

TEST REPORT
MARINE RADAR
RA40C

ENGINEERING TEST REPORT
ON RA40C 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*-----

H. Iida

Engineer of Design Section

Approved by:

-----*Y. Minegishi*-----

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	$-25 \pm 5^{\circ}\text{C}$
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.

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Data for the acceptance of the Koden Marine Radar Type RA40C

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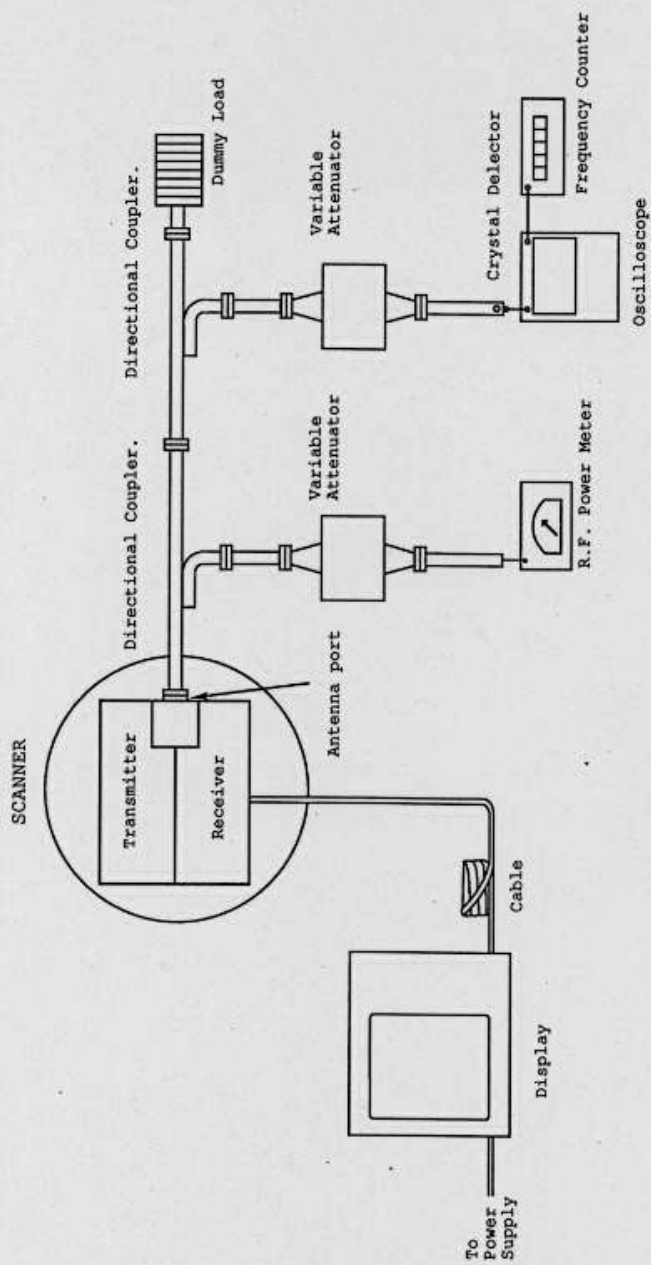
Exhibit 1

RF POWER OUTPUT (2.985)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30 MHz
Frequency Source: Fixed Cavity Resonator
Pulse Rate: 580 Hz to 1800 Hz, Selectable
as a function of Range
Pulse Width: 0.12 us to 0.8 us, Selectable
as a function of Range

TEST EQUIPMENT

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>
1. X-Band Directional Coupler	Hewlett-Packard	X752D
2. Variable Attenuator	Hewlett-Packard	X382A
3. Power Meter	Hewlett-Packard	432A
4. Crystal Detector	Hewlett-Packard	423B
5. Oscilloscope	IWATSU ELECTRIC	SS-5121B
6. Frequency Counter	ANRITSU	MF63A
7. X-Band Dummy Load	NIHON KOSHUHA	WDL095



RF POWER OUTPUT (2.985) & MODULATION CHARACTERISTICS (2.987)

Figure 1

Exhibit 1

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

120ns × 1800Hz, 300ns × 1200Hz, 0.8 × 580Hz

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:

$$P_0 = P_m / (Fr \times T)$$

P_0 : Peak Power, P_m : Mean Power, Fr : P.R.F.

