

FURUNO


OPERATOR'S MANUAL

MARINE RADAR

MODEL FR-8100D/8100DA



FURUNO ELECTRIC CO., LTD.
NISHINOMIYA, JAPAN

 **FURUNO ELECTRIC CO., LTD.**

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YOUR LOCAL AGENT/DEALER

WARNING AGAINST HIGH TENSION

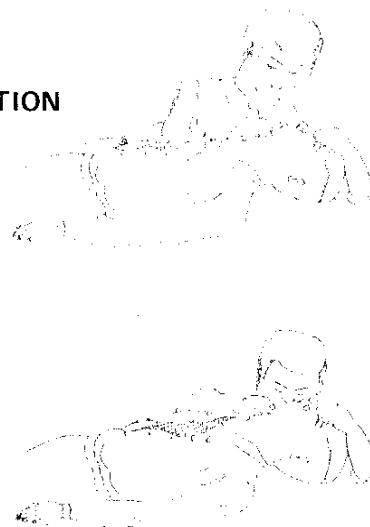
The operation of this equipment involves the use of high voltage, which endangers human life. Although the design of the equipment has been made in due consideration of measures to insure the operator's safety, adequate precaution must be exercised when reaching inside the equipment for the purpose of maintenance and service. Do not change a component or inspect the equipment with the voltage applied. A residual charge may exist in some capacitors with the equipment turned off. Always short all supply lines to the chassis with an insulated screwdriver or a similar tool prior to touching the circuit.

FIRST AID IN CASE OF ELECTRIC SHOCK

When a victim struck by electricity is found, first switch off the equipment via the main switch on the equipment or the ship's distribution board. If this is not possible, protect yourself with dry insulating material (a wooden plate or rod, cloth, your belt, etc.) and pull the victim clear of electricity. If the victim is not breathing himself, apply artificial respiration according to the "Method of Artificial Respiration". Do not give up halfway. Perseverance and continual efforts are important in artificial respiration.

METHOD OF ARTIFICIAL RESPIRATION

Lay the victim on his back. Position yourself beside the victim's head and pinch his nose by your thumb and forefinger to prevent air leakage. Insert the thumb of your other hand between the victim's teeth and lift his chin up. Then, place the arm (the one closing the victim's nose) on the victim's forehead and press the head down so that the victim's head is given a maximum backward tilt with the chin prominent and the neck bent back. Seal the victim's mouth with your mouth and blow therein about half of the deeply inhaled air every time. After exhaling, turn your head to watch for a chest contraction, whilst inhaling deeply in readiness for the next blowing. Repeat the movements faster for the first 1 to 2 minutes and 12 times per minute thereafter.



WORK ON THE SCANNER UNIT

In many cases an incidental accident worsens a casualty of electric shock. Secure a solid foothold when working at an elevated spot. Remove the scanner fuse or take other adequate safety measures before going to the scanner unit to prevent a third man from rotating the scanner.

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SPECIFICATIONS

1. SCANNER UNIT

1. Radiator Length:	123cm	200cm	200cm	240cm**
2. Radiator Type:	XN-2	XN-3	XN-3A	XN-4A
3. Horizontal Beamwidth:	1.80°	1.23°	1.23°	0.95°
4. Vertical Beamwidth:	25°	25°	20°	20°
5. Sidelobe Attenuation: within + 10° of mainlobe (+ 20° for 123cm antenna)	-24dB	-24dB	-28dB	-28dB
outside + 10° of mainlobe: (+ 20° for 123cm antenna)	-30dB	-30dB	-32dB	-32dB

** Power supply must be 24VDC for 240cm antenna.

6. Polarization:	Horizontal
7. Antenna Rotation:	24 rpm nominal (no wind load)
8. Wind Load:	Relative wind 51.5 m/s (100kts)

2. TRANSCEIVER UNIT

1. Transmitting Tube:	Magnetron
2. Frequency and Modulation:	9410MHz ± 30MHz, PON (X-band)
3. Peak Output Power:	10kW
4. Pulselength & Pulse Repetition Rate:	

Pulselength	Pulse Rep. Rate (Hz)	Range (nm)									
		0.25	0.5	0.75	1.5	3	6	12	24	48	72
Short (SP) 0.08us	approx. 2100Hz	0.08us									
Middle 1 (MP1) 0.3us	"	0.3us									
Middle 2 (MP2) 0.6us	approx. 1200Hz	0.6us									
Long (LP) 1.2us	approx. 600Hz	1.2us									

5. Modulator:	SCR line Type Pulse Modulator
6. IF:	60MHz
7. Tuning:	Manual, with tuning marker
8. Receiver Front End:	MIC (Microwave IC)
9. Bandwidth:	FR-8100D FR-8100DA
Short/Mid.1 pulse	13MHz 7MHz
Mid.2/Long pulse	3MHz 3MHz
10. Duplexer:	Circulator and Limiter
11. Noise Figure:	6dB nominal

3. DISPLAY UNIT

1. Indication System: PPI, daylight display
 2. Picture Tube: 12" rectangular CRT

3. Range (nm):	0.25	0.5	0.75	1.5	3	6	12	24	48	72
4. Range Ring Interval (nm):	0.05	0.1	0.25	0.25	0.5	1	2	4	8	12
5. Number of Rings:	5	5	3	6	6	6	6	6	6	6

6. Display Mode:
 1) Head-up "HU"
 2) Course-up "CU" *
 3) North-up "NU" *
 4) Head Set "HS" **
 * gyrocompass required
 ** when no gyro is connected
7. Bearing Resolution:
 better than 2.3° ; radiator XN-2
 " 1.73°; radiator XN-3
 " 1.73°; radiator XN-3A
 " 1.45°; radiator XN-4A
8. Bearing Accuracy: better than +1.0°
 9. Range Discrimination: 20m on 0.25nm scale
 10. VRM/Range Ring Accuracy: 0.9% or 8m, whichever is greater
11. Marks:
 Heading Mark, North Mark*, Bearing Scale, Range Ring, VRM1 & VRM2, EBL1 & EBL2, Tuning Marker, Guard Zone.
12. Numeral/Character Indication:
 Range in Use, Range Ring Interval, Display Mode (HU, NU*, CU*, HS**), Pulselength (SP, MP1, MP2, LP), Interference Rejector (IR), Alarm (GUARD), GYRO*, Echo Stretch (ES), EBL, EBL Bearing Mode (R, T*), VRM, Echo Average (EAV1, EAV2, EAV3), ZOOM, A/C Rain (FTC), Protting Time.
 * gyrocompass required
 ** when no gyro is connected
13. Echo Trail: Continuous (max. 99min 59sec), 30sec, 1min, 3min or 6min
14. Interference Rejector: Built in
 15. Off-center Display: Built in
 16. Zoom Function: Selected area is doubled in size (not activated when off-centering)
17. Alarm Function: Built in
 18. Echo Average: Correlates echo scan-to-scan
 19. Echo Stretch: Enhances echo on mid/long ranges
 20. Floating EBL: Measures range and bearing between any two targets

4. ENVIRONMENTAL CONDITIONS

1. Vibration:

Total Amplitude	Vibration Cycle
+ 1.6mm	1 to 12.5Hz
+ 0.38mm	12.5 to 25Hz
+ 0.10mm	25 to 50Hz

2. Ambient Temperature:

Scanner Unit ----- -25°C to +70°C

Display Unit ----- -15°C to +55°C

3. Humidity:

Relative Humidity 95% at +40°C

5. POWER REQUIREMENTS

12/24/32VDC, 90W (24VDC), only 24VDC mains can be used for 240cm antenna.
100/110/115/220/230VAC, 180VA (100V), 50-60 Hz, 1ø (rectifier required)

6. COLOR

Scanner Unit:

Munsell N9.5

Display Unit:

2.5GY-5/1.5 Embossed T25 (Cabinet)

N3.0 Newton No.5 (Control Panel)

COMPLETE SET

No.	Name	Type	Q'ty	Wt.(kg)	Remarks
1	Scanner Unit	XN2-C2P7N2N-014(A)	1	33.0	123cm
		XN3-C2P7N2N-014(A)		37.5	200cm
		XN3A-C2P7N2N-014(A)		36.5	200cm oval-type
		XN4A-C2P7N2N-014(A)		38.5	240cm oval-type
2	Display Unit	RDP-067	1	19	
3	Accessories	FP03-03000	1 set		
4	Installation Materials	CP03-01210	1 set		for Display Unit
		CP03-00820	1 set		for Scanner Unit
	CP03-00300(15m)	S03-4-15 (15m) S03-4-20 (20m) S03-4-25 (25m) S03-4-30 (30m)	1		Cable specify length
	CP03-00320(20m)				
	CP03-00330(25m)				
CP03-00340(30m)					
5	Spare Parts	SP03-04200	1 set		

ACCESSORIES

No.	Name	Type	Code No.	Q'ty	Remarks
1	Vinyl Cover	03-034-0401-0	000-801-657	1	
2	Hood Assembly	FP03-02910	008-223-520	1	
3	Filter	FP03-02920	008-224-760	1	

SPARE PARTS

No.	Name	Type	Code No.	Q'ty	Remarks
1	Fuse	UL-TSC 2A 125V	000-101-132	3	Display Unit
2	Fuse	FGBO 25A 125VAC	000-549-016	2	"
3	Fuse	FGBO 0.5A 125VAC	000-549-060	2	"
4	Fuse	FGBO-A 5A 125VAC	000-549-064	2	"
5	Fuse	FGBO 10A 125VAC	000-549-065	2	"
6	Carbon Brush	MG120-5x6x11 (for scanner motor)	000-631-716	2	Scanner Unit
7	L-handle Socket Wrench	M8 use, 13mm diagonal	000-830-110	1	"
8	Hex. Wrench	1.5mm diagonal	000-830-112	1	Display Unit
9	Label (1)	03-011-1051-0	301-110-510	1	Tabletop mount
10	Label (2)	03-011-1052-0	301-110-520	1	Bulkhead mount
11	Spare Parts Box	for F710	000-831-610	1	

OPTION

No.	Name	Type	Code No.	Remarks
1	External Buzzer	OP03-21	000-030-097	
2	Video Plotter	RP-3		
3	Rectifier Unit	RU-1746B-2	000-030-439 000-030-440	for 110VAC for 220VAC
4	A-D Converter	AD-10S		
5	Interswitch Unit	RJ-2		
6	Radar Slave Display	FMD-800		
7	Radar Color Display	CD-140/141		
8	Power Cable	P03-1-15 (15m)	000-560-634	CVVS-8x2C
9	Signal Cable Assy.	S03-15-5 (5m)	008-100-360	for nav. data

INSTALLATION MATERIALS

Display Unit

No.	Name	Type	Code No.	Q'ty	Remarks
1	Crimp-on Lug	8NK4	000-538-180	6	power cable connection
2	Crimp-on Lug	FV2-4 blue	000-538-118	4	rectifier
3	Hexagon Nut	M3 C2700W MBNI2	000-863-204	2	for fixing signal cable connector to DJ-1
4	Flat Washer	M3 C2600P MBNI2	000-864-104	2	
5	Spring Washer	C5191W MBNI2	000-864-204	2	
6	NH Connector Assembly	03-302(4P)	008-300-570	1	gyro signal input

Signal Cable

No.	Name	Type	Code No.	Q'ty	Remarks
1	Signal Cable Assembly	S03-4-15 (15m) S03-4-20 (20m) S03-4-25 (25m) S03-4-30 (30m)	008-299-230 008-299-280 008-299-260 008-299-270	1	Select one

Scanner Unit

No.	Name	Type	Code No.	Q'ty	Remarks
1	Crimp-on Lug	FV2-4 blue	000-538-118	1	for inner shield of signal cable
2	Crimp-on Lug	FV1.25-L3 red	000-538-111	29	for core of signal cable
3	Crimp-on Lug	320882 red	000-537-110	1	coax. cable
4	Hexagon Bolt	M12x60 SUS304	000-862-191	4	Scanner Unit installation
5	Hexagon Nut	M12 SUS304	000-863-112	4	
6	Flat Washer	M12 SUS304	000-864-132	4	
7	Spring Washer	M12 SUS304	000-864-263	4	
8	Seal Washer	03-001-3002-0	300-130-020	4	
9	Corrosion-proof Rubber (1) Mat	03-001-3001-0	300-130-010	1	
10	Ground wire	RW-4747	000-566-000	1	for grounding Scanner Unit
11	Hexagon Bolt	M6x25 SUS304	000-862-180	1	earth bolt use
12	Hexagon Nut	M6 SUS304	000-863-109	1	
13	Flat Washer	M6 SUS304	000-864-129	3	
14	Spring Washer	M6 SUS304	000-864-260	1	

Radiator (Refer to pages 5-10 and 5-11.)

No.	Name	Type	Code No.	Quantity		
				*1	*2	*3
1	Hexagon Nut	M8 SUS304	000-863-110	4	6	4
2	Hexagon Bolt w/split pin	M8x30 SUS304	000-862-151	4	6	4
3	Hexagon Bolt w/split pin	M8x25 SUS304	000-862-149	4	-	4
4	Spring Washer	M8 SUS304	000-864-262	8	6	8
5	Flat Washer	M8 SUS304	000-864-130	12		
6	Hexagon Bolt	M4x16 SUS304	000-862-113	8	-	-
7	Hexagon Screw B w/split pin	M4x16 SUS304	000-882-042	-	8	8
8	Hexagon Screw A w/split pin	M6x25 SUS304	000-881-923	-	6	-
9	Hexagon Bolt w/split pin	M4x30 SUS304	000-862-116	-	-	2
10	Spring Washer	M4 SUS304	000-864-256	8	-	2
11	Flat Washer	M4 SUS304	000-864-126	8	-	2
12	O-ring	AS568-125	000-851-840	2		
13	Three Bond	1211 (50g)	000-854-118	1		
14	Waveguide Clamp (1) E type	RSB-2006-1	360-220-061	-	1	1
15	Waveguide Packing (1)	RSB-2008-0	360-220-080	-	1	-
		03-003-4003-0	300-340-030	-	-	1
16	Washer	RSG-1002-0	360-710-020	-	6	-
17	Hexagon Screw B w/split pin	M4x25 SUS304	000-882-043	-	2	-

*1 123 cm (XN-2 scanner)

*2 200 cm (XN-3 scanner)

*3 200/240 cm (XN-3A/XN-4A scanner)

CHAPTER 1 OPERATION

GENERAL

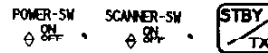
This radar is equipped with numerous functions which help the operator assess marine traffic and fishing conditions (location of floats, etc.) These functions are, however, easy to access. If you change a control setting you will see the associated reaction almost immediately on the screen. Key entry is confirmed by a beep tone, while three beeps in succession alert wrong use of key. The location of each control and touchpad and the arrangement of legends, markers, etc. on the screen are given on page 1-15.

CAUTION

1. Prior to switching on the radar, make sure that no person nor obstacle is in the vicinity of the scanner unit.
2. Because of hazardous radar energy, NEVER look into the beam of a transmitting scanner radiator at close distance.

BASIC OPERATION

Turning the Power On / Transmitting the Radar



After having confirmed that there are no obstructions around the scanner, turn the POWER and SCANNER switches to ON. DIP switch settings, program no., results of the ROM & RAM checks, total on time, total TX time, and the 3-minute timer are displayed. The 3-minute timer (magnetron warming up time) begins counting down from 3:00 to 0:00, whereupon it changes to "ST-BY," indicating the radar is ready to transmit.

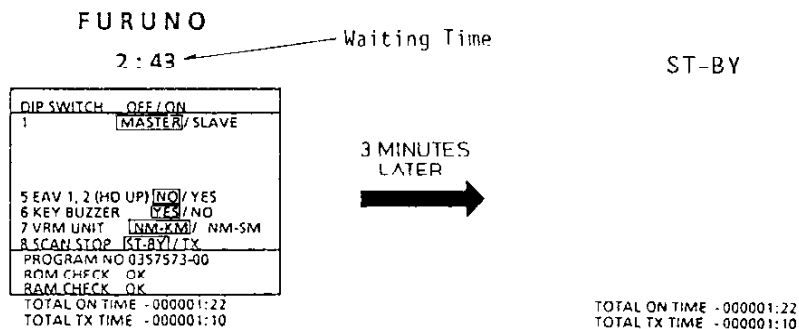


Fig.1-1

When the message ST-BY appears on the screen, press the STBY/TX touchpad to begin transmission. The display screen lights up, and any echoes received from targets are displayed on the screen. (If the STBY/TX touchpad is pressed during the 3-minute warm up period, TX appears below the timer indication and the radar will begin transmitting immediately at 0:00.)

To temporarily suspend transmission, press the STBY/TX touchpad to display ST-BY on the screen.

NOTE: Whenever the STBY/TX touchpad is pressed to begin transmission, or the RANGE +, RANGE -, PULSE, SHIFT, MODE, or X2 ZOOM touchpad is pressed, the cross hair cursor is displayed for reference on the screen for 3 seconds before being erased.

Pulselength Selection



The PULSE touchpad is used to select the pulselength. At the "short pulselength" position, picture definition in the 1.5 to 24 nm ranges is improved, while at the "long pulselength" position, the detection of echoes is improved. The pulselength selected is indicated at the upper left-hand corner of the screen: SP, short pulse; MP1, middle pulse 1; MP2, middle pulse 2; or LP, long pulse.

The pulselength and pulse repetition rate on the specifications shows the pulselength selectable in each range.

Range Selection



The RANGE touchpads are used to select the RANGE. The range selected determines automatically the fixed range ring interval. Press the + touchpad to increase the range, or press the - touchpad to lower the range. The range selected and the fixed range interval are indicated at the upper left-hand corner of the screen.

TUNE Control Adjustment



The TUNE control is used to tune the receiver to the exact frequency of the transmitter. For the first 10 minutes of operation the tuning should be checked periodically because the transmitter has not stabilized yet. Readjustment after the first 10 minutes is normally not required.

Tuning is made easy by the use of the tuning bar provided at the upper right-hand side of the display screen. The TUNE control is so adjusted to display the longest tuning bar.

To tune the receiver, first turn the A/C SEA control fully counterclockwise and set the range to 24 nm. Turn the TUNE control between its extremes until the longest tuning bar (between 4 and 5 tuning markers) is obtained.

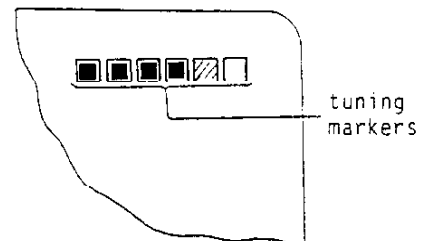


Fig.1-2 Tuning Bar

GAIN Control Adjustment



The GAIN control is used to adjust the sensitivity of the receiver, and thus the strength of echoes as they appear on the screen. It is adjusted so that the speckled noise background is just visible on the screen.

To properly set the gain, first select one of the long ranges--the speckled background noise is more apparent. Turn the GAIN control clockwise slowly until you can see feeble speckled background noise. If you set up for too little gain, weak echoes may be missed. If you turn the control too far clockwise, yielding too much speckled noise background, targets may be missed because of the poor contrast between desired echoes and the background noise on the screen.

A/C SEA Control Adjustment



In rough seas, sea clutter appears on the screen as a large number of small echoes (see Fig.1-3) which might impair radar performance in close ranges. The action of the A/C SEA (Anti Clutter Sea) circuit is to reduce the amplification of echoes at short ranges (where clutter is the greatest) and progressively increase amplification as the range increases, so that amplification will be normal at those ranges where sea clutter is not experienced. The control is effective to a maximum of about 6 miles.

The proper setting of the A/C SEA control is so that the clutter is broken up into small dots, and small targets become distinguishable. If the control is not sufficiently advanced, other targets will be hidden in the clutter, while if it is set too high, sea clutter and targets will both disappear from the screen. As a general rule of thumb, turn the control clockwise until the clutter has disappeared leeward, but a little is still visible windward. Always leave a little clutter visible on the screen, this ensures weak echoes will not be suppressed. If no clutter is visible on the screen, leave the control in the fully counterclockwise position.

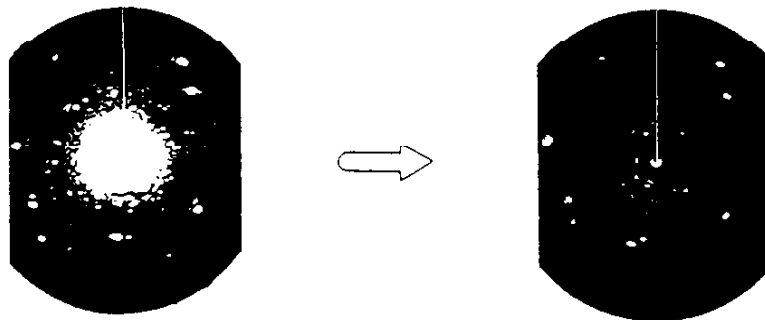


Fig.1-3 Adjusting the A/C SEA Control

Brightness/Illumination Adjustment

CRT Brightness



The BRILL (Brilliance) control adjusts the brightness of the CRT. Turn it clockwise to increase the intensity of the radar echoes blips, legends and markers. Adjust it so that radar echo blips may be observed clearly.

Mark Brilliance



The MARK BRILL touchpad is used to adjust the brilliance of the various marks and legends displayed on the screen; i.e., VRMs, EBLs, range rings, north mark (if gyro connected), heading mark and guard zone. There are four levels of brilliance: low, medium, medium high and high. Each time the touchpad is pressed the brilliance changes in the above sequence.

Panel Illumination



The PANEL DIM (panel dimmer) control adjusts the illumination for both the touchpad and control panels.

Mode Selection



The MODE touchpad is used to select the presentation mode. There are either two or three modes selectable, Head-Up (HU), Course-Up (CU), North-Up (NU) or Head Set (HS), depending on whether a gyrocompass is connected or not. Each time the touchpad is pressed the mode changes in the following sequence, and the mode selected is indicated at the top left-hand side of the screen.

with gyro : $\boxed{\text{HU} \rightarrow \text{CU} \rightarrow \text{NU}}$

without gyro : $\boxed{\text{HU} \rightarrow \text{HS}}$

Head-Up Mode

The picture is orientated so that the heading mark appears at the top of the screen. This mode is most suitable for navigation in congested areas or narrow channels.

Note that the north mark appears only when a gyrocompass is connected.

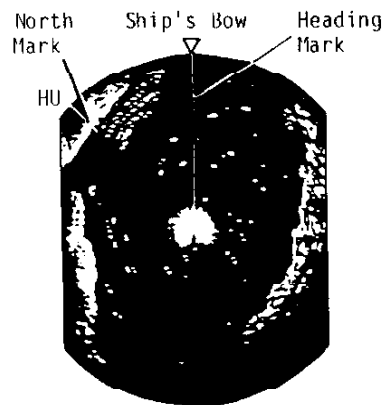


Fig.1-4 Heading-Up Mode Display

North-Up Mode

The radar picture is stabilized so that the north is at the top of the screen and the heading mark changes its position according to the orientation of the ship's heading. This mode is suitable for radar fixing of own ship's position in reference to the navigation chart. The picture is stabilized against yaw of the vessel, reducing the smearing of target echoes.

This mode is available only when a gyrocompass is connected.

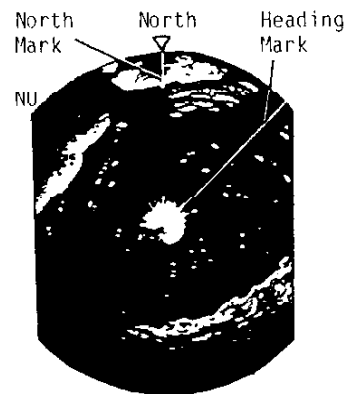


Fig.1-5 North-Up Mode Display

Course-Up Mode

Press the MODE touchpad for the CU mode at the moment the ship's bow is oriented to the desired direction (ship's course to port, waypoint, etc), and the picture is stabilized with the desired direction at the top of the screen. The heading mark changes according to the orientation of ship's heading. The picture is stabilized against yaw of the vessel.

This mode is available only when a gyrocompass is connected.

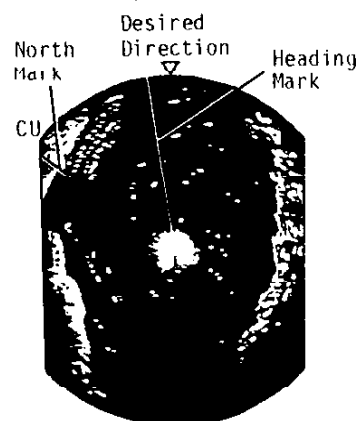
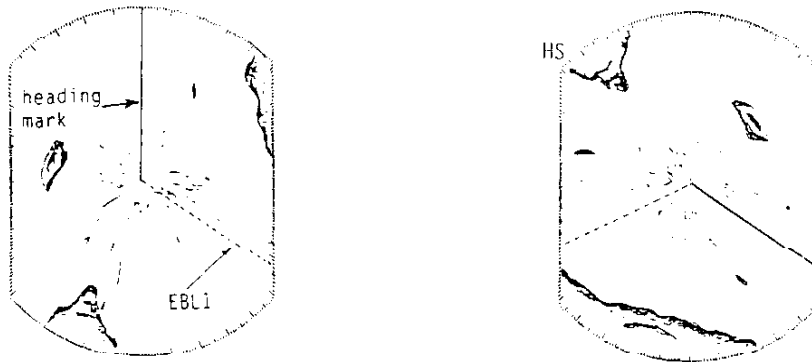


Fig.1-6 Course-Up Mode Display

Head Set Mode

The heading mark may be moved to the desired direction by using EBL and its rotary knob control.

Select the Head-up Mode; press the EBL ON touchpad to display EBL (EBL1 or EBL2); set EBL to the desired direction by rotating the rotary knob (1-7a). Then select the Head Set Mode, and the heading mark will move to where the EBL is located as shown in Fig.1-7b. Note that this mode is available only when a gyrocompass is not connected.



(a) Fig.1-7 Head Set Mode Display (b)

A/C RAIN/FTC Control Adjustment



The echoes of ships operating inside rain, hail or snowstorms may be hidden by rain clutter, which is easily recognizable by its wool-like appearance on-screen. When it impairs detection over a long distance, use the A/C RAIN (Anti Clutter Rain)/FTC (Fast Time Constant) control to reduce the clutter.

When only a slight amount of clutter is visible on the screen, turn the control clockwise to distinguish targets from the clutter. In heavy storms or partial clutter, pull out the control and adjust it to clarify the picture. (The indicator "FTC" is displayed on the screen when the control is pulled out.) Besides using it in heavy storms, the FTC may also be used in clear weather to separate groups of echoes on a congested short range picture. In all cases use discretion when adjusting the control. Advancing it too far clockwise may erase targets from the screen.

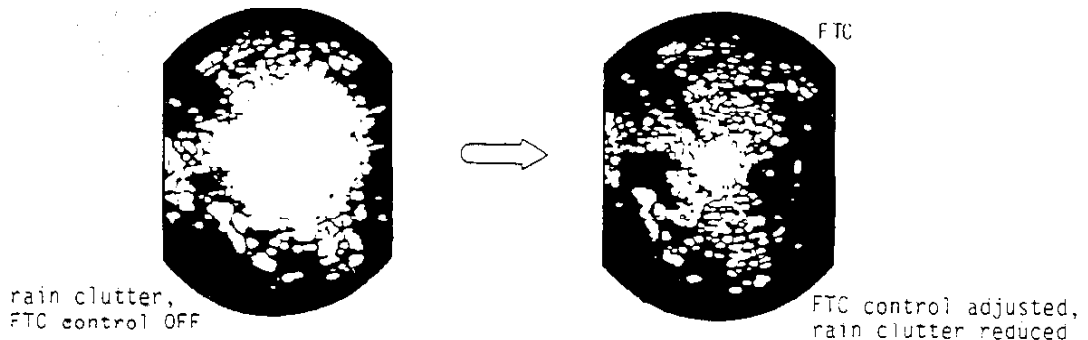


Fig.1-8 Effect of the A/C RAIN/FTC Control

Reducing Radar Interference



Radar interference may occur when in the vicinity of another shipborne radar operating in the same frequency band. It appears on the screen often as a large number of bright dots either scattered at random or in the form of "curved spokes" (Fig.1-9). This type of interference can be reduced by activating the Interference Rejector circuit. Press the IR touchpad to activate the circuit. The indicator "IR" appears at the upper right-hand corner of the screen. Press the touchpad again to switch it off when no interference exists, otherwise weak targets may be missed. Note that this function should be turned off to receive a radar beacon (racon) signal.

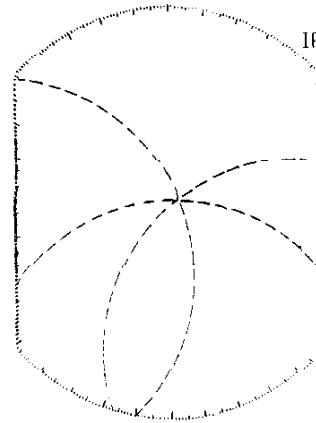


Fig.1-9 Radar Interference

Erasing the Heading Mark/North Mark



When the radar is turned on, the heading mark is displayed. The north mark is also displayed if a gyrocompass is connected. When the heading mark or north mark masks or hinders recognition of a small target echo, press and hold the HM OFF touchpad to temporarily erase them. Release hold to redisplay them.

In addition to erasing the heading mark/north mark, this touchpad can alternate between NM and KM units for the VRM(s) or select true or relative bearing readout for the EBL(s) in HU mode if a gyrocompass is connected. For further details, see the following "RANGE AND BEARING MEASUREMENT."

RANGE AND BEARING MEASUREMENT

The range to a target may be measured with the fixed range rings, erased/displayed by pressing the RING touchpad, or a Variable Range Marker (VRM). The bearing of a target may be measured by an Electronic Bearing Line (EBL).

Selection and operation of the markers used to measure range and bearing are simple. At each bottom corner of the display unit there is a touchpad control. EBL ON/OFF on the left corner and VRM ON/OFF on the right corner, and a rotary knob. The ON and OFF touchpads on each touchpad control are used to display and erase a marker and its readout from the screen. If two alike markers are displayed when the OFF portion is pressed, the readout not circumscribed is erased. Each rotary knob operates two markers, VRM1/VRM2 or EBL1/EBL2. The marker whose readout is circumscribed is currently operable by a rotary knob. To transfer control to the other marker, press the ON portion of the touchpad.

Range Measurement



The range to a target is roughly measured with the range rings, which are displayed/erased by pressing the RING touchpad.

For more accurate measurement of the range to a target you would activate the VRM. Press the VRM ON touchpad until the VRM readout you want to operate is circumscribed. Next, rotate the VRM control until the circle described by the VRM just touches the inside edge of the target blip (see Fig.1-10). The range to the target is shown at the lower right-hand corner of the screen; VRM1 readout on top and VRM2 readout below it.

