

# **FURUNO**

## **OPERATOR'S MANUAL**

COLOR RADAR

MODEL FCR-904



**FURUNO ELECTRIC CO., LTD.**  
NISHINOMIYA, JAPAN

C O N T E N T S  
\* \* \* \* \*

SPECIFICATIONS	Page 0-1 to 0-5
CHAPTER 1 OPERATION INSTRUCTIONS	1-1 to 1-19
1.1 Function of Switches, Controls and Touchpads	1-1
1.2 Operation Procedure	1-12
1.3 Range Measurement	1-13
1.4 Bearing Measurement	1-15
1.5 Alarm Setting	1-15
1.6 Changing the Specifications by an Internal DIP Switch	1-17
CHAPTER 2 REMARKS ON VIEWING PICTURE	2-1 to 2-5
2.1 Minimum and Maximum Ranges	2-1
2.2 Radar Resolution	2-1
2.3 Bearing Accuracy	2-2
2.4 Range Measurement	2-2
2.5 False Echoes	2-2
CHAPTER 3 MAINTENANCE	3-1 & 3-2
CHAPTER 4 TROUBLESHOOTING	4-1 to 4-9
SCHEMATIC DIAGRAMS	S-0 to S-8
INTERCONNECTION DIAGRAM	S-9
OUTLINE DRAWINGS	D-1 to D-3

SPECIFICATIONS OF FCR-904  
\* \* \* \* \*

SCANNER UNIT

1. Radiator: Slotted Waveguide Array
2. Radiator Length: 120cm
3. Horizontal Beamwidth: 2.0°
4. Vertical Beamwidth: 22°
5. Sidelobe Attenuation:
  - Within  $\pm 20^\circ$  of mainlobe: -27dB
  - Outside  $\pm 20^\circ$  of mainlobe: -30dB
6. Polarization: Horizontal
7. Antenna Rotation: 24 r.p.m. nominal

TRANSCEIVER MODULE (Contained in the scanner housing)

1. Transmitting Tube: Magnetron 9M302/E3513
2. Frequency & Modulation: 9410MHz  $\pm$  30MHz, P0N
3. Peak Output Power: 3kW nominal
4. Pulselength & Pulse Repetition Rate:

Range	0.25	0.5	0.75	1.5	3	6	12	24	48
Pulse Repetition Rate	Approx. 2500Hz					Approx. 840Hz			
Pulselength	0.08us (Short)					0.5us (Long)			

5. Modulator: SCR Line Type Pulse Modulator
6. I.F.: 60MHz
7. Tuning: Manual
8. Receiver Front End: MIC (Microwave IC)
9. Bandwidth: 7MHz/3MHz
10. Duplexer: Circulator with diode limiter

DISPLAY UNIT

1. Indication System: Raster scan, Daylight Display
2. Picture Tube: 10-inch rectangular color CRT
3. Range (nm):
 

0.25	0.5	0.75	1.5	3	6	12	24	48
------	-----	------	-----	---	---	----	----	----
4. Range Ring Interval (nm):
 

0.05	0.1	0.25	0.25	0.5	1	2	4	8
------	-----	------	------	-----	---	---	---	---
5. Number of Rings:
 

5	5	3	6	6	6	6	6	6
---	---	---	---	---	---	---	---	---

(\*) Ring intervals of 0.1 and 0.2km available for 0.25 and 0.5 n.m. ranges respectively with an internal DIP switch.
6. Color Assignment:
 

Echoes: 3 colors (red/yellow/green) or single color (yellow)

Background: blue or black

\*Echoes:
 

3 colors	3 colors	Single color	Single color
BLU	BLK	BLU	BLK
BLK	BLU	BLK	BLU

\*Background: BLU or BLK

\*Plotted echoes: BLK, BLU, BLK, BLU

\*: Color combination selectable.
7. Markings: Heading Mark, Bearing Scale, Range Ring, Two VRMs, Two EBLs, Alarm Zone, Tuning Bar
8. Legends: Range, Range Ring Interval, Two EBL Bearings, Two VRM Ranges, Interference Rejection (IR), Alarm (ALM), Echo Stretch (ES), ST-BY, Plot (PLOT), Plotting Time
9. Range Ring Accuracy: 1.5% or 70m, whichever is the greater
10. VRM Accuracy: 1.5% or 70m, whichever is the greater
11. Bearing Resolution: 2.0°
12. Bearing Accuracy: Better than 1°
13. Range Discrimination: Better than 32m
14. Minimum Range: Better than 39m
15. Interference Rejector: Built in
16. Radar Alarm: Built in

ENVIRONMENT CONDITION

1. Vibration:
 

Vibration Freq.	Total Amplitude
1 to 12.5Hz	$\pm 1.6\text{mm}$
12.5 to 25Hz	$\pm 0.38\text{mm}$
25 to 50Hz	$\pm 0.10\text{mm}$
2. Ambient Temperature:
 

Scanner Unit ----- -25°C to +70°C

Display Unit ----- -15°C to +55°C
3. Humidity: Relative humidity, 93%  $\pm$  2% at +40°C  $\pm$  3°C

POWER SUPPLY & POWER CONSUMPTION

12VDC (10.2 to 15.0VDC), 70W or 24/32VDC (20.4 to 40.0VDC), 65W  
 100/110/115/220/240VAC, 50/60Hz, 1 $\phi$  (Rectifier RU-3423 needed)

EQUIPMENT LIST

No.	Name	Type	Weight (kg)	Q'ty
1	Scanner Unit	RSB-0024	23	1
2	Display Unit	RDP-050	12	1
3	Accessories	FP03-02100		1 set
4	Standard Spare Parts	SP03-02800		1 set
5	Installation Materials			1 set

OPTIONAL SUPPLY

No.	Name	Type	Weight (kg)	Q'ty	Remarks
1	Rectifier	RU-3423	16.5	1	AC mains only
2	Power Cable	VV-S 2.0x2C		1	Cable length:5m
3	External Buzzer	OP03-21		1	For alarm
4	Vinyl Cover	03-019-0401		1	Code No. 008-280-560

ACCESSORIES (Type: FP03-02100, Code No.: 000-081-102)

No.	Name	Type	Code No.	Q'ty
1	Hood Assy.	FP03-02110	008-280-550	1

STANDARD SPARE PARTS (Type: SP03-02800, Code No.: 000-081-103)

No.	Name	Type	Code No.	Q'ty
1	Fuse	FGB0 15A AC125V	000-549-014	2
2	Fuse	FGB0 1A AC125V	000-549-061	2
3	Fuse	FGB0 10A AC125V	000-549-065	2
4	Hex. Wrench	Diagonal: 1.5mm	000-830-112	1
5	Carbon Brush	For RM-3622	000-430-890	2
6	L-handle Socket Wrench	For M8 hex. bolt	000-830-110	1
7	Spare Parts Box	For F710	000-831-610	1

INSTALLATION MATERIALS

For Display Unit

No.	Name	Type	Code No.	Q'ty	Remarks
1	Connector	16P2B	000-500-346	1	For power cable
2	Signal Cable Assy.	S03-11-10 (10m)	008-204-690	1	To be selected (with connector at display end)
		S03-11-15 (15m)	008-204-700		
		S03-11-20 (20m)	008-204-710		
		S03-11-30 (30m)	008-204-720		

For Scanner Unit

No.	Name	Type	Code No.	Q'ty
1	Connector	CN-7042	000-510-580	1
2	Lug	ø4	000-536-100	4
3	Crimp-on Lug	FV5.5-S3	000-538-120	1
4	Crimp-on Lug	FV1.25-3 RED	000-538-113	22
5	Seal Washer	CW1053DX	000-850-021	4
6	Hex. Bolt	M12x60 SUS304	000-862-191	4
7	Hex. Nut	M12 SUS304	000-863-112	4
8	Flat Washer	M12 SUS304	000-864-132	4
9	Spring Washer	M12 SUS304	000-864-263	4
10	Slotted Pin G-type	10x45 SUS	000-866-390	2
11	Drain Tube	03-003-3001-0	300-330-010	1
12	Hex. Bolt	M8x30 SUS304	000-862-187	4
13	Flat Washer	M8 SUS304	000-864-130	4
14	Spring Washer	M8 SUS304	000-864-262	4
15	O-ring	JISB2401-1A-G80	000-851-313	1
16	Adhesive	#1211 (50g)	000-854-118	1

Assembly from No.1 to No.11 --- Type: CP03-02801, Code No.: 008-206-960

## CHAPTER 1 OPERATION INSTRUCTIONS

Adjustment and function for the respective operating controls are discussed in this chapter. Operating personnel should familiarize themselves with all the operating controls in order to make the best possible use of the equipment.

### 1.1 Function of Switches, Controls and Touchpads (Refer to page 1-19.)

#### POWER Switch

When this switch is turned to the left, power to the radar is cut off and operation is suspended. When the switch is turned to the right, power is supplied to the radar and the antenna begins to rotate. (The scanner switch is located inside the inner panel on the left-hand side of the display unit. See page 1-18.)

Shortly after the radar set is turned on, the screen will read as shown in Fig.1-1 and the standby timer will count down from 2min. 30sec. When it reaches "0:01" the screen will display ST-BY, signifying the radar is ready for operation. Press the TX touchpad to begin transmission. The TUNE, GAIN and BRIL controls should be adjusted to display the radar picture. (If the TX touchpad is pressed before the timer counts down to 0:01 ("ST-BY" appears on the screen), "TX" will be displayed near the middle of the screen, and the radar will be set to transmit upon completion of warm-up automatically.)

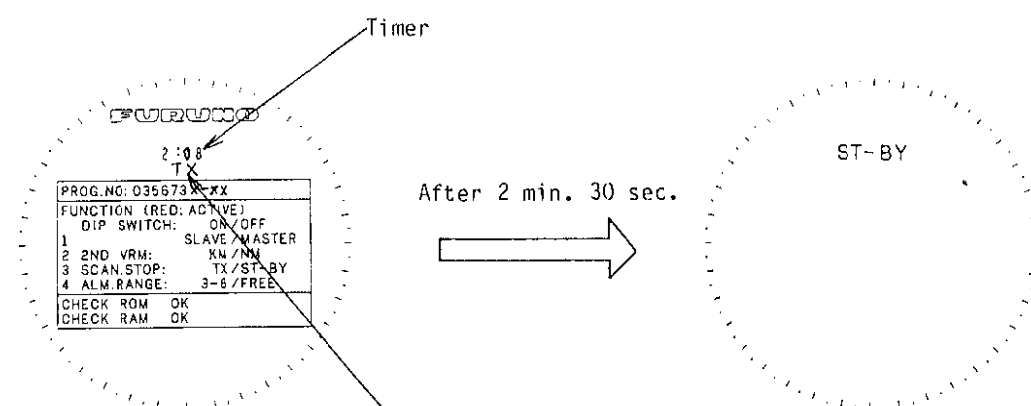


Fig.1-1

If TX touchpad is pressed during counting down of timer indication, "TX" is displayed, and the radar will transmit automatically after timer indicates 0:01.

Fig.1-2

#### GAIN Control



This control adjusts the sensitivity of the receiver. When the control is turned clockwise the sensitivity of the receiver is raised, and the echoes of targets are displayed on the screen. If the radar is set on one of the longer ranges, the radar is adjusted properly when the speckled background on the screen just fades out. On short ranges, it is recommended that the gain control be set almost fully clockwise and the SEA CLUTTER control be used to adjust the sensitivity.

#### SEA CLUTTER Control



This control reduces the gain at close ranges, in order to suppress reflections from waves near own ship. When the control is turned clockwise, the sensitivity is reduced at close ranges (where sea clutter is the greatest) and the strength of echoes on greater ranges is restored gradually. The control is adjusted so that targets masked by the clutter remain on the screen; only the clutter is removed. If the control is turned too far to the right, the echoes from desired targets may be lost. Therefore adjust the control prudently. Set the control to the fully counterclockwise position when no clutter is visible on the screen.

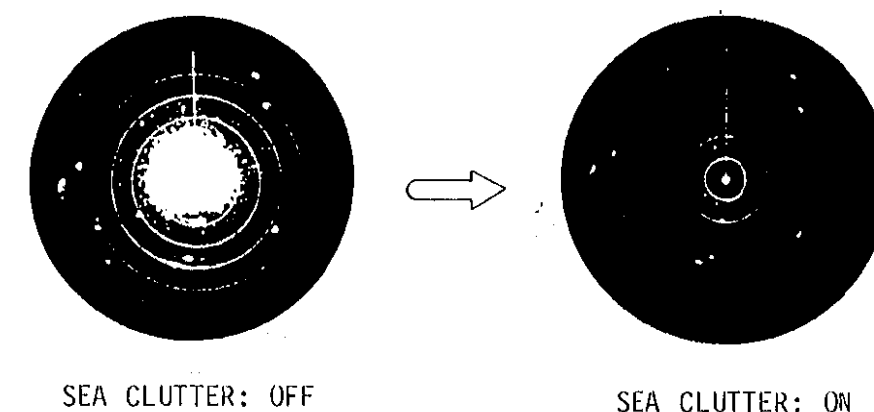


Fig.1-3

#### BRIL Control



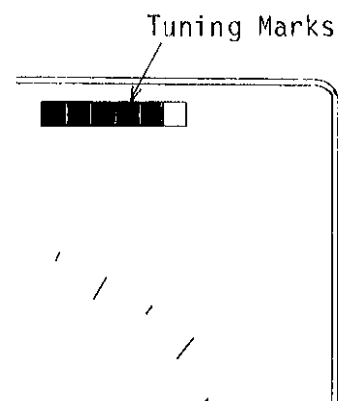
This control adjusts the brightness of the picture. Turn it clockwise to increase the brightness.

Note that the illumination of the touchpads/front panel can be adjusted by the illumination pot. (DIM) in the inner panel. See page 1-18. Turn it clockwise to increase the illumination.

### TUNE Control

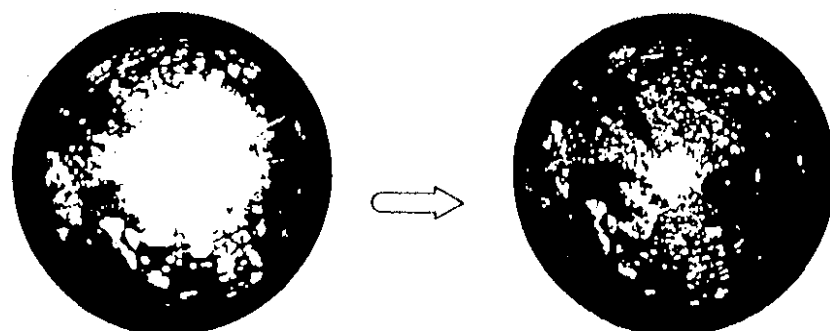


After the radar is set to transmit, this control is used to tune the receiver to the exact frequency of the transmitter. The tuning condition of the receiver can be confirmed at any time by checking the tuning bar at the top right-hand corner of the screen. The receiver is tuned properly when the greatest number of tuning marks is displayed. To tune the receiver, set the range to maximum and rotate the tune control between its extremes to display the greatest number of tuning marks (4 to 5).



### RAIN CLUTTER Control RAIN CLUTTER/ Pull-FTC

Echoes of ships operating inside rain, snow or hail storms may be hidden by the clutter displayed on the screen. When only a slight amount of clutter (e.g., rain) is visible on the screen, turn the control clockwise to distinguish target echoes from the clutter. In heavy storms or partial clutter, pull the control out and adjust it to remove clutter. Furthermore, with the control pulled out in clear weather it may be used to separate groups of echoes on a congested short range picture. In all cases, be careful not to turn the control too far clockwise because targets may be missed.



RAIN CLUTTER: OFF

RAIN CLUTTER: ON

Fig.1-4

### RANGE Switch

As shown in the Specifications, the range, fixed range ring interval and transmission pulsewidth are changed automatically when this switch is turned. The numerals engraved in white and red around the switch correspond to range and fixed range ring interval respectively. The range in use and corresponding fixed range ring interval are displayed at the top left-hand corner of the screen. See Fig.1-5.

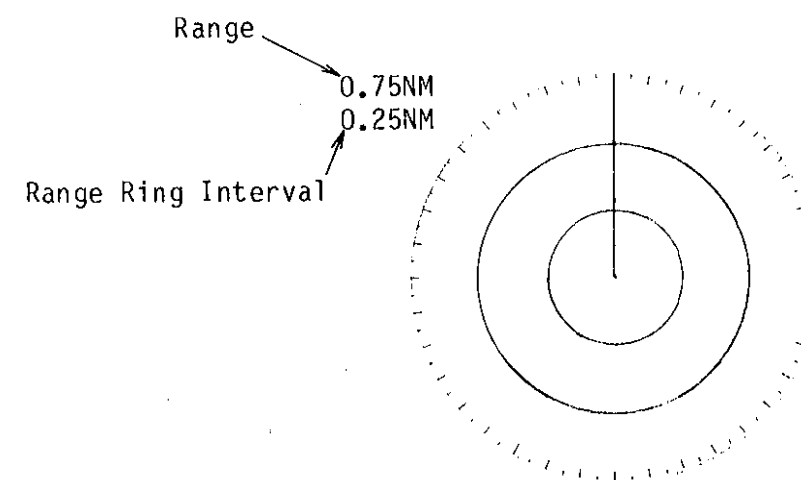


Fig.1-5

The following are the functions of each touchpad.

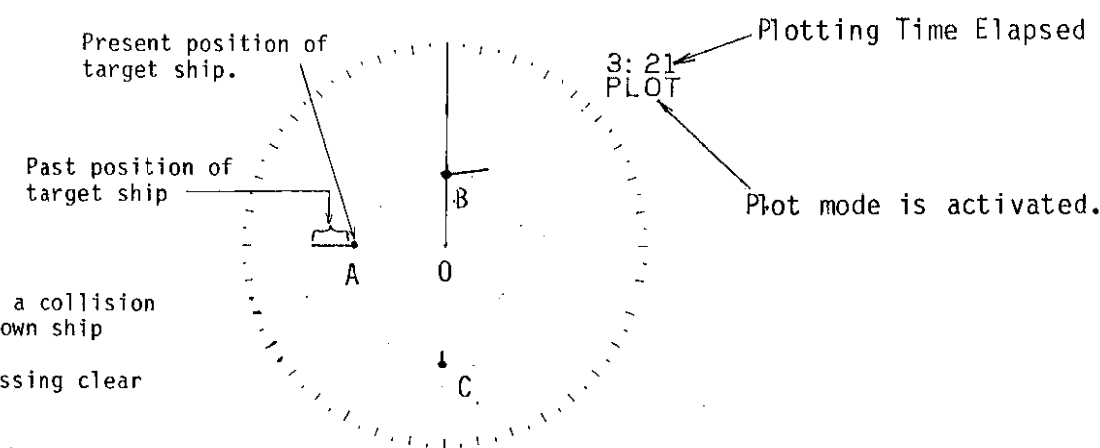
### PLOT Touchpad



This touchpad is used to display the relative movement of other ships in relation to own ship. Press the touchpad, and continuous plotting of moving targets begins. The message "PLOT" is displayed in red at the top right-hand side of the screen to remind the operator that he is observing the screen in the plot mode. The color of plotting may be changed by pressing the COLOR touchpad. When the background color is black, plotting is performed in blue and vice versa. The time elapsed after pressing the PLOT touchpad is displayed, counting up to 99 minutes and 59 seconds.

