FURUNO

OPERATOR'S MANUAL

MARINE RADAR

MODEL 1815

www.furuno.com

IMPORTANT NOTICES

General
- This manual has been authored with simplified grammar, to meet the needs of international users.
- The operator of this equipment must read and follow the descriptions in this manual.
  Wrong operation or maintenance can cancel the warranty or cause injury.
- Do not copy any part of this manual without written permission from FURUNO.
- If this manual is lost or worn, contact your dealer about replacement.
- The contents of this manual and equipment specifications can change without notice.
- The example screens (or illustrations) shown in this manual can be different from the screens you see on your display. The screens you see depend on your system configuration and equipment settings.
- Save this manual for future reference.
- Any modification of the equipment (including software) by persons not authorized by FURUNO will cancel the warranty.
- The following concern acts as our importer in Europe, as defined in DECISION No 768/2008/EC.
  - Name: FURUNO EUROPE B.V.
  - Address: Ridderhaven 19B, 2984 BT Ridderkerk, The Netherlands
- All brand and product names are trademarks, registered trademarks or service marks of their respective holders.

How to discard this product
Discard this product according to local regulations for the disposal of industrial waste. For disposal in the USA, see the homepage of the Electronics Industries Alliance (http://www.eiae.org/) for the correct method of disposal.

How to discard a used battery
Some FURUNO products have a battery(ies). To see if your product has a battery, see the chapter on Maintenance. Follow the instructions below if a battery is used. Tape the + and - terminals of battery before disposal to prevent fire, heat generation caused by short circuit.

In the European Union
The crossed-out trash can symbol indicates that all types of batteries must not be discarded in standard trash, or at a trash site. Take the used batteries to a battery collection site according to your national legislation and the Batteries Directive 2006/66/EU.

In the USA
The Mobius loop symbol (three chasing arrows) indicates that Ni-Cd and lead-acid rechargeable batteries must be recycled. Take the used batteries to a battery collection site according to local laws.

In the other countries
There are no international standards for the battery recycle symbol. The number of symbols can increase when the other countries make their own recycle symbols in the future.

⚠ SAFETY INSTRUCTIONS

Read these safety instructions before you operate or install the equipment.

⚠ **WARNING**	Indicates a condition that can cause death or serious injury if not avoided.
⚠ **CAUTION**	Indicates a condition that can cause minor or moderate injury if not avoided.

⚠ Warning, Caution	🚫 Prohibitive Action	❗ Mandatory Action

⚠ WARNING

Radio Frequency Radiation Hazard

The radar antenna sends the electromagnetic radio frequency (RF) energy. This energy can be dangerous to you, especially your eyes. Do not look at the radiator or near the antenna when the antenna is rotating.

The distances at which RF radiation levels of 100 W/m^2, 50 W/m^2 and 10 W/m^2 exist are shown in the table.

Note: If the antenna unit is installed at a close distance in front of the wheel house, prevent the transmission in that area to protect passengers and crew from microwave radiation. Set the [Sector Blanks] in the [System] menu.

Distance to 100 W/m^2 point	Distance to 50 W/m^2 point	Distance to 10 W/m^2 point
————	————	Worst case 1.1 m

⚠ CAUTION

Observe the following compass safe distances to prevent deviation of a magnetic compass.

Unit	Standard	Steering
Display unit	0.45 m	0.30 m
M1815 Antenna unit	1.70 m	1.05 m

⚠ WARNING

Do not open the equipment.

The equipment uses high voltage that can cause electrical shock. Refer any repair work to a qualified technician.

Before turning on the radar, be sure no one is near the antenna.

Prevent the potential risk of being struck by the rotating antenna, which can result in serious injury or death.

If water leaks into the equipment or something is dropped into the equipment, immediately turn off the power at the switchboard.

Fire or electrical shock can result.

If the equipment is giving off smoke or fire, immediately turn off the power at the switchboard.

Fire or electrical shock can result.

Do not disassemble or modify the equipment.

Fire, electrical shock or serious injury can result.

Do not place operate the equipment with wet hands.

Electrical shock can result.

⚠ WARNING

Use the correct fuse.

Use of a wrong fuse can result in fire or damage to the equipment.

Do not place liquid-filled containers on the equipment.

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

⚠ CAUTION

The guard zone alarm is an effective aid to anti-collison.

Its use does not relieve the operator of the responsibility to keep a vigilant watch on his or her surroundings.

The data presented by this equipment is intended as a source of navigation information.

The prudent navigator never relies exclusively on any one source of navigation information, for safety of vessel and crew.

TT safety information

⚠ WARNING

The TT function is a valuable aid to navigation. However, the navigator must check all aids available to avoid collision.

- The TT automatically tracks an automatically or manually acquired radar target and calculates its course and speed, indicating them with a vector. Since the data generated by the TT depends on the selected radar targets, the radar must be optimally tuned for use with the TT, to ensure required targets will not be lost or unnecessary targets, like sea returns and noise, will not be acquired and tracked.

- A target is not always a landmass, reef, ship, but can also be returns from the sea surface and from clutter. As the level of clutter changes with the environment, the operator must correctly adjust the sea and rain clutter controls and the gain control so that the target echoes do not disappear from the radar screen.

⚠ CAUTION

The plotting accuracy and response of this TT meets IMO standards. Tracking accuracy is affected by the following:

· Tracking accuracy is affected by course change. One to two minutes is required to restore vectors to full accuracy after an abrupt course change. (The actual amount depends on gyrocompass specifications.)

· The amount of tracking delay is inversely proportional to the relative speed of the target. Delay is approx. 15-30 seconds for the higher relative speed; approx. 30-60 seconds for the lower relative speed. The following factors can affect accuracy:
- Echo intensity
- Radar transmission pulse length
- Radar bearing error
- Gyrocompass error
- Course change (own ship and targets)

Warning Label(s)

Warning label(s) is(are) attached to the equipment. Do not remove the label(s). If a label is missing or damaged, contact a FURUNO agent or dealer about replacement.
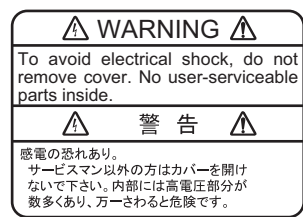
Name: Warning Label 1
Type: 86-003-1011-1
Code No.: 100-236-233-10

Name: Warning Sticker
Type: 03-142-3201-0
Code No.: 100-266-890-10

TFT display

The high quality TFT (Thin Film Transistor) LCD displays 99.99% of its picture elements. The remaining 0.01% may drop out or light,. However, this is an inherent property of the TFT; it is not a sign of malfunction.

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FOREWORD

A Word to the Owner of the MODEL1815 Marine Radar

Congratulations on your choice of the FURUNO MODEL1815 Marine Radar. We are confident you will see why the FURUNO name has become synonymous with quality and reliability.

Since 1948, FURUNO Electric Company has enjoyed an enviable reputation for innovative and dependable marine electronics equipment. This dedication to excellence is furthered by our extensive global network of agents and dealers.

Your equipment is designed and constructed to meet the rigorous demands of the marine environment. However, no machine can perform its intended function unless properly installed and maintained. Please carefully read and follow the operation and maintenance procedures set forth in this manual.

We would appreciate feedback from you, the end-user, about whether we are achieving our purposes.

Thank you for considering and purchasing FURUNO equipment.

Features

The main features are as shown below.

- The main specifications of the MODEL 1815 are outlined in the table below.

Model	Output	Range	Antenna unit size and type	Antenna RPM
Model 1815	4 kW	36 nm	48 cm, Radome	24 RPM

- The radar is operated with keys, knobs and a Cursorpad.
- Easy-to-view 8.4 inch LCD.
- Echo area display with full screen provides observation of a wider range around the vessel.
- User-programmable function key
- AIS data available with connection of FURUNO AIS Transponder/Receiver.

Program No.

0359375-01.**
**=Minor modification

Radar function availability

The Model 1815 is available in two types, [River] (river use) and [Sea] (sea use). Some functions may not available depending on the type selected See the table below for item and availability.

Type and function availability

Item	Type		Page reference
	River	**Sea**	
Automatic menu closure	Menu closes automatically.		
Effective radius dot count	240 dots		
Echo color	Select the echo display color		
Echo color customizing	Can customize the echo display color.		
Echo area	Select the display area from [Normal] or [Full Screen].		
Base text display	Can show or hide the base text indications.		
Range preset	Select the radar ranges to use.		
Unit defaults 1) range 2) speed	1) KM 2) km/h, m/s	1) NM 2) kn	
Bearing scale	Graduation every 1°, 5°, 10°, 30°, no numeric indication, displayed in the effective radius		
VRM unit	Can set the VRM unit independently from the range unit.		
Range unit	Can change the range unit when transmitting.		
AIS symbol color	Select the AIS symbol color from [Green], [Red], [Blue], [White] or [Black].		
Vector reference	Select the display mode for the vector from [Relative] or [True].		
TT number	Empty numbers numbered in ascending order		
Heading line erasure	Heading line, EBL, VRM, guard zone, etc. temporarily erased.		

中文字型由北京字研技术开发中心提供

Note on Chinese font: The Chinese font used in this equipment is Ricoh Company Ltd.'s Ricoh bitmap font.

SYSTEM CONFIGURATION

Basic configuration is shown below with solid line.

MODEL 1815
Antenna Unit
RSB-127-120
RTR-120

Power cable 1.4 m

Equipment category

Antenna Unit: Exposed to the weather
Other Equipment : Protected from the weather

- - - - - - - - - :Option

Antenna cable (FRU-CF-FF-XXM) (10/15/20 m)
* Option: CP03-37630 (30 m)

Display Unit
RDP-157

GPS navigator
Satellite compass
Heading sensor
Plotter
AIS
DSB transceiver

External Buzzer (OP03-21)

Junction Box (FI-5002)

NMEA Data Converter (IF-NMEA2K2)

Junction Box
(local supply)

Cable Assembly
(FRU-CF-F01)

Power supply
12 - 24 VDC

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1. INSTALLATION

1.1 Equipment List

Name	Type	Code No.	Qty	Remarks
Display Unit	RDP-157	—	1	
Antenna Unit	RTR-120	—	1	
Mounting Base	RTR-120	—	1	
Installation Materials	CP03-37600	000-033-122	Select one	
	CP03-37610	000-033-123		
	CP03-37620	000-033-124		
Radome Mounting Bracket	OP03-209	001-078-350	1	Option
External Buzzer	OP03-21	000-030-097	1	Option
NMEA Data Converter	IF-NMEA2K2	000-020-510	1	
Junction Box	FI-5002	000-010-765	1	
Cable Assy.	FRU-CF-FF-30M	001-464-290	1	
Flush Mount Kit	OP03-242	0001-464-280	1	Option

1.2 How to Install the Display Unit

⚠ **CAUTION**

Do not use paint, anti-corrosion products, contact spray or other items containing organic solvents on the equipment.

Organic solvents can harm paint and plastic, particularly the connectors.

The display unit can be installed on a desktop or flush mounted in a console. Do not install the unit on the overhead or a bulkhead. Select a suitable location for the unit considering the following points:

- Select a location where the controls can be easily operated.
- Locate the unit away from the direct wind from air conditioners.
- The temperature range in the mounting location should be -15°C(5°F to 55°C(131°F).
- Locate the unit away from devices that emit active gas.
- The mounting location must be well ventilated.
- Select a location where vibration and shock are minimal.
- A magnetic compass will be affected if the display unit is placed too close to the compass. Observe the compass safe distances in the safety instructions to prevent interference to the compass.
- Locate the unit away from direct sunlight to prevent heat build up inside the cabinet and condensation in the display.
- Keep the unit away from water and water splash. (The unit complies with waterproofing specification IP5.)

Desktop mount

Fasten the unit to the mounting location as shown below. For mounting dimensions, see the outline drawing at the back of this manual.

1. Fix the bracket assembly to a desktop with four self-tapping screws (5×25, supplied). Be sure to follow the recommended maintenance space show in the outline drawing. Insufficient space may damage to the connectors when disconnecting and reconnecting them.

2. Loosely screw knob into the bracket assembly.

3. Set the display unit to the bracket assembly.

4. Tighten the knob to fix the display unit.

5. Adjust the angle of the display unit for comfortable viewing angle.
   Note: Do not tilt the unit 90-degree backward or forward. The cable connector may be damaged if it contacts the bracket.

6. Attach the hard cover to the display unit to protect the unit when it is not in use.

Flush mount (in a console)

Select a flat mounting location and install the unit as shown below.

It is recommended to set up a dedicated breaker when flush mounting the unit, since it will be difficult to disconnect cables.

1. Using the paper template (supplied), make a cutout in the mounting location.

2. Unfasten four washer head screws on the rear of the display unit to remove the bracket cover and the cover sponge.
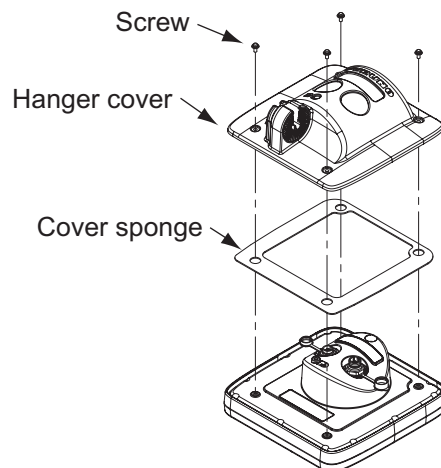
3. Set the flush mounting sponge (supplied) to the display unit.

4. Screw four threaded rods (supplied) to the display unit.

5. Set the display unit to the cutout.

6. Fasten the display unit from behind with four sets of flat washers, spring washers and wing nuts (supplied).

1.3   How to Install the Antenna Unit

Select a mounting location for the antenna unit considering the following points.

- Install the unit on a common mast, radar mast. etc.

- Install the antenna unit on a solid location, for example radar arch or on a mast on a platform. (For sailboats, a mounting bracket is optionally available.) You must put the antenna unit where there is a good complete view. Make sure that no part of the superstructure is within the scanning beam. Any obstruction causes shadow sectors. For example, a mast with a diameter smaller than the horizontal beam width causes only a small blind sector. A horizontal spreader or crosstrees in the same horizontal plane creates a large obstruction. Install the antenna unit above a horizontal spreader or crosstrees.

Horizontal beam width

12.5°
12.5°

Rear view   Rear view   Rear view

Antenna   Antenna

Mounting on a sailboat   Mounting on a power boat
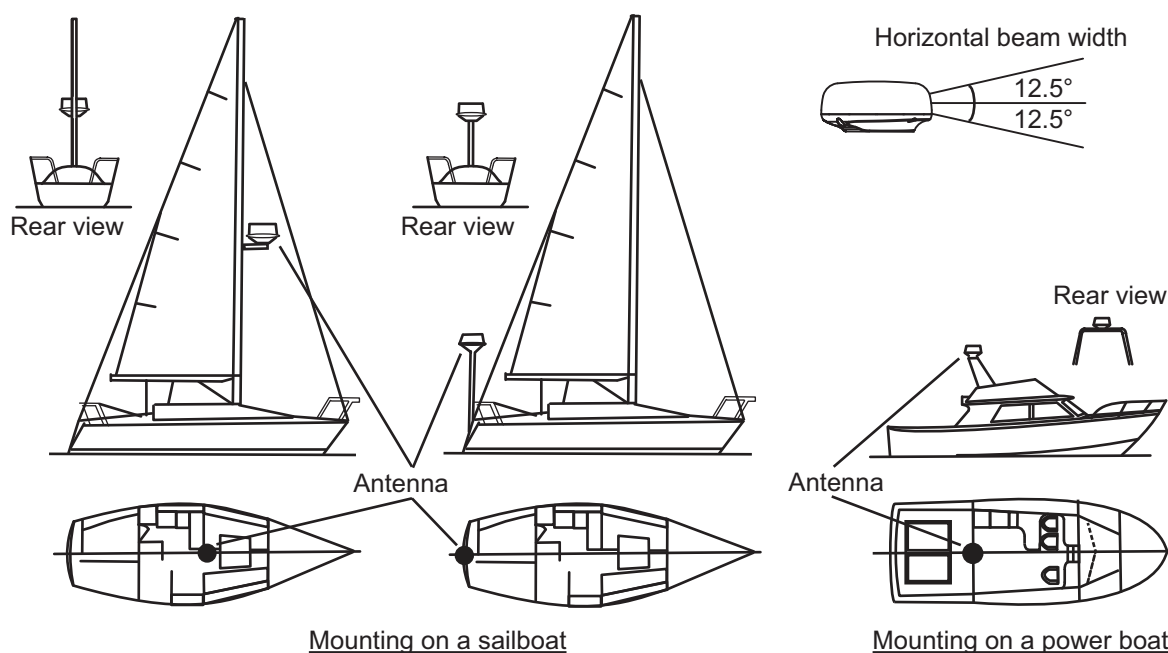
- To avoid electrical interference, do not run the antenna cable near other electrical equipment. Also do not run the cable in parallel to power cables.

- Do not install the unit where its motor noise may affect crew or passengers.

- As much as possible install the unit on the ship's centerline, to prevent misplacement of echoes (wrong bearing) on the display.

- Make sure the mounting location does not allow water to accumulate at the mounting platform.

- A magnetic compass will be affected if the display unit is placed too close to the compass. Observe the compass safe distances in the safety instructions to prevent interference to the compass.

- Do not paint the radome.

- Be sure to follow the recommended maintenance space shown in the outline drawing at the back of this manual.

- If the unit is installed on a large vessel observe the following points.

  - The antenna cable comes in lengths of 10, 15 and 20 m. Consider the length of the cable when selecting a mounting location.

• Keep the unit away from smoke and exhaust stacks. Hot air affects antenna performance. Hot air can also damage the unit. The temperature at the mounting location should not exceed 55°C(131°F)

Tools and materials for mounting

Name	Usage
Electric drill	Drill holes for mounting. Drill bit: φ11 mm
Hexagonal wrench	Fastening bolts: Diagonal: 6 mm

How to mount the antenna unit
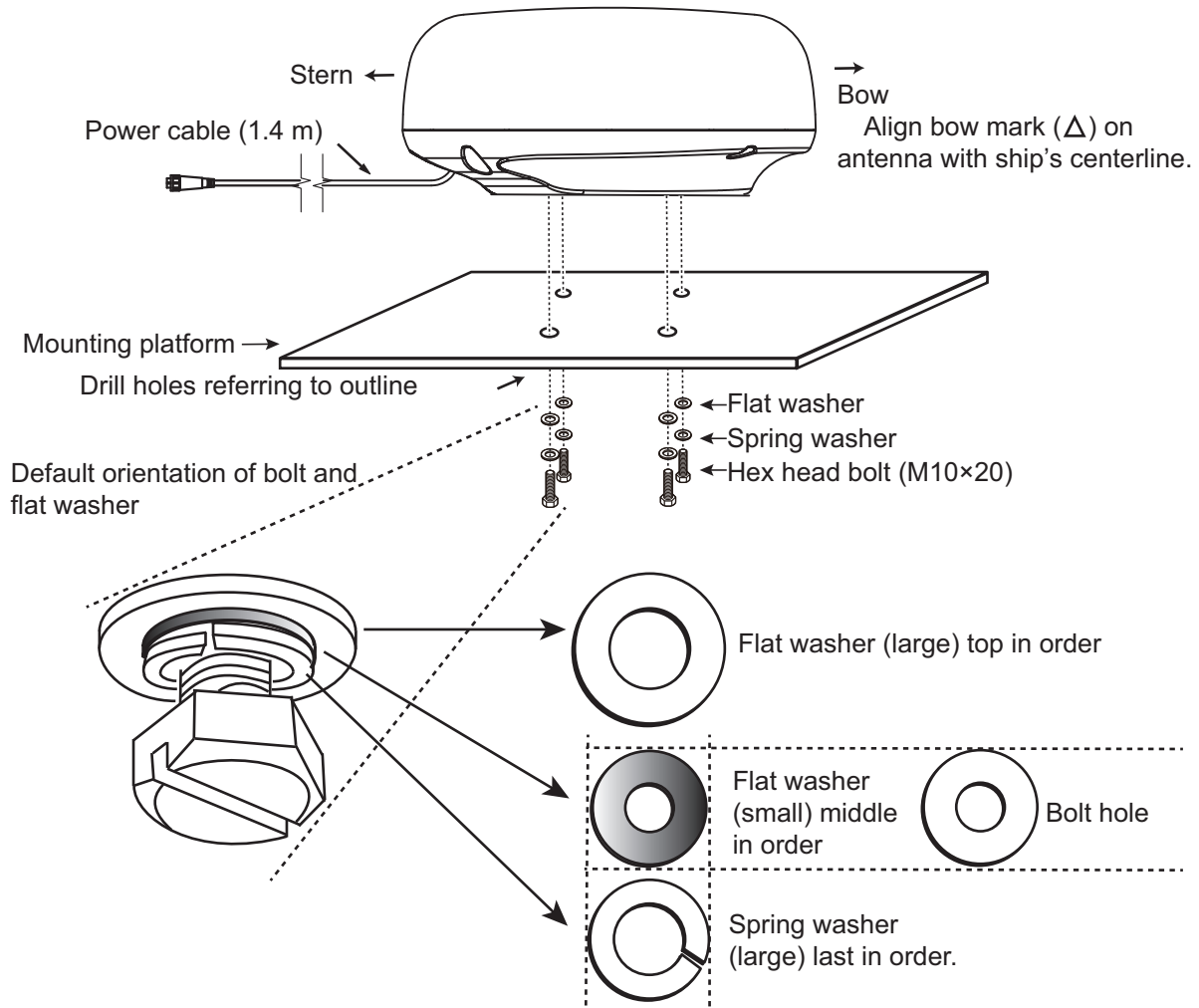
Note: The outer diameter of the small flat washer is the same size as the bolt hole. If the radome is put upside down with only the small flat washer and hex bolt in place, the hex bolt and flat washer may protrude into the radome and damage the RT unit. For this reason, DO NOT put the radome upside down when carrying the radome.

1. From the bottom of the radome, remove spring washers (M10), flat washers (M10) and hex head bolts (M10×25).

Flat washer
Spring washer
Hex head bolt (M10×20)
×4
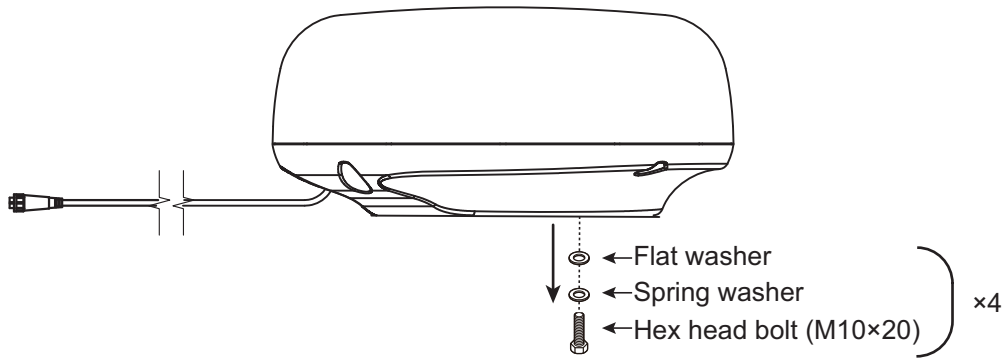
2. Use the mounting template (supplied) to mark the location of fixing holes in the mounting platform. Be sure to drill the holes parallel with the bow.

3. Lay the antenna unit on the mounting platform with the bow mark(△) on the antenna unit facing the bow.

4. Use hex bolts*, flat washers and spring washers (removed at step 1) to fasten the radar sensor to the platform. The torque for the bolts must be 19.6 to 24.5 N.m. Apply silicone sealant (local supply) to hex bolt, flat washer and spring washer as shown below.
   *See the figure below to determine the bolt length to use.

Sensor base
Determine the length of bolts according to platform thickness.
Flat washer
Platform
Spring washer
Silicone sealant (local supply)
Hex bolt
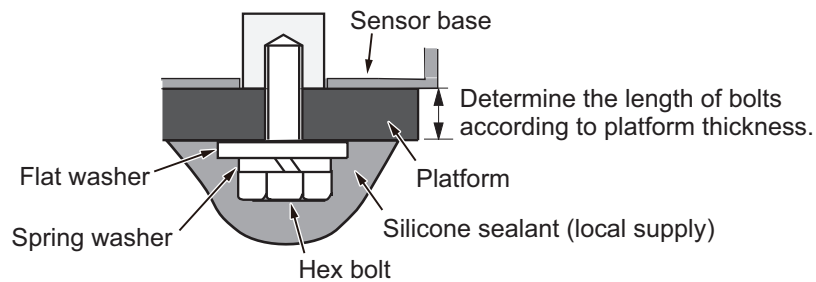
Platform thickness	Bolt size to use
5 mm or less	M10×20m
6 to 10 mm	M10×25
More than 10 mm	Local supply

5. Connect the power cable to the antenna unit. The pin arrangement is as shown below.

10 mm

Pin arrangement
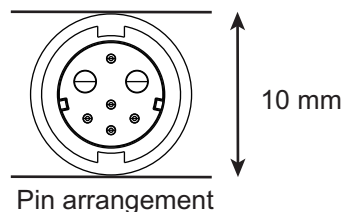
How to connect the power cable

Observe the following guidelines for connecting the power cable.

• The connectors must not strike any part of the vessel by wind, etc.

• The load applied to the connectors must not be more than their own weight.

• If the cable is passed through a mast on a sailboat, be sure the cable does not touch ropes (sheet, halyard, etc.).

• Do not fasten the cable to the hull.

1.   The cable must be fixed so no tension is applied to the connectors. To prevent tension, make a loop in the cable close to the sensor and tie the loop with cable ties, as in the figure below.
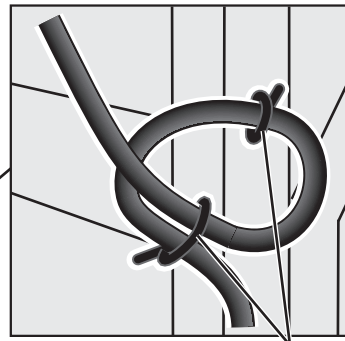
Loop cable and tie the loop with cable ties. (Min. bending radius: 80 mm)

2.   Wrap the junction of the connectors with self vulcanizing tape for waterproofing.

Connect and wrap with tape.
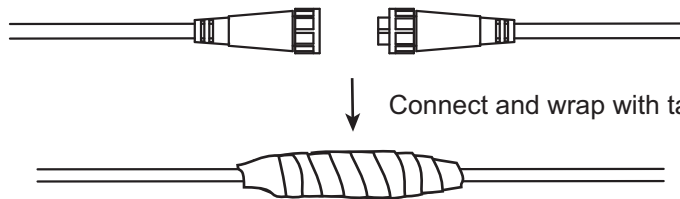
3.   Fasten the cable to the mast, etc. at the neck of each connector with a cable tie.

How to use the radome mounting bracket (option)

The optional radome mount lets you fasten the radar sensor to a mast on a sailboat.
Name, Type: Radome Mount, OP03-209
Code No.: 001-078-350

Name	Type	Code No.	Qty
Mounting plate	03-018-9001-0	100-206-740-10	1
Support plate (1)	03-018-9005-0	100-206-780-10	1
Support plate (2)	03-018-9006-0	100-206-790-10	1
Bracket (1)	03-028-9101-1	100-206-811-10	1
Bracket (2)	03-028-9101-2	100-206-812-10	1
Fixing plate	03-028-9103-1	100-206-831-10	2
Hex bolt w/washer	M8×20 SUS304	000-162-955-10	8
Hex bolt w/washer	M4×12 SUS304	000-162-956-10	4

How to assemble the bracket:

1. Fasten the fixing plates to brackets (1) and (2) with four M8×20 hex bolts.

2. Fit brackets (1) and (2) loosely with support plates (1) and (2) using four M4×12 hex bolts, so that the gap between the brackets can be adjusted.

3. Place the mounting plate on the bracket and fix it loosely with four M8×20 hex bolts.
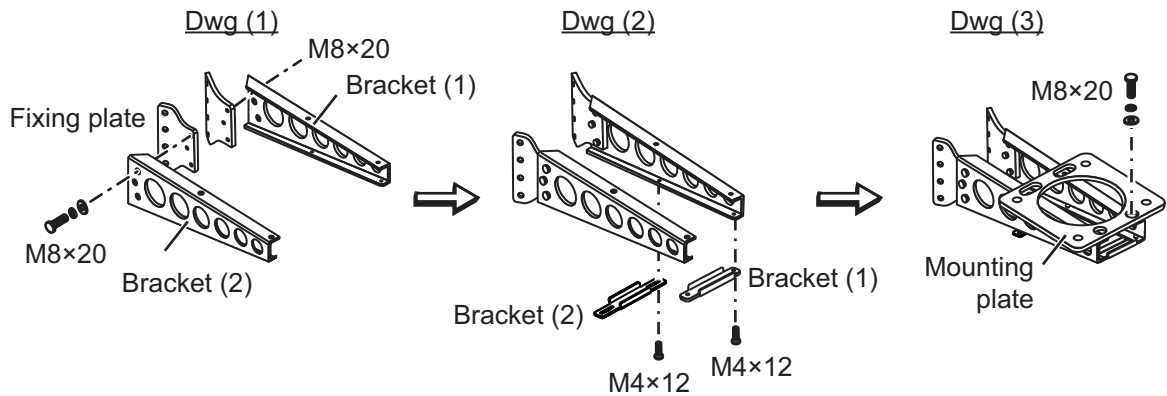
How to fasten the bracket to the mast:

1. Drill eight holes of 6.5 mm into the mast. Fasten the bracket to the mast with eight stainless steel rivets whose diameter is 6.4 mm.

2. Tighten the bolts on the bracket.

3. Fasten the antenna unit to the bracket.

1-7
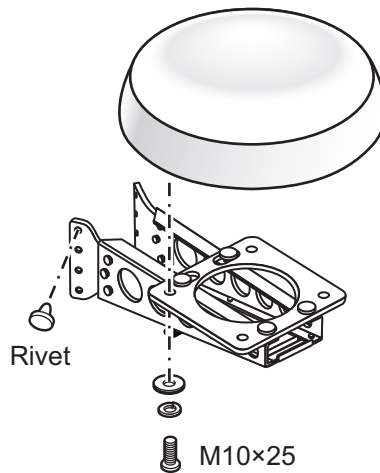
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2. WIRING

2.1 Wiring

Use the supplied cable FRU-CF-F01 to connect a satellite compass, heading sensor, GPS navigator, external buzzer, and power supply to the 12-24 VDC/NMEA connector.

Connect the antenna cable (FU-CF-xxM (10m/15m/20m/30m) to the antenna port. See the interconnection diagram at the back of this manual for details. Leave slack in the cable to ease maintenance.

Antenna cable
（FRU-CF-FF-**M, 10/15/20/30m）

Power/signal connector

Ship's switchboard, external equipment, ground terminal, etc.

Ground
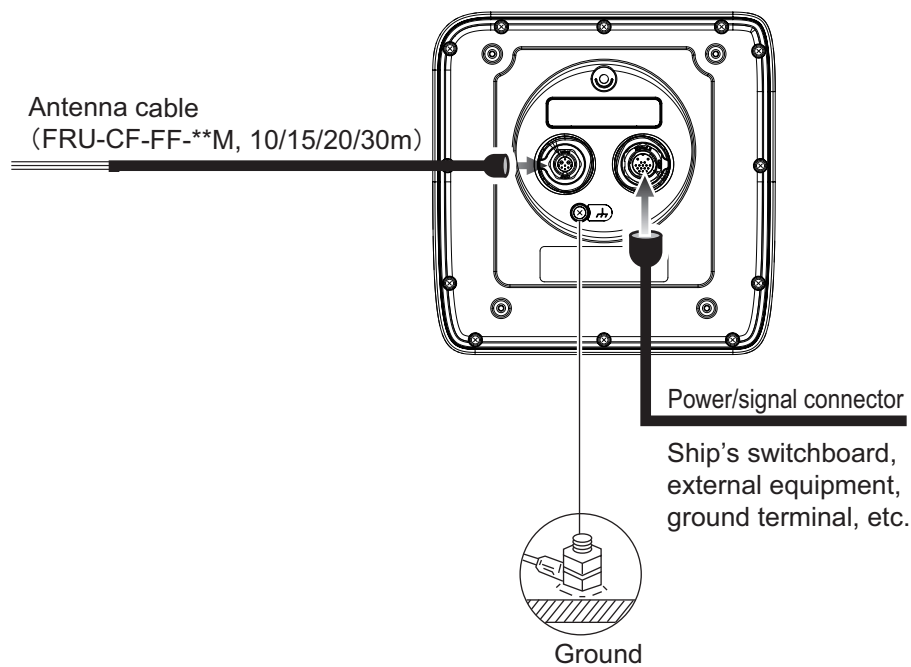
Display unit, rear view

Note 1: The display unit comes with connector caps. Use the caps to cover the connectors whenever the display unit is removed from the boat.

Note 2: Cut unused wires and wrap them with vinyl tape to keep them from touching one another.

Note 3: Use care when disconnecting cables to prevent damage to their connectors.

Note 4: If an NMEA device is to use +12 V power from this radar, do not connect the device's circuit GND or chassis GND. (Do not connect chassis GND to 12V_M.)

