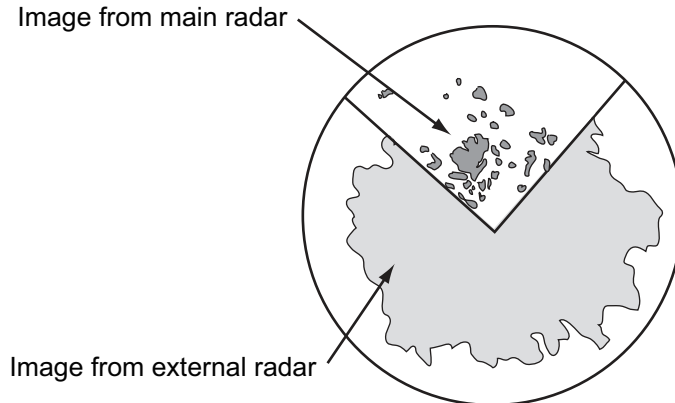# 2.29 Dual Radar (B-type only)

When installing two FAR-3xx0 series radars, the image from both radars (main radar and external radar) may be shown together on one radar display. This allows you to take advantage of the best characteristics each type of radar has to offer. The dual radar function is available only for the B type.


Example image of dual radar

The following should be done from the [RADAR INSTALLATION] menu at the time of installation in order to enable the dual radar display:

- Set the display area on both the main radar and the external radar ([2 COMBINE SECTOR], [3 COMBINE RANGE]).
- Select the number of external radar to use ([4 EXT RADAR]).
- Turn the dual radar function on ([5 COMBINE FUNC] is set to [ON]).

TT information

When a TT target crosses over the boundary line of the display area, its information is passed to the other radar display. Tracking on the TT continues. The number of the antenna which acquires a TT target is displayed in front of the TT number.

TT target crosses over the
boundary line of the display area.

Boundary lines of display area

TT information is passed to the
other radar display. Tracking on
the TT continues.
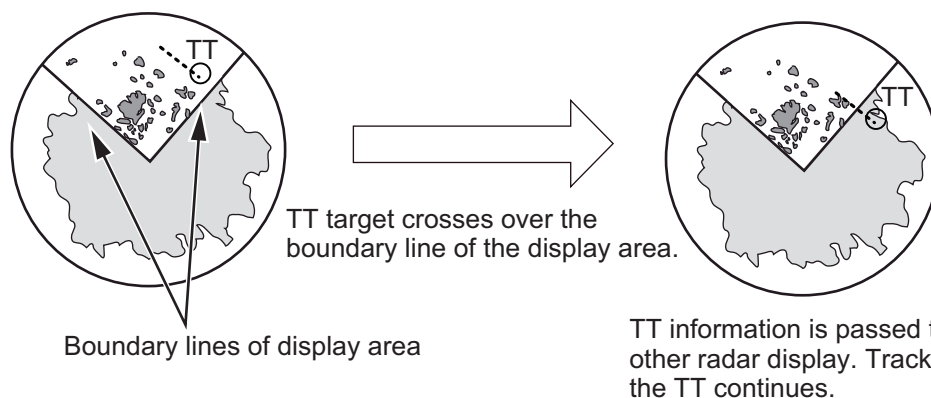
2.29.1 How to enable or disable the dual radar display

Turn on the power of main radar and external radar to set them in standby. The dual radar function is not available when one of two radars is in TX (transmit) state or turned off.

From the menu

1. Open the menu then select [1 ECHO] and [9 DUAL RADAR].
2. Select [COMBINE] to enable the dual radar display. To disable the dual radar display, select [OFF].
3. Close the menu.

From the antenna button

1. Right-click the [Antenna] button on the Status bar to show the context-sensitive menu.
2. Select [Dual Radar].
3. Select [Combine]. To disable the dual radar display, select [Off].

"(D)" appears in the [Antenna] button on the Status bar when the dual radar display is enabled.

"(D)" appears on the [Antenna] button when the dual radar display is enabled.

2.29.2 Operating considerations for the dual radar display

In the dual radar mode, you can operate the antenna displayed in the [Antenna] button on the Status bar. To operate the other antenna, select it in the [Antenna] button on the Status bar.

You can toggle each radar between standby and TX in the dual radar display. When switching to the standby mode, the Alert 730 (ALF format: 10740,1) "EXT Radar ST-BY" appears and the radar echoes are not displayed.

The following functions are based on the settings in the radar which enables the dual radar display. These settings are common with two radars.

- Off-center display
- Range scale
- Presentation mode
- Electronic chart on/off
- CU/TM reset
- Trail settings
- TT lost target filter

Notes

- The dual radar function is available between two FAR-3xx0 series radars using the LAN. FAR-2xx7 and FCR-2xx9 are not available.
- When a transmission error occurs between two radars in the dual radar mode, the Alert 750 (ALF format: 10740,3) "EXT Radar COM Error" appears and the dual radar function is turned off.
- The dual radar display is not available on the external radar which overlays the main radar image even though the dual radar is turned on.

- If TT data (two places) are passed between two radars (see page 2-45), TT targets are lost in the external equipment using TT informations (TTM) of this equipment.
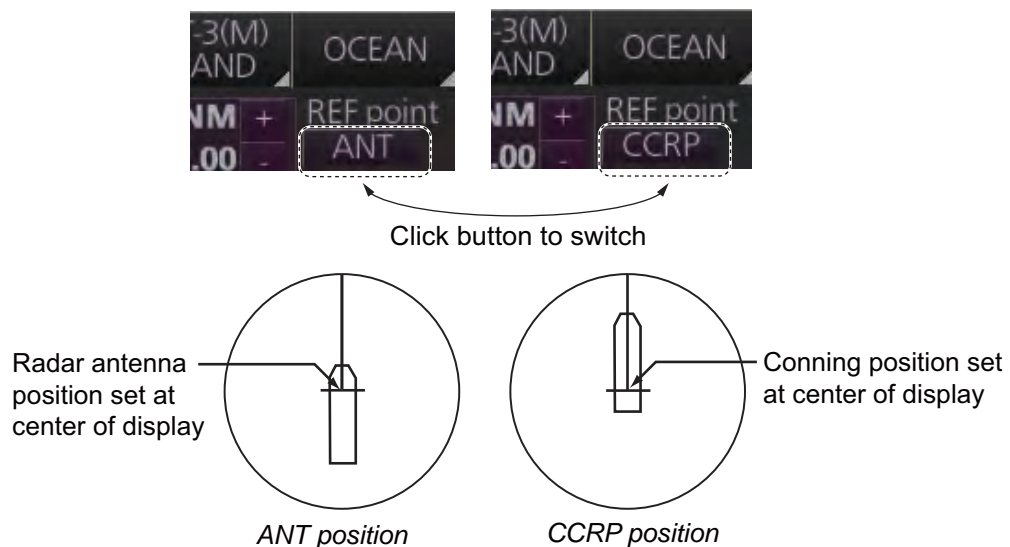
Restrictions

The followings are the restrictions of the dual radar function.

- A REF (reference) mark can be entered on the display of the main radar but not the external radar.
- TT targets can be acquired manually. [TT SELECT] is set to manual acquisition.
- The reference position is set to [CCRP] (see section 2.30). Set the same CCRP position between two radars at the time of installation.
- [ECHO AREA] is set to [CIRCLE] (see section 2.35).
- The following functions are not available in the dual radar mode.
  - Performance monitor
  - SART
  - Tune initialize
  - TT simulation mode
  - Icing prevention
  - Interswitch

2.30 CCRP (Common Consistent Reference Point)

The reference position for measurements (range, bearing, etc.) and markers (heading line, stern mark, etc.) can be the antenna position or CCRP, which is a location on own ship to which all horizontal measurements, for example range, bearing, relative course, relative speed, closest point of approach (CPA) or time to closest point of approach (TCPA), are normally referenced.

To select the reference position, click the button below [REF point] at the top-left position to select [ANT] or [CCRP] as appropriate.

Click button to switch

Radar antenna position set at center of display

Conning position set at center of display

ANT position   *CCRP position*

The position of the own ship marker changes according to reference position as above. If the CCRP is positioned outside of the effective display area, the bearing scale is indicated with the appropriate reduced detail.

Range and bearing are measured and graphics are drawn according to reference point as shown in the table below.

Category	Item	Reference point	
		CCRP	**Antenna position**
Range and bearing measurement	EBL	Range and bearing measured from CCRP	Range and bearing measured from antenna position
	VRM		
	Cursor		
	PI line		
	Range ring		
	Drop mark		
Graphics	Heading line	Drawn from CCRP	Drawn from antenna position
	Stern mark		
	Beam line		
	Own ship vector		
	Own ship track		
Bearing cursor		Drawn with CCRP at center	Drawn with antenna position at center
Course, speed		Calculated with CCRP at center	Calculated with antenna position at center
CPA, TCPA		Calculated with CCRP at center	Calculated with antenna position at center
BCR, BCT		Calculated from bow position	
Own ship data	Heading	Data from sensor, regardless of reference point selected	
	Speed		
	Course over ground		
	Speed over ground		
	Own L/L	Location of the CCRP	

2.31 Drop Mark

The drop mark is used to find the angle and distance from a point to your ship. This can be useful for marking a point to avoid while navigating to a destination. The drop marks can be shown or hidden on the screen.

Drop mark

The Drop mark box shows the angle and distance between the drop mark and your ship.

Drop mark no. (1 or 2)
Minimize button
Drop angle
Drop distance
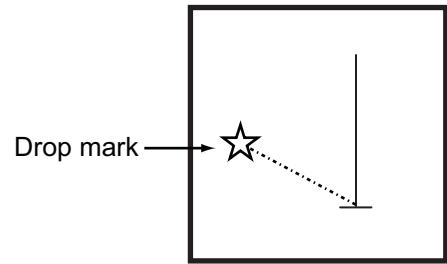
Note: The drop mark feature is inoperative when position data is lost.

2.31.1 How to show, hide the drop mark box

The drop mark box can be shown or hidden by trackball.

OFF: Click the arrow on the [Drop mark] box or right-click the box and select [DROPx Off] (x=Drop mark no.).
ON: Click the minimize box.

2.31.2 How to inscribe a drop mark

Click the desired Drop mark box at the bottom of the screen. Click a position on the display area where to put a drop mark, and a drop mark is inscribed at the position selected. The angle and distance to the point appear in the corresponding Drop mark box.

2.31.3 Drop mark bearing reference

The bearing of a drop mark is automatically referenced to True or Relative according to the presentation mode.

Presentation mode	Bearing reference
Head-up RM	Relative
STAB H UP RM	
Stern-up RM	
Course-up RM	True
North-up RM	
North-up TM	

2.31.4 How to erase a drop mark

Erase drop mark from menu

1. Open the menu then select the [5 MAP•MARK] and [1 MARK SETTING] menus.

2. Select [7 DROP MARK].

3. Select [ON] or [OFF].

4. Close the menu.

Erase drop mark by trackball

Right-click the applicable Drop mark box to show the context-sensitive menu then select [Drop1 Off] (or [Drop2 Off]). The drop mark and its data are erased.
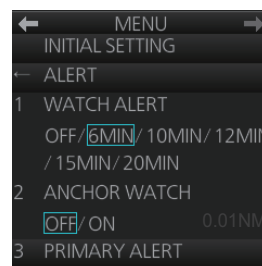
2.32 Anchor Watch

The anchor watch is used to monitor if the ship is staying at anchor. If your vessel travels more than the distance set here, the Alert 495 (ALF format: 10802) "Anchor Watch" appears in the [Alert] box and the audio alarm sounds.

Alarm setting

Your ship's position, where you start the anchor watch.

: Alarm triggered
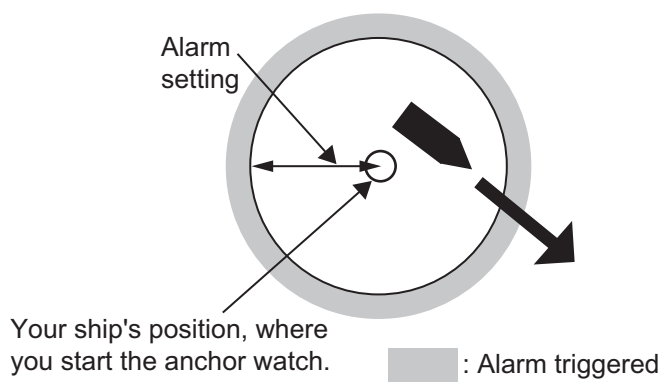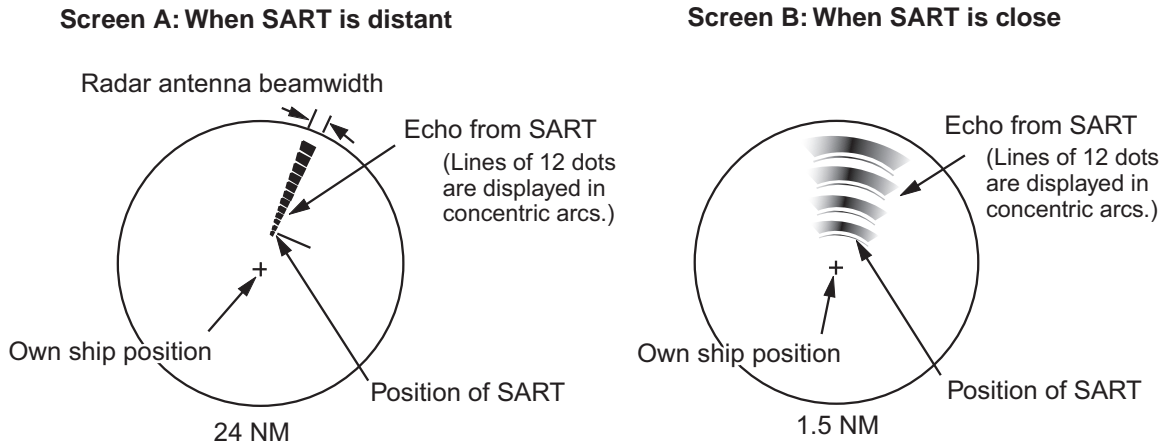
How to activate anchor watch

1. Open the menu then select [8 INITIAL SETTING] and [4 ALERT] menus.

2. Select [2 ANCHOR WATCH].

3. Select [ON]. Use the scrollwheel to set the alarm radius (0.01 to 9.99 NM).

4. Close the menu.

MENU
INITIAL SETTING
ALERT
1 WATCH ALERT
OFF/6MIN/10MIN/12MIN
/15MIN/20MIN
2 ANCHOR WATCH
OFF/ON   0.01NM
3 PRIMARY ALERT

2.33 SART

2.33.1 What is an SART?

A Search and Rescue Transponder (SART) may be triggered by any X-band (3 cm) radar within a range of approximately 8 NM. Each radar pulse received causes it to transmit a response which is swept repetitively across the complete radar frequency band.

Screen A: When SART is distant

Radar antenna beamwidth

Echo from SART
(Lines of 12 dots are displayed in concentric arcs.)

Own ship position

Position of SART

24 NM

Screen B: When SART is close

Echo from SART
(Lines of 12 dots are displayed in concentric arcs.)

