FEDERAL COMMUNICATIONS COMMISSION
Laboratory Division, FCC Equipment Authorization Branch
7435 Oakland Mills Road, Columbia, MD 21046
Telephone: (301) 362-3000, Facsimile: (301) 344-2050

Date: August 25, 1999 06:17 pm
From: Frank Coperich Telephone: (301)-362-3023
To: Charles Zanardi
Organization:
Telephone: 888-834-9330 Facsimile: 360-833-5195
This cover sheet is page 1 of ___. Please direct inquiries to the sender at the above extension.

Reference FCC ID: ADB9ZWRTR068

Applicant: Furuno USA Inc

The items indicated below must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 60 days may result in application dismissal pursuant to Section 2.917(c) and forfeiture of the filing fee pursuant to Section 1.1108.

We do not have your test report. Please re-send it or up-load to the EAS system.

Replies to this letter MUST contain the Reference Number: 9390

Please scan in.

94510

(Test Report)

FURUNO U.S.A., INC.

September 3, 1999

Federal Communications Commission
Laboratory Division, FCC Equipment Authorization Branch
7435 Oakland Mills Road, Columbia, MD 21046

Attention: Frank Coperich

Reference: FCC ID ADB9ZWRTR068 your reference number 9390

Dear Mr. Coperich:

I enclosing with this letter am a copy of the test report. The original test report was sent with the application received at the FCC on June 4, 1999.

We are anxious to receive the grant, as we would like to introduce the new radar, as soon as possible It would be greatly appreciated if you could complete the processing of the application within the next two weeks.

Thanking you in advance for your efforts.

Sincerely,

Charles Zanardi
Commercial Service Manager

Cc: J Atteridge

4400 N.W. PACIFIC RIM BLVD. • CAMAS, WA 98607-9408 • TEL: (360) 834-9300 • FAX: (360) 834-9400 • www.Furuno.com

LABOTECH

TECHNICAL INFORMATION

TEST REPORT ON THE PERFORMANCE OF MARINE RADAR

Trade Mark : FURUNO

Model : MODEL 1622

Report no. : FLI 12-99-011
Date of issue: May 14, 1999

Furuno Labotech International Co., Ltd.
9-52 Ashihara-cho, Nishinomiya City, Hyogo 662-8580, Japan
Tel. : +81-798-63-1094 Fax. : +81-798-63-1098

All tests were performed in Furuno Labotech International Co., Ltd.
All data herein contained is true and correct to our best knowledge.

All tests were performed by:

name : Katsumi Imamura

function : Test engineer

signature : K. Imamura

Review and report by:

name : Toshiro Segawa

function : QA manager

signature :

This report has been verified and approved by:

date : May 14, 1999

name : Sadatomo Kuwahara

function : Manager Engineering Section

signature : S. Kuwahara

* * * * * * CONTENTS * * * * * *

(e) Pulse Characteristics:

Range Scale (nm)	(Short)	(Middle)	(Long)
	0.125		
	0.25		
	0.5		
	0.75		
		1	
		1.5	
		2	
			3
			4
			6
			8
			12
			16
Pulselength (μs)	0.12	0.30	0.80
P.R.R.(Hz)	2100	1200	600
Duty cycle	$2.52X10^{-4}$	$3.60X10^{-4}$	$4.80X10^{-4}$
Guard Band (MHz)	12.50	5.00	1.88

Note 1: Tests were carried out for the underlined Range Scales.

(2) Modulator

(a) FET Type: 2SK1449

Trigger Voltage: Approx. +7 VDC positive

(3) Receiver

(a) Passband (MHz)

RF Stage: 100 MHz

IF Stage:

Pulselength	Short	Middle	Long
(MHz)	7	7	7

Video Amp.:

Pulselength	Short	Middle	Long
(MHz)	14	14	3

1.3 Display Unit

(a) Type: 6 (in.) monochrome LCD,
240 X 320 pixels

(b) Size of Indicator: 6 in. diagonal
effective dia. 80 mm

(c) Sweep Linearity: 2 % on all ranges

(d) Range Scales:

Range (nm)	Number of Range Rings	Range Ring Interval (nm)
0.125	2	0.0625
0.25	2	0.125
0.5	4	0.125
0.75	3	0.25
1	4	0.25
1.5	3	0.5
2	4	0.5
3	3	1
4	4	1
6	3	2
8	4	2
12	4	3
16	4	4

(e) Range Ring Accuracy: Better than 1 % of maximum scale in use
or 8 m, whichever is the greater

(f) Overall Bearing Accuracy from Scanner to Display:
Better than 1 °

(g) Target Plot Facility: Simulated afterglow in low shade

(h) Heading Indicator: Provided, automatic alignment. Heading Line and Heading Marker

(i) True Bearing Indicator: Not provided

1.4 Functional Controls

Range selector Power Switch FTC switch

Display Unit:	2 kg
Antenna Unit:	5 kg

(f) Approximate space required for installation excluding scanner

Display Unit: 381 mm (W) X 226 mm (H) X 235 mm (D)

3 RF POWER OUTPUT (FCC Rule § 2.985)

3.1 Microwave characteristics

The peak voltage was determined using the divider having a ratio of 1000 to 1 and the oscilloscope. Current pulse was viewed across the wideband current transformer with output voltage per ampere 1.00.

(1) Nominal values

Pulselength	Short	Middle	Long
Range scale (nm)	0.125	1.5	16
Pulselength (μs)	0.08	0.30	0.80
PRR (Hz)	2100	1200	600
Duty cycle	1.68×10^{-4}	3.60×10^{-4}	4.80×10^{-4}
Guard band (MHz)	18.75	5.00	1.88

(2) Measured values

Magnetron input pulse voltage

Magnetron input pulse voltage was measured at its cathode using the oscilloscope and divider with ratio 1000 to 1.

Pulselength	Short	Middle	Long
Directional coupler attenuation (dB)	40.46	40.46	40.46
Magnetron input voltage (kV)	2.35	2.35	2.35
Pulselength (μs) (50 % amplitude)	0.580	0.788	1.096
Rise time (μs) (10-90 % amplitude)	0.080	0.080	0.080
Decay time (μs) (90-10 % amplitude)	0.804	0.852	0.408

Pulselength	Short	Middle	Long
Power meter reading (mW)	0.0337	0.0478	0.0825
Magnetron output, av. (W)	0.375	0.531	0.917
Spurious response limits (dB)	38.74	40.25	42.62
Magnetron Output, peak (kW):	1.31	1.63	1.93
Magnetron efficiency (%):	37.2	35.6	36.9

Peak Power Input to RF Generator : 4.4 kW

Estimated Efficiency of RF Generator : 36.6 %

4.2 Trigger Pulse at Magnetron Cathode

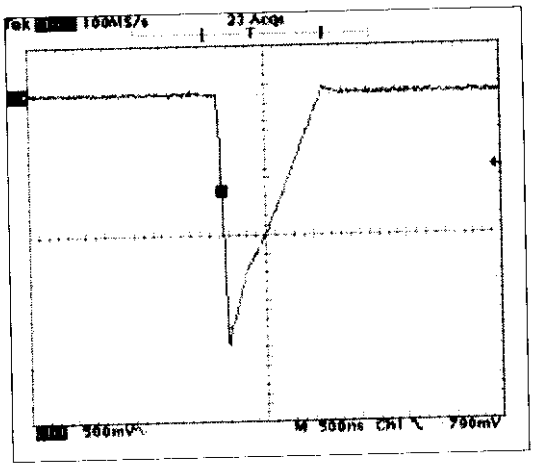


Fig. 4.2.1 Short Pulse (0.125 nm Range) Scale: 0.5 kV/div. 500 ns/div.

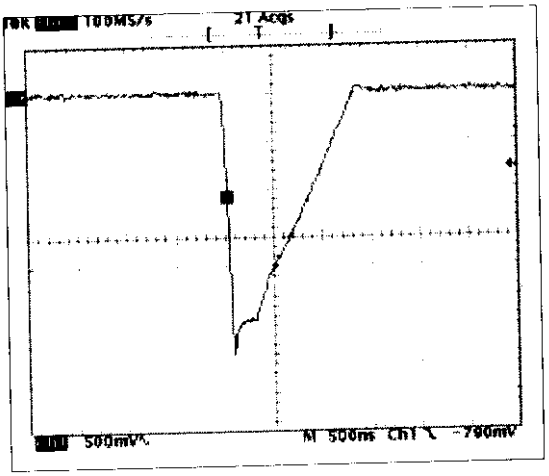


Fig. 4.2.2 Middle Pulse (1.5 nm Range) Scale: 0.5 kV/div. 500 ns/div.

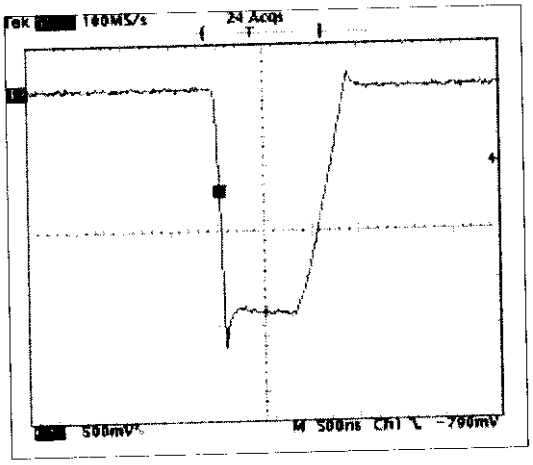


Fig. 4.2.3 Long Pulse (16 nm Range) Scale: 0.5 kV/div. 500 ns/div.

4.3.3 Measured Data:

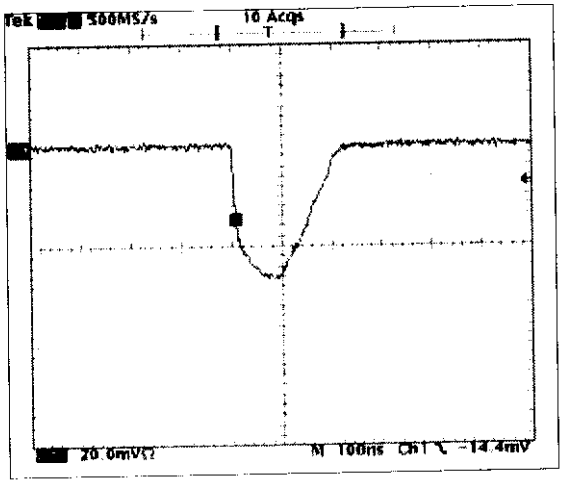


Fig. 4.3.2 Short Pulse (0.125 nm Range) Scale: 20 mV/div. 100 ns/div.

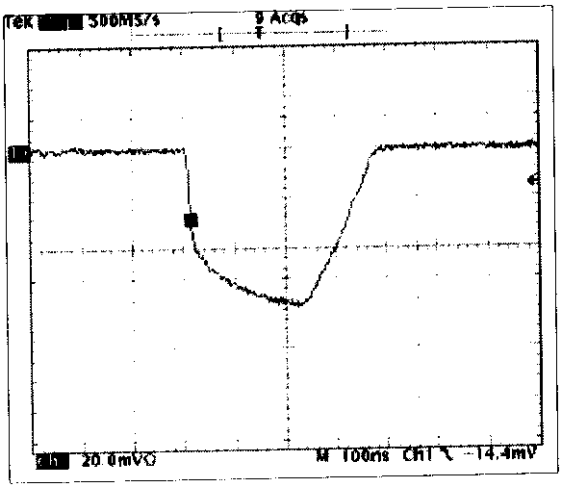


Fig. 4.3.3 Middle Pulse (1.5 nm Range) Scale: 20 mV/div. 100 ns/div.

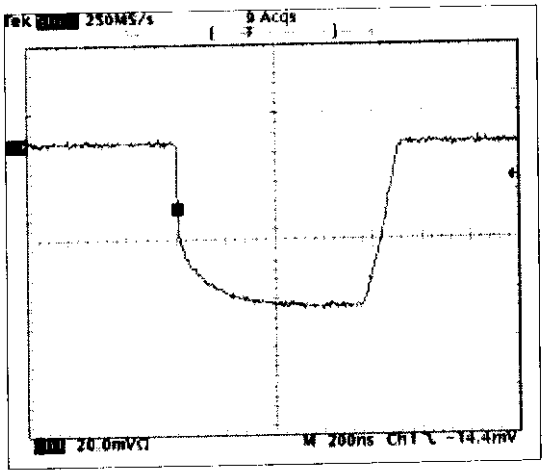


Fig. 4.3.4 Long Pulse (16 nm Range) Scale: 20 mV/div. 200 ns/div.

5 OCCUPIED BANDWIDTH (FCC Rule § 2.989)

5.1 Measuring Method

FCC rule 47 CFR 2.989 requires measurements of the occupied bandwidth which is defined in the same section as "the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission." To obtain the occupied bandwidth of the radar transmitter, a special program (program list shown below) was loaded to the Hewlett-Packard spectrum analyzer and run by entering the HP-provided POWER BANDWIDTH calculation command [PWRBW].

The result was automatically displayed on the screen on the spectrum analyzer as:

POWER_BW=----- MHz

```
10   ! HP_71000 DOWNLOAD PROGRAM
20   ASSIGN @Sa TO 718
30   CLEAR @Sa
40   CALL M_ain(@Sa)
50   LOCAL @Sa
60   END
70   !
80    SUB M_ain(@Sa)
90   M_ain:      !
100  CALL Pwr_bw(@Sa)
110  CALL Limit_line(@Sa)
120  !
130  OUTPUT @Sa;"VARDEF K_ey,0;";
140  !
150  OUTPUT @Sa;"FUNCDEF D_LP,^";
160  OUTPUT @Sa;"MOV K_ey,0;";
170  !
180  Main_menu:  !
190  OUTPUT @Sa;"REPEAT;";
200  OUTPUT @Sa;"READMENU K_ey,";
210  !  location: %Top----Bottom-%
220  OUTPUT @Sa;" l,%Limit  line  %,";
230  OUTPUT @Sa;" 2,%Power  bw    %,";
240  OUTPUT @Sa;"14,%   Exit%;";
250  !
260  OUTPUT @Sa;"IF K_ey,EQ,1;THEN;LIMIT_LINE;";
270  OUTPUT @Sa;"ELSIF K_ey,EQ,2;THEN;PWR_BW;";
280  OUTPUT @Sa;"ELSIF K_ey,EQ,I4;THEN;ABORT;";
290  OUTPUT @Sa;"ENDIF;";
300  OUTPUT @Sa;"UNTIL K_ey,EQ,14;";
310  OUTPUT @Sa;"IP;TS;";
320  OUTPUT @Sa;"ADORT;";
330  OUTPUT @Sa;"^"
340  !
350  Define_keydef:  !
360  OUTPUT @Sa;"KEYDEF 7,D_LP, %DLP     TEST%;";
370  !
380  OUTPUT   @Sa;"FUNCDEF D,^";
390  OUTPUT   @Sa;"KEYPST;";
400  OUTPUT   @Sa;"^"
410  !
420  SUBEND
430  !
440  SUB Limit_line(@Sa)
450  Limit_line:   !
460  OUTPUT @Sa;"CLRDSP;";
470  OUTPUT@Sa;"FUNCDEF LIMIT_LINE,^";
480  OUTPUT   @Sa;"PU;PA  0,654;";
490  OUTPUT   @Sa;"LINET 1;";
500  OUTPUT   @Sa;"PD;PA 100,654;";
510  OUTPUT   @Sa;"PU;PA 201,654;";
520  OUTPUT   @Sa;"PD;PA 300,654;";
530  OUTPUT   @Sa;"PU;PA 105,630;";
540  OUTPUT   @Sa;"TEXT @-35dB@;";
550  OUTPUT   @Sa;"PU;PA 205,720;";
560  OUTPUT   @Sa;"TEXT @-25dB@;";
570  OUTPUT   @Sa;"PU;PA 301,743;";
580  OUTPUT   @Sa;"LINET 1;";
590  OUTPUT   @Sa;"PD;PA 400,743;";
600  OUTPUT   @Sa;"PU;PA 601,743;";
610  OUTPUT   @Sa;"LINET I;";
620  OUTPUT   @Sa;"PD;PA 700,743;";
630  OUTPUT   @Sa;"PU;PA 701,654;";
640  OUTPUT   @Sa;"LINET I;";
650  OUTPUT@Sa;"PD;PA 1000,654;HD;";
660  OUTPUT   @Sa;"^"
670  SUBEND
680  SUB Pwr_bw(@Sa)
690  Pwr_bw:      !
700  !     Calculating Power band width
710  OUTPUT @Sa;   "VARDEF P_bw,0;";
720  OUTPUT @Sa;"FUNCDEF PWR_BW,^";
730  OUTPUT @Sa;"CLRW TRA;";
740  OUTPUT @Sa;"CLRDSP;";
750  OUTPUT @Sa;"SNGLS;";
760  OUTPUT @Sa;"MXMH   TRA;TS;TS;TS;";
770  OUTPUT @Sa;"MOV   P_bw,PWRBW   TRA,99.0;";
780  OUTPUT@Sa;"DIV P__bw,P_bw,1000000;";
790  OUTPUT @Sa;"PU;PA 10,800;HD;";
800  OUTPUT @Sa;"TEXT @POWER_BW = @;";
810  OUTPUT @Sa;"DSPLY P_bw,8,3;";
820  OUTPUT @Sa;"TEXT @ MHz @;";
830  OUTPUT @Sa;"^"
840  SUBEND
```

Fig. 5.1 Program for Calculation of Occupied Bandwidth

6 SPURIOUS EMISSIONS AT ANTENNA TERMINAL (FCC Rule § 2.991)

6.1 Test Equipment Setup:

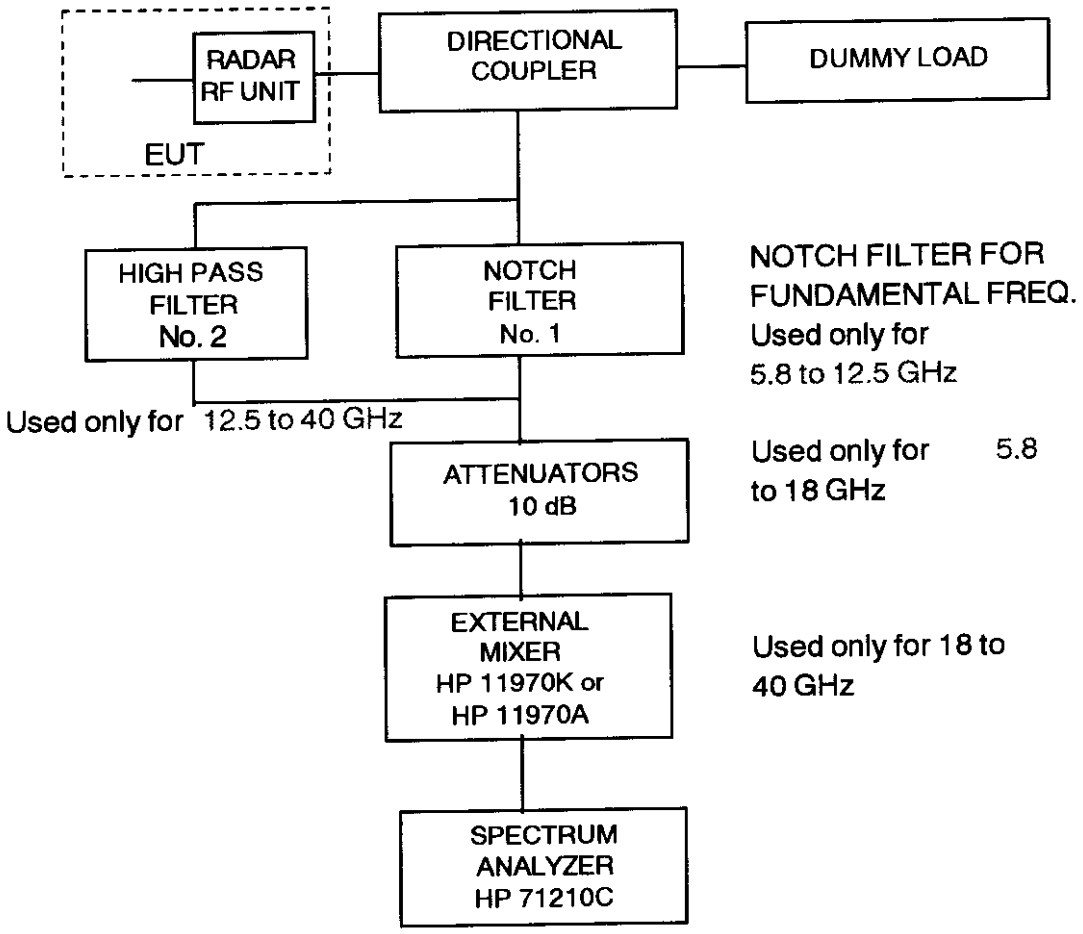


Fig. 6.1

6.2 Measuring Equipment List:

See ATTACHMENT 4 [LIST OF TEST/MEASURING EQUIPMENT].