T : Pulse Width, * P.R.F. : Pulse Repetition Frequency

Exhibit 1

TEST RESULT

<u>Transmit</u> <u>Pulse</u> <u>Width and</u> <u>P.R.F</u>	<u>Measured</u> <u>Mean Power</u>	<u>Measured</u> <u>Pulse Width</u>	<u>Measured</u> <u>P.R.F</u>	<u>Calculated</u> <u>Peak Power</u>
0.12 us 1800 Hz	0.3 W	0.125 us	1808 Hz	1.33 KW
0.3 us 1200 Hz	0.6 W	0.31 us	1169 Hz	1.65 KW
0.8 us 580 Hz	0.9 W	0.8 us	580 Hz	1.93 KW

Exhibit 2

MODULATION CHARACTERISTICS (2.987)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30MHz
Frequency Source: Fixed Cavity Resonator
Pulse Rate: 580 to 1800 Hz, Selectable
as a function of Range
Pulse Width: 0.12 us to 0.8 us, Selectable
as a function of Range

TEST EQUIPMENT

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>
1. X-Band Directional Coupler	Hewlett-Packard	X752D
2. Variable Attenuator	Hewlett-Packard	X382A
3. Power Meter	Hewlett-Packard	432A
4. Crystal Detector	Hewlett-Packard	423B
5. Oscilloscope	IWATSU ELECTRIC	SS-5121B
6. Frequency Counter	ANRITSU	MF63A
7. X-Band Dummy Load	NIHON KOSHUHA	WDL095

Exhibit 2

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

0.12 us x 1800 Hz, 0.3 us x 1200 Hz, 0.8 us x 580 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 Pusle)

(1) Short Pulse _____ photo-1
50 ns/div.
Pulse width (-3 dB) = 125 ns
Pulse repetition Frequency = 1808 Hz

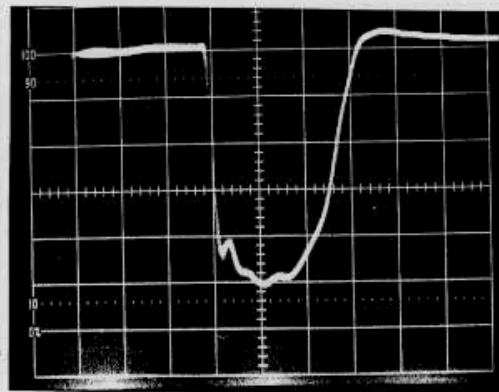


Exhibit 2

TEST RESULT

Modulation Characteristics
(Detected Pusle)

(1) Middle Pulse _____ photo-2
100 ns/div.
Pulse width (-3 dB) = 310 ns
Pulse repetition Frequency = 1169 Hz

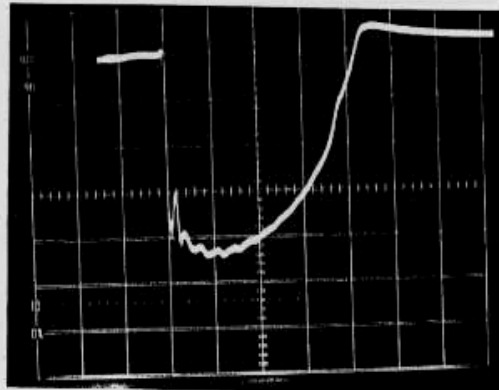


Exhibit 2

TEST RESULT

Modulation Characteristics
(Detected Pulse)

(1) Long Pulse _____ photo-3
200 ns/div.
Pulse width (-3 dB) - 800 ns
Pulse repetition Frequency - 580 Hz



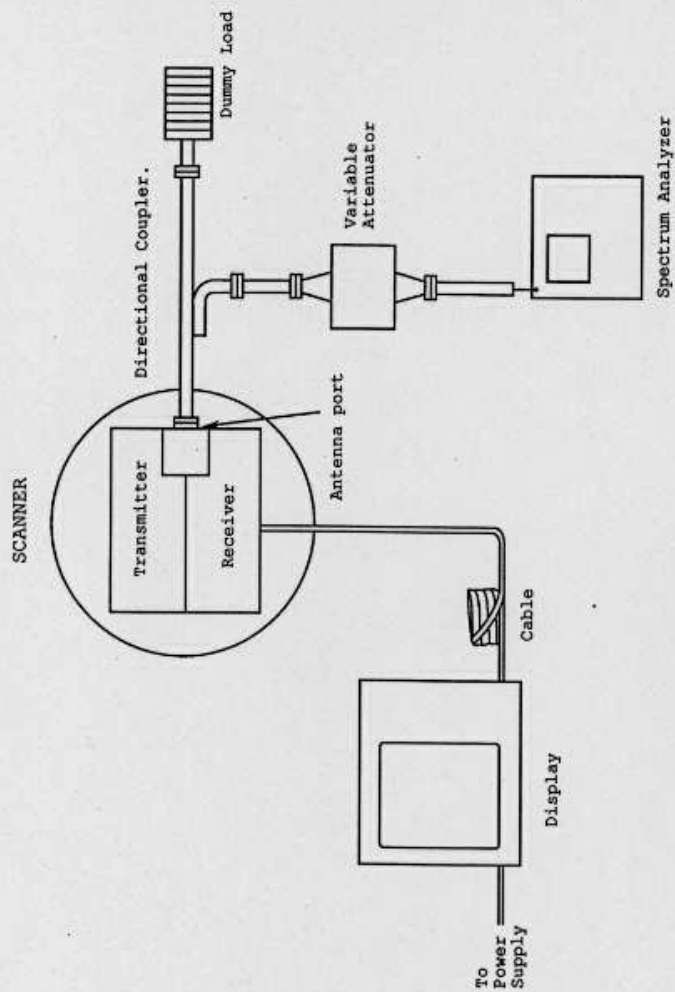
Exhibit 3

OCCUPIED BANDWIDTH (2.989)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30 MHz
Frequency Source: Fixed Cavity Resonator
Pulse Rate: 580 to 1800 Hz, Selectable as a function of Range
Pulse Width: 0.12 us to 0.8 us, Selectable as a function of Range

