FURUNO

OPERATOR'S MANUAL

15" MULTI-COLOR HIGH-PERFORMANCE SHIPBORNE RADAR

MODEL FR-1505 MARK-3 Series

FR-1505 MARK-3
FR-1510 MARK-3
FR-1525 MARK-3

FURUNO ELECTRIC CO., LTD.
NISHINOMIYA, JAPAN

⚠ SAFETY INSTRUCTIONS

⚠ WARNING

Radio Frequency Radiation Hazard

The radar antenna emits electromagnetic radio frequency (RF) energy which can be harmful, particularly to your eyes. Never look directly into the antenna aperture from a close distance while the radar is in operation or expose yourself to the transmitting antenna at a close distance.

Distances at which RF radiation levels of 100 and 10 W/m^2 exist are given in the table below.

Note: If the antenna unit is installed at a close distance in front of the wheel house, your administration may require halt of transmission within a certain sector of antenna revolution. This is possible. Ask your FURUNO representative or dealer to provide this feature.

Model	Radiator type	Distance to 100 W/m^2 point	Distance to 10 W/m^2 point	RF power density on antenna aperture
FR-1505 MARK-3 (X-band, 6 kW)	XN12AF (4')	None	2.1	75 W/cm^2
	XN20AF (6.5')	None	1.0	58 W/cm^2
FR-1510 MARK-3 (X-band, 12 kW)	XN12AF (4')	0.1 m worst case	3.5 m	150 W/cm^2
	XN20AF (6.5')		1.4 m	
FR-1525 MARK-3 (X-band, 25 kW)	XN20AF (6.5')	1.1 m worst case	10 m worst case	200 W/cm^2
	XN24AF (8')			

⚠ WARNING

ELECTRICAL SHOCK HAZARD
Do not open the equipment.

Only qualified personnel should work inside the equipment.

Turn off the radar power switch before servicing the scanner unit. Post a warning sign near the switch indicating it should not be turned on while the scanner unit is being serviced.

Prevent the potential risk of being struck by the rotating scanner and exposure to RF radiation hazard.

Wear a safety belt and hard hat when working on the scanner unit.

Serious injury or death can result if someone falls from the radar scanner mast.

Do not disassemble or modify the equipment.

Fire, electrical shock or serious injury can result.

Turn off the power immediately if water leaks into the equipment or the equipment is emitting smoke or fire.

Continued use of the equipment can cause fire or electrical shock.

Use the proper fuse.

Fuse rating is shown on the equipment. Use of a wrong fuse can result in equipment damage.

Keep heater away from equipment.

Heat can alter equipment shape and melt the power cord, which can cause fire or electrical shock.

⚠ WARNING

Do not place liquid-filled containers on the top of the equipment.

Fire or electrical shock can result if a liquid spills into the equipment.

Do not operate the equipment with wet hands.

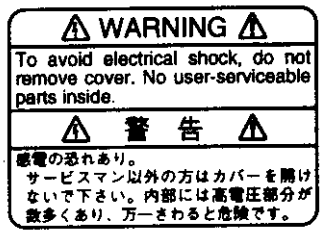
Electrical shock can result.

Keep heater away from equipment.

Heat can alter equipment shape and melt the power cord, which can cause fire or electrical shock.

⚠ CAUTION

A warning label is attached to the equipment. Do not remove the label. If the label is missing or illegible, contact a FURUNO agent or dealer.



Name: Warning Label (1)
Type: 86-003-1011-0
Code No.: 100-236-230

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INTRODUCTION

A Word to the Owner of FURUNO Radar

Thank you for purchasing this FURUNO radar. We are confident you will discover why FURUNO has become synonymous with quality and reliability.

Dedicated in the design and manufacture of marine electronics equipment for half a century, FURUNO Electric Company has gained an unrivaled reputation as a world leader in the industry. This is the result of our technical excellence as well as our worldwide distribution and service network.

Please carefully read and follow the safety information and operating and maintenance instructions set forth in this manual before attempting to operate the equipment and conduct any maintenance. Your radar set will perform to the utmost of its ability only if it is operated and maintained in accordance with the correct procedures.

Features of This Series of Radars and ATAs

- Daylight-bright rasterscan 15-inch multi-color, high-resolution display
- New microprocessing technology with high-speed high-density gate array and software expertise
- New cast aluminum scanner gearbox and new series of radiators
- Easy operation by combination of discrete keys, rotary controls, and menu operation, all logically arranged and configured
- Electronic Plotting Aid (EPA) fitted standard, Automatic Tracking Aid (ATA) option exceeding IMO and IEC standards
- Reliable CPA and TCPA warning in any plotting mode, accurate target data
- Stand-alone or integrated configuration
- Meets the current and future IMO and IEC standards as a shipborne radar. New radar standard MSC.64 (67) Annex 4 must be met for new installation on and after January 1, 1999

FR-1505 MARK-3 Series of Radars

The FURUNO FR-1505 MARK-3 Series of radars are designed to meet various customer's needs and the exacting requirements of international and national standards and regulations including:

–IMO A.477 (XII): Performance Standards for Radar Equipment (up to 31.12.1998)
–IMO MSC.64(67) Annex 4: Performance Standards for Radar Equipment (1.1.1999 and after)
–IEC 60872-2: ATA
–IEC 60936-1: Shipborne Radar Operational and Performance Requirement (1.1.1999 and after)
–IEC 60945: 1996-11(3rd Ed) Marine Navigational Equipment General Requirements

There is a choice of several models in the FR-1505 MARK-3 Series to suite your particular navigational needs and different types of vessels.

Model	Freq Band	Output
FR-1505 MARK-3	X-band	6 kW
FR-1510 MARK-3	X-band	12 kW
FR-1525 MARK-3	X-band	25 kW

All come with the EPA (Electronic Plotting Aid) fitted standard. An option is available to provide the full functionality of ATA (Automatic Tracking Aid). A Video Plotter (Chart Plotter), which provides Radar Map functions, and Performance Monitor are also optionally available.

The FR-1505 MARK-3 Series is available in the **Regular type** (R-type) and **IMO type**. The IMO type is designed as a primary radar under the 1974 SOLAS Convention on ships below 1,600 GT. The R-type satisfies the IMO and IEC standards but includes more flexibility of functionality.

The table below shows the differences between R-type and IMO-type radars. Other functions and specifications are common. The operator cannot navigate between the two types.

Differences between IMO-type and R-type radars

Item	IMO type	R-type (Regular type)
Range scales	0.125, 0.25. 0.5, 0.75, 1.5, 3, 6, 12, 24, 48, 96 nm	0.125, 0.25, 0.5, 0.75, 1.5, 3, 6, 12, 24, 48 72, 96 nm (sm, km adjustable on menu)
Target Alarm Zone (TAZ)	Radar Target Alarm Zone: 1st TAZ between 3 and 6 nm, 2nd TAZ anywhere provided the 1st TAZ is valid.	Radar Target Alarm Zone: 1st and 2nd TAZs anywhere. Alarm can be selected for inside (as TAZ) or outside (as Anchor Watch) mode.
x2 Zoom	Not available	Available on menu
Echo colors	Monochrome yellow or green in 16 tones	Choice of monochrome in 16 tones or 3 colors according to echo strengths

SPECIFICATIONS OF FR-1505 MARK-3 SERIES SHIPBORNE RADAR

ANTENNA RADIATORS

1. Type: Slotted waveguide array
2. Beamwidth:

Radiator type:	XN12AF	XN20AF	XN24AF
Length:	4 ft	6.5 ft	8 ft
Beamwidth(H):	1.8°	1.23°	0.95°
Beamwidth(V):	20°	20°	20°

Sidelobe ±10°: -28 dB (all radiators)
Polarization: Horizontal (all radiators)

3. Rotation: 24 rpm or 42 rpm
   Note: 42 rpm ins not available in 12 VDC system

RF TRANSCEIVER

1. Frequency: 9410 MHz ±30 MHz (X-band)
2. Output power:
   FR-1505 MARK-3: 6 kW
   FR-1510 MARK-3: 12 kW
   FR-1525 MARK-3: 25 kW
3. Range, Pulselength (PL) & Pulse Repetition

Range Scales	Pulselength (μs)	PRR (Hz)
0.125, 0.25	0.07	3000
0.5	0.07/0.15	3000
0.75, 1.5	2 from 0.07/0.15/0.3	3000/1500
3	2 from 0.15/0.3/0.5/0.7	3000/1500
6	2 from 0.3/0.5/0.7/1.2	1500/1000
12. 24	2 from 0.5/0.6/1.2	1000/600
48, 96	1.2	600

4. IF: 60 MHz, Logarithmic.
   BW 28/3 MHz
5. Noise figure: 6 dB
6. Duplexer: Ferrite circulator with diode limiter

DISPLAY UNIT

1. Picture tube: 15" color CRT, effective diameter: 185 mm. Yellow or green echoes in 16 levels. Rasterscan non-interlace at 48.3 kHz hor, 60 Hz vert.
2. Minimum range and discrimination:
   35 m
3. Range scales: 0.125 0.25 0.5 0.75 1.5 3 6 12, 24, 48, 72 (R-type), 96 nm
4. Range accuracy: 1° of range in use or 15 m whichever is the greater
5. Bearing discrimination: Better than 2.5°
6. Bearing accuracy: ±1°
7. Presentation: Head-up, Head-up TB, North-up, Course-up, TM sea or ground stabilization
8. Plotting facilities:
   EPA: 10 targets in different symbols (standard)
   ATA: Automatic plotting for up to 10 targets manually acquired. Complies with IMO MSC.64(69) Annex 4 and IEC 60872-2
   Common feature: Sea and ground stabilized Vectors and target trails
9. Radar map: Nav lines, coastlines, buoys, etc. produced by operator. 3000 pts.
10. Target Alarm Zone: Default 3-3.5 nm, 0.5 nm deep, ±30° of heading line
11. Parallel Index Line: Choice of 2 or 6 lines

INTERFACE

1. IEC 61162-1: OSD, RSD, etc.
2. Gyrocompass: Built-in interface (option) for sync signal (20-135 VAC, 50-400 Hz), or stepper signal (20-135 VDC), any polarity
3. Speed log: IEC 61162-1, contact closure or 200/400/500 pulses/nm

POWER SUPPLY & POWER CONSUMPTION

1. DC or AC mains
   FR-1505 MARK-3: 12/24-32 VDC, 15.4 A max at 24 V
   FR-1510 MARK-3: 12/24-32 VDC, 17.5 A max. at 24 V
   FR-1525 MARK-3: 24-32 VDC, 9.2 A max. at 24 V
   FR-1505 MARK-3: 115/230 VAC, 1φ, 50-60 Hz, 270 VA
   FR-1510 MARK-3: 115/230 VAC, 1φ, 50-60 Hz, 310 VA
   FR-1525 MARK-3: 115/230 VAC, 1φ, 50-60 Hz, 340 VA

ENVIRONMENTAL CONDITIONS

1. Ambient temperature (Complies with IEC 60945)
   Display unit: -15 to + 55°C
   Antenna unit: -25 to + 70°C (Storage)
2. Relative humidity: 93% at 40°C
3. Category of Equipment Units
   Display unit: To be installed in a protected area
   Antenna unit: To be installed in an exposed area
   Performance Monitor: To be installed in an exposed area

COATING COLOR

COATING COLOR

Display Unit: Panel: N3.0 (Dark grey)
Chassis: 2.5GY5/1.5 (Light grey)

Scanner Unit: N9.5 (White)

COMPASS SAFE DISTANCE

Equipment Unit	Standard Compass	Steering Compass
Display unit RDP-119	1.35 m*	1.0 m*
Antenna unit (6 kW)	1.65 m*	1.25 m*
Antenna unit (12 kW)	1.65 m*	1.25 m*
Antenna unit (25 kW)	2.15 m*	1.60 m*
Performance monitor PM-30	0.4 m*	0.3 m*
Interswitch RJ-2		

* Provisional until the measurement data is available from BSH.

X-RADIATION

None of the equipment or any device used in it will not give rise to does rate .5μJ/kgh (0.5 mrem/h) at 50 mm.

ELECTROMAGNETIC RADIOFREQUENCY RADIATION

Model	Radiator type	Distance to 100 W/m² point	Distance to 10 W/m² point	RF power density on antenna aperture
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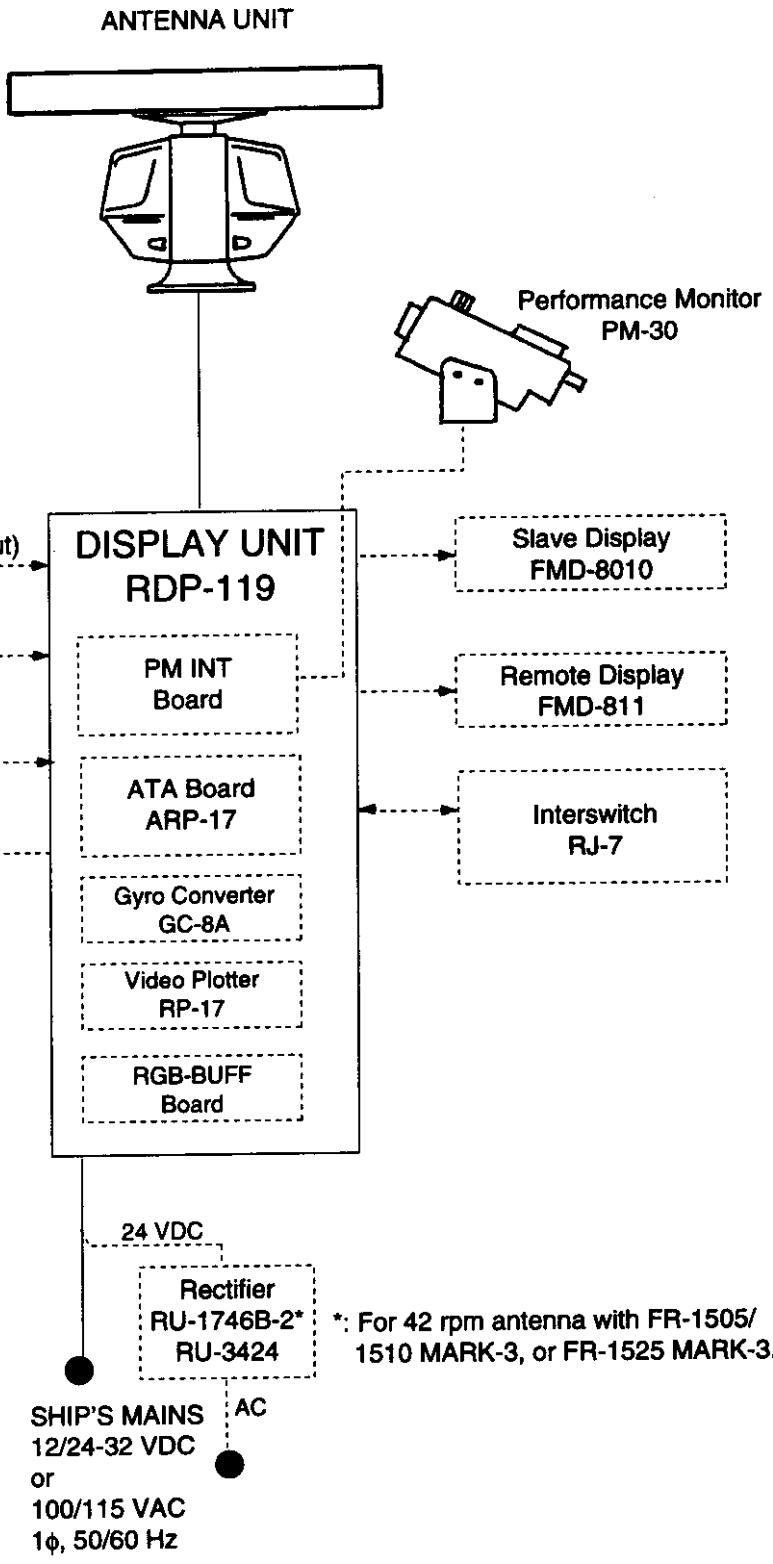
	XN20AF (6.5')	None	1.0	58 W/cm²
FR-1510 MARK-3 (X-band, 12 kW)	XN12AF (4')	0.1 m worst case	3.5 m	150 W/cm²
	XN20AF (6.5')		1.4 m	
FR-1525 MARK-3 (X-band, 25 kW)	XN20AF (6.5')	1.1 m worst case	10 m worst case	200 W/cm²
	XN24AF (8')			

CONFIGURATION OF FR-1505 MARK-3 SERIES RADARS

FR-1505 MARK-3
XN12AF-RSB0074-067 (24 rpm)
XN20AF-RSB0074-067 (24 rpm)
XN12AF-RSB0075-067 (42 rpm)
XN20AF-RSB0075-067 (42 rpm)

FR-1510 MARK-3
XN12AF-RSB0074-062 (24 rpm)
XN20AF-RSB0074-062 (24 rpm)
XN12AF-RSB0075-062 (42 rpm)
XN20AF-RSB0075-062 (42 rpm)

FR-1525 MARK-3
XN20AF-RSB0074-063 (24 rpm)
XN24AF-RSB0074-063 (24 rpm)
XN20AF-RSB0075-063 (42 rpm)
XN24AF-RSB0075-063 (42 rpm)



*: For 42 rpm antenna with FR-1505/ 1510 MARK-3, or FR-1525 MARK-3.

Note: Display unit available in AC and DC specification.
12 V power supply cannot be used with FR-1525 MARK-3 or 42 rpm with FR-1505/1510 MARK-3.

1. OPERATIONAL OVERVIEW

1.1 Turning on the Power

The [POWER]switch is located at the left corner of the display unit. Push it to switch on the radar set. To turn off the radar, push it again. The screen shows the bearing scale and digital timer approximately 15 seconds after power-on. The timer counts down three minutes of warm-up time. During this period the magnetron, that is, the transmitter tube, is warmed for transmission. When the timer has reached 0:00, the indication STBY appears, indicating that the radar is now ready to transmit pulses.

ON TIME and TX TIME values shown at the bottom of the screen are the time counts in hours and tenths of hour the radar has been powered for transmission.

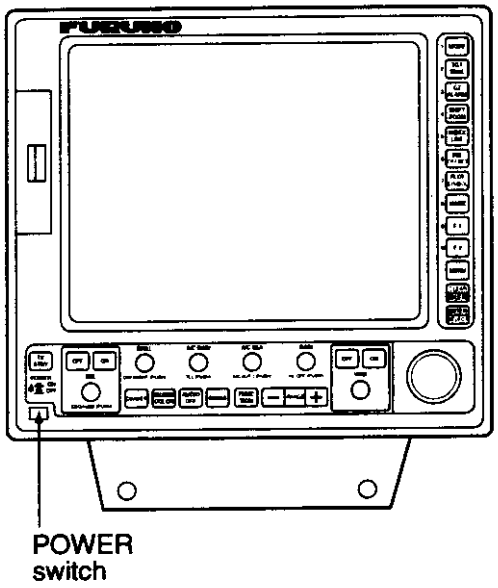
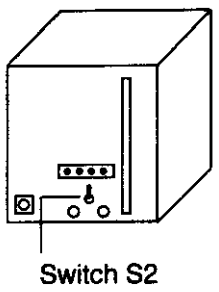


Figure 1-1 Location of power switch

Note: The display unit designed to run on AC has a power switch (S2) at its rear. If the power cannot be turned on by the power switch on the front panel, confirm that S2 is on.



1.2 Transmitter ON

After the power is turned on and the magnetron has warmed up, STBY appears at the screen center, indicating the radar is ready to transmit radar pulses.

Press the [STBY/TX] key to transmit.

When you won't be using the radar for an extended period, but you want to keep it in a state of readiness, place it in standby by pressing the [STBY/TX] key. The display shows STBY when the radar is in standby.

Video Lockup Recovery

Video freeze-up or lock-up, can occur unexpectedly on digital rasterscan radars. This is mainly caused by heavy spike noise in the power line and can be noticed by carefully watching the nearly invisible sweep line. If you suspect that the picture is not updated every scan of the antenna or no key entry is accepted notwithstanding the apparently normal picture, do Quick Start to restore normal operation.

1. Turn off the POWER switch and turn it on again within 10 seconds.
2. Push the Transmit switch labeled STBY/TX for Transmit status.

Note: This equipment has a self-diagnostic function which checks operational software periodically. If any trouble has been found, the error lamp lights. In this case, do the above procedure.

1.3 Control Description

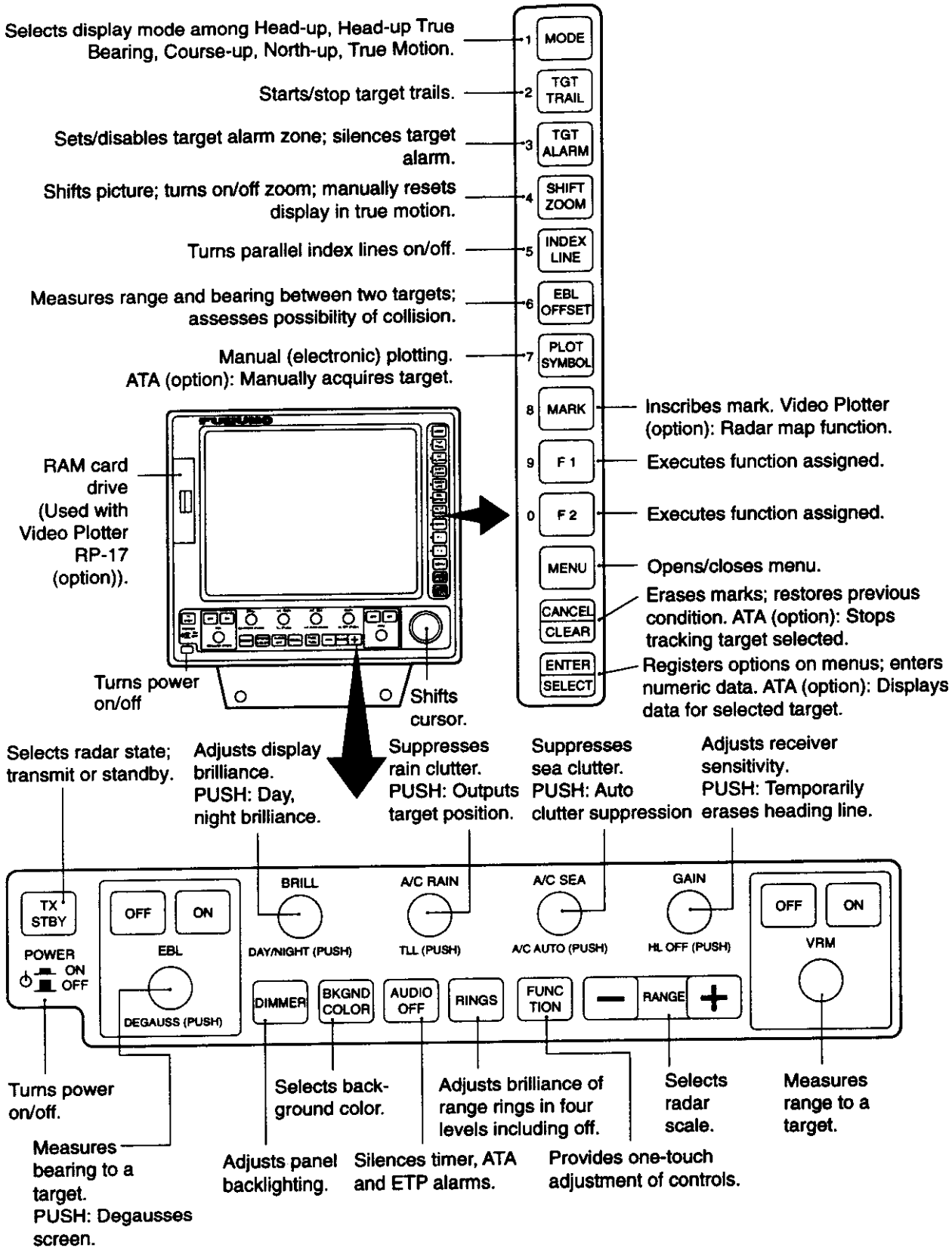


Figure 1-2 Control description

1.4 CRT Brilliance

Operate the BRILL control on the control panel of the display unit to adjust the entire screen brightness. Note that the optimum point of adjustment varies with ambient lighting conditions, especially between daytime and nighttime.

1.5 Control Panel Backlighting

Operate the [DIMMER] key to adjust control panel backlighting.

1.6 Tuning the Receiver

The radar is set for automatic tuning at the factory.

Automatic tuning

The radar receiver is tuned automatically each time the power is turned on. The tuning indicator and the label AUTO at the top right corner of the display unit shows the tuning circuit is working. The receiver may become detuned, in automatic tuning, if own ship's radar receives the radar signal of another shipborne radar. To retune, press the [STBY/TX] key twice.

Manual tuning

1. Set up for manual tuning following the procedure shown below.
2. While observing the picture on the 48 mile scale, slowly adjust the VRM rotary control to find the best tuning point while pressing and holding down the HL OFF control. Make sure that the radar has been set to the best tuning point. This condition is where the tuning indicator lights to about 80% of its total length. Note that the tuning indication will never extend to full length.

Selection of manual or automatic tuning

1. Press the [MENU] key.

MENU
1. VIDEO PLOT*
2. TGT TRAIL
3. TGT ALARM
4. WATCH TIM
5. ECHO SIG
6. FUNC
7. PLOT
8. MARK
9. BRILL
0. OTHER

* Requires optional RP Board.

Figure 1-3 Main menu

2. Press the [0] key twice to display the OTHER menu.

OTHER
1. HDG SET
2. SPD MODE [MAN] LOG *
3. MAN SPD
4. SET/DRIFT
5. DISPLAY
6. MARK DISP
7. TUNE
8. NAV DATA
9. EBL/VRM
0. OTHER

* NAV appears on R-type radar.

Figure 1-4 OTHER menu

3. Press the [7] key to display the TUNE menu.

TUNE
1. ↑
2. MODE [AUTO] MAN
3. TUNE SET

Figure 1-5 TUNE menu

4. Press the [2] key to select the option AUTO or MAN from the MODE field as required.
5. Press the [ENTER/SELECT] key.
6. Press the [MENU] key to close the menu.

1.7 Degaussing the Screen

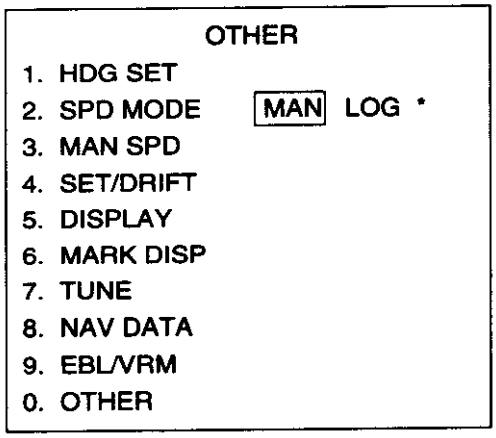
Each time the radar is turned on, the degaussing circuit automatically demagnetizes the CRT screen to eliminate color contamination caused by earth's magnetism or magnetized ship structure.

The screen is also degaussed automatically at certain time intervals, which may be selected on the menu. While being degaussed, the screen may be disturbed momentarily with vertical lines. If you wish to degauss by manual operation, push the EBL rotary control.

1.8 Initializing the Compass Readout

With a compass interfaced with the radar, ship's heading is displayed at the top of the screen. Upon turning on the radar, match the on-screen HDG readout with the compass reading by the procedure shown below. Once you have set the initial heading correctly, resetting is not usually required. However, if the HDG readout goes wrong for some reason, repeat the procedure to correct it.

1. Press the [MENU] key to display the main menu.
2. Press the [0] key twice to display the OTHER menu.



* NAV appears on R-type radar.

Figure 1-6 OTHER menu

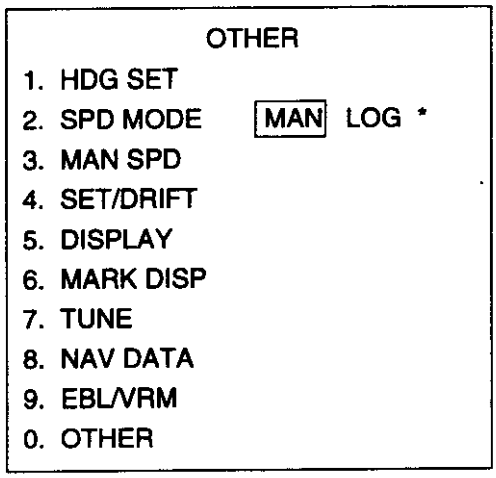
3. Press the [1] key to select HDG SET.
4. Operate the VRM rotary control to duplicate the compass readout on the radar menu display.
5. Press the [ENTER/SELECT] key.
6. Press the [MENU] key to close the menu.

1.9 Entering Own Ship's Speed

EPA requires an own ship speed input and compass signal. The speed can be entered from a speed log (automatic) or through the plotting keypad (manual).

Automatic speed input

1. Press the [MENU] key and the [0] key twice to show the OTHER menu.



* NAV appears on R-type radar.

Figure 1-7 OTHER menu

2. Press the [2] key to select the menu item SPD MODE.
3. Press the [2] key again to select the LOG option.
4. Press the [ENTER/SELECT] key to confirm your selection followed by the [MENU] key to close the menu. The ship's speed readout at the right-hand side of the screen shows own ship's speed fed from the speed log with the label "LOG."

Notes:

1) IMO Resolution A.823(19) for ARPA recommends that a speed log to be interfaced with an ARPA should be capable of providing through-the-water speed. The same concept applies to the ATA and the EPA.

