

FURUNO

OPERATOR'S MANUAL

MARINE RADAR/ARPA

MODEL FAR-2822



FURUNO ELECTRIC CO., LTD.
NISHINOMIYA, JAPAN

©FURUNO ELECTRIC CO., LTD.

9-52, Ashihara-cho,
Nishinomiya, Japan 662

Telephone: 0798-65-2111
Telefax: 0798-65-4200 (G111)

All rights reserved. Printed in Japan

(KAM0)

PUB. No. OME-33370
FAR-2822 (IMO)

-Your Local Agent/Dealer

Initial : FEB 1990
G : JUL. 11, 1994



* 0 0 0 8 0 2 3 6 9 0 0 *

IMPORTANT! SAFETY INFORMATION

Be sure to read all the safety information which follows before attempting to operate this equipment.

General Safety Information

"DANGER," "WARNING," and "CAUTION" notices appear throughout this manual. It is the responsibility of the user of this equipment to read, understand and follow these notices. If you have any questions regarding these safety instructions, please contact a FURUNO agent or dealer.

Hazardous Voltages

This equipment uses high voltage electricity which can SHOCK, BURN or cause DEATH.

TO THE USER: While the equipment has been designed with consideration for the operator's safety, DO NOT work inside this equipment unless familiar with these electrical circuits and correct electrical safety procedures.

TO THE SERVICE TECHNICIAN: Always make sure the electrical power is turned off before attempting to change a component or inspecting the inside of the equipment. A residual charge may exist in capacitors, even with the equipment turned off. Always short all supply lines to the chassis with an insulated screwdriver or a similar tool before touching the circuit.

Working on the Scanner Unit Mast

Work on the scanner unit mast is dangerous, and doubly so if the proper precautions are not taken.

1. Post an appropriate warning sign near the display unit to indicate that work on the scanner unit is being performed, to prevent accidental application of the power to the scanner unit.
2. Wear a safety helmet and always be aware of where the scanner radiator is.

Radio Frequency Radiation Hazard

This radar scanner emits high frequency radio radiation (RF) which can be harmful, particularly to your eyes. Never look directly into the scanner from a distance of less than two feet when the radar is in operation as you could injure the cornea of your eyes. Always make sure that the radar is set to either Stand-By or OFF before starting work on the scanner.

Operating Precautions

Navigation is a complex and detailed skill which requires knowledge, judgment and experience to perform effectively. Errors in navigation can lead to catastrophic injury or even death in some circumstances. Navigational errors can cause collisions between vessels, collisions with land and land-based structures, and can lead to being lost at sea.

No single navigational aid (including this radar) should ever be relied upon as the exclusive method for navigating your vessel. The navigator is responsible for checking all aid available to confirm his position. Electronic aids are meant to assist the navigator, not replace him.

The 1972 Convention on the International Regulations for Preventing Collisions at Sea (1972 COLREGS) provide statutory requirements for the operation of any vessel including the posting of lookouts. The operator of the vessel is responsible for compliance with these requirements whether or not the radar is in use.

TABLE OF CONTENTS

SPECIFICATIONS	vi
-----------------------------	-----------

PART I

Radar Operation & General

OPERATIONAL OVERVIEW	1
-----------------------------------	----------

GENERAL	1
----------------------	----------

BASIC OPERATING PROCEDURE	1
--	----------

Turning the Power On	1
----------------------------	---

Selecting the Radar	2
---------------------------	---

Adjusting Brilliance of CRT, Data and Touchpad Panel	2
--	---

Transmitting the Radar	2
------------------------------	---

Range Selection	2
-----------------------	---

Tune Control Adjustment	2
-------------------------------	---

Gain Control Adjustment	3
-------------------------------	---

Presentation Mode Selection	3
-----------------------------------	---

Suspending Transmission Temporarily	5
---	---

Suspending Transmission	5
-------------------------------	---

ELIMINATING RETURNS FROM SEA SURFACE AND RAIN CLUTTER.....	6
---	----------

Sea Returns	6
-------------------	---

Rain Clutter	6
--------------------	---

REDUCING RADAR INTERFERENCE.....	7
---	----------

RANGE AND BEARING MEASUREMENT	8
--	----------

Range Measurement	8
-------------------------	---

Bearing Measurement	9
---------------------------	---

Using the Offset EBL	9
----------------------------	---

PARALLEL CURSOR	10
------------------------------	-----------

SETTING THE ALARM.....	11
-------------------------------	-----------

SHIFTING THE DISPLAY	12
-----------------------------------	-----------

PLOTTING	13
-----------------------	-----------

Cancelling Plots	13
------------------------	----

Plot Data Table	14
-----------------------	----

SHIP'S SPEED, SET & DRIFT INPUT.....	15
---	-----------

ECHO TRAIL.....	16
------------------------	-----------

ECHO AVERAGING.....	17
----------------------------	-----------

ECHO STRETCH.....	18
--------------------------	-----------

SECOND-TRACE ECHO REJECTION	18
--	-----------

MARKING NAVIGATION FAIRWAYS & POINTS	19
---	-----------

Navigation Fairways	19
---------------------------	----

Navigation Point	19
------------------------	----

ERASING THE HEADING MARK/NORTH MARK	20
--	-----------

BRILLIANCE CONTROLS.....	20
---------------------------------	-----------

SUB PANEL CONTROLS	21
---------------------------------	-----------

SUMMARY OF CONTROL FUNCTIONS AND DISPLAY SCREEN INDICATIONS	24
APPLICATION	25
MINIMUM AND MAXIMUM RANGES.....	25
Minimum Range	25
Maximum Range	25
RADAR RESOLUTION	26
Bearing Resolution	26
Range Resolution	26
BEARING ACCURACY	26
RANGE MEASUREMENT	26
FALSE ECHOES.....	27
Multiple Echoes	27
Blind and Shadow Sectors	27
Sidelobe Echoes	28
Virtual Image	28
POSITION FIXING WITH RADAR	29
Radar Range	29
Range and Bearing	29
Two Bearings	30
MAINTENANCE	31
TROUBLESHOOTING.....	33
LOCATION OF PARTS.....	37

PART II ARPA Display & Operation

ARPA CONTROLS & INDICATIONS.....	i
DESIGN CRITERIA.....	1
CRITERIA FOR SELECTION OF TARGETS FOR TRACKING	1
QUANTIZATION	1
SUPPRESSION OF ACQUISITION IN CERTAIN AREA.....	2
QUALITATIVE DESCRIPTION OF TRACKING ERROR.....	3
Own Ship Maneuvers	3
Other Ship Maneuvers	3
EFFECT ON ACCURACY	3
Sea Returns	3
Rain	3
Snow	3
Low Clouds	3
Non-synchronous Emissions	3
Low Gain	4
Second Trace Echoes	4
Blind and Shadow Sectors	4
False or Indirect Echoes	4
Radar Interference	5
OPERATION	6
OVERVIEW	6
System Functions	6
Alarm ACQ Functions	7
Alarm Functions	7
Input Functions	7
Suppression Area Functions	8
Plot (target) Functions	8
Trial Maneuver Functions	9
Display Functions	9
START-UP PROCEDURE.....	12
AUTOMATIC ACQUISITION OF TARGETS	12
Acquisition Range	12
MANUAL ACQUISITION OF TARGETS.....	13
Acquisition of Targets in a Narrow Channel	13
At Target Swap	13
Deleting a Target	14
MINIMUM ACQUISITION RANGE	14
LIMIT LINE.....	14
Fix on Land	15
Fix on Ship	15

PLOT SELECTION (VECTOR PLOT)	16
Rel Vector	16
True Vector	16
Vector Length	16
ALARM FUNCTIONS.....	16
Collision Alarm	16
Lost Target	17
Guard Ring	17
Target Full (target saturation)	18
System Failure	18
Radar Failure	18
TRIAL MANEUVER.....	18
Delay Time	19
TARGET SELECTION	20
HISTORY DISPLAY	20
SET AND DRIFT	21
SIMULATION DISPLAY (SCENARIO MODE)	22

INTERCONNECTION DIAGRAM..... S-1

SCHEMATIC DIAGRAMS

Display Unit S-2

Scanner Unit S-5

SPECIFICATIONS OF FAR-2822 MARINE RADAR/ARPA

1. SCANNER UNIT

- 1) Type: Slotted Array
- 2) Radiator Length & Type: 200cm (XN3A), 240cm (XN4A), 300cm (XN5A)
- 3) Horizontal Beamwidth: 1.23° (XN3A), 0.95° (XN4A), 0.75° (XN5A)
- 4) Vertical Beamwidth: 20° (XN3A/XN4A/XN5A)
- 5) Sidelobe Attenuation
 within $\pm 10^\circ$ of mainlobe: -28dB (XN3A/XN4A), -26dB (XN5A)
 outside $\pm 10^\circ$ of mainlobe: -32dB (XN3A/XN4A), -30dB (XN5A)
- 6) Polarization: Horizontal
- 7) Antenna Rotation: 26 rpm nominal (60Hz, windless load)
 21 rpm nominal (50Hz, windless load)
- 8) Wind Load: Relative wind 51.5 m/s (100 kts)

2. TRANSCEIVER UNIT (contained in Scanner Unit)

- 1) Transmitting Tube: Magnetron
- 2) Frequency and Modulation: 9410 $\pm$ 30MHz (X-band), P0N
- 3) Peak Output Power: 25kW (nominal)
- 4) Modulator: SCR Line Type Pulse Modulator
- 5) IF: 60MHz (Log Amp)
- 6) Tuning: Manual, with tuning bar
- 7) Receiver Front End: MIC (Microwave IC)
- 8) Bandwidth: short pulse: 28MHz
 middle/long pulse: 3MHz
- 9) Duplexer: Ferrite Circulator with Diode Limiter
- 10) Pulselength & Pulse Repetition Rate:

Range (nm)		0.25-0.5	0.75-1.5	3	6-24	48	120
SHORT	Pulselength (us)	0.08		0.3	0.6	1.2	
	Pulse Rep. Rate* (Hz)	2200		1100	600		500
LONG	Pulselength (us)	0.08	0.3	0.6	1.2		
	Pulse Rep. Rate* (Hz)	2200	1100	600			500

* all pulse repetition rates are approximate values

Note: When the second-trace echo rejection circuit is activated, the pulse repetition rate is 500Hz on other than the 0.08 us pulselength.

3. DISPLAY UNIT

- 1) Indication System: PPI, daylight display, 15-level quantization.
 2) Picture Tube: 28" diagonal high-resolution monochrome CRT
 Radar effective diameter: equivalent to 16"

3) Range:	0.25	0.5	0.75	1.5	3	6	12	24	48	120
4) Range Ring Interval:	0.05	0.1	0.25	0.25	0.5	1	2	4	8	20
5) Number of Rings:	5	5	3	6	6	6	6	6	6	6

- 6) Display Mode: Relative Motion: Head-up, North-up*, Course-up*
 True Motion*

- * gyrocompass required
 7) Minimum Range: less than 27m on 0.25 nm scale
 8) Bearing Resolution: within 1.5° on 1.5 nm scale
 9) Bearing Accuracy: better than 1°
 10) Range Resolution: better than 32m on 1.5 nm scale
 11) VRM/Range Ring Accuracy: 0.85% or 7m, whichever is greater

- 12) Mark: Heading Marker, North Marker, Bearing Scale, Range Ring, VRM(2), EBL(2), Alarm Area, Parallel Cursor, Tuning Bar, Plot Mark, Plot Vector, Navigation Line/Point

- 13) Data: Detection Range, Range Ring Interval, VRM Range, EBL Bearing, Display Mode (HEAD UP, CSE UP, NORTH UP, TM), Pulsewidth (SP, M1P, M2P, LP), Cursor Position (bearing, range), Echo Trail Time Interval, Plot Data (bearing, range, course, speed, CPA, TCPA, BCR, BCT, vector time, plot elapsed time), Switch Setting (interference rejection, auto clutter rejection, signal processing, echo stretch, off-center, alarm acknowledge, cursor gyro mode, performance monitor)

- 14) Features: Standard
 Interference Rejection, Auto Clutter Rejection, Alarm, Echo Stretch, Echo Plot, Echo Trail, Parallel Cursor, Floating EBL, Navigation Line, Navigation Point, Off-Center (50% of range in use), Second Trace Echo rejection.

Optional
 Separatable Display Unit (CRT, Operation Unit and Processor Unit can be separated.)

ARPA FUNCTIONS

- 1) Acquisition Mode: Automatic acquisition mode and Manual acquisition mode.
- 2) Acquisition Range: 0.3 to 32 nm (or 0.3 to 24 nm by internal preset)
- 3) Suppression Area: Three limit lines are available to define suppression areas in which automatic target acquisition will not occur. Each limit line, either fixed on land or fixed on ship, may be a single straight line or a string of lines containing up to 5 corners.
- 4) Tracked Target: Automatic acquisition mode:
Automatically acquired 20 targets, plus manually acquired 20 targets.
Manual acquisition mode:
Manually acquired 40 targets
- 5) Tracking Range: 0.2 to 32 nm
- 6) Past Positions: 1 to 50 past positions of any targets being tracked at intervals of 30 sec., to 99 min. (The number of plots and plot interval preset internally.)
- 7) Vector Presentation: True or relative vectors switchable. Trend within 1 min., full accuracy within 3 min.
- 8) Vector Length: 30 sec. to 99 min.
- 9) Target Data Display: Range, bearing, course, speed, CPA, TCPA, BCR (bow crossing range) and BCT (bow crossing time) of up to 3 targets.
- 10) Own ship Data Display: Course and speed
- 11) Alarms: Audible and visual alarms against threatening targets coming into the preset CPA/TCPA limits, lost targets, targets crossing guard ring. Visual only alarm against system failure and target full situation.
- 12) Collision Warning: CPA limit ----- 0.2 to 10 nm.
TCPA limit ----- 0 to 99 min.
- 13) Guard Ring: No. of guard rings ----- 2
Guard ring width ----- 0.5 nm
Radius of guard ring --- Outer limit between 0.7 and 32 nm
Sector angle ----- 1 to 360° in any direction

4. ENVIRONMENTAL CONDITIONS

- | | |
|-------------------------|-----------------------------------|
| 1) Ambient Temperature: | Scanner Unit ----- -25°C to +70°C |
| | Display Unit ----- -15°C to +55°C |
| 2) Humidity: | Relative Humidity 95% @ +40°C |

5. POWER SUPPLY

- | | |
|------------------------|--|
| Display Unit, TR Unit: | 100/110/115VAC, 1 ϕ , 50/60Hz,
410VA approx.
220/440VAC, 50/60Hz by external
transformer |
| Scanner Motor: | 220/440VAC, 3 ϕ , 60Hz or
200/380VAC, 3 ϕ , 50Hz, 120VA;
100/220VAC, 1 ϕ , 50/60Hz, 150VA;
by external transformer: 110VAC, 3 ϕ , 60Hz;
220/440VAC, 3 ϕ , 50Hz;
110/115VAC, 1 ϕ , 50/60Hz |

6. COLOR

- | | |
|---------------|----------------------------------|
| Scanner Unit: | Munsell N9.5 |
| Display Unit: | Panel: N3.0 newtone No.5 |
| | Chassis: 2.5GY5/1.5 embossed T25 |

PART I

Radar Operation

OPERATIONAL OVERVIEW

GENERAL

The functional and logical arrangement of the front panel controls make this radar easy to use.

If you change a control setting you will see the associated reaction almost immediately on the screen. Key operation is confirmed by a beep tone, while unacceptable key entry is communicated by a series of beep tones. (for regular-type only)

BASIC OPERATING PROCEDURE

1. TURNING THE POWER ON

After having confirmed that there are no obstructions around the scanner, turn the POWER ON. The results of the self-check, total on time, total TX time, and the 3-minute timer are displayed (see Fig. 1). The 3-minute timer begins counting down from 3:00 to 0:00, whereupon it changes to "ST-BY," indicating the radar is ready to transmit. The scanner is not rotated until transmission is started.

NOTE: Self check is conducted at every POWER ON, and no display appears on the screen during the self-check period, about 40 seconds.

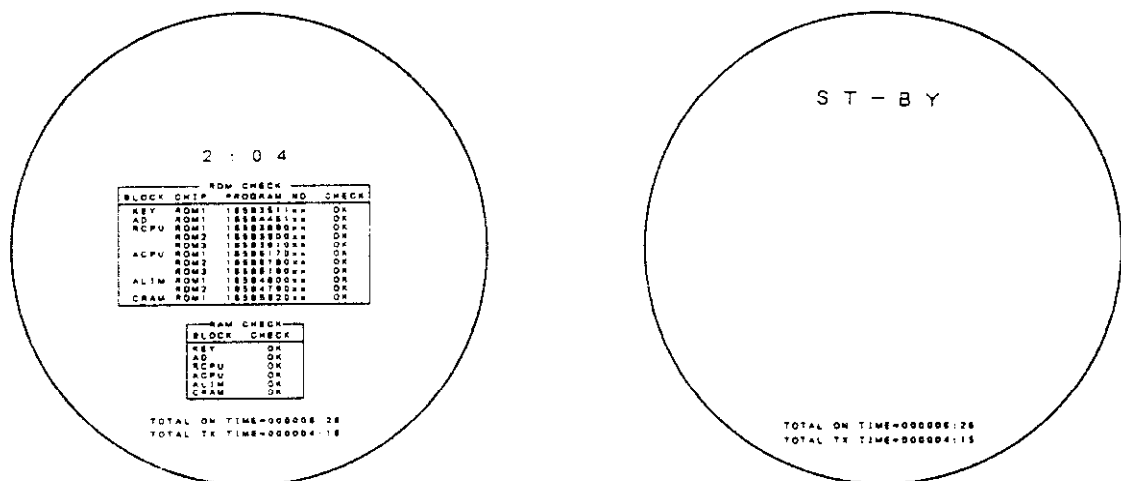


Fig. 1 Display Screen During Warm-up Period

2. SELECTING THE RADAR

Select the radar desired with the RADAR 1 or RADAR 2 touchpads; RADAR 1, master radar, RADAR 2, slave display. The radar selected is indicated at the left-hand side of the screen.

3. ADJUSTING BRILLIANCE OF CRT, DATA AND TOUCHPAD PANEL

CRT

The BRILLIANCE control adjusts the brilliance of the CRT. Temporarily set it to the 12 o'clock position.

Data

The DATA touchpad adjusts the brilliance of the touchpad panel in four levels: dim, medium, bright and off. Each time the touchpad is pressed the brilliance changes in the above sequence.

Touchpad Panel

The PANEL DIM touchpad adjusts the brilliance of the touchpad panel in four levels.

4. TRANSMITTING THE RADAR (selecting a pulselength)

When the message ST-BY appears on the screen, the radar may be transmitted by selecting an appropriate pulselength with the FUNCTION switch. As a general rule of thumb, use the short pulse when target discrimination is required, and use the long pulse when range is important. Shortly after a pulselength is selected the display screen lights up and any echoes received from targets are displayed on the screen. If the FUNCTION switch is set to a pulselength setting during the 3-minute warm-up period, TX appears below the timer indication and the radar will begin transmitting immediately at 0:00.

5. 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 and the range ring interval are indicated at the upper left-hand corner on the screen.

6. TUNE CONTROL ADJUSTMENT

The TUNE control is used to tune the receiver. 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 maximum. Turn the TUNE control between its extremes until the longest tuning bar (between 4 and 5 tuning markers) is obtained.

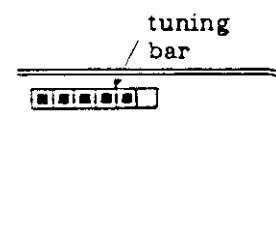


Fig. 2 Tuning Bar

7. 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 CRT.

To properly set the gain, first select one of the two longest ranges -- the speckled background is more apparent on long ranges. Turn the GAIN control clockwise slowly; you should be able to see the speckled background appear when the position of the control is between 2 and 3 o'clock. 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 display.

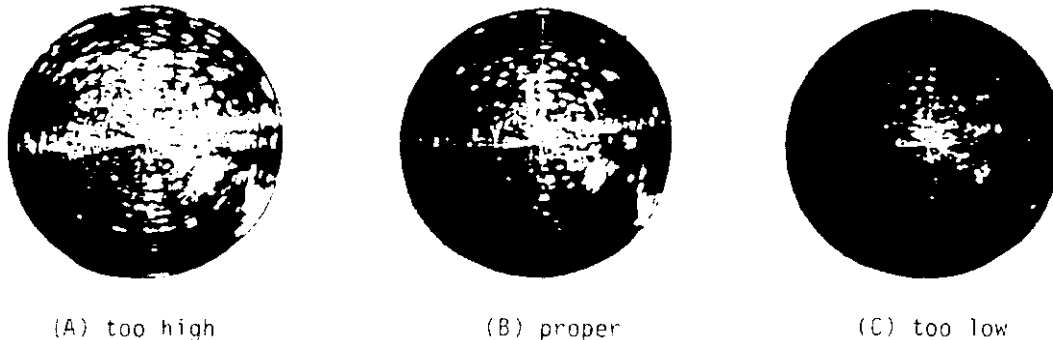
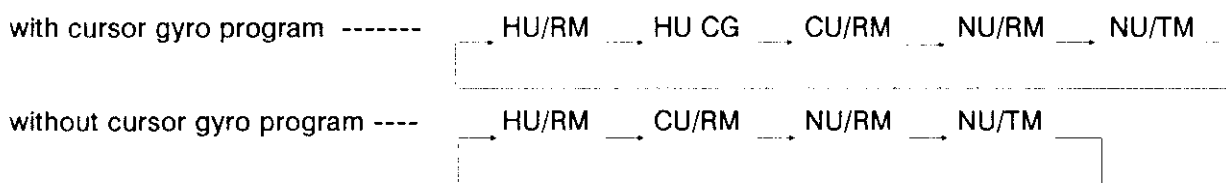


Fig. 3 Gain Control Adjustment

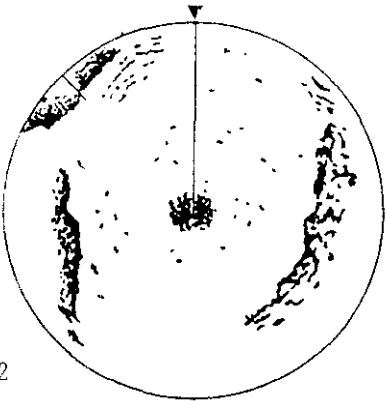
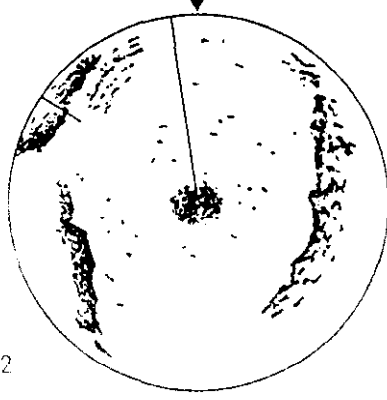
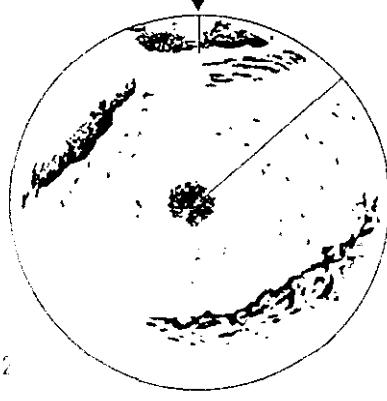
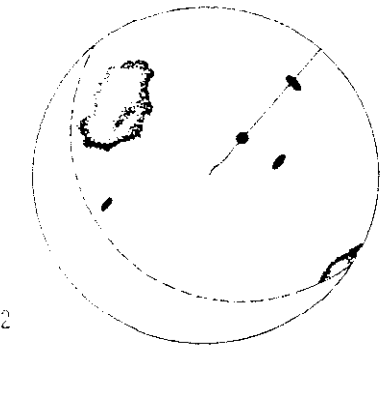
8. PRESENTATION MODE SELECTION

The SELECT touchpad is used to select the presentation mode. There are either five or four modes selectable, Head-up, Head-up CG, North-up, Course-up, True Motion, depending on whether the cursor gyro program is fitted or not. Each time the touchpad is pressed the mode and the mode indication at the left-hand side of the screen change in the following sequence.