Note that the lengths of the dash and space on VRM1 and VRM2 are different as shown in Fig.1-10.

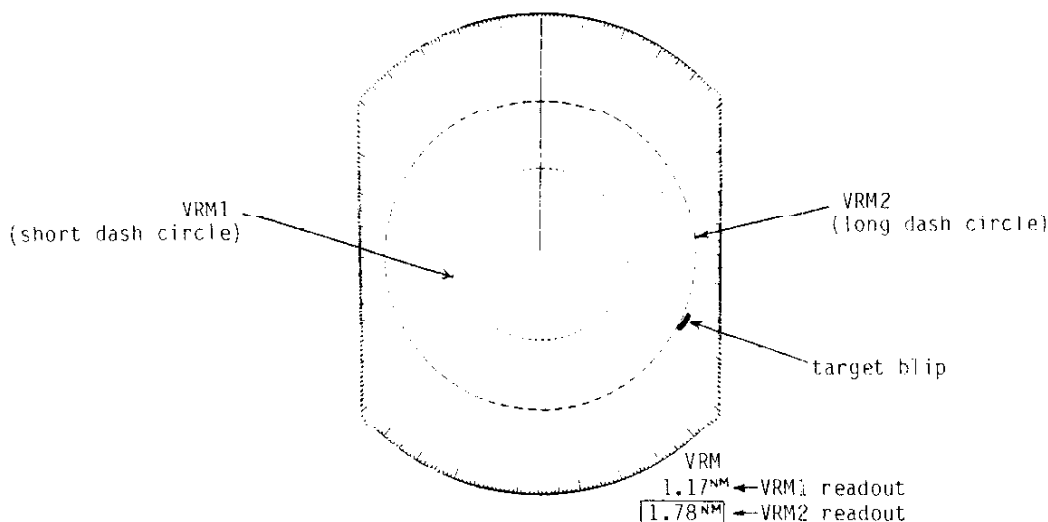


Fig.1-10 Measuring Range With a VRM

VRM Unit Selection



The unit of measurement for the VRM1/VRM2 can be changed from NM to KM (and vice versa). Press the VRM ON touchpad to select valid VRM you want to change, and then press the VRM ON touchpad while pressing and holding the VRM OFF touchpad.

Note: Change from NM to SM (statute mile) is possible by changing the setting of a DIP switch. Refer to appendix B on page B-1.

Bearing Measurement



Press the EBL ON touchpad until the EBL readout you want to operate is circumscribed. Then, rotate the EBL control until the EBL bisects the target blip (see Fig.1-11). The relative or true bearing is shown at the lower left-hand corner of the display screen; EBL1 readout on top and EBL2 readout below it. (Ship's heading is displayed just above the EBL indicator when a gyrocompass is connected.)

Note that the lengths of the dash and space on EBL1 and EBL2 are different as shown in Fig.1-11.

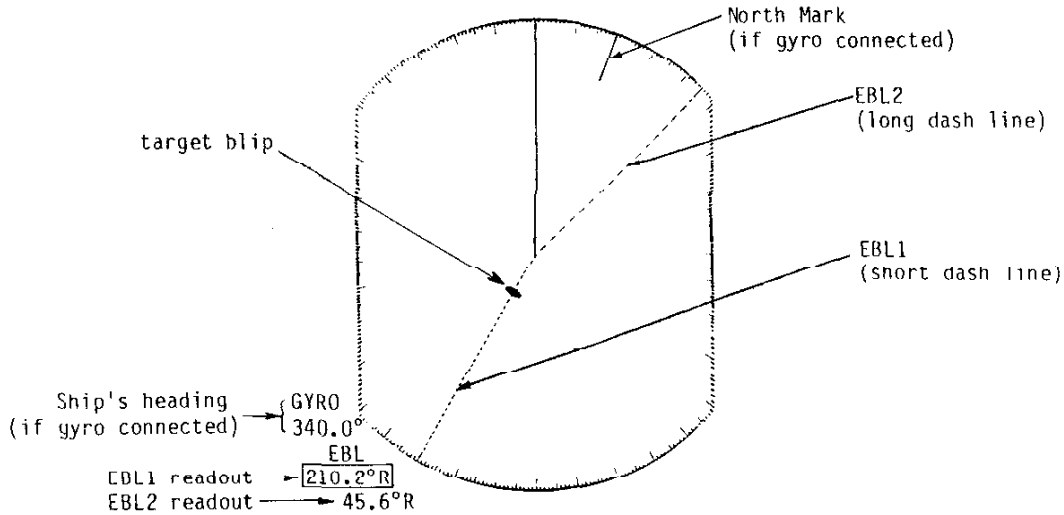
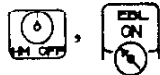


Fig.1-11 Measuring Bearing With an EBL

True Bearing Indication



EBL readouts are relative to own ship's heading in the Head-Up mode, while true (relative to north) on North-Up or Course-Up modes. When the gyro is in use, however, Head-Up mode permits EBL readout in either relative to heading or true north. Press the EBL ON touchpad to select a desired EBL. Then, press the EBL ON touchpad while pressing and holding the HM OFF touchpad, and the EBL readout alternately changes between "R(relative)" and "T(true)".

Range & Bearing Between Two Targets (Offset EBL)



The EBL1 origin and VRM1 center can be offset to measure the range and bearing between any two targets on the screen, or predict movement of another ship.

1. Move the cross hair cursor "+" to one of the two targets selected with four cursor shift touchpads.
2. Press the SHIFT touchpad while keeping the HM OFF touchpad pressed, and the EBL1 origin and the VRM1 center are offset to the cross hair cursor intersection marked by "x".
3. Adjust the EBL control so that EBL1 bisects the other target in concern, and adjust the VRM control so that VRM1 rests on the inner edge of the target. Now, the range and bearing between the two are given by VRM1 and EBL1 readouts.
4. To predict another ship's course, place EBL1 over the target after passing several minutes. If EBL1 bisects own ship, the possibility of collision exists. Refer to Fig.1-14 on page 1-11.

SHIFTING THE DISPLAY



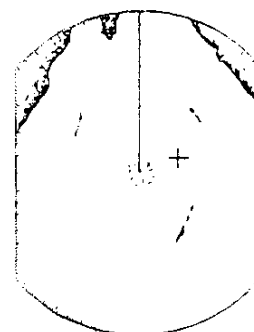
The own ship's position can be shifted to any position on the radar screen. The primary advantage of the shifted (off-center) display is that for any particular range setting the view ahead, behind or on the sides of own ship can be extended without changing the range in use.

The cross hair cursor "+", which may be maneuvered by the four cursor shift touchpads, is used to select the area to be shifted.



Note that the maximum range of the shifted display function is limited to 1.6 times for 0.25 to 40 nm ranges and 1.46 times for 72 nm range.

Procedure

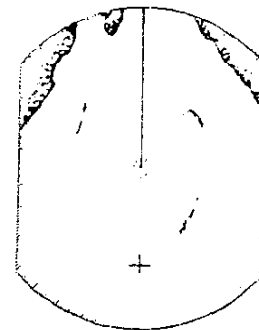
1. Press a cursor shift touchpad to present the cross hair cursor on the screen (a). Set the cursor on the area desired (b). After releasing hold of the touchpad, the cursor will flash 3 seconds before being erased.



(a)

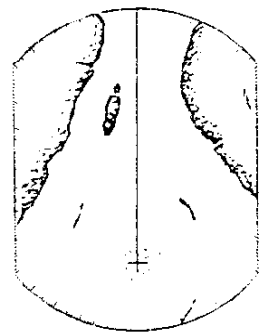
NOTE 1: The cursor can be returned to the center of the screen by pressing the  and  touchpads simultaneously.

NOTE 2: When continuously pressing a cursor shift touchpad, the cursor moves close to the bearing scale, and a series of beep tones will be generated, telling you that the cursor cannot be moved farther outward.



(b)

2. Press the SHIFT touchpad, and the own ship's position is off-centered (c). The heading mark is shifted to where the cursor was last positioned, and the cursor is redisplayed 3 seconds before being erased.



(c)

3. To cancel the shift function, press the SHIFT touchpad again.

Fig.1-12 Shifting the Display



ZOOM FUNCTION     

The area between own ship and an arbitrary location can be doubled with the zoom function. This function lets you take a closer look at an area of interest without changing the range in use.

Note that this function is not available when the shift function is on. If you attempt to activate it when the shift function is on, successive beep tones will be generated, informing you of unacceptable key entry.

Procedure

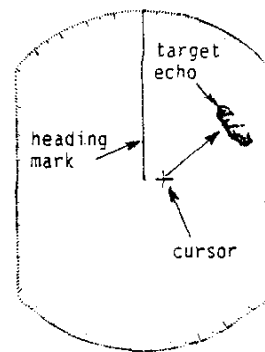
1. Press any cursor shift touchpad to display the cross hair cursor "+" (a); operate four cursor shift touchpads until the cursor is near the target (b). After releasing hold of a cursor shift touchpad, the cursor flashes 3 seconds before being erased from the screen.

NOTE 1: The cursor can be returned to the center of the screen by pressing the  and  touchpads simultaneously.

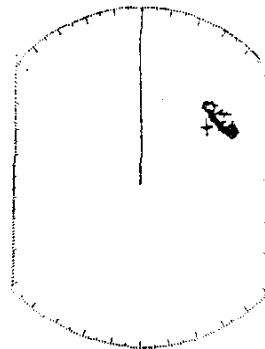
NOTE 2: When continuously pressing a cursor shift touchpad the cursor moves close to the bearing scale, a series of beep tones will be generated, telling you that the cursor cannot be moved farther outward.

2. Press the X2 ZOOM touchpad to activate the zoom function. The own ship will shift to an opposite position to the cursor in reference to the screen center, thereby producing a doubled screen size for the same range between the own ship and the target (c). The message "ZOOM" flashes at the lower right-hand side of the screen.

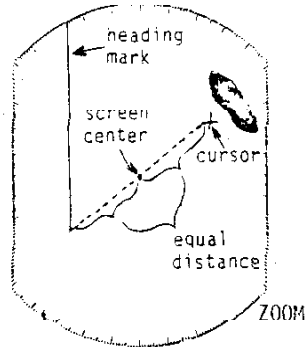
3. To cancel the zoom function, press the X2 ZOOM touchpad. The zoom function can also be cancelled by pressing the SHIFT touchpad or changing the range.



(a)



(b)



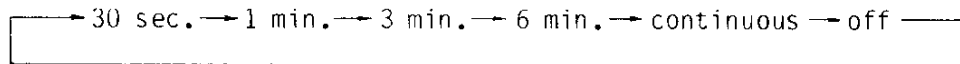
(c)

Fig.1-13 Using the Zoom Function

TRAILING TARGET ECHOES



The ECHO TRAIL touchpad is used to plot the relative movement of all targets to own ship in a lower intensity. (True motion plotting is available when connected to the RP-3 Video Plotter and gyrocompass.) This feature helps the operator to evaluate traffic situations of all targets. Each time the ECHO TRAIL touchpad is pressed, the plotting time changes in the following sequence.



When the plotting function is turned on, e.g., 30 sec. is selected, "30S" (plotting time) is indicated at the upper right on the screen, the timer shown to the left of "30S" starts counting up and the trail of every target starts extending. As soon as the timer counts 30 sec., the timer indication disappears and thereafter only plotting is continued. The trail of the target is erased from its oldest tip and only the last 30 sec. remains on the screen. The faster the relative speed of the target, the longer the trail of the target.

NOTE: If continuous plotting is selected, the timer continuously stays on the screen, and it counts up from 0:00 to 99:59 and the trail extends continuously without being erased.

If the range is changed while plotting is being performed, the indication "ECHO TRAIL" is displayed in inverse video (black characters, green background), informing the operator that the plotting mode is suspended. Return to the previous range setting to resume plotting.

To erase the traces, press the ECHO TRAIL touchpad 10 seconds after the previous press.

Collision Course?

To ascertain another ship as a hazardous target place the EBL on it. If the extension of its latest tracks is on the EBL, it can be a hazardous one. In Fig.1-14, ship A can be on collision course and ship B will pass clear to starboard.

"Offset EBL" (page 1-8) is another method to predict other ship's course. Suppose that ship C (initial position) goes to C' after several minutes. Since the offset EBL passes through own ship, possibility of collision exists.

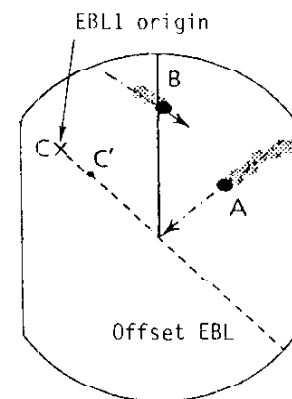


Fig.1-14

ECHO AVERAGING



Echo averaging function is turned on or off by pressing the ECHO AVG touchpad, and its basic idea is to paint stable targets in normal intensity and unstable echoes in lower intensity.

Echoes received from stable targets such as other ships (moving at the slower relative speed to own ship) appear on the screen at almost the same position for every sweep, while unstable echoes such as sea clutter appear at random. To distinguish target echoes from sea clutter, this radar uses the scan-to-scan correlation method, which stores and averages successive two or four picture frames. If the echo is stable it is presented in its actual strength level. To the contrary, if it is unstable it is suppressed in intensity, allowing you to discriminate targets from sea clutter.

To properly use the echo averaging function, first suppress sea clutter with the A/C RAIN control (A/C SEA control: fully CCW). Then, press the ECHO AVG touchpad. Each time the touchpad is depressed the level of correlation changes in the following sequence, and annunciator appears at the lower right-hand corner of the screen. EAV3 does not provide correlation but picks up the peak level among several strobes in a frame. This is useful to track target masked by short range sea clutter.

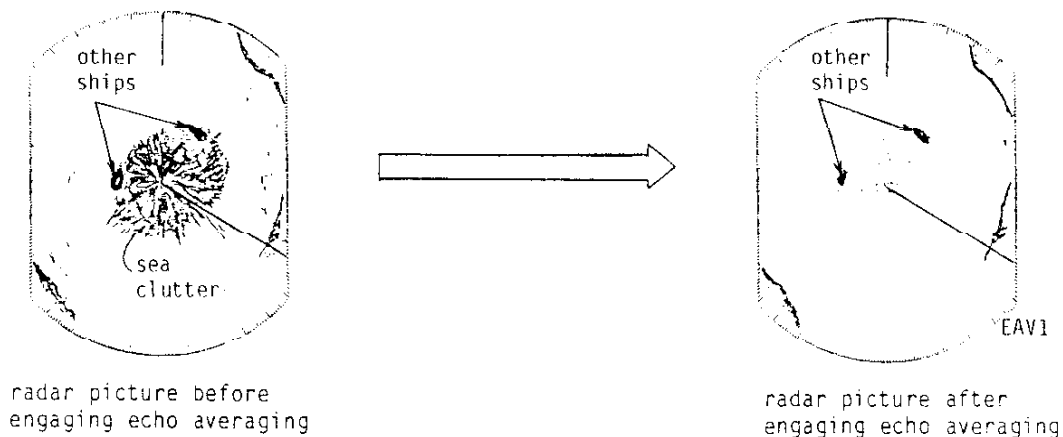
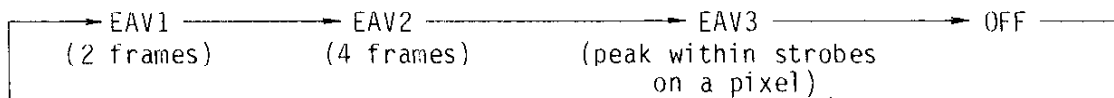


Fig.1-15 Echo Averaging Function

Echo average 1 & 2 should not be used when speed difference between own ship and other ships is large or when own ship is being subjected to heavy pitching or rolling.

Note: In Head-Up mode, EAV1 and EAV2 cannot be used. (EAV3 may be used in this mode.) It, however, is possible to make EAV1 and EAV2 work in Head-Up mode. Change the setting of DIP switch S1 #5, referring to Appendix B.

SETTING THE ALARM



An alarm may be set to visually (flashing) and audibly (beep sound) alert you should targets (ships, landmasses, etc.) above a certain signal level enter into a preset guard zone. A guard zone is defined as an area where you do not want targets to enter in. The size of the guard zone may be set between 0 and maximum range for distance and between 0° and 360° in bearing.

This alarm is very effective as an anti-collision aid when using an autopilot or navigating in narrow channels. However, it does not relieve the operator of the responsibility to watch out for possible collision situations. It should never be used as a primary means to detect possible collision situations.

The procedure to set the guard zone and alarm is as follows.

Range Setting

1. Press the VRM ON touchpad to display VRM1; and then rotate the VRM control until VRM1 is at the range desired for the inner limit of the alarm.
2. Press the VRM ON touchpad again to display VRM2; rotate the VRM control until VRM2 is at the range desired for the outer limit of the alarm.

Sector Setting

3. Press the EBL ON touchpad to display EBL1; rotate the EBL control until EBL1 is at the bearing desired for the counterclockwise limit of the alarm.
4. Press the EBL ON touchpad again to display EBL2; rotate the EBL control until EBL2 is at the bearing desired for the clockwise limit of the alarm.

Alarm Setting

5. Press the GUARD ALARM touchpad, and the indication "GUARD" will appear at the top right-hand side of the screen. Any targets entering the guard zone will trigger the alarm. The EBLs and VRMs may be operated without disturbing the settings of the alarm.

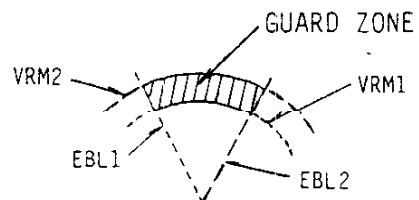


Fig.1-16 Guard Zone

To suspend the alarm sound, press the GUARD ALARM touchpad once. The message "GUARD" will be reversed. Press the GUARD ALARM touchpad again to restore sound. To cancel the alarm function, press and hold the touchpad for more than one second.

NOTE 1: When the range in use is lower than the range of the guard zone, the indication "GUARD UP RANGE" appears on the screen, replacing the indication "GUARD."

NOTE 2: The alarm sounds when targets having a certain level of strength enter the guard zone. This level includes not only ships and landmasses, but also returns from seafloor or precipitation. Since the level is changeable with the environment, the operator is required to properly adjust the gain and anti-clutter controls. It should be noted that excessively high settings of A/C controls can fail in alerting small targets.

MAGNIFYING TARGET ECHOES

As a general rule of thumb, the reflected echoes from long distance targets are displayed on the screen as weaker and smaller blips even though they are compensated by the radar's internal circuitry.

The echo stretch function is provided to magnify small targets in middle and long ranges, i.e., 1.5 nm range or higher. Press the ECHO STRETCH touchpad, and the indicator "ES" is displayed at the upper right-hand corner of the screen and the echoes are doubled lengthwise. Note that this function is inactive in short ranges; "ES" is indicated in inverse video.

DISPLAYING OWN SHIP'S POSITION & WAYPOINT (OPTION) .

Own ship's position in latitude/longitude, and range/bearing to a waypoint selected on the nav aid may be displayed at the lower center of the screen if an external navigator having NMEA0183 or FURUNO CIF format is connected. In case of FURUNO CIF format, it is necessary to cut jumper wire JP5 on the PROCESSOR board. **JP5 is connected for NMEA0183 when the radar is shipped.**

1. Press the MODE touchpad while keeping the HM OFF touchpad pressed, and WP (Waypoint) and LL (Latitude/Longitude) are displayed, provided that the waypoint number is not indicated.
2. Repeat step 1 to cancel the WP/LL indication.

Note: If a gyrocompass is connected, both a mark and a line to a waypoint are displayed on the radar screen, provided that only the line is drawn if the waypoint is out of the range selected.

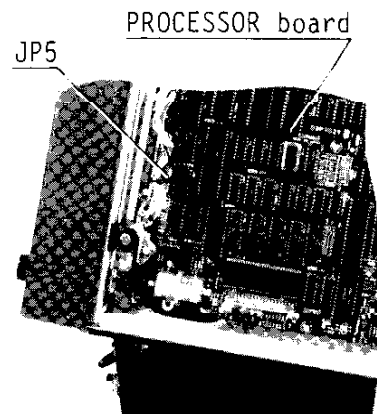
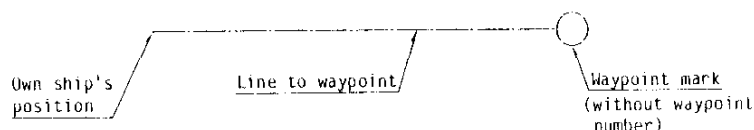


Fig.1-17

N Photo No.2496

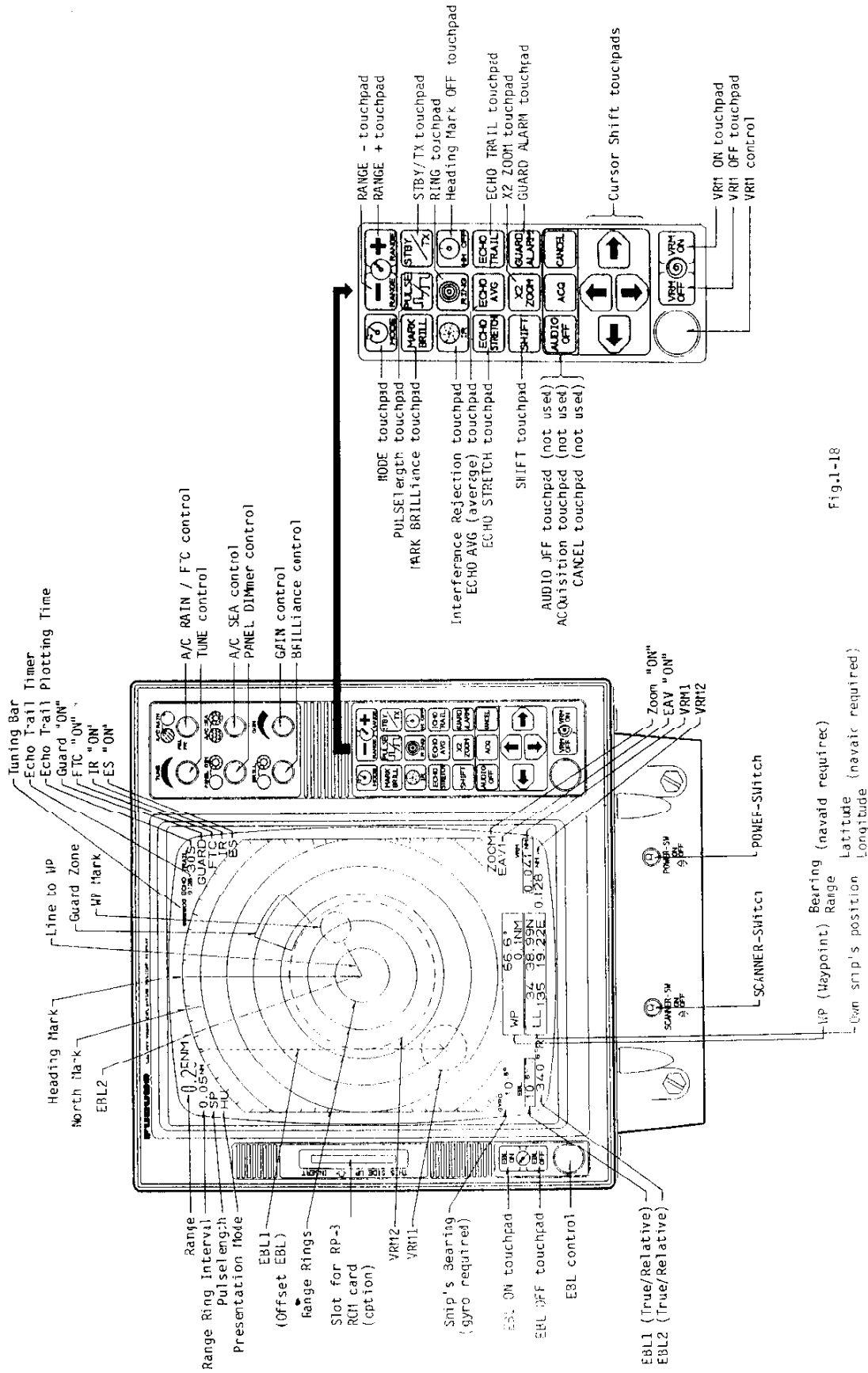


Fig.1-18

CHAPTER 2 APPLICATION

In this chapter, minimum and maximum ranges, radar resolution, range measurement, false echoes and radar plotting will be discussed.

MINIMUM AND MAXIMUM RANGES

Minimum Range

When the radar is used as a collision avoidance aid, the minimum detection range is of urgent concern. It is very dangerous for a target to disappear when it approaches the ship. The minimum range is primarily determined by the height of the antenna (vertical beam width of antenna) above the waterline.

Maximum Range

The maximum detecting range of the radar, R_{max} , varies considerably depending upon several factors such as the height of the antenna above the waterline, the height of the target above the sea, the size, shape and material of the target, and the atmospheric conditions.

Under normal atmospheric conditions, the maximum range is equal to the radar horizon or a little shorter. The radar horizon is longer than the optical one by about 6% because of the diffraction property of the radar signal. The R_{max} is given in the following equation.

$$R_{max} = 2.2 \times (\sqrt{h_1} + \sqrt{h_2})$$

where R_{max} : radar horizon (nm)
h1 : antenna height (m)
h2 : target height (m)

For example, if the height of the antenna above the waterline is 9 meters and the height of the target is 16 meters, the maximum radar range is;

$$R_{max} = 2.2 \times (\sqrt{9} + \sqrt{16}) = 2.2 \times (3 + 4) = 15.4 \text{ nm}$$

RADAR RESOLUTION

Bearing Resolution

Bearing resolution is the ability to display as separate pips the echoes received from two targets which are at the same range and close together. It is proportional to the antenna length and reciprocally proportional to the wavelength. The length of the antenna radiator should be chosen for a bearing resolution better than 2.5° (International Maritime Organization (IMO) Resolution). This condition is normally satisfied with a radiator larger than 1.2 m (4 ft).

Range Resolution

Range resolution is the ability to display as separate pips the echoes received from two targets which are on the same bearing and close to each other. This is determined by pulselength only. The usual discrimination range is 22.8 m (25 yd) on a 0.08 microsecond pulse.

BEARING ACCURACY

One of the most important features of the radar is how accurately the bearing of the target can be measured. The accuracy of bearing measurement basically depends on the narrowness of the radar beam. However, the bearing is usually taken relative to the ship's heading, and thus, proper adjustment of the heading marker at installation is an important factor in ensuring bearing accuracy. To minimize error when measuring the bearing of a target, put the target echo at the extreme position on the screen by selecting a suitable range.

RANGE MEASUREMENT

Measurement of the range to a target is also a very important function of the radar. Generally, there are two means of measuring range: the fixed range rings and the variable range marker (VRM). The fixed range rings appear on the screen with a predetermined interval and provide a rough estimate of the range to a target. The variable range marker's diameter is increased or decreased so that the marker touches the inner edge of the target, allowing the operator to obtain more accurate range measurements.

FALSE ECHOES

Occasionally echo signals appear on the screen at positions where there is no target or disappear even if there are targets. They are, however, recognized if you understand the reason why they are displayed. Typical false echoes are shown below.

Multiple Echoes

Multiple echoes occur when a short range, strong echo is received from a ship, bridge, or breakwater. A second, a third or more echoes may be observed on the display at double, triple or other multiples of the actual range of the target as shown in Fig. 2-1. Multiple reflection echoes can be reduced and often removed by decreasing the gain or properly adjusting the A/C SEA control.

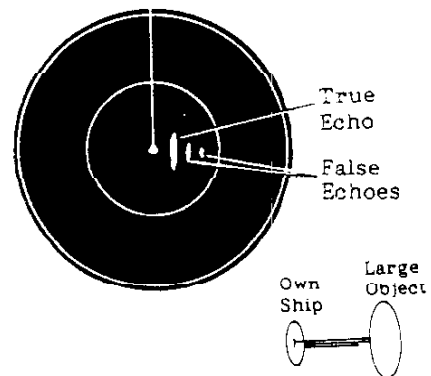


Fig.2-1 Multiple Echoes

Side-lobe Echoes

Every time the radar pulse is transmitted, some radiation escapes on each side of the beam--called "side-lobes." If a target exists where it can be detected by the side lobes as well as the main lobe, the side echoes may be represented on both sides of the true echo at the same range, as shown in Fig. 2-2. Side lobes show usually only on short ranges and from strong targets. They can be reduced through careful reduction of the gain or proper adjustment of the A/C SEA control.

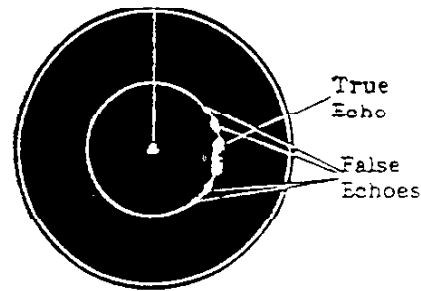


Fig.2-2 Side-Lobe Echoes

Blind and Shadow Sectors

Funnel, stacks, masts, or derricks in the path of antenna may reduce the intensity of the radar beam. If the angle subtended at the scanner is more than a few degrees, a blind sector may be produced. Within the blind sector small targets at close and long ranges may not be detected. See Fig. 2-3.

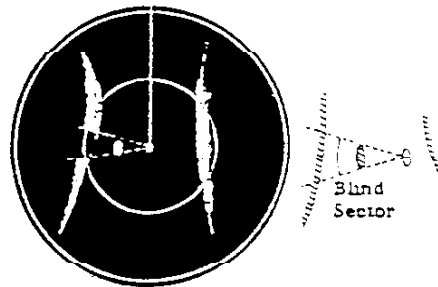


Fig.2-3 Blind and Shadow Sectors

Virtual Image

A relatively large target close to your ship may be represented at two positions on the screen. One of them is the true echo directly reflected by the target and the other is a false echo which is caused by the mirror effect of a large object on or close to your ship as shown in Fig. 2-4. If your ship comes close to a large metallic bridge, for example, such a false echo may temporarily be seen on the screen.

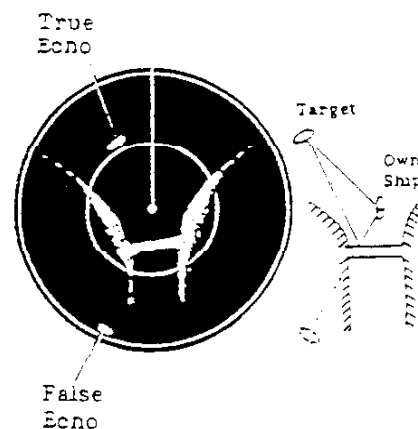


Fig.2-4 Virtual Image

POSITION FIXING WITH RADAR

Radar Range

The simultaneous measurement of the ranges to two or more fixed objects is normally the most accurate method of obtaining a fix with radar alone. Preferably at least three ranges should be used. However the use of more than three range arcs may introduce excessive error because of the time lag between measurements, i.e., you will be moving as you take successive measurements.