Own ship position

Position of SART

1.5 NM

2.33.2 How to receive an SART

This radar is equipped with a feature that optimally sets up the radar for SART detection. This feature automatically detunes the radar receiver out of its best tuning condition. This erases or weakens all normal radar echoes, but the SART marks are not erased because the SART response signal scans over all frequencies in the 9 GHz band. When the radar approaches the SART in operation, the SART marks will enlarge to large arcs, blurring a large part of the screen.

Note: For solid state radar, the SART function is not available.

1. Open the menu then select the [1 ECHO] menu.
2. Select [7 SART].
3. Select [ON].
4. Close the menu. The icon "SART" appears in the Message area on the status bar (see paragraph 1.8.1) when the SART function is active.

When the SART is activated the radar controls are automatically set as follows.

Item	Setting at activation of SART feature	Adjustable during activation of SART feature	Setting at deactivation of SART feature
CONDITION	Setting stored	Yes	Setting at deactivation
CUSTOMIZE ECHO	Grayed out, setting stored	No	Return to active display
EAV	OFF	No	Setting before activation
ES	OFF	No	Setting before activation
GAIN	Setting stored	Yes	Setting at deactivation
IR	OFF	No	Setting before activation

Item	Setting at activation of SART feature	Adjustable during activation of SART feature	Setting at deactivation of SART feature
LOW LEVEL ECHO	Setting stored	Yes	Setting at deactivation
NOISE REJECT	OFF	No	Setting before activation
OFF center	OFF	Yes	Setting at deactivation
Presentation Mode	Setting stored *1	Yes	Setting at deactivation
PULSE	LONG	No	Setting at deactivation
RAIN	Setting stored	Yes	Setting at deactivation
RAIN AUTO	MAN	No	Setting before activation
RANGE	12 NM, 12 SM, 24 km, 24 kyd	Yes *2	Setting at deactivation
SEA	Setting stored	Yes	Setting at deactivation
SEA AUTO	Setting stored	Yes	Setting at deactivation
TUNE	Setting stored	Yes	Setting at deactivation
VIDEO CONTRAST	Setting stored	Yes	Setting at deactivation
WIPER	Setting stored	Yes	Setting at deactivation

*1 North-up RM selected when the mode is North-up TM.

*2 The SART feature is deactivated if the range is changed.

2.34 Alert Box, Alert List

2.34.1 Alert box

When an alert condition is found, the applicable alert message and alert ID appear in the [Alert] box. For the alarm- and warning-type alerts a buzzer sounds. The [Alert] box is composed of the four items shown in the figure below. See chapter 20 for details.

Alert state icon

Alert message (Alert ID and alert name)

Alert list/log icon (Click to display.)

Buzzer stop icon (Click to stop buzzer temporarily.)

2.34.2   Alert list

The [Alert List] displays the status of the latest 900 system alerts, in order of genera-
tion, latest to the earliest. To display the list, click the Alert list/log icon in the [Alert]
box. The Alert list/log icon is light-blue when the list is displayed. A maximum of nine
alerts are shown per page. Unacknowledged alerts are displayed in flashing red
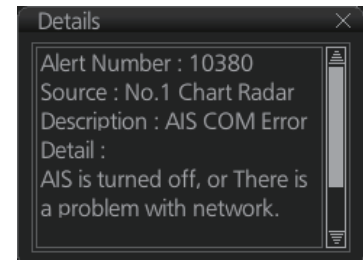(alarm) or flashing yellow-orange (warning). The ZDA sentence is required to display
time in the list.

Click to close list.
- Click to close list. (Press ← on the Control Unit to close list.)
- [BACK] shown when there are two or more pages. Switch to previous page in multiple page displays.

The name of the alert not acknowledged or not rectified.

Status icon

Switch to next page in multiple page displays. (Not shown when only one page exists.)
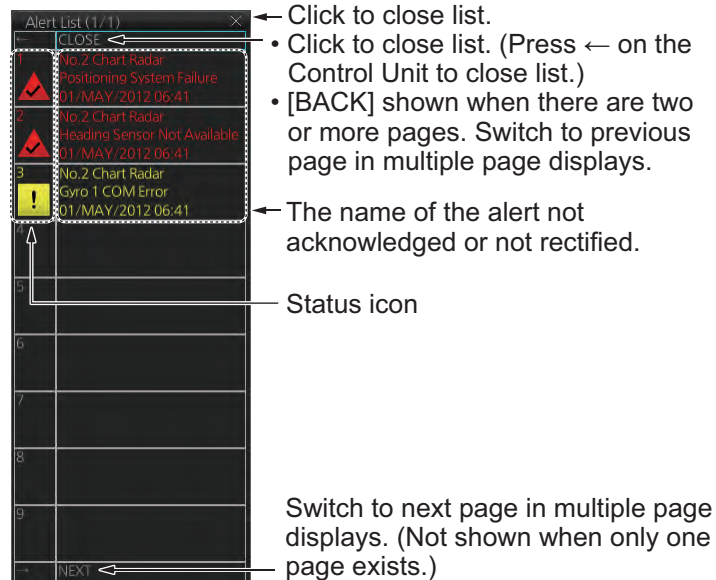
How to acknowledge or rectify from the list

Control Unit: Press appropriate numeric key.
Trackball module: Click alarm name.

How to find details about an alert

Click the status icon in the list to show details about an
alert.

Details   ×

Alert Number : 10380
Source : No.1 Chart Radar
Description : AIS COM Error
Detail :
AIS is turned off, or There is
a problem with network.

2.34.3   Changing priority of primary alerts

Alerts are categorized and prioritized as shown below.

Priority	Alert category
High	Alarm
Middle	Warning
Low	Caution

If desired, you can specify the events that are to have the same priority as "Alarm".

1.   Open the menu then select the [8 INITIAL SETTINGS] and [4 ALERT] menus.

2.   Select [3 PRIMARY ALERT].
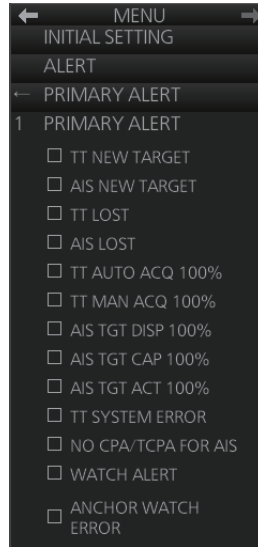
3.   Click the box to the left of an alarm name to show a circle to give that alarm the same priority as the alert category "Alarm."

4.   Close the menu.

Note: The priority is immediately changed for an inactive alert. For an active alert, the priority selected becomes effective when the alert is acknowledged and regenerated.

2.35   Echo Area

The echo display area for the B-type radar can be selected for [CIRCLE] or [WIDE].

CIRCLE   WIDE
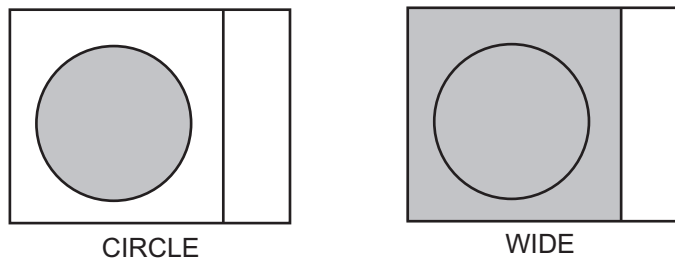
To select the echo display area type to use, open the menu, select the [1 ECHO] menu then set [2 ECHO AREA] to [CIRCLE] or [WIDE] as appropriate.

2.36   Echo Color

The default echo color is yellow. Echo color is also available in the following colors:

B type: Yellow, green, white, amber, and "color". "Color" displays echoes in red, yellow or green corresponding to the signal levels of strong, medium and weak.
IMO and A types: Yellow, green, and white.

To select the echo color, open the [1 ECHO] menu then select desired color from [3 ECHO COLOR].

2.37   Icing Prevention

You can rotate the antenna (24 rpm) without transmission to keep the antenna from freezing.
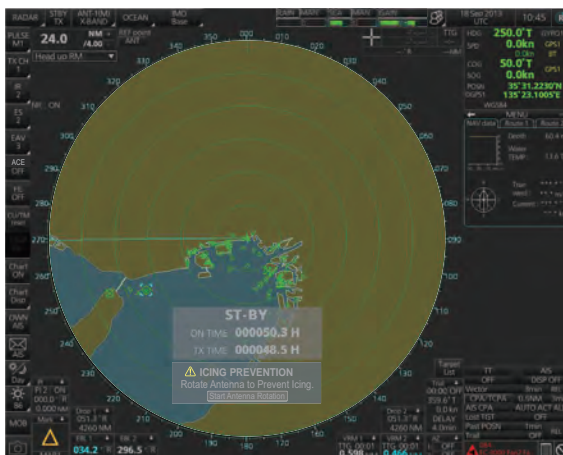
1. Open the menu then select the [8 INITIAL SETTING] menu. Select [0 ICING PRE-VENTION].

2. Select [ON]. The following message appears at the bottom of the screen.
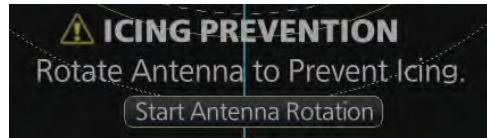
3. Click [Start Antenna Rotation] to rotate the antenna without transmission. The message changes as follow.
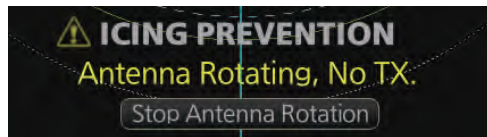
To stop the antenna rotation, click [Stop Antenna Rotation].

[STBY TX] is grayed out.

When the antenna stops   When the antenna rotates

With this feature active and the antenna stopped, pushing the **STBY TX** key on the Control Unit or click the [STBY TX] button on the Status bar rotates the antenna and transmits pulses. Operating one of the above-mentioned controls again stops transmission but the antenna rotates.

2.38 Chart Radar Functions

2.38.1 How to switch between radar and chart radar modes

Click the [CHART ON/OFF] button on the InstantAccess bar™ to show or hide the chart.

[Chart → ON/OFF] button
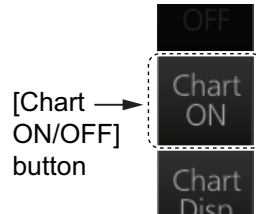
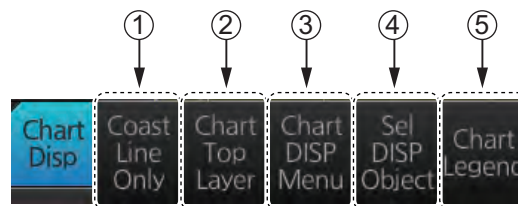#### Indication on button and corresponding mode

[Chart ON]: Chart radar mode active. (Chart and radar picture are displayed.)
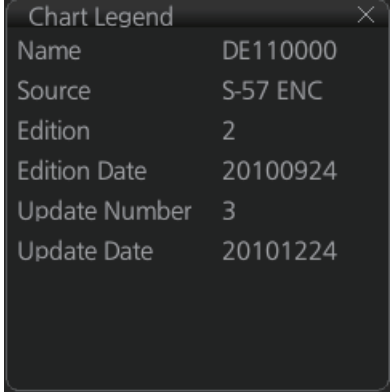[Chart OFF]: Radar mode active. (Only the radar picture is displayed.)

When the GPS position is lost, the chart radar mode cannot be used. When this occurs, the label on the button shows [Chart OFF] and the button is grayed out.

2.38.2 How to show or hide chart objects

The [Chart Disp] button on the InstantAccess bar™ has several buttons which control chart object visibility.

No.	Item	Function
1	[Coast Line Only]	Hold down the left button to temporarily display only the coastline. Chart symbols (depth contours, navigation buoys, etc.) are temporarily erased from the screen.
2	[Chart Top Layer]	Hold down the left button to temporarily put the chart objects (buoy, lighthouse, etc.) on the top layer.
3	[Chart DISP Menu]	Show the [CHART DISPLAY] menu, where you set safety contours, safety depth, etc. See the figure on the next page for the content of this menu and see section 8.2 "How to Control Visibility of Chart Objects" for details. **Note:** This menu can also be shown by right-clicking the [CHART ON/OFF] button and selecting [Chart Display Menu].
4	[Sel DISP Object]	Show the [SEL DISPLAY OBJECT] menu, where you can select the chart objects and text to show or hide. See the next page for the menus and see section 8.3 "How to Control Visibility of Symbols, Features" (symbol display) for details.