If the range is changed during the plot mode, plotting is cancelled immediately, and restarted from 0:00. To cancel the plot mode at any time press the PLOT touchpad again.

Any ship whose plot course extension passes through the center spot (sweep origin), 0, may be on a collision course with own ship (ref. A in Fig.1-6).



### Example

Ship A is on a collision course with own ship

Ship B is passing clear ahead

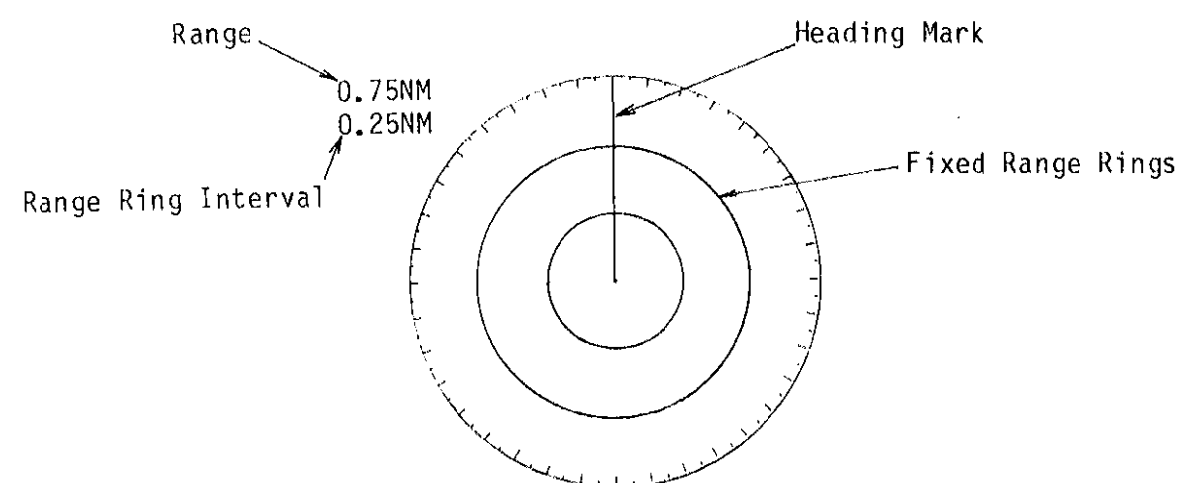
Target C may be a stationary buoy from which own ship is leaving

Fig.1-6

**TX Touchpad** 

Press this touchpad to alternate between transmit and ST-BY modes. After standby is completed, press the touchpad to begin transmitting. If the touchpad is pressed any time between power on and before the message "ST-BY" appears, "TX" will appear at the center of the screen, (see Fig.1-1) and the radar is set to transmit automatically when warm-up has elapsed.

After the radar is set to transmit the TUNE, GAIN and BRIL controls are adjusted to display the radar picture. When the radar will not be used for an extended period of time, press the TX touchpad to set the radar to ST-BY. The message "ST-BY" will appear at the middle of the screen.



**Fig.1-7**

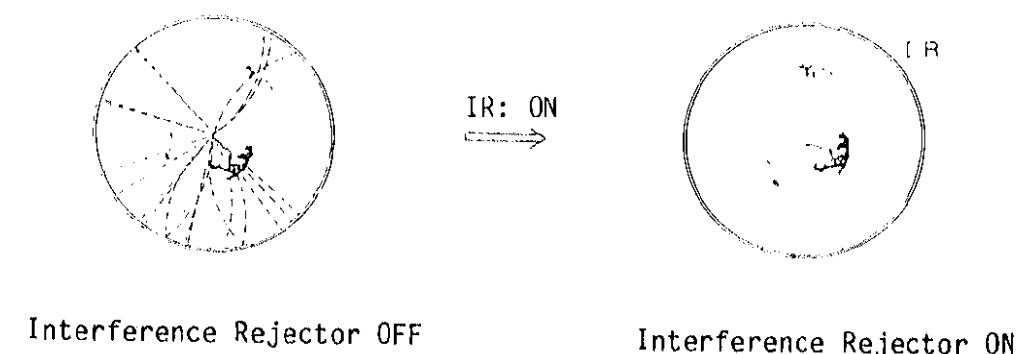
**RING (on/off) Touchpad** 

The RING touchpad is pressed to turn on/off the fixed range rings. The fixed range rings are presented on the screen everytime the power is turned on. Therefore, press the touchpad to erase the rings from the screen when they are not needed.

As noted earlier the number and interval of the rings are related to the range in use. See the Specifications. The interval is displayed below the range in use at the top left-hand corner of the screen. See Fig.1-7. By changing an internal DIP switch the range ring interval for the 0.25 and 0.5nm ranges may be displayed in kilometers, instead of nautical miles. For further details, see page 1-17.

**IR (on/off) Touchpad** 

Should radar interference from other radars operating in the vicinity be observed on the screen (see Fig.1-8) this touchpad may be pressed to eliminate or suppress the interference. The interference rejector circuit is switched on whenever power is applied. Therefore deactivate the circuit when there is no interference. The letters "IR" appear at the top right-hand side of the screen when the circuit is activated.



**Fig.1-8**

**HM OFF Touchpad** 

Should you desire to observe a small echo under the ship's heading mark, press and hold this touchpad to erase the mark from the screen. Furthermore if the "ON" portion of VRM touchpad is pressed while pressing and holding the HM OFF touchpad the unit of measurement for the VRM displayed in white changes from nautical miles to kilometers and vice versa. When the unit of measurement is kilometers the message "KM" is displayed in red.

**ECHO STRETCH Touchpad** 

On long ranges the echoes of targets are displayed as small pips. When the range is set to 1.5nm or over this touchpad may be pressed to magnify the size of small targets. The letters "ES" are displayed in red at the top right-hand side of the screen when the echo stretch function is activated. See page 1-18. If the touchpad is pressed when the range in use is less than 1.5nm, "ES" is displayed in light blue, indicating the echo stretch function is not effective. To cancel the echo stretch function, press the touchpad again (message "ES" disappears from the screen).

If the ECHO STRETCH touchpad is pressed and held for 1 second the sweep origin is off-centered to increase the size of small targets in the ship's bow direction. This function not only increases the size of the target (about 1.5 times) but also improves range resolution, making separation of targets easier. Press and hold the touchpad for 1 second to return to the normal display. Note that the location of the EBL and VRM indicators changes when the ECHO STRETCH touchpad is pressed for 1 sec. See Fig.1-9.

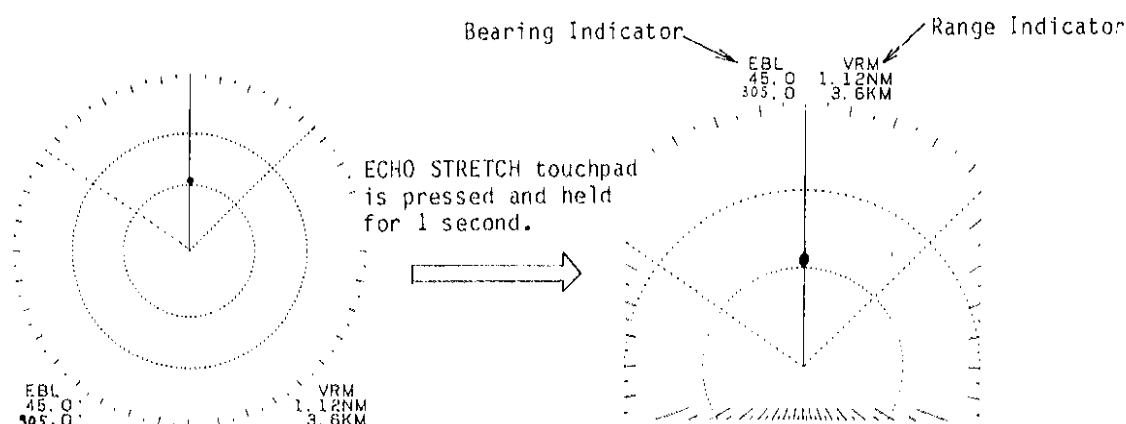
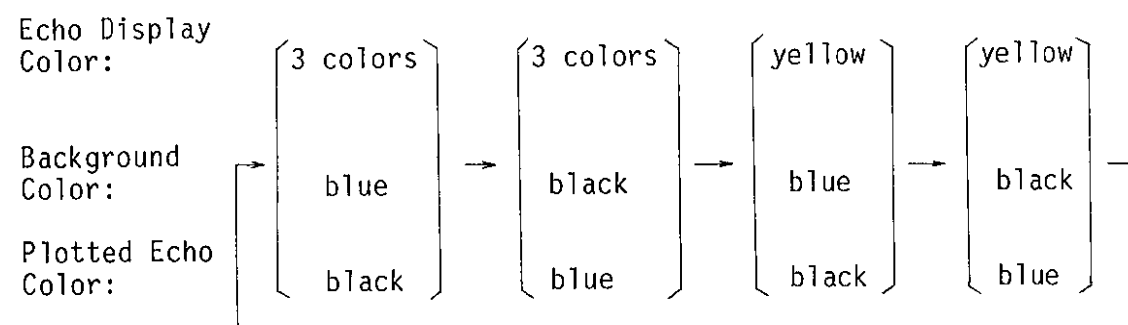


Fig.1-9

#### COLOR Touchpad



When this touchpad is pressed during normal operations, the respective echo display/background/plotted echo colors change in the sequence shown below.



(\*): 3 colors: Red/Yellow/Green

#### ALARM Touchpad

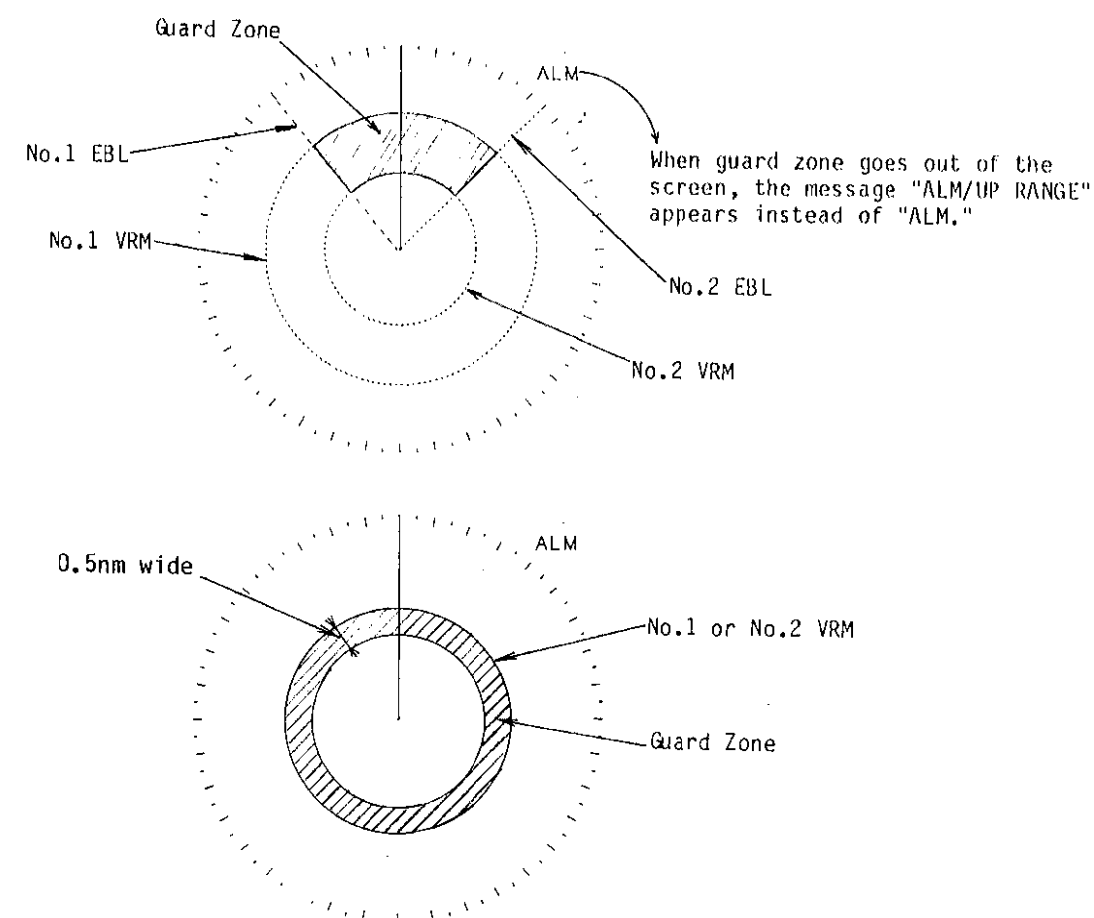


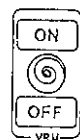
This touchpad is pressed to set/cancel the guard zone. Should any ships, landmasses, etc. come into the guard zone set by the No.1 and No.2 VRMs and EBLs an alarm will sound. The message "ALM" is displayed in red at the top right-hand side of the screen to alert the operator that the alarm is activated. When only No.1 or No.2 VRM is used to set a guard zone, a 0.5nm wide guard ring is created automatically (see figure below).

When you want to cancel the guard zone temporarily, press the touchpad once. The color of the guard zone and the "ALM" message will change from red to light blue, indicating the guard zone is deactivated temporarily. To reactivate the alarm press the touchpad again, and the color of the guard zone and "ALM" will change to red.

If the guard zone goes out of the screen when changing to a lower range, the message "ALM/UP RANGE" is displayed in light blue, and you know you must select a higher range to redisplay the guard zone on the screen.

You may cancel the alarm at any time by pressing and holding the ALARM touchpad for 1 sec. The guard zone is erased, however the No.1 and No.2 VRMs and EBLs remain on the screen, thereby allowing you to change the settings of the guard zone, if desired. For further details about how the alarm is set, see page 1-15.





VRM (on/off) Touchpad

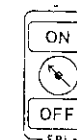
This touchpad is pressed to turn on/off No.1/No.2 VRMs and select the marker to be operated by the marker control. Each time the ON portion of the touchpad is pressed, No.1 or No.2 VRM is selected for operation with the marker control. The range indicator of each marker is displayed at the lower right-hand side of the screen, the value of No.1 VRM being on top, and the value of No.2 VRM directly below the value of No.1 VRM. See NOTE 1) & 2) shown below.

Whenever power is applied No.1 VRM and its range indicator are presented on the screen. If you press the ON portion of the touchpad after switching on the power, No.2 VRM and its range indicator will be displayed in white, the white color signifying that No.2 VRM may be operated by the marker control. (At this time the No.1 VRM marker and its indicator change to light blue, signifying that the marker cannot be operated.) Then, if you press the ON portion of the touchpad again, the marker and indicator of No.1 VRM changes from light blue to white (the marker and indicator of No.2 VRM changes to light blue). The marker for No.1 VRM may now be operated by the marker control. (If the EBL is active (displayed in white) at the time the ON portion of the VRM touchpad is pressed, the VRM last operated will be displayed in white.)

To erase a marker from the screen press the OFF portion of this touchpad. If No.1 and No.2 VRMs are displayed in different colors (white and light blue) the marker and range value shown in light blue will be erased first. Press the OFF portion again to erase the marker displayed in white, if desired. (If both EBLs are presented in light blue on the screen, the EBL colored in white previously will once again be displayed in white after erasing the VRMs.) If No.1 and No.2 VRMs are displayed in light blue when the OFF portion of the touchpad is pressed the VRM which was white last remains on the screen, but the other marker is erased. Press the OFF portion again to erase the marker colored in white. (See Fig.1-10.)

**NOTE:**

- 1) The unit of measurement for No.2 VRM may be changed from nautical miles to kilometers by an internal DIP switch. See page 1-17.  
When the ON portion of the VRM is pressed while pressing and holding the HM OFF touchpad, the unit of measurement for the VRM displayed in white is changed from nautical miles to kilometers and vice versa.  
For further details see page 1-6, "HM OFF Touchpad."
- 2) When the ECHO STRETCH touchpad is pressed and held for 1 second, the sweep origin will be off-centered, and the indicators of the VRM and EBL are moved from the lower right & left-hand sides to the top center of the screen. See Fig.1-9 on page 1-7.



EBL (on/off) Touchpad

This touchpad is pressed to turn on/off No.1/No.2 EBLs select the marker to be operated by the marker control. Each time the ON portion of the touchpad is pressed, No.1 or No.2 EBL is selected for operation with the marker control. The bearing indicator of each marker is displayed at the lower left-hand side of the screen, the value of No.1 EBL being on top, and the value of No.2 EBL directly below the value of No.1 EBL. Press the ON portion of the EBL touchpad to display No.1 EBL on the screen. The marker and bearing value of No.1 EBL are displayed in white. If you press the ON portion of the touchpad again, No.2 EBL and its indicator are displayed in white, and No.1 EBL changes to light blue, signifying that No.2 EBL is ready for operation. (If the VRM is active (displayed in white) at the time the ON portion of the EBL touchpad is pressed, the EBL last operated will be displayed in white.)

To erase a marker from the screen press the OFF portion of this touchpad. If No.1 and No.2 EBLs are displayed in different colors (white and light blue) the marker and bearing indicator shown in light blue will be erased first. Press the OFF portion again to erase the marker displayed in white, if desired. (If both VRMs are presented in light blue on the screen, the VRM colored in white previously will once again be displayed in white after erasing the EBLs.) If No.1 and No.2 EBLs are displayed in light blue when the OFF portion of the touchpad is pressed the EBL which was white last remains on the screen, but the other marker is erased. Press the OFF portion again to erase the marker colored in white. (See Fig.1-10.)

### Marker Control

This control is used to maneuver the VRMs and EBLs. Press the ON portion of the touchpad (VRM/EBL) to display in white the marker you desire to operate. Then, rotate the marker control to measure the range/bearing to a target.

