# TEST REPORT
# MARINE RADAR
# RA42C

# Foreword

The following information is being submitted in compliance with paragraphs 2.983, 2.985, 2.987, 2.989, 2.991, 2.993 and 2.995 as provided by part 83 of the FCC Rules and Regulations for Type Acceptance of the Koden Marine Radar, Type RA42C.

All testing was performed by the Koden Electronics Co., Ltd.

Uenohara Factory, 5278, Uenohara, Uenohara-Machi, Kitatsuru-Gun, Yamanashi, 409-0112, Japan.

ENGINEERING TEST REPORT
ON RA42C KODEN MARINE RADAR

APPLICANT: KODEN ELECTRONICS CO., LTD
EQUIPMENT: MARINE RADAR
TEST SITE: UENOHARA-FACTORY OF KODEN ELECTRONICS CO., LTD
TEST DATE: June in 2000
To: Whom it concern

Good engineering practice were followed while performing test for FCC type acceptance application, and the result are accurate.

Respectfully,

Report Prepared by:

H.Iida
Engineer of Design Section

Approved by:

Y.Minegishi
Manager
Design Section

STANDARD TEST CONDITIONS
and
ENGINEERING PRACTICES

Except as noted herein, the following conditions and procedure were observed during the testing:

ROOM TEMPERATURE =25±5•
ROOM HUMIDITY =20-50%

Prior to testing, the E.U.T. was tuned up in accordance with the manufacturer's alignment procedures. All external gain controls were maintained at the position of maximum and/or optimum gain throughout the testing.

MEASUREMENT DATA, unless otherwise noted, are WORST CASE measurements.

## Table of contents

Data for the acceptance of the Koden Marine Radar Type RA42C

## List of Exhibit

Exhibit Number

Exhibit 1

RF POWER OUTPUT (2.985)

| | |
|---|---|
| Type of Transmission: | P0N |
| Type of Modulation: | Pulse |
| Frequency Band: | 9410 MHz ± 30 MHz |
| Frequency Source: | Fixed Cavity Resonator |
| Pulse Rate: | 600 Hz to 2000 Hz, Selectable as a function of Range |
| Pulse Width: | 0.11 us to 0.8 us, Selectable as a function of Range |

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | X-Band Directional Coupler | Hewlett-Packard | X752D |
| 2. | Variable Attenuator | Hewlett-Packard | X382A |
| 3. | Power Meter | ANRITSU | ML83A |
| 4. | Crystal Detector | Hewlett-Packard | 423B |
| 5. | Oscilloscope | TEKTRONIX | 2445 |
| 6. | Frequency meter | Hewlett-Packard | X532B |
| 7. | X-Band Dummy Load | NIHON KOSHUHA | WDL095 |

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

110ns × 2000Hz, 250ns × 1500Hz, 0.8 × 600Hz

The Power output for each of these combinations was measured by using the following procedure:

(1) Set up the equipment as shown in Fig.1.
(2) Record reading of Power Meter.
(3) Calculate mean power according to attenuation.
(4) Measure and record pulse width and P.R.F. by using oscilloscope and frequency counter.
(5) Calculate peak power as follows:

$$P0 = Pm / (Fr \times T)$$

P0 : Peak Power, Pm : Mean Power, Fr : P.R.F.*
T : Pulse Width, * P.R.F. : Pulse Repetition Frequency

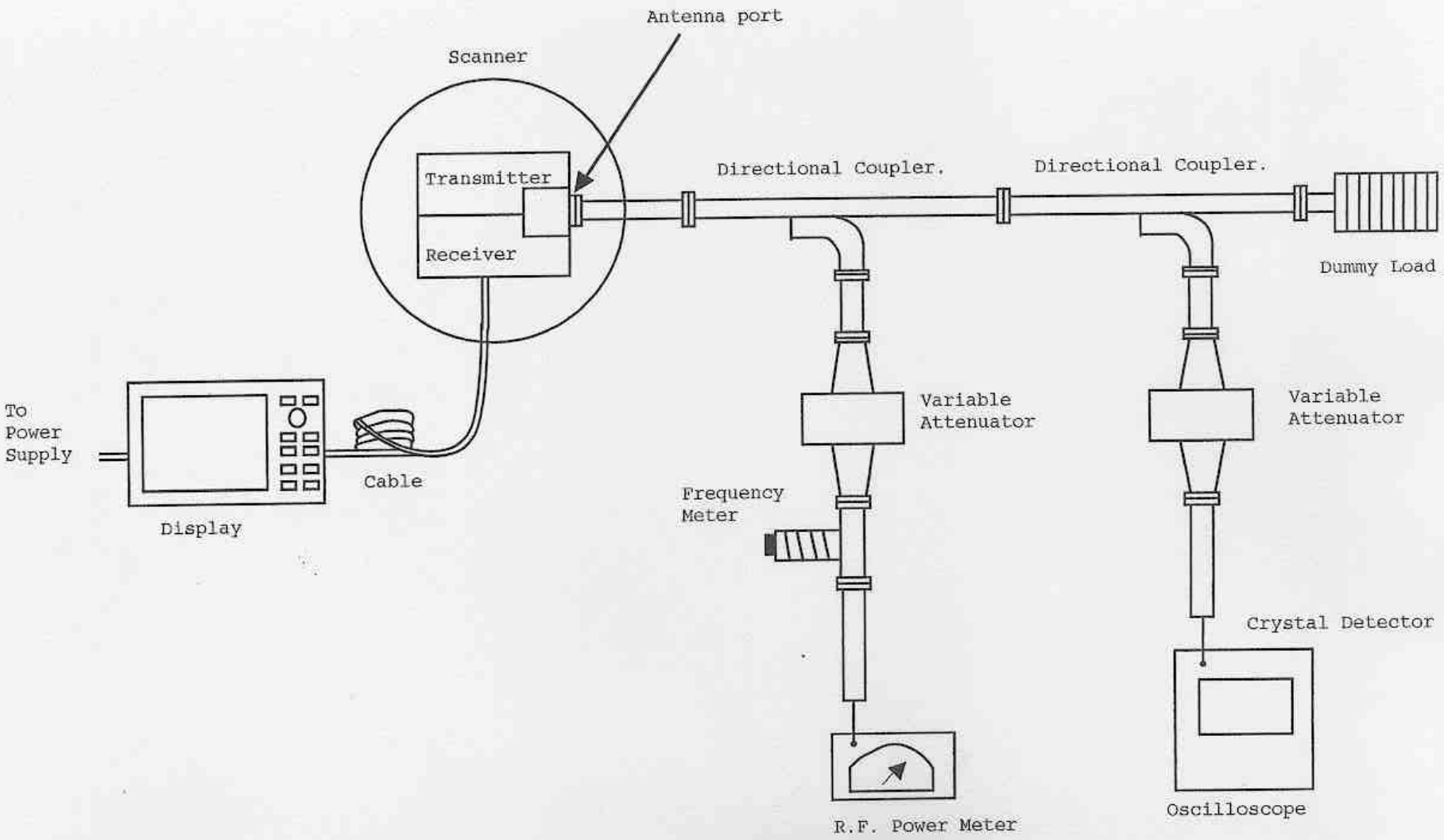



Figure 1 RF POWER OUTPUT & MODULATION CHARACTERISTICS(2.987)

Exhibit 1

TEST RESULT

| Transmit Pulse width and P.R.F. | Measured Mean Power | Measured Pulse width | Measured P.R.F. | Calculated Peak power Output |
|---|---|---|---|---|
| 110ns×2000Hz | 0.91W | 120nS | 2020Hz | 3.75kW |
| 250ns×1500Hz | 1.66W | 258nS | 1488Hz | 4.32kW |
| 800ns×600Hz | 2.01W | 784nS | 579Hz | 4.43kW |

