Designated by Ministry of International Trade and Industry

# KANSAI ELECTRONIC INDUSTRY DEVELOPMENT CENTER

HEAD OFFICE
6-6-7, NISHITEMMA
KITA-KU, OSAKA, 530 JAPAN

KEC

IKOMA
TESTING LABORATORY
10630, TAKAYAMA-CHO
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

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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.

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## 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 safety 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 ($\mu$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.

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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 quarts crystal controlled internal clock.

* provide supply voltages to the RF section (Vcc = 9.6V battery voltage; Vreg = 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 ($\mu$p).

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

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## 3.0 RF SECTION THEORY OF OPERATION

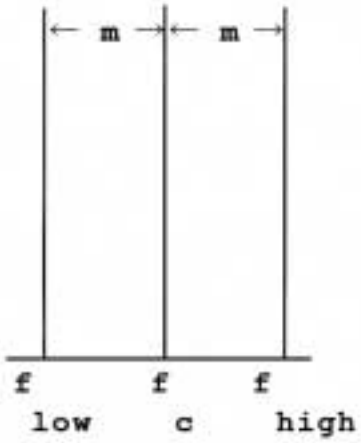
### 3.1 General

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

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

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 (×2)/buffer; it drives the Power Amplifier (PA). Its output frequency is 4× 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 modurator 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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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.

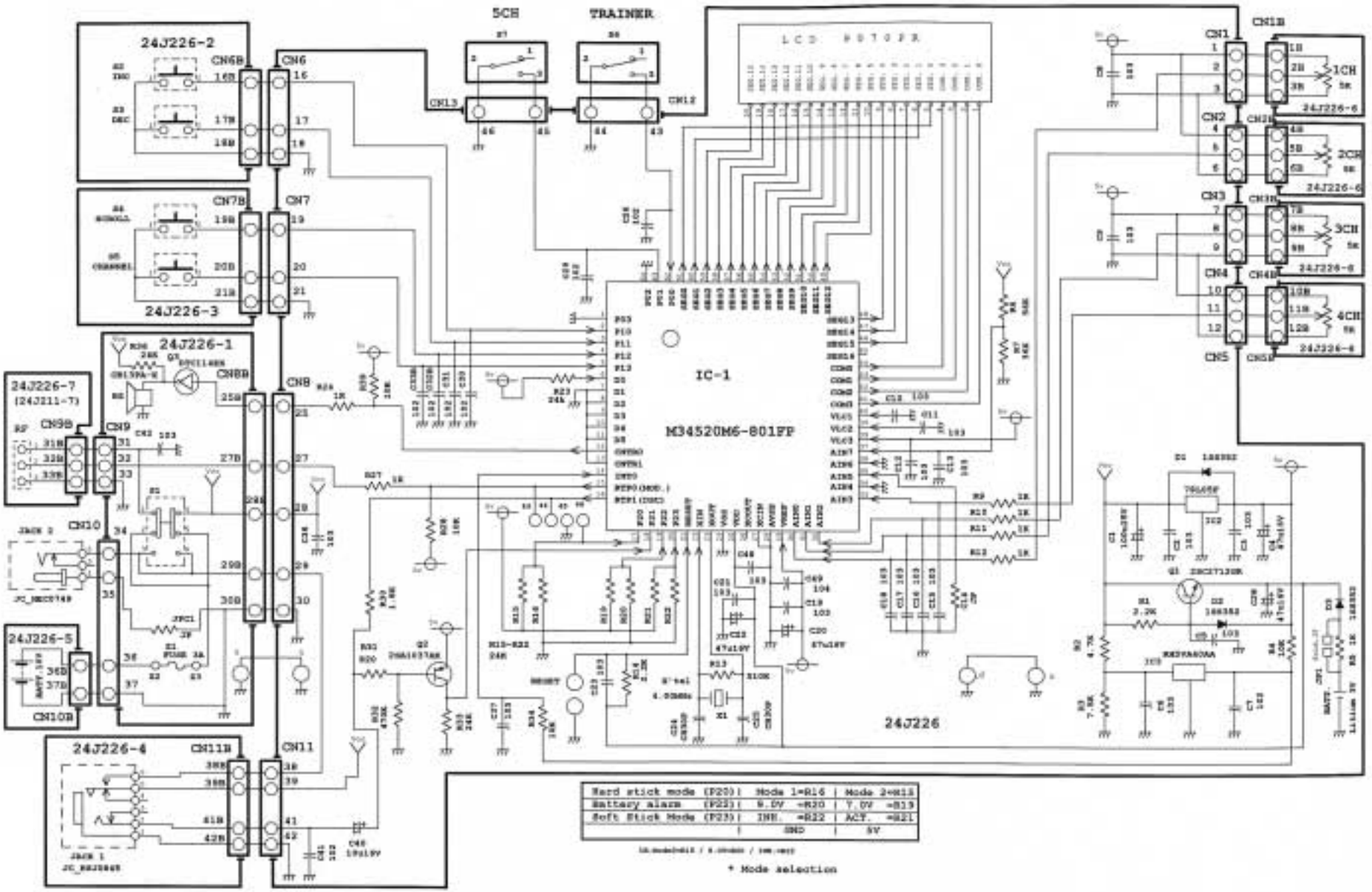
3. The MOD. IN input latch at 0 volt. Observe frequency counter.
Adjust the small ceramic trimmer capacitor on the PC assembly so that output frequency is exactly 2.0 KHz higher than the channel frequency.

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.

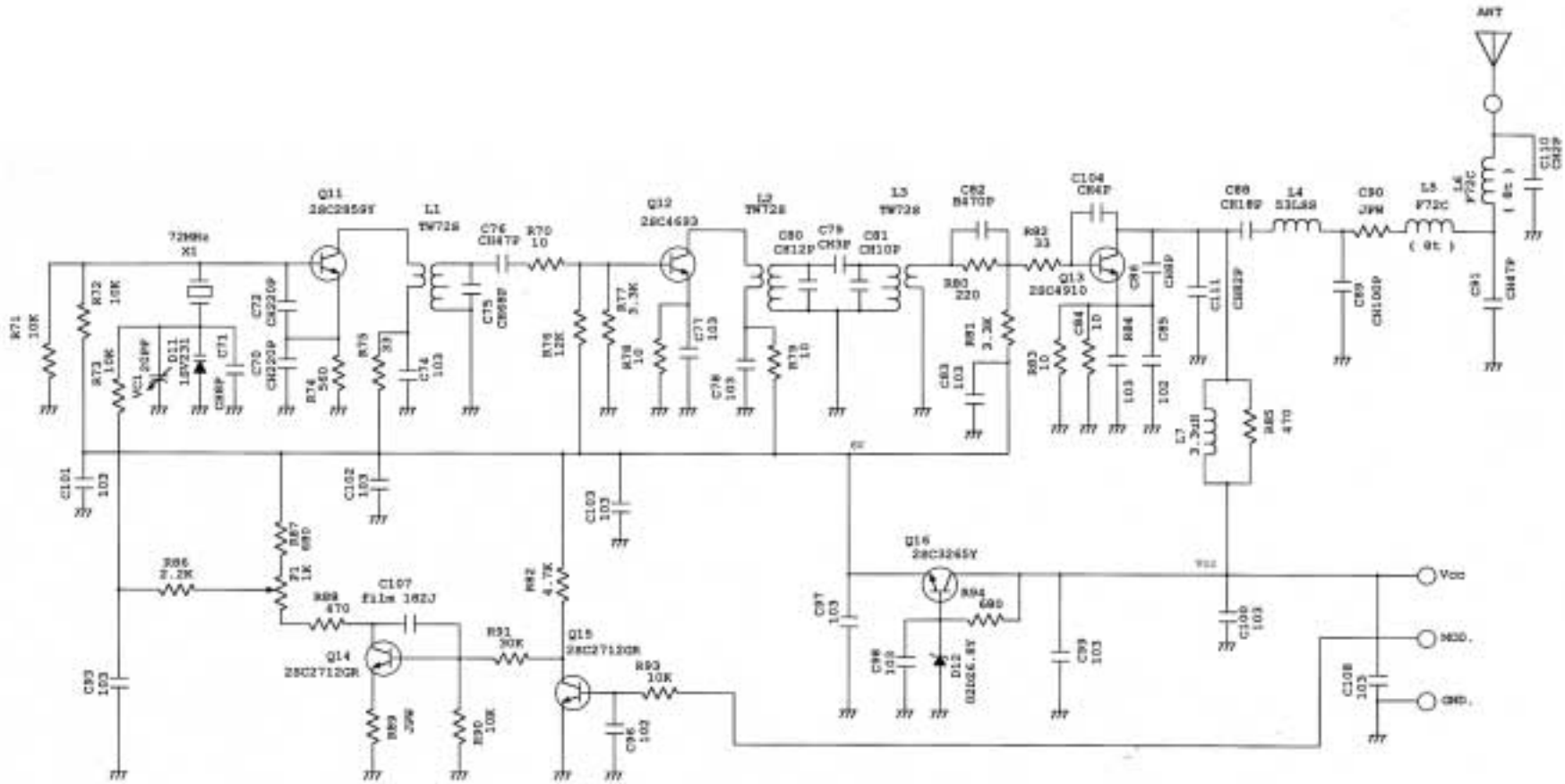
5. Repeat step 2.
Repeat step 3 and 4.

