

Designated by Ministry of International Trade and Industry

KANSAI ELECTRONIC INDUSTRY DEVELOPMENT CENTER

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KEC

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IKOMA-CITY, NARA, 630-01 JAPAN

*Corporate Juridical Person***ENGINEERING TEST REPORT**REPORT NO. A-025-99-C

Issued Date : August 9, 1999

This test report is to certify that the tested device properly complies with the requirements of:

FCC Rules and Regulations Part 95 ; Radio Control(R/C) Radio Service.

The tests necessary to show compliance to the requirements were performed and these results met the specifications of requirement. The results of this report should not be construed to imply compliance of equipment other than that which was tested. Unless the laboratory permission, this report should not be copied in part.

1. Applicant

Company Name : JAPAN REMOTE CONTROL CO., LTD.

Mailing Address : 2-2-12 EIWA, HIGASHIOSAKA-CITY, OSAKA, 577-0809 JAPAN

2. Identification of Tested Device

FCC ID : BRWXF421EX

Device Name : FM 5 CHANNEL TRANSMITTER

Trade Name : JR PROPO

Model Number : XF421EX

Serial Number : Prototype No.1 : ☒ Prototype ☐ Pre-production ☐ Production

Date of Manufacture : June, 1999

3. Test Items and Procedure

- ☒ Measurement of RF Power Output (Substitution Method)
- ☒ Modulation Characteristics
- ☒ Necessary Bandwidth
- ☒ Emission Bandwidth
- ☒ Measurement of Field Strength of Spurious Radiation
- ☒ Frequency Stability Measurement

Above all tests were performed under : FCC Part 2 Section 2.985, Section 2.987, Section 2.989, Section 2.993 and Section 2.995

4. Date

Receipt of Test Sample : August 2, 1999

Test Completed on : August 5, 1999

CERTIFIED BY :



Eizo Hariya

General Manager of Ikoma Testing Laboratory

Technical Report
Transmitter Model XF421EX
FCC ID# BRWXF421EX

T A B L E O F C O N T E N T S

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- 1.2 Application
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Technical Report
Transmitter Model XF421EX
FCC ID# BRWXF421EX

1.0 INTRODUCTION

1.1 Definition

The Model XF421EX is a transmitter for the Remote Control (R/C) of models such as airplane, helicopters, cars, boats, etc.

This Transmitter is for FM System, available for the PPM (Pulse Position Modulation).

This Transmitter is a part of the Horizon Hobbies PPM "family" of Remote Control Transmitters which at this time consists of:

Transmitter Model #	FCC ID #
F400E NET-E104	BRWNET-E104
F400EX	BRWF400EX

Separate Applications for each transmitter and for the receiver are submitted as required by the Commission.

The Manufacturer, Japan Remote Control Company (JR), manufactures all transmitters and receivers. The PPM family of R/C systems is exported by JR to the United States of America, and several European and Asian countries.

The Applicant for this Equipment Authorization, HORIZON HOBBIES, INC. will, following receipt of Grant of Equipment Authorization, import only those versions of these R/C radios which are allowed for use in the USA under the Rules and Regulations of the Federal Communications

The 72 - 73 MHz version of this transmitter is the subject of this Application; these are the units which will be offered for sale to the general public.

Technical Report
Transmitter Model XF421EX
FCC ID# BRW XF421EX

1.2 Application

The Model XF421EX R/C transmitter utilizes "Frequency Modulation" to convey the PPM encoded position of its controlsticks (joysticks) and toggle switches to its companion R/C receiver, where the PPM encoded pulse train is demodulated, decoded, and supplied to a number of servo-mechanisms for positioning of control surfaces, throttle etc. on the model.

The Frequency-Shift-Keying of the transmitter carrier takes place in the rhythm of the PPM pulse train.

Transmitter and receiver are very narrow band units; they have been designed to comply with the European requirements of 10 KHz channel spacing. As a result, they operate safely in the present 20 KHz channel spacing environment allowed at this time in the USA.

1.3 Construction

The Model XF421EX Transmitter all consist of a plastic case.

(Reference is made to Fig. 5.1, Transmitter Block Diagram)

- * control sticks and control switches
- * a 9.6V rechargeable (NiCad) battery
- * a commutator to sample the analog control voltages in sequence
- * an analog-to-digital converter (ADC)
- * a microprocessor (μ p) to create the PPM pulse train
- * a modulator driver stage
- * a RF power stage
- * a telescopic antenna

This Transmitter is to be made available by the JAPAN and USA on those carrier frequencies in the 72 - 73 MHz frequency band which are at present authorized for R/C use.

Technical Report
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2.0 ENCODER THEORY OF OPERATION

Reference is made to Figure 5.1, Transmitter Block Diagram.

The function of the encoder are to:

- * accept the analog voltages from the control inputs (joysticks, toggle switch).
- * process the analog voltages to create control mixing, adding, reversing, etc., as desired by the user.
- * sample these voltages in a cyclic rhythm under control of the system's internal timing generator.
(This process is called commutation.)
- * process these analog voltages into binary weighted digital control words by means of an Analog-to-Digital Converter (ADC).
- * store these digital representations of the analog control input into a temporary memory (RAM).
- * supply this serial data stream to a buffer-driver for modulation of the RF Transmitter.
- * provide "housekeeping" of the encoding process by means of a quartz crystal controlled internal clock.
- * provide supply voltages to the RF section ($V_{cc} = 9.6V$ battery voltage; $V_{reg} = 6.0V$ regulated voltage).

The entire program which controls the timing housekeeping, parallel-to-serial conversion process, and insertion of synchronization words and error detection codes is governed by a Central Processing Unit (CPU) under control by an internally stored program residing in Read-Only Memory (ROM). The CPU, RAM and ROM are all part of a single-chip microprocessor (μp).

Resolution of the Analog-to-Digital conversion process is nine

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3.0 RF SECTION THEORY OF OPERATION

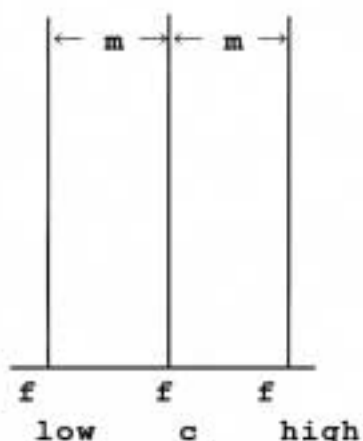
3.1 General

Reference is made to Figure 5.1, Transmitter Block Diagram.

The Horizon Hobbies Model XF421EX R/C Transmitter is a tow sticks type Transmitter.

It operates on any of the R/C frequency (Channels) allowed by the Commission in the 72 -73 MHz frequency band. Selection of the desired RF channel is made by Quarts crystal.

This transmitter employs Frequency-Sift-Keying (FSK) of the carrier frequency, whereby the output frequency is either low or high due to the symmetrical FSK modulation process, the (center) output frequency cannot be directly measured, but must be calculated by taking the average of the high and low frequency states.



m = shift from center frequency
 m = approx. 2 KHz

$$f_{\text{carrier}} = \frac{f_{\text{low}} + f_{\text{high}}}{2}$$

The peak-to-peak deviation of the FSK signal is approximately 4 KHz ("sliver modulation")

Because of the unfamiliarity of the general public with the term FSK, this modulation technique is commonly named FM.

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3.2 Block Diagram

(Reference is made to Figure 5.1)

The (up to) four control potentiometers are at the right side of the schematic drawing.

The control potentiometer, which is mechanically coupled to the control (joy) stick, is supplied with the regulated 5.0V voltage. The wiper on this pot is exactly centered in the neutral control stick position. All analog processing is performed as deviations from this center (reference) voltage.

It acts as a buffer/driver for the control potentiometer output voltage, and it allows additional input to be analog mixed to the control voltage.

The oscillator consists of an ECO type oscillator, excited by a quartz crystal. The crystal supports oscillation at the crystal's fundamental frequency (approximately 18MHz). The tuned circuit in the oscillator transistor's collector is tuned to the second harmonic of this frequency (approx. 36MHz).

Q12 acts as a frequency multiplier ($\times 2$)/buffer; it drives the Power Amplifier (PA). Its output frequency is $4\times$ crystal frequency.

The straight-through PA stage is followed by a matching and band pass/low-pass network. This network matches the low PA stage output impedance to the whip antenna.

The crystal load capacitance is affected by varicap CR1,2, which is voltage-controlled by the "rounded-off square wave from the modulator transistor. The oscillator frequency is therefore switched in the rhythm of the modulate modulation pattern (FSK).

Two DC Supply Voltage enter the RF section: 9.6 Volt "law" battery voltage supplies the PA stage only. All other stages, and bias current for all stages, including the PA, are derived from the regulated 6.0 Volt source on the main encoder board.

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4.0 FAILURE ANALYSIS

A failure analysis was conducted to ascertain that single-component failure will not result in unauthorized radiation.

It should be noted that component failure will result in return of the unit to the factory, or to an authorized repair station.

(Reference is made to Figure 5.2, Transmitter Schematic Diagram)

Failure of any of the transistors (predominant failure mode: emitter-collector short) will result in the unit becoming inoperative:

In the case of Q11 oscillator short, RF output will be nonexistent.