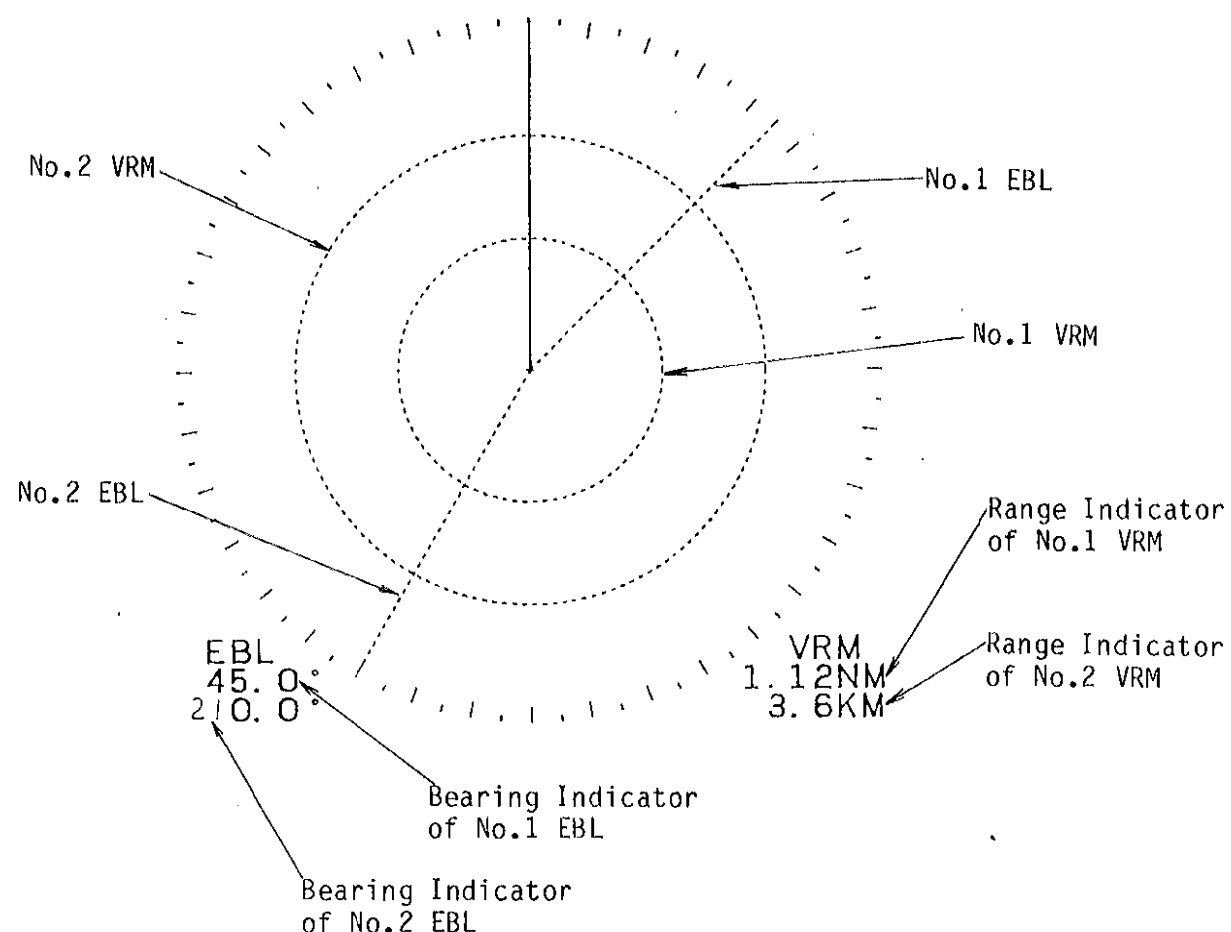


Fig.1-10

### 1.2 Operation Procedure

Confirm that the following points are satisfied before turning on the radar.

- 1) Confirm that the power supply is within the rating.
- 2) Make sure there are no obstructions around the antenna.
- 3) Check that the settings of the controls are as shown below.

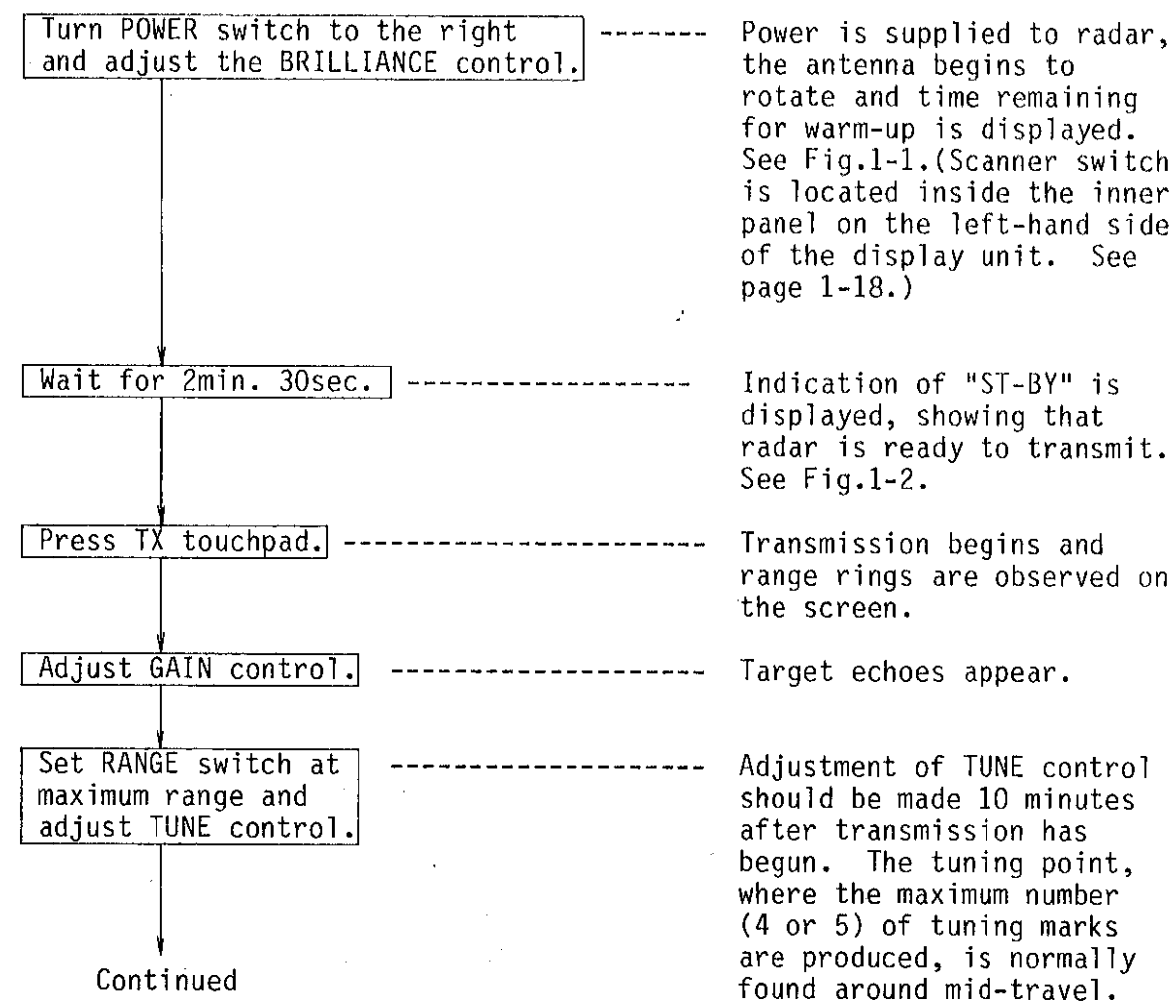
#### Controls & Switches

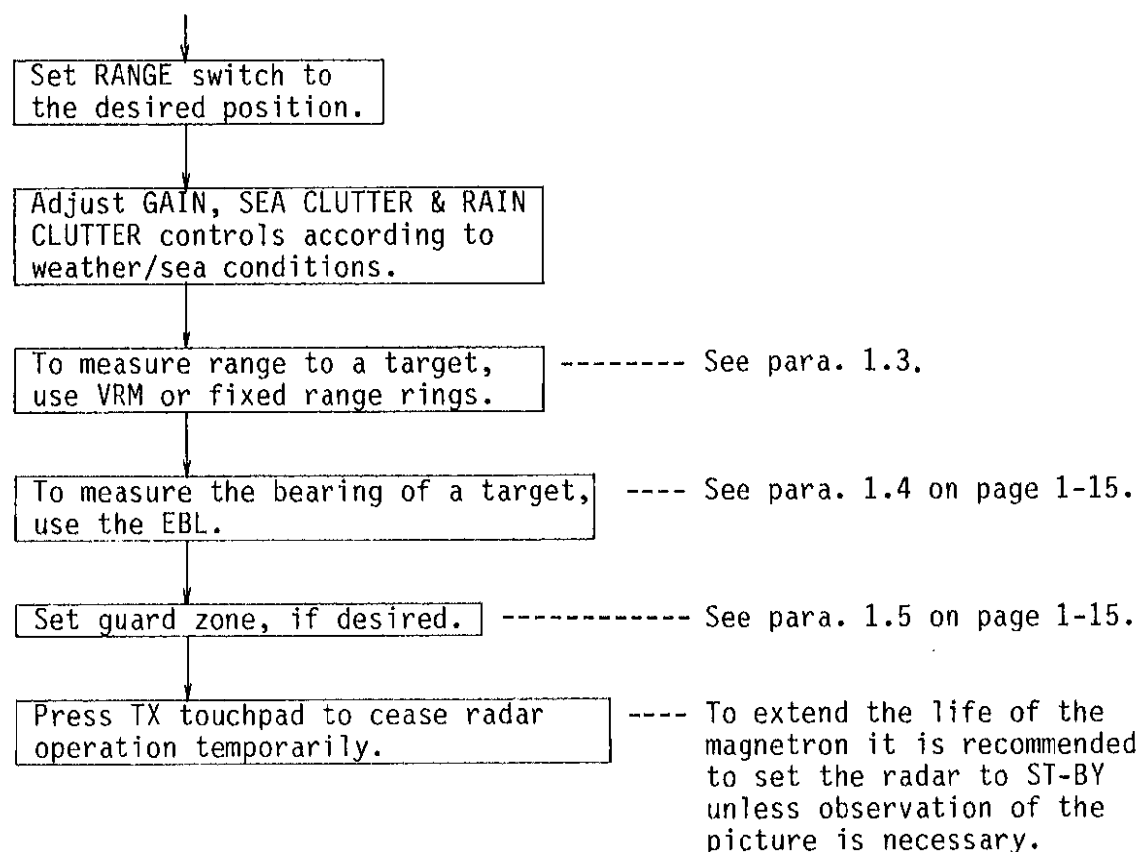
POWER  
GAIN, SEA CLUTTER, BRIL  
RAIN CLUTTER  
TUNE  
Others

#### Settings

OFF  
Fully CCW  
Fully CCW and depressed  
Center  
Any positions

#### Starting

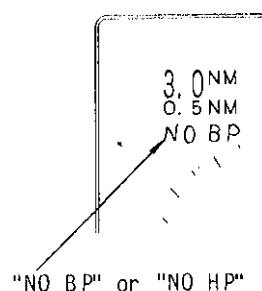




### Stopping

Ensure the GAIN and BRIL controls are turned fully counterclockwise before turning off the power.

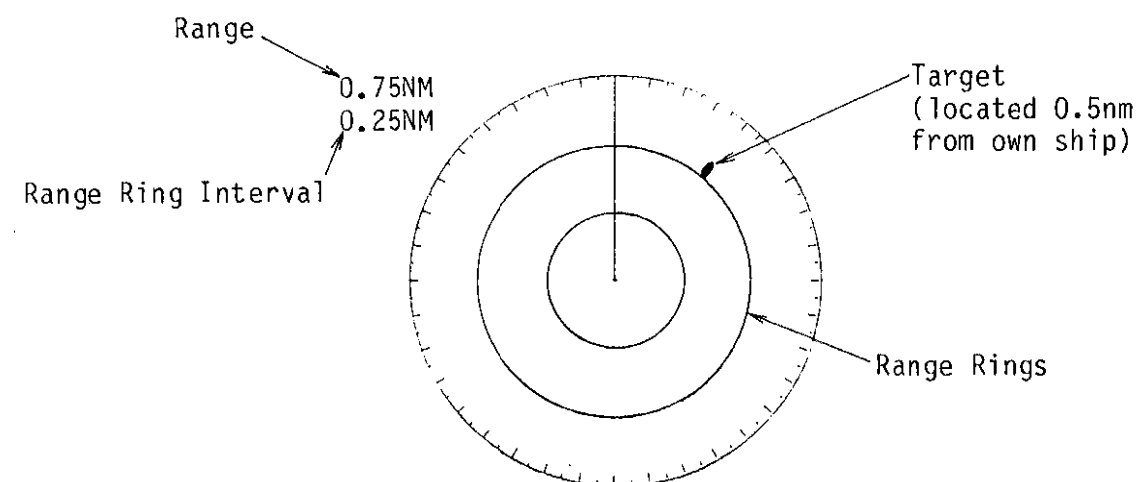
If the bearing signal from the antenna is interrupted during transmission, the message "NO BP" is displayed in red at the upper left-hand side of the screen, and the radar is set to ST-BY condition. And if the heading signal is interrupted, the message "NO HP" flashes in red instead of the message "NO BP," and the heading mark disappears from the screen. Echoes of targets are displayed at this time, however the bearing measured will be inaccurate.



## 1.3 Range Measurement

### 1) Range Measurement with the Fixed Range Rings

The range to a target is measured roughly with the fixed range rings. The rings are displayed on the screen by pressing the RING touchpad. To measure the range to a target, first check the range ring interval, shown at the upper left-hand corner of the screen. Then count the number of rings between the center of the CRT and the targets, and estimate the range to the target. The ring interval on 0.25 and 0.5nm ranges can be changed from nautical miles to kilometers and vice versa. See page 1-17.



NOTE: Two targets within 25m of each other on the same bearing cannot be separated and appear as a single target.

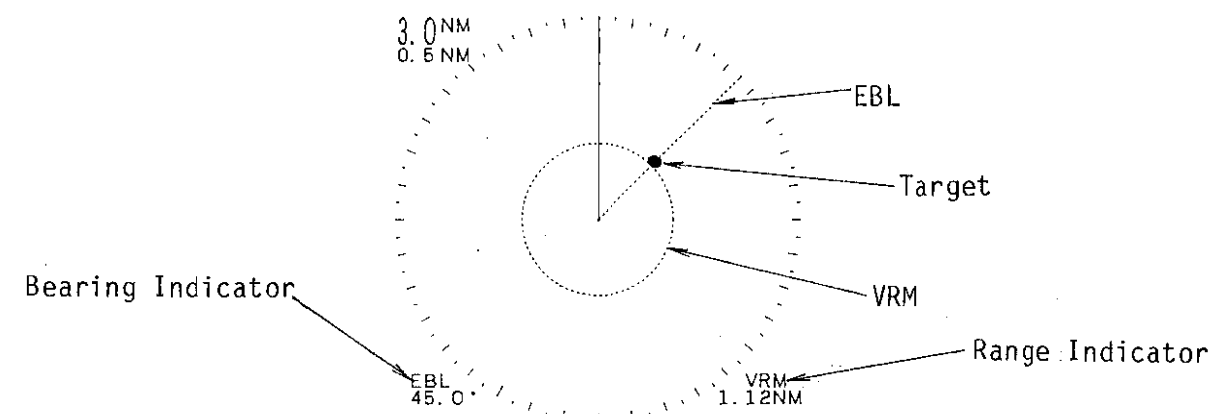
### 2) Range Measurement with the VRM

The range to targets can be measured more accurately using the VRM.

1. Press the ON portion of the VRM touchpad to display a VRM on the screen.
2. Rotate the marker control until the circle described by the VRM touches the inside edge of the target.
3. The range measured by the VRM can be read at the lower right-hand corner of the screen.

NOTE:

- 1) The unit of measurement for No.2 VRM can be switched from nautical miles to kilometers by an internal DIP switch.
- 2) By pressing and holding the HM OFF touchpad while pressing the ON portion of the VRM touchpad, the unit of measurement of the VRM displayed in white is changed from nautical miles to kilometers and vice versa. For further details see page 1-6, "HM OFF Touchpad."



#### 1.4 Bearing Measurement

1. Press the ON portion of the EBL touchpad to display an EBL on the screen.
2. Rotate the marker control to position the EBL over the center of the target.
3. The bearing measured by the EBL can be read at the lower left-hand corner of the screen. (The bearing measured is relative to own ship.)

NOTE: Two targets within 2.5° approx. in the same range cannot be separated and appear as a single target.

#### 1.5 Alarm Setting

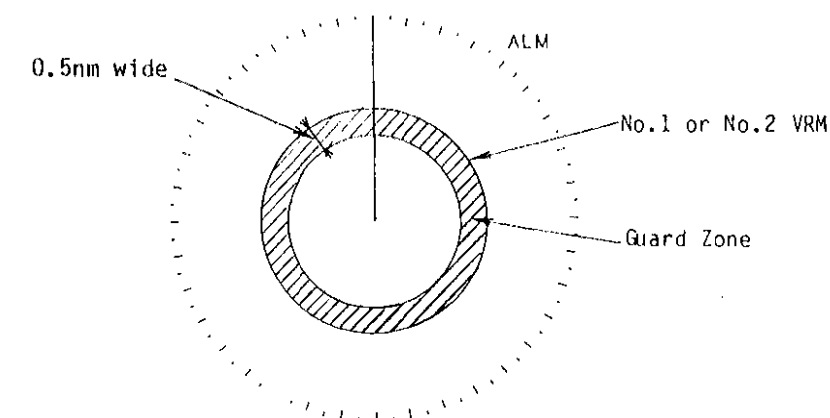
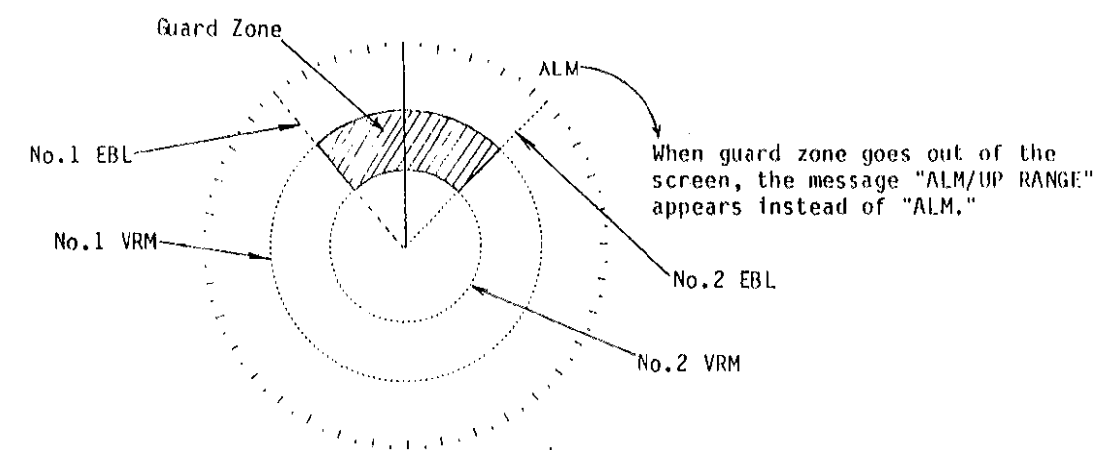
The alarm function allows the operator to set the desired range (0 to maximum range) and bearing (0 to 360°) for a guard zone. Should ships, islands, landmasses, etc. come into the guard zone an alarm will be generated. The alarm is very effective as an anti-collision aid when using an autopilot or navigating in narrow channels. Because the alarm is triggered only on "red" & "yellow" echoes, extreme caution must be exercised.