Note : (1) The characteristics of Notch Filter (No. 1) are described in Fig. 6.2 to Fig. 6.5.

(2) The characteristic of High Pass Filter (No. 2) is described in Fig. 6.6.

Characteristic of Filter No. 1 (for X-band)

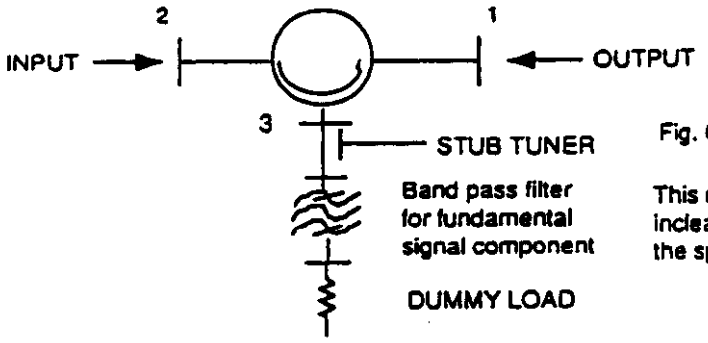


Fig. 6.2 Setup of Notch Filter No.1

This notch filter is used to inclease the dynamic range of the spectrum analyzer

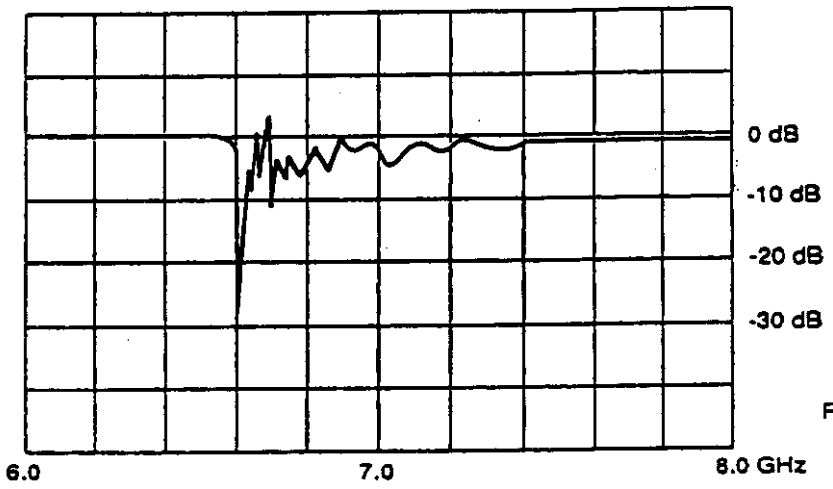


Fig. 6.3

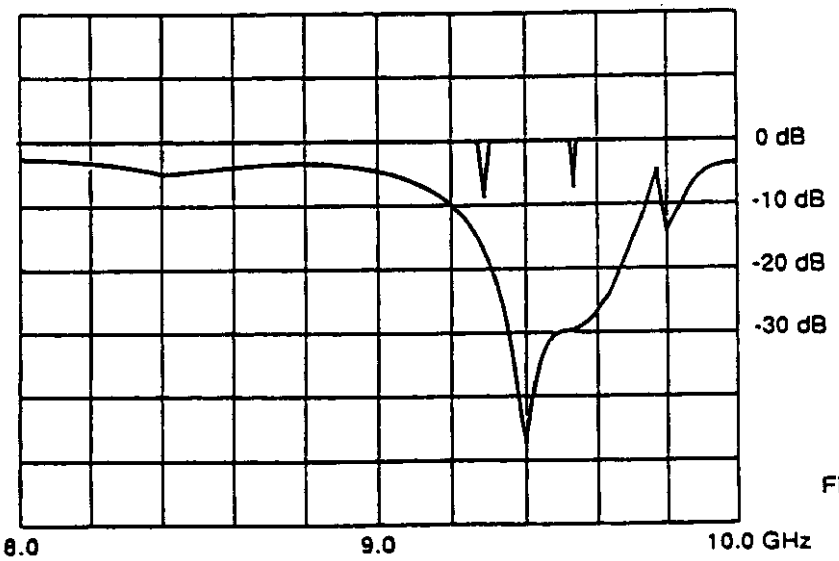


Fig. 6.4

7 FIELD STRENGTH OF SPURIOUS RADIATION (FCC Rule § 2.993)

7.1 Test Site: Rooftop of 6-story building,
FURUNO ELECTRIC CO., LTD.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan

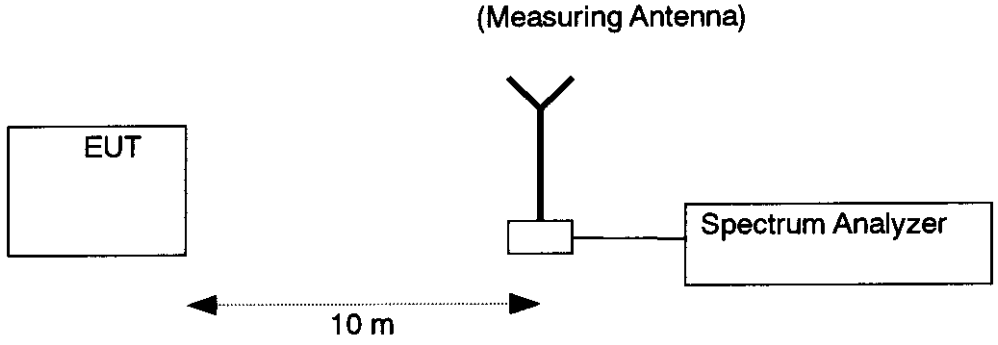
7.2 Date: Apr., 1999

7.3 Distance between the radar set and measuring antenna: 10 m

7.4 Radar Range settings: 0.125 nm (Short)/1.5 nm (Middle)/ 16 nm (Long)

7.5 Measuring Equipment List:
See ATTACHMENT 4 [LIST OF TEST/MEASURING EQUIPMENT].

7.6 Test settings:



7.7 Field Strength Limits:

(a) Frequency Range (FCC Rule § 2.997) : 10 kHz - 4GHz

(b) Emission Limits (FCC Rule § 80.211) :

Frequency removed from the assigned frequency	Frequency (MHz)	Emission attenuation (mean power, dB)
50 - 100 % (of the authorized bandwidth)	9,310 – 9,360 9,460 – 9,510	At least 25
100 - 250 %	9,160 – 9,310 9,510 – 9,660	At least 35
more than 250 %	0.01 – 9,160	

8 FREQUENCY STABILITY (FCC Rule §2.995)

8.1 Setup for Measurement

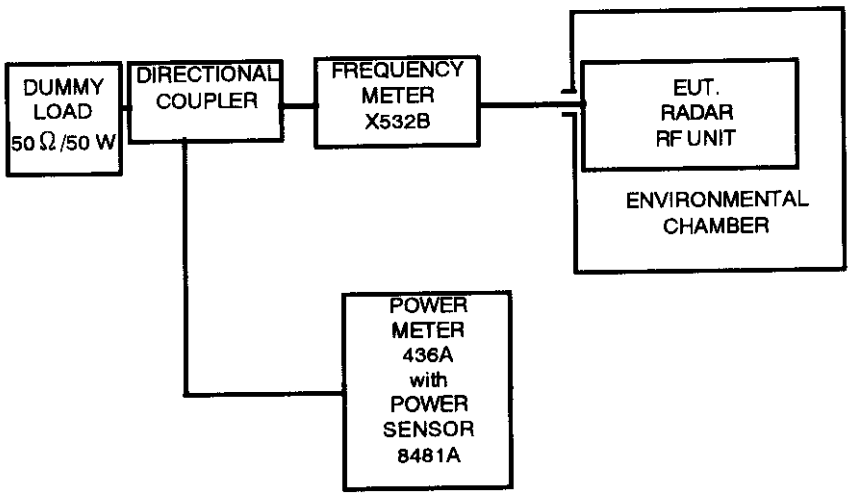


Fig. 8.1

8.2 Test Conditions:

1) Radar Range settings : 0.125 nm (Short)/1.5 nm (Middle)/ 16 nm (Long)
2) Ambient Temperature settings: - 20 to + 50 ℃ (10 ℃ step)
3) Power Supply Voltage settings: 85 /115 % of nominal voltage (20.4 to 27.6 VDC)

8.3 Measuring Equipment List:

See ATTACHMENT 4 [LIST OF TEST/MEASURING EQUIPMENT].

FREQUENCY STABILITY WITH VARIATION OF PRIMARY SUPPLY VOLTAGE:
The built-in voltage regulator allows no frequency variation against variations of ±15 % of nominal power supply voltage (20.4 to 27.6 VDC for nominal 24 VDC).

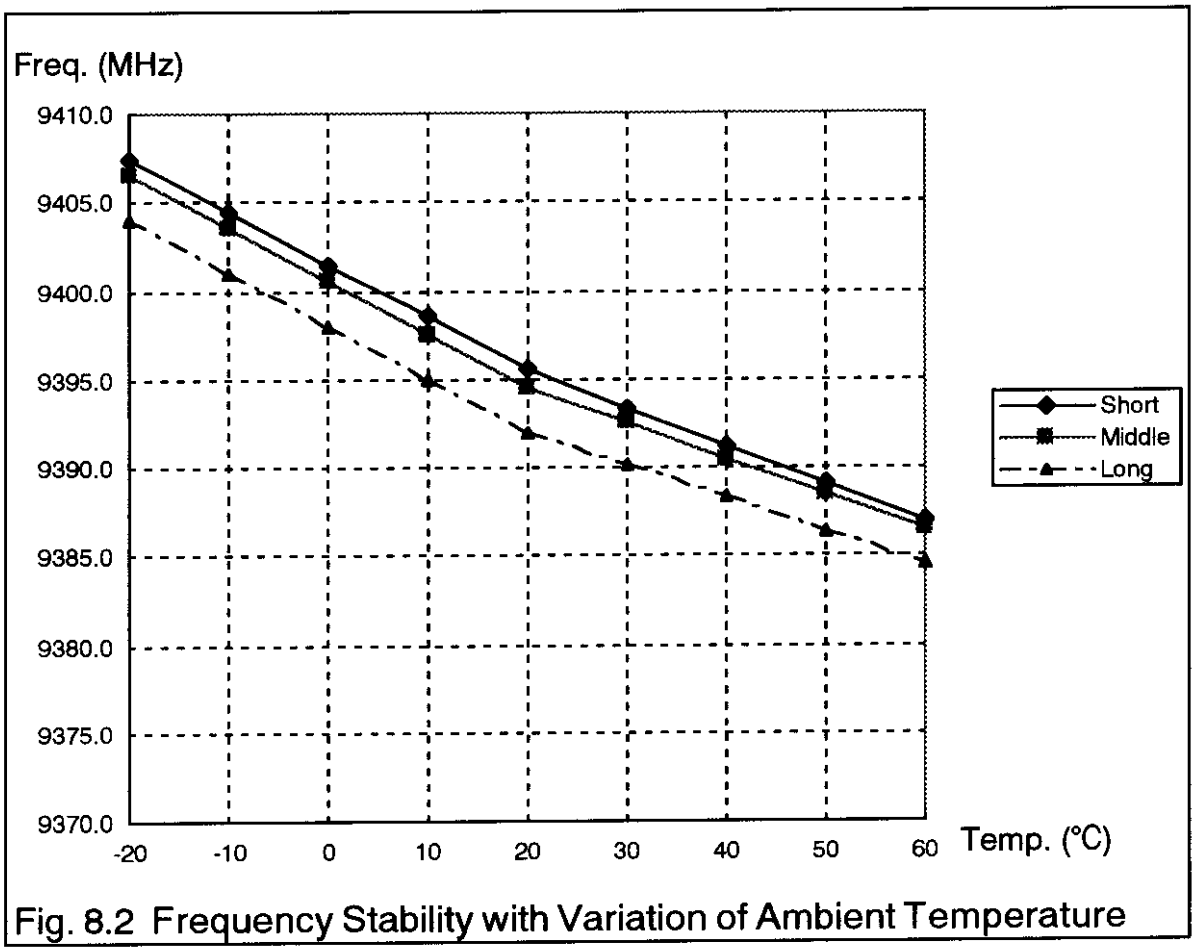


Fig. 8.2 Frequency Stability with Variation of Ambient Temperature

9.4 Test Results:

Interference levels to the respective antenna were measured at 2 m from the radar which was put in OFF, STANDBY, TRANSMIT conditions, and found within the specified limits.

9.4.1 Harmful Interference to Receiver (FCC Rule § 80.217 (a))

Limits: for 14 - 490 kHz, 5 μV/m
for 490 kHz - 1 GHz, 1 μV/m

Results: There is no spurious component which is deemed harmful interference. (Test data are shown in ATTACHMENT 3)

9.4.2 Electromagnetic Field (FCC Rule § 80.217 (b) - 1)

Limits: for below 30 MHz, 0.1 μV/m at 1 nm (-20 dBμV/m)
for 30 to 100 MHz, 0.3 μV/m at 1 nm (-10.5 dBμV/m)
for 100 to 300 MHz, 1.0 μV/m at 1 nm (0 dBμV/m)
for over 300 MHz, 3.0 μV/m at 1 nm (9.5 dBμV/m)

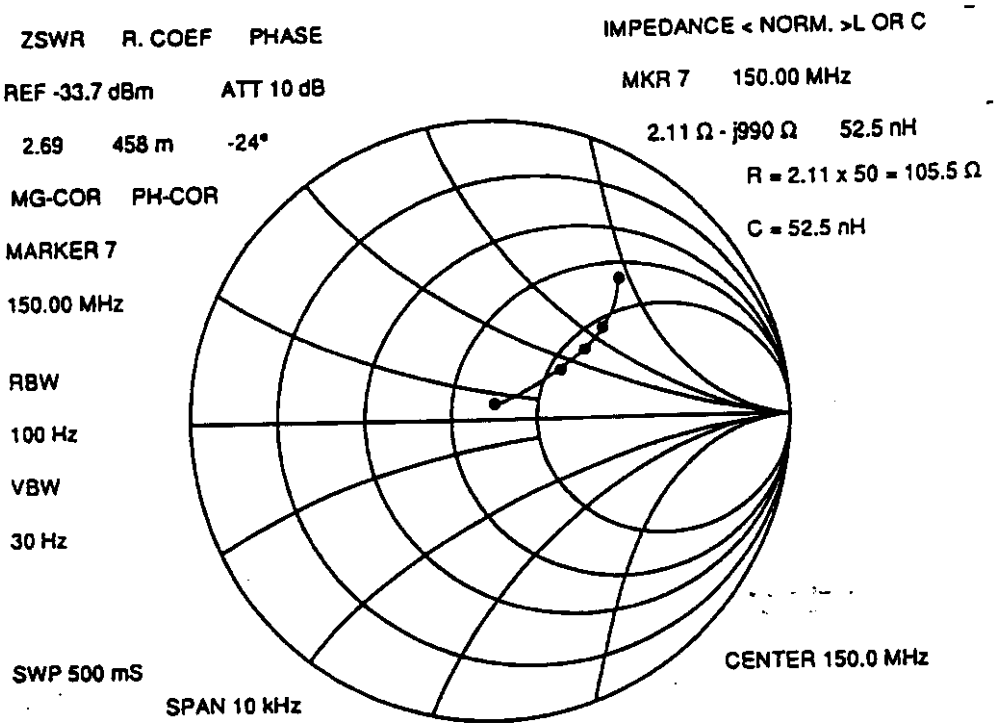
Results: Interference was measured with the antenna located 2 m from the radar and converted to levels at 1 nm. There is no spurious component exceeding the limits.
(Test data are shown in ATTACHMENT 3)

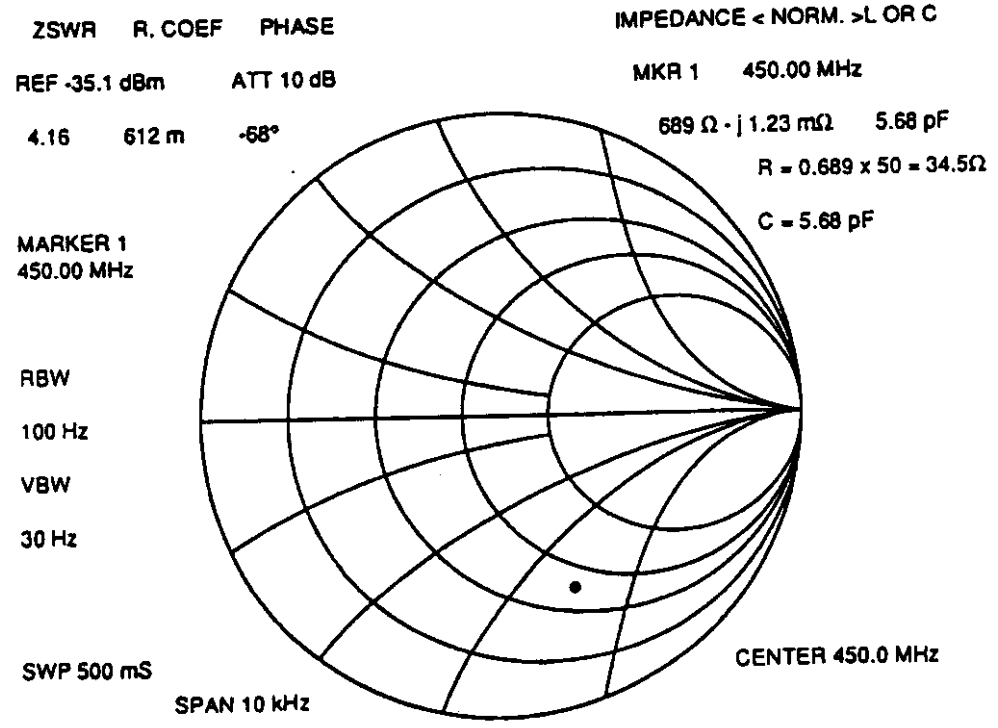
9.4.3 Power Input to an Artificial Antenna (FCC Rule § 80.217 (b) - 2)

Limits: for below 30 MHz, 400 μW
for 30 to 100 MHz, 4,000 μW
for 100 to 300 MHz, 40,000 μW
for over 300 MHz, 400,000 μW

Results: There is no spurious component exceeding the limits.
(Test data are shown in ATTACHMENT 3)

MEASUREMENT OF IMPEDANCE OF TEST ANTENNAS





11 TECHNICAL DESCRIPTION OF EQUIPMENT (FCC Rules §2.983)

11.1 Function of Each Semiconductor or Active Device (FCC Rule §2.983 (d)(6))

ANTENNA UNIT

TRANSCEIVER MODULE (RTR-068)

MD Print PCB 03P9270

CR851:	Switch
CR853:	Input Protection
CR855:	Detector (Magnetron Current)
CR856-CR857:	Transient Suppression
Q851-Q852:	Switch
Q853,Q855,Q856:	Pulse Amplifier
Q857:	MOS FET Modulator
U851:	Pulse Generator
CR802:	Voltage Regulator
CR803, CR834:	Power Switch Control
CR804:	Over current Protection
CR805, CR835:	Snubber Diode
CR831-CR832:	Rectifier
CR836-CR838:	Rectifier
Q801:	9 V Regulator
Q802, Q831:	Power Switch Control
Q803:	45 kHz PWM Inverter and Output MOS FET
Q804:	Current Detector
Q805:	Pulse Amplifier
Q832:	45 kHz Inverter and Output MOS FET
U801:	45 kHz PWM Inverter Control
U802-U804:	Voltage Detector
U805:	45 kHz Inverter Control

IF Print PCB 03P9269

CR1-CR2, CR10:	Voltage Limiter (IF Amplifier)
CR3-CR4:	Voltage Limiter (Over Voltage Protector)
CR5:	Voltage Shifter (Tuning Indicator)
CR6:	D.C. Blocking (Tuning Indicator)

CR5-CR6, Q8:	Power Switch Control
CR51-CR54:	Rectifier
CR55:	Flywheel diode
Q1:	9 V Regulator
Q4-Q5:	Power Relay Control
Q6:	45 kHz PWM Inverter Output MOS FET
Q7:	Current Detector
Q9:	Power Relay
Q10:	Switch
Q11:	Latch
Q50-Q51:	Switch
Q52-Q53:	45 kHz Backlight Inverter Output Transistor
U3:	Low Voltage/High Voltage Detection
U5:	Voltage Detector
U6:	45 kHz PWM Inverter Control
U7:	Power Switch Control
U8:	Voltage Detector
CR101-CR102:	Switch
CR103-CR104:	Level Shift
CR108:	Reverse Polarity Protector Diode
CR109:	DC Restoration
CR110, CR115:	Reverse Polarity Protector Diode
CR111-CR113:	Input Protection
CR114:	Rectifier
Q101-Q102:	Amplifier
Q103-Q104:	Buffer
Q105-Q106,	Switch
Q108, Q114:	Switch
Q107, Q109-Q110:	Pulse Amplifier
Q112-Q113:	Input Block
U101-U103:	A/D Conversion
U104:	Reset IC
U105:	Backup IC
U106-U107, U120:	Analogue Switch
U108:	CPU
U109:	CPU, RAM
U110:	D/A Converter
U111:	Sampling
U112:	GDC
U113, U116:	Video RAM
U114, U126:	Isolator

CR856 and CR857 absorb the ringing in the secondary side of T851 while C862 decouples the pulse energy that is liable to occur across the magnetron heater when T851's secondary windings are unbalanced or the load is asymmetric.