Loss of Gyro Signal

When the gyro signal is lost, the presentation mode automatically becomes HEAD UP and an asterisk appears at the CSE readout. (The asterisk does not disappear even when the gyro signal is recovered, to warn the operator that the readout is unreliable.) If this occurs, check the on-screen gyro indication. If it is wrong, align the gyro interface and press the SELECT touchpad to erase the asterisk. If you wish to select a presentation mode other than Head-up further press the SELECT touchpad until the desired mode is obtained.

Example Picture	Mode
	Head-Up/Head-Up CG 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. In the Head-up CG (Cursor Gyro) Mode the bearing scale rotates according to gyrocompass reading. Note that the north mark appears only when a gyrocompass is connected.
	Course-Up Mode † The orientation of the picture is stabilized so that the course immediately before the Course-up is selected is fixed to the top of the screen. If you make a course change, press the SELECT touchpad to get the Course-up Mode. After the course change is completed, press the CU, TM RESET touchpad if you still continue to use the Course-up Mode.
	North-Up Mode † The radar picture is stabilized so that the North is at the top of the screen and the heading mark changes according to the orientation of the ship's heading. This mode is suitable for both measuring the ship's position and as a navigation monitor on a navigational chart. The picture is stabilized against yaw of the vessel, reducing the smearing of target echoes.
	North-Up True Motion Own ship and moving objects are indicated in their true motion on the PPI, allowing the operator to observe ship's movement relative to the fixed target (for example, landmass). When the NU/TM mode is selected, the trace origin of the radar picture is reset to the center of the PPI and the echoes of the targets are indicated like in the north-up picture. When the own ship reaches a location which is 50% of the range in use it is automatically put back to a position on the screen halfway behind the center such that the extension of the heading marker passes through the screen center. The own ship mark may also be returned to screen halfway behind the center manually by pressing the CU, TM RESET touchpad. To turn on or off the automatic reset function, press the TM AUTO RESET touchpad. (TM AUTO is displayed at the left side of the screen when the function is turned on.)

† gyrocompass required

The TM AUTO RESET operation is preceded by visual alarm (and also audible alarm for N-type version).

9. SUSPENDING TRANSMISSION TEMPORARILY

To suspend transmission temporarily, set the FUNCTION switch to ST-BY.

10. SUSPENDING TRANSMISSION

To suspend transmission turn the power off.

ELIMINATING RETURNS FROM SEA SURFACE AND RAIN CLUTTER

SEA RETURNS

Sea returns appear on the screen as a large number of small echoes (see Fig. 5) which might affect radar performance. The action of the A/C 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 8 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, both sea clutter and targets will be erased 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 that weak echoes will not be suppressed. If no clutter is visible on the screen, leave the control in the fully counterclockwise position.

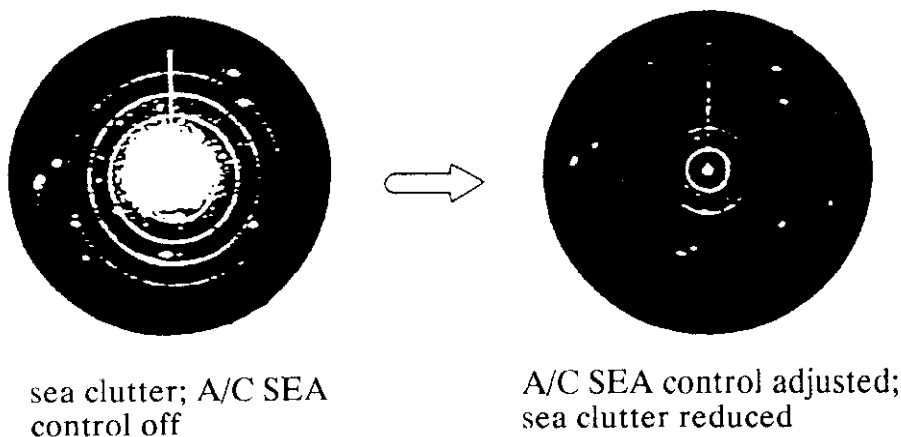


Fig. 5 Adjusting the A/C SEA Control

RAIN CLUTTER

The echoes of ships operating inside rain, hail, or snowstorms may be hidden by on-screen rain clutter. Rain clutter is easily recognizable by its wool-like appearance on-screen. When this type of interference obscures a large area of the screen, you can use the A/C RAIN (anti-clutter rain) control to reduce the clutter.

When the A/C RAIN control is turned clockwise receiver sensitivity is suppressed to break up the clutter into small speckles. Thus it 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, since advancing it too far clockwise may erase target echoes from the screen.

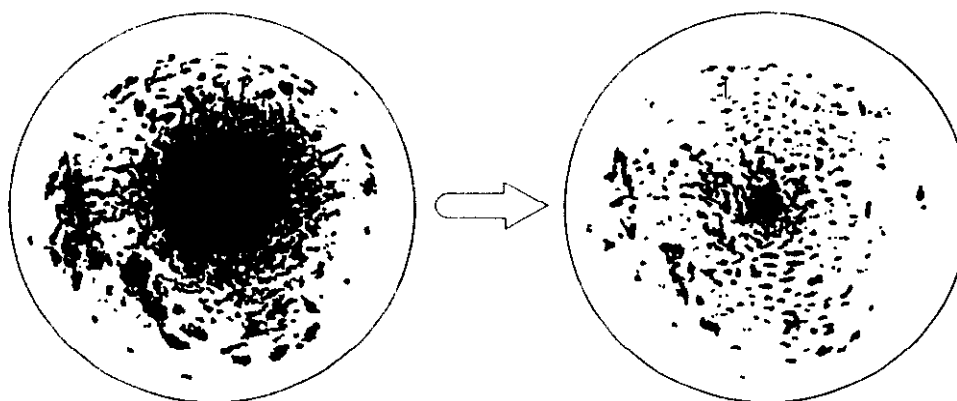


Fig. 6 Effect of the A/C RAIN Control

Automatic Clutter Control

The A/C AUTO (anti-clutter auto) touchpad controls the video circuit which automatically suppresses sea and rain clutters, overriding the manual control for A/C SEA and A/C RAIN. The ON/OFF status of the circuit is indicated at the left-hand side of the screen. It is recommended to adjust the manual A/C SEA and GAIN controls also even when the A/C AUTO circuit is ON.

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" (see Fig. 7). This type of interference can be reduced by activating the Interference Rejector circuit. Press the INT REJECT touchpad to activate the circuit. Four levels of interference rejection are available, and each time the touchpad is pressed the rejection level and the rejection level indication at the left side of the screen change in the following sequence.

IR1 → IR2 → IR3 → OFF

NOTE: Set IR OFF when receiving radar beacon.

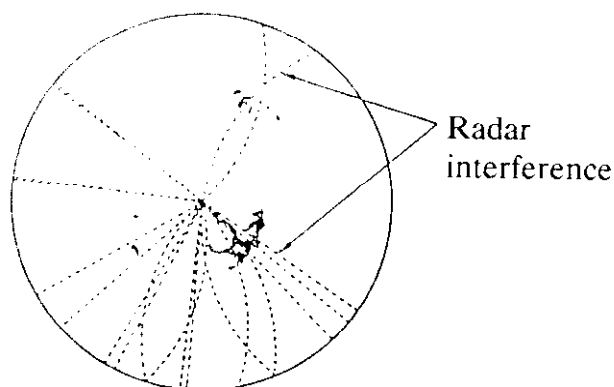


Fig. 7 Radar Interference

RANGE AND BEARING MEASUREMENT

The range to a target from own ship may be measured with the range rings (rough estimate), which are turned on and off by the RING touchpad, or a Variable Range Marker (VRM). The bearing to a target can be measured with an Electronic Bearing Line (EBL).

If the "+" cursor is displayed, range and bearing from own ship to the cursor position are displayed at upper left of the screen. Therefore, the range and bearing to a target is simply known by placing the "+" cursor on the target.

Operation of the VRM's and the EBL's is simple and straightforward. At the right and left side of the control panel there is a group of controls for VRM and EBL operation: an ON and an OFF touchpad and a rotary knob control. Each rotary knob control operates two markers, VRM No.1 and VRM No.2, or EBL No.1 and EBL No.2, which are turned on and off by the appropriate ON and OFF touchpads. Each time an ON touchpad is pressed a marker is turned on and that marker's indication (displayed at the bottom left (EBL) or bottom right (VRM) corner of the screen) is circumscribed, signifying the marker is currently operative. To erase a marker, press the OFF touchpad. The marker whose indication is not circumscribed is erased.

Note that marker differentiation is made by making the lengths of the dash of the No.1 markers shorter than those of the No.2 markers.

To measure the range to a target using the range rings, check the fixed range ring interval, shown at the top left corner of the screen, and judge the distance of the echo from the inner edge of the nearest ring.

NOTE: For N-type version, the No. 2 VRM and EBL are not provided.

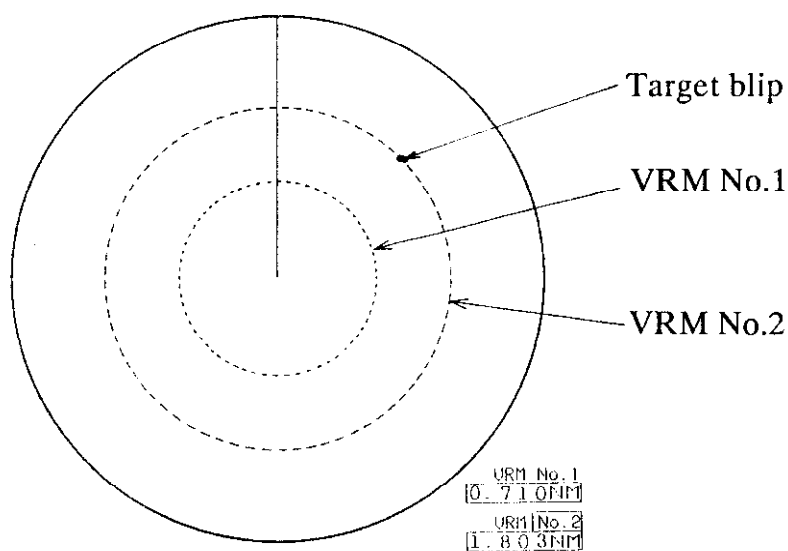


Fig. 8 Range Measurement with a VRM
(VRM No. 2 is for regular-type only)

RANGE MEASUREMENT

Press the VRM ON touchpad to display a VRM on the screen. Next, rotate the VRM rotary knob control until the circle described by the VRM just touches the inside edge of the target blip (see Fig. 8). The range to the target is shown at the lower right-hand corner of the screen; VRM No.1 on top and VRM No.2 indication below it.

VRM Measurement Unit Selection

VRM readout may be displayed in either nm ↔ km or sm ↔ km depending on the setting of an internal DIP switch. To alternate between nm and km (or sm and km), press the VRM ON touchpad while pressing and holding the HM OFF touchpad. (This feature is for regular-type only.)

BEARING MEASUREMENT

Press the EBL ON touchpad to display an EBL. Then, rotate the EBL rotary knob control until the EBL bisects the target blip (see Fig. 9). The relative bearing to the target from own ship is indicated at the lower left-hand corner of the display screen; EBL No.1 indication on top and EBL No.2 below it. If a gyrocompass is interfaced with the radar, true and relative bearings can be alternated, in the heading up mode, by pressing the TRU/REL touchpad.

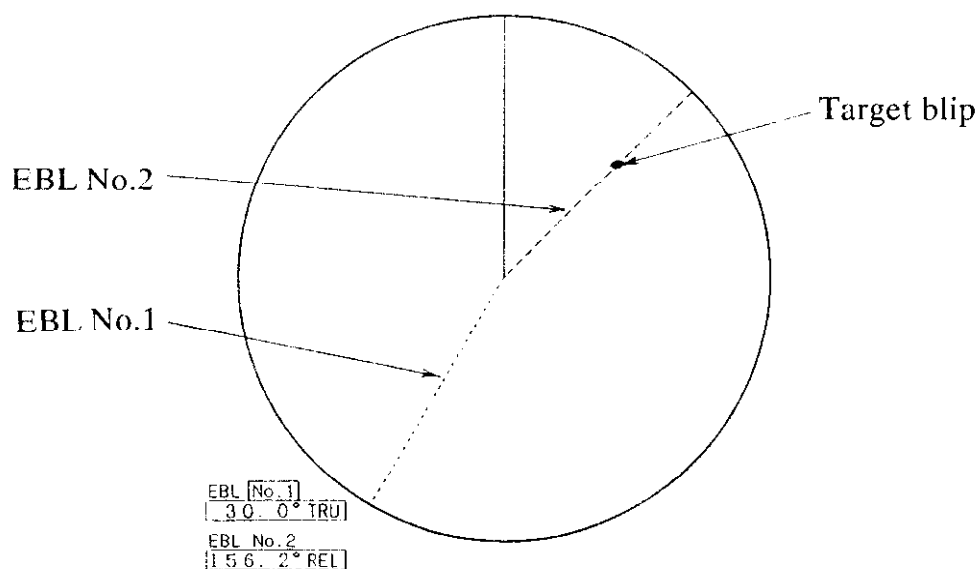


Fig. 9 Measuring Bearing With an EBL
(EBL No. 2 is for regular-type only)

Using the Offset EBL

The origin of the EBL can be placed anywhere with the trackball to provide measurements of bearing and range between two targets. This function is also useful for assessing possible collision situations.

1. Press the CURSOR touchpad to display the cursor on the screen, if it is not already displayed. Superimpose the cursor on a target echo by operating the trackball.

2. Display an EBL on the screen. Press the OFFSET touchpad, and the EBL origin is placed at the intersection of the cursor.
3. After waiting 3 or 6 minutes, operate the EBL rotary knob control until the EBL bisects the target. If the EBL passes through own ship's mark the possibility of collision may exist.
4. To measure the range between two targets, press the VRM ON touchpad to display the VRM (No.1 or No.2) associated with the active EBL. The range marker (see Fig. 10) is superimposed on the EBL. Operate the VRM rotary knob control; the range to the other target is shown on the VRM indication at the lower right-hand side of the screen.

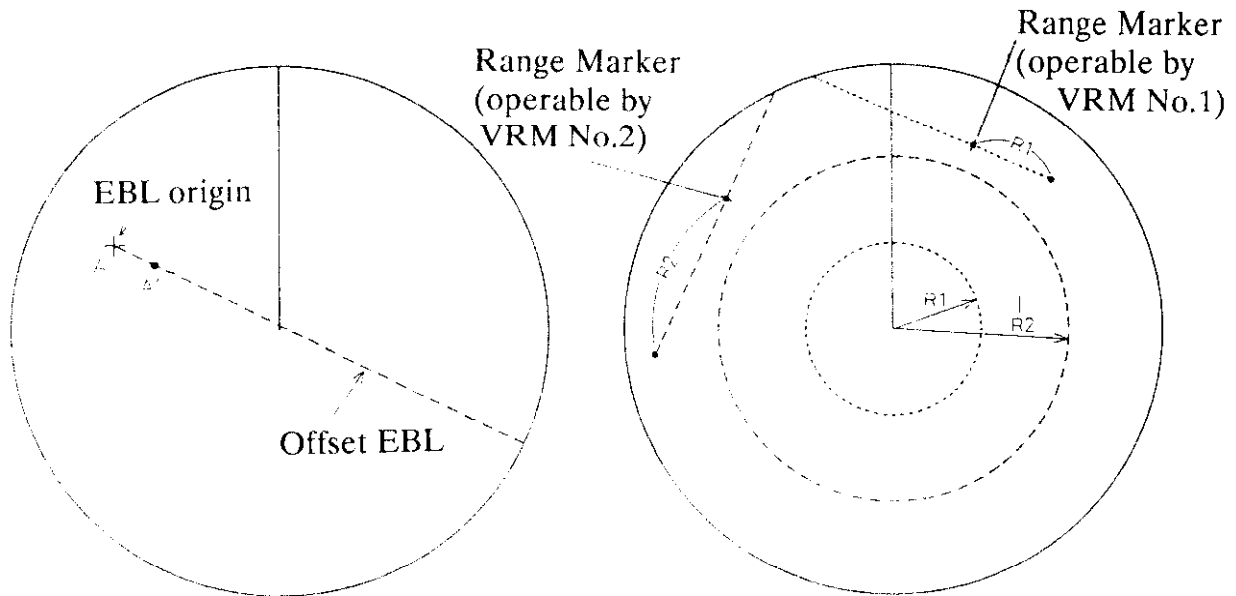


Fig. 10 Using the Offset EBL

5. To measure the range and bearing between two other targets, activate the other EBL and VRM.
6. To return an EBL to the screen center, press the OFFSET touchpad again.

Floating EBL (for N-type version)

1. Press the [EBL OFFSET] key. The EBL origin is offset to the "+" cursor position. In this condition the EBL origin can be maneuvered by the trackball together with the "+" cursor.
2. To operate only "+" cursor, detach it by pressing the [EBL OFFSET] key: (EBL origin remains fixed.)
3. To return EBL origin to own ship position, press [EBL OFFSET] key again.

PARALLEL CURSOR

An electronic parallel cursor is built in this unit. The cursor is comprised of a series of lines parallel to the line inscribed through the screen center, and it is used for maintaining a constant distance between own ship and a coastline or a partner ship.

Operating Procedure

1. To display the parallel cursor, press the INDEX LINES key.
2. To operate the parallel cursor activate EBL1.
3. To change the distance between parallel lines, which is shown at the lower right-hand corner of the screen, press the INDEX LINES SET key. (The indication "INDEX LINES DISTANCE" is displayed on the lower right-hand corner on the screen.) Activate VRM1 and adjust the range with the VRM rotary control. The shorter the distance, the greater the number of parallel lines displayed, and the maximum is 12.

NOTE: The "INDEX LINES DISTANCE" feature is for regular-type only. In case of N-type version, the parallel cursor is composed of six lines and the distance between lines are not variable.

SETTING THE ALARM

An alarm may be set to sound should targets (ships, landmasses, etc.) above a certain signal level enter into a preset guard zone. The size of the guard zone may be set between 0 and maximum range for distance and between 0 and 360° in bearing. (regular-type)

For N-type version, the guard zone is set in range between 3 and 6 miles, with its width being 0.5 mile constant, 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.**

Operating Procedure (for regular-type)

1. Press the VRM ON touchpad to display VRM No.1. Rotate the VRM rotary knob control to set the outer margin of the guard zone. Press VRM ON again and adjust the VRM rotary knob for setting with VRM No.2 the inner margin of the alarm.
2. Press the EBL ON touchpad to display EBL No.1. Rotate the EBL rotary knob control to set one of the sector margins. The guard sector is toward the right side of this EBL when viewed from the center. Press the EBL ON touchpad again and adjust the EBL rotary knob to set the other sector margin. The guard sector is toward the left of this margin when viewed from the center.
3. Press the SET/RESET touchpad. The annunciator "GUARD" is displayed at left side of the screen.
4. Should the alarm sound it can be stopped by pressing the ACKN touchpad. Press the touchpad once again to reactivate the alarm.
5. To change or erase the guard zone, keep the SET/RESET touchpad pressed for more than one second.

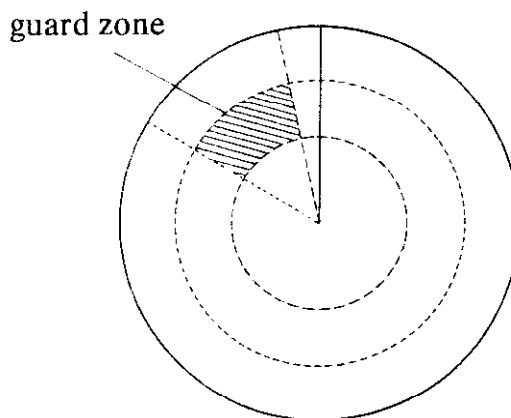


Fig. 11 Guard Zone

Alarm Usage Caution

The alarm is given to the targets having a certain level of echo strength. This level does not always imply a landmass, reef, ships or other surface target but can mean returns from sea surface or precipitation. As 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 position of A/C controls can fail in alerting small targets.

Operating Procedure (for N-type version)

1. Press the SET/RESET touchpad to enter the guard zone setting mode.
2. Press the VRM touchpad to display VRM; and then adjust the VRM control to set the outer margin of the guard zone. If you set the VRM reading to above 6 miles, the outer margin will be set to 6 miles maximum limit. If the VRM reading is set to less than 3.5 miles or VRM is not displayed (VRM off), the inner margin of the guard zone will be set to 3 miles minimum limit.
3. Press the EBL ON touchpad if the EBL is not displayed; and then adjust the EBL control to set the left margin of the guard zone.
Press the EBL ON touchpad again to display the 2nd EBL which is indicated by long dash line. Adjust the EBL control to set the right margin of the guard zone. (EBL readout for the 2nd EBL is displayed below the 1st EBL readout.)
Thereafter, each time the EBL ON touchpad is pressed, the valid EBL changes between 1st and 2nd EBL's.
If the sector margin is not set (that is, no EBL displayed), the guard zone will be of circle (doughnut-shaped appearance).
4. Press the SET/RESET touchpad. The annunciator "GUARD" is displayed at left side of the screen.
5. Should the alarm sound it can be stopped by pressing the ACKN touchpad. Press the touchpad again to reactivate the alarm.
6. To change or erase the guard zone, keep the SET/RESET touchpad pressed for more than 1 second.

Alarm Usage Caution

The alarm activates when targets having a certain level of strength enter the guard zone. This level includes not only ships and landmasses, but also returns from seaface 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.

SHIFTING THE DISPLAY

The sweep origin can be off-centered, using the trackball, by 50% of the range in use in the relative motion mode except for 120 mile range, providing increased coverage without changing the range.

1. Set the cursor on the location desired by operating the trackball. (for regular-type)
2. Press the SHIFT touchpad, and the sweep origin is off-centered.
3. To cancel the off-center display, press the SHIFT touchpad again.

NOTE: For the N-type version, the sweep origin is shifted by 50% toward ship's stern side disregarding the cross-cursor.

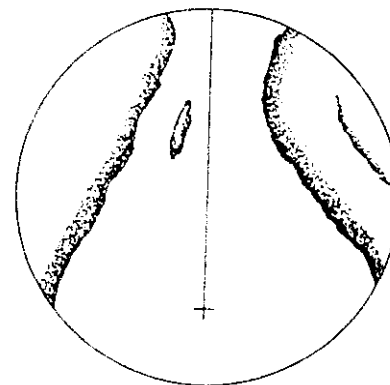
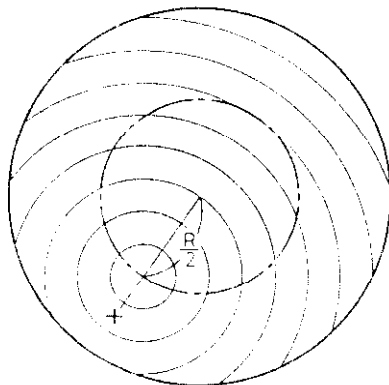
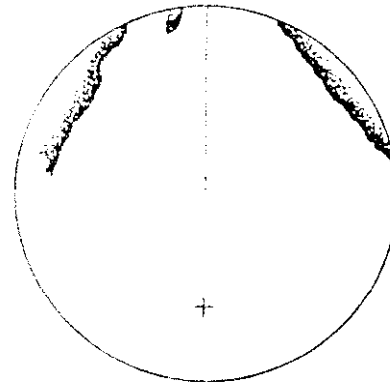


Fig. 12 Shifting the Display

Note

The maximum display shift is 50% of the range in use, even though the cursor may be placed anywhere on the screen.