When obtaining a fix, it is best to measure the most rapidly changing range last because of a smaller time lag in the radar plot from the ship's actual position. For greater accuracy, the objects selected should provide arcs with angles of cut as close to 90° as possible. Small, isolated, radar-conspicuous fixed objects whose associated range arcs intersect at angles approaching 90° provide the most reliable and accurate position fixes. Objects at longer ranges are less accurate for position fixing because they may be below the radar horizon and because the width of the radar beam increases with range.

To fix your position, first measure the range to two or more prominent navigational marks which you can identify on the chart. (The method for measuring range is given on page 1-8.) Next, with a compass sweep out the ranges from the charted positions. The point of intersection of the arcs is your estimated position. The method to obtain a position fix using radar range is illustrated in Fig. 2-5.

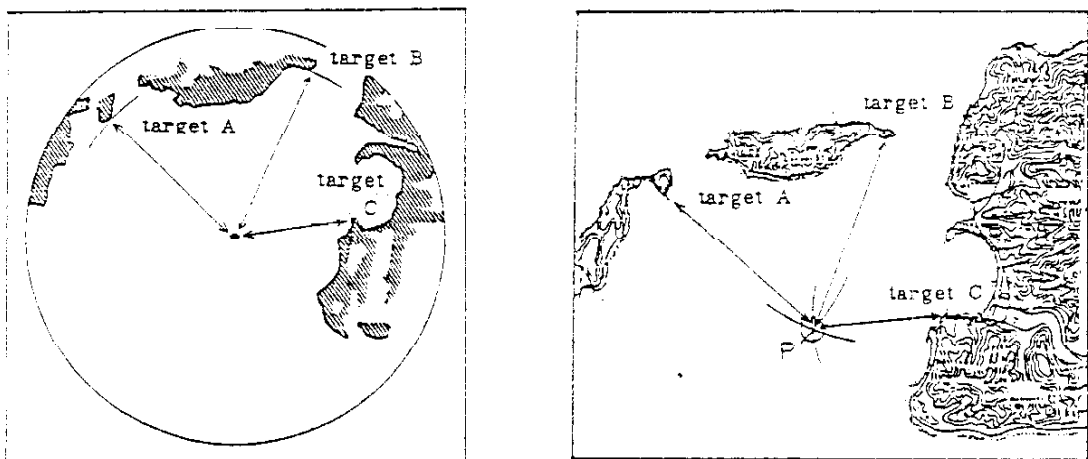


Fig.2-5 Position Fixing Using Range

Range and Bearing

The advantage of position fixing by range and bearing is the speed with which a fix can be obtained. A distinct disadvantage however is that this method is based upon only two intersecting position lines, a bearing line and range, obtained from two points of land. If possible, the object used should be small, isolated and identified with reasonable certainty. To fix

your position using range and radar bearing, measure the relative bearing of the target with the EBL, noting the exact direction of the ship's heading when doing so. Next, make allowance for compass deviation (true or magnetic) and find the true bearing of the target. Sweep out the range to the target with a compass on the chart and plot the true bearing of the target. The point of intersection is your approximate position. Fig. 2-6 illustrates how to obtain a position fix using range and bearing.

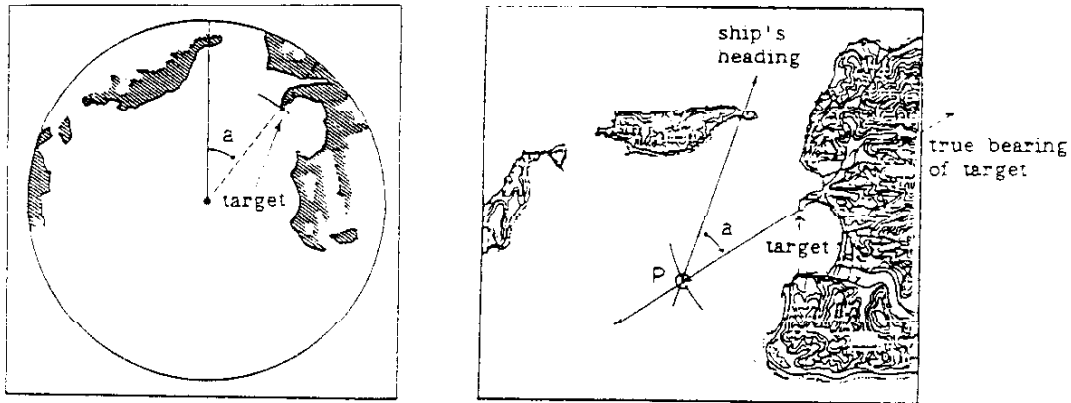


Fig.2-6 Position Fixing Using Range and Bearing

Two Bearings

Generally, fixes obtained from radar bearing are less accurate than those obtained from intersecting range arcs. The accuracy of fixing by this method is greater when the center bearings of small, isolated radar-conspicuous objects can be observed. Similar to position fixing using range and bearing, this method affords a quick means for initially determining approximate position. The position should then be checked against other means to confirm reliability.

Position fixing using two bearings is determined by measuring the relative bearings for the two targets and then determining their true bearings. Plot the two bearings on the chart; the point of intersection of the two bearings is your approximate position. Fig. 2-7 illustrates how to obtain a position fix using two bearings.

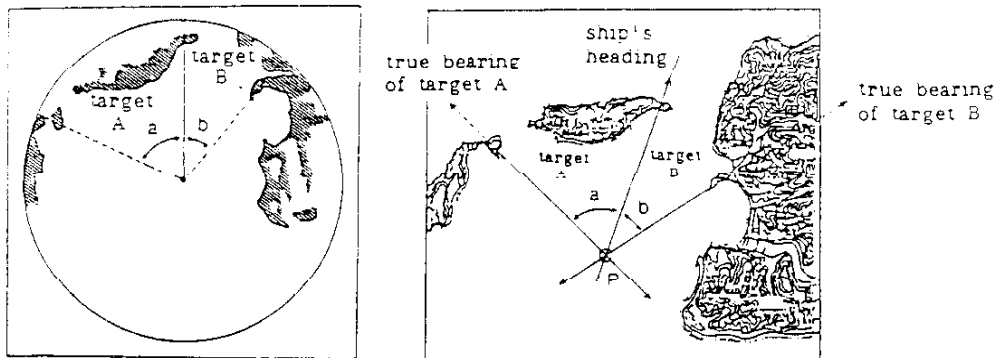


Fig.2-7 Position Fixing Using Two Bearings

CHAPTER 3 MAINTENANCE

This radar is designed and constructed to give the user many years of trouble-free operation. However, to maintain optimum performance maintenance must be performed at regular intervals. Recommended maintenance intervals and check points are given in the table below.

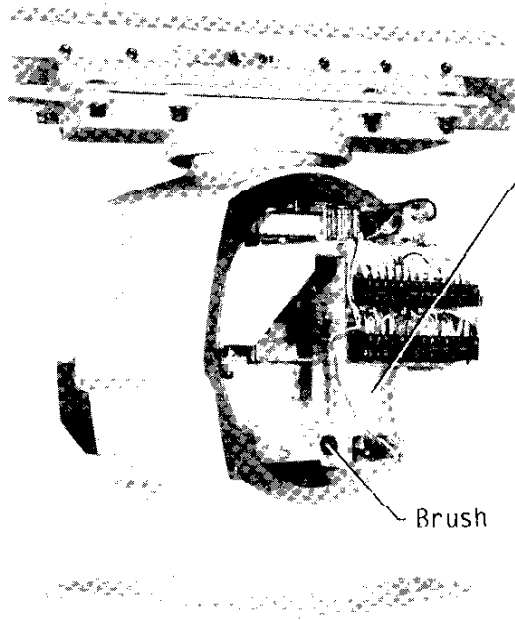
"CAUTION"

Before beginning maintenance work, be sure to switch off the radar at the main switchboard. When checking inside the units, wait for a few minutes until the high voltage components (CRT or HV capacitors) can discharge the residual charge.

Interval	Check Point	Check/Measures	Remarks
3 to 6 months	Exposed nuts and bolts on scanner unit	Check for corroded or loosened nuts/bolts. If necessary, clean them and repaint thickly. Replace them if heavily corroded.	*Sealing compound may be used instead of paint. *Put slight amount of grease if nuts and bolts are replaced.
	Scanner radiator	Check for dirt or cracks on the radiator surface. Thick dirt should be wiped off by using a soft cloth immersed in fresh water. If a crack is found, apply a slight amount of sealing compound or adhesive as first-aid treatment, then call for repair.	*Do NOT use plastic solvent (thinners or acetone) for cleaning. *When removing ice on the scanner unit, use a wooden hammer or plastic-head hammer. Crack on the scanner unit may allow water to penetrate inside, causing permanent damage to the internal circuitry.
	Terminal boards and plugs in scanner unit	Open scanner cover to check terminal board/plug connections inside. Also check if the rubber packings on each scanner cover is in good order.	*When putting cover back in position, be careful not to catch flying wires between cover and unit.
	CRT screen	Dirt on this creates symptoms identical to poor sensitivity. Clean CRT surface carefully, using care not to scratch it.	*Use a soft cloth with a slight amount of anti-static-charge spray. Never apply plastic solvent.

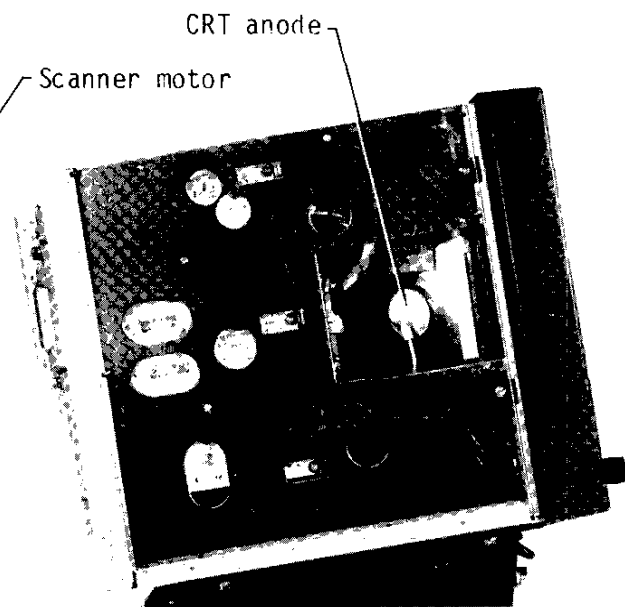
Continued

Interval	Check Item	Check/Measures	Remarks
6 months to 1 year	Scanner motor (See Fig.3-1.)	Check and clean carbon brushes and commutator. If brushes have worn out or abnormal spark is seen replace them with new one supplied as spare parts.	*Under normal use, the carbon brush will last approximately 2000 hours.
	CRT anode (See Fig.3-2.)	High tension on CRT attracts dust in environment, and moist dust will cause poor insulation.	*If any crack is found on rubber cap or wire sheath, call for service to replace damaged part. Do not touch these parts since high voltage may exist.
	Terminal boards, sockets and plugs	Check for loose connections. Clean contacts or replace plug, if necessary.	



N Photo No. 639

Fig.3-1 Scanner Unit
(Front cover removed)



N Photo No.2499

Fig.3-2 Display Unit
(Side view, cover removed)

CHAPTER 4 TROUBLESHOOTING

Whenever you suspect the radar is not functioning properly, turn it off and check plug connections on p.c.boards, then proceed to the Trouble Finding List on the next page, if necessary. If a p.c. board is found to be faulty, replace it or call for service. Do not attempt further component check in any p.c. board. Careless handling may damage the board.

"CAUTION"

There are many high tension points in the radar system. Take special care when approaching the following parts.

1. Power supply circuit (Display Unit)
2. CRT circuit (Display Unit)
3. Modulator circuit (Scanner Unit)
4. Magnetron (Scanner Unit)

Service Call

Please provide the following information when requesting service.

1. Name of the vessel
2. Vessel's location (port/berth)
3. Sailing Schedule
4. Radar model (Serial number/Date manufactured)
5. Description of the problem (include results of the troubleshooting checks)
6. Previous service

Trouble Finding List

Operation	Symptom	Check Point	Remarks
Turn POWER-SW on and adjust PANEL DIMMER control.	Illumination lamps for front panel do not come on with PANEL DIMMER turned fully CW.	<ol style="list-style-type: none"> 1. Main fuse F1351 (25A or 10A) See Fig.4-1. 2. Mains voltage/ polarity 3. POWER SUPPLY board 4. Illumination lamps 	<p>*25A for 12VDC mains, 10A for 24/32VDC mains</p> <p>*Measure mains voltage at DTB-I #1(+) and #2(-). See Fig.4-1. The voltage should be: 10.2 to 15VDC (12VDC set) 20.4 to 40VDC (24/32VDC set)</p>
Turn SCANNER-SW on.	Scanner does not rotate.	<ol style="list-style-type: none"> 1. Scanner fuse F1352 (5A) See Fig.4-1. 2. Scanner Motor brushes 3. Scanner rotating mechanism jammed 4. Power supply circuit for scanner motor 	<p>*If a bearing pulse is not sent from scanner, "NO BP" is displayed at ST-BY mode.</p> <p>*If worn, replace it with new one supplied as spare parts.</p>
Adjust BRILLIANCE control.	Nothing appears on CRT.	<ol style="list-style-type: none"> 1. CRT 2. CRT H.T. 3. DEFLECTION board 4. PROCESSOR board 	<p>*Visually check that CRT heater is lit.</p> <p>*Adjust CONTRAST pot. (RV101) and BRIGHT pot. (RV204) on DEFLECTION board. See Fig.4-2. If picture appears, CRT assembly is OK.</p>

Continued

Operation	Symptom	Check Point	Remarks
	Picture synchronization is abnormal.	<ol style="list-style-type: none"> 1. CRT assembly (DEFLECTION board, etc.) 2. PROCESSOR board 	*Adjust V-HOLD pot. (RV202) and H-HOLD pot. (RV401) on DEFLECTION board. See Fig.4-2. If synchronization is not achieved, DEFLECTION board is defective.
After "ST-BY" message, hit STBY/TX key.	Marks and legends appear abnormally.	<ol style="list-style-type: none"> 1. PROCESSOR board 	
Adjust GAIN control with A/C SEA control set at minimum.	Marks and Legends appear but no noise nor echo.	<ol style="list-style-type: none"> 1. IF amplifier (Fig.4-4) 2. Multicore cable between scanner and display units 3. PROCESSOR board 	*Check continuity and isolation of coax. cable. (Note: Disconnect the plug and lugs at the both ends of coax. cable before checking it by ohmmeter.)
	Marks, legends and noise appear but no echo. (No transmission leak appears.)	<ol style="list-style-type: none"> 1. TX fuse F1 (0.5A) See Fig.4-1. 2. Magnetron 9M602 (Fig.4-3) 3. MODULATOR board (Fig.4-3) 4. MODULATOR TRIGGER board (Fig.4-4) 5. Modulator SCR 6. PROCESSOR board (Fig.4-1) 	<p>*If fuse is blown, replace it. If it blows again, the magnetron or modulator's components may be faulty.</p> <p>*Connect a multimeter between test points "MAG. CUR"(+) and "TP.GND"(-) on INTERFACE board and transmit radar on 72 nm range. See Fig.4-1. If the voltage is 3 to 5VDC, check points 2 to 5 shown left may be OK.</p> <p>*Connect a multimeter, set at 10VAC range, between test points TP5 TX-TRIG (+) and TP3 GND(-) on PROCESSOR board. If the voltage changes on every range, the board is operating normally.</p>

Continued

Operation	Symptom	Check Point	Remarks
	Sweep line on the screen is out of synchronization with the antenna.	1. BEARING SIGNAL GEN. board (Scanner Unit) 2. PROCESSOR board	
	Poor bearing accuracy	1. Adjustment of heading SW S1 on PANEL board. 2. PROCESSOR board	*The message "NO HD" blinks on the screen when a heading pulse is not received.
Adjust TUNE control.	Poor sensitivity	1. Deteriorated Magnetron 2. Detuned MIC 3. Dirt on radiator face	*Set range to 72nm and measure voltage between test points "MAG.CUR"(+) and "TP.GND"(-) on INTERFACE board. It should be 3 to 5VDC. See Fig.4-1.
Pull FTC (A/C RAIN) control.	No FTC effect	1. PANEL board 2. PROCESSOR board	
Adjust A/C RAIN control.	No A/C RAIN effect	1. PANEL board 2. STC board	
Change range.	Radar picture does not change.	1. Poor contact of touchpad key 2. PROCESSOR board	
Hit each touchpad key.	Prescribed function is not carried out.	1. Poor contact of touchpad key 2. PROCESSOR board	

NOTE: When the gyro signal is lost, the presentation mode automatically becomes Head-Up, the legend "GYRO" flashes and the gyro readout disappears. If this happens, check connection between J20 on the INTERFACE board and A-D converter AD-10S or between the gyrocompass and AD-10S. When the gyro signal is restored, the readout reappears on screen but "GYRO" continues to flash to warn the operator that the readout is unreliable. To remedy this situation, check the on-screen gyro indication. If it is wrong, reset AD-10S, and then hit the MODE key to stop the flashing of the legend "GYRO."

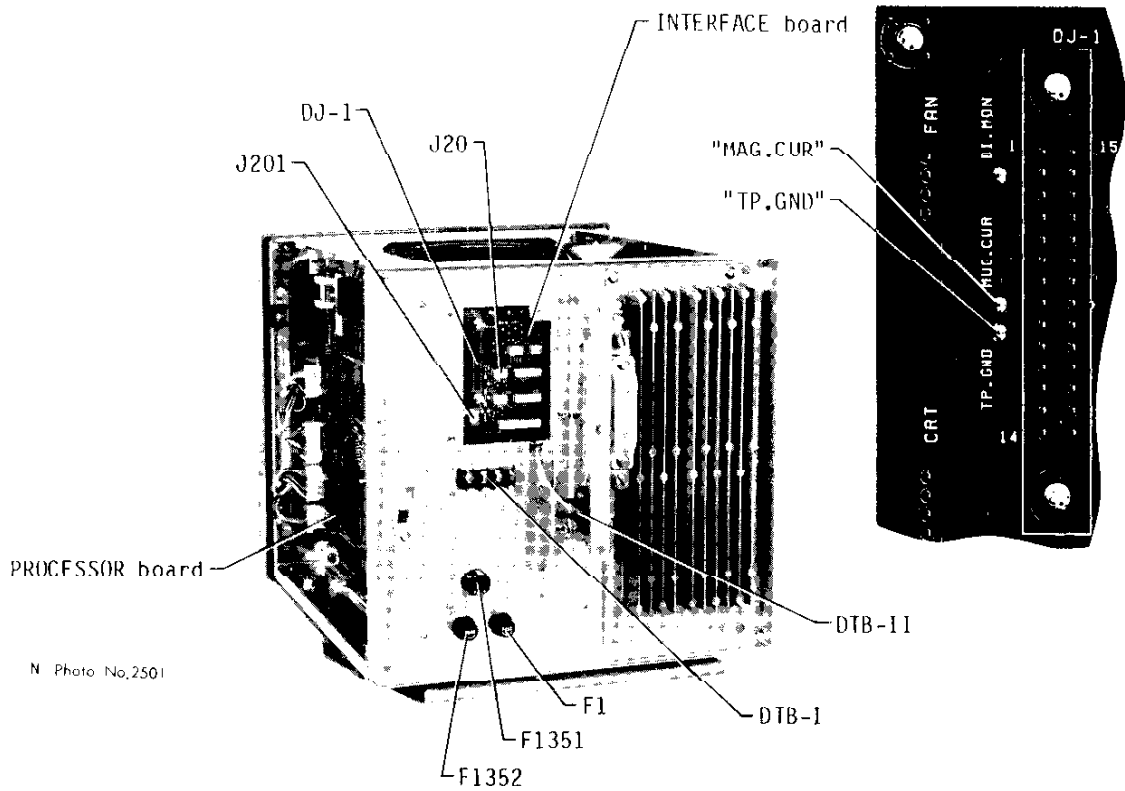


Fig.4-1 Display Unit (Rear view)

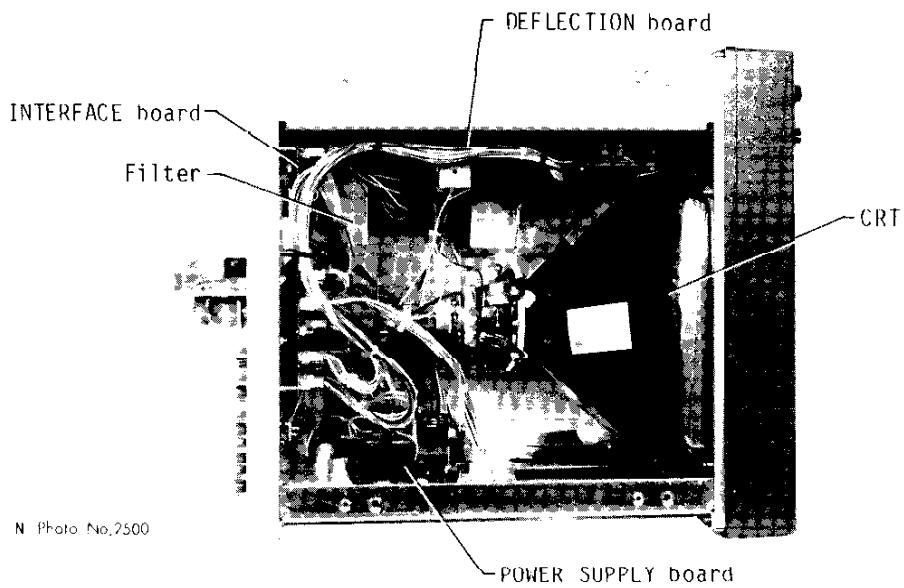


Fig.4-2 Display Unit (Top view)

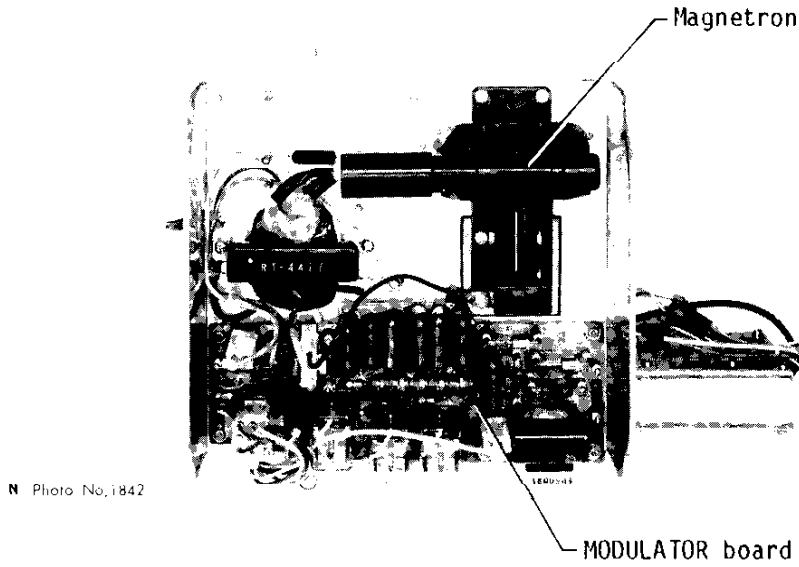


Fig.4-3 RF Transceiver Module (Bottom view, cover removed)

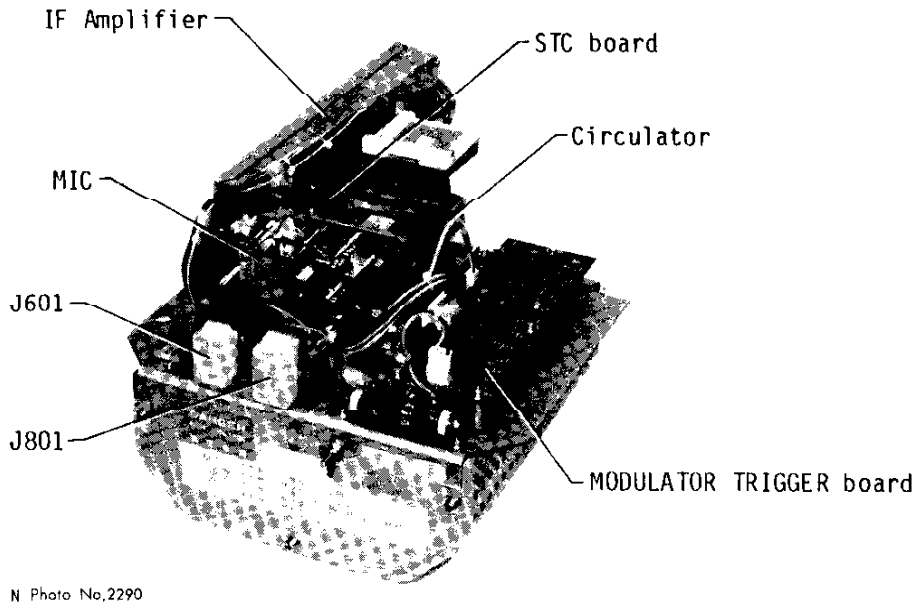


Fig.4-4 RF Transceiver Module

CHAPTER 5 INSTALLATION

GENERAL

This radar system is mainly composed of two units, the display and scanner units, and directly operates from the ship's mains of 12, 24 or 32VDC. For operation from 100, 110, 115, 220 or 230VAC, a rectifier unit is required.

When the radar is first unpacked, check that all units, parts and materials are contained, referring to the complete set, installation materials, spare parts and accessories lists. All steel and wood works should be arranged locally.

SCANNER UNIT INSTALLATION

Siting Considerations

The scanner unit is generally installed on the top of the wheelhouse or on the radar mast on an appropriate platform. When siting the unit, consideration must be given to the following points.

- 1) The standard supply interconnecting cable RW-3839-2 run between the scanner unit and the display unit is 15m in length. If additional cable is required for particular installation, an unbroken length must be used (i.e., no splices allowed), and its maximum length is 100 meters.
- 2) A funnel, mast or derrick post in line of sight of the radiator may cause blind sectors on the radar picture. A shadow sector between 355° 5' must be avoided by carefully planning the installation site.
- 3) Deposits and fumes from the funnel or other exhaust vent can adversely affect the aerial performance and hot gas tends to distort the radiator portion. The scanner unit must not be mounted in a place where it may be subjected to temperature in excess of 70°C.
- 4) The unit must not be positioned in close proximity to a direction finder (DF) aerial; separation of more than two meters is recommended.
- 5) The compass safe distance: 2.5 meters for standard compass, 2.0 meters for steering compass, should be observed.

Mounting and Connecting

Note the following cautions before beginning work on the scanner unit.

- 1) Do not lift the scanner unit by the radiator.
- 2) The seal washers and corrosion-proof rubber mat supplied as installation materials should be used to prevent electrolytic corrosion.

- 3) Run the supplied ground wire between the ground terminal fitted on the scanner bottom and the mounting platform ground terminal as illustrated below.

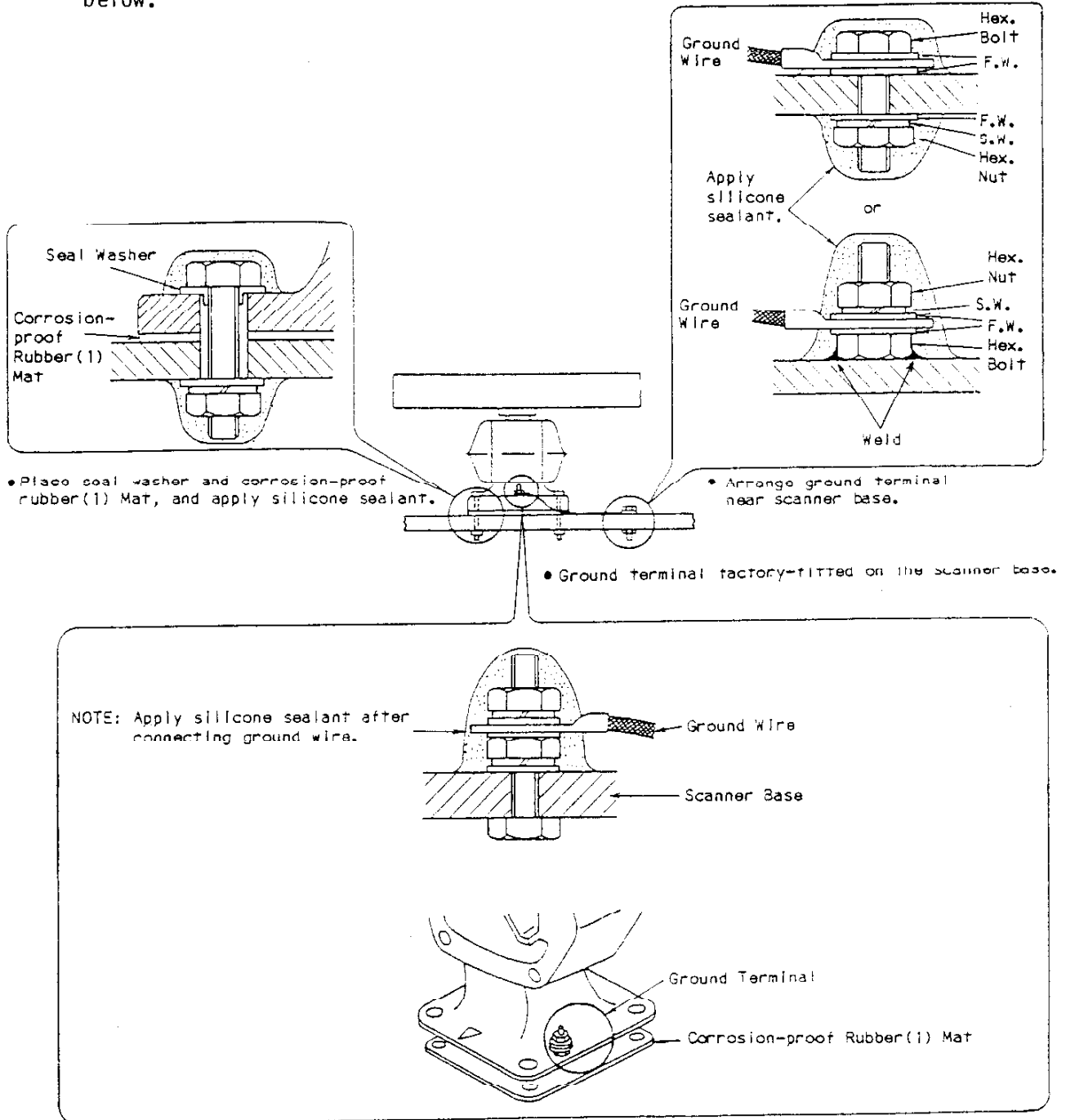


Fig.5-1 Remarks on Installation of the Scanner Unit.