	Connector	Color	Remarks
1	DC-P-IN(+)	RED	Power input, 12-24 VDC
2	DC-M-IN(-)	BLK	
3	TD1-A	GRN/BLK(1)	IEC61162-2/NMEA1
4	TD1-B	GRN/RED(1)	
5	RD1-H	GRY/BLK(1)	
6	RD1-C	GRY/RED(1)	
7	TD2-A	GRN/BLK(2)	IEC61162-2/NMEA2
8	TD2-B	GRN/RED(2)	
9	RD2-H	GRY/BLK(2)	
10	RD2-C	GRY/RED(2)	
11	RD3-H	GRY/BLK(3)	IEC61162-2/NMEA3
12	RD3-C	GRY/RED(3)	
13	12V-P(+)	BRN	Power output, 12-24 VDC
14	12V-M(-)	ORG	
15	EXT-BUZZ-EN	WHT	External buzzer
16	SHIELD	BLK	Drain wire, to ship's switchboard's ground terminal

Ground

⚠ **CAUTION**

Do not fail to ground the display unit.

If the ground is poor or there is no ground, interference to the radar and other equipment can result.

Grounding guidelines:

• The ground wire (local supply) should be 2sq or higher.

• The length of the ground wire should be as short as possible.

• For an FRP vessel, fasten a 20 cm×30 cm earthing plate to the outside of the ship's hull and attach the ground wire to a bolt on the plate.

• Attach a closed-end lug (⌸⊙) to the ground wire. Do not use an open-end lug (⌸⊏).

• External equipment whose signal line is connected to ground cannot be directly connected to this equipment if the positive polarity of the vessel's DC power is connected to ground.

3. INITIAL SETTINGS

3.1 How to Select Language

Do the following to select the language to use.

1. Press the (⏻ TX) key on the display unit to turn on the power.

2. Press the **MENU/ESC** key to show the menu.

```
┌─────────────────┬──────────────────────────────┐
│      Menu       │            Factory           │
│ AIS             │ Language        : English     │
│ GPS             │ Usage           : Sea         │
│                 │                               │
│ ▼ System        │                               │
│  Initial        │                               │
│  Tests          │                               │
│  Sector Blanks  │                               │
│  Units          │                               │
│  TT             │                               │
│  Installation   │                               │
│  Factory        │ [ENTER]: Enter                │
│                 │ [MENU/ESC]: Back              │
├─────────────────┴──────────────────────────────┤
│ Use this menu for factory setup                 │
└─────────────────────────────────────────────────┘
```
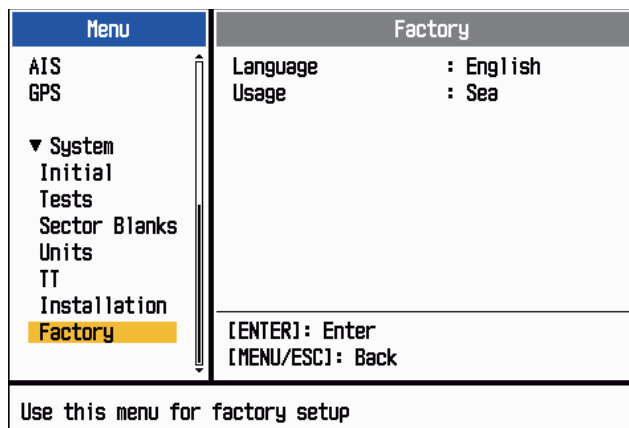
3. Press ▲, ▼ on the Cursorpad to select [Factory], then press the **ENTER** key. The cursor moves to the menu item section and [Language] is selected. Press the **ENTER** key again to show the language options.

```
┌──────────┐
│ English  │
│ Français │
│ Español  │
│ Deutsch  │
│ Italiano │
│ Português│
│ Dansk    │
│ Norsk    │
│ 中文     │
│ Viet nam │
└──────────┘
```

4. Press ▲, ▼ on the Cursorpad to select a language, then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

3.2 How to Select Radar Purpose

1. Press the **MENU/ESC** key to show the menu.

2. Press ▲, ▼ on the Cursorpad to select [Factory], then press the **ENTER** key.

Menu	Factory
AIS	Language : English
GPS	Usage : Sea
▼ System	
Initial	
Tests	
Sector Blanks	
Units	
TT	
Installation	
Factory	[ENTER]: Enter
	[MENU/ESC]: Back
Use this menu for factory setup	

3. Press ▲, ▼ on the Cursorpad to select [Usage], then press the **ENTER** key.

River
Sea

4. Press ▲, ▼ on the Cursorpad to select a [River] or [Sea], then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

3.3 Initial Settings

1. Press the **MENU/ESC** key to show the menu.

2. Press ▲, ▼ on the Cursorpad to select [Installation], then press the **ENTER** key.

Menu	Installation
AIS	Simulation : Off
GPS	Antenna Rotation : Rotate
	Heading Alignment : 0.0°
▼ System	Sweep Timing : 0
Initial	MBS Adjustment : 0
Tests	Auto Install Setup
Sector Blanks	Total On Time : 000000.0H
Units	Total TX Time : 000000.0H
TT	Memory Reset
Installation	
Factory	[ENTER]: Enter
	[MENU/ESC]: Back
Use this menu for installation	

3. While holding down and pressing the **ENTER** key, press the **ALARM** key five times to unlock the [Installation] menu.

4. Press ▲, ▼ on the Cursorpad to select the item to set, then press the **ENTER** key.

5. Press ▲, ▼ on the Cursorpad to select the option required, then press the **ENTER** key

6. After setting all items, press the **MENU/ESC** key to close the menu.

Item description

- [**Simulation**]: Normally, set to [Off.] To view the demonstration picture, select [On].
- [**Antenna Rotation**]: Select [Rotate] to rotate the antenna and transmit radar pulses. The [Stop] setting, which transmits radar pulses without rotating the antenna, is for use by the service technician.
- [**Heading Alignment**]: You have installed the antenna unit so that the unit faces toward the bow. A target at the front of the boat and aligned with the bow must appear on the heading line (zero degrees). If the target does not appear on the heading line, do the procedure shown below to adjust the heading.

  1. Set ship heading toward an acceptable target (for example, ship at anchor or buoy) at a range between 0.125 and 0.25 nautical mile.
  2. Transmit the radar at the range of 0.25 nautical mile and measure the bearing of that target relative to ship heading with an EBL.
  3. Open the [Installation] menu and select [Heading Adjust].
  4. Press the **ENTER** key to show the heading adjustment window.
  5. Press ▲ or ▼ to set the value measured at the above step 2. Check that the target appears on the heading line.
  6. Press the **ENTER** key to finish.

- [**Sweep Timing**]: This adjustment gives correct radar performance on short ranges. The radar measures the time required for a transmitted echo to go to the target and return to the source. The received echo appears on the display according to the measured time. The sweep must start from the center of the display.A trigger pulse created in the display unit goes to the antenna unit through the signal cable to activate the transmitter (magnetron). The time taken by the signal to move to the antenna unit changes, according to the length of the signal cable. During this period, the display unit must wait before the radar starts the sweep. When the display unit is not adjusted correctly, the echoes from a straight object will not appear as a straight line. The target appears "pushed" or "pulled" near the picture center. The range to objects are shown at wrong distances.
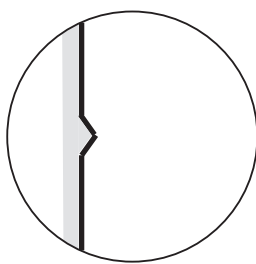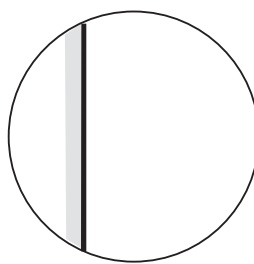
(1) Target pulled   (2) Correct   (3) Target pushed outward
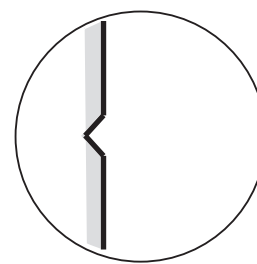
  1. Transmit on the shortest range, then adjust the gain and the A/C SEA.
  2. Visibly select a target that creates a straight line (harbor wall, straight piers).
  3. Open the [Installation] menu and select [Timing Adjust].
  4. Press the **ENTER** key to show the timing adjustment window.
  5. Press ▲ or ▼ to make straight the target selected at step 2, then press the **ENTER** key to finish.

- [**Main Bang Suppression**]: Reduce the main bang (black hole at center of screen), which appears at the display center on short ranges, as follows.

  1. Transmit on the shortest range.

  2. Open the [Installation] menu and select [MBS Adjust].

  3. Press the **ENTER** key to show the MBS adjustment window.

  4. Press ▲ or ▼ on the Cursorpad so that the main bang is reduced.

  5. Press the **ENTER** key to finish.

- **How to automatically set the equipment**: The tuning, timing, and video can be automatically adjusted as follows.
  Note: Before doing this procedure, transmit the radar more than 10 minutes on a long range and check that [Sector Blank] is [Off].

  1. Transmit on the maximum range.

  2. Open the [Installation] menu and select [Auto Initial Setup], then press the **ENTER** key.

  3. Press ▲ on the Cursorpad to select [Yes], then press the **ENTER** key.

  The tuning adjustment begins automatically, and the message "Tuning adjusting" appears during tuning adjustment. After the tuning adjustment is completed, the timing and video are adjusted in that order. The messages "Timing adjusting" and "Video adjusting" appear during those adjustments. After all adjustments are completed, the window disappears. If the result for any item is not best for your conditions, manually adjust the item according to the procedure in this section.

- [**Total On Time**]: You can set the total on time as shown below.

  1. Open the [Installation] menu and select [Total On Time].

  2. Press the **ENTER** key.

  3. Press ▲ or ▼ on the Cursorpad to set value. The range is 000000.H to 999999.9 H.

  4. Press the **ENTER** key to finish.

- [**Total TX Time**]: You can set the total TX time as shown below.

  1. Open the [Installation] menu and select [Total TX Time].

  2. Press the **ENTER** key.

  3. Press ▲ or ▼ on the Cursorpad to set value. The range is 000000.H to 999999.9 H.

  4. Press the **ENTER** key to finish.

- [**Memory Clear**]: The memory clear feature restores all settings to default, including the default settings for the antenna connected to LAN.

  1. Open the [Installation] menu and select [Memory Clear].

  2. Press the **ENTER** key.

  3. Press ▲ or ▼ on the Cursorpad to select [Yes], then press the **ENTER** key.

  4. Press the **ENTER** key to finish.

4. OPTIONAL EQUIPMENT

4.1 External Buzzer

The external buzzer alerts you to violation of the guard zone in a remote location. Connect the buzzer to the display unit as shown below, using the external buzzer installation kit.
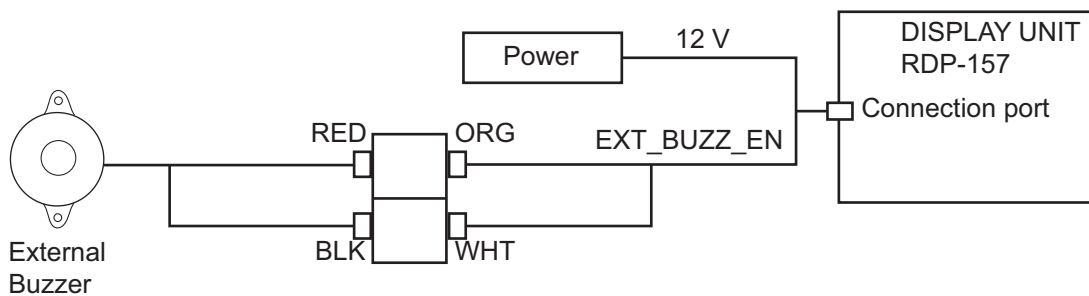
External Buzzer Installation Kit
 Type: OP03-31, Code No.: 000-030-097

	Name	Type	Code No.	Qty	Remarks
1	Buzzer	PKB42SWH2940	000-153-221-10	1	Connector at both ends
2	Cable Tie	CV-70N	000-162-185-10	4	
3	Heat Shrink Tube	3×0.25 BLK	000-165-283-10	1	40 mm
4	Double-sided Tape	9760	000-800-851-00	1	25 m×25 mm

As shown in the illustration below, cut the connector from the end of the cables. Fabricate the cables as shown below, then connect the cables to the terminal board in the display unit.

Fabricate the cables as shown.

Terminal Board (local supply)

TD1_A
TD1_B
RD1_H
RD1_C
TD2_A
TD2_B
RD2_H
RD2_C
RD3_H
RD3_C
12V_P
ORG 12V_M
WHT EXT_BUZZ_EN

RED

BLK

EXTERNAL
BUZZER
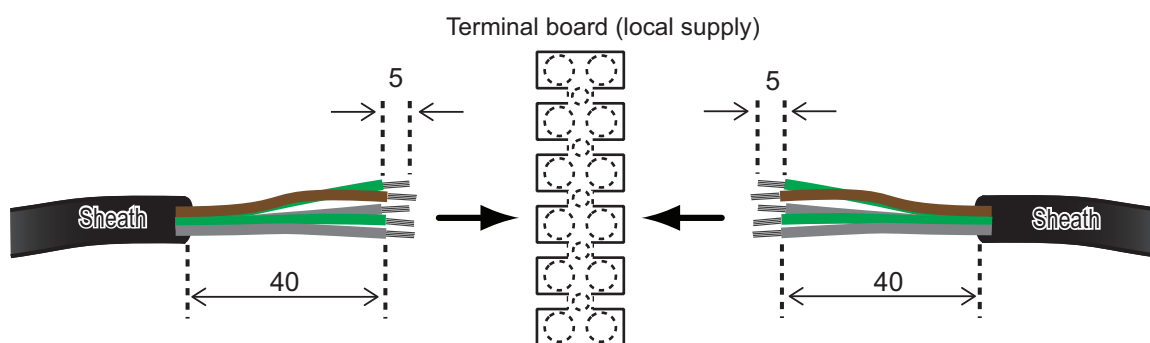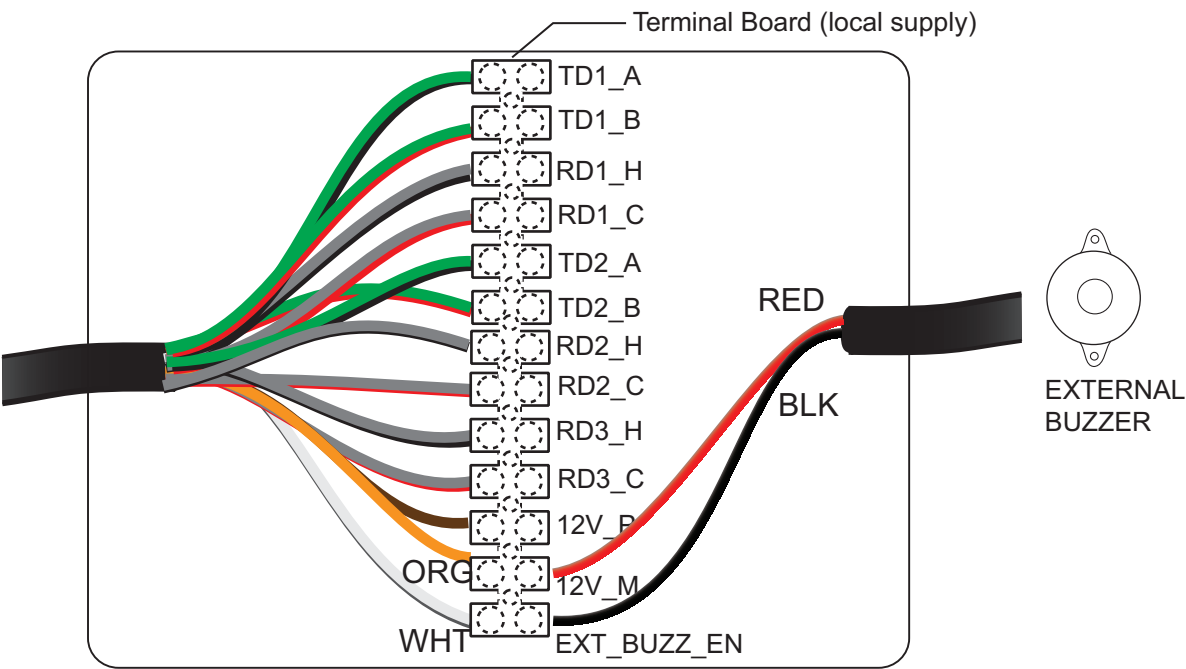
5.   OPERATION

5.1   Controls

Display unit

The display unit has six keys, two knob controls and a Cursorpad that control the radar. When you correctly do an operation, the unit beeps one time. If the operation is incorrect, the unit beeps three times.

Control	Description
MENU/ESC	• Open/close the menu. • Cancel selection (setting),
Cursorpad	• Select the menu items and options. • Move the cursor.
ENTER	• Save selected menu option. • Acquire target to track its movement. • Select TT or AIS target to display its data.
MODE	Show the mode selection window.
ALARM	Set the target alarm, which checks for targets in the operator-set area.
FUNC	Execute the function assigned to this key.
RANGE (PUSH FOR GAIN)	Select the detection range.
DATA BOX	Select the data box to display on the radar screen.
⏻ TX	**Short push**: Turn on the power. **Long push**: Turn off the power. • Adjust the display brilliance. • Switch the radar between standby and TX.

5.2   How to Turn the Radar On/Off and Transmit

Press the ⏻ key to turn on the radar. To turn off the radar, press and hold down the key until the screen turns off.

Start-up screen

When you turn on the power, the initialization screen appears followed by the start-up screen. The start-up screen shows the model name, program number and the results of the ROM and RAM check, OK or NG (No Good). If the test results are normal, the stand-by screen ([Normal] or [Nav]) appears approx. 5 sec. later, and the time remaining for magnetron warm-up (approx. 90 seconds) is counted down on the screen. **If NG appears, contact your dealer for instruction**.

After the magnetron has warmed, the indication [ST-BY] at the screen center. The radar is now ready to transmit radar pulses.

Push the ⏻ key to show the [Brill/Panel] window.

The cursor is selecting [TX/STBY]. Press the **ENTER** key to transmit the radar pulses.

The ⏻ key switches between standby and transmit. The antenna rotates in transmit and is stopped in standby. Because the magnetron ages with use, set the radar in stand-by when you are not using the radar, to extend the life of the magnetron.

5.3   Display Indications

Offcenter
(M: Manual, A: Auto, C: Custom)

Heading

North marker

Trail reference

Trail time

Range → **1.5NM**   HDG **350.0°**   TRAIL(T) ←   TUNEAUTO ← Tuning indicator
Range ring interval → 0.5   OFFCENT(A)   15 S
Display mode → H UP   ALM1_IN   ⎫ ← Target Alarm 1 (2)
Zoom indication → ZOOM(R)   ALM2_IN   ⎬   indications
WTC   ⎭
← WATCHMAN
← Target alarm zone 1
← No. 2 EBL
Range ring → ← Heading line
Bearing scale →
No. 1 VRM → ← No. 2 VRM
No. 1 EBL →
Zoom cursor → ← Zoom window
Cursor → +
Target alarm zone 2 →
Echo stretch → ES 1   IR 1 ← Interference rejector
Echo averaging → EAV 1
EBL   VRM
No. 1 EBL bearing → 270.0°R   VECT TRUE 05:00   0.889NM ← No. 1 VRM range
No. 2 EBL bearing → 22.0°R   + 241.0°R 1.592NM   0.422NM ← No. 2 VRM range

Vector time

Cursor data
(Range and bearing or L/L position)

Nav data: Appears at screen bottom when [Data Box]
in the [Display] menu is set to [Nav] or [All]. Appropriate
sensors required to display nav data.

OWN SHIP		+ CURSOR		WAYPOINT	
LAT	34°56.123N	LAT	34°56.123N	BRG	14.8°
LON	135°34.567E	LON	135°34.567E	RNG	0.876NM
SPEED	12.3KN	TTG	01:00	TTG	00:20

Display indications

5.4 How to Adjust Display Brilliance, Panel Dimmer

You can adjust the display brilliance and panel dimmer as follows:

1. Press the ⏻ key to show the [Brill/Panel] window.

```
          Brill/Panel
 TX/STBY         : Push [ENTER]
                   ◀ Min   Max ▶
 Brill    (1~16) 10 ▣▣▣▣▣▣▢▢
 Panel    (1~ 8)  3 ▣▣▢▢▢▢▢▢
 [ENTER]: Enter [↑/↓]: Select
 [MENU/ESC]: Close
```

Brill/Panel dialog box

2. Press the **ENTER** key (or ▲, ▼) to select [Brill] or [Panel] as required.

3. Use the Cursorpad (◀ or ▶) to adjust. (For brilliance, you can also use the ⏻ key.)

4. Press the **MENU/ESC** key to close the window.

5.5 Menu Description

This MODEL 1815 series has 14 menus and 7 sub menus. Below is the basic procedure for menu operation.

1. Press the **MENU/ESC** key to open the menu.

Menu   Currently selected menu

Title bar →

```
      Menu                        Echo
 Brill/Color ▲      Auto SEA         : Advanced
 Display            Echo Stretch     : Off
 Echo               Echo Average     : Off
 Alert Settings     Noise Rejector   : Off
 Trails             Wiper            : Off
 Tuning             Int Rejector     : Off
 Others             Display-Curve    : 1
 Target             Low Level Echo   : 0
 OS/Barge Mark
 TT
 AIS               [ENTER]: Enter
                   [MENU/ESC]: Back
 ▼
 Adjust echo features
```

Cursor →

Menu items and current settings

Guide message
(The simple explanation for the current menu.)

Scroll bar (Indicates menus currently not shown in menu window. Black vertical line indicates location in menu. You can see the menus and sub menus currently not shown by using ▲ or ▼.)

Menu

2. Use the Cursorpad (▲ or ▼) to select a menu or a sub menu. The cursor (yellow) in the Menu column indicates the menu currently selected. The menu items in the right window change according to the menu selected.

   Menu description
   [Brill/Color]: Adjust the brilliance and color.
   [Display]: Set up the display-related features.
   [Echo]: Adjust the echo features.
   [Alert Settings]: Customize the user settings.
   [Alarm]: Set up the alarm items.
   [Trails]: Process trails of the radar targets.
   [Tuning]: Adjust the radar tuning.
   [Others]: Set up other items.
   [Target]: Set up the targets configuration.
   [OS/Barge Mark]: Set up the own ship mark and barge mark.
   [TT]: Set up tracked targets.
   [AIS]: Set up AIS targets.
   [GPS]: Set up GP-320B (Black-Box GPS).
   [System]
    [Initial]: Initial settings.
    [Tests]: System diagnostic and LCD test.
    [Sector Blanks]: Set up the sector blanks to prevent the transmission in a certain area.
    [Units]: Set up units.
   [TT]: Set up TT system.
     [Installation] and [Factory]: For use by the installer. See the Installation Manual.

3. Press the **ENTER** key to switch the control to the menu items column. The cursor in the menu column now turns gray and the cursor in the menu items column is yellow.
   To switch the control from the menu items column to the menu column, use the **MENU/ESC** key. The color of the title bar of the active column is blue and of the inactive column is gray.

4. Use the Cursorpad (▲ or ▼) to select a menu item and press the **ENTER** key. A window with options for the related menu item appears.

Day
Night
Twilight
Custom

   ```
    ▲
    8
    ▼
   (1~8)
   ```
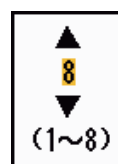
   Display Color options   *Echo Brill setting window*
   Example windows

5. Use the Cursorpad (▲ or ▼) to select an option or numeric value.

6. Press the **ENTER** key to save your selection. To close the window without saving, press he **MENU/ESC** key (instead of the **ENTER** key).

7. Press the **MENU/ESC** key to close the menu.

5.6 Tuning

In default, the radar receiver can be tuned automatically after turning the radar to TX. If you require fine tuning in manual, do the following:

1. Transmit the radar and select the maximum range with the **RANGE** knob.

2. Press the **MENU/ESC** key to open the menu.

3. Use the Cursorpad (▲ or ▼) to select [Tuning] and press the **ENTER** key.

```
 ┌──────────────┬──────────────────────────┐
 │    Menu      │        Tuning            │
 ├──────────────┼──────────────────────────┤
 │ Trails       │ Tuning Mode     : Auto   │
 │ Tuning       │ Manual Tuning   : 6.00V  │
 │ Others       │ Tuning Initialization    │
 │ Target       │                          │
 │ OS/Barge Mark│                          │
 │ TT           │                          │
 │ AIS          │                          │
 │ GPS          │                          │
 │              │                          │
 │ ▶ System     │                          │
 │              │ [ENTER]: Enter           │
 │              │ [MENU/ESC]: Back         │
 ├──────────────┴──────────────────────────┤
 │ Radar tuning adjustment                  │
 └──────────────────────────────────────────┘
```
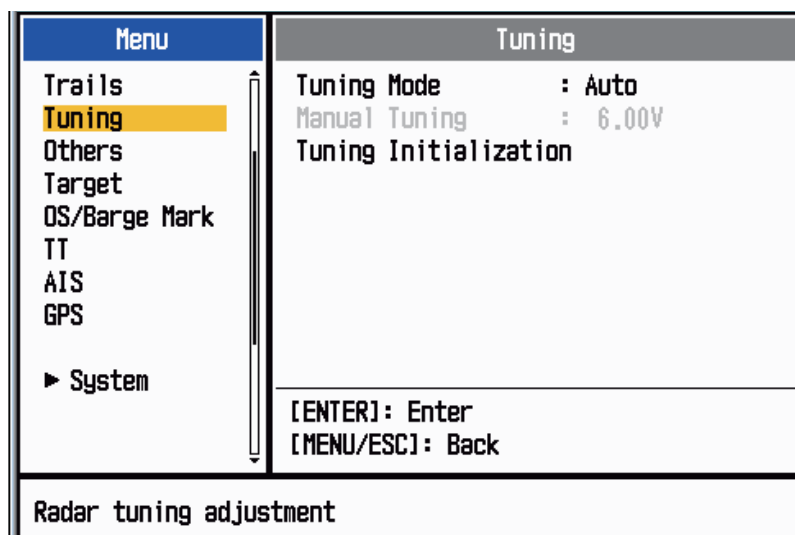
Tuning menu

4. Use the Cursorpad (▲ or ▼) to select [Tuning Mode] and press the **ENTER** key.

```
┌────────┐
│ Auto   │
│ Manual │
└────────┘
```

Tuning Mode options

5. Use the Cursorpad (▲ or ▼) to select [Manual] and press the **ENTER** key.

6. Use the Cursorpad (▲ or ▼) to select [Manual Tuning] and press the **ENTER** key to show the manual tuning setting window.

```
┌─────────────────┐
│       ▲         │
│     6.00V       │
│       ▼         │
│ (0.00V~12.00V)  │
└─────────────────┘
```
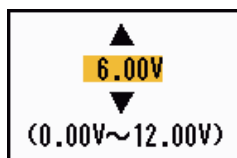
Manual Tuning setting window

7. Use the Cursorpad (▲ or ▼) to adjust the tuning while you look at the tuning bar at the upper-right corner of the display. The best tuning point is where

    TUNE MAN ◄── Tuning method (Manual)
    ████▐◄── Tuning bar
    └── Vertical bar

    the tuning bar moves to maximum value. The vertical bar on the tuning bar shows the tuning voltage.

8. Press the **ENTER** key.

9. Press the **MENU/ESC** key to close the menu.
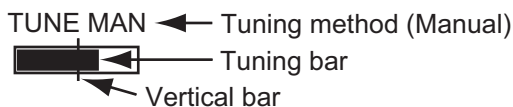
Note: If the automatic tuning does not give the correct tuning, run the [Tuning Initialization] again.

5.7   Display Modes

This radar has the display modes shown below. All modes except head-up require a heading signal. The true motion mode additionally requires position data.

Relative Motion (RM)

- [Head Up] (H UP)
- [Course Up] (C UP)
- [North Up] (N UP)
- [True View]

True Motion (TM)

- [True Motion] (TM)

5.7.1   How to select the display mode

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

Menu	Display	
Brill/Color	Display Mode	: Head Up
Display	Zoom	: Off
Echo	Zoom Reference	: Relative
Alert Settings	Off-center mode	
Trails	Save Off-center	
Tuning	Echo Area	: Full Screen
Others	Text Display	
Target	STBY Display	: Normal
OS/Barge Mark		
TT	[ENTER]: Enter	
AIS	[MENU/ESC]: Back	
Select a presentation mode		
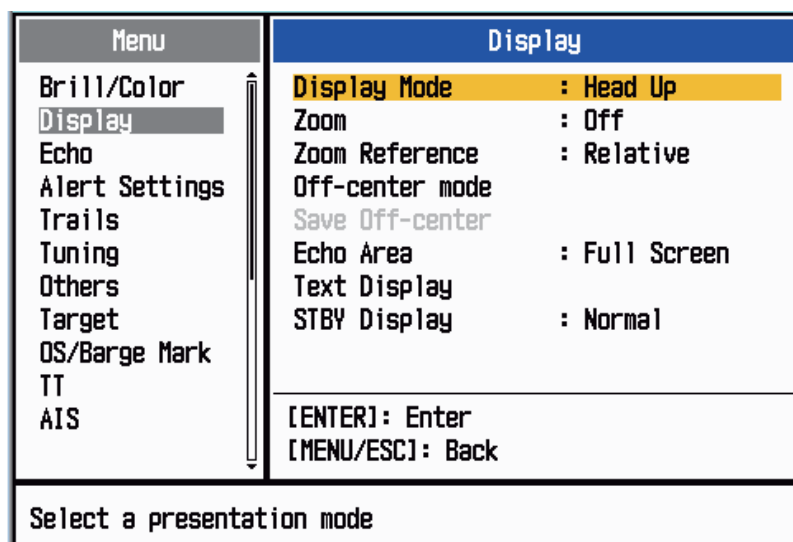
Display menu

3. Use the Cursorpad (▲ or ▼) to select [Display Mode] and press the **ENTER** key.

```
Head Up
Course Up
North Up
True Motion
True View
```
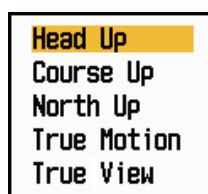
Display Mode options

4. Use the Cursorpad (▲ or ▼) to select a display mode and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

Note 1: The display mode is automatically switch to head up if the heading signal becomes lost.

Note 2: All modes except head-up require a heading signal in AD-10 format or NMEA format. If the heading signal is lost, the mode is changed to head-up and the north marker disappears. The display for heading is XXX.X and the alarm sounds. The message "GYRO" (AD-10 format data) or "NMEA_HDG" (NMEA format data) appears in the alarm message display. To stop the audio alarm, press any key. When the heading signal is restored, check the heading. The numeric value is displayed at the heading indication when the heading signal is restored.

5.7.2   Description of display modes

Head-up mode

A display without azimuth stabilization in which the line that connects the center with the top of the display indicates your heading. Targets are shown at their measured distances and their directions relative to your heading. The short dotted line on the bearing scale is the north marker.
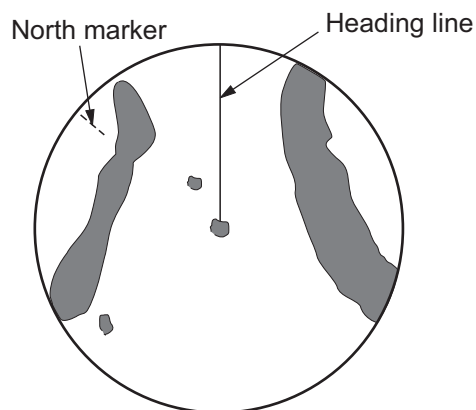
Course-up mode

The radar picture is stabilized and displayed with the currently selected course at the top of the screen. When you change the heading, the heading line moves with the course selected. If you select a new course, select the course-up mode again to display the new course at the top of the display.

Targets are shown at their measured distances and their directions relative to the set course, which is at the 0-degree position. The heading line moves according to the yawing and any course change.
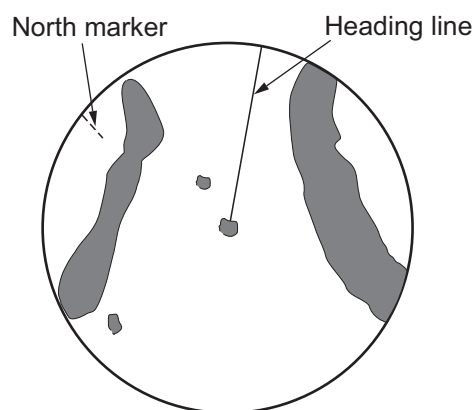
North-up mode

Targets are shown at their measured distances and their true (compass) directions from your ship. North is at the top of the screen. The heading line changes its direction according to your heading.
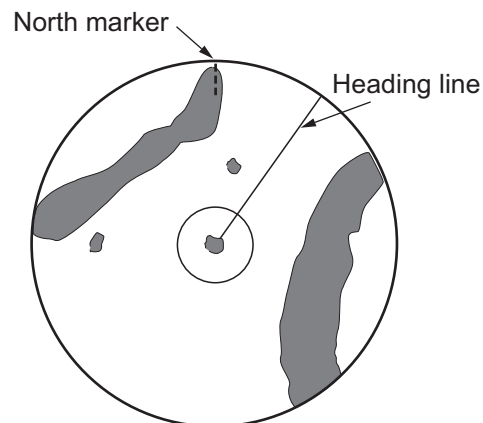
True motion mode

Your ship and other objects in motion move with their true courses and speed. All fixed targets, like landmasses, appear as fixed echoes in ground stabilized TM.