PLOTTING

The track of up to 10 operator-selected targets can be plotted manually, providing the operator with a history of target movement. Five plots/target are available on a first-in, first-out basis.

1. Display the cursor if it is not already displayed. Superimpose the cursor on the target desired by operating the trackball.
2. Select a plotting symbol with the PLOT MARK touchpads followed by the PLOT touchpad. The selected symbol is displayed.
3. Wait at least 30 seconds, place the cursor on the same target, select a symbol and press the PLOT touchpad. If the [CANCEL] touchpad is pressed within 3 seconds, the new plotting is cancelled. For plotting other targets, repeat this procedure.
4. CPA and TCPA will be indicated with a vector on the target.

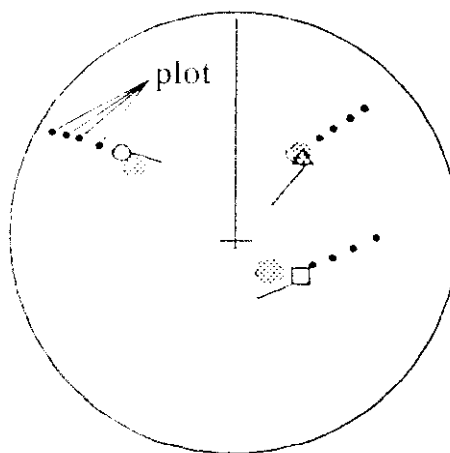


Fig. 13 Plot Display

Target Vector

Trend of motion of each plotted target is shown by a vector. The vectors remain unchanged without being updated; therefore, care should be taken to clear less important target vectors. Vector time length, which is selectable by the VECTOR TIME touchpad, is shown in the plot data table at the top right-hand side of the screen. (30 seconds to 99 minutes in 0.5 minute step)
The vector is displayed in relative to own ship on RM (relative motion) mode and true vector is displayed on TM (true motion) mode.

CANCELLING PLOTS

Individual

Press [corresponding plot symbol key], CANCEL.

All

Press ALL TARGET, CANCEL.

Note

When the presentation mode is changed or when the RESET touchpad is pressed in the Course-up Mode, the past plots and vectors are all erased automatically.

PLOT DATA TABLE

The plot data display table, an example of which is shown below, shows data about plotted targets and is located at the right side of the screen. To display the data about a target, press a plot symbol touchpad followed by the SELECT touchpad. The data of three targets can be displayed. To erase a target data, press the corresponding plot symbol key followed by the SELECT touchpad.

Vector Time

Current vector time length is shown. REL is displayed on RM mode showing the relative vector and TRU is displayed on TM mode showing the true vector.

Timer

Elapsed time since plot updating is displayed in 1 second step.

Range/Bearing to Plot Mark

Range and bearing to the last-entered plot mark are indicated. The bearing indication is relative to ship's heading in the Head-up Mode, true relative to North in the North-up and Course-up Modes.

Course/Speed of Plotted Target

Course and speed of target are displayed. REL is displayed on RM mode showing the relative vector and TRU is displayed on TM mode showing the true vector. Note that these indications are not updated during plot intervals.

CPA/TCPA

Closest Point of Approach (CPA) and Time of Approach (TCPA) are displayed for the last plotted target. Note that the CPA/TCPA indications are not updated during plot intervals.

BCR/BCT

These indications show the distance and time at which the target will pass own ship's bow. If a target is projected to cross own ship's stern, a minus (-) sign will be placed in front of the data for BCR.

VECTOR TIME 99MIN REL									
PLOT	00	00							
RZNG	000	00							
BRG	000	00							
CSE	000	00							
SPD	000	00							
CPA	000	00							
TCPA	000	00							
BCR	000	00							
BCT	000	00							
PLOT	00	00							
RZNG	000	00							
BRG	000	00							
CSE	000	00							
SPD	000	00							
CPA	000	00							
TCPA	000	00							
BCR	000	00							
BCT	000	00							
PLOT	00	00							
RZNG	000	00							
BRG	000	00							
CSE	000	00							
SPD	000	00							
CPA	000	00							
TCPA	000	00							
BCR	000	00							
BCT	000	00							

Fig. 14 Plot Data Table

NOTE: If it is not required to display the data items CPA/TCPA/BCR/BCT, they can be turned off by setting DIP switch S1 #4 on the AD board to the "ON" (OMIT) side.

SHIP'S SPEED, SET & DRIFT INPUT

For true motion display and plotting, this radar requires speed input and gyro signal. Further, for accurate true motion display, set and drift (ocean current) data are required.

Automatic Input

Press the LOG touchpad to automatically input ship's speed signal from a log.

Manual Input

Press the MANUAL SPEED SET touchpad. Enter ship's speed with the R [+/-] touchpad. Press the MANUAL touchpad to register speed setting.

SET, DRIFT

1. Press the SET, DRIFT touchpad to display the set and drift setting screen.
2. Set SET and DRIFT with L [+/-] and R [+/-] touchpads, respectively.
3. Press the SET, DRIFT touchpad once again to register set and drift settings.

ECHO TRAIL

The ECHO TRAIL touchpad is used to plot the relative movement of targets to own ship, simulating the afterglow in a lower intensity. Each time the ECHO TRAIL touchpad is pressed the plotting time changes in the following sequence.



To change the plotting time indication, press the touchpad successively (no pause between presses).

When the plotting function is turned on (for example, 30 sec. is selected) the trail of every target starts extending and the on-screen timer starts counting up.

As soon as the timer counts 30 sec. it stops counting 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 afterglow is produced by memory read-write function with last-in, first-out basis over the selected time span. In the relative trail mode, the greater the relative speed of the target, the longer the afterglow.)

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

If the range or presentation mode is changed while plotting is being performed, the elapsed time indication is erased, informing the operator that the plotting mode is suspended. Return to the previous range setting/presentation mode to resume plotting.

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

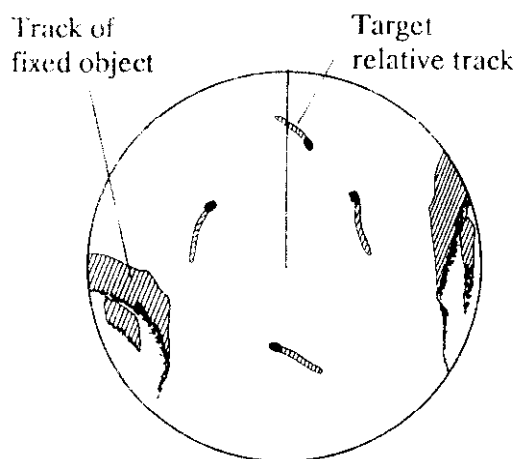


Fig. 15a Target Plotting
(Relative Trail)

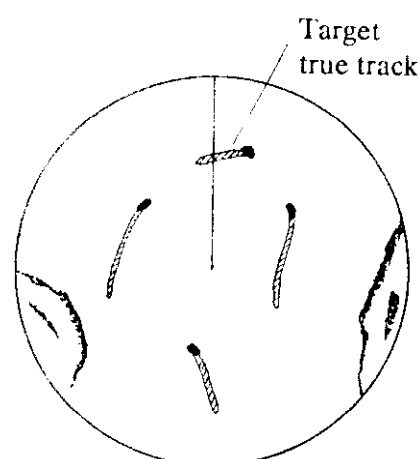


Fig. 15b Target Plotting
(True Trail)

True Trail/Relative Trail

True and relative can be switched by pressing the [SELECT] touchpad with the [HM OFF] touchpad kept depressed on the Relative Motion mode. (True only for True Motion mode)

ECHO AVERAGING

The ECHO AVERAGE touchpad is used to suppress sea clutter.

Echoes received from stable targets such as other ships (not moving at a fast relative speed to own ship) appear on the screen at almost the same position for every rotation of the sweep. On the other hand, unstable echoes such as sea clutter appear at random, sometimes making discrimination of target echoes difficult.

To distinguish target echoes from sea clutter this radar uses the scan-to-scan correlation method. The scan-to-scan correlation method stores and averages successive picture frames. If the echo is stable it is presented in its actual strength level. And if it is unstable its brilliance is suppressed, allowing you to discriminate targets from sea clutter.

To properly use the echo averaging facility it is recommended to first suppress sea clutter with the A/C SEA control. Then, press the ECHO AVERAGE touchpad. There are three levels of correlation, corresponding to the number of picture frames to be correlated, and the level in use is shown at the left side of the screen. Each time the touchpad is depressed the level of suppression changes in the following sequence. (Gyrocompass must be connected.)

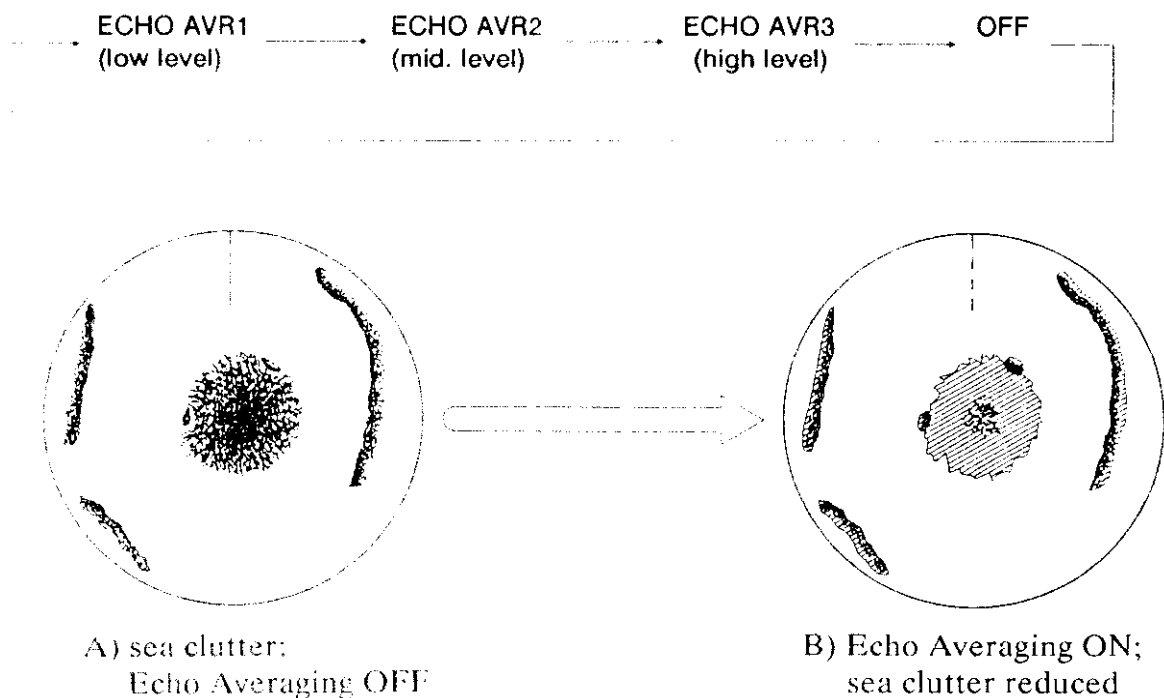


Fig. 16 Echo Averaging

Echo Average Usage Cautions

Echo average should not be used under the following conditions.

- speed difference between own ship and other ships is large
- own ship is pitching and rolling
- for receiving radar beacon

True echo average may be useful to detect stationary small targets while own ship is running. True and relative can be switched by pressing the [SELECT] touchpad key with the [HM OFF] touchpad kept depressed. (True only for True Motion mode)

ECHO STRETCH

On long ranges the echoes of targets are displayed only as small pips, making them difficult to see. To enhance target video on these ranges, press the ECHO STRETCH touchpad. There are two levels of echo stretch, and each time the touchpad depressed the indication ECHO STR 1 or ECHO STR 2 appears at the left-hand side of the screen.

The echo stretch function is effective when the pulselength is 0.3us or longer, i.e., on the 3nm and longer ranges when the FUNCTION Switch is set at SHORT pulse, the 0.75 nm and longer ranges at LONG pulse.

Caution

The echo stretch function magnifies not only small target pips but also returns from sea surface, rain and radar interference. For this reason make sure these types of interference are sufficiently suppressed before activating this function.

SECOND-TRACE ECHO REJECTION

Echoes from very distant targets may appear as false echoes (second-trace echoes) on the screen, returning after the next transmission pulse has been transmitted.

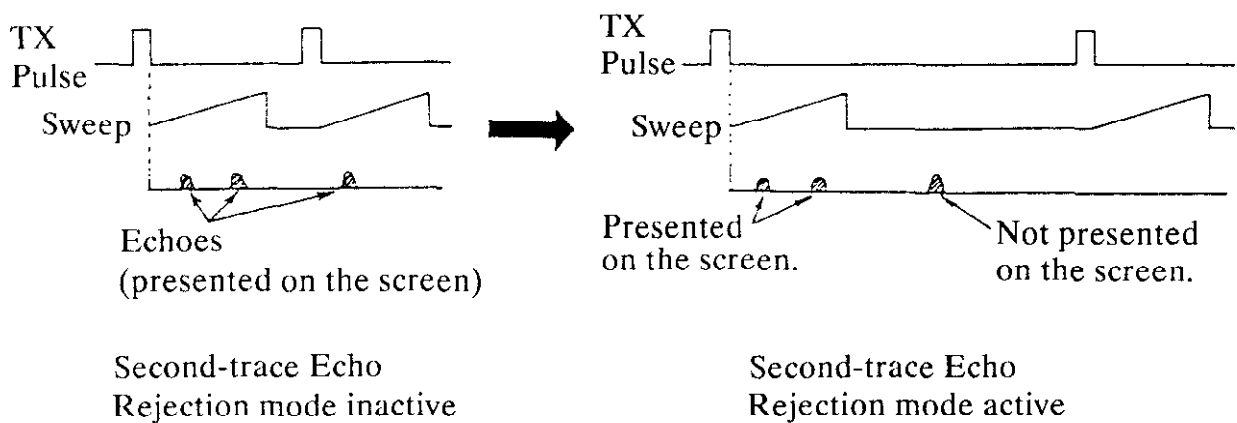


Fig. 17 Second-Trace Echo Rejection

To erase second-trace echoes, press and hold the INT REJECT touchpad while pressing and holding the HM OFF touchpad. The pulselength indication at the top of the screen appears in inverse video to inform you that the second-trace echo rejection circuit is on. Note that the second-trace echo rejection is ineffective when the pulselength is 0.08. (The pulselength indication appears in inverse video, however the rejection circuit is inactive.)

The rejection circuit may be turned off by pressing the HM OFF and INT REJECT touchpads simultaneously.

MARKING NAVIGATION FAIRWAYS & POINTS

NAVIGATION FAIRWAYS

A maximum of two navigation fairways can be electronically marked on the screen and each fairway (line) may contain up to five corners.

Operating Procedure

1. Press either NAV LINE 1 or NAV LINE 2 key.
2. Using the trackball, locate the cursor on the L/L position desired for a point, and then press the ENT key. Repeat this procedure to enter other points.

NOTES

- The on-screen distance between points must be at least 4mm.
 - When more than five corners are entered the oldest point is erased to make room for the latest point.
 - The CANCEL key may be pressed within 10 seconds after pressing the ENT key to erase the previous entered point.
 - The appropriate NAV LINE key may be pressed during line entry to escape.
3. To erase a navigation line (fairway), press the appropriate NAV LINE key followed by depressing the CANCEL key for more than 2 seconds.

Editing a Navigation Line

1. Press the appropriate NAV LINE key.
2. Place the cursor on the point to be deleted. The point should blink.
3. Press the CANCEL key to delete the point. (This must be done within two seconds after designating the point.)
4. Place the cursor on the point to be entered, and then press the ENT key.

NAVIGATION POINT

Navigation points, for example, a buoy, a lighthouse, etc., can be marked on the screen. A maximum of five points can be marked and each mark is assigned a number sequentially.

To enter a point press the NAV POINT key followed by ENT key. The point is marked with the next sequential number and is connected to the own ship mark by a dashed line. When new point is entered, the previous point disappears from the screen, but still registered in the memory.

The registered point can be called in the screen one by one by pressing the NAV POINT key.

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.

BRILLIANCE CONTROLS

Controls are provided to adjust the brilliance of the CRT, alphanumeric indications, legends, etc. Most brilliance controls (touchpads) are located at the left-hand side of the display unit, except for the CRT brilliance-adjusting control which is located to the right of FUNCTION switch.

Each brilliance-adjusting touchpad provides four levels of brilliance; dim, medium, bright and off. Each time one of these touchpads is pressed the brilliance changes in the aforementioned sequence.

CRT

The BRILLIANCE control adjusts CRT brightness. Adjust it so that radar echo blips may be observed clearly.

Heading Mark

The HM touchpad may be used to adjust the brightness of the heading mark.

Plot Symbol

The PLOT SYMBOL touchpad controls the brightness of the plot symbols.

Data

The brightness of data readouts may be adjusted with the DATA touchpad.

Cursor

The CURSOR touchpad controls the brilliance of the cursor.

Ring

The RING touchpad controls the brilliance of the range rings.

Mark

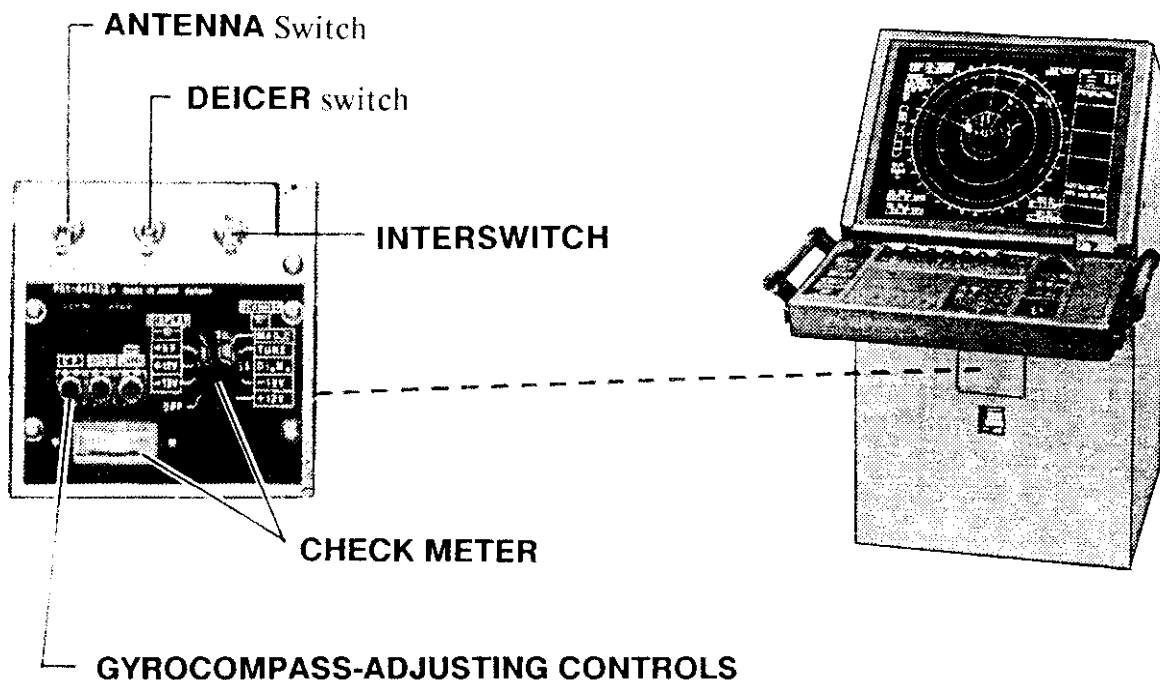
The MARK touchpad controls the brightness of the VRM, EBL, North Mark and Guard Zone.

Panel

The PANEL DIM touchpad may be used to adjust the brilliance of the control panel.

SUB PANEL CONTROLS

The sub panel located at the front of the display unit (precessor unit) contains various controls not normally used in every day operations. Access to these controls may be made by pulling the knob of panel lid.



ANTENNA Switch

This switch turns the antenna radiator rotation on and off.

DEICER switch (when optional deicer is incorporated)

This switch turns the deicer on and off.

INTERSWITCH (when optional interswitch RJ-6 is incorporated)

This switch selects the cross configuration between two radars or independent radar operation. Refer to the table on next page.

R J - 6 INTERSWITCH	STRAIGHT CONFIGURATION	CROSS CONFIGURATION
No. 1 RADAR DISPLAY No. 2 RADAR DISPLAY		

SET DIP SWITCH S3 #1 ON AD BOARD (18P8293) TO "1" (OFF) FOR NO. 1 RADAR, AND TO "2" (ON) FOR NO. 2 RADAR.

GYROCOMPASS-ADJUSTING CONTROLS

North-up and Course-up presentation modes require the compass signal in step-by-step or synchronous form. This adjustment is required when the radar is not synchronized with the gyrocompass. When the external A-D Converter AD-10S is used, the adjustment is made on its front panel.

1. Press the **HOLD** switch to disconnect the computing circuit from the gyrocompass.
2. Press the **UP** or **DOWN** switch until the compass reading is duplicated on the "CSE" reading at the upper right corner on the screen.
3. Press the **HOLD** switch again to engage the radar circuit with the gyrocompass (HOLD lamp will go off). If the gyro reading on the screen ("CSE") deviates from the compass reading, adjust it with the **UP** or **DOWN** switch.

CHECK METER

Magnetron current, MIC detecting current, and output voltage of power supplies can be checked with the check meter.

Position of Selector Switch	Normal Reading on Check Meter	Remarks
-12V (output voltage)	6-8	0.25-mile range, ST-BY
+ 12V (output voltage)	6-8	0.25-mile range, ST-BY
+ 5V (output voltage)	6-8	0.25-mile range, ST-BY
MAG. C (magnetron current)	4-8.5	48-mile range, TX
TUN (tuning status)	5-10	48-mile range, TX
DI. M (MIC detecting current)	6-8	0.25-mile range, ST-BY
-12V (for scanner unit)	6-8	for TR-up type radar only
+ 12V (for scanner unit)	6-8	for TR-up type radar only

FIG. 18A SUMMARY OF CONTROL FUNCTIONS

EBL

- ON touchpad**
This touchpad may be pressed to display an EBL.
- OFF touchpad**
This touchpad may be pressed to erase an EBL.
- INDEX LINES touchpad**
This touchpad turns the electronic parallel cursor on and off.
- OFFSET touchpad**
This touchpad offsets and resets the origin of an EBL.
- TRUE REL touchpad**
Pressing this touchpad alternates between true and relative bearing readout in the head-up mode.
- ROTARY knob control**
This control maneuvers the EBL's.

RADAR 1 RADAR 2 - These keys select the radar to be used.

BRILLIANCE

- HM touchpad**
This touchpad controls the brilliance of the heading marker.
- PLOT SYMBOL touchpad**
The brilliance of plot marks and vectors is controlled by this touchpad.
- RING touchpad**
Press this touchpad to adjust the brilliance of the range rings.
- DATA touchpad**
The brilliance of alphanumeric data may be adjusted with this touchpad.
- CURSOR touchpad**
This touchpad controls the brilliance of the cursor.
- MARK touchpad**
The brilliance of the VRM's, EBL's, Guard Zone and North Mark is controllable with this touchpad.
- PANEL DIM touchpad**
Press this touchpad to adjust the brilliance of the touchpad panel.