Q12 or Q13 failure will result in very low, if any, output. Failure of Q11, Q12 or Q13 will register on the unit's meter which indicates collector current into the PA stage.

Failure of the MOD IN input (latch at 0 or 9.6 Volt) or modulator transistor Q14, Q15, will result in either the high frequency (carrier frequency + 2 KHz), or the low frequency (carrier frequency - 2 KHz) being transmitted. Although this failure would render the unit inoperative, the frequency tolerance would still fall within the channel bandwidth and tolerance requirements of .002% of 72 MHz = 1.44 KHz.

Failure of the varactor diode D11 (open or short) results in a measured frequency drop of 9.2 KHz (varactor short) or no change (varactor open).

Although a varactor-short failure would bring the generated frequency out-of-tolerance, the unit will become inoperative, power will be turned off, and the unit will be returned for service (Note that even in this failure mode, no harmful energy is being transmitted on neighboring channels).

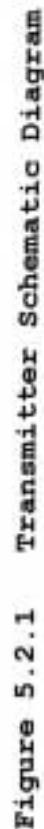
Failure of the quartz crystal, X1, will inevitably result in no, or strongly reduced, output.

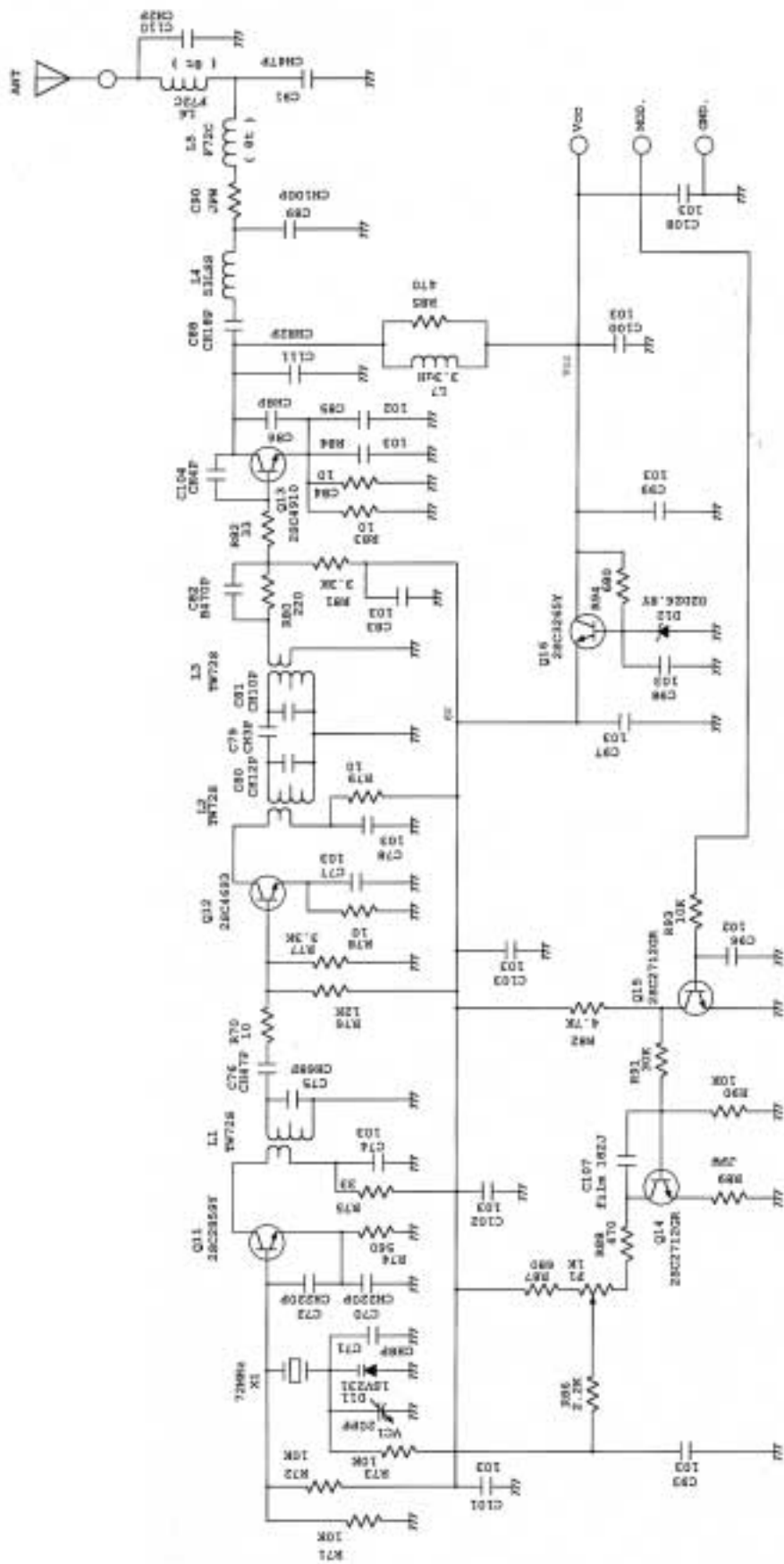
All other incidental failures will render the unit inoperative and because for return of the transmitter to the service facility.

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FCC ID# BRW XF421EX

Transmitter R.F. Tune Up Procedure

1. Remove six screws from transmitter. Break seal on case and remove PC assembly. Put PC assembly on bench, component side up.
2. Refer to transmitter schematic Figure 5.2.2. Soften bees wax on cores in L1, L2, L3 and L4. Using synchroscope with small 50 ohm loop, starting at L1, adjust these cores for maximum synchroscope reading. Repeat this tuning sequence until no further increase in synchroscope reading can be obtained.
3. The MOD. IN input latch at 0 volt. Observe frequency counter. Adjust the small ceramic trimmer capacitor on the PC assembly so that output frequency is exactly 2.0 KHz higher than the channel frequency.
4. The MOD. IN input latch at 9.6 Volt. Adjust the small trimmer resistor on PC assembly so that output frequency is exactly 2.0 KHz lower than channel frequency for the module.
5. Repeat step 2.
Repeat step 3 and 4.
6. Using spectrum analyzer with small 50 ohm loop, verify that sub harmonic and harmonic components are at least 50 dB below carrier component. Pay special attention to 90 MHz and 144 MHz components.
7. Remove PC assembly from Transmitter. Reapply bees wax to L1, L2, L3 and L4. Put PC assembly back into its case, replace the 6 screws and re-seal opposite edge.





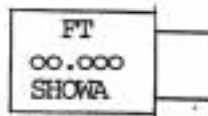
FCC ID# BRWXP421EX Figure 5.2.2 Transmitter Schematic Diagram

SPECIFICATION OF CRYSTAL UNIT

ORDERD BY J.R

SPEC. No TX FM 72MHz

1. FREQUENCY 18 MHZ (72MHZ) TX
2. HOLDER TYPE HC-50/U
3. FREQUENCY TOLERANCE ± 7 PPM/+25°C
4. EQUIVALENT RESISTANCE 20 OHMS MAX/SERIES
5. OPERABLE TEMPERATURE RANGE -20 °C----- +60 °C
6. TEMPERATURE DRIFT ± 20 PPM
7. LOADING CAPACITY 52 PF
8. DRIVE LEVEL *50μW*
9. SHUNT CAPACITY 7 PF MAX
10. MODE OF OSCILLATION FUNDAMENTAL (AT CUT)
11. INSULATION RESISTANCE 500 M OHMS MIN AT 100 V DC
12. SHOCK TEST
DROPPING FROM 75 CM HEIGHT 3 TIMES ON FIRM WOOD
VARIATION : FREQUENCY LESS THAN ± 5 PPM
RESISTANCE LESS THAN ± 15 %
13. VIBRATION TEST
FREQUENCY 10 TO 55HZ; AMPLITUDE 1.5mmP-P 1 CYCLE/MINUTES
TEST TIME 120 MINUTES IN EACH DIRECTION
VARIATION : FREQUENCY LESS THAN ± 5 PPM
RESISTANCE LESS THAN ± 15 %
14. AGING
 ± 5 PPM/YEAR
15. MARKING