- 4) Do not paint the radiator aperture.
- 5) Apply silicone sealant to bolts, nuts and washers to make future removal easier.

Fixing the Scanner Housing to the Chosen Site

1. Drill four bolt holes (15mm dia.) and one cable entry hole (approx. 50mm dia.) in the radar mast platform or the deck. See the scanner outline drawings on page 5-4 or page 5-5.
2. Place the corrosion-proof rubber mat on the chosen site.
3. Place the scanner on the mat and orientate the scanner so that the forward mark on the scanner base faces the ship's bow.
4. Insert the seal washers onto the bolts; apply silicone sealant over the bolts and nuts.
5. Fix the scanner to the chosen site, using the M12x60 bolts, nuts and washers supplied.

Connecting the Multicore Cable

Only the multicore cable runs to the scanner unit. The procedure for connecting the multicore cable to the scanner unit is as follows.

6. Pass the open end of the cable toward the scanner unit through a pipe or waterproof cable gland fitted through the top of the wheelhouse or bulkhead.
7. Open the scanner housing covers by removing the four bolts. Remove two transceiver fixing bolts and disconnect plugs P601 and P801; take out the transceiver module. See Fig.5-3 on page 5-6.

NOTE: To prevent magnetron demagnetization, do not place the transceiver module directly on a steel deck, etc. Place it on top of non-magnetic material (wood platform, styrofoam, etc.) or tilt it on its side as illustrated in the figure below.

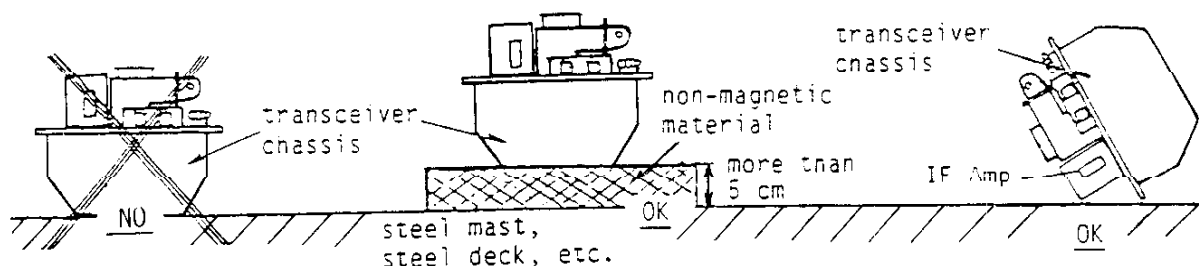
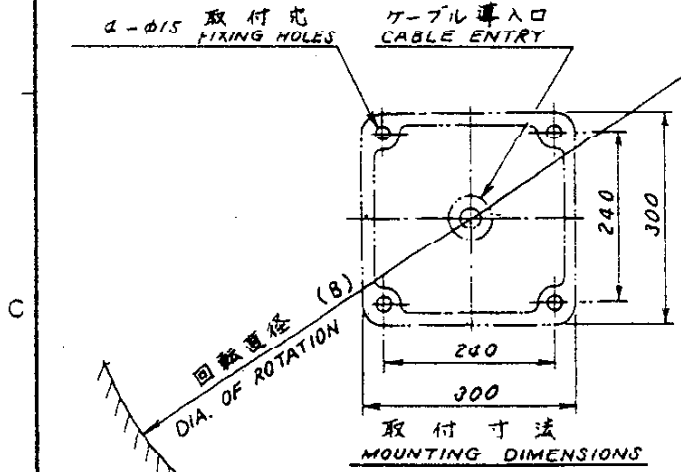
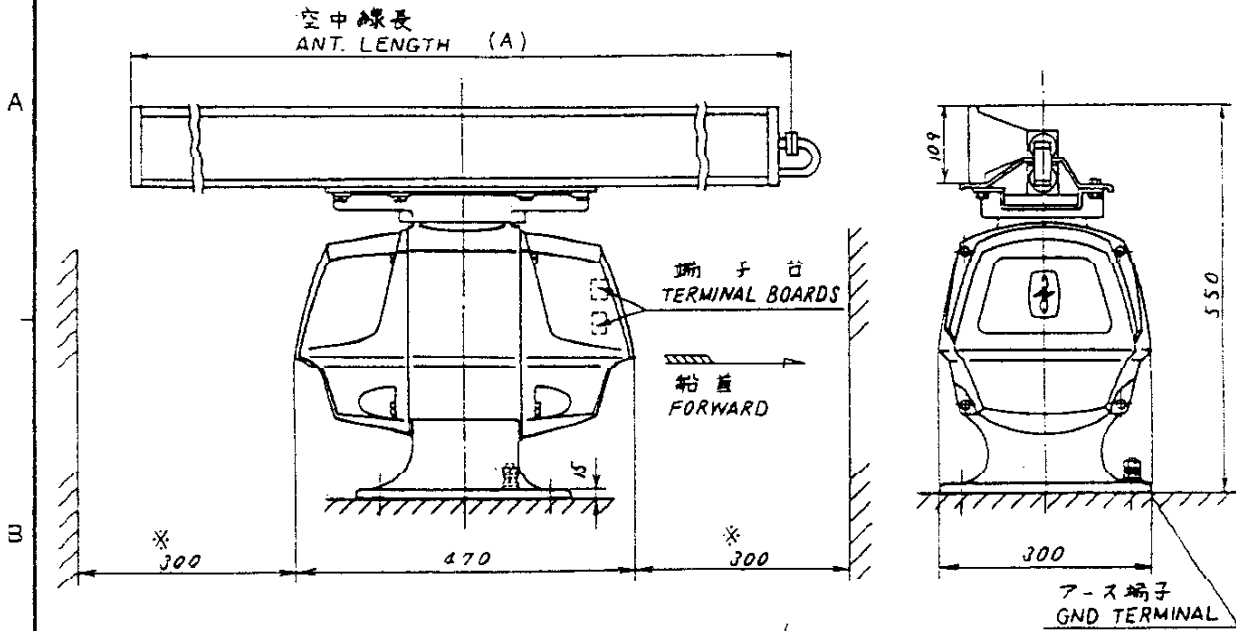


Fig.5-2 Preventing Magnetron Demagnetization

8. Remove the cable gland at the bottom of the scanner housing.
9. Pass the multicore cable through the scanner base and the cable gland (removed in step 8). See Fig.5-4.

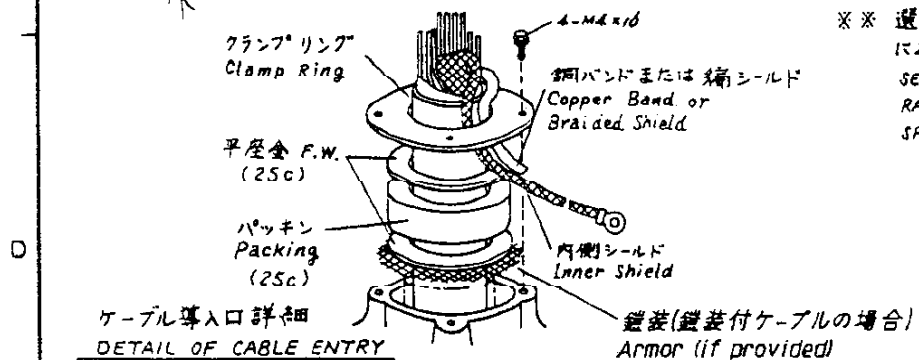


NOTE 1. ※: 推奨サービス空間
RECOMMENDED SERVICING CLEARANCE.

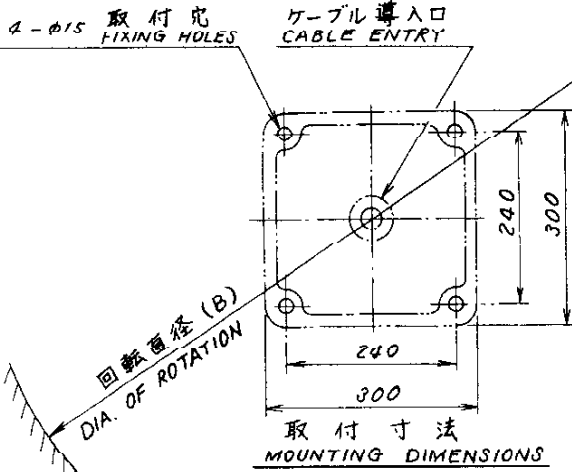
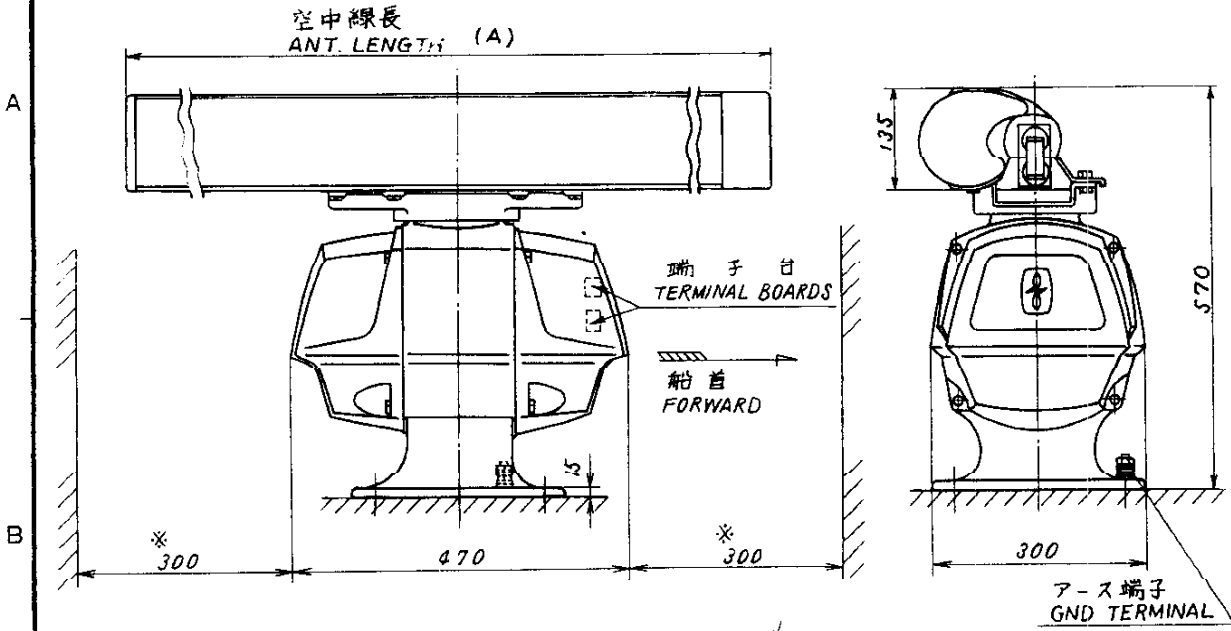
NOTE 2.

種類※ ANT. TYPE	100mm 型 TYPE	123cm 型 TYPE	200cm 型 TYPE
空中線長 (A) ANT. LENGTH	910mm	1250mm	2000mm
回転直径 DIA. OF (B) ROTATION	1100mm	1400mm	2200mm
重量 WEIGHT	32kg	33kg	37.5kg

※※ 選択可能な空中線部種類は、レーダー型式により異なる。各仕様を参照のこと。
SELECTABLE ANTENNA TYPE DEPENDS ON RADAR MODEL. SEE INDIVIDUAL SPECIFICATIONS.



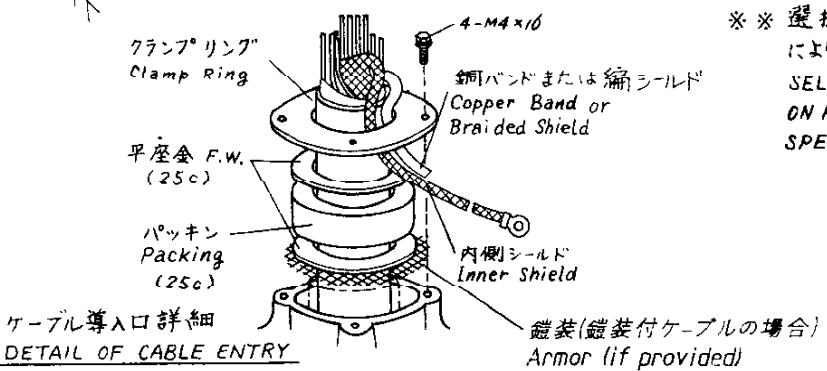
承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	備考 REMARKS
JAN. 12 '79		三角法 THIRD ANGLE PROJECTION				
JAN. 17 '79		R 度 SCALE	1/10			
Jan. 16 '79		重量 WEIGHT	kg			
		名称 TITLE	レーダー-空中線部外觀図 RADAR SCANNER UNIT XN1/2/3-CP7N2N/C2P8N2N			
		図番 DWG. NO.	C3237-001-P			



NOTE 1. ※: 推奨サービス空間
RECOMMENDED SERVICING CLEARANCE.

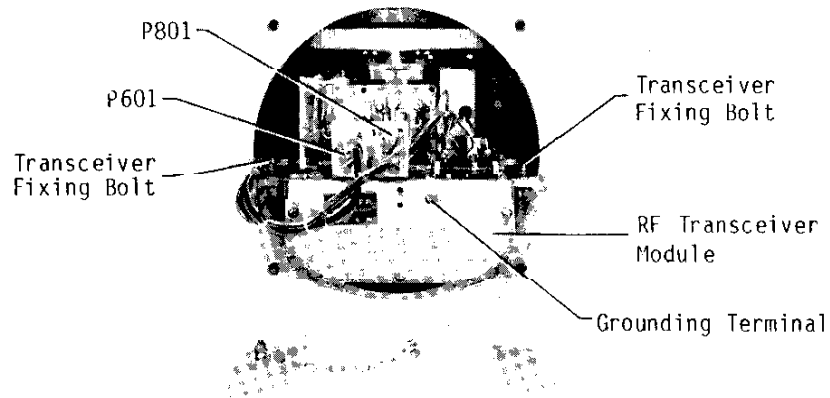
NOTE 2.

種類 ※※ ANT. TYPE	200cm型TYPE (XN-3A)	240cm型TYPE (XN-4A)
空中線長 (A) ANT. LENGTH	2070 mm	2570 mm
回転直径 DIA. OF (B) ROTATION	2200 mm	2700 mm
重量 WEIGHT	36.5 kg	39.5 kg



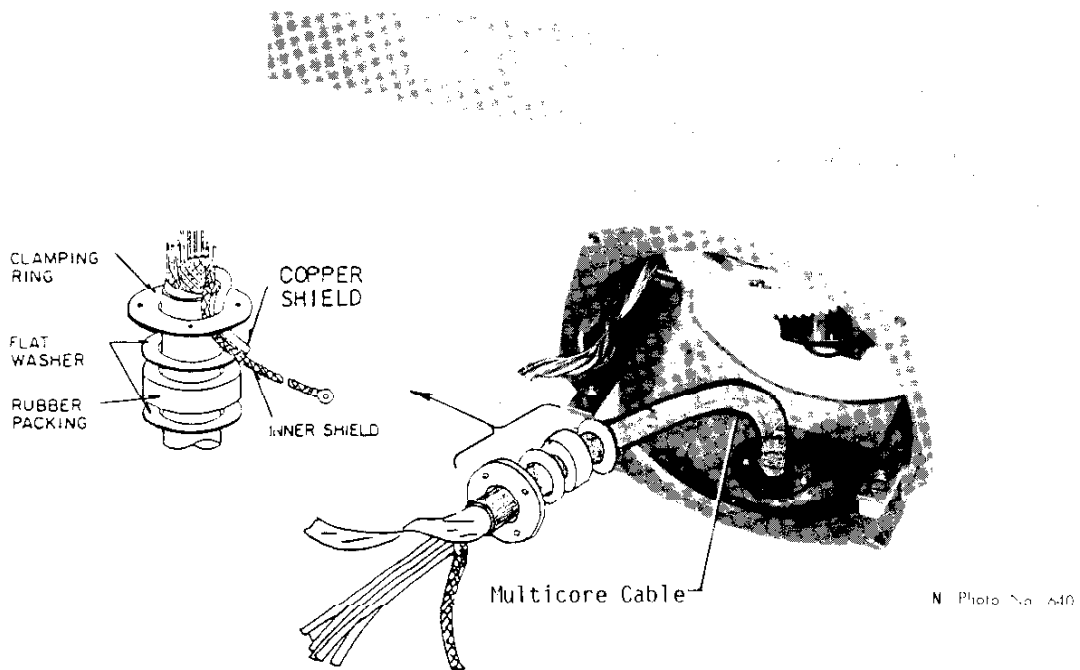
※※ 選択可能な空中線部種類は、レーダー型式により異なる。各仕様を参照のこと。
SELECTABLE ANTENNA TYPE DEPENDS ON RADAR MODEL. SEE INDIVIDUAL SPECIFICATIONS.

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	回番 DWG. NO.	備考 REMARKS
承認 APPROVED	DEC. 27. '82	三角法 THIRD ANGLE PROJECTION			名称 TITLE レーダー-空中線部外観図 RADAR SCANNER UNIT XN3A/4A-C2P7N2N/C2P8N2N
検図 CHECKED	DEC. 29. '82	尺度 SCALE	1/10		
製図 DRAWN	Dec. 27. '82	重量 WEIGHT	kg	図番 DWG. NO.	



N Photo No.2278

Fig.5-3 Scanner Unit (Front cover opened)



N Photo No. 640

Fig.5-4 Passing Multicore Cable Thru Scanner Base

10. Cut the cable to an appropriate length, and fabricate the cable end by referring to the instructions given below.

Fabricating the Multicore Cable

- 11a. Remove 450mm of the vinyl sheath, taking care not to cut the copper shield. (a)
- 11b. Slide the washer, rubber packing, washer, and clamping ring of the cable gland over the cable as shown in (b).
- 11c. Unwind the copper shield and separate the outer layer wires from those in the braided shield (inner wires). (c)
- 11d. Take out the wires and coaxial wire (2C-2V) from the inside layer. (d)
- 11e. Label inner and outer wires to aid identification.
- 11f. Cut each lead wire to a suitable length, taking into consideration their location on terminal board RTB-801.
- 11g. Remove about 6mm of the vinyl insulation from the end of each wire; then fix a $\phi 3$ red crimp-on lug (FV1.25-L3) to each wire. (e)
- 11h. Spread out the inner shield of the multicore cable and cut it off, leaving about 500mm. Put vinyl tubing or taping over the braided shield and solder a $\phi 4$ blue crimp-on lug (FV2-4) at the end of the shield.
- 11i. Pull on each crimp-on lug to make sure the connection is tight.
- 11j. Peel off about 50mm of the vinyl sheath of the coaxial cable (2C-2V), remove about 6mm from the inner core, and then put crimp-on lugs, 320882 and FV1.25-L3, on the inner core and the shield, respectively. Put cloth tape over the shield and core. (f)

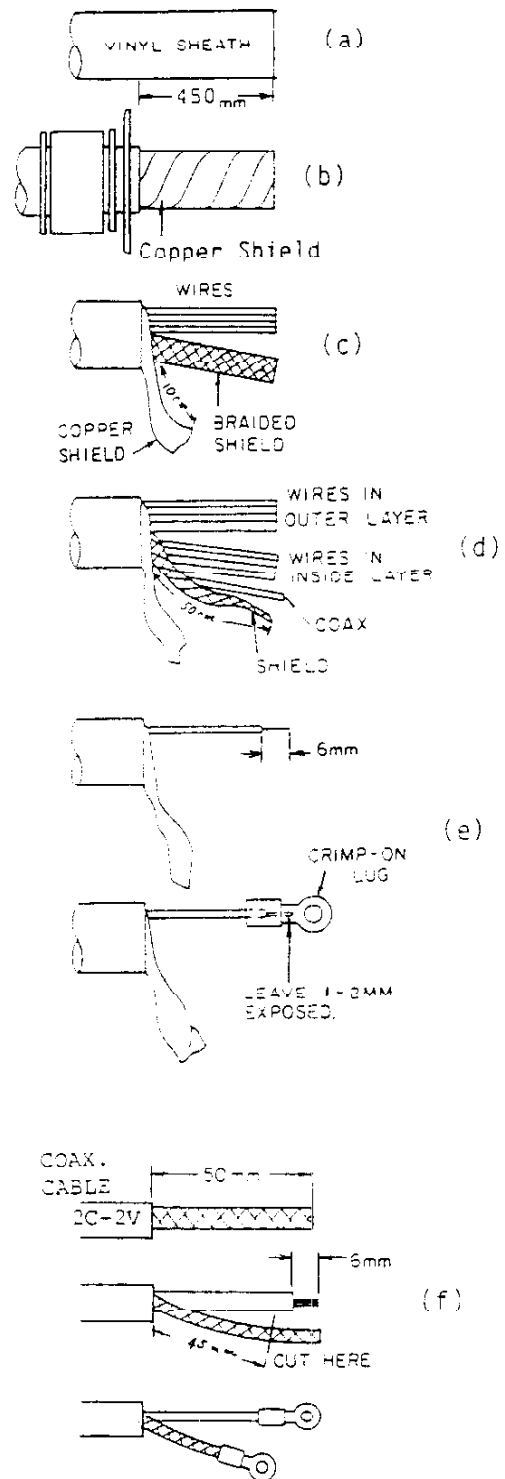


Fig.5-5 Fabricating the Multicore Cable

Final Preparations Inside the Scanner Housing

12. Tighten the cable gland to the scanner base. Ground the copper shield of the multicore cable with the clamping ring as shown in Fig.5-6.

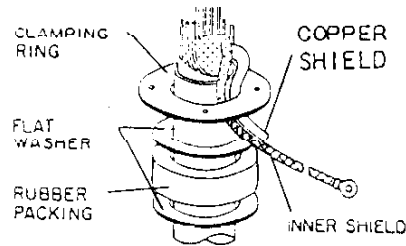
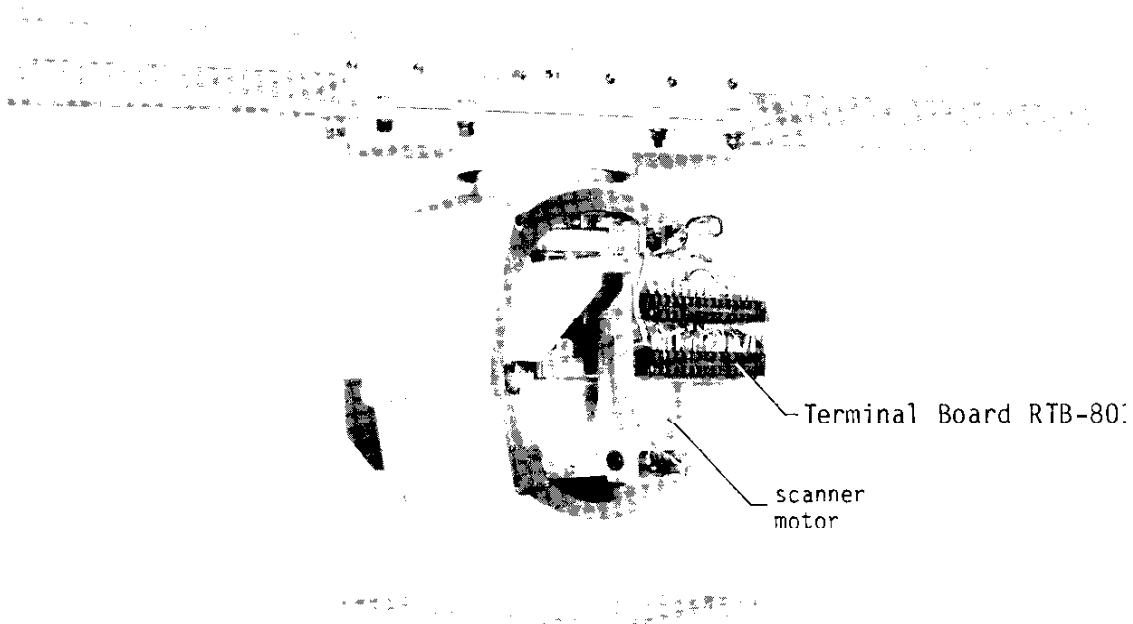


Fig.5-6 Grounding the Copper Shield

13. Connect the lead wires to terminal board RTB-801, referring to Fig.5-7 and the interconnection diagram on page 5-12. The inner shield of the multicore cable should be connected to the ground terminal on the RF transceiver module. Replace the scanner housing covers after completing the next section.



N Photo No. 639

Fig.5-7 Location of Terminal Board RTB-801

Assembling the Radiator

Apply silicone sealant to all bolts, nuts and washers to prevent corrosion. Detailed installation instructions are given in the scanner unit assembling drawings on page 5-10 or page 5-11.

14. Apply grease (not silicone sealant) to the O-ring and insert it into the groove of the radiator flange. Fix the feeder waveguide to the radiator flange.
15. Loosely fix the antenna radiator to the radiator bracket.
16. Place the greased O-ring in the groove of the rotary waveguide flange. Fix the feeder waveguide to the rotary waveguide flange.
17. Fix the feeder waveguide to the bottom of the radiator.
18. Tighten the bolts fixing the antenna radiator to the radiator bracket.
19. Replace the transceiver module and secure it with the two bolts removed in step 7. Reconnect plugs P801 and P601.
20. Ensure all wirings are made correctly.
21. Temporarily close the scanner housing cover. You will need to get inside the housing again to make various adjustments. Refer to pages 5-21 thru 5-26.

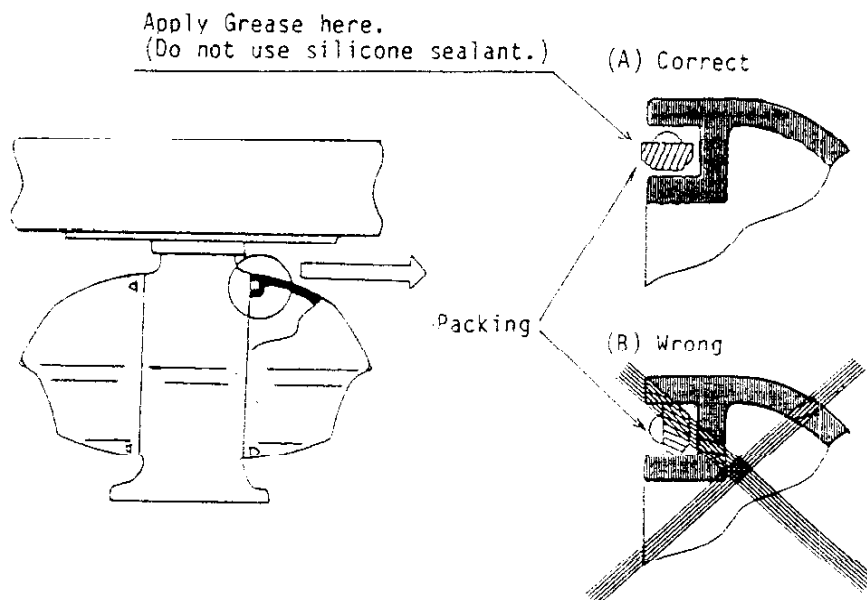


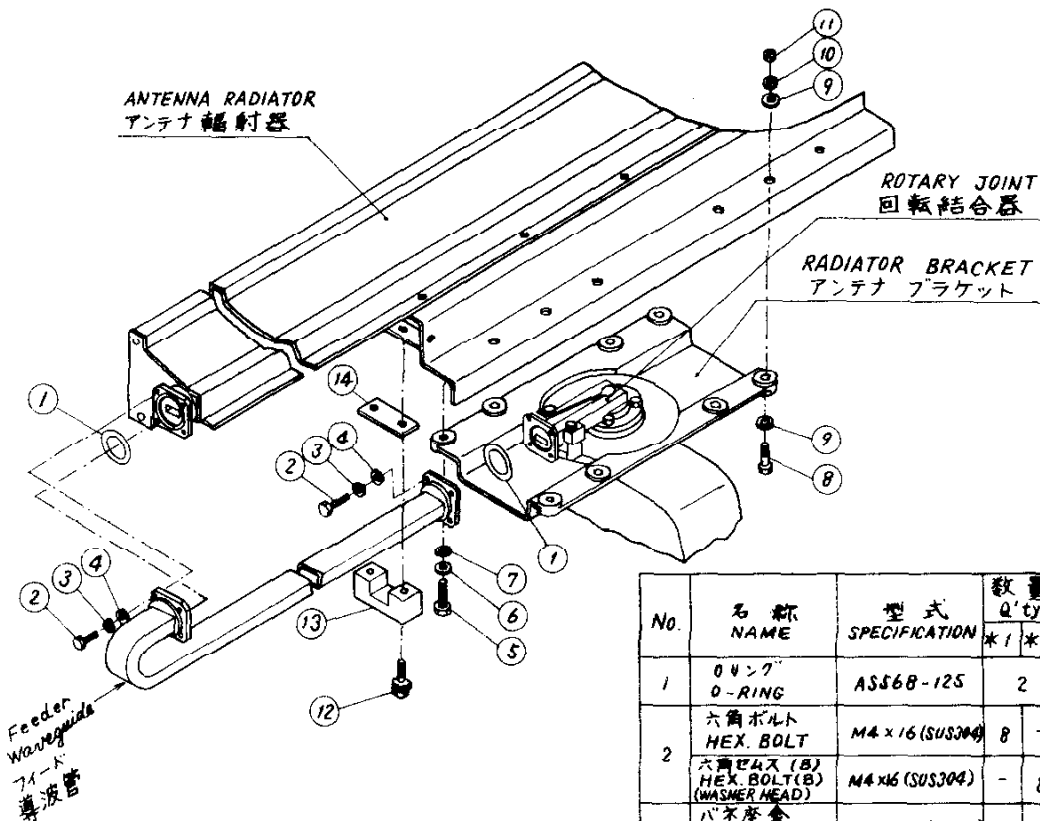
Fig.5-8 Installing the packings

A

B

C

D



No.	名称 NAME	型式 SPECIFICATION	数量 Q'ty	
			*1	*2
1	O-RING	ASS68-125	2	
2	六角ボルト HEX. BOLT	M4×16(SUS304)	8	-
	六角ワッシャー (B) HEX. BOLT (B) (WASHER HEAD)	M4×16(SUS304)	-	8
3	バネ座金 SPRING WASHER	FOR M4用(SUS304)	8	-
4	平座金 FLAT WASHER	FOR M4用(SUS304)	8	-
5	六角ボルト HEX. BOLT	M8×25(SUS304)	4	-
	六角ワッシャー (A) HEX. BOLT (A) (WASHER HEAD)	M6×25	-	6
6	バネ座金 SPRING WASHER	FOR M8用(SUS304)	4	-
7	平座金 FLAT WASHER	FOR M8用(SUS304)	4	-
8	六角ボルト HEX. BOLT	M8×30(SUS304)	4	6
9	平座金 FLAT WASHER	FOR M8用(SUS304)	8	12
10	バネ座金 SPRING WASHER	FOR M8用(SUS304)	4	6
11	六角ナット HEX. NUT	M8(SUS304)	4	6
12	六角ワッシャー (B) HEX. BOLT (B) (WASHER HEAD)	M4×25	-	2
13	導波管押え WIG CLAMP	RSB-2006-1	-	1
14	導波管パッキン WIG PACKING	RSB-2008-0	-	1

NOTE 1. 電蝕防止のため、組立時にボルト、ナット、ワッシャー及びフランジ面のOリング溝外側の部分に支給のシリコンシーラント(無酸性)を塗布する。Oリング及びOリング溝には塗布しないこと。
 APPLY SILICONE SEALANT (SUPPLIED, NON-ACID TYPE) ON BOLTS, NUTS, WASHER AND WAVEGUIDE FLANGE OUTSIDE O-RING GROOVE TO AVOID ELECTRICAL CORROSION. (DO NOT APPLY SEALANT TO O-RINGS AND O-RING GROOVES.)