FUNCTION switch
This switch is used to set the radar in ST-BY, select pul-selength and enable checking by the performance monitor.
NOTE: When set to "PERF M" position, the radar transmits on long range even if the performance monitor is not connected.

BRILLIANCE control
This control adjusts the brilliance of the CRT.

TUNE control
This control tunes the receiver; adjust it to display the longest tuning bar.

A/C RAIN control
Rain/snow returns may be suppressed with this control.

A/C SEA control
Sea surface returns may be suppressed with this control.

GAIN control
This control adjusts receiver sensitivity.

RANGE SELECTION touchpads
These two touchpads select a range.

TRACKBALL
The trackball maneuvers the cursor.

SELECT touchpad
Presentation mode is selectable with this touchpad.

CU, TM RESET touchpad
Press this touchpad to manually return own ship mark to screen center (CU Mode), or to a location 50% of the range in use (TM Mode).

TM AUTO RESET touchpad
This touchpad turns the own ship mark recentering function on and off.

SHIFT touchpad
Pressing this key offsets the sweep origin within 50% of the range of the use.

ON touchpad
Press this touchpad to display a VRM.

OFF touchpad
This touchpad may be used to erase a VRM.

INDEX LINES SET touchpad
This touchpad is used to adjust the range between the parallel cursor lines.

ROTARY knob control
Rotate this control to maneuver the VRM's.

NAV LINE touchpads
These touchpads are used to enter and erase navigation lines (fairways).

NAV POINT touchpad
This touchpad, when pressed, enters a navigation point.

ENTER touchpad
This touchpad registers a navigation line or navigation point into the memory.

CANCEL touchpad
Press this touchpad to erase a navigation point or navigation line.

A/C AUTO touchpad
This touchpad turns the automatic clutter reduction circuit on and off.

INT REJECT touchpad IR1 ~ 3
This touchpad turns the interference rejection circuit on and off.

ECHO AVERAGE touchpad ECHO AVR 1 ~ 3
Sea surface returns can be suppressed in three levels by this touchpad.

ECHO STRETCH touchpad ECHO STR 1 ~ 2
Press this touchpad on long ranges to enhance target detection ability.

ECHO TRAIL touchpad
This touchpad, when pressed, plots the trail of all targets.

HM OFF touchpad
Press and hold this touchpad to erase the heading marker and north marker. Release hold to redisplay them.

CURSOR DATA touchpad
This touchpad, if pressed when the cursor is displayed, turns the cursor data display on and off.

ORIGIN MARK touchpad
This touchpad turns the origin mark on and off.

SET RESET touchpad
Press this touchpad to enable setting and resetting of the guard zone.

ACKN touchpad
This touchpad may be pressed to temporarily deactivate/reactivate the guard zone.

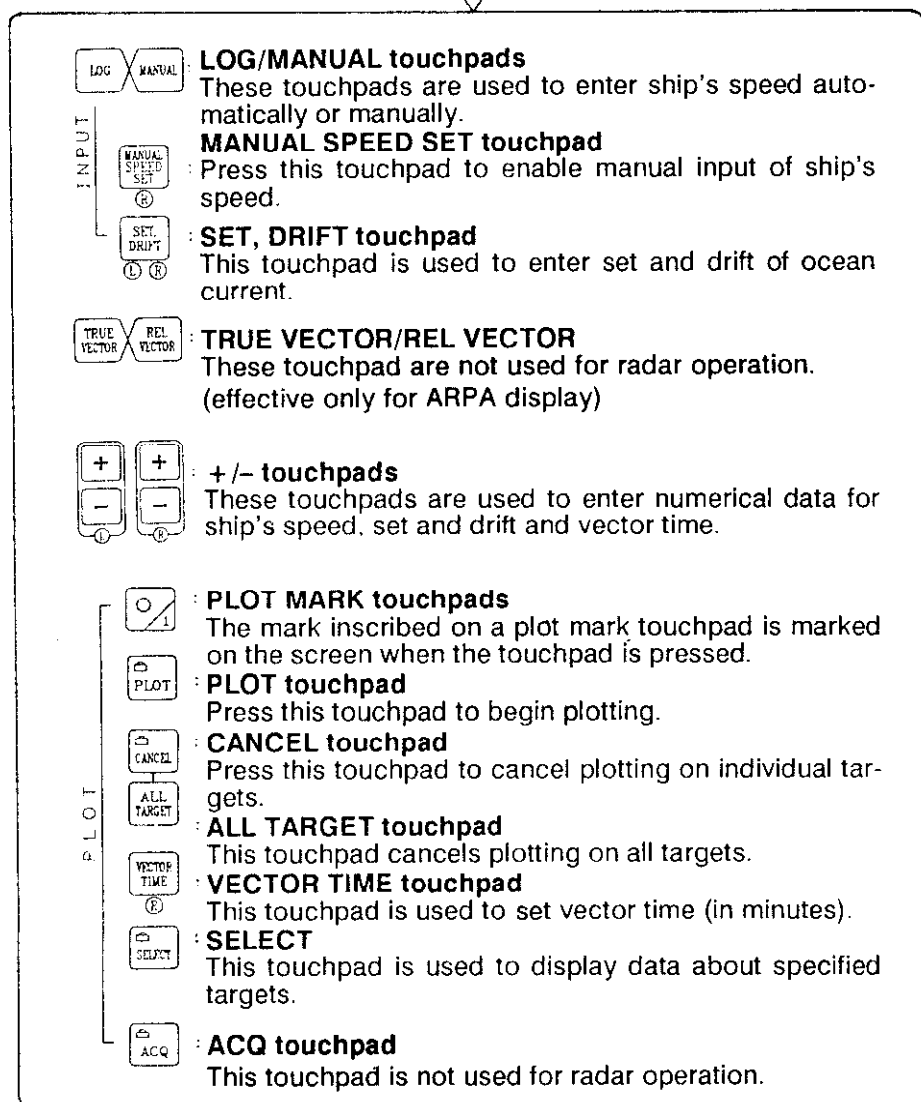
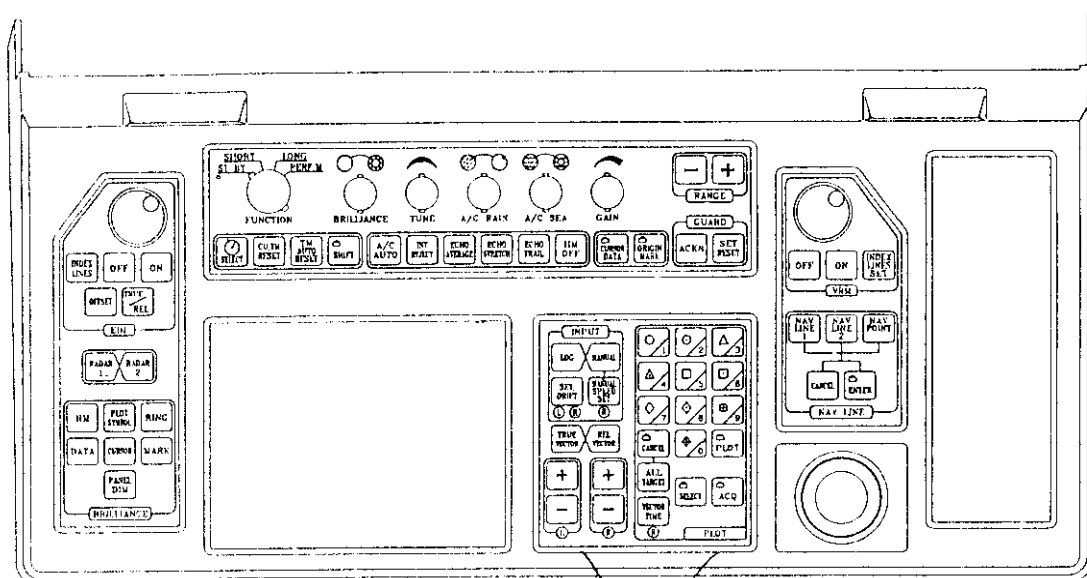


Fig. 18B SUMMARY OF CONTROL FUNCTIONS

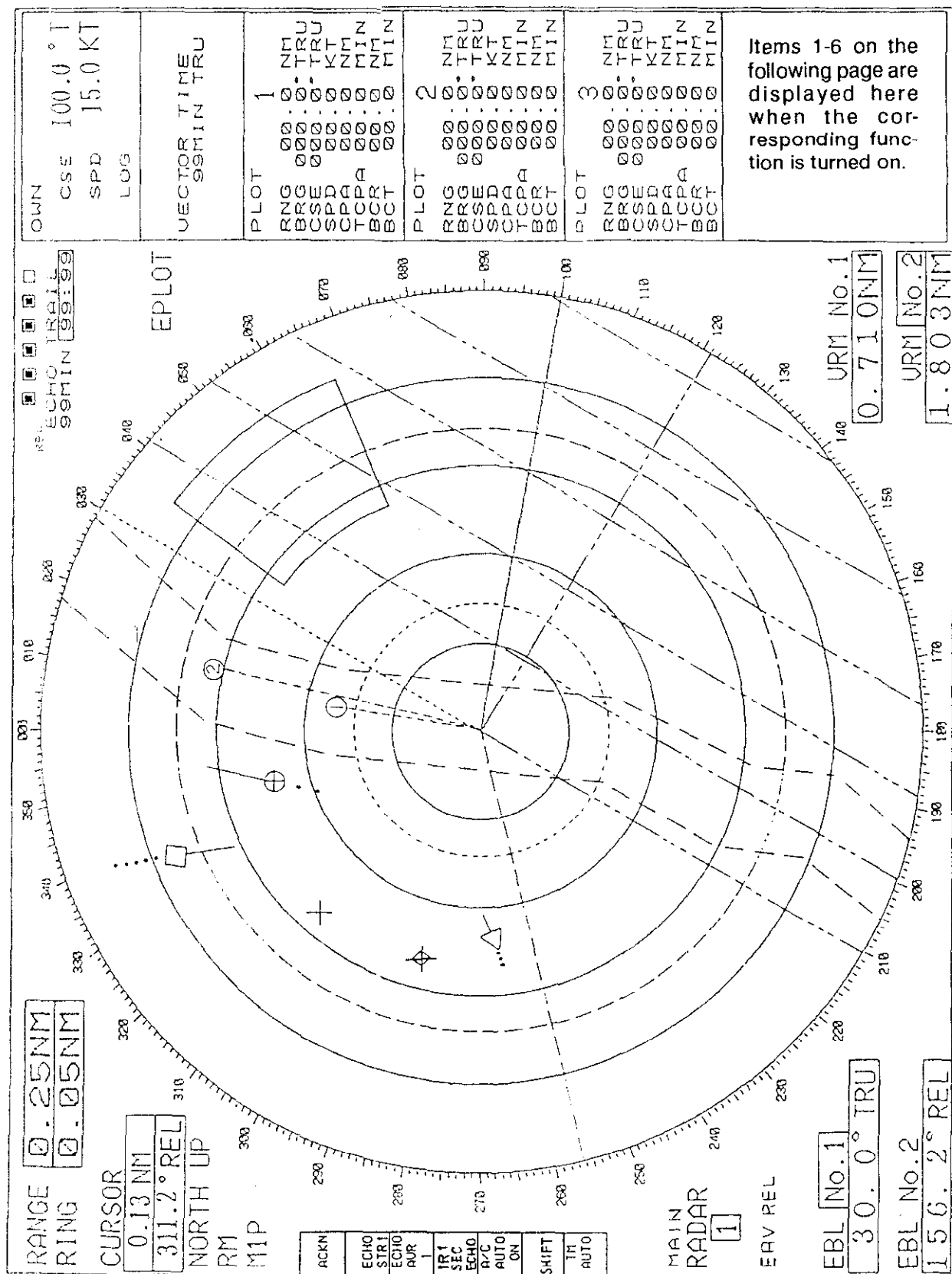


Fig. 19 DISPLAY SCREEN INDICATIONS

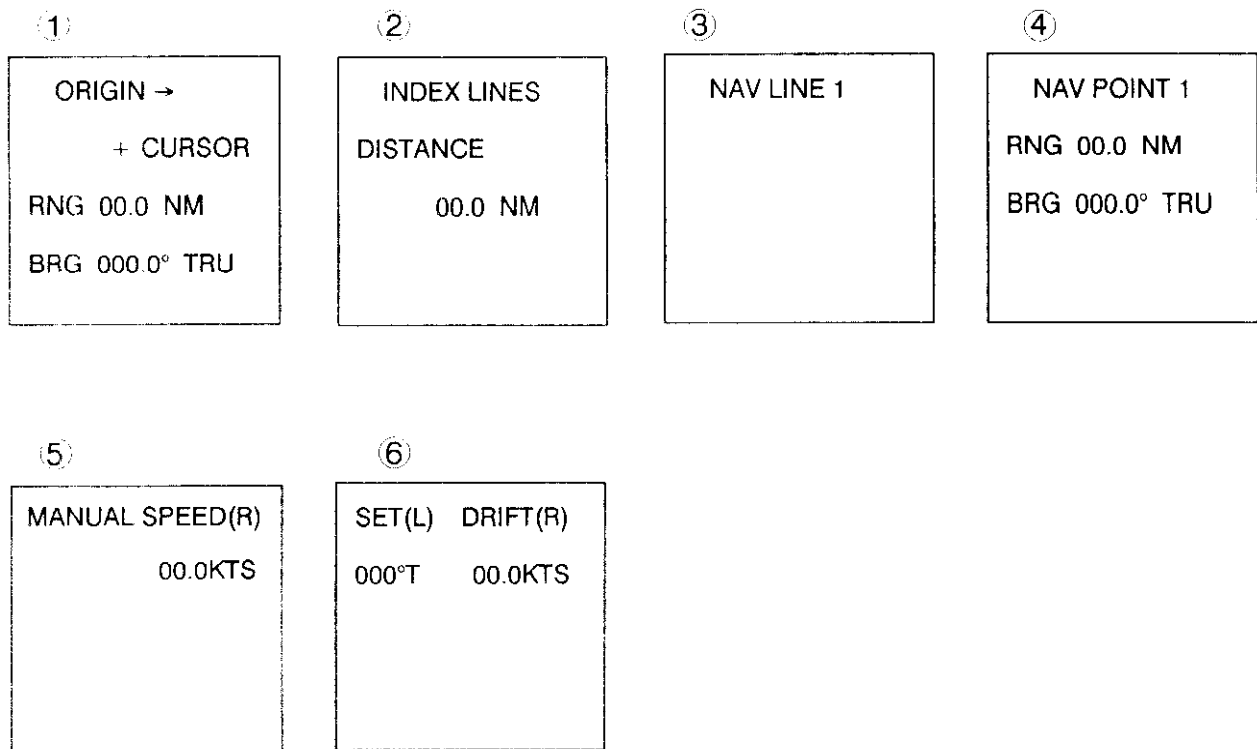


Fig. 20 INDICATIONS IN BOX AT LOWER
RIGHT-HAND CORNER OF SCREEN

APPLICATION

In this section minimum and maximum ranges for target detection, radar resolution, range measurement, false echoes and radar plotting are discussed.

MIN AND MAX RANGES FOR TARGET DETECTION

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)
 h_1 : antenna height (m)
 h_2 : target height (m)

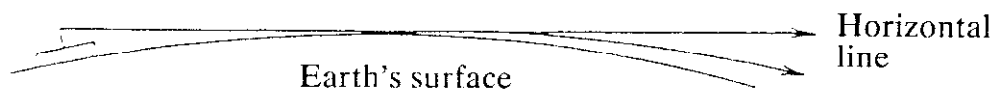


Fig. 21 Radar Horizon

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° (IMO Resolution). This condition is normally satisfied with a radiator larger than 1.2m (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 pulse length only. The usual discrimination range is 22.8m (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. 22. Multiple reflection echoes can be reduced and often removed by decreasing the gain or properly adjusting the A/C SEA control.

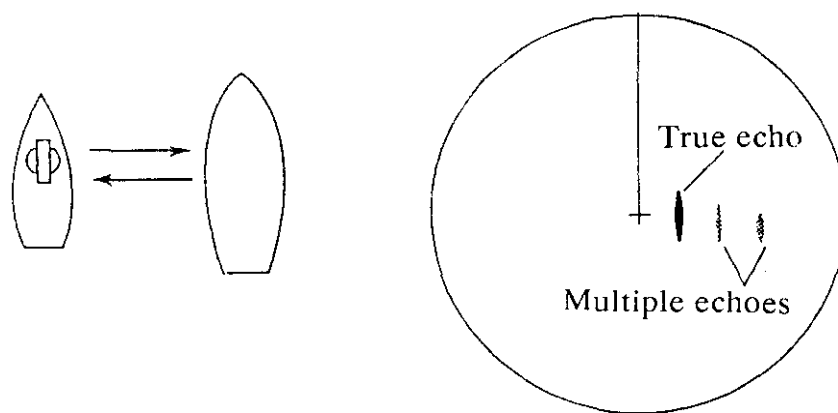


Fig. 22 Multiple Echoes

BLIND AND SHADOW SECTORS

Funnels, stacks, masts, or derricks in the path of the 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. 23.

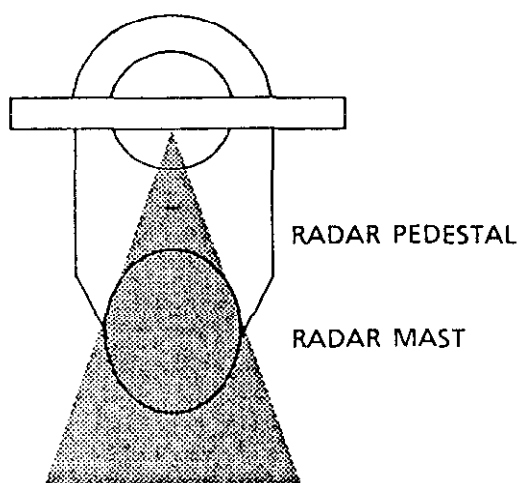


Fig. 23 Blind and Shadow Sectors

SIDELOBE ECHOES

Every time the radar pulse is transmitted, some radiation escapes on each side of the beam, -- called "sidelobes". 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. 24. 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.

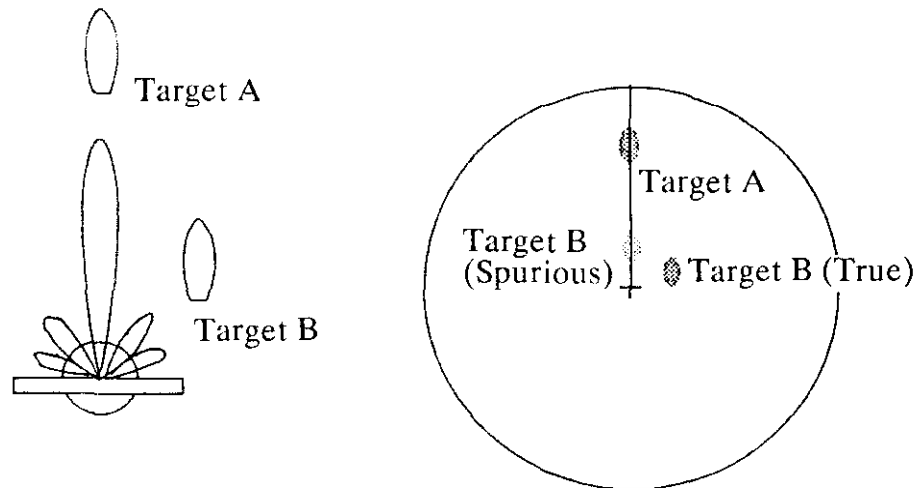


Fig. 24 Sidelobe Echoes

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. 25. If your ship comes close to a large metallic bridge, for example, such a false echo may temporarily be seen on the screen.

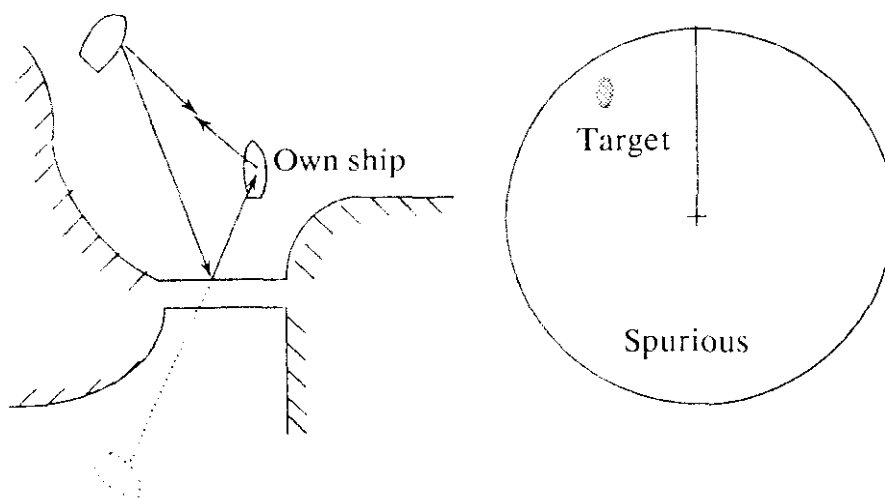


Fig. 25 Virtual Image

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. Next, with a compass sweep out the ranges from the charted positions. The point of intersection of the arcs is your estimated position.

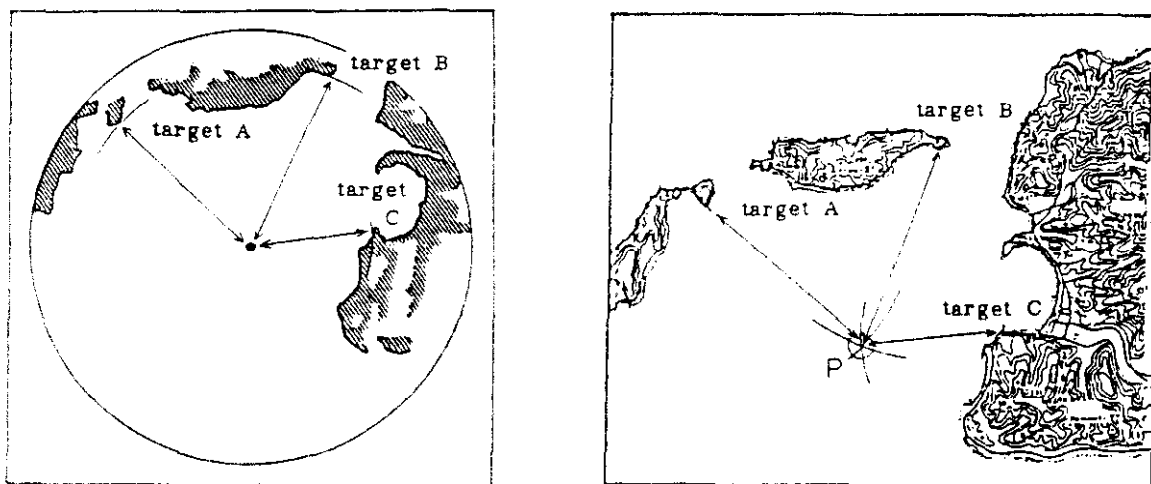


Fig. 26 Position Fix Using Range

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.