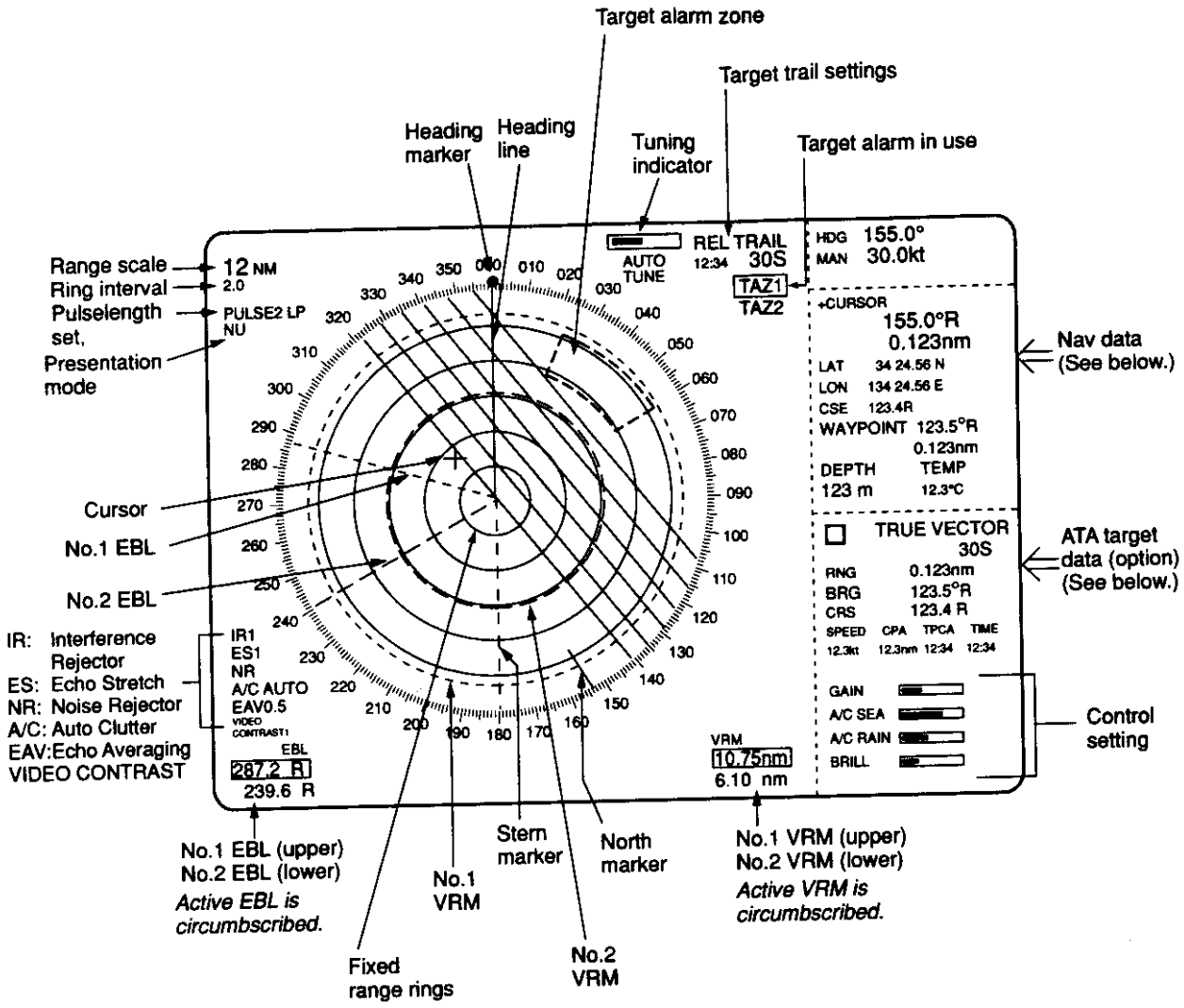
2) Be sure not to select LOG when a speed log is not connected. If the log signal is not provided, the ship's speed readout at the screen top will be blank.

Manual speed input

If the radar is not interfaced with a speed log, or the speed log does not feed correct speed enter the ship's speed as follows:

1. Press the [MENU] key and the [0] key twice to show the OTHER menu.
2. Press the [2] key several times to select MAN from the SPD MODE field.
3. Press the [3] key to select the MAN SPD.
4. Enter speed with the numeric keys.
5. Press the [ENTER/SELECT] key to confirm your selection followed by the [MENU] key to close the menu. The ship's speed readout at the right-hand side of the screen shows own ship's speed fed from the speed log with the label "MAN."

1.10 On-screen Legends and Markers



HDG 155.0° ← Heading

MAN 30.0kt ← Speed and its source (LOG, NAV, or MAN) (NAV not available on IMO radar)

CURSOR 155.0°R ← Bearing (R: Relative, T: True) and range from own ship to cursor
0.123nm

LAT 34°24.56'N ← Cursor position in latitude and longitude
LON 134°24.56'E

CSE 123.4°R ← Ship's course (Relative on Head-up; Rel/True on other modes)

WAYPOINT 123.5°R ← Range and bearing (T: True, R: Relative) from own ship to waypoint
0.123nm

DEPTH TEMP ← Depth: meters, feet, fathoms, Water temperature, °C or °F
123 m 12.3°C

☐ REL VECTOR ← Vector bearing reference
30S REL: Relative
TRUE: True

RNG 0.123nm
BRG 123.5°R ← Range, bearing, course, speed, CPA, TCPA, Time to TCPA for target
CRS 123.4°R
SPEED CPA TPCA TIME
12.3kt 12.3nm 12:34 12:34

Figure 1-8 On-screen legends and markers

1.11 Presentation Modes

This radar has the following presentation modes: Head-up, Head-up/TB, Course-up, North-up, and True Motion.

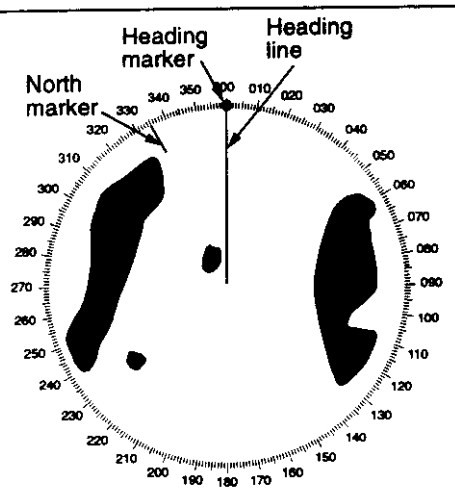
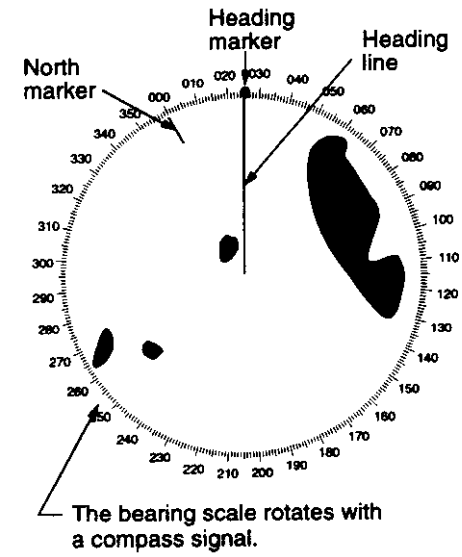
Selecting presentation mode

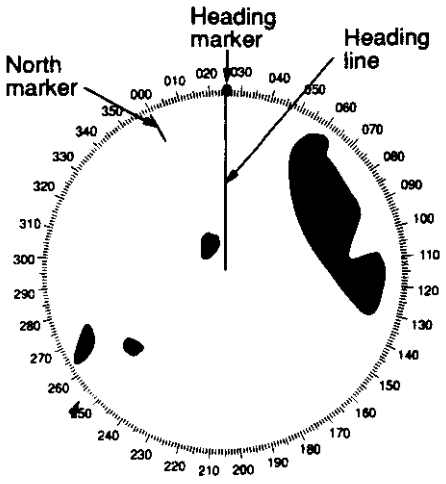
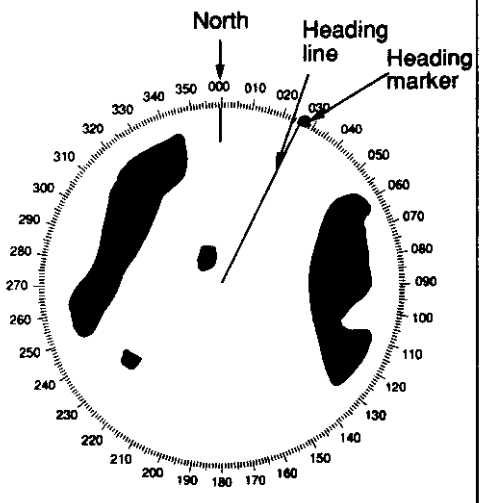
Press the [MODE] key on the panel at the right side of the display unit. Each time the [MODE] key is pressed, the presentation mode and mode indication at the upper-left corner of the screen change cyclically.

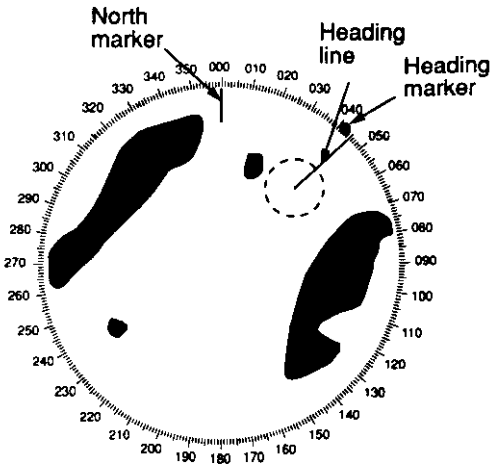
Note: When a failure occurs in the gyrocompass, the radar will automatically be switched to unstabilized presentation mode. All compass related data will read Relative values.

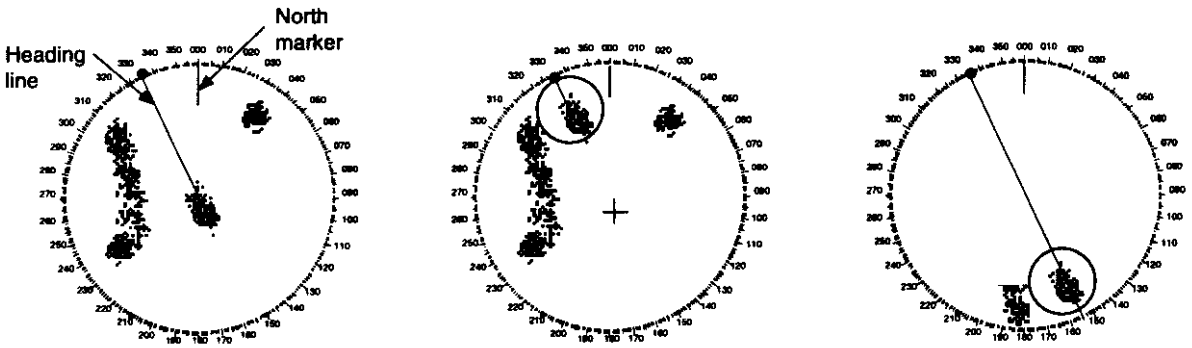
Loss of Compass Signal

When the compass signal is lost, the presentation mode automatically becomes head-up and the compass readout at the screen top shows asterisks (***.*). Also HEADING FAIL appears in red characters at the lower-right corner of the screen. The message SET HEADING appears at the lower-left corner of the screen. This alert stays on when the heading signal is restored, to warn the operator that the readout may be unreliable. When the compass signal is restored, HEADING FAIL disappears and SET HEADING prompts you to readjust heading indication. Press the MODE key, and the asterisks go off. Then, match the on-screen HDG readout with the heading reading (see paragraph 1.8) and press the CANCEL/CLEAR key to erase the message SET HEADING.

Presentation mode, representative display	Description
	**Head-up Mode** A display without azimuth stabilization in which the line connecting the center with the top of the display indicates own ship's heading. The target pips are painted at their measured distances and in their directions relative to own ship's heading. A short line on the bearing scale is the north marker indicating compass north. A failure of the compass input will cause the north marker to disappear and the HDG readout to show asterisks (***.*) and the message SET HEADING appears at the lower-left corner of the screen.
	**Head-up TB (True Bearing) Mode** Radar echoes are shown in the same way as in the head-up mode. The difference from normal head-up presentation lies in the orientation of the bearing scale. The bearing scale is compass stabilized, that is, it rotates in accordance with the compass signal, enabling you to know own ship's heading at a glance. This mode is available only when the radar is interfaced with a compass. If the compass fails, the bearing scale returns to the state of head-up mode.

Presentation mode, representative display	Description
	**Course-up Mode** An azimuth stabilized display in which a line connecting the center with the top of the display indicates own ship's intended course (namely, own ship's previous heading just before this mode has been selected). Target pips are painted at their measured distances and in their directions relative to the intended course which is maintained at the top of screen while the heading line moves in accordance with ship's yawing and course changes. This mode is useful to avoid smearing of picture during course change. After a course change, press the [SHIFT] key to reset the picture orientation if you wish to continue using the course-up mode. The heading line gets back to perpendicular.
	**North-up Mode** In the north-up mode, target pips are painted at their measured distances and in their true (compass) directions from own ship, north being maintained up of the screen. The heading line changes its direction according to the ship's heading. If the compass fails, the presentation mode changes to head-up and the north marker disappears. Also, the HDG readout shows asterisks (***.*) and the message SET HEADING appears at the lower-left corner of the screen.

Presentation mode, representative display	Description
	**True Motion Mode** Own ship and other moving objects move in accordance with their true courses and speeds. In ground stablized TM, all fixed targets, such as landmasses, appear as stationary echoes. In the sea stablized TM without set and drift input, the landmass can move on the screen. When own ship reaches a point corresponding to 75% of the radius of the display, the own ship is automatically reset to a point of 75% radius opposite to the extension of the heading line passing through the display center. Resetting can be made at any moment before the ship reaches the limit by pressing the [SHIFT] key. Automatic resetting is preceded by a beep sound. If the compass fails, the presentation mode is changed to the head-up mode and the north marker disappears. The HDG readout at the top of the screen shows asterisks (***.*) and the message SET HEADING appears at the lower-left corner of the screen.



(a) True motion is selected

(b) Own ship has reached a point 75% of display radius

(c) Own ship is automatically reset to 75% of radius

Automatic resetting of own ship position in true motion mode

1.12 Selecting the Range Scale

The range selected automatically determines the range ring interval, the number of range rings and pulse repetition rate, for optimal detection capability in short to long ranges. You can select pulselength on the ranges from 0.75 to 24 nautical miles, and two sets of pulselengths are preset at installation, on the ECHO SIG menu. For how to select pulselengths see the paragraph below.

Press the [RANGE] key to select range. The range, range ring interval and pulselength appear at the top left corner of the display.

1.13 Selecting the Pulselength

The pulselength in use is displayed at the upper-left position of the screen using the abbreviations shown in the table below.

Appropriate pulselengths are preset to individual range scales and function keys. Therefore, you are not usually required to select them. If you are not satisfied with the current pulselength settings, however, it is possible to change them by the ECHO SIG menu as below.

You can choose the pulselength 1 or 2 on the scales 0.75 to 24 nm ranges.

Selecting pulselength 1 or 2

1. Press the [MENU] key to display the Main menu.
2. Press the [5] key twice to select ECHO SIG.

ECHO SIG

1. COLOR	[YEL]	GRN	*	
2. CLTR SWEEP	[OFF]	ON(LINK)	ON(FIX)	
3. SWEEP LVL	[1]	2	3	
4. ENHANCE	[OFF]	ON		
5. 2ND ECHO	[OFF]	ON		
6. PULSE 1				
7. PULSE 2				

* MULTI appears on R-type.

Figure 1-9 ECHO SIG menu

3. Press the [6] key or [7] key to select PULSE 1 or PULSE 2 as appropriate.
4. Press the [ENTER/SELECT] key.
5. Press the [MENU] key.

Indication of PULSE 1 or PULSE 2 alternates at the upper left corner of the display.

Table 1-1 Available pulselengths

Legend	Pulselength
S1 (Short pulse)	0.07 µs
S2 (Short pulse)	0.15 µs
M1 (Medium pulse 1)	0.3 µs
M2 (Medium pulse 2)	0.5 µs
M3 (Medium pulse 3)	0.7 µs
L (Long pulse)	1.2 µs

Presetting pulselengths 1 and 2

Pulselength 1 and 2 can be preset on the PULSE 1 and PULSE 2 in the ECHO SIG menu. A longer pulse provides an increased detection range, but with reduced discrimination. If you need discrimination in preference to detection, choose a shorter pulse However short the radar satisfies the detecting requirements of the IMO.

1. Press the [MENU] key.
2. Press the [5] key twice to display the ECHO SIG menu.
3. Press the [6] or [7] key as appropriate to select PULSE 1 or PULSE 2.

PULSE 1

1. ↑					
2. 0.5-1NM	[S1]	S2			
3. 0.75NM	S1	[S2]	M1		
4. 1.5NM	S1	[S2]	M1		
5. 3NM	S2	M1	[M2]		
6. 6NM	M1	M2	[M3]	L	
7. 12-24NM	M1	M2	[M3]	L	

Figure 1-10 PULSE menus

4. Press appropriate numeric key among 2-7 to select pulselength and range.

5. Press the [ENTER/SELECT] key.
6. Press the [MENU] key.

1.14 Adjusting the Sensitivity

The GAIN control adjusts the sensitivity of the receiver. It works in precisely the same manner as the volume control of a broadcast receiver, amplifying the signals received.

The proper setting is such that the background noise is just visible on the screen. If you set up for too little sensitivity, weak echoes may be missed. On the other hand excessive sensitivity yields too much background noise; strong targets may be missed because of the poor contrast between desired echoes and the background noise on the display.

To adjust receiver sensitivity, transmit on long range, and adjust the GAIN control so background noise is just visible on the screen.

1.15 Suppressing Sea Clutter

Echoes from waves cover the central part of the display with random signals known as sea clutter. The higher the waves, and the higher the scanner above the water, the further the clutter will extend. When sea clutter masks the picture, suppress it by the A/C SEA control, rotate for manual adjustment, push for automatic adjustment.

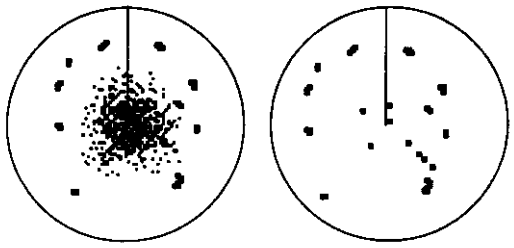
Manual adjustment by the A/C SEA control

The A/C SEA control reduces the amplification of echoes at short ranges (where clutter is the greatest) and progressively increases amplification as the range increases, so amplification will be normal at those ranges where there is no sea clutter.

The proper setting of the A/C SEA control should be such that the clutter is broken up into small dots, and small targets become distinguishable.

If the control is set too low, targets will be hidden in the clutter, while if it is set too high, both sea clutter and targets will disappear from the display. In most cases adjust the control until clutter has disappeared to leeward, but a little is still visible windward.

1. Confirm that the sensitivity is properly adjusted, and then transmit on short range.
2. Adjust the A/C SEA control so small targets are distinguishable but some clutter remains on the display.



A/C SEA control off

A/C SEA control adjusted

Figure 1-11 How to adjust the A/C SEA control

Automatic adjustment by the A/C AUTO control

The A/C AUTO control automatically suppresses sea clutter as well as rain clutter. Push the A/C SEA control to turn on the automatic A/C circuit. A/C appears at the bottom left corner when the A/C circuit is on.

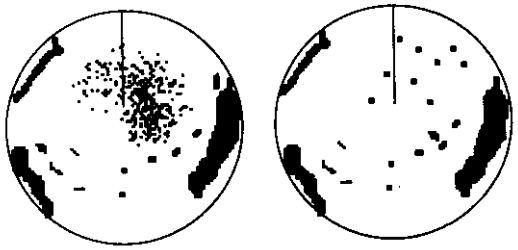
⚠ CAUTION

Turn off the A/C AUTO feature when its use is not required; it can erase weak target echoes.

1.16 Suppressing Precipitation Clutter

The vertical beamwidth of the scanner is designed to see surface targets even when the ship is rolling. However, by this design the unit will also detect rain clutter (rain, snow, or hail) in the same manner as normal targets. Figure 1-11 shows the appearance of rain clutter on the display.

The A/C RAIN control adjusts the receiver sensitivity as the A/C SEA control does but rather in a longer time period (longer range). Clockwise rotation of this control increases the anti-clutter effect.



A/C RAIN control OFF

A/C RAIN control adjusted

Figure 1-12 Effect of A/C RAIN control

1.17 Interference Rejector

Mutual radar interference may occur in the vicinity of another shipborne radar operating in the same frequency band (9 GHz). It is seen on the screen as a number of bright spikes either in irregular patterns or in the form of usually curved spoke-like dotted lines extending from the center to the edge of the picture. This type of interference can be reduced by activating the interference rejector circuit.

The interference rejector is a kind of signal correlation circuit. It compares the received signals over successive transmissions and suppresses randomly occurring signals. There are three levels of interference rejection depending on the number of transmissions that are correlated. These are indicated by the legends IR1, IR2 and IR3 at the upper-left position of the screen.

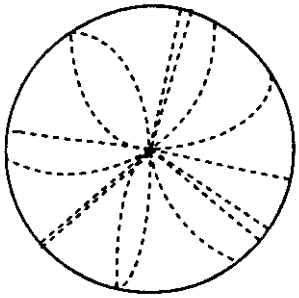


Figure 1-13 Interference

To activate the interference rejector;

1. Press the [F1] key. The following display appears.

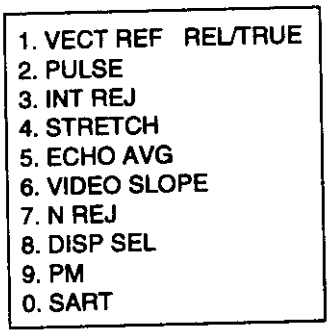


Figure 1-14 F1 key menu

2. Press the [3] key to select interference rejection level (OFF, 1, 2, or 3) from the INT REJ field. Select level is shown as IR1, IR2 or IR3 at the bottom left-hand corner on the display.

1.18 Measuring the Range

Measuring range by the fixed range rings

Use the fixed range rings to obtain a rough estimate of the range to a target. They are concentric solid circles about own ship, or the sweep origin. The number of rings is automatically determined by the selected range scale and their interval is displayed at the upper-left position of the screen.

Measuring range by the variable range marker (VRM)

Use the Variable Range Markers (VRMs) for more accurate measurement of the range to a target. There are two VRMs, No.1 and No.2, which appear as dashed rings so that you

can discriminate them from the fixed range rings. The two VRMs can be distinguished from each other by different lengths of dashes.

1. Press the [VRM ON] key to display either of the VRMs. Successive presses of the [VRM ON] key toggles the active VRM between No.1 and No.2 and the currently active VRM readout is circumscribed.
2. Rotate the VRM rotary control clockwise or counterclockwise to align the active VRM with the inner edge of the target of interest and read its distance (unit: nm) at the lower-right corner of the screen. Each VRM remains at the same geographical distance when you operate the [RANGE+] or [RANGE-] key. This means that the apparent radius of the VRM ring changes in proportion to the selected range scale.
3. Press the [VRM OFF] key to erase each VRM

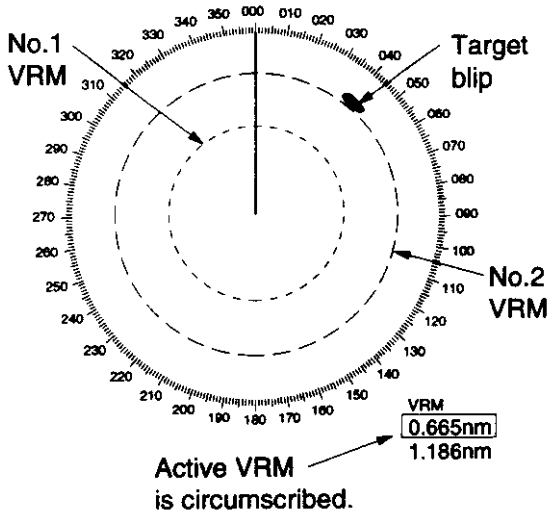


Figure 1-15 How to measure range by VRM

1.19 Measuring Bearing

Use the Electronic Bearing Lines (EBLs) to find bearing of a target. There are two EBLs, No.1 and No.2, which are toggled by successive presses of the [EBL ON] key. Each EBL is a straight dashed line extending out from the own ship position up to the circumference of the radar picture. The fine dashed line is the No.1 EBL and the coarse dashed one is the No.2 EBL.

1. Press the [EBL ON] key to display either of the EBLs. Successive presses of the [EBL ON] key toggles the active EBL between No.1, No.2 and index lines (if displayed) and the currently active EBL readout is circumscribed.
2. Rotate the EBL rotary control clockwise or counterclockwise until the active EBL bisects the target of interest, and read its bearing at the lower-left corner of the screen.
3. Press the [EBL OFF] key to erase each EBL.

The EBL readout is affixed by "R" (relative) if it is relative to own ship's heading, or "T" (true) if it is referenced to the North, as determined by the item CURS/EBL/VRM on the OTHER menu.

Note: Bearing reference cannot be selected for IMO type (no menu selection). For the IMO type, relative bearing is selected in the HU mode, and true bearing in HUTB, CU, NU and TM modes.

Each EBL carries a range marker, a short line crossing the EBL at right angles, and its distance from the EBL origin is indicated at the VRM readout whether or not the corresponding VRM is displayed. The range marker changes its position along the EBL with the rotation of the VRM rotary control.

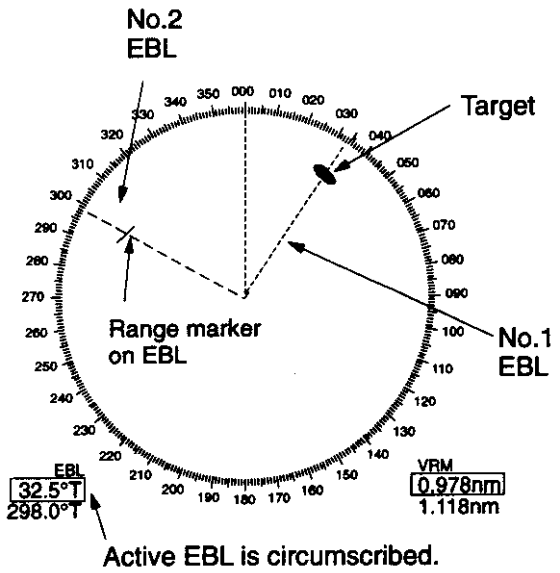


Figure 1-16 Measuring bearing by EBL

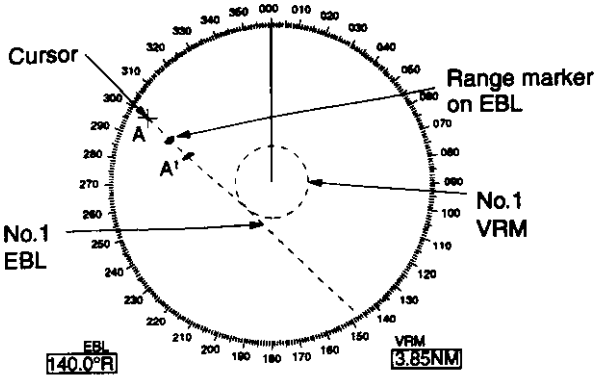
1.20 Collision Assessment by the Offset EBL

The origin of the EBL can be placed anywhere with the trackball to enable measurement of range and bearing between any targets. This function is also useful for assessment of the potential risk of collision.

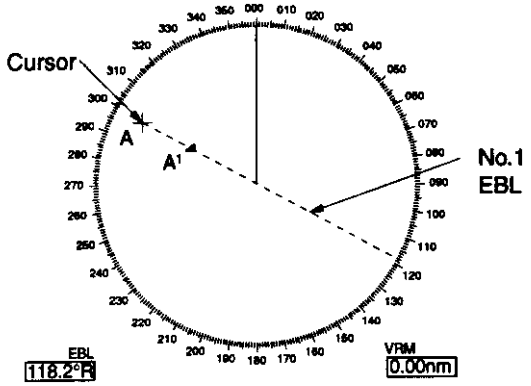
To assess possibility of collision:

1. Press the [EBL ON] key to display or activate an EBL (No.1 or No. 2).
2. Place the cursor (+) on a target of interest (A in the illustrated example) by operating the trackball.
3. Press the [EBL OFFSET] key, and the origin of the active EBL shifts to the cursor position. Press the [EBL OFFSET] key again to anchor the EBL origin.
4. After waiting for a few minutes (at least 3 minutes), operate the EBL rotary control until the EBL bisects the target at the new position (A'). The EBL readout shows the target ship's course, which may be true or relative depending on the settings on the OTHER menu.

   If relative motion is selected, it is also possible to read CPA (Closest Point of Approach) by using a VRM as shown below (Figure (a)). If the EBL passes through the sweep origin (own ship) as illustrated (Figure (b)), the target ship is on a collision course.
5. To return the EBL origin to the own ship position, press the [EBL OFFSET] key again.



(a) Evaluating target ship's course and CPA in relative motion mode



(b) Target ship on collision course

Figure 1-17 How to assess risk of collision

1.21 Measuring Range and Bearing Between Two Targets

1. Press the [EBL OFFSET] key, and place the origin of the No.1 EBL on a target of interest (target 1 in the illustrated example) by operating the trackball.
2. Turn the EBL rotary control until the EBL passes through another target of interest (target 2).
3. Turn the VRM rotary control until the range marker on the No. 1 EBL aligns with target 2. The active VRM readout at the lower-right corner of the screen indicates the distance between the two targets.
4. To return the EBL origin to the own ship position, press the [EBL OFFSET] key again.

You can repeat the same procedure on third

and fourth targets (targets 3 and 4) by using the No.2 EBL and No.2 VRM.

Bearing is shown relative to own ship with suffix "R" or as a true bearing with suffix "T" depending on EBL relative/true settings on the OTHER menu.

