

FUTABA CORPORATION OF AMERICA

Application
For
Class II Permissive Changes
of the Futaba Wireless Modem with Pencil and Diversity Flat Antennas
(FCC ID: AZPFRH-SD03TU2)

June 9, 1999



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1.0 GENERAL DESCRIPTION

1.1 Related Submittals Grants

The Futaba Wireless Modem was tested by PDE Laboratories, INC on March 1997. The product was certified by the FCC as being in compliance with the requirement of sections 15.209 and 2.247 of FCC rules on February 10, 1998. This report describes the tests performed to support of a Class II permissive change. The changes made to the product are two additional antennas, which can be used with the wireless modem. No changes to the Futaba Wireless modem were made. The operating frequency range of the modem is 2433-2473 MHz. This is single application for Class II permissive change to 15.247(b) and 15.204(c). There are no other simultaneous applications.

1.2 Product Description

The Futaba Wireless modem Model: FRH-SD03TU (TTL Serial Interface), s/n 70200000
91-49275 Voltek AC Adapter, 9 VDC, 1.1A

The modem was connected to each of the following antennas during the tests:

Flat Diversity Antenna, p/n FAA01EJ010, gain 2.14dBi
Two extension cables (1m) p/n 1M38A01201
Pencil Type Antenna, Futaba p/n 01300069, gain 2.0dBi
SMA Conversion Adapter (F-F) p/n 1M10A01101

1.3 Test Methodology

Radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All measurements were performed in Open Area Test Sites. Preliminary scans were performed in the Open Area Test Sites only to determine worst case modes. For each scan, the procedure for maximizing emissions in Appendices D and E were followed. All Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

1.4 Test Facility

The test site facility used to collect the radiated and conducted measurement data is located at 7435 4th Street North, Oakdale, Minnesota. This test facility has been fully described in a report dated on September 1996 submitted to your office. Please reference the site filing number: 31040/SIT 1300F2, dated December 26, 1996.



2.0 SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was powered from 9VDC Power adapter. The EUT was set up as tabletop equipment and connected to the laptop computer via serial cable and set for continuous transmission of the text file. The receiving modem Futaba FRH-SD04TU was connected to the PC and placed out of the test site. The EUT was tested with pencil and flat antennas at the minimum (2433MHz), medium, and Maximum (2479 MHz) operating frequency. The EUT was set up in Operation Mode 1-Data Transparent Mode 1 and transmission rate 19200bit per second; DIP Switches 1 and 2 ON, DIP Switches 3-8 OFF.

2.2 EUT Exercising Software

The system was exercised in Operating Mode 1-Data Transparent Mode with transmission rate 19200 bps. The text file was continuously transmitted from the EUT to the remote host unit (receiver).

Data setting

Data length: 8 bits, Stop Bit Length: 1 bit, Parity Bit: None

Flow Control: XON/XOFF

2.3 Special Accessories

There are no special accessories necessary for compliance of these products.

2.4 Equipment Modification

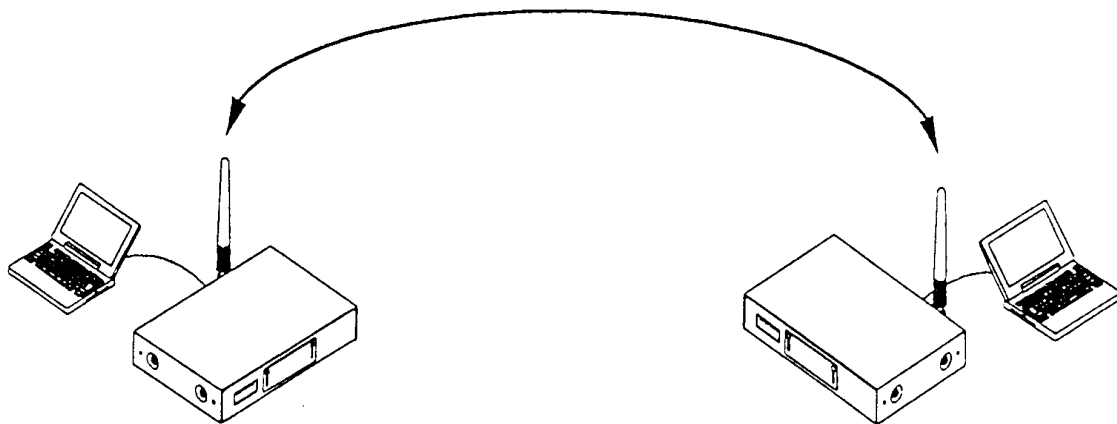
No modifications were installed during the testing.

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2.5 Support Equipment List and Description

KEYBOARD	GATEWAY 2000 KEYTRONIC 104+, P/N 7001049
MOUSE	MICROSOFT INTELLIMOUSE, P/N 7001047
MOUSE	IBM 13H6690, S/N 23-635534
Lap top computer	IBM 2620-80F, s/n 78-Z4671
Minitower computer	Gateway 2000p/n 3500435
Receiver	Futaba FRH-SD05TU, s/n 810001 with Converter No 4

2.6 Test Configuration Block Diagram (see Exhibit I)



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3.0 EMISSION RESULTS

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and graphical representations of the emissions are included.

3.1 Field Strength Calculation

The field strength is calculated by adding the Peak reading on the EMI Receiver to the factors associated with preamplifiers (if any), antennas and cables. A sample calculation is included below.

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in dB μ V/m

RA = Receiver Amplitude (including preamplifier) in dB μ V

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

Assume a receiver reading of 47 dB μ V is obtained. The antenna factor of 19.5 dB and cable factor of 3.5 dB is added. The net field strength for comparison to the appropriate emission limit is 70 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(70 \text{ dB}\mu\text{V/m})/20] = 3162.3 \mu\text{V/m}$$

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3.2 Radiated Emission Data (see Exhibit II)

Radiated emissions were measured for signals within forbidden bands of 15.205. These frequencies, for 2433-2479 MHz transmitters, are:

- 2nd harmonic (4866-4958 MHz)
- 3rd harmonic (7299-7437 MHz)
- 5th harmonic (12165-12395 MHz)
- 8th harmonic (19464-19832 MHz), and
- 9th harmonic (21897-22311MHz)

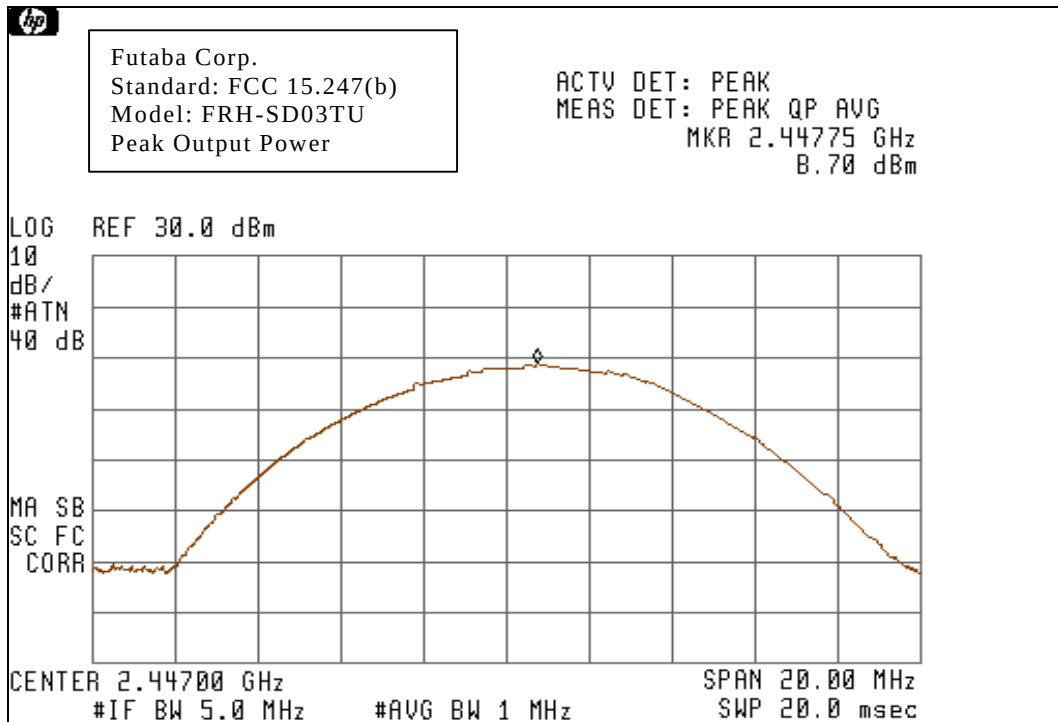
All other harmonic emissions (for 2433-2479 MHz transmitters) are outside of the forbidden bands. All readings are **Peak** unless stated otherwise.