When your ship reaches a point that is 75% of the radius of the display, the position is reset. The ship appears at 75% radius opposite to the extension of the heading line on the display center. You can manually reset your ship symbol with the off-center feature.
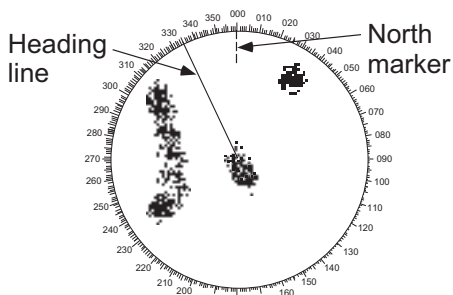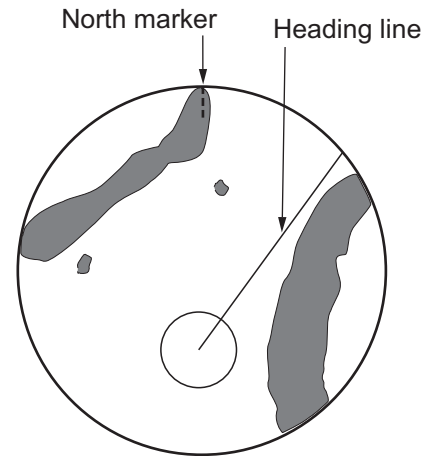
(a) True motion is selected
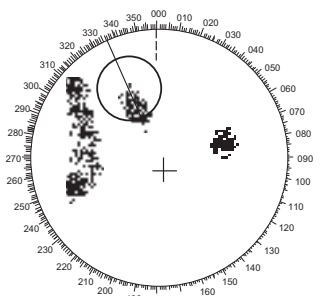
(b) Your ship has reached a point 75% of display radius
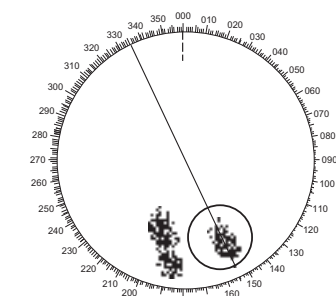
(c) Your ship is automatically reset to 75% of display radius

Automatic reset of your ship marker in true motion mode

True view mode

The echoes move in real time depending on the change of the heading of your ship. Heading line is at the top of the screen. When the heading signal is lost, this function is not available and the display mode automatically changes to the head-up mode. The [Wiper] is not available in this mode.

Note: The wiper feature is inoperative when the true view mode is in use.

The echoes move depending on the change of the heading of your ship during one sweep.

5-9
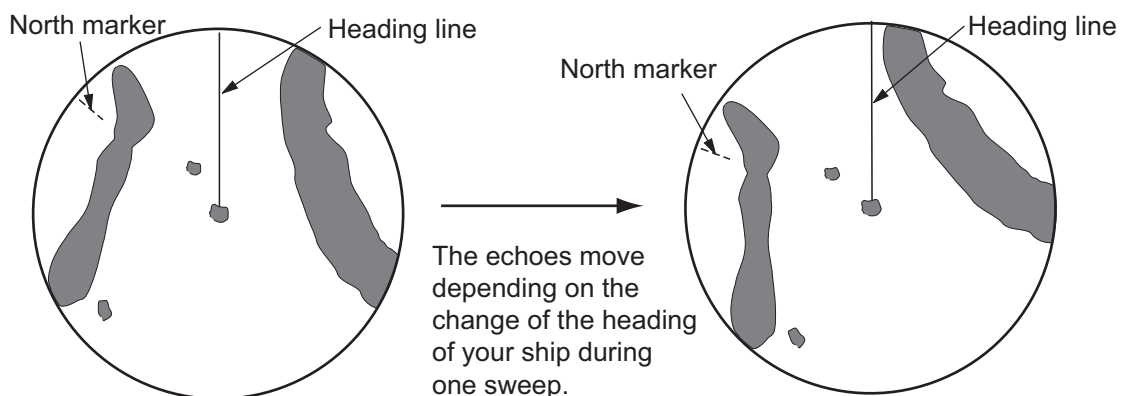
5.8   How to Select the Range Scale

The selected range scale, range ring interval and pulse length are shown at the top left corner on the screen. When an objective target comes closer, reduce the range scale so that a target appears in 50-90% of the display radius.

Rotate the **RANGE** knob to select range, clockwise to increase the range, or counter-clockwise to decrease the range.

5.9   How to Adjust the Gain (sensitivity)

The gain functions to adjust the sensitivity of the receiver for the best reception. The gain can be adjusted automatically or manually.

1.   Press the **RANGE** knob to show the [GAIN/SEA/RAIN] window.

AUTO: Automatic, MAN: Manual

GAIN setting bar
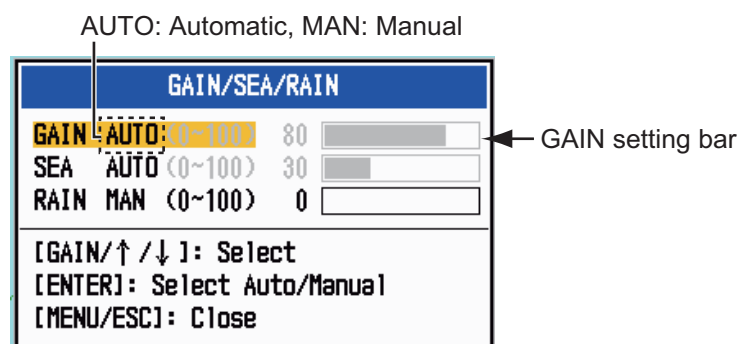
GAIN/RAIN/SEA window

2.   The cursor is selecting [GAIN]. Press the **ENTER** key to show [GAIN AUTO] or [GAIN MAN] as required. For manual adjustment, see the section below.

3.   Press the **MENU/ESC** key to close the window.

Manual adjustment of gain

1.   Rotate the **RANGE** knob (or use ◄ or ► on the Cursorpad) to adjust the gain so that weak noise appears on all of the screen. If the gain is too low, weak echoes are erased. If the gain is too high, the background noise hides weak targets.

2.   Press the **MENU/ESC** key to close the window.

5.10 How to Reduce the Sea Clutter

The reflected echoes from the waves appear around your ship and have the name "sea clutter". The sea clutter extends according to the height of waves and antenna above the water. When the sea clutter hides the targets, use the sea clutter function to reduce the clutter, either manually or automatically.

How to select sea clutter adjustment type

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Auto Sea] and press the **ENTER** key.

Auto Sea options

4. Use the Cursorpad (▲ or ▼) to select [Coastal] or [Advanced] then press the **ENTER** key. The window for Gain/Sea/Rain indicator appears for confirmation.
   [Coastal]: Suppress both land and sea clutter. For cruising along a coastline.
   [Advanced]: Automatically discriminate land echoes from sea reflections to suppress only sea reflections. Use this mode for general use.

5. Press the **MENU/ESC** key to close the window.

6. Press the **MENU/ESC** key to close the menu.

How to select the sea clutter adjustment method

1. Press the **RANGE** knob to show the [GAIN/SEA/RAIN] window.
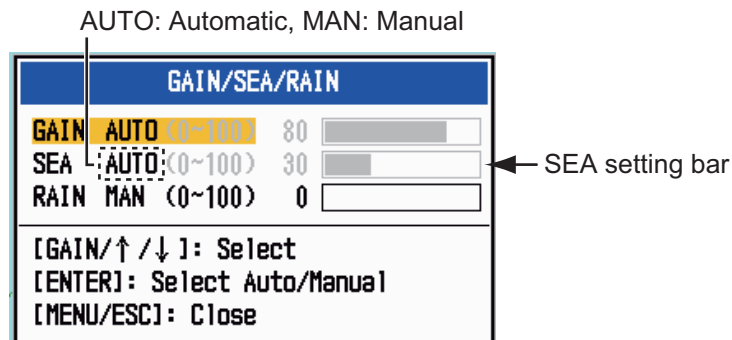
GAIN/RAIN/SEA window

2. Use the Cursorpad to select [SEA]. Press the **ENTER** key to show [SEA AUTO] or [SEA MAN] as required. For manual adjustment, see the section below.

3. Press the **MENU/ESC** key to close the window.

Manual adjustment of sea clutter

1. Rotate the **RANGE** knob (or use ◀ or ▶ on the Cursorpad) to adjust the sea clutter.
   Note: When the sea clutter is properly adjusted, the clutter is broken into small dots, and small targets become identified. If the setting is not enough, targets are hidden in the clutter. If the setting is higher than necessary, both sea clutter and targets disappear from the display. Normally adjust the knob until the clutter has disappeared to leeward, but a small amount of the clutter is visible windward.
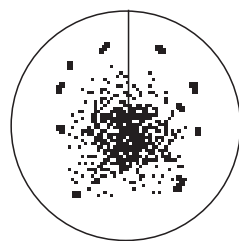
Sea clutter at
screen center
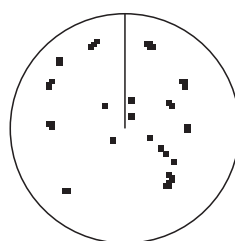
Sea clutter properly adjusted;
sea clutter reduced

Sea clutter

2. Press the **MENU/ESC** key to close the window.

5.11   How to Reduce the Rain Clutter

The reflections from the rain or snow appear on the screen. These reflections have the name "rain clutter". When the rain clutter is strong, targets in the rain clutter are hidden in the clutter. Reflections from the rain clutter are easily identified from true targets by their wool-like appearance.

The rain clutter function works like the sea clutter function, adjusting the receiver sensitivity, but in longer range. If the setting is high, the rain clutter is more reduced. The rain control breaks the continuous display of rain or snow reflections into a random pattern. When the rain clutter hides the targets, adjust the rain clutter (automatic or manual) to reduce the clutter.

How to select the rain clutter adjustment method

1. Press the **RANGE** knob to show the [GAIN/SEA/RAIN] window.

AUTO: Automatic, MAN: Manual

RAIN setting bar
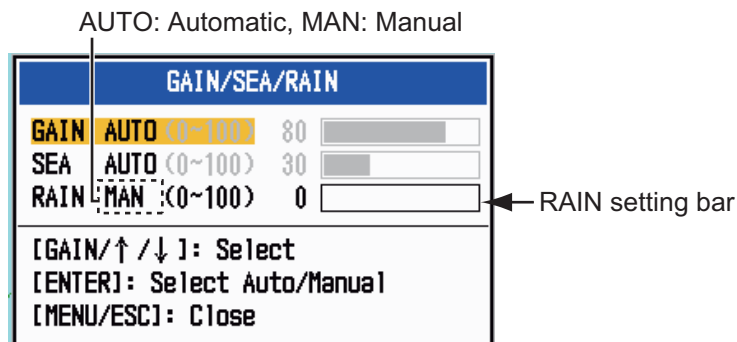
GAIN/RAIN/SEA window

2. Use the Cursorpad to select [RAIN]. Press the **ENTER** key to show [RAIN AUTO] or [RAIN MAN] as required. For manual adjustment, see the section below.

3. Press the **MENU/ESC** key to close the window.

Manual adjustment of rain clutter

1. Rotate the **RANGE** knob (or use ◄ or ► on the Cursorpad) to adjust the rain clutter.

2. Press the **MENU/ESC** key to close the window.

5.12 Cursor

The cursor functions to find the range and bearing (default function) to a target or the latitude and longitude position of a target. Use the Cursorpad to position the cursor and read the cursor data at the screen bottom.
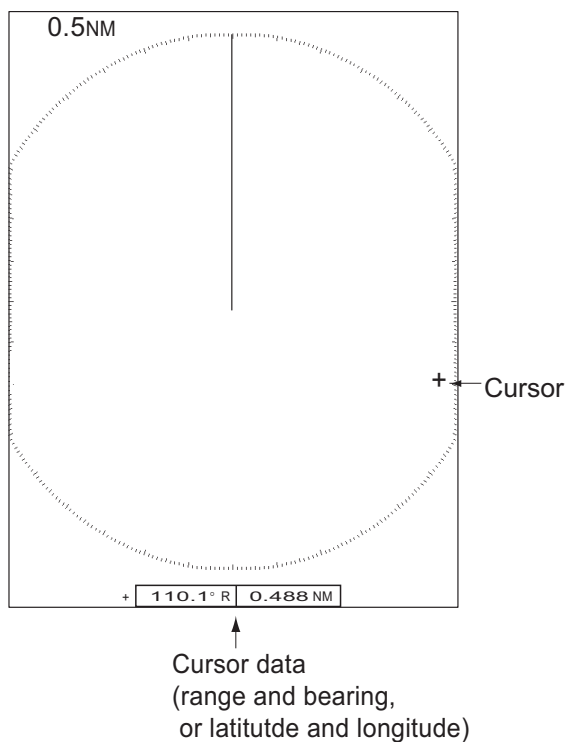
Cursor data

Cursor data

You can show the cursor data as range and bearing (from your ship to the cursor) or latitude and longitude. Position and heading signal are required.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.

Others menu

3. Use the Cursorpad (▲ or ▼) to select [Cursor Data] and press the **ENTER** key.
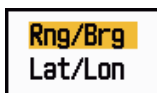
Cursor Position options

4. Use the Cursorpad (▲ or ▼) to select [Rng/Brg] or [Lat/Lon] then press the **ENTER** key. (When the navigation data is displayed, cursor latitude and longitude position cannot be displayed.)

5. Press the **MENU/ESC** key to close the menu.

5.13   Interference Rejector

The radar interference can occur when your ship is near the radar of another ship that operates on the same frequency band with your radar. The interference shows on the screen as many bright dots. The dots can be random or in the shape of dotted lines that run from the center to the edge of the display. You can identify the interference from the normal echoes, because the interference does not appear in the same location at the next antenna rotation. When this feature is turned on, "IR 1", "IR 2" or "IR 3" appears at the lower-right corner.
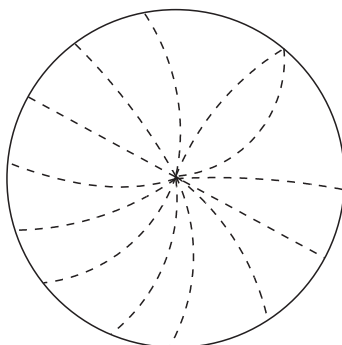
Interference

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Int Rejector] and press the **ENTER** key.

Int Rejector options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key. [3] removes the interference the most.

5. Press the **MENU/ESC** key to close the menu.

Note: When there is no interference, turn off the interference rejector so you do not miss the small targets.

5.14 Noise Rejector

White noise can appear on the screen as random "marks". You can reduce this noise as follows:

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Noise Rejector] and press the **ENTER** key.

Off
On

Noise Rejector options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu.

5.15 How to Measure the Range to a Target

You can measure the range to a target in three methods. You can use the fixed range rings, the cursor (if set to measure range and bearing), and the VRM (Variable Range Marker).

Use the fixed range rings to get a rough estimate of the range to a target. The fixed range rings are the concentric solid circles about your ship. The number of rings changes with the selected range scale. The interval of the range ring is displayed at the upper-left corner of the screen. Count the number of rings between the center of the display and the target. Check the range ring interval and measure the distance of the echo from the nearest ring.

5.15.1 How to adjust range ring brilliance

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Brill/Color] and press the **ENTER** key.

Menu	Brill/Color	
Brill/Color	Echo Brill	: 8
Display	Rings Brill	: 1
Echo	Mark Brill	: 1
Alert Settings	HL Brill	: 4
Trails	Character Brill	: 4
Tuning	Viewing Position	: Right-Center
Others	Display Color	: Day
Target	Echo Color	: Yellow
OS/Barge Mark	Background Color	: Black
TT		
AIS	[ENTER]: Enter	
	[MENU/ESC]: Back	
Adjust echo brilliance		

Brill/Color menu

3. Use the Cursorpad (▲ or ▼) to select [Rings Brill] and press the **ENTER** key.

4. Use the Cursorpad (▲ or ▼) to select an option and press the **ENTER** key. [4] is the brightest. [Off] turns off the range rings.

5. Press the **MENU/ESC** key to close the menu.

| Off |
| 1 |
| 2 |
| 3 |
| **4** |
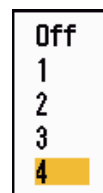
5.15.2 How to measure the range with a VRM

There are two VRMs, No. 1 and No. 2. The VRMs are dashed rings so that you can identify the rings from the fixed range rings. You can identify VRM 1 from VRM 2 by different lengths of dashes. The dashes of the No. 1 VRM are shorter than those of the No. 2 VRM.

1. Press the **MODE** key to show the [Mode] window.

2. Use the Cursorpad to select [VRM] then press the **ENTER** key.

3. Select [VRM 1] or [VRM 2] as required, then press the **ENTER** key. The VRM indication appears at the bottom right corner, inside a rectangle.

4. Use the Cursorpad to align the VRM with the inner edge of the target. Read the distance at the lower-right corner of the screen. The size of the VRM ring changes in proportion to the selected range scale.

5. To anchor the VRM, press the **ENTER** key. To re-activate the VRM, select it from the [Mode] window.

```
      Mode
Off-center
EBL
VRM
Trail Time
Trail Erase
TLL
─────────────────
[MODE/↑/↓]: Select
[ENTER]: Enter
[MENU/ESC]: Close
```

6. To erase a VRM, press the **MODE** key to open the [Mode] window, select [VRM], then select the VRM to erase. Press the **MENU/ESC** key to erase the VRM and its indication. (If a VRM's indication is already in a rectangle, simply press the **MENU/ESC** key to erase the VRM and its indication.)

How to measure the range with the VRM

5.15.3 How to select VRM unit

You can select the unit of measurement used by the VRM. The selections are nautical miles (NM), kilometers (KM), statute miles (SM) or kiloyard (KYD). The cursor range unit is also changed when the VRM unit is changed.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [VRM Unit] and press the **ENTER** key.

NM: 0.1 NM or above
YD: Less than 0.1 NM

4. Use the Cursorpad (▲ or ▼) to select the unit and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

5.16 How to Measure the Bearing to a Target

Use the Electronic Bearing Line (EBL) to take a bearing of a target. There are two EBLs, No. 1 and No. 2. Each EBL is a straight dashed line from the center of the screen to the edge. The dashes of the No. 1 EBL are shorter than those of the No. 2 EBL.

5.16.1 How to measure the bearing with an EBL

1. Press the **MODE** key to show the [Mode] window.

2. Use the Cursorpad to select [EBL] then press the **ENTER** key.

3. Select [EBL 1] or [EBL 2] as required, then press the **ENTER** key. The EBL indication appears at the bottom left corner, inside a rectangle.

4. Use the Cursorpad to place the EBL through the center of the target. Read the distance at the bottom left corner of the screen. The cursor on the EBL provides an estimate of the range to a target.

5. To anchor the EBL, press the **ENTER** key. To reactivate the EBL, select it from the [Mode] window.

6. To erase a EBL, press the **MODE** key to open the [Mode] window, select [EBL], then select the EBL to erase. Press the **MENU/ESC** key to erase the EBL and its indication. (If a EBL's indication is already in a rectangle, simply press the **MENU/ESC** key to erase the EBL and its indication.)

Mode
Off-center
EBL
VRM
Trail Time
Trail Erase
TLL
[MODE/↑/↓]: Select
[ENTER]: Enter
[MENU/ESC]: Close
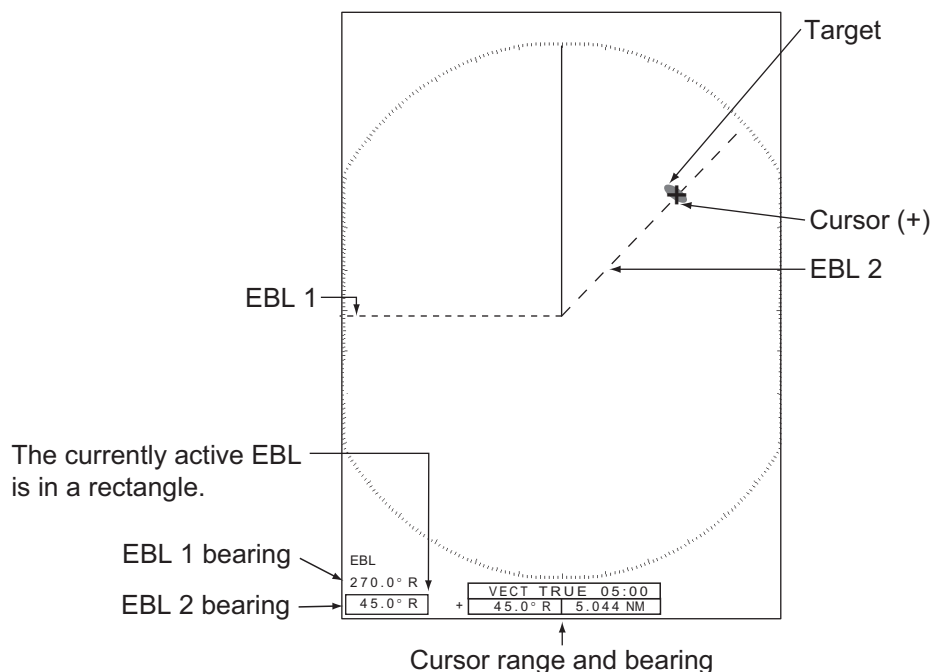
5.16.2 EBL reference

"R" (relative) follows the EBL indication if the bearing is relative to the heading of your ship. "T" (true) follows the EBL indication if the bearing is in reference to the north. You can select relative or true in the head-up and true view modes. The bearing indication is true in all other modes. True bearing requires a heading sensor.

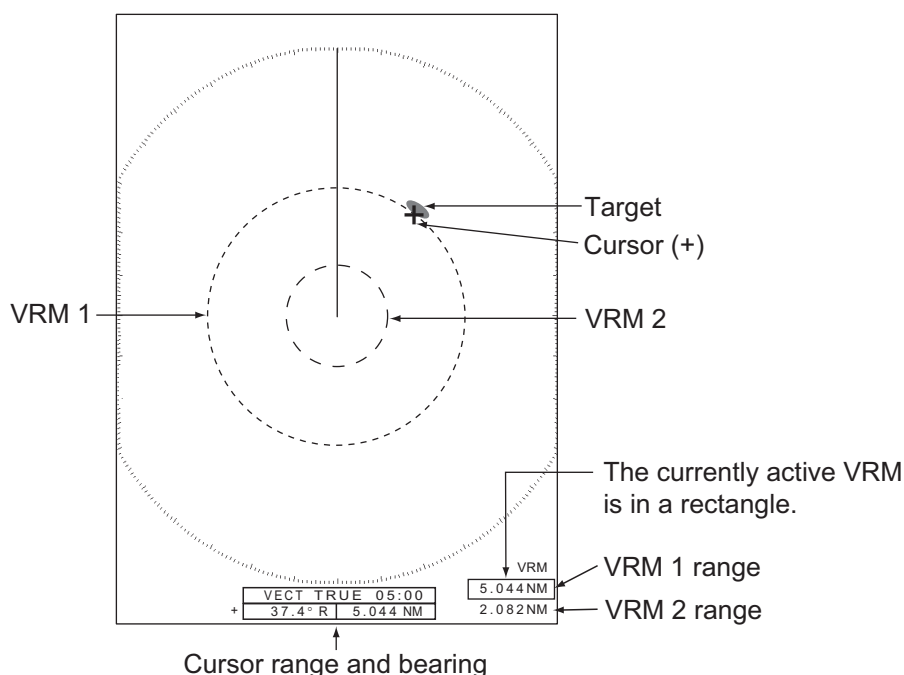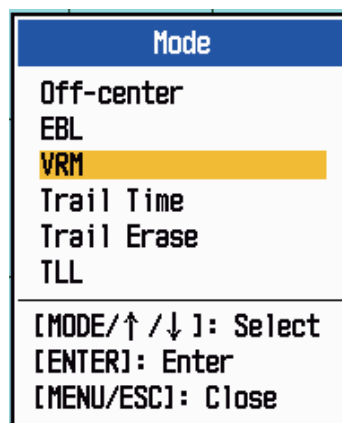1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [EBL Reference] and press the **ENTER** key.
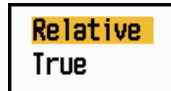
4. Use the Cursorpad (▲ or ▼) to select [Relative] or [True] then press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu.

5.17 How to Measure the Range and Bearing Between Two Targets

You can move the origin of the EBL to measure the range and bearing between two targets.

1. Press the **MODE** key.

2. Select [EBL], followed by [EBL 1], then press the **ENTER** key.

3. Use the Cursorpad to put the cursor on the center of the target A.

4. Press the **MODE** key, and the origin of the EBL moves to the cursor position.

5. Use the Cursorpad to put the cursor on the center of the target B, then press the **ENTER** key.

6. Press the **MODE** key, select [VRM] followed by [VRM 1], then press the **ENTER** key

7. Use the Cursorpad to set the VRM on the inner edge of the target B.

8. Read the bearing and range indications at the bottom of the screen.
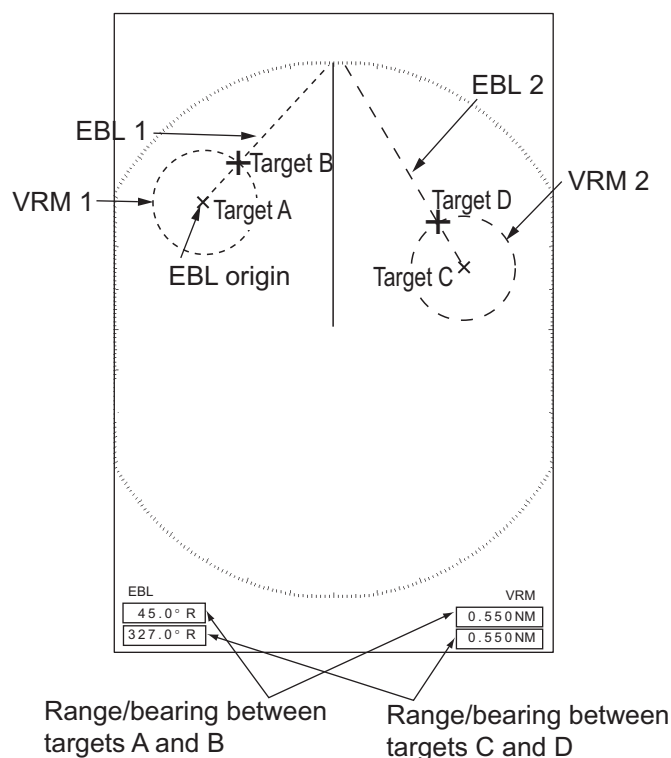
The range and bearing to another target (C and D in the figure above) can be measured using [EBL 2] and [VRM 2].

To cancel the this function, turn off the EBL and VRM.

5.18 Target Alarm

The target alarm looks for targets (ship, landmass, etc.) in the area you set. Audiovisual alarms are released when a target enters (or exits) the alarm area.

⚠ **CAUTION**

🚫 **Do not depend on the alarm as the only means to detect possible collision situations.**

⚠ **Adjust the sea clutter, rain clutter and gain correctly so that the alarm system does not miss target echoes.**

5.18.1 How to set a target alarm zone

The following procedure shows you how to set a target alarm zone.

1. Press the **ALARM** key to activate ALARM 1 or ALARM 2. Press the **ALARM** key to change the active ALARM between No. 1 and No. 2. The indication of the currently active ALARM is in a rectangle at the upper-right corner of the screen.

2. Use the Cursorpad to move the cursor to the position A and press the **ENTER** key.

3. Move the cursor to the position B and press the **ENTER** key. The rectangle that shows alarm status indication at the upper-right corner of the screen disappears.

Target alarm zone 1 (Length of dash and interval for alarm zone 2 are longer than alarm zone 1.)

ALM1_IN
ALM2_OUT ← Alarm status

A

+B

Cursor
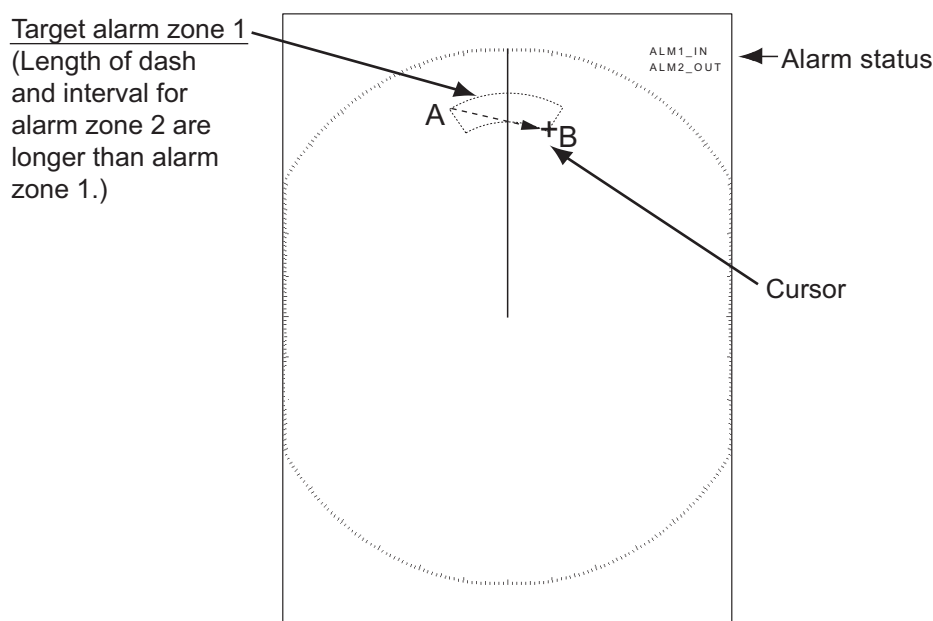
How to set a target alarm zone

Note 1: To set a 360-degree guard zone, set the position B in the same bearing as the position A.

Note 2: When the target alarm zone is not within the range in use, the indication "ALM1(or 2)_RNG" replaces "ALM1(or 2)_IN(or OUT)" in the alarm status area. (When the target alarm zone is within the range of full off-centering, the indication does not change.) Select a range which displays the target alarm zone.

5.18.2 How to stop the audio alarm

When a target enters (or exits) the target alarm zone, the target flashes and the alarm sounds. The alarm message appears at the bottom of the screen. To stop the audio alarm, press any key. When the target enters (or exits) the target alarm zone again, the audio alarm sounds.

5.18.3 How to select the alarm type

You can set the target alarm to activate against targets entering or exiting the alarm zone.

"In" target alarm   "Out" target alarm
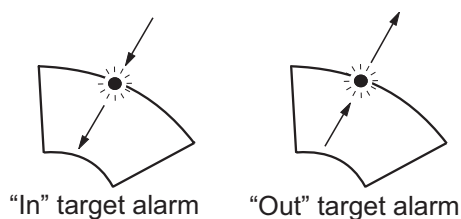
In and Out target alarms

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Alert Settings] and press the **ENTER** key.

Alarm menu

3. Use the Cursorpad (▲ or ▼) to select [Target Alarm 1] or [Target Alarm 2] then press the **ENTER** key.

Target Alarm options

4. Use the Cursorpad (▲ or ▼) to select [In] or [Out].
    [In]: When a target enters a target alarm zone, the alarm sounds.
    [Out]: When a target exits a target alarm zone, the alarm sounds.

5. Press the **ENTER** key followed by the **MENU/ESC** key.

5.18.4 How to sleep a target alarm temporarily

When you do not require a target alarm temporarily, you can sleep the target alarm. The alarm zone remains on the screen, but any targets that enter (or exit) the alarm zone do not trigger the audio and visual alarms.

1. Press the **ALARM** key to select the ALARM 1 or ALARM 2 indication at the upper-right corner on the screen. The selected indication is in a rectangle.

2. Press the **MENU/ESC** key. The alarm indication now shows "ALM1(or 2)_ACK".

To activate a sleeping target alarm zone, press the **ALARM** key to select the ALARM 1 or ALARM 2 and press the **ENTER** key. The alarm indication then changes to "ALM1(or 2)_IN(or OUT)".

5.18.5 How to deactivate a target alarm

1. Press the **ALARM** key to select the ALARM 1 or ALARM 2 indication at the upper-right corner on the screen. The selected indication is in a rectangle.

2. Press the **MENU/ESC** key. The alarm indication now shows "ALM1(or 2)_ACK".

3. Press the **ALARM** key. The alarm indication "ALM1(or 2)_ACK" is shown in a dashed-line rectangle.

4. Press the **MENU/ESC** key. The target alarm zone and the alarm indication are erased from the screen.

5.18.6 How to select the target strength which triggers a target alarm

You can select the target strength which triggers the target alarm as follows:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Alarm] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Alarm Level] and press the **ENTER** key.
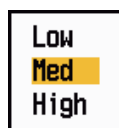
Alarm Level options

4. Use the Cursorpad (▲ or ▼) to select the echo strength level.

5. Press the **ENTER** key followed by the **MENU/ESC** key.

5.18.7 How to turn the buzzer on/off

You can turn on/off the panel buzzer or external buzzer for target alarms. The panel buzzer is for this equipment. The external buzzer is for the optional buzzer, which is connected to this equipment to give the target alarm at a remote location.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Alarm] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Panel Buzzer] (or [External Buzzer] for optional buzzer) and press the **ENTER** key.


Panel Buzzer and External Buzzer options

4. Use the Cursorpad (▲ or ▼) to select [On] or [Off] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

5.19 How to Off-center the Display

You can off-center your ship position to expand the view field without selecting a larger range scale. The display can be off-centered manually, or automatically according to speed of the ship.

Note: Off-centering is not available in the true motion mode.

5.19.1 How to select the off-center mode

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Off-center mode] and press the **ENTER** key.
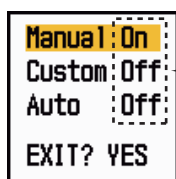
4. Use the Cursorpad (▲ or ▼) to select [Manual], [Custom] or [Auto] then press the **ENTER** key. Press the **ENTER** key to change between on and off.

5. After setting all options, use the Cursorpad (▼) to select [EXIT? YES] and press the **ENTER** key.

6. Press the **MENU/ESC** key to close the menu.

5.19.2 Off-center the display

The mode selected from the menu appears at top left corner of the display, when the off-center feature is activated - "OFFCENT(M)" (Manual), "OFFCENT(C)" (Custom) or "OFFCENT(A)" (Auto).