TEST EQUIPMENT

	<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>
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



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

Figure 2

Exhibit 3

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

120 ns \times 1800 Hz, 300 ns \times 1200 Hz, 800 ns \times 580 Hz

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

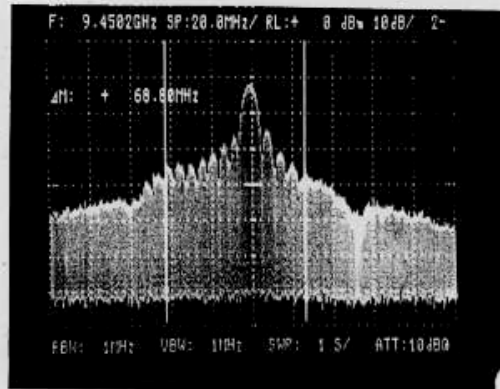
- (1) Connect the equipment as shown in Fig.3.
- (2) Adjust center frequency, span reference level of spectrum analyzer and attenuator if necessary, such that the display nearly fills the screen.
- (3) Measure and record spectrum and bandwidth

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.

Exhibit 3

TEST RESULT

Transmission Spectrum of 120 ns X 1800 Hz



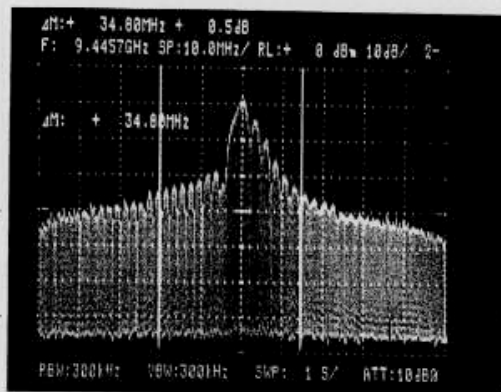
Center frequency	:	9.4502GHz
Frequency span	:	20.0 MHz/div.
Level	:	10 dB/div.
Resolution band width	:	1 MHz/div.
Video band width	:	1 MHz/div.
Sweep time	:	1 sec/div.

Occupied band width : 68.8 MHz

Exhibit 3

TEST RESULT

Transmission Spectrum of 300 ns X 1200 Hz



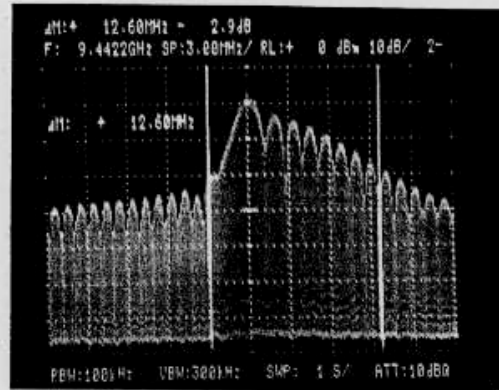
Center frequency	:	9.4457GHz
Frequency span	:	10.0 MHz/div.
Level	:	10 dB/div.
Resolution band width	:	300 kHz/div.
Video band width	:	300 kHz/div.
Sweep time	:	1 sec/div.

Occupied band width : 34.8 MHz

Exhibit 3

TEST RESULT

Transmission Spectrum of 800 ns X 580 Hz



Center frequency	:	9.4422GHz
Frequency span	:	3.0 MHz/div.
Level	:	10 dB/div.
Resolution band width	:	100 kHz/div.
Video band width	:	300 kHz/div.
Sweep time	:	1 sec/div.

Occupied band width : 12.6 MHz

Exhibit 3

TEST RESULT

<u>Pulse</u>	<u>Bandwidth</u>
120 ns × 1800 Hz	68.8 MHz
300 ns × 1200 Hz	34.8 MHz
800 ns × 580 Hz	12.6 MHz

Exhibit 4

SPURIOUS EMISSION AT ANTENNA TERMINAL (2.991)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30MHz
Frequency Source: Fixed cavity resonator
Pulse Rate: 580 Hz to 1800 Hz, Selectable as a function of Range

TEST EQUIPMENT

	<u>Equipment</u>	<u>Manufacture</u>	<u>Model</u>
1.	Directional Coupler	Hewlett-Packard	X752D
2.	Variable Attenuator	Hewlirtt-Packard	X382A
3.	Spectrum Analyzer	Anritsu	MS710C

Exhibit 4

TEST PROCEDURE

The Marine Radar is capable of generating the following pulse:

120 ns \times 1800 Hz, 300 ns \times 1200 Hz, 800 ns \times 580 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

- (2) 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).