Exhibit 2

MODULATION CHARACTERISITICS (2.987)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9410 MHz ±•30MHz
Frequency Source: Fixed Cavity Resonator
Pulse Rate: 600 to 2000 Hz, Selectableas a function of Range
Pulse Width: 0.11 us to 0.8 us, Selectable as a function of Range

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | X-Band Directional Coupler | Hewlett-Packard | X752D |
| 2. | Variable Attenuator | Hewlett-Packard | X382A |
| 3. | Power Meter | ANRITSU | ML83A |
| 4. | Crystal Detector | Hewlett-Packard | 423B |
| 5. | Oscilloscope | TEKTRONIX | 2445 |
| 6. | Frequency meter | Hewlett-Packard | X532B |
| 7. | X-Band Dummy Load | NIHON KOSHUHA | WDL095 |

TEST PROCEDURER

The Marine Radar is capable of generating the following pulses:
0.11 us x 2000 Hz, 0.25 us x 1500 Hz, 0.8 us x 600 Hz

The Modulation characteristics for each of these combinations was measured by using the following procedure:

(1) Set up the equipment as shown in Fig.1.
(2) Obtain a convenient display on the oscilloscope and adjust peak to the suitable cursor line.
(3) Decrease variable attenuator 3 dB, and measure the pulse width at the cursor line.
(4) Photograph the oscilloscope display.
(5) Note and record the Frequency Readout of the counter as "Pulse Repetition Frequency".

Exhibit 2

TEST RESULT

Modulation Characteristics
(Detected Pulse)

(1) Short Pulse

Pulse width (-3 dB) = 120 ns
Pulse repetition Frequency = 2020 Hz


50 ns/div.

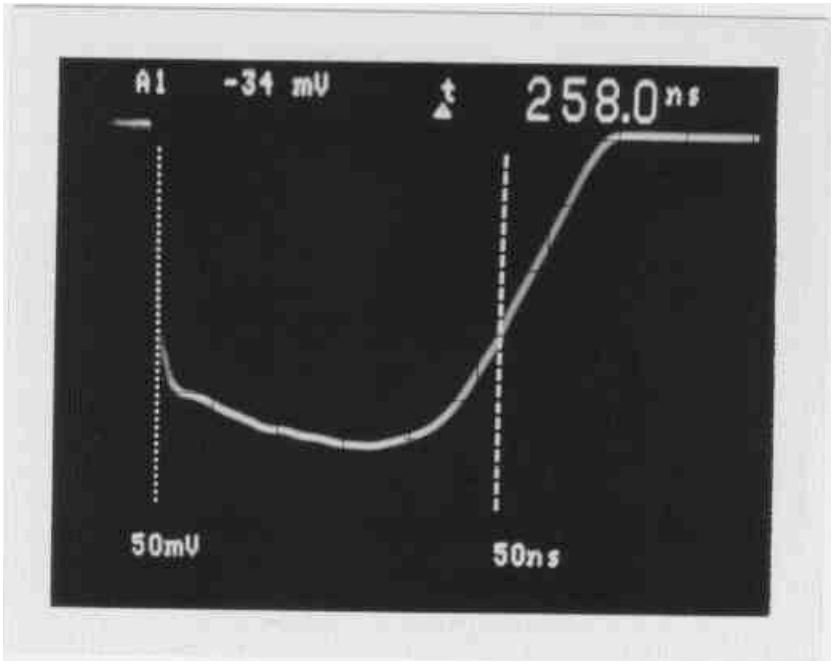
Exhibit 2

TEST RESULT

Modulation Characteristics
(Detected Pulse)

(2) Middle Pulse

Pulse width (-3 dB) = 258 ns
Pulse repetition Frequency = 1488 Hz




50 ns/div.

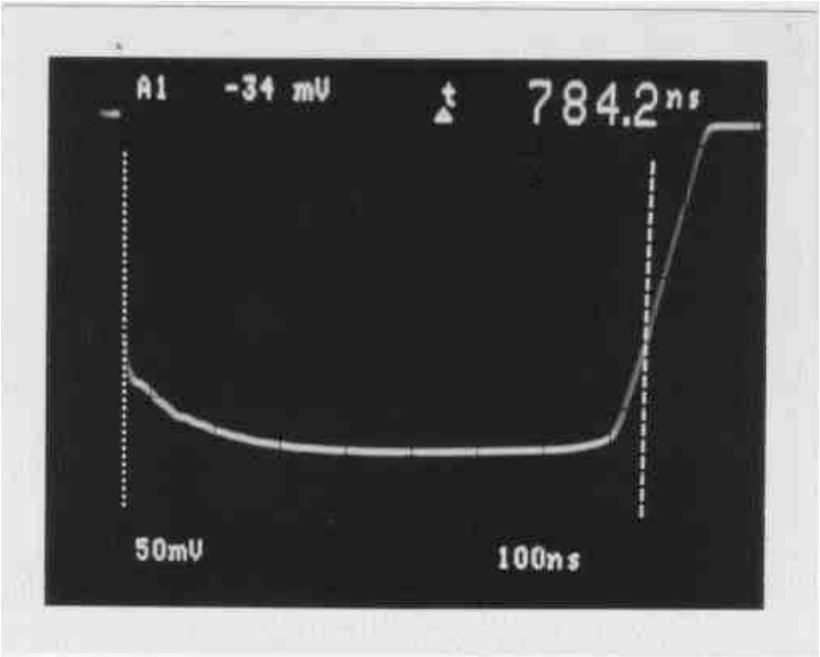
Exhibit 2

TEST RESULT

Modulation Characteristics
(Detected Pulse)

(3) Long Pulse

Pulse width (-3 dB) = 784 ns
Pulse repetition Frequency = 579 Hz




100 ns/div.

Exhibit 3

OCCUPIED BANDWIDTH (2.989)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9410 MHz ± 30 MHz
Frequency Source: Fixed Cavity Resonator
Pulse Rate: 600 to 2000 Hz, Selectable as a function of Range
Pulse Width: 0.11 us to 0.8 us, Selectable as a function of Range

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | X-Band Directional Coupler | Hewlett-Packard | X752D |
| 2. | Variable Attenuator | Hewlett-Packard | X382A |
| 3. | X-Band Dummy Load | NIHON KOSHUHA | WDL095 |
| 4. | Spectrum Analyzer | Anritsu | MS710C |

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:
110 ns × 2000 Hz, 250 ns × 1500 Hz, 800 ns × 600 Hz

The occupied bandwidth for each of these combinations was measured by using the following procedure:

(1) Connect the equipment as shown in Fig.3.
(2) Adjust center frequency, span reference level of spectrum analyzer and attenuator if necessary, such that the display nearly fills the screen.
(3) Measure and record spectrum and bandwidth

The bandwidth is calculated so that the total powers lower than the lowest frequency in the bandwidth and higher than the highest frequency in the bandwidth occupy 0.5% of the transmitted total power respectively.