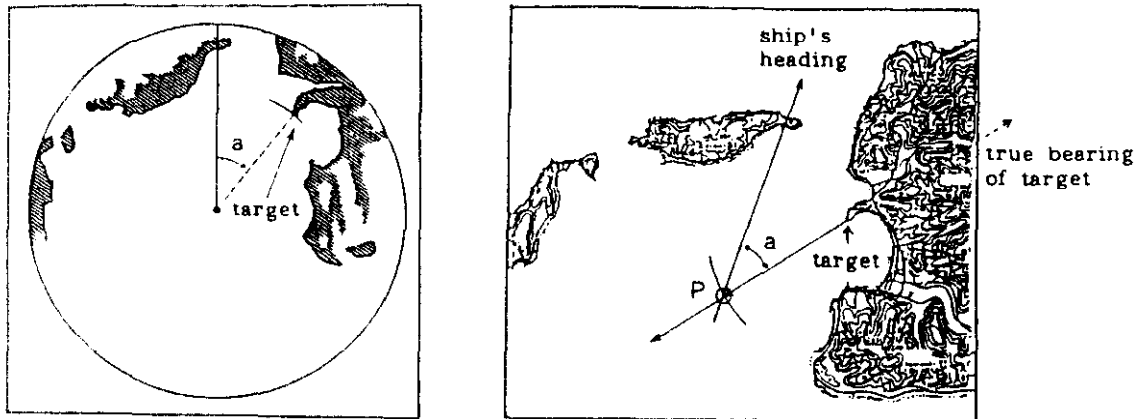


Fig. 27 Position Fix Using Range and Bearing

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.

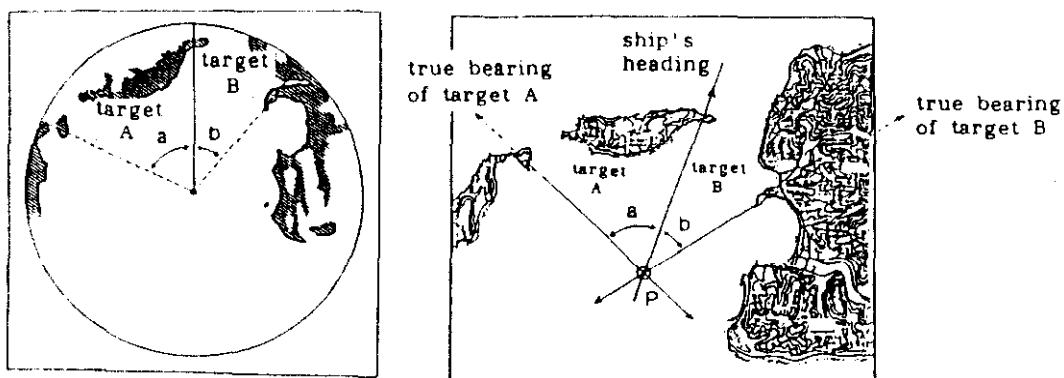


Fig. 28 Position Fix Using Two Bearings

MAINTENANCE

Good performance depends on regular maintenance. Following the recommended maintenance checks prescribed in this section will not only prevent unexpected malfunctions but will also lengthen equipment life.

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 if heavily corroded.	* Sealing compound may be used instead of paint. * Put slight amount of grease on new nuts and bolts.
	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 radiator is cracked, apply a slight amount of sealing compound or adhesive as a temporary remedy, then call for repair.	* DO NOT use plastic solvent (acetone) for cleaning. * If removing ice from the scanner unit, use a wooden hammer or plastic-head hammer. Crack on the unit may cause water ingress, causing permanent damage to the circuits inside.
	Terminal boards and plugs in scanner unit	Open scanner cover to check terminal board/plug connections inside. Also check the rubber packing of the scanner cover for wear.	* When putting cover back in position, be careful not to catch flying wires between cover and unit.
	CRT screen	Dust or dirt on CRT creates symptoms identical to poor sensitivity. Clean CRT surface carefully.	* Use a soft cloth with a slight amount of anti-static-charge spray. NEVER USE PLASTIC SOLVENT.

Interval	Check Item	Check/Measures	Remarks
6 months to 1 year	CRT anode and approach	High tension on CRT attracts dust in environment, and moist dust will cause poor insulation. ASK YOUR DEALER TO CLEAN ANY HIGH VOLTAGE PARTS.	* If the rubber cap or wire sheath is cracked, ask your dealer to replace damaged part.
	Terminal boards, sockets and plugs	Check for loose connections. Check contacts and plugs for proper seating, etc.	

NOTE: To rotate the antenna in ST-BY, make a short circuit between J435 #1 and #2 on pcb DTB-8425 (in processor unit). Note that the "ANTENNA" switch in the sub-panel of display unit (processor) is disabled when a short circuit between J435 #1 and #2 is made.

LIFE EXPECTANCY OF MAJOR PARTS

Parts		Type	Life Expectancy	Remarks
1	Scanner Motor	RM-8123 RM-8124 RM-8247	gears: more than approx. 10000 hours †	wind speed 40m/s
2	Magnetron	9M752 or M5187(F)	2000 ~ 3000 hours	

† nominal value

TROUBLESHOOTING

Whenever you suspect the radar is not functioning properly, turn it off and check plug connections on p.c. boards. If plug connections are secure, proceed to the Trouble Finding List beginning on the next page. If a board is found to be faulty, replace it or call for service. Do not attempt further component check on any p.c. board. Careless handling may permanently 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 (Processor Unit)
2. CRT circuit (Display Unit)
3. Modulator circuit & Magnetron (Transceiver Unit)

Operation	Symptom	Check Point	Remarks
Turn Power on and adjust panel brightness with PANEL DIM touchpad	Panel does not light up at any touchpad setting (other than OFF).	1. Blown power fuse F1, F2. 2. Mains voltage/polarity 3. Power Supply Board 4. Illumination lamps	
Adjust CRT BRILLIANCE control.	Nothing appears on the display.	1. CRT 2. CRT voltage 3. RCPU Board	* If CRT heater is lit, CRT is normal.
After ST-BY appears, begin transmitting	Scanner is not rotating. (ST-BY indication is continuously displayed.)	1. Defective antenna drive motor relay (thermal relay K2) 2. DTB-8425 3. Antenna drive mechanism	* Press the relay reset button. * Check that antenna switch is on.
	Marks, etc. are not displayed	1. AD Board 2. RCPU Board	

Continued

Operation	Symptom	Check Point	Remarks
Adjust GAIN control with A/C SEA control set at minimum.	Marks and legends appear but no noise nor echo.	1. IF amplifier 2. Multicore cable between the scanner and display 3. Video Amplifier Board	* Check continuity and isolation of coaxial cable (Note: Disconnect the plug and lugs at both ends of coaxial cable before checking it by ohmmeter.)
	Marks, legends and noise appear but no echo. (No transmission leak appears.)	1. TX fuse F801 (Transceiver Unit) 2. Magnetron 3. Modulator Board 4. Modulator Trigger Board 5. Modulator SCR 6. AD Board	* If fuse is blown replace it. If it blows again the magnetron or modulator circuit may be defective. * Check magnetron current with the check meter in the sub panel.
	Sweep rotation is not synchronized with antenna rotation.	1. Bearing Signal Generator Board (Scanner Unit) 2. AD Board	
	Incorrect bearing of picture.	1. AD Board 2. RCPU Board 3. Gyro Interface	* The message "HD SIG MISSING" appears on the screen when heading pulse is not received during ST-BY.

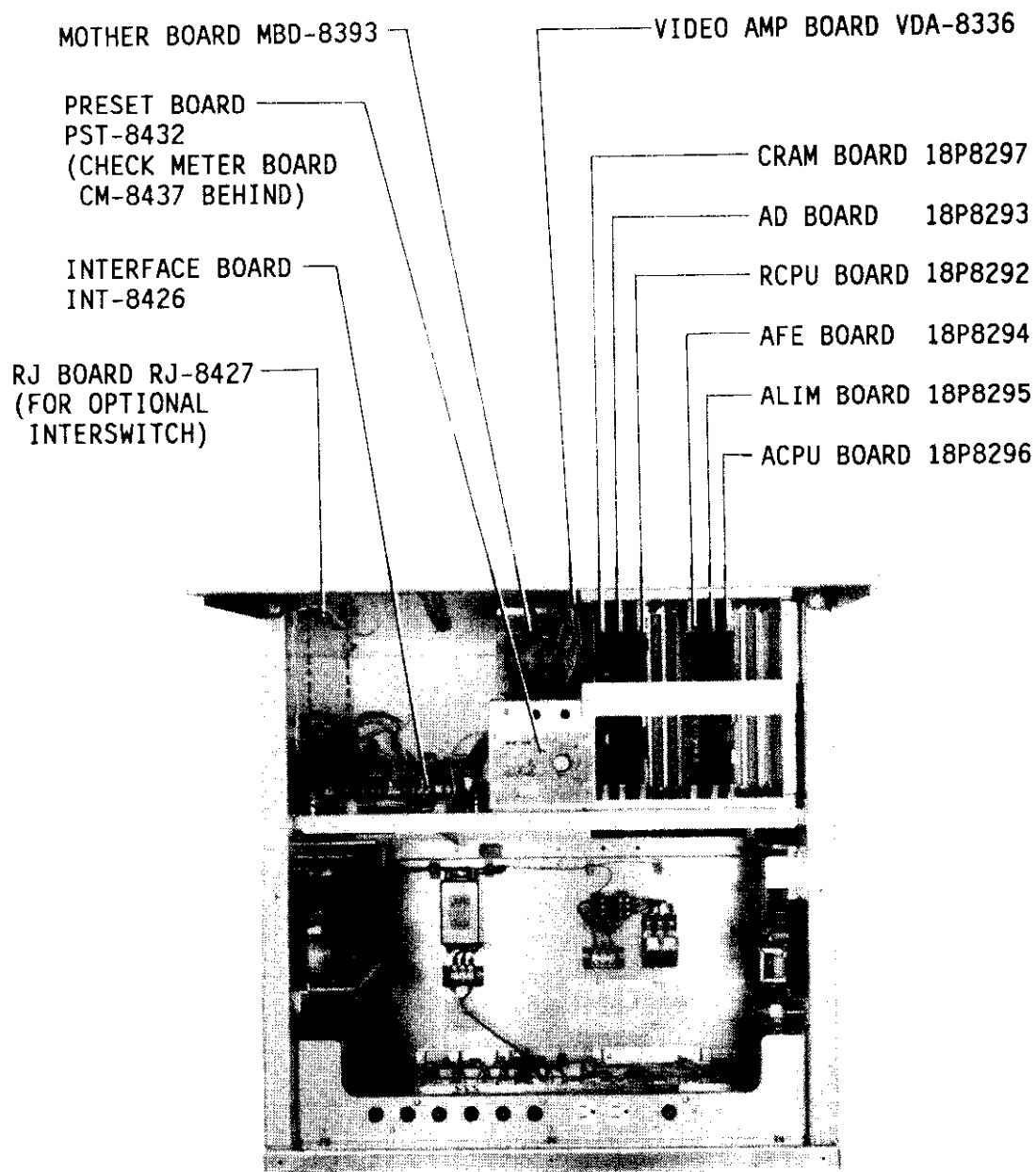
Continued

Operation	Symptom	Check Point	Remarks
Adjust TUNE control.	Poor sensitivity	1. Deteriorated magnetron 2. Detuned MIC 3. Dirt on radiator face	* With the radar transmitting on the 48nm range, check magnetron current with the check meter. If the current is below the normal value, magnetron may be defective. * Check MIC detecting current with the check meter. If it is below the normal value, MIC may have become detuned.
Change range.	Radar picture does not change.	1. Defective RANGE touchpad 2. AD Board 3. RCPU Board 4. Mother Board	
Activate Int. Rej. circuit.	Int. Rej. not performed (interference rejection level) not displayed).	1. Bad contact of touchpad 2. AD Board 3. Mother Board	
Activate Echo Stretch.	Echo Stretch not performed ("ECHO STR" not displayed).	1. Bad contact of touchpad 2. AD Board	
Operate RING touchpad.	Range rings are not displayed.	1. Bad contact of touchpad 2. RCPU Board	

Defective Touchpads

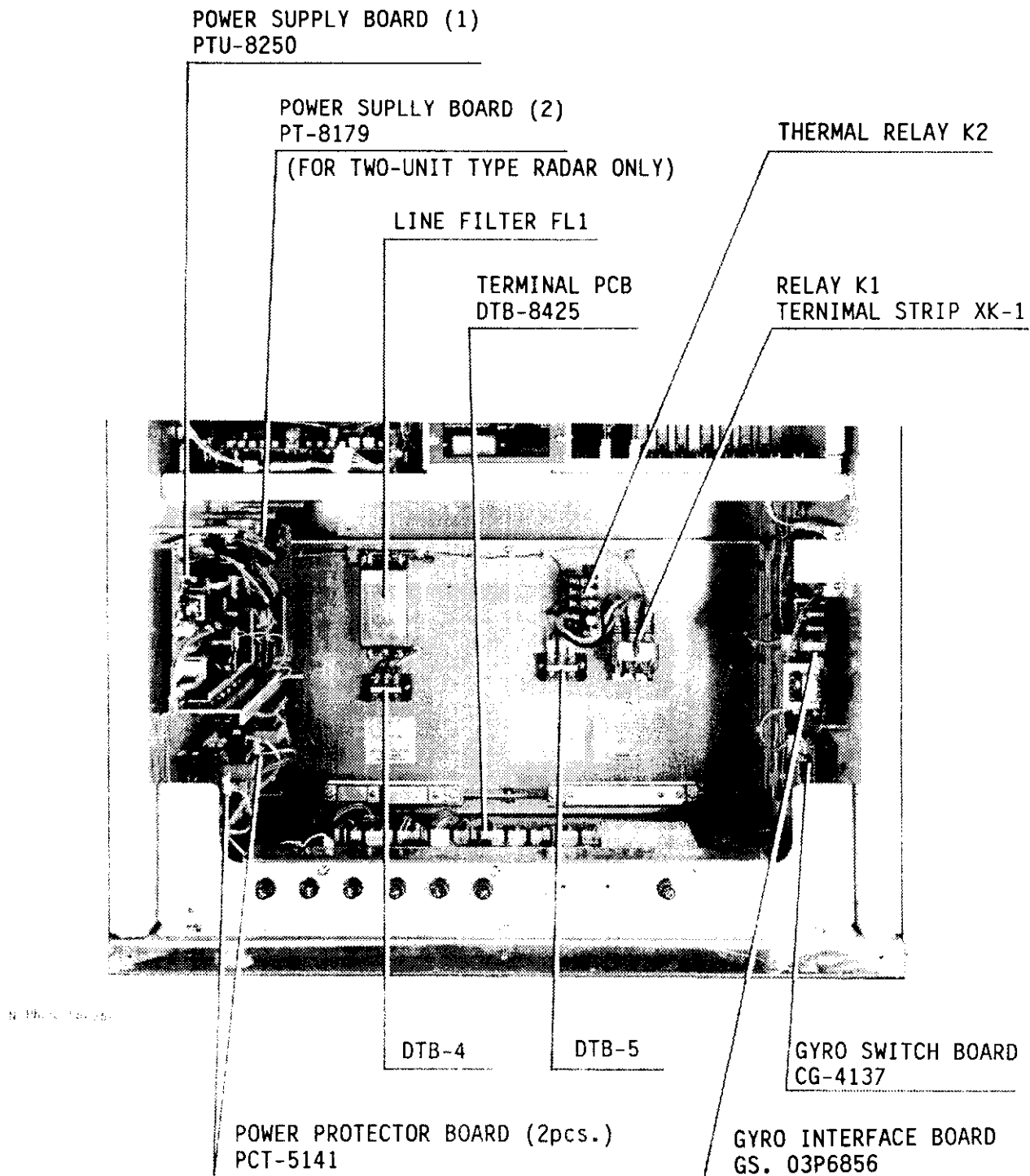
If any touchpad is not operating properly, first suspect poor contact. If there is good contact, the CPU Board or RCPU Board may be defective.

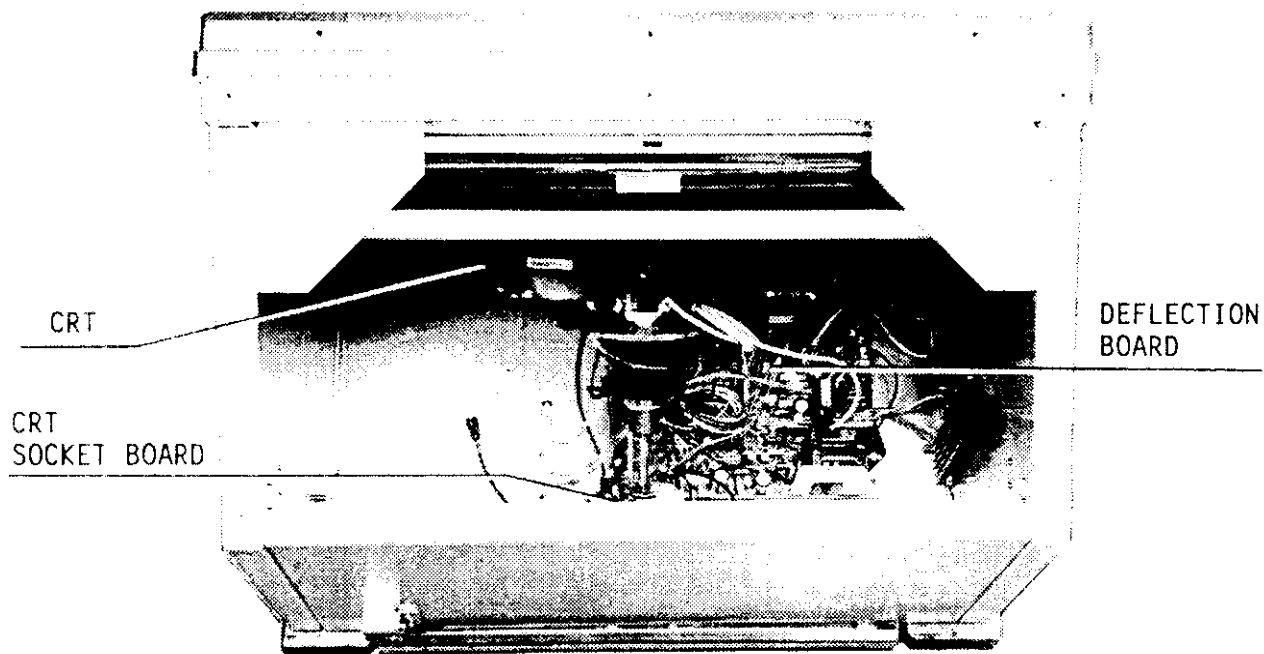
LOCATION OF PARTS



N Photo No. 2717

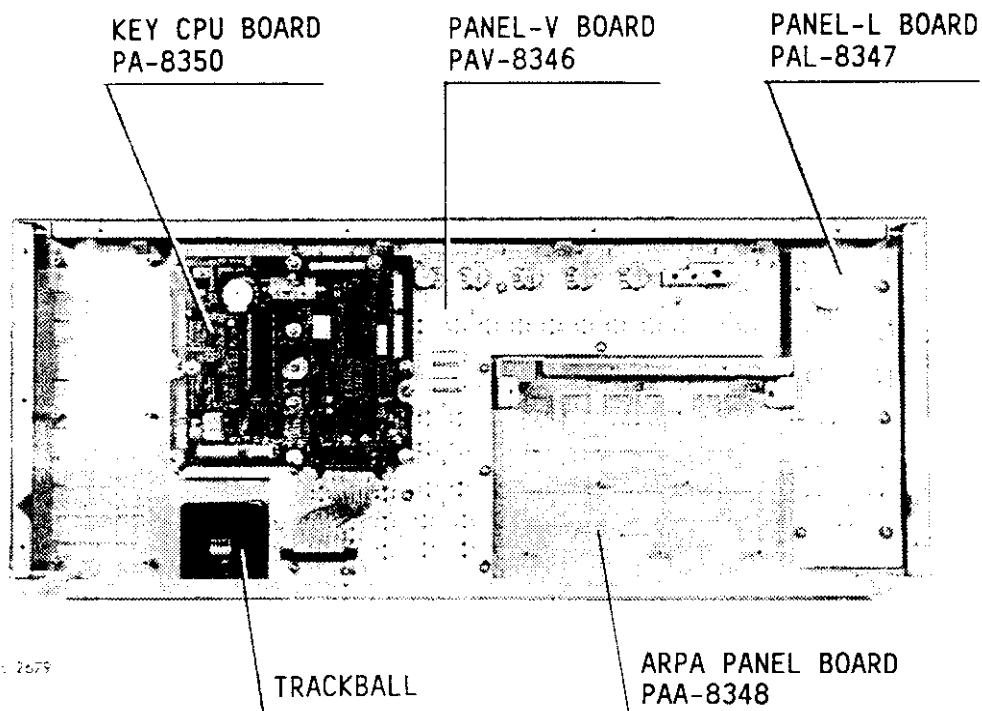
DISPLAY UNIT





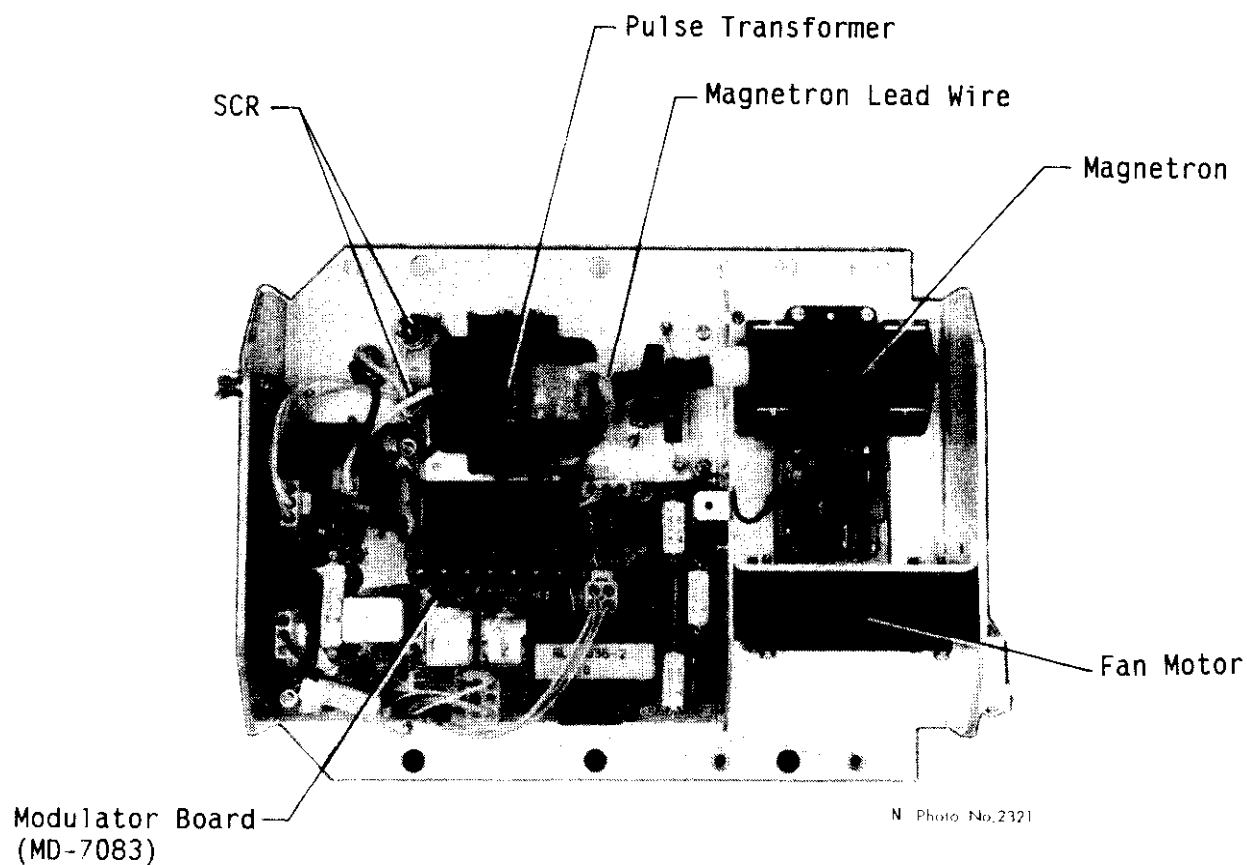
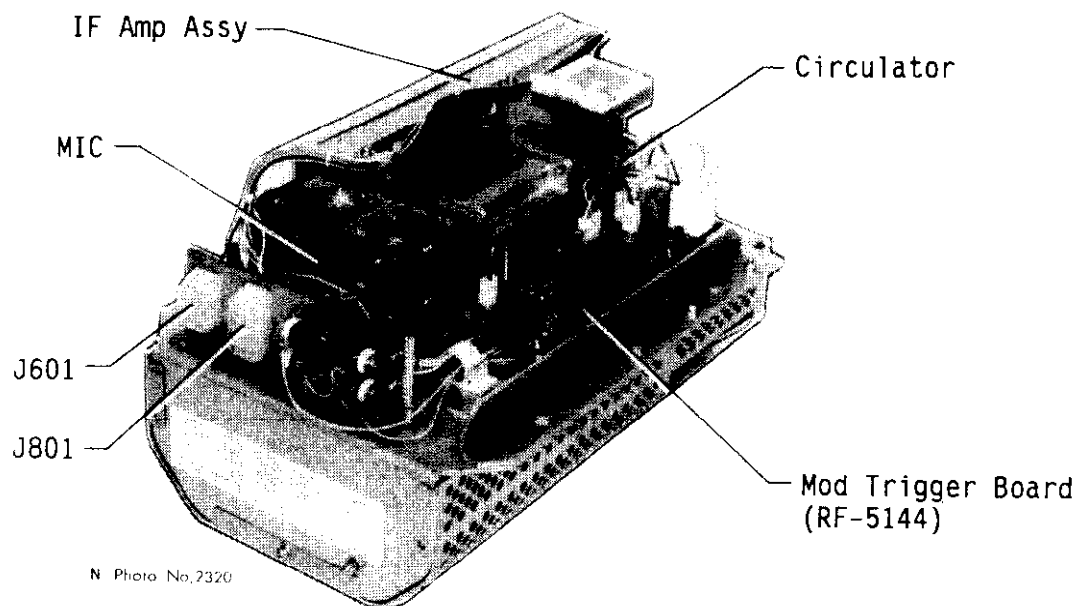
N Photo No. 2678