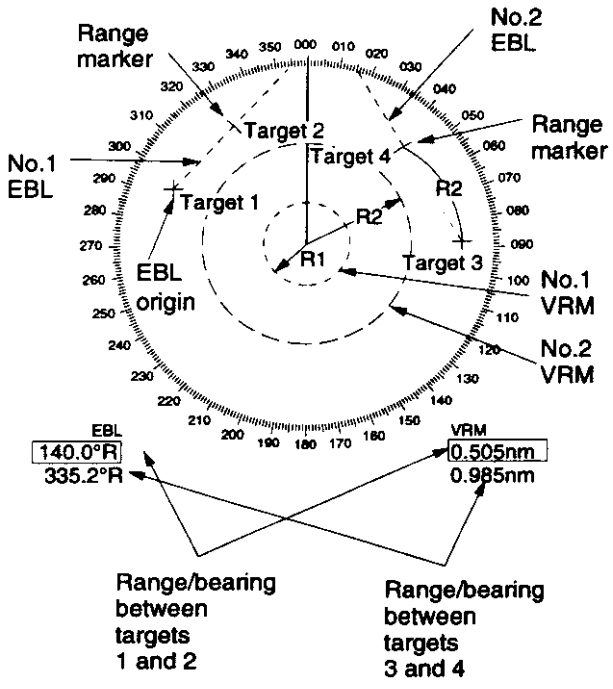


Figure 1-18 Measuring range and bearing between two targets

1.22 Setting a Target Alarm Zone

⚠ CAUTION

The target alarm feature should never be relied upon as the sole means for detecting the risk of potential collision. The operator of a ship is not relieved of the responsibility to keep lookout for avoiding collisions, whether or not the radar is in use.

The target alarm serves to alert the navigator to targets (ships, landmasses, etc.) entering a certain area, with visual and audible alarms.

The zone has a fixed width of 0.5 nm in the radial direction (depth) and is adjustable only within 3.0 to 6.0 nm from own ship. On the R-type, the outer and inner boundaries can be set at any distance. On any radar type, the sector of the zone can be set anywhere between 0 and 360 degrees in any direction.

To set target alarm zones:

1. Press the [MENU] key.
2. Press the [3] key twice to show the TGT ALARM menu.

TGT ALARM		
1. AREA NO.	NO 1	NO 2
2. MODE1	IN	OUT
3. MODE2	IN	OUT

*1 MODE (IN/OUT) shown on R-type.

Figure 1-19 TGT ALARM menu

2. Press the [1] key to select guard zone to use; NO 1 or NO 2.
3. Press the [ENTER/SELECT] key.
4. Press the [MENU] key.
5. Place the cursor (+) at point "A" (see figure below) using the trackball. Press the [TGT ALARM] key. SET TAZ1(2) appears. When both alarms are prepared the active alarm is circumscribed.
6. Move the cursor (+) to point "B" and press the [TGT ALARM] key again. Then, an echo watch zone as illustrated is created and the label TAZ1 (or 2) appears instead of SET TAZ1 (or 2) at the lower-right corner of the screen.

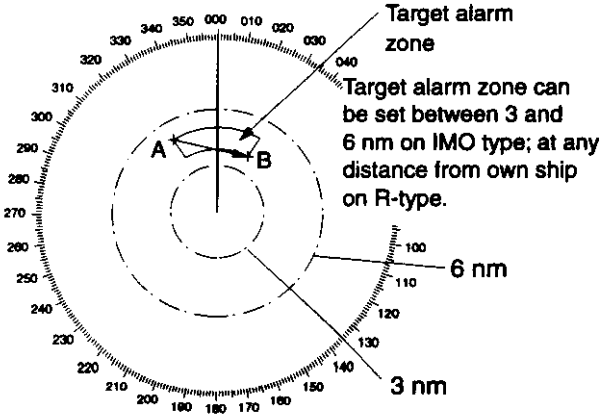


Figure 1-20 Target alarm

Note: If you wish to create a target alarm zone having a 360-degree coverage around own ship, set point "B" in almost the same direction (approx. ±3°) as point "A" and press the [TGT ALARM] key.

Two alarm zones can be set as described above. To change the active alarm zones, do steps 1 thru 4 in the above procedure. (When both alarms are prepared the active alarm is circumscribed.)

Acknowledging alarm

A target entering the ALARM zone produces both visual (flashing) and audible (beeping) alarms. To silence the audible alarm, press the [TGT ALARM] key shortly. ACKN replaces IN (orOUT).

This will deactivate the audible alarm but will not stop the flashing of the target in the target alarm zone. To reactivate the audible alarm, press the [TGT ALARM] key again.

To silence the audible alarm, you may press the [TGT ALARM] key. However, in this case, the label ACKN does not appear.

Deactivating target alarm

Hold the [TGT ALARM] key depressed for at least 5 seconds.

Note: The target alarm is given to targets having a certain level of echo strength. This level does not always imply a landmass, reef, ships or other surface objects but can mean returns from the sea surface or precipitation. Properly adjust the GAIN, A/C SEA, and A/C RAIN controls to reduce noise to avoid generation of the guard alarm against false targets.

Inward and outward target alarms

On the R-type, an inward or outward target alarm can be selected on the TGT ALARM menu. On the IMO type, only the inward guard alarm is available. The inward guard alarm generates visual and audible warnings when a target enters the target alarm zone from any direction. The outward target alarm is produced when a target leaves the target alarm zone. (This is not a target alarm by definition but some users find this feature valuable.)

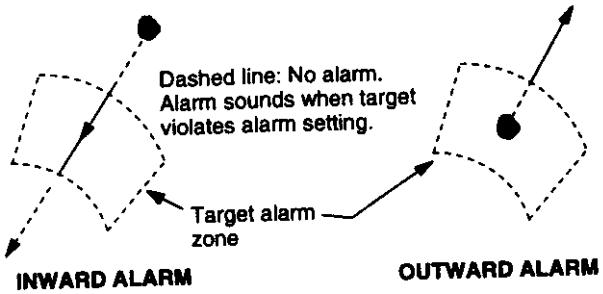


Figure 1-21 Inward and outward alarms

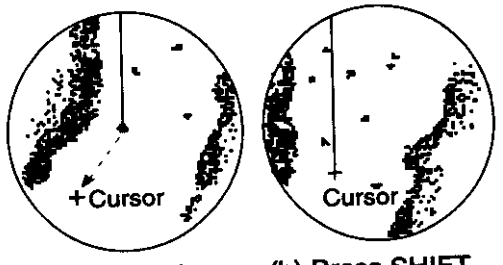
1.23 Off-centering (shift)

Own ship position, or sweep origin, can be displaced to expand the view field without switching to a larger range scale. The sweep origin can be off-centered to a point specified by the cursor, up to 75% of the range in use in any direction.

This feature is not available on the longest range scale or in the true motion mode. The number of range rings increases keeping the original range intervals unchanged.

To off center the radar picture:

1. Place the cursor at a position where you wish to move the sweep origin by operating the trackball.
2. Press the [SHIFT/ZOOM] key with a touch-and-release action. Then, the sweep origin is off-centered to the cursor position. However, the heading line is left in the same position.
3. To cancel off-centering, press the [SHIFT/ZOOM] key again.



(a) Select location with cursor.

(b) Press SHIFT key to offcenter.

Figure 1-22 Off-centered display

1.24 Echo Averaging

The echo average feature effectively suppresses sea clutter. Echoes received from stable targets such as ships appear on the screen at almost the same position every rotation of the scanner. On the other hand, unstable echoes such as sea clutter appear at random positions.

To distinguish real target echoes from sea clutter, echo average performs scan-to-scan correlation. Correlation is made by storing and averaging echo signals over successive picture frames. If an echo is solid and stable, it is presented in its normal intensity. Sea clutter is averaged over successive scans resulting in the reduced brilliance, making it easier to discriminate real targets from sea clutter.

To properly use the echo average function, it is recommended to first suppress sea clutter with the A/C SEA control and then do the following:

1. Press the [F1] key.
2. Press the [5] key twice to select ECHO SIG.

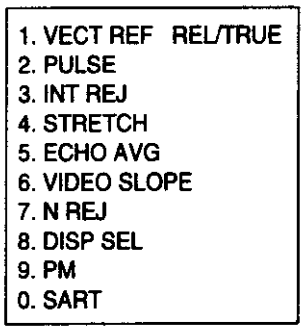


Figure 1-23 F1 menu

3. Press the [5] key to select echo averaging level desired from the ECHO AVG field.

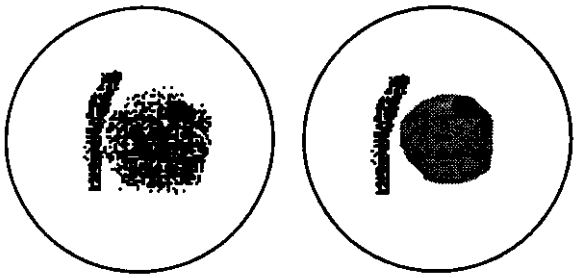
   OFF: No averaging effect

   0.5: Distinguishes small targets from sea clutter.

   1: Helps distinguish targets from sea clutter and suppresses brilliance of unstable echoes

   2: Distinguishes small stationary targets such as navigation buoys.

   3: Stably displays distant targets.



(a) Echo average OFF (b) Echo average ON

Figure 1-24 Echo averaging

Echo averaging uses scan-to-scan signal correlation technique based on the true motion over the ground of each target. Thus, small stationary targets such as buoys will be shown while suppressing random echoes such as sea clutter. True echo average is not however effective for picking up small targets running at high speeds over the ground.

Echo average is inoperable when a compass signal is not available. If you wish to use this feature without a compass signal, consult a FURUNO representative.

Manual speed entry is done at the menu item MAN SPD on the OTHER menu, which is accessed by pressing the [MENU] key followed by the [0] key.

⚠ CAUTION

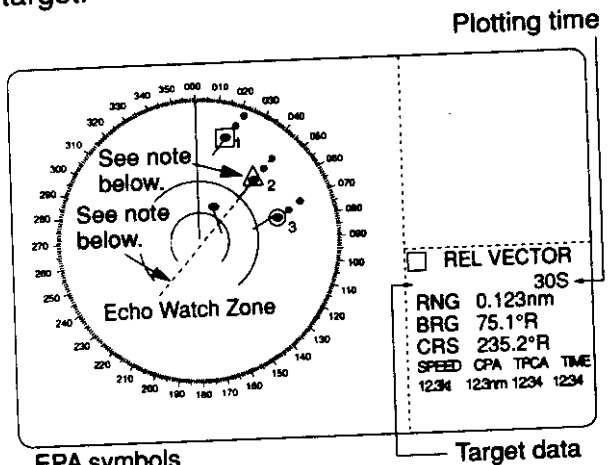
Do not use the Echo Average feature under heavy pitching and rolling; loss of targets can result.

1.25 Electronic Plotting Aid (EPA)

10 operator-selected targets can be plotted electronically to assess their motion trend. Five past positions can be displayed for each of the plotted targets. If you enter a 6th plot on a certain target, the oldest plot (past position) will be erased.

A vector appears when you enter a second plot for the target and is updated each time a new plot is entered. The vector shows the target motion trend based on its latest two plots.

Target data is shown in the data display area which shows range, bearing, course, speed, CPA and TCPA of the last-plotted or selected target.



EPA symbols
○: Target plotted
□: Target plotted and data indicated.
△: Target on a collision course

Note:
Target 2 is on a collision course as the extension of its vector goes through the own ship position. Placing the offset EBL will help for assessment. TCPA is counted up to 99.9 min and beyond that it is indicated as TCPA > 99.9 MIN.

Figure 1-25 EPA display

Note: EPA requires speed input (automatic or manual) and a compass signal. The vector and data are updated on real time between plot entries, but do not neglect to plot a new position over a long period of time. Otherwise, the accuracy will be reduced. Note that the plots will be lost when the compass fails; start the plotting exercise again.

Plotting a target

1. Place the cursor on a target of interest by operating the trackball.
2. Press the [PLOT SYMBOL] key. An unused plot symbol is marked at the cursor position.
3. Watching the EPA time shown at the right side of the screen, wait for at least 30 seconds. Place the cursor (+) on the target at its new location, press the [PLOT SYMBOL] key.

   The plot symbol moves to the new target position and previous position is marked by a small dot.
4. To acquire other targets, repeat the above steps selecting different plot symbols.

Note: If a target once plotted is not plotted again within 12 minutes, the warning "UPDATE PLOT" will appear on the upper right margin of the screen and the plot symbol of the target flashes. Plotting of a target will be ceased if the time between consecutive plots exceeds 12 minutes. If you want to continue plotting this target, reacquire it within one minute. Otherwise, the target will be regarded as a "lost target" and its plot symbol and target data will be erased. The larger the plotting interval, the less accurate the plotted target data. Plotting of each target should normally be made every 3 or 6 minutes as far as possible. You can use a Watch Alarm to warn yourself every 3 or 6 minutes.

Within 30 seconds, you can cancel a last plot by the [CANCEL/CLEAR] key and make a re-entry at a different position. After 30 seconds, the last entry is processed to produce a vector.

True or relative vector, vector time

Vectors can be displayed relative to own ship's heading (Relative) or with reference to the North (True). This feature is available in all presentation modes (compass must be working correctly). The current vector mode is indicated at the upper-right corner of the screen.

Vector time (or the length of vectors) can be set to 30 seconds, 1, 2, 3, 6, 12, 15 or 30 minutes and the selected vector time is indicated at the upper-right corner of the screen.

1. Press the [MENU] key followed by the [7] key twice to select PLOT.

PLOT MENU 1

1. MARK DISP	OFF	[ON]
2. ERASE		
3. VECT REF	[REL]	TRUE
4. VECT TIME	[30S]	1M 3M 6M 15M 30M
5. CPA SET	[OFF]	0.5NM 1NM 2NM 3NM 4NM 5NM 6NM
6. TCPA SET	[30S]	1M 2M 3M 4M 5M 6M 12M
7. HISTORY	[OFF]	ON
8. INTVAL	[30S]	1M 2M 3M 6M
9. REF TGT		
0. ↓		

Figure 1-26 PLOT menu

2. Press the [3] key select REL or TRUE from the VECT REF field as appropriate.
3. Press the [4] to select appropriate vector time from the VECT TIME field.
4. Press the [ENTER/SELECT] key to confirm your selection.
5. Press the [MENU] key to close the menu.

The vector tip shows an estimated position of the target after the selected vector time elapses. It can be valuable to extend the vector length to evaluate the risk of collision with any target.

Target data

The radar calculates motion trends (range, bearing, course, speed, CPA and TCPA) of all plotted targets.

In the head-up and head-up true bearing modes, target bearing, course and speed shown in the upper-right target data field become true (T) relative to north or relative (R) relative to own ship in accordance with true/relative vector setting. In the north-up, course-up, and true motion modes, the target data field always displays true bearing, true course and speed over the ground.

Reading the target data

Press the [PLOT SYMBOL] key and the corresponding plot symbol key. Then, the following target data is displayed at the left side of the CRT. Three target data can be displayed.

RNG/BRG (Range/Bearing): Range and bearing from own ship to last-plotted target with suffix "T" (True) or "R" (Relative) plot symbol.

CSE/SPD (Course/Speed): Course and speed are displayed for the last-plotted target with suffix "T" (True) or "R" (Relative) plot symbol.

CPA/TCPA: CPA (Closest Point of Approach) is the closest range the target will approach to own ship. TCPA is the time to CPA. Both CPA and TCPA are automatically calculated. TCPA is counted up to 99.9 min and beyond that it is indicated as TCPA > *99.9 MIN.

Terminating target plotting

With EPA you can plot up to 10 targets. You may wish to terminate plotting of less important targets to newly plot other threatening targets.

With Trackball: Place the cursor (+) on a target which you do not want to be tracked any longer by operating the trackball and press the [CANCEL/CLEAR] key.

All Targets: To terminate plotting of all targets at once:

1. Press the [MENU] key followed by the [7] key.
2. Press the [2] key twice to select OFF from the ERASE field.
3. Press the [ENTER/SELECT] key followed by the [MENU] key.

Setting CPA/TCPA alarm ranges

When the predicted CPA of any target becomes smaller than a preset CPA alarm range and its predicted TCPA less than a preset TCPA alarm limit, the EPA releases an audible alarm and displays the warning label COLLISION appears on the screen. In addition, the EPA symbol changes to a triangle and flashes together with its vector.

Provided that this feature is used correctly, it will help prevent the risk of collision by alerting you to threatening targets. It is important that GAIN, A/C SEA, A/C RAIN and other radar controls are properly adjusted.

CPA/TCPA alarm ranges must be set up properly taking into consideration the size, tonnage, speed, turning performance and other characteristics of own ship.

> **⚠ CAUTION**
>
> **CPA/TCPA Alarm**
>
> The CPA/TCPA alarm feature should never be relied upon as the sole means for detecting the risk of collision.
> The navigator is not relieved of the responsibillity to keep visual lookout for avoiding collisions, whether or not the radar or other plotting aid is in use.

To set the CPA/TCPA alarm ranges:

1. Press the [MENU] key.
2. Press the [7] key twice to display the PLOT menu.

PLOT MENU 1

1. MARK DISP	OFF	[ON]
2. ERASE		
3. VECT REF	[REL]	TRUE
4. VECT TIME	[30S]	1M 3M 6M 15M 30M
5. CPA SET	[OFF]	0.5NM 1NM 2NM 3NM 4NM 5NM 6NM
6. TCPA SET	[30S]	1M 2M 3M 4M 5M 6M 12M
7. HISTORY	[OFF]	ON
8. INTVAL	[30S]	1M 2M 3M 6M
9. REF TGT		
0. ↓		

Figure 1-27 PLOT menu

3. Press the [5] key for CPA SET or [6] key for TCPA set.
4. Press the [5] key or [6] key again to select CPA or TCPA range desired.
5. Press the [ENTER/SELECT] key to register your selection.
6. Press the [MENU] key to close the menu.

Silencing CPA/TCPA audible alarm

Press the [AUDIO OFF] key to acknowledge and silence the CPA/TCPA audible alarm.

The warning label COLLISION and the flashing of the triangle plot symbol and vector remain on the screen until the dangerous situation is gone or you intentionally terminate tracking of the target by using the trackball.

Past plot points

Past plot points may be marked on the display by dots. Up to nine dots can be displayed as follows:

1. Press the [MENU] key.
2. Press the [7] key twice to select PLOT.

PLOT MENU 1

1. MARK DISP	OFF	[ON]
2. ERASE		
3. VECT REF	[REL]	TRUE
4. VECT TIME	[30S]	1M 3M 6M 15M 30M
5. CPA SET	[OFF]	0.5NM 1NM 2NM 3NM 4NM 5NM 6NM
6. TCPA SET	[30S]	1M 2M 3M 4M 5M 6M 12M
7. HISTORY	[OFF]	ON
8. INTVAL	[30S]	1M 2M 3M 6M
9. REF TGT		
0. ↓		

Figure 1-28 PLOT menu

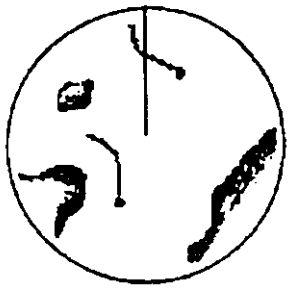
3. Press the [7] key to select OFF or ON from the HISTORY field as appropriate.
4. Press the [ENTER/SELECT] key to register your selection followed by the [MENU] key to close the menu.

1.26 Target Trails (Echo Trails)

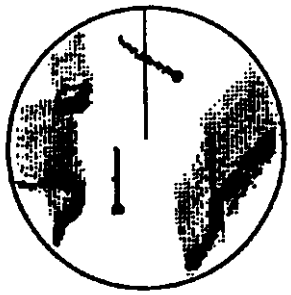
It is possible to display the trails of the radar echoes of targets in the form of synthetic afterglow. Target trails are selected either relative or true and may be sea or ground stabilized. The simulated afterglow can be selected in a single tone or gradual shading depending on a setting on the TGT TRAIL menu.

True or relative trails

You may display target trails relative to north or own ship's heading on Relative Motion. True motion trails require a compass signal and own ship speed input to cancel out own ship's movement and present true target movements in accordance with their over-the-ground speeds and courses.



a) True target trails-no smearing of stationary targets



a) Relative target trails-all targets moving relative to own ship

Figure 1-29 Target trails

Note: When true trail is selected on the RM mode, the legend TRUE TRAIL appears in red.

To select true or relative target trail presentation:

1. Press the [MENU] key.
2. Press the [2] key twice to show the TGT TRAIL menu.

TGT TRAIL

1. TIME	15S [30S]	1M 6M 30M CONT
2. MODE	[REL]	TRUE
3. SHADE	MONO	[MULTI]
4. TRAIL COPY	[OFF]	ON
5. THIN TRAIL	[OFF]	ON

Figure 1-30 TGT TRAIL menu

3. Press the [2] key several times to select REL or TRUE from the MODE field as appropriate.

4. Press the [ENTER/SELECT] key to confirm your selection, then the [MENU] key to close the menu.

Trail gradation

Target trails may be shown in monotone or multitone. Gradual shading paints the trails getting thinner with time just like the afterglow on an analog PPI radar.

Monotone (Single) *Gradual shading (Multi)*

Figure 1-31 Monotone and multitone target trails

1. Press the [MENU] key.
2. Press the [2] key twice to select TGT TRAIL.

TGT TRAIL		
1. TIME	15S [30S] 1M 6M 30M CONT	
2. MODE	[REL]	TRUE
3. SHADE	MONO	[MULTI]
4. TRAIL COPY	[OFF]	ON
5. THIN TRAIL	[OFF]	ON

Figure 1-32 TGT TRAIL menu

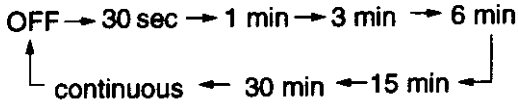
3. Press the [3] key to select SINGLE or MULTI from the SHADE field as appropriate.
4. Press the [ENTER/SELECT] key and the [MENU] key in order.

Displaying and erasing target trails

Press the [TGT TRAIL] key to activate or deactivate the target trails feature.

Each press of the [TGT TRAIL] key within 5 seconds cyclically changes target trail length (time) to 30 seconds, 1, 3, 6, 15, 30 minutes, continuous target trail, and OFF.

The current target trail setting is displayed at the upper right-and corner of the screen.



Suppose that "3 MIN" has just been selected. If the [TGT TRAIL] key is pressed more than 5 seconds later, target trails are removed from the display (memory still alive with target trail timer count going on). Next hitting of the key calls out the target trails on the screen. To proceed to a longer plot interval, successively push the [TGT TRAIL] key with a hit-and-release action. The larger the target trail length, the larger the target trail plot interval.

Note: Holding the [TGT TRAIL] key depressed for about 3 seconds will cause a loss of target trail data so far stored in an memory.

Restoring trails

Trails are cancelled and restarted whenever the range is changed. However, you can continue trails on the same range, without restarting, when the range is changed to a next larger or smaller range scale. Note however that when the range is changed, only those target trails within the previous range are continued; no trails are generated for targets outside of the previous range.

1. Press the [MENU] key.
2. Press the [2] key twice to select TGT TRAIL.
3. Press the [4] key to select ON from the TRAIL COPY field.
4. Press the [ENTER/SELECT] key and [MENU] key in order.

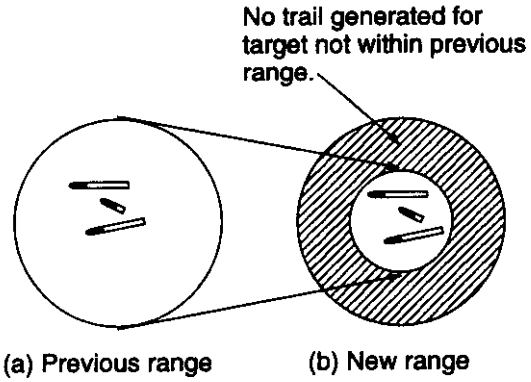


Figure 1-33 How trail copy works

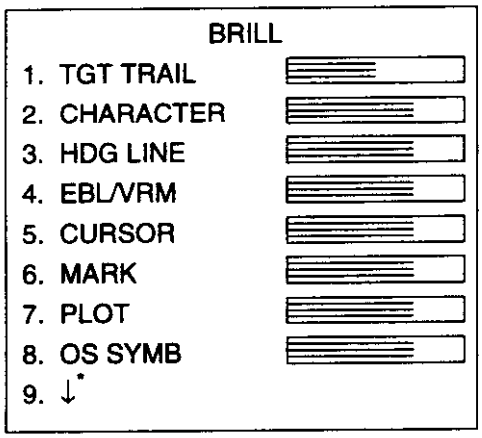
Resetting target trails

To reset (or clear) the target trail memory, hold the [TGT TRAIL] key depressed for about 3 seconds. Target trails are cleared and the trailing process restarts from time count zero at current target trail plot interval.

Trail brilliance

The brilliance of target trails can be adjusted on the BRILL menu as follows:

1. Press the [MENU] key.
2. Press the [9] key twice to display the BRILL menu.



* Requires RP Board.

Figure 1-34 BRILL menu

3. Press the [1] key to select TGT TRAIL.
4. Operate the VRM rotary control to adjust brilliance. Current brilliance is shown by the bar graph.
5. Press the [ENTER/SELECT] key to conclude your selection followed by the [MENU] key to close the menu.

1.27 Parallel Index Lines

Parallel index lines are useful for keeping a constant distance between own ship and a coastline or a partner ship when navigating. The orientation of the index lines is controlled with the EBL rotary control without and the intervals between the lines adjusted with the VRM rotary control (provided that No.2 VRM is active).

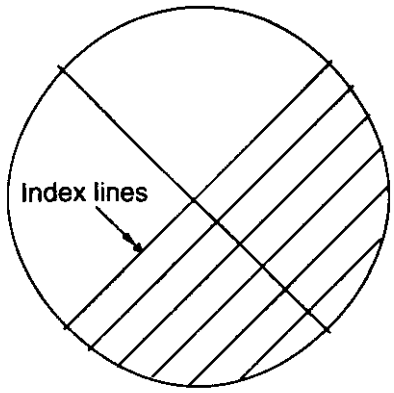


Figure 1-35 Parallel index lines

Displaying/erasing the index lines

Press the [INDEX LINE] key to display/erase the index lines.

Selecting number of index lines to display

Maximum number of the index lines can be set for 2 or 6 on the MARK DISP sub menu in the OTHER menu.

1.28 Origin Mark

You can mark any reference points, prominent target or a point of particular interest using the origin mark feature. This mark is geographically fixed, namely, ground stabilized. Twenty such origin marks can be entered.

To use the origin mark:

1. Place the cursor (+) at a point where you want to place a reference mark by operating the trackball.
2. Press the [MARK] key. The origin mark appears at the cursor position, of which range and bearing are indicated at the upper-right section of the screen.

Origin mark reference

The origin mark can be set relative to own ship, or referenced to land (sea or ground stabilized).

1. Press the [MENU] key.
2. Press the [8] key twice to select MARK.

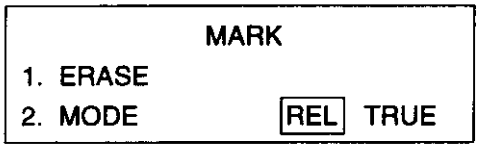


Figure 1-36 MARK menu

3. Press the [2] to select the REL or TRUE as required.
4. Press the [ENTER/SELECT] key.
5. Press the [MENU] key.

Erasing origin marks

Erasing individual origin marks

Select the origin mark with the cursor and then press the [CANCEL/CLEAR] key.

Erasing all origin marks

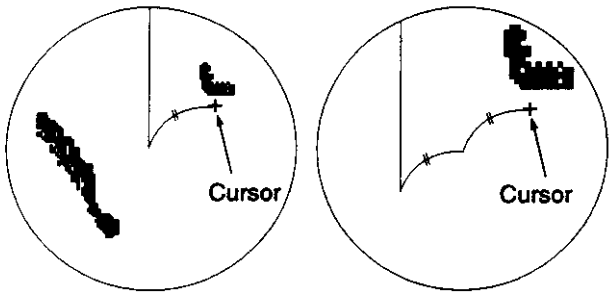
1. Press the [MENU] key.
2. Press the [8] key twice to select MARK.
3. Press the [1] to select the ON option from the ERASE field.
4. Press the [ENTER/SELECT] key.
5. Press the [MENU] key.

1.29 Zoom

The zoom function is available on the R-type radar only, and it enlarges an area of interest as large as twice the normal viewing.

1. Place the cursor (+) close to the point of interest by operating the trackball.
2. Press and hold down the [SHIFT/ZOOM] key for about two seconds. The area around the cursor and own ship is enlarged twice as large as the original size.
4. To cancel zoom, press and hold down the [SHIFT/ZOOM] key about two seconds.

Note: The zoom feature is inoperative when the display is off centered.



(a) Cursor placed at point of interest

(b) Zoom in (R-type only)

Figure 1-37 Zoom

1.30 Markers

Heading line and heading marker

The heading line indicate the ship's heading in all presentation modes. The heading line is a line from the own ship position to the outer edge of the radar display area and appears at zero degrees on the bearing scale in head-up mode, it changes the orientation depending on the ship orientation in the north-up and true motion modes. The heading marker appears as a small circle on the bearing scale to indicate the heading when the display is shifted or is in the north-up or TM mode.

Temporarily erasing heading line

To temporarily extinguish the heading line to look at targets existing dead ahead of own ship, press the GAIN control. The heading line reappears when the control is released.

North marker

The north marker appears as a short dashed line. In the head-up mode, the north marker moves around the bearing scale in accordance with the compass signal.

Stern marker

The stern marker (a dot-and-dash line) appears opposite to the heading line. It can be displayed/erased on the MARK DISP sub menu in the OTHER menu.

Own ship marker

The own ship marker (⌂) can be displayed/erased on the MARK DISP sub menu in the OTHER menu.

1.31 Suppressing Second-trace Echoes

In certain situations, echoes from very distant targets may appear as false echoes (second-trace echoes) on the screen. This occurs when the return echo is received one transmission cycle later, that is, after a next radar pulse has been transmitted.

To activate or deactivate the second-trace echo rejector:

1. Press the [MENU] key followed by the [5] key twice to display the ECHO SIG menu.

ECHO SIG

1. COLOR	[YEL]	GRN	*
2. CLTR SWEEP	[OFF]	ON(LINK)	ON(FIX)
3. SWEEP LVL	[1]	2	3
4. ENHANCE	[OFF]	ON	
5. 2ND ECHO	[OFF]	ON	
6. PULSE 1			
7. PULSE 2			

* MULTI appears on R-type.

Figure 1-38 ECHO SIG menu

2. Press the [5] key to select OFF or ON.
3. Press the [ENTER/SELECT] key to conclude your selection followed by the [MENU] key to close the menu.

1.32 [F2] Key

The [F2] key provides programmed parameters by the user. For example, you can program the [F2] key as below.