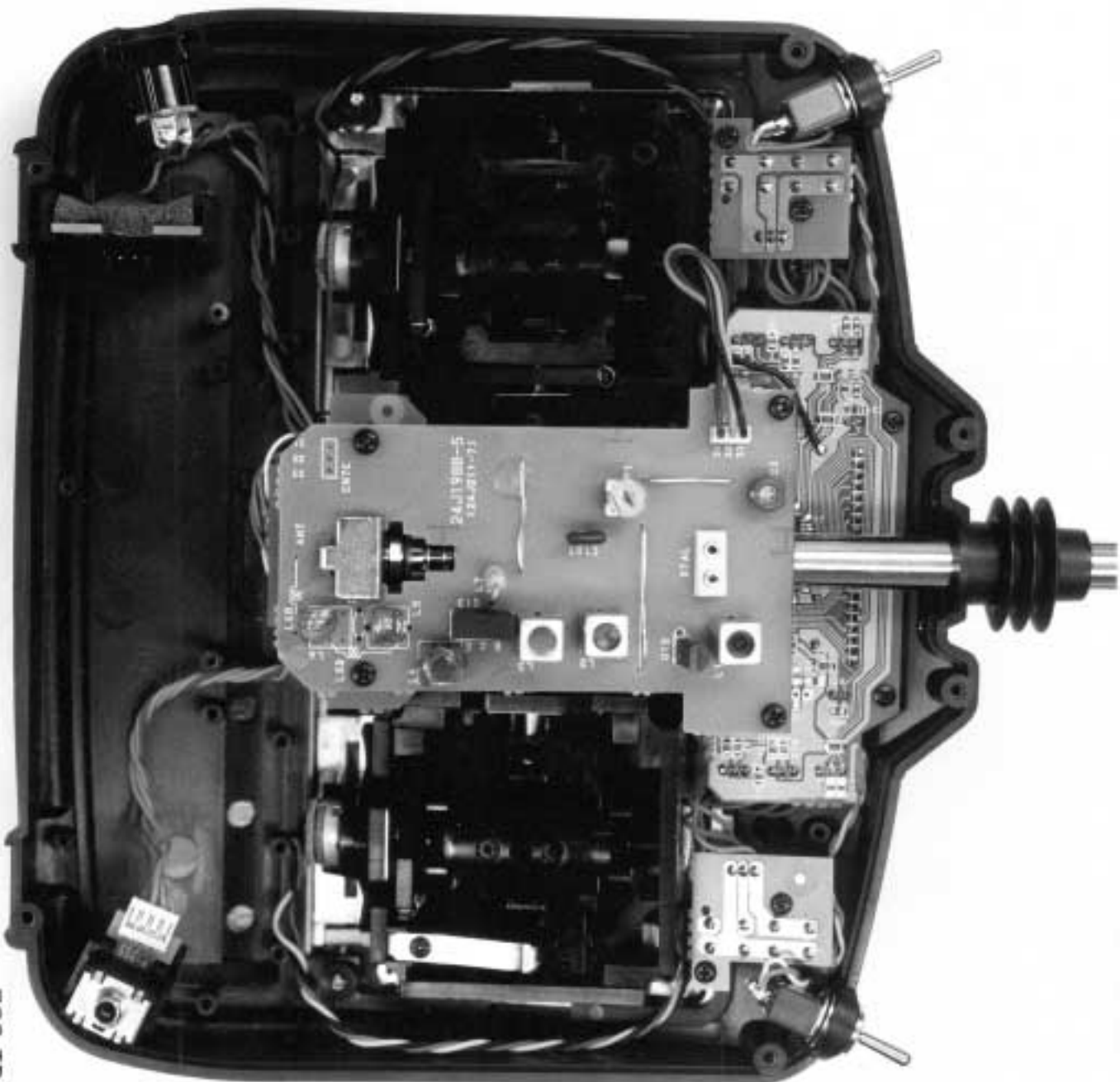


SHOWA CRYSTAL CO.LTD.

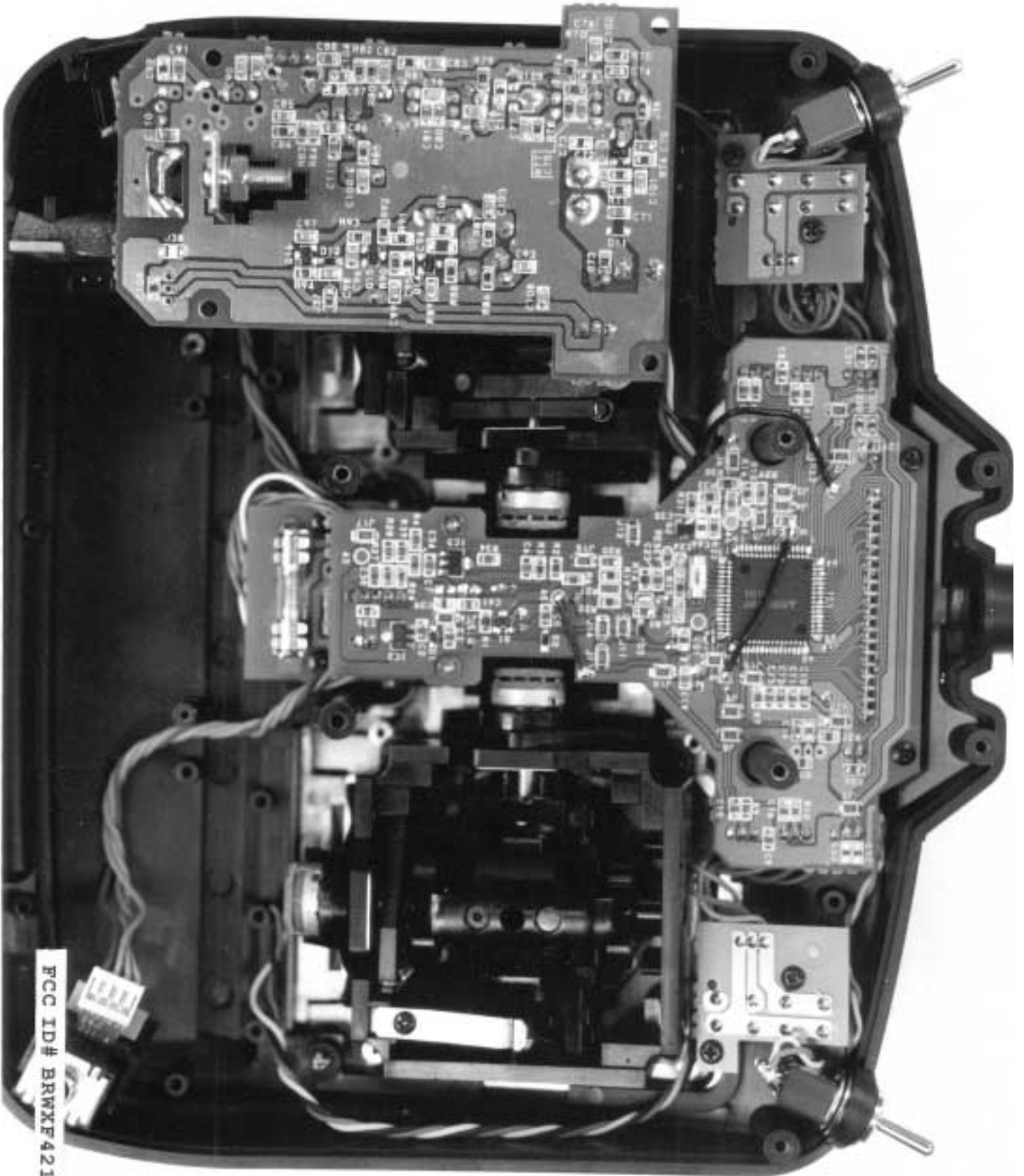
Appendix 5.5
Transmitter Oscillator Specification