DISPLAY UNIT (CRT MONITOR)

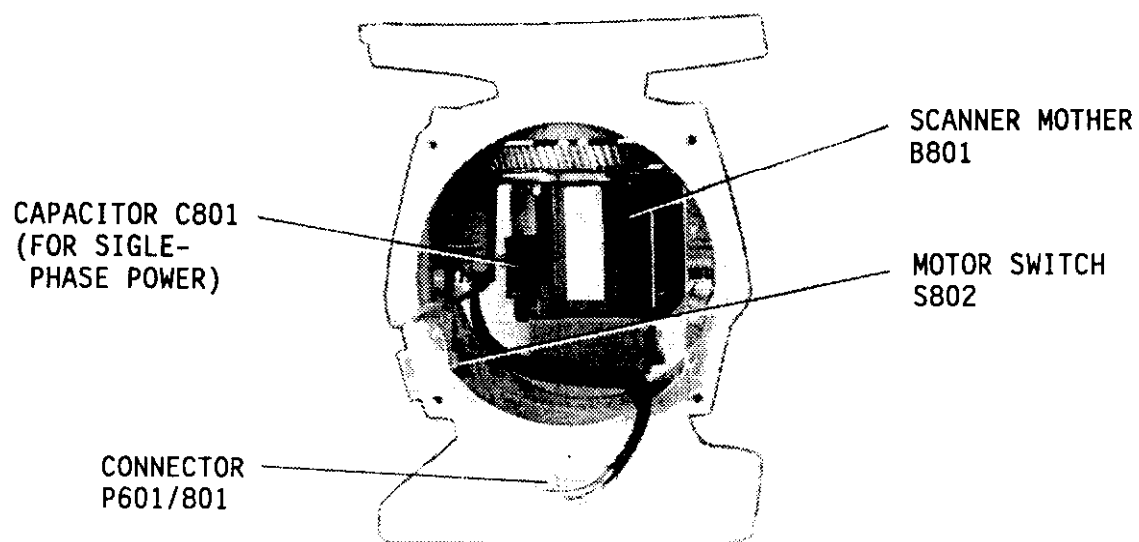


N Photo No. 2679

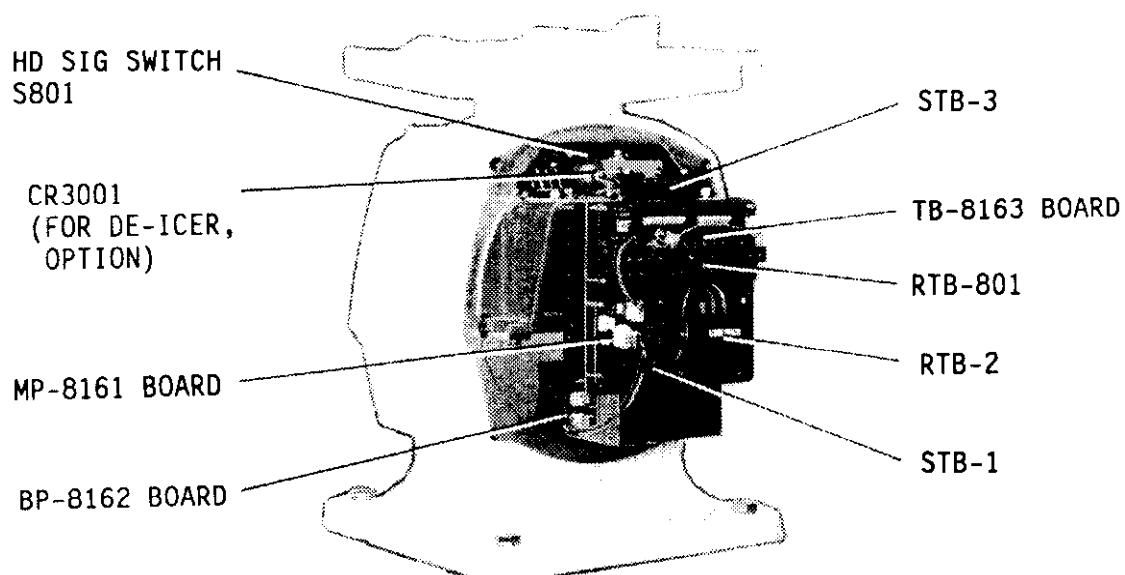
DISPLAY UNIT (KEYBOARD)



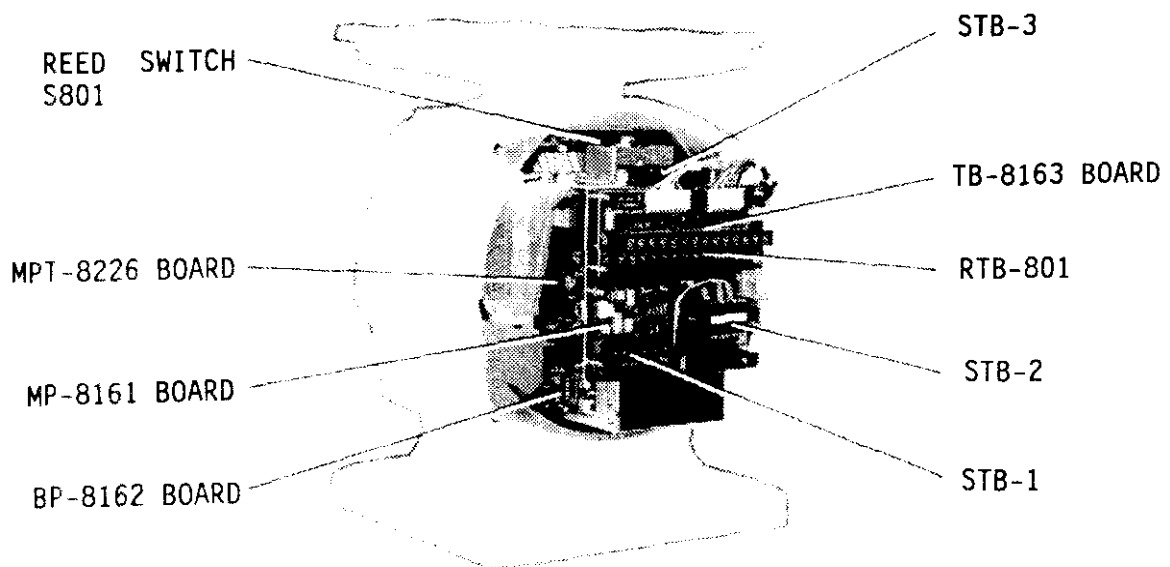
RF Module



SCANNER UNIT (STERN SIDE)



SCANNER UNIT (FOR 3-PHASE POWER SUPPLY)



SCANNER UNIT (FOR SINGLE-PHASE POWER SUPPLY)

PART II

ARPA Display & Operation

FIGURE 1 ARPA CONTROLS

ARPA
RADAR

ARPA/RADAR touchpad
This touchpad turns the ARPA system on and off. When the ARPA system is off only the radar functions.

AUTO
ACQ

AUTO ACQ touchpad
This touchpad alternates manual target acquisition mode and automatic target acquisition mode.
Automatic Mode: 20 targets are acquired automatically and/or manually.
Manual Mode: 40 targets can be acquired.

ALARM ACKN

LOST
TARGET

LOST TARGET touchpad
Press this touchpad to turn the lost target alarm off.

AUDIO
OFF

AUDIO OFF touchpad
This touchpad silences the audible alarm.

CPA
TCPA
SET

1 2

CPA TCPA SET touchpad
This touchpad is used to set the Collision Alarm.

GUARD
RING
SET

YBL VRM

GUARD RING SET touchpad
Press this touchpad to enable construction of a guard ring.

TRIAL
MANEUVER

TRIAL

TRIAL touchpad
This touchpad is used to enable the Trial Maneuver function.

SPEED

SPEED touchpad
Press this touchpad to enter Trial Speed.

DELAY
TIME

DELAY TIME touchpad
This touchpad is used to set the Delay Time for a trial-maneuver.

TRIAL
RUN

TRIAL RUN touchpad
Press this touchpad to show the trial situation.

SUPPRESSION AREA

LINE 1

LINE touchpads
The touchpads LINE 1, LINE 2 and LINE 3 touchpads are used to select a limit line to be displayed or erased.

MINI
ACQ

MINI ACQ touchpad
The MINI ACQ touchpad is used to eliminate false acquisition of sea clutter.

FIX ON
LAND

FIX ON
SHIP

FIX ON LAND and FIX ON SHIP touchpads
These touchpads are used to fix a limit line in range relative to own ship or land.

LINE
ENT

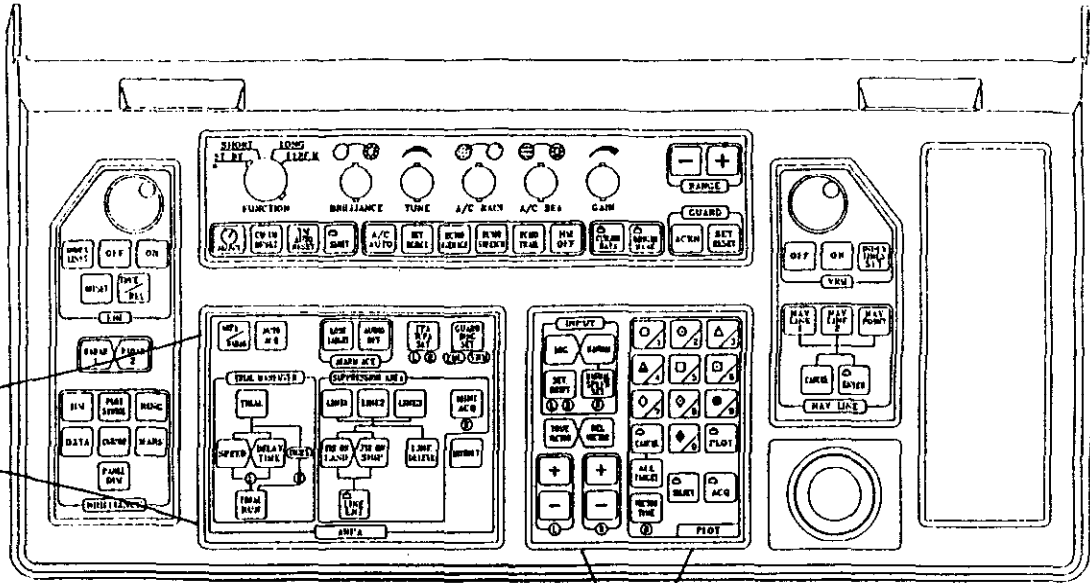
LINE ENT touchpad
This touchpad is used to set the points desired for a limit line.

LINE
DELETE

LINE DELETE touchpad
Press this touchpad to delete a limit line.

HISTORY

HISTORY touchpad
Pressing this touchpad displays time-spaced dots marking the past positions of any targets being tracked.



LOG

MANUAL

LOG and MANUAL touchpads
These touchpads are input selectors and permit selection of either manual speed input or automatic speed input (from log).

MANUAL
SPEED
SET

1 2

MANUAL SPEED SET touchpad
This touchpad enables manual input of speed.

SET
DRIFT

1 2

SET, DRIFT touchpad
This touchpad enables presetting of current set and drift.

TRUE
VECTOR

REL
VECTOR

TRUE VECTOR and REL VECTOR touchpads
These touchpads are used to select true vector display or relative vector display.

+

-

1 2

DATA ENTRY touchpads
These touchpads function to enter data for set and drift, speed and vector length.

NUMERAL touchpads

1 10

Touchpads 1-10 may be used when you desire to distinguish acquired targets with symbols.

PLOT

PLOT touchpad
This touchpad does not function in the ARPA system.

CANCEL

CANCEL touchpad
This touchpad may be pressed to delete an acquired target.

ALL
TARGET

ALL TARGET touchpad
Press this touchpad to cancel tracking on all targets.

VECTOR
TIME

1 2

VECTOR TIME touchpad
This touchpad enables selection of vector length.

SELECT

SELECT touchpad
The navigation information for any tracked target is displayed by pressing this touchpad.

ACQ

ACQ touchpad
This touchpad turns the manual target acquisition mode on and off.

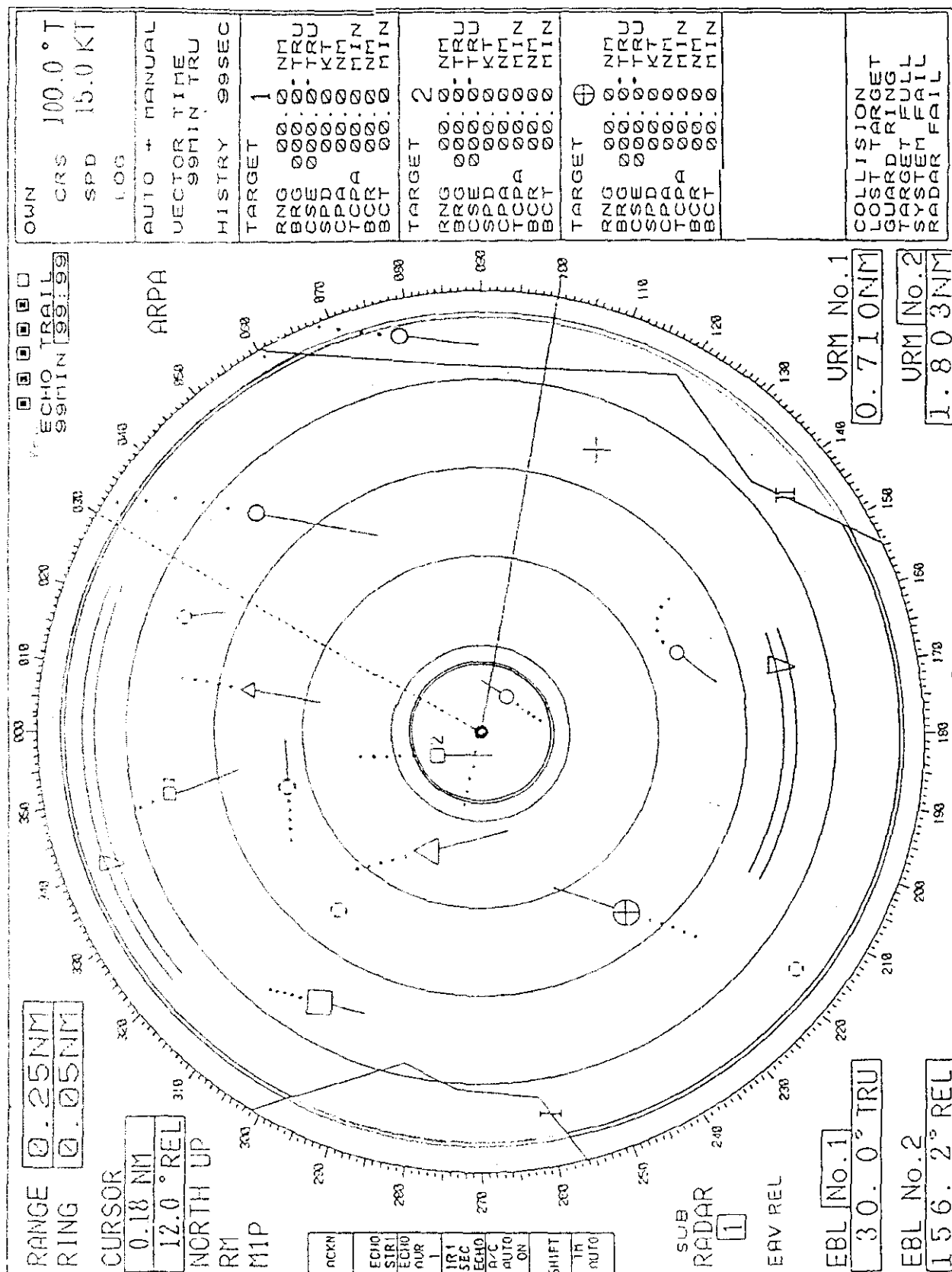


FIGURE 2 ARPA INDICATIONS

DESIGN CRITERIA

CRITERIA FOR SELECTION OF TARGETS FOR TRACKING

The FURUNO ARPA video processor extracts target echoes in the radar signals and discriminates the echo size. Target whose echo measurements are greater than those of the largest ship in range or tangential extent are usually land and are displayed only as normal radar video. All smaller ship-sized echoes which are less than this dimension are further analyzed and are tracked and displayed as small circles superimposed over the radar echo. The closest 20 targets within 0.3 to 32 nm are analyzed and the closest 20 are selected for tracking and display. (Forty targets are available in the manual acquisition mode.) The other targets are monitored continuously and if a target's range decreases so that it is closer than one of the 20 being displayed, the farthest target will be deleted and the closer target displayed. This analysis occurs continuously.

When a target is first displayed, it is shown as having zero true speed but develops a course vector as more information is collected. In accordance with the International Maritime Organization Automatic Radar Plotting Aid (IMO ARPA) requirements, an indication of the motion trend is available after 1 minute and full vector accuracy is achieved after 3 minutes of plotting.

Automatic Acquisition

A weak intermittent echo, such as a wooden boat in a heavy sea, may be seen on the radar but may not be immediately acquired and tracked by the ARPA. The ARPA will automatically acquire and track such a target when it becomes strong and consistent. An echo is accepted as quantized video when it is returned four times with no more than five scans misses between each returned scan. Targets sheltered by land or beyond limit lines, even though visible on the radar PPI, will not be acquired and tracked. Targets sheltered by land or beyond the limit lines may require approximately one minute after coming into the acquisition area or at a range shorter than the limit line before acquisition and tracking will occur.

Manual Acquisition

Manual acquisition is available between 0.3 and 32 nm regardless of the target situation (sheltered by land or beyond limit lines).

QUANTIZATION

The entire picture is converted to a digital form called "Quantized Video." A sweep range is divided into small segments and each range element is "1" if there is radar echo return above a threshold level, or "0" if there is no return.

The digital radar signal is then analyzed by a ship-sized echo discriminator. As the antenna scans, if there are three successive radar pulses with 1's indicating an echo presence at the exact same range, a target "start" is initiated. Since receiver noise is random, it is not three bang correlated, and it is filtered out and not classified as an echo.

The same is true of radar interference. Electronic circuits track both the closest and most distant edges of the echo. At the end of the scanning of the echo, the discriminator indicates the measured maximum range extent and total angular extent subtended by the echo. If the echo is larger than a ship-sized echo in range extent and/or angular width, adjusted as a function of range, it is declared to be a coastline and the closest edge is put into memory as a map of the area. This land outline is used to inhibit further acquisition and tracking of ship-sized echoes beyond the closest coast outline. Three successive scans of coastal outline are retained in memory to allow for signal variation. All smaller echoes are declared to be ship-sized and the middle of the leading edge is used to provide precise range and bearing coordinates of each echo on every scan. This range/bearing data is matched to previous data and analyzed from scan-to-scan for consistency. When it is determined to be as consistent as a real target, automatic acquisition occurs and tracking is initiated. Continued tracking and subsequent calculations develop the relative course and speed of the target just as a man would do when plotting the relative course and speed of the target on the scope with a grease pencil.

The true course and speed of own ship are computed from own ship's gyro and speed inputs, and the resulting course and speed of each tracked target is easily computed by vector summing of the relative motion with own ship's course and speed. The resulting true or relative vector is displayed for each of the tracked targets. This process is updated continually for each target on every scan of the radar.

SUPPRESSION OF ACQUISITION IN CERTAIN AREA

When vessels enter and leave ports, where traffic density increases significantly, a large advantage can be gained by a system which uses discriminator type, all area, automatic acquisition. Near shore, discriminator auto-acquisition is far superior since ship-sized echoes are distinguished from receiver noise, other radar signals, random sea clutter, and large land echoes. The performance of auto-acquisition is enhanced when manually controlled Limit Lines (Suppression Line) are used. These lines reject all auto-acquisition and tracking at ranges beyond the lines. This allows the operator to select the particular area around own ship where fully automatic acquisition plotting is desired. It also allows selection of a specific tracking zone when there are too many echoes for the ARPA to plot simultaneously with full accuracy. In an area along a shoreline which has many small craft, buoys, etc. limit lines can allow targets of no interest to be rejected. For some shorelines, particularly sandy sloping ones, radar land returns are broken up and look like many ship-size echoes. These numerous echoes can "full" the automatic acquisition system and divert some of its plotting capacity.

A limit line positioned between own ship and the shore inhibits this wastage and makes better use of the data processing capacity available. The limit lines are gyro stabilized and fixed in range to own ship or land as selected by the operator and thus do not need frequent adjustment.

QUALITATIVE DESCRIPTION OF TRACKING ERROR

The FURUNO ARPA accuracies comply with or exceed IMO standards.

OWN SHIP MANEUVERS

For slow turns there is no effect. For very high turning rates (greater than 150°/minute, depending on gyro), there is some influence on all tracked targets which last for a minute or two and then all tracked targets revert to full accuracy.