Manual (Indication: "OFFCENT(M)")

You can move your ship position to the current cursor position on all modes except true motion, within 75% of the available display area.

1. Put the cursor on the position where to off-center the display.
2. Press the **MODE** key, select [Off-center], then press the **ENTER** key.

Custom (Indication: "OFFCENT(C)")

You can move your ship position to the position which you preset. Follow the procedure shown below to register the cursor position. Then, the display is off-centered by the amount set here, when you activate the off-center function.

1. Turn off the off-center display.
2. Put the cursor on the position where to off-center the display.
3. Press the **MODE** key, select [Off-center], then press the **ENTER** key.
4. Press the **MENU/ESC** key to open the menu.
5. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.
6. Use the Cursorpad (▲ or ▼) to select [Save Offcenter] and press the **ENTER** key. The message "Complete" appears.
7. Press any key to close the message window.
8. Press the **MENU/ESC** key to close the menu.

Auto (Indication: "OFFCENT(A)")

The amount of automatic move is calculated according to speed of the ship. The maximum amount is 75% of the range in use. The formula to calculate automatic shift is shown below.

$$\frac{\text{Speed of ship}}{\text{Offcenter speed setting}} \times 0.75 = \text{Amount of move (\%)}$$

If the offcenter speed setting is 15 knots and the speed of the ship is 10 knots, for example, the amount of move at the stern of your ship will be 50% of the available display area.

How to select offcenter speed

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Initial] sub menu in [System] menu and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Offcenter Speed] and press the **ENTER** key.
4. Use the Cursorpad (▲ or ▼) to select the speed to use and press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu.
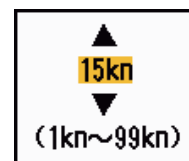
5.20 Zoom

The zoom function expands the length and width of a selected target as much as twice its normal size, in the zoom window. You select the target to zoom with the zoom cursor. The selected target is zoomed in the zoom window.

TT and AIS symbols can be displayed in the zoom window, but are not zoomed. You can process TT and AIS targets that are in the zoom window, in the same method as on the normal radar display.

There are three types of zoom.

[Relative]: The zoom cursor is fixed to the range and bearing from your ship.**[True]:** The zoom cursor is fixed to set geographical position.**[Target]:** The zoom cursor is fixed to the zoomed AIS or TT target.

5.20.1 Zoom mode

You can select the zoom mode from [Relative], [True] or [Target].

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Zoom Reference] and press the **ENTER** key.
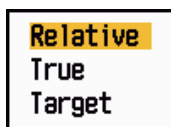
Zoom Mode options

4. Use the Cursorpad (▲ or ▼) to select [Relative], [True] or [Target] then press the **ENTER** key.
   Note: True zoom mode requires a heading signal and position data.
5. Press the **MENU/ESC** key to close the menu.

5.20.2 How to zoom

Relative or True zoom mode

1. Use the Cursorpad to put the cursor on the position desired.
2. Press the **MENU/ESC** key to open the menu.
3. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.
4. Use the Cursorpad (▲ or ▼) to select [Zoom] and press the **ENTER** key.

Zoom options

5. Use the Cursorpad (▲ or ▼) to select [On] and press the **ENTER** key.
   The ZOOM indication appears at the upper-left corner on the screen. The zoom window and the zoom cursor also appear (see the illustration on the next page). To quit the zoom, select [Off] instead of [On] and press the **ENTER** key.
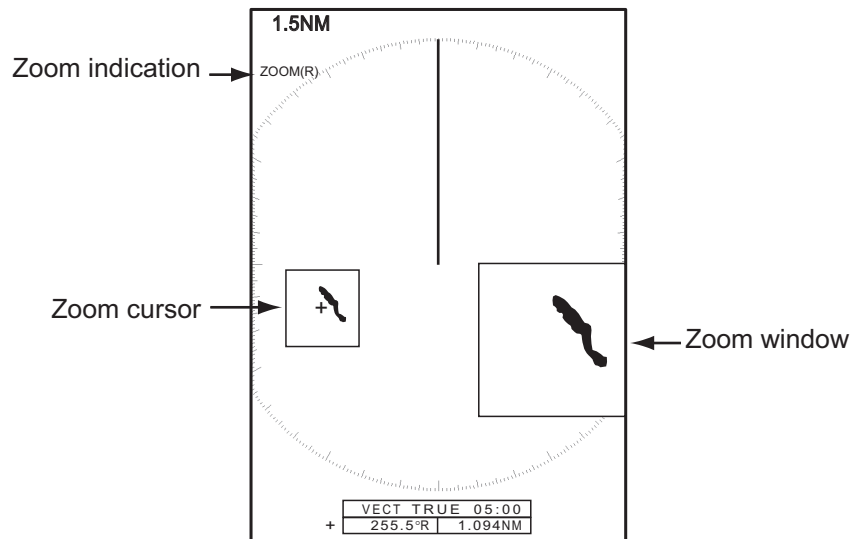
6. Press the **MENU/ESC** key to close the menu.

Target zoom mode

The TT or AIS target as below can be displayed in the zoom window:

TT: The symbol is enlarged twice its normal size. AIS: The symbol is enclosed in a broken square. (The symbol is not enlarged.)

The zoom cursor moves with the TT or AIS target.

Note: If neither TT nor AIS targets are selected, the message "NO TARGET." appears. Press any key to erase the message.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Zoom] and press the **ENTER** key.
4. Use the Cursorpad (▲ or ▼) to select [On] and press the **ENTER** key.
    The ZOOM indication appears at the upper-left corner on the screen. The zoom window and the zoom cursor also appear (see the following illustration). To quit the zoom, select [Off] instead of [On] and press the **ENTER** key.
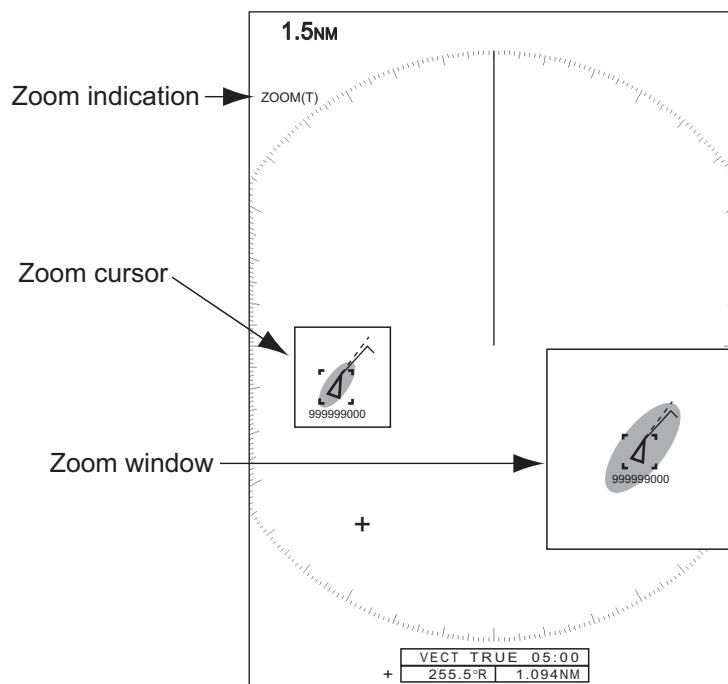
Target zoom mode
(example: AIS)

5. Press the **MENU/ESC** key to close the menu.

5.21 Echo Stretch

The echo stretch feature enlarges the targets in the range and bearing directions to make the targets easier to see. This feature is available on any range. There are three levels of echo stretch, [1], [2] and [3]. [3] enlarges the targets the most.

Note: The echo stretch magnifies the targets, sea and rain clutters, and radar interference. Correctly adjust the sea clutter, rain clutter and radar interference before you activate the echo stretch.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Echo Stretch] and press the **ENTER** key.
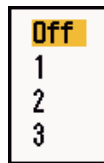
Echo Stretch options

4. Use the Cursorpad (▲ or ▼) to select an echo stretch option and press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu. When the echo stretch is active, "ES 1 (2, or 3)" appears at the lower-left corner on the display.

5.22 Target Trails

The trails of the radar targets can be shown simulated in afterglow to check target movement. The target trails are selected for either relative or true. True motion trails require a heading signal and position data.

5.22.1 Trail time

1. Press the **MODE** key to open the [Mode] window.
2. Select [Trail Time] and press the **ENTER** key.
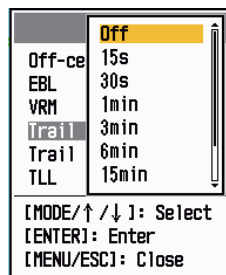
Time options

3. Use the Cursorpad (▲ or ▼) to select time and press the **ENTER** key.
4. Press the **MENU/ESC** key to close the menu.

The selected time appears at the top right corner.

5.22.2 Trail mode

You can display the echo trails in true or relative motion.

True mode

The true trails show true target movements according to their over-the-ground speeds and courses. The stationary targets do not show the trails. The true trails require a heading signal and position data.

Relative mode

The relative trails show other ships' movements relative to your ship. The stationary targets also show the trails.
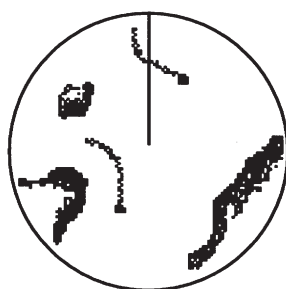
True target trails   Relative target trails

True trails and relative trails

To select the trail mode, do the following:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Mode] and press the **ENTER** key.
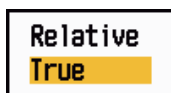
Mode options

4. Use the Cursorpad (▲ or ▼) to select [Relative] or [True] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

The selected trail mode and trail time appear at the top right corner.

TRAIL(T) ◄——— Trail Mode (T: True, R: Relative)
15 S ◄——— Trail Time

Trail indications

5.22.3 Trail gradation

Trails can be shown in single or multiple gradation. Multiple gradation fades the gradation over time.

1. Press the **MENU** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Gradation] and press the **ENTER** key.

Gradation options

4. Use the Cursorpad (▲ or ▼) to select [Single] or [Multi] then press the **ENTER** key.

Single	Multiple
(Monotone shading)	(Gradual shading)
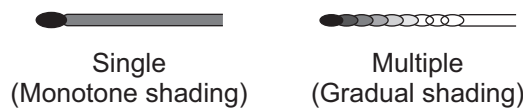
Trail gradation

5. Press the **MENU** key to close the menu.

5.22.4 Trail color

You can select the color for trails as follows:

1. Press the **MENU** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Color] and press the **ENTER** key.
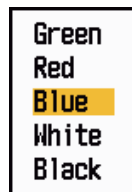
Color options

4. Use the Cursorpad (▲ or ▼) to select a color and press the **ENTER** key.
5. Press the **MENU** key to close the menu.

5.22.5 Trail level

You can select which target strength to display.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Level] and press the **ENTER** key.

Level options

4. Use the Cursorpad (▲ or ▼) to select [1], [2] or [3] then press the **ENTER** key.
   [1]: Display the trails for all targets (including weak targets).
   [2]: Display the trails for medium-to-strong level targets.
   [3]: Display the trails for only strong targets.

5. Press the **MENU/ESC** key to close the menu.

5.22.6 How to restart, stop the trails

When the range is changed while the trail feature is active, trails within the previous range scale can be stopped and restarted.

1. Press the **MENU** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Restart] and press the **ENTER** key.

Restart options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.
   [Off]: The previous trails data are saved when the range is changed. The trails are not restarted and the saved trails are not updated. When you return the range scale to the previous range scale, the saved trails are displayed and updated.
   [On]: The previous trails are zoomed in or out depending on the changed scale and updated.

Copied trail picture

Before changing range   After changing range
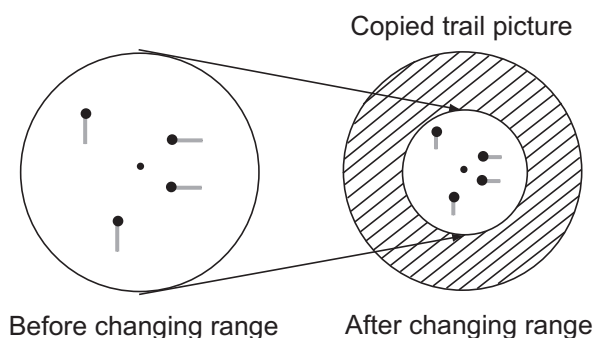
How trail copy operates

Note: If the newly selected range is less than or equal to 1/4 of the previous range, trails are erased. If the newly selected range is longer than the previous range, the previous trails are left to be displayed.

5. Press the **MENU** key to close the menu.

5.22.7 Narrow trails

You can display the target trails in thin trails. When there are many targets on the screen, you can separate trails close to one another with this function.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Narrow] and press the **ENTER** key.

Narrow options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

5.22.8 Your ship trail

You can show the trail of your ship as follows:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Own Ship] and press the **ENTER** key.

Own Ship options

4. Use the Cursorpad (▲ or ▼) to select [Off], [1] or [2] then press the **ENTER** key.
   [Off]: Hide the trail of your ship.
   [1]: Show the trail of your ship.
   [2]: Show the trail of your ship, but hide the trail of sea clutter near your ship.

5. Press the **MENU/ESC** key to close the menu.

5.22.9 How to erase all trails

All trails can be erased as follows.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Trails] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Trail Erase] and press the **ENTER** key.

4. You are asked if you are sure to erase all trails. Press ▲ on the Cursorpad to select [Yes] then press the **ENTER** key.

A beep sounds upon completion of the erasure.

5.23 How to Program the FUNC Key

The **FUNC** key can be programmed to do the function you assign.

Function key operation

Press the **FUNC** key to do the function assigned to the key. Press the key successively to change the setting.

How to change a function key program

1. Press the **MENU/ESC** key to open the menu.
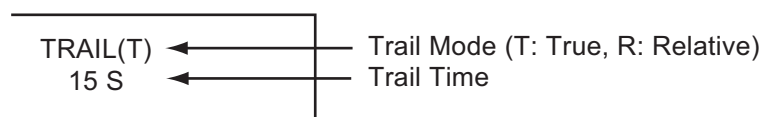
2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Func Setup] and press the **ENTER** key.

4. Use the Cursorpad (▲ or ▼) to select a function from the list and press the **ENTER** key. Below are the available functions.

Off	Echo Stretch
TLL	Echo Average
Rings Brill	Int Rejector
Mark Brill	Display-Curve
HL Brill	Watchman
Char.Brill	Trail Time
Viewing Posn.	Trail Erase
Display Color	Trail Grad.
Echo Color	Trail Color
Back. Color	Vector Ref.
Char. Color	TT-Display
Echo Col. Mode	TT-Erase Lost
Display Mode	AIS-Display
Zoom	AIS-Erase Lost
Echo Stretch	

Function list

5. Press the **MENU/ESC** key to close the menu.

5.24 Echo Average

To identify true target echoes from the sea clutter, echoes are averaged over successive picture frames. If an echo is solid and stable, the echo is shown in its normal intensity. The brilliance of sea clutter is reduced to easily identify true targets from the sea clutter.

Note 1: Do not use the echo average function under heavy pitching and rolling. You can lose a target.

Note 2: This feature requires a heading signal and position data. When either signal becomes lost, echo average is deactivated.

To correctly use the echo average function, first reduce the sea clutter:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Echo Average] and press the **ENTER** key.

```
Off
1
2
Auto
```
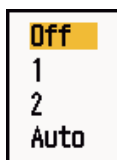
Echo Average options

4. Use the Cursorpad (▲ or ▼) to select an echo averaging option and press the **ENTER** key.
   [Off]: Deactivate the echo average.
   [1]: Identify true targets from the sea clutter and reduce the brilliance of unstable echoes.
   [2]: Identify true targets from the sea clutter that you cannot reduce the brilliance with setting 1.
   [Auto]: Identify true targets from the sea clutter. Detect far and unstable targets.

5. Press the **MENU/ESC** key to close the menu. The selected echo average ("EAV 1", "EAV 2" or "EAV(A)") appears at the lower-left corner of the display.

5.25 Wiper

The wiper feature automatically reduces the brilliance of unwanted weak signals (noise, sea clutter, rain clutter, etc.) and unnecessary signals, like radar interference, to clear the picture of unnecessary echoes. The result of wiper depends on the wiper setting used and whether echo averaging is turned on or off, as described below.

Echo averaging and wiper states and wiper effect

	Wiper 1	Wiper 2
Echo Average Off	Processing content A	
Echo Average On (1, 2, Auto)	Processing content A	Processing content B

Processing content A: The brilliance of unnecessary weak echoes, like noise and radar interference, is reduced to clear the picture. The difference between wiper 1 and 2 is that brilliance is lowered more slowly in 1.
Processing content B: Echo averaging is automatically turned on from off when the wiper feature is turned on. You can see how the picture changes with the echo averaging turned off and turned on.

To activate the wiper feature, do the following:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Wiper] and press the **ENTER** key.

```
Off
1
2
```

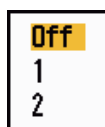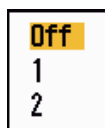*Wiper options*

4. Use the Cursorpad (▲ or ▼) to select [1] or [2] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

Note: When the [Display Mode] is [True View], this function is not available.

5.26   Characteristics Curve

You can change the characteristics curve to reduce unwanted weak echoes (sea reflections, etc.). Select [1], [2] or [3] depending on conditions when unwanted weak echoes hide wanted targets.

1.   Press the **MENU/ESC** key to open the menu.

2.   Use the Cursorpad (▲ or ▼) to select [Echo] and press the **ENTER** key.

3.   Use the Cursorpad (▲ or ▼) to select [Display-Curve] and press the **ENTER** key.

Display-Curve options

4.   Use the Cursorpad (▲ or ▼) to select [1], [2] or [3] then press the **ENTER** key.
     [1]: Reduce weak echoes.
     [2]: Normal use
     [3]: Display weaker echoes in stronger color compared to [1].
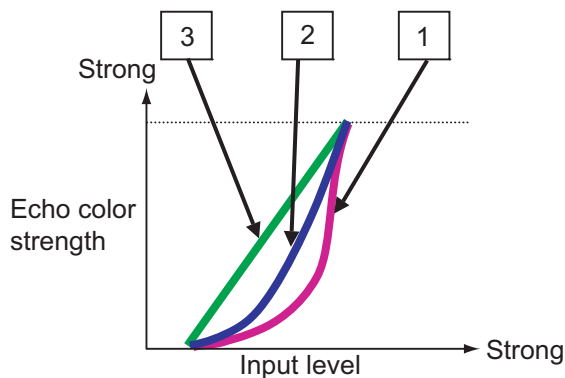
Display curve

5.   Press the **MENU/ESC** key to close the menu.

5.27   Own Ship and Barge Markers

This section shows you how show and set up the own ship and barge markers.

5.27.1   How to show the own ship marker

1.   Press the **MENU/ESC** key to open the menu.

2.   Use the Cursorpad (▲ or ▼) to select [OS/Barge Mark] and press the **ENTER** key.

3.   Use the Cursorpad (▲ or ▼) to select [OS Mark] and press the **ENTER** key.

4.   Use the Cursorpad (▲ or ▼) to select [On], then press the **ENTER** key.

5. Use the Cursorpad to select [OS Length] then press the **ENTER** key.
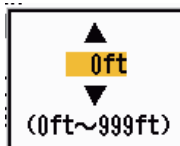
6. Use the Cursorpad to set the length of own ship then press the **ENTER** key.

7. Use the Cursorpad to select [OS Width] then press the **ENTER** key.

8. Use the Cursorpad to set the width of own ship then press the **ENTER** key.

9. Press the **MENU/ESC** key to close the menu.

The own ship mark appears on the display, scaled according to the length and width entered here.

5.27.2 How to show the barge marker

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [OS/Barge Mark] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Barge Mark] and press the **ENTER** key.

4. Use the Cursorpad (▲ or ▼) to select [On], then press the **ENTER** key.

5. Use the Cursorpad to select [Barge Position] then press the **ENTER** key.

6. Use the Cursorpad to select [Bow] or [Stern], then press the **ENTER** key.

7. Use the Cursorpad to select [Barge Length] then press the **ENTER** key.
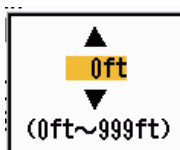
8. Use the Cursorpad to set the length of the barge, then press the **ENTER** key.

9. Use the Cursorpad to select [Barge Beam] then press the **ENTER** key.

10. Use the Cursorpad to select [Barge Arrangement], then press the **ENTER** key.

11. The cursor is selecting [Column1(PORT)]. Press the **ENTER** key.
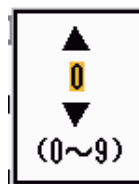
12. Use the Cursorpad to set the number of barges in the port column.

13. Set other columns similar to how you did in steps 11 and 12.

14. After setting all required columns, select [Close This Window], then press the **EN-TER** key.

15. Press the **MENU/ESC** key to close the menu.

5.28 Watchman

The Watchman sounds the buzzer to tell the operator to check the radar display. The radar transmits for one minute and then goes into standby for the selected time interval. If the target alarm is active and a target is found in the alarm zone, Watchman is cancelled, and the radar transmits continuously.
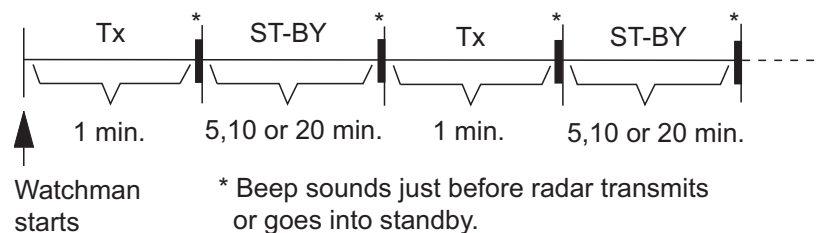
How watchman operates

In standby, the timer near the <WATCH> label at the center of the screen counts down the remaining time until the transmission. When the set time interval has passed, the audio alarm sounds, the timer disappears and the radar transmits for one minute. After one minute, the audio alarm sounds and the watch alarm timer again begins the countdown sequence.

If you press the **STBY/TX** key before the set time interval comes, the radar goes into transmission.

Do the following to activate the Watchman:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Alarm] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Watchman] and press the **ENTER** key.

Watchman options

4. Use the Cursorpad (▲ or ▼) to select [Off] or the time ([5min], [10min] or [20min]) then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

To turn off watchman, select [Off] at step 4.

5.29 Alarm Message

The alarm status window shows all currently violated alarms.

Note: The alarm status window is not automatically displayed when an alarm occurs.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Alarm] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Alarm Status] and press the **ENTER** key.

Alarm Status display

4. Press the **MENU/ESC** key to close the alarm status display.

5. Press he **MENU/ESC** key to close the menu.

Alarm category	Meaning
SIGNAL MISSING*	
TRIGGER	Trigger signal lost (only for remote display)
HEADING	Heading signal lost
BEARING	Bearing signal lost
GYRO	AD-10 format gyro signal lost
VIDEO	Video signal lost

Alarm category	Meaning
POSITION	NMEA format position data lost
NMEA_HDG	NMEA format heading signal lost
TARGET ALARM1(2)	
IN	An echo has entered a target alarm zone.
OUT	An echo has exited a target alarm zone.
TT ALARM	
COLLISION	CPA and TCPA of an TT target is less than CPA and TCPA alarm settings.
LOST	Acquired TT target becomes lost.
PROXIMITY	The range to an TT target is less than the user-set proximity alarm range.
AIS ALARM	
COLLISION	CPA and TCPA of an AIS target is less than CPA and TCPA alarm settings.
PROXIMITY	The range to an AIS target is less than the user-set proximity alarm range.
AIS SYSTEM*	
TX	TX stopped or TX error
ANT	Antenna VSWR problem
CH1	TDM2 RX1 board problem
CH2	TDM2 RX2 board problem
CH70	RX channel 70 problem
FAIL	System failure
MKD	Minimum input device lost
EPFS	Navigator (GPS, etc.) problem
L/L	Position data lost
SOG	Speed data lost
COG	Course data lost
HDG	Heading data lost
ROT	Rate of turn data lost
OTHER*	
OVER_TEMP	The temperature of the equipment is more than the specified value.

*: Have a qualified technician check the equipment.

5.30 Color Selections

5.30.1 Preset colors

This radar is preset with color combinations that provide best viewing in daytime, nighttime and twilight. Below are the default color settings for each display item and display color setting.

Display item, color design and color

Display item	Day	Night	Twilight	Custom
Characters	Black	Red	Green	Green
Range rings, marks	Green	Red	Green	Green
Echo	Yellow	Green	Green	Yellow
Background	White	Black	Blue	Black

1. Press the **MENU** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Brill/Color] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Display Color] and press the **ENTER** key.

Display Color options

4. Use the Cursorpad (▲ or ▼) to select the color design and press the **ENTER** key.

5. Press the **MENU** key to close the menu.

5.30.2 Custom colors

The custom color design lets you select preferred echo, background, characters, range rings and marks colors. Select [Custom] in the [Display Color] menu item (see section 1.34.1) to use the user selected echo, background, characters, range rings and marks colors.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Brill/Color] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Echo Color] and press the **ENTER** key.

Echo Color options

4. Use the Cursorpad (▲ or ▼) to select an echo color and press the **ENTER** key. [Multi] displays echoes in colors of red, yellow and green according to descending echo strength.

5. Use the Cursorpad (▲ or ▼) to select [Background Color] and press the **ENTER** key.

```
Black
DK Blue
Blue
White
```

Background Color options

6. Use the Cursorpad (▲ or ▼) to select a background color and press the **ENTER** key.

7. Use the Cursorpad (▲ or ▼) to select [Character Color] and press the **ENTER** key.

```
Green
Red
White
```

Character Color options

8. Use the Cursorpad (▲ or ▼) to select a character color (including range rings and marks) and press the **ENTER** key.

9. Press the **MENU/ESC** key to close the menu.

5.31 Echo Area

You can select the display area from [Normal] or [Full Screen].

Area in which echoes are displayed

| Normal | Full Screen |
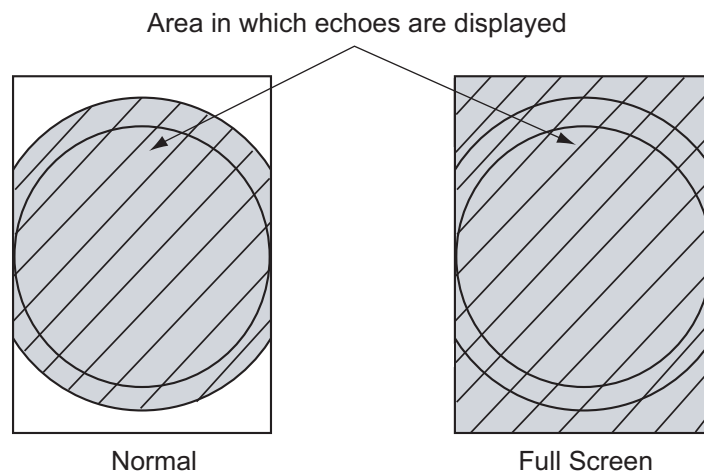
Echo area

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Echo Area] and press the **ENTER** key.

```
Normal
Full Screen
```
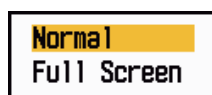
Echo Area options

4. Use the Cursorpad (▲ or ▼) to select [Normal] or [Full Screen] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

5.32 Initial Sub Menu

The [Initial] sub menu in the [System] menu contains the items which allow you to customize your radar to meet your needs.

5.32.1 How to open the Initial sub menu

1. Press the **MENU** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Initial] and press the **ENTER** key.

```
┌─────────────────┬──────────────────────────────┐
│     Menu        │          Initial             │
├─────────────────┼──────────────────────────────┤
│ Target Trails   │ Key Beep        : On         │
│ Tuning          │ Offcenter Speed : 15kn       │
│ Others          │ Compass Type    : True       │
│ Target          │ Range Preset                 │
│ ARPA            │ Wind Direction  : Apparent   │
│ AIS             │ NMEA Port 1     : Auto       │
│ GPS             │ NMEA Port 2     : Auto       │
│                 │ NMEA Mixing Out : Off        │
│ ▼ System        │                              │
│ Initial         │                              │
│ Tests           │ [ENTER]: Enter [CANCEL/HL OFF]: Back │
│                 │ [MENU]: Exit                 │
├─────────────────┴──────────────────────────────┤
│ Turning on/off beep sounds                      │
└─────────────────────────────────────────────────┘
```

Initial sub menu

5.32.2 Description of Initial sub menu

[Key Beep]: When a key is pressed, a beep sounds. You can turn on or off this beep.

[Off-center Speed]: Set the speed of your ship to calculate amount of your ship's off-center. The setting range is 1-99 (kn).

[Compass Type]: Select the type of bearing sensor connected to the radar; [True] (gyrocompass, satellite compass) or [Magnetic] (magnetic compass).

[Range Preset]: You can select the radar ranges. Select a range and press the **ENTER** key to switch on and off. At least two ranges must be turned on. The maximum range available depends on the radar model. 0.0625 is not available in KM (kilometers).

0.0625 On	0.0625 Off	0.0625 On
0.125 On	0.125 On	0.125 On
0.25 On	0.25 On	0.25 On
0.5 On	0.5 On	0.5 On
0.75 On	0.75 On	0.75 On
1 Off	1 Off	1 Off
1.5 On	1.5 On	1.5 On
1.6 Off	1.6 Off	1.6 Off
2 Off	2 Off	2 Off
3 On	3 On	3 On
3.2 Off	3.2 Off	3.2 Off
4 Off	4 Off	4 Off
6 On	6 On	6 On
8 Off	8 Off	8 Off
12 On	12 On	12 On
16 Off	16 Off	16 Off
24 On	24 On	24 On
32 Off	32 Off	32 Off
36 On	36 On	36 On
48 Off	48 Off	48 Off
64 Off	64 Off	64 Off
Exit? Yes	Exit? Yes	Exit? Yes
NM (nautical miles)	KM (kilometers)	SM (statute miles)

[Wind Direction]: Wind direction is shown as [Apparent] or [True].

[NMEA Port 1]: Set the baud rate of the equipment connected to Port 1 ([Auto], [4800], or [38400] (bps)). [Auto] provides automatic detection of baud rate from 4800, 9600, 19200 or 38400 (bps).

[NMEA Port 2]: Same function as Port 1 but for Port 2.

[NMEA Mixing Out]: Data input to Port 1 may be output from Port 2 mixed with data output to Port 2. Select [On] to use this feature.

5.33   Sector Blank

You must prevent the transmission in some areas to protect passengers and crew from microwave radiation. Also, if the reflections of echoes from the mast appear on the screen, you must prevent the transmission in that area. You can set two sectors.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Sector Blanks] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Sect-Blank 1 (or 2) Status] and press the **ENTER** key.

Sect-Blank Status options

4. Use the Cursorpad (▲ or ▼) to select [On] and press the **ENTER** key.

5. Use the Cursorpad (▲ or ▼) to select [Sect-Blank 1 (or 2) Start] and press the **ENTER** key.
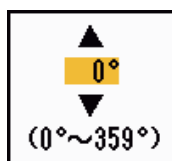
Sect-Blank Start setting window

6. Use the Cursorpad (▲ or ▼) to set the start point of the sector and press the **ENTER** key.

7. Use the Cursorpad (▲ or ▼) to select [Sect-Blank 1 (or 2) End] and press the **ENTER** key.
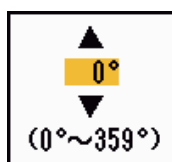
Sect-Blank End setting window

8. Use the Cursorpad (▲ or ▼) to set the end point of the sector and press the **ENTER** key.
   Note 1: You can not set the sector more than 180 degrees.
   Note 2: You can not set the total width of sector 1 and sector 2 more than 270 degrees.

9. Press the **MENU/ESC** key to close the menu.

As shown in the following illustration, dashed lines mark the start and end points of the sector.

Sector blank
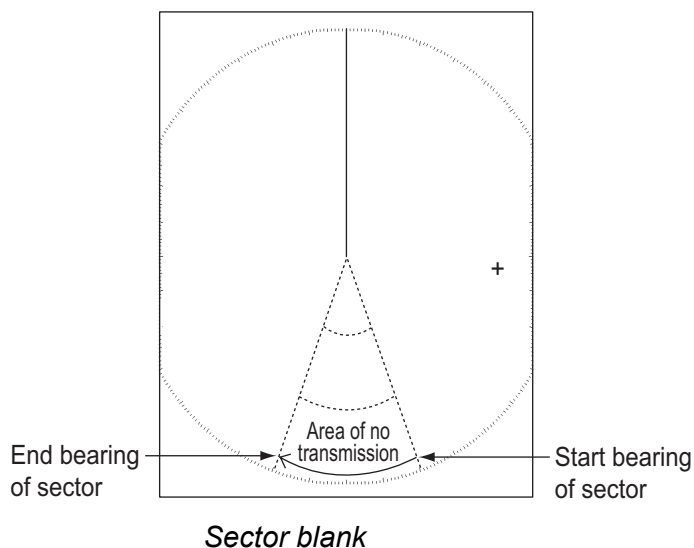
5.34 Other Menu Items

This section describes the menu items not previously described.

5.34.1 Brill/Color menu

[View Position]: You can select the angle from where you see the screen.
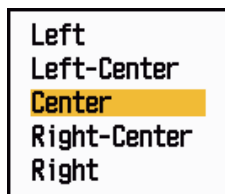
View Position options

[Menu Transparency]: You can select the degree of transparency of the menu window so the menu window does not hide the echo display. [4] is the greatest degree of transparency. [Off] functions to hide the echo display behind the menu window completely.