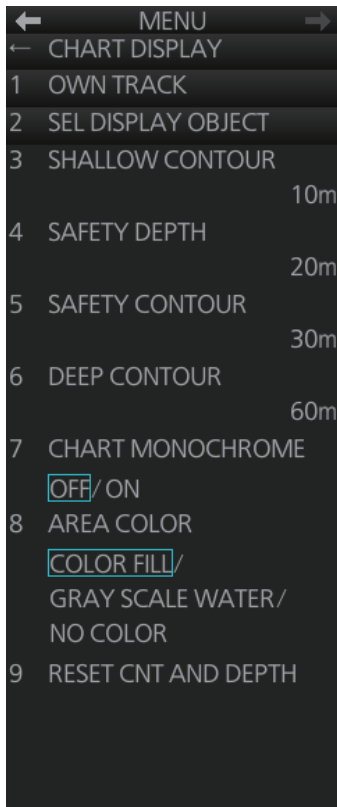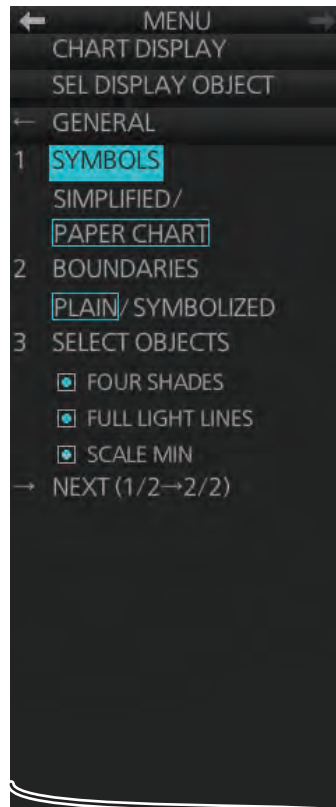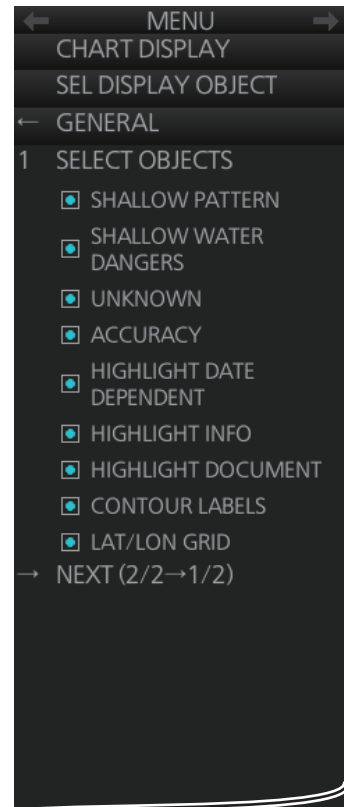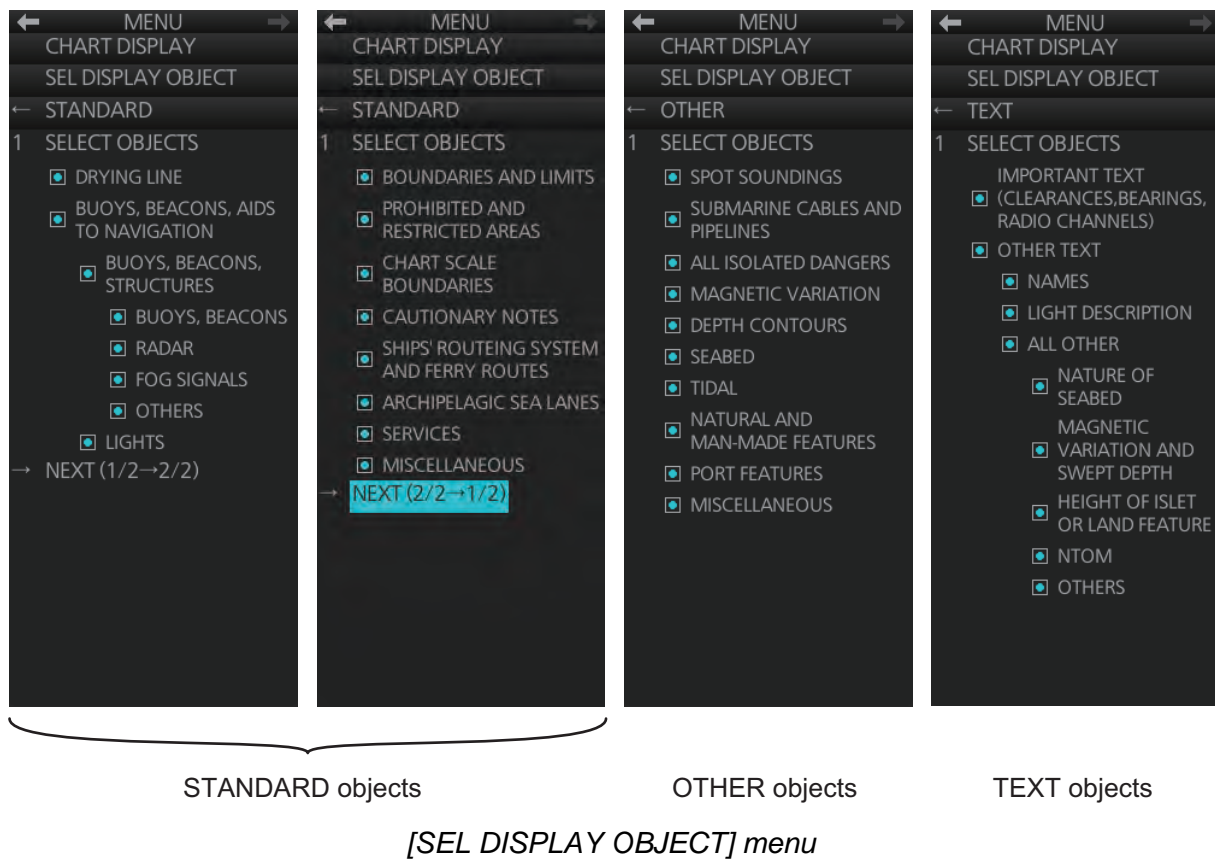| No.	Item	Function
5	[Chart Legend]	Show the chart information for your current position, with your vessel at the center. See chapter 9 and chapter 10 for a description of the chart legends.

Chart Legend window:

Chart Legend	
Name	DE110000
Source	S-57 ENC
Edition	2
Edition Date	20100924
Update Number	3
Update Date	20101224

CHART DISPLAY menu:

```
←   MENU   →
←  CHART DISPLAY
1   OWN TRACK
2   SEL DISPLAY OBJECT
3   SHALLOW CONTOUR
                    10m
4   SAFETY DEPTH
                    20m
5   SAFETY CONTOUR
                    30m
6   DEEP CONTOUR
                    60m
7   CHART MONOCHROME
    OFF/ ON
8   AREA COLOR
    COLOR FILL/
    GRAY SCALE WATER/
    NO COLOR
9   RESET CNT AND DEPTH
```

GENERAL menu:

```
←   MENU   →
    CHART DISPLAY
    SEL DISPLAY OBJECT
←   GENERAL
1   SYMBOLS
    SIMPLIFIED/
    PAPER CHART
2   BOUNDARIES
    PLAIN/ SYMBOLIZED
3   SELECT OBJECTS
    ⊙ FOUR SHADES
    ⊙ FULL LIGHT LINES
    ⊙ SCALE MIN
→   NEXT (1/2→2/2)
```

```
←   MENU   →
    CHART DISPLAY
    SEL DISPLAY OBJECT
←   GENERAL
1   SELECT OBJECTS
    ⊙ SHALLOW PATTERN
    ⊙ SHALLOW WATER
       DANGERS
    ⊙ UNKNOWN
    ⊙ ACCURACY
    ⊙ HIGHLIGHT DATE
       DEPENDENT
    ⊙ HIGHLIGHT INFO
    ⊙ HIGHLIGHT DOCUMENT
    ⊙ CONTOUR LABELS
    ⊙ LAT/LON GRID
→   NEXT (2/2→1/2)
```

CHART DISPLAY menu   GENERAL menu

STANDARD objects   OTHER objects   TEXT objects

[SEL DISPLAY OBJECT] menu

2.38.3 How to create and recall custom sets of chart display objects

You can create one custom set of chart display objects and recall them when required. For example, you can create a custom set of chart display objects to display when you navigate a certain coastline.

How to create a custom set of chart display objects
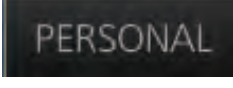
1. Open the menu then select the [6 CHART DISPLAY] and [2 SEL DISPLAY OB-JECT] menus.

2. Open the [2 STANDARD ITEMS], [3 OTHER ITEMS], [4 IMPORTANT TEXT] and [5 OTHER TEXT] menus and turn objects and text on or off as appropriate.

3. Click [SEL DISPLAY OBJECT] on the menu.

4. Select [1 SAVE TO PERSONAL] to save the settings. The confirmation message "Attention: Do you wish to overwrite current settings to PERSONAL?" appears.

5. Click the [OK] button to save the settings.

How to activate the custom set of chart display objects

Click the [Chart database] button (see paragraph 2.38.4) on the Status bar then select [PERSONAL].

2.38.4 Chart database information

You can select the quantity of objects and text to display on the chart radar screen, with the [Chart database] button on the Status bar. There are four different pre-defined settings available and one user-definable ([PERSONAL]). Indication of selected setting appears on the label of the [Chart database] button. The [Chart ON/OFF] button (on the InstantAccess bar™) must be ON to show the [Chart database] button. The [Chart database] button is grayed out if the [Chart ON/OFF] button is OFF.

[Chart database] button	Selection	Setting in [SEL DISP OBJECT] menu
	[IMO Base]	Nothing checked in [GENERAL], [STANDARD], [OTHER] or [TEXT].
	[IMO Primary]	Nothing else checked but [BUOYS AND BEACONS] in [STANDARD] and [SHALLOW WATER DANGERS] in [GENERAL]. This is the "Primary Chart Information Set (PCIS)", based on IEC 62388 Ed.2 section12.1.5.1, IEC61174 and IMO Resolution MSC.232(82).
	[IMO Standard]	All objects checked in [STANDARD]; nothing checked in [GENERAL], [OTHER] or [TEXT].
	[IMO All]	Everything checked in [STANDARD] and [OTHER].
	[PERSONAL]	Use the settings recorded for [GENERAL], [STANDARD], [OTHER] and [TEXT].

2.38.5 How to set value for shallow contour, safety depth, safety contour and deep contour

You can set values for shallow contour, safety depth, safety contour and deep contour, on the [CHART DISPLAY] menu. Colors used for depth presentation on the electronic chart are controlled by setting values for shallow contour, safety depth, safety contour and deep contour. Soundings on the electronic chart, which are equal to or less than the value of safety depth, are highlighted. For details, see the ECDIS operator's manual.

Note: The shallow contour cannot be set higher than the safety contour.

1. Open the menu then select the [6 CHART DISPLAY] menu.
2. Select [3 SHALLOW CONTOUR], [4 SAFETY DEPTH], [5 SAFETY CONTOUR], or [6 DEEP CONTOUR].
3. Spin the scrollwheel to set the value then push the left button.
4. Close the menu.

To reset the value for shallow contour, safety depth, safety contour and deep contour, open the menu then select [6 CHART DISPLAY] and [9 RESET CNT AND DEPTH] menus. The message "Do you wish to restore default contour and depth settings?" appears. Select [Yes].

2.38.6   How to select the chart color and tone

You can select color and tone for chart display.

1.   Open the menu then select the [6 CHART DISPLAY] menu.

2.   Select [7 CHART MONOCHROME].

3.   Select [OFF] or [ON] as appropriate.
      [OFF]: Displays the chart in multicolor.
      [ON]: Displays the chart in monochrome.

4.   Select [8 AREA COLOR].

5.   Select [COLOR FILL], [GRAY SCALE], or [NO COLOR] as appropriate.
      [COLOR FILL]: Displays chart in multi color.
      [GRAY SCALE]: Displays water area in gray scale.
      [NO COLOR]: Does not fill the chart.

6.   Close the menu.

2.38.7   How to show/hide the curved EBL

The [Curved EBL] function shows the planned steering radius. You can use this function to determine the best location to begin a turn. You can also use the [Curved EBL] function to determine whether a turn is being conducted as planned.

To show/hide the [Curved EBL], click the [ON]/[OFF] button on the [Curved EBL] page of the [Overly/ NAV Tools] box.

Note: This function is only available when a EC-3000 with TCS function- ality is connected to the network.

1.   Open the menu and select [5 MAP•MARK] and [MARK SETTING].

2.   Select [DISP CURVED EBL] from page 2 of the [MARK SETTING] menu.

3.   Select [ON] to display the curved EBL, [OFF] to hide the curved EBL.

4.   Close the menu.
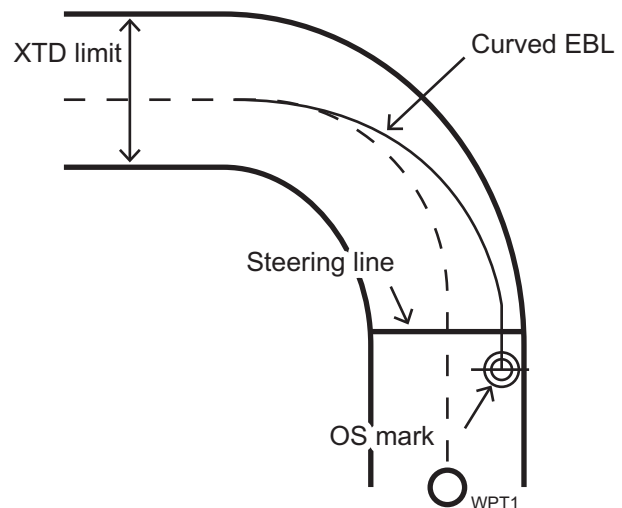
2.38.8 Chart scale indications

The system alerts you to the availability of larger scale ENC and overscale, at the top-left position.

When the radar display range is higher than the chart scale of the ENC chart, the indication, "Larger scale ENC" is displayed. For example, the radar range is 24 NM and the range available with the ENC chart is less than 12 NM.

When the radar display range is lower than the chart scale of the ENC chart, the indication "Overscale x.xx" (x.xx=overscale factor). For example, the radar range is 0.25 NM and the chart scale is 0.5 NM.

Location of chart scale indications

If both conditions exist, both indications are displayed.
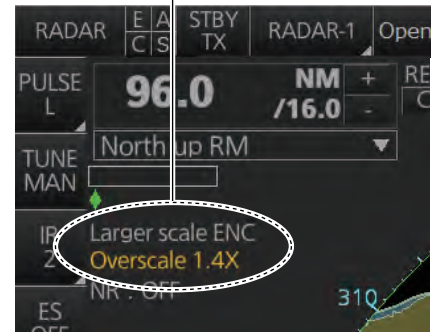
2.38.9 Chart status

The indication "Chart Status" appears at the top-right position on the screen when the display date for the currently displayed chart has passed.
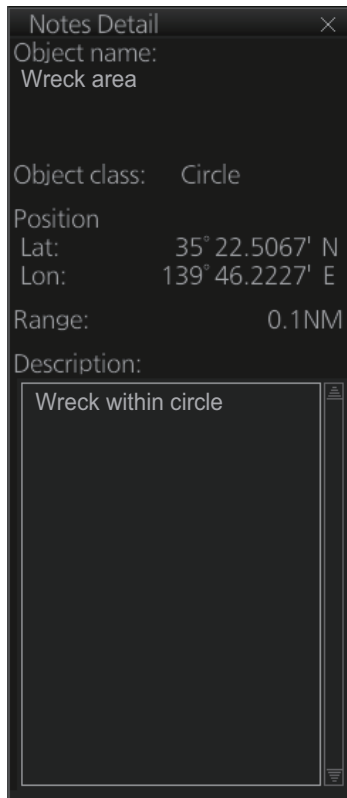
2.38.10 Chart alert function

The chart alert function operates in chart mode only. There are two types of chart alerts: your ship's predicted course, and route alert. See chapter 11 for details.

For the ship's predicted course alert, the operator sets a safety contour. (See paragraph 8.2.1 for how to set a safety contour suitable for the ship.) The operator also sets the parameters for own ship predicted movement. (See section 11.2 "How to Activate Own Ship Look-ahead Area".)

For the route alert, route planning (see section 12.4 "How to Create a New Route") and route monitoring (see section 14.1 "How to Start Route Monitoring") functions are available.

2.38.11 Notes details

"Notes" provides messages for the operator relative to a specific ship position. The chart radar compares the Notes position and own ship position and displays the Notes when own ship is at the distance from the Notes specified in route planning. To display the Notes at other times, right-click the display area to show the context-sensitive menu, then select [Notes Detail]. In the example below, the Notes about a wreck are shown.

Notes Detail ✕
Object name:
 Wreck area

Object class: Circle

Position
Lat: 35° 22.5067' N
Lon: 139° 46.2227' E

Range: 0.1NM

Description:

Wreck within circle

- [Object name]: The name assigned to the Notes.
- [Object class]: The type of object (point, line, area or circle) linked to the Notes.
- [Position]: Position of the object in latitude and longitude.
- [Range]: The range to the object.
- [Description]: A description of the object, input in the Voyage planning mode.

2.39 Radar Observation

2.39.1 General

Minimum range

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

It is mainly dependent on the pulse length, antenna height, and signal processing such as main bang suppression and digital quantization. It is a good practice to use a shorter range scale as far as it gives favorable definition or clarity of picture. The IMO Resolution MSC.192(79) requires the minimum range to be less than 40 m, respectively. This series of radars satisfy this requirement.