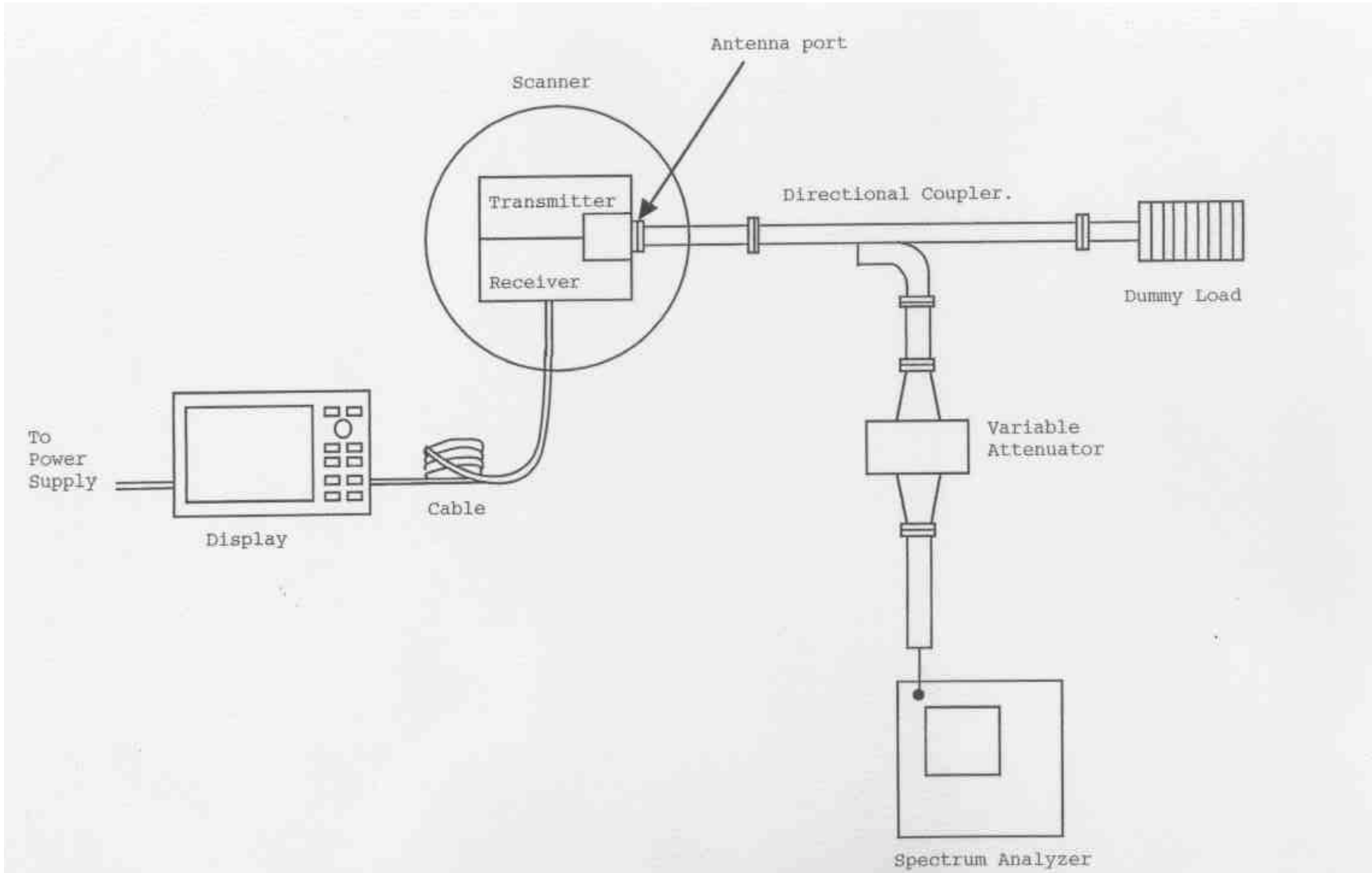
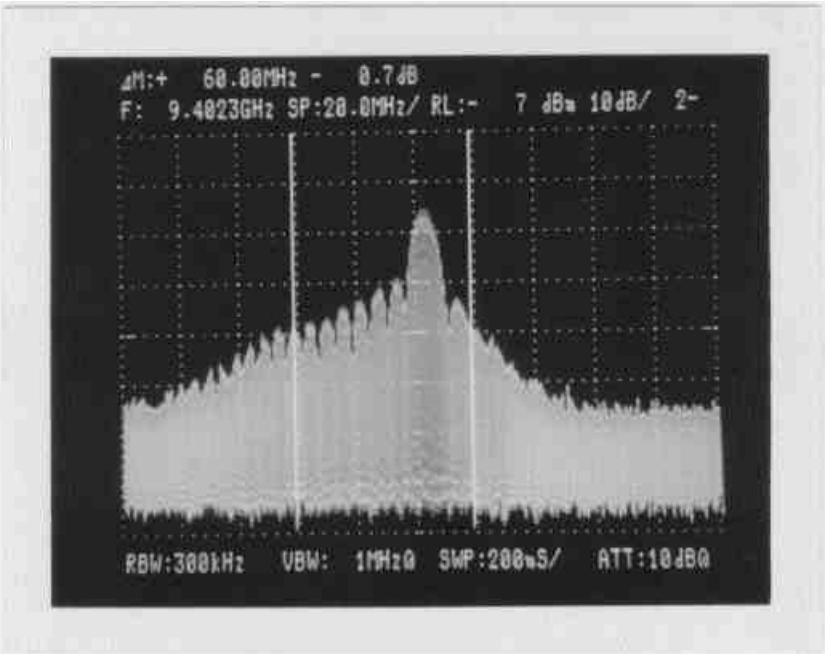



Figure 2 OCCUPIED BAND WIDTH(2.989) & SPURIOUS EMISSION AT ANTENNA TERMINAL(2.991)

Exhibit 3

TEST RESULT

Transmission Spectrum of 110 ns × 2000 Hz



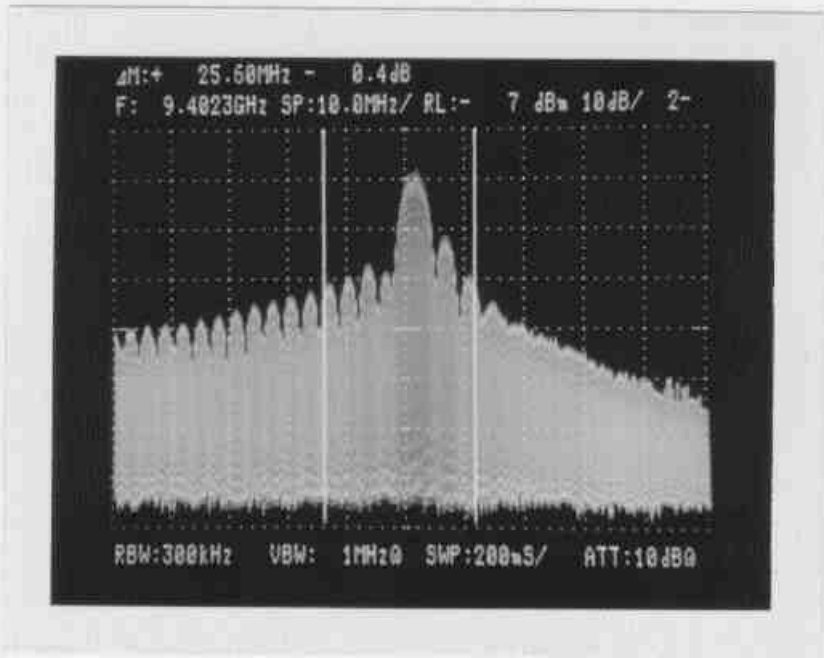

| | | |
|---|---|---|
| Center frequency | : | 9.4023GHz |
| Frequency span | : | 20.0 MHz/div. |
| Level | : | 10 dB/div. |
| Resolution band width | : | 300 kHz/div. |
| Video band width | : | 1 MHz/div. |
| Sweep time | : | 200 msec/div. |