Note: Alpha blending technology is used for transparency effects.
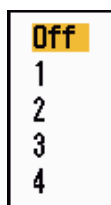
Menu Transparency options

[Echo Color Mode]: You can select the color palette from [System] or [Custom]. [System] is the preset color palette and [Custom] is the color palette you can set yourself. This function is not available in the [IEC] or [Russian-River] mode.

Echo Color Mode options

[Custom Echo Color]: You can customize the echo color with the following two methods. This function is not available in the [IEC] or [Russian-River] mode.
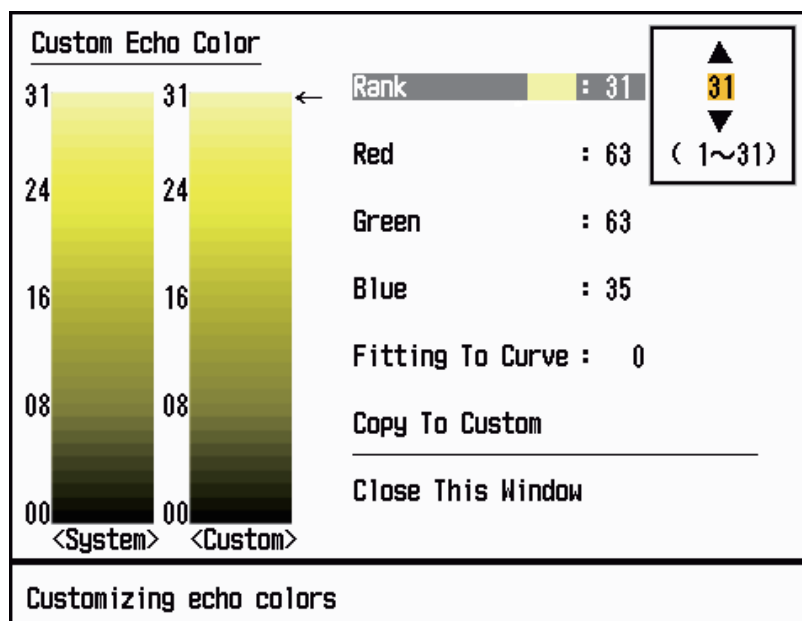
Custom Echo Color setting window

Method 1: 1) Select the echo rank to change on the [Rank] (setting range: 1 - 31).

2) Set the RGB values for selected echo rank on the [Red], [Green] and [Blue] (setting range: 0 - 63).

Method 2: 1) Select 31 on the [Rank].

2) Set the RGB values for 31 echo rank on the [Red], [Green] and [Blue] (setting range: 0 - 63).

3) Interpolate the RGB values between the maximum rank and minimum rank on the [Fitting To Curve] with the following curves (setting range: -20 to 20).

   Setting range > 0: Logarithmic curve, useful to emphasize the weak echoes.

   Setting range = 0: Straight line

   Setting range < 0: Exponential curve, useful to emphasize the strong echoes.

[Copy To Custom]: Copy the color palette from [System] to [Custom].

5.34.2 Display menu

[Base Text Display]: You can select on/off for the text indications of the following items on the display. The settings on this function are used when you set [Echo Area] to [Full Screen] on the [Display] menu. This function is not available in the [IEC] or [Russian-River] mode.

```
Range    On
Mode     On
Alarm    On      ← Press the ENTER key
Echo     On         to change between
EBL/VRM  On         on and off.
+Cursor  On

EXIT? YES
```
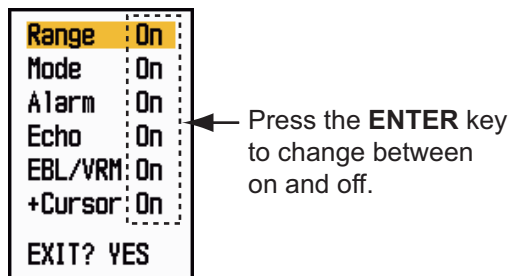
Base Text Display options

The text indications set to off appear when you operate any key. The indications disappear when there is no key operation for 10 seconds.

[Gain/Sea/Rain Bar]: Open the Gain/Sea/Rain indicator. You can check the current settings.

```
        Gain/Sea/Rain
GAIN MAN  (0~100)   0 [          ]
SEA  MAN  (0~100)   0 [          ]
RAIN MAN  (0~100)   0 [          ]
[CANCEL/HL OFF]: Close
```

Gain/Sea/Rain Bar

[STBY Display]: Set the function of the standby display.

```
Normal
Nav
Economy
```

STBY Display options

[Normal]: Display "ST-BY" at the screen center.
[Nav]: Display navigation data.
[Economy]: Turn off the LCD backlighting. The radar must be switched from TX to ST-BY to activate this mode.

5.34.3 Echo menu

[Color Erase]: Erase the lower echo color whose level is set here. Set a large value to display only the stronger echoes.

```
▲
0
▼
( 0~11)
```
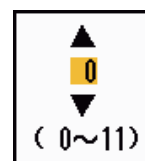
5.34.4 Units menu

You can select the unit of measurement for range, ship speed, depth, temperature and wind speed on the [Units] sub menu in the [System] menu. You can not open this sub menu in normal operation. To open this menu, select [Units], hold the **MENU/ESC** key and press the **ALARM** key five times.

Menu	Units
AIS	Range Unit : NM
GPS	Ship Speed Unit : kn
	Depth Unit : m
▼ System	Temperature Unit : °C
Initial	Wind Speed Unit : kn
Tests	
Sector Blanks	
Units	
TT	[ENTER]: Enter
Installation	[MENU/ESC]: Back
Factory	
Select range unit	

Units sub menu

[Range Unit]: NM, KM, SM

[Ship Speed Unit]: kn, km/h, mph

[Depth Unit]: m, ft, fa, pb, HR

[Temperature Unit]: °C, °F

[Wind Speed Unit]: kn, km/h, mph, m/s

5.35 Navigation Data

5.35.1 Navigation data during standby

The navigation data is shown in standby when [STBY Display] on the [Display] menu is set to [Nav]. Appropriate sensors are required to display the data.

Speed → **SPEED** 29.7kn

Depth → **DEPTH** 452ft

Wind speed → **WIND SPEED** 25.1kn

TRIP 148.0NM ← Standby indication / Trip

TEMPERATURE 65.8°F ← Water temperature

WIND DIRECTION 3.0° (R) ← Wind direction

ST-BY

<WATCH> 09:50 ← Time until TX in watchman

Heading indicator

Course → **CRS** 0.2°

Bearing to destination waypoint → **BRG** 106.0°

Waypoint mark →

Cross track error (numeric value) → **XTE** R 0.40NM

HDG 217.2° ← Heading

⊚WPT TTG 00:31 ← Time to go to destination waypoint

RNG 15.80NM ← Range to go to destination waypoint

OWN SHIP LAT 38° 49.951N LON 124° 46.507E ← Your ship position

Cross track error (graphic): For example, when the indicator is off to the right side, steer your ship to the left to go to the destination waypoint

L XTE | **XTE R**
1 0.5 0 <NM> 0.5 1

Navigation data display at standby

5.35.2 Navigation data at the bottom of the screen

The navigation data is displayed at the bottom of the screen.

- Cursor latitude position
- Cursor longitude position
- Time to go to cursor position

OWN SHIP		+ CURSOR		WAYPOINT	
LAT	34°56.123N	LAT	34°56.123N	BRG	14.8°
LON	135°34.567E	LON	135°34.567E	RNG	0.876NM
SPEED	12.3KN	TTG	01:00	TTG	00:20

Your ship position and speed

- Bearing from your ship to waypoint
- Range from your ship to waypoint
- Time to go from your ship position to waypoint
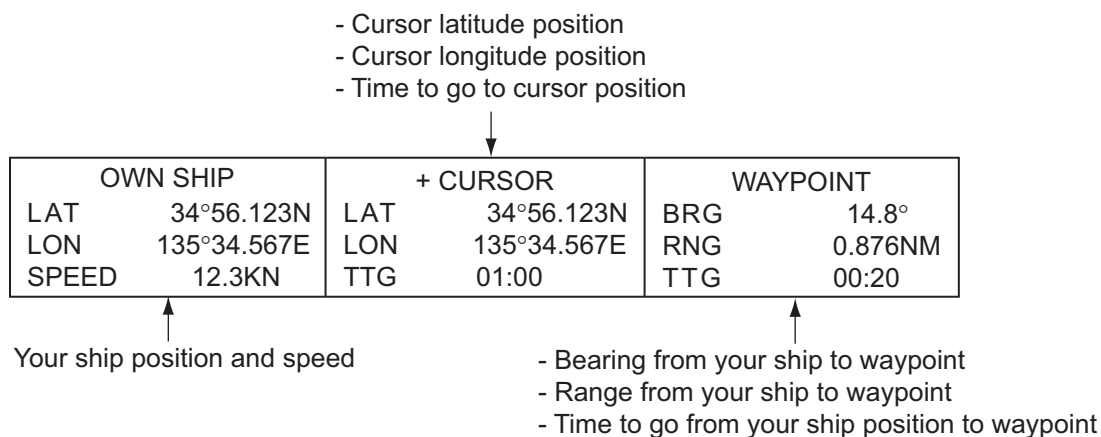
Navigation data

To show or hide the navigation data at the bottom of the screen, do the following:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Data Box] and press the **ENTER** key.
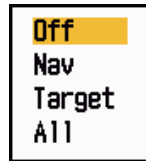
Data Box options

4. Use the Cursorpad (▲ or ▼) to select an option and press the **ENTER** key.
   [Off]: Turn off the data display.
   [Nav]: Navigation data
   [Target]: TT and AIS target data (See section 3.8 and 4.5.)
   [All]: Navigation data plus TT and AIS target data

5. Press the **MENU/ESC** key to close the menu.

5.36 Waypoint Marker

The waypoint marker shows the location of the destination waypoint set on a navigation plotter. The heading signal or course data are required. You can turn on/off the waypoint marker as follows:
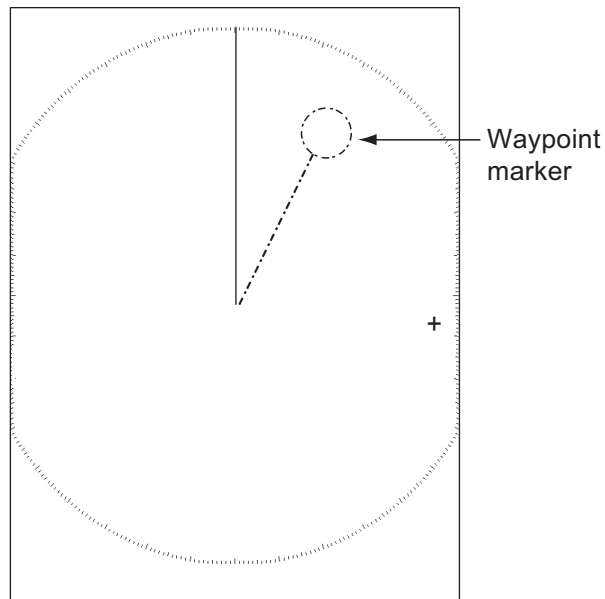
Waypoint marker

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [WPT Mark] and press the **ENTER** key.

WPT Mark options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

5.37 How to Send the Target Position and Enter the Origin Mark

The **TLL** key functions to send the cursor position to a chart plotter and put an origin mark (▷) at the cursor position on the radar. Use the Cursorpad to put the cursor on a target. Press the **MODE** key to open the [Mode] window, select [TLL] then press the **ENTER** key. You can enter up to 20 origin marks on the radar display. When the capacity for origin marks is reached, the oldest mark is erased to make room for the latest mark, to keep a maximum of 20 marks. To erase a mark, put the cursor on the mark and press the **MENU/ESC** key.

TLL key mode

You can select how to handle TLL position.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Others] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [TLL Mode] and press the **ENTER** key.

TLL Output
Origin Mark
Both

TLL Key Mode options

4. Use the Cursorpad (▲ or ▼) to select [TLL Output], [Origin Mark] or [Both] then press the **ENTER** key.
   [TLL Output]: Send the latitude and longitude of the cursor position to a chart plotter. (Position and heading signal are required.)
   [Origin Mark]: Enter an origin mark at the cursor position on the radar display. (Position and heading signal are required.)
   [Both]: Send the target position to a chart plotter and enter an origin mark on the radar display.

5. Press the **MENU/ESC** key to close the menu.

Note: All origin marks are deleted and not saved when the power is turned off.

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6. HOW TO INTERPRET THE RADAR DISPLAY

6.1 General

6.1.1 Minimum and maximum ranges

<u>Minimum range</u>

The minimum range is defined by the shortest distance at which, using a scale of 0.0625 or 0.125 nm, a target having an echoing area of 10 m^2 is shown separate from the point representing the antenna position.

The minimum range depends on the pulse length, antenna height, and signal processing (like main bang suppression and digital quantization). Use a shorter range scale as far as it gives favorable definition or clarity of picture. This MODEL 1835 series meets the requirements of IEC 62252 5.14.1 (Class A).

<u>Maximum range</u>

The maximum detection range, Rmax, varies depending on the height of the antenna, 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 or a little shorter than the optical horizon. The radar horizon is longer than the optical one by approximately 6% because of the diffraction property of the radar signal. The Rmax is shown in the following formula.

$R_{max} = 2.2 \times (\sqrt{h1} + \sqrt{h2})$
where R_{max}: radar horizon (nautical miles)
h1: antenna height (m)
h2: target height (m)
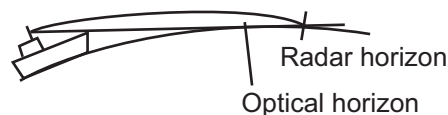
If the height of the antenna is 9 m and the height of the target is 16 m, the maximum radar range is;

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

Note: The detection range is reduced by precipitation (which absorbs the radar signal).

6.1.2   Radar resolution

The bearing resolution and range resolution are important in radar resolution.

Bearing resolution

The bearing resolution is the ability of the radar to display the echoes received from two targets at the same range as the separate echoes. The bearing resolution is proportional to the antenna length and the wavelength.
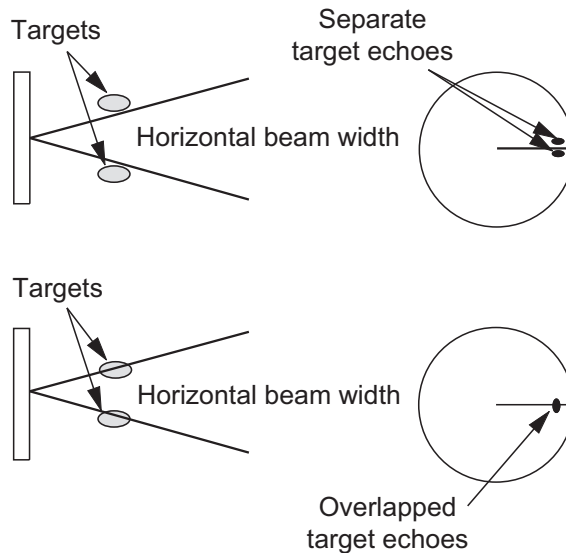
Range resolution

The range resolution is the ability to display the echoes received from two targets on the same bearing as separate echoes. The range resolution is determined by only pulse length.

The test targets used to determine the range and bearing resolution are radar reflectors that have an echoing area of 10 m^2.
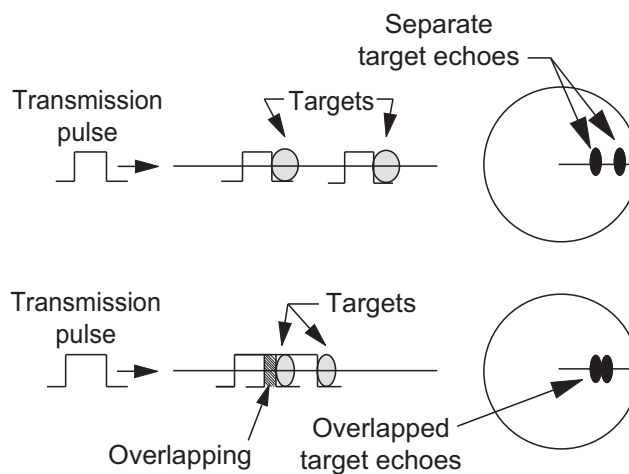
6.1.3 Bearing accuracy

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 depends on the narrowness of the radar beam. The bearing is taken relative to the heading of the ship. Correct adjustment of the heading line at installation is important to get accurate bearings. To minimize the error when you measure the bearing of a target, put the target echo at the extreme position on the screen by selecting a suitable range.

6.1.4 Range measurement

Measurement of the range to a target is important function of the radar. There are three methods of measuring range: the fixed range rings, the Variable Range Marker (VRM), and the cursor (if set to measure range and bearing). The fixed range rings appear on the screen with a given interval and provide a rough estimate of the range to a target. The diameter of VRM is increased or decreased so that the marker touches the inner edge of the target. The VRM is a more accurate range measurement than the fixed range rings.

6.2 False Echoes

The echo signals can appear on the screen at positions where there is no target or disappear when there are targets. These false echoes are shown below.

6.2.1 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 can be seen on the display at double, triple or other multiples of the actual range of the target as shown below. You can reduce and remove the multiple reflection echoes with the sea clutter function.

Multiple echoes
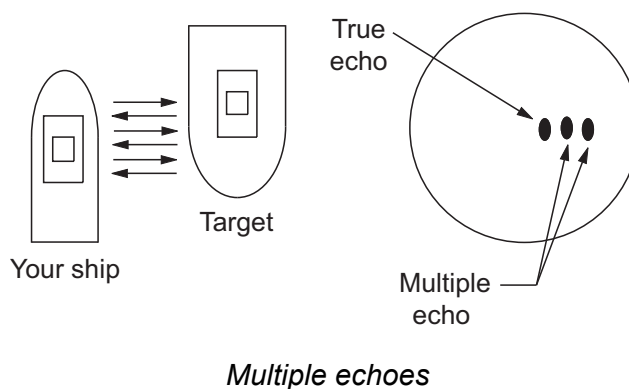
6.2.2   Sidelobe echoes

When the radar pulse is transmitted, some radiation escapes on each side of the beam, called "sidelobes". If a target is where a target can be detected by the sidelobes as well as the mainlobe, the side echoes can be shown on both sides of the true echo at the same range. Sidelobes show normally only on short ranges and from strong targets. You can reduce the sidelobes with the sea clutter function.
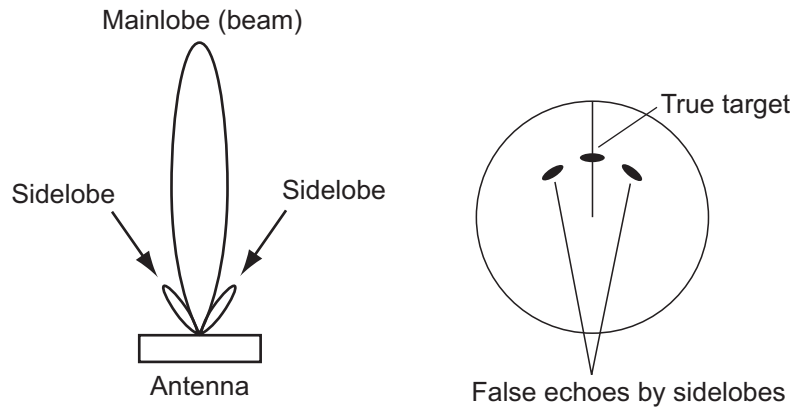
Sidelobe echoes

6.2.3   Virtual image

A large target close your ship can appear at two positions on the screen. One of them is the true echo reflected by the target. The other is a false echo which is caused by the mirror effect of a large object on or close your ship as shown in the following figure. If your ship comes close to a large metal bridge, for example, a false echo can temporarily appear on the screen.
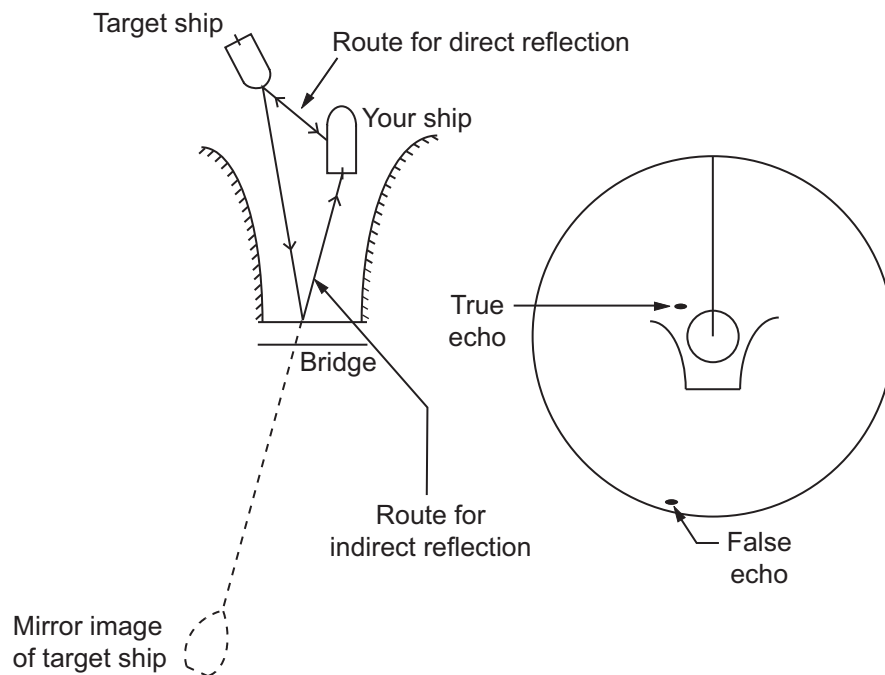
Virtual image

6.2.4   Shadow sector

Funnels, stacks, masts, or derricks near the antenna interrupt the radar beam, and a non-detecting sector can occur. Targets can not be detected within this sector.

Radar position · Wharf and its echo · Shadow sector occurs because wharf is hidden behind ship. · Large ship

Radar position · Wharf and its echo · Shadow sector occurs because obstruction (like mast) is in path of radar beam. · Size of blind sector depends on size of obstruction and range.
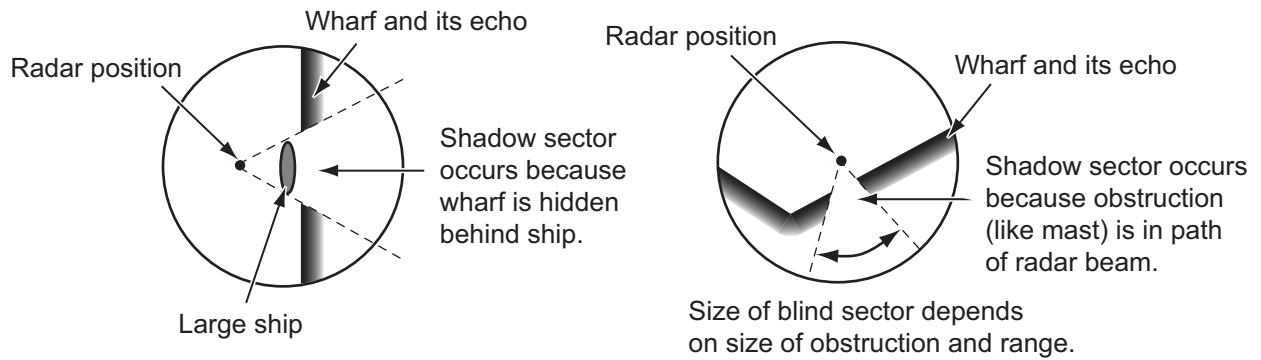
Shadow sector

6.3 SART (Search and Rescue Transponder)

6.3.1 SART description

When any X-band radar reaches within a range of approximately 8 nm, a Search and Rescue Transponder (SART) sends a response to the radar signal. The transmitter signal of response is 12-sweeps signal between 9,500 MHz to 9,200 MHz. The time of slow sweep signal is 7.5 μs and the time of fast sweep signal is 0.4 μs. When the radar receives this SART signal, a line of 12 dots appears. When the position of SART is distant, the radar display shows only slow sweep signals like the illustration of screen A.

When the radar reaches the SART within approximately 1 nm, the radar display can also show the 12 responses of fast sweep signals like the illustration of screen B. The position of the SART is the closest position of the radar echoes.

SART echo
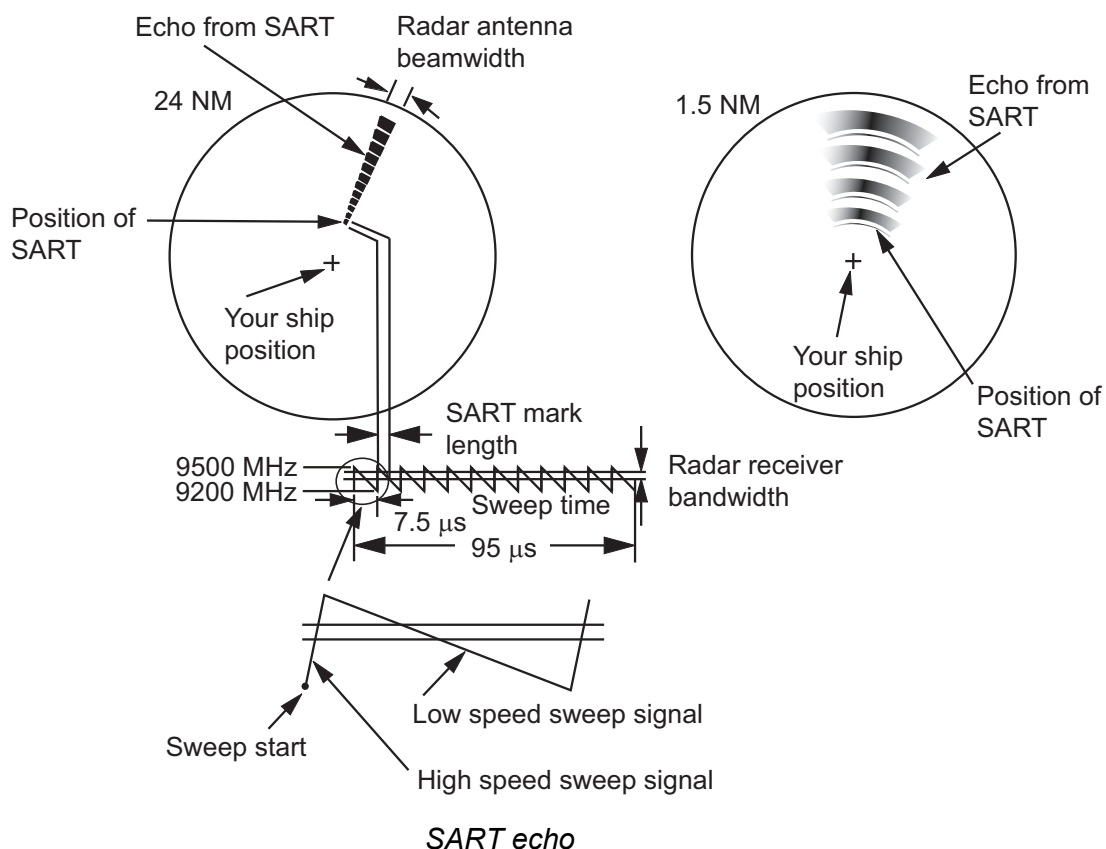
6.3.2   General remarks on receiving SART

SART range errors

When the SART is at a range greater than approximately 1 nm, the first dot is displayed at 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 range echoes are displayed at 150 m beyond the true position.

Range scale

When you find the SART position, do as follows:

1.   Use the **RANGE** key to set the range scale to 6 nm or 12 nm.
2.   Turn off [Int Rejector].

SART display

To display only the SART echo clearly on the radar screen, reduce the tuning on manual mode. The normal radar echoes get weak, however, the SART echoes remain. Your ship comes close to the SART, the arc for the SART display becomes larger. Most of the radar screen becomes fuzzy. Adjust the sea clutter and gain to display the necessary screen.

6.4 RACON

A RACON is a radar beacon which emits radar-receivable signals in the radar frequency spectrum (X- or S-band). There are several signal formats; in general, the RACON signal appears on the radar screen as a rectangular echo originating at a point just beyond the position of the radar beacon. It has a Morse coded pattern. Note that the position on the radar display is not accurate.

Echoes on the radar screen
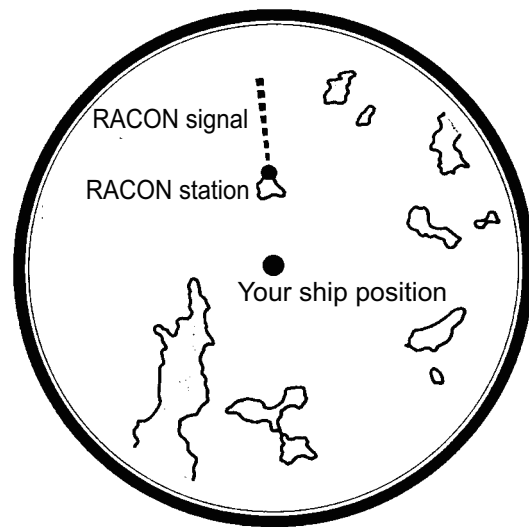
Echo description

RACON

7. TT OPERATION

The TT (Tracked Target) feature manually or automatically acquires and tracks ten targets. Once a target is acquired, a target is automatically tracked within 0.1 to 16 nm.

7.1 Precautions for Use

⚠ CAUTION

**Do not depend on one navigation device
for the navigation of the ship. The navigator must check all aids available to confirm position. Electronic aids are not a replacement for basic navigation principles and common sense.**

· The TT automatically tracks an automatically or manually acquired radar target and calculates its course and speed, indicating them by a vector. Since the data from the auto plotter depend on the selected radar targets, the radar must be optimally tuned for use with the auto plotter, to ensure required targets will not be lost or unnecessary targets like sea returns and noise will not be acquired and tracked.

· A target is not always a landmass, reef, ship, but can be returns from the sea surface and clutter. As the level of clutter changes with the environment, the operator must correctly adjust the **SEA**, **RAIN** and **GAIN** controls so that the target echoes do not disappear from the radar screen.

⚠ CAUTION

**The plotting accuracy and response of this TT meets IMO standards.
The tracking accuracy is affected by the following:**

· The tracking accuracy is affected by course change. One to two minutes is required to restore vectors to full accuracy after a sudden course change. (The actual amount depends on gyrocompass specifications.)
· The amount of tracking delay is inversely proportional to the relative speed of the target. Delay is on the order of 15-30 seconds for high relative speed; 30-60 seconds for low relative speed.

The display accuracy is affected by the following:

· Echo intensity
· Pulse width of radar transmission
· Radar bearing error
· Gyrocompass error
· Course change (your ship or target)

7.2 Controls for Use with TT

ENTER: Acquire cursor-selected target. Display data for tracked target (in the data box at the bottom of the screen).

MENU/ESC: (1) Remove data of cursor-selected tracked target from the data box. (2) Stop tracking the cursor-selected target (when its data is not displayed in the data box). (3) Access the [Target] and [TT] menus for TT operations.

Cursorpad: Select a target to acquire (or cancel the tracking). Select a target to show (or remove) target data.

7.3   TT Display On/Off

You can turn the TT display on or off. The system continuously tracks TT regardless of this setting.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [TT] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

TT-Display options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

7.4   How to Acquire and Track the Targets

Ten targets are acquired and tracked manually or automatically.

7.4.1   Manual acquisition

You can acquire up to ten TT. When the automatic acquisition ([Auto Acquisition] on the [TT] menu) is set to on, you can manually acquire up to five targets.

1. Use the Cursorpad to put the cursor on the target to acquire.

2. Press the **ENTER** key.

The TT symbol changes over time as below. A vector which indicates the motion direction of the target appears approximately one minute after acquisition.
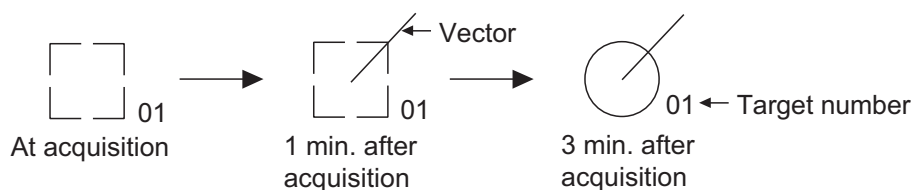
TT symbol

Target number

River and Sea (Non-IEC system): An acquired target gets the youngest unused number. When a target is lost and disappears from the number list, the next acquired target takes the number of that lost target (for example, In a 5 target list, if the target 2 is lost, the next acquired target takes the number of target 2).

IEC and Russian-River (IEC system): An acquired target gets the youngest unused number. When a target is lost and disappears from the number list, the next acquired target takes the next sequential number until reaching a maximum 10. If the target number reaches a maximum 10, the next acquired target takes the number of a previously lost target.

7.4.2 Automatic acquisition

When you set an automatic acquisition area, the TT can acquire up to five targets automatically.

The automatic acquisition area is 2.0 to 2.5 nm in range and ±45° on either side of the heading line in bearing. When you change the automatic acquisition to manual acquisition, targets being tracked in automatic acquisition are continuously tracked.
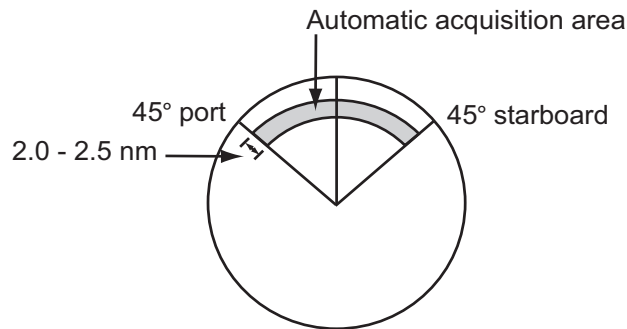
Automatic acquisition area

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [TT] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Auto Acquisition] and press the **ENTER** key.