Also incorporated in the PCB 03P9270 are the TX HV circuit and magnetron heater power supply circuit. The TX HV circuit provides a high tension of about 300 V to the pulse forming network through CR837,CR838. A DC voltage of 8.0 V is supplied to the magnetron heater through CR836.

Duplexer and Frequency Converter

Since this radar uses a patch array antenna for transmission and reception, an efficient device is required for switching the transmission and receiver. This radar employs circulator U801 (Composed of the circulator and the MIC) for this purpose. It is a passive derectional coupler with three ports.

The microwave energy produced by the magnetron enters the circulator from port RF1. It is fed to port RF2 with little loss of energy; port MIC-INPUT at this is isolated. In the same manner, the received signal entering into RF2 is transferred to port MIC-INPUT, isolating port RF1. This operation of the circulator protects the receiver during transmission and minimizes the loss of the received signal.

A diode limiter, made up of a pair of PIN diodes, is incorporated in the first stage of the MIC (microwave IC). It is a passive switching device which allows the low-level RF signal to pass through and prohibits relatively strong microwave energy, such as the leak from the circulator during each TX cycle or the TX pulses received directly from other radars operating in the proximity, to enter the sensitive receiver circuit.

When a low-level signal is received, the PIN diodes remain in the cutoff state, and the limiter's input impedance matches the characteristic impedance of the receiver allowing the signal to be delivered to the frequency converter of the MIC. When strong microwave energy is received, the PIN diodes are put in the conductive state (or short-circuited) causing the input energy to be attenuated. The strong input is further reduced to about 150 mW by the limiter diode.

The MIC converts 9 GHz RF signal into an intermediate frequency of 60 MHz. It is achieved by mixing the received signal with the local oscillator signal in the frequency converter of the MIC. The built-in local oscillator oscillates at a frequency 60 MHz higher than the magnetron frequency of 9410 MHz.

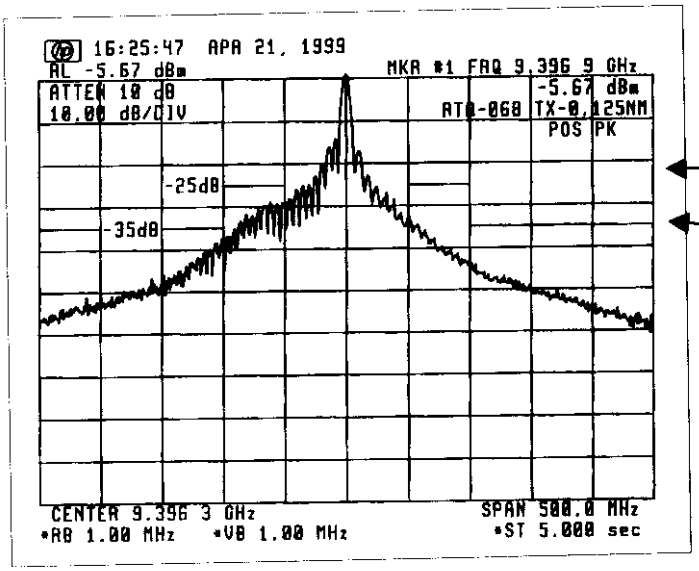
12 OPERATOR'S MANUAL INCL. CIRCUIT DIAGRAMS (FCC Rule §2.983)

(See separate covers)

ATTACHMENT 1

[TEST DATA FOR 6. SPURIOUS EMISSIONS AT ANTENNA TERMINALS]

1. Spurious emissions for 0.125 nm Range:



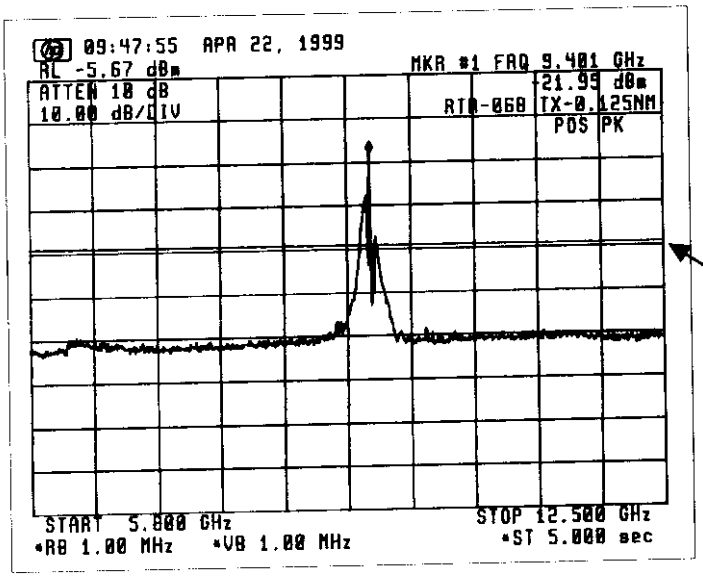
Ref. level: -5.67 dBm

Emission limitations:

(a) 25 dB for 50 to 100 % of the authorized BW (100 MHz)

(b) 35 dB for 100 to 250 % of the authorized BW (100 MHz)

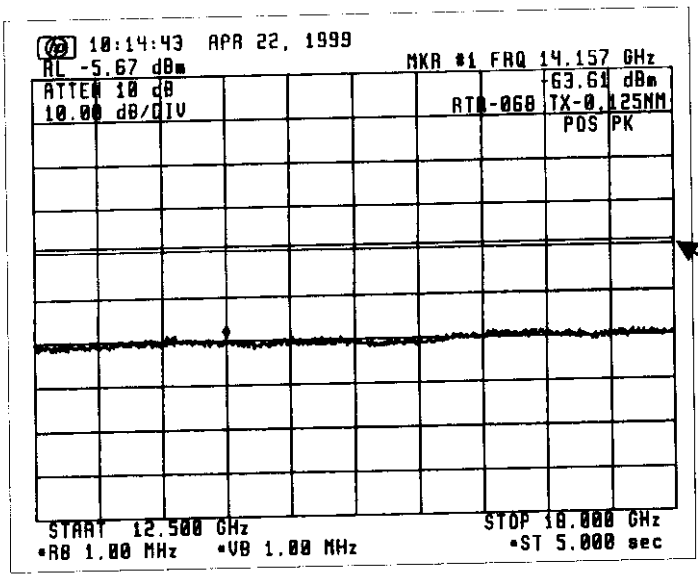
Fig. 1.1 Without Filter



Emission limitations:

(c) 43 + 10 log Pm = 38.74 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 1.2 With Filter No.1

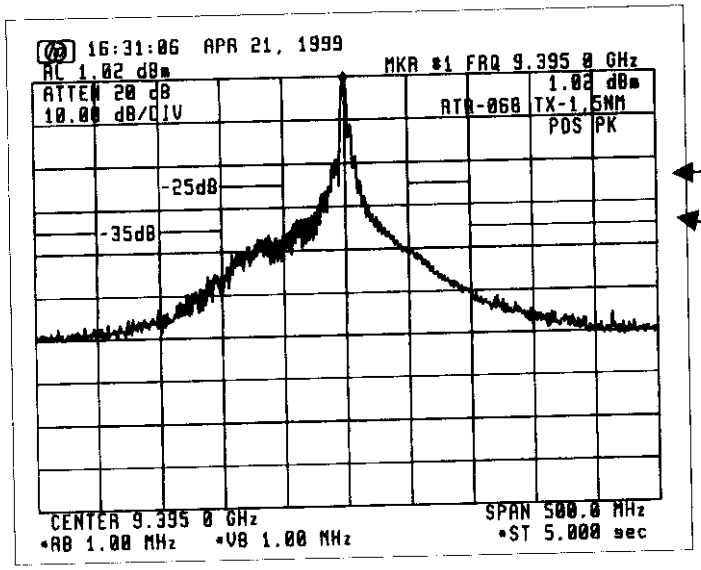


Emission limitations:

(c) 43 + 10 log Pm = 38.74 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 1.3 With Filter No. 2

2. Spurious emissions for 1.5 nm Range:



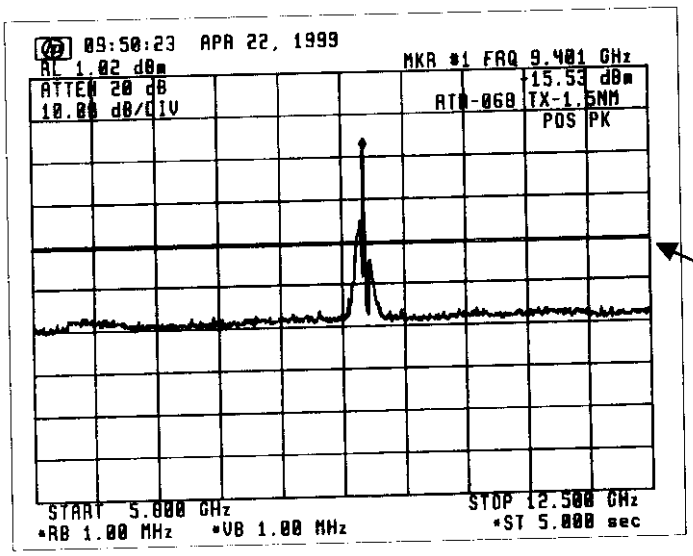
Ref. level: 1.02 dBm

Emission limitations:

(a) 25 dB for 50 to 100 % of the authorized BW (100 MHz)

(b) 35 dB for 100 to 250 % of the authorized BW (100 MHz)

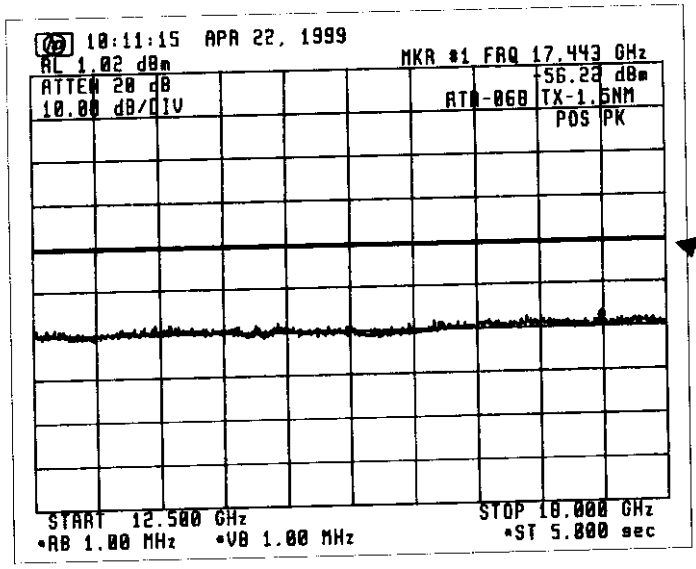
Fig. 2.1 Without Filter



Emission limitations:

(c) 43 + 10 log Pm = 40.25 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 2.2 With Filter No.1

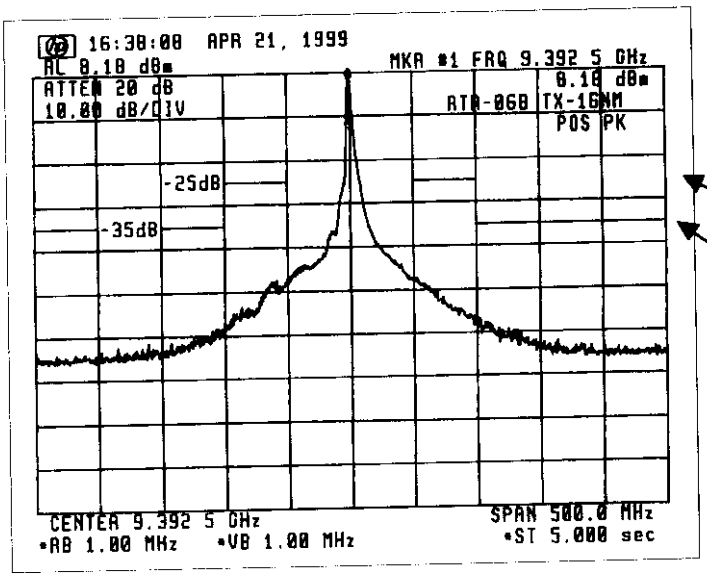


Emission limitations:

(c) 43 + 10 log Pm = 40.25 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 2.3 With Filter No. 2

3. Spurious emissions for 16 nm Range:



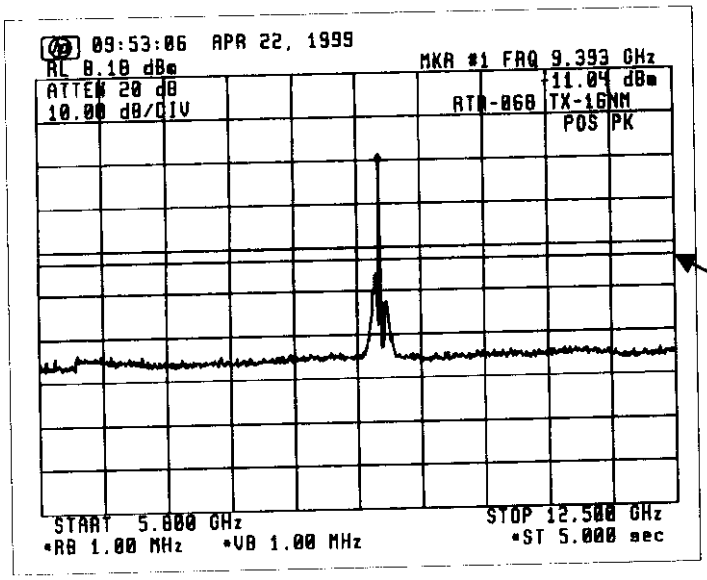
Ref. level: 8.18 dBm

Emission limitations:

(a) 25 dB for 50 to 100 % of the authorized BW (100 MHz)

(b) 35 dB for 100 to 250 % of the authorized BW (100 MHz)

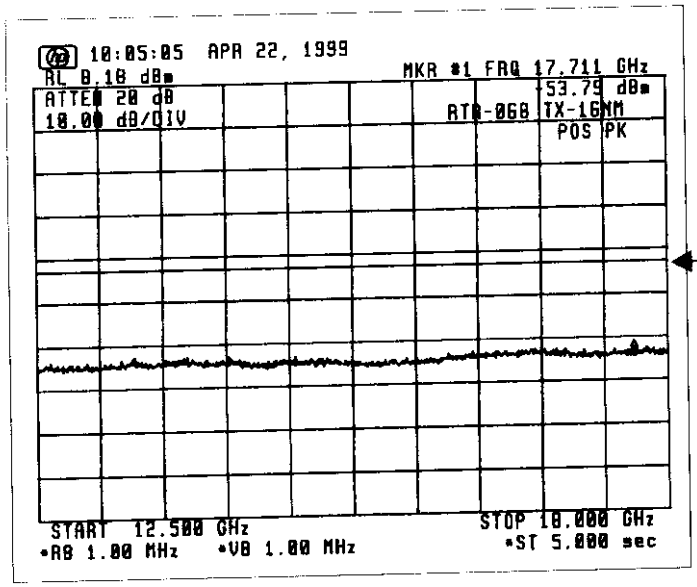
Fig. 3.1 Without Filter



Emission limitations:

(c) 43 + 10 log Pm = 42.62 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 3.2 With Filter No.1

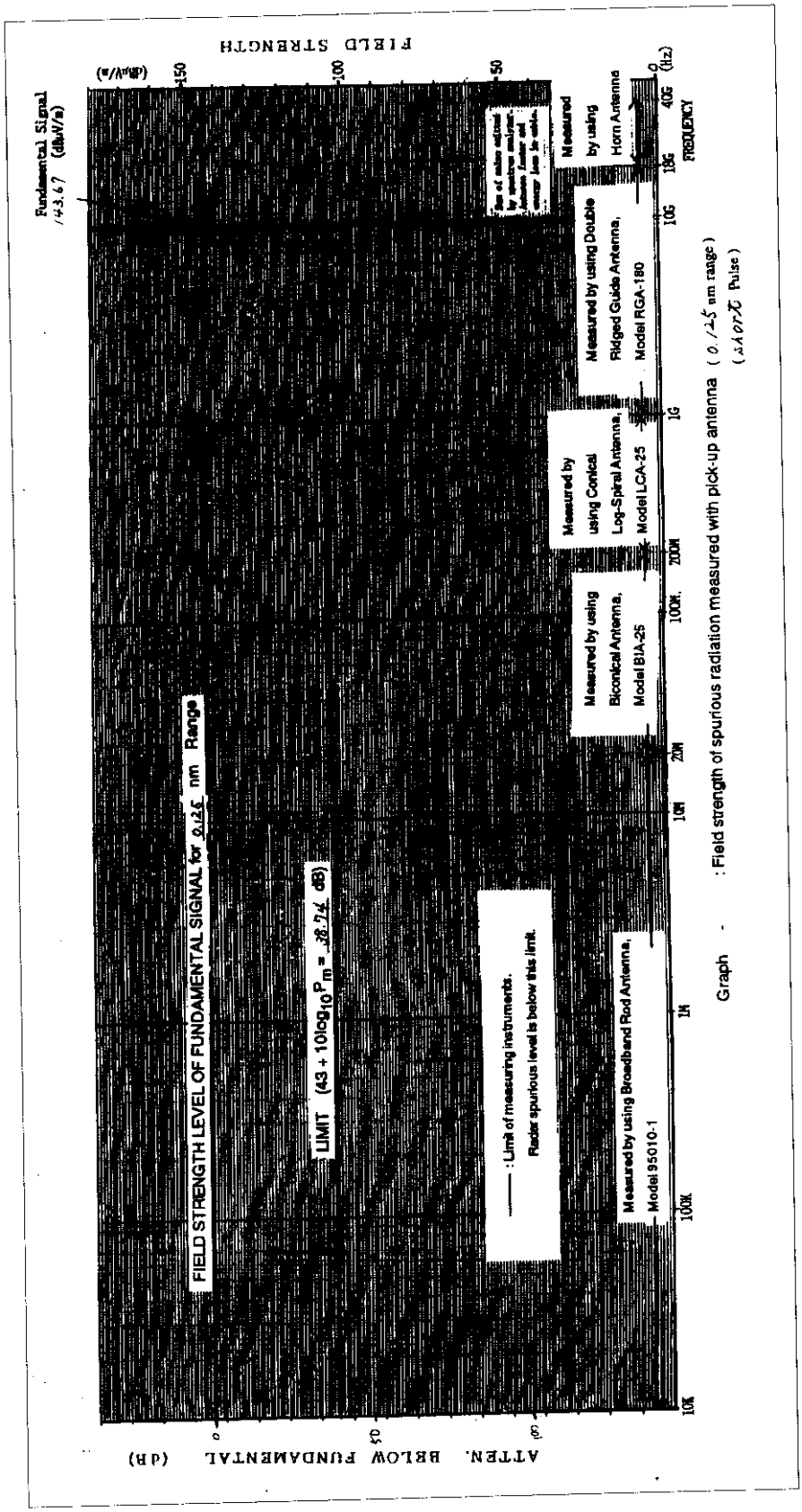


Emission limitations:

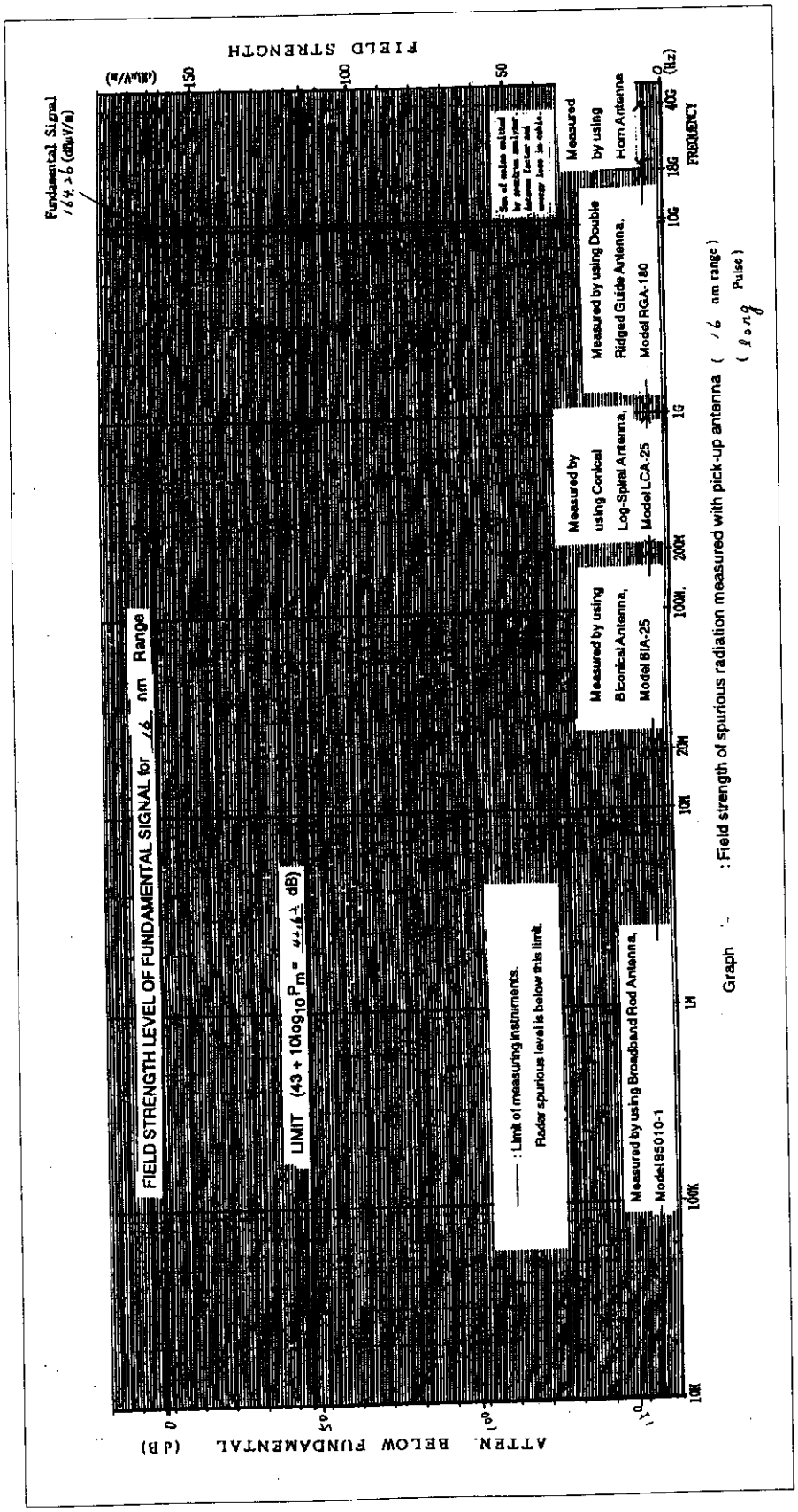
(c) 43 + 10 log Pm = 42.62 dB for more than 250 % of the authorized BW (100 MHz)

Fig. 3.3 With Filter No. 2

ATTACHMENT 2 [TEST DATA FOR 7. FIELD STRENGTH OF SPURIOUS RADIATION]



Graph - : Field strength of spurious radiation measured with pick-up antenna (0.125 nm range)
(MAGNETRON Pulse)



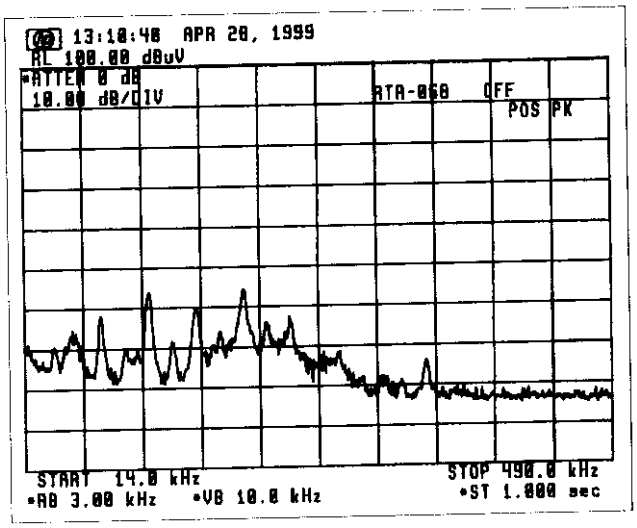
Graph : Field strength of spurious radiation measured with pick-up antenna (16 nm range)
(long Pulse)

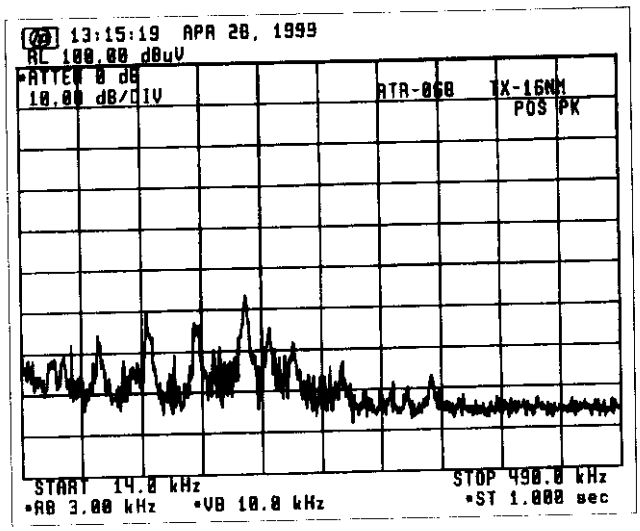
ATTACHMENT 3

[TEST DATA FOR 9. SUPPRESSION OF INTERFERENCE ABOARD SHIPS]

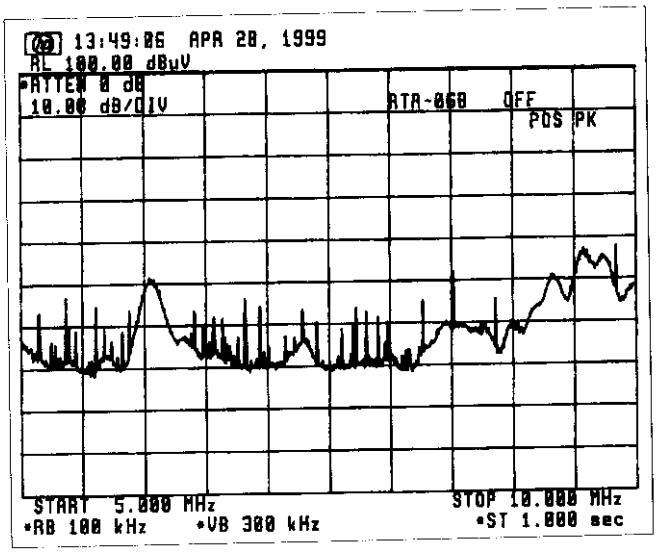
1. Harmful Interference to Receiver

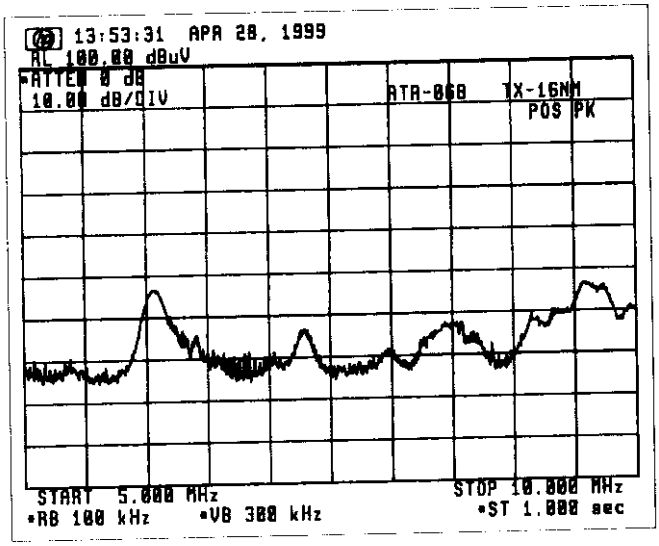
(Band : 14 kHz - 490 kHz)



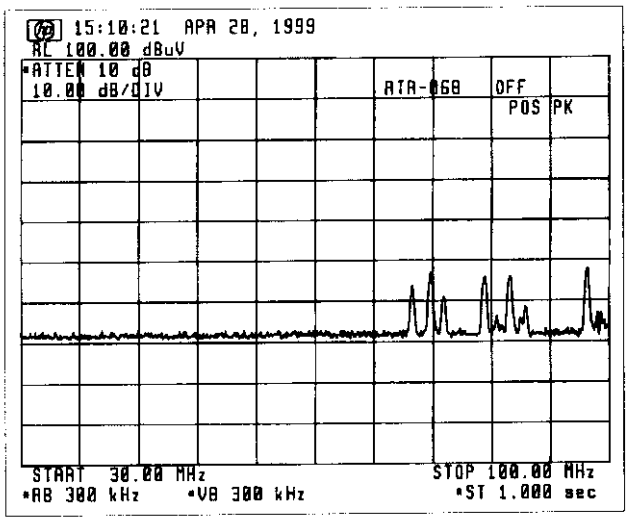


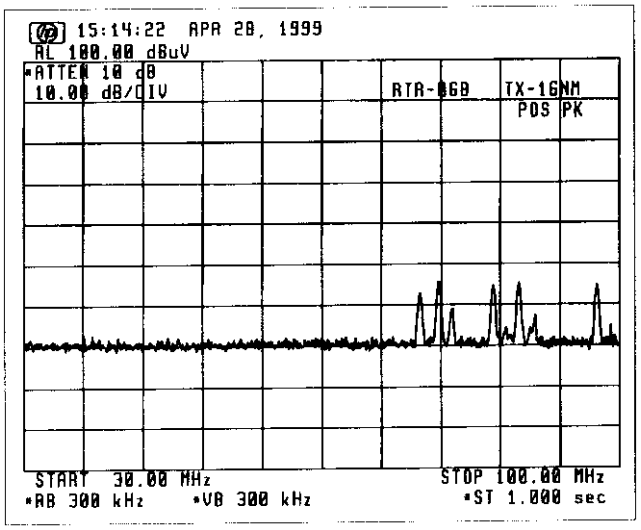
(Band : 5 MHz - 10 MHz)



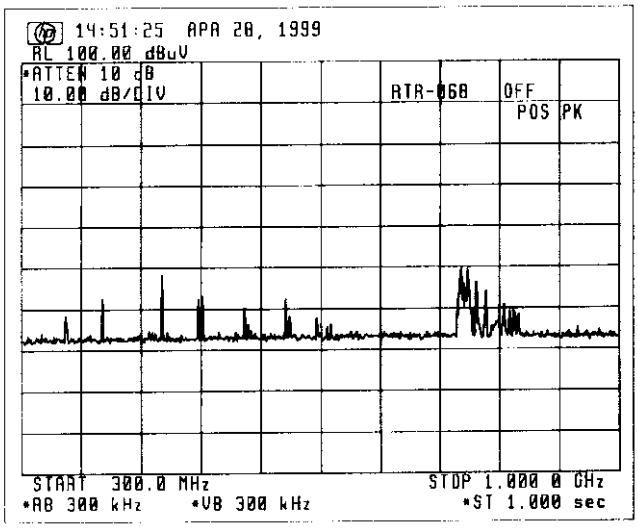


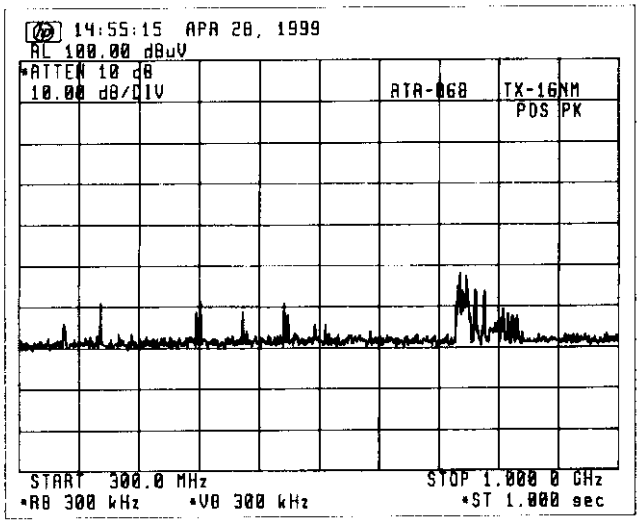
(Band : 30 MHz - 100 MHz)



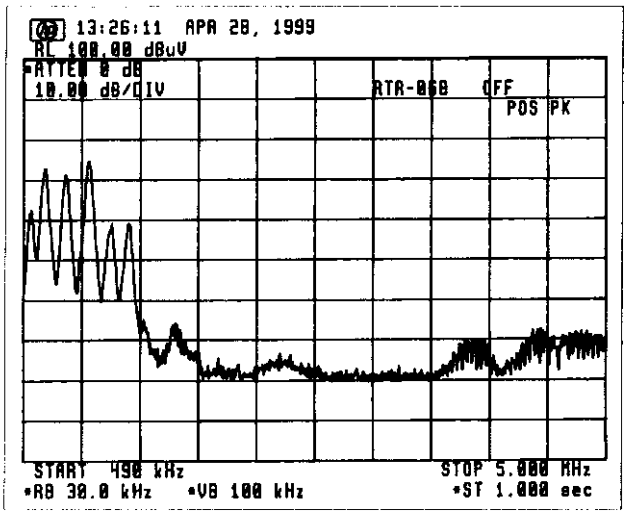


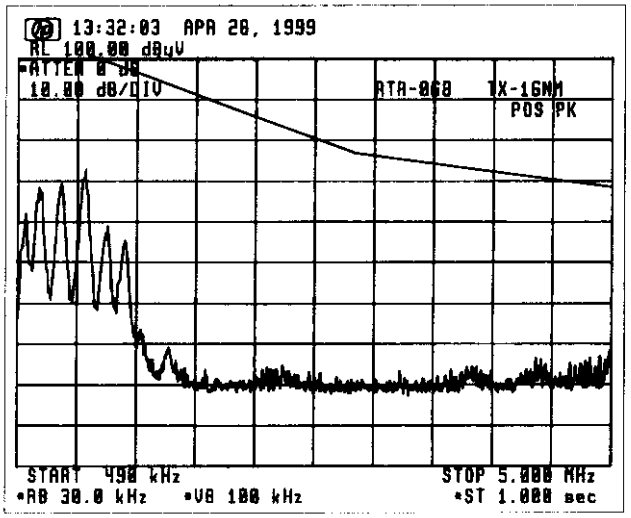
(Band : 300 MHz - 1 GHz)





(Band : 490 kHz - 5 MHz, Limit at 1 nm = 0.1 μV/m = -20 dBμV/m)

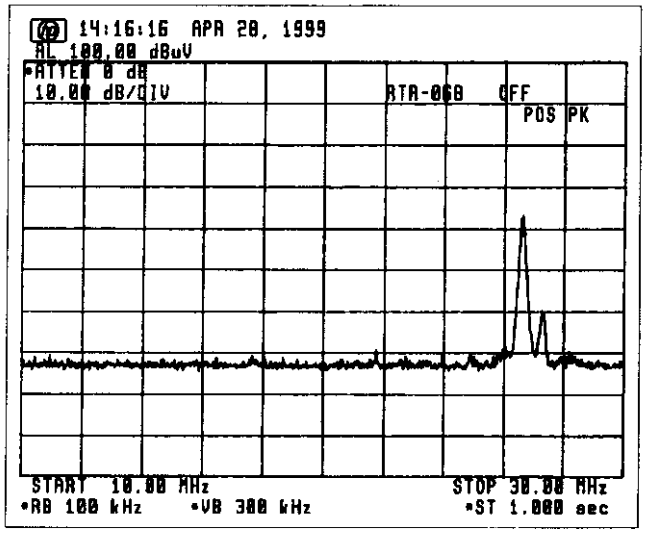


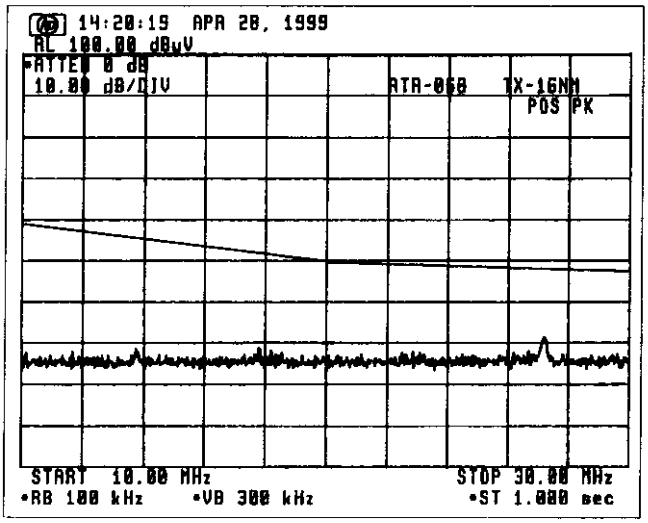


Ref. level (dBμV/m)
= 100 - 126 = -26 (at 0.5 MHz)
= 100 - 96 = 4 (at 3 MHz)
= 100 - 88 = 12 (at 5 MHz)

-20 dBμV/m limit line

(Band : 10 MHz - 30 MHz, Limit at 1 nm = 0.1 μV/m = -20 dBμV/m)

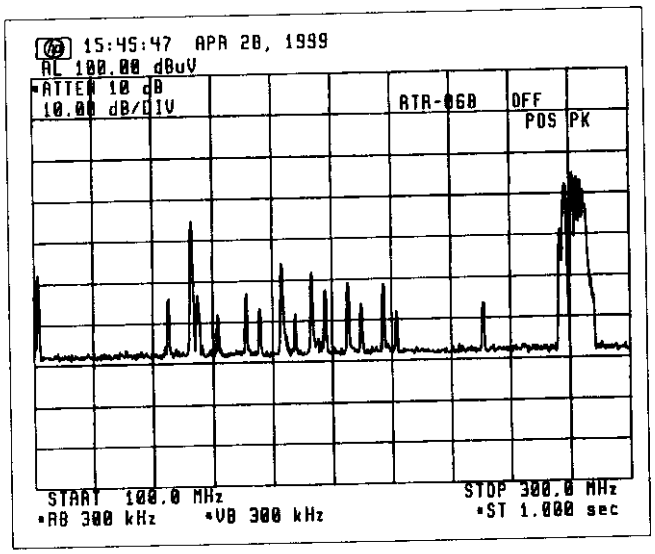


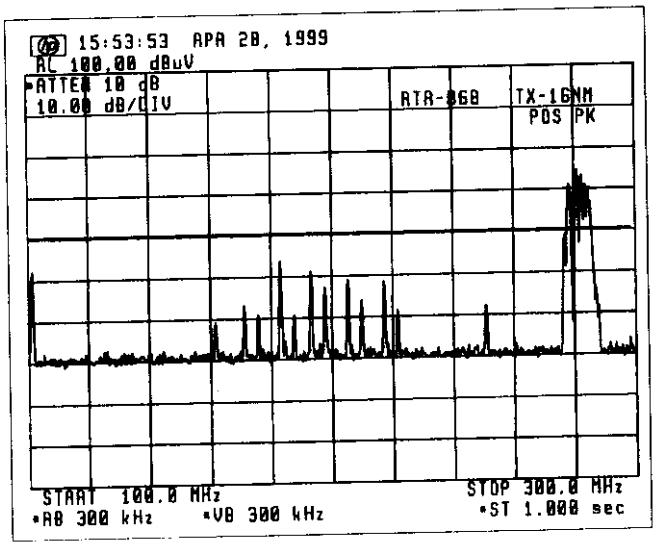


Ref. level (dBμV/m)
= 100 - 78 = 22 (at 10 MHz)
= 100 - 70 = 30 (at 20 MHz)
= 100 - 67 = 33 (at 30 MHz)

-20 dBμV/m limit line

(Band : 100 MHz - 300 MHz, Limit at 1 nm = 1 μV/m = -0 dBμV/m)





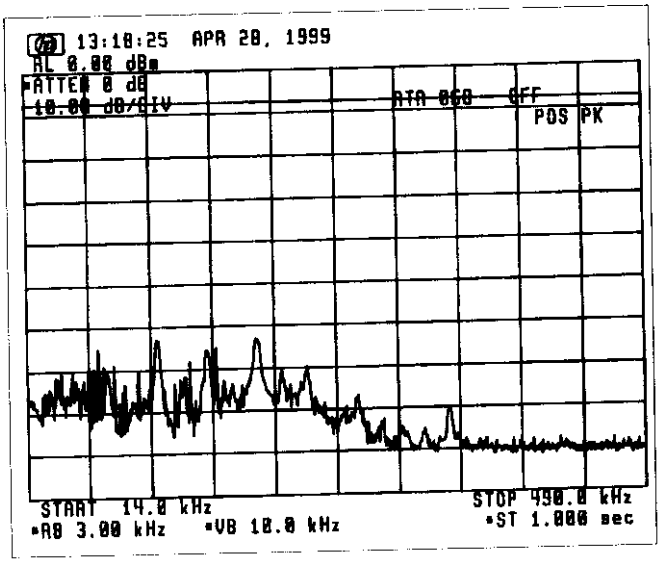
Ref. level (dBμV/m)
= 100 - 60 = 40

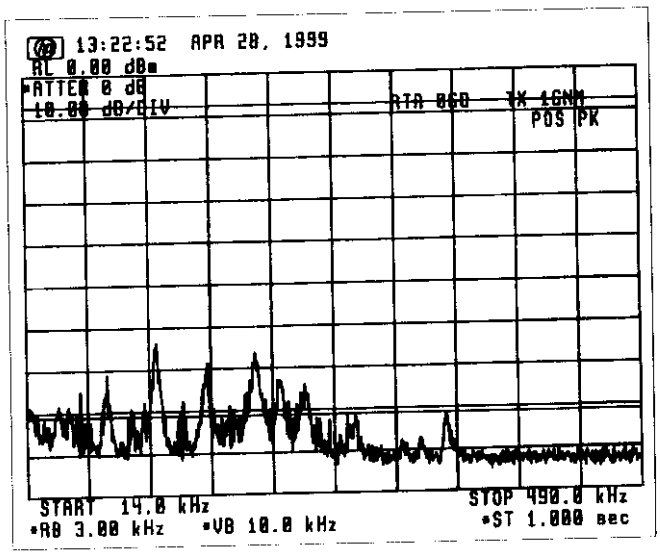
0 dBμV/m limit line

All components above the limit are from external noise or signals, not from RADAR.

