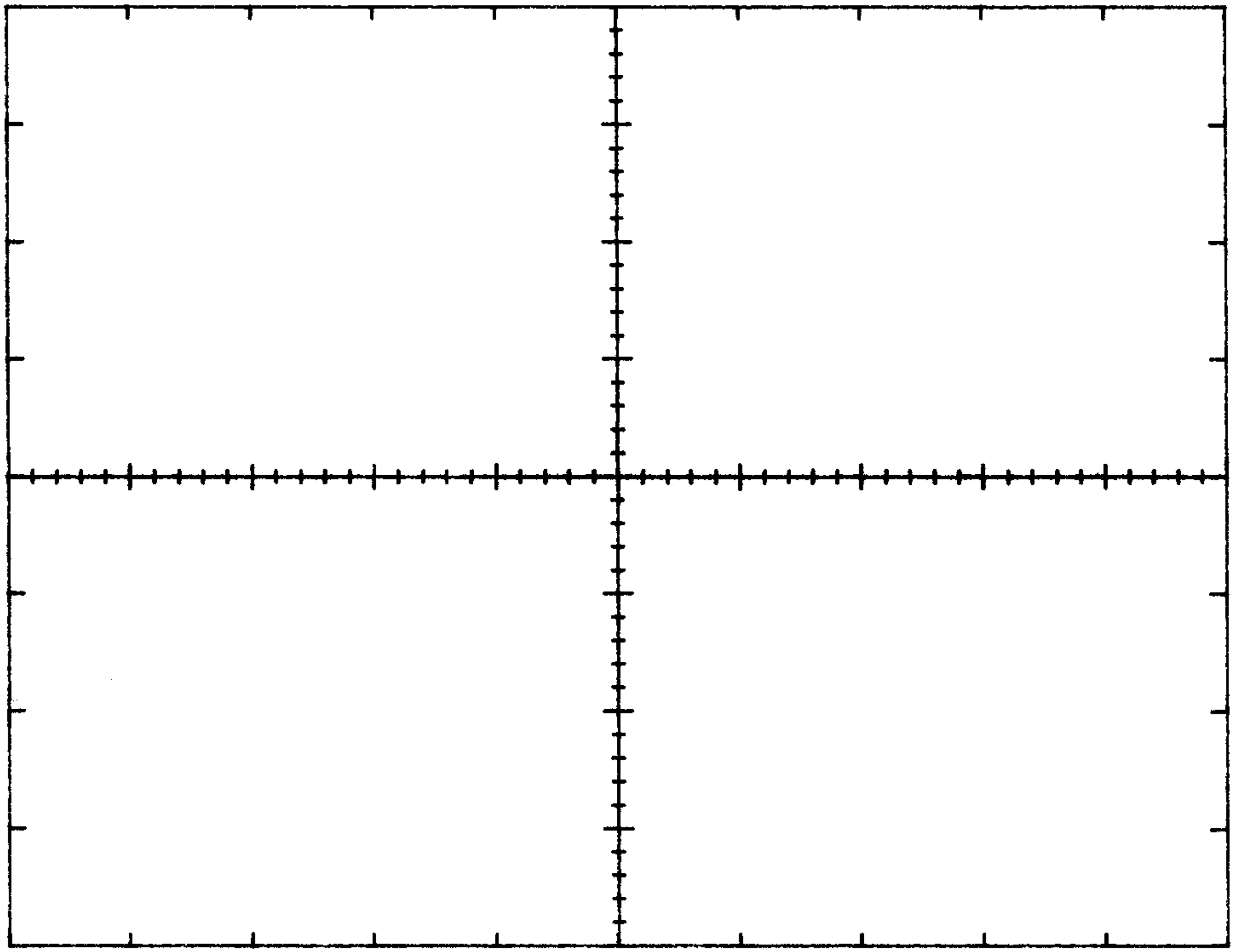


Plot 2.14