Although the alarm is useful as anti-collision aid, it does not relieve the operator of the responsibility to watch out for possible collision situations. The alarm should not be used as a primary means to detect possible collision situations.

##### Procedure

1. Press the ON portion of the VRM touchpad to display No.1 or No.2 VRM on the screen. Then, the marker is maneuvered by rotating the marker control to set the inner or outer range of the guard zone.
2. Press the ON portion of the VRM touchpad again to display the other VRM on the screen. Maneuver the marker with the marker control to set the inner or outer range of the guard zone, depending on which was set in step 1.
3. Press the ON portion of the EBL touchpad to display No.1 EBL on the screen. Rotate the marker control to set the counterclockwise limit of the guard zone.
4. Press the ON portion of the EBL touchpad to display No.2 EBL on the screen. Rotate the marker control to set the clockwise limit of the guard zone.
5. Press the ALARM touchpad. The message "ALM" and the guard zone are displayed in red, signifying the guard zone is now set. The range of the guard zone is the area enclosed by the settings of No.1 and No.2 VRMs, and the bearing sector of the guard zone is the area enclosed by the settings of No.1 EBL (left side) and No.2 EBL (right side). The VRM and EBL markers may be operated freely without disturbing the settings of the alarm. If the guard zone goes out of the screen when changing to a lower range, the message "ALM/UP RANGE" will appear in light blue, informing you to up the range to redisplay the guard zone on the screen.

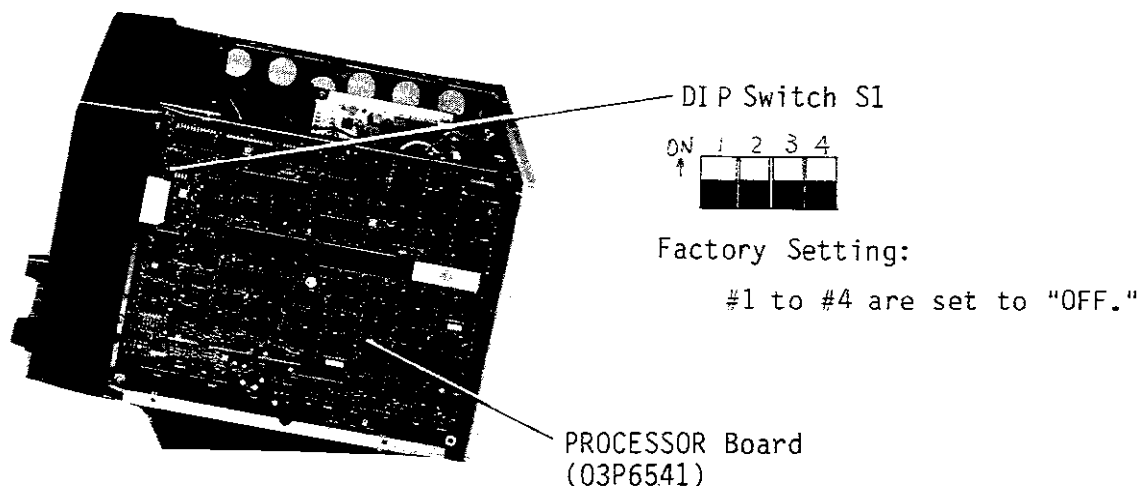
6. Any ships, islands, landmasses, etc. coming into the guard zone will trigger the alarm, telling the operator to proceed with caution. To suspend the alarm temporarily press the ALARM touchpad again. (The color of "ALM" and the guard zone change to light blue.) Press the ALARM touchpad to reactivate the alarm, and the color of "ALM" and the guard zone change to red. The guard zone may be cancelled at any time by pressing and holding the ALARM touchpad for 1 second.
7. A 0.5nm "guard ring" may be set by pressing the ALARM touchpad after setting only No.1 or No.2 VRM. The setting of No.1 or No.2 VRM corresponds to the outer limit of the guard zone. See the figure below.
8. One of the guard rings can be limited between 3 and 6nm, as some authorities stipulate, by setting a DIP switch (refer to page 1-17).



## 1.6 Changing the Specifications by an Internal DIP Switch

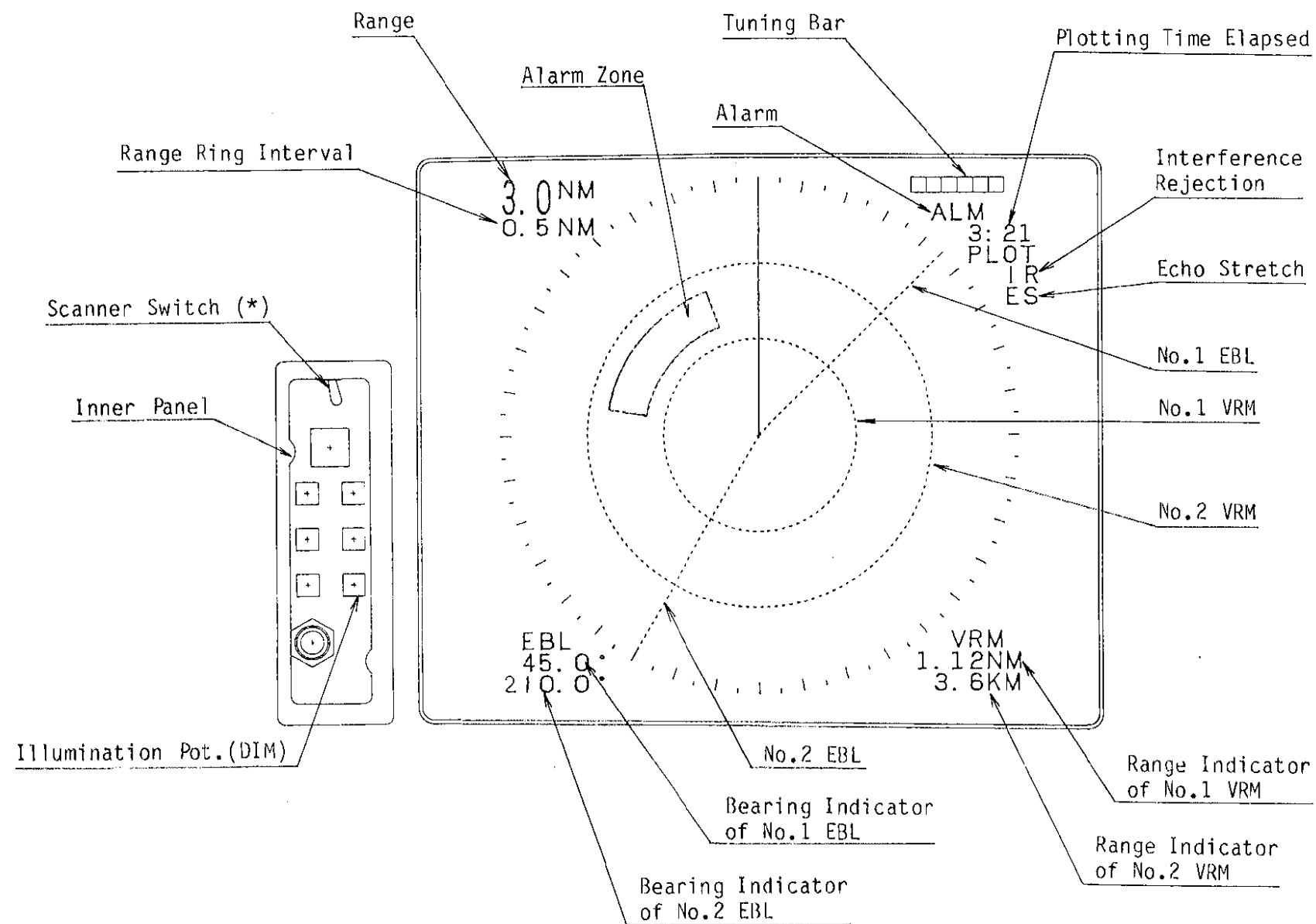
A 4-bit DIP switch S1 is located on the PROCESSOR board (03P6541). The specifications of the radar are changed according to the setting of the DIP switch, as shown below.

NOTE: When the change of the DIP switch setting is required in the field, turn off the radar before changing the setting.

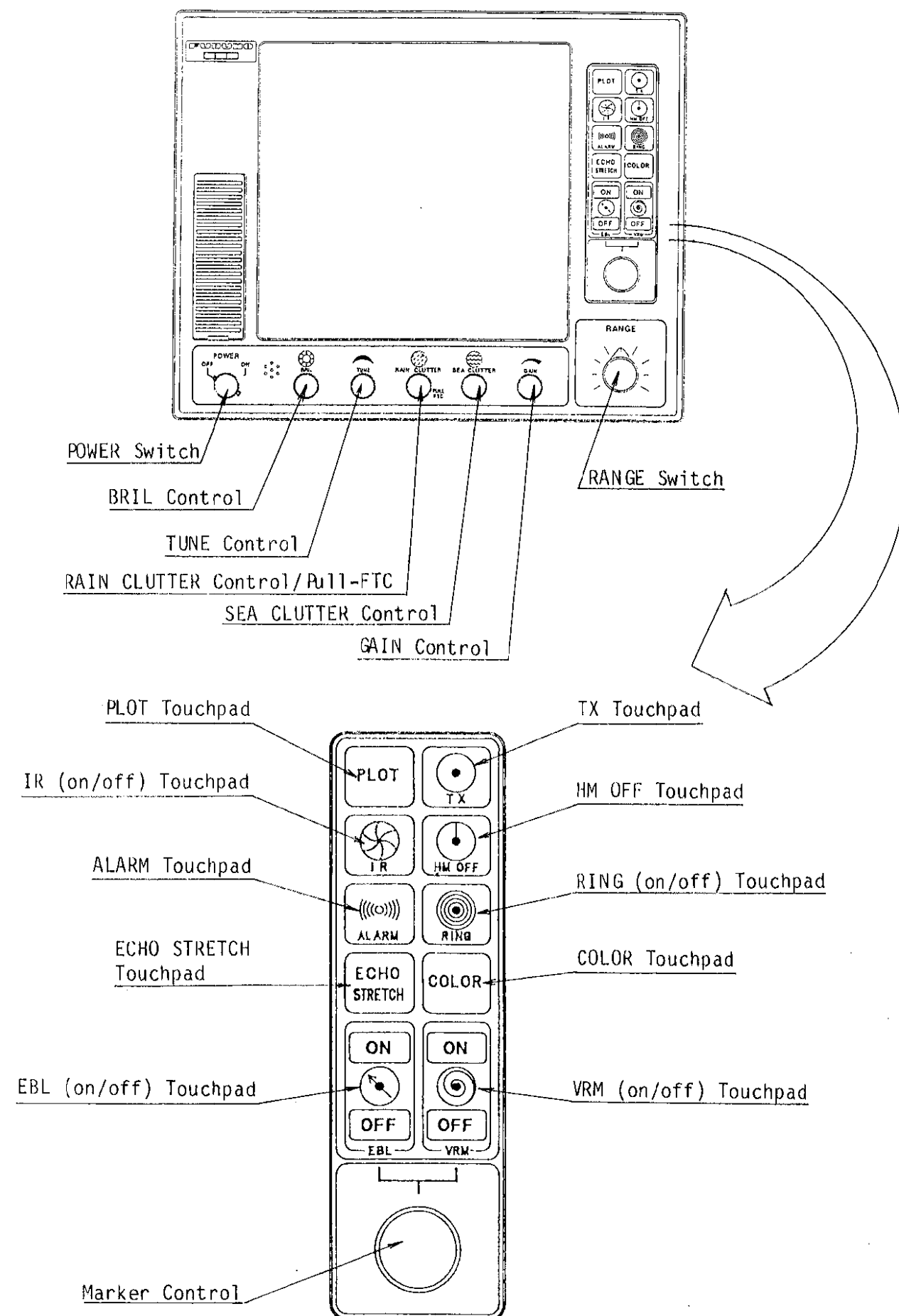


Switch Number	Specification
Switch #2	<p>ON - The range value of No.2 VRM and the fixed range ring interval on the 0.25 and 0.5nm ranges are both displayed in kilometers. (There are 4 range ring intervals on the 0.25nm range, each at a 0.1km interval. And the fixed range rings on the 0.5nm range are spaced every 0.2km).</p> <p>OFF - The value of No.2 VRM and the interval of the range rings are displayed in nautical miles.</p>
Switch #3	<p>ON - When the antenna switch (located in the inner panel) is set to OFF during transmission, antenna rotation is suspended.</p> <p>OFF - When the antenna switch is set to OFF during transmission, antenna rotation is suspended and the radar is put in standby condition.</p>
Switch #4	<p>ON - The range of the alarm is fixed between 3 and 6nm.</p> <p>OFF - Any range may be used to set the alarm.</p>

NOTE: DIP switch #1 is set at the factory; do not change the position.



(\*): Because the antenna switch is set to "ON" when shipped from the factory, make sure there are no personnel or obstruction near the antenna before switching on the power. Furthermore, according to the setting of an internal DIP switch, the radar may be changed from transmission to standby when the antenna switch is turned to "OFF." See page 1-17.



CHAPTER 2 REMARKS ON VIEWING PICTURE

2.1 Minimum and Maximum Ranges

Maximum range

The maximum detecting range of the radar, Rmax, varies considerably depending upon several factors such as the height of the antenna above the sea, 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 Rmax is given in the following equation.

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

where Rmax: Radar horizon (n. mile)  
 h1 : Antenna height (meter)  
 h2 : Target height (meter)

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

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

Minimum Range

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

2.2 Radar Resolution

Bearing Resolution

Bearing resolution is the ability to discriminate two targets which are located at the same range and close to each other. It is proportional to the length of the antenna and reciprocally proportional to the wave length. The usual bearing resolution is 1 to 3 degrees.

Range Discrimination

Range discrimination is the ability to distinguish two targets which are in the same direction and close to each other. This is determined by pulselength only. The average discrimination range is 25 yards on a 0.08 micro-second pulse.

2.3 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 the 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, the adjustment of the heading marker at installation is an important factor to determine 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.

2.4 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 the range: the fixed range rings which appear on the screen with a predetermined interval as a reference of the range measurement, and the variable range marker which can be moved inwards and outwards so that it will touch the inside edge of the target. The range to the target measured by the VRM is displayed digitally.

2.5 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 presented. Typical false echoes are shown below.

Multiple Reflection

When a wide and plane target such as the sideboard of a ship, bridge, building on a pier and breakwater exists near the ship, radar pulses are multi-reflected between your ship and the target. This results in presentation of multiple echoes on the screen. The multiple echoes appear at equal intervals after the true echo as shown in Fig.2-1.

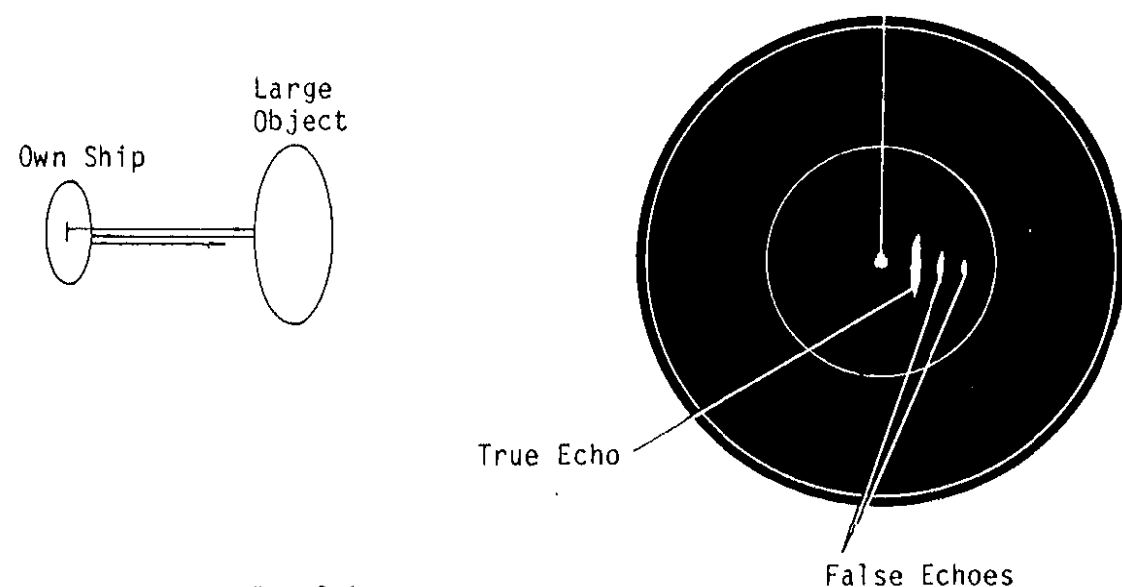


Fig.2-1

#### Spurious Echoes

When the radar pulse is emitted from the antenna radiator, some of the total emitted energy escapes on each side of the main beam--sidelobes. If the target is strong, it can be detected by the sidelobes as well as the main lobe, the spurious echoes may be represented at both sides of the true echo with the same range as shown in Fig.2-2. Spurious echoes can be removed by adjusting the GAIN and SEA CLUTTER controls.