3. Power Input to an Artificial Antenna

(Band : 14 kHz - 490 kHz, Limit at 2 m = -81 dBm)

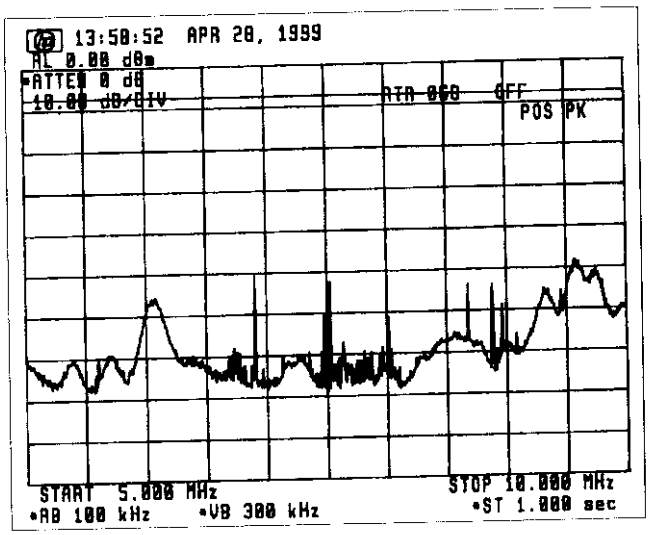


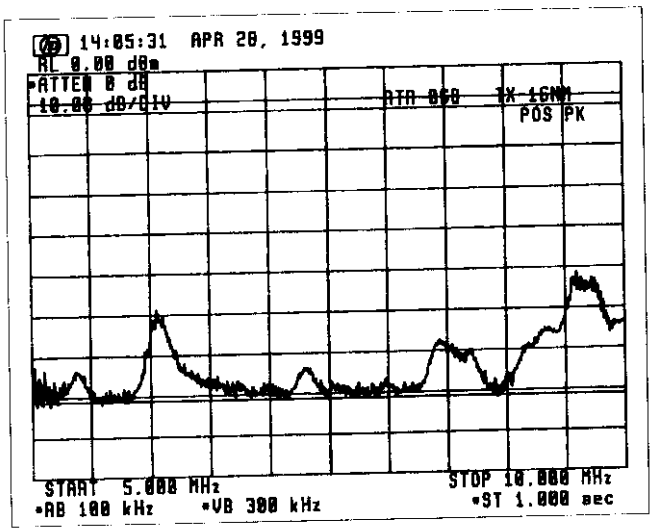


-81 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 5 MHz - 10 MHz, Limit at 2 m = -81 dBm)

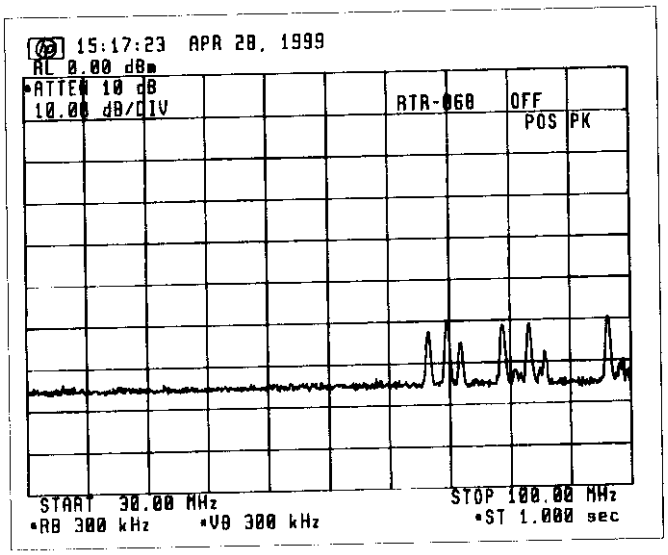


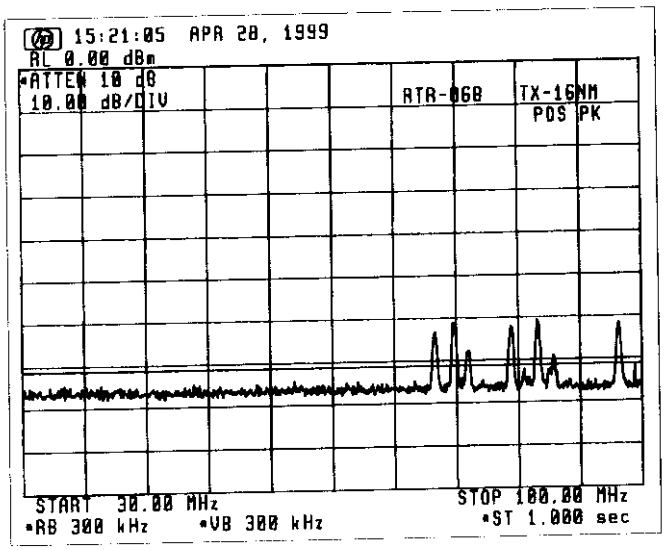


-81 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 30 MHz - 100 MHz, Limit at 2 m = -71 dBm)

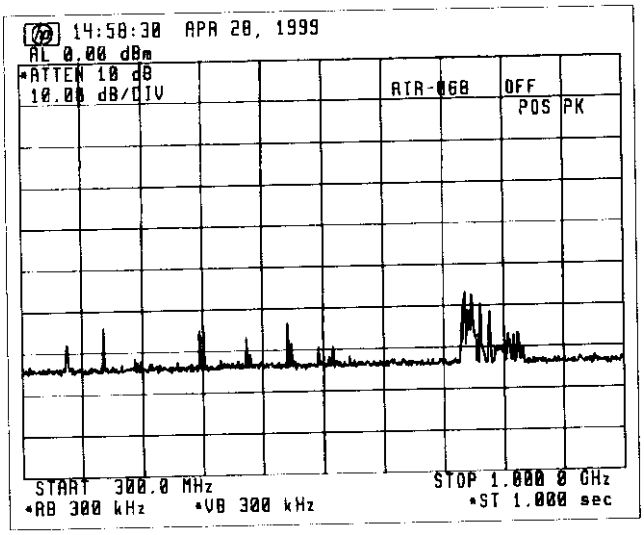


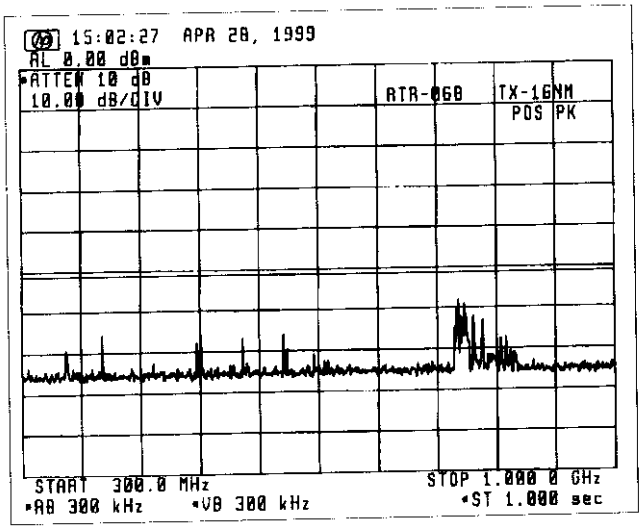


-71 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 300 MHz - 1 GHz, Limit at 2 m = -51 dBm)





-51 dBm limit line

ATTACHMENT 4 [List of Test/Measuring Equipment] (for X-band radar)

3. RF Power Output

Model	Type	Serial no.	Mfr.
Spectrum Analyzer	71210C	2927A02847	HP
Oscilloscope	TDS680B	B030202	Tektronix
Directional Coupler	5D364S	R05762	Shimada
Voltage Divider	P6015	----	Tektronix
Current Transformer	2100	----	Pearson Electronics
Power Meter	436A	2410A19137	HP
Power Sensor	8481A	2349A39603	HP
Frequency Counter	TR5824A	41940036	Advantest
Frequency Meter	X532B	1441A00523	HP
Crystal Detector	423B	1822A34712	HP
Step Attenuator	8494B	1510A07310	HP
Step Attenuator	8495B	1350A04754	HP
Dummy Load	----	8411057	Shimada

4. Modulation Characteristics

Model	Type	Serial no.	Mfr.
Oscilloscope	TDS680B	B030202	Tektronix
Step Attenuator	8494B	1510A07310	HP
Step Attenuator	8495B	1350A04754	HP
Crystal Detector	423B	1822A34712	HP
Directional Coupler	5D364S	R05762	Shimada
Dummy Load	-----	8411057	Shimada
Voltage Divider	P6015	----	Tektronix
Spectrum Analyzer	71210C	2927A02847	HP

8. Frequency Stability

Model	Type	Serial no.	Mfr.
Power Meter:	436A	2410A19137	HP
Power Sensor:	8481A	2349A39603	HP
Frequency Meter:	X532B	1441A00523	HP
Directional Coupler:	5D364S	R5762	Shimada
Dummy Load:	----	8411057	Shimada
Environmental Chamber:	PL-4E	1632712	Tabai Espec

9. Suppression of Interference Aboard Ships

Model	Type	Serial no.	Mfr.
Spectrum Analyzer:	71210C	2927A02847	HP
6 m Whip Antenna	14 k - 10 MHz	----	Furuno
4 m Whip Antenna	10 - 30 MHz	----	Furuno
VHF Whip Antenna	30 - 300 MHz	150M-W2UM	Anten
UHF Whip Antenna	300 - 1000 MHz	----	Anten
RF Vector Impedance Meter:	4815A	2048A03354	HP
Spectrum Analyzer	TR4172	30690116	Advantest
Spectrum Analyzer	8566B	2637A03642	HP
Atten uator (10 dB)	8491A	36122	HP

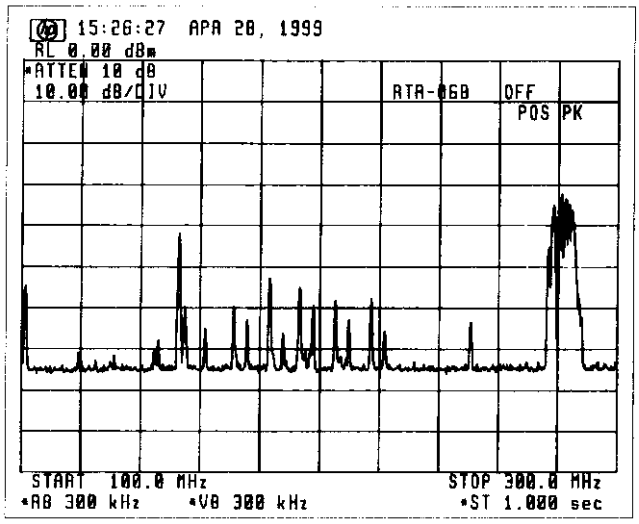
6. Spurious Emissions at Antenna Terminal

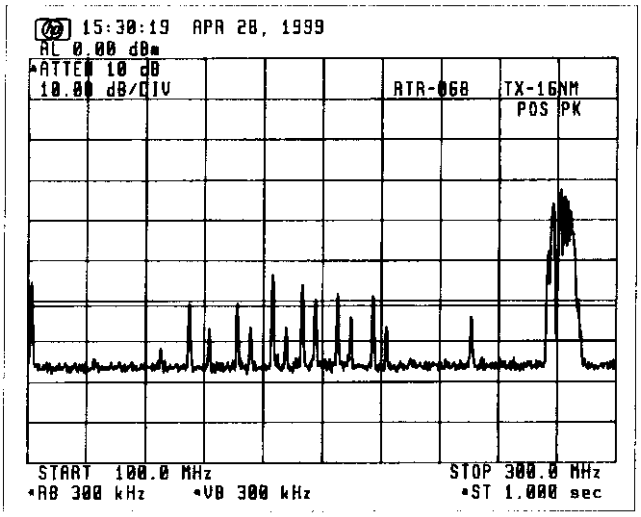
Model	Type	Serial no.	Mfr.
Spectrum Analyzer	71210C	2927A02847	HP
Attenuator (10 dB)	8491B	28845	HP
External Mixer:	11970K	2332A00589	HP
External Mixer:	11970A	2332A01187	HP
Directional Coupler	5D364S	R05762	Shimada
Dummy Load	-----	8411057	Shimada
Notch Filter			
Circulator	MA8L32#82	----	Microwave Associates
Bandpass filter	-----	R9904	Shimada
High Pass Filter	-----	-----	Furuno

7. Field Strength of Spurious Radiation

Model	Type	Serial no.	Mfr.
Broadband Rod Antenna	95010-1		Advanced Electronics
Biconical Antenna	BIA-25	2650	Electro Metrics
Conical Log-Spiral Antenna	LCA-25	2886	Electro Metrics
Double Ridged Guide Horn Antenna	:RGA-180	2248	Electro Metrics
Horn Antenna:	----	----	Toshiba
Spectrum Analyzer:	71210C	2927A02847	HP
External Mixer:	11970K	2332A00589	HP
External Mixer:	11970A	2332A01187	HP
~~Notch Filter~~			
~~Circulator~~	~~MA8L32#82~~		~~Microwave Associates~~
~~Bandpass filter~~		~~R9904~~	~~Shimada~~
Attenuator (10 dB)	8491B	28845	HP
~~Attenuator (20 dB)~~	~~8491A~~	~~40072~~	~~HP~~

(Band : 100 MHz - 300 MHz, Limit at 2 m = -61 dBm)

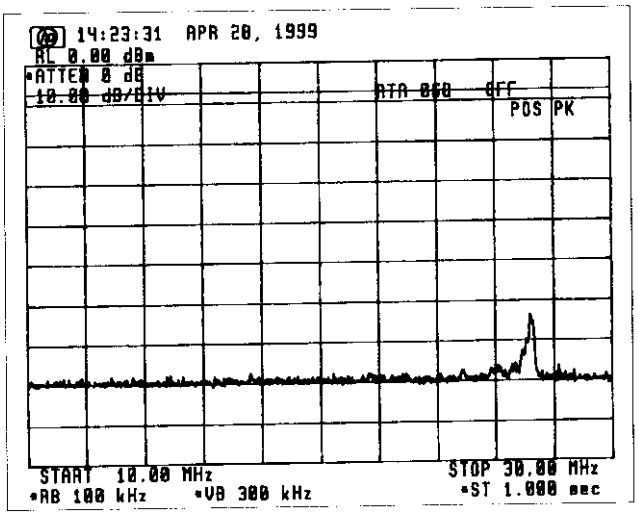


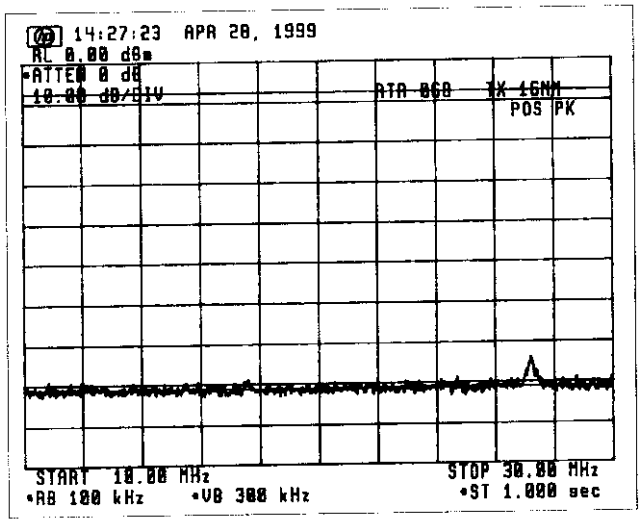


-61 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 10 MHz - 30 MHz, Limit at 2 m = -81 dBm)

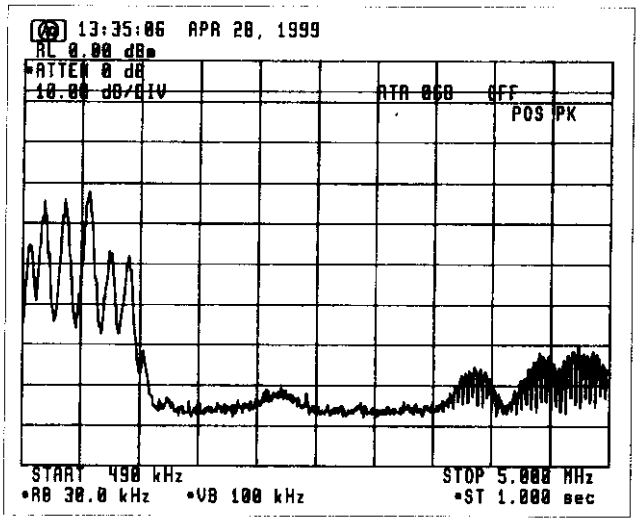


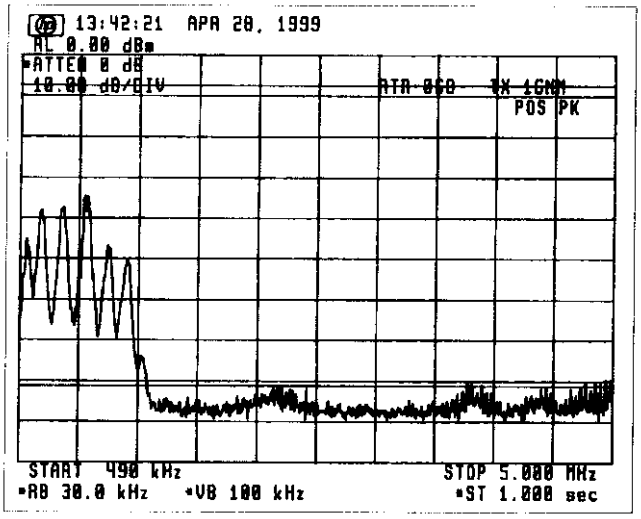


-81 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 490 kHz - 5 MHz, Limit at 2 m = -81 dBm)

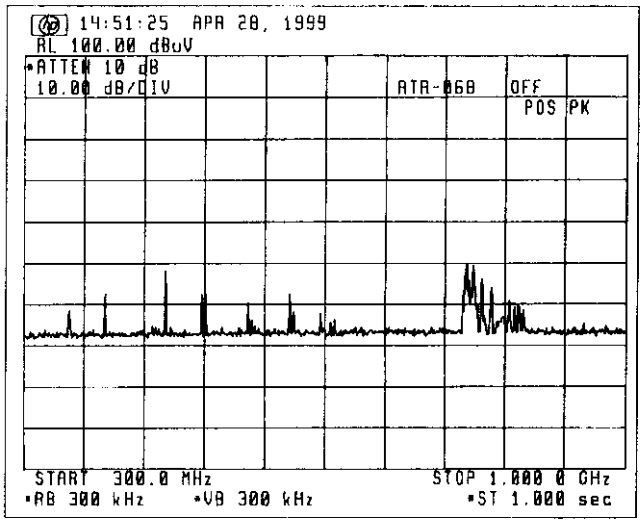


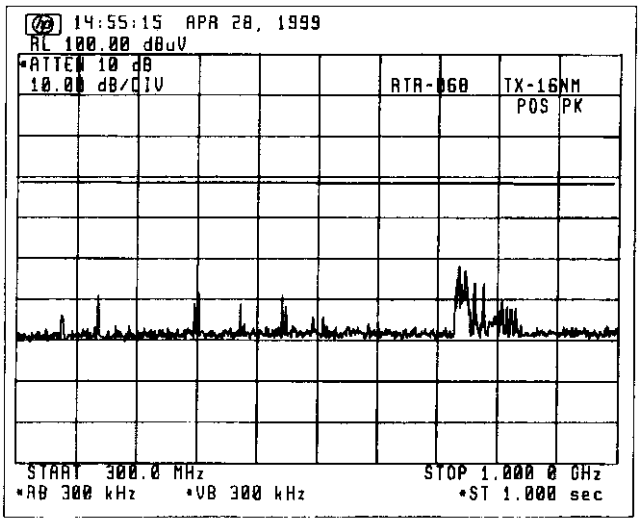


-81 dBm limit line

All components above the limit are from external noise or signals, not from RADAR.