Presetting the [F2] key

1. Press the [MENU] key.
2. Press the [6] key twice to display the FUNC menu.

FUNC

1. FUNC1	[OFF]	ON
2. FUNC2	[OFF]	ON
3. FUNC3	[OFF]	ON
4. FUNC1 SET		
5. FUNC2 SET		
6. FUNC3 SET		
7. F•2 SET		

Figure 1-39 FUNC menu.

3. Press the [7] key twice to select F•2 SET. The following display appears:

[F•2 MENU]

1. TRAIL TIME	26. HUTB MODE
2. TRAIL MODE	27. TUNE A/M
3. TRAIL SHADE	28. EXT WPT
4. TRAIL LEVEL	29. OS POSN
5. ALARM AREA	30. CURS BRG
6. ALARM MODE	31. EBL1 T/R
7. PANEL DIMMER	32. EBL2 T/R
8. TGT COLOR	33. CURS RNG
9. ECHO AVG	34. VRM1 RNG
10. INT REJ	35. VRM2 RNG
11. ECHO STRETCH	36. CLTR SWEEP
12. NOSE REJ	
13. ECHO ENHANCE	
14. 2ND ECHO	
15. VIDEO CONTR	
16. PLOT MENU	
17. MARK MODE	
18. BRILL MENU	
19. DRIFT MENU	
20. NAV DATA	
21. DISPLAY	
22. SART	
23. TIMER ALM MENU	
24. STERN MK	
25. OS MARK	

Select by VRM control
and hit ENTER key.

Figure 1-40 User key setup menu

4. Select function desired with the VRM rotary control.

4. Press the [ENTER/SELECT] key to register your selection, and then press the [MENU] key to finish.

Then, with a single press of the [F2] you can turn on the function preprogrammed in the procedure above.

1.33 [F1] Key

The [F1] key allows instant access to often-used menu items.

1. Press the [F1] key. The following menu appears.

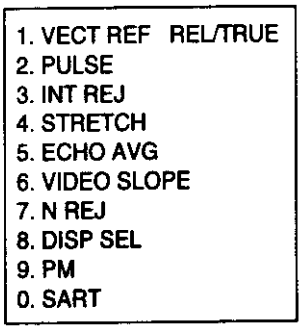


Figure 1-41 F1 menu

2. Press appropriate numeric key. For example, press the [4] key to select desired echo stretch level.

1.34 FUNCTION Key

The FUNCTION key works similar to the automatic dialing feature on a telephone, playing back control settings just as they were registered. Instead of manually adjusting controls to set up for a particular condition, for example, navigation in a harbor, you can have the [FUNCTION] key to do it for you.

Presetting the FUNCTION key

The radar's internal computer offers several navigation condition setups as outlined in the table below. For instance, you might want to select HBR (Harbor) as objective "FUNC1" of the [FUNCTION] key. Then, when you select F1 with this key the radar will be instantly set to magnify target echoes on the 1.5 nm range or lower.

The navigation condition setup options assignable to the [FUNCTION] key are shown in the table below.

Each setup option defines a combination of several radar settings for achieving optimum setup for a particular navigating situation. Those involved are echo average, interference rejector, echo stretch, noise rejector, enhanced video, video contrast, automatic anti-clutter.

Adjusting these features on a function key menu changes the original function key settings. To restore the original settings for a particular function key, it is necessary to display the relevant function key menu and select appropriate menu options.

1. Press the [MENU] key.
2. Press the [6] key twice to display the FUNC menu.

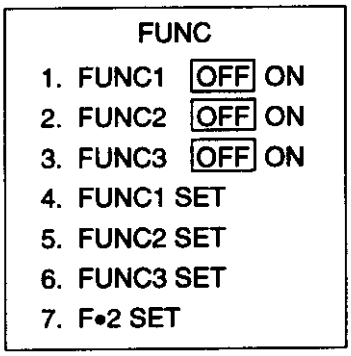


Figure 1-42 FUNC menu

3. Press [4], [5] or [6] twice to select which function number to preset. For example, press the [4] key to select FUNC1.

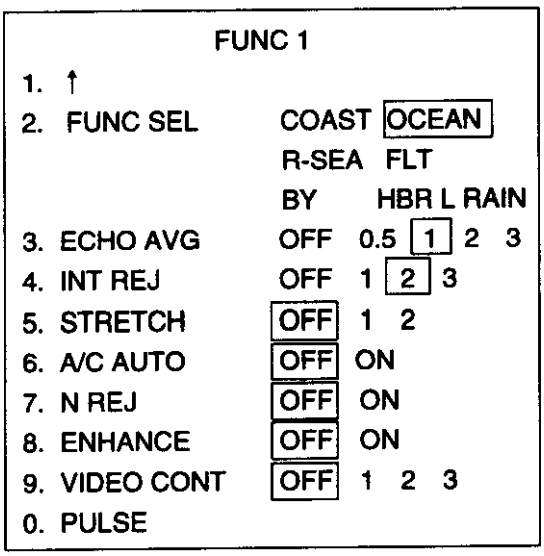


Figure 1-43 FUNC 1 menu

4. Press the [2] several times to select function desired.
5. Press the [ENTER/SELECT] key. The settings of items 3-9 automatically change according to selection made at step 4. You
6. Press the [MENU] key.

Activating/deactivating a function

Press the [FUNCTION] key. Each time the key is pressed a preset function the preset functions enabled on the FUNC menu are turned on or off cyclically.

You may enable/disable preset functions from the menu as follows:

1. Press the [MENU] key followed by the [6] key twice to display the FUNC menu.
2. Press the [1], [2] or [3] key to enable or disable a preset function as appropriate.
3. Press the [ENTER/SELECT] key to register your selection and the [MENU] key to close the menu.

Table 1-3 Function description

Label	Description
COAST	Optimum setting for short range detection using a range scale between 1.5 and 6 nm on calm seas.
OCEAN	Optimum setting for long range detection using a range scale between 6 and 24 nm.
R-SEA	Optimum setting for heavy seas usng a range scale between 3 and 12 nm.
FLT	Optinum setting for detection of fishing floats on a range scale of 1.5 nm or lower.
BY	Optimum setting for detection of buoys (nav, radio, etc.) on a range scale of 1.5 nm or lower.
HBR	Optimum setting for short range detection in a harbor using a range scale of 1. 5 nm or lower.
L(ONG)	Optimum setting for long range detection using a long range scale.
RAIN	Optimum setting for heavy rain conditions using a range scale between 6 and 24 nm.

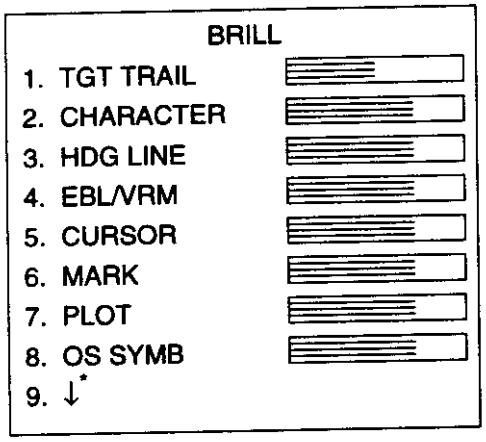
Table 1-4 FUNCTION key default settings

Item	3. ECHO AVG	4. INT REJ	5. ECHO STRETCH	6. NOISE REJ	7. ENHANCED VIDEO	8. VIDEO CONTRAST	9. A/C AUTO
COAST	1	2	OFF	OFF	OFF	2	OFF
OCEAN	1	2	OFF	OFF	OFF	2	OFF
R-SEA	1	2	OFF	OFF	OFF	2	ON
FLT	1	2	OFF	OFF	OFF	2	ON
BY	1	2	2	ON	OFF	3	OFF
HBR	OFF	2	OFF	OFF	OFF	2	OFF
L	1	2	OFF	ON	OFF	2	OFF
RAIN	0.5	1	OFF	OFF	OFF	2	OFF

1.35 Adjusting Brilliance of Screen Data

You can adjust relative brilliance levels of various marks and alphanumeric readouts displayed on the screen as follows:

1. Press the [MENU] key.
2. Press the [9] key twice to show the BRILL menu.



* Requires RP Board.

Figure 1-44 BRILL menu

3. Select a desired menu item by pressing the corresponding numeric key. As an example, press the [1] key if you want to change the brilliance of target trails.
4. Operate the VRM rotary control to adjust brilliance. Current brilliance level is displayed by the bar-graph to the right of each menu item.
5. Press the [ENTER /SELECT] key conclude your selection followed by the [MENU] key to close the menu.

1.36 Echo Stretch, Enhanced Video

Echo stretch

On long ranges target echoes tend to shrink in the bearing direction, making them difficult to see. On short and medium ranges such as 1.5, 3 and 6 nm scales, the same size targets get smaller on screen as they approach the own ship. These are due to the inherent property of the radiation pattern of the antenna. To enhance target video, use the echo stretch function. There are two types: echo stretch 1 (ES1) to enlarge in bearing direction for long range detection, and echo stretch 2 (ES2) to enlarge in range direction on 1.5-6 nm scales.

To activate the echo stretch:

1. Press the [F1] key.
2. Press the [4] key twice to display the ECHO SIG menu.

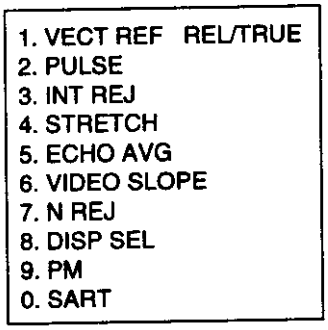


Figure 1-45 F1 menu

3. Press the [4] key to select echo stretch function desired. Select level appears at the lower left-hand position. Each one functions as in the figure below.

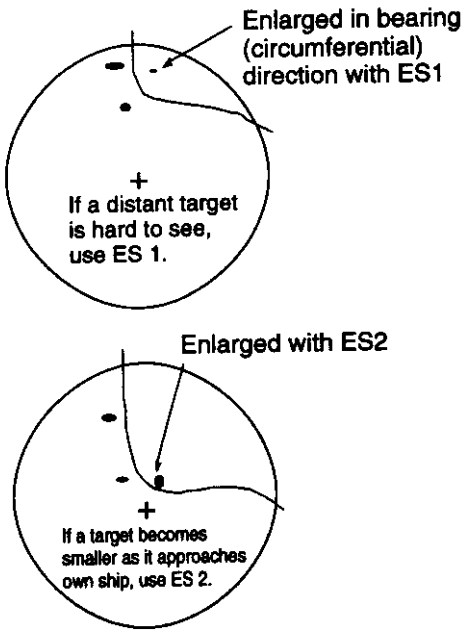


Figure 1-46 Echo stretch

Notes:

1) If the 1.5 nm range is preset for pulselength of S1 or S2, and the 3 nm scale for S2, the echo stretch is not available on those range scales.

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

Enhanced video

The enhanced video function works similar to the echo stretch function, enlarging target echoes in bearing and range direction on 1.5-6 nm scales.

1. Press the [MENU] key followed by the [5] key twice to show the ECHO SIG menu.

ECHO SIG			
1. COLOR	[YEL]	GRN	*
2. CLTR SWEEP	[OFF]	ON(LINK)	ON(FIX)
3. SWEEP LVL	[1]	2	3
4. ENHANCE	[OFF]	ON	
5. 2ND ECHO	[OFF]	ON	
6. PULSE 1			
7. PULSE 2			

* MULTI appears on R-type.

Figure 1-47 ECHO SIG menu

2. Press the [4] key to select OFF or ON from the ENHANCE field as appropriate

3. Press the [ENTER/SELECT] key, and then press the [MENU] key.

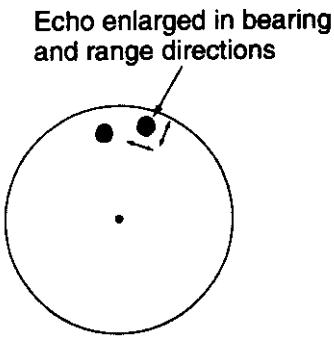


Figure 1-48 How the enhance function works

1.37 Watch Timer

The watch timer works like an alarm clock, sounding visual ("WATCH") and audible alarms at a predetermined interval.

To silence the alarm, press the [AUDIO OFF] key. The label WATCH turns to normal color and the alarm timer is reset to the initial value and starts the count-down sequence again.

To activate the timer:

1. Press the [MENU] key followed by the [4] key twice to select WATCH TIM.

WATCH TIM				
1. ALM INTVL	[OFF]	3M	6M	12M
		15M	20M	

Figure 1-49 WATCH TIM menu

2. Press the [1] key to select desired interval (3, 6, 12, 15, 20 min) from the ALM INTVL field.

3. Press the [ENTER/SELECT] key to conclude your selection followed by the [MENU] key to close the menu.

1.38 Noise Rejector

The noise rejector suppresses white noise, which appears on as many dots scattered randomly over the display.

To suppress white noise:

1. Press the [F1] key.

1. VECT REF REL/TRUE
2. PULSE
3. INT REJ
4. STRETCH
5. ECHO AVG
6. VIDEO SLOPE
7. N REJ
8. DISP SEL
9. PM
0. SART

Figure 1-50 F1 menu

2. Press the [7] key to turn the noise rejector on or off as appropriate. NR appears at lower left-hand position when the noise rejector is on.

1.39 Navigation Data

Various navigation data can be displayed (and their format selected) with connection of appropriate external sensors. You can select which navigation data to display as follows:

1. Press the [MENU] key, and then the [0] key twice to show the OTHER menu.
2. Press the [8] key twice to select display the NAV DATA menu.
3. Press appropriate numeric key to turn data on/off, select format.
4. Press the [ENTER/SELECT] key, and then press the [MENU] key.

1.40 Alarm Output

Alarm signal can be output. Select the alarm(s) to output as follows:

1. Press the [MENU] key.
2. Press the [0] key twice.
3. Press the [0] key twice again to select the sub menu OTHER.
4. Press the [4] key to select OUTPUT ALM.

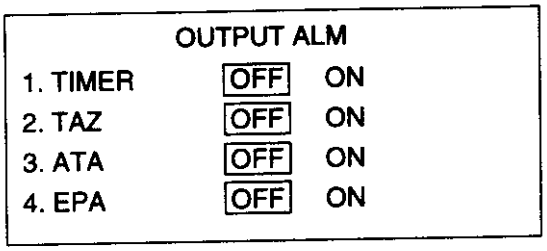


Figure 1-51 OUTPUT ALM menu

5. Press appropriate numeric key to select the alarm you want to output.
6. Press the [ENTER/SELECT] key followed by the [MENU] key.

1.41 Outputting Target Position

Target position can be output (in IEC 61162-1 format) to a video plotter and marked on its screen with a symbol. Select target with the trackball and push the A/C RAIN control. Target position is output to the video plotter connected to the NAV connector on the SPU Board inside the radar display unit. This function requires position data and compass signal.

1.42 Degaussing Interval

The screen is degaussed automatically at certain time intervals, as well as each time the radar is turned on, to demagnetize the CRT screen to eliminate color contamination caused by earth's magnetism or magnetized ship structure. You can select the degaussing interval and the degaussing degree as follows:

1. Press the [MENU] key followed by the [0] key twice to select OTHER.
3. Press the [0] key twice again to select the sub menu OTHER.

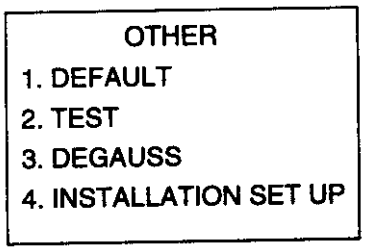


Figure 1-52 OTHER sub menu

4. Press the [3] key to display the DEGAUSS menu.

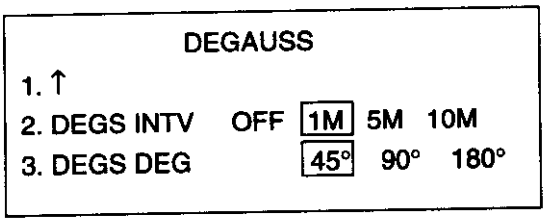


Figure 1-53 DEGAUSS menu

5. Press the [2] key to select desired degaussing interval (OFF, 1, 5, 10 min) from the DEGS INTV field.

6. Press the [3] key to select desired degaussing degree (45°, 90°, 180°) from the DEGS DEG field. For example, selecting 45° will automatically degauss the screen when the ship makes a turn which is between 45° and 89°.
5. Press the [ENTER/SELECT] key followed by the [MENU] key.

1.43 Background Color

The [BKGND COLOR] key selects the color of the background, characters, menu, markers and indications from the color combinations shown below. Each press of the key selects one of five color combinations.

Arrangement	1	2	3	4	5
Radar Display Area	BLK	L-BLU	L-BLU	L-BLU	BLK
Outside Radar Display Area	BLK	BLK	BLK	L-BLU	BLK
Characters	GRN	GRN	GRN	WHT	RED
Menu	YEL	YEL	YEL	YEL	YEL
Menu Highlight	RED	RED	RED	RED	RED
EBL/VRM	BLU	GRN	GRN	GRN	BLU
Range Rings	GRN	WHT	WHT	WHT	GRN
Cursor	WHT	GRN	GRN	GRN	WHT
Heading Line	GRN	WHT	WHT	WHT	GRN
Target Alarm Zone	WHT	BLU	BLU	BLU	WHT
North Mark	WHT	BLU	BLU	BLU	WHT
Stern Marker	WHT	BLU	BLU	BLU	WHT

1.44 Clutter Sweep

The clutter sweep feature suppresses sea and rain clutters within the trackball-selected area, to discriminate specific targets from noise. The user may select the area to process and the level of suppression to apply as follows:

1. Press the [MENU] key.
2. Press the [5] key twice to select the ECHO SIG menu.
3. Press the [2] key to turn on/off the clutter sweep function:

   OFF: Turns off clutter wiper feature.
   ON(LINK): Sweep area moves with trackball operation. Sweep cursor shown by dashed lines.
   ON(FIX): Sweep area is fixed on the screen. Sweep cursor shown by solid lines.
4. Press the [3] key (SWEEP LVL) several times to select level of suppression to use; "3" provides the highest level of noise suppression.
5. Press the [ENTER/SELECT] key to register your selection and the [MENU] key to finish.
6. Operate the trackball to select area to process.

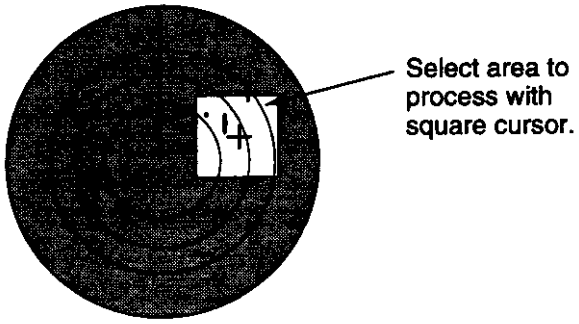


Figure 1-54 Selection of area to process with clutter sweep

The clutter sweep feature may also be activated by the [F2] key.

1.45 Day, Night Brilliance

The secondary function of the BRILL control is to provide instant bright or dim brilliance. Push the control to select bright or dim brilliance.

1.46 Radar Map (RP-17 required)

A radar map is a combination of map lines and symbols whereby the user can define and input the navigation, route planning and monitoring data on the radar equipment. Map lines are navigational facility whereby the observer can define lines to indicate channels or traffic separation schemes. Also called **nav lines**, these lines can be ground stabilized to stop them from drifting. (Definition in IEC 60936-1 and IEC 60872-1)

In this series of radar, a radar map may contain 3,000 points of mark and line data on one map. One map can be memorized to facilitate the repeated use on the routine navigation area.

The user can create a radar map on-real time base while using the radar for navigation or at leisure time at anchor or while the radar is not being used. Place of a map can be made for any waterways apart from the actual own ship location. The map data is stored on EEROM card which is mounted on the main processor board socket. When the optional RP board RP-17 and RAM card are installed in the display unit, much more data can be created and copied to another card.

Preparation

Selecting navaid

1. Press the [MENU] key.
2. Press the [0] key twice.
2. Press the [0] key twice again to display the NAV DATA menu.
3. Press [2] key to select navigation data input device.
4. Press the [ENTER/SELECT] key to register your selection and the [MENU] key to close the menu.

Notes:

1) Own ship position display requires an input from radionavigational equipment such as a GPS receiver in accordance with the data format as defined by IEC 61162-1.
2) Wind, water current, depth, water temperature are not displayed when relevant sensors are not fitted and the text are for these is used for displaying another target data.

Displaying external waypoint

Waypoint defined on another navaid can be displayed by setting EXT WP to ON on the NAV DATA menu. This can be done by the keying sequence of MENU, [0], [0], [0], [0], [3].

Note: When the waypoint is more than 5000 nm away from own ship, the data shows ">5000 nm".

Making a radar map

Mark entry

Marks can be entered in 3 different ways.

1. Press the [MENU] key and the [8] key twice to display the MARK menu.

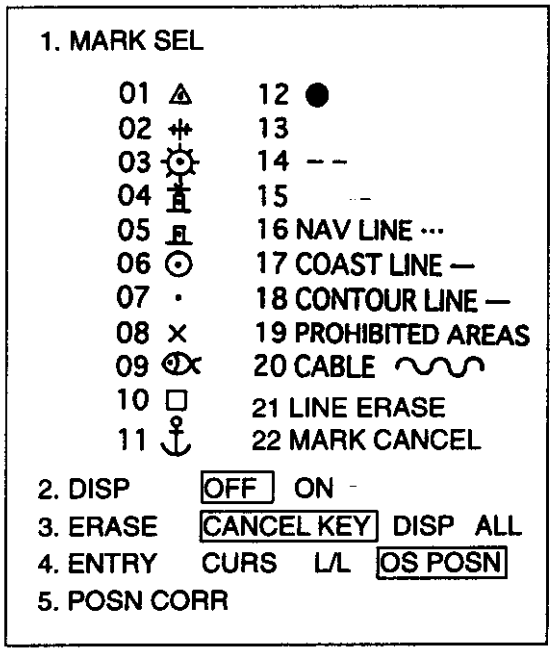


Figure 1-55 MARK menu

2. Press the [4] key to select the entry mode: CURS, L/L or OS POSN (Own Ship Position). For L/L, key in position with the ten keys.
3. Press the [ENTER/SELECT] key.

4. Press the [1] key and key in mark to enter with the ten keys.
5. Press the [ENTER/SELECT] key.
6. Press the [MARK] key to enter mark.
7. Repeat step 6 to continue entering the same mark with the same entry method. To enter a different mark or change mark entry method, repeat above procedure. The map is automatically stored in the radar's memory.

Example: How to draw a coastline by cursor

1. Press the [MENU] key and the [8] key twice to display the MARK menu.
2. Press [1] [1] [7] (for coastline mark) and press the [ENTER/SELECT] key.
3. Press the [4] key to select CURS and press the [ENTER/SELECT] key.
4. Press the [MENU] key.
5. Place the cursor mark on a required position and press the [MARK] key.
6. Place the cursor at a next position and press the [MARK] key. One line appears connecting designated two points.
7. Repeat step 6 to establish the coastline.

Position, bearing correction

There may be some instances where the chart latitude and longitude are by some seconds. You can compensate this error as follows:

1. Press the [MENU] key.
2. Press the [8] key twice to display the MARK menu.
3. Press the [5] key. The following display appears:

```
MARK
1. POSN CORR    [OFF] ON
2. POSN SET     00.00'N  00.00'E
3. BRG CORR     MAN [AUTO]
4. BRG SET      000.0°
```

Figure 1-56 Display for position, bearing correction

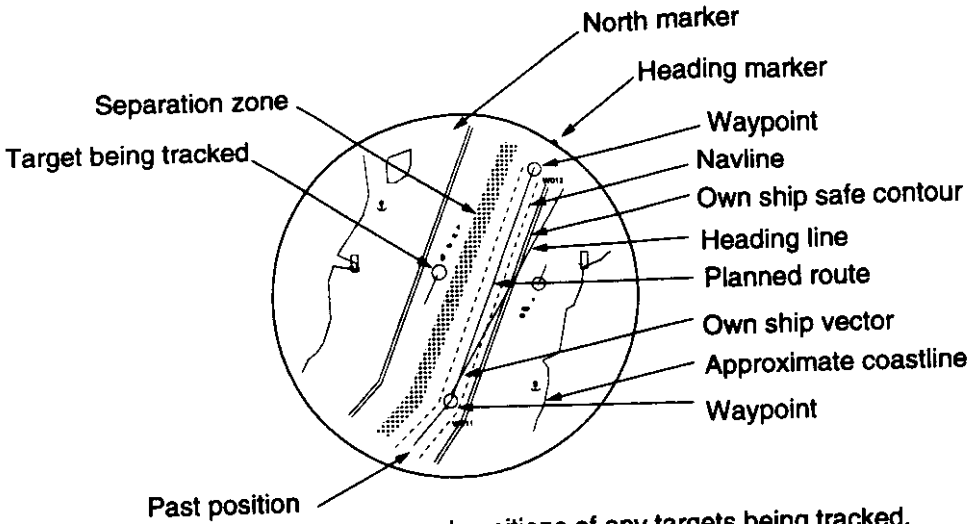
4. For position correction, press the [1] key to select ON from the POSN CORR field and press the [ENTER/SELECT] key.
5. Press the [2] key twice, and then operate the trackball to show adjust amount of position correction.
6. Press the [ENTER/SELECT] key.
7. **For bearing correction,** press the [3] key to select MAN from the BRG CORR field, and then press the [ENTER/SELECT] key.
8. Press the [4] key twice, and then operate the EBL control to adjust amount of bearing correction.
9. Press the [ENTER/SELECT] key followed by the [MENU] key.

Displaying the radar map

1. Press the [MENU] key to display the Main menu.
2. Press the [8] key twice to display the MARK menu.
3. Press the [2] key to select ON from the DISP field.
4. Press the [ENTER/SELECT] key followed by the [MENU] key.

Erasing contents of the radar map

1. Press the [MENU] key.
2. Press the [3] key twice to select method of erasure: CANCEL KEY (individual marks), DISPLAY (marks currently displayed), or ALL (all marks).
3. Press the [ENTER/SELECT] key followed by the [MENU] key.



ATA: Equally time-spaced positions of any targets being tracked.
Note-not equally geographically spaced.
EPA: Past plot positions may not be equally time-spaced, depending on operator preference.

Figure 1-57 Concept of radar map, ground stabilized

1.47 Alarms

The table below shows the alarm indications which appear on the display screen.

Table 1-5 Alarms

Fault	Audible alarm	Visual alarm	To quit alarm status
Heading failure	beeps	Heading label reads "***.**" and the message "HDG SIG MISSING" appears. SYSTEM FAIL HEADING in red. Display is automatically switched to Head-up mode within 1 min. (IEC 60936-1/3.12.1.1)	Match the on-screen Heading readout with the actual compass reading, if necessary. Then, press the CANCEL key to erase the message SET HEADING. To stop audible alarm press the AUDIO OFF key.
Target alarm	Beeps	Target flashes.	Press TGT ALARM key. (Section 1.20).
Watch alarm	Beeps	WATCH 0:00 (Label "WATCH" turns red and time count freezes at "0:00.").	Press the AUDIO OFF key. The label WATCH turns to normal video and the timer is reset (Section 1.37).
Own ship lat/lon Cursor lat/lon	None	"***.**" in own ship position field "***.**" in cursor position field	Make sure that own ship position data is fed from external radionav equipment.
System failure	None	Message "BRG SIG MISSING" appears. No radar echoes.	
Incorrect keystroke	Double beep tone	None	Correct keystroke is responded by a single beep provided that KEY BEEP ON is selected at installation.
Log failure	2 beeps	LOG **.* and "SYSTEM FAIL LOG" appear, if no log signal is input for 30 sec while the ship speed has been more than 5.0 kt for 3 min at below 0 kt.	If the log has failed, use the Manual Speed mode, or other appropriate sensor.

2. OPERATION OF AUTOMATIC TRACKING AID (ATA) ARP-17

2.1 Introduction

The FR-1505 MARK-3 series radar can accomodate an optional ATA (Automatic Tracking Aid) module complying with IMO MSC.64(69) Annex 4 and IEC 60872-2. With the optional ATA circuit board (ARP -17) Fitted in the display unit, the radar will automatically acquire 10 targets coming into the acquisition area. Once a target is acquired automatically or manually it is automatically tracked within 0.2 to 32 nm, whether inside or outside the acquisition area.