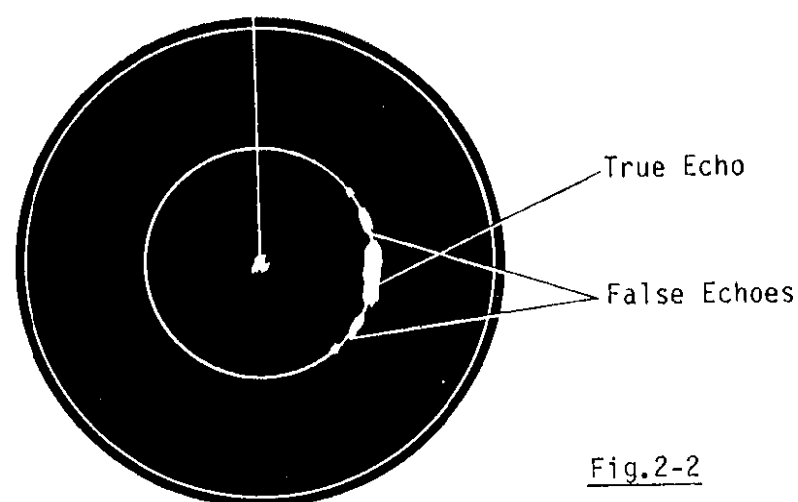


Fig.2-2

#### Second-trace Echoes

If radio wave propagation is extraordinary, echoes from very distant targets may appear on the screen. In this case, they may return after the echoes from the next transmission pulse have appeared. Thus false echoes appear together with the true echoes of the near distant targets.

#### 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.2-3. If, for example, your ship comes close to a large steel bridge such a false echo may temporarily be seen on the scope.

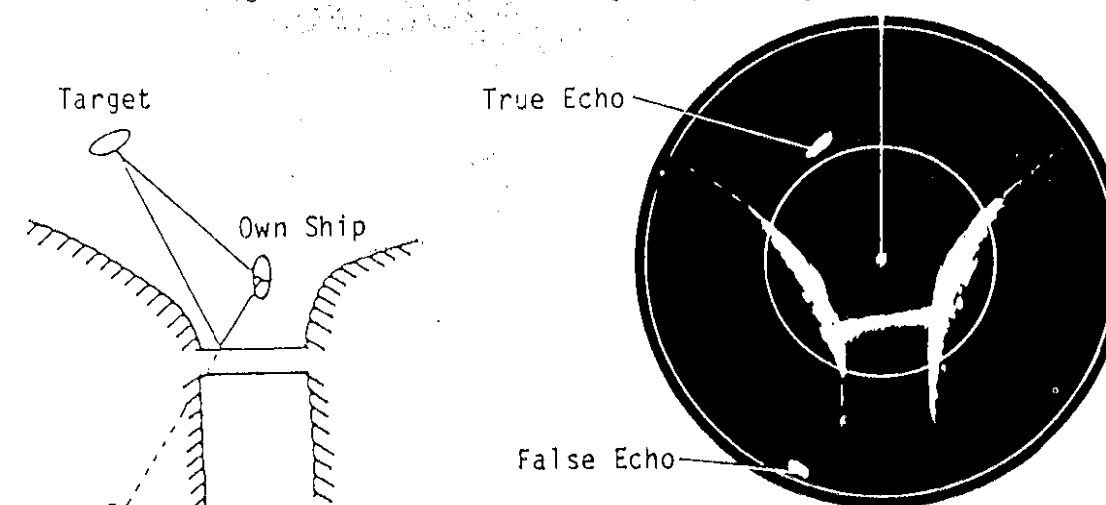


Fig.2-3

#### Dead Angle (Blind Sector)

A funnel, mast or derrick post near the radar antenna may intercept the radar beam. In that case, no target is detected within a certain angle--called a "dead angle." A large object close to your ship may produce a similar effect.

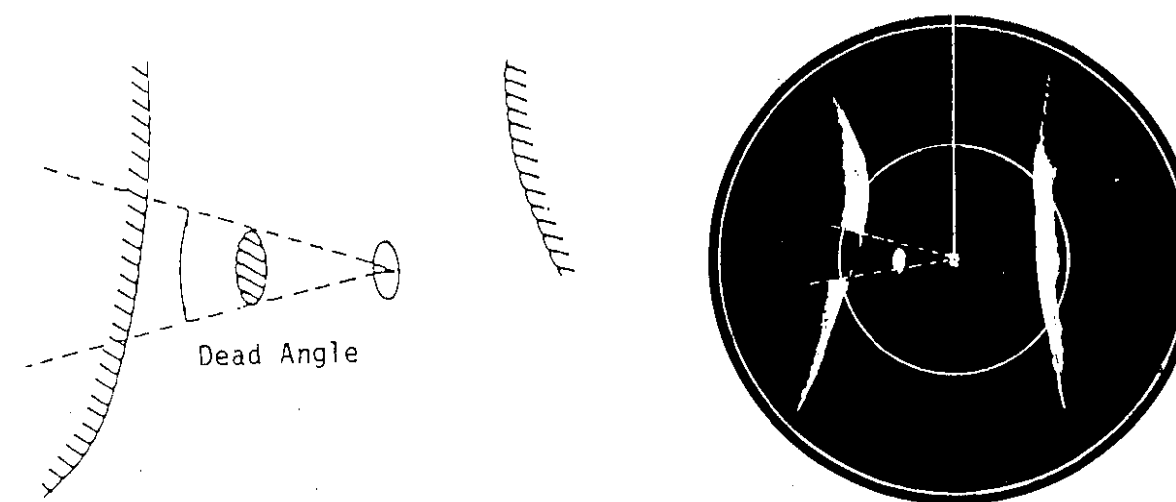


Fig.2-4

### Radar Interference

When another ship is operating a radar the same frequency as your own ship's radar, the radar pulses emitted from the other ship are received and appear on your radar screen as the curved spokes shown in Fig.2-5.

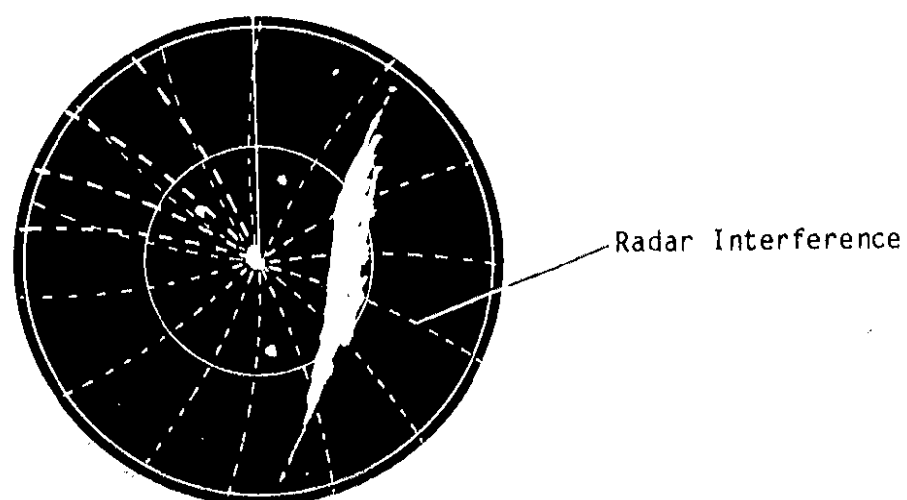


Fig.2-5

### CHAPTER 3 MAINTENANCE

To maintain optimum performance of the equipment for an extended period, general check and maintenance should be made periodically.

#### "CAUTION"

Before maintenance work, be sure to switch off the radar at the main switch-board. 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	Item	Check/Measures	Remarks
3 to 6 months	Exposed bolts and nuts on scanner unit	Check for corroded or loosened bolts/nuts. If necessary, clean them and repaint thickly. Replace them with new ones if heavily corroded.	*Sealing compound may be used instead of paint.  *Put slight amount of grease if bolts and nuts 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 any 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 will cause permanent damage to the internal circuitry due to water leakage.
	Terminal boards and plugs in scanner unit	Open scanner cover to check terminal board/plug connections inside. Also check if the rubber packing of the scanner cover is in good order.	*When putting cover back in position, do not pinch flying wires.
	CRT screen	Dirt on this creates symptom identical to poor sensitivity. Clean CRT surface using special care not to scratch it.	*Use a soft cloth with a slight amount of anti-static-charge spray. Never apply plastic solvent.

Interval	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 ones.	*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 rubber cap is abnormally dusty or if any cracks are found on rubber cap or wire sheath, call for service. Do not try to clean or repair it for yourself, because these components are extremely delicate and high voltage may exist.
	Terminal boards, sockets and plugs	Check for loose connections. Clean contacts or replace plug, if necessary.	

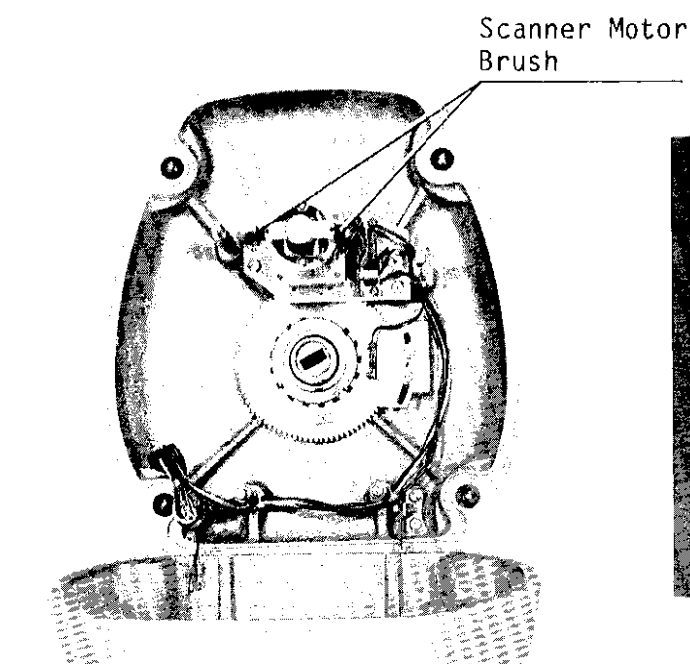


Photo No.933

Fig.3-1

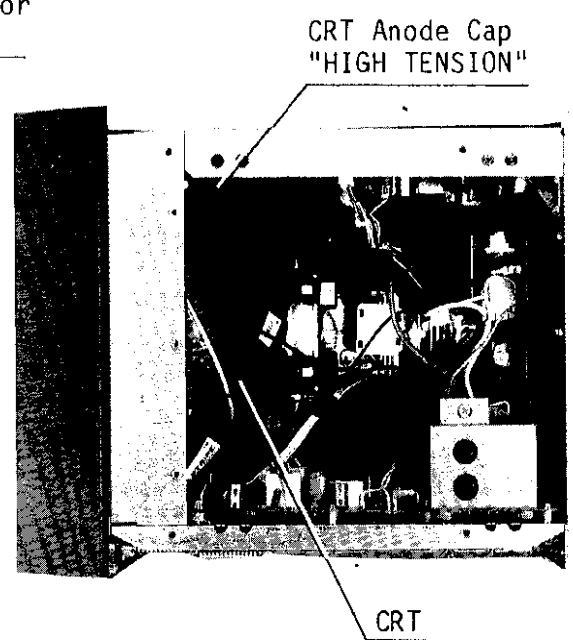


Fig.3-2

## CHAPTER 4 TROUBLESHOOTING

Whenever an abnormality is encountered, perform a self-check of the memory IC as shown below.

1. Turn the radar OFF.
2. Switch ON the power.
3. The self-check of the ROM/RAM will appear as shown in Fig.4-1. If an error is found in the ROM/RAM the message "ERROR" will be displayed next to the faulty ROM/RAM. If no error is detected "OK" will be indicated.

After the self-check is conducted, check;

1. The connector on each circuit board.
2. The screws on each terminal board.

If the above check is normal, proceed to the trouble finding list on page 4-3. If a board is found to be faulty, replace it with a new one or call for service. Do not attempt further component check on a p.c. board. Careless handling may cause more serious trouble.

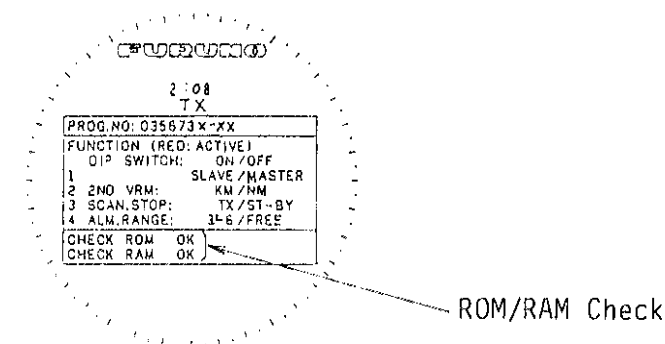


Fig.4-1

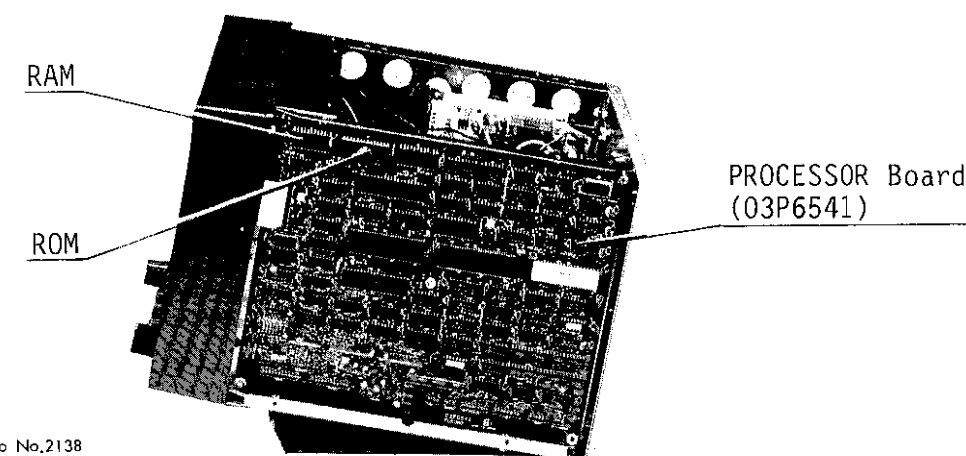


Photo No.2138

Fig.4-2 Display Unit, Right Side View

**"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)

Notes on Service Call

To obtain effective service, the following information should be given at a service call.

1. Name of the vessel
2. Vessel's position (port/berth)
3. Sailing Schedule
4. Radar model
5. Serial number/Date manufactured
6. Symptom of trouble  
(Results of checks along with the Trouble Finding List)
7. Previous service

Trouble Finding List

Operation	Symptom	Check Point	Remarks
Turn POWER switch ON.	Power does not come on. (Illumination lamps on front panel do not light.) NOTE: If the illumination pot. (DIM) inside the inner panel is set fully CCW turn it CW. See Fig.4-3.	1. Power Fuse F1351 (Fig.4-4.)  2. Mains Voltage    3. Diode CR10 on POWER SUPPLY board (See Fig.4-5.)	*Measure input voltage. The voltage should be; 12 V dc set: 10.2 - 15.0V  24/32 V dc set: 20.4 - 40V  *If CR10 is not lit, the overcurrent protection circuit is active. (CR10 is normally lit.) To check which DC line is shorted, disconnect (in order) P12/P13/P14 (see Fig.4-5). If CR10 lights up when the radar is turned on with P14 disconnected, the PROCESSOR board connected to P14 may be faulty. If CR10 does not light with P12/P13/P14 disconnected the CRT circuit connected to P17 may be faulty. (Never disconnect P17.)
	Scanner does not rotate.	4. POWER SUPPLY board  1. Scanner Switch (Fig.4-3)  2. Fuse for Scanner Motor F1352 (1A) (Fig.4-4)  3. Scanner Motor  4. Power Circuit for Motor	*Make sure the scanner switch inside the inner panel is set to ON.

Operation	Symptom	Check Point	Remarks
Adjust BRIL control.	Nothing occurs on the screen.	1. CRT  2. CRT High Voltage    3. DEFLECTION board (Fig.4-4)  4. PROCESSOR board (Fig.4-5)	*If CRT heater is lit, CRT is OK.
After ST-BY message appears press TX key.	Radar does not transmit.	1. Check if the message "NO BP" is displayed at the upper left-side of the screen.  2. Bad contact in touchpad key  3. PROCESSOR board	*If it is displayed the bearing pulse from the scanner is not being sent. Check whether the signal cable connector (Fig.4-4) is secured tightly or not. If it is OK, check whether the wiring in the scanner is loose or not.
Adjust GAIN with SEA CLUTTER set to minimum.	Marks and legends appear but no noise or target echoes.	1. IF AMP board in scanner  2. Coaxial Cable between scanner and display  3. PROCESSOR board	

Continued

Operation	Symptom	Check Point	Remarks
	Marks, legends and noise appear but no target echoes.	1. PROCESSOR board       2. Magnetron 3. Modulator Circuit	*Connect a multi-meter (10VDC range) between TP4 (TX trigger) and GND (chassis). Set radar to transmit and switch the range. If the pointer on the multimeter flicks at the moment the range is changed, the TX trigger circuit of the PROCESSOR board is OK. See Fig.4-5.  *If the TX trigger signal is normal, check the trigger line of the cable between the scanner and display. If the cable is normal, the modulator circuit or the magnetron may be faulty. A check of the magnetron current can be made by referring to page 4-9.
	The sweep and antenna rotation are not synchronized.	1. Bearing Signal Generator in scanner  2. PROCESSOR board 3. Heading Alignment Switch (Fig.4-3)	*If CR2 (Fig.4-5) on the PROCESSOR board flashes every 2-3 sec. the heading signal from the scanner is being sent out properly.  *Adjust the Heading Alignment Switch inside the inner panel.

Continued

Operation	Symptom	Check Point	Remarks
Adjust the TUNE control.	Poor sensitivity	1. Deteriorated Magnetron  2. Detuned MIC  3. Water leakage in scanner	*Set the range to maximum and measure the magnetron current (see page 4-9). If the voltage is far out of the rating the magnetron should be replaced.
Change the range.	Picture range does not change.	1. CONTROL PANEL board located behind the RANGE switch.  2. PROCESSOR board	*Check the level of #10 of J7 on the PROCESSOR board. If the level changes in succession (H -- L -- H ...) when the range is changed, the CONTROL PANEL board is OK. (See Fig.4-5.)
Rotate the Marker control.	The EBL/VRM does not move.	1. PROCESSOR board  2. Marker control (Rotary encoder)	
Press each touchpad key.	Nothing occurs on the screen.	1. Bad contact in touchpad key.  2. PROCESSOR board	*Check whether J3 on the PROCESSOR board is loose or not (see Fig.4-5).