Maximum range

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

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

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

where Rmax: radar horizon (NM)
h1: antenna height (m)
h2: target height (m)

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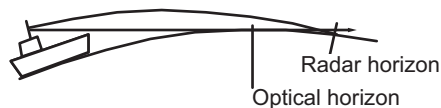
For example, if the height of the antenna above the waterline is 9 meters and the height of the target is 16 meters, the maximum radar range is;

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

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

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

Bearing resolution
Bearing resolution is the ability of the radar to display as separate pips the echoes received from two targets which are at the same range and close together. It is proportional to the antenna length and reciprocally proportional to the wavelength. The length of the antenna radiator should be chosen for a bearing resolution better than

2.5° (IMO Resolution). This condition is normally satisfied with a radiator of 1.2 m (4 ft) or longer in the X-band.

Range resolution
Range resolution is the ability to display as separate pips the echoes received from two targets which are on the same bearing and close to each other. This is determined by pulse length only. Practically, a 0.08 microsecond pulse offers the discrimination better than 40 m as do so with all FURUNO radars. Test targets for determining the range and bearing resolution are radar reflectors having an echoing area of 10 m^2.

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

2.39.2 False echoes

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

Multiple echoes
Multiple echoes occur when a transmitted pulse returns from a solid object like a large ship, bridge, or breakwater. A second, a third or more echoes may be observed on the display at double, triple or other multiples of the actual range of the target as shown below. Multiple reflection echoes can be reduced and often removed by decreasing the gain (sensitivity) or properly adjusting the sea clutter.
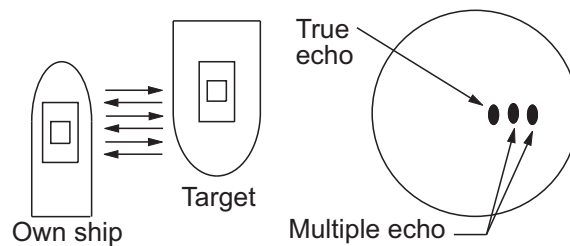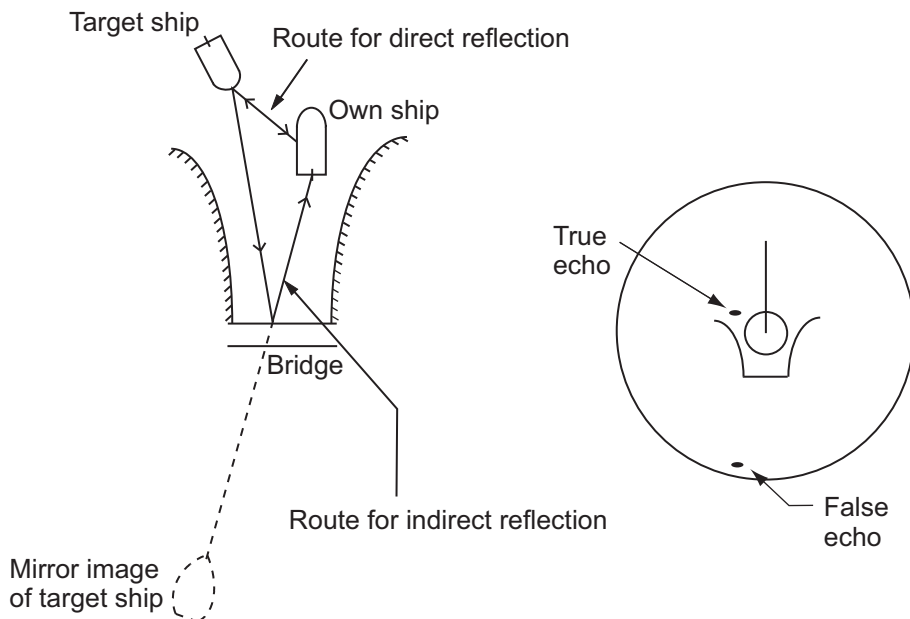
Sidelobe echoes

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

Mainlobe (beam)

Sidelobe   Sidelobe

Antenna

True target

False echoes by sidelobes
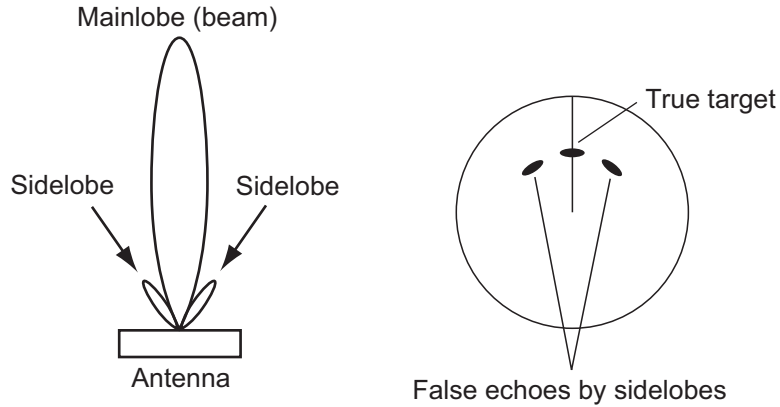
Virtual image

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

Target ship   Route for direct reflection

Own ship

Bridge

Route for indirect reflection

Mirror image of target ship

True echo

False echo

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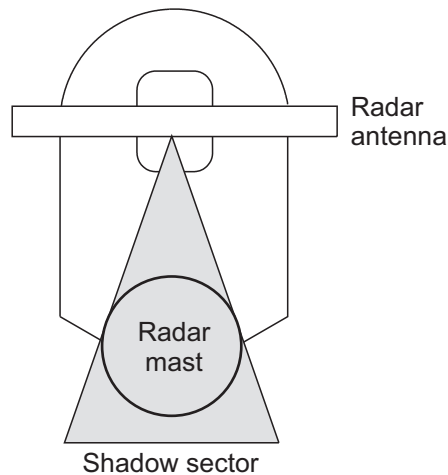
2.39.3 RACON

A RACON is a radar beacon which emits radar receivable signals in the radar frequency spectrum. 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.
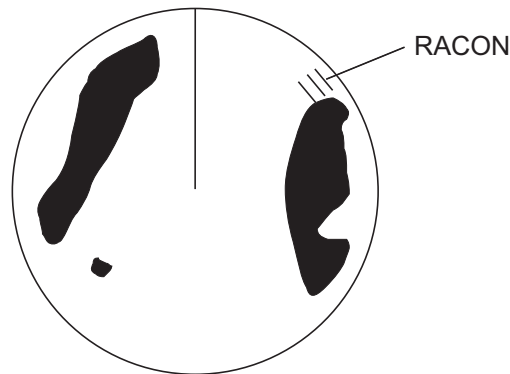
2.39.4 Radar Target Enhancer (RTE)

An RTE is a radar transponder that is mounted on navigation buoys and masts of small crafts to significantly improve their detection by radar. Unlike a SART or RACON, which are passive, the RTE receives a radar signal, amplifies it and re-transmits it, with the intention of making the target's signal look larger on a radar display.

3. TARGET TRACKING (TT)

3.1 About TT

The TT tracks and plots the movement of up to 200 radar targets and fully complies with IMO standards for TT.

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 radar targets selected, 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.

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)

3.2 How to Show, Hide the TT Display

Click the TT mode indication at the bottom-right position to show [OFF] to hide the TT display, or [AUTO]*, [MAN]* or [MAN/AUTO]* to show the TT display. You can right-click the TT mode indication to show a context-sensitive menu with the choices shown above. In this case, click the applicable option.

* The indication shown depends on the setting of [TT SELECT] in the [TT•AIS] menu.

TT	AIS	
OFF	DISP ALL	
Vector	20min	True-G
CPA/TCPA	0.5NM	3min
AIS CPA	AUTO ACT ALL	
Lost TGT	ALL	
Past POSN	OFF	True-G
Trail	OFF	

3.3 How to Input Your Ship's Speed

The TT requires own ship's speed and heading data. The speed can be STW, SOG, or echo-referenced speed (based on 3 max. stationary objects) taken from this radar. Manual input is also possible.

For automatic or manual speed input, see section 1.16. For echo-referenced speed input see the next section.

3.3.1 Echo-referenced speed input

The use of echo-referenced speed is recommended when:

• The speed log is not operating properly or not connected to the radar.
• The vessel has no device that can measure ship's leeward movement (doppler sonar, speed log, etc.) when leeward movement cannot be disregarded.

If you select echo-referenced speed, the TT calculates own ship's speed relative to a fixed reference target. The number of targets may be 1, 2 or 3. They appear as tracked targets, each denoted with a small circle. When a plural number of objects are selected, the mean value is used.

Note: This feature is not available when the AIS is active.

1. Right-click the display area to show the context-sensitive menu then select [REF Mark].
2. Select a small fixed island or any radar prominent point located at 0.1 to 24 NM from own ship.
3. Use the trackball to put the cursor (+) on the target selected at step 2.
4. Push the left button to insert the reference mark.
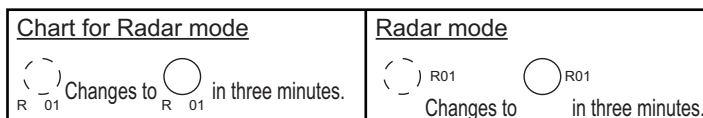
5. Repeat steps 2-4 to continue entering reference marks. Three may be entered.
6. Right click the Sensor information, datum box then select [Select Sensor] and [Setting]. Open the [SPD] page and put a checkmark at [Reference SPD]. Click the [OK] button to finish.

Notes on speed input by reference target

• Reference targets are only used for the calculation of true speed.
• Do not use reference target generated true speed to calculate relative speed. Relative speed data is not accurate because response to speed change is slow, hampering the TT's ability to accurately judge the possibility of collision.
• Select a stationary target as a reference target to calculate own ship speed as ground tracking speed. Do not choose a moving target as a reference target. A moving target produces error in the vector for TT and AIS, which results in wrong collision avoidance information. Further, an unstable stationary target produces inaccurate speed data and the target itself may become lost.
• When a reference target is lost or goes out of the acquisition range, the reference target mark flashes and the Alert 528 (ALF format: 193,2) "REF Target Lost" appears in the [Alert] box. If all reference targets are lost, the speed indication disappears. Select a different reference target if the currently selected one is lost.

- When all tracked targets are deleted, the reference target mark is also deleted and the target-based speed becomes invalid.
- Loss of reference target will affect the calculation of true speed and true course of targets. Further, own ship speed will be inaccurate.

How to cancel echo-referenced speed input

Right click the Sensor information, datum box then select [Select Sensor] and [Setting]. Open the [SPD] page and select a speed sensor.

3.4 Automatic Acquisition

This radar can automatically acquire and track a maximum of 200 targets. The maximum number of acquired targets ([NUMBER OF TT]) is set at the time of installation. The options are 200 ([MAX]) and 100.

The number of automatically and manually acquired targets is determined by the setting of [TT SELECT] in the [TT] menu.

A target just acquired automatically is marked with a dashed circle and a vector appears within one minute to indicate the target's motion trend. Within three minutes, the initial tracking stage is finished and the target becomes ready for stable tracking. At this time, the dashed circle changes to a solid circle.

Note: When connecting with the FAR-2xx7 series radar, the maximum number of acquired targets ([NUMBER OF TT]) should be set to 100 in the [RADAR INSTALLATION] menu. The service man only can set the [RADAR INSTALLATION] menu. Contact your dealer.

3.4.1 How to enable auto acquisition

1. Right-click the TT mode indication then select [TT Menu] to show the [TT] menu.
2. Select [1 TT SELECT] and the acquisition condition.

[NUMBER OF TT] is [MAX]		[NUMBER OF TT] is [100]	
Menu setting	Acquisition condition	Menu setting	Acquisition condition
[MANUAL 200]	200 targets manually, Not available for auto acquisition	[MANUAL 100]	100 targets manually, Not available for auto acquisition
[MANUAL 150 • AUTO 50]	50 targets automatically, 150 targets manually	[MANUAL 75 • AUTO 25]	25 targets automatically, 75 targets manually
[MANUAL 100 • AUTO 100]	100 targets automatically, 100 targets manually	[MANUAL 50 • AUTO 50]	50 targets automatically, 50 targets manually
[MANUAL 50 • AUTO 150]	150 targets automatically, 50 targets manually	[MANUAL 25 • AUTO 75]	75 targets automatically, 25 targets manually
[AUTO 200]	200 targets automatically, Not available for manual acquisition	[AUTO 100]	100 targets automatically, Not available for manual acquisition

3. Close the menu.

Note 1: The TT indication in the TT/AIS setting box shows [AUTO], [MAN/AUTO] or [MAN] depending on the acquisition condition selected.

Note 2: When the menu-set number of automatically acquired targets have been acquired, the Alert 523 (ALF format: 190,4) "TT Auto ACQ 100%" appears in the [Alert] box.

3.4.2   How to set an automatic acquisition zone

You can set an automatic acquisition zone to automatically track any targets entering the zone. The acquisition zone can be fan-shaped or polygonal. The maximum tracking range is set during the installation.

Fan-shaped zone of AZ1: The range is fixed at 3 - 6 NM (width 0.5 - 1.0 NM).
Fan-shaped zone of AZ2: The range is available between 0.7 - 24 (or 32) NM (width 0.5 - 1.0 NM)
Polygon zone of AZ2: The zone can be set within the range of 0.125 NM to 96 NM.

Note: When processing two acquisition zones, create the zones in numerical order and turn them off in reverse numerical order.

To set the zone for AZ2, first set the zone for AZ1.
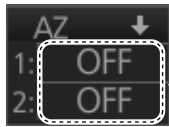
To turn off the zone for AZ1, first turn off the zone for AZ2.

When a target enters an acquisition zone, the following occurs:

- the buzzer sounds
- the Alert 521 (ALF format: 192,1) "TT New Target" appears in the [Alert] box
- the symbol of the target is red and flashes
- the AIS function is automatically turned on if it is off

1. Click one of the boxes AZ1 or AZ2 at the right side of the screen. The indication in the AZ box changes from [OFF] to [SET].

For example, click here for AZ1.
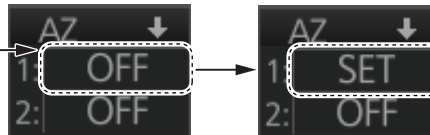
2. Click point A.
3. Click point B. The indication in the AZ box changes from [SET] to [WORK].