The power output within the band 2433- 2479 MHz was measured at the Wireless modem antenna output port and the Spectrum Analyzer. The output of the modem was connected to a HP 85462A Analyzer via 6" RG-8 coaxial cable with SMA adapter. The result of this measurement was 8.7dBm (including 0.1dBm cable loss). See Graph 1. The requirement is that the peak power in the band 2400-2483.5 MHz must not exceed 1 Watt (30dBm).

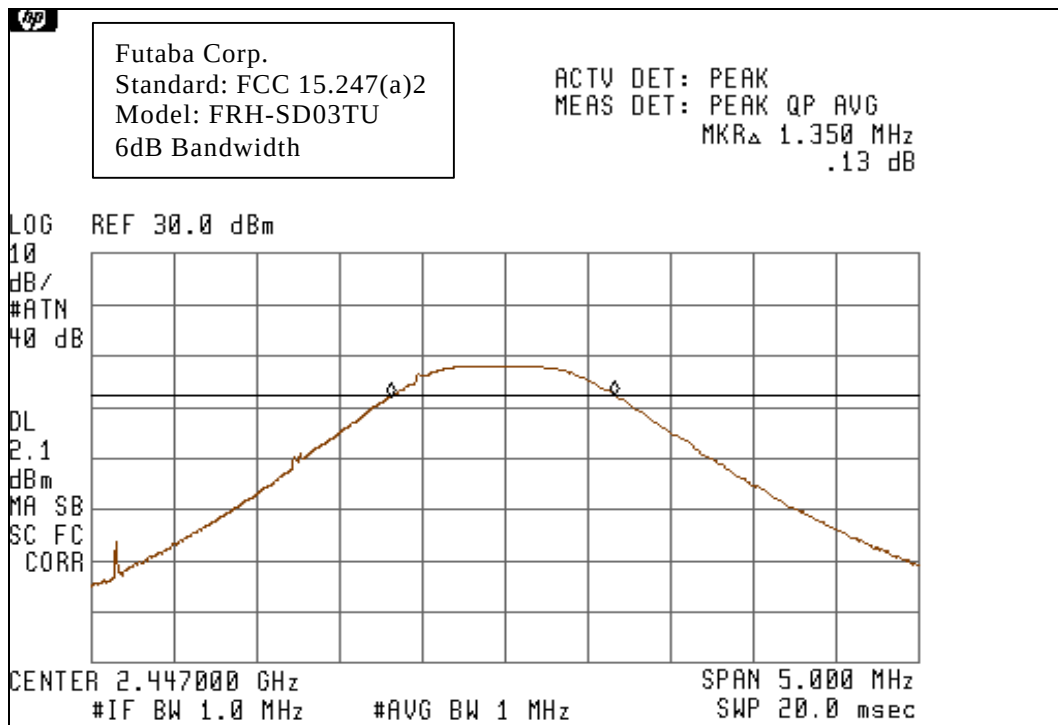
The operating bandwidth was measured while the modem was sending typical data. The resolution bandwidth of the spectrum analyzer was 1MHz, and 6dB bandwidth was 1.35 MHz. See Graph 2. The minimum bandwidth for direct sequence spread spectrum transmitters is 500 kHz.

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Graph 1



Graph 2



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3.3 TEST EQUIPMENT

Receivers/Spectrum Analyzers

DESCRIPTION	SERIAL NO.	LAST CAL DATE	CAL DUE	TICK IF USED
HP 85462A Receiver RF Section	3325A00106	09/98	09/99	X
HP 85460A RF Filter Section	3330A00109	09/99	09/99	X
Advantest R3271A	55050084	03/99	03/00	X
HP 83017A Microwave Amplifier	3123A00475	03/99	03/99	X

Antennas

DESCRIPTION	SERIAL NO	LAST CAL DATE	CAL DUE	TICK IF USED
Schaffner-Chase Bicono-Log Antenna	2468	08/98	08/99	
EMCO Horn antenna 3115	9507-4513	07/98	07/99	X
EMCO Log-Periodic Antenna	4515	01/99	01/00	

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4.0 Test Procedures

The EUT is warmed up for 15 minutes prior to the test. Measurements of the signals from this unit were made at all harmonic frequencies, which could fall within forbidden band. A double ridge guide horn was used. The maximum permissible output level outside the 2400-2483.5 MHz band is more than 20 dB below the maximum in band power level. The horn antenna was mounted to the antenna mast and placed at distance of 3 meters from the Wireless modem. Measurements were made of the radiated emissions in the frequency range 1 GHz to 24 GHz. When an emission was detected, the antenna height and the position of the turntable were adjusted through their full range to maximize the signal. The measurements were made in both horizontal and vertical polarization. The data were then reduced by applying the antenna factors and cable loss factors and the data tabulated together with the limit. Please note that an average factor of 20dB was applied to the peak signal level. The IF Bandwidth or Resolution Bandwidth used for measurement of radiated signal strength was 1 MHz. Measurements below 6GHz have been taken using HP 85462A receiver and above 6GHz by Advantest R3271A spectrum analyzer.

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EXHIBIT I

CONFIGURATION PHOTOGRAPHS

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See Test Setup Photograph Files

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EXHIBIT II

EMISSIONS TEST DATA

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Radiated Emissions

Date:

03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions

All measurements were taken using a Peak detector

Pencil Antenna

Fundamental Frequency 2443 MHz

Table # 1

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Margin dB
V	4886*	24.6	35.7	4.7	0.0	65.0	54	20	-9.0
H	4886*	14.3	35.4	4.7	0.0	54.4	54	20	-19.6
V	7329*	36.3	38.4	5.6	35.2	45.1	54	20	-28.9
H	7329*	27.2	38.3	5.6	35.2	35.9	54	20	-38.1
V	9772	28.5	39.8	6.8	34.0	41.1	54	20	-32.9
H	9772	27.8	38.9	6.8	34.0	39.5	54	20	-34.5
V	12215*	24.9	41.9	7.5	33.5	40.8	54	20	-33.2
H	12215*	24.8	41.7	7.5	33.5	40.5	54	20	-33.5
V	14658	24.8	41.7	8.3	32.8	42.0	54	20	-32.0
H	14658	24.8	41.6	8.3	32.8	41.9	54	20	-32.1

Note: No Radiated emissions were detected above the floor noise after 5th harmonic

RB 1MHz

* Harmonics in the forbidden band 15.205

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Radiated Emissions

Date: 03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions

All measurements were taken using a Peak detector

Flat Antenna

Fundamental Frequency 2443 MHz

Table # 2

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Margin dB
V	4886*	22.5	35.7	4.7	0.0	62.9	54	20	-11.1
H	4886*	32.9	35.4	4.7	0.0	73.0	54	20	-1.0
V	7329*	31.6	38.4	5.6	35.2	40.4	54	20	-33.6
H	7329*	57.0	38.3	5.6	35.2	65.7	54	20	-8.3
V	9772	28.1	39.8	6.8	34.0	40.7	54	20	-33.3
H	9772	31.9	38.9	6.8	34.0	43.6	54	20	-30.4
V	12215*	27.4	41.9	7.5	33.5	43.3	54	20	-30.7
H	12215*	27.3	41.7	7.5	33.5	43.0	54	20	-31.0
V	14658	28.4	41.7	8.3	32.8	45.6	54	20	-28.4
H	14658	28.3	41.6	8.3	32.8	45.4	54	20	-28.6