(Band : 300 MHz - 1 GHz, Limit at 1 nm = 3 μV/m = -9.5 dBμV/m)

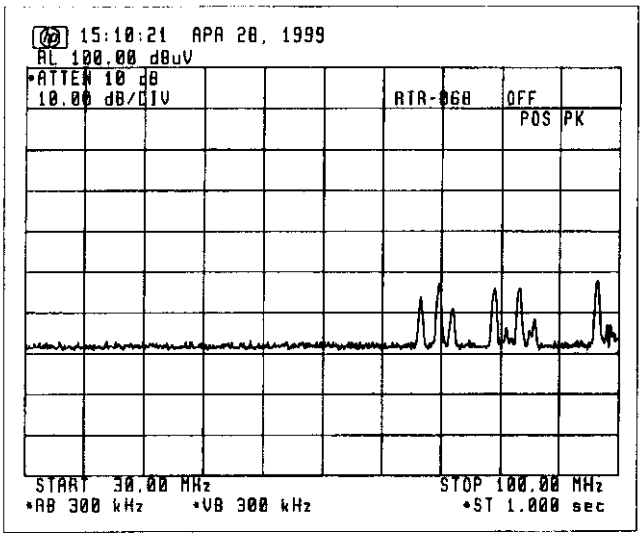


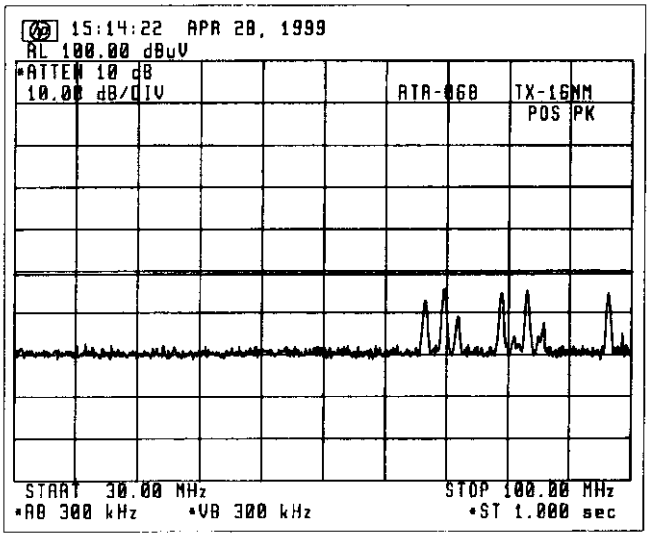


Ref. level (dBμV/m)
= 100 - 59.5 = 40.5

9.5 dBμV/m limit line

(Band : 30 MHz - 100 MHz, Limit at 1 nm = 0.3 μV/m = -10.5 dBμV/m)

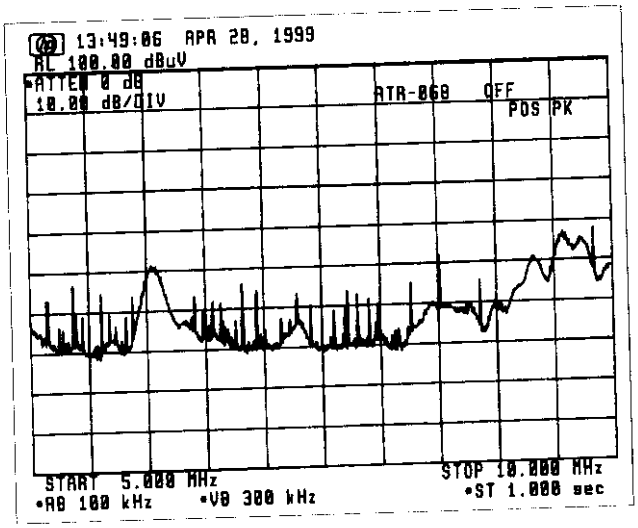




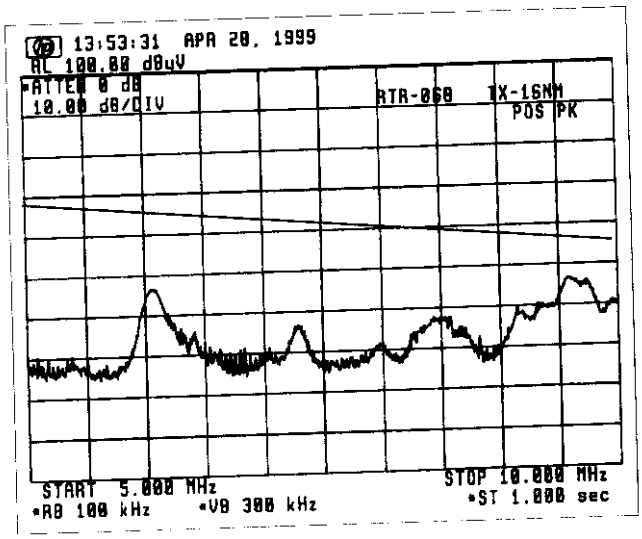
Ref. level (dBμV/m)
= 100 - 61 = 39

- 10.5 dBμV/m limit line

(Band : 5 MHz - 10 MHz, Limit at 1 nm = 0.1 μV/m = -20 dBμV/m)



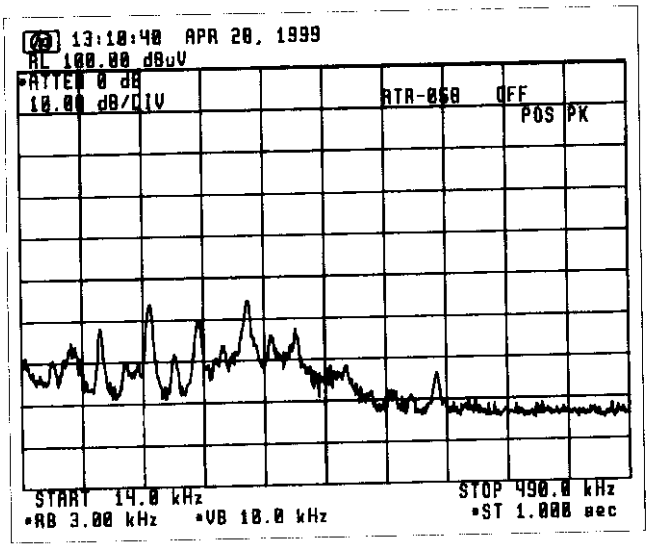
Ref. level (dBμV/m)
= 100 - 88 = 12 (at 5 MHz)
= 100 - 83 = 17 (at 7 MHz)
= 100 - 78 = 22 (at 10 MHz)



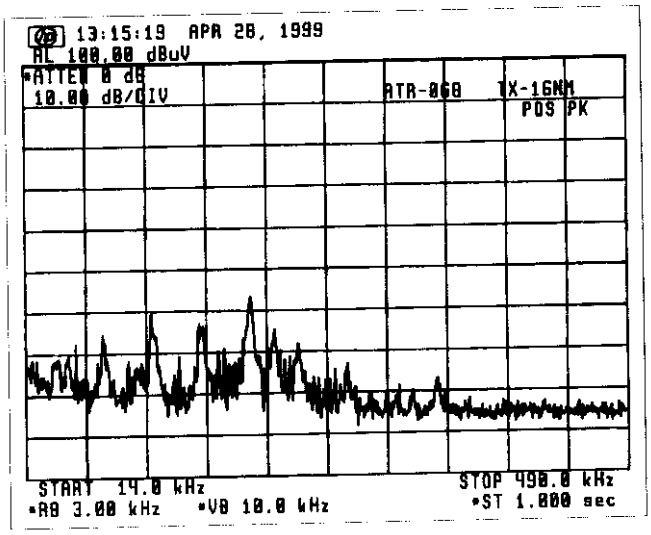
-20 dBμV/m limit line

2. Electromagnetic Field

(Band : 14 kHz - 490 kHz, Limit at 1 nm = 0.1 μV/m = -20 dBμV/m)

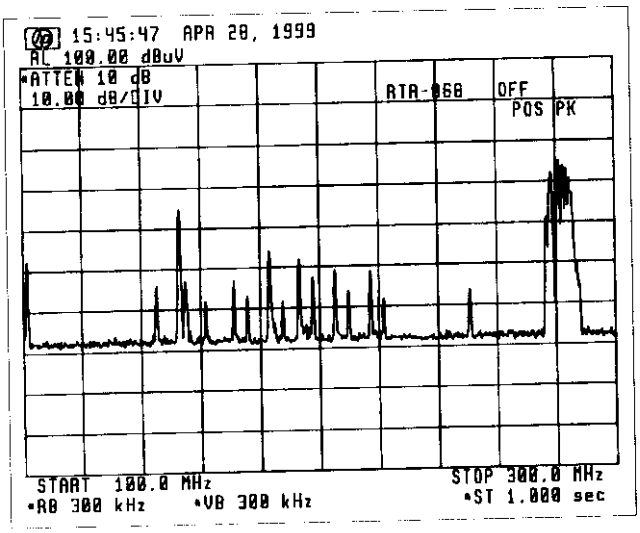


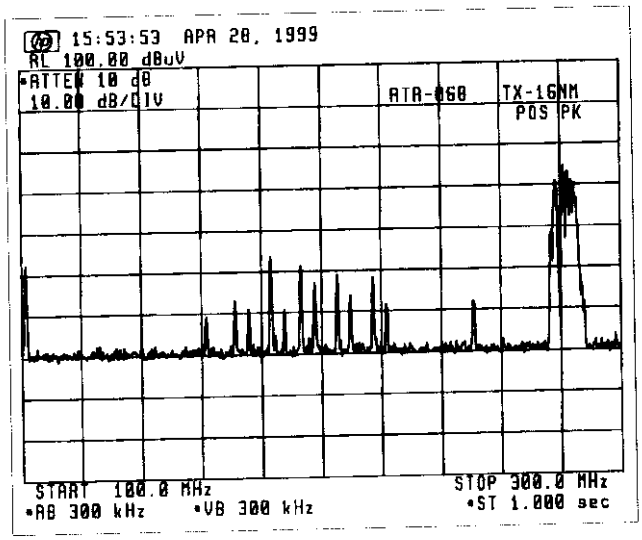
-26 dBμV/m



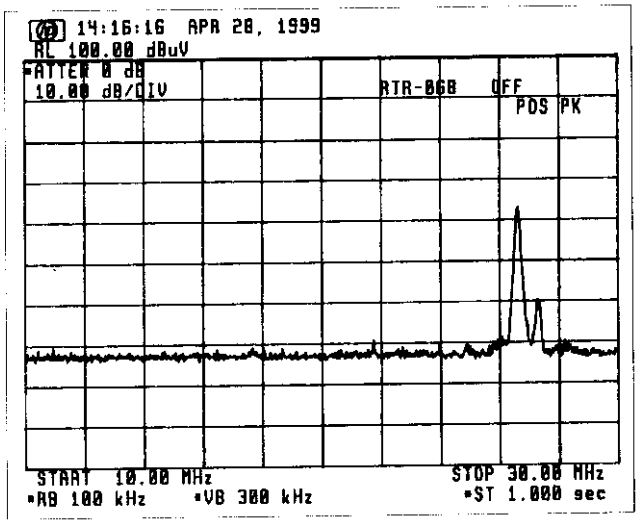
-26 dBμV/m

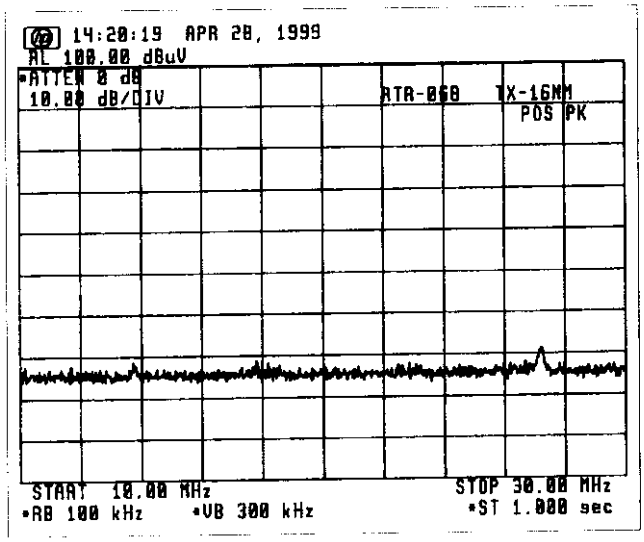
(Band : 100 MHz - 300 MHz)



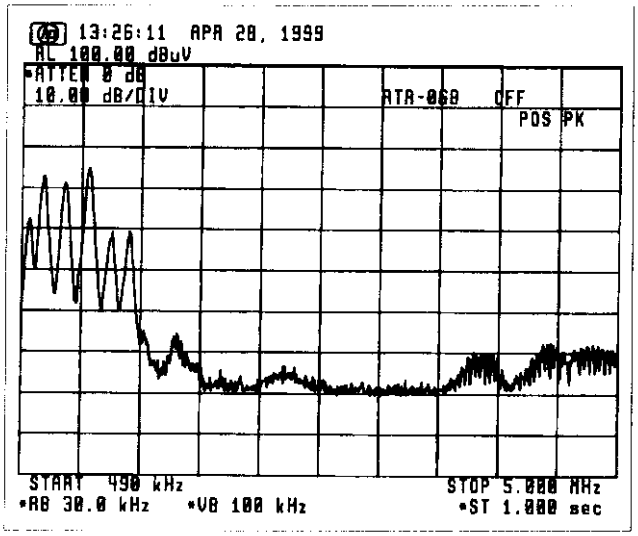


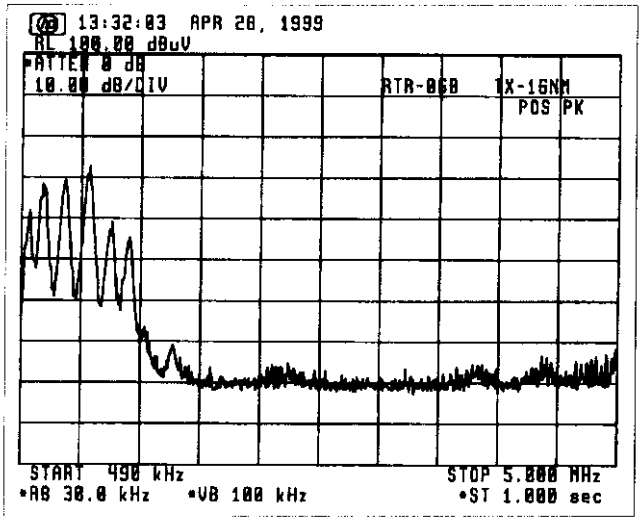
(Band : 10 MHz - 30 MHz)

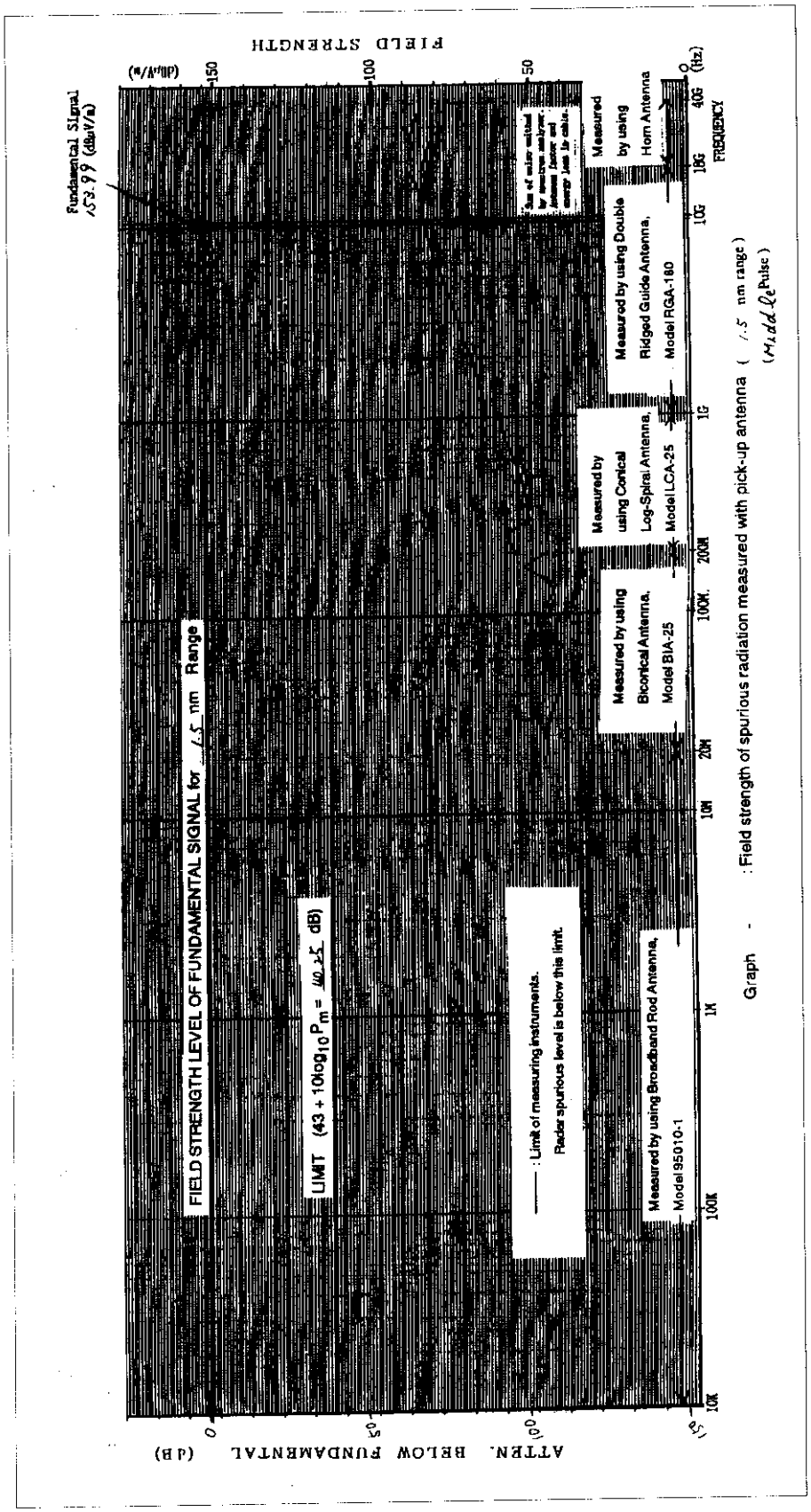




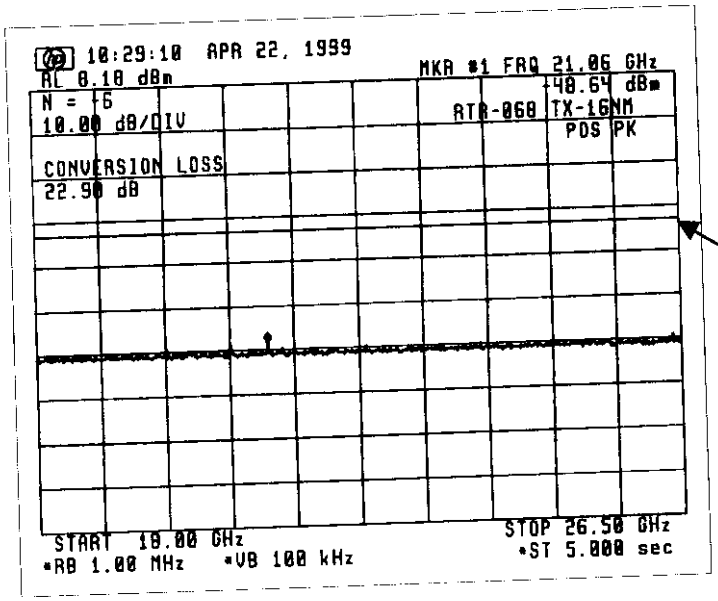
(Band : 490 kHz - 5 MHz)