Exhibit 4

TEST RESULT

9445 MHz	0 dB
2nd	-65 dB

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

Limit: $-(43 + 10 \log 0.9) = -42.5\text{dB}$
mean power: 0.9 watts at 0.8 us \times 580 Hz.

Exhibit 5

SPURIOUS EMISSIONS FIELD STRENGTH (2.993)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30 MHz
Frequency Source: Fixed cavity resonator
Pulse Rate: 580 Hz to 1800 Hz, Selectable as a function of range

TEST EQUIPMENT

	<u>Equipment</u>	<u>Manufacture</u>	<u>Model</u>
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(Duble Rdged Guide)
6.	Spectrum analyzer	Anritsu	MS710C
7.	Mains Network	Anritsu	MN424B

Exhibit 5

CALIBRATION

All test equipment is calibrated and maintained by Kodan Test Equipment section.

TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

120 ns \times 1800 Hz, 300 ns \times 1200 Hz, 800 ns \times 580 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 to 23 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

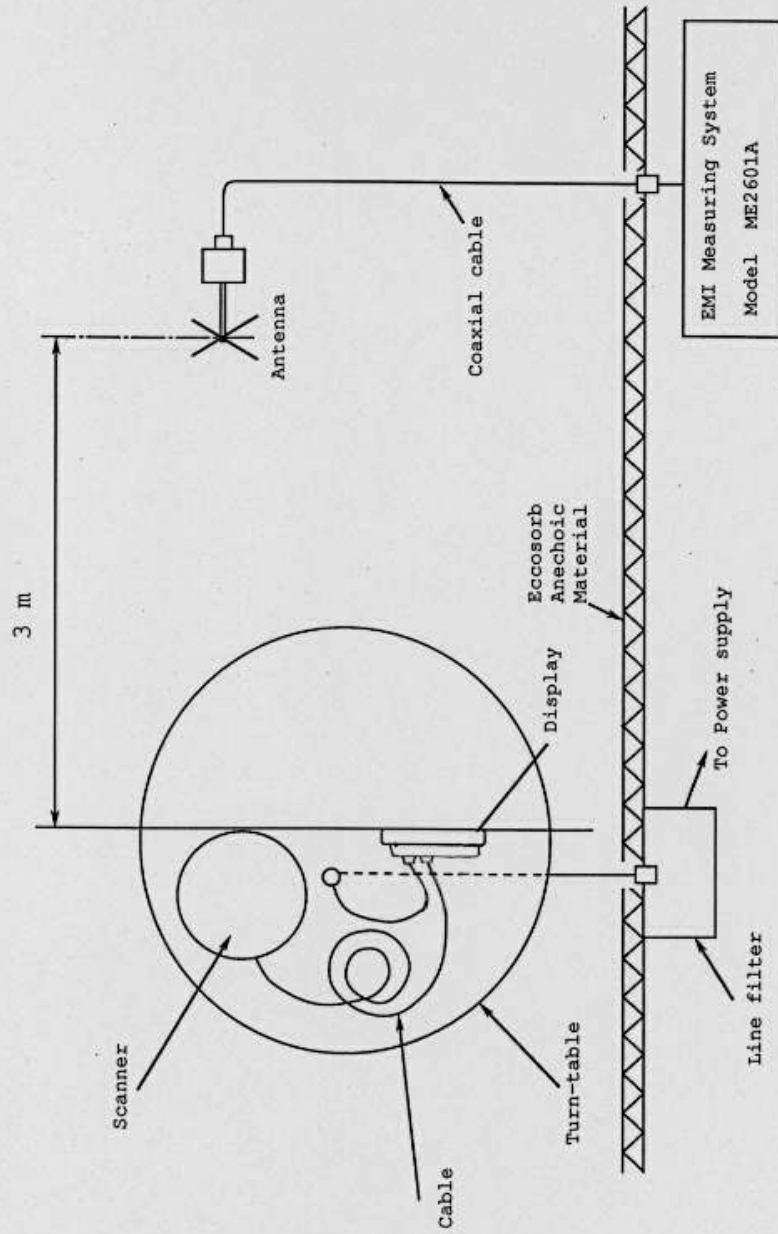
Spurious emission limit is calculated as follows:

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: $-(43 + 10 \log 0.9) = -42.5\text{dB}$

mean power: 0.9 watts at 0.8 us \times 580 Hz

Exhibit 5



(10kHz - 1GHz)
Spurious Emission Field Strength (2.993)