Note: No Radiated emissions were detected above the floor noise after 5th harmonic
RB 1MHz

* Harmonics in the forbidden band 15.205

A

Radiated Emissions

Date: 03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions
All measurements were taken using a Peak detector

Pencil Antenna

Fundamental Frequency 2449 MHz

Table # 3

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Mar
V	4898	24.1	35.7	4.7	0.0	64.5	54	20	-9.
H	4898	14.6	35.4	4.7	0.0	54.7	54	20	-19
V	7374	47.3	38.4	5.6	35.2	56.1	54	20	-17
H	7374	31.4	38.3	5.6	35.2	40.1	54	20	-33
V	9796	27.9	39.8	6.8	34.0	40.5	54	20	-33
H	9796	27.7	38.9	6.8	34.0	39.4	54	20	-34
V	12245	28.4	41.9	7.5	33.5	44.3	54	20	-29
H	12245	27.3	41.7	7.5	33.5	43.0	54	20	-31
V	14694	29.5	41.7	8.3	32.8	46.7	54	20	-27
H	14694	29.4	41.6	8.3	32.8	46.5	54	20	-27

Note: No Radiated emissions were detected above the floor noise after 5th harmonic

RB 1MHz

* Harmonics in the forbidden band 15.205

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Radiated Emissions

Date: 03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions

All measurements were taken using a Peak detector

Flat Antenna

Fundamental Frequency 2449 MHz

Table # 4

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Margin dB
V	4898*	23.5	35.7	4.7	0.0	63.9	54	20	-10.1
H	4898*	32.2	35.4	4.7	0.0	72.3	54	20	-1.7
V	7374*	33.1	38.4	5.6	35.2	41.9	54	20	-32.1
H	7374*	56.5	38.3	5.6	35.2	65.2	54	20	-8.8
V	9796	27.7	39.8	6.8	34.0	40.3	54	20	-33.7
H	9796	29.0	38.9	6.8	34.0	40.7	54	20	-33.3
V	12245*	26.4	41.9	7.5	33.5	42.3	54	20	-31.7
H	12245*	26.6	41.7	7.5	33.5	42.3	54	20	-31.7
V	14694	29.4	41.7	8.3	32.8	46.6	54	20	-27.4
H	14694	29.8	41.6	8.3	32.8	46.9	54	20	-27.1

Note: No Radiated emissions were detected above the floor noise after 5th harmonic

RB 1MHz

* Harmonics in the forbidden band 15.205

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Radiated Emissions

Date: 03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions

All measurements were taken using a Peak detector

Pencil Antenna

Fundamental Frequency 2479 MHz

Table # 5

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Margin dB
V	4958*	28.9	35.7	4.7	0.0	69.3	54	20	-4.7
H	4958*	16.3	35.4	4.7	0.0	56.4	54	20	-17.6
V	7437*	54.0	38.4	5.6	35.2	62.8	54	20	-11.2
H	7437*	28.0	38.3	5.6	35.2	36.7	54	20	-37.3
V	9916	31.3	39.8	6.8	34.0	43.9	54	20	-30.1
H	9916	27.2	38.9	6.8	34.0	38.9	54	20	-35.1
V	12395*	26.8	41.9	7.5	33.5	42.7	54	20	-31.3
H	12395*	26.9	41.7	7.5	33.5	42.6	54	20	-31.4
V	14874	26.7	41.7	8.3	32.8	43.9	54	20	-30.1
H	14874	27.8	41.6	8.3	32.8	44.9	54	20	-29.1

Note: No Radiated emissions were detected above the floor noise after 5th harmonic
RB 1MHz

* Harmonics in the forbidden band 15.205

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Radiated Emissions

Date: 03-26-99

Company:

FUTABA Corp.

Nmodel No.:

FRH-SD03TU

Test Engineer:

Norman Shpilsher

Special Config. Info:

Standard:

FCC Part 15, Subpart C, 15.209

Note:

The table shows the worst case radiated emissions
All measurements were taken using a Peak detector

Flat Antenna

Fundamental Frequency 2479 MHz

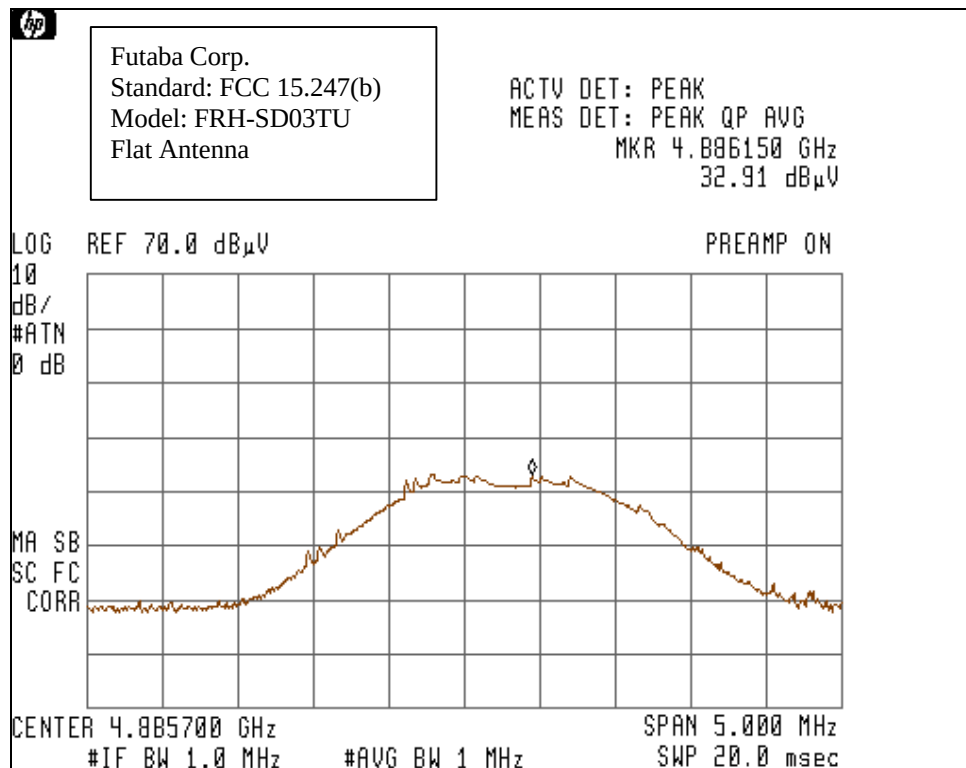
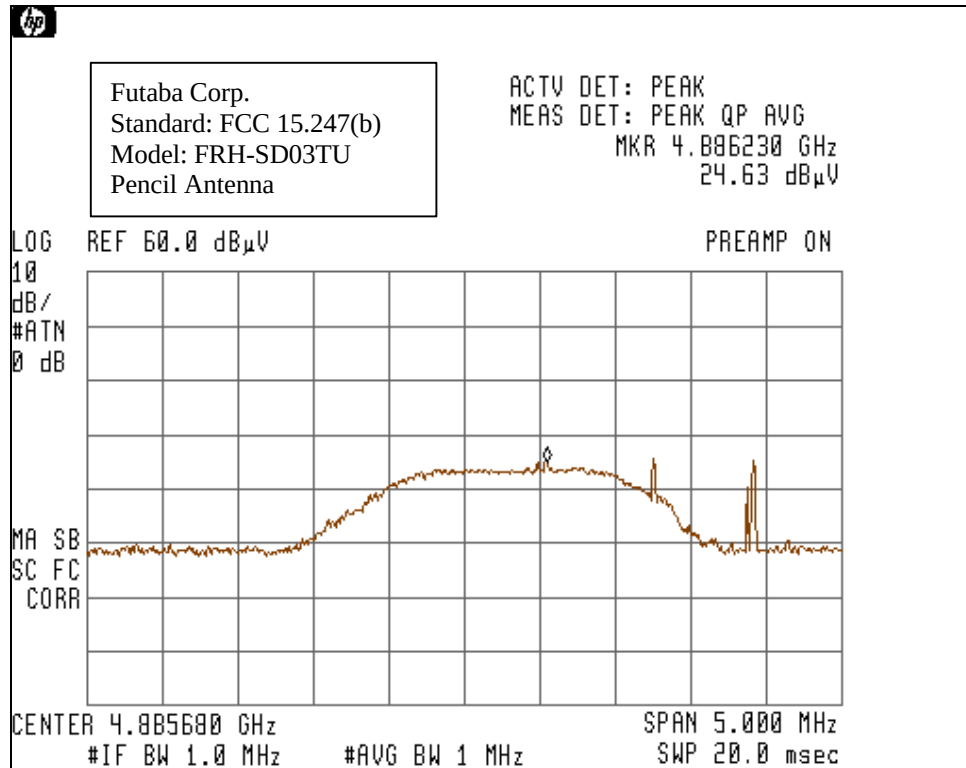
Table # 6