Occupied band width : 60.0 MHz

Exhibit 3

TEST RESULT

Transmission Spectrum of 250 ns × 1500 Hz



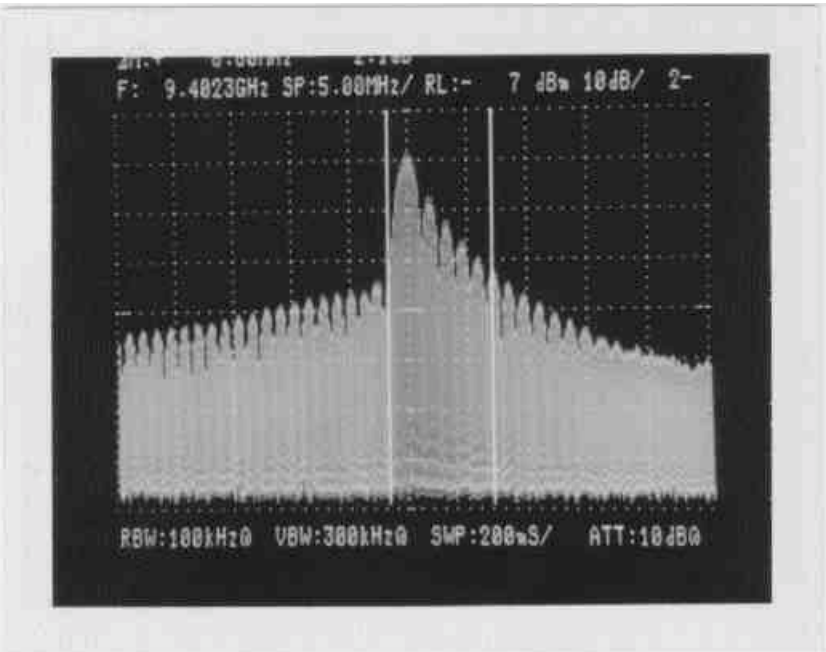

| | | |
|---|---|---|
| Center frequency | : | 9.4023GHz |
| Frequency span | : | 10.0 MHz/div. |
| Level | : | 10 dB/div. |
| Resolution band width | : | 300 kHz/div. |
| Video band width | : | 1 MHz/div. |
| Sweep time | : | 200 msec/div. |

Occupied band width : 25.6 MHz

Exhibit 3

TEST RESULT

Transmission Spectrum of 800 ns × 600 Hz




| | | |
|---|---|---|
| Center frequency | : | 9.4023GHz |
| Frequency span | : | 5.0 MHz/div. |
| Level | : | 10 dB/div. |
| Resolution band width | : | 100 kHz/div. |
| Video band width | : | 300 kHz/div. |
| Sweep time | : | 200 msec/div. |

Occupied band width : 8.8 MHz

Exhibit 3

TEST RESULT

| Pulse | Bandwidth |
|---|---|
| 110 ns × 2000 Hz | 60.0 MHz |
| 250 ns × 1500 Hz | 25.6 MHz |
| 800 ns × 600 Hz | 8.8 MHz |

Exhibit 4

SPURIOUS EMISSION AT ANTENNA TERMINAL (2.991)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9410 MHz ± 30MHz
Frequency Source: Fixed cavity resonator
Pulse Rate: 600 Hz to 2000 Hz, Selectable as a function of Range

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | Directional Coupler | Hewlett-Packard | X752D |
| 2. | Variable Attenuator | Hewlett-Packard | X382A |
| 3. | Spectrum Analyzer | Anritsu | MS710C |

TEST PROCEDURE

The Marine Radar is capable if generating the following pule:
110 ns × 2000 Hz, 250 ns × 1500 Hz, 800 ns × 600 Hz

The spurious emission at the antenna terminal for each of these combinations were measured by using the following procedure:

(1) Set up the equipment as shown in Fig.2
(2) At first, the 0 dB reference level for the main Pulse was established.
(3) The spectrum was searched over the range 0 to 23 GHz using spectrum analyzer.

NOTE

The FCC limit is calculated as follows:
Spurious limit (L)=43 + 10 Log P, in dB below the transmitter

output power, where P is the mean power output in watts (See Exhibit 1).

TEST RESULT

| | |
|---|---|
| 9410 MHz | 0 dB |
| 2nd | -65 dB |

All other spurious and harmonics up to 23 GHz were found to be than -70dB below maximum mean power, and/or 20 dB below limit.

Limit: -(43 + 10 log 2.01) = -46.0 dB
mean power:2.01 watts at 0.8 us × 600 Hz.

Exhibit 5

SPRIOUS EMISSIONS FIELD STRENGTH (2.993)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9410 MHz ± 30 MHz
Frequency Source: Fixed cavity resonator
Pulse Rate: 600 Hz to 2000 Hz, Selectable as a function of range

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | EMI Measuring system | Anritsu | ME2601A |
| 2. | Antenna(10 kHz • 30 MHz) | AIL TECH | 95010-1 |
| 3. | Antenna(30 MHz • 200 MHz) | EMCO | 3104(Biconical) |
| 4. | Antenna(200 MHz • 1 GHz) | EMCO | 3164(Log-Periodic) |
| 5. | Antenna(1 GHz • 23 GHz) | EMCO | 3115(Double Ridged Guide) |
| 6. | Spectrum analyzer | Anritsu | MS710C |
| 7. | Mains Network | Anritsu | MN424B |

CARIBRATION

All test equipment is calibrated and maintained by Koden Quality Assurance Dept.

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

110 ns × 2000 Hz, 250 ns × 1500 Hz, 800 ns × 600 Hz

The spurious emissions field strength for each of these combination was measured using following procedure.

(1) Set up the equipment as shown in Fig.3.
(2) Using the automatic EMI Measuring System, measure and record the spurious radiated emissions from 10 kHz to 1 GHz. The computer in the Measuring system program automatically adds antenna factors and cable losses to the raw voltage measurements to obtain field strength units.

(3) Set up the equipment as shown in Fig.4.

(4) Measure and record spurious radiated emissions from 1 GHz to 18GHz (antenna limit). Observe and note any emissions from 1GHz to23 GHz.

(5) Calculate the field strength of spurious emissions from 1 GHz to 18 GHz by add in antenna factor (including cable loss) to the observed reading.

(6) Set up the equipment as shown in Fig.5.

(7) Using the automatic EMI Measuring system, measure and record terminal interference voltage from 10 kHz to 30 MHz.