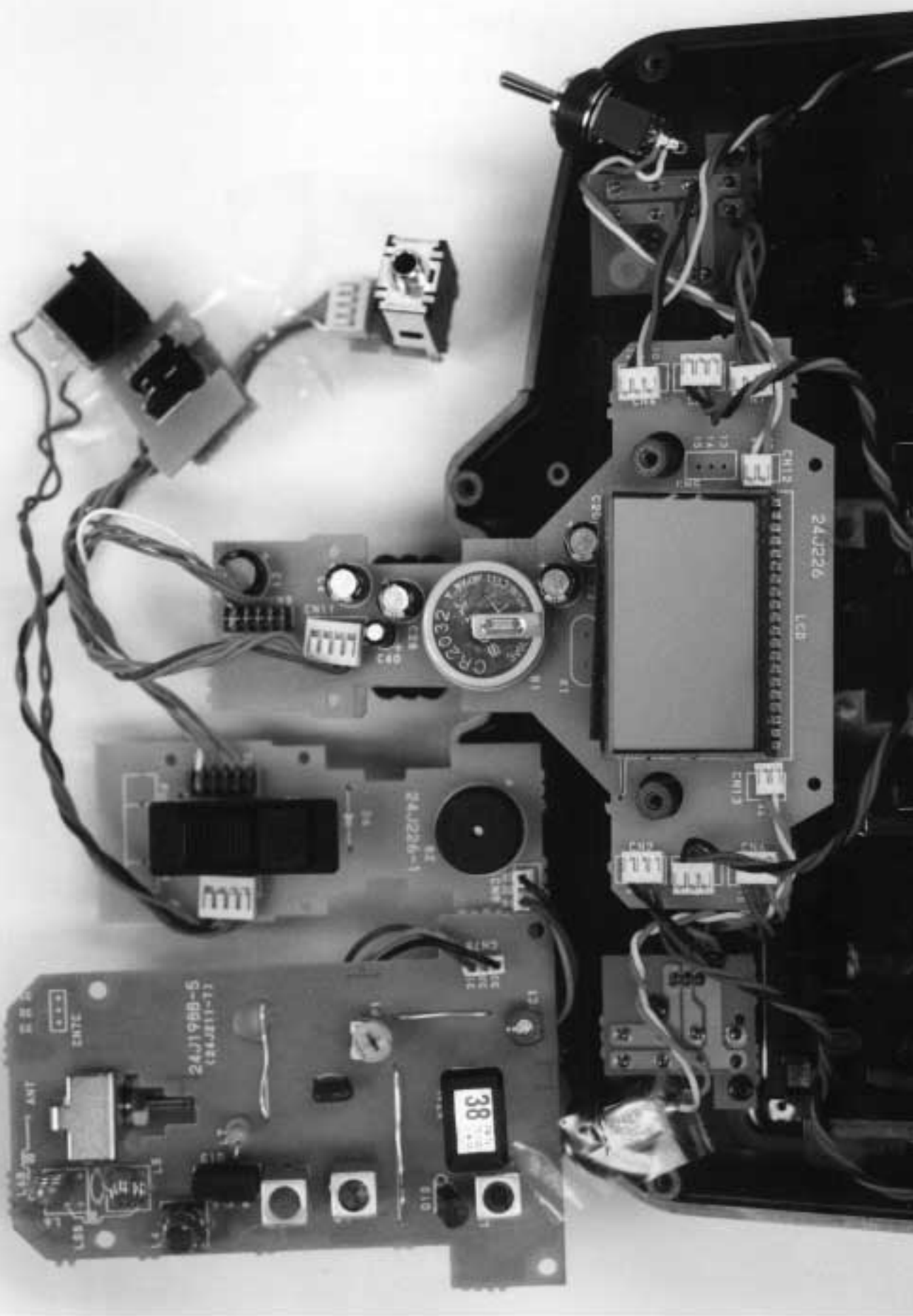
FCC ID# BRWXP421EX



FCC ID# BRWXP421EX



FCC ID# BRWXF421EX



FCC ID# BRWXP421EX



FCC ID# BRWXP421EX



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Repeat step 3 and 4.
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ENGINEERING TEST REPORT**1. GENERAL INFORMATION****1.1 Product Description**

The Model No. XF421EX(referred as EUT in this report) is the FM 5 channel transmitter.

1)Technical Specifications

Transmitting Frequency : 72.01~72.99MHz (72.55 MHz in EUT)
Emission Designator : 3K40F1D

2) Contained Oscillator

4th OVER-TONE : 18.1375 MHz

3) Rated Power Supply : DC 9.6 V (Ni-Cd battery)**1.2 Description for Equipment Authorization****1) Rules Part(s) under which Equipment operated**

FCC Rule Part 95 ; Radio Control(R/C) Radio Service

2) Kind of Equipment Authorization

(☒) Certification (☐) Verification

3) Procedure of Application

(☒) Original Equipment (☐) Modification

1.3 Test Facility

Name : KANSAI ELECTRONIC INDUSTRY DEVELOPMENT CENTER (KEC)
IKOMA TESTING LABORATORY
Open Test Site No.1

Address : 12128, Takayama-cho Ikoma-city, Nara, 630-0101 Japan

This test facility has been filed in FCC under the criteria in ANSI C63.4-1992.
The laboratory has been accredited by the NVLAP (Lab.Code:200207-0) based on
ISO/IEC Guide 25.

ENGINEERING TEST REPORT**2. TESTED SYSTEM****2.1 Test Mode**

The compliance tests were performed under the following operation mode.

1) Measurement of Field Strength of Spurious Radiation :

The EUT was continuously transmitted in normal modulation mode.

2) Frequency Stability Measurement :

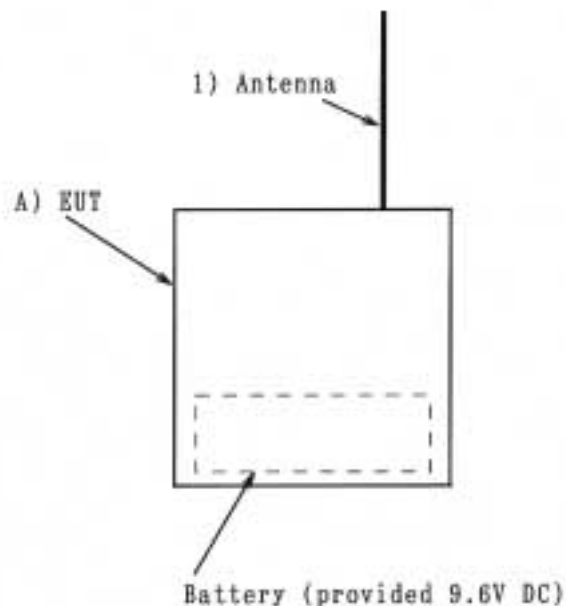
The EUT was continuously transmitted in the following two non-modulation mode.

(1) F-Low

(2) F-High

3) Except above two test items :

See the page of each test items.

2.2 Block Diagram of EUT System

[Note]

See 2.3 List of EUT System and 2.4 List of Antenna.

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2.3 List of EUT System

No	Device Name	Model Number (Serial Number)	FCC ID (Trade Name)	Note	Remark
A	FM 5 CHANNEL TRANSMITTER	XF421EX	BRWXP421EX	Battery : Ni-Cd 9.6V	1)

[Remark]

1) : EUT

2.4 List of Antenna

No	Type	Length (m)	Note	Remark
1	Built-in Rod Antenna	1.04		1)

[Remark]

1) : Accessory of EUT

ENGINEERING TEST REPORT

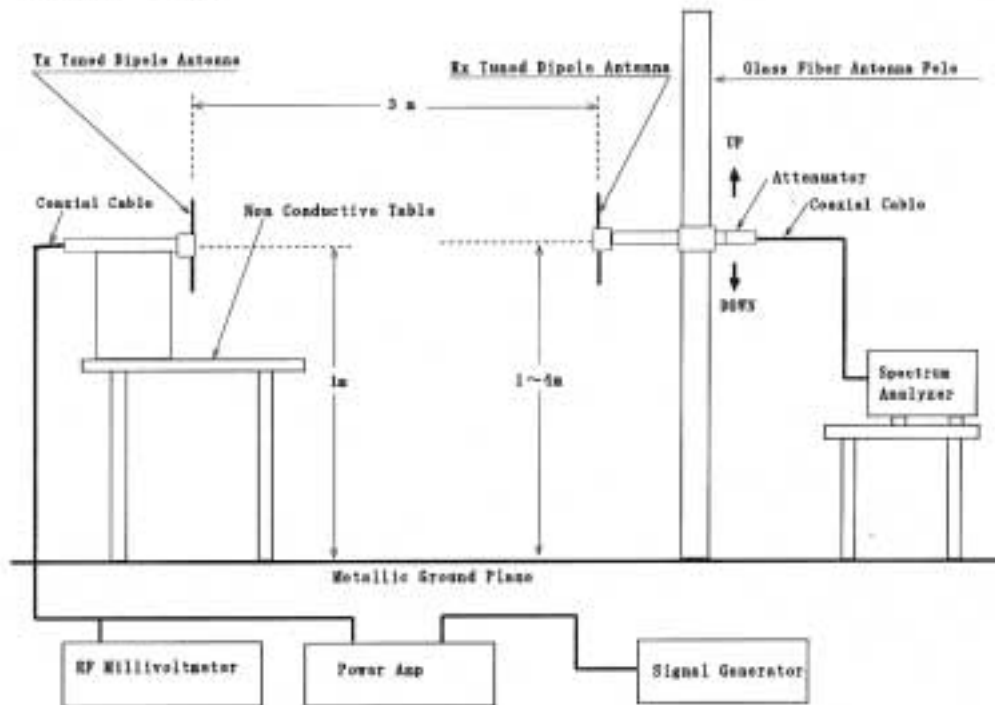
3. RF POWER OUTPUT

3.1 Reference Rule and Specification

FCC Rule Part 95 [§95.639] and Part 2 Subpart J [§2.985]

3.2 Test Configuration

[Open Site]



3.3 Test Procedure

- 1) Tune-up the transmitter.
- 2) The receiving antenna is adjusted to the correct length for the carrier frequency.
- 3) Raise and lower the receiving antenna to obtain a maximum reading on the Spectrum Analyzer with the antenna at horizontal polarity. Then the turntable is rotated to further increase this maximum reading. Repeat this procedure of raising and lower the antenna and rotating the turntable until the highest possible signal has been obtained.
Record this maximum reading.
- 4) Repeat step3 with the antenna polarized vertically.
- 5) Remove the transmitter and replace it with the half-wave antenna. The center of these antennas are approximately at the same location as the center of the transmitter.
- 6) Feed the half-wave antenna at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable.
With the antennas at both ends horizontally polarized and with the signal generator tuned to the carrier frequency, raise and lower the receiver antenna to obtain a maximum reading at the Spectrum Analyzer. Adjust the level of the signal generator output until the previous recording maximum reading for this set of conditions is obtained.
- 7) Repeat step6 with both antennas vertically polarized.

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3.4 Test Result

CARRIER FREQUENCY [MHz]	SPECTRUM ANALYZER READING [dB μ V]		RF METER READING [dBm]		CABLE LOSS [dB]	RF OUTPUT POWER [mW]	LIMIT [mW]
	Horiz.	Vert.	Horiz.	Vert.			
72.55	112.3	106.6	21.5	19.8	0.6	123.0	750

The RF Power Output can be calculated from following formula:

$$\text{RF Power (mW)} = 10^{(Mr - Lo) \div 10}$$

where,

Mr: RF Meter Reading (dBm)
Lo: Loss of Cable (dB)

[Environment]

Temperature : 27 °C Humidity : 64 %

[Summary of Test Results]

Above data shows that the test device complies with the requirements.
Minimum margin was 7.9 dB, horizontal polarization.