Menu tree

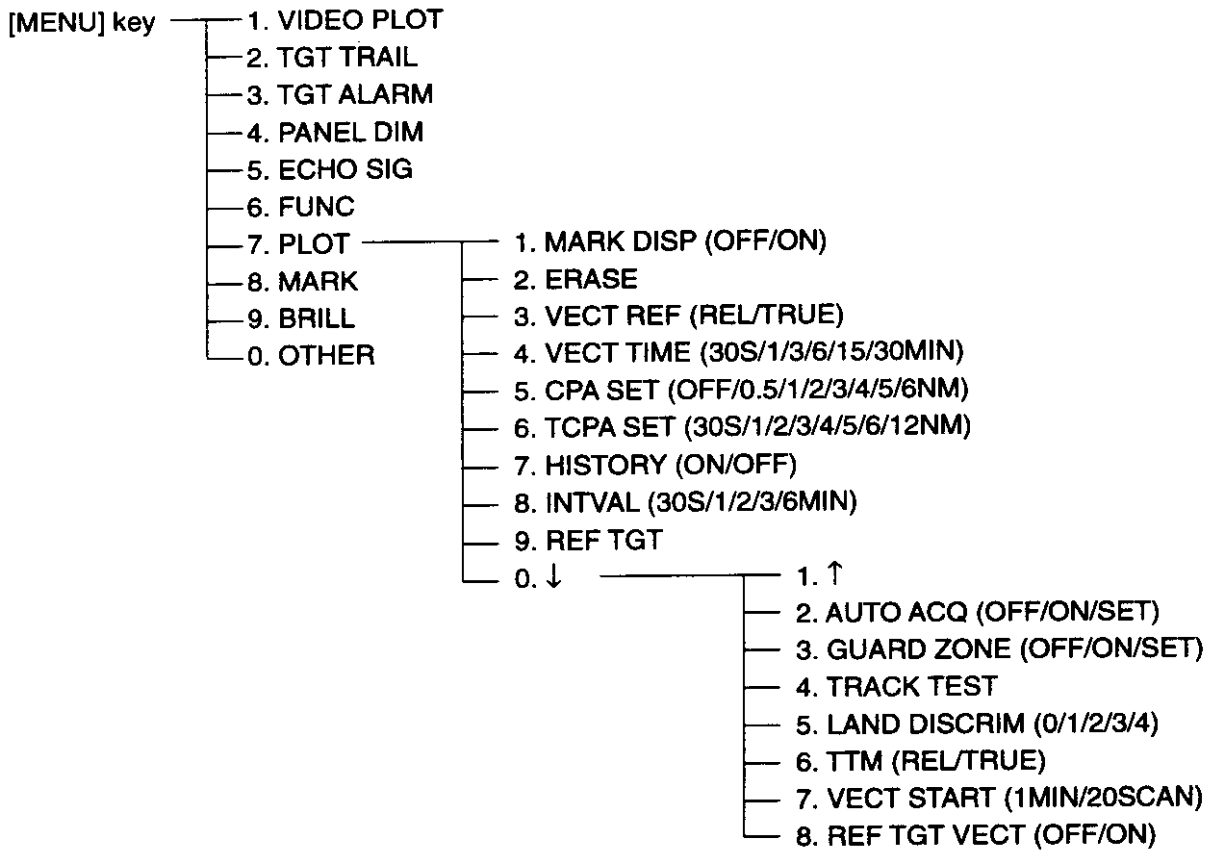


Figure 2-1 Menu tree

Menu description

Menu Item	Function
1. MARK DISP	Turns target data display on/off.
2. ERASE	Erases all plot symbols.
3. VECT REF	Selects vector reference; true or relative.
4. VECT TIME	Sets vector time.
5. CPA SET	Sets CPA alarm range.
6. TCPA SET	Sets TCPA alarm range
7. HISTORY	Turns past position display on/off.
8. INTVAL	Selects past position display plotting interval.
9. TGT BASED SPD	Selects number of reference targets to use.
0. ↓	Automatic Tracking Aid.
2. AUTO ACQ	Sets an automatic acquisition area.
3. GUARD ZONE	Sets a guard zone.
4. TRACK TEST	Test ATA processor for proper operation.
5. LAND DISCRIM	Sets size of echo to be recognized as landmass. The larger the figure the larger the landmass. Default setting is "2".
6. TTM	Turns target data output on/off.
7. VECT START	Start displaying a vector after 20 scans.
8. REF TGT VECT	Turns vector display on/off for reference target.

2.2 Criteria of Tracking

A target measuring 800 m or more in the radial or circumferential direction is regarded as a landmass and not acquired or tracked. Echoes smaller than 800 m are regarded as targets to be tracked.

The FURUNO ARPA ATA video processor detects targets in midst of noise and discriminates radar echoes on the basis of their 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 regarded as ships and displayed as small circles superimposed over the video echo.

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 Marine Organization Automatic Radar Plotting Aid (IMO ARPA) requirements, an indication of the motion trend should be available within 20 scans of antenna and full vector accuracy within 60 scans. The FURUNO ARPA s/ATAs comply with these requirements.

Acquisition and tracking

A target which is hit by 5 consecutive radar pulses is detected as a radar echo.

Auto acquisition is not defined in paints but in time, which should be less than 3 s of initial stage.

Manual acquisition is done by designating a detected echo with the trackball. Automatic acquisition is done in the acquisition areas when a target is detected 5-7 times continuously depending upon the congestion. Track-

ing is achieved when the target is clearly distinguishable on the display for 5 consecutive or alternate paints out of 10 consecutive scans whether acquired automatically or manually.

Targets not detected in 5 consecutive scans become "lost targets."

Quantization

The entire picture is converted to a digital from called "Quantified 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 5 consecutive 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 closet 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 closet 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. 5 consecutive 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 calculation 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.

Automatic acquisition areas and suppression lines

Performance of auto-acquisition is enhanced by controlling the limit lines (suppression lines) in the former series of FURUNO ARPAs. In the ATA, the automatic acquisition rings are used instead of the limit lines.

Auto acquisition rings work as suppression lines when viewed from the opposite direction. The should be placed clear of a landmass or shoreline. The acquisition areas may be a full 360 degree circle or sector of any angles. They are gyro stabilized.

Qualitative description of tracking error

The FURUNO ARPA accuracy complies 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 at high relative speed, or 3 to 6 seconds at low (near 0) relative speed. It is less accurate during a turn due to lag, but accuracy recovers quickly.

2.3 Activating, Deactivating the ATA

The ATA is activated/deactivated through the menu. Acquired targets are tracked internally when the ATA is deactivated.

1. Adjust the A/C RAIN, A/C SEA and GAIN controls for proper radar picture.
2. Press [MENU], [7], [7] to show the PLOT menu.

```
PLOT MENU 1
1. MARK DISP      OFF [ON]
2. ERASE
3. VECT REF       [REL] TRUE
4. VECT TIME      [30S] 1M 3M 6M
                  15M 30M
5. CPA SET        [OFF] 0.5NM 1NM
                  2NM 3NM 4NM
                  5NM 6NM
6. TCPA SET       [30S] 1M 2M 3M
                  4M 5M 6M 12M
7. HISTORY        [OFF] ON
8. INTVAL         [30S] 1M 2M 3M 6M
9. REF TGT
0. ↓
```

Figure 2-2 PLOT menu

3. Press the [1] key to select ON or OFF from the MARK DISP field.
4. Press the [ENTER/SELECT] key.
5. Press the [MENU] key to close the menu.

2.4 Entering Own Ship's Speed

The ATA requires own ship's speed and heading data. Of these, the speed data can be entered automatically from a speed log, navaid or manually through the menu.

Note: It is customary to use a speed relative to water for collision avoidance and a speed over the ground for navigation purpose.

Automatic speed input

1. Press [MENU], [0], [0] to display the OTHER menu.

```
OTHER
1. HDG SET
2. SPD MODE       [MAN] LOG *
3. MAN SPD
4. SET DRIFT
5. DISPLAY
6. MARK/LINE
7. TUNE
8. NAV DATA
9. EBL/VRM
0. OTHER
```

* NAV appears on R-type radar.

Figure 2-3 OTHER menu

2. Press the [2] key to select LOG or NAV from the SPD MODE field.
3. Press the [ENTER/SELECT] key.
4. Press the [MENU] key to close the menu.

Notes:

1) IMO Resolution A.823(19) for ARPA recommends that a speed log to be interfaced with an ARPA should be capable of providing through-the-water speed.
2) Be sure not to select LOG when a speed log is not connected. If the log signal is not provided, the ship's speed readout at the screen top will be blank.

3) SPEED **.* and SIGNAL MISSING " LOG" appears if no log signal is present for 30 s while the ship speed has been more than 5.0 kt or for 3 min below 5.0 kt.

4) With the serial speed inputs and SOG selection, if the type of data is changed from SOG to STW, the label SOG appears in red at the upper right corner on the screen.

Manual speed input

Select MAN at step 2 above, press the [3] key twice, and enter speed by operating the VRM control.

Target-based speed input

This mode is used when the ship's SDME (log) is not operating properly, ship's speed is changed minutely (in case of no log), or the vessel has no device which detects ship's leeward movement (doppler sonar 2-axis speed log, etc.) and leeward movement is not disregarded.

Note 1: The ATA calculates own ship's speed relative to a fixed target. Therefore, when selecting a target, a larger ground mass or a long coast line is not suitable as a reference target because of obscure reference point.

Note 2: A vector can be displayed for the reference target. This can be done with REF TGT VECT on the PLOT menu.

1. Select a small ground mass target (small island, lighthouse) 0.2 to 24 nautical miles from own ship.
2. Place the cursor on the target.
3. Press [MENU], [7], [7], [0], [0], [9], [9].
4. Place the cursor on the target and press the [PLOT SYMBOL] key.
5. Press the [MENU] key.

Reference targets are marked with a square symbol with a reference number (R1, R2, R3).

2.5 Acquiring Targets

The ATA permits automatic acquisition (10 targets) plus manual acquisition (10 targets), or fully manual acquisition (20 targets) within a range of 0.2 to 32 miles. The targets are automatically numbered and the same numbers are not used more than one until the maximum capacity is reached.

Before starting the ATA, check that heading and speed readouts at the top of the screen are reasonable.

Manual acquisition

1. Place the cursor (+) on a target of interest by operating the trackball.
2. Press the [PLOT SYMBOL] key.

The plot symbol changes its shape according to the status as below. A vector appears in about 20 antenna scans after acquisition indicating the target's motion trend. If the target is consistently detected for three minutes, the plot symbol changes to a solid mark. If acquisition fails, the target symbol blinks and disappears shortly.

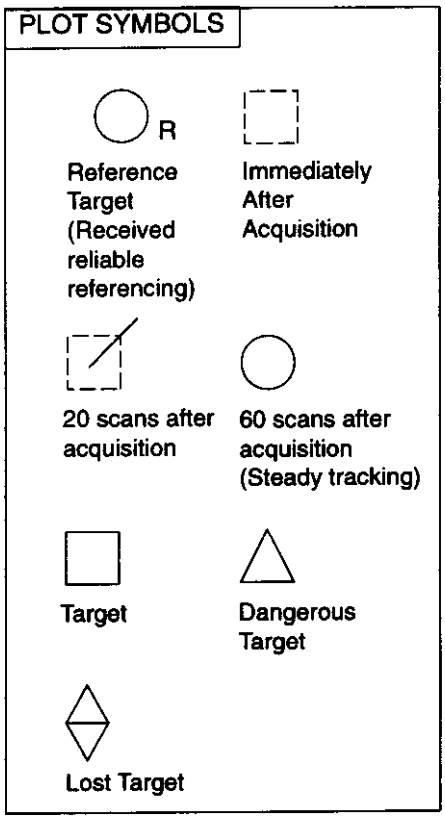


Figure 2-4 Plot symbols

⚠ CAUTION

TARGET SWAP

When a tracked target near another tracked target, the targets may be "swapped." When two targets come close to each other, one of the two can become a "lost target." Should this happen, reacquisition of the "lost target" is required after the two targets have separated.

Automatic acquisition

1. Press [MENU], [7], [7] to display the PLOT menu.
2. Press the [0] key twice.
3. Press the [2] key to select SET from the AUTO ACQ field.
4. Press the [ENTER/SELECT] key.
5. Place the cursor at upper (lower) left edge of area and press the [ENTER/SELECT] key.
6. Place the cursor at the lower (upper) right edge of the area and press the [ENTER/SELECT] key.

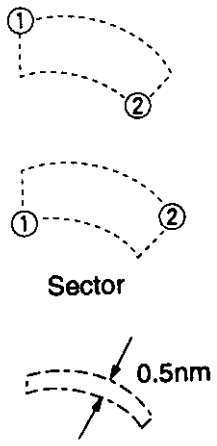


Figure 2-5 Automatic acquisition area

2.6 Terminating Tracking of Targets

When the ATA has acquired 10 targets, no more acquisition occurs unless targets are lost. Should this happen, cancel tracking of individual targets or all targets by the procedure described below.

Individual targets

Place the cursor (+) on a target which you do not want to be tracked any longer by operating the trackball and press the [CANCEL/CLEAR] key.

All targets

All targets can be canceled from PLOT menu as follows.

1. Press [MENU], [7], [7] to show the PLOT menu.
2. Press the [2] key twice to select ERASE.
3. Press the [ENTER/SELECT] key.
4. Press the [MENU] key.

2.7 Vectors

True or relative vector

Target vectors are displayed in relative or true mode. Own ship does not have a vector in relative mode. You may select true or relative vector with VECT REF on the PLOT menu.

Vector time

From the PLOT menu, VECT TIME (or the length of vectors) can be set to 30 seconds, 1, 3, 6, 15 or 30 minutes and the selected vector time is indicated on the screen.

The vector tip shows an estimated position of the target after the selected vector time elapses. It can be valuable to extend the vector length to evaluate the risk of collision with any target.

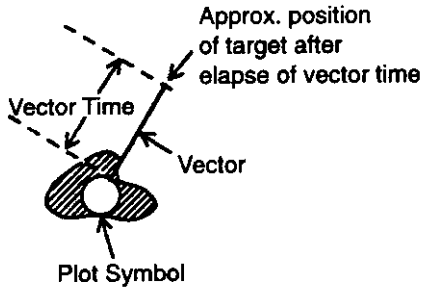
Vector start time

Whenever the range is changed the vectors for tracked targets is reestablished. You can select when to start reestablishment of the vectors with VECT START on the PLOT menu. The operator has the choices of 1 min or 20 scans.

2.8 Displaying Target Data

The ATA calculates motion trends (range, bearing, course, speed, CPA and TCPA) of all targets under tracking, and displays data of selected target at the top right corner of the screen.

Note: At the speed under 5 kts the target data is displayed with a delay because of filtration.



RNG XXXNM
BRG XXX.X° T
CSE XXX.X° T
SPD XX.XKT
CPA XXXNM←Range at CPA
TCPA : ←Time to CPA

Figure 2-6 Target data example

Displaying data

Place the cursor on a wanted target and press the [ENTER/SELECT] key. Data on the selected target is displayed on the screen. The data includes the follows;

BRG/RNG (Bearing/Range): **RNG/BRG** (Range/Bearing): Range and bearing from own ship to the selected target with suffix "T" (True) or "R" (Relative).

CSE/SPD (Course/Speed): Course and speed are displayed for the selected target with suffix "T" (True) or "R" (relative).

CPA (Closest Point of Approach) is the closest range a target will approach to own ship. Do not mix it with the operator preset CPA alarm limit.

TCPA is the time to CPA measured with present speeds of own ship and the targets. Both CPA and TCPA are automatically calculated. When a target ship has passed clear of own ship, the CPA is displayed and the TCPA appears as "**.*". TCPA is counted up to 99.9 min. and beyond this it is indicated as TCPA>99.9 min.

Note 1: MARK DISP on the PLOT menu must be turned on to display target data.

Note 2: Target data may be displayed with reference to North (True) or own ship heading (Relative). The desired reference may be selected with TARGET DATA on the PLOT menu.

2.9 Past Position Display

The ATA displays equally time-spaced dots (maximum 10 dots) marking the past positions of any targets being tracked.

If a target changes its speed, the spacing will be uneven. If it changes the course, its plotted course will not be a straight line in TM mode.

To turn the past position display on/off:

1. Press [MENU], [7], [7] to display the PLOT menu.
2. Press the [7] key to select ON or OFF from the HISTORY field.

Selecting plotting interval

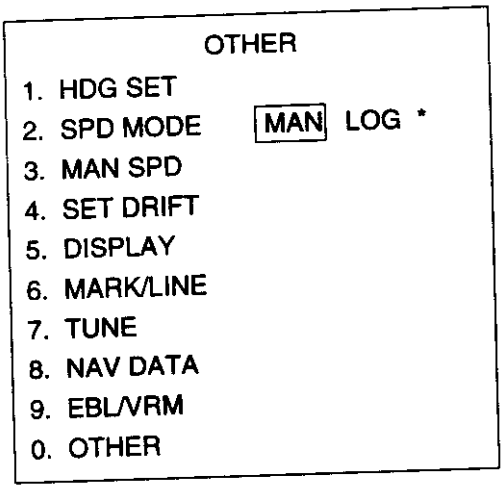
On the PLOT menu, select desired past position display plotting interval from the 8. INTVAL field.

2.10 Set and Drift

Set, the direction of ocean current, can be manually entered in the nearest degree. Drift, the speed of current, can also be entered manually, in 0.1 knot increments. 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 stationary targets. Thus, the speed and course of own ship over the ground are reciprocally calculated and compared with the relative bearing and range to the reference target to produce a Set and Drift. These values are applied to all targets. If stationary objects have vectors, the set and drift should be corrected until they lose their vectors.

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

1. Press [MENU], [0], [0] to display the OTHER menu.



* NAV appears on R-type radar.

Figure 2-7 OTHER menu

3. Press the [4] key twice to select SET/DRIFT.

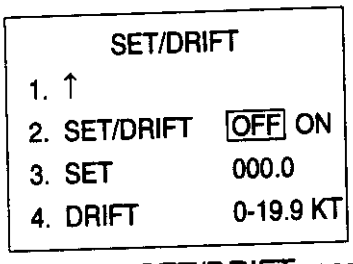


Figure 2-8 SET/DRIFT menu

4. Press the [2] key to select ON from the SET/DRIFT field, and then press the [ENTER/SELECT] key.
5. Press the [3] key twice, enter SET value, and then press the [ENTER/SELECT] key.
6. Press the [4] key twice, enter DRIFT value, and then press the [ENTER/SELECT] key.
7. Press the [MENU] key.

2.11 Alarms

CPA/TCPA alarm

Visual and audible alarms are generated when the predicted CPA and TCPA of any target become less than their preset limits. Press the [AUDIO OFF] key to acknowledge and silence the CPA/TCPA audible alarm.

The ATA continuously monitors the predicted range at the Closest Point of Approach (CPA) and predicted time to CPA (TCPA) of each tracked target to own ship.

When the predicted CPA of any target becomes smaller than a preset CPA alarm range and its predicted TCPA less than a preset TCPA alarm limit, the ATA releases an audible alarm. In addition, the target plot symbol changes to a triangle and flashes together with its vector.

Provided that this feature is used correctly, it will help prevent the risk of collision by alerting you to threatening targets. It is important that GAIN, A/C SEA, A/C RAIN and other radar controls are properly adjusted and the ATA is set up so that it can track targets effectively.

CPA/TCPA alarm ranges must be set up properly taking into consideration the size, tonnage, speed, turning performance and other characteristics of own ship.

The CPA/TCPA alarm feature should never be relied upon as a sole means for detecting the risk of collision. The navigator is not relieved of the responsibility to keep visual lookout for avoiding collisions, whether or not the radar or other plotting aid is in use.

Follow the steps shown below to set the CPA/TCPA alarm ranges:

1. Press [MENU], [7], [7] to display the PLOT menu.
2. Press [5] (CPA SET) to select CPA limit desired from the CPA SET line.
3. Press the [ENTER/SELECT] key.
4. Press [6] (TCPA SET) to select a TCPA limit desired.
5. Press the [ENTER/SELECT] key.
6. Press the [MENU] key to close the menu.

Silencing CPA/TCPA audible alarm

Press the [AUDIO OFF] key to acknowledge and silence the CPA/TCPA audible alarm.

The flashing of the triangle plot symbol and vector remain on the screen until the dangerous situation is no longer present or you intentionally terminate tracking of the target by using the [CANCEL/CLEAR] key.

Lost target alarm

When the system detects a lost target, tracking on the target is discontinued and the target symbol becomes a flashing diamond (◈). The normal plotting symbol is restored to the target when the target is manually acquired.

Confirming Lost Target

1. Place cursor on target.
2. Press the [CANCEL/CLEAR] key.

Guard zone alarm

When a target comes in the guard zone, the buzzer sounds and the indication "GUARD ZONE" appears. The intruding target is denoted by an inverted triangle mark.

You can set the guard zone as follows:

1. Press the [MENU], [7], [7] to display the PLOT menu.
2. Press the [0] key twice.
3. Press the [2] key to select GUARD ZONE.
4. Press the [2] key again to select SET and press the [ENTER/SELECT] key.
5. Set the cursor on one boundary of the guard ring and press the [ENTER/SELECT] key. Set the cursor on the other boundary and press the [ENTER/SELECT] key.

To disable the guard ring, select OFF at step 4 in the above procedure and press the [ENTER/SELECT] key.

2.12 Track Test (Simulation Display)

The simulation display tests the ATA processor for proper operation. The figure below shows the starting picture of the simulation display. Each mark moves as time passes. Check that each target's data is reasonable. **Do this test when the radar is not being used.**

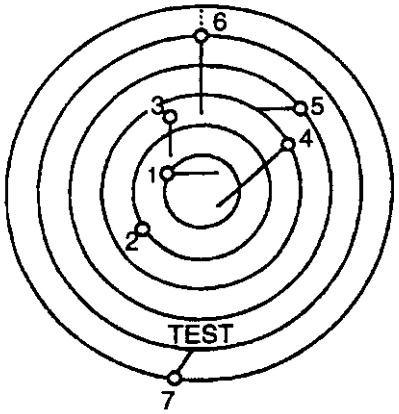


Figure 2-9Track test display

1. Press [MENU], [7], [7], [0], [0], [4], [4].
2. Press the [ENTER/SELECT] key to start the test.
3. It takes approximately three minutes for all vectors to be displayed completely on the screen. The simulation display does not need radar, gyrocompass nor speed log input; seven targets on various courses and speeds are provided.

Target	Course	Speed	CPA*	TCPA*
Target 1	90.0° R	10.0 kt	1.0 nm	10.4 min
Target 2	0.0° R	0.0 kt	4.0 nm	—
Target 3	180.0° R	10.0 kt	1.7 nm	28.2 min
Target 4	216.5° R	23.8 kt	0.9 nm	15.0 min
Target 5	273.5° R	14.2 kt	6.0 nm	22.5 min
Target 6	180.0° R	20.0 kt	0.0 nm	30.0 min
Target 7	24.6° R	15.6 lkt	4.0 nm	43.6 min

* Initial data

4. The simulation continues for five minutes and then repeats. To quit the test sequence, turn the power off.

2.13 Outputting Target Data

Target data may be output to external equipment as follows:

1. Press [MENU], [7], [7], [0], [0].
2. Press the [7] key to select OFF, REL, TRUE from the TGT DATA OUT field as appropriate.
3. Press the [ENTER/SELECT] key followed by the [MENU] key.

2.14 Diagnostic Sequence

You can check the ATA Board for proper operation as follows. The self test does not require operator intervention. It runs automatically when the power is placed on at regular intervals or on operator demand.

1. Press [MENU], [0], [0], [0], [0].
2. Press the [2] key twice to start the diagnosis sequence. The results of the test appear as shown below.

```
FR-1505 SERIES TEST
Program No.            03591521**
ROM Check              OK
RAM Check              OK
Antenna Rotation       24RPM
Tx Trigger Frequency   3000Hz
Video Level            000
Video Signal           OK


ARP TEST
1. Program No.    18590411**  18590421**
2. ROM Check      OK          OK
3. RAM Check      OK
4. Speed Log      OK  0.0 KT
5. Course         OK
6. Trigger        OK
7. Video Signal   OK
8. Bearing Pulse  OK
9. Heading Pulse  OK
10. Minimum       0003
11. Scan Time     0274
12. Manual Acq.   00
13. Auto Acq.     00
14. FE-Data 1     0000
15. FE-Data 2     0000

Press MENU key to escape.
Press ENTER to check CRT.
```

** Program No.

Figure 2-10 Diagnositic test results

3. If NG appears for any ATA-related item, call for service.

3. RADAR OBSERVATION

3.1 General

Minimum and maximum ranges

Minimum range

The minimum range is defined by the shortest distance at which, using a scale of 1.5 or 0.75 nm, a target having an echoing area of 10 m^2 is still shown separate from the point representing the scanner position.

It is mainly dependent on the pulselength, scanner height, and signal processing such as main bang suppression and digital quantization. It is a good practice to use a shorter range scale as far as it gives favorable definition or clarity of picture. The IMO Resolution A. 477 (XII) and IEC 936 require the minimum range to be less than 50 m. All FURUNO radars satisfy this requirement.

Maximum range

The maximum detecting range of the radar, Rmax, varies considerably depending on several factors such as the height of the scanner 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 Rmax is given in the following equation.

$$R_{max} = 2.2 \times (\sqrt{h1} + \sqrt{h2})$$

where Rmax: radar horizon (nautical miles)
h1: scanner height (m)
h2: target height (m)

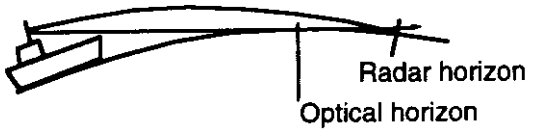


Figure 3-1 Radar horizon

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

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

It should be noted that the detection range is reduced by precipitation (which absorbs the radar signal).

X-band and S-band

In fair weather, the above equation does not give a significant difference between X- and S-band radars. However, in heavy precipitation condition, an S-band radar would have better detection than an X-band radar.

Radar resolution

There are two important factors in radar resolution (discrimination): bearing resolution and range resolution.

Bearing resolution

Bearing resolution is the ability of the radar 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 scanner length and reciprocally proportional to the wavelength. The length of the scanner radiator should be chosen for a bearing resolution better than 2.5° (IMO Resolution). This condition is normally satisfied with a radiator of 1.2 m (4 ft) or longer in the X-band. The S-band radar requires a radiator of nominal 12 feet (3.6 m) in our product range.

Range resolution

Range resolution is the ability to display as separate pips the echoes received from two targets which are on the same bearing and close to each other. This is determined by pulselength only. Practically, a 0.08 microsecond pulse offers the discrimination better than 35 m as do so with all FURUNO radars.

Test targets for determining the range and bearing resolution are radar reflectors having an echoing area of 10 m^2.

Bearing accuracy

One of the most important features of the radar is how accurately the bearing of a 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 line 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.

3.2 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 transmitted pulse returns from a solid object like a large 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 below. Multiple reflection echoes can be reduced and often removed by decreasing the gain (sensitivity) or properly adjusting the A/C SEA control.

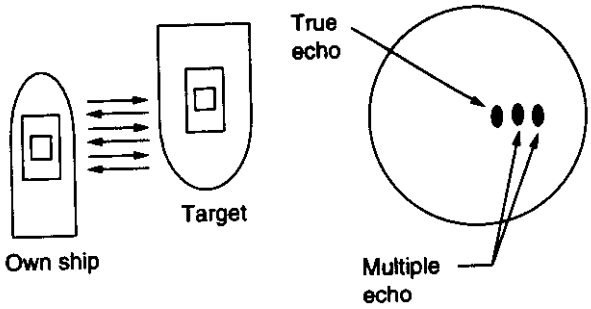


Figure 3-2 Multiple echoes

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. 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.

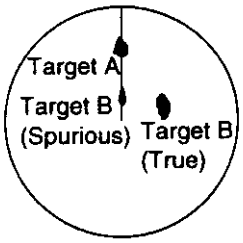


Figure 3-3 Sidelobe echoes

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

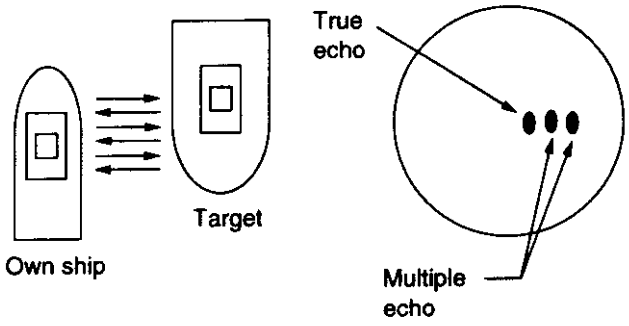


Figure 3-4 Virtual image

Shadow sectors

Funnels, stacks, masts, or derricks in the path of the scanner block the radar beam. If the angle subtended at the scanner is more than a few degrees, a non-detecting sector may be produced. Within this sector targets can not be detected.

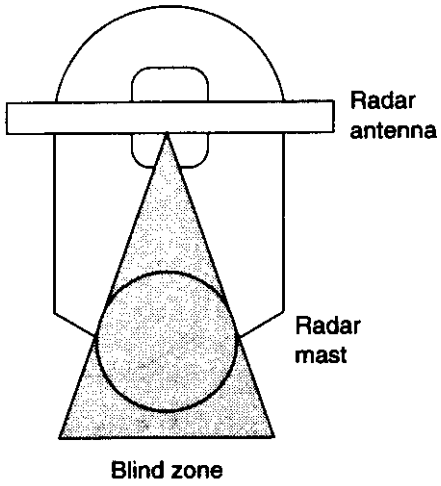


Figure 3-5 Shadow sectors

3.3 SART (Search and Rescue Transponder)

A Search and Rescue Transponder (SART) may be triggered by any X-Band (3 cm) radar within a range of approximately 8 nm. Each radar pulse received causes it to transmit a response which is swept repetitively across the complete radar frequency band. When interrogated, it first sweeps rapidly (0.4 µs) through the band before beginning a relatively slow sweep (7.5 µs) through the band back to the starting frequency. This process is repeated for a total of twelve complete cycles. At some point in each sweep, the SART frequency will match that of the interrogating radar and be within the pass band of the radar receiver. If the SART is within range, the frequency match during each of the 12 slow sweeps will produce a response on the radar display, thus a line of 12 dots equally spaced by about 0.64 nautical miles will be shown.

When the range to the SART is reduced to about 1 nm, the radar display may show also the 12 responses generated during the fast sweeps. These additional dot responses, which also are equally spaced by 0.64 nm, will be interspersed with the original line of 12 dots. They will appear slightly weaker and smaller than the original dots.

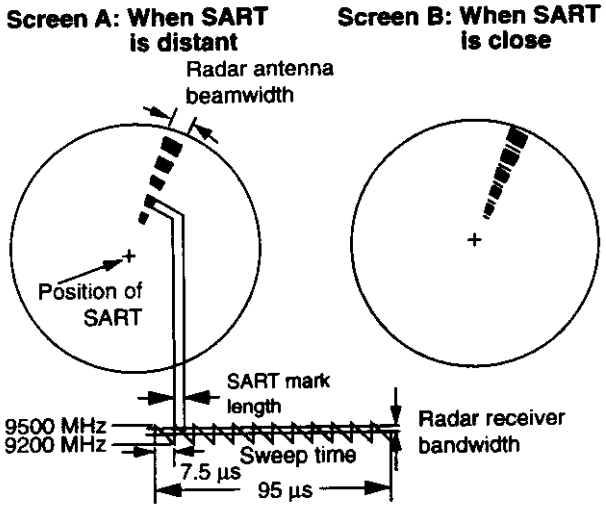


Figure 3-6 Appearance of SART signal on the radar display

Showing SART marks on the radar display

Range scale of 6 or 12 nm with normal radar settings should display SART signals. However, this radar has a special feature which enhances SART signals. This is done as below:

Summary to detect SART response

1. Press the [F1] key.

1. VECT REF REL/TRUE
2. PULSE
3. INT REJ
4. STRETCH
5. ECHO AVG
6. VIDEO SLOPE
7. N REJ
8. DISP SEL
9. PM
0. SART

Figure 3-7 F1 menu

2. Press the [0] key to turn SART on or off as appropriate.

General remarks on receiving SART

SART range errors

When responses from only the 12 low frequency sweeps are visible (when the SART is at a range greater than about 1 nm), the position at which the first dot is displayed may be as much as 0.64 nm beyond the true position of the SART. When the range closes so that the fast sweep responses are seen also, the first of these will be no more than 150 meters beyond the true position.