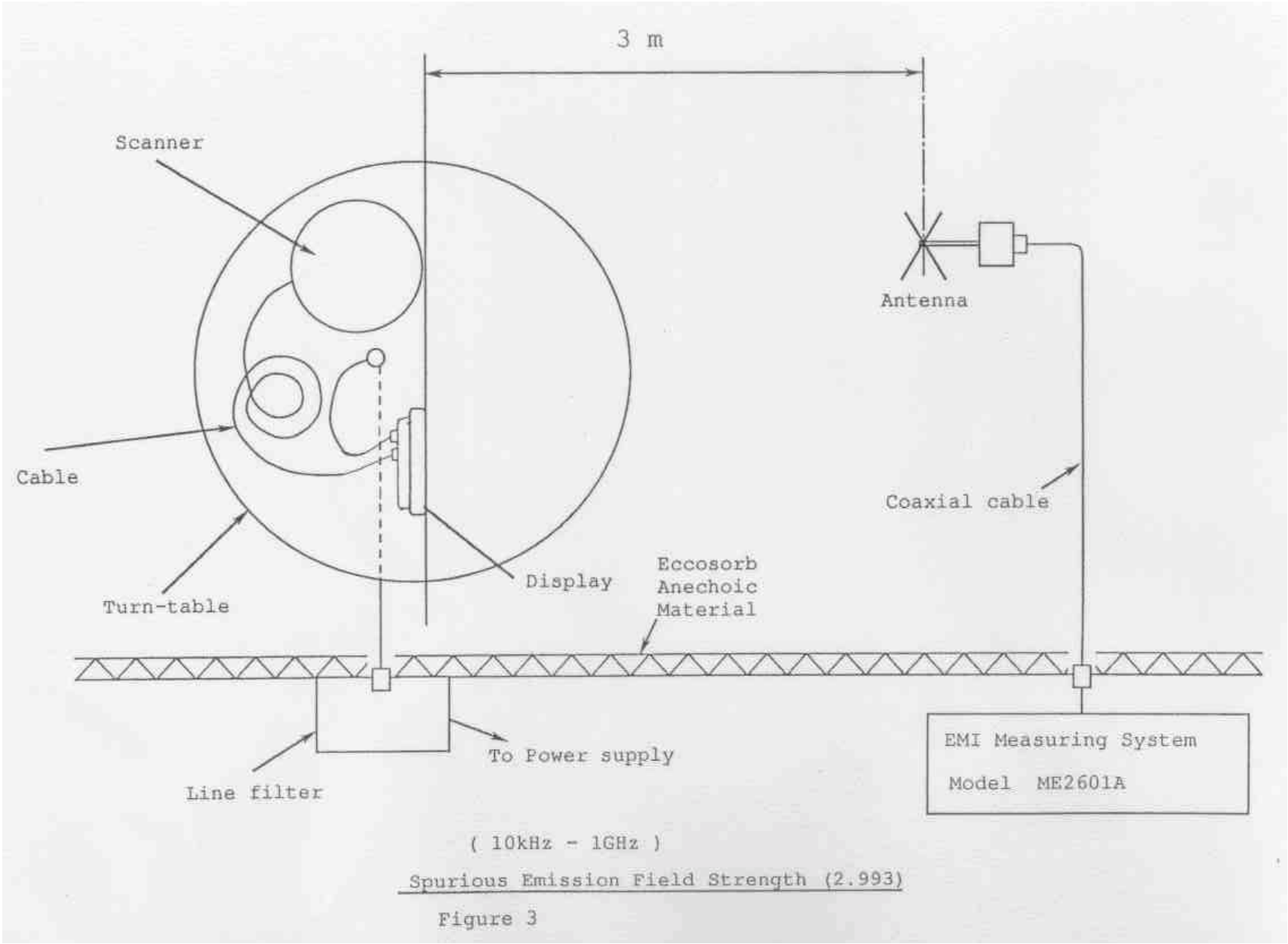
Note

Spurious emission limit is calculated as follows:

Limit (L) = 43 +10 log P, in dB below the fundamental field strength ,where P is the mean power output in watts (See Exhibit 1).

Limit: -(43 + 10 log 2.01) = -46.0 dB

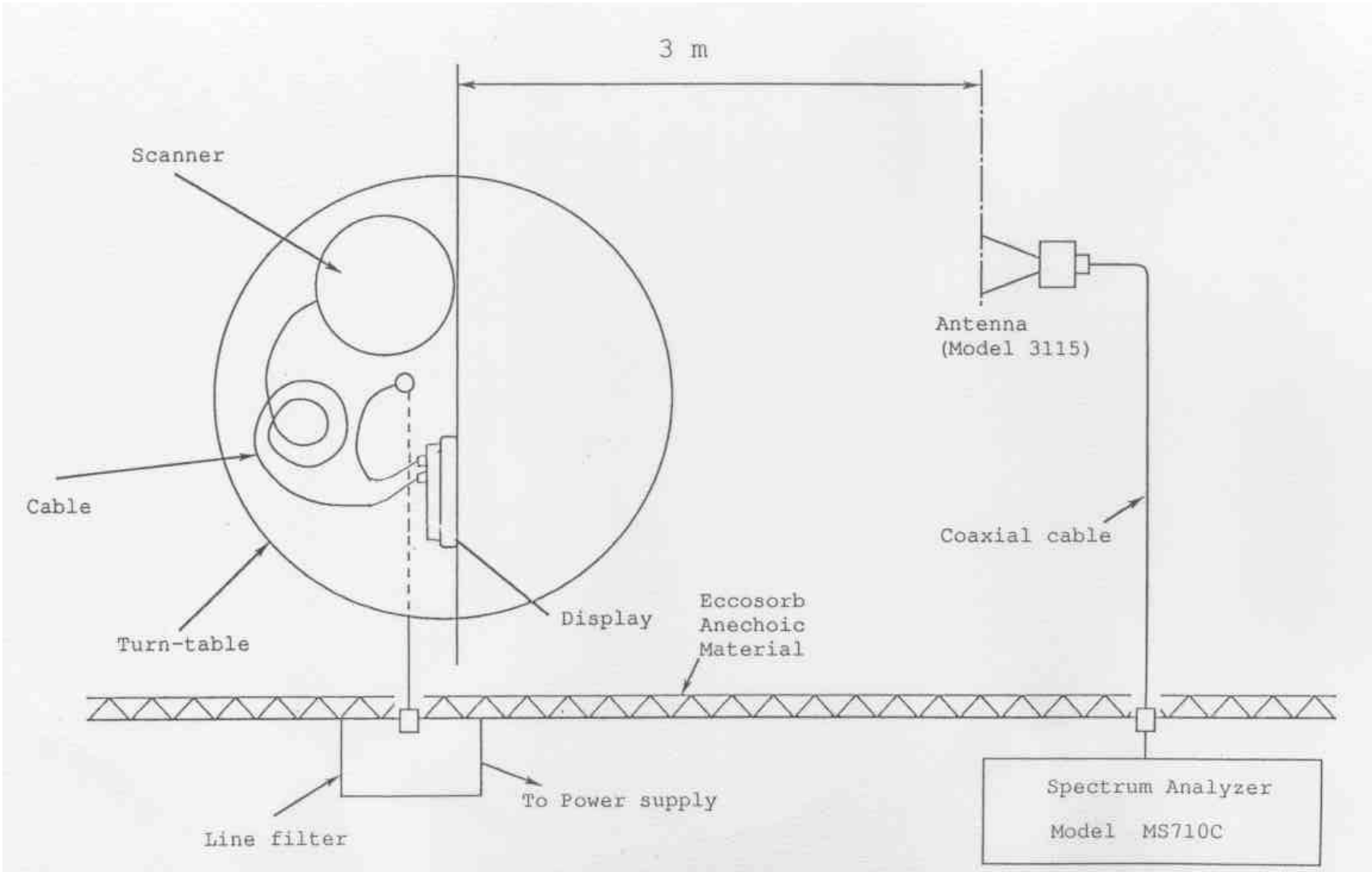
mean power:2.01 watts at 0.8 us × 600 Hz




( 10kHz - 1GHz )

Spurious Emission Field Strength (2.993)