Tested Date : August 2, 1999

Tester Signature

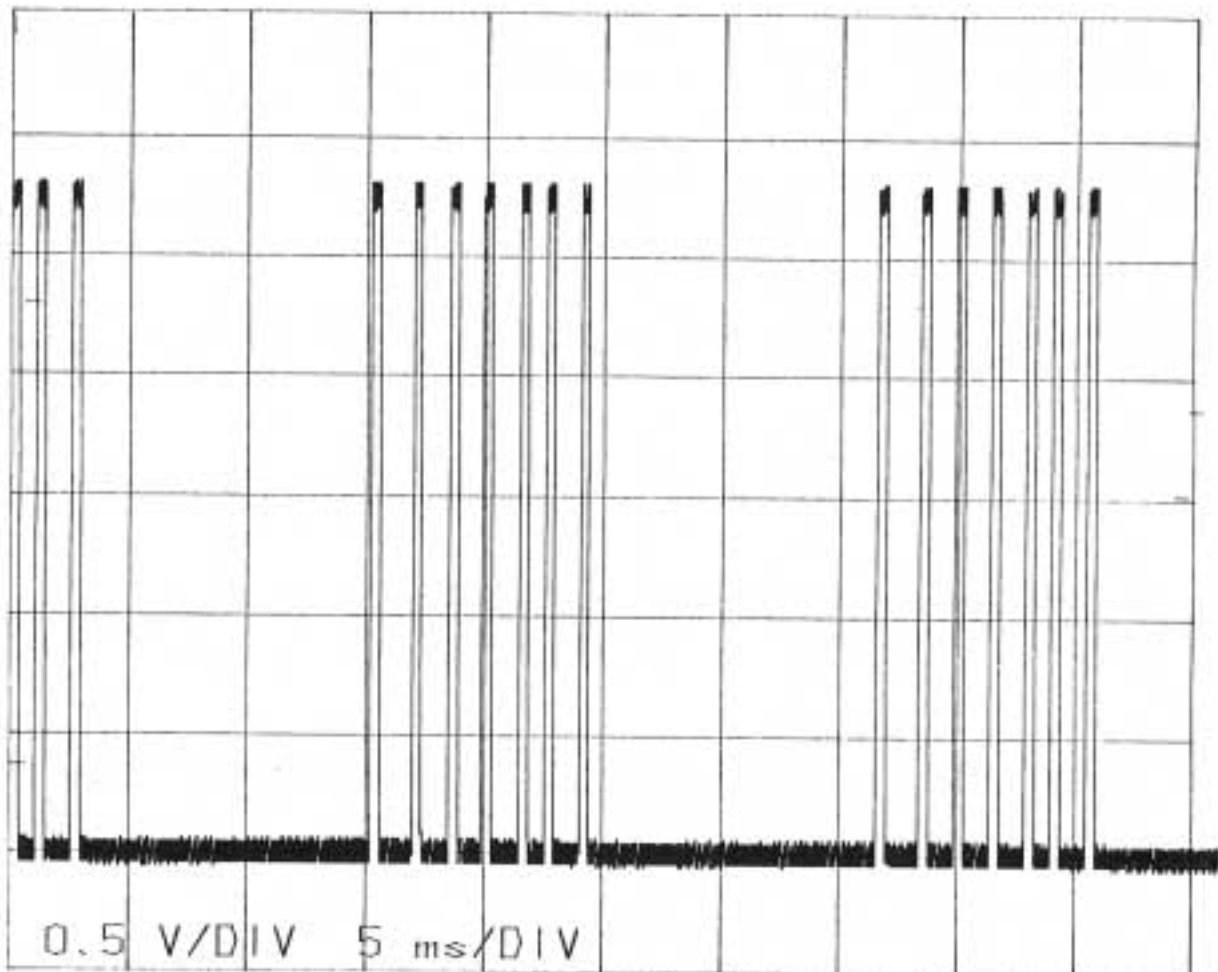
Y. Kawai
Yasunari Kawai

ENGINEERING TEST REPORT**4. MODULATION CHARACTERISTICS****4.1 Reference Rule and Specification**

FCC Rule Part 2 Subpart J [§2.987]

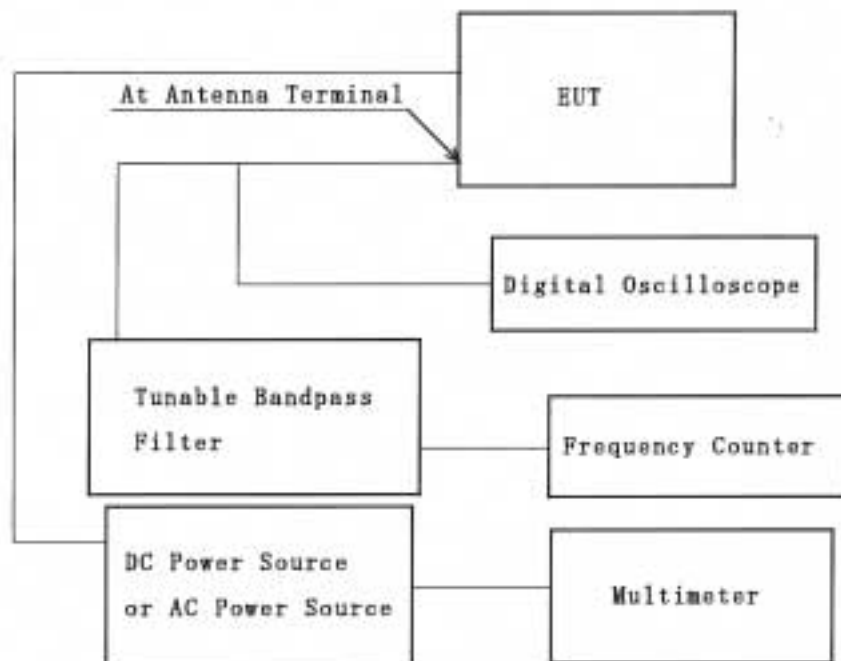
4.2 Test Results**Encoded Waveform****1) Operation Mode of EUT**

Modulation : Normal Modulation



ENGINEERING TEST REPORT**5. NECESSARY BANDWIDTH****5.1 Reference Rule and Specification**

FCC Rule Part 95 Subpart E [§95.633(b)]

5.2 Test Configuration**5.3 Test Results****1) Measurement of the Peak Frequency Deviation(D)**

F_{low} (low frequency of carrier) : 72.548486 [MHz]
 F_{high} (high frequency of carrier) : 72.550117 [MHz]

[Environment]

Temperature : 20 °C Humidity : 55%

[Calculation of the Peak Frequency Deviation]

$$D = (F_{high} - F_{low}) / 2 = 0.82 [\text{kHz}]$$

D [kHz] : the Peak Frequency Deviation

ENGINEERING TEST REPORT

- Continued -

2) Measurement of the Maximum Moduration Frequency(M)

Encoded Waveform

(See the Test Results of 4. MODULATION CHARACTERISTICS)

[Environment]

Temperature : 20 °C Humidity : 55%

[Calculation of the Maximum Moduration Frequency]

From Encoded Waveform, the Modulation Pulse Width (most minimum) was readed on the plotted graph.

$$T = 3.6 \text{ [mm]} / 16.0 \text{ [mm / DIV]} \times 5 \text{ [ms / DIV]}$$
$$= 1.13 \text{ [ms]}$$

$$M = 1 / T$$
$$= 0.88 \text{ [kHz]}$$

T [ms] : the Modulation Pulse Width (most minimum)
M [kHz] : the Maximum Moduration Frequency

3) Calculation of the Necessary Bandwidth(B)

From the result 1) and 2) , the Necessary Bandwidth(B) was culculated as follows

$$B = 2M + 2D = 3.40 \text{ [kHz]}$$

B [kHz] : the Necessary Bandwidth

[Summary of Test Result]

Above test results show that the Necessary Bandwidth is less than 8.0 kHz

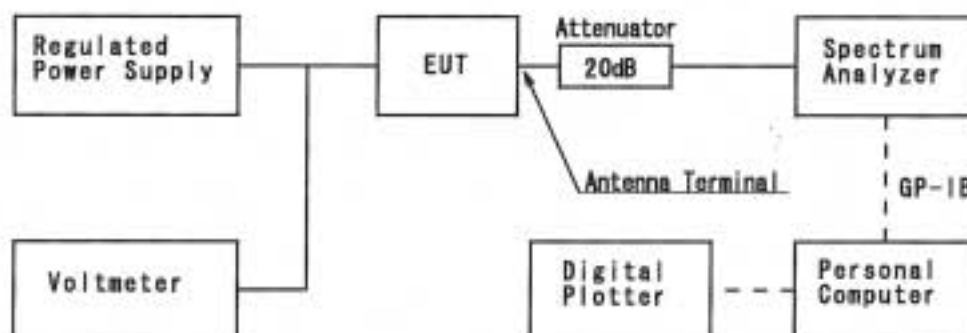
Tested Date: August 5, 1999

Tester Signature

Y. Kawai
Yasunari Kawai

ENGINEERING TEST REPORT**6. EMISSION BANDWIDTH****6.1 Reference Rule and Specification**

FCC Rule Part 95 [§95.633],[§95.635] and Part 2 Subpart J [§2.989]

6.2 Test Configuration

ENGINEERING TEST REPORT**6.3 Test Result**

See next figure (the picture of spectrum analyzer)

Occupied Bandwidth

I measured by the spectrum analyzer TR4172 which could measure 99% occupied bandwidth(OBW).