2. Oリングにきずをつけたり、ごみを付着させないように注意の事。
 DO NOT PINCH O-RING AND KEEP IT CLEAN.

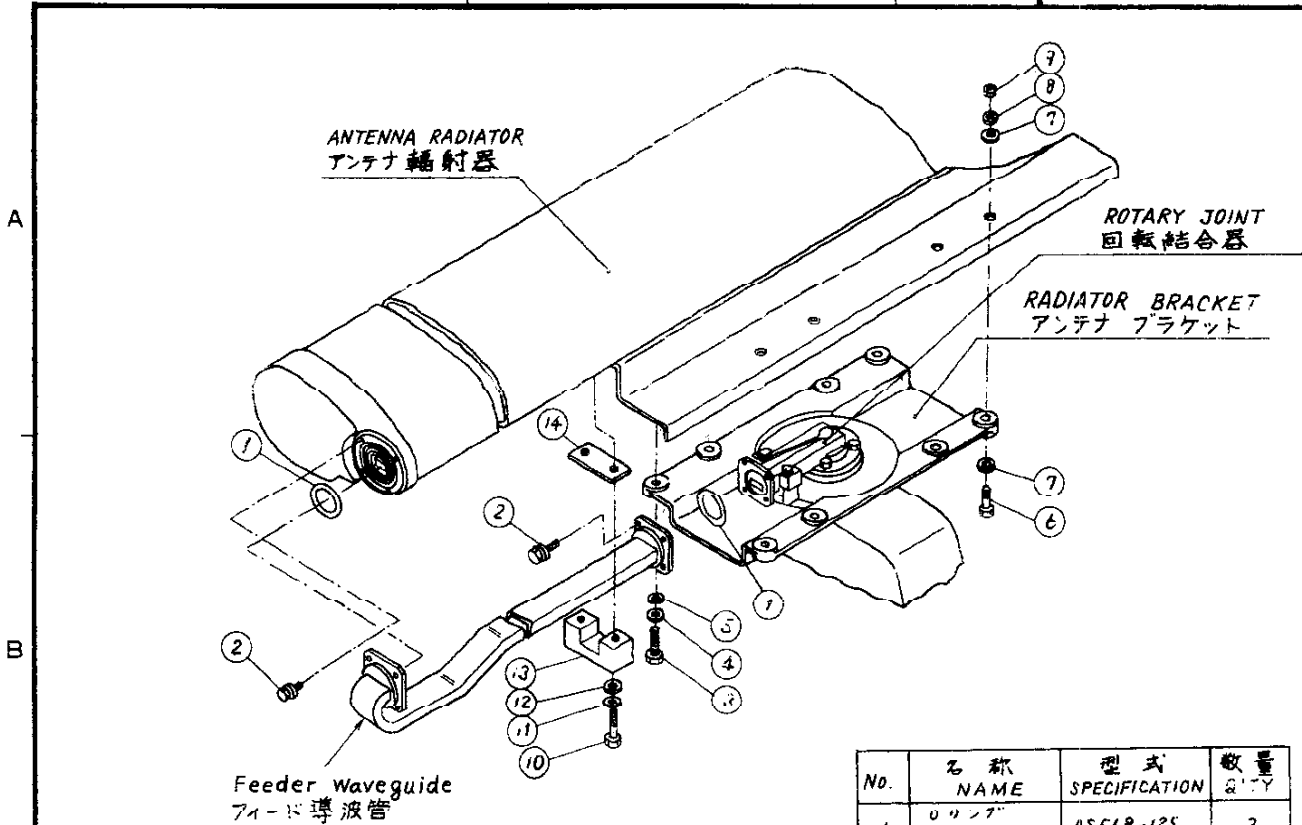
3. Oリング及びスキャナカバーのパッキンにはグリースを使用すること。シリコンシーラントは使用不可。
 FOR PACKINGS OF SCANNER COVERS AND O-RINGS, DO NOT USE SILICONE SEALANT, BUT RATHER USE GREASE.

*1: 900/1230mm アンテナ用 (XN-1/2)
 FOR 900/1230mm RADIATOR (XN-1/2)

*2: 2000mm アンテナ (XN-3) 用
 FOR 2000mm RADIATOR (XN-3)

品番 ITEM	品名 NAME	材質 MATERIAL	数量 QTY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	三角法 THIRD ANGLE PROJECTION	名称 TITLE	空中線部組立図 SCANNER UNIT ASSEMBLING		
検 CHECKED	尺 SCALE	空中線長 ANT. LENGTH: 900, 1230 & 2000mm (XN-1/2/3)			
製 DRAWN	重 WEIGHT	kg	図番 DWG. NO. C3237-025-H		

REV: 2/83, 8/83, 7/88



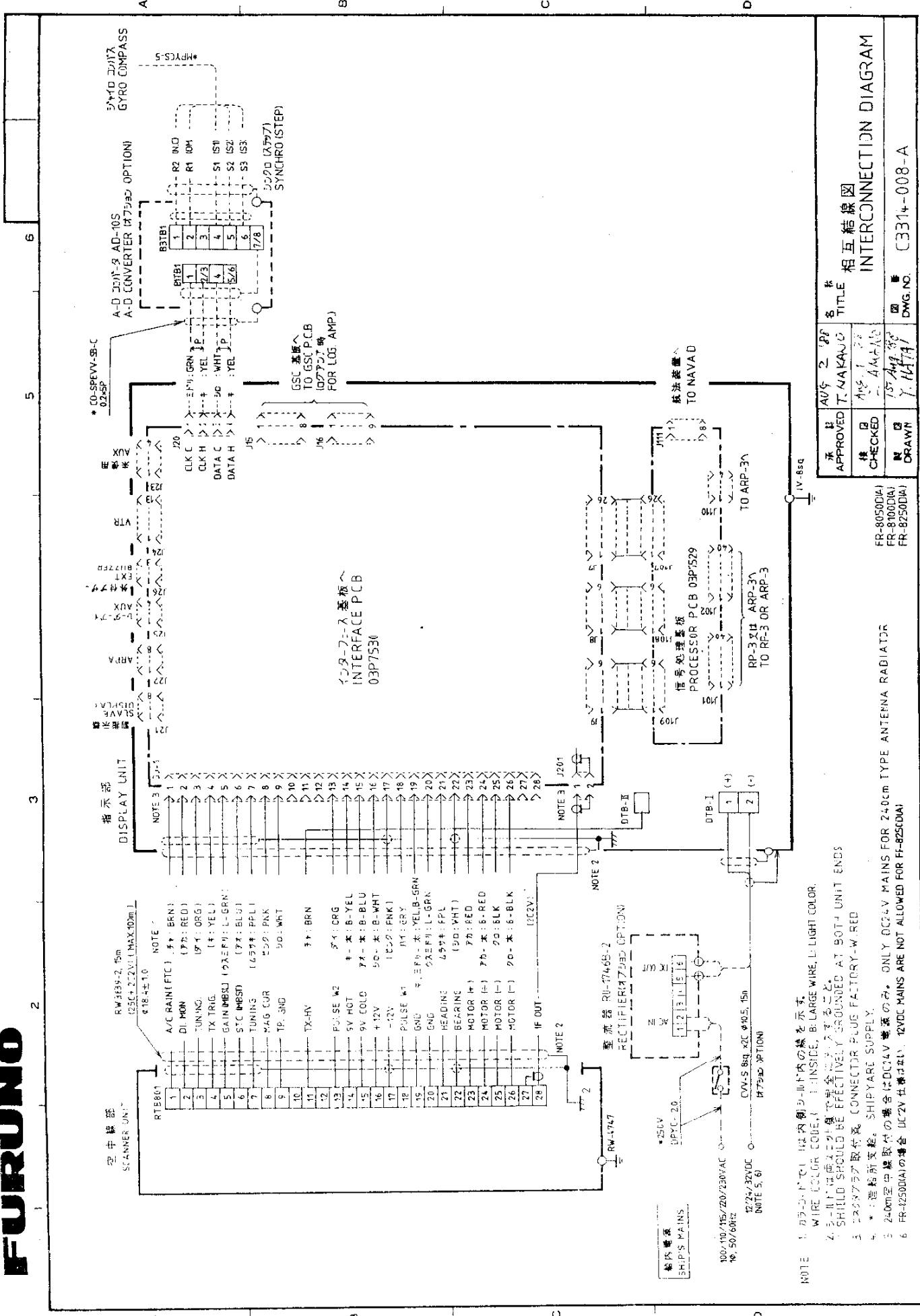
NOTE 1. 電蝕防止のため、組立時にボルト、ナット、ワッシャー及びフランジ面のOリング溝外側の部分に支給のシリコンシーラント(無酸性)を塗布する。Oリング及びOリング溝には塗布しないこと。
 APPLY SILICONE SEALANT (SUPPLIED, NON-ACID TYPE) ON BOLTS, NUTS, WASHER AND WAVEGUIDE FLANGE OUTSIDE O-RING GROOVE TO AVOID ELECTRICAL CORROSION. (DO NOT APPLY SEALANT TO O-RINGS AND O-RING GROOVES.)

2. Oリングにきずをつけない。ごみを付着させないように注意の事。
 DO NOT PINCH O-RING AND KEEP IT CLEAN.

3. Oリング及びスキャナカバーのパッキングにはグリースを使用すること。シリコンシーラントは使用不可。
 FOR PACKINGS OF SCANNER COVERS AND O-RINGS DO NOT USE SILICONE SEALANT, BUT RATHER USE GREASE.

No.	名称 NAME	型式 SPECIFICATION	数量 Q'TY
1	Oリング O-RING	ASS60-12S	2
2	六角ボルト(B) HEX. BOLT(B) (WASHER HEAD)	M4x16(SUS304)	8
3	六角ボルト HEX. BOLT	M8x20(SUS304)	2
4	バネ座金 SPRING WASHER	FDR M8用(SUS304)	4
5	平座金 FLAT WASHER	FDR M8用(SUS304)	4
6	六角ボルト HEX. BOLT	M8x30(SUS304)	4
7	平座金 FLAT WASHER	FDR M8用(SUS304)	8
8	バネ座金 SPRING WASHER	FDR M8用(SUS304)	4
9	六角ナット HEX. NUT	M8(SUS304)	4
10	六角ボルト HEX. BOLT	M4x30(SUS304)	2
11	バネ座金 SPRING WASHER	FDR M4用(SUS304)	2
12	平座金 FLAT WASHER	FDR M4用(SUS304)	2
13	導波管押え WIG CLAMP	R5B-2006-1	1
14	導波管間座 WIG PACKING	03-003-4003-0	1

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	MAY. 25. '79	三角法 THIRD ANGLE PROJECTION	名称 TITLE	空中線部組立図 SCANNER UNIT ASSEMBLING (XN3A/XN4A/XN5A)	
検図 CHECKED	MAY. 25. '79	尺・度 SCALE	図番 DWG. NO.	C3249-017-E	
製図 DRAWN	25. 5. 79	重量 WEIGHT	kg		



承認者 APPROVED	2 T. NAKAJI	各機 TITLE	相互接続図 INTERCONNECTION DIAGRAM
検出 CHECKED	1 A. HATA	図番 DWG. NO.	C3314-008-A
描出 DRAWN	1 Y. HATA		

FR-8050(DA)
FR-8100(DA)
FR-8250(DA)

指示部
DISP UNIT

空機部
SCANNER UNIT

FURUNO ELECTRIC CO., LTD.

DISPLAY UNIT INSTALLATION

Siting Considerations

Locate the display unit in a place where it can be viewed and operated conveniently but where there is no danger of salt or fresh water spray or immersion.

The magnetic compass may be affected if the display unit is placed too close to it, because of the magnetic fields generated in the radar. The compass safe distance; 1.0 meters for standard compass, 0.75 meters for steering compass, must not be disregarded.

The orientation of the display unit should be so that the radar screen is viewed while the operator is facing the bow. This makes determination of position much easier.

The mount can be installed either on a tabletop or on a bulkhead. The mounting dimensions for this unit are shown on page 5-15. You can use the mounting cradle itself as a template for marking the mounting bolt holes. Since the unit weights 19 kg reinforce the mounting place, if necessary.

Make sure you allow enough clearance to get to the connectors behind the unit. Leave at least a foot or so of "service loop" of cables behind the unit so that it can be pulled forward for servicing or easy removal of the connectors. The recommended clearances for servicing ease are given on page 5-15.

Mounting

Tabletop

1. Remove the two bolts (M8x40) fixing the display unit to the mounting cradle.
2. Drill four mounting holes (12mm dia.) through the tabletop.
3. Secure the mounting cradle to the tabletop by using M10 bolts, nuts and washers. 9mm radius coach screws may be substituted for the M10 bolts.
4. Place the display unit on the mounting cradle and secure them at the front of the display unit with the two bolts removed at step 1.

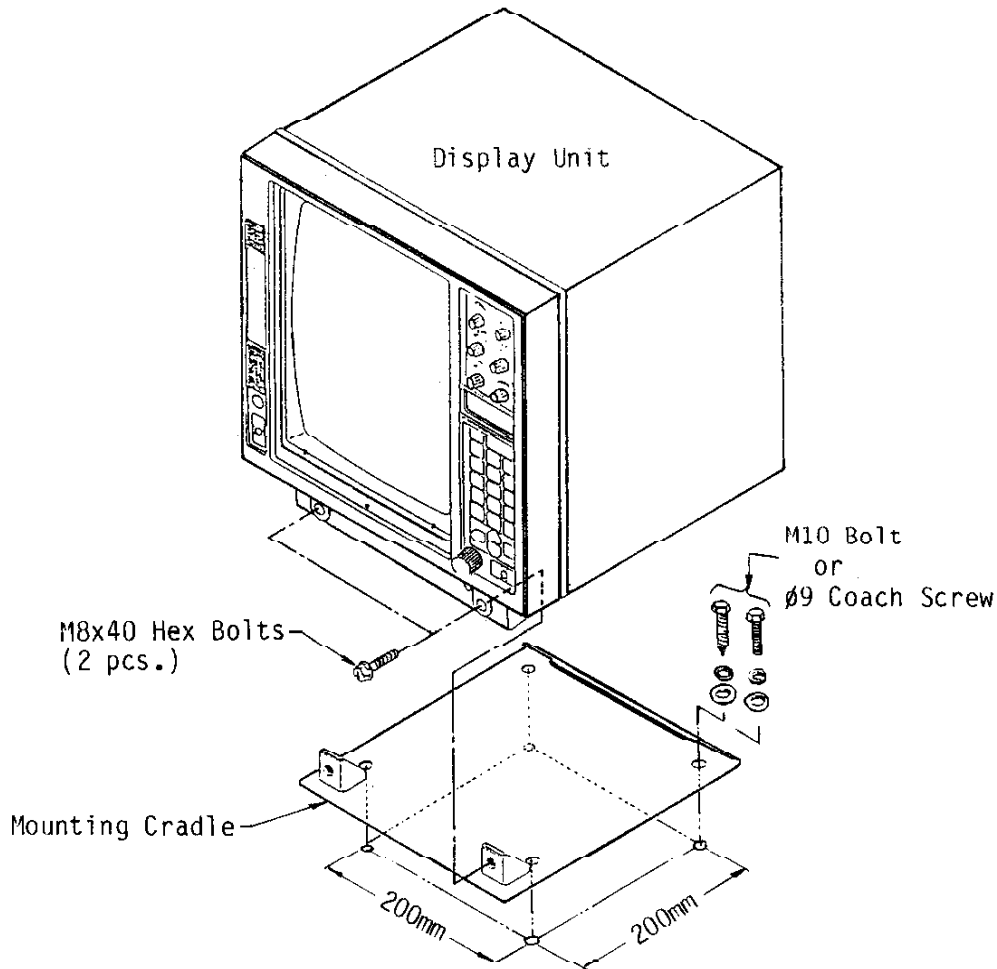
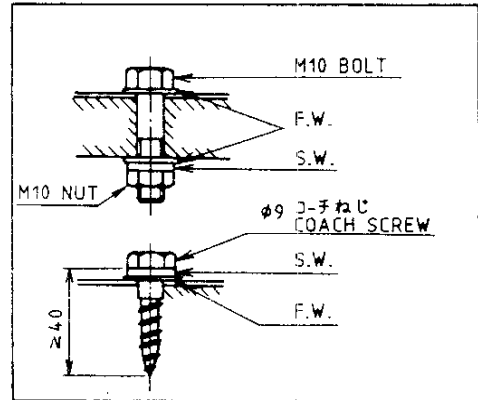
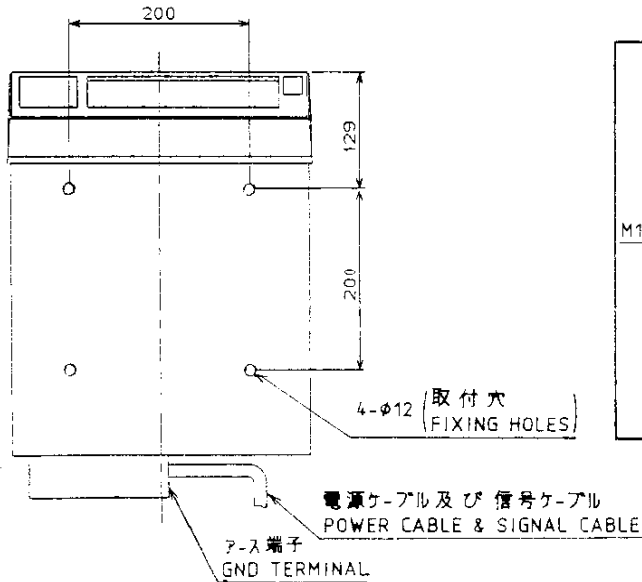
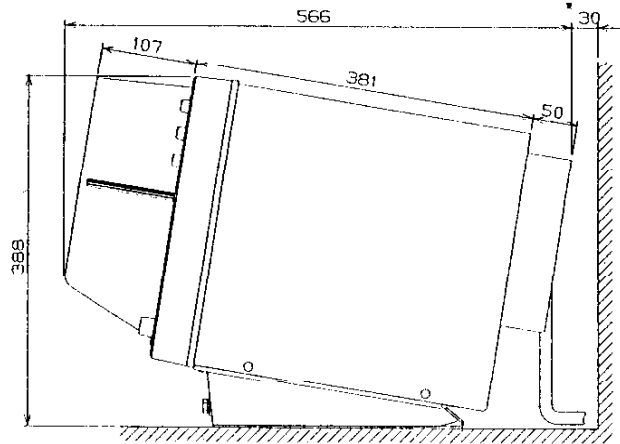
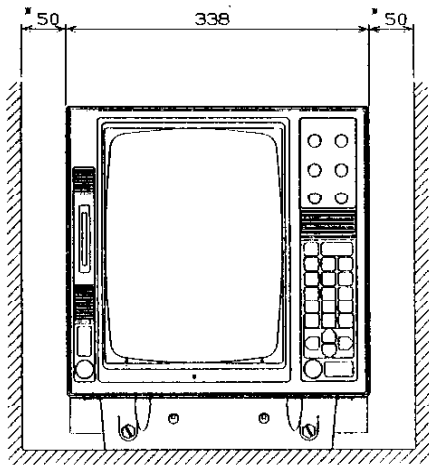


Fig.5-9 Tabletop Mounting

A
B
C
D



NOTE 1 * : 推奨サービス空間。
RECOMMENDED SERVICING CLEARANCE.

NOTE 2 : 装備ケーブルはサービス時、指示部を前方に十分引き出せるよう余裕をもたせること。
SUFFICIENT EXTRA CABLINGS SHOULD BE ALLOWED AT THE BACK OF THE UNIT SO THAT THE UNIT CAN BE DRAWN OUT WITH THE CABLES CONNECTED FOR MAINTENANCE.

コンパス安全距離
COMPASS SAFE DISTANCE

標準コンパス STANDARD COMPASS	1.0m
操舵コンパス STEERING COMPASS	0.75m

FR-8050D(A)/8100D(A) 8250D(A)	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q.TY	図番 DWG.NO.	摘要 REMARKS
承認 APPROVED	JUNE 21 1988 M. Takata	三角法 THIRD ANGLE PROJECTION				名称 TITLE レーダー 指示部外寸図 RADAR DISPLAY UNIT
検 CHECKED		尺度 SCALE				1/8
製 DRAWN	JUNE 21 1988 T. HATAI	重量 WEIGHT				19 kg 図番 DWG.NO. C3314-007-A

Bulkhead

1. Take the top cover off by loosening six M4x10 cosmetic screws.
2. Loosen two M8x40 hex bolts at the front of the display unit, and the mounting cradle comes free. Secure the mounting cradle to the bulkhead.
3. After disconnecting flying connector P/J1351, loosen four M6x20 hex bolts and separate the ramp base with the bottom plate from the display unit.
4. Loosen four M3x6 screws to separate the bottom plate from the ramp base.
5. Loosen the lock nuts for the POWER and SCANNER switches on the ramp base and turn them upside down, and secure the lock nuts. Attach the label (2) supplied as the spare parts to the ramp base.
6. Refix the bottom plate to the ramp base.
7. Connect the flying connector, and fix the ramp base to the top of the display unit with four M6x20 hex bolts removed in step 3.
8. Fix the top cover to the bottom of the display unit.
9. Fix the unit to the mounting cradle.

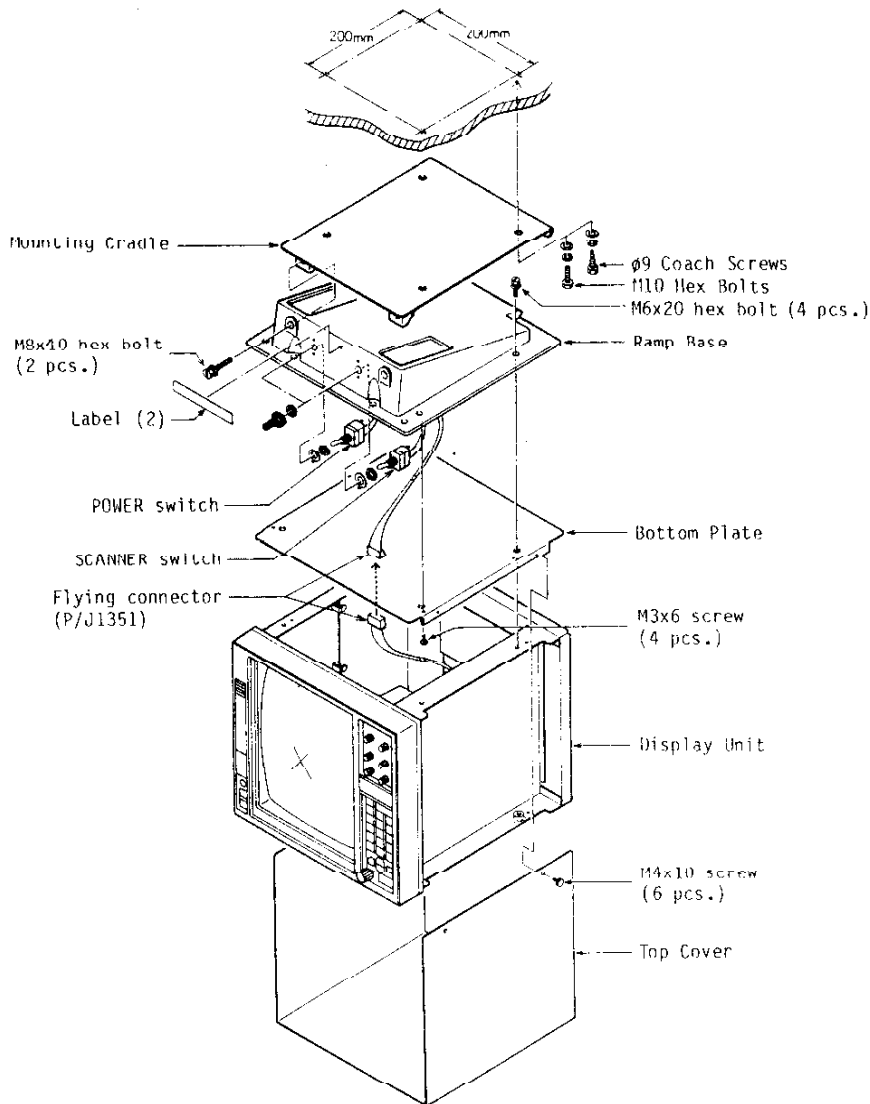


Fig.5-10 Bulkhead Mounting

Connections

Two cables run to the display unit, the multicore cable from the scanner unit and the power cable from the ship's mains or rectifier. The multicore cable is terminated with factory-wired connectors at the display side. Fabricate the power cable (optional supply) as follows.

Fabricating the Power Cable

5. Remove 200mm of the vinyl sheath, taking care not to nick the braided shield.
6. Unwind the cloth tape and cut it off.
7. Take out about 40mm of the inner core of the braided shield; cut off the jute.
8. Remove about 10mm of the insulators from the cores and fix the supplied crimp-on lugs to the cores.
9. Wrap the braided shield with vinyl tape, leaving space for clamping.

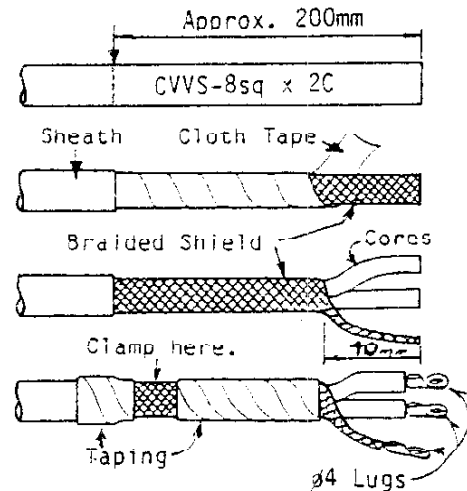


Fig.5-11 Fabricating the Power Cable

Connecting the Multicore Cable

10. Expose the copper shield of the multicore cable by removing the vinyl tape at the point shown below.

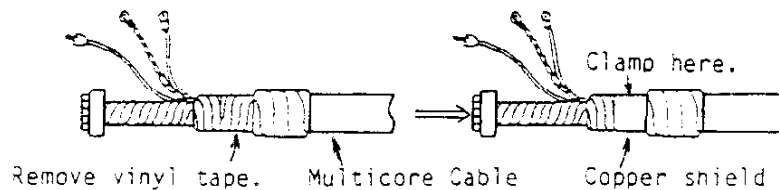


Fig.5-12 Multicore Cable (Display Unit side)

11. Take off the rear cover by loosening five M4x8 fixing screws.
12. Separate the clamp plate from the cable clamp by loosening two M4x10 fixing screws. Then secure the multicore cable and power cable so that the cable shield is completely grounded thru the clamp.
13. Cables of optional equipment(s) should be secured by the cable clamp after loosening two M6x35 hex bolts.
14. Dress the end of the multicore cable through the cutout in the rear panel; and then connect the coaxial cable plug P201, multicore cable connector DP-1, TX-HV line and inner shield of the multicore cable.

15. Ground the inner shield of the multicore cable to the chassis through a screw beside the terminal board DTB-II.
16. Connect the power cable to the terminal board DTB-I; positive core to #1 and negative core to #2. Ground the shield of the power cable to the chassis through a screw beside the terminal board DTB-I.

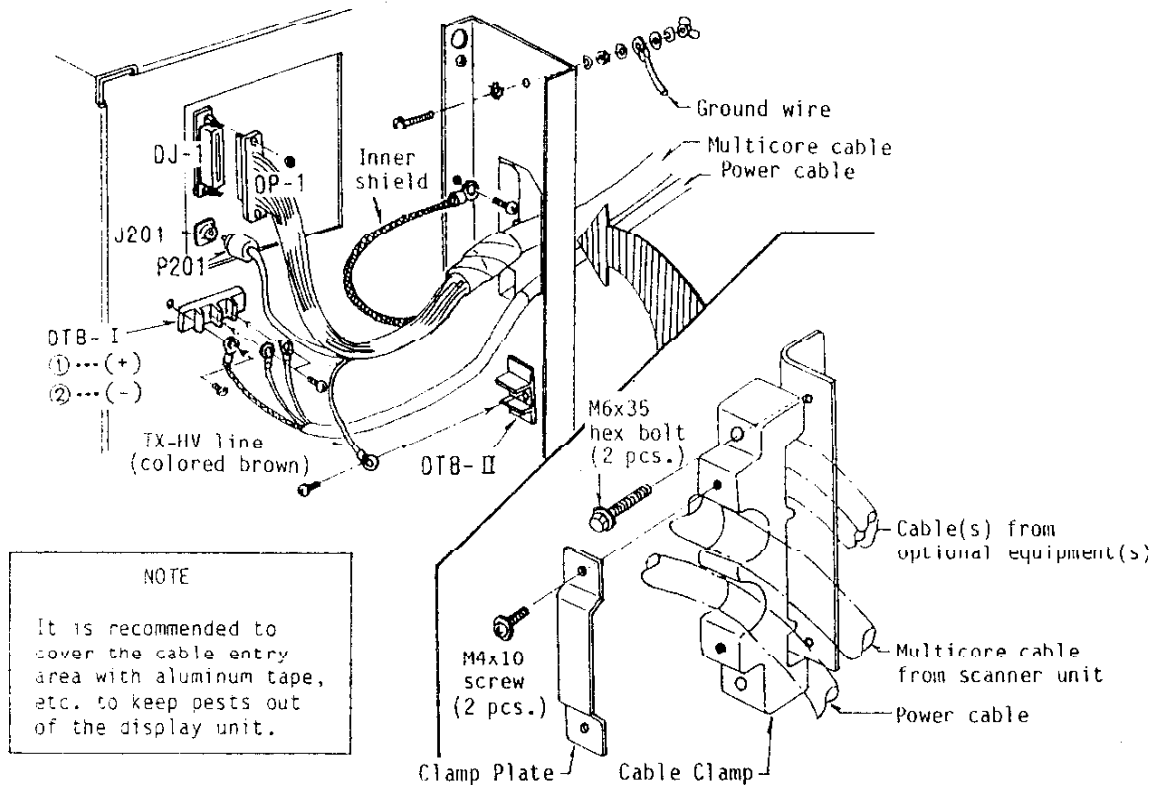


Fig.5-13 Display Unit (Rear cover removed)

Confirmation on the POWER SUPPLY Board

There are some jumper wires which must be changed with respect to the ship's mains. The POWER SUPPLY board is located on the left side of the display unit and the jumpers are accessible when the display cover is removed.