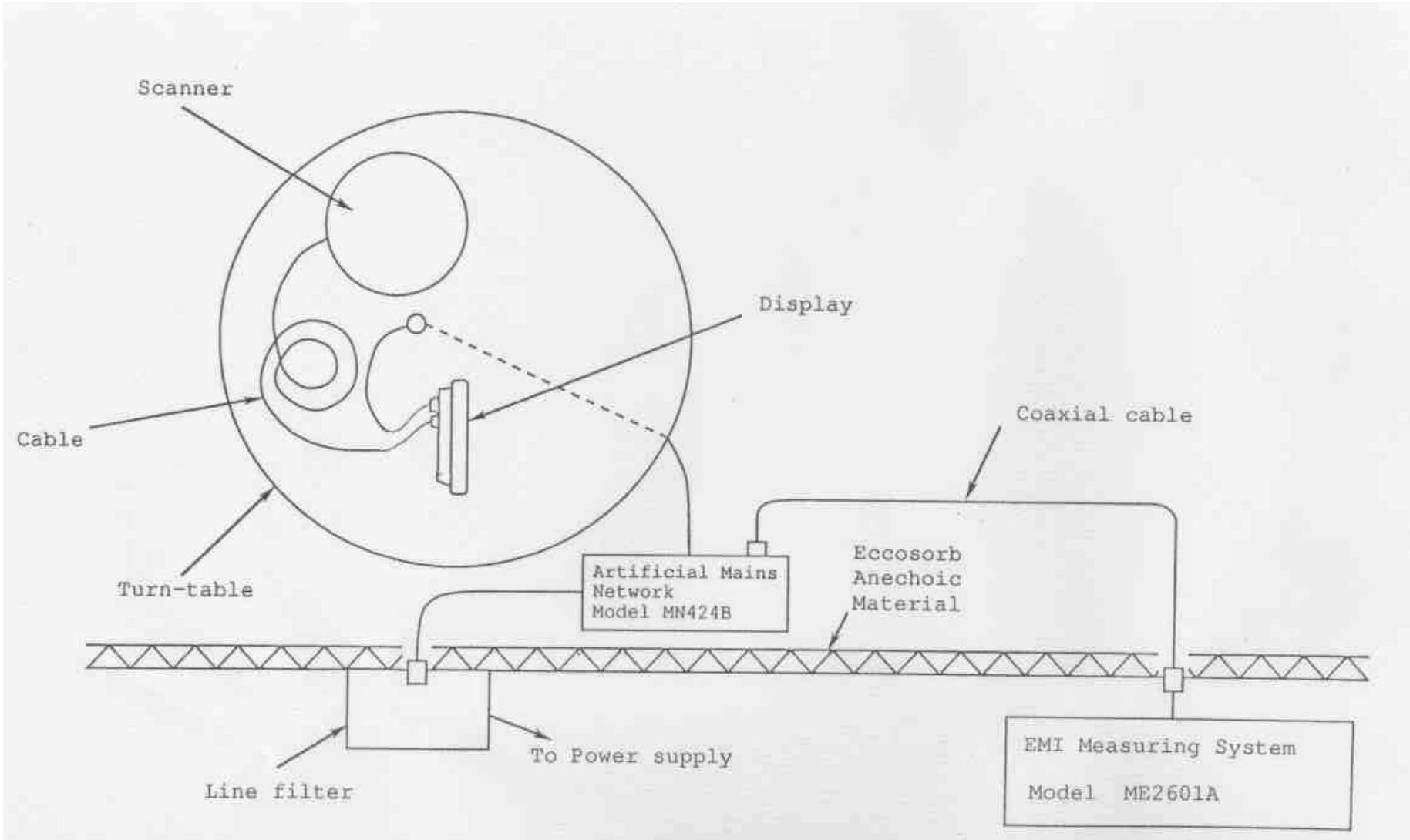
Figure 3




( 1GHz - 18GHz )

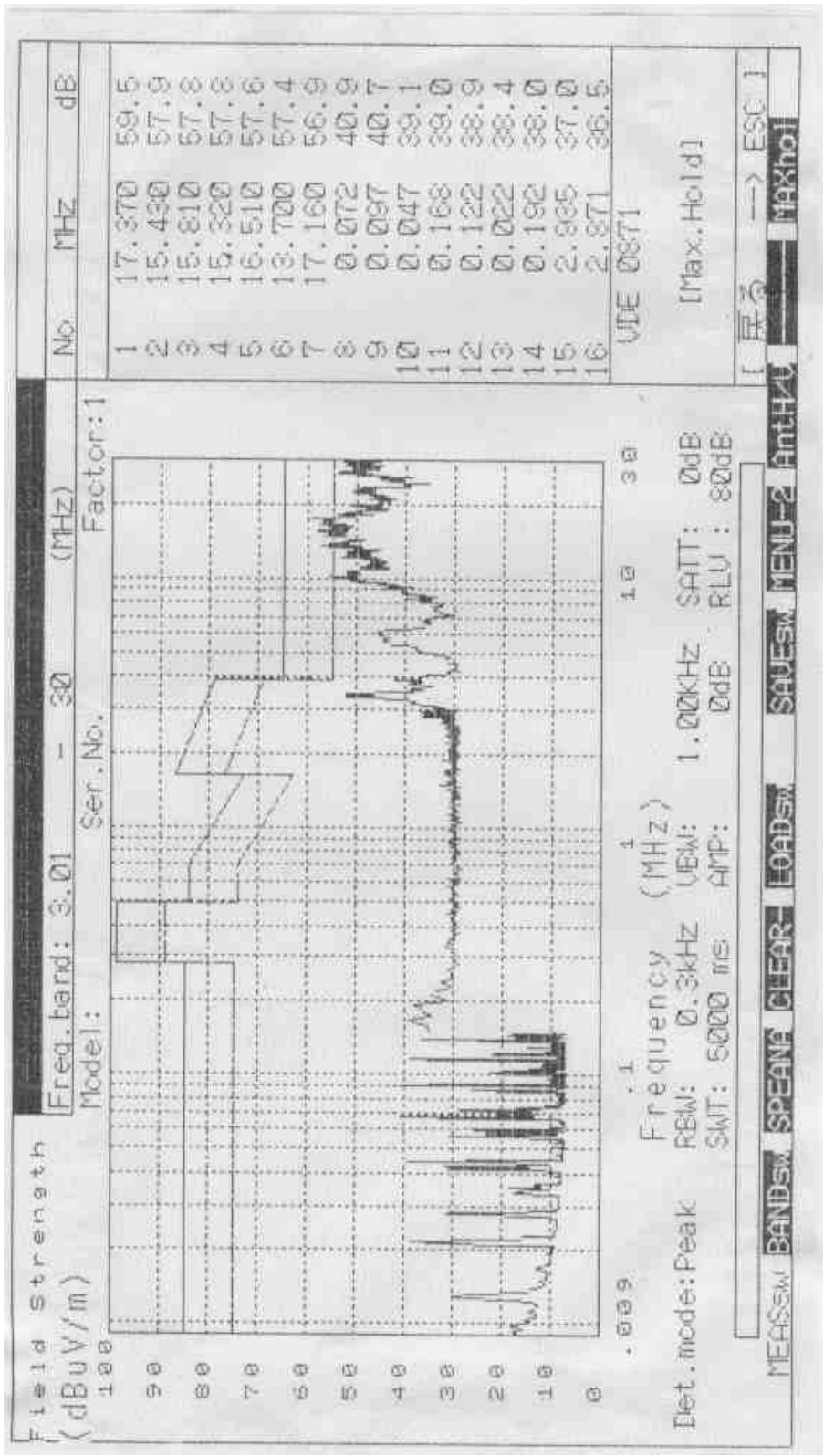
Spurious Emission Field Strength (2.993)