Figure 3

Exhibit 5

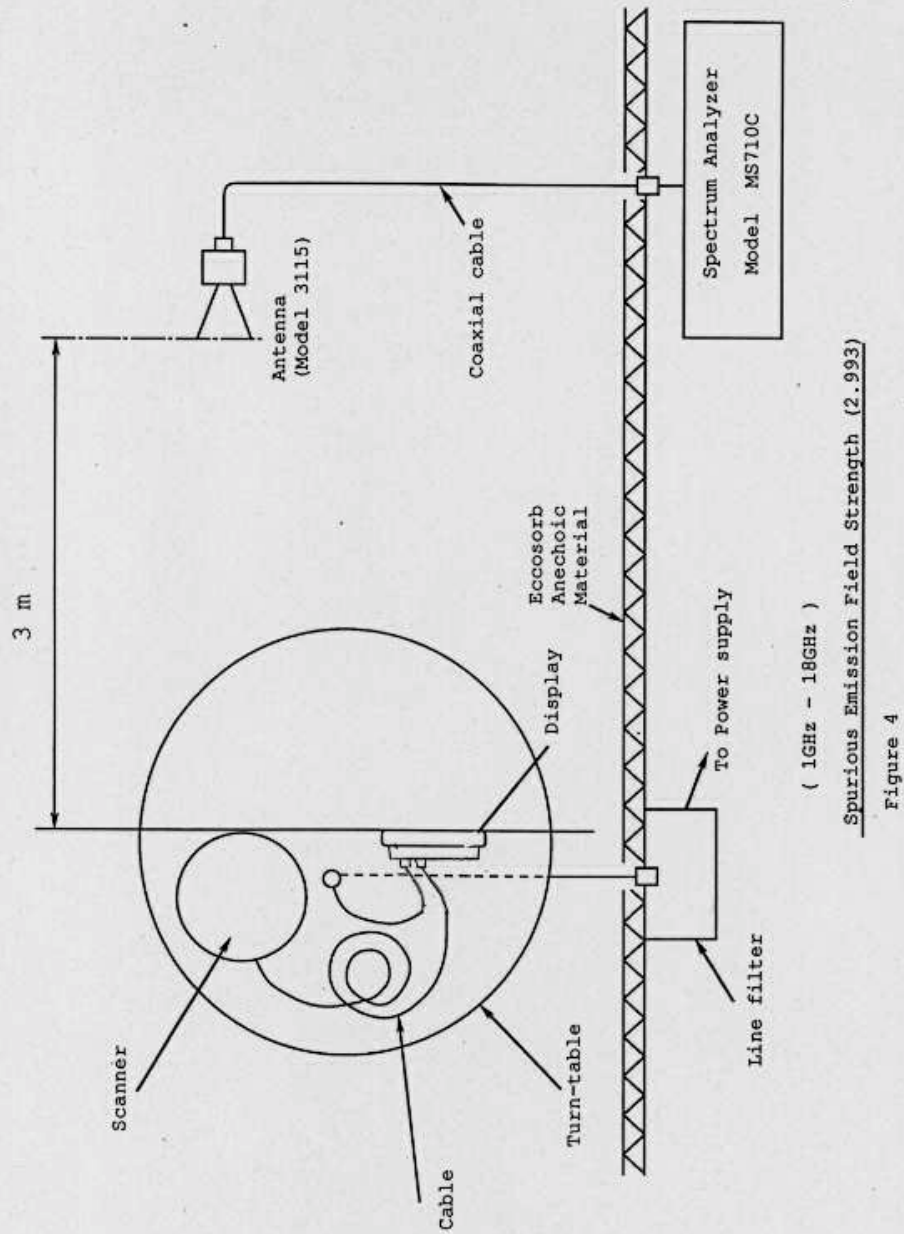
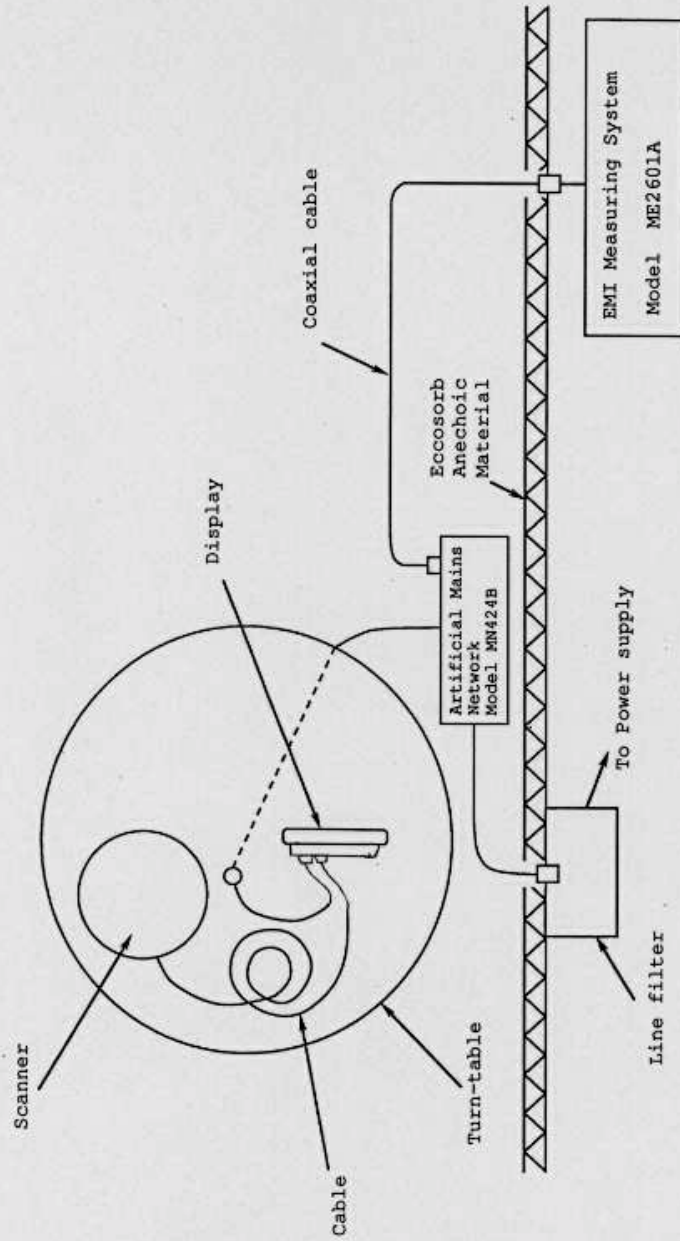