There are 1001 data on horizontal axe of display.

One of them is V_n . Then all power P becomes following fomula.

$$P = \sum_{n=1}^{1001} \frac{V_n^2}{R} \quad \text{.....} \quad (1)$$

where, R is input impedance of TR4172.

If, at number X points from the left edge of display, sum of power becomes 0.5% of P and at number Y points, sum of power become 99.5% of P ,

$$0.005P = \sum_{n=1}^X \frac{V_n^2}{R} \quad \text{.....} \quad (2)$$

$$0.995P = \sum_{n=1}^Y \frac{V_n^2}{R} \quad \text{.....} \quad (3)$$

From(1)~(3), OBW becomes next.

$$OBW = \frac{f_{SPAN}(Y-X)}{1000}$$

where, F_{SPAN} is frequency span of the spectrum analyzer.

ENGINEERING TEST REPORT

Operation Mode of EUT

Normal modulation

EUT was operated the various position of JPM STICKS & OTHER SWITCHES. (Reference level is the unmodulated level.)

Trace mode of Spectrum Analyzer : Maximum Hold

Occupied Bandwidth = 5.4kHz (99% Power)

M1=72.5475MHz(0.5% Power Point)

M2=72.5529MHz(99.5% Power Point)

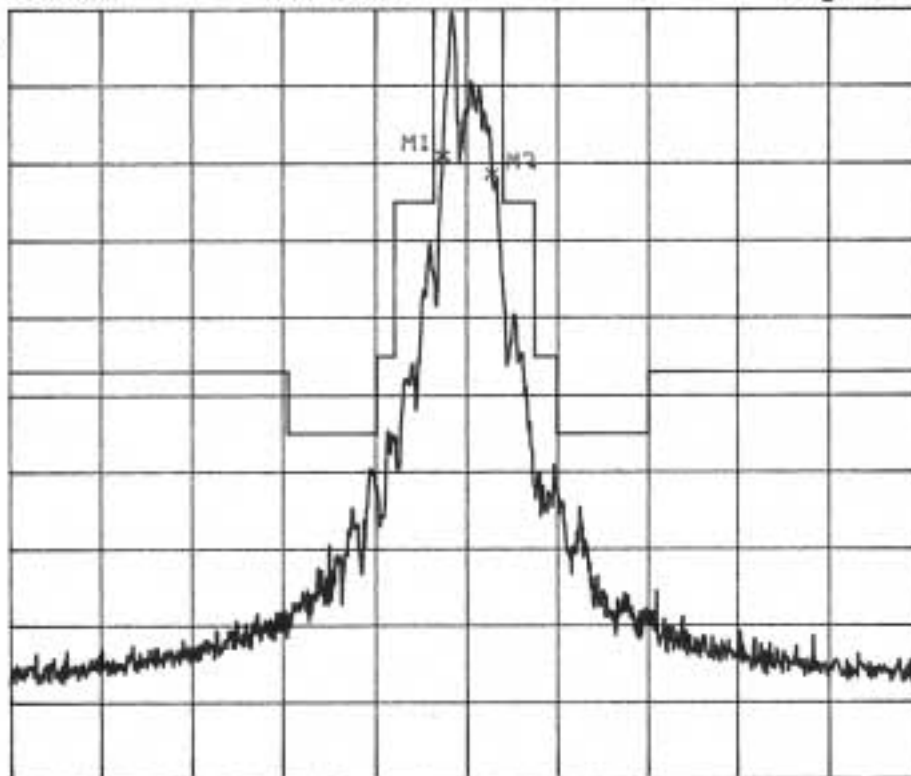
Model No. XF421EX, Applicant : JAPAN REMOTE CONTROL CO., LTD.

REF 20.9dBm

ATT 10dB

August 3, 1999

10 dB/



CENTER 72.55MHz

RBW 300Hz

VBW 1MHz

SPAN 100kHz

SWP 5s

ENGINEERING TEST REPORT

Operation Mode of EUT

Non modulation
[F Low]

Occupied Bandwidth = .9kHz (99% Power)

M1=72.548MHz(0.5% Power Point)

M2=72.5489MHz(99.5% Power Point)

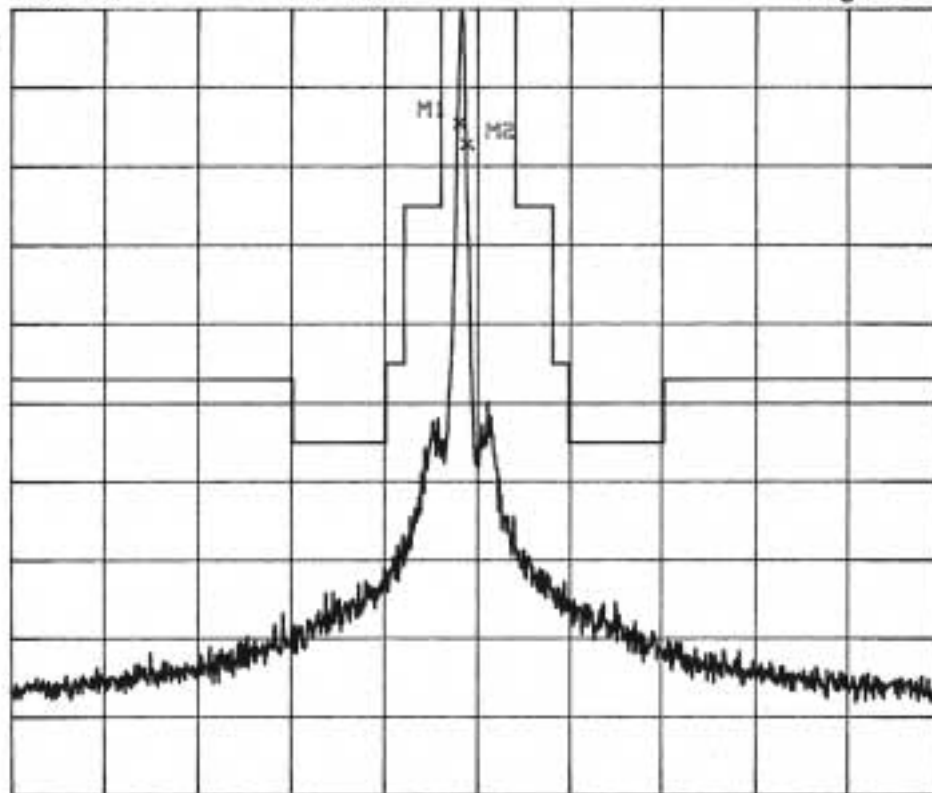
Model No. XF421EX, Applicant : JAPAN REMOTE CONTROL CO., LTD.