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# BRWXF421EX Figure 5.2.1 Transmitter Schematic Diagram

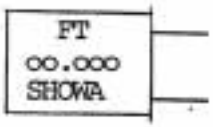



**FCC ID# BRWXF421EX  Figure 5.2.2  Transmitter Schematic Diagram**

SPECIFICATION OF CRYSTAL UNIT

ORDERD BY J.R SPEC. No TX 7M 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

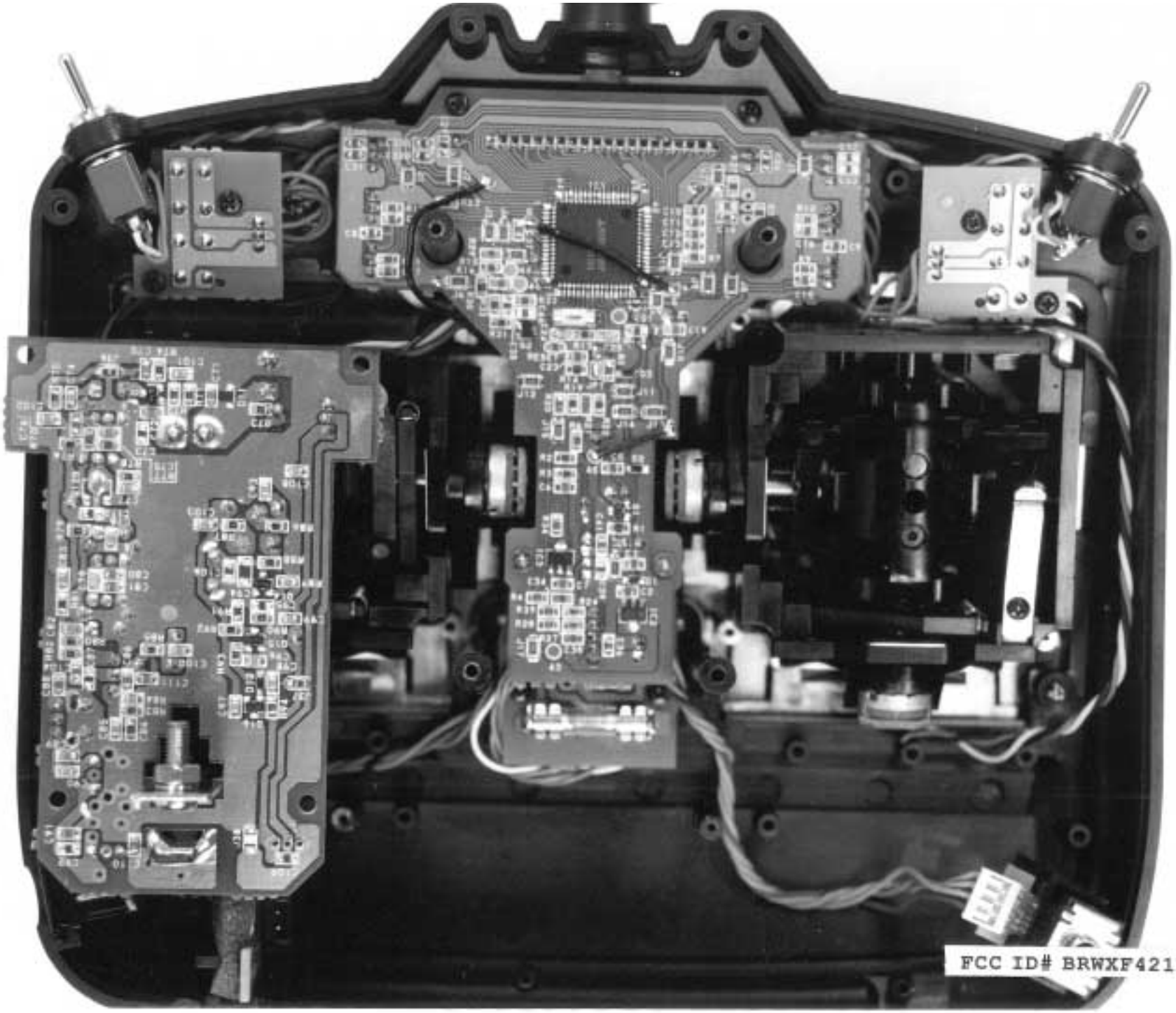



SHOWA CRYSTAL CO.LTD.