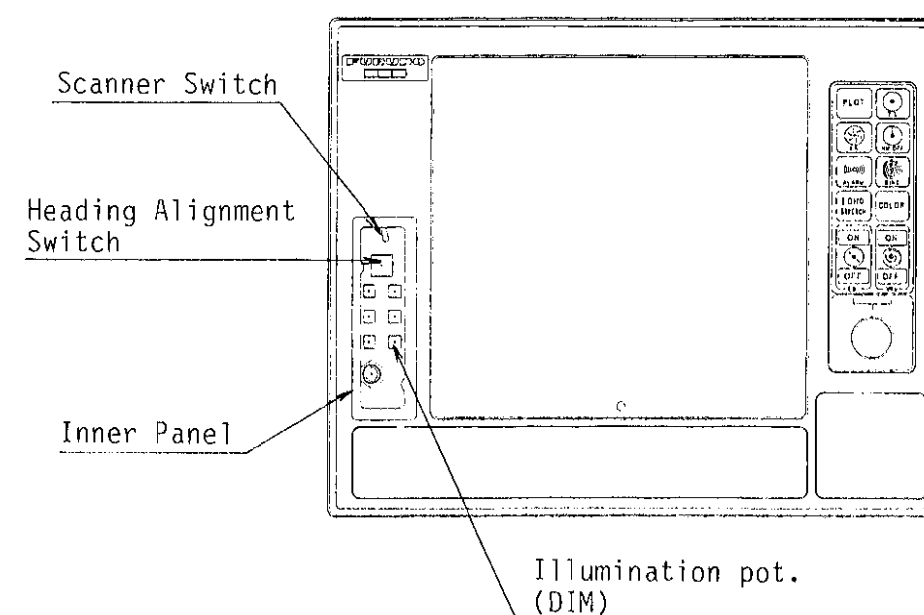


Fig.4-3 Location of Controls Inside Inner Panel

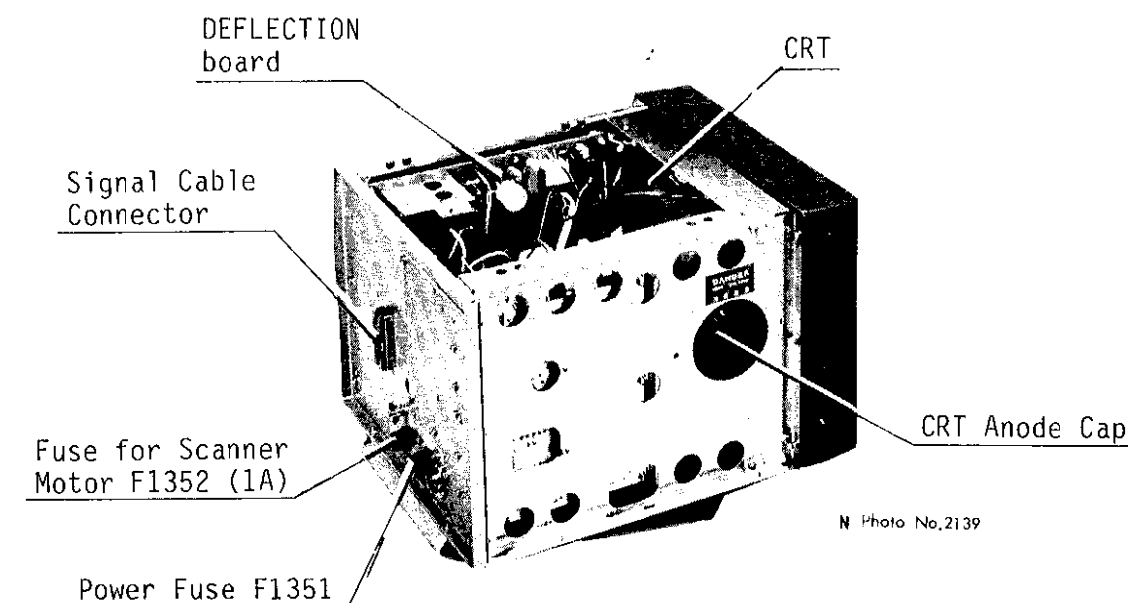
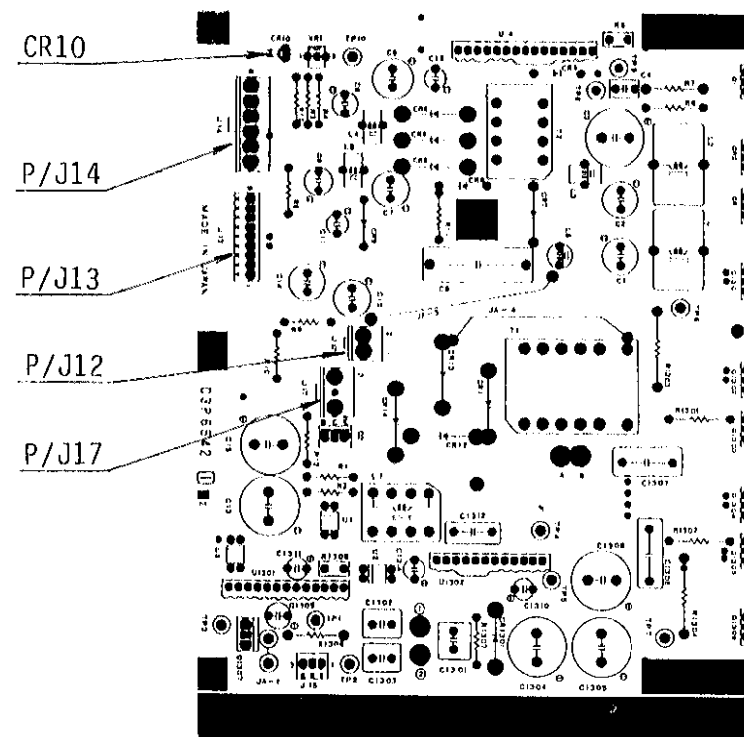
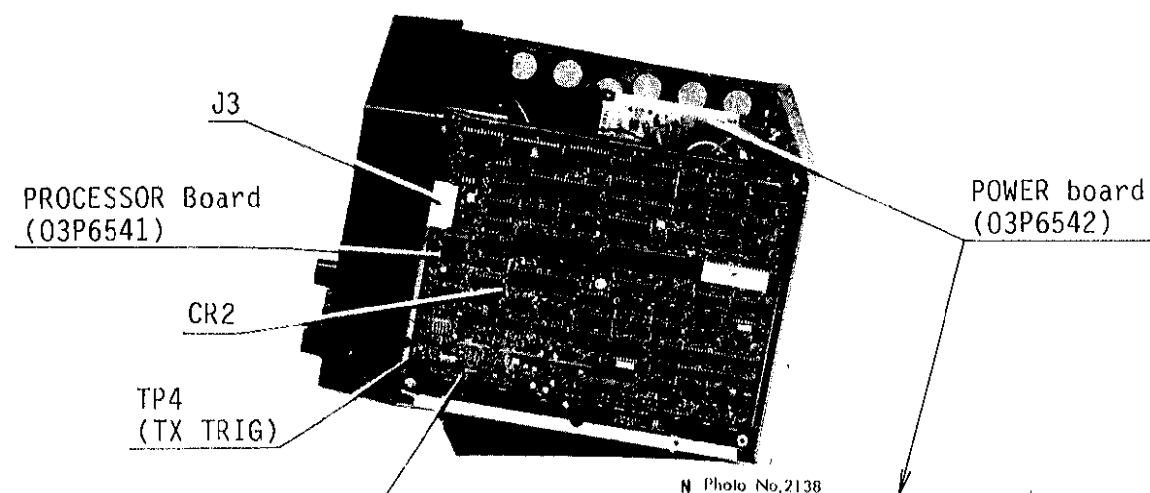


Fig.4-4



Parts Side

Fig.4-5

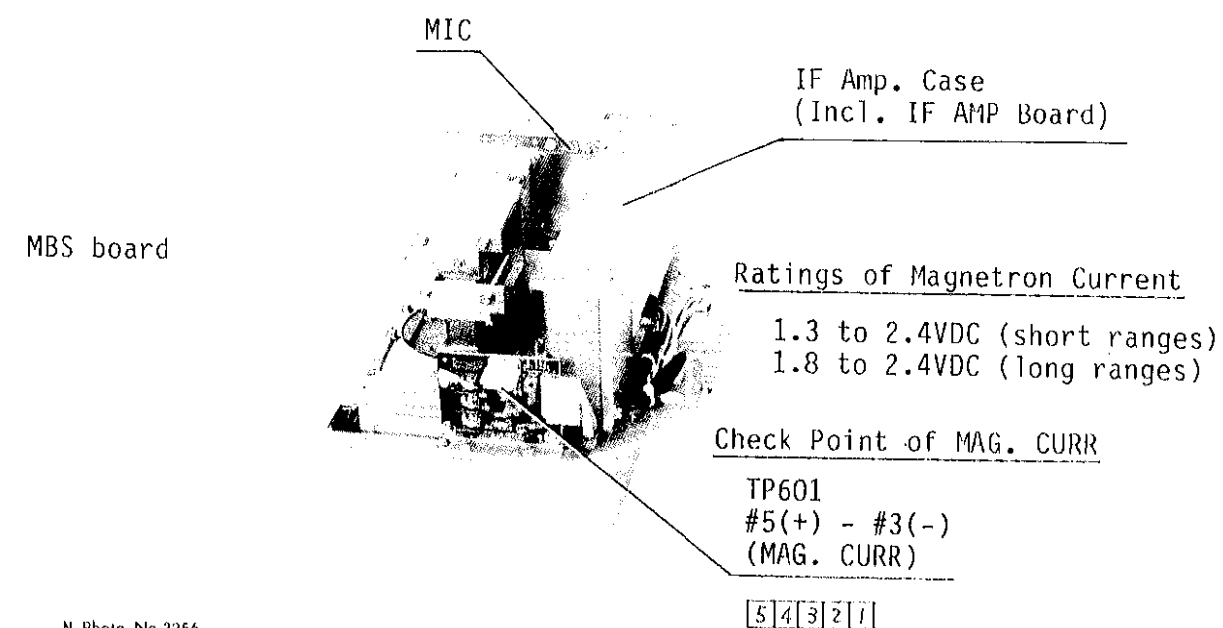


Fig.4-6 Transceiver Module

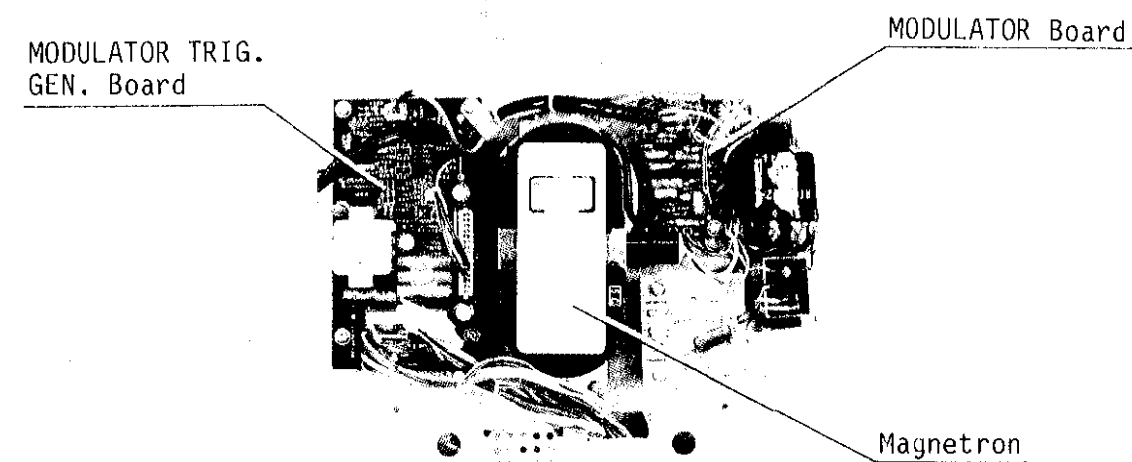


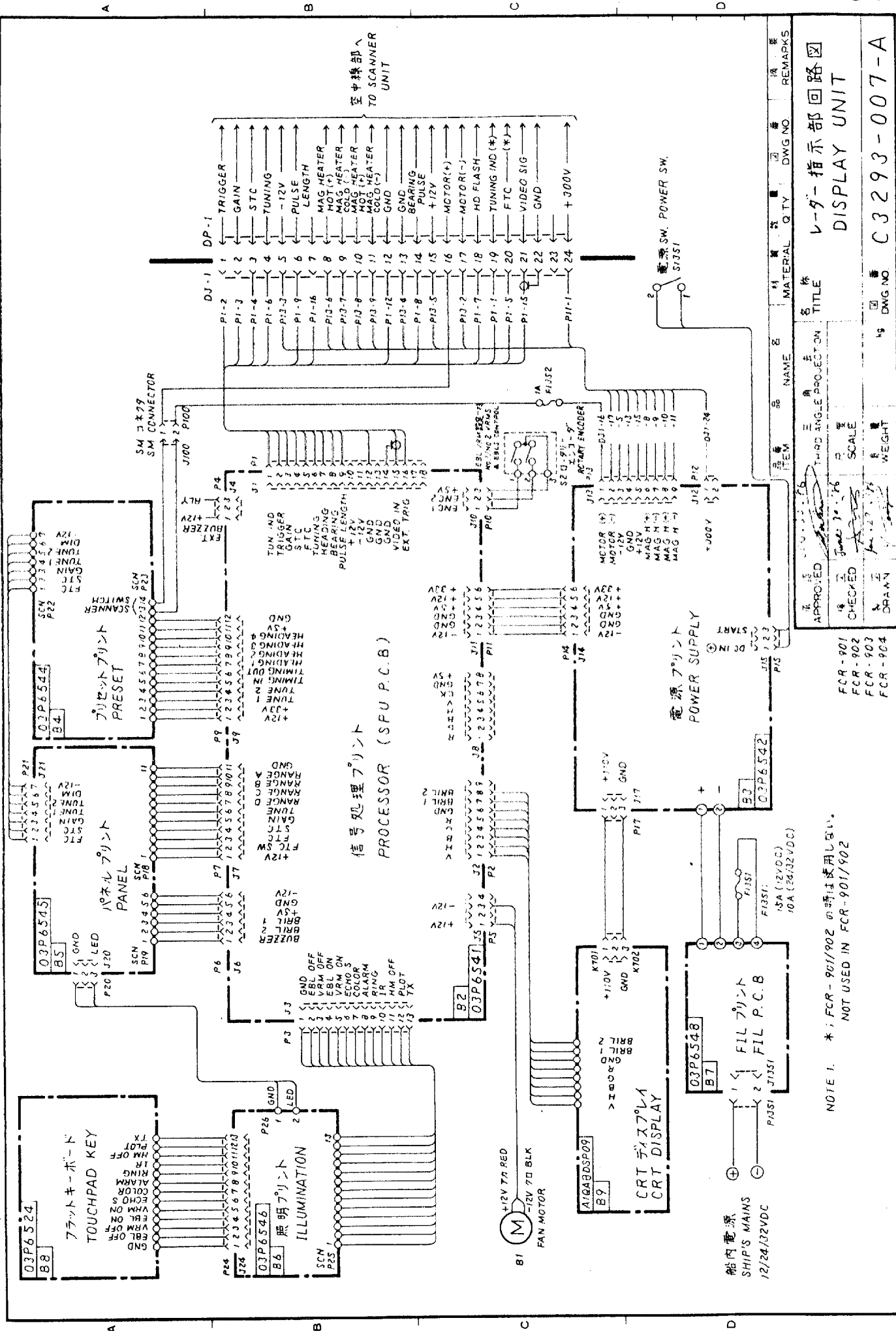
Fig.4-7 Transceiver Module, Rear View

CONTENTS OF SCHEMATIC DIAGRAMS

No.	Name	Type	Drawing No.	Page
1	DISPLAY UNIT		C3293-007	S-1
2	PRESET BOARD	03P6544	C3293-005	S-2
3	TOUCHPAD KEY BOARD	03P6524	E3293-006	S-3
4	PANEL BOARD & ILLUMINATION BOARD	03P6545 & 03P6546	C3293-001	S-4
5	CRT DISPLAY	A1QA8DSP09	C3293-009	S-5
6	POWER SUPPLY BOARD	03P6542	C3293-008	S-6
7	SCANNER UNIT		C3306-006	S-7
8	IF AMPLIFIER	IF-6515	C3292-021	S-8
9	INTERCONNECTION DIAGRAM		C3293-003	S-9

CONTENTS OF OUTLINE DRAWINGS

No.	Name	Type	Drawing No.	Page
1	SCANNER UNIT		C3306-002	D-1
2	DISPLAY UNIT		C3293-010	D-2
3	RECTIFIER	RU-3423	C3002-005	D-3