REF 20.9dBm

ATT 10dB

August 3, 1999

10 dB/



CENTER 72.55MHz

RBW 300Hz

VBW 1MHz

SPAN 10kHz

SMP 5s

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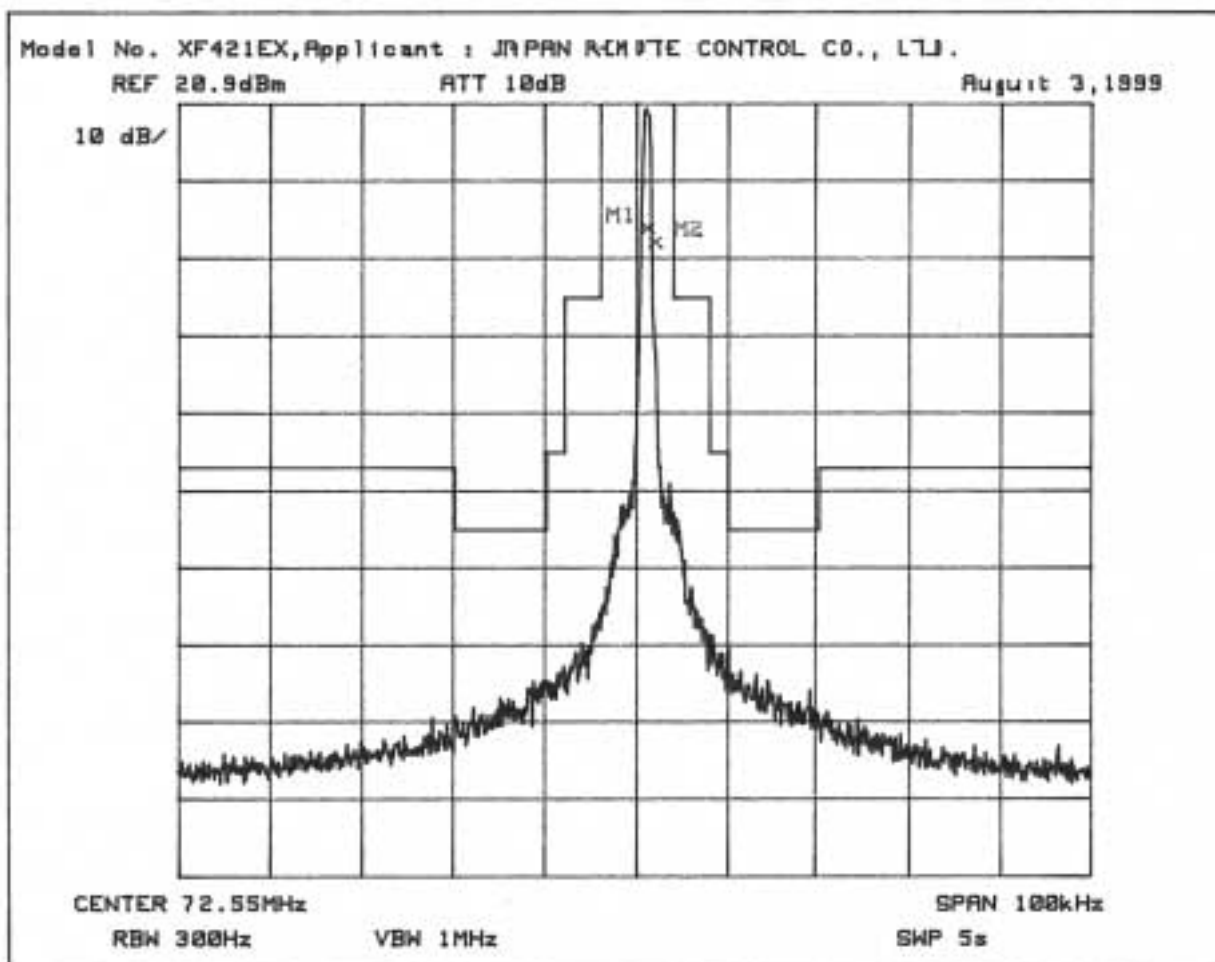
Operation Mode of LUT

Non modulation
[F High]

Occupied Bandwidth = .9kHz (99% Power)

M1=72.5513MHz (0.5% Power Point)

M2=72.5522MHz (99.5% Power Point)



ENGINEERING TEST REPORT**7. FIELD STRENGTH OF SPURIOUS RADIATION****7.1 Reference Rule and Specification**

FCC Rule Part 95 [§95.635] and Part 2 Subpart J [§2.993]

7.2 Test Procedure

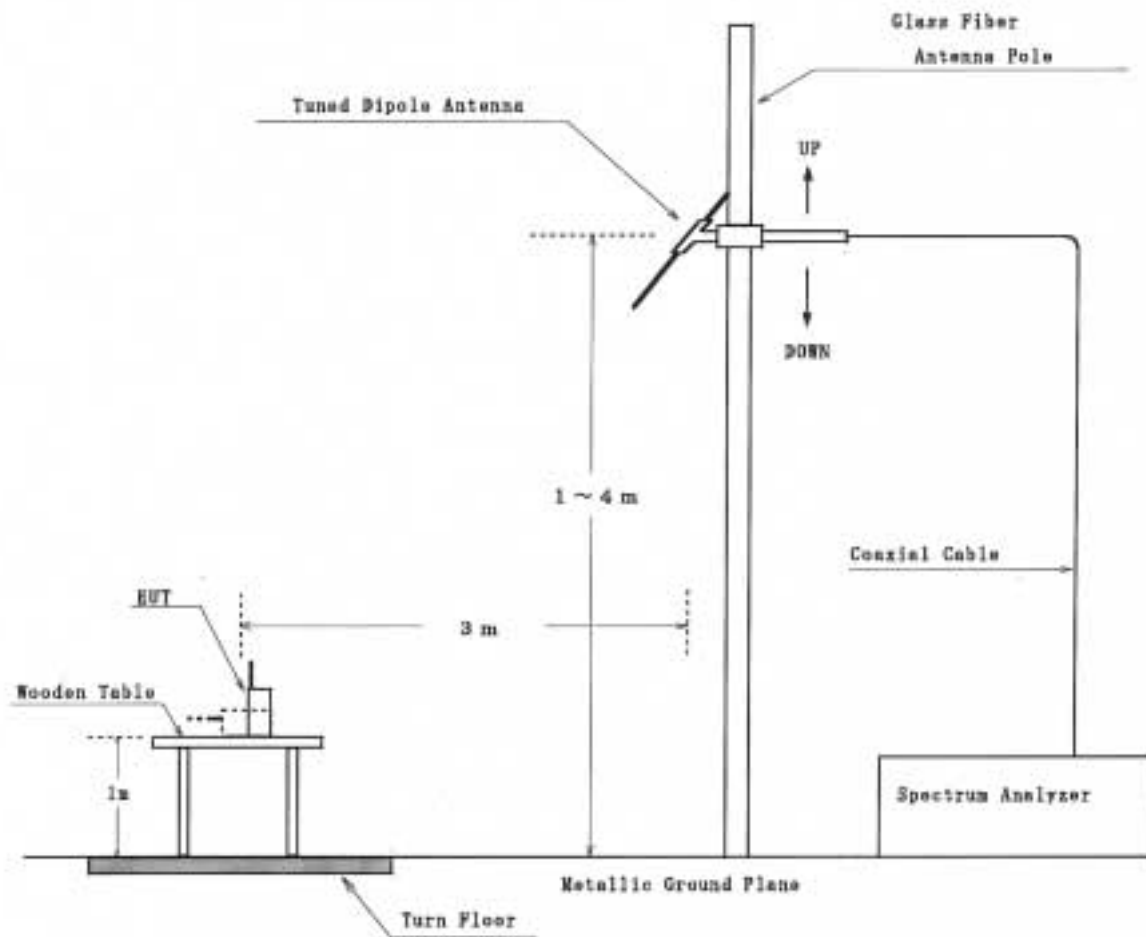
- 1) Tune-up the transmitter(EUT).
- 2) Device Vertical : Place the device so that it's longest axis is vertical.
- 3) For each spurious measurement the receiving antenna is adjusted to the correct length for the frequency involved. These measurements are made from the lowest radio frequency generated in the EUT or 25MHz to the tenth harmonic of the carrier.
- 4) For each spurious frequency, raise and lower the receiving antenna to obtain a maximum reading on the spectrum analyzer with the antenna at horizontal polarity. Then the turntable is rotated to further increase this maximum reading. Repeat this procedure of raising and lower the antenna and rotating the turntable until highest possible signal has been obtain. Record this maximum reading.
- 5) Repeat Step4 for each spurious frequency with the antennae polarized vertically.
- 6) Device Horizontal : Place the device so that it's longest axis is horizontal.
- 7) Repeat Step3, Step4, and Step5
- 8) The attenuation of the spurious in dB can be calculated from the following formula:

$$\text{Spurious Attenuation [dB]} = \text{Field Strength of Carrier Emission [dB}\mu\text{V/m]} - \text{Field Strength of Spurious Emission [dB}\mu\text{V/m]}$$

ENGINEERING TEST REPORT

7.3 Test Configuration

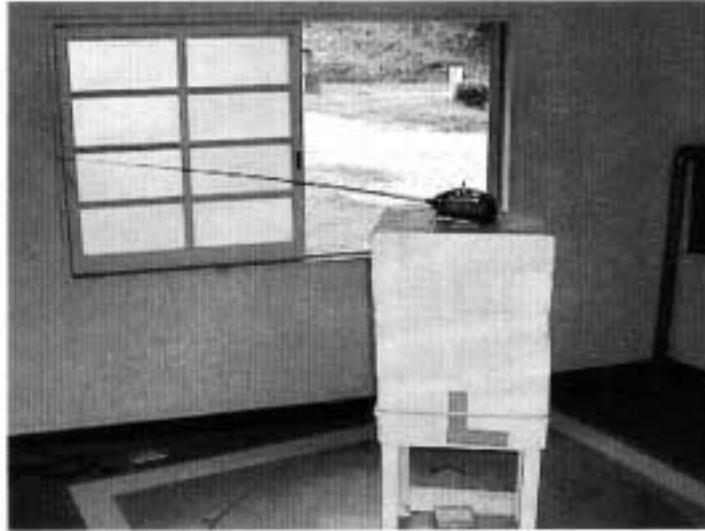
[Open Site]



ENGINEERING TEST REPORT

7.4 Photographs of EUT System Configuration

Horizontal
Placing



Vertical
Placing



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7.5 Test Results

EMISSION FREQUENCY	METER READING at 3m [dB μ V]		ANTENNA FACTOR	MAXIMUM FIELD STRENGTH	ATTENUATION FROM CARRIER	LIMIT
	Horiz.	Vert.				
[MHz]			[dB]	[dB μ V/m]	[dB]	[dB]
<u>Carrier Emission</u>						
72.55	112.3	106.6	6.8	119.1	—	—
<u>Spurious Emission</u>						
108.83	50.0	48.8	10.7	60.7	58.4	46.9
145.10	41.6	34.1	13.7	55.3	63.8	46.9
181.38	42.3	37.4	15.7	58.0	61.1	46.9
217.65	49.6	40.3	17.3	66.9	52.2	46.9
290.20	38.5	33.5	20.0	58.5	60.6	46.9
326.48	35.8	32.4	21.1	56.9	62.2	46.9
362.75	30.3	27.8	22.1	52.4	66.7	46.9
435.30	28.8	35.3	24.2	59.5	59.6	46.9
471.58	<25.0	26.3	25.2	51.5	67.6	46.9
507.85	36.5	34.5	26.4	62.9	56.2	46.9
580.40	37.4	34.4	27.9	65.3	53.8	46.9
652.95	31.8	25.3	29.0	60.8	58.3	46.9
725.50	32.3	25.7	30.0	62.3	56.8	46.9

[Note]

Limit of the attenuation of the spurious in dB:

$$56 + 10\log(\text{Power}) = 56 + 10\log(0.1230) = 46.9 \text{ dB}$$

[Environment]

Temperature : 27°C Humidity : 64%

[Summary of Test Results]

Minimum Margin was 5.3 dB at 217.65 MHz, horizontal polarization.