Auto Acquisition options

4. Use the Cursorpad (▲ or ▼) to select [On] and press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu.

7.5 How to Stop the Tracking of TT

When ten targets have been acquired, no more acquisition occurs unless targets are cancelled. If you acquire additional targets, you must cancel one or more individual targets, or all targets. Use one of the following procedures.

7.5.1 How to stop the tracking of selected targets

1. Use the Cursorpad to put the cursor on the target to cancel the tracking.
2. Press the **MENU/ESC** key to cancel the tracking and erase the TT symbol. The unit beeps twice and the symbol is erased from the screen.

7.5.2 How to stop the tracking of all targets

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [TT] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [All Cancel] and press the **ENTER** key.

```
Are you sure ?
     Yes
     No
```
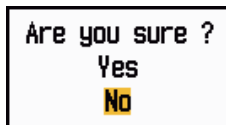
All Cancel options

4. Use the Cursorpad (▲) to select [Yes] and press the **ENTER** key. All symbols are erased from the screen and the long beep sounds.

5. Press the **MENU/ESC** key to close the menu.

7.6 Vector Attributes

7.6.1 What is a vector?

A vector is a line extending from a tracked target. A vector shows speed and course of the target. The top of a vector shows estimated position of the target after the selected vector time elapses. If you extend the vector length (time), you can evaluate the risk of collision with any target.

Vector time

Predicted position of the target in 15 minutes later

Vector

Current position of the target
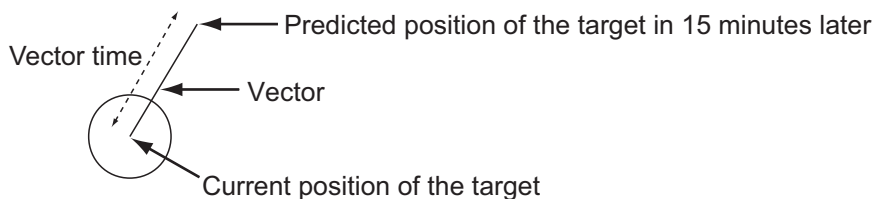
When vector time is 15 minutes

7.6.2 Vector time and vector reference

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.

```
Menu                    Target
Brill/Color      Vector Time        :  6min
Display          Vector Reference   :  True
Echo             Past Positions     :  5
Alert Settings   Past Posn Interval :  1min
Trails           CPA                :  Off
Tuning           TCPA               :  1min
Others           Proximity          :  Off
Target
OS/Barge Mark
TT               [ENTER]: Enter
AIS              [MENU/ESC]: Back

Set target vector time
```

Target menu

3. Use the Cursorpad (▲ or ▼) to select [Vector Time] and press the **ENTER** key.

Vector Time setting window

4. Use the Cursorpad (▲ or ▼) to select time and press the **ENTER** key.

5. Use the Cursorpad (▲ or ▼) to select [Vector Reference] and press the **ENTER** key.

Vector Reference options

6. Use the Cursorpad (▲ or ▼) to select [Relative] or [True] then press the **ENTER** key. This function is not activate for [IEC] or [Russian-River] purpose. The mode is set to [True].
   [Relative]: Other ships' vectors are displayed relative to your ship. This mode helps find targets on a collision course. If a ship is on a collision course with your ship, the vector of a ship points toward your ship position.
   [True]: Your ship's and other ships' vectors are displayed at their true motions. This mode helps discriminate between moving and stationary targets.

7. Press the **MENU/ESC** key to close the menu.

Note: The functions of the [Target] menu are shared by TT and AIS.

7.6.3 Vector of your ship

The vector of your ship is shown as an arrow from your ship position. The vector of your ship is shown on the following conditions:

• Select [True] on the menu item [Vector Reference] on the [Target] menu

Note: The vector of your ship is shown in the same color as the TT symbol color.
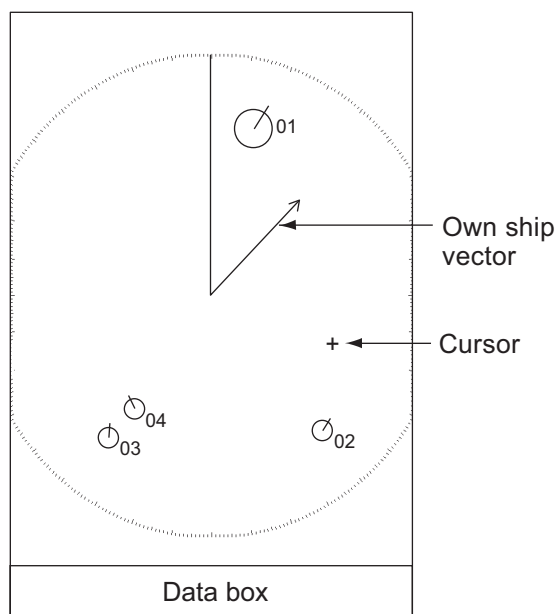
7.7 Past Position Display (target past position)

This radar can display time-spaced dots (maximum ten dots) that mark the past positions of any TT. You can evaluate actions of a target by the spacing between dots. Below are examples of dot spacing and target movement.

(a) Ship turning   (b) Ship running straight   (c) Ship reduced speed   (d) Ship increased speed
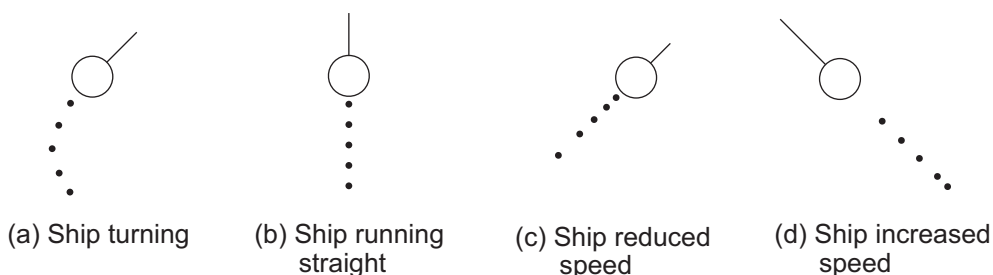
Target movement and past position display

You can select the number of past position dotes to display and the time interval to display the dots.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Past Positions] and press the **ENTER** key.
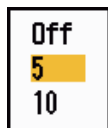
Past Positions options

4. Use the Cursorpad (▲ or ▼) to select number of past position dots to display (5 or 10) or select [Off] to turn off the history display.
5. Press the **ENTER** key.

6. Use the Cursorpad (▲ or ▼) to select [Past Posn Interval] and press the **ENTER** key.

Past position interval options

7. Use the Cursorpad (▲ or ▼) to select the time interval and press the **ENTER** key.

8. Press the **MENU/ESC** key to close the menu.

7.8 TT Data

You can show the data or a TT in the data box at the bottom of the screen. To display TT data, the menu item [Display] on the [TT] menu must be set for [On] and the menu item [Data Box] on the [Display] menu must be set for [Target] or [All].

1. Use the Cursorpad to put the cursor on an TT.

2. Press the **ENTER** key to show the data of the target.
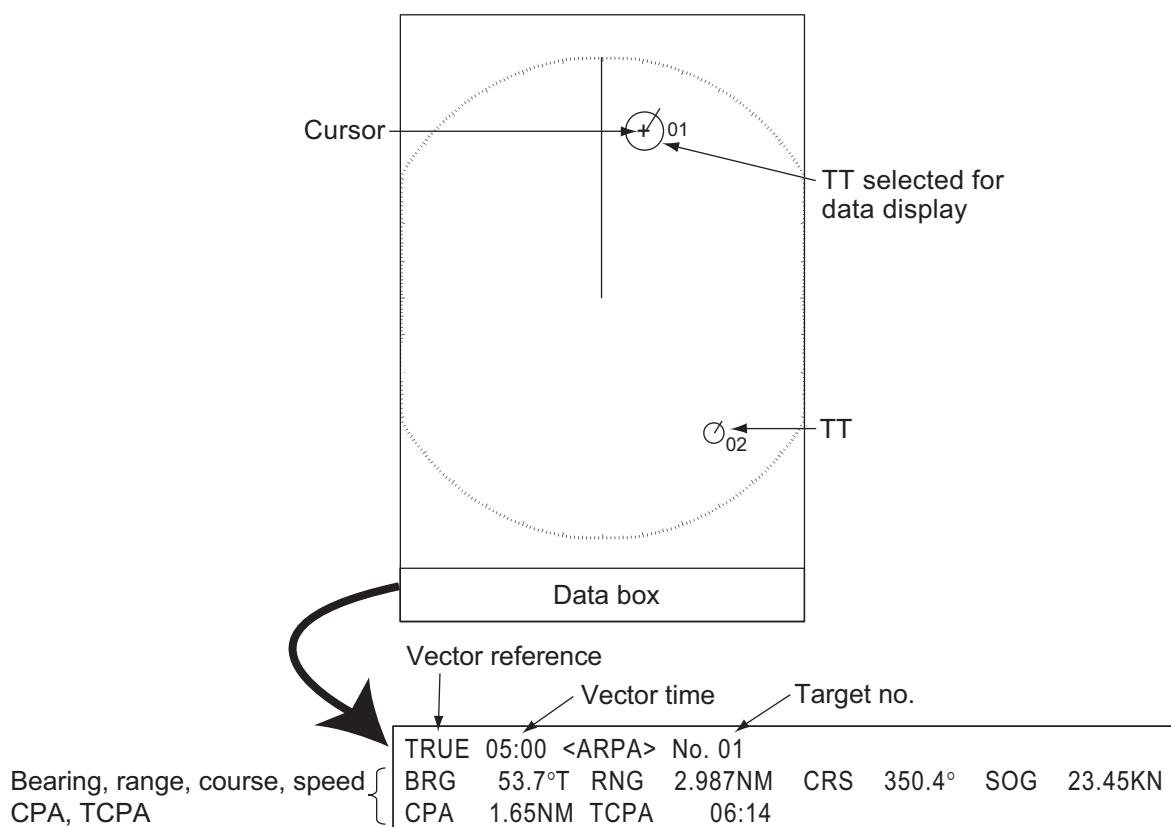
TT data

The symbol for the selected TT is enlarged double to distinguish from other symbols.

To remove the data of a target from a data box, put the cursor on its target symbol and press the **MENU/ESC** key.

7.9   CPA/TCPA Alarm

Set CPA (Closest Point of Approach) alarm range and TCPA (predicted Time to CPA) alarm time to alert you to targets that can be on a collision course. When CPA and TCPA of any TT become less than the preset CPA and TCPA alarm settings, the audio alarm sounds. The alarm message "COLLISION" appears. The target symbol changes to a dangerous target symbol (triangle) and flashes with its vector. You can stop the audio alarm with any key. The flashing of the triangle stops when the tracked TT is not in the CPA and TCPA alarm setting. The TT continuously monitors CPA and TCPA of all TT.

Before alarm
is released

After alarm
is released

(Flashing)

Dangerous target symbol

This feature helps identify targets that can be on a collision course. Correctly adjust the gain, sea clutter and rain clutter.

> ⚠ **CAUTION**
>
> **Do not depend on the CPA/TCPA alarm as the only method to detect the risk of collision. The navigator is not released of the responsibility to keep visual caution for collision situations, whether or not the radar or other plotting aid is in use.**

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [CPA] and press the **ENTER** key.

| Off |
| 0.5NM |
| 1NM |
| 2NM |
| 3NM |
| 5NM |
| 6NM |

CPA options

4. Use the Cursorpad (▲ or ▼) to select CPA distance and press the **ENTER** key.

5. Use the Cursorpad (▲ or ▼) to select [TCPA] and press the **ENTER** key.

```
30s
1min
2min
3min
4min
5min
6min
12min
```
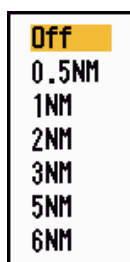
TCPA options

6. Use the Cursorpad (▲ or ▼) to select TCPA and press the **ENTER** key.

7. Press the **MENU/ESC** key to close the menu.

7.10 Proximity Alarm

The proximity alarm alerts you when a TT is within the range you set. The audio alarm sounds and the alarm message "PROXIMITY" appears. The target symbol changes to a dangerous target symbol (triangle, see section 3.9) and flashes with its vector. Press any key to stop the audio alarm. The flashing continues until the target is not within the range set, the alarm range is changed to exclude the target, or the proximity alarm is deactivated.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Proximity] and press the **ENTER** key.

```
Off
0.5NM
1NM
2NM
3NM
5NM
6NM
12NM
24NM
```

Proximity options

4. Use the Cursorpad (▲ or ▼) to select the range and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

7.11 Lost Target

When the system detects a lost TT, the audio alarm sounds and the alarm message "LOST" appears. The target symbol becomes a flashing square like the following illustration. When the system detects the target again, the target symbol becomes a normal symbol.

Before alarm   *After alarm*
is released   *is released*
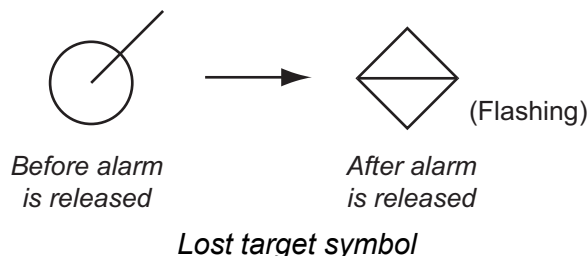
Lost target symbol

To erase a lost TT symbol, put the cursor on the symbol and press the **MENU/ESC** key. If you leave a lost target symbol flashing, the symbol disappears after one minute.

You can remove all lost TT from the screen as follows:

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [TT] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Erase Lost Targets] and press the **ENTER** key.
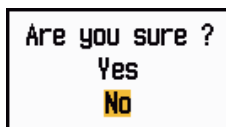
Erase Lost Targets confirmation message

4. Use the Cursorpad (▲) to select [Yes] and press the **ENTER** key. All lost targets symbols are erased from the screen and the long beep sounds.
5. Press the **MENU/ESC** key to close the menu.

7.12 Symbol Color

You can select the TT symbol color from Green, Red, Blue, White or Black.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [TT] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Color] and press the **ENTER** key.

Color options

4. Use the Cursorpad (▲ or ▼) to select the color and press the **ENTER** key.
5. Press the **MENU/ESC** key to close the menu.

Note: Symbols can not be shown in the same color as the background color.

8. AIS OPERATION

Connected to the FURUNO AIS Transponders FA-150, FA-100, FA-50 or the AIS Receiver FA-30, the MODEL 1815 can show the name, position and other navigation data of the nearest 100 AIS transponder-equipped ships.

This radar accepts position data fixed by WGS-84 geodetic datum. Set the datum to WGS-84 on the GPS navigator connected to this radar. If this radar is interfaced with the FURUNO GPS Navigator GP-320B.

Controls for Use with AIS

ENTER: Activate cursor-selected target. Display data for selected active target (in the data box at the bottom of the screen).

MENU/ESC: Remove data of cursor-selected AIS target from the data box. Sleep cursor-selected target (when its data is not displayed in the data box). Access the [Target] and [AIS] menu.

Cursorpad: Select a target to activate (or sleep). Select a target to show (or remove) target data.

8.1 AIS Display On/Off

You can turn the AIS display on or off. The system continues processing AIS targets regardless of on/off for AIS display when the AIS transponder is turned on.
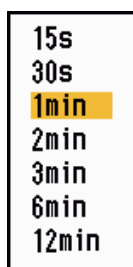
1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

AIS menu

3. Use the Cursorpad (▲ or ▼) to select [Display] and press the **ENTER** key.

AIS-Display options

4. Use the Cursorpad (▲ or ▼) to select [Off] or [On] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

8.2   AIS Symbols

When the AIS is turned on, AIS targets are displayed with AIS symbol as below.

| Sleeping target | Activated target | Dangerous target | Lost target | Target selected for data display |

AIS symbols

Note: The AIS symbols are momentarily erased after the screen is redrawn when the heading is changed on the head-up mode.

8.3   Activating, Sleeping Targets

When you change a sleeping target to an activated target, a vector shows the course and speed of that target. You can easily judge the target movement by the vector.

SOG (Speed Over Ground) and
COG (Course over Ground) vector

ROT
(Rate of Turn)

Heading line

(If there is no heading data,
the line points in direction of COG.)
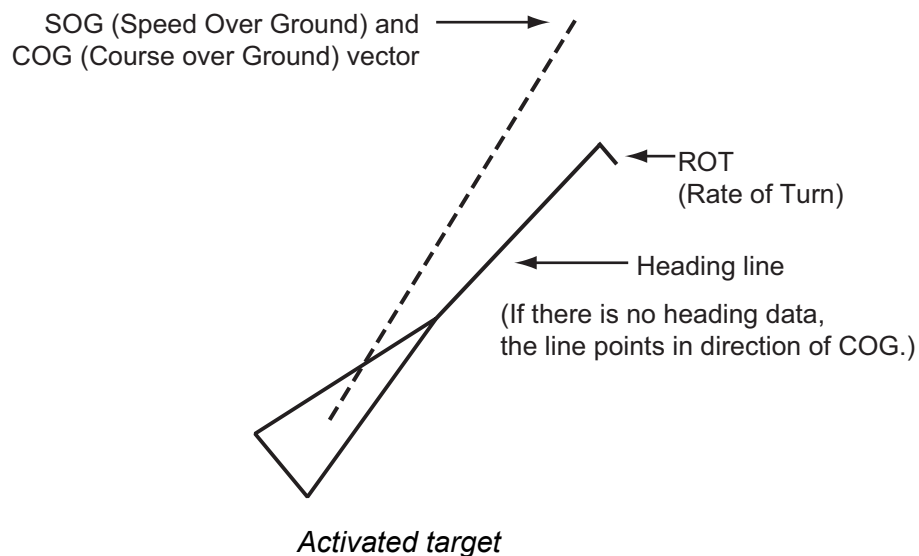
Activated target

When there are many activated targets on the screen, you can not easily distinguish the activated targets from the radar images or TT. You can sleep an activated target for easy view of radar images.
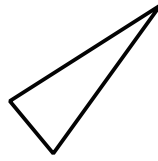
Sleeping target

To activate a target: Put the cursor on the target and press the **ENTER** key.

To sleep a target: Put the cursor on the target and press the **MENU/ESC** key.

8.4   AIS Target Data

You can show the AIS target data in the data box at the bottom of the screen. To display AIS target data, the menu item [Display] on the [AIS] menu must be set for [On] and the menu item [Data Box] on the [Display] menu must be set for [Target] or [All].

1.   Use the Cursorpad to put the cursor on an activated target.

2.   Press the **ENTER** key to show the data of the target.
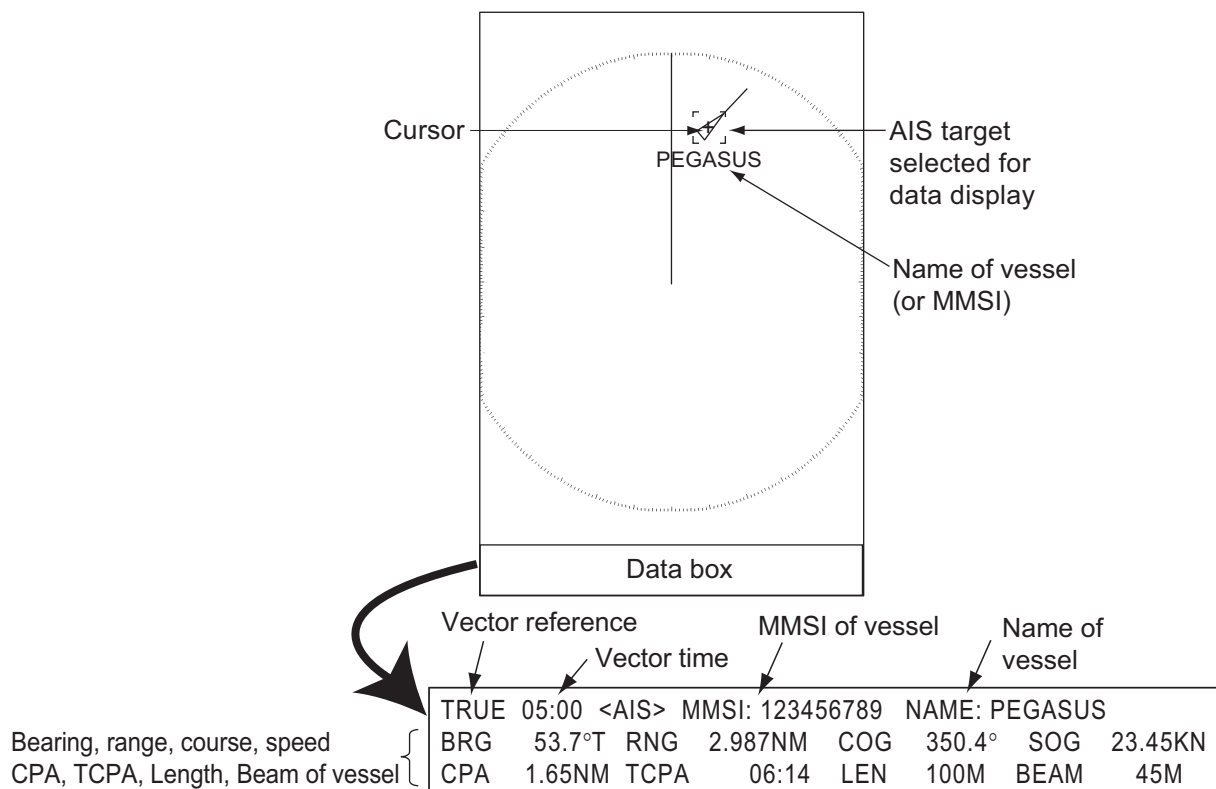
AIS target data

To remove the target data from a data box, put the cursor on its target symbol and press the **MENU/ESC** key.

8.5   How to Sort Targets

You can sort the AIS targets received from the AIS transponder by range from your ship, by sector, by CPA or TCPA.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

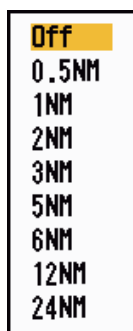3. Use the Cursorpad (▲ or ▼) to select [Sort By] and press the **ENTER** key.
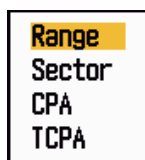
Sort By options

4. Use the Cursorpad (▲ or ▼) to select sorting method and press the **ENTER** key.
    [Range]: Sort targets within the display range set (see section 4.7), from nearest to furthest.
    [Sector]: Sort targets within the display sector set (see section 4.8) and within 24 nm, from nearest to furthest.
    [CPA]: Sort targets within 24 nm by CPA, from closest to furthest.
    [TCPA]: Sort targets within 24 nm by TCPA, from earliest time to latest time.

5. Press the **MENU/ESC** key to close the menu.

8.6   Display Range

You can set the AIS system to show only those AIS targets within the range you set. The setting range is 0.1-36 nm for MODEL 1835, 0.1-48 nm for MODEL 1935, 0.1-64 nm for MODEL 1945. Actual range depends on the AIS Transponder. If the target sorting method is selected to [Range], the target data within the range set here is transmitted to this radar.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Range] and press the **ENTER** key.

*AIS-Range setting window (for MODEL 1835)*

4. Use the Cursorpad (▲ or ▼) to set the display range and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

**Note:** The unit of measurement for range is NM.

8.7 How to Display the Targets within a Specific Sector

You can display AIS targets only within a specific sector. If the target sorting method is selected to [Sector], the target data within the sector set here is transmitted to this radar.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Sector Start] and press the **ENTER** key.

Sector Start setting window

4. Use the Cursorpad (▲ or ▼) to set the start point for the sector and press the **ENTER** key.

5. Use the Cursorpad (▲ or ▼) to select [Sector End] and press the **ENTER** key.
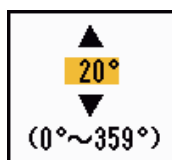
Sector End setting window

6. Use the Cursorpad (▲ or ▼) to set the end point for the sector and press the **ENTER** key.

7. Press the **MENU/ESC** key to close the menu.

8.8 Number of Targets to Display

You can select the maximum number of AIS targets to display. The setting value is 10 to 100. When the screen becomes cluttered with AIS targets, you can limit the number of AIS targets to show. Targets are selected and displayed according to sort method. (See section 4.6.)

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Number of Targets] and press the **ENTER** key.
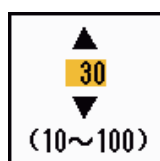
Number of Targets setting window

4. Use the Cursorpad (▲ or ▼) to select the number of targets to display and press the **ENTER** key.

5. Press he **MENU/ESC** key to close the menu.

8.9   Vector Attributes

8.9.1   What is a vector?

A vector is a line extending from a tracked target. A vector shows speed and course of the target. The top of a vector shows estimated position of the target after the selected vector time elapses. If you extend the vector length (time), you can evaluate the risk of collision with any target.

8.9.2   Vector time and vector reference

1. Press he **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Vector Time] and press the **ENTER** key.

Vector Time setting window

4. Use the Cursorpad (▲ or ▼) to select time and press the **ENTER** key.

5. Use the Cursorpad (▲ or ▼) to select [Vector Reference] and press the **ENTER** key.

Vector Reference options

6. Use the Cursorpad (▲ or ▼) to select [Relative] or [True] then press the **ENTER** key. This function is not activate for [IEC] or [Russian-River] purpose. The mode is set to [True].
    [Relative]: Other ships' vectors are displayed relative to your ship. This mode helps find targets on a collision course. If a ship is on a collision course with your ship, the vector of a ship points toward your ship position.
    [True]: Your ship's and other ships' vectors are displayed at their true motions. This mode helps discriminate between moving and stationary targets.

7. Press the **MENU/ESC** key to close the menu.

8.10 Past Position Display (target past position)

This radar can display time-spaced dots (maximum ten dots) that marks the past positions of any tracked AIS target. You can evaluate actions of a target by the spacing between dots. Below are examples of dot spacing and target movement.

(a) Ship turning   (b) Ship running straight   (c) Ship reduced speed   (d) Ship increased speed
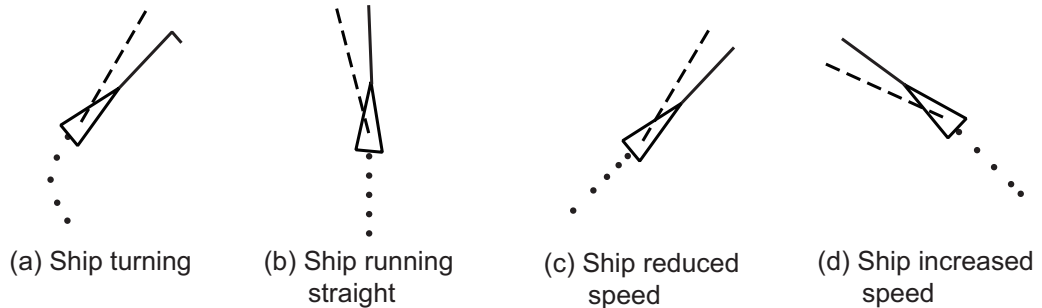
Target movement and past position display

You can select the number of history dots to display and the time interval to display the history dots.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Past Positions] and press the **ENTER** key.
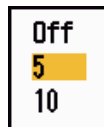
Past Positions options

4. Use the Cursorpad (▲ or ▼) to select number of past position dots to display (5 or 10) or select [Off] to turn off the past position display.

5. Press the **ENTER** key.

6. Use the Cursorpad (▲ or ▼) to select [Past Posn Interval] and press the **ENTER** key.
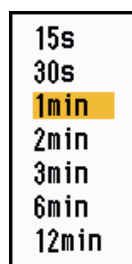
Past Position Interval options

7. Use the Cursorpad (▲ or ▼) to select time interval and press the **ENTER** key.

8. Press the **MENU/ESC** key to close the menu.

8.11 CPA/TCPA Alarm

Set CPA (Closest Point of Approach) alarm range and TCPA (predicted Time to CPA) alarm time to alert you to targets that can be on a collision course. When CPA and TCPA of any AIS target (including a sleeping target) become less than the preset CPA and TCPA alarm settings, the audio alarm sounds. The alarm message "COLLISION" appears. The target symbol changes to a dangerous target symbol (red) and flashes with its vector. You can stop the audio alarm and flashing with any key. The dangerous target symbol is displayed until the AIS target is not in the CPA and TCPA alarm setting. The AIS continuously monitors CPA and TCPA of all AIS targets.

This feature helps identify targets that can be on a collision course.

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [CPA] and press the **ENTER** key.

```
Off
0.5NM
1NM
2NM
3NM
5NM
6NM
```

CPA options

4. Use the Cursorpad (▲ or ▼) to select CPA distance and press the **ENTER** key.
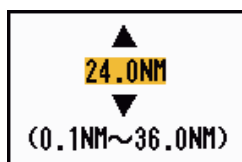5. Use the Cursorpad (▲ or ▼) to select [TCPA] and press the **ENTER** key.

```
30s
1min
2min
3min
4min
5min
6min
12min
```
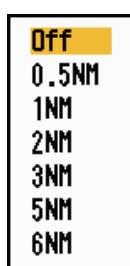
TCPA options

6. Use the Cursorpad (▲ or ▼) to select TCPA and press the **ENTER** key.
7. Press the **MENU/ESC** key to close the menu.

8.12 Proximity Alarm

The proximity alarm alerts you when an AIS target is within the range you set. The audio alarm sounds and the alarm message "PROXIMITY" appears. The target symbol changes to a dangerous target symbol (red) and flashes with its vector. Press any key to stop the audio alarm and flashing. The dangerous target symbol is displayed until the target is not within the range set, the alarm range is changed to exclude the target, or the proximity alarm is deactivated.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Target] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Proximity] and press the **ENTER** key.

```
Off
0.5NM
1NM
2NM
3NM
5NM
6NM
12NM
24NM
```

Proximity options
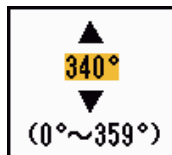
4. Use the Cursorpad (▲ or ▼) to select the range and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

8.13 Lost Target

When AIS data is not received from a target at fixed interval (3-5* report intervals), the target symbol changes to the lost target symbol (flashing). No audio or visual alarm is given for a lost target.

Lost target symbol

* The interval at which AIS data is sent depends on speed of the AIS transponder. For detailed information, refer to the Operator's Manual for the AIS transponder.

You can remove all lost AIS targets from the display as follows:

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Erase Lost Targets] and press the **ENTER** key.

```
Are you sure ?
      Yes
      No
```
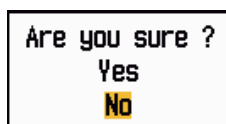
Erase Lost Targets confirmation message

4. Use the Cursorpad (▲) to select [Yes] and press the **ENTER** key. All lost targets symbols are erased from the screen and the long beep sounds.

5. Press the **MENU/ESC** key to close the menu.

8.14 Symbol Color

You can select the AIS symbol color among Green, Red (unavailable in the [IEC] or [Russian-River] purpose), Blue, White or Black.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Color] and press the **ENTER** key.

Color options

4. Use the Cursorpad (▲ or ▼) to select the color and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

Note: Symbols can not be shown in the same color as the background color.

8.15 How to Ignore Slow Targets

You can prevent activation of the CPA/TCPA alarm against AIS targets that are traveling at a speed lower than set here. The AIS symbols are not affected by this setting.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [AIS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Ignore Slow Targets] and press the **ENTER** key.
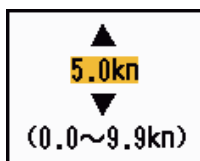
Ignore Slow Targets setting window

4. Use the Cursorpad (▲ or ▼) to select speed (0.0 - 9.9 kn) and press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

9. GPS OPERATION

If the FURUNO GPS Navigator GP-320B is connected to this radar, you can set GP-320B from this radar.

9.1 Navigator Mode

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Mode] and press the **ENTER** key.

Mode options

4. Use the Cursorpad (▲ or ▼) to select [GPS] or [WAAS] then press the **ENTER** key.

5. Press the **MENU/ESC** key to close the menu.

9.2 Datum

Select the type of datum which matches the paper charts you use for navigation. Select [WGS-84] if the radar is connected to an AIS Transponder.

1. Press he **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Datum] and press the **ENTER** key.

Datum options

4. Use the Cursorpad (▲ or ▼) to select the type of datum and press the **ENTER** key. If you select [WGS-84] or [Tokyo], go to step 7. If you select [Other], go to the next step.
5. Use the Cursorpad (▲ or ▼) to select [Datum No] and press the **ENTER** key.

Datum No setting window

6. Use the Cursorpad (▲ or ▼) to select the datum number and press the **ENTER** key. (The setting range is 001 - 192 and 201 - 254. Refer to the appendix 2 "GEODETIC CHART LIST".)
7. Press he **MENU/ESC** key to close the menu.

9.3   WAAS Setup

Geostationary satellites, the type used with WAAS, provide more accurate position data when compared to GPS. These satellites can be tracked automatically or manually. Auto tracking automatically searches for the best geostationary satellite from your current position.

1. Press he **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [WAAS] and press the **ENTER** key.

WAAS options

4. Use the Cursorpad (▲ or ▼) to select [Auto] or [Manual] then press the **ENTER** key. If you select [Auto], go to step 7. If you select [Manual], go to the next step.

5. Use the Cursorpad (▲ or ▼) to select [WAAS No] and press the **ENTER** key.

WAAS No setting window

6. Use the Cursorpad (▲ or ▼) to select WAAS number and press the **ENTER** key. (The setting range is 120 - 158. Refer to the following table.)