OTHER SHIP MANEUVERS

Target ship courses lag 15 to 30 seconds if high relative speed, or 3 to 6 seconds if low (near 0) relative speed.

It is less accurate during a turn due to lag, but recovers accuracy quickly.

EFFECT ON ACCURACY

SEA RETURNS

If radar anti-clutter is adjusted properly, there is negligible effect. Distant wave clutter, not affected by Anti-Clutter Sea control adjustment, is filtered out by three bang correlation and scan-to-scan matching of data.

RAIN

Clutter can be acquired and tracked and will appear as many targets near own ship. Adjust the Anti-Clutter Rain control. If it is heavy rain, switch to S-band if provided, or switch on the interference rejector on the radar. If heavy clutter still exists, switch to manual acquisition. Accuracy can be affected.

SNOW

Similar to Rain.

LOW CLOUDS

Usually no effect. If necessary, adjust the Anti-Clutter Rain control.

NON-SYNCHRONOUS EMISSIONS

No effect

LOW GAIN

Insufficient or low radar receiver gain will result in some targets not being acquired at the maximum detection range. ARPA display will be missing one or more targets that could be seen if the radar gain were increased. The setting of the correct radar receiver gain is not critical but the target should be on the radar PPI and be clearly visible and well defined at least once in every three radar antenna scans. The ARPA will acquire a radar echo that is present once in every six antenna scans and continue tracking if 1 in 10. Experience has shown that even though the echo is displayed with a consistency greater than this, the actual video echo return does not have this consistency. The brightening and apparent targets on the radar display are the result of the BRIGHTNESS control setting and PPI phosphor excitation.

SECOND TRACE ECHOES

When the radar beam is super refracted, strong echoes may be received at such long ranges that they appear on a different timebase sweep than the transmitted pulse. This gives an incorrect range indication. Second and third trace echoes can be tracked if they are consistent enough to meet acquisition and tracking criteria but target course and speed data will be in error.

BLIND AND SHADOW SECTORS

Radar shadow or blind areas caused by obstructions aboard ship, i.e., funnels, mast, etc. in the path of the radar beam can result in reduction of radar beam intensity in that particular direction. This may eliminate the detection of some targets. The ARPA system will lose track of targets shortly after they are lost on the radar picture and if they remain in a blind zone. These targets will however be reacquired and tracked when they pass out of the blind zone and again present normal radar echo. The angular width and bearing of any shadow sector should be determined for their influence on the radar. In certain cases false echoes in the shadow sector cause the ARPA system to acquire, track, and vector them. Shadow sectors should be avoided.

INDIRECT ECHOES

A target at close range is usually picked up directly, but it can also be received as a reflection from a large, flat surface. This will result in the radar presenting two or more echoes on the PPI display each at a different range. The ARPA will track the true echo at its correct bearing and range and also the false echo if it is consistent and provides an echo at least once every 6 scans to acquire and once every 10 scans to sustain tracking. Reduction in radar GAIN can eliminate the multiple echoing but care should be taken as range detection also will be reduced.

RADAR INTERFERENCE

Most radar frequency interference, though clearly visible on the radar screen, does not affect the ARPA function. If interference is extreme due to another radar operating at close range, spiral "dotting" and/or false targets may appear momentarily. The interference rejector can clear the display.

OPERATION

OVERVIEW

ARPA information is generated by the processor unit and displayed on the radar screen. There are three blocks of touchpads which are concerned with the ARPA function: ARPA, INPUT and PLOT blocks.

In the ARPA section, there are three basic functional groups of touchpads (ALARM ACK, SUPPRESSION AREA and TRIAL MANEUVER). You will notice that there are two shapes for the touchpads: the shape of a touchpad where the operator may directly make a selection is different from the others, and two such touchpads are paired, e.g., LOG/MANUAL at the top right of the keyboard.

The INPUT block is used to enter data which the processor unit requires to make speed and course calculations for targets acquired. The letters "L" and "R" mean that the [+] and [-] touchpads "Left" and "Right" would be adjusted, respectively.

The PLOT block is used to process ARPA-selected targets and display ARPA information.

For each function selected, the keys are grouped in the manner of a flow chart. For example, when you depress either the [LINE 1], [LINE 2] or [LINE 3] touchpad, the next touchpad that would be pressed would be either the [FIX ON LAND], [FIX ON SHIP] or [LINE DELETE] touchpad.

The function of each touchpad is explained below.

SYSTEM FUNCTIONS

[ARPA/RADAR]

This touchpad enables or disables the ARPA presentation on the PPI.

[AUTO ACQ]

Target acquisition can be selected to be either automatic/manual or manual by means of this touchpad.

ALARM ACQ FUNCTIONS

[LOST TARGET]

When a lost target is detected, the target symbol will begin flashing and the audio alarm is released. To acknowledge the lost target, press this touchpad. Then the lost target mark will disappear and the audio and visual alarms will be turned off.

[AUDIO OFF]

There are various cases that trigger the audio alarm in the system, i.e., collision alarm, intrusion into guard ring, etc. This touchpad is pressed to stop the audio alarm.

ALARM FUNCTIONS

[CPA, TCPA SET]

Both the projected Closest Point of Approach (CPA) and Time to CPA (TCPA) of all tracked targets are monitored continuously. If the CPA of any target is calculated to be within the CPA range limit and is also within the TCPA limit, both audio and visual alarms are automatically activated. The setting of CPA range and TCPA is carried out after pressing this touchpad.

[GUARD RING SET]

If a target broaches the boundary set by the guard ring, the buzzer sounds and the GUARD RING label lights up. This touchpad is used to preset the guard ring radius.

INPUT FUNCTIONS

[LOG] and [MANUAL]

This is an input speed selector and permits selection of either manual speed input or automatic speed input (log). The selected input is displayed on the screen.

[SET, DRIFT]

This touchpad is used to preset "Set" and "Drift." The set and drift corrections may be used to increase the accuracy of vector data.

[MANUAL SPEED SET]

This touchpad is used to change the menu on the data readout for manual input of speed. The preset speed data is shown digitally on the readout.

SUPPRESSION AREA FUNCTIONS

[LINE 1], [LINE 2] and [LINE 3]

These touchpads select one of the Limit Lines to be displayed or to be erased. The operator may utilize the Limit Lines (maximum of three lines) to eliminate targets of no interest (i.e., land breakup, localized rain clutter, anchored ships, buoys).

[MINI ACQ]

This touchpad is used to eliminate false "acquisition" of sea clutter. Within the range set, no new targets will be acquired. A double ring shows the area affected by the setting chosen. For the manual acquisition mode the range is fixed at 0.3 nm.

[FIX ON LAND] and [FIX ON SHIP]

These touchpads are used to fix a limit line in range relative to the own ship or land. (The [FIX ON SHIP] touchpad is inoperative for Norwegian flag vessels.)

[LINE DELETE]

Depressing this touchpad deletes the Limit Line selected.

[LINE ENT]

The Limit Line is entered by selecting two desired points. This touchpad is used to enter these points (Limit Line) after using the trackball to select the desired point on screen.

PLOT (TARGET) FUNCTIONS

[SELECT]

The navigation information for any tracked target is displayed on the data readout by depressing this touchpad.

[ALL TARGET]

This touchpad selects all targets being tracked so that they may be deleted collectively.

[CANCEL]

Pressing this touchpad deletes the target(s) selected by the trackball or the [ALL TARGET] touchpad.

[ACQ]

This touchpad may be used to acquire a target manually.

TRIAL MANEUVER FUNCTIONS

[TRIAL]

Depressing this touchpad changes the menu of the data readout for a Trial Maneuver.

[SPEED]

To set the Trial Speed, press this key.

[DELAY TIME]

To set the Delay Time for the trial maneuver, press this touchpad.

[TRIAL RUN]

Depressing this touchpad shows the trial situation.

DISPLAY FUNCTIONS

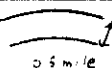
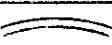
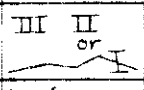
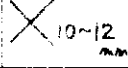
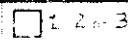
[HISTORY]

When this touchpad is pressed, the ARPA system will display equally time-spaced dots marking the past positions of any targets being tracked.

The following is a list of the ARPA symbols used in the ARPA presentation.

Table 1 ARPA Symbols

Item	Symbol	Location	Display Conditions	Remarks
CURSOR		trackball location		illumination adjustable, fixed size
Own Ship Mark	•	L/L position of own ship	displayed continuously	fixed size
Manually Acquired Target		on target	until 50 sec. after acquisition	fixed size
			between 50 sec. to 3 min. after acquisition	
			3 min. after acquisition	
			targets in collision course, blinking	
			collision course acknowledged	
			lost target (within 3 min. after acquisition), blinking	
			lost target, blinking	
Auto-matically Acquired Target		on target	until 50 sec after acquisition	
			from 50 sec. to 3 min. after acquisition	
			3 min. after acquisition	
			targets in collision course, blinking	
			collision course acknowledged	

Item	Symbol	Location	Display Conditions	Remarks
Auto-matically Acquired Target (con't.)	 		lost target (within 3 min. after acquisition), blinking lost target, blinking	
Guard Ring		designated location		size according to radar range
Minimum Acquisition Range		designated location		size according to radar range
Maximum Acquisition Range		32/24 mile range 32/24 mile range, selectable	manual acquisition mode automatic acquisition mode	size according to radar range
Limit Line		designated location		size according to radar range
Target Selecting		marks at near target		fixed size
Target Selected		selected on target		fixed size
Intrusion into Guard Ring		on target in guard ring		fixed size
Trial Maneuver		displayed at bottom of PPI		fixed size
History of Targets				
Plot Symbols	        	on target		fixed size

START-UP PROCEDURE

The following sequence of events will serve as a guideline for start-up of the ARPA system.

1. Press the [ARPA/RADAR] touchpad to turn the ARPA systems on. ("ARPA" appears on the screen.)

When the power to the gyrocompass is not turned on, the radar is not turned on, or speed log data is not entered (for example, speed log is turned on, but own ship is stationary), an error message "RADAR FAIL" will appear.

2. Adjust panel illumination by pressing the [PANEL DIM] touchpad.
3. Adjust the brightness of the data readout by operating the [DATA] touchpad.
4. Select the radar to be used.
5. Set gyro heading.
6. Set ship's speed.

If speed log is connected, press the [LOG] touchpad in the INPUT selection group. To enter the speed manually, follow the steps below.

- 1) Press the [MANUAL SPEED SET] touchpad and adjust the [+], [-] touchpad "R" to set ship's speed, observing the "MANUAL SPEED" menu on the readout. If the INPUT selection is for LOG, the entered speed is disabled for the ARPA calculation.
- 2) Press the [MANUAL] touchpad to register speed data.

When the speed log data is in error due to tide current, for example, and manual input of speed is inconvenient, the "target based speed" mode, described below, may be useful. Note that this mode is effective for the ARPA function mode only.

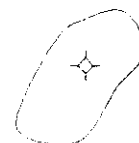
Target Based Speed

- 1) Find small (isolated) ground mass on the screen, such as a small island, a lighthouse, the tip of a cape, in 0.3 to 32 mile range.

NOTE: The processor calculates the own ship speed from the own ship movement relative to the center of the stationary target. If the target presentation is unstable or its contour changes easily, correct speed can not be obtained. Also, do not select a large ground mass or long coast line as a target.

2) Move the "+" cursor onto the selected target by maneuvering the TRACKBALL.

3) Press the [MANUAL SPEED SET] touchpad for more than 2 seconds. A base target mark appears on the cursor crossing and the own ship data display changes from "LOG" or "MANUAL" to "REFERENCE." However, for the first 50 seconds, the own ship speed is held to the value just before the mode changes.



4) After 3 minutes, the appearance of the base target mark changes from broken line to solid line.

5) To escape from the target based speed mode, press the [MANUAL SPEED SET] touchpad again for more than 2 seconds. When all targets are deleted, the base target mark also is deleted and the target based speed mode is cancelled.

NOTE: When the target used for target based speed calculation is lost or it goes out of 0.2 to 32 mile range, its base target mark blinks and the speed readout changes to asterisks, to indicate ARPA data is unreliable. Quit the target based speed mode and, if necessary, select another stationary target.

Other controls not mentioned in steps 1 through 6 above may be adjusted to the operator's preference or to suit the existing conditions. Provided the ship's radar is operating properly, the ARPA system is now ready for use.

AUTOMATIC ACQUISITION OF TARGETS

AUTO + MANUAL appears on the screen when the automatic acquisition mode is selected.

ACQUISITION RANGE

Under automatic acquisition, targets within the acquisition area are automatically acquired and tracked. Targets thus acquired are marked with a broken circle. Three minutes after acquisition the broken circle will be replaced by a solid one to indicate complete acquisition. The range for automatic acquisition is between 0.3 and 32 nm but the minimum range may be limited by means of the minimum acquisition ring, as described in the section of "Minimum ACQ."

However, if there are more than 20 targets within 32 miles, the system will automatically track only the closest 20. A circle of double ring shows the maximum acquisition range on the PPI. This circle automatically expands and contracts depending on the range of the farthest target acquired by the CPU.

MANUAL ACQUISITION OF TARGETS

Manual acquisition is possible in any function by using the following procedure.

1. Rotate the TRACKBALL to place the cursor over the desired target.
2. Press the [ACQ] touchpad. The target so acquired will be marked with a thick broken circle symbol. (If acquisition could not be made the circle blinks.)

Targets consistently received for three successive antenna scans are marked with a circle symbol. If not, acquisition fails and the target mark will also disappear. Manual acquisition is available between 0.3 and 32 nm.

If an important target automatically acquired is nearing the suppression area, it can be changed to manual acquisition; thus the target can continue to be tracked beyond the limit line. The ARPA symbol will change from a thin circle to a thick circle upon selecting the manual acquisition. Details of the Limit Line are described on the following page.

The manually acquired target can be marked with one of 10 plot symbols for easy identification. Select the target by "+" cursor and press a desired plot symbol (numeral) touchpad followed by [ACQ] touchpad. (ARPA plot symbol mark enlargement feature, which is turned on and off by internal DIP switch, lets the operator enlarge a plot symbol for five seconds by pressing a plot symbol touchpad.)

The following describes the typical uses of manual target acquisition.

ACQUISITION OF TARGETS IN A NARROW CHANNEL

If own ship is in narrow and restricted waters, the automatic acquisition system will eventually saturate because of the close-in land echoes. At this point, when the channel is about 1/3 mile wide or less, acquisition should be switched from automatic to manual. In the manual mode, the channel ahead can be very narrow, yet ship echoes in the waterway dead ahead can be manually acquired by the watch officer and tracked with full accuracy and response.

AT TARGET SWAP

When an acquired target nears another target, tracking may be "swapped." When the two acquired targets near each other, one of the two may become a lost target. Should this happen, manual acquisition might be required after the two targets separate.

DELETING A TARGET

To delete a target that is being tracked, rotate the TRACKBALL to place the cursor (+) over the target to be deleted and depress the [CANCEL] touchpad. When the cursor is placed correctly over the desired target, a flashing cross mark "X" will appear on it.

To delete all targets being tracked, depress the [ALL TARGET] touchpad followed by the [CANCEL] touchpad. In the AUTO ACQ mode, acquisition is automatically regained after four successive radar scans.

MINIMUM ACQUISITION RANGE

The target acquisition is done between 0.3 nm and 32 nm.

The minimum range covered by automatic acquisition can be increased to eliminate auto-acquisition near own ship.

Manual acquisition can still be done inside this circle and targets automatically or manually acquired outside the circle will continue to be tracked through the area inside the circle.

Use the following procedure to set the minimum acquisition range in the AUTO ACQ mode.

1. Adjust the radar sweep brilliance to 70% of the control range and the sensitivity with the [GAIN] control for slight level of background noise.
2. Adjust the [ANTI-CLUTTER SEA] control to suppress sea clutter without eliminating small, close in targets.
3. Press the [MIN ACQ] touchpad.
4. Adjust the [+], [-] touchpad "R" to set the minimum acquisition ring (double ring just beyond the sea clutter area).

LIMIT LINE

The ARPA system has a facility to suppress acquisition in certain areas for automatic target acquisition modes. The area of acquisition is shown on the PPI by three chord lines (called "Limit Line"). In the following situations, the Limit Line may be used to advantage.

- 1) When vessels enter and leave ports, where traffic density increases significantly, manual acquisition of echoes has been shown to increase the radar observer's work load by a considerable amount.
- 2) In an area along a shoreline which has many small craft, buoys, etc. (In other words, in a zone where there are too many echoes for the ARPA to plot simultaneously with full accuracy.)

The Limit Line containing up to five corners can be placed at any position from own ship by repeating to enter points as follows.

1. Press the [LINE 1] touchpad.
2. When the ARPA system is energized, the FIX ON LAND mode is selected. To change the mode, press the [FIX ON SHIP] touchpad.

CAUTION

The limit line should not be used as a nav line nor to mark a shoal, wreck or any underwater object in FIX ON SHIP mode. For Norwegian flag vessels, this switch is inoperative.

FIX ON LAND

When the [FIX ON LAND] touchpad is selected, the limit line is gyro stabilized and fixed in range relative to the land and thus does not need frequent adjustment.

This function is useful to reject tracking of geographically fixed objects, such as landmasses. The limit lines will not move on the PPI with the movement of own ship (When in the TRUE MOTION mode).

FIX ON SHIP

In this mode, the limit line is fixed relative to own ship.

3. Rotate the TRACKBALL so that the cursor (+) is placed at the point desired. Then, press the [LINE ENT] touchpad. The number corresponding to the LINE touchpad depressed will appear on the screen.
4. Rotate the TRACKBALL to move the cursor to a location to which a limit line is desired to run from the first mark position. Press the [LINE ENT] touchpad and a line will join the two selected locations.
5. Move the cursor to a location to which a line is desired to run from the last entered point. Press the [LINE ENT] touchpad and a line passing over the cursor position is drawn from the last entered point, making a corner.
Repeat the above procedure to make a limit line containing corners (max. 5 corners). Press the [LINE 1] touchpad to complete the setting of limit line.
6. Repeat steps 3 thru 5 after pressing the [LINE 2] and/or [LINE 3] touchpads for another limit lines.
Do not forget to press the corresponding [LINE 1], [LINE 2] or [LINE 3] touchpad to finish the each limit line setting.
7. To delete a Limit Line, press the LINE touchpad corresponding to the line number desired followed by depressing the [LINE DELETE] touchpad for more than 2 seconds.

PLOT SELECTION (VECTOR PLOT)

The ARPA system provides a choice of either a True or Relative vector plot. Depressing the touchpad [REL VECTOR] or [TRUE VECTOR] changes the selection and the selected function is shown on the screen.

REL VECTOR

The relative motion plot provides the simplest, most accurate display for quick identification of all threatening surface targets and assessment of collision risks.

In the relative motion mode, all stationary targets are shown with vectors equivalent to own ship's speed on a reciprocal course to actual own ship's course.

TRUE VECTOR

The true motion plot shows target aspect and the relationship to all displayed ships. Although own ship speed and course errors affect the displayed aspect on the TRUE motion plot, the projected relative feature position is correct.

VECTOR LENGTH

The [VECTOR TIME] touchpad is used to select an interval scaling for vector lengths. Any time in 0.5 minute increments from 30 seconds to 99 minutes may be selected. It can be extremely valuable to extend either true or relative vector lengths to obtain an appreciation of TCPA's and CPA's for particular targets. The vector length selected is indicated in the 2nd block from the top on the data readout.

ALARM FUNCTIONS

There are six conditions that trigger the audible and visual alarms in the system: a Collision Alarm which warns you that a closest point of approach (CPA) and time-to-CPA (TCPA), selected by the operator, has been violated; a Lost Target Alarm which warns you that there is no radar return from a tracked target; a Guard Ring Alarm which warns you that a target has violated the preset guard ring; a Target Full Alarm to signal that the target acquired manually has reached 20 (40 on manual ACQ mode) or that the maximum acquisition range comes closer than within 1 mile of the minimum acquisition range; a Radar Fail Alarm which is generated when there is no signal from the radar, and a System Fail Alarm which warns you that the self-check sequence of the system has detected a failure.

COLLISION ALARM

The projected closest point of approach (TCPA and CPA) of all tracked targets is monitored continuously. When the CPA of any target is calculated to be within the CPA range limit set by the [+], [-] touchpad "L" and is also within the TCPA limit set by the [+], [-] touchpad "R," the automatic audio and visual alarms are activated. Land is

discriminated against and does not falsely activate the alarm.

Note that this function is effective only for a target which has been tracked for more than 1 minute.

1. Press the [CPA, TCPA] touchpad.
2. Set the CPA and TCPA limits by adjusting the [+], [-] touchpads "L" and "R," respectively. The data for CPA/TCPA is displayed digitally at the bottom of the readout.

The CPA may be set from 0.2 nm to 10 nm in steps of 0.1 nm and the TCPA from 0 to 99 minutes in steps of 0.5 minute.

3. When the CPA or TCPA limit is violated by a tracked target, the audio and visual alarms are released. The target which violated the CPA or TCPA is marked with a blinking thick (automatically acquired target) or thin (manually acquired target) triangle. The alarm message "COLLISION" is also indicated in the message window on the screen.
4. Depressing the [AUDIO OFF] touchpad will silence the audio and the target mark stops blinking.

LOST TARGET

A lost target is a target which has been previously acquired and tracked but for which no return has been received, or which has moved into an inhibited acquisition area (sheltered by land or beyond limit lines), or for which the priority has become lowest in order for the system to acquire a new target of higher priority.

When the system detects a lost target, the target symbol will begin blinking and the LOST TARGET visual alarm is displayed. At the same time, the audio alarm is released for a period of 2 seconds.

To acknowledge the lost target, press the [LOST TARGET] touchpad. The lost target mark will disappear and the audio and visual alarms will be turned off.

If the lost target is not acknowledged by the operator, the target symbol will continuously blink. And if the acquisition condition becomes satisfactory, the target will be re-acquired and tracked.

GUARD RING

When a target crosses the guard ring from outside, the buzzer sounds and the GUARD RING visual alarm is displayed. Depressing the [AUDIO OFF] touchpad will silence the buzzer sound. The intruding target is also visually identified by an inverted triangle symbol.

Targets outside the acquisition area or land at any place do not activate the alarms.

1. To set the guard ring, depress the [GUARD RING SET] touchpad. The range of the guard ring is displayed on the data readout during this function. If the guard ring is not required, set the ring less than 0.7 nm.
2. Set the outer range of alarm with VRM rotary control.
3. Set left and right boundaries of guard ring with EBL No.1 and No.2, respectively. If a 360° guard ring is required omit this step.
4. Press the [GUARD RING SET] touchpad to activate the guard ring. If a second guard ring is required, repeat steps 1-4.

TARGET FULL (TARGET SATURATION)

The TARGET FULL visual alarm is displayed when the target acquired manually reach 20 (40 on manual ACQ mode) or the maximum acquisition range becomes closer than 1 mile of the minimum acquisition range (maximum auto-acquired targets, 20 in short range).

The buzzer is not activated in case of target saturation. If there are too many auto-acquired targets in a short range, remove unnecessary targets by using the limit lines. If 20 targets are already acquired, manually eliminate less important targets by using the [CANCEL] touchpad.

SYSTEM FAILURE

The SYSTEM FAIL visual alarm is displayed and buzzer sounds 1 second when the diagnostic self-check facility detects any abnormality in the ARPA processing circuit.

RADAR FAILURE

The RADAR FAIL visual alarm is displayed when a fault with the radar has been detected (power to the radar is not turned on, the lack of heading pulse, bearing pulse, trigger, video, gyro signal or speed log signal).

TRIAL MANEUVER

This function shows the likely consequences of proposed changes of own ship's speed and/or course.