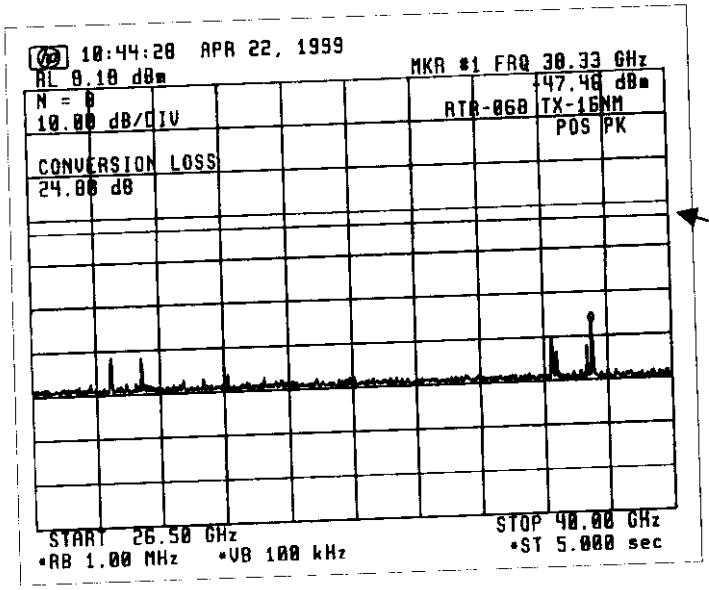
Graph - : Field strength of spurious radiation measured with pick-up antenna (4.5 nm range)
(Model 2e Pulse)



Emission limitations:

(c) 43 + 10 log Pm = 42.62 dB
for more than 250 % of
the authorized BW (100 MHz)

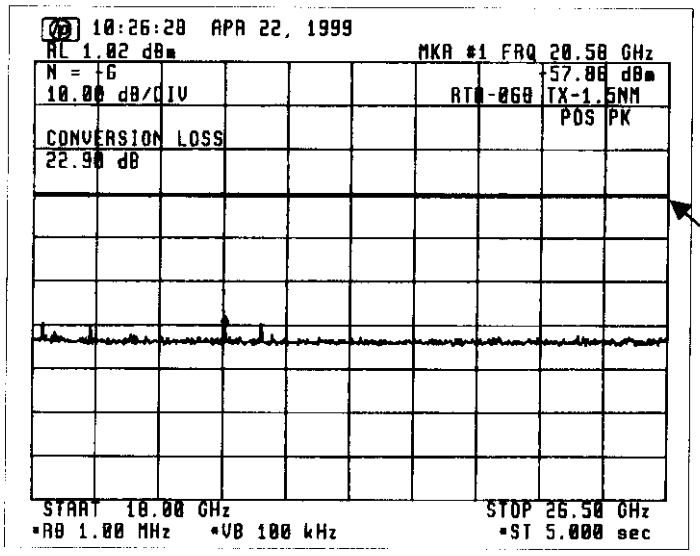
Fig. 3.4 With Filter No. 2



Emission limitations:

(c) 43 + 10 log Pm = 42.62 dB
for more than 250 % of
the authorized BW (100 MHz)

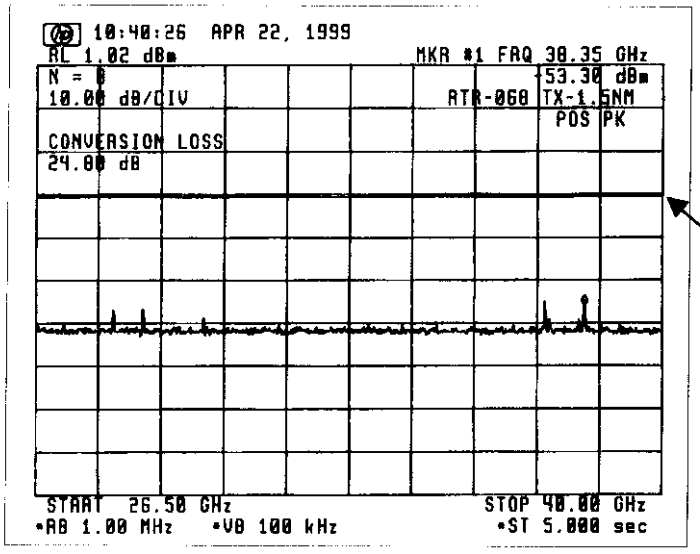
Fig. 3.5 With Filter No. 2



Emission limitations:

(c) 43 + 10 log Pm = 40.25 dB
for more than 250 % of
the authorized BW (100 MHz)

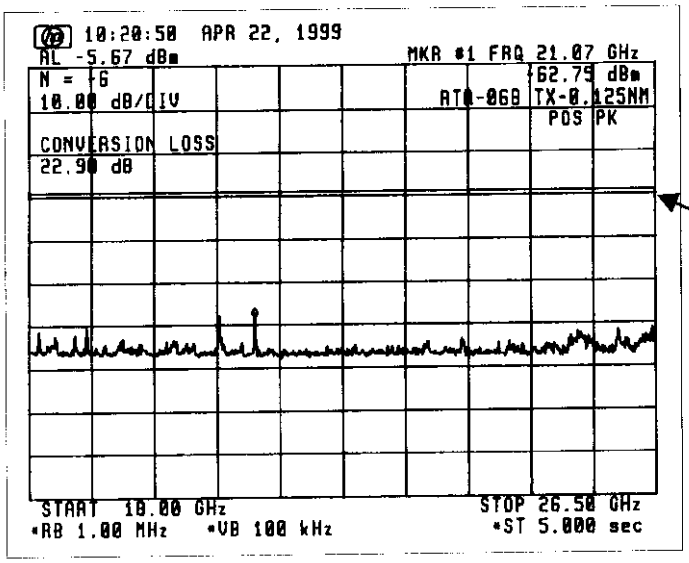
Fig. 2.4 With Filter No. 2



Emission limitations:

(c) 43 + 10 log Pm = 40.25 dB
for more than 250 % of
the authorized BW (100 MHz)

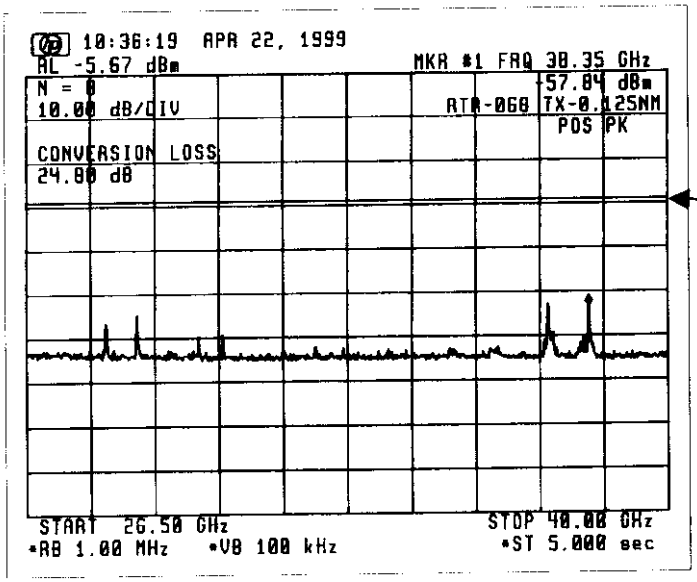
Fig. 2.5 With Filter No. 2



Emission limitations:

(c) 43 + 10 log Pm = 38.74 dB
for more than 250 % of
the authorized BW (100 MHz)

Fig. 1.4 With Filter No. 2



Emission limitations:

(c) 43 + 10 log Pm = 38.74 dB
for more than 250 % of
the authorized BW (100 MHz)

Fig. 1.5 With Filter No. 2

IF Amplifier Block PCB 03P9269

The Converted 60 MHz IF signal is amplified by the IF amplifier, the detected output of which is delivered to the display unit video amplifier. The 60 MHz IF signal from the MIC is fed to the base of Q1 through C1 and C2.

The signal from Q1 is fed to the broad band amplifier U1. The output of U1 is inductively coupled to the second-stage broad band amplifier U2.

Gain/STC signals are applied respectively to U1 pin 5 and U2 pin 14 via the STC circuit. The output of U2 is then coupled to video Amplifier Q4. The video signal is taken from emitter of Q4 through C15 and sent to the display via the video cable.

The IF amplifier block also incorporates an STC circuit. The STC circuit made up of Q2 and Q3 changes the gain of the amplifier in the function of time so that the gain is minimum at the time of transmission and increases gradually to maximum gain with time (range).

The amount of current flowing into Q3 is determined by the time constant of the parallel-series capacitor network consisting of C48, C49, C52, R41, R42 and R44. It gradually decreases as the capacitor are charged. The rate of charge is inversely proportional to "t", the elapsed time after transmission. The current flowing into Q3 is also controlled by the dc potential in addition to the time constant of the capacitor/resistor network.

The time-varying waveform produced at the cathod of CR8 is DC-restored by the STC control voltage (provided from the display) and applied to U1 pin 5 and U2 pin 14. Since it is provided with positive by the gain control potentiometer, it slices the waveform at a certain level and amplifies the rest of the waveform.

U115:	CPU ROM
U117:	Buffer
U118:	Gate Array
U119:	Date Transmission
U121:	OR Gate
U122, U124:	Inverter
U123:	AND Gate
U125:	Clock Generator
U127:	Analogue Switch

PNL Print PCB PNL9194

CR1-CR11:	Backlight LED
CR12:	Input Protection
Q1:	Buzzer Drive
Q2:	LED Drive
Q3:	Amplifier
Q4-Q5:	Switch

11.2 Description of the circuits employed for suppression of spurious radiation, for limiting or shaping the control pulse, and for limiting or controlling power

(FCC Rule § 2.983 (d)-(11))

ANTENNA UNIT

TRANSCEIVER MODULE (RTR-068)

Modulator/Block PCB 03P9270

The primary function of the modulator is to produce narrow high tension pulses to drive the magnetron. To produce such pulses, the modulator block incorporates a modulator trigger circuit, a modulating pulse generator and a booster pulse transformer.

The modulator trigger circuit is composed of U851 and associated components. It generates pulses that fire modulator FET Q857. Normally, the circuit is stable with U851 off. The pulse to fire the modulator FET is produced when U851 turns on upon receiving the TX trigger pulse from the display unit. When U851 turns on at the positive-going edge of the TX trigger pulse, it produces a narrow pulse. This narrow pulse is boosted by pulse transformer T851 by the ratio 1:9. The resultant pulse, its level being 2.2 kV, is provided to oscillate the magnetron.

CR7:	Voltage Limiter (Tuning Indicator)
CR8:	D.C. Blocking (STC)
CR9:	Voltage Slicer (GAIN)
Q1:	IF Amplifier
Q2:	Transistor Switch (STC GATE)
Q3:	Voltage Buffer (GAIN/STC)
Q4:	Video Amplifier
Q5-Q6:	Video Amplifier (Tuning Indicator)
Q7-Q8:	Transistor Switch (Tuning Indicator)
Q9:	Rectifier (Tuning Indicator)
Q10:	IF Amplifier (Tuning Indicator)
U1-U2:	IF Amplifier
U3-U4:	Voltage Regulator

INT Print PCB 03P9271

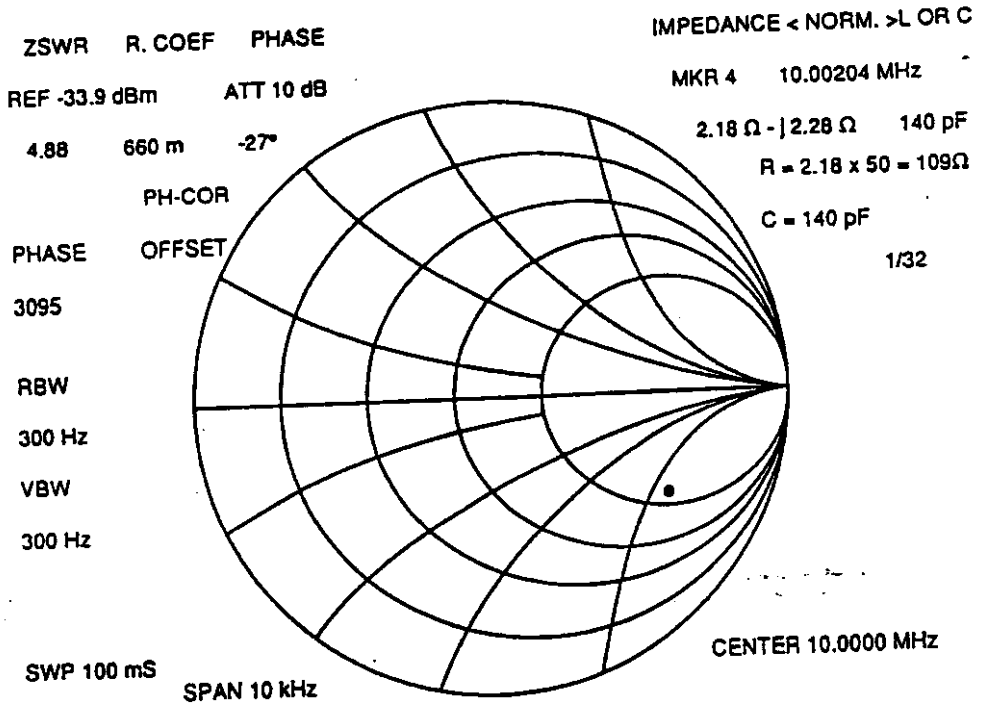
CR2:	Voltage Limiter
CR3-CR6:	Transient Suppression
CR7:	DC Blocking
CR8:	Reverse Polarity Protector Diode
Q1, Q11-Q13:	Transistor Switch
Q2:	Video Amplifier
Q3-Q10:	Current Buffer
Q14-Q16:	Voltage Buffer
U1:	Transmit/Receive Control
U2:	Reset Block
U3:	Control Signal Generator
U4:	Video Amplifier
U5:	CPU
U6:	Clock Generator
U7:	D/A Converter

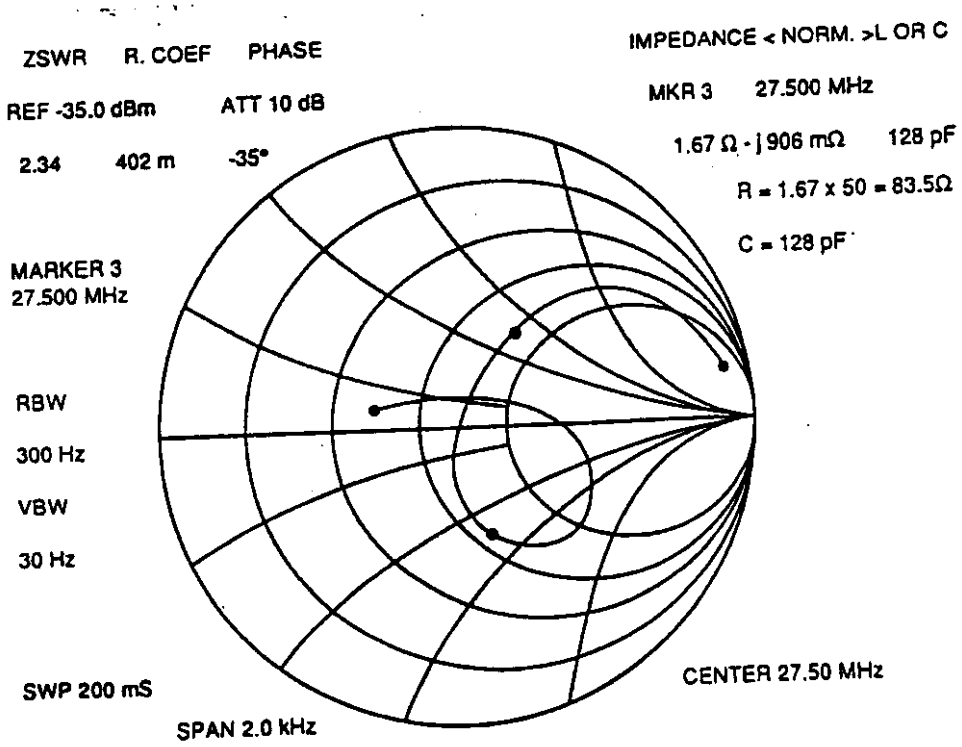
Display Unit

DU Print PCB 03P9268

CR1:	Reverse Polarity Protection Diode
CR2:	Voltage Regulator
CR3-CR4:	Input Protection

MEASUREMENT OF IMPEDANCE OF TEST ANTENNAS





9 SUPPRESSION OF INTERFERENCE ABOARD SHIPS (FCC Rule § 80.217)

9.1 Measuring Antenna Characteristics at Representative Frequencies:

Whip antennas are used to determine the level of interference caused by the radar to shipboard receivers. These antennas have the following characteristics (refer to impedance charts attached):

Length	Test Frequency (Hz)	Impedance (Ω)	θ	R (Ω)	C or L
6 m	500.5 k	1 k	-90 °	0	80 pF
6 m	1.992 M	1.25 k	-86 °	87.2	64 pF
6 m	10.00204 M	158		109	140 pF
4 m	27.5 M	95		83.5	128 pF
5/8_	150 M	116.5		105.5	52.5 nH
1/4_	450 M	70.5		34.5	5.68 pF

9.2 Test Site:

Rooftop of 6-story building,
Furuno Electric Company, Ltd.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 JAPAN

9.3 Measuring Instrument List:

See ATTACHMENT 4 [LIST OF TEST/MEASURING EQUIPMENT].
(Instruments for mesuring antenna characteristics are listed below.)

(1) RF Vector Impedance Meter, HP 4815A
(2) Spectrum Analyzer, ADVANTEST TR4172
(3) Spectrum Analyzer, HP 8566B
(4) Antennas,
for 14 k - 10 MHz, 6 m whip
for 10 - 30 MHz, 4 m whip
for 30 - 300 MHz, VHF whip
for 300 - 1000 MHz, UHF whip

8.4 Frequency Tolerance Limits:

"The frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized band width, where "T" is the pulse duration in microseconds. "
(FCC Rule § 80.209)

1) Center frequency (f_0): 9410 MHz

2) Authorized bandwidth (f(AUBW)): 100 MHz

"Upper limit frequency of the authorized band", f(UAUBW) = f_0 + f(AUBW)/2 = 9460 MHz

"Lower limit frequency of the authorized band", f(LAUBW) = f_0 - f(AUBW)/2 = 9360 MHz

3) Assignable frequency bandwidth : 200 MHz (between 9300 MHz and 9500 MHz)
(FCC Rule § 80.375 (d)-(1))

"Upper limit frequency of the assignable band", f(UASB) = 9500 MHz

"Lower limit frequency of the assignable band", f(LASB) = 9300 MHz

4) Guard Band (f(1.5/T)) :

Pulselength	Short	Middle	Long
Range Scale (nm)	0.125	1.5	16
Pulselength (μsec)	0.08	0.30	0.80
Guard Band f(1.5/T) (MHz)	18.75	5.00	1.88

8.5 Test Results:

Shown on Fig. 8.2.

(1) "Upper Tolerance Frequency measured (at - 20 ℃)", f(U) = 9397.0 MHz

(2) "Lower Tolerance Frequency measured (at + 50 ℃)", f(L) = 9389.4 MHz

(3)-(a)

f(U) + max. f(1.5/T) = 9415.75 MHz < f(UAUBW) = 9460 MHz $\leqq$ f(UASB) = 9500 MHz

(3) - (b)

f(L) - max. f(1.5/T) =9370.625 MHz > f(LAUBW) = 9360 MHz $\geqq$ f(LASB) = 9300 MHz

So, both are found within the specified limits.

Frequency removed from the assigned frequency	Frequency (MHz)	Emission attenuation (mean power, dB)
	9,660 - 40,000	At least 43 + 10 log $_{10}$ (mean power in watts)

Note : (1) Assigned frequency (center frequency) = 9410 MHz

(2) Authorized bandwidth = 100 MHz

7.8 Test Results:

As shown in ATTACHMENT 2, the field strengths of spurious radiation generated by EUT are found lower than the specified limits.