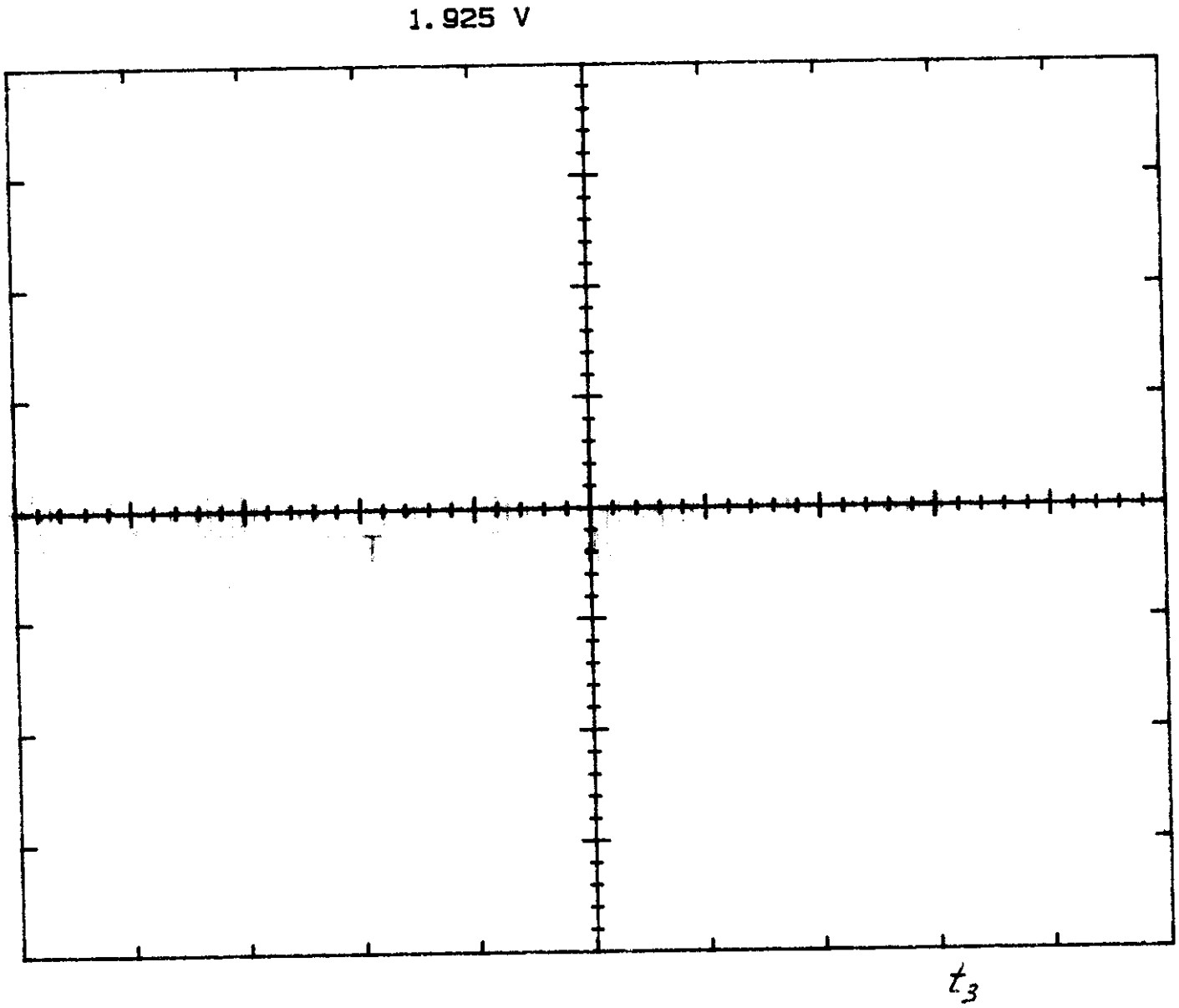


Plot 2.15

1.910 V

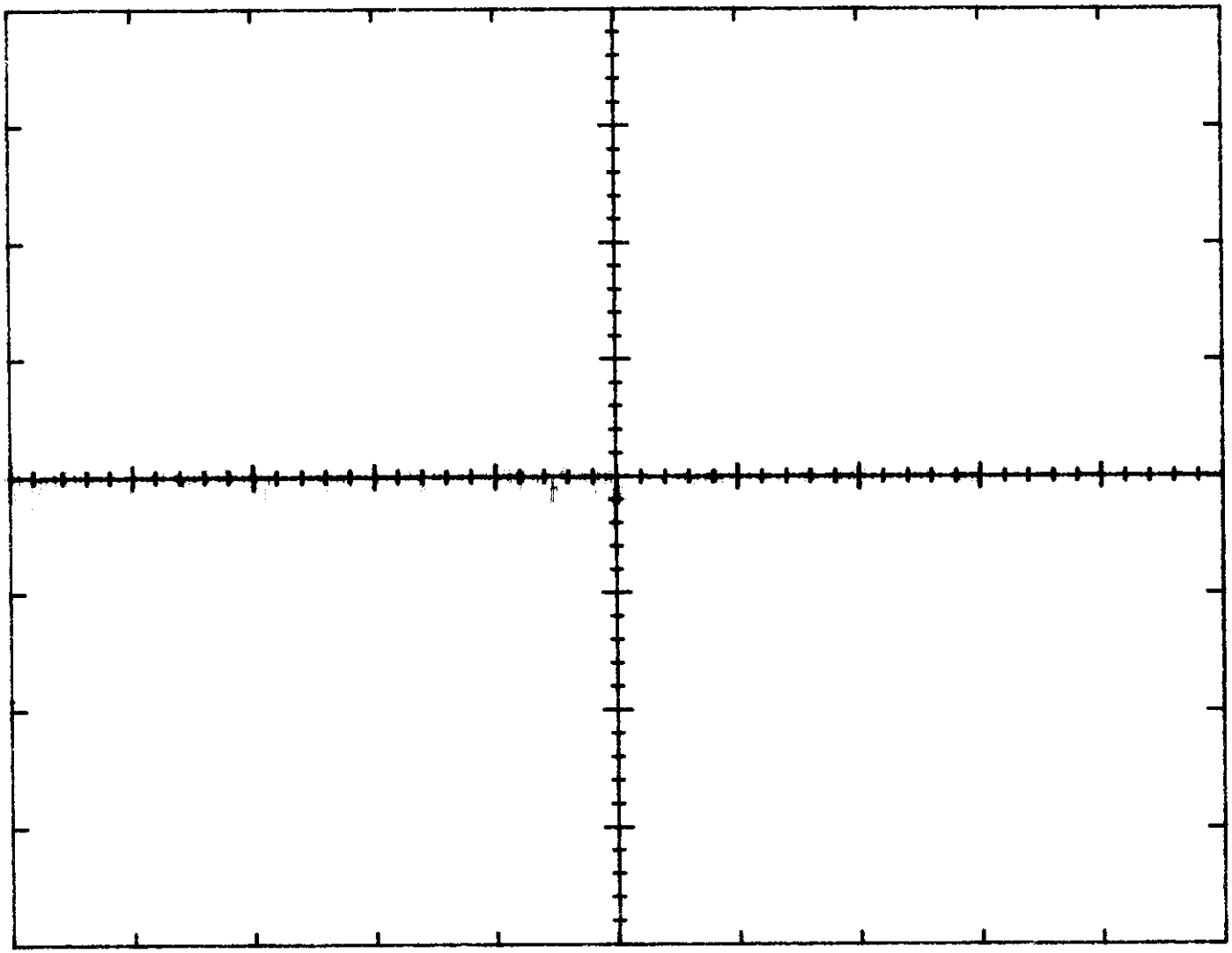


Plot 2.16



Plot 2.17

1.910 V



Plot 2.18

515.0mV