Antenna Polarity	Frequency MHz	Peak Reading dBuV	Antenna Factor(dB/m)	Cable Factor(dB)	Amplifier Gain(dB)	Net at 3m. dBuV/m	Limit dBuV/m	Peak Corr. Factor(dB)	Ma
V	4958*	21.3	35.7	4.7	0.0	61.7	54	20	-1.7
H	4958*	32.3	35.4	4.7	0.0	72.4	54	20	-1.7
V	7437*	30.4	38.4	5.6	35.2	39.2	54	20	-3.7
H	7437*	58.4	38.3	5.6	35.2	67.1	54	20	-6.7
V	9916	28.4	39.8	6.8	34.0	41.0	54	20	-3.7
H	9916	38.1	38.9	6.8	34.0	49.8	54	20	-2.7
V	12395*	27.5	41.9	7.5	33.5	43.4	54	20	-3.7
H	12395*	26.9	41.7	7.5	33.5	42.6	54	20	-3.7
V	14874	26.6	41.7	8.3	32.8	43.8	54	20	-3.7
H	14874	27.8	41.6	8.3	32.8	44.9	54	20	-2.7

Note: No Radiated emissions were detected above the floor noise after 5th harmonic
RB 1MHz

* Harmonics in the forbidden band 15.205

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EXHIBIT II

ANNTENNAS TECHNICAL SPECIFICATIONS

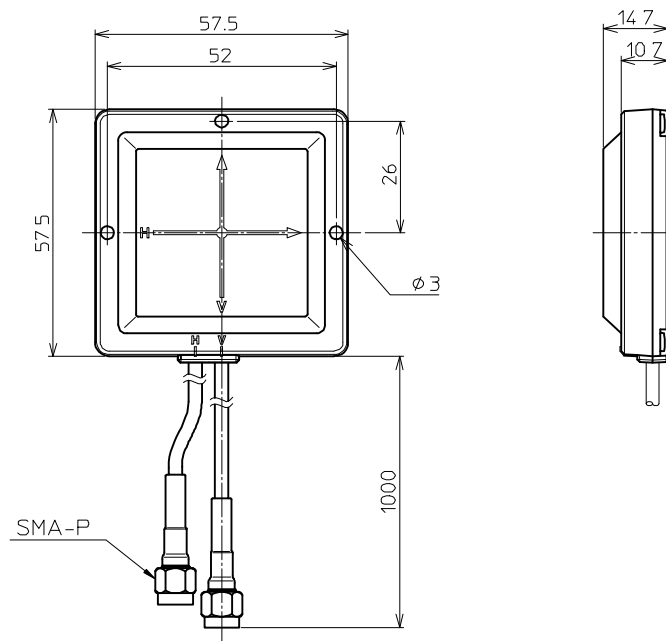
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Flat Antenna for diversity (Futaba P/N FAA01EJ010)

1. Specifications

frequency range :	2400~2497MHz
impedance :	50 Ω
reflection loss :	10 dB min.
gain :	2.14 dBi max.
maximum input power :	0.5 W
cable :	1.5D2V or equivalent
connector :	SMA-P
environment condition :	suitable for outdoor use

2. Dimensions (mm)



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Pencil type antenna

1. Specifications

frequency Range : 2400~2497MHz
impedance : 50 Ω
VSWR : 2.1 max.
gain : 2.0 dBi max.
maximum input power : 0.5 W
connector : SMA-P
environment condition : suitable for outdoor use

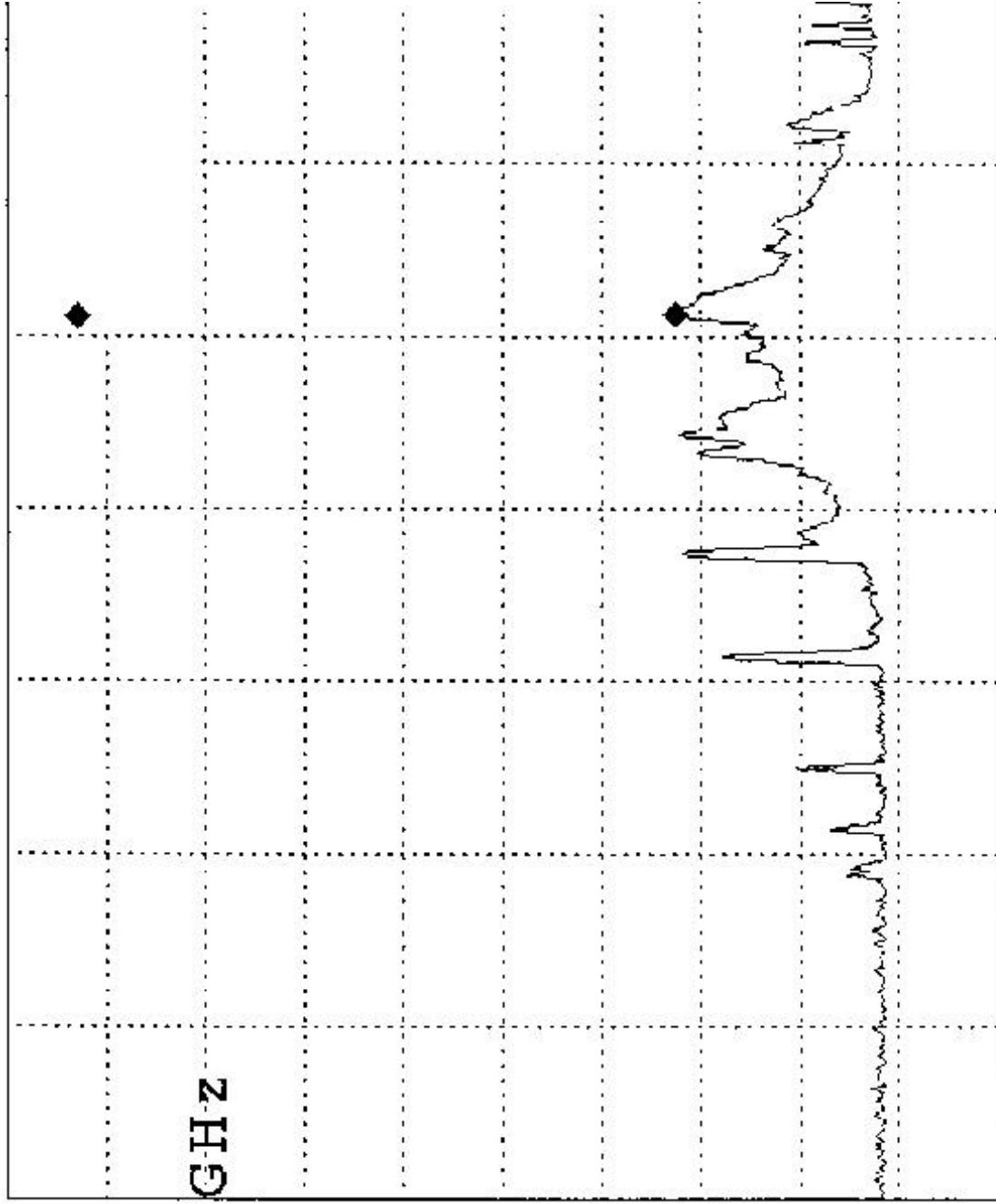
2. Dimensions (mm)