Jumper	24 or 32VDC mains	12VDC mains
JP-1	without jumper	with jumper
JP-2	Common - H	Common - L
JP-3	Common - H	Common - L
JP-4	Common - H	Common - L
JP-5	Common - H	Common - L

The 8ft radiator (XN-4A) can be used when the ship's mains is 24VDC. In this case, the jumper terminal JP-6 should be bridged as shown on the next page.

Jumper	2.4m (8ft)	1.2m (4ft) and 2m (6.5ft)
JP-6	SC-SM	SC-INV

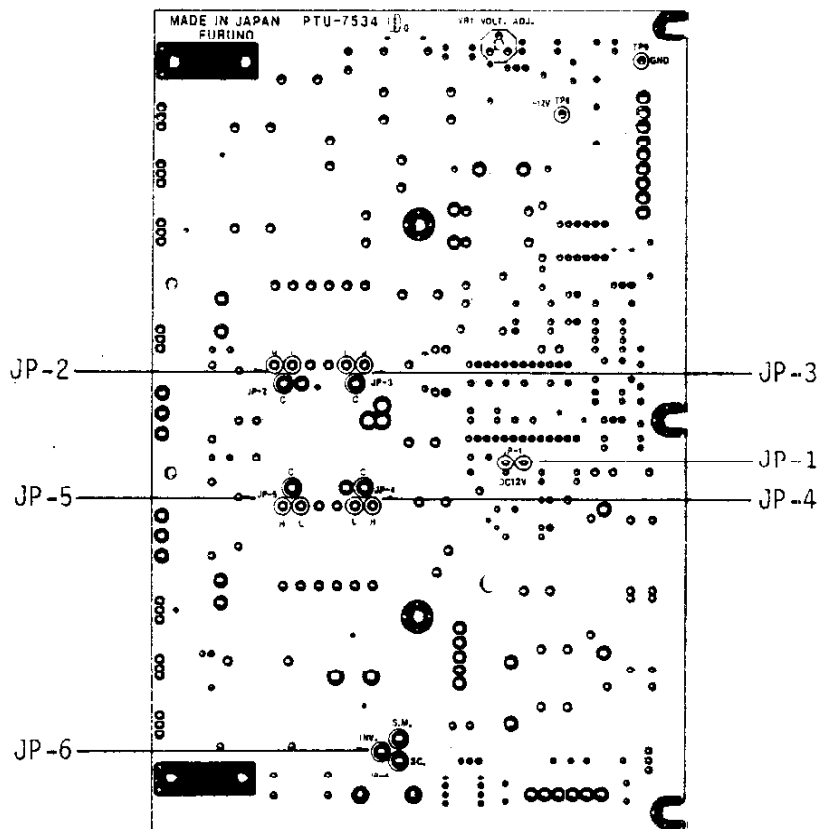


Fig.5-14 Power Supply Board

RECTIFIER UNIT INSTALLATION AND CONNECTION

For the set driven by 100/110/115/220/230VAC ship's mains a rectifier unit (RU-1746B-2) is required. The unit can be mounted in any dry, well-ventilated place. The mounting dimensions are shown in the outline drawing on the next page. The compass safe distance, 1.8 meters, standard compass, and 1.0 meters, steering compass, should be observed.

For connection to this unit, refer to both the diagram on the next page and the interconnection diagram on page 5-12.

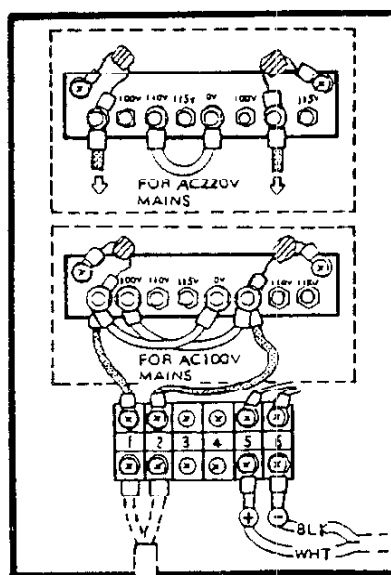
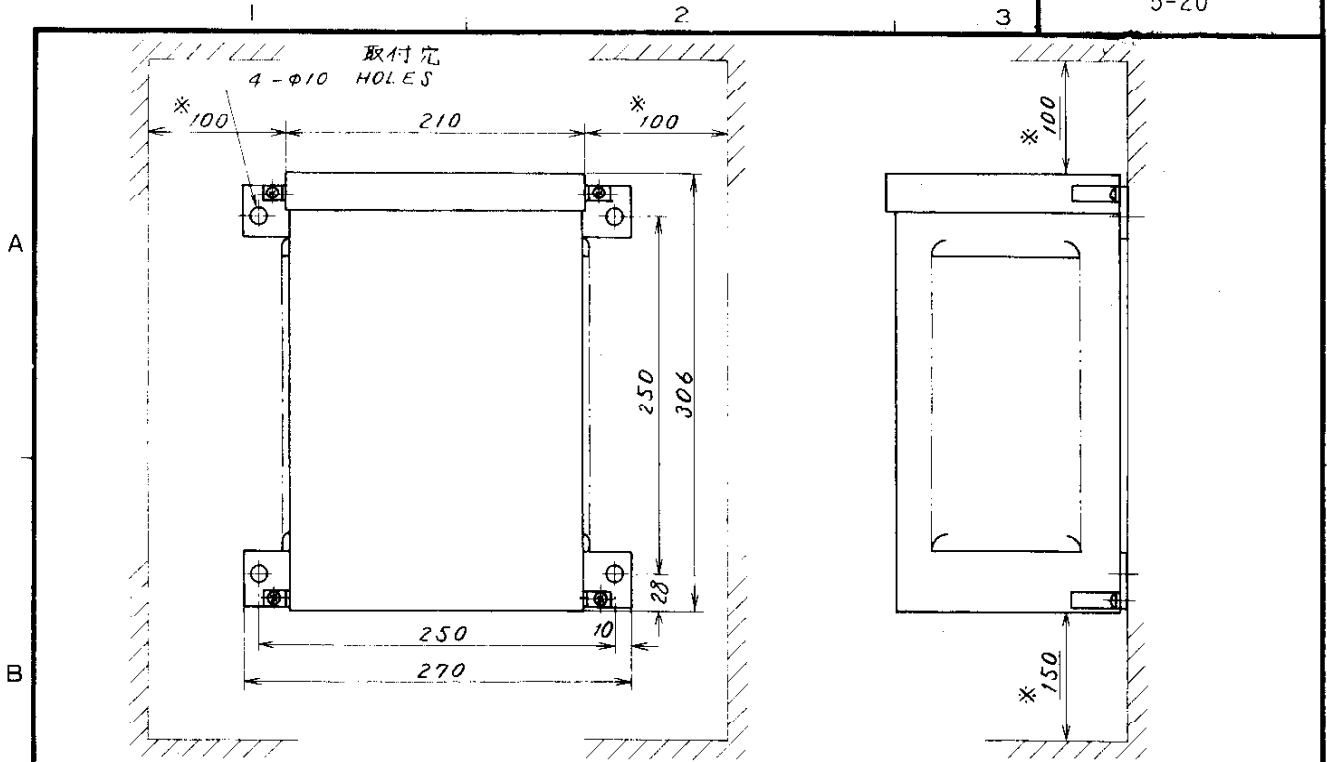
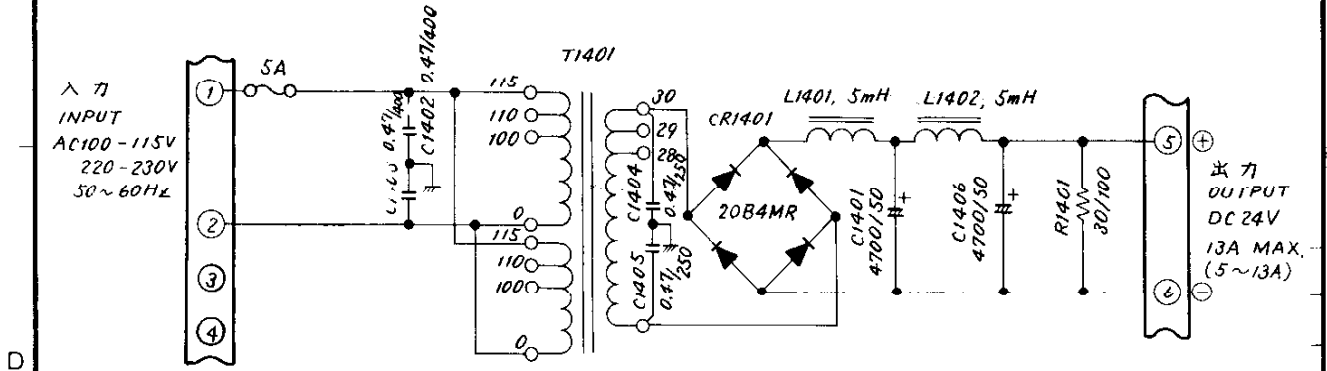
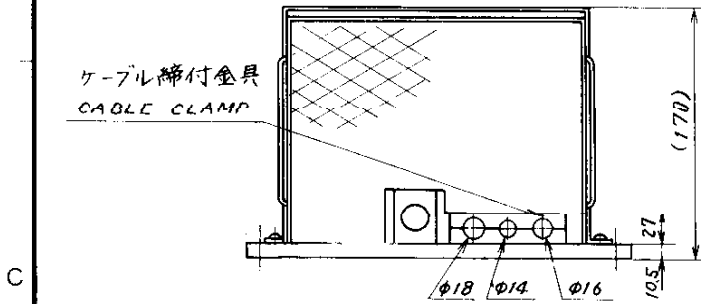


Fig.5-15 Connections to the Rectifier Unit



NOTE 1. ※: 推奨サービス空間
RECOMMENDED SERVICING CLEARANCE.



注 A^c220V入力に対しては T1401 の一次巻線を直列に接続する。

NOTE FOR 220VAC INPUT, CONNECT T1401 PRIMARY WINDINGS IN SERIES.

品番 ITEM	品名 NAME	材質 MATERIAL	数量 QTY	図番 DWG.NO.	摘要 REMARKS
承認 APPROVED	三角法 THIRD ANGLE PROJECTION	名称 TITLE			
検図 CHECKED	尺度 SCALE	RU-1746B-2 整流器 RECTIFIER UNIT			
製図 DRAWN	重量 WEIGHT	図番 DWG.NO.			
	17 kg	C 3002-002-L			

ADJUSTMENT AT INSTALLATION

Preoperation Checks

After completion of all wiring and interconnections, check that there is no wrong nor loose connection on the terminal boards. Check that the connectors and circuit boards are firmly connected to corresponding jacks and plugs. Then, apply the power and check radar functions item by item according to the following procedure.

1. Set the controls as follows.

POWER-SW & SCANNER-SW ----- OFF
 BRILLIANCE control ----- fully counterclockwise
 A/C RAIN, FTC control ----- fully counterclockwise, pushed in
 A/C SEA & GAIN controls ----- fully counterclockwise
 TUNE control ----- mid-travel

Turn the power on and confirm that the input voltage at the terminals #1(+) and #2(-) of DTB-I are as below. (If the power is supplied through a rectifier, change of tap connection in the transformer may be required. See page 5-20.)

Specified Voltage	Allowance
12VDC	10.2 to 15.0VDC
24/32VDC	20.4 to 40.0VDC

2. In about 3 minutes after switching on the radar, turn the BRILL control clockwise and the indication ST-BY is displayed on the screen. Turn the SCANNER-SW to ON and check that the antenna rotates at a speed between 20 and 25 rpm.

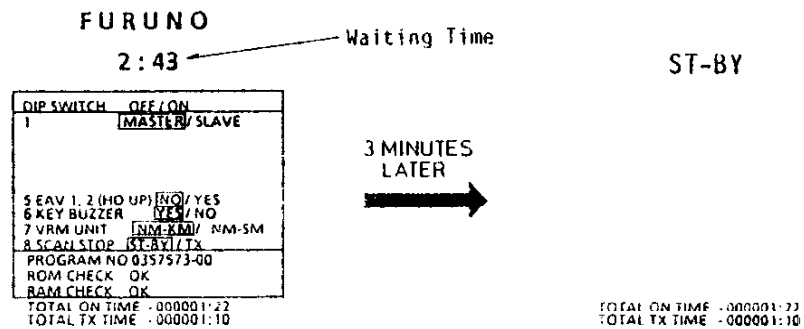


Fig.5-16

3. Press the STBY/TX touchpad to begin transmitting.
4. Gradually turn the GAIN control clockwise, and confirm that noise and/or echoes appear on the CRT.
5. Adjust the TUNE control to obtain best tuning.
6. Check the function of other controls, switches and touchpads by operating them one by one.

Adjustments

The location of the preset potentiometers on the PANEL board is shown below. Pry off the panel cover with a small screwdriver.

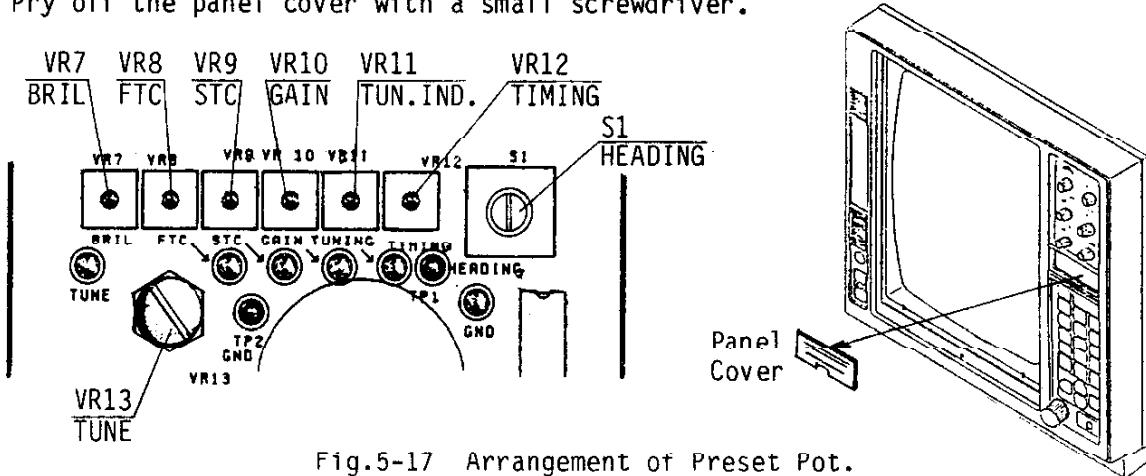


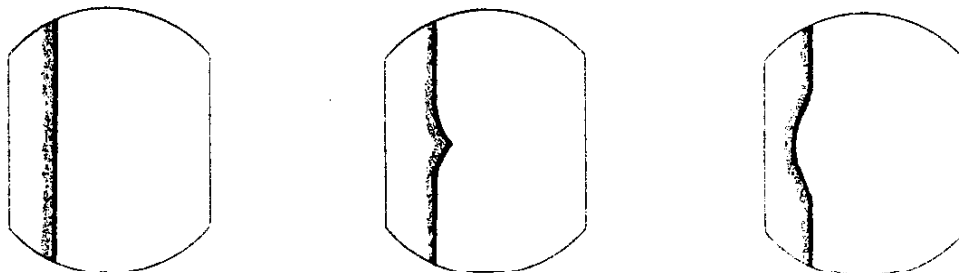
Fig.5-17 Arrangement of Preset Pot.

Transmission Timing

Transmission timing differs with respect to the length of the multicore cable between the display and the scanner units. Even if the standard cable of 15m in length is used, the adjustment must be performed. The following problems may occur if the adjustment is not made.

- * Straight wharf or breakwater appears bent inward or outward at the center of the screen on 0.25 nm range. (See Fig.5-18.)
- * Range error is found on short range.
- * Dark area appears at the center of the screen.

The adjustment is made with VR12 (TIMING) while observing the radar screen.



a. PROPER SETTING
Straight target
appears as a
straight line
on the screen.

b. TURN VR12 CCW
TO CORRECT.
Straight target
is pulled inward.

c. TURN VR12 CW
TO CORRECT.
Straight target
is pushed outward.

Fig.5-18 Transmission Timing

Heading Alignment

The scanner unit has been installed to face straight ahead in the direction of the bow. Some small error, however, may be observed on the display for most installations because of the difficulty in achieving accurate initial positioning of the scanner unit. The following adjustment will compensate for this error.

1. Set the range to 3 nm; select the head-up mode; and operate the radar to obtain a normal picture on the screen.
2. Select a suitable target echo (small island, end of quay, etc.) located on or around the heading mark and near the edge of the screen.
3. Press the EBL ON touchpad to present an EBL on the screen.
4. Operate the rotary knob control until the EBL bisects the target and read the relative bearing "A" to the target.
5. On a navigational chart find the relative bearing "B" of the target from the ship's heading.

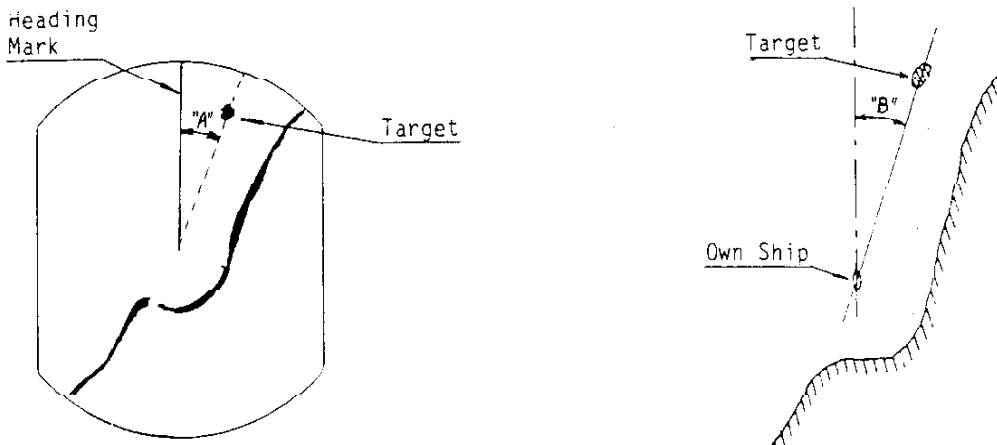
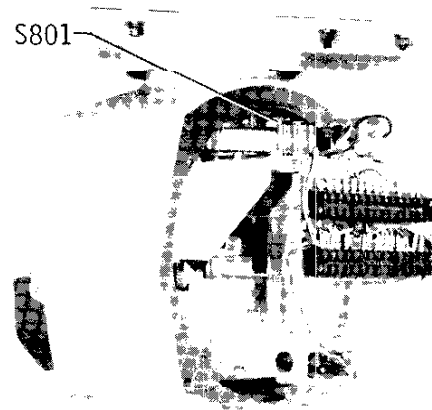


Fig.5-19 Heading Alignment

6. Both the bearings "A" and "B" should be same. If the difference is within $+5^\circ$, adjust rotary code switch S1 (HEADING, working range $+5^\circ$ in steps of 0.7° . Clockwise rotation shifts the picture CW.) See Fig.5-17 for the location of S1.
7. If the difference is more than $+5^\circ$, set S1 to "0" and then adjust the position of reed switch S801 located inside the scanner unit. When the bearing "A" is greater than "B", slightly turn the mounting plate of S801 CW. To the contrary, when "A" is smaller than "B", slightly turn it CCW. Secondly adjust S1 at the display as in step 6.



N Photo No. 639

Fig.5-20

Tuning & Tuning Indicator Sensitivity

Optimum tuning should be obtained with the maximum number of tuning markers displayed. If not, take the following procedure.

1. Set the controls and switches as follows.

RANGE: maximum range, GAIN: properly adjusted, A/C SEA & A/C RAIN: fully CCW and pushed in, ECHO STRETCH & IR: OFF, TUNE: mid-travel

2. Transmit the radar and wait for 10 minutes approx. for magnetron oscillation to stabilize.
3. Adjust VR13 (TUNE) so that a comparatively weak long range echo is discerned with maximum definition. See Fig.5-17 for the location of VR13.
4. Adjust VR11 (TUN.IND) so that four tuning markers of the tuning bar light up with the fifth marker blinking. See Fig.5-17 for the location of VR11.

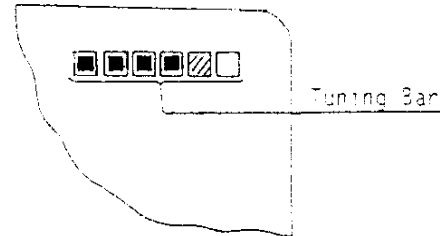


Fig.5-21 Tuning Bar

Main Bang Suppression

After the transmission timing adjustment is made, perform the following procedure to minimize the main bang effect.

1. Transmit the radar on 0.25 nm and adjust the GAIN and A/C SEA controls for the best picture definition.
2. Find VR1 (MBS Pot.) on the STC Board (ASTC-6995 for DA-type and BST-6995 for D-type) in the scanner unit.
3. Turn VR1 CW until a black circle of 20-30m (0.014 nm) in radius is obtained at the center of the screen (sweep origin).

NOTE: Too high a setting of MBS will cause the target echo in close ranges to disappear.

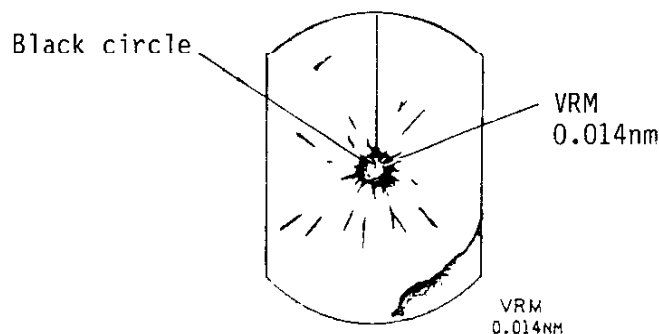
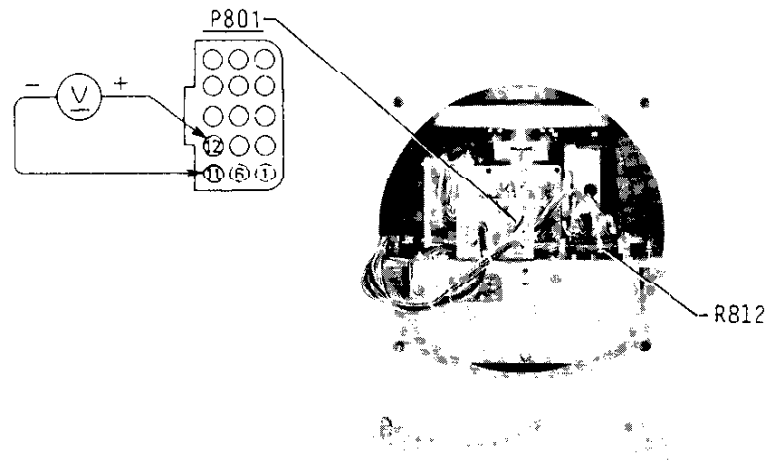


Fig.5-22 Suppressing the Main Bang

Magnetron Heater Voltage

If the length of the multicore cable is different from the standard one (15m), the Magnetron Heater Voltage should be adjusted as follows. The location of test points is shown in the figure below.

1. Turn off the SCANNER-SW, and turn on the POWER-SW.
2. Operate the radar in stand-by, 0.25 nm range; turn the BRILL control fully counterclockwise.
3. Connect a multimeter set to the range of 10VDC, between P801 #12(+) and #11(-).
4. Adjust the sliding contact of R812 to obtain the multimeter reading of 7.0 to 7.6V.



N Photo No.2278

Fig.5-23 Location of Test Points to Adjust Magnetron Heater Voltage

CRT Brilliance

The minimum brightness of the CRT can be adjusted to suit operator's needs, by adjusting VR7 (BRIL). See Fig.5-17 for its location.

Others

Adjustments of preset gain, A/C sea and A/C rain are shown in this section. If the radar does not meet the following conditions, adjust corresponding preset potentiometers VR10 (GAIN), VR9 (STC) and VR8 (FTC). See Fig.5-17 for its location. Set the controls as below.

A/C SEA ----- fully CCW (min.)
A/C RAIN ----- fully CCW (min.) and push in
IR ----- on
ECHO STRETCH --- off
ECHO AVG ----- off
ECHO TRAIL ----- off

for Preset Gain

1. Transmit and tune the radar on the range of 48 nm.
2. Gradually turn the GAIN control clockwise and confirm that a little background noise appears when the control is within the 12 to 3 o'clock range. If not, adjust VR10.

for A/C Sea

1. Transmit and tune the radar on the range of 24 nm.
2. Set the GAIN control to a position where a little background noise appears on the screen.
3. Turn the A/C SFA control fully CW and confirm that no background noise appears in the range of 0 to 7 nm (min.) or 0 to 14 nm (max.) for DA-type, while 0 to 5nm (min.) or 0 to 10 nm (max.) for D-type. If not, adjust VR9.

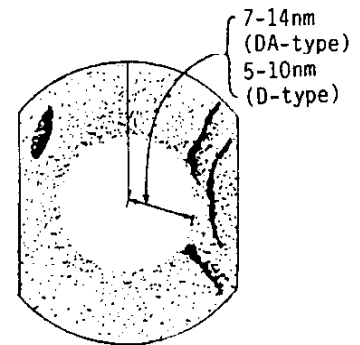


Fig.5-24

for A/C Rain

1. Transmit and tune the radar on the range of 24 nm.
2. Set the GAIN control to a position where a little background noise appears on the screen.
3. Turn the A/C RAIN control (pushed in) to the position of 2 o'clock and confirm that no background noise appears in the range of 0 to 8 nm (min.) or 0 to 17 nm (max.) If not, adjust VR8.

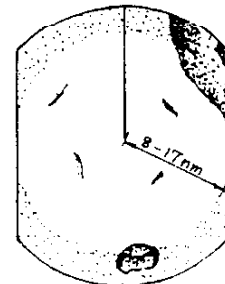


Fig.5-25

APPENDIX A SETTING TOTAL ON TIME & TOTAL TX TIME

The total on time (no. of hours the power has been applied) and the total TX time (no. of hours radar has been transmitted) are displayed during ST-BY period.

These times can be set or readjusted as desired to keep track of maintenance intervals, magnetron life, etc.

Procedure

1. Turn the power on and set the radar to stand-by.
2. While pressing and holding down the HM OFF touchpad, alternately press the + and - touchpads five times each.
3. Release hold of the HM OFF touchpad. The total on time and total TX time are displayed and a cursor circumscribes the first numeral on the "TOTAL ON TIME" line.

↙ Cursor
 TOTAL ON TIME : **0** 0 0 2 3 1 : 0 9
 TOTAL TX TIME : 0 0 0 1 9 8 : 0 9

4. Press the + and - touchpads to set the cursor on the desired position; press the + touchpad to advance the cursor, or press the - touchpad to move the cursor reversely.

The cursor moves in the direction of the arrow each time the [+] touchpad is pressed.

ON TIME :
 0 **0** 0 2 3 1 : 0 9

 TX TIME :
 0 0 0 1 9 8 : 0 9

Press the [-] touchpad to reverse cursor movement.

5. After placing the cursor on the desired numeral, press and hold the HM OFF touchpad and then press the + or - touchpad to count the numeral (0-9) upward or downward, respectively.
6. Repeat steps 4 and 5 to change other numerals.
7. Press the STBY/TX touchpad to return to the normal operating mode.

APPENDIX B DIP SWITCH

The specifications of this radar can be changed by switching the settings of DIP switch S1 on the PROCESSOR board. The specifications of each switch are given in the table below.

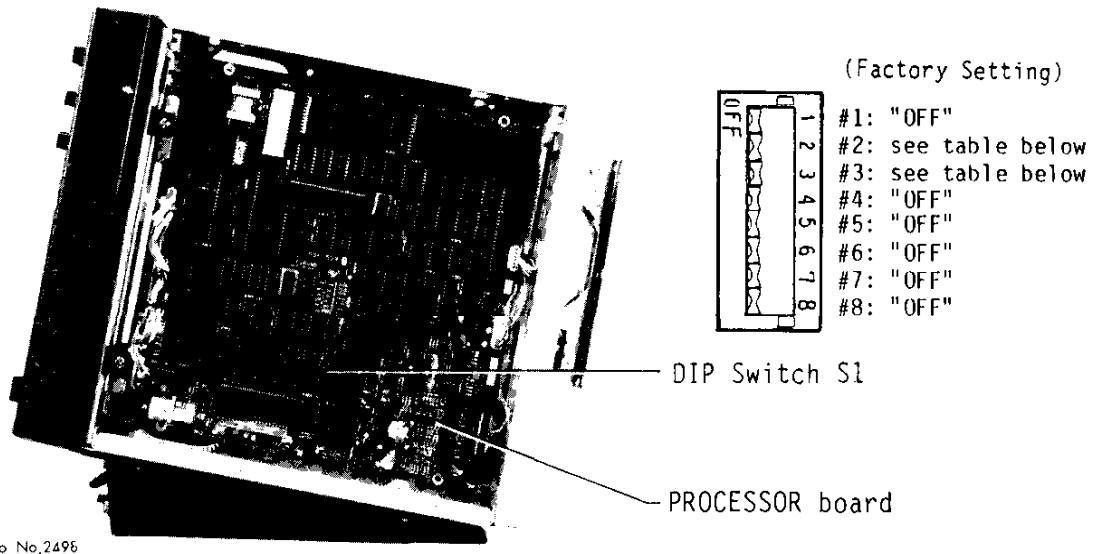


Fig.B-1 Display Unit (cover removed)

No.	Specification	OFF	ON
1	Radar Selection	Main Radar	Sub Radar
2	Model Selection	FR-8050D(A)	No.2 OFF No.3 OFF
3		FR-8100D(A)	No.2 ON No.3 OFF
		FR-8250D(A)	No.2 OFF No.3 ON
4	WP & L/L Indication (if nav aid connected)	Nav Data	
5	Use of Echo Averaging Levels 1 & 2 in the Head-up Mode	NO	YES
6	Key Operation Confirmation (beep tone)	YES	NO
7	Unit of Variable Range Marker	NM/KM	NM/SM
8	Transmit or no when scanner rotation is suspended.	NO (ST-BY)	YES (TX)

The settings of the DIP switch are displayed for 3 minutes after the power is turned on. Active settings are circumscribed.