When doing a trial, your own ship's vector changes to the heading and reflects the speed entered by the [+], [-] touchpads. The new resulting CPA/TCPA can be read on the screen. If that CPA/TCPA is unsatisfactory, various trial courses, trial speed and delay time can be entered until a safe CPA is found.

Use the following procedure to simulate a trial maneuver. The maneuver is performed without interrupting the updating of target information.

1. Depress the [REL VECTOR] touchpad. The relative presentation provides the simplest, quickest identification of all threatening targets and assessment of the

collision risks.

2. Find a target which looks like it is on a collision course to own ship. Rotate the TRACKBALL to put the cursor (+) over it and press the [SELECT] touchpad. The selected target will be marked with a square symbol.
3. Depress the [TRIAL] touchpad to enter into the trial setting mode.
4. Depress the [SPEED] touchpad and adjust the [+], [-] touchpad "L" to enter the trial speed. The speed entered is displayed at the lower section of the data readout.
5. Depress the [DELAY TIME] touchpad and adjust the [+], [-] touchpad "L" to set the time how many minutes later the maneuvering is started.

DELAY TIME

The delay time control sets the delay of the trial maneuver to start from 0 to 99 minutes later.

If the delay time is set for 5 minutes for instance, the APPA simulates trial maneuvering starting in 5 minutes later, with using the preset data (including ship's dynamic characteristic data). Then the calculation result of the simulation is displayed for the selected target.

NOTE: The ship's dynamic characteristic data is preset by the technician. Refer to the memo in the separate sheet "ARPA OPERATOR'S GUIDE".

OWN SHIP DYNAMIC CHARACTERISTICS

SPEED RATE	KTS/SEC
TURN RATE	DEG/SEC

6. Adjust the [+], [-] touchpad "R" to enter the trial course. The label "COURSE" is a mere indication and not a switch.
7. Depress the [TRIAL RUN] touchpad. While the trial situation is shown, the letter T is indicated at the bottom of the PPI.

The trial situation is shown for one minute and the display will be automatically returned to actual situation. The trial run can be suspended by depressing the [TRIAL RUN] touchpad to avoid the automatic escape of trial mode.

During the trial situation, the trial speed and delay can be freely changed to find out the safest course for own ship.

The CPA and TCPA resulting from the trial maneuver are automatically indicated.

8. At any time, the trial situation can be changed to the normal display by pressing the [TRIAL] touchpad again.

NOTE: When the internal DIP switch S92 #2 (on PAV-8346 board) is set "ON," the trial data (COURSE, SPEED, DELAY TIME) of the Trial mode can be adjusted by the rotary encoders rather than [+], [-] keys.

COURSE ----- VRM rotary knob control

SPEED/DELAY TIME ----- EBL rotary knob control

Note that the VRM and EBL can not be adjusted during the Trial mode.

TARGET SELECTION

The information on any acquired target can be selectively displayed on the data readout. Rotate the TRACKBALL to place the cursor (+) over the desired target and press the [SELECT] touchpad. For the target marked with plot symbol, press the corresponding plot symbol (numeral) touchpad followed by [SELECT] touchpad. Thereafter, the [SELECT] touchpad turns the data display on and off.

There are three windows for the data readout. The data readout in the upmost window is continuously displayed, while the data readouts in the second and third windows are changed to newly selected data on a first-in, first-out basis.

TARGET	1		⇒ Target No. (or plot symbol)
RNG	XX.X	NM	⇒ Range from own ship to target
BRG	XXX.X°	TRU	⇒ Bearing from own ship to target
CSE	XXX.X°	TRU	⇒ Course of target (North reference)
SPD	XX.X	KT	⇒ Speed of target
CPA	XX.X	NM	⇒ Projected closest point of approach of target
TCPA	XX.X	MIN	⇒ Estimated time of closest point of approach
BCR	XX.X	NM	⇒ Range at which target will cross own ship's bow
BCT	XX.X	MIN	⇒ Estimated time at which target will cross ow ship's bow

NOTE: If a target is projected to cross own ship's stern, a minus (-) sign will be placed in front of the data for BCR.

Data items CPA/TCPA/BCR/BCT can be omitted if not required. Refer to page 14 in PART I.

HISTORY DISPLAY

By depressing the [HISTORY] touchpad, the ARPA system displays equally time-spaced dots (quantity depending on internal setting; 5 (factory setting), 1 thru 50) marking the past positions of any targets being tracked. An internal preset control permits the adjustment of the time spacing of the dots between 0.5 and 99 minutes at 1 minute steps. Newly acquired targets will have no dots and they may be viewed in true or relative vector mode. One dot will appear every two minutes (or other preset time) until all are shown. If a target changes its speed, the spacing will be uneven. If it changes course, they will not be in a straight line.

To delete the past position plots, depress the [HISTORY] touchpad again.

SET AND DRIFT

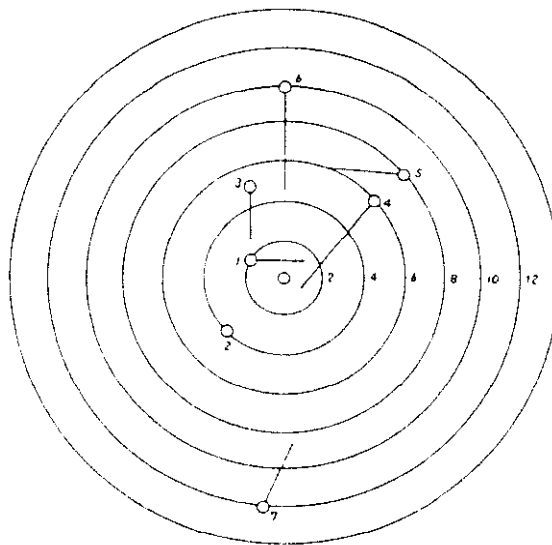
Set (direction of tide) can be manually entered in 1 degree steps by depressing the [SET, DRIFT] touchpad and adjusting the [+], [-] touchpad "L". Drift (speed of tide) can be entered in 0.1 knot steps between 0 and 99.9 knots by the [+], [-] touchpad "R". Values entered are indicated on the ARPA data readout.

Set and drift corrections are beneficial for increasing the accuracy of the vector data. The correction is best made on relative motion with TRUE VECTOR, watching landmasses, buoys or any stationary objects. If these objects have vectors, the tide direction and speed should be corrected until they lose the vectors and appear stationary.

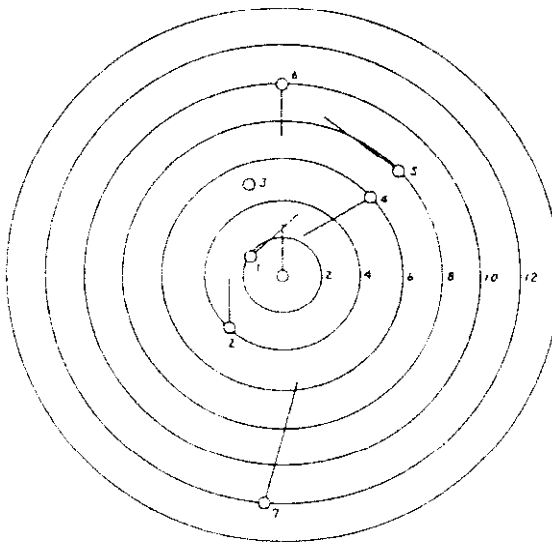
If the ship is equipped with a device to indicate ocean current movements, the values shown on it can be used.

SIMULATION DISPLAY (SCENARIO MODE)

The simulation display tests the ARPA processor for proper operation.



Simulation Display (Relative Vector)



Simulation Display (True Vector)

The above figures are the starting condition of the simulation display with the own ship speed of 10.0 knots.

- 1) As soon as the ROM/RAM check appears (after power is turned on), press [4] touchpad followed by [PLOT] touchpad. The radar confirms each key input by releasing one and three beep tones, respectively. Wait for a while until the simulation display appears.
- 2) It takes approximately three minutes for all vectors to be displayed completely on the screen. The simulation display does not need radar, gyro and speed log input, and provides 7 targets on various courses and speeds. (The radar echo is not displayed.) By entering 10.0 knots for own ship speed, navigation information for each target should be as tabulated below.

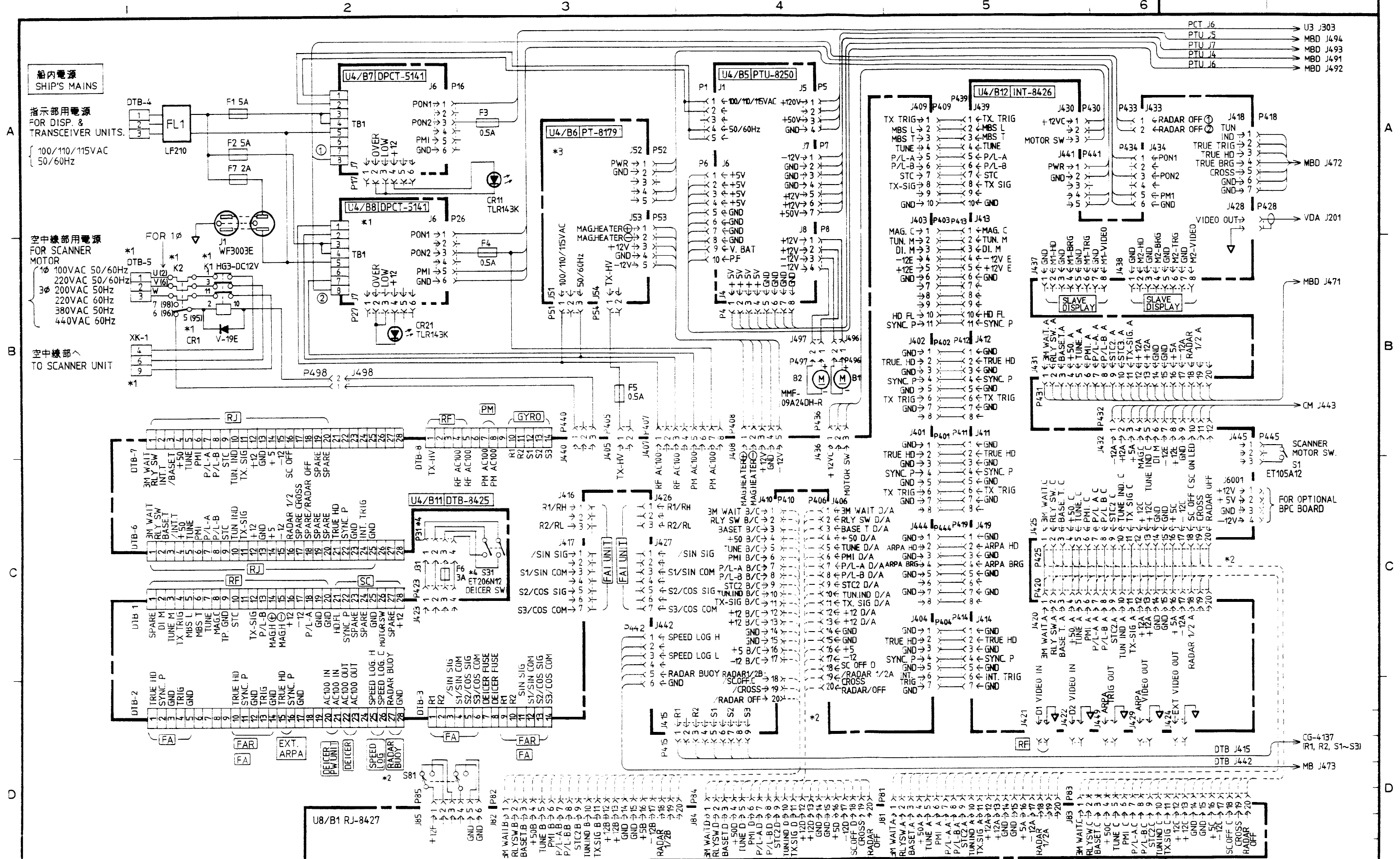
	TRUE				RELATIVE			
	Course	Speed	Range	Bearing	Course	Speed	CPA	TCPA
Target 1	45°	14.1 knots	2.0 nm	300.0°	90.0°	10.0 knots	1.0 nm	10.4 min.
Target 2	0°	10.0 knots	4.0 nm	225.0°	0.0°	0	4.0 nm	
Target 3	0°	0	5.0 nm	340.0°	180.0°	10.0 knots	1.7 nm	28.2 min.
Target 4	237.1°	16.8 knots	6.0 nm	45.0°	216.5°	23.8 knots	0.9 nm	15.0 min.
Target 5	307.5°	17.8 knots	8.0 nm	45.0°	273.5°	14.2 knots	6.0 nm	22.5 min.
Target 6	180.0°	10.0 knots	10.0 nm	00.0°	180.0°	20.0 knots	Collision	30.0 min.
Target 7	15.0°	25.0 knots	12.0 nm	185.0°	24.6°	15.6 knots	4.0 nm	43.6 min.

- 3) The simulation continues for 5 minutes and then repeats.
To quit the scenario mode, turn the power off.

NOTE: ARPA operations can be conducted on the simulation mode as well as the normal ARPA mode except for the following points.

- 1) The limit line does not affect the simulation display.
- 2) A deleted target can not be re-acquired manually due to no radar echo. In this case, you will have to wait until the target is re-acquired automatically.





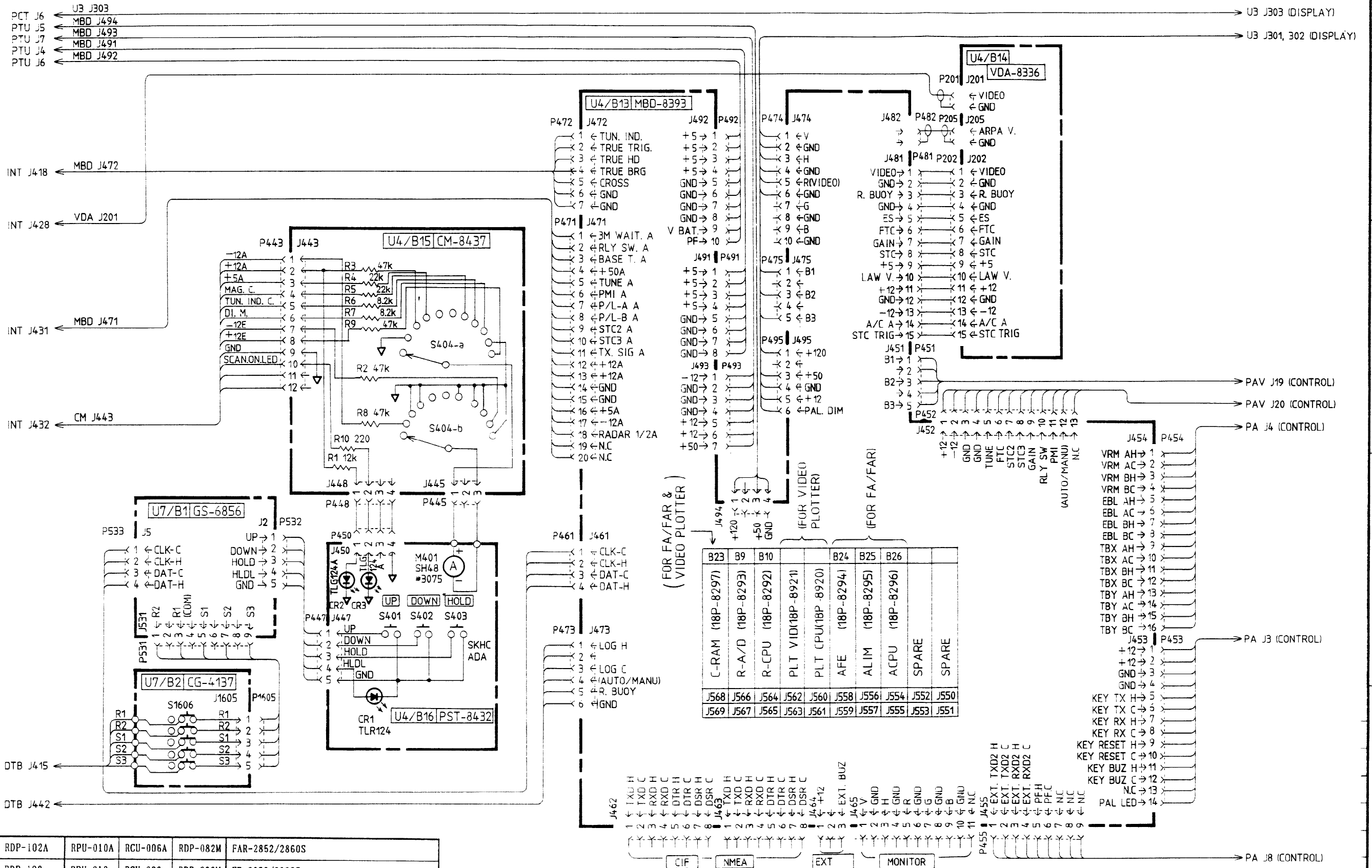
注 *1はFAの時不要。
 *2の破線はRJ仕様時の接続(実線はRJ仕様でない時)。
 a) RJ仕様でRJ基板を含む接続方法は J420-J81, J410-J82, J425-J83, J406-J84
 b) RJ仕様でRJ基板を含まない接続方法は J420-J406, J410-J425
 c) S81はRJ基板を含む指示器のみ取付け接続する。
 *3は2ユニットの時のみ必要 他は不要。
 *4は永結防止(オプション)付の時のみ取付ける。

NOTE *1: NOT USED FOR FA-2800
 *2: BROKEN LINE SHOWS CONNECTION FOR RADAR INTERSWITCHING CONFIGURATION (RJ SPEC).
 a) CONNECTION IN DISPLAY WITH RJ-8427 BOARD. J420-J81, J410-J82, J425-J83, J406-J84.
 b) CONNECTION IN DISPLAY (RJ SPEC) WITHOUT RJ-8427 BOARD. J420-J406, J410-J425.
 c) S81 IS ADDED ONLY WHEN RJ-8427 BOARD IS INCORPORATED. *3: USED FOR TWO UNIT-TYPE RADAR. *4: WHEN DEICER IS INSTALLED.

承認 APPROVED	名称 TITLE
検図 CHECKED	FA/FR/FAR-2800 SERIES シリウス 処理部(制御部)総合回路図 (1/2) PROCESSOR UNIT
製図 DRAWN	製番 DWG. NO.
	C3331-K10-F

A
B
C
D

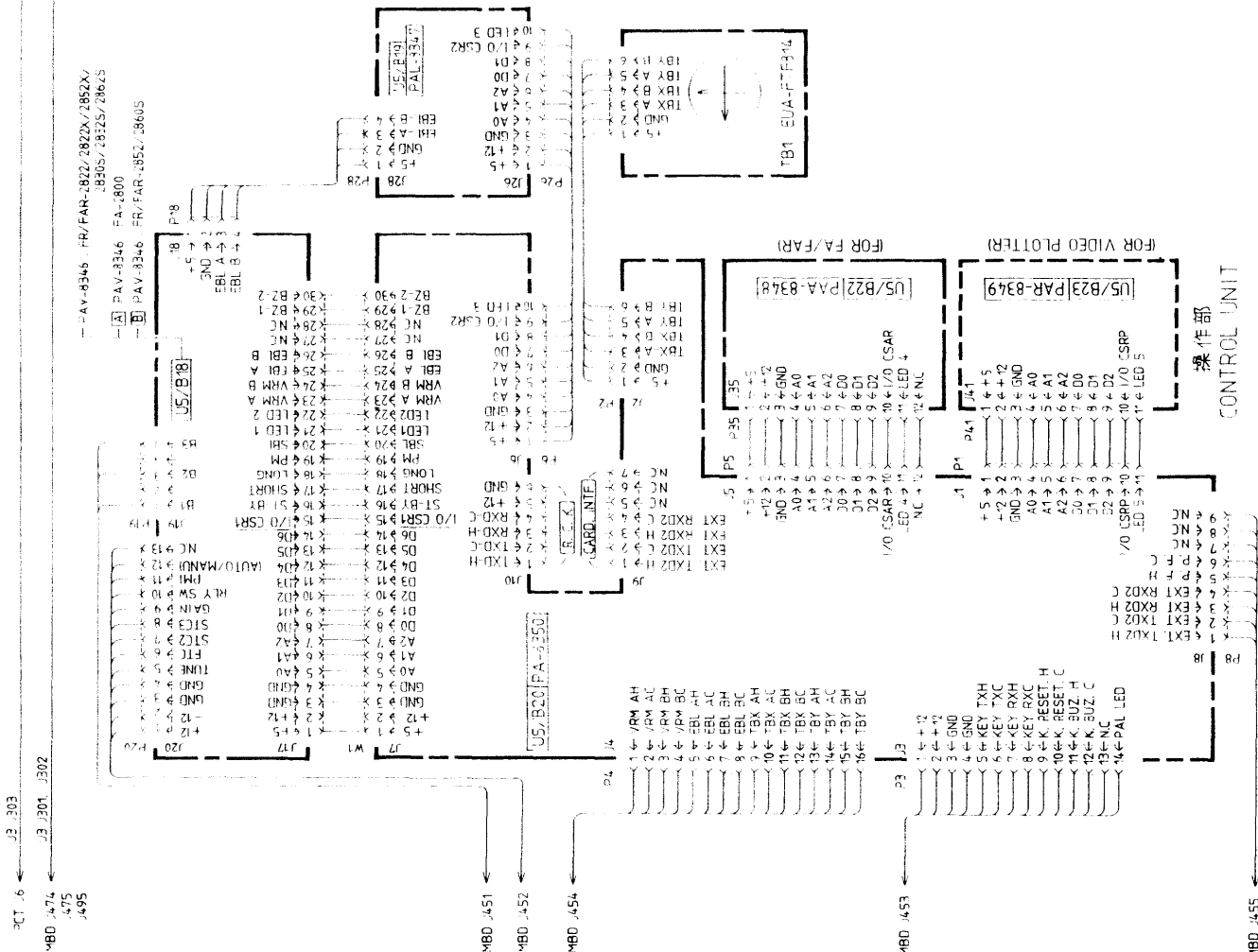
A
B
C
D



RDP-102A	RPU-010A	RCU-006A	RDP-082M	FAR-2852/2860S
RDP-102	RPU-010	RCU-006	RDP-082M	FR-2852/2860S
RDP-082B	RPU-005B	RCU-003B	RDP-082M	FA-2800
RDP-082A	RPU-005A	RCU-003A	RDP-082M	FAR-2822/2822X/2852X/2830S/2832S/2862S
RDP-082	RPU-005	RCU-003	RDP-082M	FR-2822/2822X/2852X/2830S/2832S/2862S
コンソール型名 CONSOLE TYPE	PROCES'R セパレート型	CONTROL SEPARATE TYPE	DISPLAY	適用機種 APPLIED MODELS

操作部、指示部の回路は図番 C3331-K09を参照。
REFER TO DWG.NO.C3331-K09 FOR CONTROL AND
DISPLAY UNIT.

承認 APPROVED	名称 TITLE
検図 CHECKED	FA/FR/FAR-2800 SERIES シリーズ 処理部(制御部)総合回路図 (2/2) PROCESSOR UNIT
製図 DRAWN	図番 DWG.NO
	C3331-K11-F



指示部
DISPLAY UNIT

操作部
CONTROL UNIT

承認	設計	図名	FA/FR/FAR-2800 SERIES 指示部
検査	検査	図名	操作部 指示部 総合回路図
確認	確認	図名	CONTROL UNIT & DISPLAY
図面	図面	図名	23331-K09-D
図面	図面	図名	DWG NO
図面	図面	図名	