Futaba Corp.
Standard FCC 15.247(b)
Model PRH-SD33TU
Pencil Antenna Band Freq. 2465 MHz

REF 70.0 dB μ V ATT 0 dB Sat Ma
5dB/

MKR
7.32913 GHz



RBW 1 MHz
VBW 3 kHz
SWP 50 ms

CENTER 7.32900 GHz

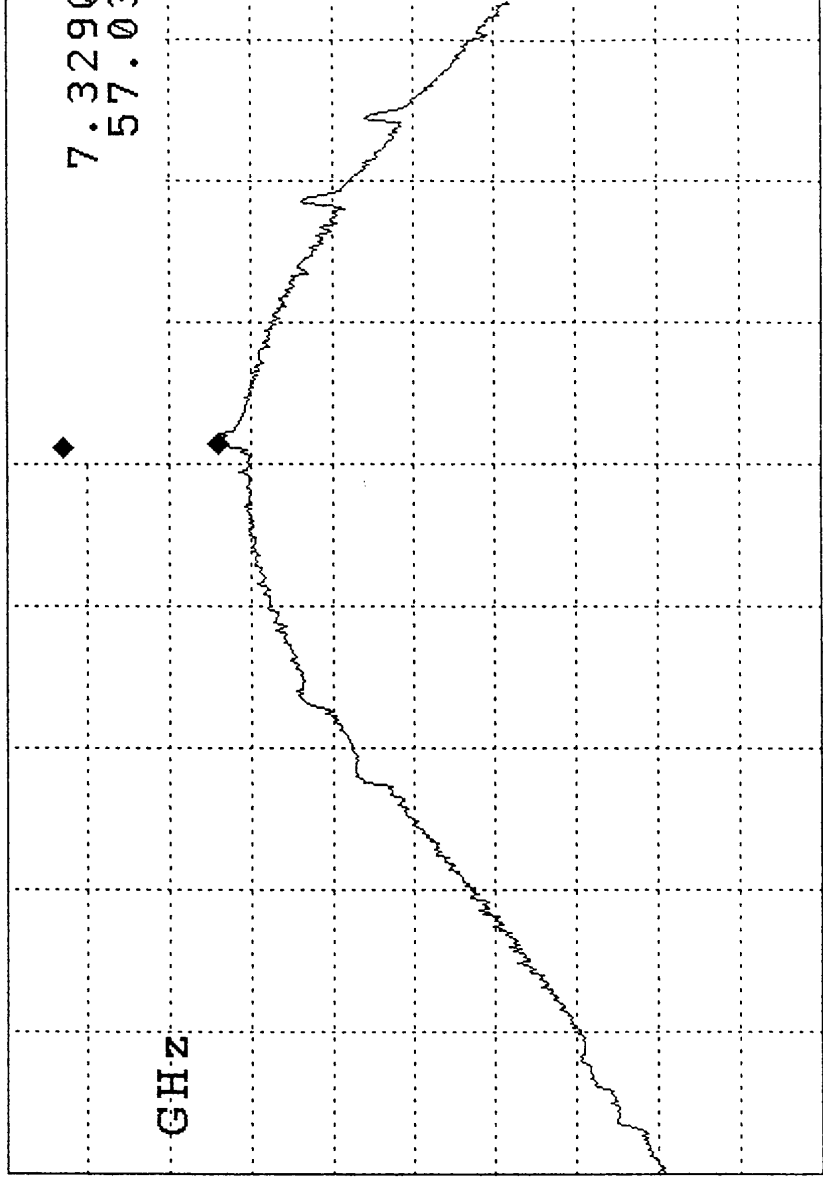
S

Futaba Corp.
Standard: FCC15.247(b)
Model: FRH-SD03TU
Flat Antenna, Fund. Freq. 2443 MHz

REF 70.0 dB μ V ATT 0 dB Sat Mar 27 07: A_write&r
5dB/

MKR 7.329071 GHz

7.3290
57.03



RBW 1 MHz
VBW 3 kHz
SWP 50 ms

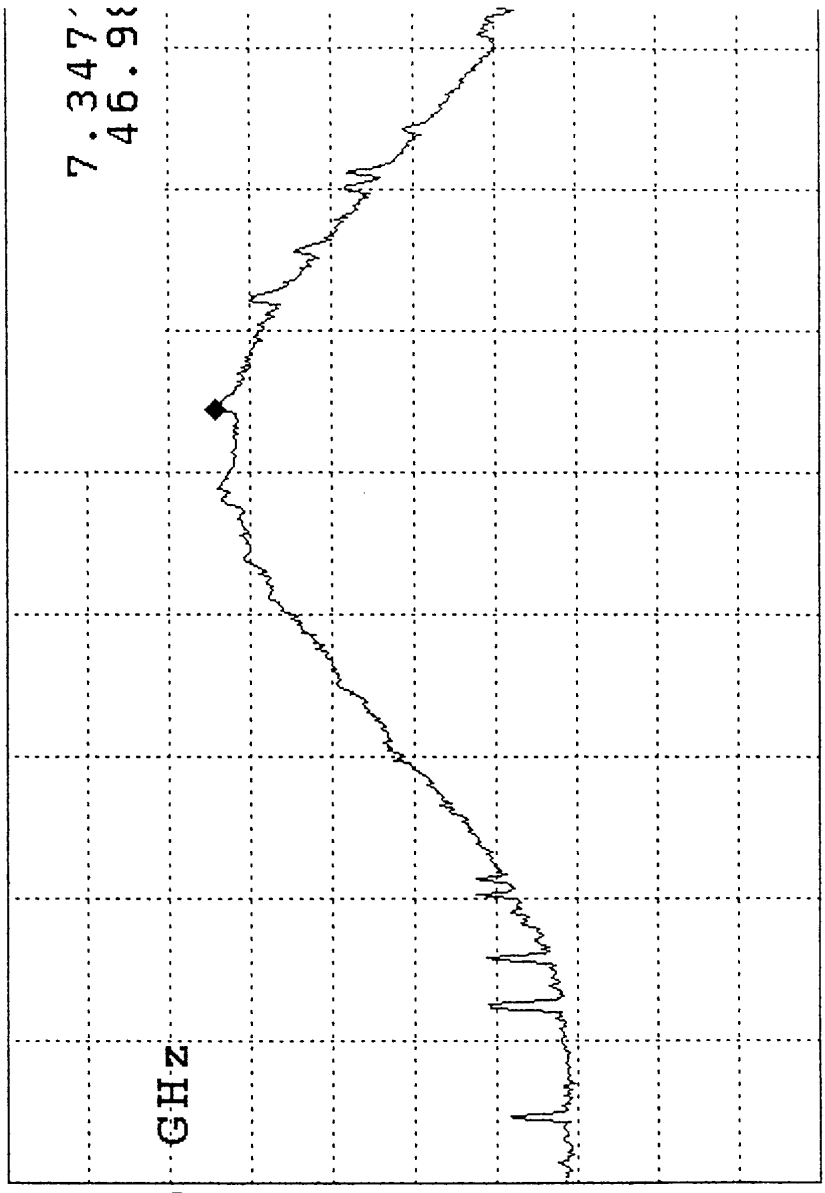
Futaba Corp.
Standard: FCC IS.247(b)
Model: FRIH-SD03TU
Pencil Antenna, Fund. Freq. 2449 MHz