DIP SWITCH	OFF / ON
1	<input checked="" type="checkbox"/> MASTER / SLAVE
5 EAV1.2 (HD UP)	<input checked="" type="checkbox"/> NO / YES
6 KEY BUZZER	<input checked="" type="checkbox"/> YES / NO
7 VRM UNIT	<input checked="" type="checkbox"/> NM ↔ KM / NM ↔ SM
8 SCAN STOP	<input checked="" type="checkbox"/> ST-BY / TX
PROGRAM NO : 0357573-00	
ROM CHECK OK	
RAM CHECK OK	

TOTAL ON TIME=000019:55

TOTAL TX TIME=000010:09

APPENDIX C MODIFICATION TO CHANGE THE ANTENNA IN LENGTH

This radar is so designed that the 123cm or 200cm antenna is driven from the inverter circuit, while the 240cm antenna is directly driven from 24VDC mains. That is, 12 or 32VDC ship's mains cannot be used for 240cm antenna.

Remove the display cover and change jumper JP-6 on the POWER SUPPLY board (PTU-7534) when the antenna length is changed from 123cm (XN-2) or 200cm (XN-3 or 3A) type to 240cm (XN-4A) type, or vice versa.

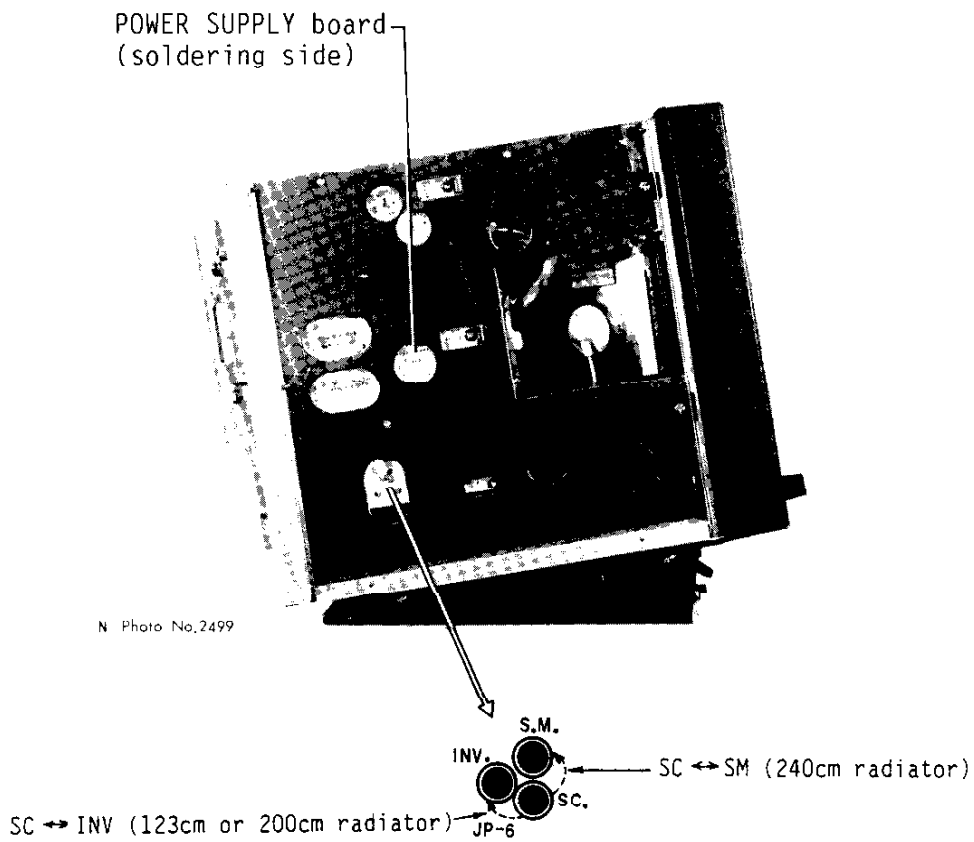


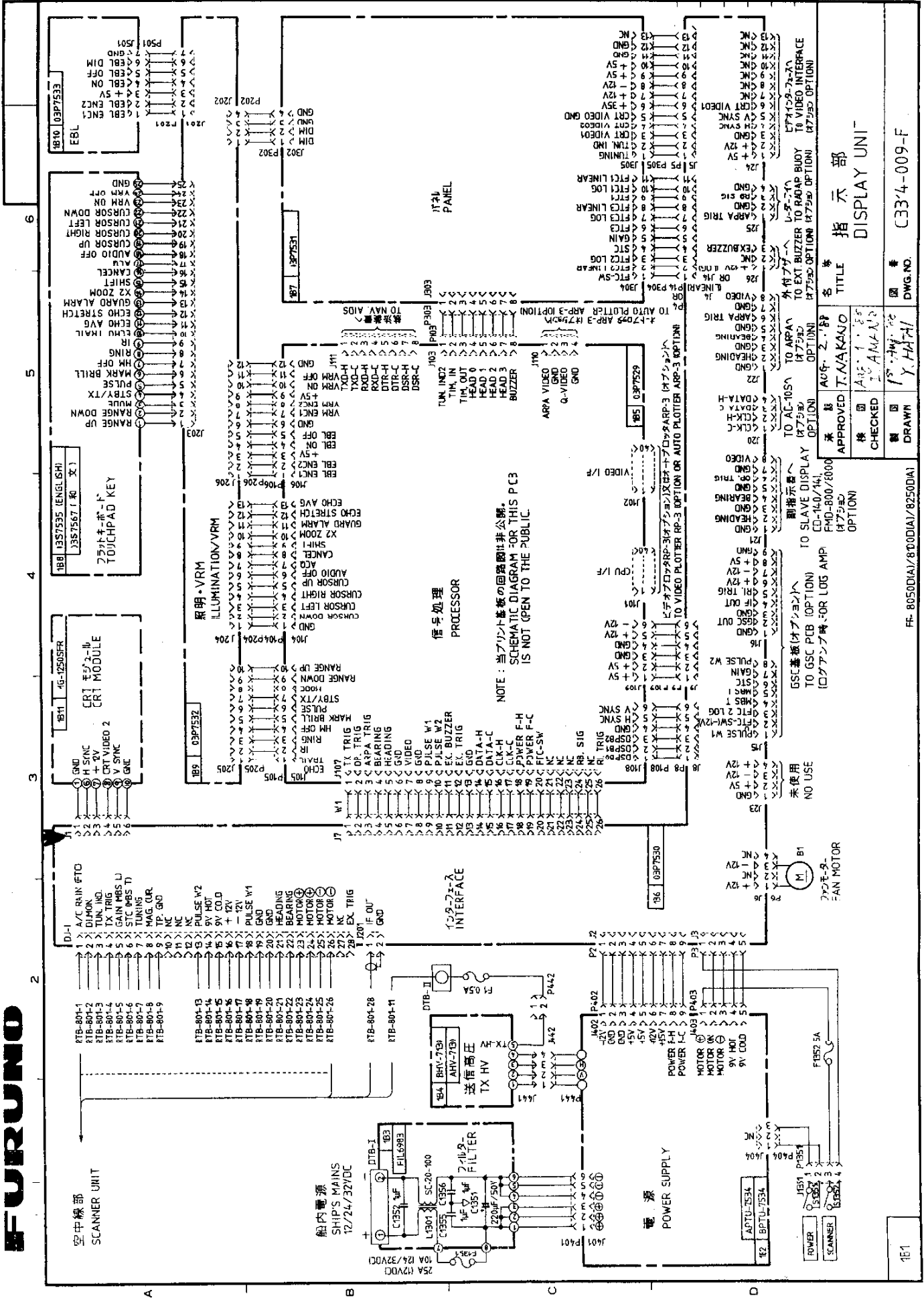
Fig.C-1 Display Unit Left-side View

LIST OF SCHEMATIC DIAGRAMS

No.	Item	Type	Dwg. No.	Page	Remarks
1	DISPLAY UNIT		C3314-009	S-1	
2	POWER SUPPLY PCB	PTU-7534	C3314-010	S-2	
3	INTERFACE PCB	03P7530	C3314-011	S-3	
4	PANEL PCB	03P7531	C3314-012	S-4	
5	ILLUMINATION/VRM PCB	03P7532	C3314-013	S-5	
	EBL PCB	03P7533			
	TOUCHPAD KEY	03P7535			
6	CRT DISPLAY	MG-1250SFR	C3276-008	S-6	
7	TX HV	BHV-7130	C3307-005	S-7	
8	SCANNER UNIT		C3307-013	S-8a	D-type
			C3307-016	S-8b	DA-type
9	STC PCB	ASTC-6995	C3307-011	S-9	DA-type
		BSTC-6995			D-type
10	IF AMPLIFIER	BIF-4879	C3307-026	S-10a	D-type
		BIF-5668	C3307-014	S-10b	DA-type
11	INTERCONNECTION DIAGRAM		C3314-008	5-12	

LIST OF OUTLINE DRAWINGS

No.	Item	Type	Dwg. No.	Page	Remarks
1	SCANNER UNIT	XN2-C2P7N2N-014(A)	C3237-001	5-4	123cm
		XN3-C2P7N2N-014(A)			
		XN3A-C2P7N2N-014(A) XN4A-C2P7N2N-014(A)	C3249-011	5-5	200cm oval 240cm oval
2	DISPLAY UNIT	RDP-067	C3314-007	5-15	
3	RECTIFIER UNIT	RU-1746B-2	C3002-002	5-20	AC Mains

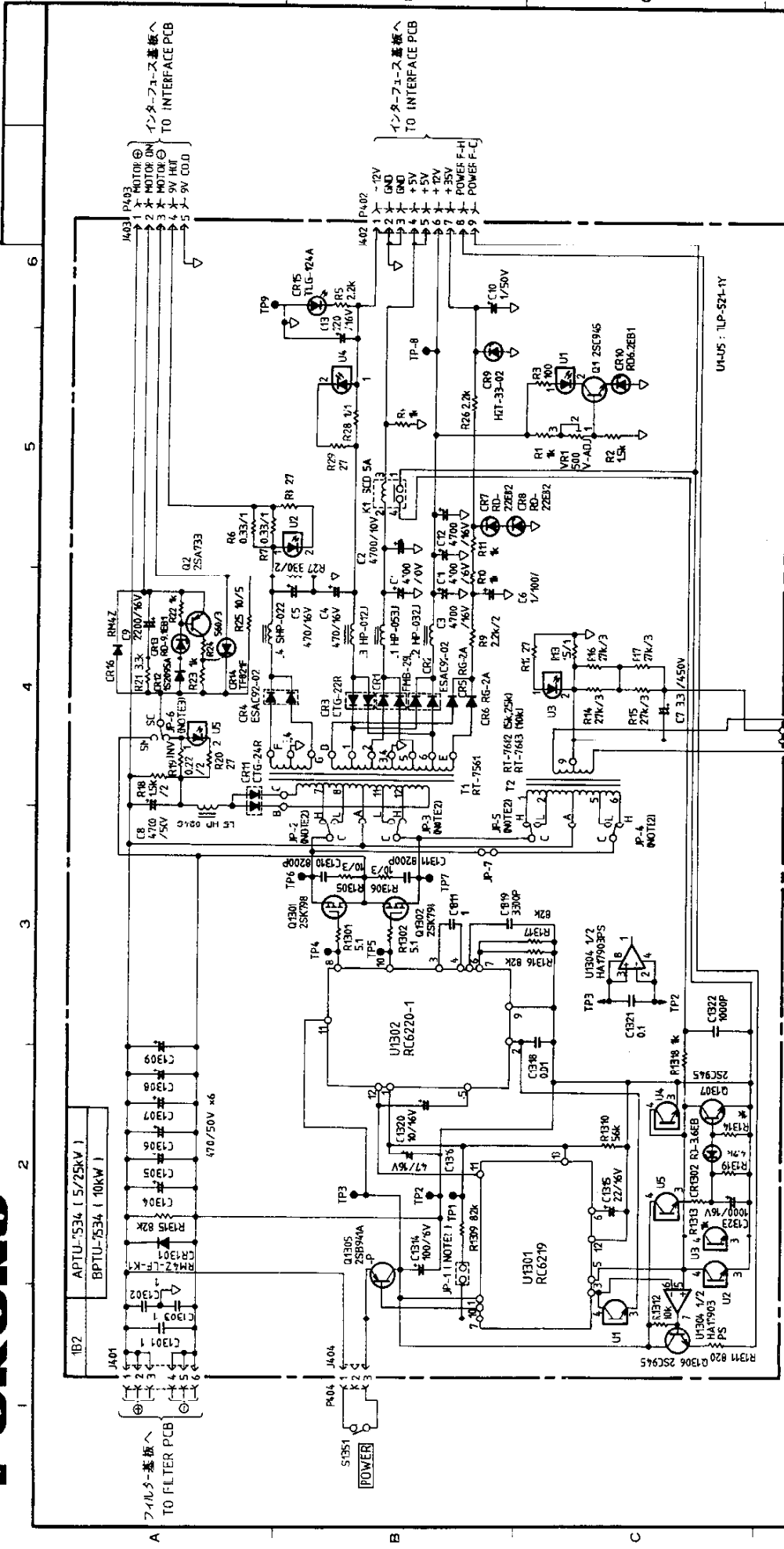


NOTE: 当プリント基板の回路図は非公認。
SCHEMATIC DIAGRAM FOR THIS PCB
IS NOT OPEN TO THE PUBLIC.

承認者 (APPROVED)	Y. TAKAKAWA
検閲者 (CHECKED)	A. I. TAMAKI
製図者 (DRAWN)	Y. HATAI
国番 (DWG. NO.)	C3374-009-F

指示部
DISPLAY UNIT

FR-8650D(A)/8700D(A)/8250D(A)



NOTE 1. 特記なき抵抗の単位は全にΩ、0.25W、又コンデンサはμF.
 ALL RESISTANCE IN OHMS, 0.25W, CAPACITANCE IN MICRO
 FARADS UNLESS NOTED OTHERWISE.

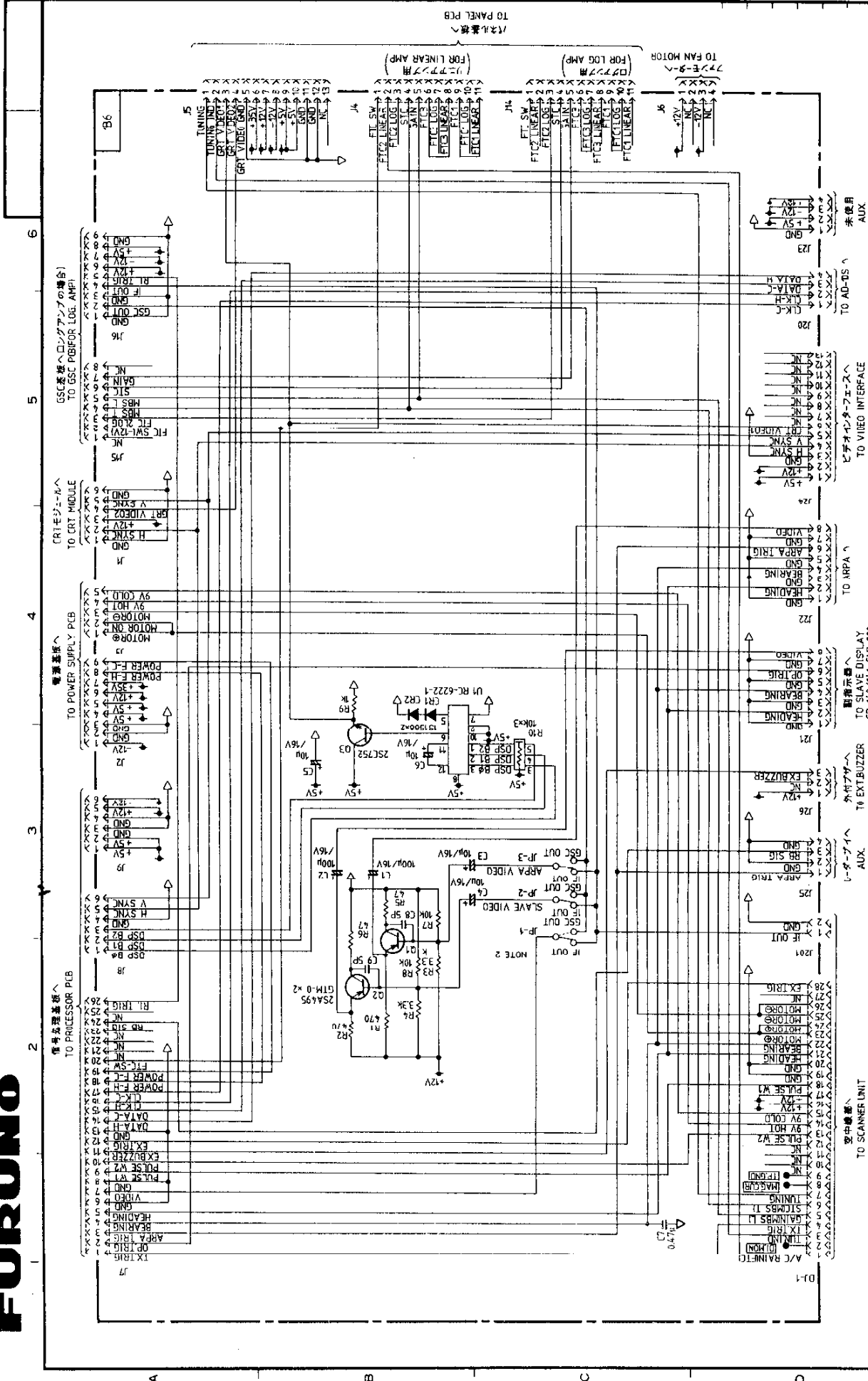
NOTE 2. 電源仕様に上り右のジャンパー
 を変える。
 CHANGE JUMPER CONNECTIONS
 ACCORDING TO SHIP'S MAINS
 VOLTAGE.

NOTE 3. 空中線型式より右のジャンパーする。
 CHANGE CONNECTION WITH THE
 TYPE OF ANTENNA RADIATOR.

MAINS VTG	J-1	J-2 ~ J-5
12VDC	SHORT	CONNECT
24/32VDC	OPEN	CONNECT
RADIATOR	J-6	船内電源 SHIP'S MAINS
XN-4A (2.4m)	INV	24V DC ONLY
その他 OTHERS	INV	12/24/32V DC

承認者 APPROVED	名 称 TITLE
検閲者 CHECKED	PTU-7534 電源基板 POWER SUPPLY
製図者 DRAWN	図 号 DWG. NO.
	C3314-010-C

FR-805001A/810001A/825001A

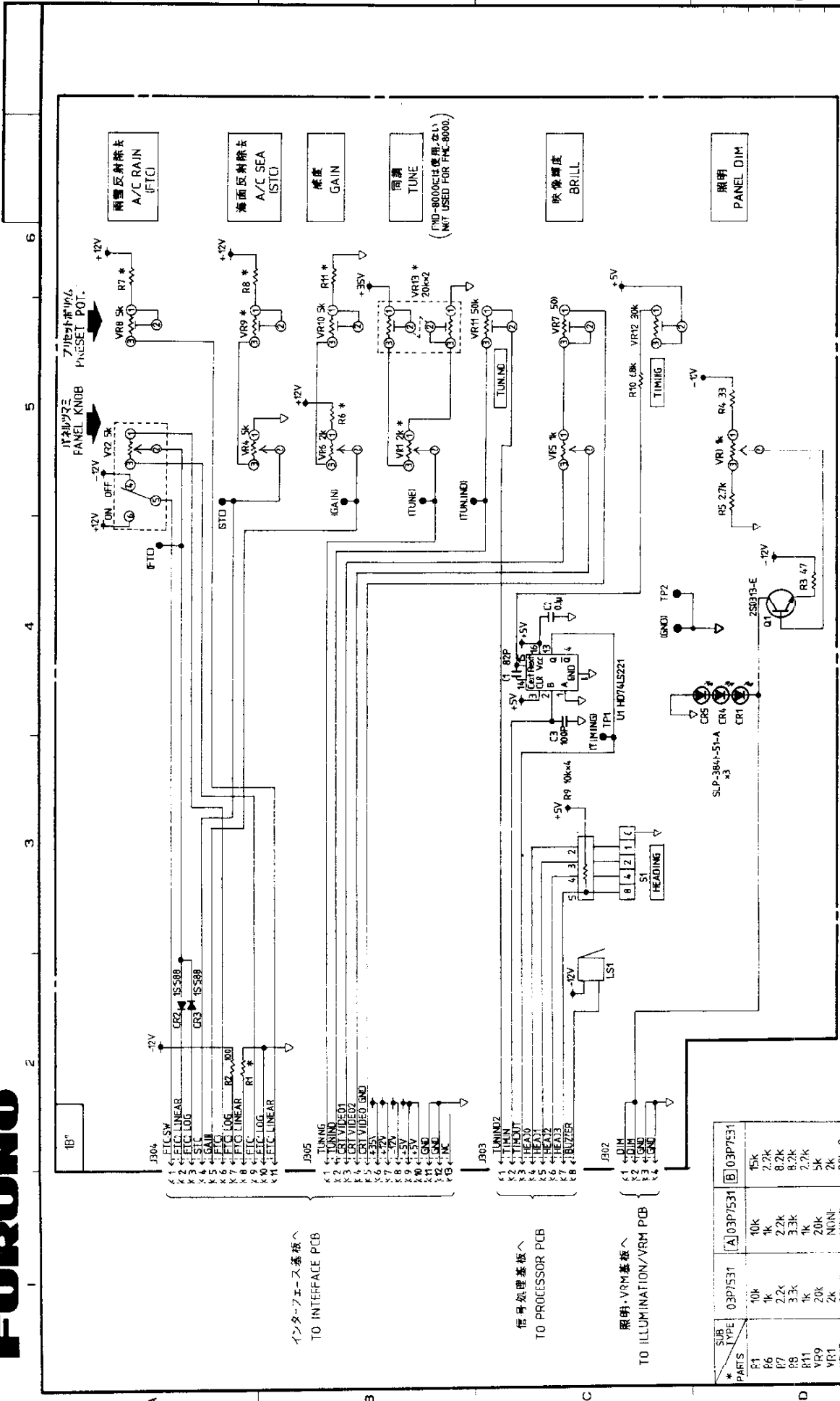


承認	設計	図面	検査	製図	DATE
AVG. 2. 野	AVG. KAGIC	AVG. 野	AVG. 野	AVG. 野	15. Aug. 80
<p>名称: インターフェース基板 TITLE: 03P7530 INTERFACE PCB 図番: C3314-011-C DWG. NO: C3314-011-C</p>					

TO SCANNER UNIT
 TO SLAVE DISPLAY
 TO VIDEO INTERFACE
 TO AD-DS
 TO FAN MOTOR
 TO PANEL PCB
 TO PROCESSOR PCB
 TO POWER SUPPLY PCB
 TO CRT MODULE
 TO GSC FOR LOG. AMPH

NOTE 1: 特定の抵抗の値は全I.O. 0.15W 又 コンデンサは、
 ALL RESISTANCE IN OHMS, 0.25W, CAPACITANCE IN FARADS UNLESS NOTED OTHERWISE.
 2: JP-1の設置は03P7530の場合...IF OUT側, 03P7530の場合...GSC OUT側.
 CONNECTIONS OF JP-1: FOR 03P7530...IF OUT, FOR 03P7530...GSC OUT.
 3: JP-2, JP-3の設置はそれぞれ異なる副機とARPAの仕様に合わせる。IF OUT...IF GSC OUT...GSC OUT...
 SET JP-2 & JP-3 RESPECTIVELY FOR CONNECTED SLAVE DISPLAY & ARPA. IF OUT...LINEAR, GSC OUT...LOG. FR-8000S/8300CS
 FR-8000S/8300CS
 FR-80500A/87000A/82500A

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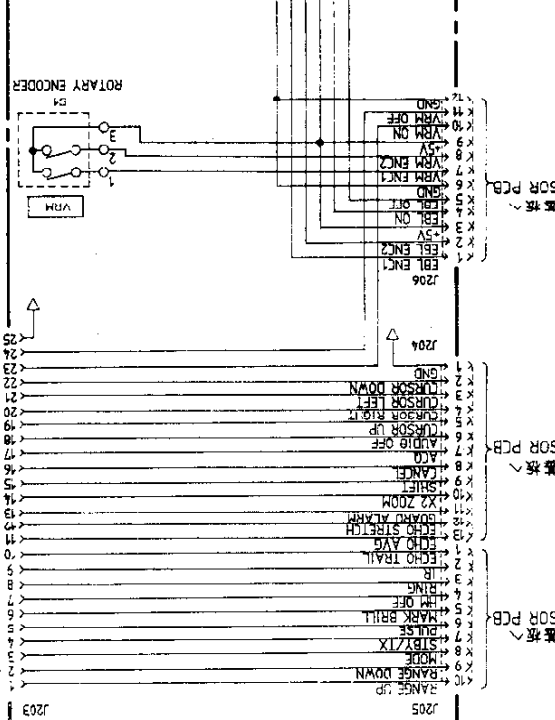
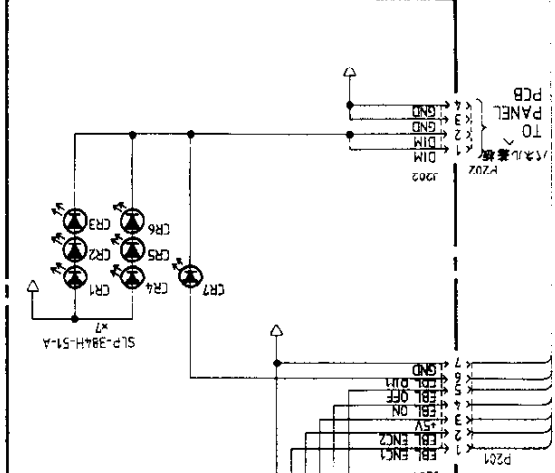
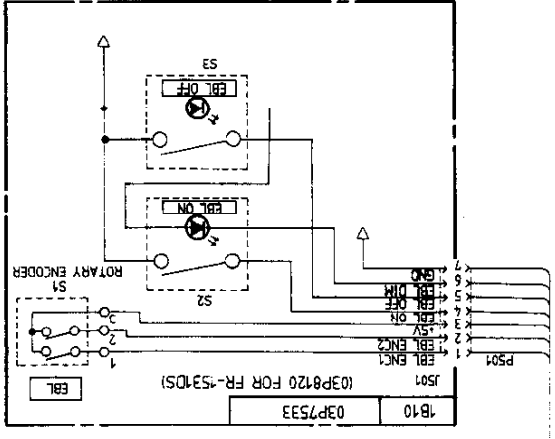
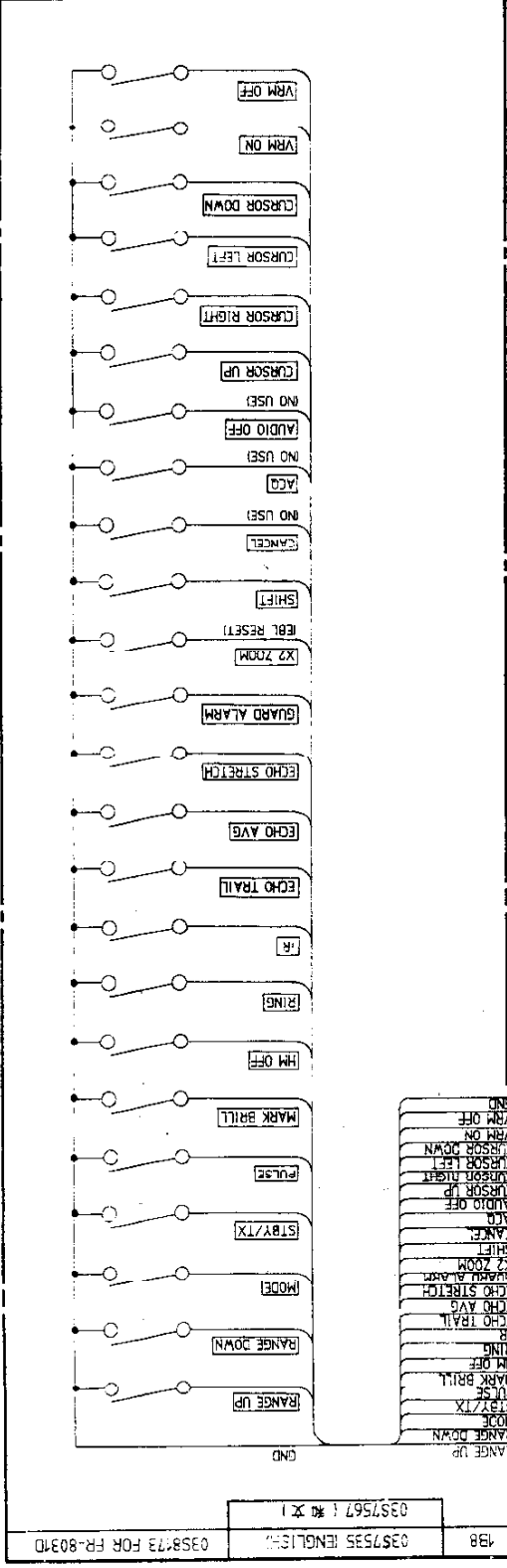
ITEM	NAME	MATERIAL	QTY	REMARKS
APPROVED	角田			
CHECKED	角田			
DRAWN	角田			
THIRD ANGLE PROJECTION		TITLE		
SCALE		03P7531 PANEL PCB		
WEIGHT		DWG. NO. C3314-012-E		

NOTE1 特配な抵抗の単位は全てΩ, 0.25W X コンデンサはF.
 ALL RESISTANCE IN OHMS, 0.25W CAPACITANCE
 IN FARADS UNLESS NOTED OTHERWISE.