**Appendix 5.5**
**Transmitter Oscillator Specification**


FCC ID# BRWXF421EX

FCC ID# BRWXF421EX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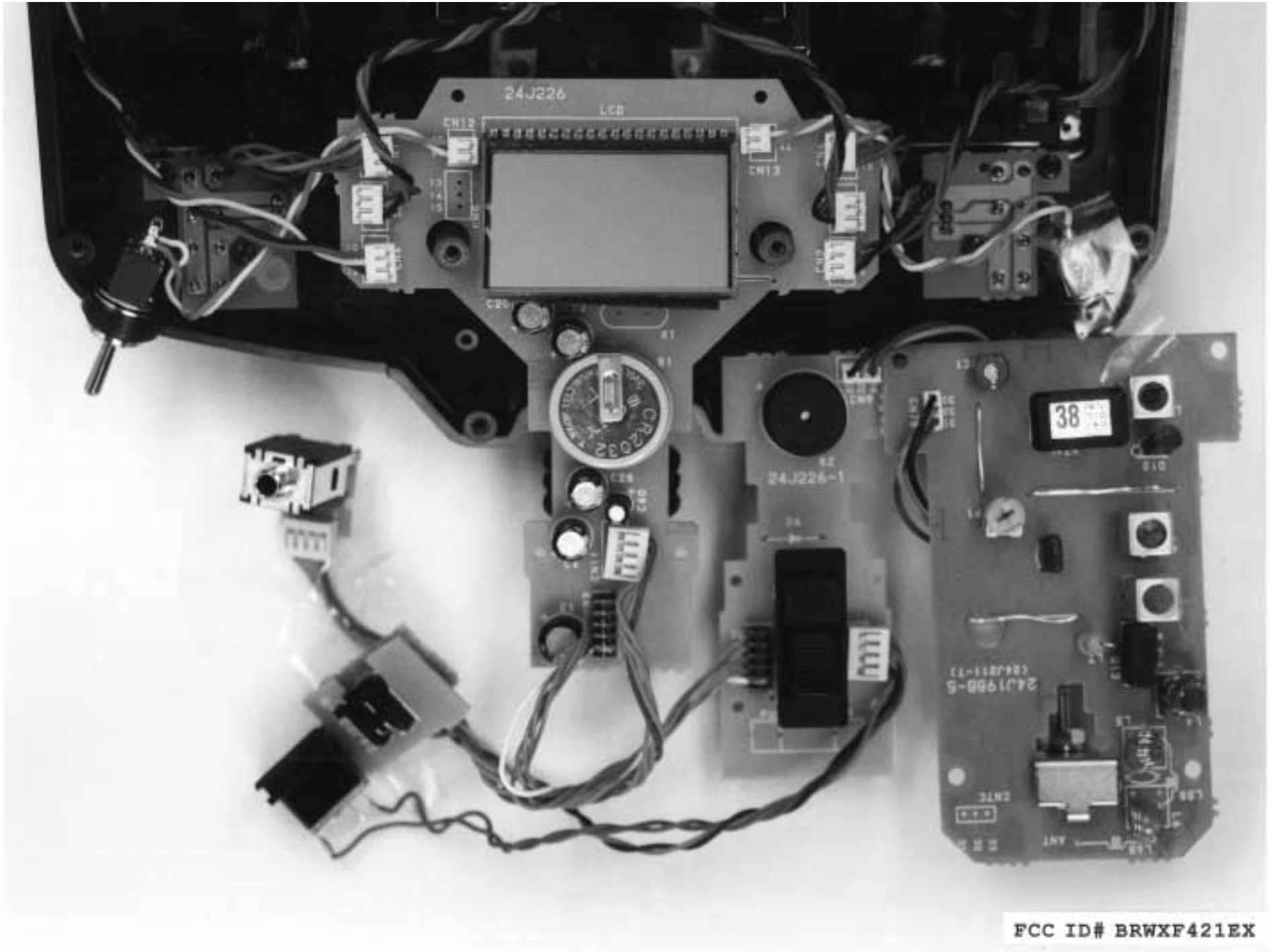
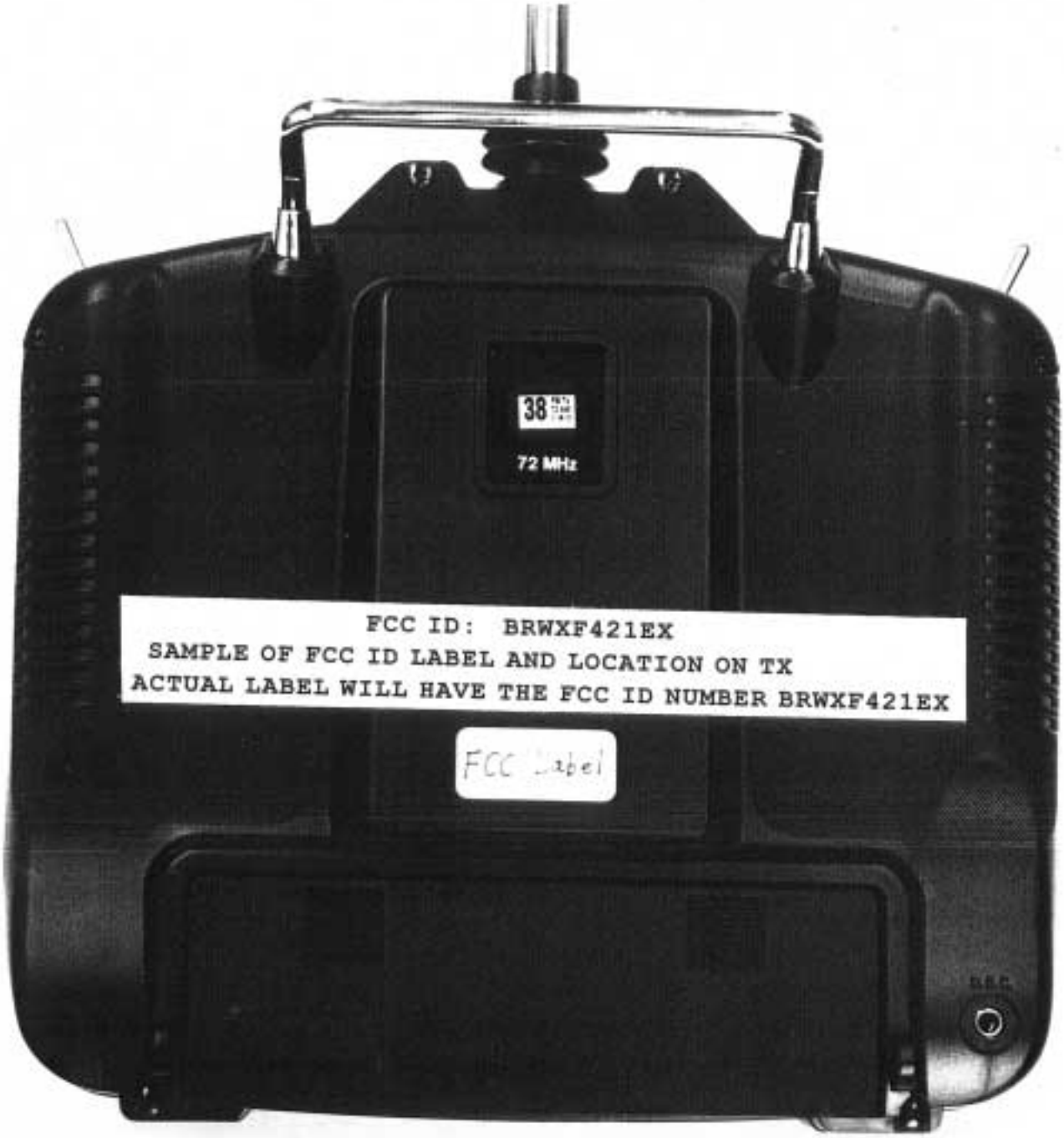



FCC ID# BRWXF421EX


FCC ID# BRWXF421EX


38
72 MHz
FCC ID: BRWXF421EX
SAMPLE OF FCC ID LABEL AND LOCATION ON TX
ACTUAL LABEL WILL HAVE THE FCC ID NUMBER BRWXF421EX
FCC Label

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Transmitter R.F. Tune Up Procedure

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# ENGINEERING TEST REPORT

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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.

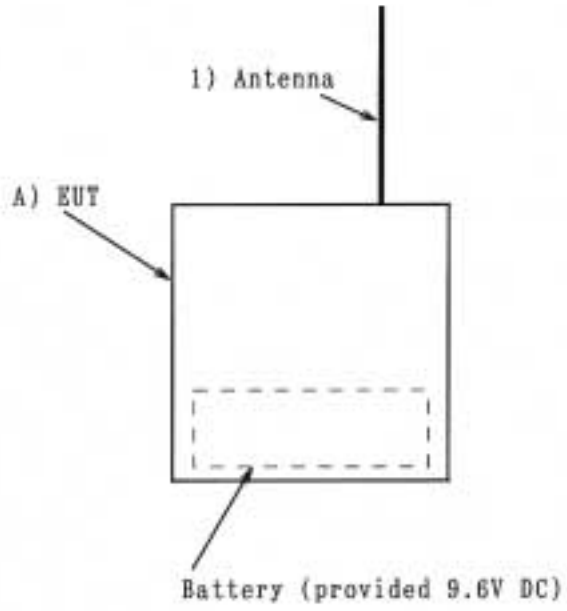
(1) F-Low

(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.