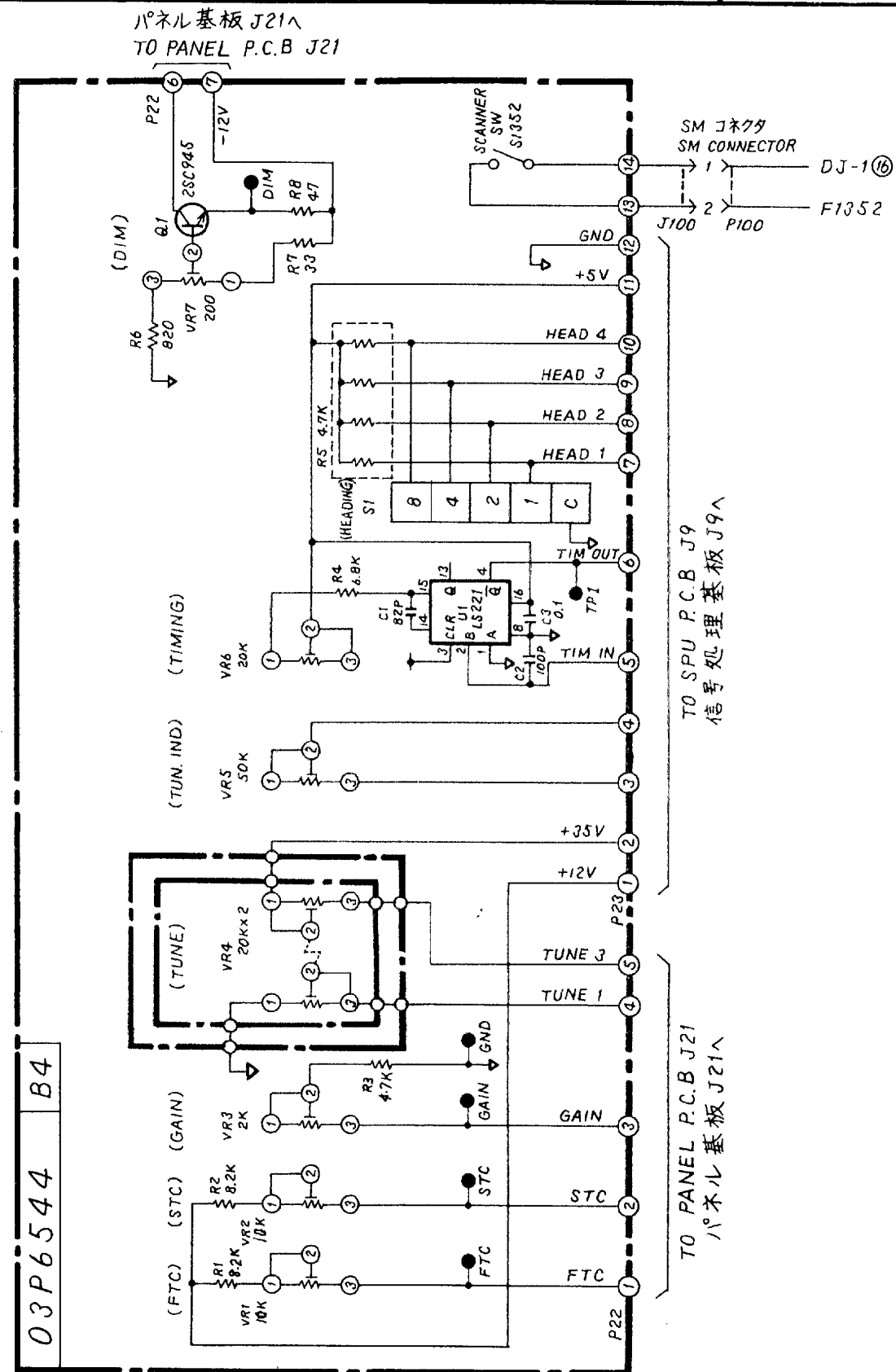


NOTE 1. \* ; FCR - 901/902 の時は使用しない。  
NOT USED IN FCR - 901/902

FCR-901  
FCR-902  
FCR-903  
FCR-904

S-1

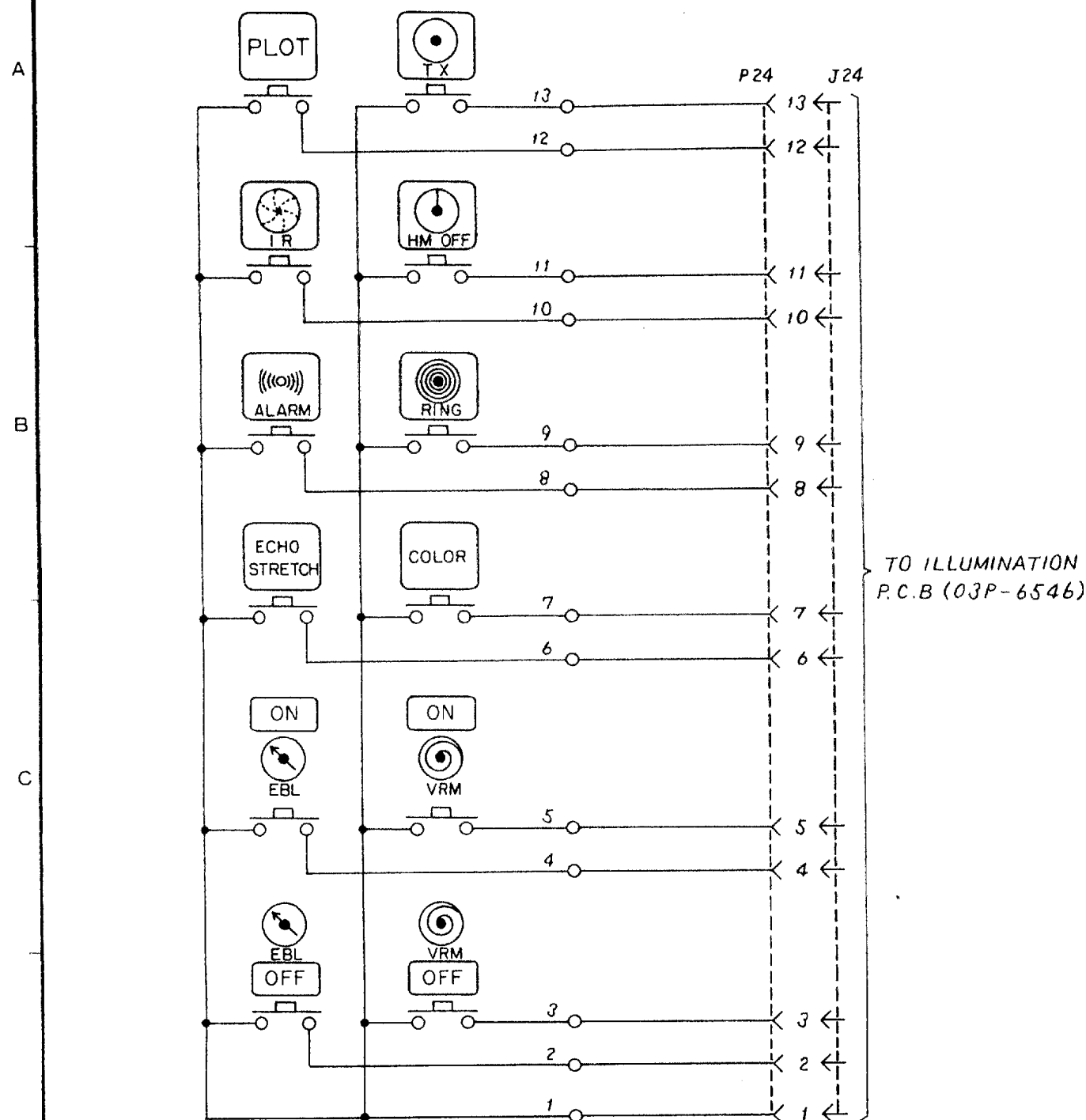
**FURUNO ELECTRIC CO., LTD.**



TO SPU P.C.B J9  
信号处理基板 J9A

TO PANEL P.C.B J21  
パネル基板 J21へ

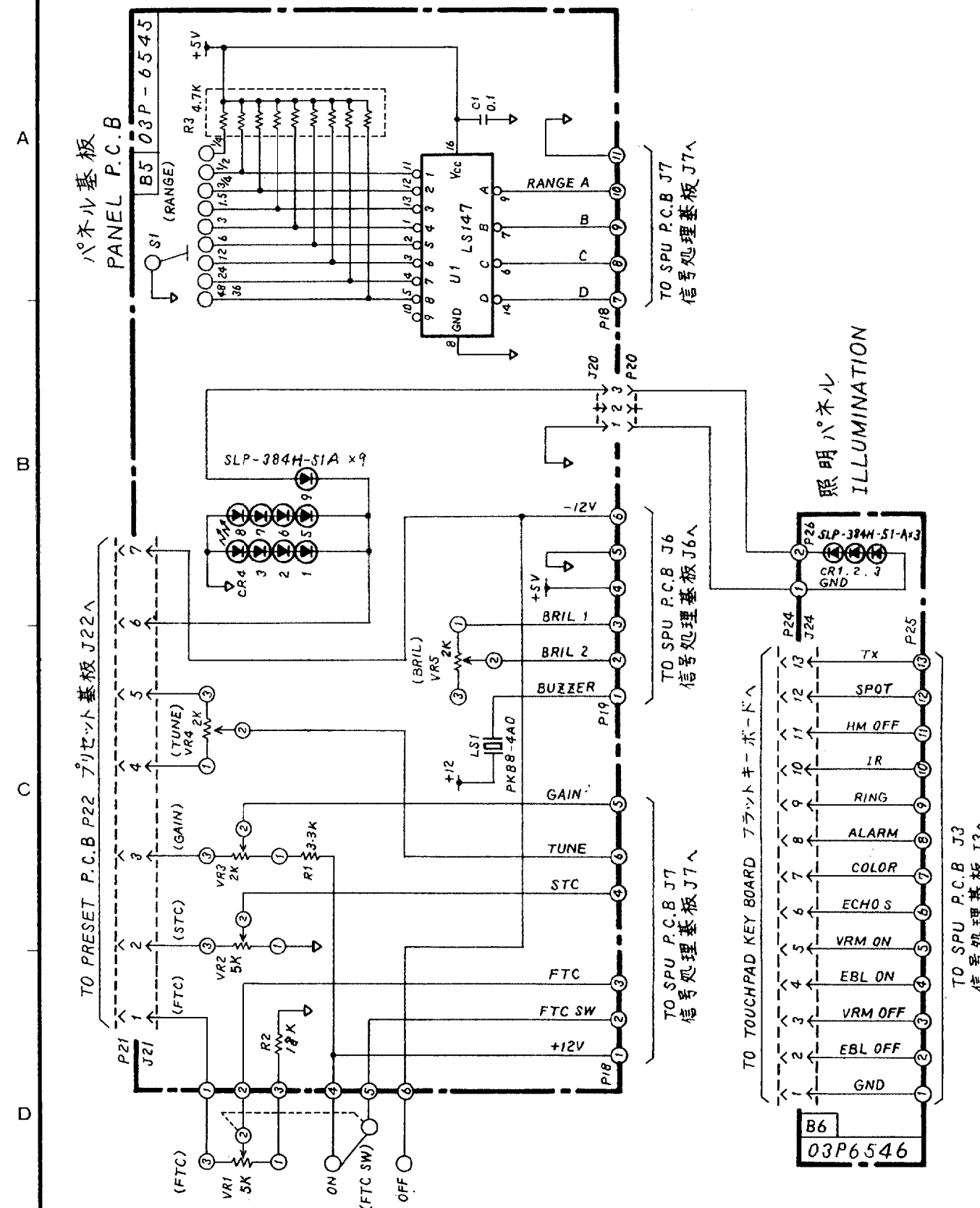
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検査 CHECKED	June.30.86 <i>[Signature]</i>	尺度 SCALE	<i>[Mark]</i>	03P6544			
製図 DRAWN	June.27.86 <i>[Signature]</i>	重量 WEIGHT	kg	図番 DWG.NO.	C3293-005-C		



FCR-901/902/903/904

承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
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June 27 '86		尺度 SCALE			図番 DWG.NO. E3293-006-A	
June 27 '86		重量 WEIGHT	kg			

FURUNO ELECTRIC CO., LTD.

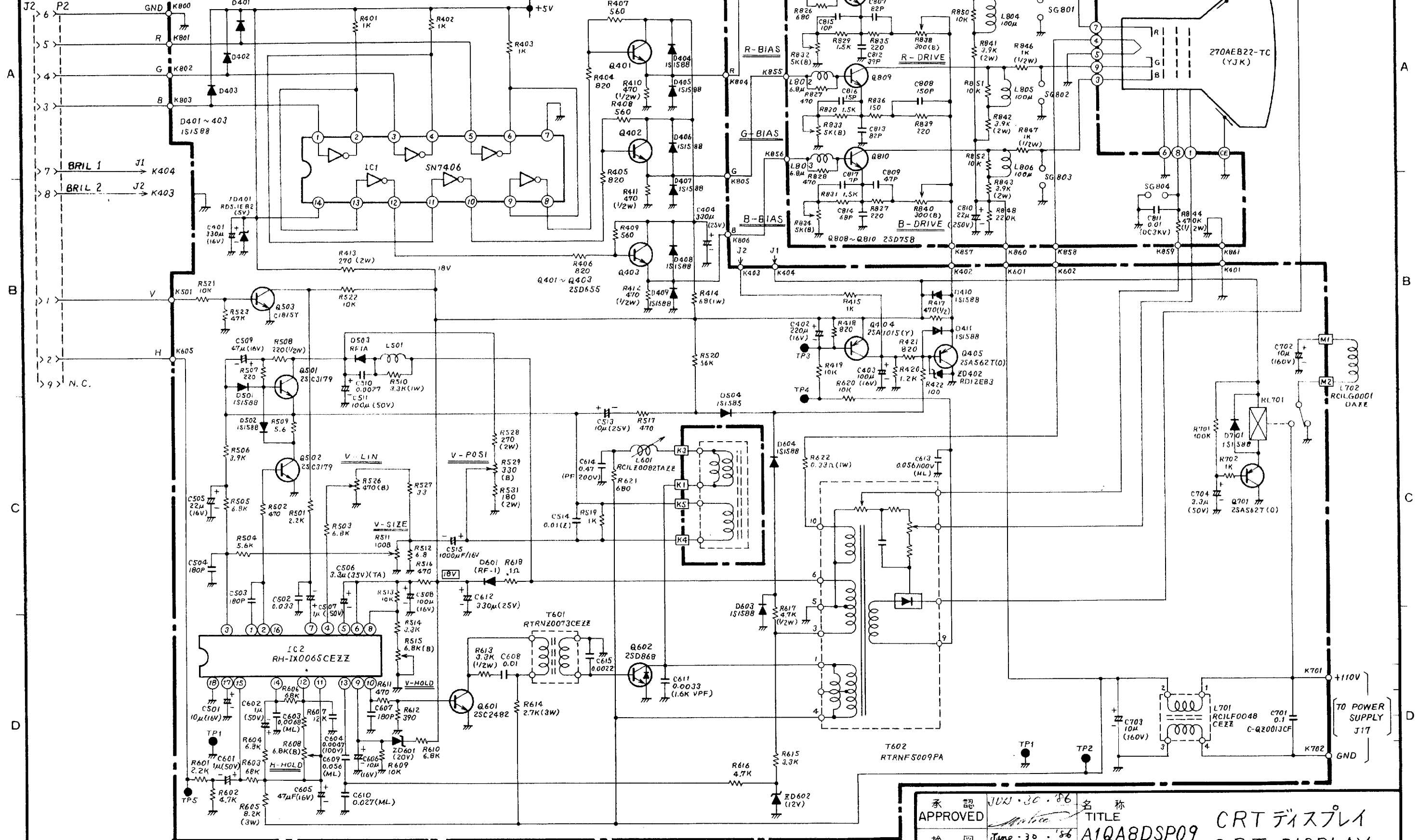


FCR-901/902/903/904

承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
June 30 '86		三角法 THIRD ANGLE PROJECTION			名称 TITLE 03P6545 パネルプリント、照明プリント回路図 03P6546 PANEL & ILLUMINATION	
June 30 '86		尺度 SCALE			図番 DWG.NO. C3293-001-C	
June 27 '86		重量 WEIGHT	kg			

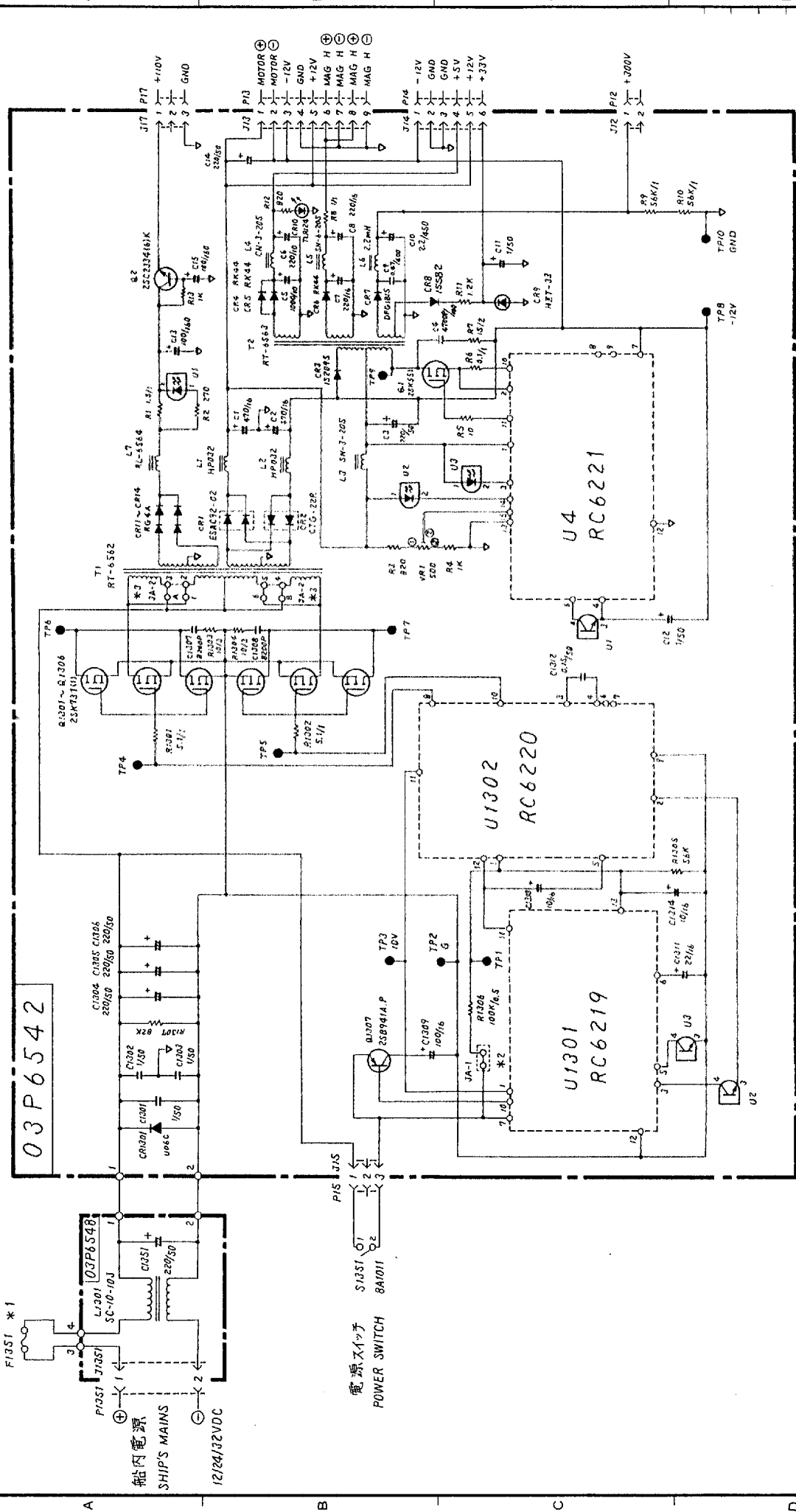
FURUNO ELECTRIC CO., LTD.