SUB TYPE	03P7531	A 03P7531	B 03P7531	FR-80310
PARTS	10k	10k	15k	
F1	1k	1k	2.2k	
F6	2.2k	2.2k	8.2k	
F7	3.3k	3.3k	8.2k	
F8	1k	1k	2.2k	
F9	20k	20k	5k	
VR1	NONI	NONI	2k	
VR2	20kx2	NONE	20kx2	
適用規格	FR-80300 (A)	FR-80300 (A)	FR-80300 (A)	FR-80310
APPLIED TO	82500 (A)	82500 (A)	82500 (A)	
	83000	83000	83000	
	85000	85000	85000	

承認	Aug-2 '88	名 称	03P7532 照明・VRM基板 ILLUMINATION/VRM PCB
検査	T. NAKAJO	TITLE	03P7533 EBL基板FCB EBL基板FCB
検 査			03P7534 232外半水-1 TOUCHPAD LET
製 図		図 番	03P7567
DRAWN		DWG. NO.	C3314-013-D

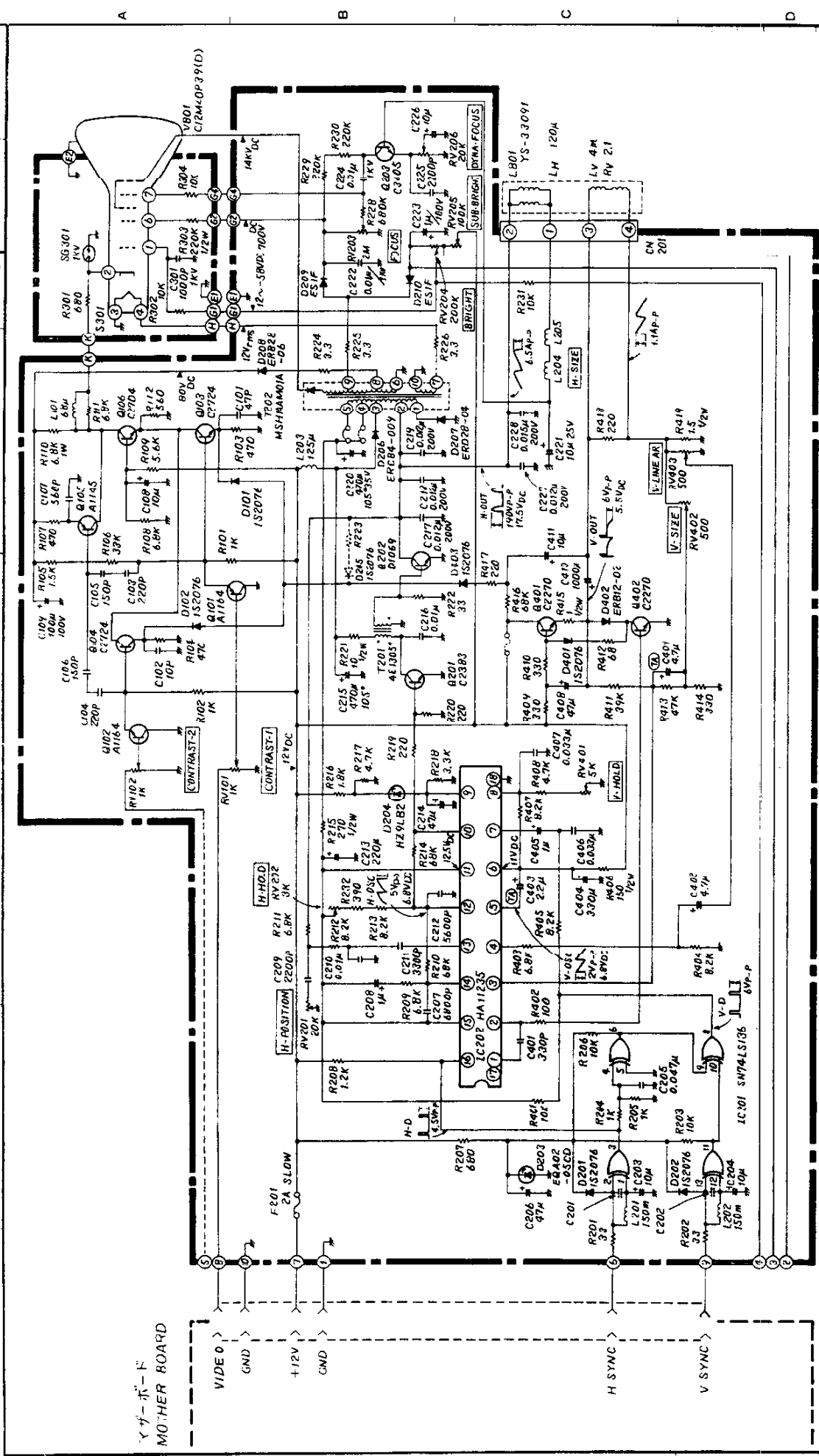
FR-1531DS, FR-4031D, FMD-8000
FR-80500DA/81000DA/82500DA



198	03P7535 (ENGLISH)	03S8173 FOR FR-8031D
	03P7567 (和文)	

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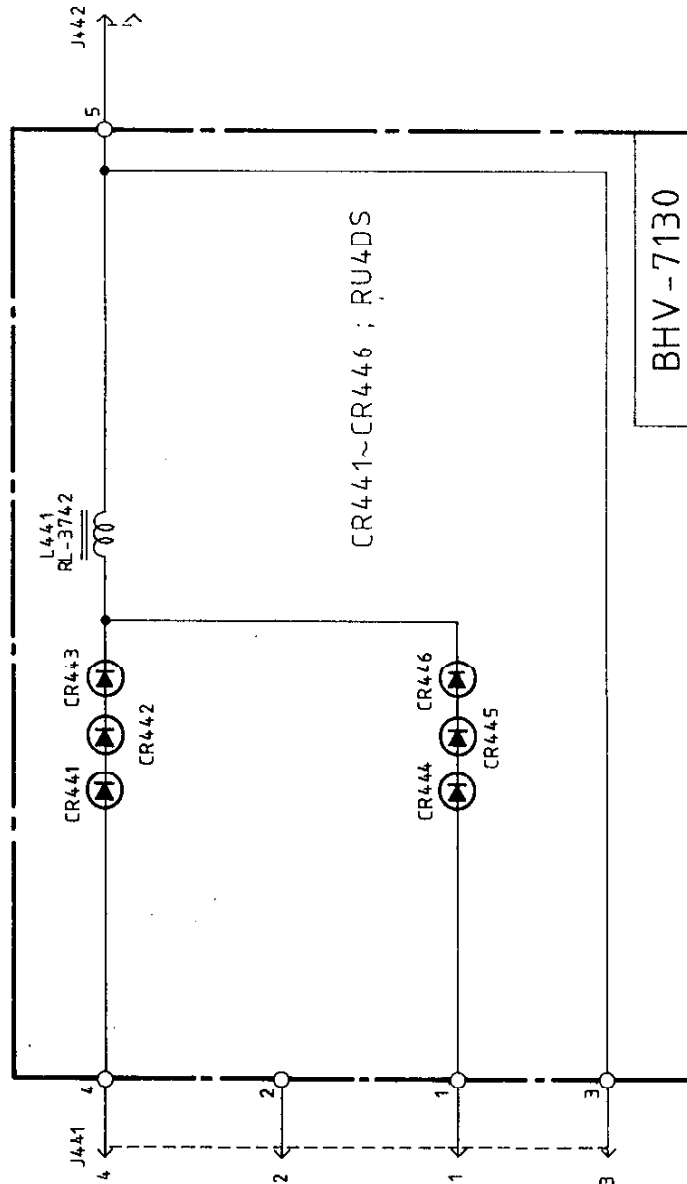
マザーボード
MOTHER BOARD



承認 APPROVED	検査 CHECKED	製図 DRAWN	品名 ITEM NAME	材料 MATERIAL	数量 QTY	図番 DWG. NO.	備考 REMARKS
第三角投影 THIRD ANGLE PROJECTION			名称 TITLE	表示部 CRT DISPLAY (MG-12505FR)			
縮尺 SCALE 1:1			重量 WEIGHT	国番 DWG. NO. C3-5-008-M			

NOTE 1: 特記なき抵抗の単位は全 Ω , 0.25W, \times コンデンサはF.
 ALL RESISTANCE IN Ω MS, 0.25W, CAPACITANCE
 IN FARADS UNLESS NOTED OTHERWISE.

A
B
C
D

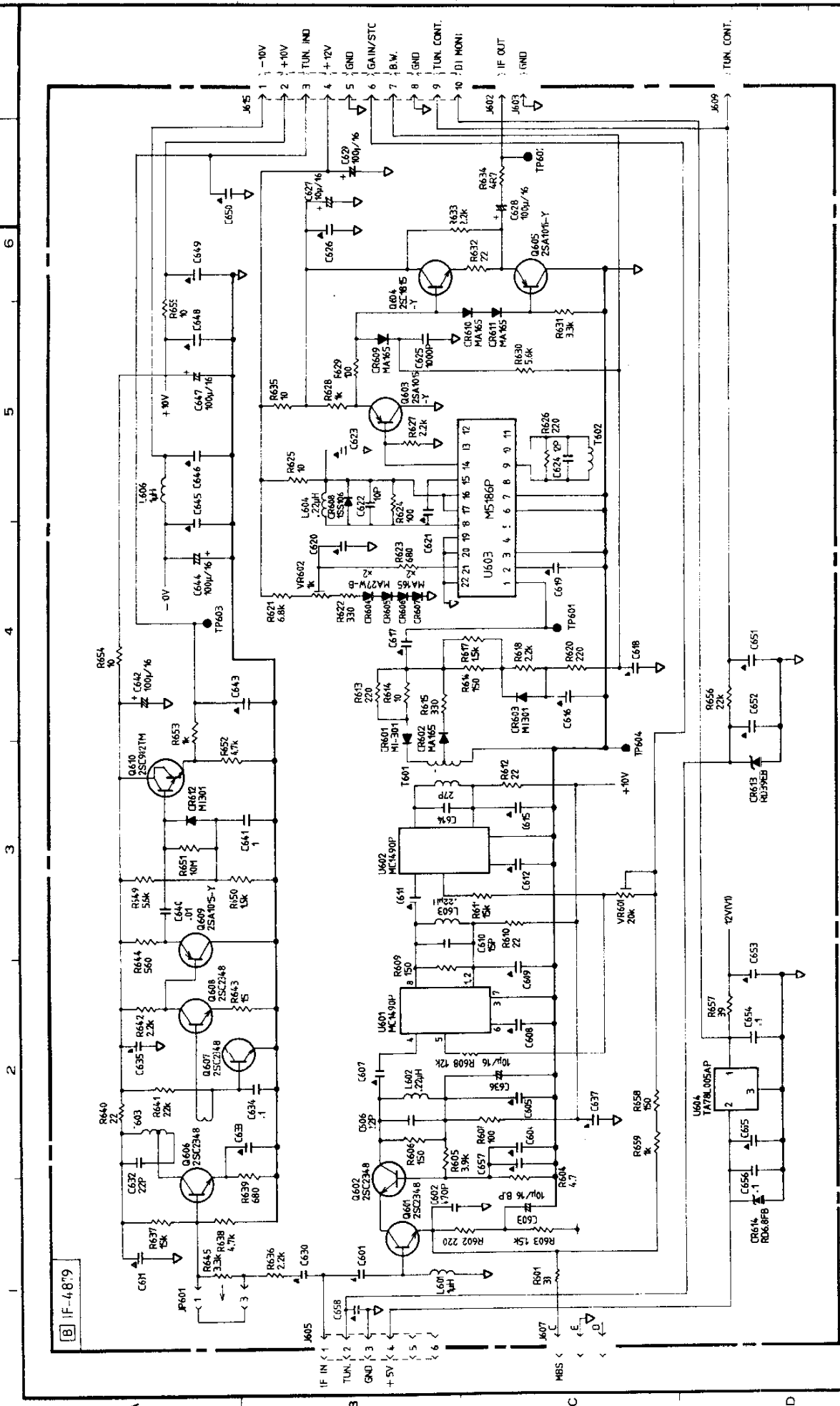


FOR 5kW/10kW RADARS

承認 APPROVED	M. 204. 17 7. 11/1987	名称 TITLE	送信 高压 TX HV
検 CHECKED	APR. 23. '87 I. Amano	BHV-7130	
製 DRAWN	April. 23. '87 Y. Tomiyama	番 DWG. NO.	C3307-005-H

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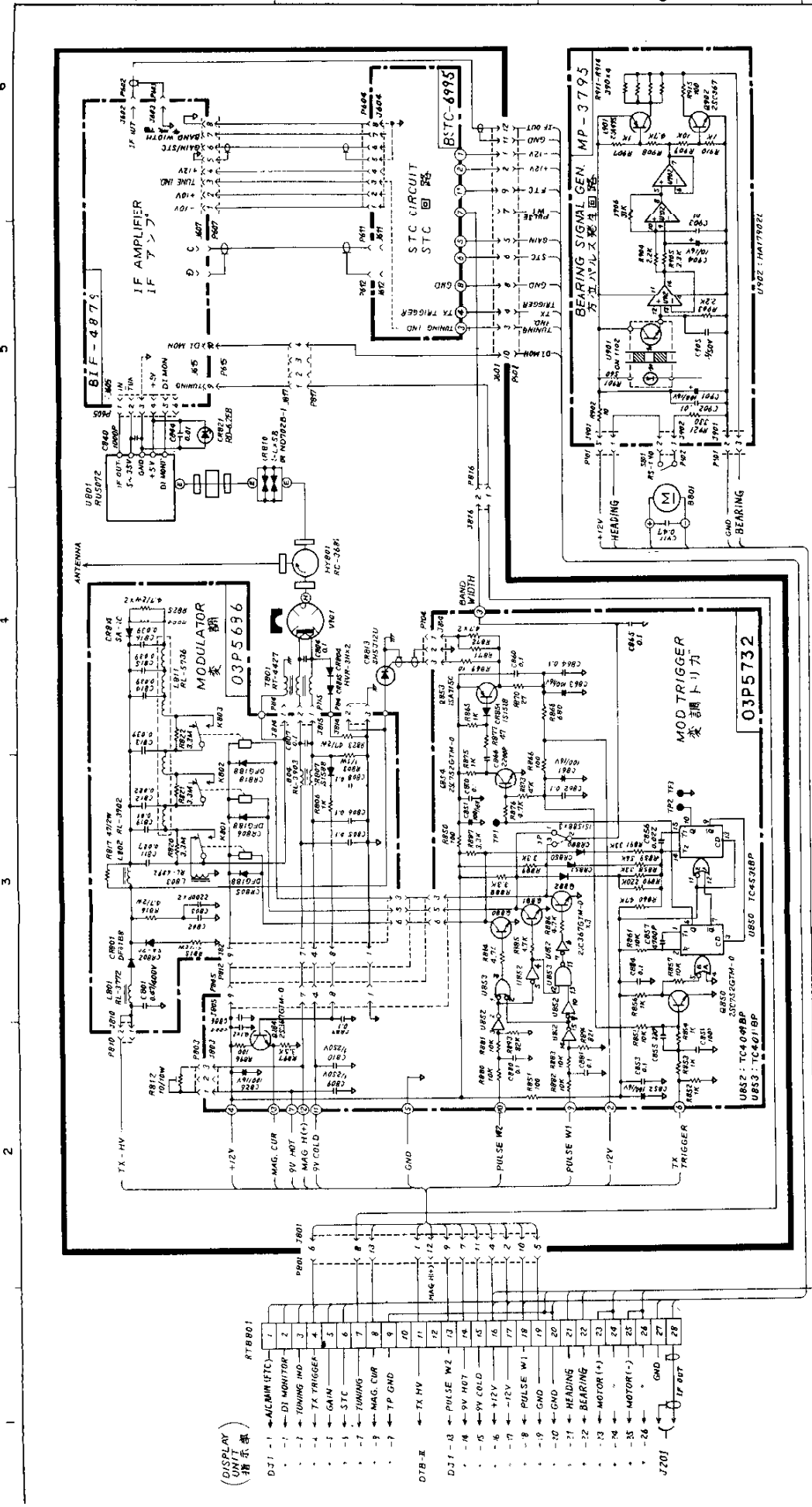


名 称	TITLE
品 名	BIF-4879 IF AMP
図 番	C3314-K01-D
検 査	APPROVED
検 査	CHECKED
制 図	DRAWN

RR-8000 SERIES
RR-15000 SERIES

注1. ▲ : 0.01μF, 50V
2. 特異無き抵抗の単位はΩ, 1/6W
又, コンデンサはμF.

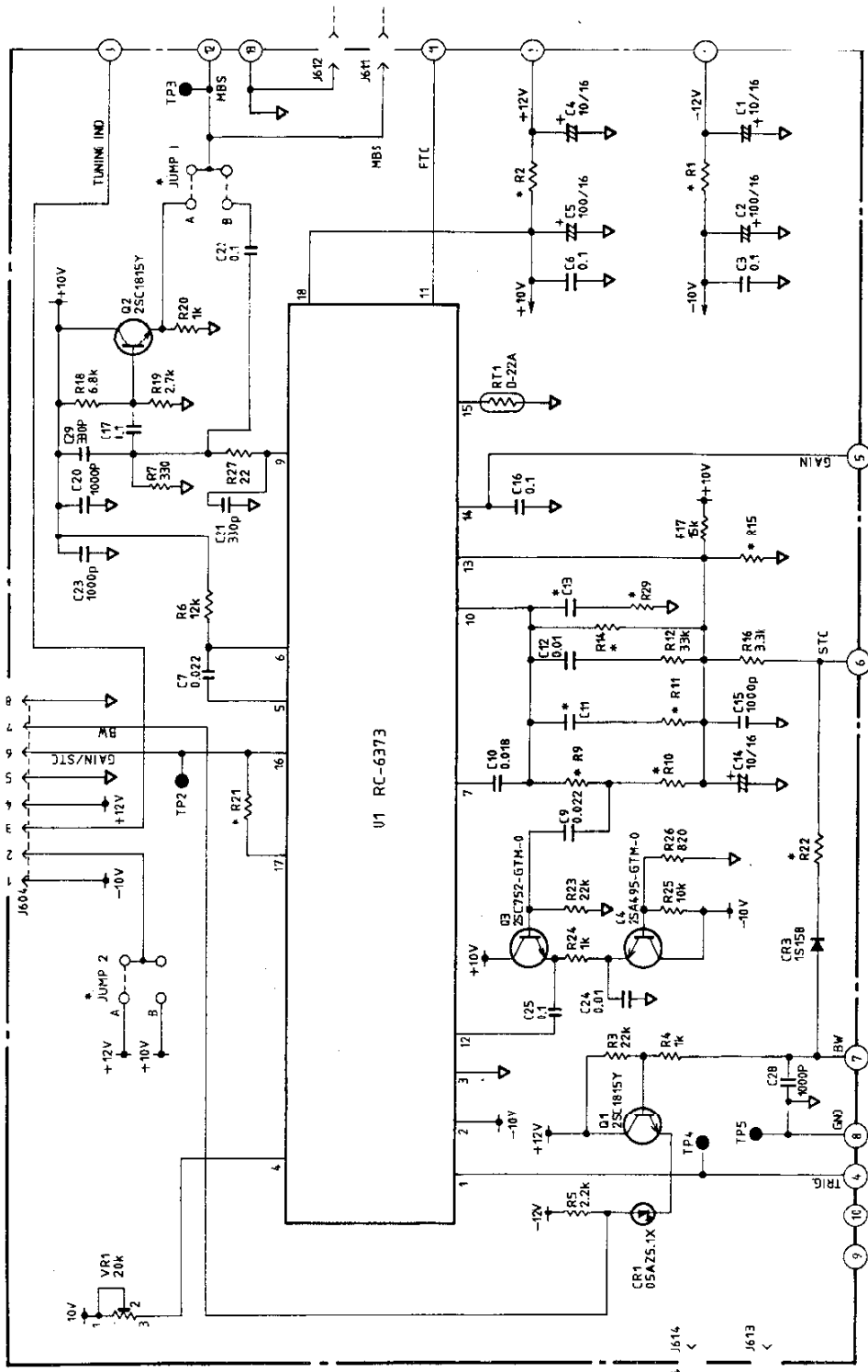
NOTE1. ▲ : 0.01μF, 50V
2. ALL RESISTANCE IN Ω, 1/6W AND
CAPACITANCE IN μF UNLESS NOTED
OTHERWISE



NOTE 1 特記なき抵抗は全て0.1 μ F, 1/4W, コンデンサは4F.
 ALL RESISTANCE IN OHMS, 1/4W, CAPACITANCE IN MICRO FARADS
 UNLESS NOTED OTHERWISE.

DATE	MAY 14 1955	REV	1	TITLE	SCANNER UNIT
APPROVED	J. A. MARRAS	THIRD ANGLE PROJECTION			
CHECKED	J. A. MARRAS	SCALE			
DRAWN	Y. GEM/STW	WEIGHT	49.0	DWG. NO.	03305

PR - 8350D/2700
 FR - 1505D/1700



NOTE: 1. 特記なき抵抗の単位は全て Ω, 1/4 W, コンデンサは全て μF, コイルは H.
 ALL RESISTANCE IN OHMS 1/4 W, CAPACITANCE IN MICRO FARADS AND INDUCTANCE IN HENRY UNLESS NOTED OTHERWISE.

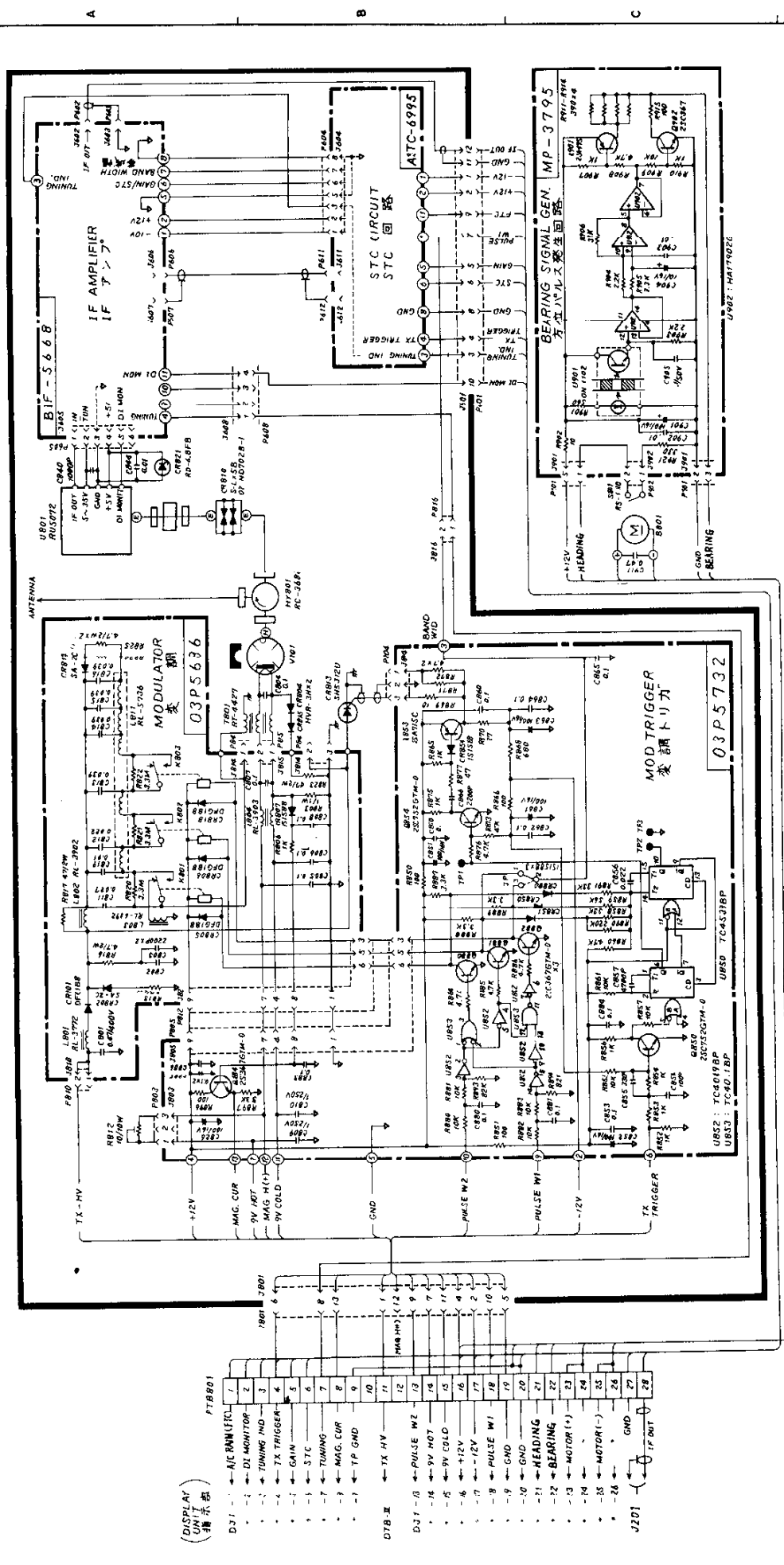
2 (*)

	JUMP 1	JUMP 2	R1	R2	R9	R11	R15	R22	R29	C11	C15	C17	R29	C13	R10	R4
BST(6995) (D TYPE)	B	B	68Ω	27Ω	8.2kΩ	18kΩ	33Ω	—	3300PF	10kΩ	1800PF	100Ω	220PF	4.7kΩ	22Ω	—
ASTC(6995) (DA TYPE)	A	A	56Ω	56Ω	68kΩ	15kΩ	22Ω	22k	8200PF	—	—	—	—	—	8.2kΩ	—

3. コネクタを除く基板内部品の部品番号は 700 番台。
 ADD 700 TO PARTS NUMBER EXCEPT FOR CONNECTORS.

承認 APPROVED	検査 CHECKED	製図 DRAWN	部品 PARTS	部品 PARTS
Mag. J. Ameno	Mag. J. Ameno	Mag. J. Ameno	ASTC-6995 BSTC-6995	STC 基板 STC P.C.B.
			図番 DWG. NO.	C3307-011-J

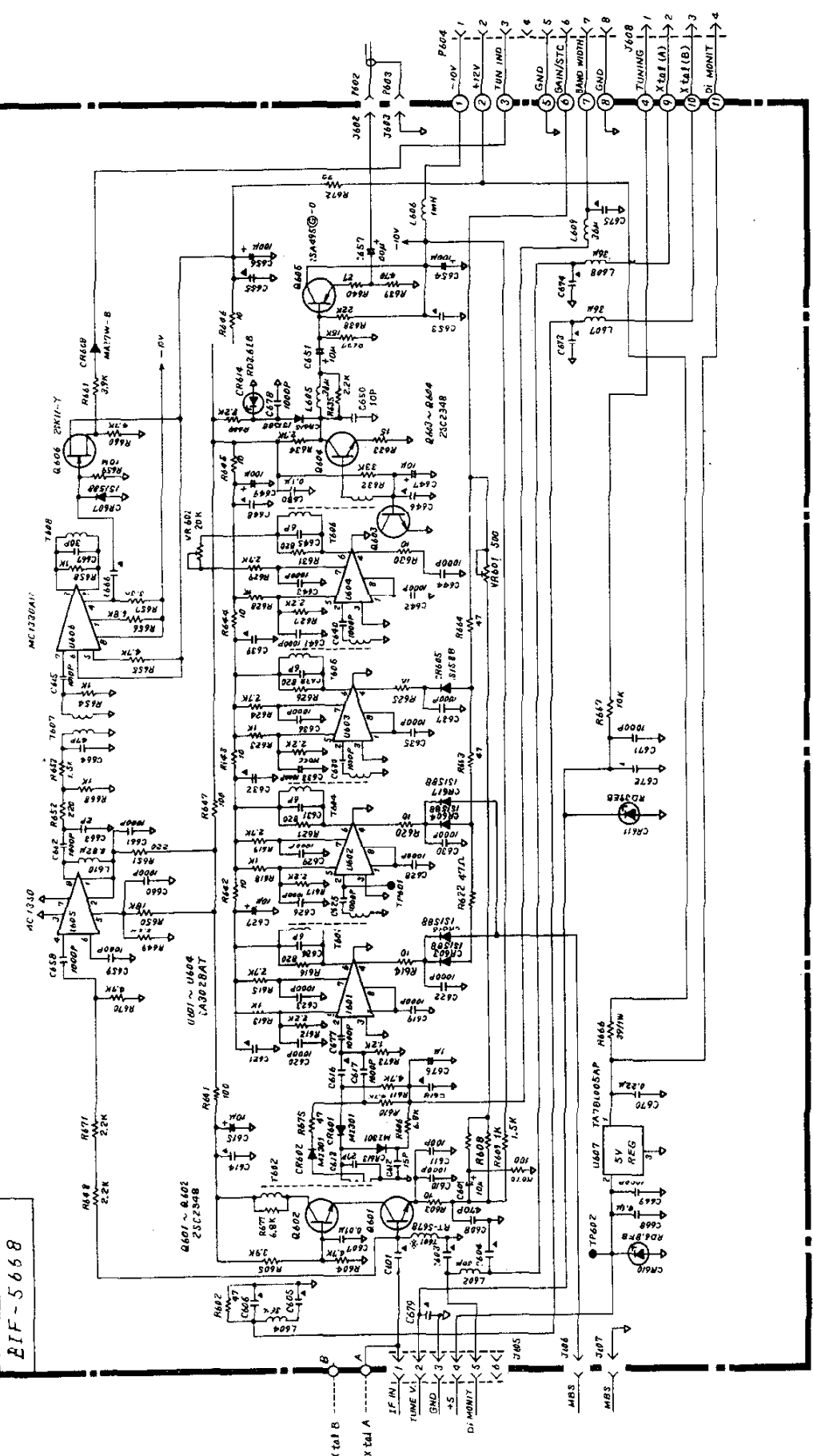
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NOTE 1. 特記なき抵抗は全てΩ, 1/4W, コンデナは4K.
 ALL RESISTANCE IN OHMS, 1/4W, CAPACITANCE IN MICRO FARADS
 UNLESS NOTED OTHERWISE.

APPROVED: T. TAKAKI (THIRD ANGLE PROJECTION) TITLE: SCANNER UNIT 空中線部
 CHECKED: I. A. HARA (SCALE) DRAWN: T. TANI (WEIGHT) NO. 49 DWG. NO. C3307-01A
 P-R-305 CDA/8 00 DA FR-1505DA/1510 DA

FURUNO



NOTE 1. 特別な記載は全て、1/4W コンデンサは F, コイルは H.
 ALL RESISTANCE IN OHMS 1/4W, CAPACITANCE IN FARADS
 AND INDUCTANCE IN HENRIES UNLESS NOTED OTHERWISE.

2. ▲ : 0.01μF, 50V

承認	検査	品名	数量	材料	国産	DWG. NO.	備考
APPROVED	CHECKED	品名	数量	材料	国産	DWG. NO.	備考
May-19-67	I. Adams	IF AMP					
THIRD ANGLE PROJECTION		名称 IF アンプ					
SCALE		TITLE IF AMPLIFIER					
WEIGHT		(BIF-5668)					
DRAWN		DWG. NO. C3307-014-F					

FR-8000A SERIES
 FR-1500A SERIES

FURUNO ELECTRIC CO., LTD.

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