# ENGINEERING TEST REPORT

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 | BRWXF421EX | 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

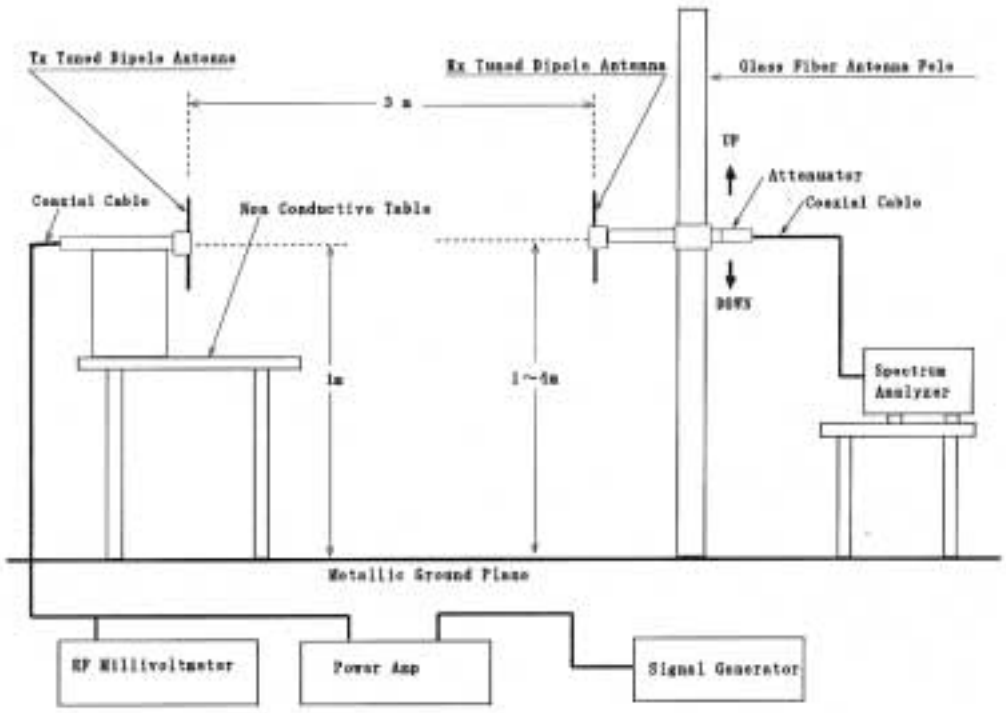
## 3. RF POWER OUTPUT

### 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 obtain.
   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 its obtained.
7) Repeat step6 with both antennas vertically polarized.

# ENGINEERING TEST REPORT

3.4 Test Result

| CARRIER FREQUENCY | SPECTRUM ANALYZER READING [dBμV] | | RF METER READING [dBm] | | CABLE LOSS | RF OUTPUT POWER | LIMIT |
|---|---|---|---|---|---|---|---|
| [MHz] | Horiz. | Vert. | Horiz. | Vert. | [dB] | [mW] | [mW] |
| 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:

$$\text{RF Power (mW)} = 1^{(Mr - Lo) \div 10}$$

where,

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

[ Environment ]

Temperature : 27 ℃ 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

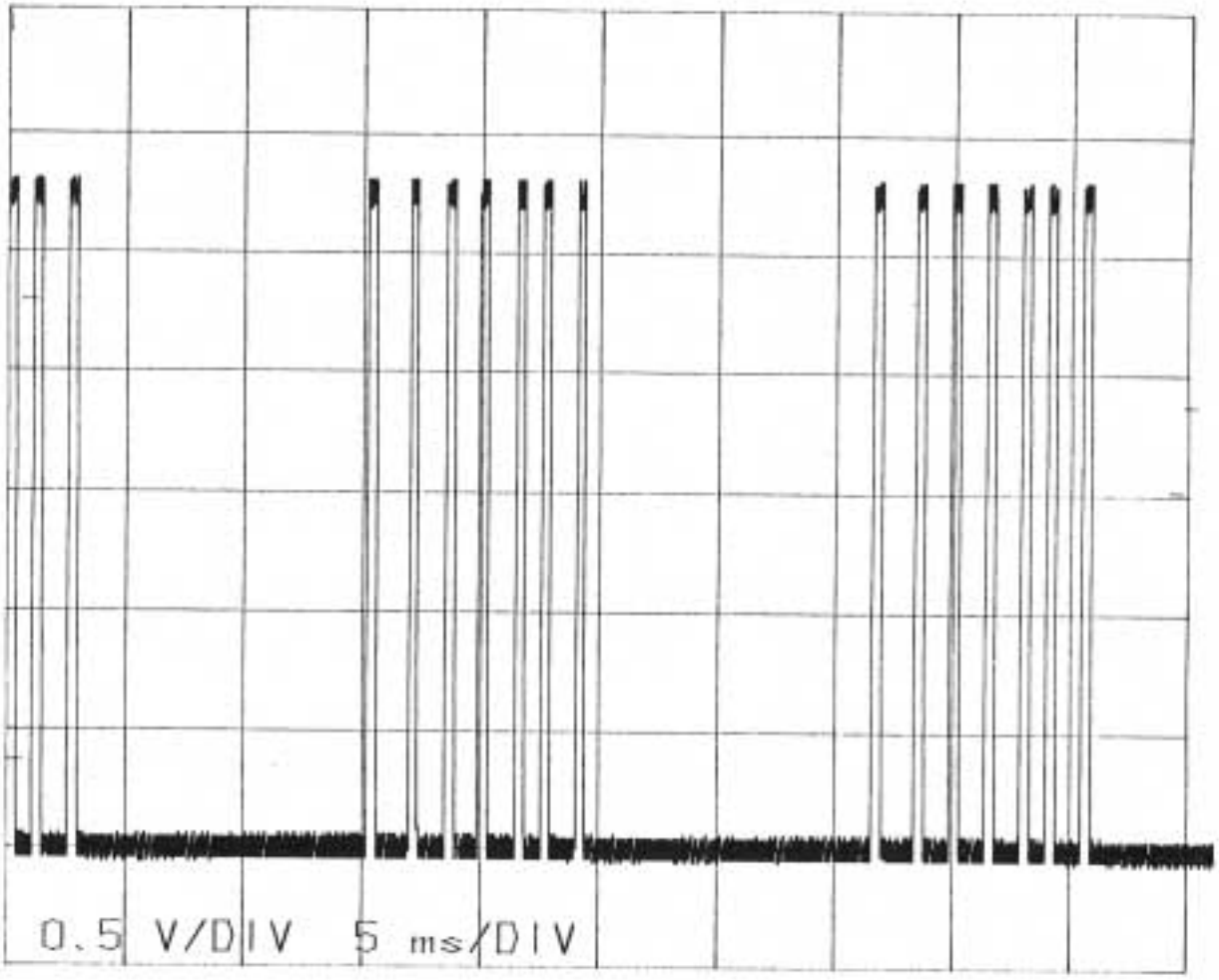
FCC Rule Part 2 Subpart J [§2.987]