Acquisition zone

Other acquisition zone examples
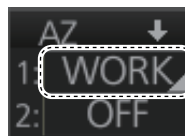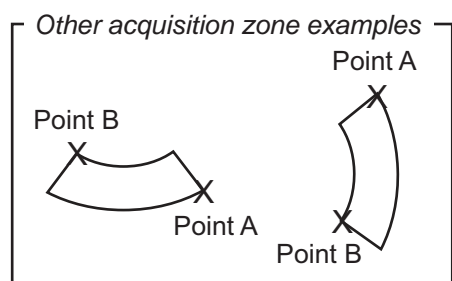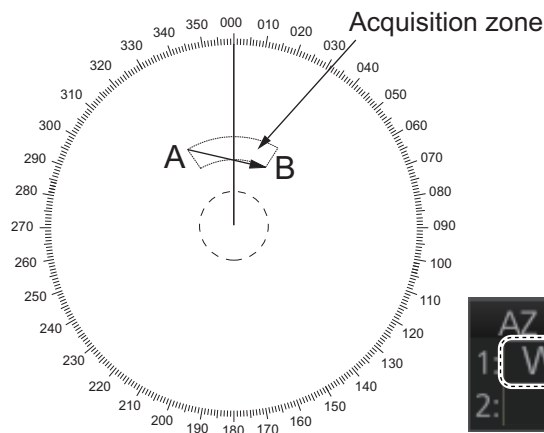
Note 1: You are alerted when the capacity for automatic acquisition is 95% and 100%. These alerts are 522 (ALF format: 10190,4) "TT Auto ACQ 95%" and 523 (ALF format: 190,4) "TT Auto ACQ 100%".

Note 2: If the range scale is changed to less than half of the acquisition zone, the AZ box shows [OUT]. If the left button is pushed in this state, the acquisition alarm zone goes into [SLEEP] state (inactive).

How to sleep, deactivate an acquisition zone

Use the trackball to select the appropriate AZ box. Sleep or deactivate the acquisition zone as appropriate:
Sleep acquisition zone: Push the left button momentarily to remove the acquisition zone from the screen. The indication in the AZ box changes from [WORK] to [SLEEP]. To reactivate and display the acquisition zone, repeat this procedure to display [WORK].
Deactivate acquisition zone: Click applicable AZ box and select [OFF].

How to acknowledge the acquisition zone audio alarm

Press the **ALARM ACK** key, or click the [Alert] box.

Acquisition zone stabilization

The acquisition zone may be referenced to heading or North. Open the menu then select the [TT•AIS] and [1 ACQUISITION ZONE] menus. Set [1 AZ STAB] to [STAB HDG] or [STAB NORTH] as appropriate. For a polygon acquisition zone, stabilization can be selected to [2 AZ POLYGON].

3.5   Manual Acquisition

This radar can manually acquire and track a maximum of 200 targets. The maximum number of acquired targets ([NUMBER OF TT]) is set at the time of installation. The options are 200 ([MAX]) and 100.

The number of automatically and manually acquired targets is determined by the setting of [TT SELECT] in the [TT] menu.

Note: When connecting with the FAR-2xx7 series radar, the maximum number of acquired targets ([NUMBER OF TT]) should be set to 100 in the [RADAR INSTALLATION] menu. The service man only can set the [RADAR INSTALLATION] menu. Contact your dealer.

3.5.1   How to set manual acquisition conditions

1. Right-click the TT mode indication then select [TT Menu] to show the [TT] menu.

2. Select [1 TT SELECT] and the acquisition condition.

[NUMBER OF TT] is [MAX]		[NUMBER OF TT] is [100]	
Menu setting	Acquisition condition	Menu setting	Acquisition condition
[MANUAL 200]	200 targets manually, Not available for auto acquisition	[MANUAL 100]	100 targets manually, Not available for auto acquisition
[MANUAL 150 • AUTO 50]	50 targets automatically, 150 targets manually	[MANUAL 75 • AUTO 25]	25 targets automatically, 75 targets manually

[NUMBER OF TT] is [MAX]		[NUMBER OF TT] is [100]	
[MANUAL 100 • AUTO 100]	100 targets automatically, 100 targets manually	[MANUAL 50 • AUTO 50]	50 targets automatically, 50 targets manually
[MANUAL 50 • AUTO 150]	150 targets automatically, 50 targets manually	[MANUAL 25 • AUTO 75]	75 targets automatically, 25 targets manually
[AUTO 200]	200 targets automatically, Not available for manual acquisition	[AUTO 100]	100 targets automatically, Not available for manual acquisition

3. Close the menu.

3.5.2 How to manually acquire a target

Acquire a target from the Control Unit

Use the trackball to put the cursor on the target you want to acquire. Push the **ACQ/ ACT** key.

Acquire a target by the trackball module

1. When the target to acquire and the AIS symbol overlap one another, push the right button to show the context-sensitive menu then select [Target Data/ACQ/ACT] and [TT Only] to acquire the target.

2. Put the cursor on the target to acquire then push the left button.

The plotting symbol is drawn by a dashed circle during the initial acquisition stage. A vector appears approximately one minute after acquisition. The vector indicates the motion trend of the target. If the target is consistently detected for three minutes, the plotting symbol changes to a solid circle. If acquisition fails, the target symbol blinks.

Note 1: For successful acquisition, the target should be within 24 NM (or 32 NM, depending on initial setting) from own ship and not obscured by sea or rain clutter.

Note 2: You are alerted when the capacity of manual acquisition is 95% and 100%. These alerts are Alert 524 (ALF format: 10190,5) "TT MAN ACQ 95%" and Alert 525 (ALF format: 190,5) "TT MAN ACQ 100%". If the capacity is 100% you cannot acquire more targets. Cancel tracking of non-threatening targets if you wish to acquire additional targets manually.

Note 3: When a target being tracked nears another target being tracked, the targets may be "swapped". When two targets acquired either automatically or manually come close to each other, one of the two may become a lost target. If this occurs, manual re-acquisition of the lost target may be necessary after the two have separated.

Note 4: You can reuse a target number. This is useful when you acquire the "wrong" target. Drag and drop the symbol onto the correct target.

3.6 How to Stop Tracking Targets (including reference targets)

When the TT has acquired the menu-set number of targets, the Alert 523 (ALF format: 190,5) "TT AUTO ACQ 100%" (automatic acquisition) or 525 (ALF format: 190,4) "TT MAN ACQ 100%" (manual acquisition) appears in the [Alert] box and no more auto or manual acquisition occurs unless targets are lost. Should this happen, cancel tracking of less important targets to acquire new targets.

3.6.1 How to cancel tracking on individual tracked targets

Cancel tracking on a target from the Control Unit

1. Use the trackball to put the cursor (+) on the TT or reference target to cancel tracking.
2. Push the **TARGET CANCEL** key.

Cancel tracking on a target by the trackball module

1. Right-click the operational area of the screen to show the context-sensitive menu.
2. Select [Target Cancel] and [Any] or [TT Only] as applicable.
3. Click the TT or reference target to cancel tracking.

3.6.2 How to cancel tracking on all TTs

Cancel tracking on all target from the menu

1. Right-click the TT mode indication on the bottom-right of the screen then select [TT Menu] to show the [TT] menu.
2. Select [2 ALL CANCEL].
3. Select [YES].
4. Close the menu.

Cancel tracking on all target from the Control Unit

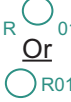Long-press the **TARGET CANCEL** key to erase all displayed TT target data.

3.7 TT Symbols and TT Symbol Attributes

3.7.1 TT symbols

The symbols used in this equipment comply with IEC 62288.

Symbol	Default color	Name	Description
•	Green	Past position marker	Past position point
◌	Green	Target under acquisition	Plotting symbol selected for a target acquired manually is shown in broken lines.
◌	Red	Target under automatic acquisition	Thick, broken circle around an echo to indicate the target under acquisition and initial stage of tracking, before steady-state tracking.

Symbol	Default color	Name	Description
○	Green	Acquired target	Solid circle with vector indicating steady state tracking (within three minutes after acquisition)
○	Red	Acquired target in ACQ zone (before acknowledgment)	Solid circle with vector indicating steady state tracking (within three minutes after acquisition)
○	Red	Dangerous target	Dangerous TT (thick, solid circle)
R ○ 01 Or ○R01	Green	Reference target	Used to calculate own ship's over-the-ground speed (echo-referenced speed) for ground stabilization.
△	Green	Association target	Association TT is shown in AIS symbol and TT data.
△	Red	Association dangerous target	Association dangerous TT is shown in AIS symbol and TT data.
⊗	Red	Lost target	Lost TT is shown with cross mark.
⌐ ⌐	Green	Target selected	TT selected to show its data.
T	White	Trial maneuver	Displayed (flashing) during trial maneuver test.
S	White	TT test	Displayed (flashing) during TT test.

3.7.2 TT symbol brilliance

1. Right-click the [BRILL] button on the InstantAccess bar™ then select [Brill Menu].
2. Go to page 2, select [4 TT SYMBOL] then spin the scrollwheel to adjust the brilliance.

```
←            MENU            →
  INITIAL SETTING
←  BRIGHTNESS
1  EBL
                    15
2  VRM
                    15
3  PI LINE
                    15
4  TT SYMBOL
                    15
5  AIS SYMBOL
                    15
6  MARK
                    15
7  CHART
                    15
→  NEXT (2/2→1/2)
```
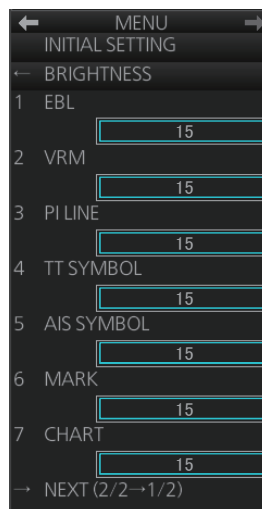
3.7.3 Color for TT symbol

You can select the color for the TT symbol as follows:

1. Right-click the TT mode indication then select [Symbol Menu] to show that menu.
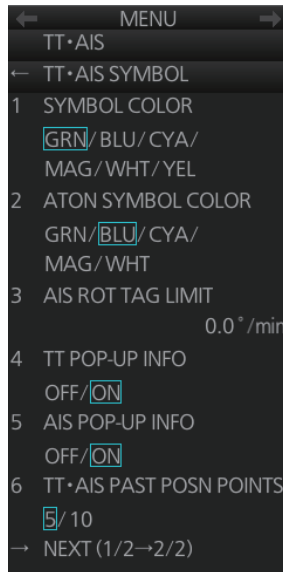
2. Select [1 SYMBOL COLOR] and desired color. (Yellow is available with the A- and B-type.)

3.8 How to Display TT Data

The TT mode provides the full functionality of TT as required by the IMO MSC.192(79) and IEC 62288, including display of range, bearing, course, speed, CPA and TCPA of all tracked targets.

The target bearing is show in relative bearing in the head-up mode and true bearing in the course-up, north-up and true motion modes, with the suffix "R" (Relative) or "T" (True).

The target speed and course are shown as speed over the ground or speed through the water depending on speed source.

3.8.1 How to display target data for individual TT

You can show the data for two (19-inch display) or three (23-inch display) tracked targets in the TT information window.

From the Control Unit

Put the cursor on a target then push the **TARGET DATA** key.

By trackball module

Click the target for which you want to show its data.

Tracked target data

- To erase data from a data box, click the appropriate close data button.
- The basic target data display for a TT consists of the following information:
  - TT no. Target numbering starts from "1". When a target is erased the number will not be reused until the power is re-set or more than 200 targets are acquired.
  - Bearing (BRG) and distance (RNG) of the target from own ship
  - True speed over the ground (SOG) and true course over the ground (COG) of the target
  - CPA and TCPA. A negative TCPA value means that you have already passed the closest point and the TT is going away from own ship.
 - Bow Crossing Range (BCR) and Bow Crossing Time (BCT)

|		
Title bar → TT		⤺ ↓ ↑ ✕
TT no. →	001 ✕	002 ✕
Bearing → BRG	137.0° T	138.5° T
Range → RNG	8.587NM	8.726NM
Course over ground → T COG	040.0° T	062.5° T
Speed over ground → T SOG	9.81kn	7.35kn
CPA → CPA	5.724NM	5.847NM
TCPA → TCPA	-33:24	-35:48
Bow crossing range → BCR	-7.171NM	-7.326NM
Bow crossing time → BCT	-12:05	-13:03

Number of TT/AIS target data box to display

You can select how many target data boxes to display with the following procedure.

1. Open the menu, then select [4 INFORMATION BOX] and [4 TARGET DATA].

2. Select the number of boxes to display from [1 BOX], [2 BOX], or [3 BOX].
   Note: The [3 BOX] option is not available for 19 inch monitors.

3. Close the menu.

The target data are displayed from bottom up in order of acquisition. When target data box(es), information box and zoom display are available, target data box(es) has priority.

[3 BOX] selected
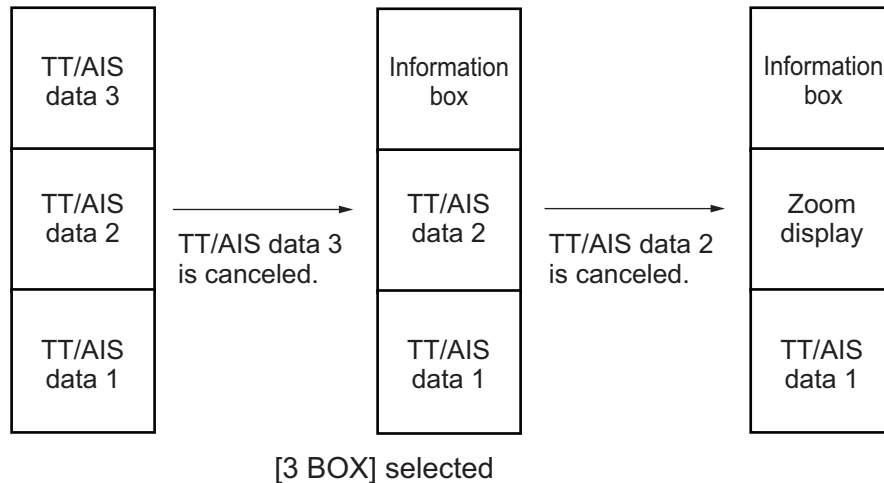
3.8.2 TT pop-up information

The TT pop-up shows abbreviated TT data (target no., COG, SOG, CPA and TCPA) for the selected TT. Simply put the cursor on the TT symbol to show the pop-up. The pop-up can be enabled or disabled with [TT POP-UP INFO] in the [TT•AIS SYMBOL] menu.


```
TT(02)
COG:    227.3°T
SOG:     8.27kn
CPA:  5.012NM
TCPA:    -13:45
```
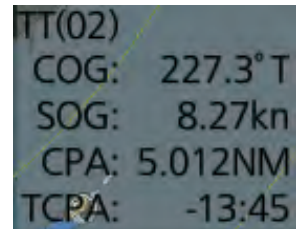
3.8.3 Target list

The target list shows the data for all tracked targets and AIS targets. To show the list, click the [Target List] button at the right side of the screen or press the **TARGET LIST** key on the Control Unit. (The button is light-blue when the target list is displayed.)

To close the list, click the Close button (×) on the list or press the **TARGET LIST** key.