REF 59.8 dBμV ATT 0 dB Sat Mar 27 01: A_write&n
5dB/

MKR 7.347155 GHz

7.3471
46.98

RBW 1 MHz
VBW 3 kHz
SWP 50 ms



CENTER 7.346933713 GHz SPAN 1

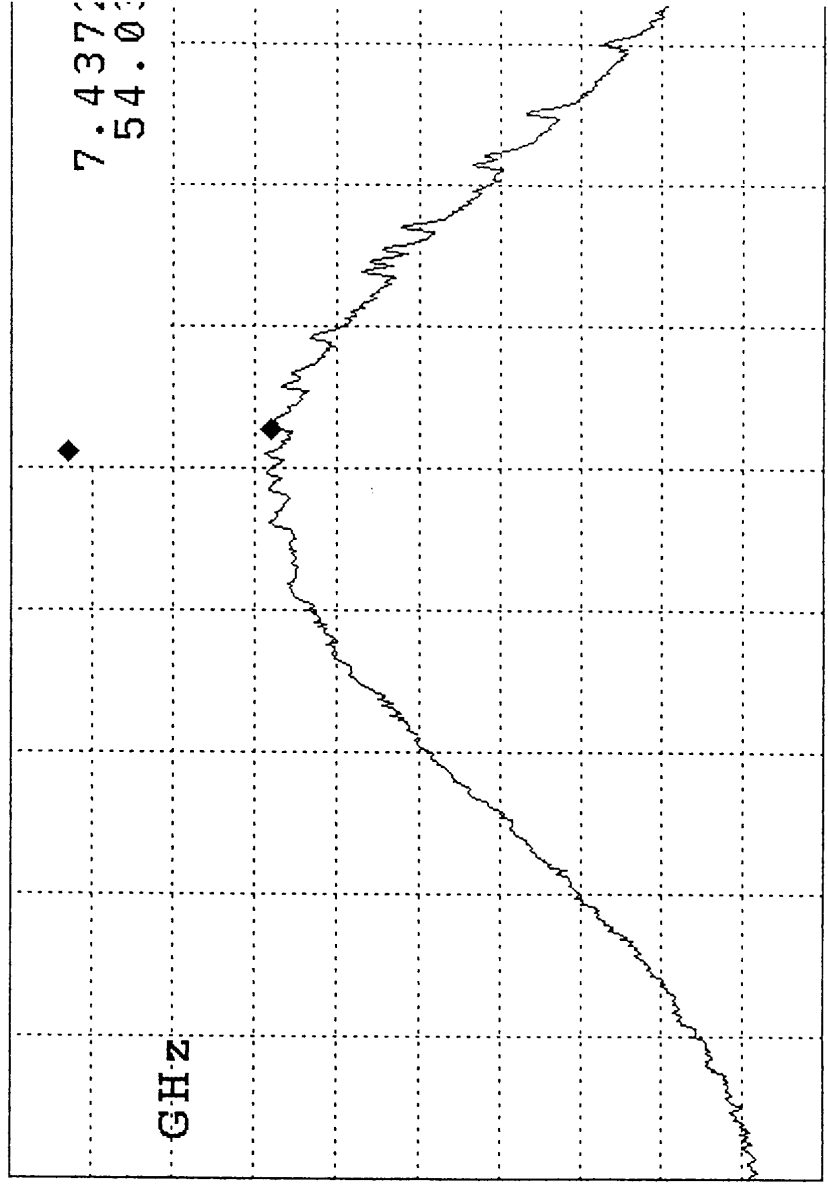
Futaba Corp.
Standard: FCC 15.247(b)
Model: FRH-SD03TU
Pencil Antenna, Fund. Freq. 2479 MHz

REF 70.0 dB μ V ATT 0 dB Sat Mar 27 05:
5dB/ A_write

MKR 7.437238 GHz

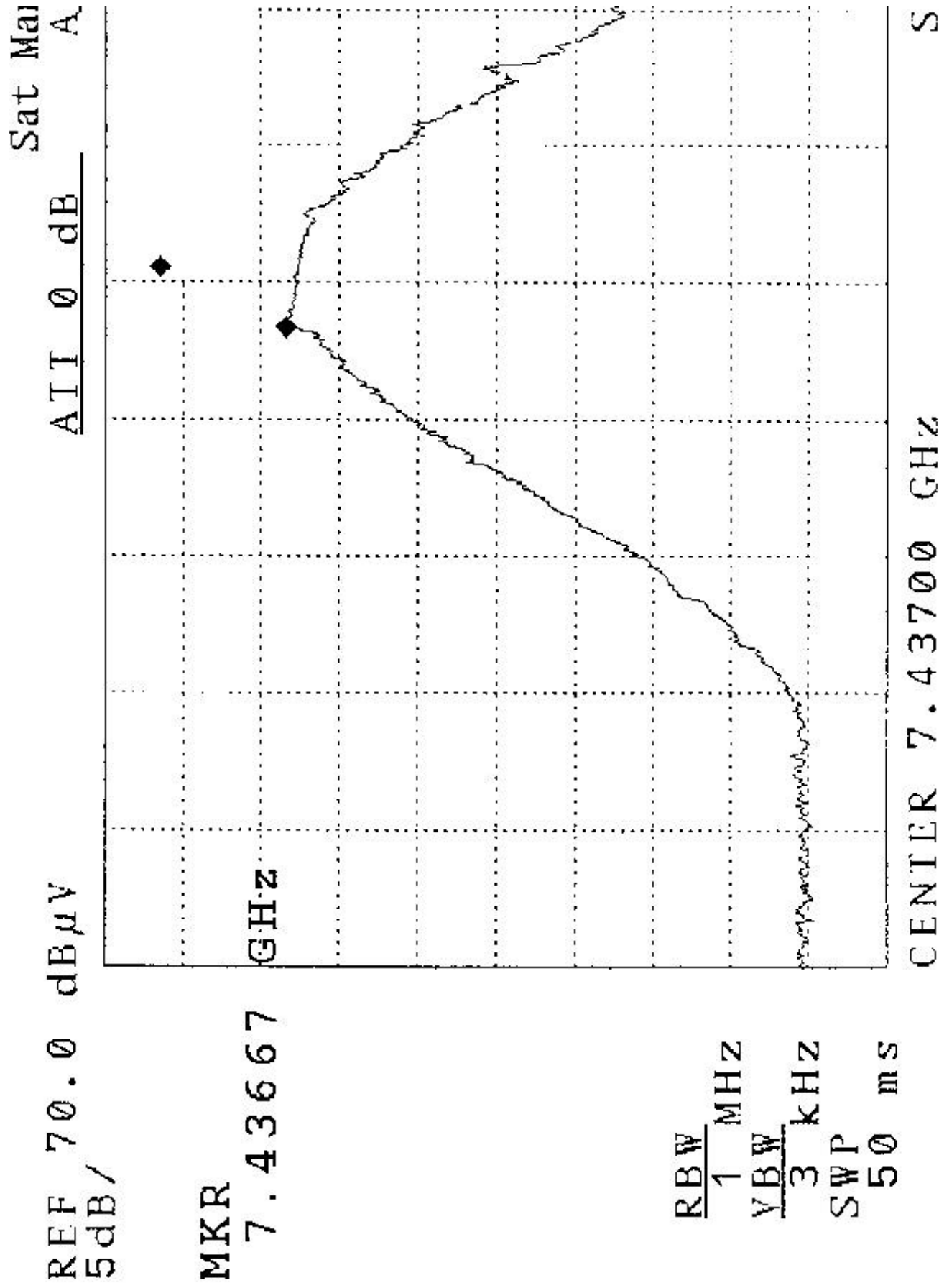
7.437238
54.00

RBW 1 MHz
VBW 3 kHz
SWP 50 ms



CENTER 7.437102 GHz SPAN 1

Futaba Corp.
Standard: FCC IS 247(b)
Model: FRII-SDC3TG
Flat Antenna, Freq. Freq 2479 MHz