Exhibit 5



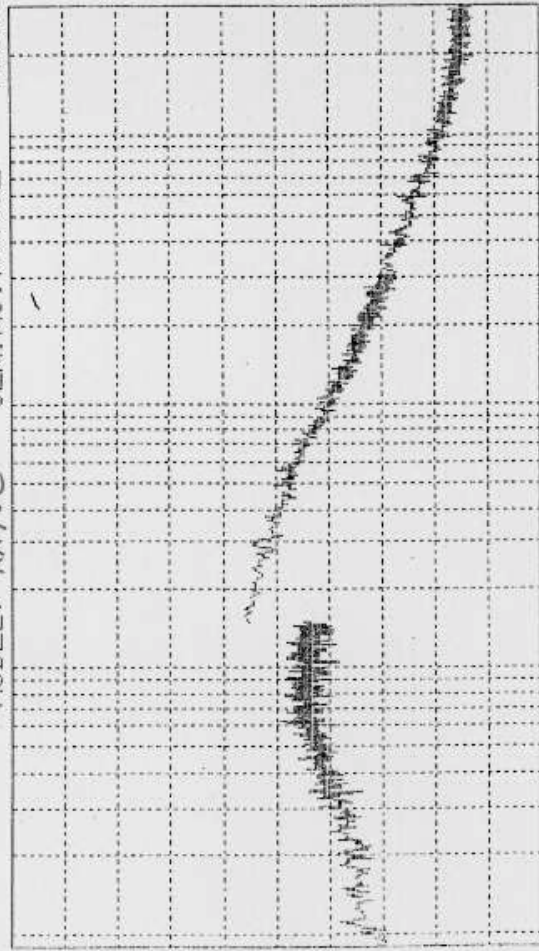
(10kHz - 30MHz)

Spurious Emission Terminal Interference Voltage
Figure 5

Field Strength

($\mu\text{V}/\text{m}$)

MODEL: RA40C SER.No. R5100L FACTOR:1



DET. MODE: PEAK RBW: 10.0KHz VBW: 10.000KHz SATT: 0dB
SWT: 2000 ms AMP: -30dB RLV: 80dB

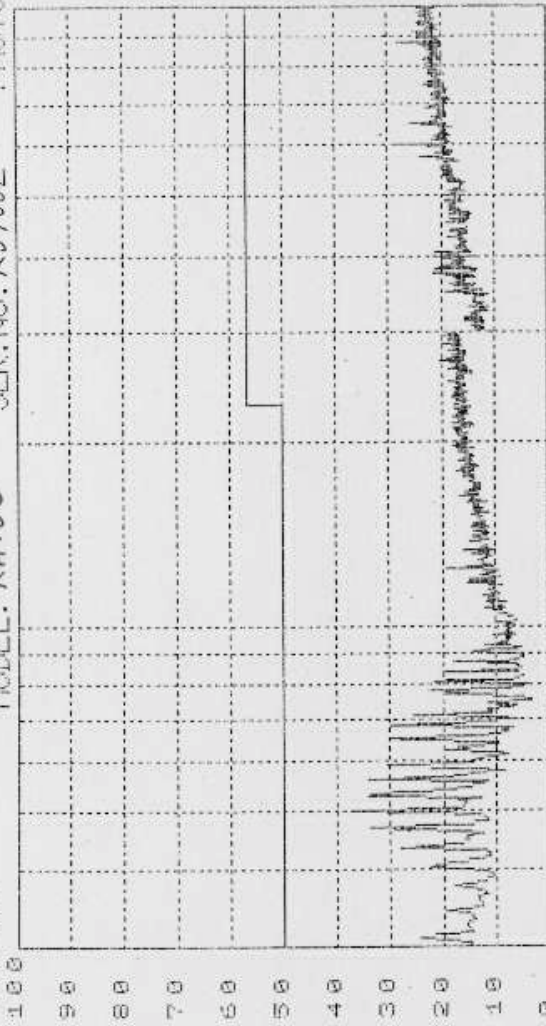
22:37:18

2

Field Strength

(dBuV/m)