SPU P.C.B  
信号処理基板



FCR-901/902/903/904

承認 APPROVED	JUN. 30. '86	名称 TITLE	CRTディスプレイ
検査 CHECKED	June 30. '86	A1QA8DSP09	C.R.T. DISPLAY
製図 DRAWN	June 27. '86	図番 DWG. NO.	C3293-009-B

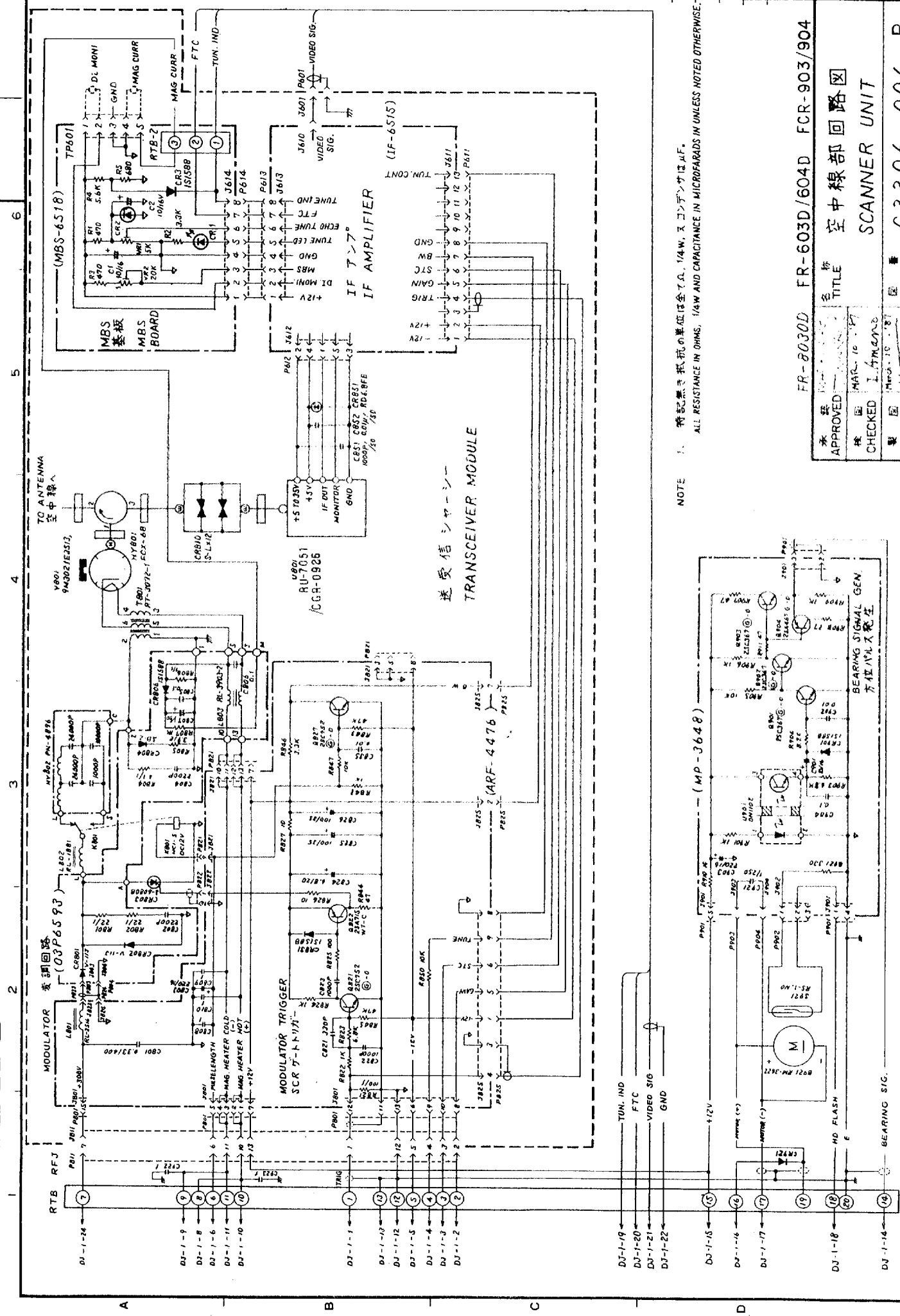


NOTE 船内電源により以下の様にジャンパー接続及びヒューズ F1351 を変更。  
CHANGE JUMPER CONNECTION AND FUSE F1351 ACCORDING TO SHIP'S MAINS.

船内電源 SHIP'S MAINS	F1351	*1	*2	*3	接続 CONNECTED	接続しない NOT CONNECTED
DC12V	15A	JA-1	JA-2	JA-3	接続 CONNECTED	接続しない NOT CONNECTED
DC24V/32V	10A	JA-1	JA-2	JA-3	接続しない NOT CONNECTED	接続 CONNECTED

ITEM	NAME	材料	数量	国産	備考
APPROVED	THIRD ANGLE PROJECTION	03P6542			
CHECKED	SCALE	03P6548			
DRAWN	WEIGHT				

03P6542 POWER SUPPLY  
03P6548  
C3293-008-C  
FURUNO ELECTRIC CO., LTD.



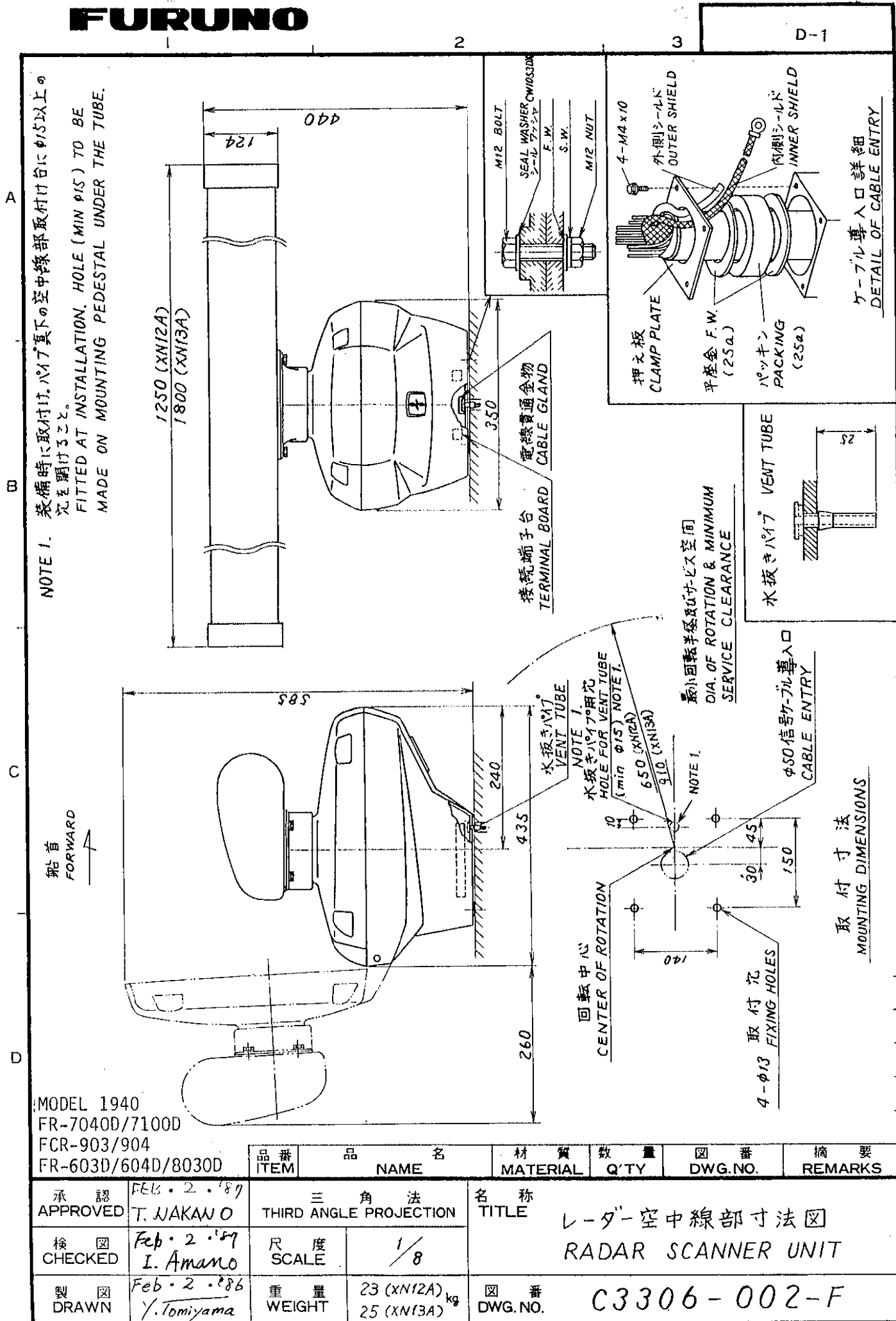
NOTE 1. 特記無き抵抗の単位は全て Ω, 1/4W, スココンダクタは μF.  
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.

FR-6030D	FR-603D/604D	FCR-903/904
APPROVED	THIRD ANGLE PROJECTION	03P6542
CHECKED	SCALE	03P6548
DRAWN	WEIGHT	

03P6542 POWER SUPPLY  
03P6548  
C3293-008-C  
FURUNO ELECTRIC CO., LTD.

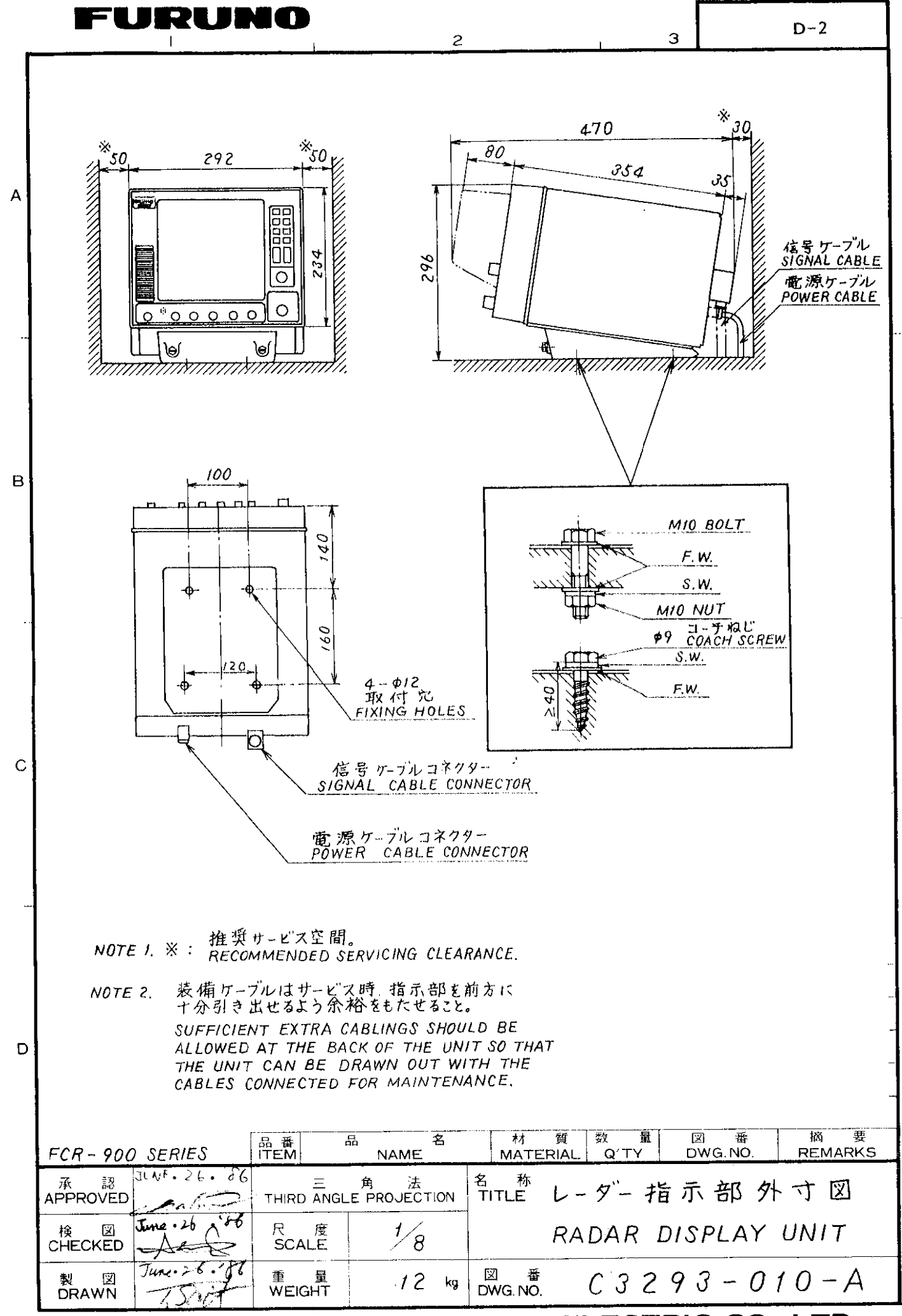


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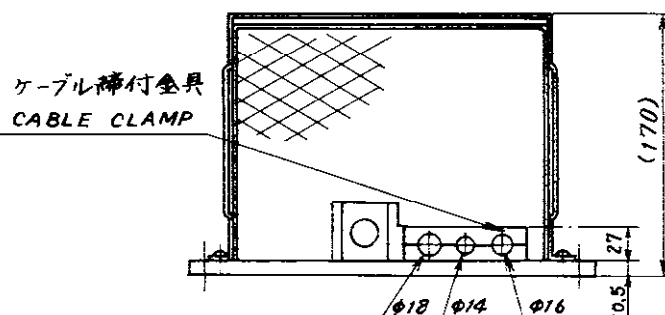
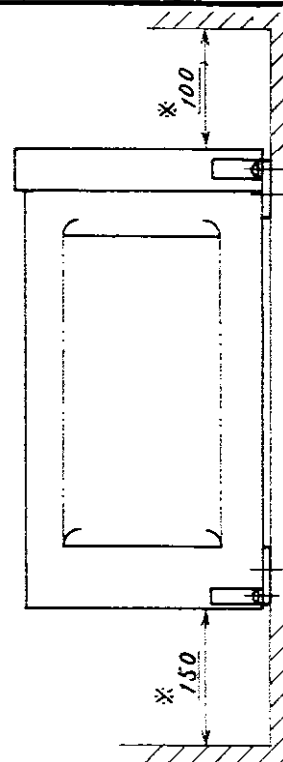
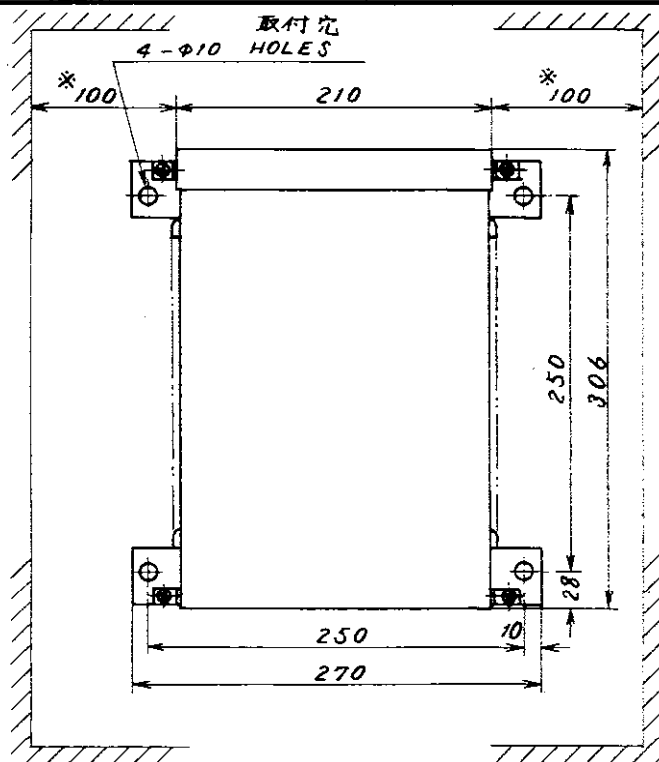
FURUNO ELECTRIC CO., LTD.

A

B

C

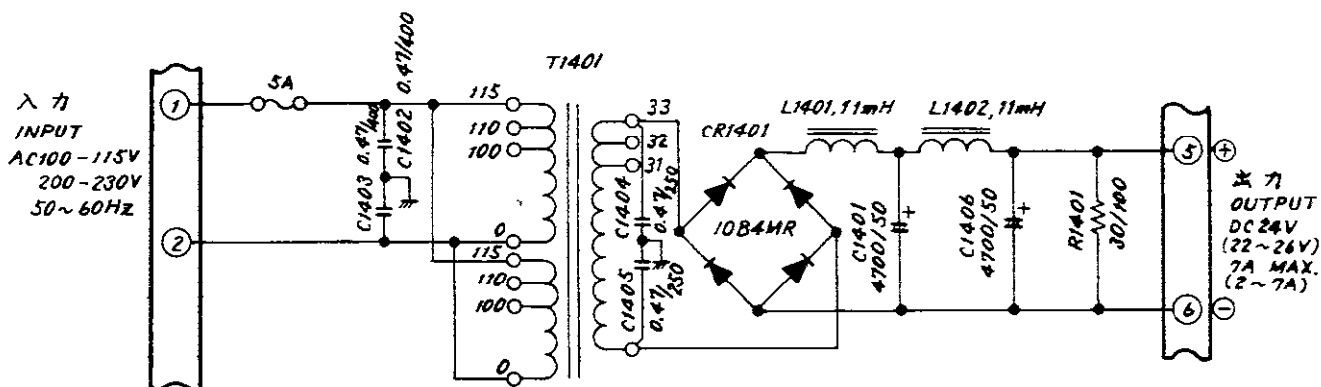
D



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

2. コンパス安全距離  
COMPASS SAFE DISTANCE.

スタンダード STANDARD	2.1M
ステアリング STEERING	1.5M



注 AC220V 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.	備考 REMARKS
承認 APPROVED	三角法 THIRD ANGLE PROJECTION	名称 TITLE			
検図 CHECKED	尺度 SCALE				
製図 DRAWN	重量 WEIGHT	図番 DWG.NO.			

REV.: 8/85

FURUNO ELECTRIC CO., LTD.