Figure 4

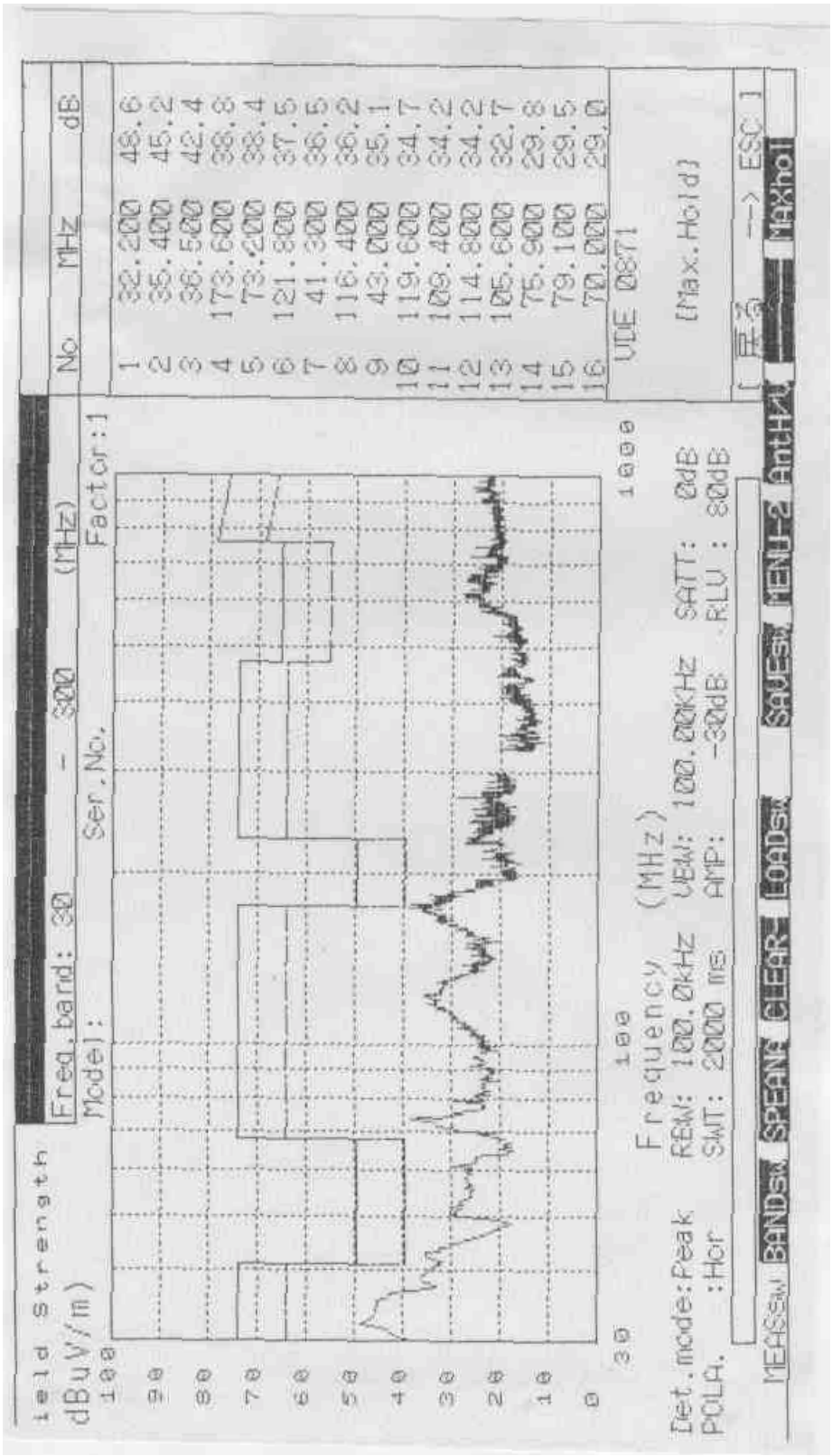



Spurious Emission Terminal Interference Voltage

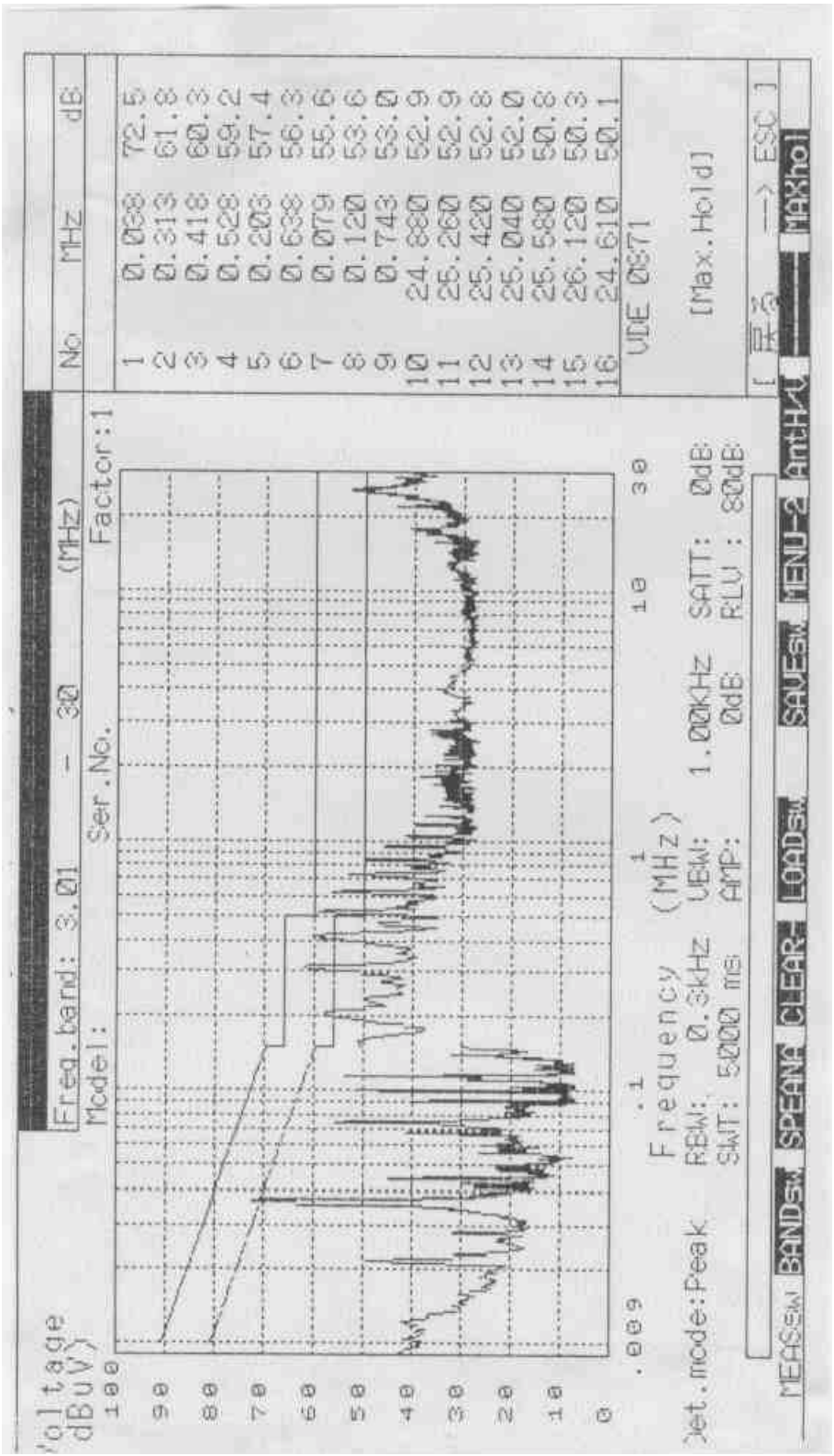
Figure 5




(Radiated Interference Field Strength 10kHz ~ 30 MHz)




(Radiated Interference Field Strength 30 MHz ~ 1000MHz)




(Terminal Interference Voltage 10 kHz ~ 30 MHz)

Test result(All data)

| | Frequency | Measurement Level | Ratio to Main Transmission | Refer to |
|---|---|---|---|---|
| Spurious Emission Field Strength | 9.410GHz<br>10kHz to 30MHz<br>30MHz to 1GHz<br>1GHz to 18GHz<br>18GHz to 23GHz | 147dBu/m<br>Max. 60dBu/m<br>Max. 49dBu/m<br>Max. 60dBu/m<br>(Max. 70dBu/m) | 0dB<br>-87dB<br>-98dB<br>-87dB<br>(-77dB) | Figure 4<br>Figure 3<br>Figure 3<br>Figure 4<br>Figure 4 |
| Terminal Interference Voltage | 10kHz to 30MHz | 73dBu | (-74dB) | Figure 5 |

Exhibit 6

FREQUENCY STABILITY (2.995)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9410 MHz ± 30 MHz
Pulse Rate: 600 Hz to 2000 Hz, Selectable as a function of range
Pulse Width: 0.11 us to 0.8 us, Selectable as a function if Range

TEST EQUIPMENT

| | Equipment | Manufacturer | Model |
|---|---|---|---|
| 1. | Temperature Chamber | TABAI ESPEC | TBL-1.5HW4G2AC |
| 2. | Directional Coupler | Hewlett-Packard | X752D |
| 3. | frequency meter | Hewlett-Packard | X532B |
| 4. | X-Band Dummy Load | NIHON KOSHUHA | WDL095 |
| 5. | Variable Attenuator | Hewlett-Packard | X382A |
| 6. | Power Meter | ANRITSU | ML83A |

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

0.11 us x 2000 Hz, 0.25 us x 1500 Hz, 0.8 us x 600 Hz

The circuitry of the Radar contains a key-inhibit timer that prevents transmission unit the magnetron has warmed-up for 2 minutes. Consequently, all data are taken after the 2 minutes warmed-up.