Radar bandwidth

This is normally matched to the radar pulselength and is usually switched with the range scale and the associated pulselength. Narrow bandwidths of 3-5 MHz are used with long pulses on long range and wide bandwidths of 10-25 MHz with short pulses on short ranges.

Any radar bandwidth of less than 5 MHz will attenuate the SART signal slightly, so it is preferable to use a medium bandwidth to ensure optimum detection of the SART.

Radar side lobes

As the SART is approached, side lobes from the radar scanner may show the SART responses as a series of arcs or concentric rings. These can be removed by the use of the anti-clutter sea control although it may be operationally useful to observe the side lobes as they may be easier to detect in clutter conditions and also they will confirm that the SART is near to the ship.

Gain

For maximum range SART detection the normal gain setting for long range detection should be used, that is, with background noise speckle visible.

A/C SEA control

For optimum range SART detection, this control should be set to the minimum. Care should be exercised as wanted target in sea clutter may be obscured. Note also that in clutter conditions the first few dots of the SART response may not be detectable, irrespective of the setting of the anti-clutter sea control. In this case, the position of the SART may be estimated by measuring 9.5 nautical miles from the furthest dot back towards own ship.

Some sets have automatic/manual anti-clutter sea control facilities in which case the operator should switch to manual.

A/C RAIN control

This should be used normally (to break up areas of rain) when trying to detect a SART response which, being a series of dots, is not affected by the action of the anti-clutter rain circuitry. Note that Racon responses, which are often in the form of a long flash, will be affected by the use of this control.

Some sets have automatic/manual anti-clutter rain control facilities in which case the operator should switch to manual.

Note: This SART information is excerpted from IMO SN/Circ 197 Operation of Marine Radar for SART Detection.

3.4 RACON (Radar Beacon)

A racon is a radar transponder which emits a characteristic signal when triggered by a ship's radar (usually only the 3 centimeter band). The signal may be emitted on the same frequency as that of the triggering radar, in which case it is superimposed on the ship's radar display automatically.

The racon signal appears on the PPI as a radial line originating at a point just beyond the position of the radar beacon or as a Morse code signal (figure below) displayed radially from just beyond the beacon.

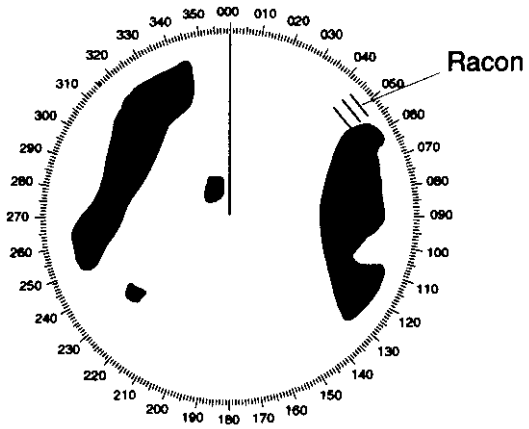


Figure 3-8 Appearance of RACON signal on the radar display

4. OPERATION OF VIDEO PLOTTER RP-17 (OPTION)

The Video Plotter RP-17 is an optional circuit board which is accommodated in the display unit of the FR-1505 MARK-3 series radars. It permits use of two memory cards: a memory card(RAM) for storing the operator-created radar maps, and the other is a chart card(ROM) storing FURUNO made digital charts.

The memory card enables the operator to create radar maps more precisely than the standard supplied radar map card (150 points per map). The radar map can hold a maxium of 3,000 points. The card permanently retains the data you have entered from the radar display or by Lat/Long positions. Own ship and other ship tracks may be stored at a selected interval. To display Nav line, RTE and WPL sentences are necessary. WPL ID sentence received in figure only. The data can be copied for other ships of the same shipping company.

Charts are superimposed on the radar picture without disturbing the radar observation. The chart area is dependent on the radar range in use.

The drive for the ROM card can also drive the Electronic Reference Chart (ERC). The ERC is a digital chart published by the Japanese Hydrographic Bureau. Note it is not an ENC used for ECDIS.

For details, refer to the separate manual for the Video Plotter RP-17.

5. MAINTENANCE

⚠ WARNING

ELECTRICAL SHOCK HAZARD
Do not open the equipment.

Only qualified personnel should work inside the equipment.

Turn off the radar power switch before servicing the scanner unit. Post a warning sign near the switch indicating it should not be turned on while the scanner unit is being serviced.

Prevent the potential risk of being struck by the rotating scanner and exposure to RF radiation hazard.

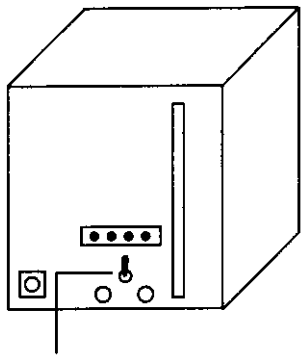
Wear a safety belt and hard hat when working on the scanner unit.

Serious injury or death can result if someone falls from the radar scanner mast.

⚠ NOTICE

ATTENTION TECHNICIANS: Turn off the Switch (S2) on sets designed to operate on AC power before servicing the equipment.

(Circuits still remain alive when the power switch on the front panel is turned off.)



5.1 Periodic Maintenance Schedule

Periodic checks and maintenance are important for proper operation of any electronic systems. This chapter contains maintenance instructions to be followed to obtain optimum performance and the longest possible life of the equipment.

Interval	Check point	Check and measures	Remarks
Weekly	Display unit	Periodically clean the exterior of display unit with a dry soft cloth. Use of commercially available CRT cleaner (spray) having antistatic effect is recommended.	A CRT screen produces static charge which attracts dust. DO NOT use strong solvents like paint thinner or abrasive cleaners for cleaning. Dust and dirt on CRT creates symptoms similar to poor sensitivity.

(Continued on next page)

Interval	Check point	Check and measures	Remarks
3 to 6 months (for qualified technicians only)	Exposed nuts and bolts on scanner unit	Check for corroded or loosened nuts and bolts. If necessary, clean and repaint them thickly. Replace them if heavily corroded.	Sealing compound may be used instead of paint. Apply a small amount of grease between nuts and bolts for easy removal in future.
	Scanner radiator	Check for dirt and cracks on radiator surface. Thick dirt should be wiped off with soft cloth dampened with fresh water. if a crack is found, 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 you need to remove ice from scanner unit, use a wooden hammer or plastic head hammer. Crack on the unit may cause water ingress, causing serious damages to internal circuits.
3 to 6 months (for qualified technicians only)	Terminal strips and plugs in scanner unit	Open antenna cover to check terminal strip and plug connections inside. Also check the rubber gasket of antenna covers for deterioration.	When closing scanner covers in position, be careful not to catch loose wires between covers and unit.
6 months to one year (for qualified technicians only)	CRT and surrounding components	High voltage at CRT and surrounding components attract dust in environment which will cause poor insulation. Ask your nearest FURUNO representative or dealer to clean internal high-voltage components.	If CRT anode rubber cap or wire sheath is cracked, ask your dealer to replace it. For service technician: Wait at least 3 minutes until high voltage components (CRT and HV capacitors) discharge their residual charges before accessing them.
	Terminal strips, sockets, earth terminal	Check for loose connections. Check contacts and plugs for proper seating, etc.	

5.2 Life Expectancy of Major Parts

Model	Magnetron	Code No.	Life
FR-1505M3	E3560 MG5389	000-139-050 000-135-146	About 3,000 hrs
FR-1510M3	E3566	000-141-073	About 3,000 hrs
FR-1525M3	MG5436	000-140-762	About 3,000 hrs

5.3 Replacement of Batteries

The GYRO CONVERTER Board (option) and the RP Board have a battery. The battery for the RP Board preserves data when the power is turned off, and its life is about five years. When the battery voltage is low, NG (No Good) appears at the diagnostic test for the RP board. When this happens, contact your dealer to request replacement of the battery.

PCB Name	Battery Type	Code number
RP Board	ER3S	000-127-759
GC Board	CR 1/2 8.L	000-103-769

6. TROUBLESHOOTING

⚠ WARNING

ELECTRICAL SHOCK HAZARD
Do not open the equipment.

Only qualified personnel should work inside the equipment.

Turn off the radar power switch before servicing the scanner unit. Post a warning sign near the switch indicating it should not be turned on while the scanner unit is being serviced.

Prevent the potential risk of being struck by the rotating scanner and exposure to RF radiation hazard.

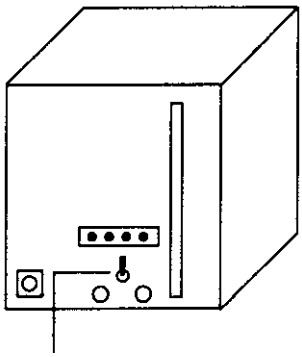
Wear a safety belt and hard hat when working on the scanner unit.

Serious injury or death can result if someone falls from the radar scanner mast.

⚠ NOTICE

ATTENTION TECHNICIANS: Turn off the Switch (S2) on sets designed to operate on AC power before servicing the equipment.

(Circuits still remain alive when the power switch on the front panel is turned off.)



6.1 Easy Troubleshooting

This paragraph describes how to cure operational problems, which can be made by observing the radar picture and using operator controls and keys without opening the display unit, antenna unit or other equipment units.

The table below shows user-level troubleshooting procedures.

Problem	Remedy
No own ship marker	Check that OS MARK ON is selected at the MARK/LINE submenu in the OTHER menu. Also, own ship information (length, width, etc.) should have been entered in initial settings. Consult a FURUNO representative or dealer for details.

6.2 Advanced-level Troubleshooting

This paragraph describes how to cure hardware and software troubles which should be carried out by qualified service personnel.

Note: This radar equipment contains complex modules in which fault diagnosis and repair down to component level are not practicable by users.

Serviceman qualification

All adjustments of radio transmitter during or coinciding with the installation, servicing, or maintenance which may affect the proper operation must be performed by or under the immediate supervision and responsibility of a person holding an operator certificate containing a ship radar endorsement.

This is what the U.S. Codes of Federal Regulations part 80.169 implies (not exact extract).

As such, every administration sets forth its own rule; service personnel must be aware of this kind of competency requirements.

Service call

When making a service call to your service agent, check S/N and symptom beforehand.

Problem	Check point and probable cause	Remedy
Power turned on but radar does not operate at all. Control panel is not illuminated either.	1. Blown fuse F1 or F2 2. Mains voltage/polarity 3. Power Supply Board 4. Illumination lamps	1. Replace blown fuse. 2. Correct wirings and input voltage. 3. Replace Power Supply Board. 4. Replace defective lamps.
CRT brilliance adjusted but no picture	1. DISPLAY submenu settings 2. CRT voltage 3. SPU Board	1. In case of single display installation (without radar interswitching), make sure MAIN is selected on the DISPLAY submenu (OTHER menu). 2. Check high voltage supply with utmost care. 3. Replace SPU Board.
Scanner not rotating	1. Scanner drive mechanism (Note that the message BRG SIG MISSING appears in stand-by.) 2. Confirm that scanner is set to rotate on menu.	1. Check scanner drive mechanism. 2. Contact a FURUNO agent.
Alphanumeric data and marks are not displayed in Transmit status.	1. SPU Board	1. Replace SPU Board.

Problem	Check point and probable cause	Remedy
Adjust GAIN control with A/C SEA control set at minimum. Marks and legends appear but no noise or echo.	1. IF amplifier 2. Signal cable between antenna and display 3. Video Amplifier Board	1. Replace IF amplifier. 2. Check continuity and isolation of coaxial cable. (Note: Disconnect the plug and lugs at both ends of coaxial cable before checking it by ohmmeter.) 3. Check video coax line for secure connection. If connection is good, replace SPU Board.
Marks, legends and noise appear but no echo. (Transmission leak, representing own ship position, is absent.)	1. Magnetron 2. Modulator Board 3. SPU Board	1. Check magnetron current. 2. Replace Modulator Board. 3. Replace SPU Board.
Picture not updated	1. Bearing Signal Generator Board (scanner unit) 2. SPU Board 3. Video lockup	1. Check the connection of signal cable. 2. Replace SPU Board. 3. Turn off and on radar.
Incorrect orientation of picture	1. SPU Board 2. Gyro Interface	1. The message "HD SIG MISSING" appears when the heading pulse is not received during stand-by. 2. Replace gyro interface.
Tuning manually adjusted but poor sensitivity	1. Deteriorated magnetron 2. Detuned MIC 3. Dirt on radiator face 4. Second trace rejection is ON.	1. With radar transmitting on 48 nm range, check magnetron current. If current is below normal value, magnetron may be defective. Replace magnetron. 2. Check MIC detecting current. If it is below normal value, MIC may have become detuned. MIC must be tuned. 3. Clean radiator surface. 4. Disable the second-trace rejector referring to paragraph 1.30.
Range changed but radar picture does not change	1. Defective RANGE key 2. SPU Board 3. Mother Board 4. Video lockup	1. Try to hit [+] and [-] RANGE keys several times. If unsuccessful, replacement of keypad may be required. 2. Replace SPU Board. 3. Replace Mother Board. 4. Turn off and on radar.

Problem	Check point and probable cause	Remedy
Interference rejector inoperable (interference rejection level not displayed)	1. SPU Board 2. Mother Board	1. Replace SPU Board. 2. Replace Mother Board.
Echo stretch ineffective (Neither "ES1" nor "ES2" is displayed.)	1. SPU Board	1. Replace SPU Board.
Only 2 parallel index lines (6 lines wanted)	1. Incorrect setting of index line interval	1. Set index line interval referring to paragraph 1.26.
Range rings are not displayed.	1. Adjust the brilliance of range rings with the intensity is increased. 2. SPU Board	1. Replace associated circuit board if unsuccessful. 2. Replace SPU Board.
Poor discrimination at range	1. Sea clutter control not functioning properly.	1. Improper setting of A/C SEA control. If A/C SEA is seen only at very close range, suspect inaccurate frequency of crystal oscillator.
True motion presentation not working correctly.	1. Poor contact of MODE key. 2. Selection is not accessed. 3. Speed entry is incorrect. 4. TM display inaccurate	1. Try to press MODE key a little harder. 2. Press MODE key until "TM" appears. 3. Enter correct own ship speed referring to paragraph 1.24. 4. Make sure that speed and compass inputs are accurate.
Target not tracked correctly	1. Poor definition of targets in sea clutter	1. Adjust A/C SEA and A/C RAIN controls referring to paragraphs 1.14 and 1.15.

6.3 Diagnostic Test

A diagnostic test program is provided to enable testing of major circuit boards in the radar display unit. Note that the normal radar picture is lost during this test.

Proceed as follows to execute the diagnostic test:

1. Press [MENU] [0] [0] to show the OTHER main.
2. Press the [0] key twice to select the OTHER sub menu.
3. Press the [2] key twice to select TEST.

   The diagnostic test is executed and the screen shows test results as shown on the next page. OKs appear for normal operation. ARP TEST results appear only when optional ARP Board is mounted. If NG (No Good) appears, corresponding components may be defective. Consult your dealer.
4. Small squares displayed on the test results screen are for testing the controls and keys (except POWER and [ENTER/SELECT] keys). As you operate these controls and keys, corresponding squares are highlighted, indicating that your control/key operations are properly recognized.
5. Press the [ENTER/SELECT] key to check the display circuit. See the illustration page 6-7.
6. To terminate the diagnostic test, press the [MENU] key.

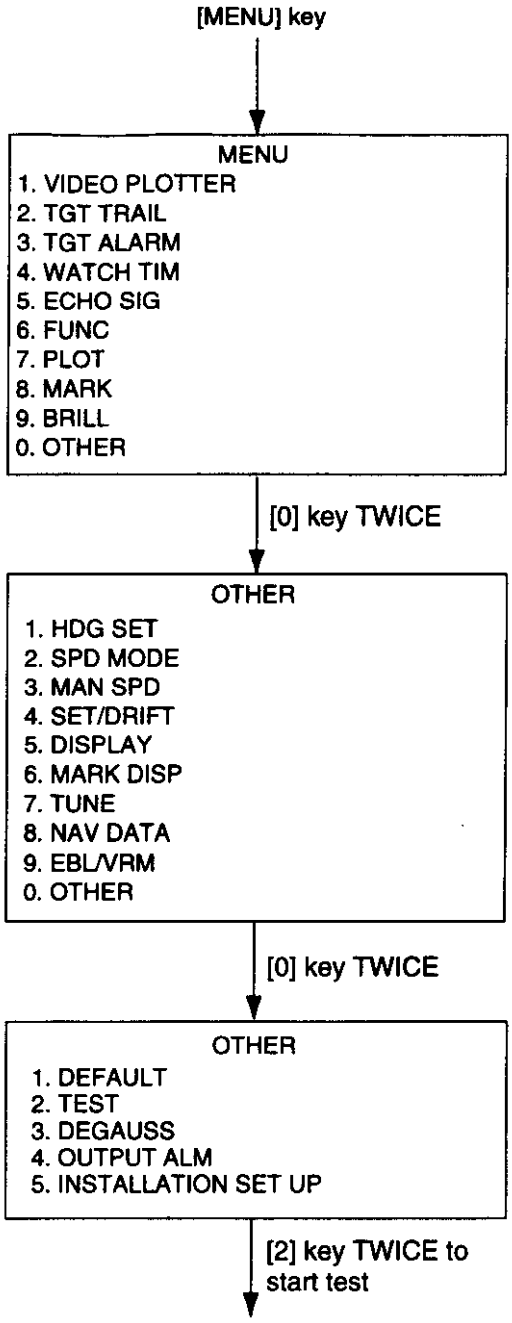


Figure 6-1 Sequence for diagnostic test

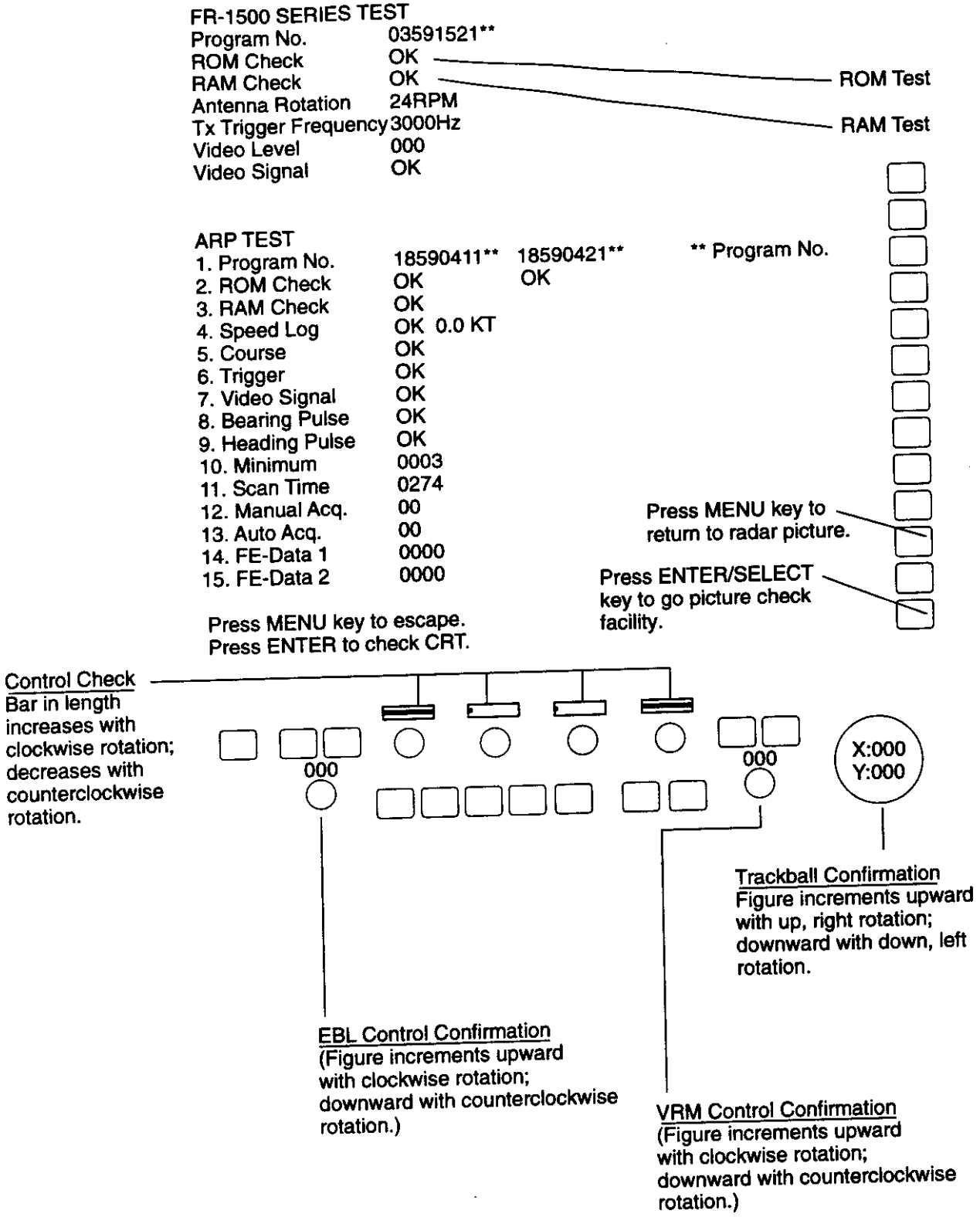


Figure 6-2 Test results screen

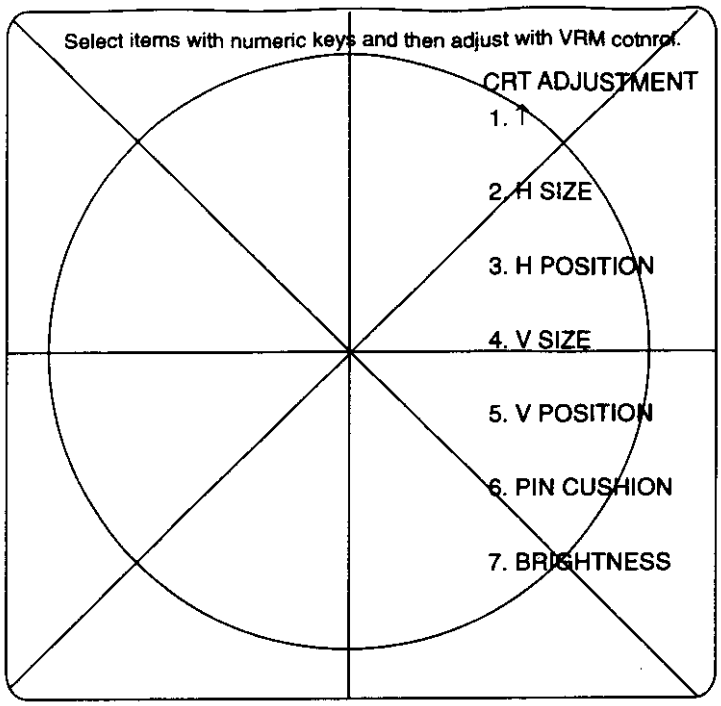
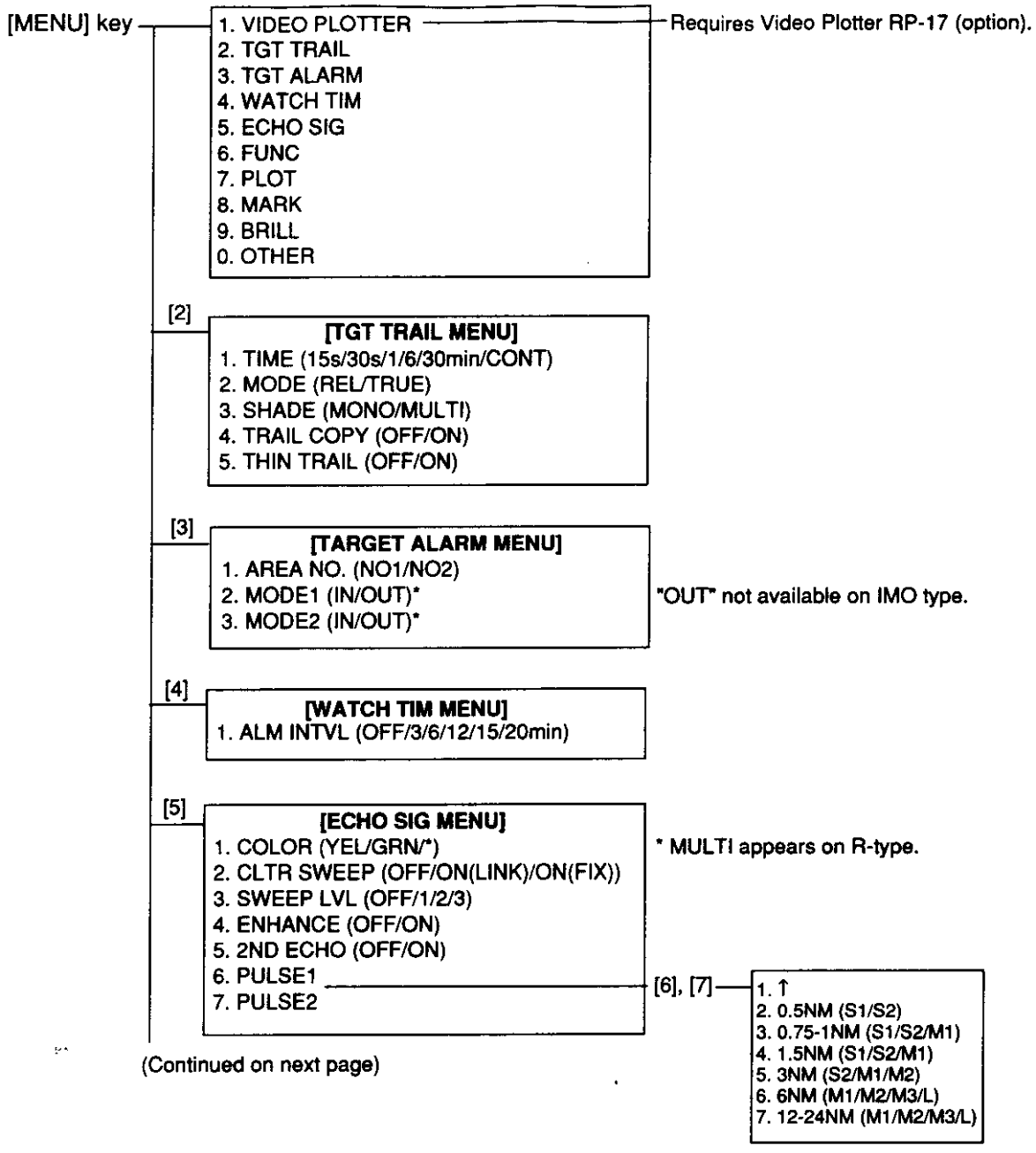