Filter targets: →

ALL TGT
TT ONLY
AIS ONLY
DISP FILTER

Click to refresh data →

Target List (1/ 1)   ×
Sort by: CPA   ▼   ← Sort targets by:
Filter: ALL TGT   ▼
←   CLOSE

CPA
TCPA
BCR
BCT
RANGE
SPEED
NAME

1   TT Target
No. 21
BRG: 125.5°T   RNG 3.434NM
CPA: 2.923NM TCPA: 12:00

2   AIS Target   (INFO: A) ← [INFO] column: Click to show/hide the
FURUNO   target information for each target. The
BRG: 120.2°T   RNG: 5.211NM   information displayed varies depending
CPA: 3.345NM TCPA: 14:30   on the target selected.
                                     • For AIS targets: The order in which the
3   AIS Target   targets appear in the details window is
VOYAGER   displayed (A, B or C). For example, a
BRG: 88.2°T   RNG: 7.321NM   target with the indication "B" in the [INFO]
CPA: 3.662NM TCPA: 16:25   column appears in the second target
                                     details box.
                                     "C" is not shown for 19" monitors.
0   Refresh data   • For TT targets: The target number (01
→ Next   to 200) appears.
                                     • For reference targets: The referrence
                                     number (R01 to R03) appears.

How to sort the list

You can sort the list by CPA, TCPA, BCR, BCT, RANGE, SPEED or NAME, with the [Sort by] drop-down list.

How to filter the list

The list shows all tracked targets and AIS targets received. If you do not need to see all targets you can filter unnecessary ones. Use the [Filter] drop-down list to select what targets to filter: Show all targets, TT only, AIS targets only, or show only the AIS targets that meet the criteria set on the [DISP FILTER] menu.

3.9   Vector Modes

Target vectors can be displayed relative to own ship's heading (Relative) or North (True).

Note: IMO recommends the use of the true vector mode in sea stabilization or relative vector mode for collision avoidance.

3.9.1   Description of vectors

Stabilization modes

It is important to select the optimum stabilization mode for the radar display. To assess risk of collision the relative motion of a target gives the clearest indication of CPA and may be monitored by observing either the direction of the target's relative trail, or the CPA predicted by the relative vector. By default, relative motion displays relative target trails and true motion displays true target trails. Where true target trails is selected, a sea stabilized display will indicate all targets' motion through the water. A ground stabilized display will indicate all targets' motion over the ground.

In coastal, estuarial and river waters where a significant set and drift may be experienced, a sea stabilized display will produce significant target trails from all fixed (stationary) objects possibly producing an unacceptably high level of clutter and masking. In such circumstances a ground stabilized display may reduce its effect and enable the observer to detect clearly the trails of moving targets, thus enhancing the observer's situational awareness.

However, the display should be considered only as an approximation of the course and speed made good over the ground. Among other factors, the accuracy of the ground-stabilization is affected by inaccuracies in speed and heading inputs as well as radar measurement imprecision and will require the display to be readjusted periodically. The information displayed should be interpreted with due regard to these factors.

Note: It should be noted that in determining a target's aspect by radar; the calculation of its true track is dependent on the choice and accuracy of the own ship's course and speed input. A ground-stabilized target plot may accurately calculate the ground track of the target, but the target's heading may be significantly different from its track when experiencing set, drift or leeway. Similarly, a sea stabilized target plot may be inaccurate when own ship and the target, are experiencing different rates of set, drift or leeway.

Ground stabilization and sea stabilization

Target vectors can be ground stabilized or sea stabilized. To select speed over the ground or speed through the water data, open the page from the menu. Select for ground stabilization or for sea stabilization. The Vector mode indication shows the stabilization mode in the true motion as [True-G] or [True-S].

Sea stabilization is a mode where own ship and all targets are referenced to the sea using a compass heading and single-axis log water speed inputs in the true motion mode. Ground stabilization is a mode where own ship and all targets are referenced to the ground using the ground track or set and drift inputs. If the accuracy seems unsatisfactory, enter set and drift corrections. Note that set and drift should not be used when the radar is displaying AIS targets.
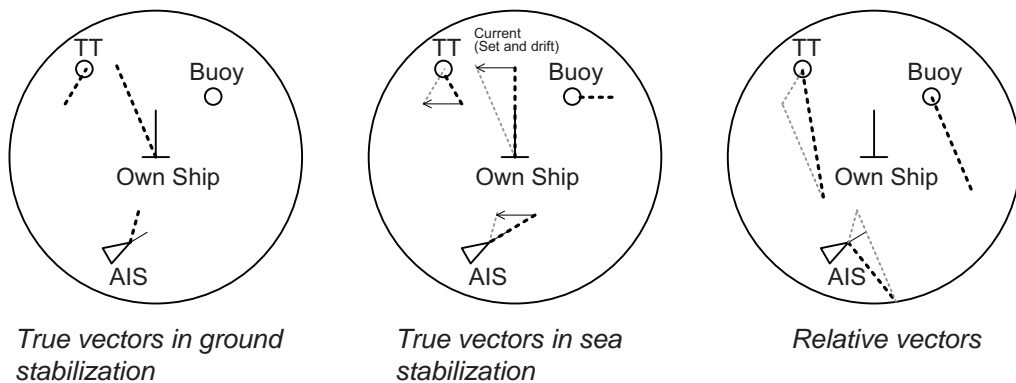
True vector

In the true motion mode, all fixed targets such as land, navigational marks and ships at anchor remain stationary on the radar screen with vector length zero. But in the presence of wind and/or current, the vectors appear on fixed targets representing the reciprocal of set and drift affecting own ship unless set and drift values are properly entered.

In the true vector mode, there are two types of stabilization: ground stabilization (True-G) and sea stabilization (True-S). The stabilization mode is automatically selected according to speed selection, as shown in the table below. Manual selection is available with [Stabilization Mode] in the [SPD] page in the [Sensor Settings] menu.

Speed selection	True vector mode
LOG(WT)	True-S
LOG(WTC)	True-G
LOG(BT)	True-G
GPS(BT)	True-G
REF(BT)	True-G
MAN(WT)	True-S
MAN(WTC)	True-G

Relative vector

Relative vectors on targets that are not moving over the ground such as land, navigational marks and ships at anchor will represent the reciprocal of own ship's ground track. A target whose vector passes through own ship is on a collision course. (Dotted lines in the figure are for explanation only.)

True vectors in ground stabilization

True vectors in sea stabilization

Relative vectors

3.9.2 Vector motion and length

Vectors may be displayed in true or relative motion. Vector time (or the length of vectors) can be set between 30 seconds and 60 minutes.

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

From the Control Unit

Vector motion: Push the **VECTOR MODE** key consecutively to select relative or true vector mode. Your selection is shown in the Vector mode indication.

Vector length: Push the **VECTOR TIME** key consecutively to select vector time, among 30 seconds, 1 minute, 3 minutes, 5 minutes, 6 minutes, 10 minutes, 20 minutes, 30 minutes, 45 minutes and 60 minutes.

By trackball module

Vector motion: Click the vector motion indication at the right side of the screen to select relative or true vector mode.

Vector length: Click the vector time indication at the right side of the screen to select time among 30 seconds, 1 minute, 3 minutes, 5 minutes, 6 minutes, 10 minutes, 20 minutes, 30 minutes, 45 minutes and 60 minutes. Or, spin the scrollwheel to select the length from 30 seconds or 1 - 60 minutes, in one-minute intervals.
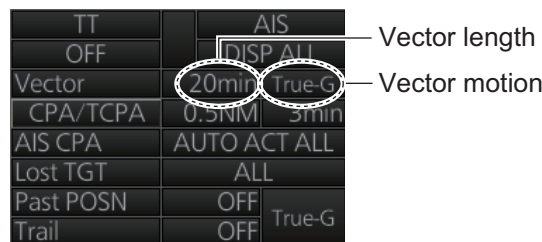
3.10 Past Position Display

The past position display shows equally time-spaced dots marking the past positions of any targets being tracked.
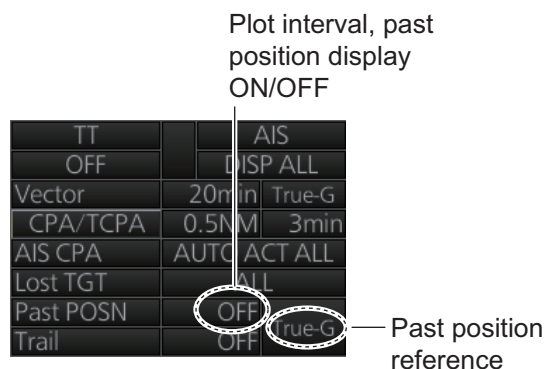
If a target changes its speed, the spacing will be uneven. If it changes the course, its plotted course will not be a straight line. See the illustration below for dot pattern and ship status.
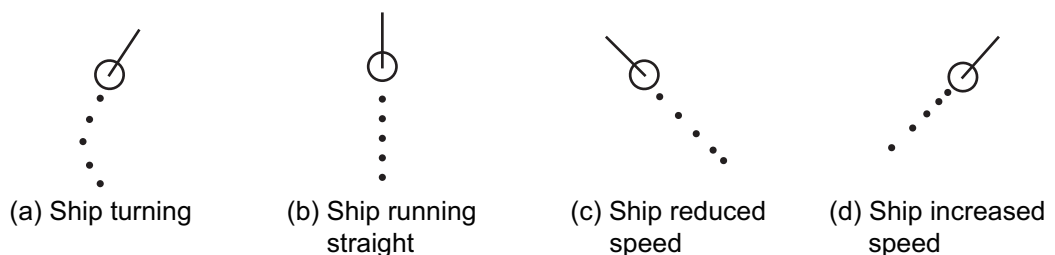
(a) Ship turning   (b) Ship running straight   (c) Ship reduced speed   (d) Ship increased speed

3.10.1 How to enable/disable the past position display, select past position reference

Click the indications circled in the figure below to set the plot interval (or disable the display) and the past position reference (true or relative).

Plot interval, past position display ON/OFF

TT	AIS
OFF	DISP ALL
Vector	20min	True-G
CPA/TCPA	0.5NM	3min
AIS CPA	AUTO	ACT ALL
Lost TGT	ALL
Past POSN	OFF
Trail	OFF	True-G

Past position reference

3.10.2 Past position points

You can show 5 or 10 past position points per tracked target. Right-click the past position indication then select [Past POSN Menu] to show that menu. Set [6 TT•AIS PAST POSN POINTS] to [5] or [10].

3.11 How to Enter Set and Drift

Set, the direction in which a water current flows, can be manually entered in 0.1-degree steps. Drift, the speed of the tide, can also be entered manually in 0.1 knot steps.

When course through water and speed through water are available, activate set and drift to get course over ground and speed over ground.

Set and drift corrections are beneficial for increasing the accuracy of vectors and target data. Refer to the tide table on board the ship for setting information. These values are applied to all targets. If stationary targets have vectors, set and drift values should be adjusted until they lose vectors.

Note: For the IMO type, turn off the AIS function in order to enter set and drift.

To enter set and drift do the following:

1. Right-click the Sensor information then select [OS Info Menu] to show the [OWN SHIP INFO] menu.
2. Select [2 SYSTEM SETTING] or [3 LOCAL SETTING] as appropriate.

3. Use the right and left arrow buttons to select the [SPD] page.

Set speed and course of drift
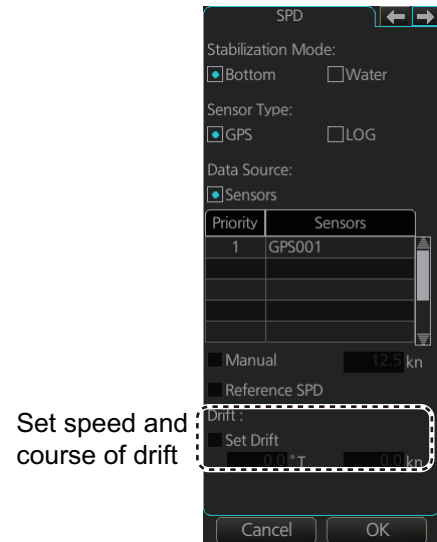
4. Set [Stabilization Mode] to [Water].

5. Click the [Set Drift] box to show a checkmark in the box.

6. Put the cursor in the course input box then spin the scrollwheel to select the set.

7. Put the cursor in the drift input box then spin the scrollwheel to select the drift.

8. Click [OK].

9. Close the menu.

Note: Set and drift should be checked periodically for correctness.

3.12   TT CPA/TCPA Alarm

The TT continuously monitors the predicted range at the Closest Point of Approach (CPA) and predicted time to CPA (TCPA) of each TT. When the predicted CPA of any TT becomes smaller than the preset CPA range and its predicted TCPA less than the preset TCPA limit, the audio alarm sounds and the Alert 526 (ALF format: 191,1) "TT CPA/TCPA" appears in the [Alert] box. In addition, the symbol of the offending TT is red and flashes together with its vector.

This feature, when used correctly, helps prevent the risk of collision by alerting you to threatening targets. It is important that the gain, sea clutter and rain clutter and other radar controls are properly adjusted.

The accuracy of TT calculations is a function of several variables including target glint, clutter conditions and signal-to-noise ratio. The design of the TT minimizes the effects of these variables but you must be aware that such errors will produce inaccuracies in the derived CPA and TCPA in particular during the initial tracking period.

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

The TT CPA/TCPA alarm should not be solely relied upon to warn you of collision situations. The operator should check all aids to navigation to monitor possible collision situations.

3.12.1 How to set the CPA and TCPA limits

To set the CPA and TCPA ranges, do the following:

1. If the values for CPA and TCPA are blank, click [CPA/TCPA] to show them.

2. Click the CPA indication to select desired CPA range (0.1-20 NM).

3. Click the TCPA indication to select desired TCPA time (1-60 minutes).

CPA setting   TCPA setting

3.12.2 How to enable, disable the TT CPA/ TCPA alarm

The TT CPA/TCPA alarm can be enabled or disabled from the TT/AIS box. Click the indication shown in the right figure to enable or disable the TT CPA/TCPA alarm. The alarm is disabled when the CPA and TCPA settings are not shown.

3.12.3 How to acknowledge the TT CPA/TCPA alarm

When the CPA or TCPA of a target is within the CPA and TCPA limits, the Alert 526 (ALF format: 191,1) "TT CPA/TCPA" appears in the [Alert] box and the audio alarm sounds. To acknowledge the alarm and silence the buzzer, push the **ALARM ACK** key on the Control Unit, or click the alert indication in the [Alert] box.

The alert in the [Alert] box and the flashing of the plotting symbol and vector continue until the dangerous situation is gone or you intentionally terminate tracking of the target.

3.13 TT Lost Target Alert

Tracked targets not detected in nine consecutive scans become "lost targets". When this occurs;

- A red × is put on the TT symbol (flashing) of the lost target. (The lost target symbol disappears after the lost target alert is acknowledged.)
- The audio alert sounds and the Alert 527 (ALF format: 193,1) "TT Lost" appears in the [Alert] box.

3.13.1 How to enable, disable the TT lost target alert

The [Lost TGT] indication at the bottom-right position enables, disables the lost target alert. Click the indication to select [OFF], [FILT] or [ALL] as appropriate.