Futaba Corp.
 Standard: FCC 15.247(b)
 Model: FRH-SD03TU
 Pencil Antenna, Fund. Freq. 2449 MHz

REF 62.0 dBμV
 5dB/

ATT 0 dB

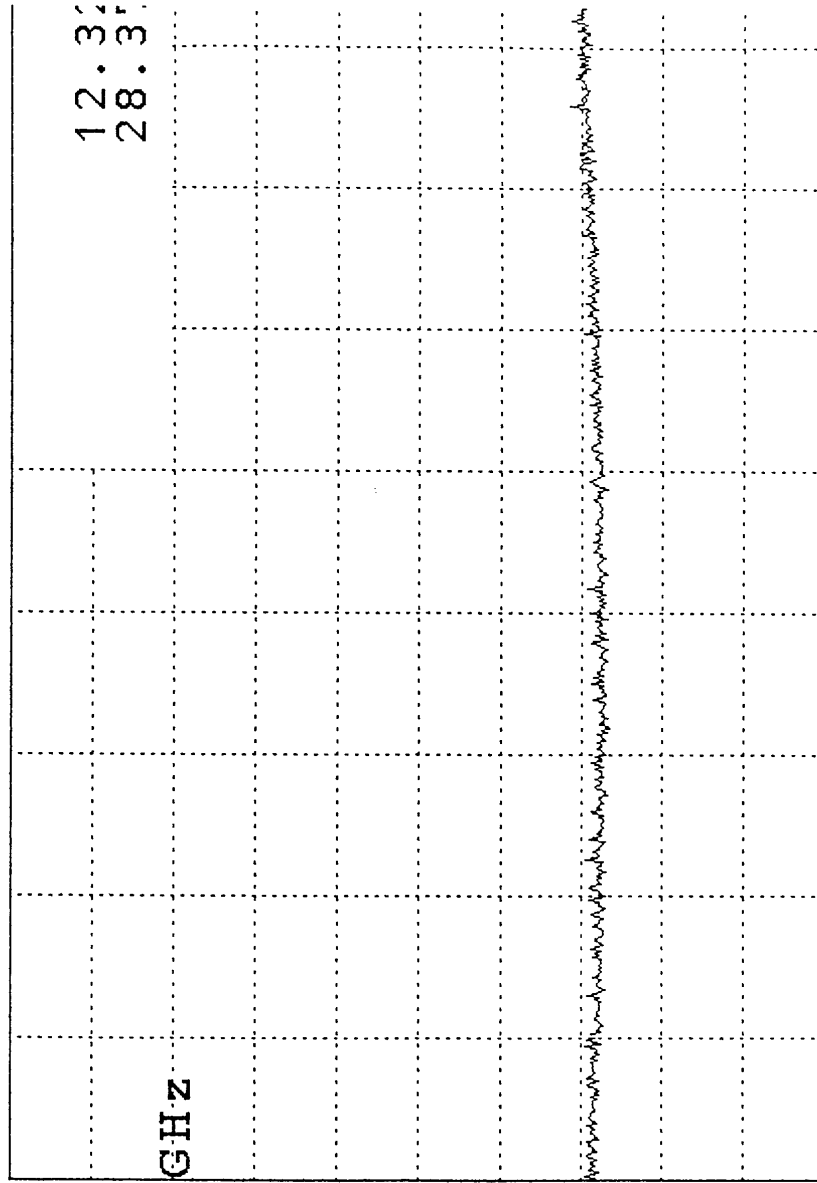
Sat Mar 27 02:

A_write

CENTER
 12.2450

GHZ

RBW 1 MHz
 VBW 10 kHz
 SWP 50 ms



CENTER 12.2450 GHZ

SPAN 20

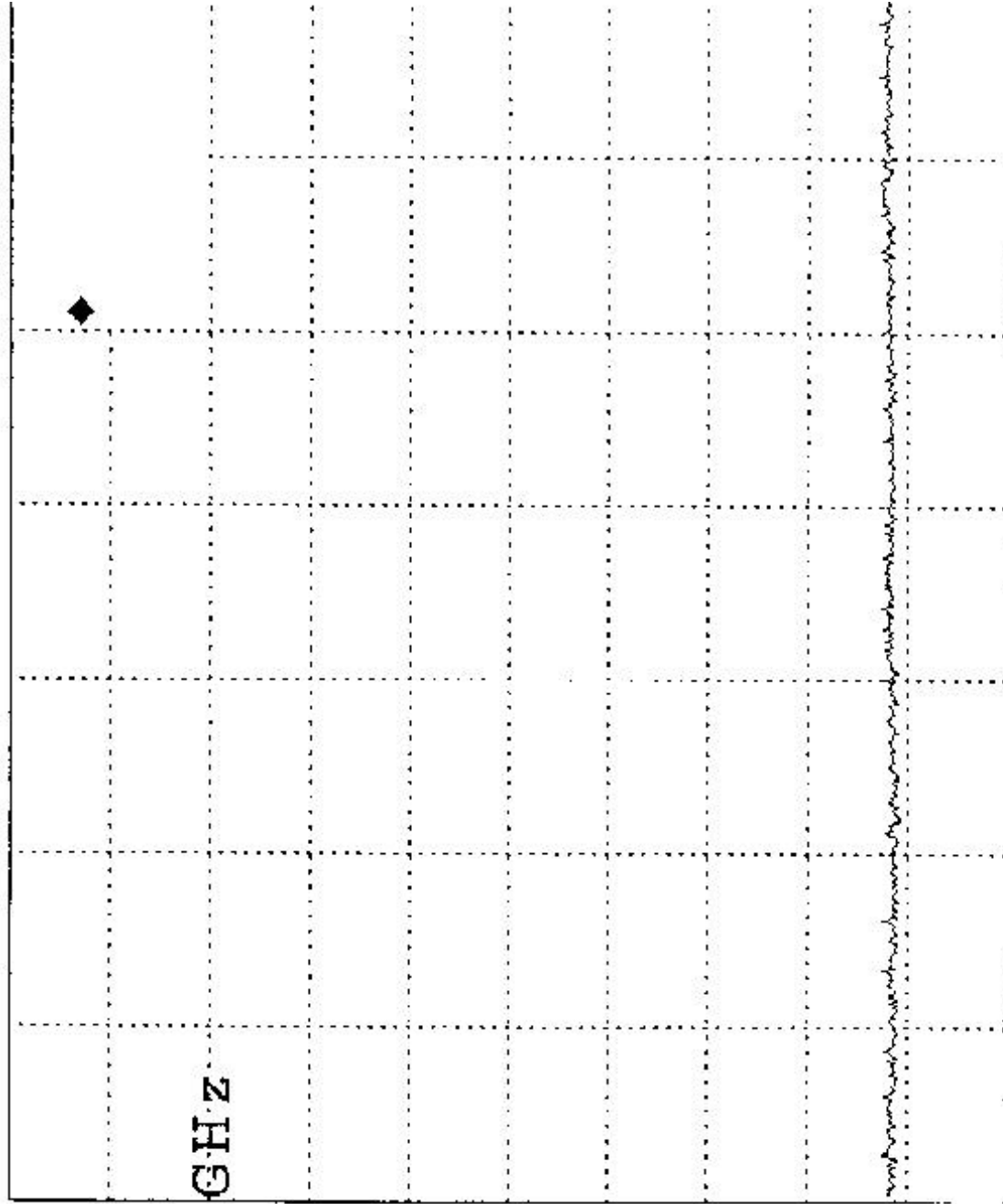
Endura Corp.
Standard FCC IS 247(b)
Model PRH-SD031C
Flat Antenna Band Freq. 2429 MHz