Figure 6-3 Test pattern

MENU OVERVIEW



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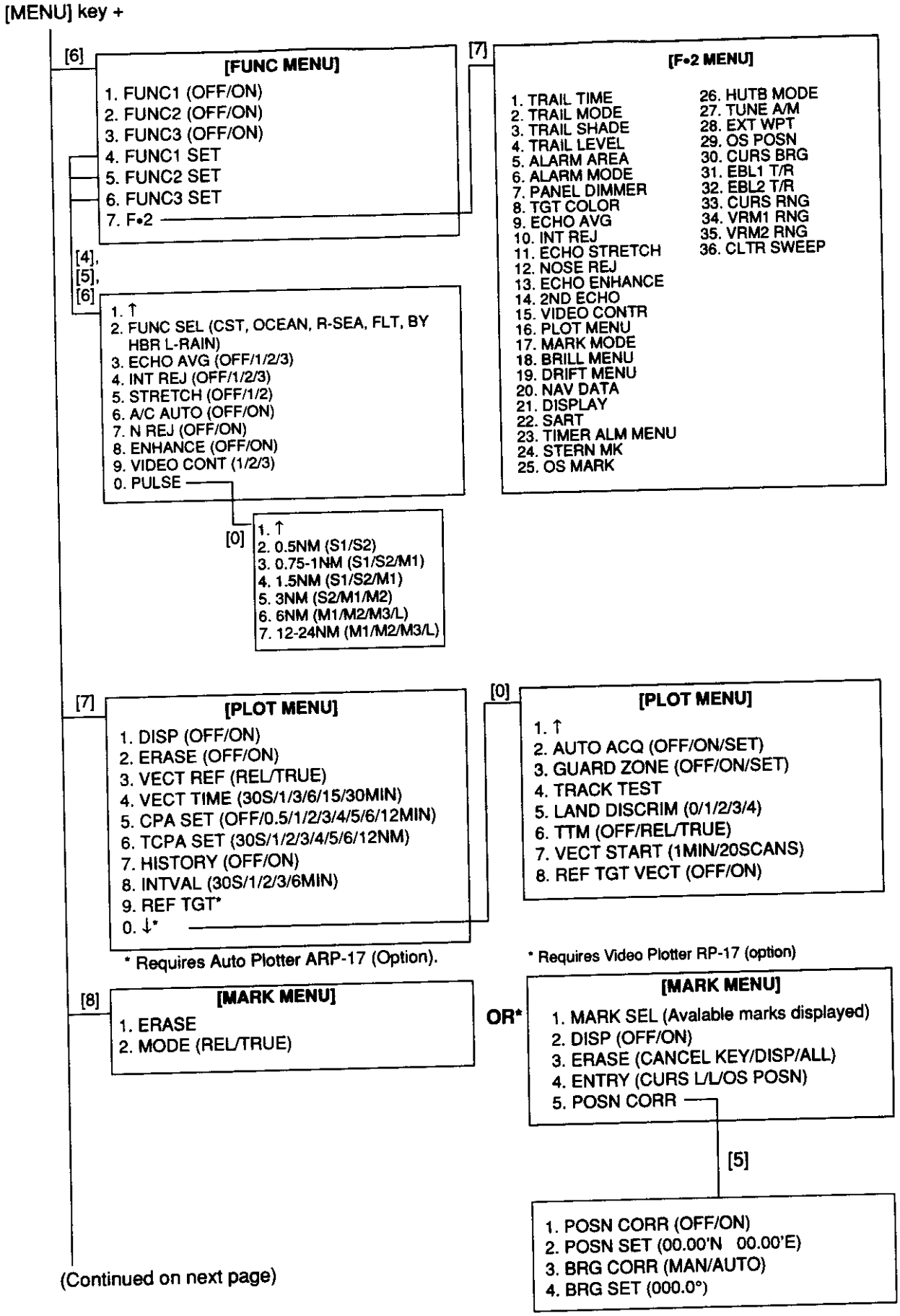
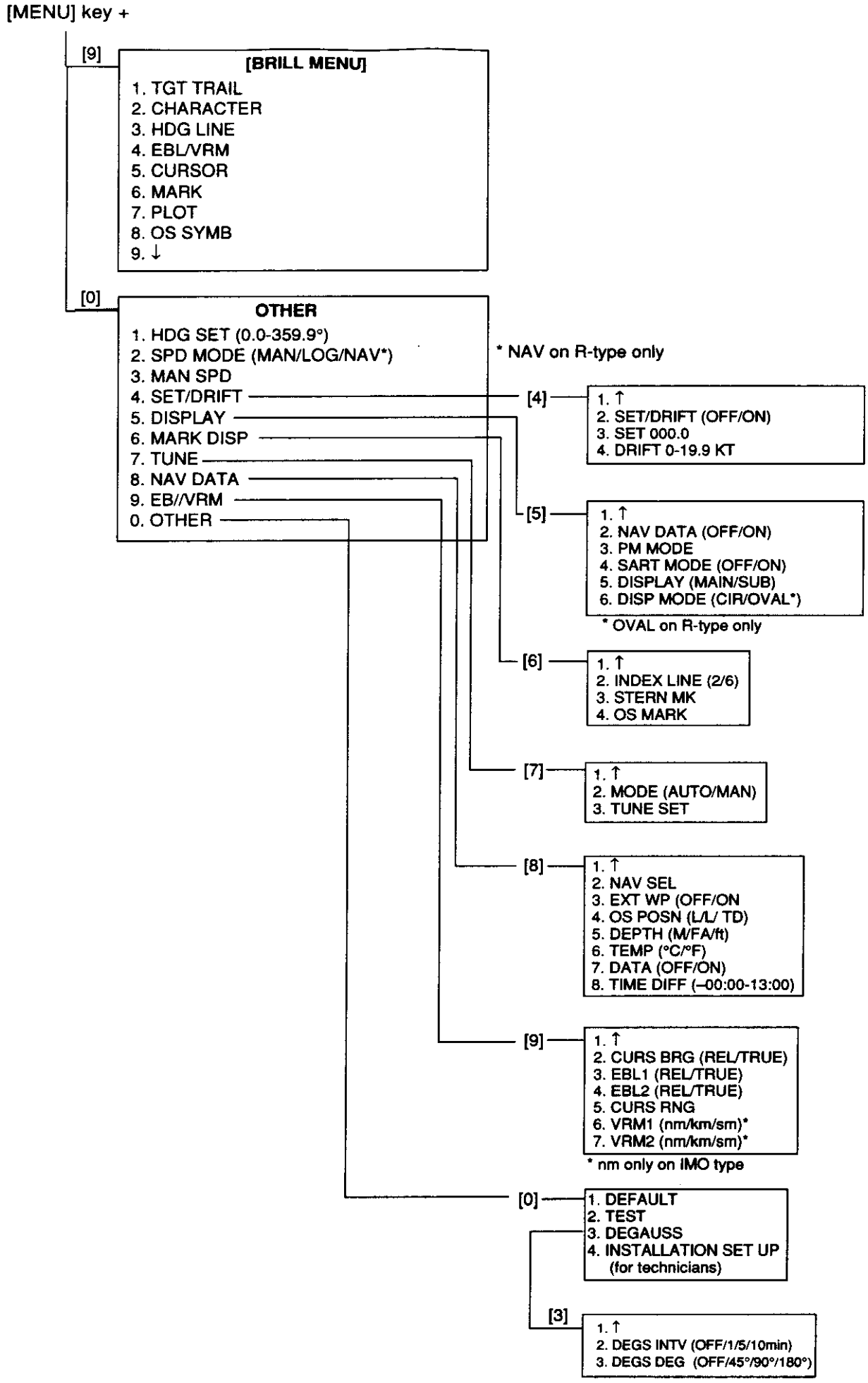


(Continued on next page)


[MENU] key +
[9]
[BRILL MENU]
1. TGT TRAIL
2. CHARACTER
3. HDG LINE
4. EBL/VRM
5. CURSOR
6. MARK
7. PLOT
8. OS SYMB
9. ↓
[0]
OTHER
1. HDG SET (0.0-359.9°)
2. SPD MODE (MAN/LOG/NAV*)
3. MAN SPD
4. SET/DRIFT
5. DISPLAY
6. MARK DISP
7. TUNE
8. NAV DATA
9. EB//VRM
0. OTHER
* NAV on R-type only
[4]
1. ↑
2. SET/DRIFT (OFF/ON)
3. SET 000.0
4. DRIFT 0-19.9 KT
[5]
1. ↑
2. NAV DATA (OFF/ON)
3. PM MODE
4. SART MODE (OFF/ON)
5. DISPLAY (MAIN/SUB)
6. DISP MODE (CIR/OVAL*)
* OVAL on R-type only
[6]
1. ↑
2. INDEX LINE (2/6)
3. STERN MK
4. OS MARK
[7]
1. ↑
2. MODE (AUTO/MAN)
3. TUNE SET
[8]
1. ↑
2. NAV SEL
3. EXT WP (OFF/ON
4. OS POSN (L/L/ TD)
5. DEPTH (M/FA/ft)
6. TEMP (°C/°F)
7. DATA (OFF/ON)
8. TIME DIFF (–00:00-13:00)
[9]
1. ↑
2. CURS BRG (REL/TRUE)
3. EBL1 (REL/TRUE)
4. EBL2 (REL/TRUE)
5. CURS RNG
6. VRM1 (nm/km/sm)*
7. VRM2 (nm/km/sm)*
* nm only on IMO type
[0]
1. DEFAULT
2. TEST
3. DEGAUSS
4. INSTALLATION SET UP
(for technicians)
[3]
1. ↑
2. DEGS INTV (OFF/1/5/10min)
3. DEGS DEG (OFF/45°/90°/180°)

APPENDIX A
OPTIONAL EQUIPMENT, PARTS LOCATION

A.1 Performance Monitor (Option)

A performance monitor is required for a radar installed on vessels of 300 GT and upward engaged in international voyages. The FURUNO PM-30 satisfies the requirement covering 9410 ± 50 MHz. The following describes how to use these performance monitors.

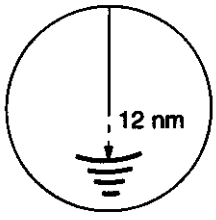
The performance monitor is an independent unit, namely, it is not interconnected with any unit of the radar system except for the 100 VAC power cable. In some radars the power cable is not routed via the power switch or other control of the radar and the monitor is operated as completely a separate device.

Operating the performance monitor

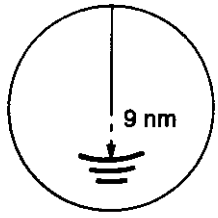
When Radar Interswitch RJ-7 is connected, set it to the "straight" mode. Select PM ON by pressing [MENU], [0], [0], [0], [0], [5], [5], [3], and the range scale is automatically set to 24 nm. The radar screen will show several arcs, opposite to the heading marker (provided that the performance monitor is installed behind the radar antenna as is normally the case). If the radar transmitter and receiver are in good working conditions in as much as the original state when the monitor was turned up, the innermost are should appear at 12 nm and there should be a total of 4 arcs.

The range of the innermost arc reduces 3 nm with every 3 dB loss of transmitted power. Meanwhile the receiver sensitivity can be evaluated from the number of visible arcs; one arc is lost every 3 dB deterioration of the sensitivity.

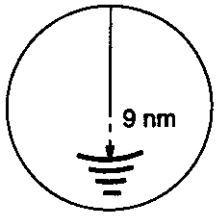
Transmitter performance		Receiver performance	
Range to innermost arc	Loss	No. of arcs	Loss
12 nm	0 dB	4	0 dB
9 nm	3 dB	3	3 dB
6 nm	6 dB	2	6 dB
3 nm or less or none	>10 dB	1	>9 dB
		0	>12 dB



TRANSMITTER: normal
RECEIVER: normal



TRANSMITTER: 3 db loss
(Transmitter system has lost half initial power. Suspect magnetron and feeder system.)
RECEIVER: 3 db loss
(Receiver has lost half of normal sensitivity. Suspect receiver front end, water ingress to feeder system, etc.)



TRANSMITTER: 3 db loss
(Transmitter system has lost half of initial power. Suspect magnetron and feeder system.
RECEIVER: normal

A.2 Interswitch Unit RJ-7 (Option)

The interswitching unit RJ-7 permits independent or coordinated operation of two radar systems among FR-1505 MARK-3 series.

A.3 Parts Location

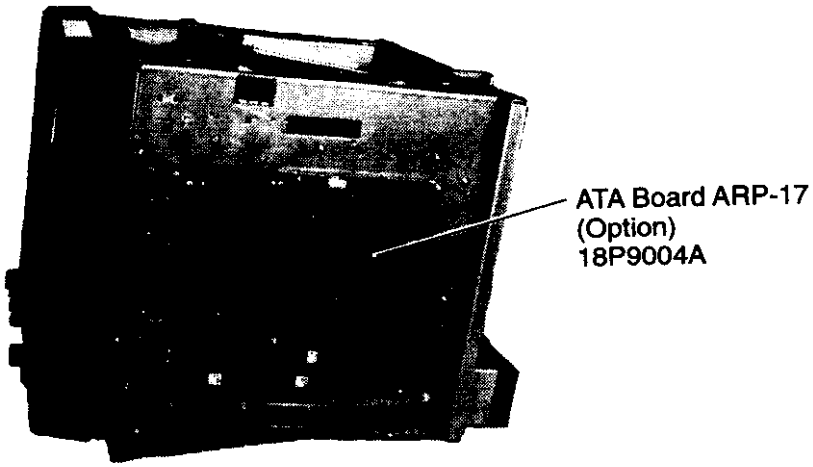


Figure A-1 Display unit, right side view

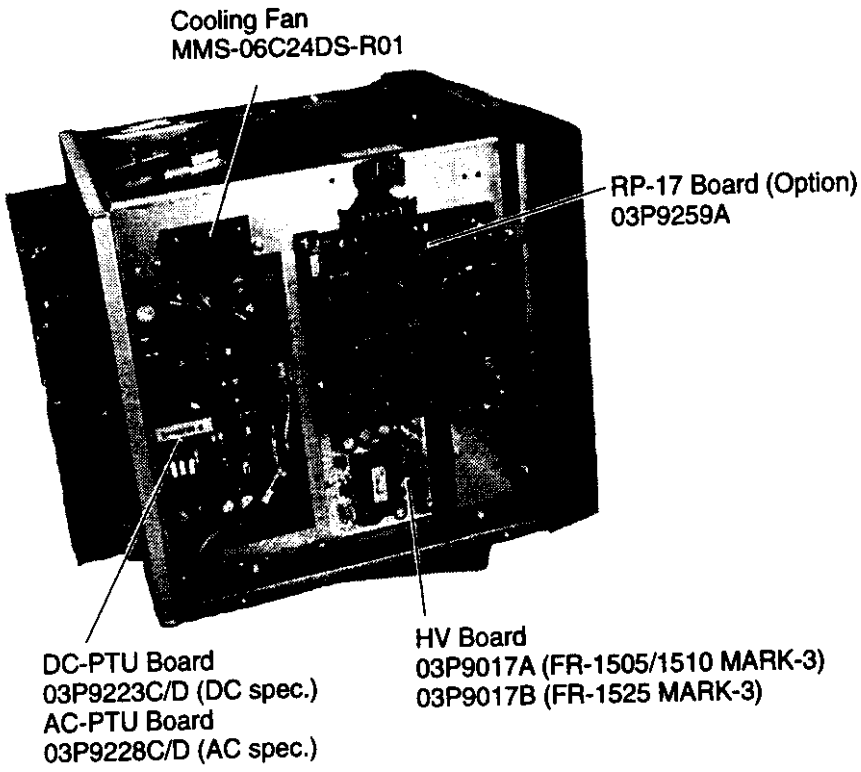


Figure A-2 Display unit, left side view

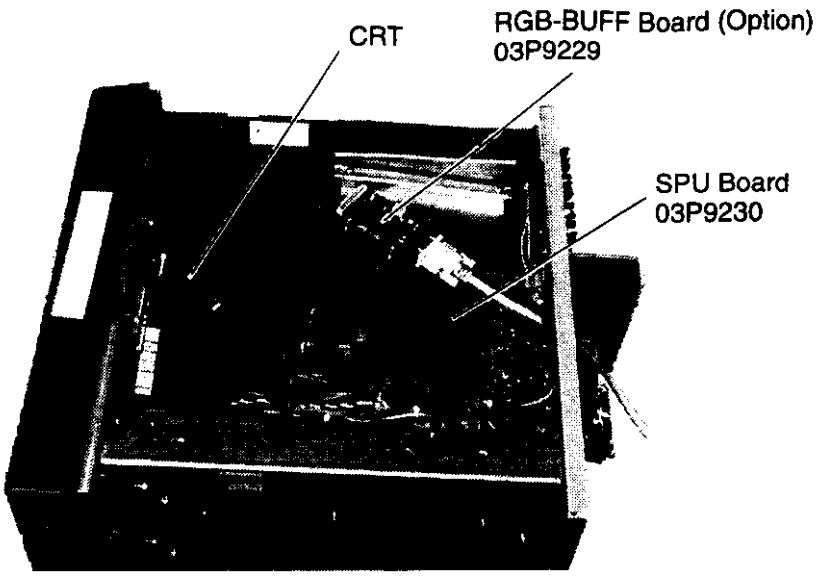


Figure A-3 Display unit, top view

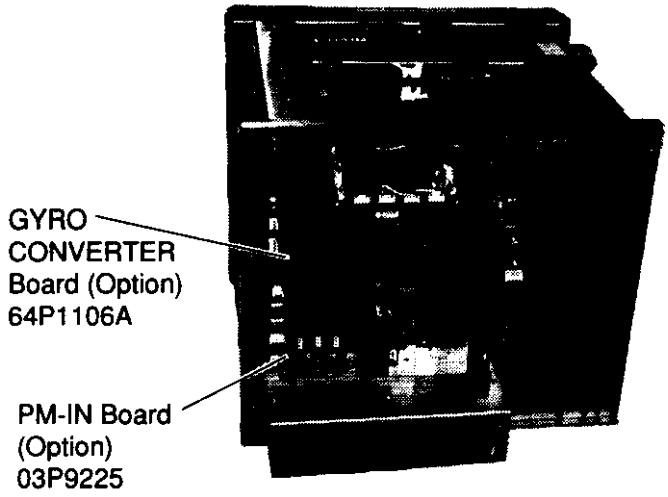


Figure A-4 Display unit, rear view

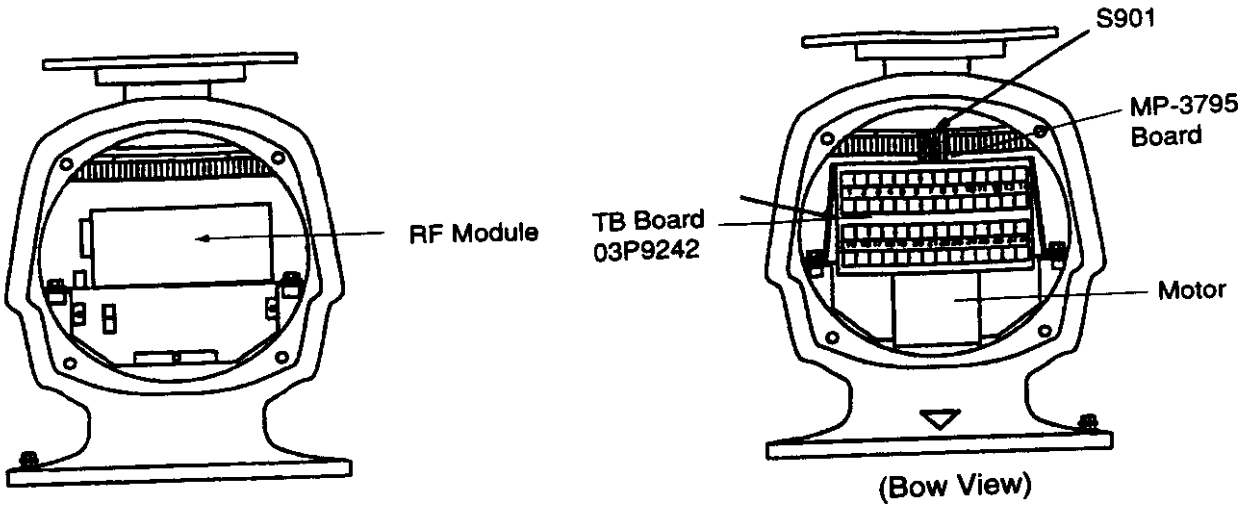


Figure A-5 Scanner unit

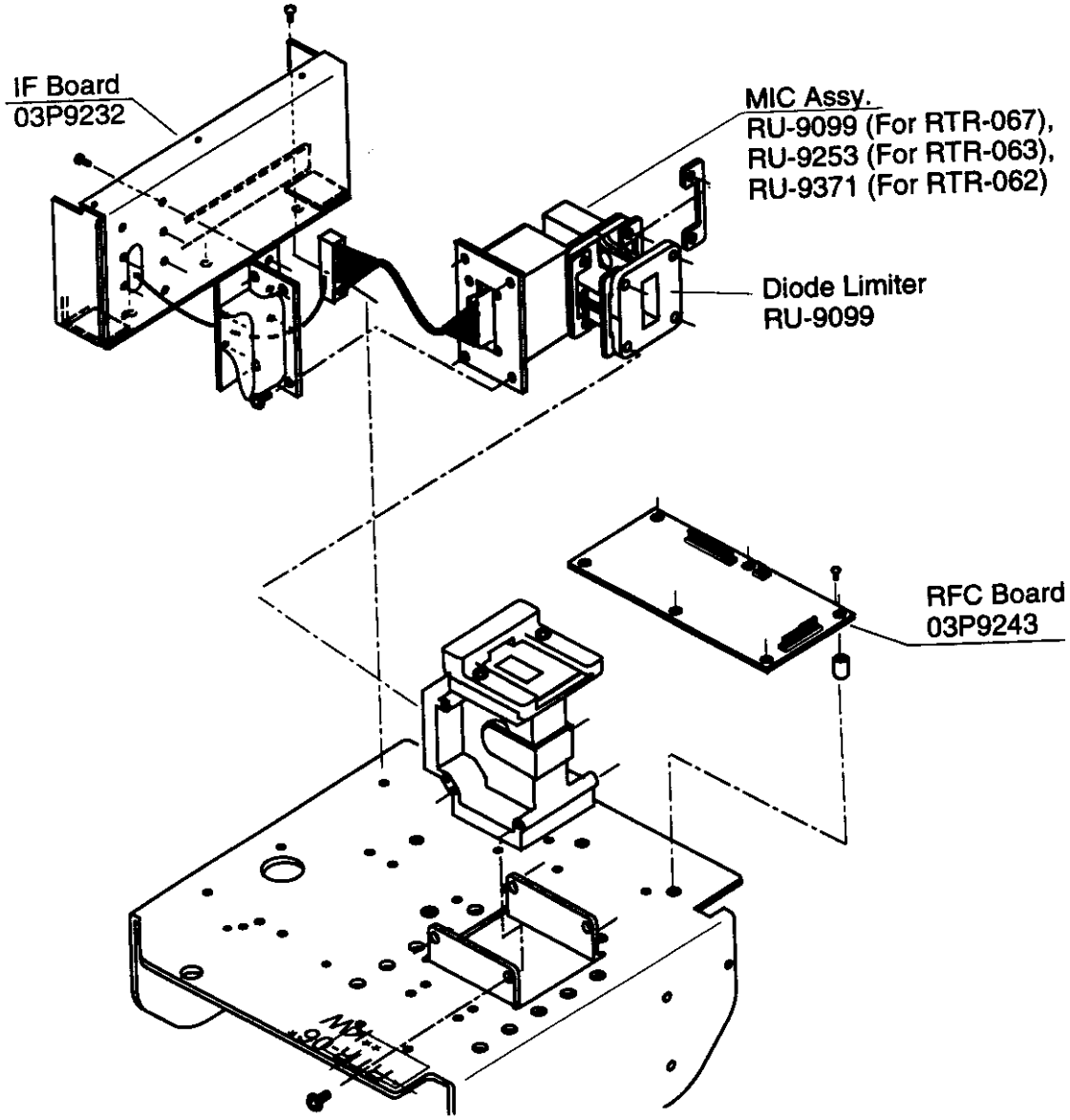


Figure A-6 RF module

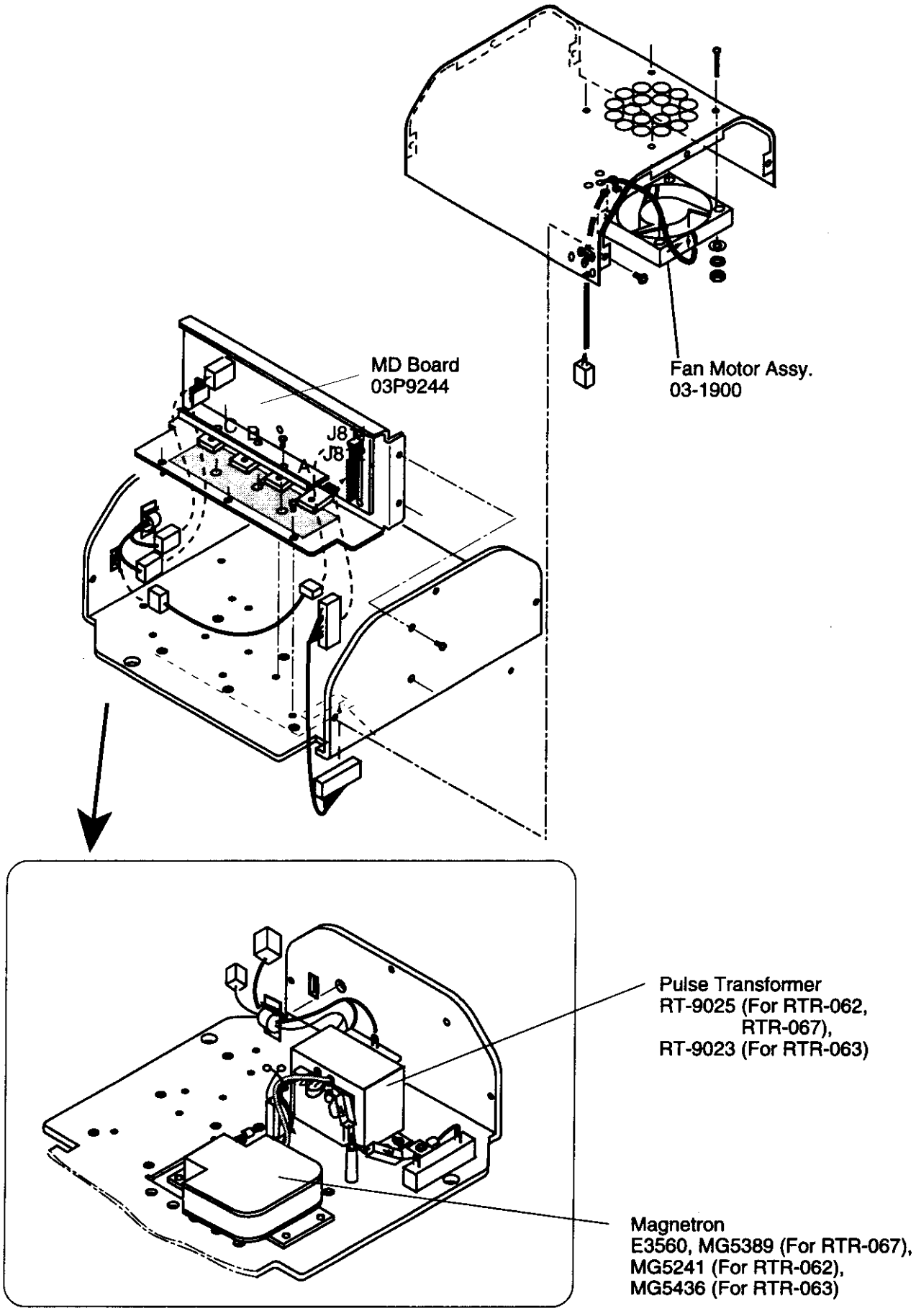


Figure A-7 RF module, rear view

A.4 Antenna Unit Circuit Diagram

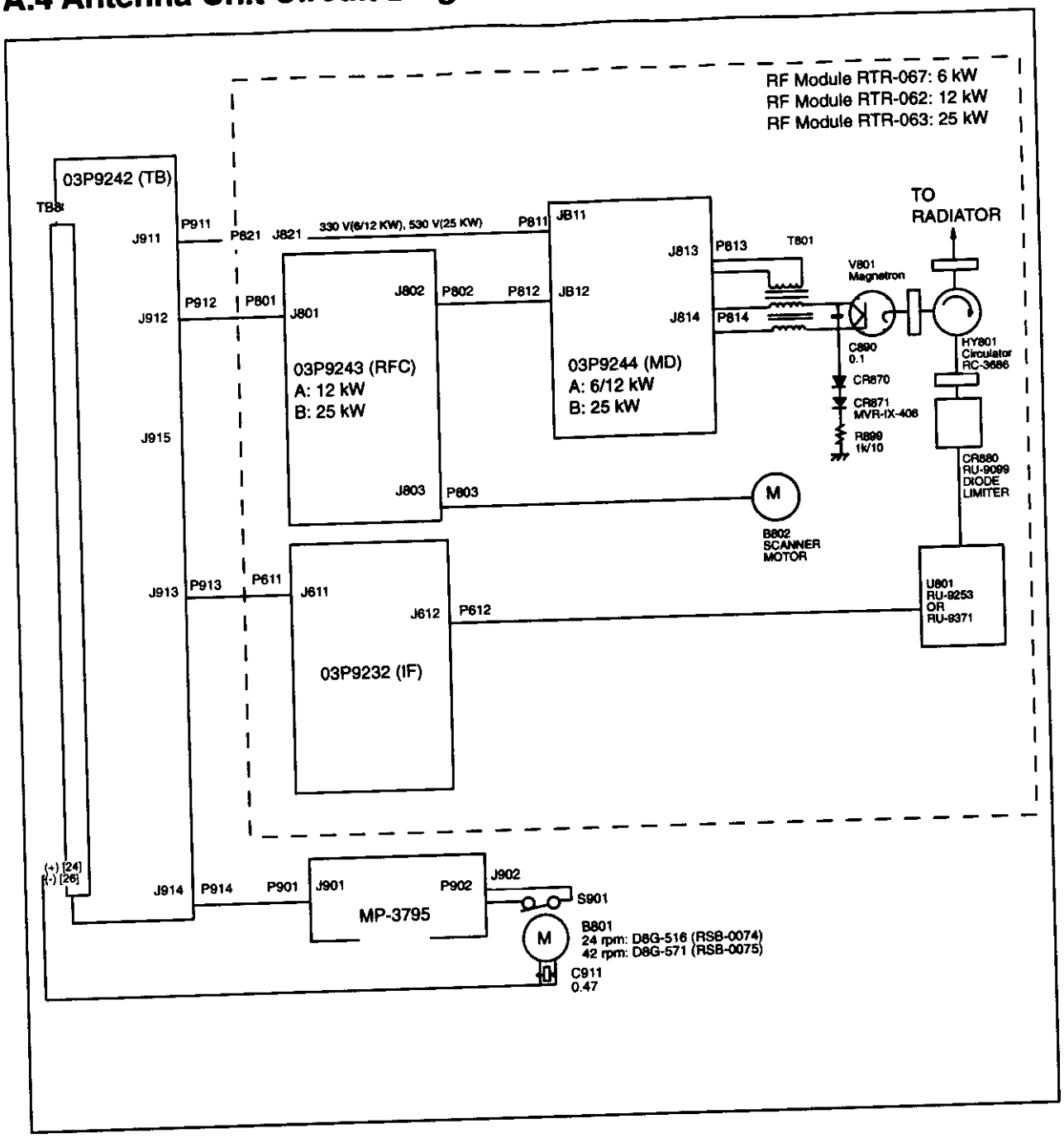


Figure A-8 Antenna circuit diagram

APPENDIX B
DIGITAL INTERFACE (IEC6162-1)

1. I/O Sentences for Channel 1

Input

BWC, BWR, DBS, DBT, DPT, GGA, GLL, HDT, MTW (*), MWV, RMA, RMB, RMC, RTE, VDR, VTG(*), VWR, VWT, WPL, ZDA, * not recommended in IMO type

Output

OSD (every 3.5 s), RSD (3 s), TTL (When A/C RAIN control is pressed.))

2. I/O Sentences of Channel 2

Input

VBW, VHW

Output

TTM

3. Serial Signal I/O Circuit

See page AP-2.

4. Sentence Description

See page AP-4 and after.

Sentences without checksum will not be accepted as a proper data.

5. Priority

Nav data sentences below are read left to right, and in case of timeout the sentence right of last read sentence is read. In case of multiple high priority sentences the sentences having the highest priority is read. ** is read regardless of talker. Timeout is 90 seconds unless specified otherwise. Different timeouts for data sentences are required by German authorities.