MODEL: RA40C SER. No. R5100L FACTOR: 1



Frequency (MHz)

DET. MODE: PEAK RBW: 100.0KHz VBW: 100.000KHz SATT: 0dB
POLARITY: HOR SWT: 2000 ms AMP: -30dB RLV: 80dB

21:10:17

2

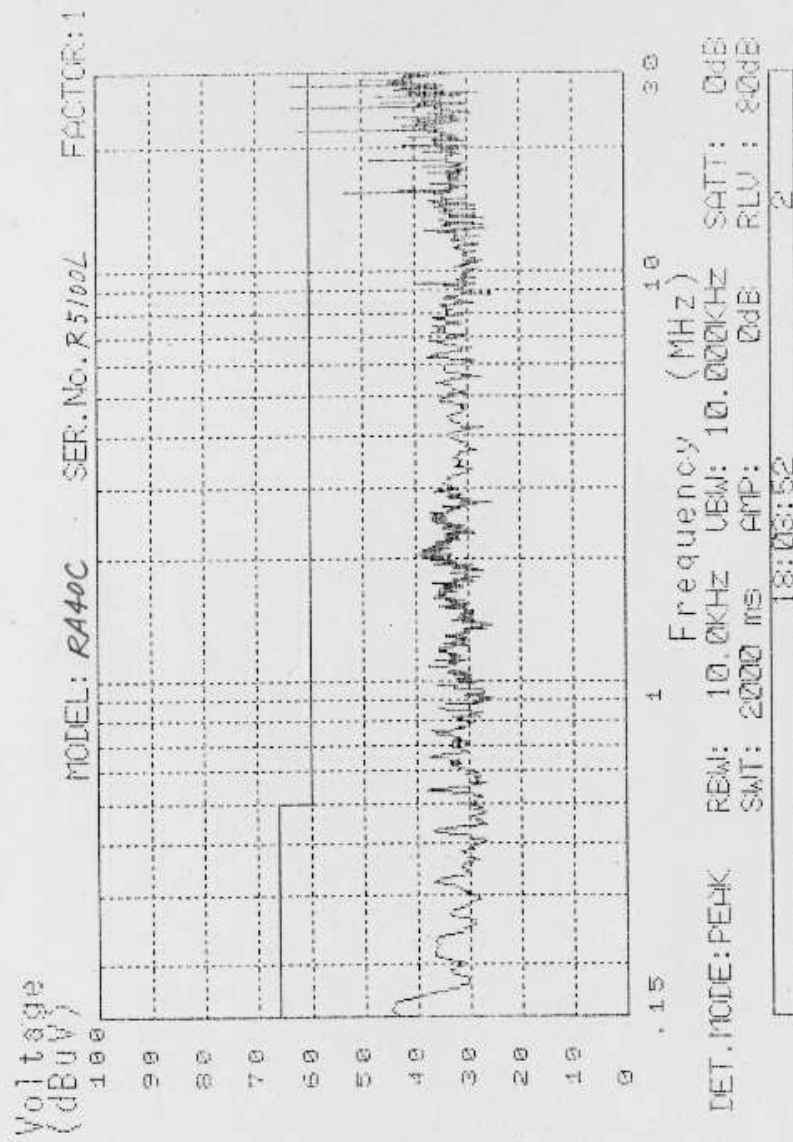


Exhibit 5

TEST RESULT (All data)

	Frequency	Measurement Level	Radio to Main Transmission	Refer to
Spurious Emission Field Strength	9.445MHz 10kHz to 30MHz 30MHz to 1GHz 1GHz to 18GHz 18GHz to 23GHz	Max. 139dBu/m Max. 56dBu/m Max. 37dBu/m Max. 60dBu/m (Max. 70dBu/m)	0dB -83dB -102dB -79dB (-69dB)	Fig. 4 Fig. 3 Fig. 3 Fig. 4 Fig. 4
Terminal Interference Voltage	10kHz to 30MHz	Max. 63dBu	-76dB	Fig. 5

Note: All spurious ratio were smaller than -60dB.

Exhibit 6

FREQUENCY STABILITY (2.995)

Type of Transmission: P0N
Type of Modulation: Pulse
Frequency Band: 9445 MHz \pm 30 MHz
Pulse Rate: 580 Hz to 1800 Hz, Selectable as a function of range
Pulse Width: 0.12 us to 0.8 us, Selectable as a function if Range

TEST EQUIPMENT

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>
1. Temperature Chamber	Besthel	CLH-P
2. Directional Coupler	Hewlett-Packard	X752D
3. Resonate Cavity (frequency meter)	Hewlett-Packard	X552B
4. X-Band Dummy Load	NIHON KOSHUHA	WDL095
5. Variable Attenuator	Hewlett-Packard	X382A
6. R.F. Power meter	Hewlett-Packard	432A