### 4.2 Test Results

Encoded Waveform

1) Operation Mode of EUT

Modulation : Normal Modulation



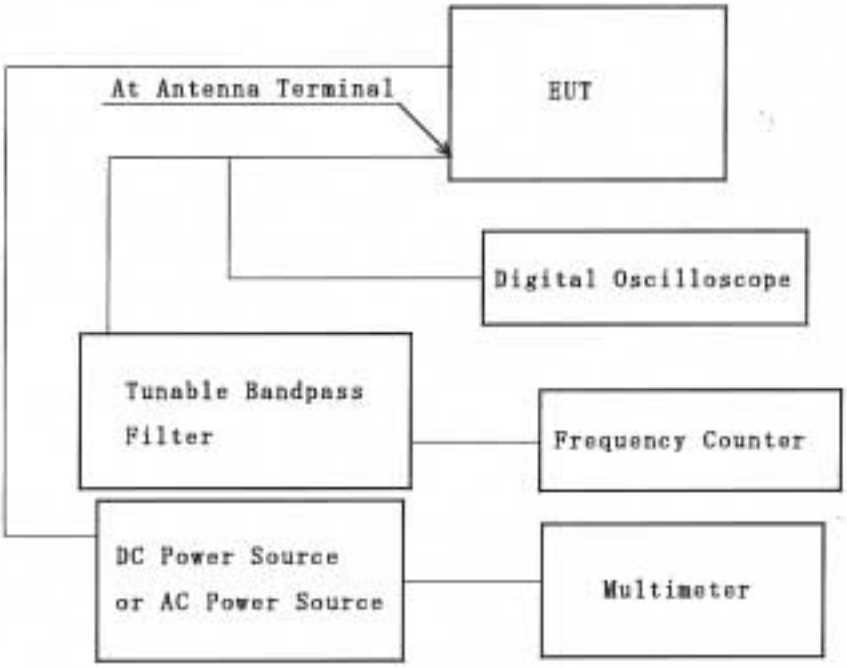
# ENGINEERING TEST REPORT

## 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)

Flow (low frequency of carrier) : 72.548486[ MHz ]
Fhigh (high frequency of carrier) : 72.550117[ MHz ]

[ Environment ]

Temperature : 20 ℃ Humidity : 55%

[ Calculation of the Peak Frequency Deviation ]

D = ( Fhigh - Flow ) / 2 = 0.82 [ kHz ]

D [ kHz ] : the Peak Frequency Deviation

# ENGINEERING TEST REPORT

- Cotinued -

2) Measurement of the Maximum Moduration Frequency(M)

Encoded Waveform
(See the Test Results of 4. MODULATION CHARACTERISTICS)

[ Environment ]

Temperature : 20 ℃ 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 [ mm ] / 16.0 [ mm / DIV ]×5 [ ms / DIV ]
= 1.13 [ ms ]

M= 1 / T
= 0.88 [ kHz ]

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

3) Culculation of the Necessary Bandwidth(B)

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

B = 2M + 2D = 3.40[ 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

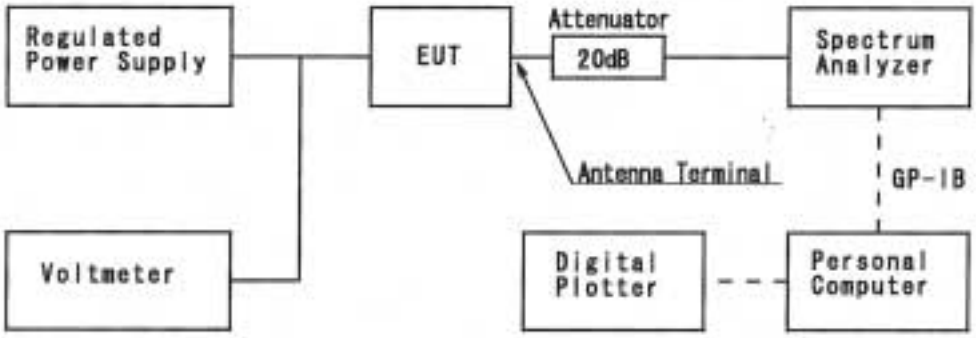
# ENGINEERING TEST REPORT

## 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 Vn. Then all power P becomes following fomula.

$$P = \sum_{n=1}^{1001} \frac{V_n^2}{R} \qquad \cdots\cdots (1)$$

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,

$$0.005P = \sum_{n=1}^{X} \frac{V_n^2}{R} \qquad \cdots\cdots (2)$$

$$0.995P = \sum_{n=1}^{Y} \frac{V_n^2}{R} \qquad \cdots\cdots (3)$$

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

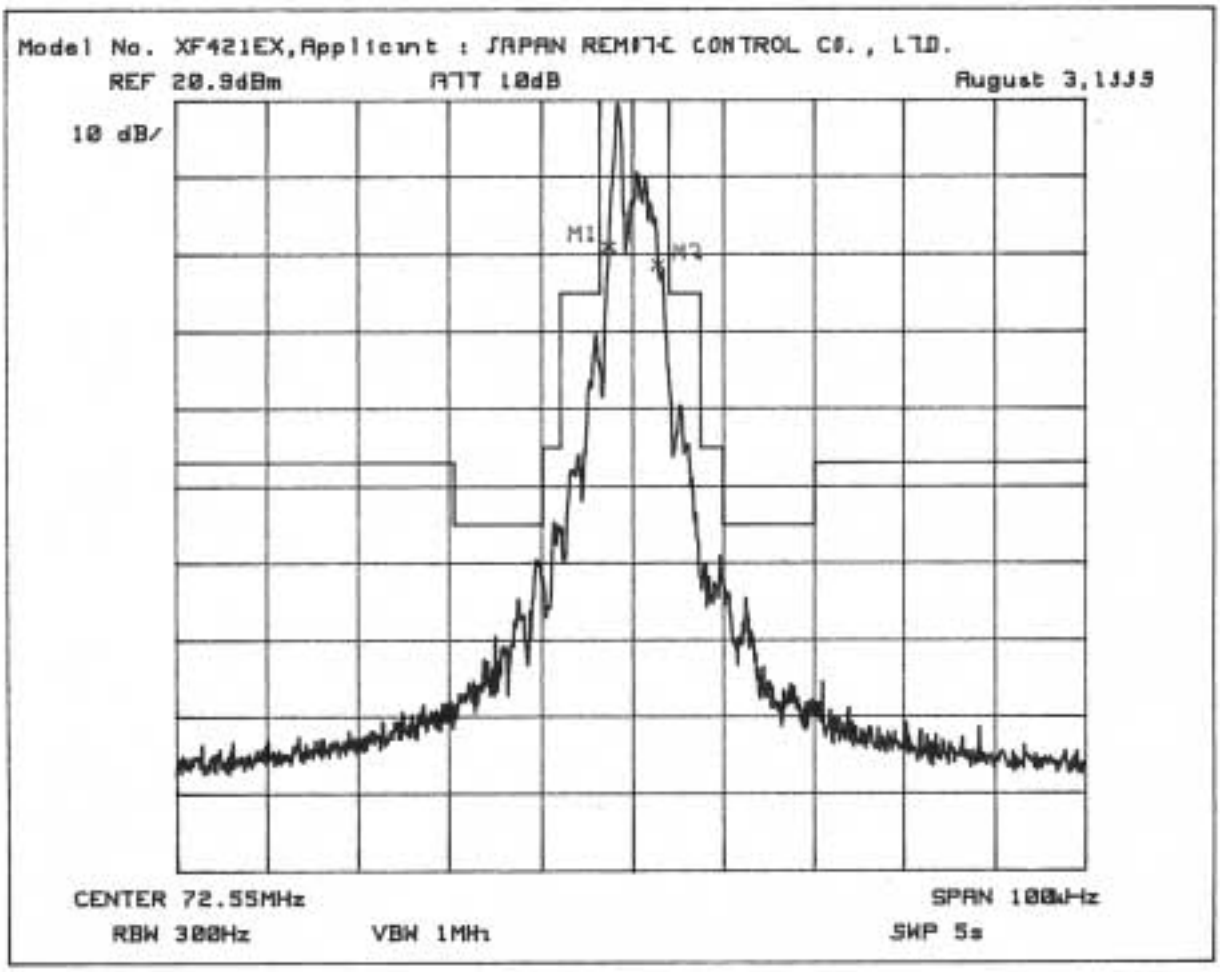
EUT was operated the various position of JOY STICKS & OTHR SWTCHES.(Reference level is the unmodulated level.)