Position data

GPGGA > GPRMC > GPGLL > LCRMA > LCGLL > **GLL
Timeout: 30 seconds

Date, time data

GPZDA
Timeout: 10 seconds

Course heading, speed over ground

In case of log

VDVBW > **VBVBW

In case of navigator

GPVTG > GPRMC

Course heading, speed over water

VDVBW > **VBW >VD VHW

Relative wind angle and speed

** MWV > **VWT > **VWR

Tide data

**VDR

Water depth data

SDDPT > SDDBT > SDDBS > **DBT > **DBS

Water temperature data

**MTW

Waypoint range and bearing data

GPBWR > GPBWC > GPRBM > **BWR > **BWC > **RMB

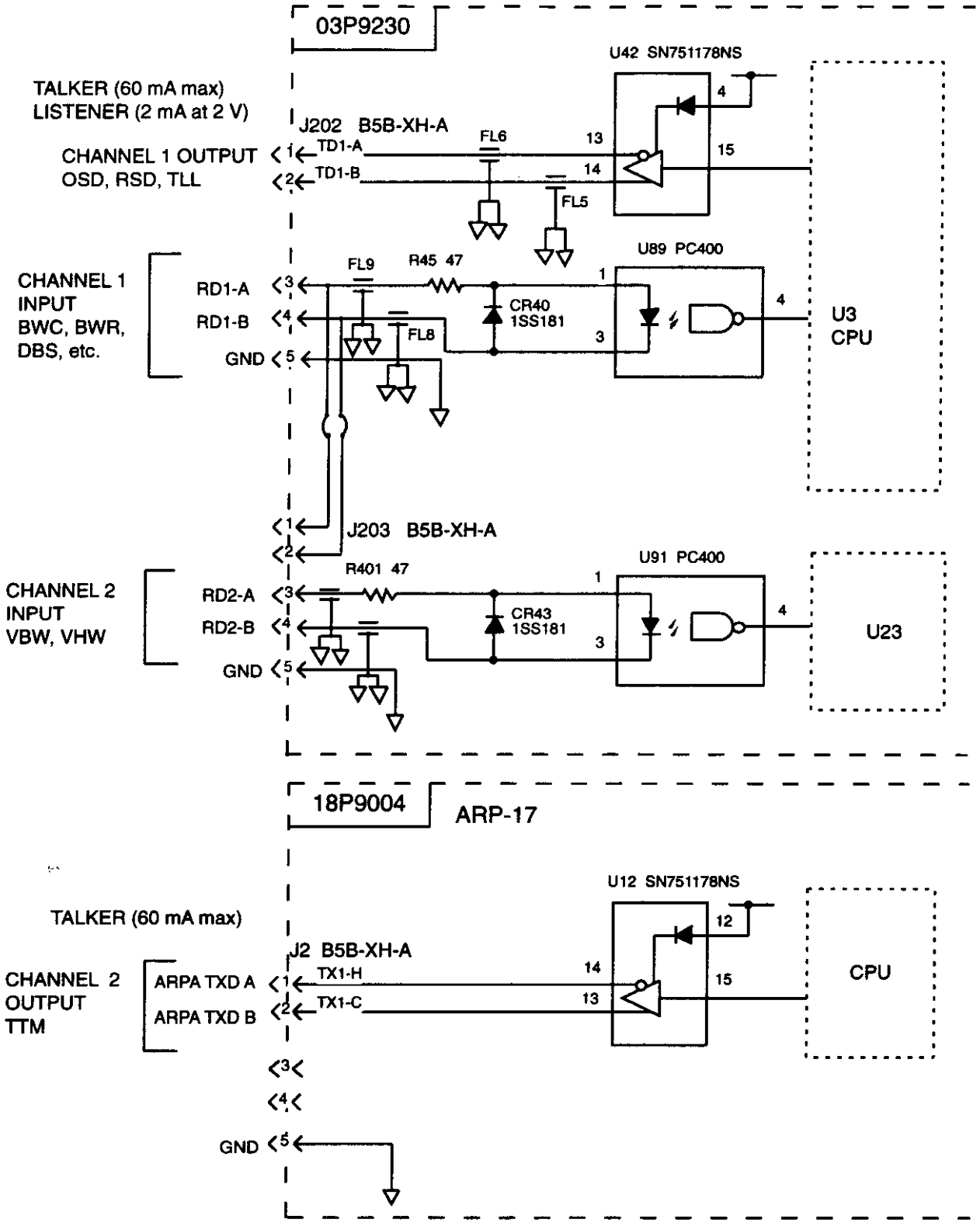
Route data (WPL, RTE)

*WPL
*RTE

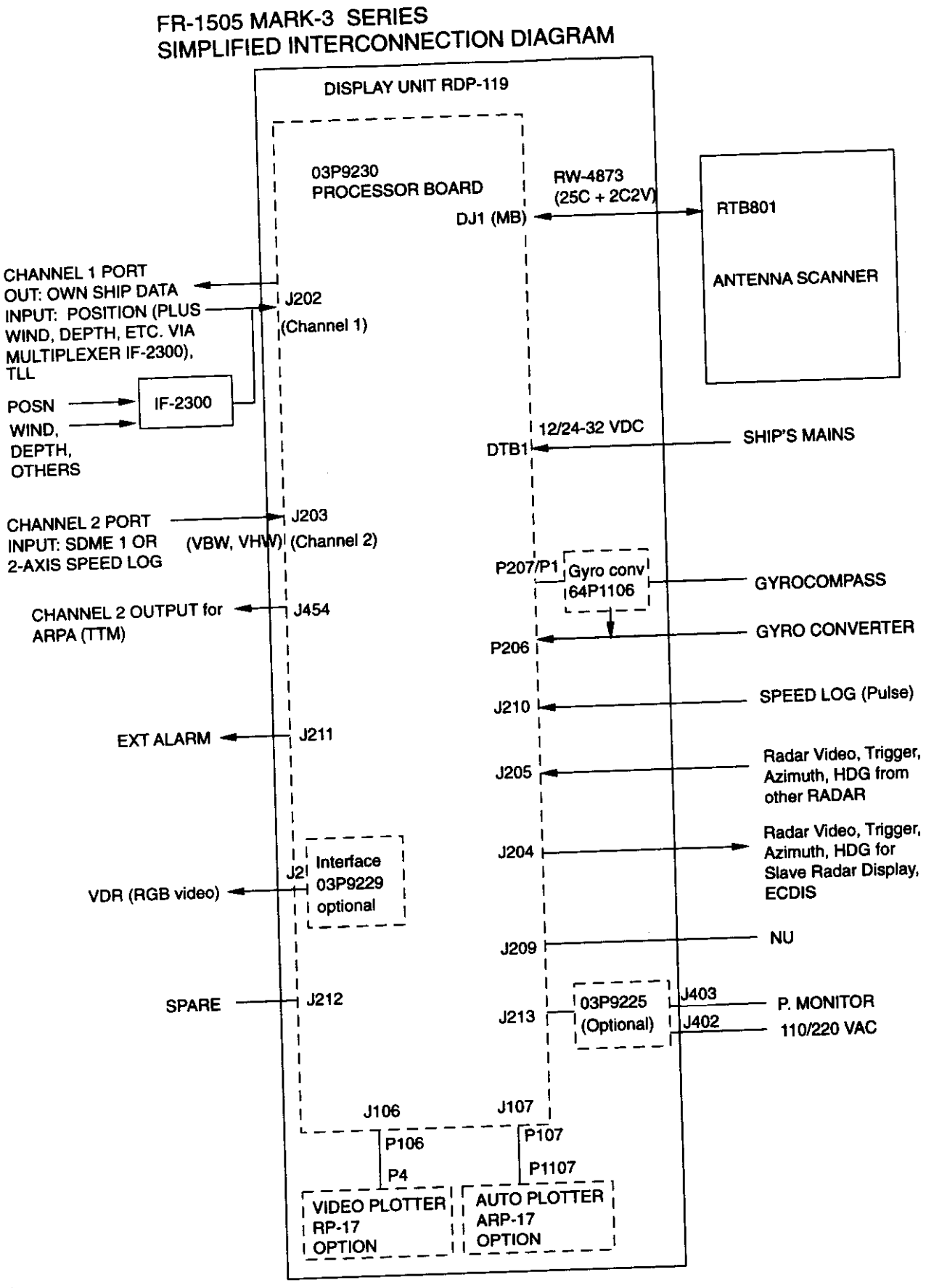
Ship's heading

**HDT

FR-1505 Mark-3 SERIES
SERIAL INTERFACE I/O CIRCUIT



FR-1505 MARK-3 series simplified interconnection diagram

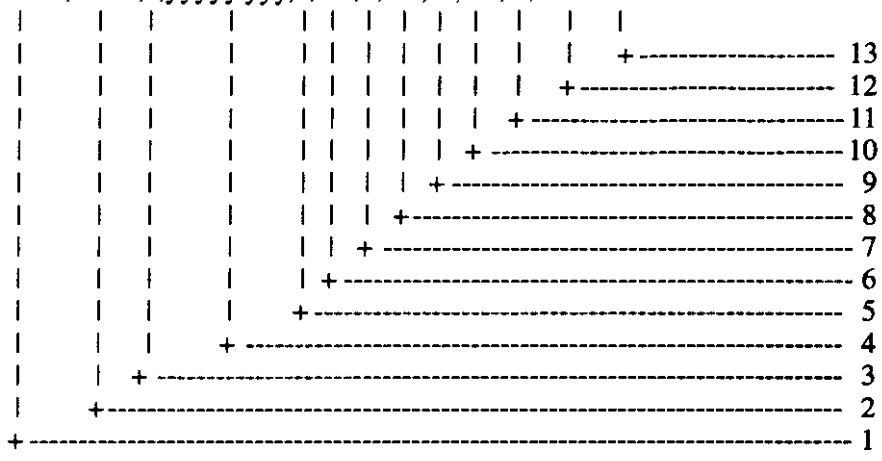


Sentence description

Input sentences

BWC - Bearing and distance to waypoint - great circle

$—BWC,hhmmss.ss,llll.lll,a,yyyyy.yyy,a,x.x,T,x.x,M,x.x,N,c—c*hh<CR><LF>

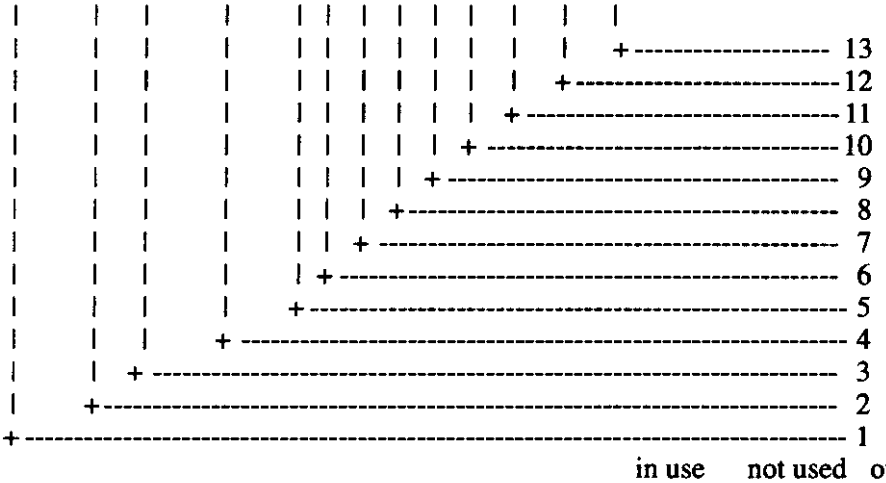


	in use	not used	output
1. 2.3.4.5. Not used		*	*
6.7. Bearing (degrees true)		*	
8.9. Bearing (degrees magnetic)		*	
10.11. Distance (n. miles)		*	
12. Not used		*	
13. Checksum	*		

BWR - Bearing and distance to waypoint - rhumb line

Time (UTC) and distance and bearing to, location of, a specified waypoint from present position. $—BWR data is calculated along the rhumb line from present position rather than along the great circle path.

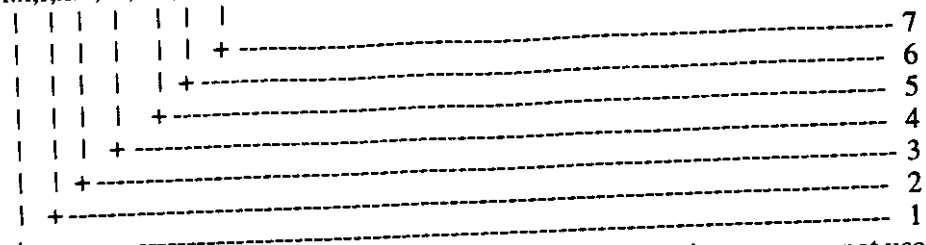
$—BWR,hhmmss.ss,llll.lll,a,yyyyy.yyy,a,x.x,T,x.x,M,x.x,N,c—c*hh<CR><LF>



	in use	not used	output
1.2.3.4.5. Not used		*	
6.7. Bearing (degrees true)		*	
8.9. Bearing (degrees magnetic)		*	
10.11. Distance (n. miles)		*	
12. Waypoint ID		*	
13. Checksum			

DBS - Depth below sea surface

$—DBS,x.x,f,x.x,M,x.x,F*hh<CR><LF>

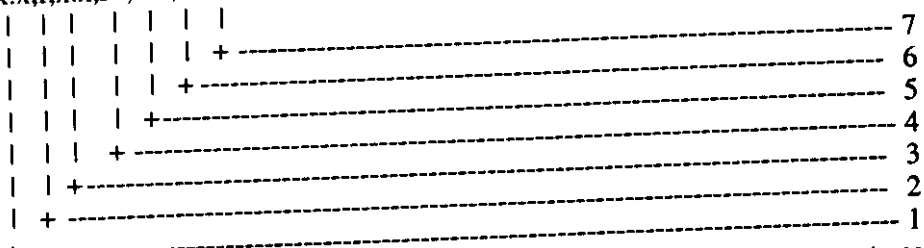


	in use	not used	output
1.2. Depth (feet)	*		
3.4. Depth (meters)	*		
5.6. Depth (fathoms)	*		
7. Checksum			

DBT - Depth below transducer

Water depth referenced to the transducer.

$—DBT,x.x,f,x.x,M,x.x,F*hh<CR><LF>

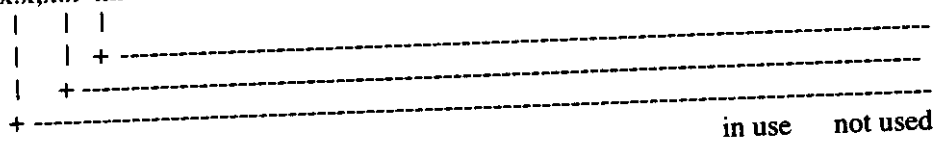


	in use	not used	output
1.2. Depth (feet)	*		
3.4. Depth (meters)	*		
5.6. Depth (fathoms)	*		
7. Checksum			

DPT - Depth

IMO Resolution A.224 (VII). Water depth relative to the transducer and offset of the measuring transducer. Positive offset numbers provide the distance from the transducer to the waterline. Negative offset numbers provide the distance from the transducer to the part of the keel of interest.

$—DPT,x.x,x.x*hh<CR><LF>

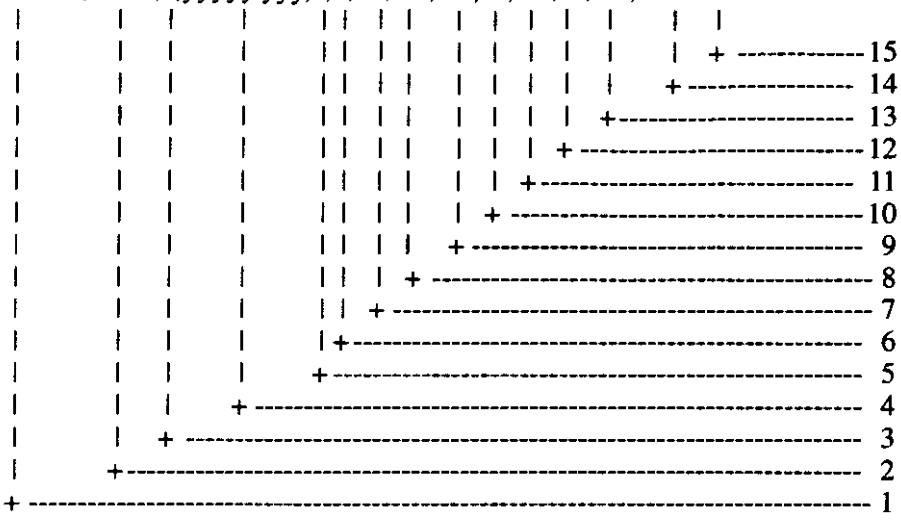


	in use	not used	output
1. Water depth relative to transducer (meters)	*		
2. Offset from transducer (meters) = distance from transducer to water-line	*		
3. Checksum			

GGA - GPS position

Time, position and fix related data for a GPS receiver.

$—GGA,hhmmss.ss,llll.lll,a,yyyyy.yyy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

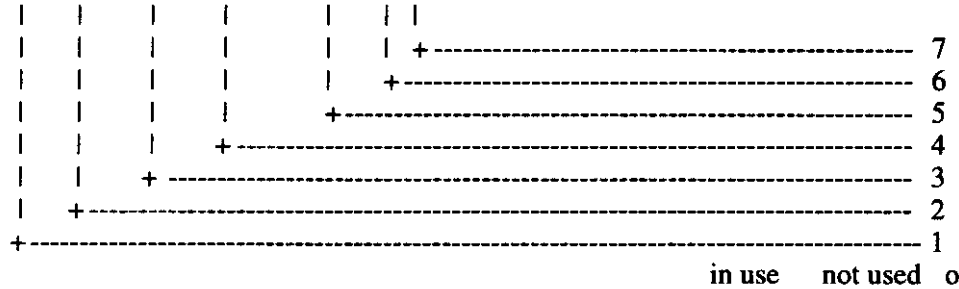


1. UTC of position
2.3.4.5. Latitude (N/S) and longitude (E/W) *
6. Status (1,2,3 = data valid 0 = data invalid) *
7.8.9.10.11.12.13..14 Not used
15. Checksum * * :in use

GLL - GPS Position

Latitude and longitude of present vessel position, time of position fix and status.

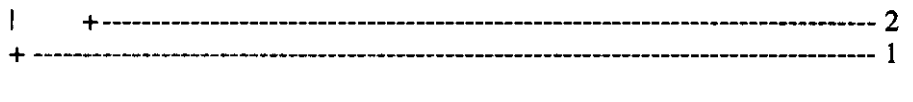
$—GLL,llll.lll,a,yyyyy.yyy,a,hhmmss.ss,A*hh<CR><LF>



	in use	not used	output
1.2.3.4. Latitude (N/S) and Longitude (E/W)	*		
5. Not used		*	
6. Status (A = data valid V = data invalid)	*		
7. Checksum	*		

HDT - Heading true

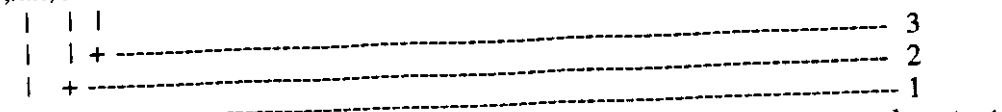
$—HDT, x.x, T*hh <CR> <LF>



1. Heading, degree true
2. Checksum

MTW - Water temperature

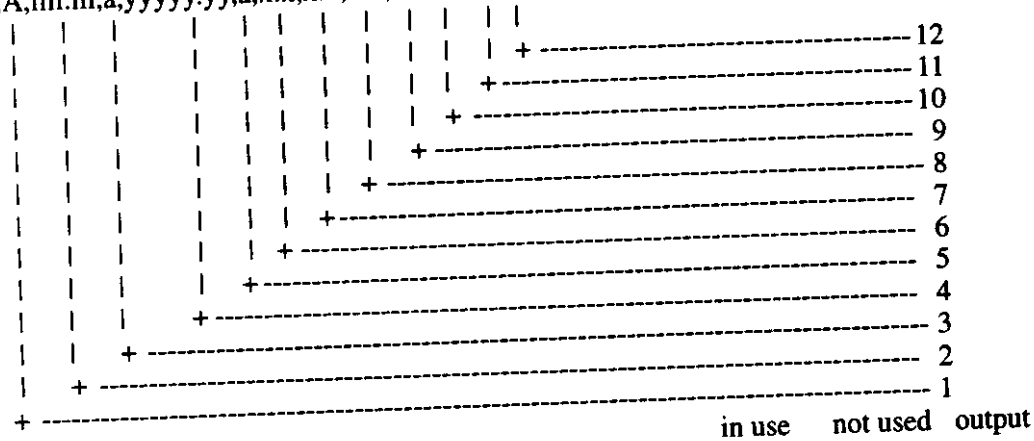
$—MTW,x.x,C*hh<CR><LF>



	in use	not used	output
1.2. Water temperature (C)	*		
3. Checksum	*		

RMA - Recommended minimum specific LORAN-C data

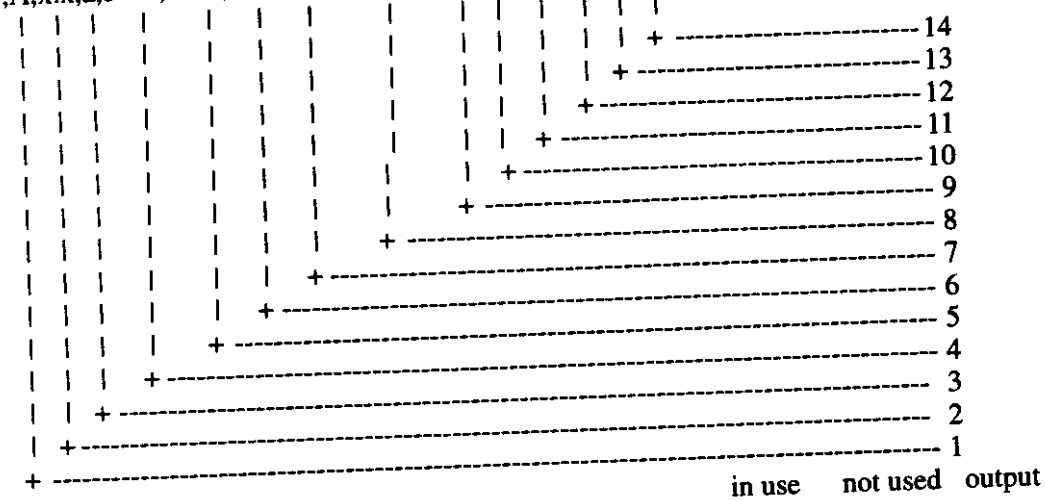
$—RMA,A,llll.lll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>



	in use	not used	output
1. Status (A = data valid, V = Blink, cycle or SNR warning)	*		
2.3.4.5. Latitude (N/S) and longitude (E/W)	*		
6.7. Time difference A, Time difference B (00000.0 - 99999.9 microseconds)		*	
8. Speed over ground (knots)	*		
9. Bearing (degrees)		*	
10.11. Magnetic variation (000.0 - 179.9 degrees), Degrees (E/W)		*	
12. Checksum	*		

RMB - Recommended minimum navigation data

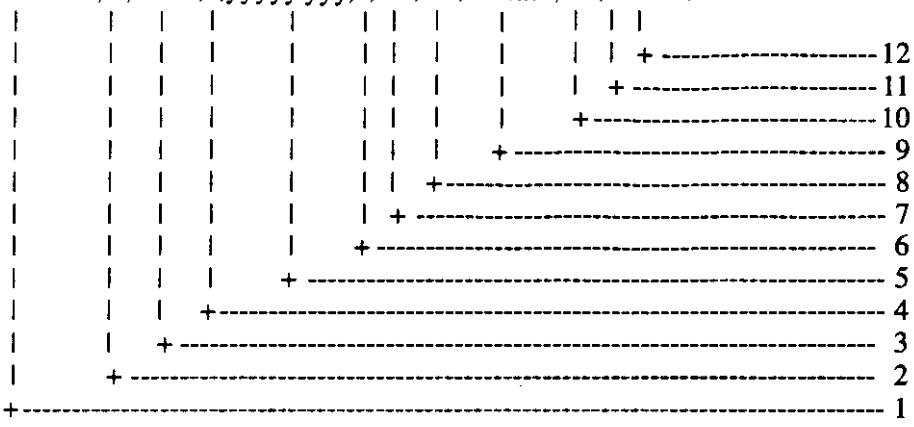
$—RMB,A,x.x,a,c—c,c—c,llll.lll,a,yyyyy.yyy,a,x.x,x.x,x.x,A*hh<CR><LF>



	in use	not used	output
1. Status (A = data valid, V = navigation receiver warning)	*		
2.3.4.5.6.7.8.9. Not used		*	
10. Range to destination (n. miles)	*		
11. Bearing to destination (degrees true)		*	
12. 13. Not used		*	
14. Checksum, mandatory for RMC	*		

RMC - Recommended specific GPS/TRANSIT data

$—RMC,hhmmss.ss,A,llll.lll,a,yyyyy.yyy,a,x.x,x.x,xxxxxx,x.x,a*hh<CR><LF>

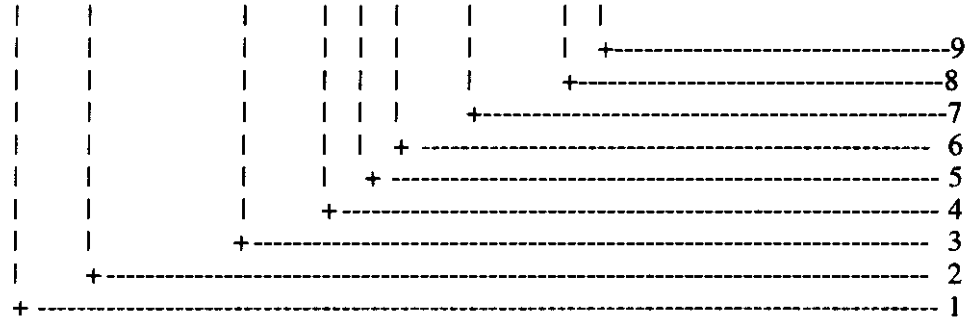


	in use	not used	output
1. Not used		*	
2. Receive status	*		
(A = data valid V = Navigation receiver warning)			
3.4.5.6. Latitude (N/S) and longitude (E/W)	*		
7. Speed over ground (knots)		*	
8. Course over ground (degrees)		*	
9. Not sued		*	
10. Magnetic variation (000.0 - degrees)			
11. Degrees E/W		*	
12. Checksum	*		

TLL - Target latitude and longitude

Target number, name, position and time tag for use in systems tracking targets.

$—TLL, xx, 1111.11, a, yyyyy.yy, a, c—c, hhmmss.ss, a, a*hh<CR><LF>

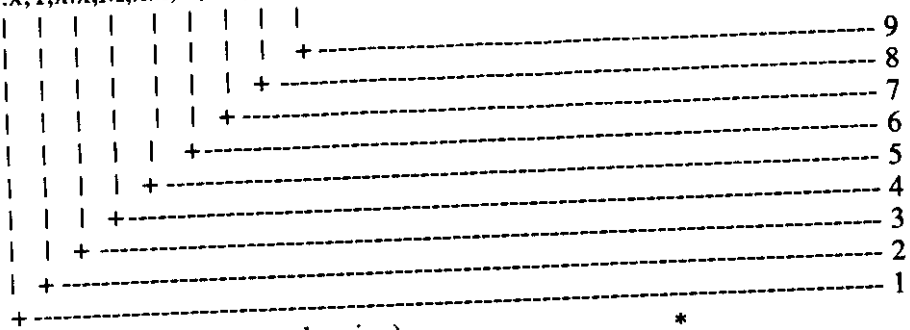


1. Target number (00-99)
2. 3. Latitude (N/S)
4. 5. Longitude (E/W)
6. Target name
7. UTC of data
8. Target status (see note)
9. Reference target (R, null otherwise)

NOTE - Target status: L = lost, tracked target has been lost
Q = query, target in the process of acquisition
T = tracking

VHW - Water speed and heading

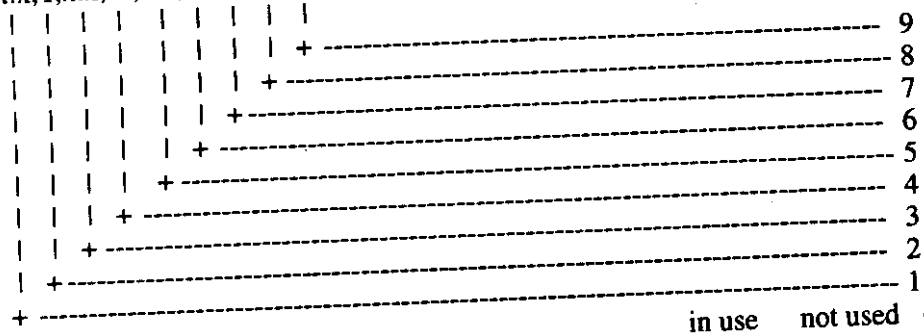
$—VHW,x.x,T,x.x,M,x.x,N,x.x,K*hh<CR><LF>



1.2. Longitudinal heading (T = true bearing)	*	
3.4. Longitudinal heading (M = magnetic bearing)	*	
5.6. Water speed (knots)		
7.8. Not used	*	*: in use
9. Checksum		

VTG - Course over ground and ground speed

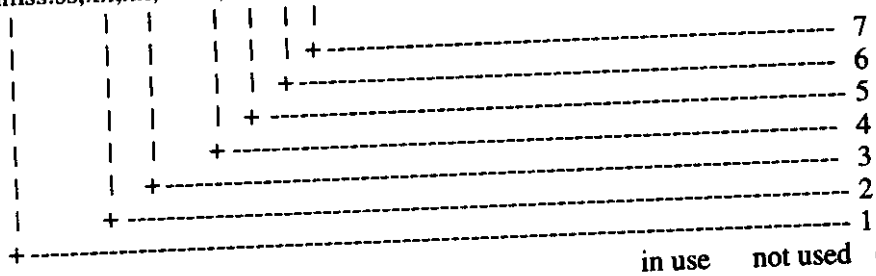
$—VTG,x.x,T,x.x,M,x.x,N,x.x,K*hh<CR><LF>



	in use	not used	output
1.2. Longitudinal heading (T = true bearing)	*		
3.4. Longitudinal heading (M = magnetic bearing)	*		
5.6. Water speed (knots)		*	
7.8. Not used	*		
9. Checksum			

ZDA - Time, Date

$—ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>



	in use	not used	output
1. UTC	*		
2. Day, 0 to 31	*		
3. Month, 01 to 12	*		
4. Year	*		
5. Local zone description (hour)	*		
6. Local zone description (minute)	*		
7. Checksum			