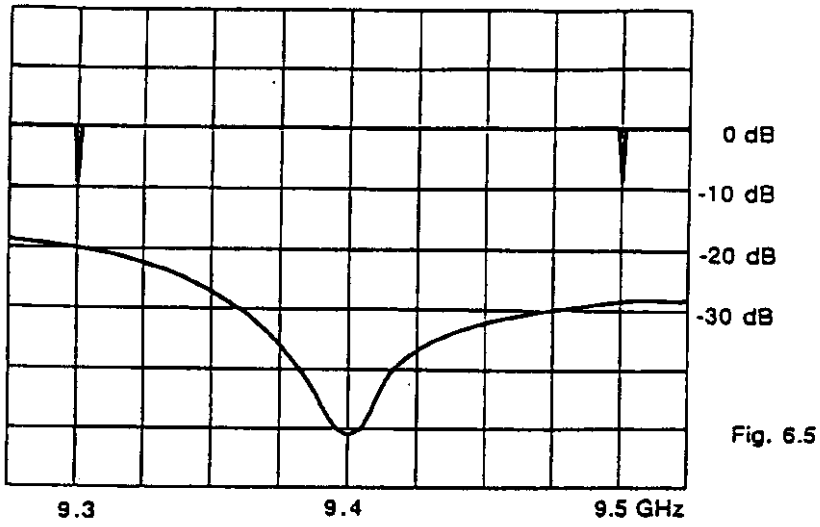
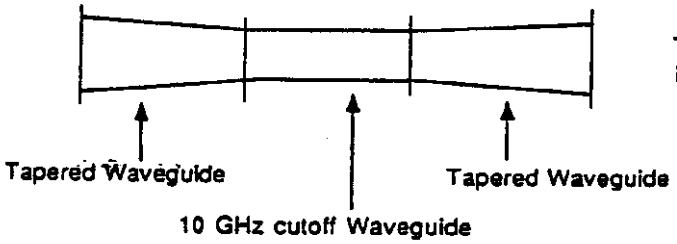


Fig. 6.5

Characteristic of Filter No. 2 (for X-band)



This filter is used to filter out the high level fundamental signal to avoid damage to the analyzer.

High Pass Filter Construction

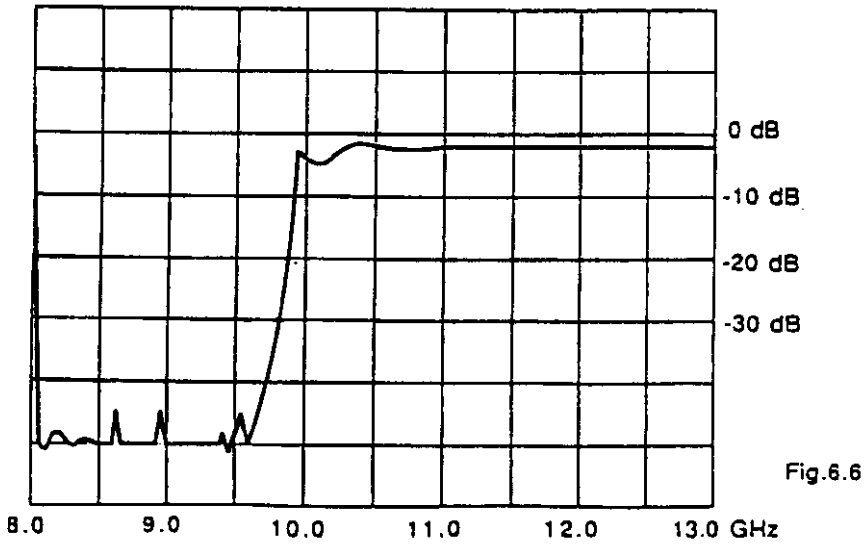


Fig.6.6

6.3 Test Conditions:

Radar Range Settings: 0.125 nm (Short)/1.5 nm (Middle)/ 16 nm (Long)

6.4 Emission Limits:

(a) Frequency Range (FCC Rule §2.997) : 10 kHz - 40 GHz

(b) Emission Limits (FCC Rule §80.211) :

Frequency removed from the assigned frequency	Frequency (Hz)	Emission attenuation (mean power ,dB)
50 - 100 % (of the authorized bandwidth)	9310 - 9360 M 9460 - 9510 M	At least 25
100 - 250 %	9160 - 9310 M 9510 - 9660M	At least 35
more than 250 %	10 k - 9160M 9660- 40,000 M	At least 43 + 10 $\log_{10}$ (mean power in watts)

Note : (1) Assigned frequency (center frequency) = 9410 MHz

(2) Authorized bandwidth = 100 MHz

6.5 Test Results:

As shown in ATTACHMENT 1, the spurious emissions at antenna terminal of EUT are found lower than the specified limits.

(Note: Spurious emissions for 10 kHz to 5 GHz are not found due to the antenna terminal structure. (wave guide tube)).

5.2 Test Equipment Setup:

Same as Clause 6.1.

5.3 Measuring Equipment List:

Same as Clause 6.2.

5.4 Test Result:

The test result is shown below.

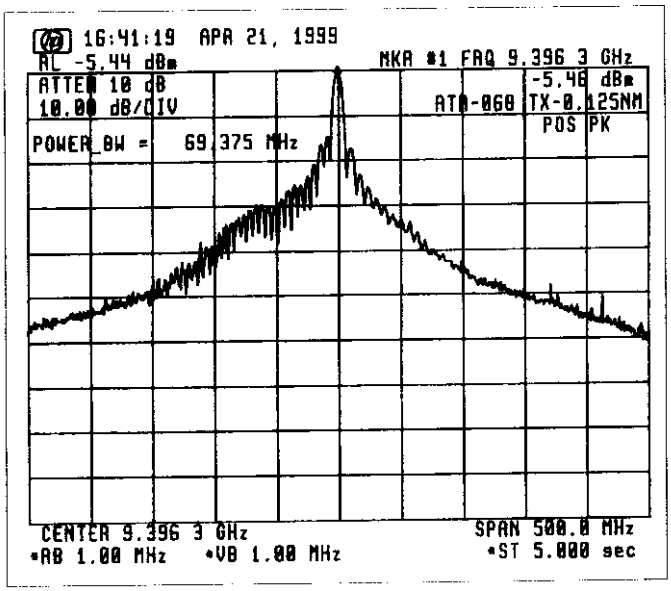


Fig. 5.2 Measurement of Occupied Bandwidth

Occupied bandwidth = 69.375 MHz

4.4 Radar Pulse Spectrum:

Measured by the spectrum analyzer.

(Test Equipment Setup and Measuring Equipment List are same as Clause 6.1 and 6.2.)

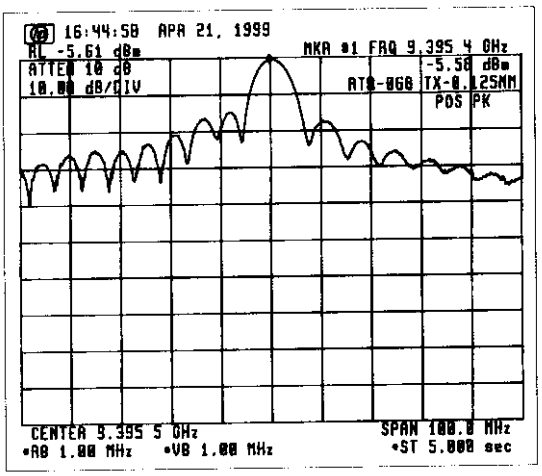


Fig. 4.4.1 For Short Pulse (0.125 nm Range)

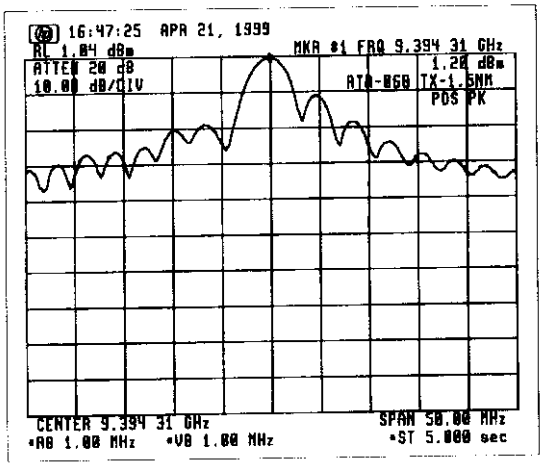


Fig. 4.4.2 For Middle Pulse (1.5 nm Range)

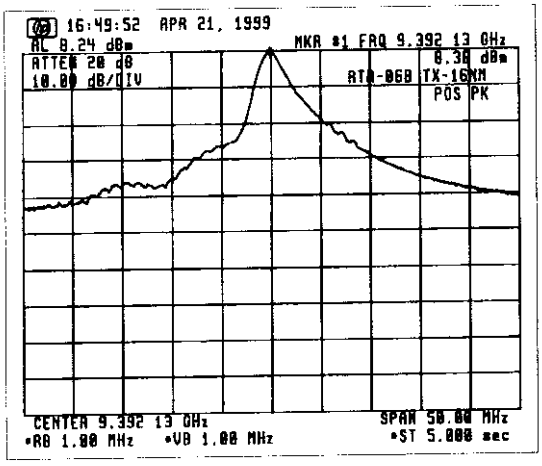


Fig. 4.4.3 For Long Pulse (16 nm Range)

4.3 **Magnetron Output** (detected):

4.3.1 Setup for Measurement:

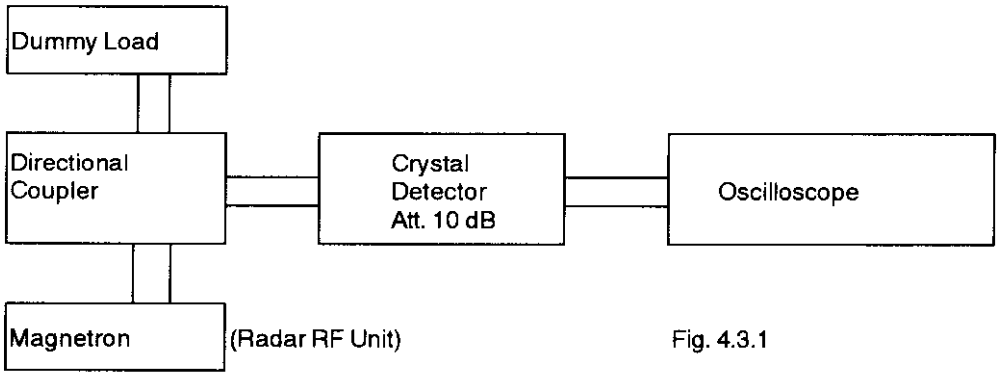


Fig. 4.3.1

4.3.2 Measuring Equipment List:

See ATTACHMENT 4 [LIST OF TEST/MEASURING EQUIPMENT].

4 MODULATION CHARACTERISTICS (FCC Rule § 2.987)

4.1 FET Trigger Pulse

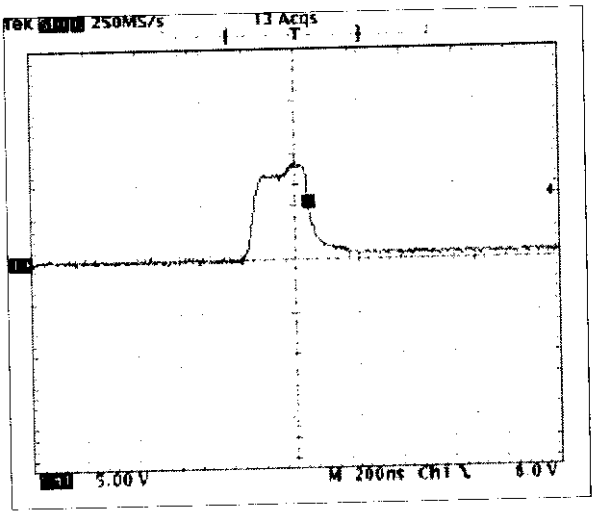


Fig. 4.1.1 Typical waveform of Trigger Pulse Scale: 5 V/div., 200 ns/div.

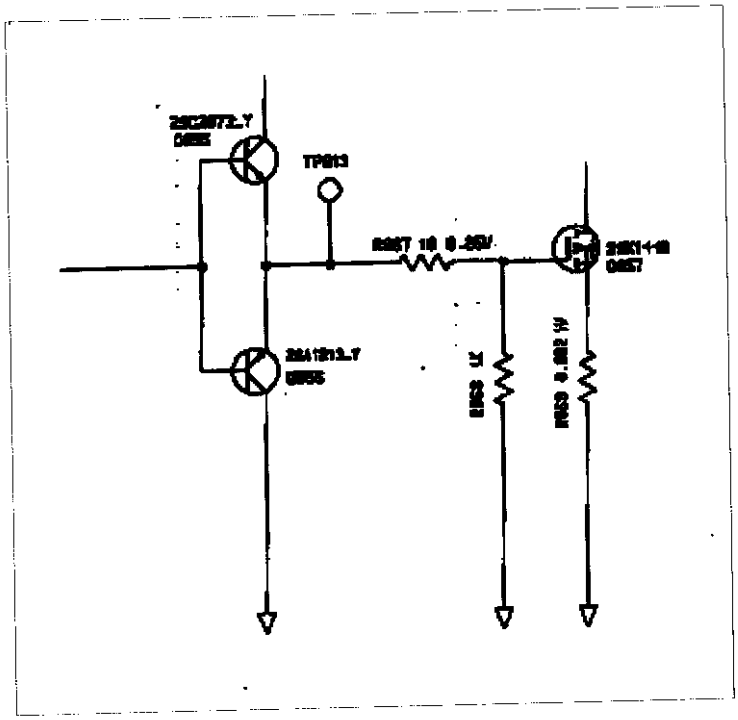


Fig. 4.1.2 Test Point for Trigger Pulse
(in MD board (03P9270) of Radar Antenna Unit)

Magnetron input pulse current

Magnetron input pulse current was observed across the wideband current transformer with output voltage per ampere 1.00.

Pulselength	Short	Middle	Long
Magnetron input current (A)	1.50	1.95	2.20
Pulselength (µs) (50 % amplitude)	0.120	0.267	0.798
Rise time (µs) (10-90 % amplitude)	0.073	0.195	0.244
Decay time (µs) (90-10 % amplitude)	0.090	0.104	0.108

RF envelope of the magnetron output pulse

The RF envelope of the magnetron output pulse was measured using a diode and the oscilloscope with the following results:

Pulselength	Short	Middle	Long
Pulselength (µs) (-3 dB points)	0.134	0.274	0.800
Rise time (µs) (10-90 % amplitude)	0.043	0.107	0.180
Decay time (µs) (90-10 % amplitude)	0.093	0.108	0.116

Estimated efficiency

The estimated efficiency of the RF generator (magnetron) was determined by the following measurements and calculation. Power output from magnetron was measured using the directional coupler, power meter and the oscilloscope.

Pulselength	Short	Middle	Long
Range scale (nm)	0.125	1.5	16
P.R.R (Hz)	2129.9	1190.3	595.1
Duty cycle	2.85×10^{-4}	3.26×10^{-4}	4.76×10^{-4}
Magnetron input, av. (W)	1.01	1.49	2.48
Magnetron input, peak (kW)	3.53	4.58	5.21

2 IDENTIFICATION OF EQUIPMENT (FCC Rule §2.925)

The following nameplates are permanently fixed on the corresponding equipment units.

FCC ID: ADB9ZWRTR068

Material of nameplate: Polyester film, 0.1 mm thick

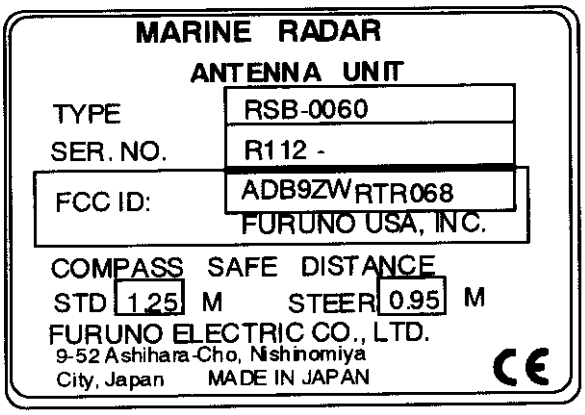


Fig. 2.1 Nameplate for Antenna Unit

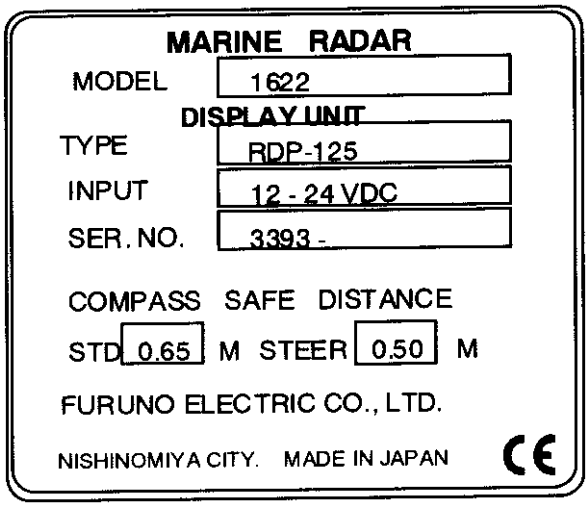


Fig. 2.2 Nameplate for Display Unit

STC control	Gain control	Panel dimmer [2]
Heading line off	Echo stretch [2]	MENU
Guard zone set/Audio alarm off		Range ring on/off
Interference rejector [2]	ST-BY/TX	Arrow keys (VRM/EBL/GUARD)
VRM on/off	SHIFT	Range set [2]
Zoom	EBL on/off	Echo Trail
Contrast	PLOT brilliance [2]	Navigation on/off [1),2)]
Anchor watch [2]	Display brilliance	

1) Valid when interfaced with navaid

2) Selected on menu

1.5 Operational Features

(a) Is positive means provided to indicate whether or not the overall operation of the equipment is such that it may be relied upon to provide effective operation in accordance with its primary function:

Magnetron/Xtal checker

(b) Is the equipment for continuous operation: Yes

(c) Is provision made for operation with shore based radar beacons (RACONS):

Yes (RACONS and SART)

1.6 Line Power Supply Requirements

(a) Input Voltage: 12 - 24 VDC

(b) Power Drain: 35 W

1.7 Construction Features

(a) Does equipment embody replacement units with chassis type assembly: Yes

(b) Are fuse alarms provided: Fuses are provided.

(c) State units that are weatherproof: Antenna Unit (IEC 60529 - IPX6)

(d) If all units are not housed in a single container, indicate number and give description of individual units:

1 × Display Unit	Type:	RDP-125
1 × Antenna Unit	Type:	RSB-0060 (24 rpm)
Transceiver	Type:	RTR-068 (contained in the Antenna unit)

(e) Approximate Weight of Complete Installation:

(b) Gain (overall) (dB): Sufficient to cause limiting, approximately 130

(c) Overall Noise Figure (dB): 10 (typical)

(d) Video Output Voltage (V): 5 V positive

(e) Features Provided:

Sensitivity Time Controls (Anti-clutter Sea),

Fast Time Constant (Anti-clutter Rain)

(f) If receiver is tunable, describe method of adjusting frequency:

Adjustment of tuning voltage of receiver local oscillator

(Automatic and manual)

1.2.2 Antenna

(a) Antenna Rotation ON-OFF Switch:

Not Provided.

(b) Reflector: Microstrip antenna

(c) Type of Beam: Vertical fan

(d) Beam Width (between half-Radiator power points)

Horizontal	6.20 °
Vertical	25 °

(e) Polarization: Horizontal

(f) Antenna Gain: 20.0 dB

(g) Attenuation of Major Side Lobes with respect to main beam:

Within ±20 °	-20 dB or less
Outside ±20 °	-25 dB or less

(h) Scanning (rotating or oscillating):

Rotating over 360 ° continuously clockwise

(i) Antenna Rotation Rate: 24 rpm

(j) Number of Degrees Scanned: 360 °

(k) Sector Scan: Not provided.

(l) Type of Transmission System: Contained in scanner unit

(m) Rated Loss of Transmission System per hundred feet:

None. Transmission path is only in the antenna scanner unit.

1 GENERAL INFORMATION

1.1 General

(a) Manufacturer: Furuno Electric Co., Ltd.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan

(b) Model: MODEL 1622
Serial no.: 3393-0002

(c) Primary Function: Search, Navigation and anticollison

(d) Discrimination

Range Discrimination: 25 meters on a range scale of 1.5 nm

Bearing Discrimination: 6.20° on a range scale of 1.5 nm

(e) Minimum Range: 37 meters on a range scale of 0.25 nm

(f) Frequency Range: Fixed frequency, X-band
Type of Emission: P0N

(g) Power Supply: 12 - 24 VDC

1.2 Antenna Unit

1.2.1 Transceiver

Type: RTR-068

(1) Transmitter

(a) Assignable Frequency for Shipborne Radar:
Between 9300 and 9500 MHz (FCC Rule § 80.375 (d)-(1))

(b) Type of RF Generator
Magnetron Type: E3588
Peak Output Power: 2 kW nominal

(c) Magnetron Ratings
Center frequency of Magnetron: 9410 MHz
Tolerances

	E3588
Manufacturing:	±30 MHz
Pulling:	27 MHz

Tolerance for 20 ° C temperature variation: -5 MHz

(d) Guard Band:

Guard Band is specified to be equal to 1.5/T MHz, where "T" is the pulselength in microseconds. See para (e). (FCC Rule § 80.209)