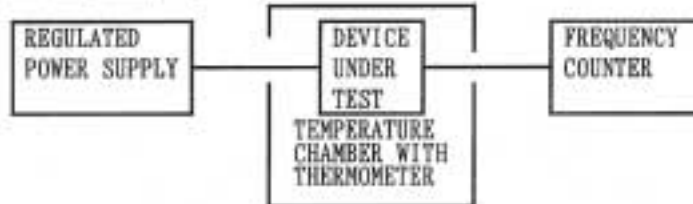
Tested Date : August 2, 1999

Tester Signature


 Masunari Kawai

ENGINEERING TEST REPORT**8. FREQUENCY STABILITY MEASUREMENT****8.1 Reference Rule and Specification**

FCC Rule Part 95 [§ 95.623] and Part 2 Subpart J [§ 2.995]

8.2 Frequency vs Temperature TestTest Setup DiagramTest Result

Test Voltage: 9.6V

REFERENCE FREQUENCY [MHz]	TEMPERATURE [°C]	FREQUENCY DRIFT [%]	LIMIT [%]
72.55	-30	-0.000513	±0.002
	-20	0.000061	
	-10	0.000298	
	0	0.000334	
	+10	0.000278	
	+20	0.000161	
	+30	0.000065	
	+40	0.000110	
	+50	0.000130	

8.3 Frequency vs Voltage TestTest Setup Diagram : Same as (1)Test Result

Temperature : +20°C

REFERENCE FREQUENCY [MHz]	SUPPLIED VOLTAGE [Volt]	FREQUENCY DRIFT [%]	LIMIT [%]
72.55	9.0	0.000123	±0.002

Note Reduced primary supply voltage to the operating and point which shall be specified by the manufacturer.

[Environment] Temperature : 27°C Humidity : 55%

[Summary of Test Results]

Above data shows that the test device complies with the requirements.

Tested Date : August 4 & 5, 1999

Tester Signature

Yasunari Kawai

ENGINEERING TEST REPORT

9. LIST OF TEST INSTRUMENTS

Instrument	Manufacturer	Model No	Specifications	KEC Control No.	If used, checked by "X".	Last Cal.	Next Cal.
Test Receiver	Rohde & Schwarz	ESVP	Frequency Range 20 MHz - 1 GHz	FS-48-3	<input type="checkbox"/>	1999/5	2000/5
Spectrum Analyzer	Advantest	TR4172	Frequency Range 50 Hz - 1.8 GHz	FS-44	<input type="checkbox"/>	1999/5	2000/5
Biconical Antenna	Schwarzbeck	BBA9106	Frequency Range 30 MHz - 300 MHz	AN-80	<input type="checkbox"/>	1999/2	2000/2
Log-Periodic	Schwarzbeck	UHALP 9107	Frequency Range 300 MHz - 1 GHz	AN-215	<input type="checkbox"/>	1999/2	2000/2
Tuned Dipole	Kyoritsu	KBA-511S	Frequency Range 25 MHz - 500 MHz	AN-135	<input checked="" type="checkbox"/>	1999/3	2000/3
	Kyoritsu	KBA-611S	Frequency Range 500 MHz - 1 GHz	AN-137	<input checked="" type="checkbox"/>	1999/3	2000/3

ENGINEERING TEST REPORT

- Continued -

Instrument	Manufacturer	Model No	Specifications	KEC Control No.	if used, checked by "X".	Last Cal.	Next Cal.
Tuned Dipole Antenna	Kyoritsu	KBA-511S	Frequency Range 25 MHz - 500 MHz	AN-134	<input checked="" type="checkbox"/>	1999/3	2000/3
	Kyoritsu	KBA-611S	Frequency Range 500 MHz - 1 GHz	AN-136	<input checked="" type="checkbox"/>	1999/3	2000/3
Signal Generator	Wiltron	6759A-10	Frequency Range 10 MHz - 26.5 GHz	SG-38	<input type="checkbox"/>	1998/9	1999/9
		6769B	Frequency Range 10 MHz - 40.0 GHz	SG-42	<input type="checkbox"/>	1998/9	1999/9
	Anritsu	MG3601A	Frequency Range 0.1 MHz - 1040 MHz	SG-40	<input type="checkbox"/>	1998/9	1999/9
				SG-41	<input checked="" type="checkbox"/>	1998/9	1999/9
Power Amp.	ENI	601L	Frequency Range 0.8 MHz - 1 GHz	AM-24	<input checked="" type="checkbox"/>	1999/6	2000/6
		411LA	Frequency Range 0.15 MHz - 300 MHz	AM-25	<input type="checkbox"/>	1999/6	2000/6
	Amplifier Research	100W1000 M1	Frequency Range 80 MHz - 1 GHz	AM-55	<input type="checkbox"/>	1999/6	2000/6
RF Millivolt-meter	Rohde & Schwarz	URV5	Frequency Range 10 kHz - 2 GHz	VV-24	<input type="checkbox"/>	1999/3	2000/3
				VV-28	<input type="checkbox"/>	1999/3	2000/3
				VV-29	<input checked="" type="checkbox"/>	1999/3	2000/3
				VV-32	<input type="checkbox"/>	1999/3	2000/3
Coaxial Cable	Suhner	SUCOFLEX 104	Length : 1m [SMA(p)-SMA(p)]	CL-42	<input type="checkbox"/>	1999/2	2000/2
			Length : 10m [SMA(p)-SMA(p)]	CL-45	<input type="checkbox"/>	1999/2	2000/2
				CL-46	<input checked="" type="checkbox"/>	1999/2	2000/2
Attenuator	Weinschel Engineering	2	Frequency Range 1 MHz - 20 GHz -10 dB	AT-26-3	<input type="checkbox"/>	1999/2	2000/2

ENGINEERING TEST REPORT

- Continued -

Instrument	Manufacturer	Model No	Specifications	KEC Control No.	If used, checked by "X".	Last Cal.	Next Cal.
Regulated DC Power Supply	Kikusui	PAB18-3A	Output 0~18V, 3A	PD-32	<input checked="" type="checkbox"/>	—	—
Temperature Chamber with Thermometer	Tabai Mfg.	MC-710	Temperature Range -75 - +100 °C	CH-31	<input checked="" type="checkbox"/>	—	—
Frequency Counter	Advantest	TR5823H	Freq. Range 1 mHz-1300 MHz	CU-17	<input checked="" type="checkbox"/>	1999/5	2000/5
Spectrum Analyzer	Advantest	TR4172	Frequency Range 50 Hz - 1.8 GHz	SA-27	<input checked="" type="checkbox"/>	1999/7	2000/7
Digital Plotter	Hewlett Packard	7090A	Plot Area A3 size	RE-17	<input checked="" type="checkbox"/>	—	—
Multimeter	John Fluke	37	Volt Range 0.1mV - 1000 V Ampere Range 0.01 mA - 20 A	MM-91	<input checked="" type="checkbox"/>	1999/2	2000/2
Personal Computer	Hewlett Packard	9121	Memory 512kB Language BASIC	PC-38-2	<input checked="" type="checkbox"/>	—	—
Digital Oscilloscope	Matsushita Communication Ind.	VP-5740A	Frequency Range DC -10 MHz	OS-22	<input checked="" type="checkbox"/>	1999/5	2000/5

ENGINEERING TEST REPORT

- Continued -

Instrument	Manufacturer	Model No	Specifications	KEC Control No.	if used, checked by "X".	Last Cal.	Next Cal.
Regulated DC Power Supply	Kikusui	PAB18.3A	Output 0~18V, 3A	PD-32	<input checked="" type="checkbox"/>	—	—
Frequency Counter	Advantest	TR5823H	Freq.Range 1 mHz.1300 MHz	CU-17	<input checked="" type="checkbox"/>	1999/5	2000/5
Digital Plotterr	Hewlett Packard	7090A	Plot Area A3 size	RE-17	<input checked="" type="checkbox"/>	—	—
Multimeter	John Fluke	37	Volt Range 0.1mV . 1000 V Ampere Range 0.01 mA . 20 A	MM-91	<input checked="" type="checkbox"/>	1999/3	2000/3
Digital Oscilloscope	Matsushita Communication Ind.	VP.5740A	Frequency Range DC .10 MHz	OS-22	<input checked="" type="checkbox"/>	1999/5	2000/5