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)



# ENGINEERING TEST REPORT

## Operation Mode of EUT

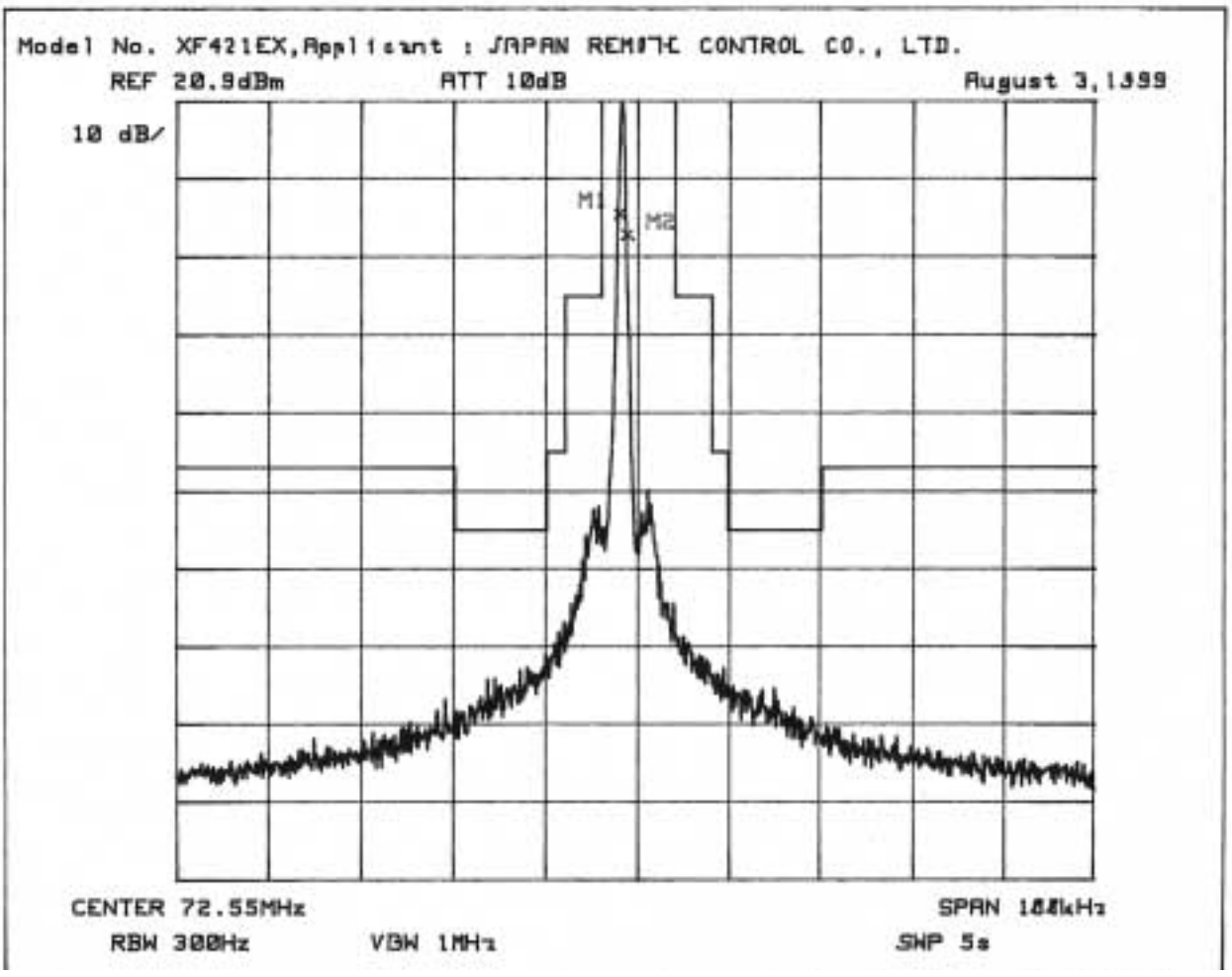
Non modulation

[F Low]

## Occupied Bandwidth = .9kHz (99% Power)

M1=72.548MHz(0.5% Power Point)

M2=72.5489MHz(99.5% Power Point)