REF 70.0 dBμV
5dB/

ATT 0 dB

Sat Me /

MKR
12.2786 GHz



RBW 1 MHz
VBW 3 kHz
SWP 70 ms

CENTFR 12.245000 GHz

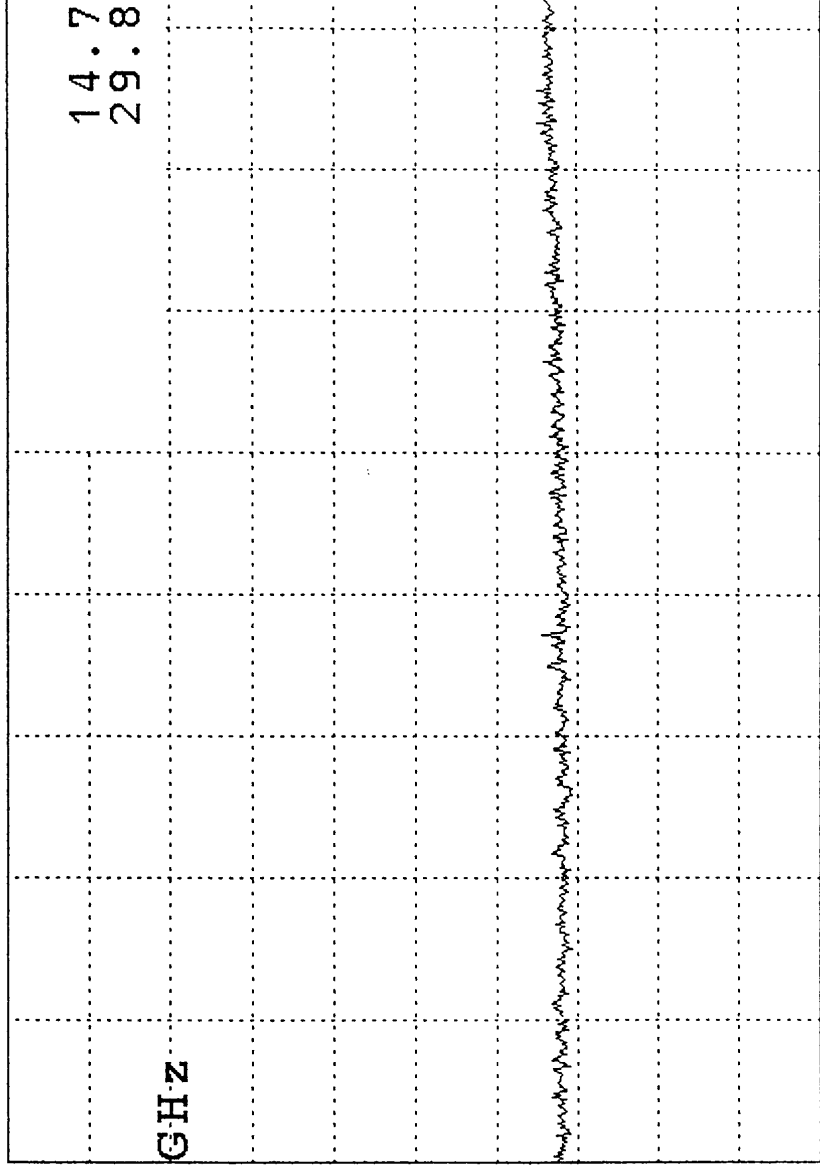
Futaba Corp.
Standard: FCC 15.247(b)
Model: FRH-SD03TU
Flat Antenna

REF 62.0 dBμV ATT 0 dB Sat Mar 27 02: A_write&

MKR
14.7926 GHz

14.7
29.8

RBW 1 MHz
VBW 10 kHz
SWP 60 ms



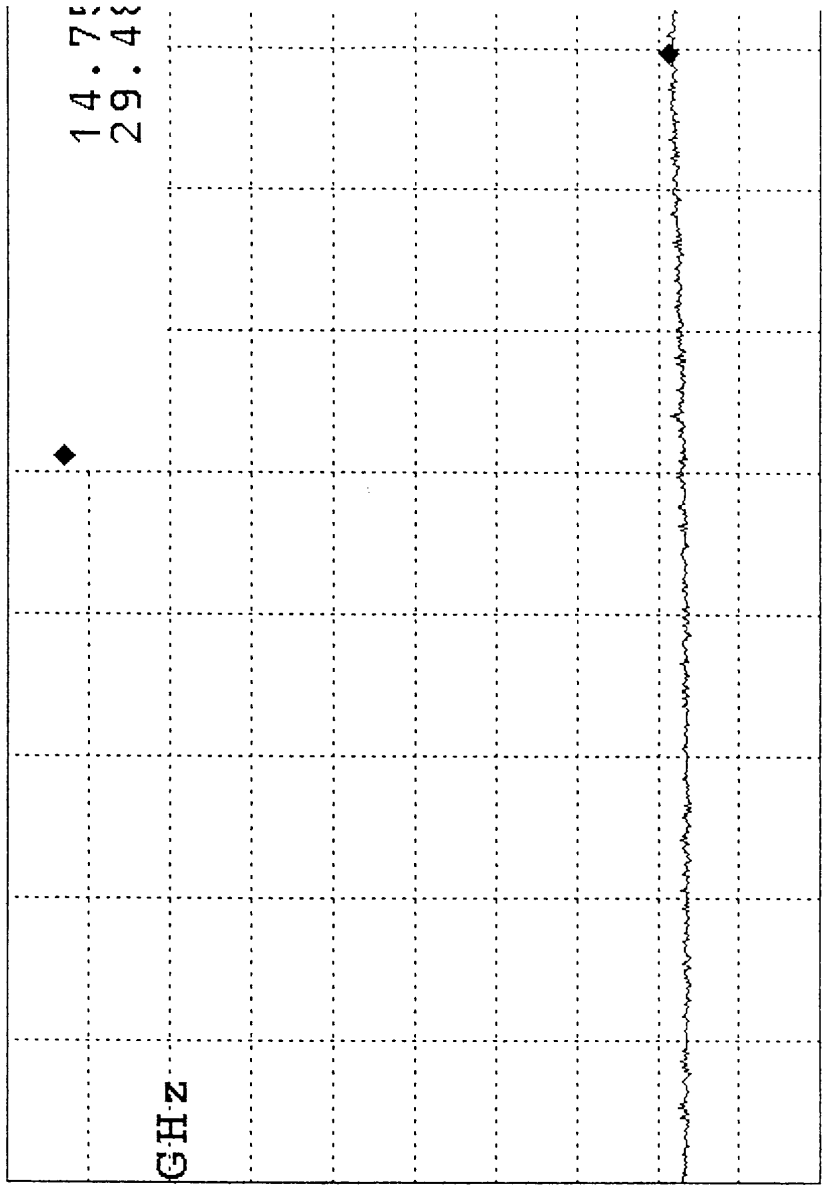
CENTER 14.7926 GHz SPAN 2

Futaba Corp.
Standard: FCC 15.247(b)
Model: FRH-SD03TU
Pencil Antenna

REF 70.0 dB μ V ATT 0 dB Sat Mar 27 03: A_write

MKR
14.7534
GHz

RBW 1 MHz
VBW 3 kHz
SWP 140 ms



CENTER 14.7534 GHz SPAN 200 kHz