7. Press he **MENU/ESC** key to close the menu.

Provider	Satellite type	Longitude	Satellite No.
WAAS	Inmarsat-3-F4 (AOR-W)	142°W	122
	Inmarsat-3-F3 (POR)	178°E	134
	Intelsat Galaxy XV	133°W	135
	TeleSat Anik F1R	107.3°W	138
EGNOS	Inmarsat-3-F2 (AOR-E)	15.5°W	120
	Artemis	21.5°E	124
	Inmarsat-3-F5 (IOR-W)	25°E	126
MSAS	MTSAT-1R	140°E	129
	MTSAT-2	145°E	137

9.4 Satellite Monitor

The Satellite Monitor provides the information about GPS and WAAS satellites. See your GPS navigator's owner's manual for detailed information.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Satellite Monitor] and press the **ENTER** key.

DOP (Dilution of Precision, 0.0 - 99.0)

GPS mode
2D, 3D,
W2D, W3D

SNR of tracked GPS satellites
Satellites whose SNR is above
40 are used to fix position.

North marker

GPS satellite no.*

WAAS satellite

Satellites in ring
have elevation
angle of 5°

Satellites in ring
have elevation
angle of 45°

Altitude
15m

* Satellites used to fix
position are shown in red.

Altitude of
GPS antenna
from sea
surface

SNR of tracked
WAAS satellite

Satellite monitor

4. Press the **ENTER** key to close only the satellite monitor display.

9.5   Self Test

1. Press he **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.

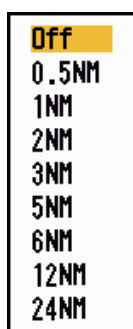3. Use the Cursorpad (▲ or ▼) to select [Self Test] and press the **ENTER** key.

```
┌─────────────────────────────┐
│         Self Test           │
│                             │
│   Program No. : 48502380XX  │
│                             │
│   Result     : OK           │
│                             │
└─────────────────────────────┘
```
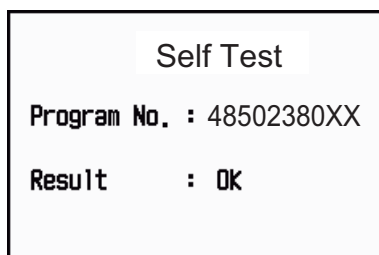
XX: Program No.
(Program No. subject to change
depending on GPS Navigator.)

Self Test display

[Program No.]: 10 digit number
[Result]: The result of the test, [OK] or [NG] (No Good). If NG appears, try the self test again. If it appears again, contact your dealer for advice.

4. Use the Cursorpad (▲ or ▼) to select WAAS number and press the **ENTER** key. (The setting range is 120 - 158. Refer to the following table.)

5. Press the **MENU/ESC** key to close the menu.

9.6 Cold Start

Cold start, which clears the Almanac from the GPS receiver, can be necessary in the following conditions:

- If you have turned off the power of the GPS receiver for a long time.
- The ship has moved far away from the previous fixing position (e.g., more than 500 km).
- Other reason that prevents the receiver from finding its position within five minutes after you turn on the power.

To do cold start, do the following:

1. Press the **MENU/ESC** key to open the menu.
2. Use the Cursorpad (▲ or ▼) to select [GPS] and press the **ENTER** key.
3. Use the Cursorpad (▲ or ▼) to select [Cold Start] and press the **ENTER** key.

```
Are you sure ?
      Yes
      No
```
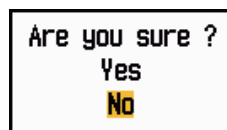
Cold Start options

4. Use the Cursorpad (▲) to select [Yes] and press the **ENTER** key. After processing cold start, the long beep sounds. (To stop cold start, press the **MENU/ESC** key instead of the **ENTER** key.)
5. Press the **MENU/ESC** key to close the menu.

10. MAINTENANCE, TROUBLE-SHOOTING

This chapter has information about maintenance and troubleshooting that the user can follow to care for the equipment.

⚠ WARNING

ELECTRICAL SHOCK HAZARD
Do not open the equipment.

Only qualified personnel can work inside the equipment.

Turn off the power before you service the antenna unit. Post a warning sign near the power switch indicating that the power should be left off while you are servicing the antenna unit.

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

When you work on the antenna unit, wear a safety belt and hard hat.

Serious injury or death can result if a person falls from the radar antenna mast.

NOTICE

Do not apply paint, anti-corrosive sealant or contact spray to plastic parts or equipment coating.

Those items contain products that can damage plastic parts and equipment coating.

10.1 Preventive Maintenance

Regular maintenance helps keep your equipment in good condition and prevents future problems. Check the items shown in the table below to help keep your equipment in good condition for years to come.

Maintenance

Interval	Item	Check point	Remedy
When necessary	LCD	Dust on the LCD	Remove the dust from the LCD with the tissue paper and an LCD cleaner. To remove dirt or salt, use the LCD cleaner. Change the tissue paper often so as not to scratch the LCD.
3 to 6months	Ground terminal on display unit	Check for tight connection and rust.	Tighten or replace as necessary.
	Display unit connectors	Check for tight connection.	Tighten if the connectors are loosened.
	Exposed nuts and bolts on the antenna unit	Check for corroded or loosened bolts.	Clean and repaint as necessary. Use sealing compound instead of paint.
	Antenna radiator	Check for dirt and cracks on the radiator surface.	Clean radiator surface with fresh-water-moistened cloth. Do not use plastic solvents to clean.

10.2 Fuse Replacement

The fuse on the power cable protects the equipment from overcurrent and equipment fault. If the fuse blows, find the cause before you replace the fuse. Use the correct fuse. A wrong fuse can damage the equipment.

> ⚠ **WARNING**
>
> **Use the correct fuse.**
>
> A wrong fuse can damage the equipment and cause fire.

Unit	Type	Code No.	Remarks
Display unit (fitted on power cable)	FRU-2P5S-FU-5A-B	000-168-869-10	12-24 VDC

10.3 Magnetron Life

When the life of the magnetron is reached, the targets do not appear on the display. If long-range performance appears to have decreased, contact a FURUNO agent or dealer about replacement of the magnetron. The magnetron changes with the type of antenna unit.

Part	Magnetron type	Code No.	Estimated life
Magnetron	E3571	000-146-867-11	Approx. 2,000 hours

10.4   Simple Troubleshooting

This section provides simple troubleshooting procedures which the user can follow to restore normal operation. If you cannot restore normal operation, do not check inside the unit. Have a qualified technician check the equipment.

Simple troubleshooting

Problem	Remedy
You cannot turn on the power.	• Check for blown fuse. • Check that the power connector is fastened. • Check for corrosion on the power cable connector. • Check for damaged power cable. • Check battery for correct voltage output.
There is no response when a key is pressed.	Turn off and on the power. If you do not get a response, the key is damaged. Contact your dealer for instructions.
The power is on and you operated the power key to transmit. The marks and letters appear, but no echo appears.	Check that the antenna cable is fastened.
Tuning is correctly adjusted, but sensitivity is poor.	Replace the magnetron. Contact your dealer.
The range is changed, but radar picture does not change.	• Try to change the range again. • Turn off and on the display unit.
Poor discrimination in range because of many echoes from the waves.	Adjust the sea clutter
The true motion presentation is not working correctly.	• Check that the setting of [Display Mode] in the [Display] menu is set to [True Motion]. • Check if the heading and position data are input and correct.
The range rings are not displayed.	Check that the setting of [Rings Brill] in the [Brill/Color] menu is set to other than [Off].
Target is not tracked correctly because of sea clutter.	Adjust the sea clutter and rain clutter.

10.5 Advanced-level Troubleshooting

This section describes how to cure hardware and software troubles which the qualified service persons must do.

Advanced-level troubleshooting

Problem	Probable cause or check points	Remedy
Power cannot be turned on.	1) Mains voltage/polarity 2) Power supply board	1) Correct the wiring and input voltage. 2) Replace power supply board.
Brilliance adjusted but no picture.	1) SPU Board	1) Replace SPU board.
Antenna not rotating.	1) Antenna drive mechanism	1) Replace the antenna drive mechanism.
Data and marks not displayed in transmit.	1) SPU board	1) Replace SPU board.
Set [GAIN] to maximum with [SEA] set at minimum. Marks and indications appear but no noise or echo.	1) Signal cable between antenna and display unit 2) IF amplifier 3) Video amplifier board	1) Check continuity and isolation of coaxial cable. 2) Replace IF amplifier. 3) Check coax line for fasten connection. If connection is good, replace SPU board.
Marks, indications and noise appear but no echo. (Transmission leak representing your 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 or picture freeze-up.	1) Bearing signal generator 2) SPU board 3) Video freeze-up	1) Check that signal cables are fastened. 2) Replace SPU board. 3) Turn off and on the radar.
Radar is correctly tuned but sensitivity is poor.	1) Dirt on radiator face 2) Deteriorated magnetron 3) Detuned MIC	1) Clean radiator. 2) Check the magnetron current with the radar transmitting on 48 nm range. If the current is below normal, magnetron may be defective. Replace the magnetron. 3) Check MIC detecting current. If MIC detecting current is below normal value, MIC may have become detuned.

Problem	Probable cause or check points	Remedy
Range changed but radar picture does not change.	1) Faulty **RANGE** knob. 2) SPU board 3) Video freeze-up	1) Try to rotate the **RANGE** knob. If you can not operate the **RANGE** knob, replace the knob. 2) Replace SPU board. 3) Turn off and on radar.
Range rings are not displayed.	1) Adjust their brilliance on the [Brill/Color] menu. 2) SPU Board	1) Replace associated circuit board if unsuccessful. 2) Replace SPU Board.

10.6　Diagnostic Test

The diagnostic test checks the system for correct operation. This test is for use by service technicians, but the user can do this test to provide the service technician with information.

1. Press the **MENU** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Tests] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Self Test] and press the **ENTER** key.

```
[ SELF  TEST ]
ROM                : OK
RAM                : OK
NMEA1              : --
NMEA2              : --
LAN                : OK
APPLICATION VERSION: 03589375-XX.XX
FPGA VERSION       : 0359372-XX.XX
IP ADDRESS         : xxx.xx.x.xx
MAC ADDRESS        : xx-xx-xx-xx-xx-xx


POWER SUPPLY       : 24.0 V
TEMPERATURE        :  0 ℃
```

← Key, buzzer, knob control and cursorpad check

```
              INPUT NMEA

BWC: OK   BWR: --   DBT: --   DPT: OK

GGA:      GLL: OK   GNS: --

HDG: OK   HDM: --   HDT: OK   THS: --

MTW: OK   MWV: --   RMB: OK   RMC: OK

VHW: --   VTG: OK   VWT: --   VWR: OK

XTE: OK   ZDA: OK
```

0

OFF

`[MENU/ESC] x 3: Exit [FUNC]: Alarm Test`

XX.XX: Program version no.

Self Test screen

Test results

- [ROM], [RAM]: The results of the ROM and RAM test are displayed as [OK] or [NG] (No Good).

- [NMEA1], [NMEA2]: The results of the ports NMEA1 and NMEA2 are displayed as OK or "- -". Ports NMEA1 and NMEA2 require a special connector to test them. When a special connector is not connected, "- -" is shown. If "- -" is displayed with a special connector, contact your dealer for instruction.

- [LAN]: LAN check results, [OK] or [NG].

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- [APPLICATION VERSION], [FPGA VERSION]: The program numbers and program version numbers (XX.XX) are displayed.
- [IP ADDRESS]: IP address of the equipment is shown.
- [MAC ADDRESS]: IMAC address of the equipment is shown.
- [POWER SUPPLY]: The voltage of the power supply is shown.
- [INPUT NMEA] window: The condition of all the NMEA sentences being input to this radar are displayed as OK or "- -". "- -" means no data input. Sentences are updated every second.

Key check

Press each key one by one. A key's on-screen location becomes green if the key is normal.

Buzzer check

The **FUNC** key tests on/off for the panel buzzer or external buzzer. To stop the buzzer, press the **FUNC** key again.

Knob control check

Rotate each control knob. The digit to the right of the control icon increments or decrements with control operation. Push each knob. The knob corresponding on-screen circle changes in green if the knob is normal.

Cursorpad check

Press each arrow and diagonal dot one by one. The on-screen location changes in green if the key is normal.

4. Press the **MENU/ESC** key three times to escape from the test.
5. Press the **MENU/ESC** key to close the menu.

10.7   LCD Test

1.   Press the **MENU/ESC** key to open the menu.

2.   Use the Cursorpad (▲ or ▼) to select [Tests] and press the **ENTER** key.

3.   Use the Cursorpad (▲ or ▼) to select [LCD Pattern] and press the **ENTER** key.

Black → **MENU/ESC** key → White → **MENU/ESC** key → Red → **MENU/ESC** key

Green → **MENU/ESC** key → Blue → **MENU/ESC** key → Checker board design → **MENU/ESC** key → 7 tones of gray
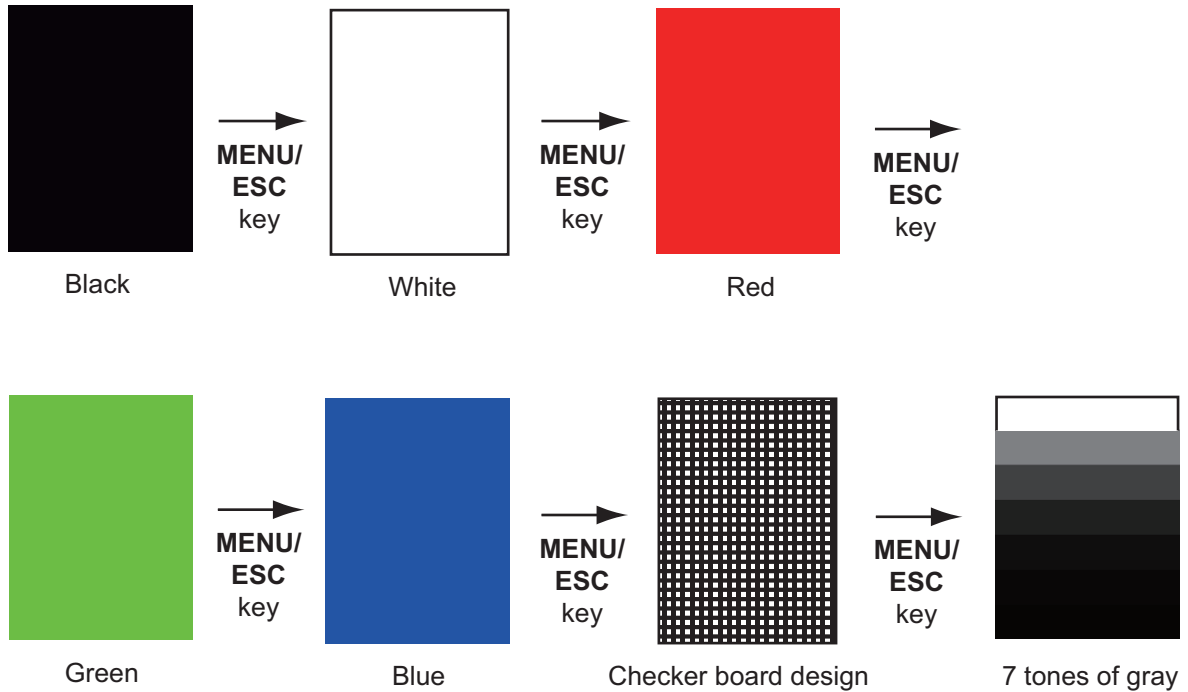
4.   Press the **MENU/ESC** key several times to close the menu.

Note 1: You can cancel the test at any time when you press the **MENU/ESC** key.

Note 2: You can adjust the screen brilliance with the 🔘 key during the test.

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10.8   Radar Sensor Test

This test checks the antenna unit DRS4DL (RSB-127) for proper operation.

1. Press the **MENU/ESC** key to open the menu.

2. Use the Cursorpad (▲ or ▼) to select [Tests] and press the **ENTER** key.

3. Use the Cursorpad (▲ or ▼) to select [Radar Sensor Test] and press the **ENTER** key.

```
[ RADAR  SENSOR  TEST ]
BOOTER VERSION     : --
APPLICATION VERSION: --
FPGA VERSION       : --
IP ADDRESS         : --
MAC ADDRESS        : --
ROM                : --
RAM                : --
TX-HV              : -- V
5V                 : -- V
12V                : -- V
ANTENNA STATUS     : --
HEADING PULSE      : --
TX TRIGGER         : --
VIDEO STATUS       : --
ANTENNA ROTATION   : -- rpm
TUNING VOLTAGE     : -- V
TUNE INDICATOR     : --
TOTAL ON TIME      : -- H
TOTAL TX TIME      : -- H
MAGNETRON MONITOR  : -- V

TT ECHO            : --
TT LAND ECHO       : --




[MENU/ESC]: Exit
```

Radar sensor test

4. Press the **MENU/ESC** key three times to close the test screen.

APPENDIX 1 MENU TREE

MENU/ESC key

— Brill/Color —— Echo Brill (1 - 8, *8*)
—— Rings Brill (Off, 1, 2, 3, *4*)
—— Mark Brill (1, 2, 3, *4*)
—— HL Brill (1, 2, 3, *4*)
—— Character Brill (1, 2, 3, *4*)
—— Viewing Position (Left, Left-Center, *Center*, Right-Center, Right)
—— Display Color (Day, Night, Twilight, *Custom*)
—— Echo Color (*Yellow*, Green, Orange, Multi)
—— Background Color (*Black*, DK Blue, Blue, White)
—— Character Color (*Green*, Red, White)
—— Menu Transparency (*Off*, 1, 2, 3, 4)
—— Echo Color Mode (*System*, Custom)
—— Custom Echo Color

> Default settings in boldface italic

— Display —— Display Mode (*Head Up*, Course Up, North Up, True Motion, True View)
—— Zoom (*Off*, On)
—— Zoom Mode (*Relative*, True, Target)
—— Off-center mode (*Manual*, Custom, Auto)
—— Save Off-center
—— Echo Area (*Normal*, Full Screen)
—— Text Display (Range, Mode, Alarm, Echo, EBL/VRM, +Cursor)
—— STBY Display (*Normal*, Nav, Economy)

— Echo —— Auto SEA (Coastal, Advanced)
—— Echo Stretch (*Off*, 1, 2, 3)
—— Echo Average (*Off*, 1, 2, Auto)
—— Noise Rejector (*Off*, On)
—— Wiper (*Off*, 1, 2)
—— Int Rejector (*Off*, 1, 2, 3)
—— Display-Dynamic (Narrow, *Normal*, Wide)
—— Display-Curve (*1*, 2, 3)
—— Low Level Echo (0-11, *0*)

— Alert Settings —— Target Alarm 1 (*In*, Out)
—— Target Alarm 2 (*In*, Out)
—— Alarm Level (Low, *Med*, High)
—— Watchman (*Off*, 5min, 10min, 20min)
—— Panel Buzzer (Off, *On*)
—— External Buzzer (Off, *On*)
—— Alarm Status

(*Continued on next page*)

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— Trails ——————— Gradation (Single, **Multi**)
———— Color (Green, Red, **Blue**, White, Black)
———— Mode (**Relative**, True)
———— Level (1, **2**, 3)
———— Restart (Off, **On**)
———— Narrow (**Off**, On)
———— Own Ship (Off, 1, 2)
———— Trail Erase

— Tuning ——————— Tuning Mode (**Auto**, Manual)
———— Manual Tuning
———— Tuning Initialization

— Others ——————— FUNC Setup (**Display Color**, etc.)
———— WPT Mark (**Off**, On)
———— EBL Reference (**Relative**, True)
———— VRM Unit (**NM**, KM, SM, KYD, NM&YD)
———— Cursor Position (**RNG/BRG**, LAT/LON)
———— TLL Key Mode (**TLL Output**, Origin Mark, Both)

— Target ——————— Vector Time (1min - 30min, **6min**)
———— Vector Reference (Relative, **True**)
———— Past Positions (Off, **5**, 10)
———— Past Posn Interval (15s, 30s, **, 1min**, 2min, 3min, 6min, 12min)
———— CPA (**Off**, 0.5NM, 1NM, 2NM, 3NM, 5NM, 6NM)
———— TCPA (30s, **1min**, 2min, 3min, 4min, 5min, 6min, 12min)
———— Proximity (**Off**, 0.5NM, 1NM, 2NM, 3NM, 5NM, 6NM, 12NM, 24NM)

— OS/Barge ——————— OS Mark (**Off**, On)
Mark ———— OS Length (0-999(ft), **0**)
———— OS Beam (0-999(ft), **0**)
———— Barge Mark (**Off**, On)
———— Barge Position (**Bow**, Stern)
———— Barge Length (0-999(ft), **0**)
———— Barge Beam (0-999(ft), **0**)
———— Barge Arrangement

— TT ——————— Display (**Off**, On)
———— Color (**Green**, Red, Blue, White, Black)
———— Auto Acquisition (**Off**, On)
———— ACK Lost Targets
———— All Cancel

AP-2

```
AIS ──── Display (Off, On)
         Color (Green, Red, Blue, White, Black)
         Number of Targets (10-100, 30)
         Sort By (Range, Sector, CPA, TCPA)
         Range (0.1NM - 36.0NM, 24NM)
         Sector Start (0° - 359°)
         Sector End (0° - 359°)
         Ignore Slow Targets (0.0 - 9.9kn, 5.0kn)
         Erase Lost Targets

GPS ──── Mode (GPS, WAAS)
         Datum (WGS-84, Tokyo, Other)
         Datum Number (001 -192, 201 - 254, 001)
         WAAS (Auto, Manual)
         WAAS No (120-158, 120)
         Satellite Monitor
         Self Test
         Cold Start

System ─── Initial ─── Key Beep (Off, On)
                       Offcenter Speed (1kn-99kn, 15kn)
                       Compass Type (Magnetic, True)
                       Range Preset
                       Wind Direction (Apparent, True)
                       NMEA Port 1 (Auto, 4800bps, 38400bps)
                       NMEA Port 2 (Auto, 4800bps, 38400bps)
                       NMEA Mixing Out (Off, On)

           Tests ───── Self Test
                       LCD Pattern
                       Radar Sensor Test

           Sector ─── Sect-Blank 1 Status (Off, On)
           Blanks     Sect-Blank 1 Start (0° - 359°)
                      Sect-Blank 1 End (0° - 359°)
                      Sect-Blank 2 Status (Off, On)
                      Sect-Blank 2 Start (0° - 359°)
                      Sect-Blank 2 End (0° - 359°)
```

(Continued from previous page)

```
└─ System ─┬─
           │
           ├─ Units ──┬─ Range Unit (NM, KM, SM)
           │          ├─ Ship Speed Unit (kn, km/h, mph)
           │          ├─ Depth Unit (m, ft, fa, pb, HR)
           │          ├─ Temperature Unit (°C, °F)
           │          └─ Wind Speed Unit (kn, km/h, mph, m/s)
           │
           ├─ Installation (For use by the installer. Not accessible by user.)
           │
           └─ Factory (For use by the installer. Not accessible by user.)
```

APPENDIX 2 GEODETIC CHART LIST

001: WGS84		
002: WGS72		
003: TOKYO	: Mean Value (Japan, Korea & Okinawa)	
004: NORTH AMERICAN 1927	: Mean Value (CONUS)	
005: EUROPEAN 1950	: Mean Value	
006: AUSTRALIAN GEODETIC 1984	: Australia & Tasmania	
007: ADINDAN-MN	: Mean Value (Ethiopia & Sudan)	
008: ADINDAN-E	: Ethiopia	
009: ADINDAN-MA	: Mali	
010: ADINDAN-SE	: Senegal	
011: ADINDAN-SU	: Sudan	
012: AFG	: Somalia	
013: AIN EL ABD 1970	: Bahrain Is.	
014: ANNA 1 ASTRO 1965	: Cocos Is.	
015: ARC 1950-MN	: Mean Value	
016: ARC 1950-B	: Botswana	
017: ARC 1950-L	: Lesotho	
018: ARC 1950-M	: Malawi	
019: ARC 1950-S	: Swaziland	
020: ARC 1950-ZR	: Zaire	
021: ARC 1950-ZM	: Zambia	
022: ARC 1950-ZB	: Zimbabwe	
023: ARC 1960-MN	: Mean Value (Kenya & Tanzania)	
024: ARC 1960-K	: Kenya	
025: ARC 1960-T	: Tanzania	
026: ASCENSION IS. 1958	: Ascension Is.	
027: ASTRO BEACON "E"	: Iwo Jima Is.	
028: ASTRO B4 SOR. ATOLL	: Tern Is.	
029: ASTRO POS 71/4	: St. Helena Is.	
030: ASTRONOMIC STATION 1952	: Marcus Is.	
031: AUSTRALIAN GEODETIC 1966	: Australia & Tasmania	
032: BELLEVUE (IGN)	: Efate & Erromango Is.	
033: BERMUDA 1957	: Bermuda Is.	
034: BOGOTA OBSERVATORY	: Columbia	
035: CAMPO INCHAUSPE	: Argentina	
036: CANTON IS. 1966	: Phoenix Is.	
037: CAPE	: South Africa	
038: CAPE CANAVERAL	: Mean Value (Florida & Bahama Is.)	
039: CARTHAGE	: Tunisia	
040: CHATHAM 1971	: Chatham Is. (New Zealand)	
041: CHUA ASTRO	: Paraguay	
042: CORREGO ALEGRE	: Brazil	
043: DJAKARTA (BATAVIA)	: Sumatra Is. (Indonesia)	
044: DOS 1968	: Gizo Is. (New Georgia Is.)	
045: EASTER IS. 1967	: Easter Is.	
046: EUROPEAN 1950-WE	: Western Europe	
047: EUROPEAN 1950-CY	: Cyprus	
048: EUROPEAN 1950-EG	: Egypt	
049: EUROPEAN 1950-ESC	: England, Scotland, Channel & Shetland Is.	
050: EUROPEAN 1950-EIS	: England, Ireland, Scotland & Shetland Is.	
051: EUROPEAN 1950-GR	: Greece	
052: EUROPEAN 1950-IR	: Iran	
053: EUROPEAN 1950-SA	: Italy, Sardinia	
054: EUROPEAN 1950-SI	: Italy, Sicily	
055: EUROPEAN 1950-NF	: Norway & Finland	
056: EUROPEAN 1950-PS	: Portugal & Spain	
057: EUROPEAN 1979	: Mean Value	
058: GANDAJIKA BASE	: Republic of Maldives	
059: GEODETIC DATUM 1949	: New Zealand	
060: GUAM 1963	: Guam Is.	
061: GUX 1 ASTRO	: Guadalcanal Is.	
062: HJORSEY 1955	: Iceland	
063: HONG KONG 1963	: Hong Kong	
064: INDIAN-TV	: Thailand & Vietnam	
065: INDIAN-BIN	: Bangladesh, India & Nepal	
066: IRELAND 1965	: Ireland	
067: ISTS 073 ASTRO 1969	: Diego Garcia	
068: JOHNSTON IS. 1961	: Johnston Is.	
069: KANDAWALA	: Sri Lanka	
070: KERGUELEN IS.	: Kerguelen Is.	
071: KERTAU 1948	: West Malaysia & Singapore	
072: LA REUNION	: Mascarene Is.	
073: L. C. 5 ASTRO	: Cayman Brac Is.	
074: LIBERIA 1964	: Liberia	
075: LUZON	: Philippines (excl. Mindanao Is.)	
076: LUZON-M	: Mindanao Is.	
077: MAHE 1971	: Mahe Is.	
078: MARCO ASTRO	: Salvage Islands	
079: MASSAWA	: Eritrea (Ethiopia)	
080: MERCHICH	: Morocco	
081: MIDWAY ASTRO 1961	: Midway Is.	
082: MINNA	: Nigeria	
083: NAHRWAN-O	: Masirah Is. (Oman)	
084: NAHRWAN-UAE	: United Arab Emirates	
085: NAHRWAN-SA	: Saudi Arabia	
086: NAMIBIA	: Namibia	
087: MAPARIMA, BWI	: Trinidad & Tobago	
088: NORTH AMERICAN 1927WU	: Western United States	
089: NORTH AMERICAN 1927EU	: Eastern United States	
090: NORTH AMERICAN 1927AK	: Alaska	

091: NORTH AMERICAN 1927BH	: Bahamas (excl. San Salvador Is.)	
092: NORTH AMERICAN 1927SS	: Bahamas, San Salvador Is.	
093: NORTH AMERICAN 1927CN	: Canada (incl. Newfoundland Is.)	
094: NORTH AMERICAN 1927AB	: Alberta & British Columbia	
095: NORTH AMERICAN 1927EC	: East Canada	
096: NORTH AMERICAN 1927MO	: Manitoba & Ontario	
097: NORTH AMERICAN 1927NE	: Northwest Territories & Saskatchewan	
098: NORTH AMERICAN 1927YK	: Yukon	
099: NORTH AMERICAN 1927CZ	: Canal Zone	
100: NORTH AMERICAN 1927CR	: Caribbean	
101: NORTH AMERICAN 1927CA	: Central America	
102: NORTH AMERICAN 1927CU	: Cuba	
103: NORTH AMERICAN 1927GR	: Greenland	
104: NORTH AMERICAN 1927MX	: Mexico	
105: NORTH AMERICAN 1983AK	: Alaska	
106: NORTH AMERICAN 1983CN	: Canada	
107: NORTH AMERICAN 1983CS	: CONUS	
108: NORTH AMERICAN 1983MX	: Mexico, Central America	
109: OBSERVATORIO 1966	: Corvo & Flores Is. (Azores)	
110: OLD EGYPTIAN 1930	: Egypt	
111: OLD HAWAIIAN-MN	: Mean Value	
112: OLD HAWAIIAN-HW	: Hawaii	
113: OLD HAWAIIAN-KA	: Kauai	
114: OLD HAWAIIAN-MA	: Maui	
115: OLD HAWAIIAN-OA	: Oahu	
116: OMAN	: Oman	
117: ORDNANCE SURVEY OF GREAT BRITAIN 1936-NM	: Mean Value	
118: ORDNANCE SURVEY OF GREAT BRITAIN 1936-E	: England	
119: ORDNANCE SURVEY OF GREAT BRITAIN 1936-IM	: England, Isle of Man & Wales	
120: ORDNANCE SURVEY OF GREAT BRITAIN 1936-SSI	: Scotland & Shetland Is.	
121: ORDNANCE SURVEY OF GREAT BRITAIN 1936-WL	: Wales	
122: PICO DE LAS NIVIES	: Canary Is.	
123: PITCAIRN ASTRO 1967	: Pitcairn Is.	
124: PROVISIONS SOUTH CHILEAN 1963: South Chile (near 53°S)		
125: PROVISIONAL SOUTH AMERICAN 1956MN: Mean Value		
126: PROVISIONAL SOUTH AMERICAN 1956BO: Bolivia		
127: PROVISIONAL SOUTH AMERICAN 1956NC: Chile-Northern Chile (near 19°S)		
128: PROVISIONAL SOUTH AMERICAN 1956SC: Chile-Southern Chile (near 43°S)		
129: PROVISIONAL SOUTH AMERICAN 1956CO: Columbia		
130: PROVISIONAL SOUTH AMERICAN 1956EC: Ecuador		
131: PROVISIONAL SOUTH AMERICAN 1956GY: Guyana		
132: PROVISIONAL SOUTH AMERICAN 1956PR: Peru		
133: PROVISIONAL SOUTH AMERICAN 1956VN: Venezuela		
134: PUERTO RICO	: Puerto Rico & Virgin Is.	
135: QATAR NATIONAL	: Qatar	
136: QORNOQ	: South Greenland	
137: ROME 1940	: Sardinia Is.	
138: SANTA BRAZ	: Sao Miguel, Santa Maria Is. (Azores)	
139: SANTO (DOS)	: Espirito Santo Is.	
140: SAPPER HILL 1943	: East Falkland Is.	
141: SOUTH AMERICAN 1969MN	: Mean Value	
142: SOUTH AMERICAN 1969AG	: Argentina	
143: SOUTH AMERICAN 1969BO	: Bolivia	
144: SOUTH AMERICAN 1969BR	: Brazil	
145: SOUTH AMERICAN 1969CH	: Chile	
146: SOUTH AMERICAN 1969CO	: Columbia	
147: SOUTH AMERICAN 1969EC	: Ecuador	
148: SOUTH AMERICAN 1969GY	: Guyana	
149: SOUTH AMERICAN 1969PA	: Paraguay	
150: SOUTH AMERICAN 1969PR	: Peru	
151: SOUTH AMERICAN 1969TT	: Trinidad & Tobago	
152: SOUTH AMERICAN 1969VZ	: Venezuela	
153: SOUTH ASIA	: Singapore	
154: SOUTHEAST BASE	: Porto Santo & Madeira Is.	
155: SOUTHWEST BASE	: Faial, Graciosa, Pico, Sao Jorge & Terceria Is.	
156: TIMBALAI 1948	: Brunei & East Malaysia (Sarawak & Sabah)	
157: TOKYO JP	: Japan	
158: TOKYO KP	: Korea	
159: TOKYO OK	: Okinawa	
160: TRISTAN ASTRO 1968	: Tristan da Cunha	
161: VITI LEVU 1916	: Viti Levu Is. (Fiji Is.)	
162: WAKE-ENIWETOK 1960	: Marshall Is.	
163: ZANDERIJ	: Surinam	
164: BUKIT RIMPAH	: Bangka & Belitung Is. (Indonesia)	
165: CAMP AREA ASTRO	: Camp Mcmurdo Area, Antarctica	
166: G. SEGARA	: Kalimantan Is. (Indonesia)	
167: HERAT NORTH	: Afghanistan	
168: HU-TZU-SHAN	: Taiwan	
169: TANANARIVE OBSERVATORY 1925	: Madagascar	
170: YACARE	: Uruguay	
171: RT-90	: Sweden	
172: TOKYO	: Mean Value (Japan, Korea & Okinawa)	
173: AIN EL ABD 1970	: Bahrain Is.	
174: ARC 1960	: Mean Value (Kenya, Tanzania)	
175: ARS-A	: Kenya	

176:	ARS-B	:	Tanzania
177:	ASCENSION IS. 1958	:	Ascension Is.
178:	CAPE CANAVERAL	:	Mean Value (Florida & Bahama Is.)
179:	EASTER IS. 1967	:	Easter Is.
180:	EUROPEAN 1950	:	Portugal & Spain
181:	JHONSTON IS. 1961	:	Jhonston Is.
182:	NAHRWAN	:	Saudi Arabia
183:	NAPARIMA, BWI	:	Trinidad & Tobago
184:	NORTH AMERICAN 1927	:	Caribbeen
185:	OLD HAWAIIAN	:	Oahu
186:	SAPPER HILL 1943	:	East Falkland Is.
187:	TIMBALAI 1948	:	Brunei & East Malaysia (Sarawak & Sabah)
188:	TOKYO	:	Japan
189:	TOKYO	:	South Korea
190:	TOKYO	:	Okinawa
191:	WAKE-ENIWETOK 1960	:	Marshall Is.
192:	HU-TZU-SHAN	:	Taiwan
201:	ADINDAN	:	Burkina Faso
202:	ADINDAN	:	Cameroon
203:	ARC 1950	:	Burundi
204:	AYABELLE LIGHTHOUSE	:	Djibouti
205:	BISSAU	:	Guinea-Bissau
206:	DABOLA	:	Guinea
207:	EUROPEAN 1950	:	Tunisia
208:	LEIGON	:	Ghana
209:	MINNA	:	Cameroon
210:	M' PORALOKO	:	Gebon
211:	NORTH SAHARA 1959	:	Algeria
212:	POINT58	:	Mean Solution (Burkina Faso & Niger)
213:	POINTE NOIRE 1948	:	Congo
214:	SIERRA LEONE 1960	:	Sierra Leone
215:	VOIROL 1960	:	Algeria
216:	AIN EL ABD 1970	:	Saudi Arabia
217:	INDIAN	:	Bangladesh
218:	INDIAN	:	India & Nepal
219:	INDIAN 1954	:	Thailand
220:	INDIAN 1960	:	Vietnam (near 16N)

221:	INDIAN 1960	:	Con Son Is. (Vietnam)
222:	INDIAN 1975	:	Thailand
223:	INDONESIAN 1974	:	Indonesia
224:	CO-ORDINATE SYSTEM 1937 OF ESTONIA	:	Estonia
225:	EUROPEAN 1950	:	Malta
226:	EUROPEAN 1950	:	Tunisia
227:	S-42 (PULKOVO 1942)	:	Hungary
228:	S-42 (PULKOVO 1942)	:	Poland
229:	S-42 (PULKOVO 1942)	:	Czechoslovakia
230:	S-42 (PULKOVO 1942)	:	Latvia
231:	S-42 (PULKOVO 1942)	:	Kazakhstan
232:	S-42 (PULKOVO 1942)	:	Albania
233:	S-42 (PULKOVO 1942)	:	Romenia
234:	S-JTSK	:	Czechoslovakia
235:	NORTH AMERICAN 1927	:	East of 180W
236:	NORTH AMERICAN 1927	:	West of 180W
237:	NORTH AMERICAN 1983	:	Aleutian Is.
238:	NORTH AMERICAN 1983	:	Hawaii
239:	SOUTH AMERICAN 1969	:	Baltra, Galapagos Is.
240:	ANTIGUA IS. ASTRO 1943	:	Antigua, Leeward Is.
241:	DECEPTION IS.	:	Deception Is., Antarctica
242:	FORT THOMAS 1955	:	Nevis, St. Kitts, Leeward Is.
243:	ISTS 061 ASTRO 1968	:	South Georgia Is.
244:	MONTSERRAT IS. ASTRO 1958	:	Montserrat, Leeward Is.
245:	FEUNION	:	Mascarene Is.
246:	AMERICAN SAMOA 1962	:	American Samoa Is.
247:	INDONESIAN 1974	:	Indonesia
248:	KUSAIE ASTRO 1951	:	Caroline Is., Fed. States of Micronesia
249:	WAKE Is. ASTRO 1952	:	Wake Atoll
250:	EUROPEAN 1950	:	Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, and Syria
251:	HERMANNSKOGEL	:	Yugoslavia (Prior to 1990) Slovenia, Croatia Bonsia and Herzegovina Serbia
252:	INDIAN	:	Pakistan
253:	PULKOVO 1942	:	Russia
254:	VOIROL 1874	:	Tunisia/Algeria

APPENDIX 3 DIGITAL INTERFACE

Input Sentences

All ports common

ALR, BMC, BMR, DBT, DPT, GGA, GLL, GNS, GSA, GSV, HDG, HDM, HDT, MTW, MWV, RMB, RMC, THS, TTM, VDM, VHW, VTG, VWR, VWT, XTE, ZDA

Output Sentences

The NMEA(HDG) port does not handle all output sentences.