# ENGINEERING TEST REPORT

## Operation Mode of EUT

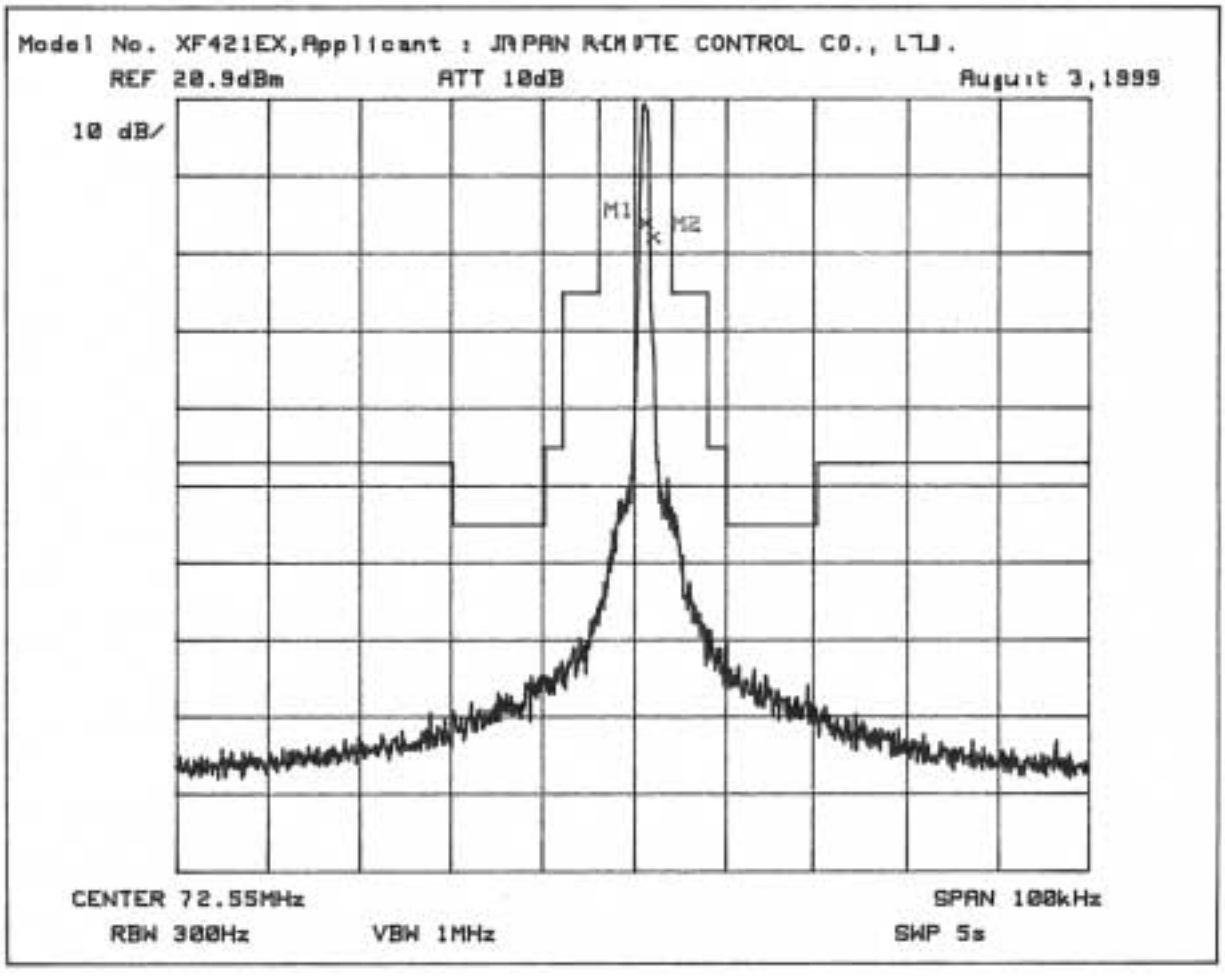
Non modulation

[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

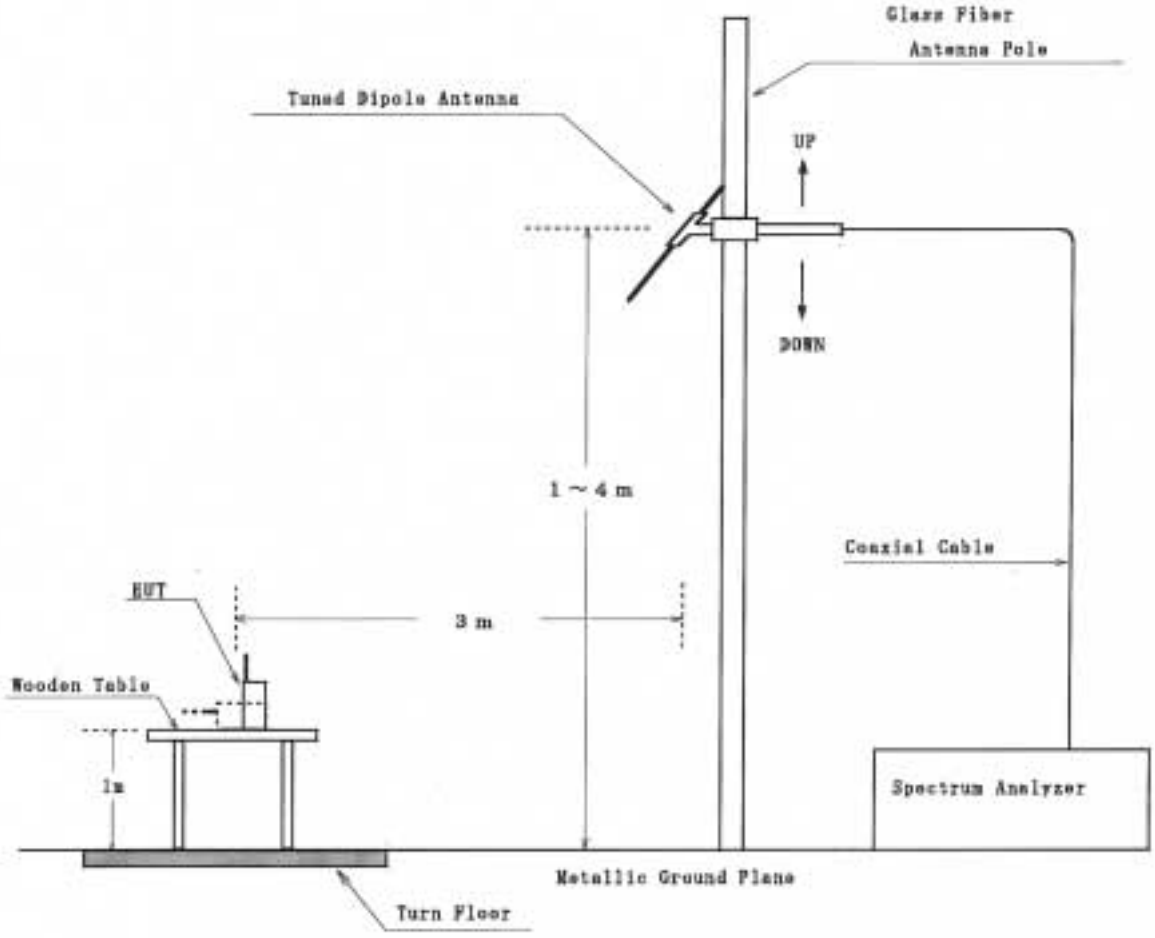
1) Tune-up the transmitter(EUT).
2) Device Vertical : Place the device so that it's longest axis is vertical.
3) For each spurious measurement the receiving antenna is adjusted to the correct length for the frequency involved. These measurements are made from the lowest radio frequency generated in the 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:

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

# ENGINEERING TEST REPORT

7.3 Test Configuration

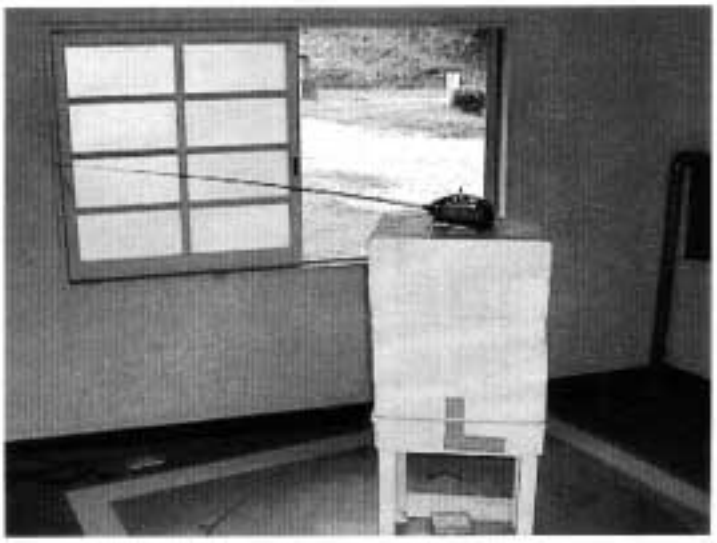
[ Open Site ]