(1) Set up the equipment in the temperature chamber as shown in Fig.6. Set the chamber to -20• and allow the equipment to stabilize.
(2) Turn the equipment on and measure the transmitted frequency using the resonate cavity frequency meter. Measure each the pulse types at one minute intervals until unit stability is achieved or 10 minutes have elapsed, whichever is longer.
(3) Increase the chamber temperature by 10• and repeat step 1 and 2.

Continue in 10• increments until 50• has been achieved.

(4) Measure the output frequency at room ambient temperature following voltages applied to the power input.

12V input: Apply 10.2V and 13.8V

24V input: Apply 20.4V and 27.6V

32V input: Apply 27.2V and 36.8V

(5) Calculate test frequency limits from the followings;

The frequency of the principal emission must not be nearer to the edge of the authorized band than 1.5/t in MHz, (where t is the shortest pulse used, in micro second).

t = 0.11us(nominal)

1.5/t = 13.64 MHz

Band Limit = 9.300000 to 9.500000 GHz

Emission Limit =9.31364 to 9.48636 GHz

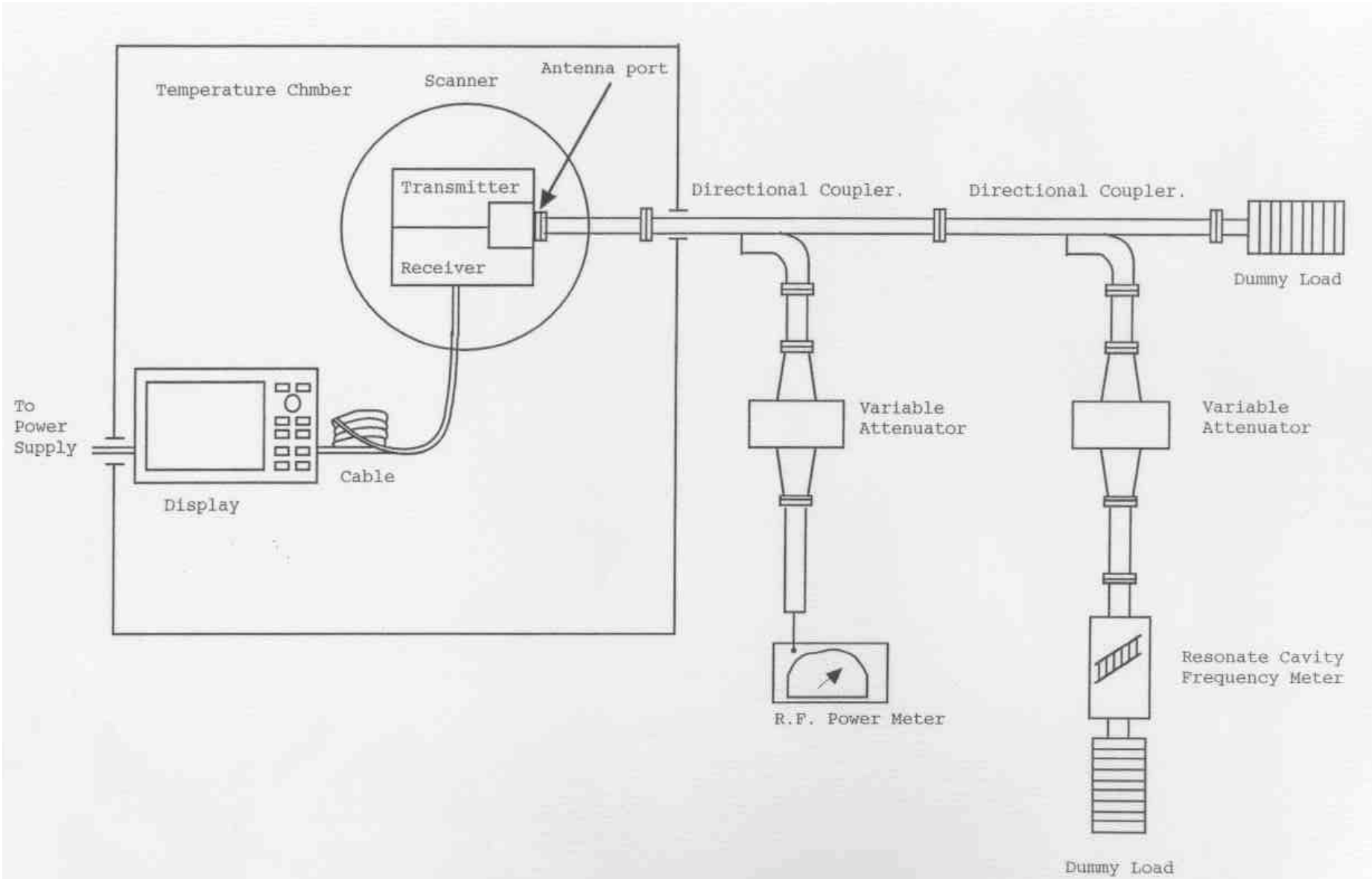



Figure 6 FREQUENCY STABILITY(2.995)

Exhibit 6

TEST DATA

Temperature Stability

| Pulse Type | | 110ns×2000Hz | 250ns×1500Hz | 800ns×600Hz |
|---|---|---|---|---|
| Frequency(GHz) | Initial | Final | Final | Final |
| Temperature(•) | | | | |
| -20 | 9.417 | 9.418 | 9.416 | 9.414 |
| -10 | 9.415 | 9.416 | 9.414 | 9.412 |
| 0 | 9.413 | 9.413 | 9.411 | 9.409 |
| +10 | 9.410 | 9.411 | 9.409 | 9.407 |
| +20 | 9.407 | 9.408 | 9.406 | 9.405 |
| +30 | 9.405 | 9.405 | 9.403 | 9.402 |
| +40 | 9.402 | 9.403 | 9.401 | 9.400 |
| +50 | 9.400 | 9.400 | 9.399 | 9.398 |

Voltage Stability

| Applied Voltage(Vdc) | Initial Frequency(GHz) | Final Frequency(GHz) |
|---|---|---|
| 10.2 | 9.409 | 9.407 |
| 12.0 | 9.409 | 9.407 |
| 13.8 | 9.409 | 9.407 |
| 24.0 | See note below | |
| 27.2 | 9.409 | 9.407 |
| 32.0 | 9.409 | 9.407 |
| 36.8 | 9.409 | 9.407 |

Note: All data taken in the 110 ns × 2000Hz mode.

Note: Qualification at both 12Vdc qualifies 24Vdc input by similarity.

*** Final reading taken 5 minutes following initial reading.