ACK, RSD, TLL, TTM

FURUNO Proprietary Sentences

Input: PFEC (GPast, GPstd, GPtst, GPwav, DRtnm, DRtsm, idfnc, pireq)
Output: PFEC (GPclr, GPint, GPpsp, GPset, GPtrq, GPwas, idatr, idfnc, pidat,)

Data Sentences

Input: PFEC (GPast, GPstd, GPtst, GPwav, DRtnm, DRtsm, idfnc, pireq)
Output: PFEC (GPclr, GPint, GPpsp, GPset, GPtrq, GPwas, idatr, idfnc, pidat,)

Sentence Description

ALR-Set Alarm State

```
$**ALR,Hhmmss.ss,xxx,A,A,c—c,*hh<CR><LF>
            1     2 3 4  5
```
1. Time of alarm condition change, UTC (000000.00 to 240001.00)
2. Unique alarm number (identifier) at alarm source (000 to 999)
3. Alarm condition (A=threshold exceeded, V=not exceeded)
4. Alarm acknowledge state (A=acknowledged, V=not acknowledged)
5. Alarm description text (alphanumeric)

BMC- Bearing and Distance to Waypoint-Great Circle

```
$ GPBWC,hhmmss.ss,llll.ll, a,lllll.ll,a,yyy.y,T, yyy.y,M,yyy.y,N,c--c,A,*hh<CR><LF>
             1       2  3    4    5 6    7   8  9  10  11 12 13
```
1. UTC of observation (000000.00 to 240001.00)
2. Waypoint latitude (0.00000 to 9000.00000)
3. N/S
4. Waypoint longitude (0.00000 to 18000.00000)
5. E/W
6. Bearing, degrees true (0.00 to 360.00)
7. Unit, True
8. Bearing, degrees (0.00 to 360.00)
9. Unit, Magnetic
10. Distance, nautical miles (0.000 to 10000)
11. Unit, N
12. Waypoint ID (Max. 13 characters)
13. Mode Indicator (A=Autonomous D=Differential S=Simulator)

BWR-Bearing Waypoint to Waypoint

$ GPBWR,hhmmss.ss,llll.ll,a,lllll.ll,a,yyy.y,T,yyy.y,M,yyy.y,N,c--c,A,*hh<CR><LF>
                  1   2 3 4   5   6   7 8   9 10 11 12 13

1. UTC of observation (000000.00 to 240001.00)
2. Waypoint latitude (0.00000 to 9000.00000)
3. N/S
4. Waypoint longitude (0.00000 to 18000.00000)
5. E/W
6. Bearing, degrees true (0.00 to 360.00)
7. Unit, True
8. Bearing, degrees (0.00 to 360.00)
9. Unit, Magnetic
10. Distance, nautical miles (0.000 to 10000)
11. Unit, N
12. Waypoint ID (Max. 13 characters)
13. Mode Indicator (A=Autonomous D=Differential S=Simulator)

DBT-Depth Below Transducer

$**DBT,xxxx.x,f,xxxx.x,M,xxxx.x,F,*hh<CR><LF>
            1   2   3   4   5   6

1. Water depth (0.00 to 99999.99)
2. feet
3. Water depth (0.00 to 99999.99)
4. Meters
5. Water depth (0.00 to 99999.99)
6. Fathoms

DPT-Depth

$**DPT,x.x,x.x,x.x,*hh<CR><LF>
        1   2   3

1. Water depth relative to the transducer, meters (0.00 to 99999.99)
2. Offset from transducer, meters (-99.99 to 99.99)
3. Minimum range scale in use (no use)

GGA-Global Positioning System (GPS) Fix Data

$**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   2   3   4   5 6 7   8   9 10 11 12 13 14

1. UTC of position (no use)
2. Latitude (0.00000 to 9000.00000)
3. N/S
4. Longitude (0.00000 to 18000.00000)
5. E/W
6. GPS quality indicator (1 to 5, 8)
7. Number of satllite in use (00 to 99)
8. Horizontal dilution of precision (0.00 to 999.99)
9. Antenna altitude above/below mean sea level (-999.99 to 9999.99)
10. Unit, m
11. Geoidal separation (-999.99 to 9999.99)
12. Unit, m
13. Age of differential GPS data (0 to 99)
14. Differential reference station ID (0000 to 1023)

GLL-Geographic Position - Latitude/Longitude

$**GLL,llll.lll,a,yyyyy.yyy,a,hhmmss.ss,a,x,*hh<CR><LF>
          1   2   3   4   5   6 7
1. Latitude (0.00000 to 9000.00000)
2. N/S
3. Longitude (0.00000 to 18000.00000)
4. E/W
5. UTC of position (no use)
6. Status (A=data valid V=data invalid)
7. Mode indicator (A=Autonomous D=Differential S=Simulator)

GNS-GNSS Fix Data

$**GNS,hhmmss.ss,llll.lll,a,lllll.lll,a,c--c,xx,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>
            1   2   3   4   5 6   7 8   9   10 11 12 13
1. UTC of position (no use)
2. Latitude (0.00000 to 9000.00000)
3. N/S
4. Longitude (0.00000 to 18000.00000)
5. E/W
6. Mode indicator
   N=No fix A=Autonomous D=Differential P=Precise R=Real Time Kinematic
   F=Float RTK E=Estimated Mode M=Manual Input Mode S=Simulator Mode
7. Total number of satellites in use (00 to 99)
8. HDOP (0.0 to 999.99)
9. Antenna altitude, meters (-999.99 to 9999.99)
10. Geoidal separation (-999.99 to 9999.99)
11. Age of differential data (0 to 999)
12. Differential reference station ID (0000 to 1023)
13. Naivgational status indicator

GSA-GNSS DOP and Active Satellites

$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,*hh<CR><LF>
       1 2   3   4   5   6
1. Mode (M=manual, forced to operate in 2=2D 3=3D mode
         A=automatic, allowed to automatically switch 2D/3D)
2. Mode (1=fix not available 2=2D 3=3D)
3. ID number of satellites used in solution (01 to 96, null)
4. PDOP (0.00 to 999.99)
5. HDOP (0.00 to 999.99)
6. VDOP (0.00 to 999.99)

GSV-GNSS Satellites in View

$**GSV,x,x,xx,xx,xx,xxx,xx..........,xx,xx,xxx,xx,*hh<CR><LF>
       1 2 3 4 5   6   7   8   9
1. Total number of messages (1 to 9)
2. Message number (1 to 9)
3. Total number of satellites in view (01 to 99)
4. Satellite ID number (01 to 96)
5. Elevation, degrees (00 to 90)
6. Azimuth, degrees true (000 to 359)
7. SNR(C/No) (00 to 99(dB-Hz), null when not tracking)
8. Second and third SVs
9. Fourth SV

AP-9

HDG-Heading, Deviation and Variation

```
$**HDG,x.x,x.x,a,x.x,a*hh<CR><LF>
        1   2 3 4 5
```
1. Magnetic sensor heading, degrees (0.00 to 360.00)
2. Magnetic deviation, degrees (0.0 to 180.00)
3. E/W
4. Magnetic variation, degrees (0.0 to 180.00)
5. E/W

HDM-Heading, Magnetic

```
$**HDM,x.x,M*hh<CR><LF>
        1  2
```
1. Heading, degrees (0.00 to 360.00)
2. Magnetic (M)

HDT- HeadingTrue

```
$**HDT,xxx.x,T*hh<CR><LF>
         1  2
```
1. Heading, degrees (0.00 to 360.00)
2. True (T)

MTW-Water Temperature

```
$**MTW,x.x,C<CR><LF>
       |__|
        1
```
1. Water temperature, degrees C (-9.999 to 99.999)

RMB-Recommended Minimum Specific Navigation Information

```
$GPRMB,A,x.x,L,CCCC,CCCC,xxxx.xx,a,xxxxxx.xx,a,xxx.x,xxx,xx.x,A,a*hh <CR><LF>
         1 2 3  4    5      6    7     8     9  10   11  12 1314
```
1. Data status (A=Data valid, V=Navigation receiver warning)
2. Cross track error (NM) (0.00 to 9.99)
3. Direction to steer (L/R)
4. Origin waypoint ID
5. Destination waypoint ID
6. Destination waypoint latitude (0.0000 to 9000.000)
7. N/S
8. Destination waypoint longitude (0.0000 to 18000.000)
9. E/W
10. Range to destination, nautical miles (0.000 to 10000)
11. Bearing to destination, degrees true (0.0 to 359.9)
12. Destination closing velocity, knots (-99.9 to 99.9)
13. Arrival status (A=Arrival circle entered or perpendicular passed, V=Not entered/passed)
14. Mode indicator (A= Autonomous D= Differential mode E=Estimated (dead reckoning mode) M=Manual input mode S= Simulator N=Data not valid)

RMC-Recommended Minimum Specific GNSS Data

$**RMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,ddmmyy,x.x,a,a,a*hh<CR><LF>
              1   2 3 4   5   6 7   8   9   10 11 1213

1. UTC of position fix (000000 - 235959)
2. Status (A=data valid, V=navigation receiver warning)
3. Latitude (0000.00000 - 9000.0000)
4. N/S
5. Longitude (0000.00000 - 18000.0000)
6. E/W
7. Speed over ground, knots (0.00 - 99.94)
8. Course over ground, degrees true (0.0 - 360.0)
9. Date (010100 - 311299)
10. Magnetic variation, degrees E/W (0.00 - 180.0/NULL)
11. E/W
12. Mode indicator (A= Autonomous mode D= Differential mode S= Simulator
    F=Float RTK P=Precise R=Real time kinematic E=Estimated (DR) M=Manual)
13. Navigational status indication (S=Safe C=Caution U=Unsafe V=Navigational status not valid)

THS-True Heading and Status

$**THS,xxx.x,a*hh<CR><LF>
         1   2

1. Heading, degrees True (0.00 to 360.00)
2. Mode indicator (A=Autonomous E=Estimated M=Manual input
   S=Simulator V=Data not valid)

TTM-Tracked Target Message

$**TTM,05,12.34,23.4,R,45.67,123.4,T,1.23,8.23,N,c--c,T,R,hhmmss.ss,M*hh<CR><LF>
        1   2   3   4   5   6   7   8   9 10 11 12 13   14   15

1. Target number (00 to 999)
2. Target distance from own ship (0.000 - 99.999)
3. Bearing from own ship,degrees (0.0 - 359.9)
4. True or Relative (T)
5. Target speed (0.00 - 999.99, null)
6. Target course, degrees (0.0 - 359.9, null)
7. True or Relative
8. Distance of closet point of approach (0.00 - 99.99, null)
9. Time to CPA, min., "-" increasing (-99.99 - 99.99, null)
10. Speed/distance units (N=nm)
11. Target name (null)
12. Target status (L=Lost Q=Acquiring T=Tracking)
13. Reference target (R, NULL otherwise)
14. UTC of data (null)
15. Type of acquisition (A=Automatic M=Manual)

VDM-AIS VHF Data-Link Message

!**VDM,x,x,x,x,s--s,x,*hh<CR><LF>
          1 2 3 4   5   6
1. Total number of sentences needed to transfer the message (1 to 9)
2. Message sentence number (1 to 9)
3. Sequential message identifier (0 to 9, NULL)
4. AIS channel Number (A or B)
5. Encapsulated ITU-R M.1371 radio message (1 - 63 bytes)
6. Number of fill-bits (0 to 5)

VHW- Water Speed and Heading

$GPVHW,x.x,T,x.x,M,x.x,N,x.x,K,*hh <CR><LF>
              1 2 3 4 5 6 7 8
1. Heading, degrees (0.0 to 359.9, null)
2. T=True (fixed)
3. Heading, degrees (0.0 to 359.9, null)
4. M=Magnetic (fixed)
5. Speed, knots (0.0 to 9999.9)
6. N=Knots (fixed)
7. Speed, knots (0.0 to 9999.9)
8. K=km/hr (fixed)

VTG- Course Over Ground and Ground Speed

$GPVTG,x.x,T,x.x,M,x.x,N,x.x,K,a,*hh <CR><LF>
              1 2 3 4 5 6 7 8 9
1. Course over ground, degrees (0.0 to 359.9)
2. T=True (fixed)
3. Course over ground, degrees (0.0 to 359.9)
4. M=Magnetic (fixed)
5. Speed over ground, knots (0.00 to 9999.9)
6. N=Knots (fixed)
7. Speed over ground (0.00 to 9999.9)
8. K=km/h (fixed)
9. Mode indicator (A=Autonomous, D=Differential E=Estimated (dead reckoning)
   M=Manual input S=Simulator N=Data not valid)

VWR-Wind Relative Bearing and Velocity

$**VWR,x.x,x,x.x,N,x.x,M,x.x,K<CR><LF>
            1 2 3 4 5 6 7 8
1. Measured wind angle relative to the vessel, degrees (0.0 to 180.0)
2. L=Left semicircle, R=Right semicircle
3. Velocity, knots (0.0 to 9999.9)
4. Unit (N, fixed)
5. Velocity (0.0 to 999.9)
6. Unit (M, fixed)
7. Velocity, km/h
8. Unit (K, fixed)

VWT- True Wind Speed and Angle

```
$**VWT,x.x,x,x.x,N,x.x,M,x.x,K<CR><LF>
        1  2 3  4 5  6 7  8
```
1. Measured wind angle relative to the vessel, degrees (0.0 to 180.0)
2. L=Left semicircle, R=Right semicircle
3. Velocity, knots (0.0 to 9999.9)
4. Unit (N, fixed)
5. Velocity (0.0 to 999.9)
6. Unit (M, fixed)
7. Velocity, km/h
8. Unit (K, fixed)

XTE- Cross-Track Error, Measured

```
$**XTE,A,A,x.x,a,N,a,*hh<CR><LF>
        1 2 3  4 5 6
```
1. Status: A=data valid V=LORAN C blink or SNR warning
2. Status: V=LORAN C blink or SNR warning
3. Magnitude of cross-track error (0.0000 - 9.9999)
4. Direction to steer, L/R
5. Units, nautical miles (fixed)
6. Mode indicator (A=Autonomous mode D=Differential mode S=Simulator mode)

ZDA- Time and Date

```
$GPZDA,hhmmss.ss,xx,xx,xxxx,xx,xx<CR><LF>
            1      2  3   4   5  6
```
1. UTC (000000 to 235959)
2. Day (01 to 31)
3. Month (01 to 12)
4. Year (UTC, 0000 to 9999)
5. Local zone, hours (-13 to ±13)
6. Local zone, minutes (00 to ±59)

AP-13

APPENDIX 4 JIS CABLE GUIDE

Cables listed in the manual are usually shown as Japanese Industrial Standard (JIS). Use the following guide to locate an equivalent cable locally.

JIS cable names may have up to 6 alphabetical characters, followed by a dash and a numerical value (example: DPYC-2.5).

For core types D and T, the numerical designation indicates the *cross-sectional Area (mm^2)* of the core wire(s) in the cable.

For core types M and TT, the numerical designation indicates the *number of core wires* in the cable.

1. Core Type
D: Double core power line
T: Triple core power line
M: Multi core
TT: Twisted pair communications
    (1Q=quad cable)

2. Insulation Type
P: Ethylene Propylene Rubber

3. Sheath Type
Y: PVC (Vinyl)

4. Armor Type
C: Steel

5. Sheath Type
Y: Anticorrosive vinyl sheath

6. Shielding Type
S: All cores in one sheath
-S: Individually sheathed cores
SLA: All cores in one shield, plastic tape w/aluminum tape
-SLA: Individually shielded cores, plastic tape w/aluminum tape

DPYCY

TPYCY
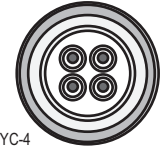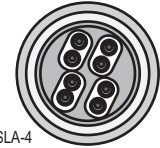
MPYC-4

TTYCSLA-4

```
        1 2 3 4 5  6                      1  2  3  4
EX: TTYCYSLA - 4                  MPYC - 4
    Designation type┘ └# of twisted pairs┘   Designation type┘  └# of cores┘
```

The following reference table lists gives the measurements of JIS cables commonly used with Furuno products:

Type	Core Area	Core Diameter	Cable Diameter	Type	Core Area	Core Diameter	Cable Diameter
DPYC-1.5	1.5mm^2	1.56mm	11.7mm	TTYCS-1	0.75mm^2	1.11mm	10.1mm
DPYC-2.5	2.5mm^2	2.01mm	12.8mm	TTYCS-1T	0.75mm^2	1.11mm	10.6mm
DPYC-4	4.0mm^2	2.55mm	13.9mm	TTYCS-1Q	0.75mm^2	1.11mm	11.3mm
DPYC-6	6.0mm^2	3.12mm	15.2mm	TTYCS-4	0.75mm^2	1.11mm	16.3mm
DPYC-10	10.0mm^2	4.05mm	17.1mm	TTYCSLA-1	0.75mm^2	1.11mm	9.4mm
DPYCY-1.5	1.5mm^2	1.56mm	13.7mm	TTYCSLA-1T	0.75mm^2	1.11mm	10.1mm
DPYCY-2.5	2.5mm^2	2.01mm	14.8mm	TTYCSLA-1Q	0.75mm^2	1.11mm	10.8mm
DPYCY-4	4.0mm^2	2.55mm	15.9mm	TTYCSLA-4	0.75mm^2	1.11mm	15.7mm
MPYC-2	1.0mm^2	1.29mm	10.0mm	TTYCY-1	0.75mm^2	1.11mm	11.0mm
MPYC-4	1.0mm^2	1.29mm	11.2mm	TTYCY-1T	0.75mm^2	1.11mm	11.7mm
MPYCSLA-4	1.0mm^2	1.29mm	11.4mm	TTYCY-1Q	0.75mm^2	1.11mm	12.6mm
MPYC-7	1.0mm^2	1.29mm	13.2mm	TTYCY-4	0.75mm^2	1.11mm	17.7mm
MPYC-12	1.0mm^2	1.29mm	16.8mm	TTYCY-4S	0.75mm^2	1.11mm	21.1mm
TPYC-1.5	1.5mm^2	1.56mm	12.5mm	TTYCY-4SLA	0.75mm^2	1.11mm	19.5mm
TPYC-2.5	2.5mm^2	2.01mm	13.5mm	TTYCYS-1	0.75mm^2	1.11mm	12.1mm
TPYC-4	4.0mm^2	2.55mm	14.7mm	TTYCYS-4	0.75mm^2	1.11mm	18.5mm
TPYCY-1.5	1.5mm^2	1.56mm	14.5mm	TTYCYSLA-1	0.75mm^2	1.11mm	11.2mm
TPYCY-2.5	2.5mm^2	2.01mm	15.5mm	TTYCYSLA-4	0.75mm^2	1.11mm	17.9mm
TPYCY-4	4.0mm^2	2.55mm	16.9mm				

SPECIFICATIONS OF MARINE RADAR
MODEL1815

1　ANTENNA UNIT

1.1	Antenna type	Patch array
1.2	Radiator length	18-inch
1.3	Horizontal beam width	5.2°
1.4	Vertical beam width	25°
1.5	Sidelobe	-20 dB or less (within ±20° of main-lobe)
		-25 dB or less (outside ±20° of main-lobe)
1.6	Rotation	24 rpm

2　TRANSCEIVER MODULE (CONTAINED IN ANTENNA UNIT)

2.1	Tx frequency	9410±30 MHz
2.2	Radiation type	P0N
2.3	Output power	4 kW
2.4	Duplexer	Ferrite circulator
2.5	Intermediate frequency	60 MHz
2.6	Range scale, Pulse length (PL) and Pulse repetition rate (PRR)	

Range (NM)	PL (μs)	PRR (Hz approx.)
0.0625 to 1.5	0.08	360
1.5 to 2	0.3	360
3 to 36	0.8	360

2.7	Minimum range	25 m
2.8	Range resolution	25 m
2.9	Range accuracy	1 % of range in use or 0.01 NM, whichever is greater
2.10	Bearing resolution	5.2°
2.11	Bearing accuracy	±1°

3　DISPLAY UNIT

3.1	Screen type	8.4-inch color LCD, 640 (V) x 480 (H) dots, VGA
3.2	Effective radar diameter	128 mm
3.3	Brightness	0.27 to 600 cd/m^2 typical (16 steps)
3.4	Range scales and Ring interval	

Range scale (NM)	0.0625	0.125	0.25	0.5	0.75	1	1.5	2	3	4	6	8	12	16	24	36
Ring interval (NM)	0.03125	0.0625	0.125	0.125	0.25	0.25	0.5	0.5	1	1	2	2	3	4	6	12
Number of rings	2	2	2	4	3	4	3	4	3	4	3	4	4	4	4	3

3.5	Marks	Heading line, Bearing scale, Range ring, Tuning indicator, Cursor, North mark, Variable range marker (VRM), Electric bearing line (EBL), Target alarm zone, Zoom window, Waypoint mark*, Origin mark*
3.6	Alphanumeric indication	Range, Range ring interval, Display mode (H UP/ C UP/ N UP/ TM/ TRUE VIEW), Off-center (OFFCENT (M/A/C)), Heading data*, Target trails, Tuning indicator, Target alarms, Echo stretch (ES),

Echo average (EAV), Electric bearing line (EBL), Vector time*, Range and bearing to cursor or cursor position*, Interference rejecter (IR), Auto anti-clutter (A/C Auto), Variable range marker (VRM), Navigation data*(position, speed, course), ARPA/AIS/ships target data*

*: external data required

4   INTERFACE

4.1	Number of ports	
	NMEA	3 ports (IEC61162-2, I/O: 2, I: 1)
	Contact closure	1 port (output for external buzzer, 0.3 A max.)
4.2	Data sentences	
	Input	ALR, BWC, BWR, DBT, DPT, DTM, GGA, GLL, GNS, GSA, GSV, HDG, HDT, HDM, MTW, MWV, RMB, RMC, THS, TTM, VDM, VHW, VTG, VWR, VWT, XTE, ZDA
	Output	ACK, RSD, TLL, TTM

5   POWER SUPPLY

12-24 VDC: 3.0-1.5 A

6   ENVIRONMENTAL CONDITIONS

6.1	Ambient temperature	
	Antenna unit	-25°C to +55°C (storage: -30°C to +70°C)
	Display unit	-15°C to +55°C (storage: -30°C to +70°C)
6.2	Relative humidity	95% or less at +40°C
6.3	Degree of protection	
	Antenna unit	IP26
	Display unit	IP56
6.4	Vibration	IEC 60945 Ed.4

7   UNIT COLOR

7.1	Antenna unit	N9.5 (cover), PANTONE2945C (bottom)
7.2	Display unit	N2.5

INDEX

Declaration of Conformity

[MODEL1815]

Bulgarian (BG)	С настоящото Furuno Electric Co., Ltd. декларира, че горепоменат тип радиосъоръжение е в съответствие с Директива 2014/53/ЕС. Цялостният текст на ЕС декларацията за съответствие може да се намери на следния интернет адрес:
Spanish (ES)	Por la presente, Furuno Electric Co., Ltd. declara que el tipo de equipo radioeléctrico arriba mencionado es conforme con la Directiva 2014/53/UE. El texto completo de la declaración UE de conformidad está disponible en la dirección Internet siguiente:
Czech (CS)	Tímto Furuno Electric Co., Ltd. prohlašuje, že výše zmíněné typ rádiového zařízení je v souladu se směrnicí 2014/53/EU. Úplné znění EU prohlášení o shodě je k dispozici na této internetové adrese:
Danish (DA)	Hermed erklærer Furuno Electric Co., Ltd., at ovennævnte radioudstyr er i overensstemmelse med direktiv 2014/53/EU. EU-overensstemmelseserklæringens fulde tekst kan findes på følgende internetadresse:
German (DE)	Hiermit erklärt die Furuno Electric Co., Ltd., dass der oben genannte Funkanlagentyp der Richtlinie 2014/53/EU entspricht. Der vollständige Text der EU-Konformitätserklärung ist unter der folgenden Internetadresse verfügbar:
Estonian (ET)	Käesolevaga deklareerib Furuno Electric Co., Ltd., et ülalmainitud raadioseadme tüüp vastab direktiivi 2014/53/EL nõuetele. ELi vastavusdeklaratsiooni täielik tekst on kättesaadav järgmisel internetiaadressil:
Greek (EL)	Με την παρούσα η Furuno Electric Co., Ltd., δηλώνει ότι ο προαναφερθέντας ραδιοεξοπλισμός πληροί την οδηγία 2014/53/ΕΕ. Το πλήρες κείμενο της δήλωσης συμμόρφωσης ΕΕ διατίθεται στην ακόλουθη ιστοσελίδα στο διαδίκτυο:
English (EN)	Hereby, Furuno Electric Co., Ltd. declares that the above-mentioned radio equipment type is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address:
French (FR)	Le soussigné, Furuno Electric Co., Ltd., déclare que l'équipement radioélectrique du type mentionné ci-dessusest conforme à la directive 2014/53/UE. Le texte complet de la déclaration UE de conformité est disponible à l'adresse internet suivante:
Croatian (HR)	Furuno Electric Co., Ltd. ovime izjavljuje da je gore rečeno radijska oprema tipa u skladu s Direktivom 2014/53/EU. Cjeloviti tekst EU izjave o sukladnosti dostupan je na sljedećoj internetskoj adresi:
Italian (IT)	Il fabbricante, Furuno Electric Co., Ltd., dichiara che il tipo di apparecchiatura radio menzionato sopra è conforme alla direttiva 2014/53/UE. Il testo completo della dichiarazione di conformità UE è disponibile al seguente indirizzo Internet:
Latvian (LV)	Ar šo Furuno Electric Co., Ltd. deklarē, ka augstāk minēts radioiekārta atbilst Direktīvai 2014/53/ES. Pilns ES atbilstības deklarācijas teksts ir pieejams šādā interneta vietnē:

Lithuanian (LT)	Aš, Furuno Electric Co., Ltd., patvirtinu, kad pirmiau minėta radijo įrenginių tipas atitinka Direktyvą 2014/53/ES. Visas ES atitikties deklaracijos tekstas prieinamas šiuo interneto adresu:
Hungarian (HU)	Furuno Electric Co., Ltd. igazolja, hogy fent említett típusú rádióberendezés megfelel a 2014/53/EU irányelvnek. Az EU-megfelelőségi nyilatkozat teljes szövege elérhető a következő internetes címen:
Maltese (MT)	B'dan, Furuno Electric Co., Ltd., niddikjara li msemmija hawn fuq-tip ta' tagħmir tar-radju huwa konformi mad-Direttiva 2014/53/UE. It-test kollu tad-dikjarazzjoni ta' konformità tal-UE huwa disponibbli f'dan l-indirizz tal-Internet li ġej:
Dutch (NL)	Hierbij verklaar ik, Furuno Electric Co., Ltd., dat het hierboven genoemde type radioapparatuur conform is met Richtlijn 2014/53/EU. De volledige tekst van de EU-conformiteitsverklaring kan worden geraadpleegd op het volgende internetadres:
Polish (PL)	Furuno Electric Co., Ltd. niniejszym oświadcza, że wyżej wymieniony typ urządzenia radiowego jest zgodny z dyrektywą 2014/53/UE. Pełny tekst deklaracji zgodności UE jest dostępny pod następującym adresem internetowym:
Portuguese (PT)	O(a) abaixo assinado(a) Furuno Electric Co., Ltd. declara que o mencionado acima tipo de equipamento de rádio está em conformidade com a Diretiva 2014/53/UE. O texto integral da declaração de conformidade está disponível no seguinte endereço de Internet:
Romanian (RO)	Prin prezenta, Furuno Electric Co., Ltd. declară că menționat mai sus tipul de echipamente radio este în conformitate cu Directiva 2014/53/UE. Textul integral al declarației UE de conformitate este disponibil la următoarea adresă internet:
Slovak (SK)	Furuno Electric Co., Ltd. týmto vyhlasuje, že vyššie spomínané rádiové zariadenie typu je v súlade so smernicou 2014/53/EÚ. Úplné EÚ vyhlásenie o zhode je k dispozícii na tejto internetovej adrese:
Slovenian (SL)	Furuno Electric Co., Ltd. potrjuje, da je zgoraj omenjeno tip radijske opreme skladen z Direktivo 2014/53/EU. Celotno besedilo izjave EU o skladnosti je na voljo na naslednjem spletnem naslovu:
Finnish (FI)	Furuno Electric Co., Ltd. vakuuttaa, että yllä mainittu radiolaitetyyppi on direktiivin 2014/53/EU mukainen. EU-vaatimustenmukaisuusvakuutuksen täysimittainen teksti on saatavilla seuraavassa internetosoitteessa:
Swedish (SV)	Härmed försäkrar Furuno Electric Co., Ltd. att ovan nämnda typ av radioutrustning överensstämmer med direktiv 2014/53/EU. Den fullständiga texten till EU-försäkran om överensstämmelse finns på följande webbadress:

Online Resource

http://www.furuno.com/en/support/red_doc

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