[OFF]: Disable the alert.
[FILT]: Get the alert against the targets whose criteria meet the settings made in section 3.13.2.
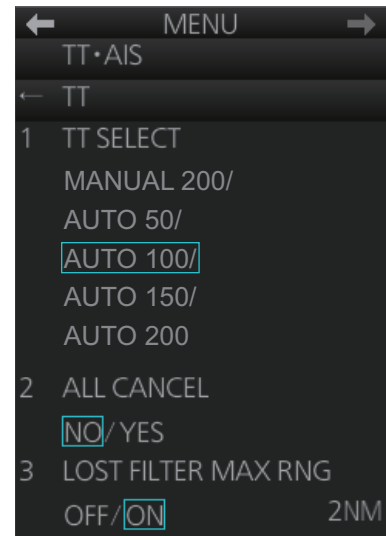[ALL]: Get the alert against all lost targets.

Note: The [Lost TGT] setting is shared commonly between TT and AIS.

3.13.2 How to set the TT lost target filter

If you are in an area where tracked targets are lost frequently, you may want to disable the lost target alert against certain tracked targets, by maximum range.

1. Right-click the TT mode indication then select [TT Menu] to show that menu.
2. Select [3 LOST FILTER MAX RNG].
3. Select [ON]. Select the range setting then spin the scrollwheel to set the range. Any TT lost targets beyond this range will not trigger the TT lost target alert.
4. Close the menu.

```
←        MENU         →
  TT·AIS
←  TT
1  TT SELECT
   MANUAL 200/
   AUTO 50/
   AUTO 100/
   AUTO 150/
   AUTO 200
2  ALL CANCEL
   NO / YES
3  LOST FILTER MAX RNG
   OFF / ON          2NM
```

3.14 Trial Maneuver

The trial maneuver feature simulates the effect of own ship's movement against all tracked targets, without interrupting the updating of target information. It is available for use with the TT and AIS functions. For more accurate results, use relative motion and sea stabilization (water tracking).

3.14.1 Types of trial maneuvers

There are two types of trial maneuvers: dynamic and static.

Dynamic trial maneuver

A dynamic trial maneuver displays predicted positions of the tracked targets and own ship. You enter own ship's intended speed and course with a certain "delay time." Assuming that all tracked targets maintain their present speeds and courses, the targets' and own ship's future movements are simulated in 0.5-second increments indicating their predicted positions in 30-second intervals as illustrated in the right figure.

The delay time represents the time lag from the present time to the time when own ship will actually start to change her speed and/or course. You should therefore take into consideration own ship's maneuvering characteristics such as rudder delay, turning delay and acceleration delay. This is particularly important on large vessels. How much the delay is set the situation starts immediately and ends in a minute.
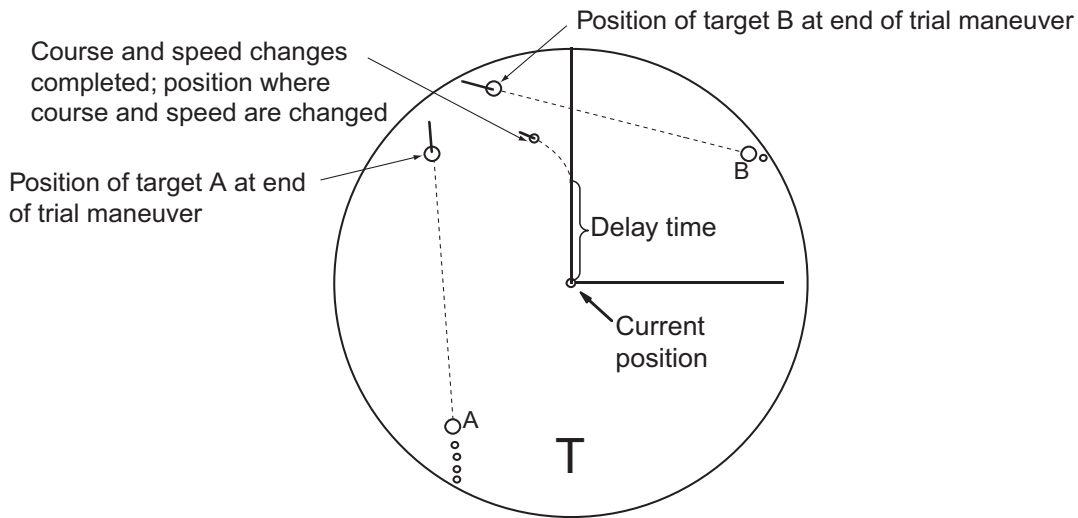

Delay time = 2 m 30 s.

Current position
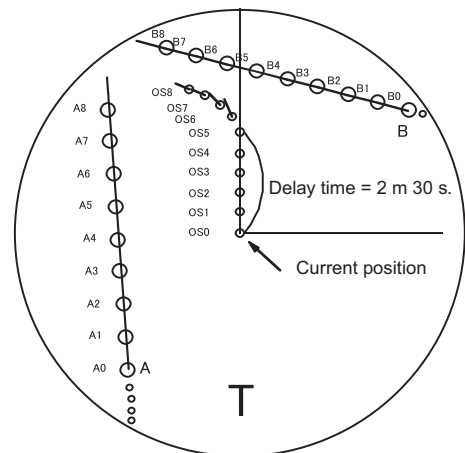
In the example shown below, own ship will advance straight ahead (even after a maneuver) for a delay time of 2:30 and alters speed and course until operator-specified intended speed and course are achieved (position OS7 in this example).

Static trial maneuver

The static trial maneuver shows the relationship between your ship and tracked targets at the completion of the trial maneuver. The expected position of TTs at the end of the trial maneuver are shown on the display.

By shortening and extending the trial time you can find the safe time to make a maneuver. Thus, the static trial maneuver will be convenient when you wish to know the maneuver result immediately.

Position of target B at end of trial maneuver

Course and speed changes completed; position where course and speed are changed

Position of target A at end of trial maneuver

Delay time

Current position

## 3.14.2 How to do a trial maneuver

To do a trial maneuver:

1. Right click the DELAY setting in the [Trial] box (see step 7) then select [Trial Maneuver Menu].

2. Select [1 TRIAL MANEUVER] then select [STATIC] or [DYNAMIC] as appropriate.

3. Select [2 SPEED RATE] then set the speed rate with the scrollwheel.

4. Select [3 TURN RATE] then set the turn rate with the scrollwheel.
   Note: Two sets of trial speed and trial turn rate combinations are provided. This is done to provide accurate trial maneuver results for various ship's speeds and turn rates.

5. **For the B-type radar**, select [4 TGT DATA] then select whether to use [ACTUAL] or [TRIAL] data. (Skip this step if your radar is the IMO or A type.)

6. Close the menu.
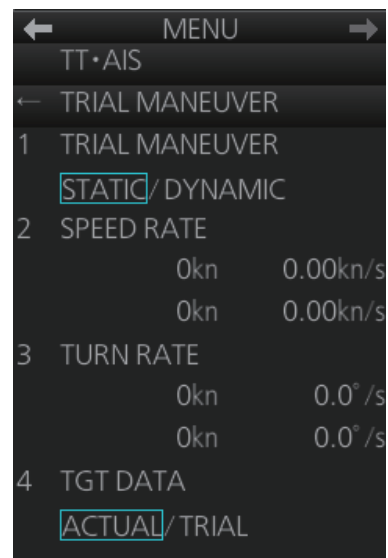
7. Find the [Trial] box at the right side of the screen.

Trial time ———►
Trial course ———►
Trial speed ———►
Trial delay time ———►
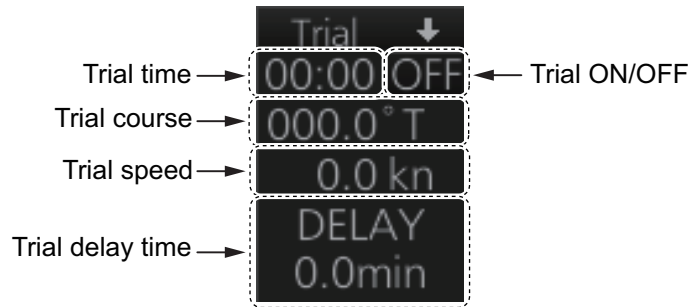
Trial ———► ◄——— Trial ON/OFF

8. Right-click the Trial title bar, select [Trial Mode] then select a trial mode, [Static] or [Dynamic].

9. Click the Trial ON/OFF indication to show [ON].

10. Put the cursor on the Trial course indication. Spin the scrollwheel to set the trial course.

11. Put the cursor on the Trial speed indication. spin the scrollwheel or use the Control Unit to set the trial speed.

12. Put the cursor on the [DELAY] indication. Spin the scrollwheel to set the amount of delay. This is the time after which own ship takes a new situation, not the time the simulation begins. Change the delay time according to own ship loading condition, etc.

The time indication depends on trial mode:

Dynamic mode: The position of your ship and TTs is displayed every 30 seconds and updating occurs every 0.5 seconds.

Static mode: The position of your ship and TTs when set course and speed are reached are displayed. Put the cursor in the Trial time indication and roll the scrollwheel. Increase or decrease the time to get a safe maneuver. If a maneuver is unsafe, change speed, course and delay until it is safe.

The trial maneuver takes place with the letter "T" displayed at the bottom of the screen. The time appears at the top-right position on the display. If any TT is predicted to be on a collision course with own ship (that is, the target ship comes within preset CPA/TCPA limits), the target plotting symbol flashes. If this happens, change own ship's trial speed, course or delay time to obtain a safe maneuver.

3.14.3 How to terminate a trial maneuver

The termination method depends on the trial mode as follows:
Dynamic mode: The trial is terminated when 60 minutes is shown in the Trial time indication.
Static mode: The trial is terminated when you terminate the trial maneuver manually.

To terminate the trial maneuver manually, click the Trial ON/OFF indication to show [OFF].
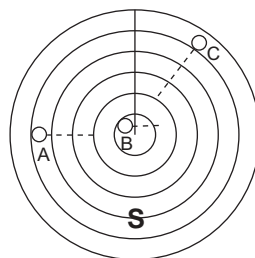
3.15 TT Simulation Mode

You can simulate the risk of collision by using the TT simulation mode and the trial maneuver together.

1. Execute the TT simulation mode as follows:

   1) Open the menu then select [8 INITIAL SETTING] and [8 TT SIMULATION MODE].

   2) The confirmation message "Attention: Do you wish to start TT SIMULATION MODE?" appears. Click the [OK] button to start the test.

2. The normal operation is suspended then three simulated targets appear on the display.
   The indication "S" appears at the bottom of the effective display area during the simulation mode. The simulation may be terminated any time by going to the STBY mode.
   Three simulated targets move as the following table. The simulated target is automatically generated with the relative movement in the following table based on own ship's movement at the start of simulation mode.
   Note: If own ship moves after the start of simulation mode, the movement of the simulated target is not matched with the values in the following table.

	Range (R)	Bearing (R)	Speed (R)	Course (R)	CPA	TCPA
Target A	9.5 NM	270.0°	20.0 kn	90.0°	0.0 NM	28.5 min
Target B	1.1 NM	333.0°	10.2 kn	90.2°	1.0 NM	2.9 min
Target C	9.3 NM	45.0°	19.9 kn	225.1°	0.0 NM	28.0 min

3. Acquire the simulated targets after the TT simulation mode is performed. The tracking state changes from unstable to stable and the vector appears. You can simulate the movement of each function with changing true/relative vector, stabilization through the water/over the ground, range or length of vector.

4. After the target B crosses in front of own ship, that is the target B is not a dangerous target, you can simulate the risk of collision by using the trial maneuver as follows:

   1) Set the TT CPA/TCPA alarm. For example, set 0.5 nm for CPA, 30 min for TCPA.

   2) Execute the trial maneuver (see section 3.14). In the static mode, the movements of own ship and the target after the time set as the trial time elapses are displayed. If the target is dangerous after the time set as the trial time elapses, its symbol is the one for the dangerous target. Adjust the trial course and trial delay time so the target symbol does not become the dangerous symbol when executing the trial maneuver.

3.16 TT Alerts

The table below list situations that cause the TT to trigger visual and audio alerts. To acknowledge the audio alerts, push the **ALARM ACK** key, or click the [Alert] box.

Alert No.	Message	Category	Description
ALR: 521 ALF: 192,1	TT New Target	Warning	Tracked target entered the acquisition zone.
ALR: 522 ALF: 10190,4	TT Auto ACQ 95%	Caution	The capacity for auto acquisition has reached 95%.
ALR: 523 ALF: 190,4	TT Auto ACQ 100%	Warning	The capacity for auto acquisition has reached 100% and no more target acquisition is possible. Cancel tracking on unnecessary targets.
ALR: 524 ALF: 10190,5	TT Man ACQ 95%	Caution	The capacity for manual acquisition has reached 95%.
ALR: 525 ALF: 190,5	TT Man ACQ 100%	Warning	The capacity for manual acquisition has reached 100% and no more target acquisition is possible. Cancel tracking on unnecessary targets.
ALR: 526 ALF: 191,1	TT CPA/TCPA	Alarm	Tracked target on collision course. Take evasive action.
ALR: 527 ALF: 193,1	TT Lost	Warning	Tracked target lost. Check target.
ALR: 528 ALF: 193,2	REF Target Lost	Warning	Tracked target used for speed input is lost. To continue using reference target for speed input, select another tracked target.

3.17 Criteria for Selecting Targets for Tracking

The FURUNO TT video processor detects targets in midst of noise and discriminates radar echoes on the basis of their size. Target whose echo measurements are greater than those of the largest ship in range or tangential extent are usually land and are displayed only as normal radar video. All smaller ship-sized echoes that are less than this dimension are further analyzed and regarded as ships and displayed as small circles superimposed over the video echo.

When a target is first displayed, it is shown as having zero true speed but develops a course vector as more information is collected. In accordance with the IMO requirements for TT, an indication of the motion trend should be available within 20 scans of antenna and full vector accuracy within 60 scans. The FURUNO TT complies with these requirements.

Echo detection (quantization)

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

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

The same is true of radar interference. Electronic circuits track both the closest and most distant edges of the echo. At the end of the scanning of the echo, the discriminator indicates the measured maximum range extent and total angular extent subtended by the echo. If the echo is larger than a ship-sized echo in range extent and/or angular width, adjusted as a function of range, it is declared to be a land. This land echo is not used by TT acquisition and tracking process. All smaller echoes are declared to be ship sized and the middle of the leading edge is used to provide precise range and bearing coordinates of each echo on every scan. This range/bearing data is matched to previous data and analyzed from scan-to-scan for consistency. When it is determined to be as consistent as a real target, automatic acquisition occurs and tracking is initiated. Continued tracking and subsequent calculation develop the relative course and speed of the target.

Acquisition

A target that is hit by five consecutive radar pulses is judged to be a radar echo. Manual acquisition is done by designating a detected echo with the trackball. Automatic acquisition is done in the acquisition areas when a target is detected 5-7 times continuously depending upon the congestion.

Tracking

The range and bearing of an echo are found from the relative distance of the target from the radar antenna. The distance a tracked target moves between radar antenna rotations is used to calculate the relative speed of the tracked target. However, because of calculation error, smoothing is applied to get stable target speed and course data. When a target changes course, smoothing is reduced in order to quickly follow target movement.

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

Required tracking facilities are available within 0.1-32 nm on range scales including 3, 6, 12 nm, full plotting information is available within one scan when the range scale is changed. Targets not detected in nine consecutive scans become "lost targets."