Exhibit 6

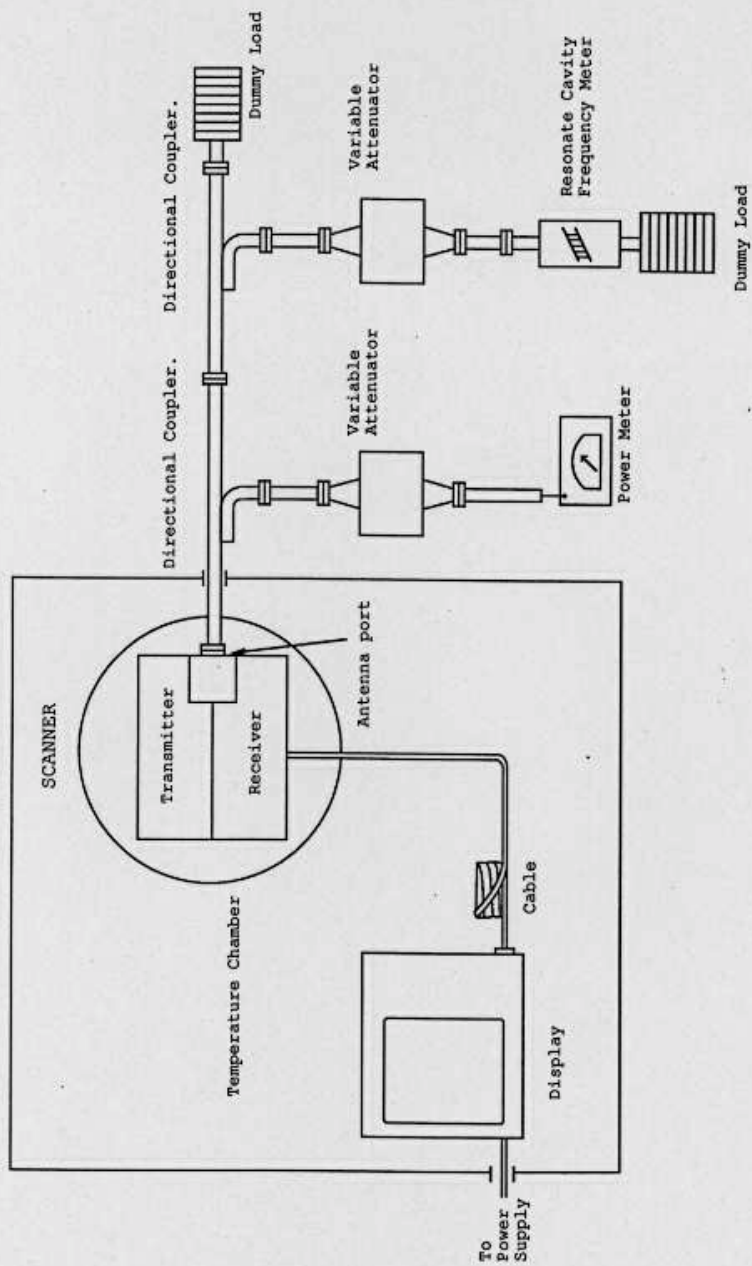
TEST PROCEDURE

The Marine Radar is capable of generating the following pulses:

0.12 us x 1800 Hz, 0.3 us x 1200 Hz, 0.8 us x 580 Hz

The circuitry of the Radar contains a key-inhibit timer that prevents transmission until 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°C 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°C and repeat step 1 and 2.
Continue in 10°C increments until 50°C 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
- (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).
 $t = 0.12\text{us}(\text{nominal})$
 $1.5/t = 12.75 \text{ MHz}$
Band Limit - 9.300000 to 9.500000 GHz
Emission Limit -9.312500 to 9.487500 GHz



FREQUENCY STABILITY (2.995)

Figure 6

Exhibit 6

TEST DATA

Temperature Stability

Pulse Type	120 ns × 1800 Hz	300 ns × 1200 Hz	800 ns × 580 Hz
Frequency(GHz)	Initial/Final	Initial/Final	Initial/Final

Temperature °C			
-20	9.455/9.461	9.455/9.453	9.452/9.450
-10	9.453/9.459	9.452/9.450	9.449/9.447
0	9.451/9.457	9.450/9.448	9.447/9.445
+10	9.449/9.445	9.446/9.446	9.444/9.443
+20	9.447/9.443	9.445/9.443	9.442/9.440
+30	9.445/9.441	9.443/9.441	9.440/9.438
+40	9.443/9.439	9.441/9.438	9.438/9.435
+50	9.441/9.437	9.439/9.437	9.435/9.432

Exhibit 6

TEST DATA-Continued

Voltage Stability

<u>Applied Voltage(Vdc)</u>	<u>Initial Frequency(GHz)</u>	<u>Final Frequency(GHz)</u>
<u>10.2</u>	9.447	9.443
<u>12.0</u>	9.447	9.443
<u>13.8</u>	9.447	9.443
<u>24.0</u>	See note below	
<u>27.2</u>	<u>9.447</u>	9.443

Note: All data taken in the 120 ns \times 1.8kHz mode.

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

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