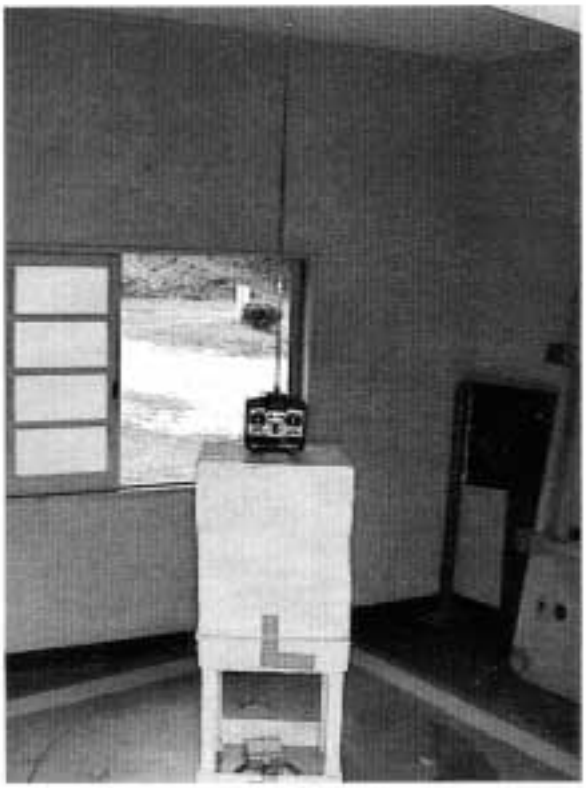
# ENGINEERING TEST REPORT

7.4 Photographs of EUT System Configuration

Horizontal
Placing



Vertical
Placing



# ENGINEERING TEST REPORT

7.5 Test Results

| EMISSION FREQUENCY | METER READING at 3m [dBμV] | | ANTENNA FACTOR | MAXIMUM FIELD STRENGTH | ATTENUATION FROM CARRIER | LIMIT |
|---|---|---|---|---|---|---|
| [MHz] | Horiz. | Vert. | [dB] | [dBμV/m] | [dB] | [dB] |
| Carrier Emission | | | | | | |
| 72.55 | 112.3 | 106.6 | 6.8 | 119.1 | – | – |
| Spurious Emission | | | | | | |
| 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 + 10Log(Power) = 56 + 10Log(0.1230) = 46.9 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 Y. Kawai
Yasunari Kawai

# ENGINEERING TEST REPORT

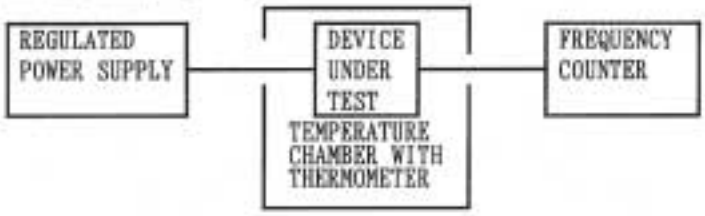
## 8. FREQUENCY STABILITY MEASUREMENT

### 8.1 Reference Rule and Specification

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

### 8.2 Frequency vs Temperature Test

Test Setup Diagram




Test Result Test Voltage: 9.6V

| REFERENCE FREQUENCY [MHz] | TEMPERATURE [℃] | 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 Test

Test Setup Diagram : Same as (1)

Test Result Temperature : +20℃

| 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℃ 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 Y. Kawai
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 | ☐ | 1999/5 | 2000/5 |
| Spectrum Analyzer | Advantest | TR4172 | Frequency Range 50 Hz - 1.8 GHz | FS-44 | ☐ | 1999/5 | 2000/5 |
| Biconical Antenna | Schwarzbeck | BBA9106 | Frequency Range 30 MHz - 300 MHz | AN-80 | ☐ | 1999/2 | 2000/2 |
| Log-Periodic | Schwarzbeck | UHALP 9107 | Frequency Range 300 MHz - 1 GHz | AN-215 | ☐ | 1999/2 | 2000/2 |
| Tuned Dipole | Kyoritsu | KBA-511S | Frequency Range 25 MHz - 500 MHz | AN-135 | ☒ | 1999/3 | 2000/3 |
| | Kyoritsu | KBA-611S | Frequency Range 500 MHz - 1 GHz | AN-137 | ☒ | 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 | ☒ | 1999/3 | 2000/3 |
| | Kyoritsu | KBA-611S | Frequency Range 500 MHz - 1 GHz | AN-136 | ☒ | 1999/3 | 2000/3 |
| Signal Generator | Wiltron | 6759A-10 | Frequency Range 10 MHz - 26.5 GHz | SG-38 | ☐ | 1998/9 | 1999/9 |
| | | 6769B | Frequency Range 10 MHz - 40.0 GHz | SG-42 | ☐ | 1998/9 | 1999/9 |
| | Anritsu | MG3601A | Frequency Range 0.1 MHz - 1040 MHz | SG-40 | ☐ | 1998/9 | 1999/9 |
| | | | | SG-41 | ☒ | 1998/9 | 1999/9 |
| Power Amp. | ENI | 601L | Frequency Range 0.8 MHz - 1 GHz | AM-24 | ☒ | 1999/6 | 2000/6 |
| | | 411LA | Frequency Range 0.15 MHz - 300 MHz | AM-25 | ☐ | 1999/6 | 2000/6 |
| | Amplifier Research | 100W1000 M1 | Frequency Range 80 MHz - 1 GHz | AM-55 | ☐ | 1999/6 | 2000/6 |
| RF Millivolt-meter | Rohde & Schwarz | URV5 | Frequency Range 10 kHz - 2 GHz | VV-24 | ☐ | 1999/3 | 2000/3 |
| | | | | VV-28 | ☐ | 1999/3 | 2000/3 |
| | | | | VV-29 | ☒ | 1999/3 | 2000/3 |
| | | | | VV-32 | ☐ | 1999/3 | 2000/3 |
| Coaxial Cable | Suhner | SUCOFLEX 104 | Length : 1m [SMA(p)-SMA(p)] | CL-42 | ☐ | 1999/2 | 2000/2 |
| | | | Length : 10m [SMA(p)-SMA(p)] | CL-45 | ☐ | 1999/2 | 2000/2 |
| | | | | CL-46 | ☒ | 1999/2 | 2000/2 |
| Attenuator | Weinschel Engineering | 2 | Frequency Range 1 MHz - 20 GHz -10 dB | AT-26-3 | ☐ | 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. |
|---|---|---|---|---|---|---|---|
| Regurated DC Power Supply | Kikusui | PAB18-3A | Output 0~18V, 3A | PD-32 | ☒ | — | — |
| Temperature Chamber with Thermometer | Tabai Mfg. | MC-710 | Temperature Range -75 - +100 ℃ | CH-31 | ☒ | — | — |
| Frequency Counter | Advantest | TR5823H | Freq.Range 1 mHz-1300 MHz | CU-17 | ☒ | 1999/5 | 2000/5 |
| Spectrum Analyzer | Advantest | TR4172 | Frequency Range 50 Hz - 1.8 GHz | SA-27 | ☒ | 1999/7 | 2000/7 |
| Digital Plotterr | Hewlett Packard | 7090A | Plot Area A3 size | RE-17 | ☒ | — | — |
| Multimeter | John Fluke | 37 | Volt Range 0.1mV - 1000 V Ampere Range 0.01 mA - 20 A | MM-91 | ☒ | 1999/2 | 2000/2 |
| Personal Computer | Hewlett Packard | 9121 | Memory 512kB Language BASIC | PC-38-2 | ☒ | — | — |
| Digital Oscilloscope | Matsushita Communication Ind. | VP-5740A | Frequency Range DC -10 MHz | OS-22 | ☒ | 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. |
|---|---|---|---|---|---|---|---|
| Regurated DC Power Supply | Kikusui | PAB18.3A | Output 0~18V, 3A | PD-32 | ☒ | — | — |
| Frequency Counter | Advantest | TR5823H | Freq.Range 1 mHz.1300 MHz | CU-17 | ☒ | 1999/5 | 2000/5 |
| Digital Plotterr | Hewlett Packard | 7090A | Plot Area A3 size | RE-17 | ☒ | — | — |
| Multimeter | John Fluke | 37 | Volt Range 0.1mV . 1000 V Ampere Range 0.01 mA . 20 A | MM-91 | ☒ | 1999/3 | 2000/3 |
| Digital Oscilloscope | Matsushita Communication Ind. | VP.5740A | Frequency Range DC .10 MHz | OS-22 | ☒ | 1999/5 | 2000/5 |