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

The REF point for tracked target calculation can be the radar antenna position or the CCRP. For CCRP, the displayed value includes the distance between the CCRP and the antenna position. Therefore, when switching the REF point, the range, bearing, CPA and TCPA of the tracked targets change.

Qualitative description of tracking error

The FURUNO TT's accuracy complies with or exceeds IMO standards.

Own ship maneuvers

For slow turns there is no effect. For very high turning rates (greater than 150°/minute, depending on gyro), then all tracked targets revert to full accuracy.

Other ship maneuvers

Target ship courses; lag 15 to 30 seconds at high relative speed, or 3 to 6 seconds at low (near 0) relative speed. It is less accurate during a turn due to lag, but accuracy recovers quickly.

3.18 Factors Affecting Target Tracking

Sea returns

If the radar anti-clutter control is adjusted properly, there is no serious effect because distant wave clutter, not eliminated by this control, is filtered out by more than one bang correlation and scan-to-scan matching of data.

Rain and snow

Rain clutter can be acquired and tracked as targets. Adjust the rain clutter control to suppress the clutter. If it is heavy rain, switch on the interference rejector on the radar. If heavy clutter still exists, switch to manual acquisition. Accuracy can be affected.

Low clouds

Usually no affect. If necessary, adjust the rain clutter control.

Non-synchronous emissions

No effect.

Low gain

Insufficient or low radar receiver gain will result in some targets not being acquired at long distance. The TT display will be missing on one or more targets that could only be visible if the radar sensitivity control (**GAIN** control) were increased.

The setting of the correct radar receiver gain is not critical but the target should be on the radar PPI and be clearly visible and well defined.

Manual acquisition is done if a target is positively displayed more than once. Automatic acquisition is done when the target is detected 5-7 times continuously.

Tracking continues if a return echo is received at least once in nine antenna rotations. However, the fewer the return echoes the lower the accuracy. If no return echo is received within nine antenna rotations the target is declared a lost target.

Second trace echoes

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

Blind and shadow sectors

Radar shadow or blind areas caused by obstructions aboard the ship, for example, funnels and masts, in the path of the radar beam can result in reduction of radar beam intensity in that particular direction. This may eliminate the detection of some targets.

The TT system will lose track of targets shortly after they are lost on the radar picture and if they remain in a blind zone. These targets will however be acquired and tracked when they pass out of the blind zone and again present normal radar echo. The angular width and bearing of any shadow sector should be determined for their influence on the radar. In certain cases false echoes in the shadow sector cause the TT system to acquire, track, and vector them. Shadow sectors should be avoided.

Indirect echoes

A target at close range is usually picked up directly, but it can also be received as reflection from a large, flat surface. This will result in the radar presenting two or more echoes on the display, each at a different range. The TT system can acquire and track a false echo if it is detected in five consecutive scans. Reduction in radar gain can eliminate the multiple echoing but care should be taken as range detection also will be reduced.

Radar interference

If interference is extreme due to another radar operating at close range, spiral "dotting" and/or false targets may appear momentarily. The interference rejector can clear the display.

Delay of sensor input

If the refresh rate of the gyrocompass signal is too slow, error in target bearing occurs when own ship turns. To prevent this error, the refresh rate of the gyrocompass signal must be as indicated in the System Configuration drawings.

4. AIS OPERATION

An AIS transponder can be connected to this radar to overlay AIS targets on the radar display. The radar can store up to 2,000 AIS targets in its storage buffer. When this buffer becomes full of AIS targets, the Alert 533 (ALF format: 190,2) "AIS Target Capacity 100%" is generated to alert you to full storage buffer. The storage buffer contains automatic dead reckoning for all AIS targets, which is based on reported Speed Over the Ground (SOG), Course Over the Ground (COG), Rate Of Turn (ROT) and heading. The storage buffer also contains calculation of range, bearing, CPA, TCPA, etc. The CPA and TCPA limits set for dangerous targets are common for TT and AIS targets.

This radar can activate 500 AIS targets. The Alert 535 (ALF format: 190,1) "AIS Target Activate 100%" is generated when 500 AIS targets are activated.

This radar can display a maximum of 1,000 AIS targets. The Alert 531 (ALF format: 190,3) "AIS Target Display 100%" is generated when 1,000 AIS targets, which includes both activated and sleeping targets, are displayed.

The frequency for update of AIS transponder-sent data depends on speed and course of tracked AIS target. The table below shows the IMO standardized reporting rates for the AIS transponder. Based on the table below, the radar defines which AIS targets are in tracking or lost. When you acknowledge a lost target alert, the corresponding AIS symbol will be removed from the display.

Type of Ship	IMO nominal reporting interval	Lost target indication (reporting interval >)
Class A: Navigation status is "anchor" or "not under command" or "moored" or "aground", and SOG ≤ 3kn	3 min	10 min
Class A: Navigation status is "anchor" or "not under command" or "moored" or "aground", and SOG > 3kn	10 s	50 s
Class A: 0kn ≤ SOG < 14kn	10 s	50 s
Class A: 14kn ≤ SOG ≤ 23kn	6 s	30 s
Class A: SOG > 23kn	2 s	10 s
Class B: "CS" SOG < 2kn	3 min	10 min
Class B: "CS" SOG ≥ 2kn	30 s	150 s
Class B: "SO" 0 kn ≤ SOG < 2kn	3 min	10 min
Class B: "SO" 2 kn ≤ SOG < 14kn	30 s	150 s
Class B: "SO" 14 kn ≤ SOG ≤ 23kn	15 s	75 s
Class B: "SO" SOG > 23kn	5 s	25 s
Class A and Class B: no SOG available	N/A	10 min
AIS SAR aircraft	10 s	50 s
AIS aid to navigation	3 min	10 min
AIS base station	10 s	50 s
AIS search and rescue transponder	N/A	10 min

Note: AIS operations on IMO-types require the WGS-84 Datum. Make sure the GPS connected to the radar is set to WGS-84.

An AIS transponder "sees" all ships fitted with an AIS transponder belonging to either a Class A or Class B AIS. Additionally, the AIS transponder receives messages from ships and non-ships (AIS SAR aircraft, AIS aid to navigation, AIS base station, and AIS search and rescue transmitter).

There can be several hundreds or several thousands of AIS targets, and of those only a few will be significant for your ship. To remove unnecessary AIS targets from the radar display, the feature "active and sleeping AIS targets" is available. Initially any new AIS target received by an AIS transponder is not active (="sleeping"). Such sleeping targets are shown with a small triangle. The operator can pick any AIS target and change it from sleeping to active. Active AIS targets are shown with a large triangle with speed vector, headline, ROT indicator, etc. Further, the operator can pick active AIS targets and change their status to sleeping.

An indication of AIS target activated capacity limit is given well before it is reached. When 95% of 500 targets are activated, the Alert 534 (ALF format: 10190,3) "AIS Target Activate 95%" appears. When 500 targets are activated, the Alert 535 (ALF format: 190,3) "AIS Target Activate 100%" appears.

An indication of AIS target display capacity limit is given well before it is reached. When 95% of 1,000 targets are displayed, the Alert 530 (ALF format: 10190,1) "AIS Target Display 95%" appears. When 1,000 targets are displayed, the Alert 531 (ALF format: 190,3) "AIS Target Display 100%" appears.

An indication of AIS target processing capacity limit is given well before it is reached. The Alert 533 (ALF format: 190,2) "AIS Target Capacity 100%" appears when 2,000 targets are in the storage buffer.

This radar generates AIS-related alerts. These are Alert 536 (ALF format: 191,2) "AIS CPA/TCPA" and Alert 537 (ALF format: 193,3) "AIS Lost". Only active AIS targets generate alerts. The operator can activate or sleep AIS target alerts as desired. The feature "active and sleeping AIS targets" is very effective for focusing on only those AIS targets that need supervision. This radar further eases the task of the operator by automatically changing non-active targets to active targets, if their CPA and TCPA are within a preset limit.

4.1   How to Deactivate the AIS Function

Long-click the AIS mode indication at the bottom-right position to display [FUNC OFF] to deactivate the AIS function (sleep all AIS targets) and AIS messaging facility. To activate AIS, push the left button again.

Note: You cannot enable AIS if any of the items listed below are active.

- Manual speed
- Manual set & drift
- Speed is calculated from reference targets

4.2   How to Show, Hide the AIS Display

Targets that are being tracked by an AIS transponder can also be displayed on the display. Click the AIS mode indication to select [DISP OFF], [DISP FILT] or [DISP ALL].

[DISP OFF]: Turn off the AIS display. (Tracking continues internally.)
[DISP FILT]: Filter AIS targets according to the settings of the AIS target filter. See section 4.4.
[DISP ALL]: Display all AIS targets.

4.3   AIS Symbols

Symbol	Default color	Name	Description
●	Green	AIS tracked target past position point	Mark past position.
▽	Green	Sleeping AIS target	Denote sleeping AIS symbol. (Lines are thinner than Active AIS symbol.)
◁	Green	Activated AIS target	Denote active AIS target, with vector for course and speed. (Lines are thicker than sleeping AIS symbol.) Color can be changed with the menu.
◁	Red (fixed)	Activated target in AZ (without acknowledgment)	Unacknowledged active AIS target in acquisition zone, with vector for course and speed. (Lines are thicker than sleeping AIS symbol.)
◁	Green	Activated target in AZ (with acknowledgment)	Acknowledged active AIS target in acquisition zone, with vector for course and speed. (Lines are thicker than sleeping AIS symbol.) Color can be changed with the menu.
	Green	Activated target, true scale symbol	Active AIS target with symbol shown in true scale. Association AIS symbol or activate AIS symbol is displayed within the ship's symbol when activated. This symbol disappears when the size of the true scale symbol is smaller than 3 mm on the display.
⊗	Blue	AIS SART test	Denote AIS SART (search and rescue radar transponder) test.
⊗	Red (fixed)	AIS SART active	Denote AIS SART (search and rescue radar transponder) active.
◁	Red (fixed)	Dangerous AIS target	Target's CPA and TCPA are within the CPA and TCPA settings. Vector shown. The symbol flashes until acknowledgment.
⊘	Green	Association AIS target	AIS and TT target declared as "association target". AIS symbol and AIS data are used.
⊘	Red (fixed)	Association AIS dangerous target	AIS and TT target declared as "association target". AIS symbol and AIS data are used. Target's CPA and TCPA are within limits set.

Symbol	Default color	Name	Description
	Green	Heading-turn indicator	Show target's direction of turning.
	Green	SAR Aircraft	Denote SAR aircraft.
BS	Blue	AIS base station	Denote AIS base station.
	Green	AIS select symbol	Target selected to display its data.
	Green	SAR vessel	SAR (search and rescue) vessel
	Red (fixed)	AIS lost symbol	X is superimposed on the AIS target symbol and is flashing.
	Green	Non HDG/COG sleeping AIS target	Denote sleeping AIS symbol without HDG and COG. Dashed line.
	Green	Non HDG/COG activated AIS target	Denote active AIS symbol without HDG and COG. Dashed line.

Note 1: The equipment continues to process AIS targets when the AIS feature is switched off. When the AIS is again turned on, symbols are immediately displayed.

Note 2: AIS symbols are momentarily erased after the screen is redrawn when the heading is changed from the head-up mode.

Note 3: When no AIS data is received, the Alert 380 (ALF format: 10380,131) "AIS COM Error" appears in the [Alert] box. Check the AIS transponder.

Note 4: An AIS target is declared a lost target if it is not detected in five consecutive reporting periods (see the table on page 4-1).

Note 5: Physical and virtual AIS AtoN symbols that may appear are listed in the table on the following page.
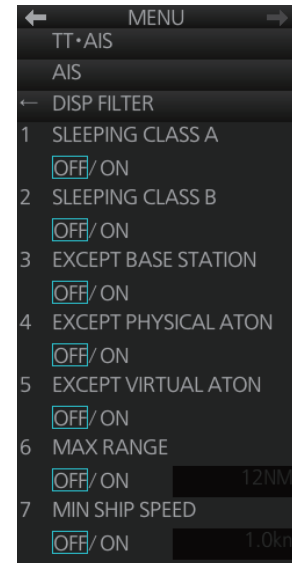
AIS Physical AtoN Symbol	AIS Virtual AtoN Symbol	Default Color	Meaning
◇	⟨+⟩	Blue	Basic shape
⊙ over ◇	⊙ over ◇+	Blue	RACON
✚ over ◇	✚ over ⟨+⟩	Blue	Emergency wreck mark
North cardinal (physical)	North cardinal (virtual)	Blue	North cardinal mark
East cardinal (physical)	East cardinal (virtual)	Blue	East cardinal mark
South cardinal (physical)	South cardinal (virtual)	Blue	South cardinal mark
West cardinal (physical)	West cardinal (virtual)	Blue	West cardinal mark
Port hand (physical)	Port hand (virtual)	Blue	Port hand mark
Starboard hand (physical)	Starboard hand (virtual)	Blue	Starboard hand mark
Isolated danger (physical)	Isolated danger (virtual)	Blue	Isolated danger
Safe water (physical)	Safe water (virtual)	Blue	Safe water
Special mark (physical)	Special mark (virtual)	Blue	Special mark
Off Posn ◇+	—	Line: Yellow* Char: Yellow*	Off position (Displayed with yellow line and yellow text)
Unlit ◇	Unlit ◇+	Line: Blue Char: Yellow*	Light fail or at reduced range (Displayed with yellow text)
Racon err ◇	Racon err ◇+	Line: Blue Char: Yellow*	RACON error (Displayed with yellow text)
—	Missing ⟨◇+⟩	Line: Yellow* Char: Yellow*	Missing (Displayed with yellow dashed line and yellow text)

* Color not changeable.

4.4 How to Filter AIS Targets

If the screen becomes cluttered with AIS targets, you can filter out unnecessary AIS targets, from the [DISP FILTER] menu.

1. Right-click the AIS mode indication then click [AIS Menu] to show that menu.

2. Open the [5 DISP FILTER] menu.

3. At [1 SLEEPING CLASS A] - [5 VIRTUAL ATON], disable or enable tracking of respective item as appropriate.

4. Select [6 MAX RANGE] and set the maximum range to display an AIS target. A sleeping AIS target not within the range set here is not displayed.

5. Set the minimum ship speed for AIS targets, with [7 MIN SHIP SPEED]. Any sleeping AIS target whose speed is slower than that set here will not be displayed.

6. Close the menu.

Note: This function is not available for an activated target.

MENU
TT·AIS
AIS
← DISP FILTER
1 SLEEPING CLASS A
OFF / ON
2 SLEEPING CLASS B
OFF / ON
3 EXCEPT BASE STATION
OFF / ON
4 EXCEPT PHYSICAL ATON
OFF / ON
5 EXCEPT VIRTUAL ATON
OFF / ON
6 MAX RANGE
OFF / ON   12NM
7 MIN SHIP SPEED
OFF / ON   1.0kn

4.5 How to Activate Targets

When you convert a sleeping target to an activated target, an activated target's course and speed are shown with a vector. You can easily judge target movement by monitoring the vector.

4.5.1 How to activate specific target
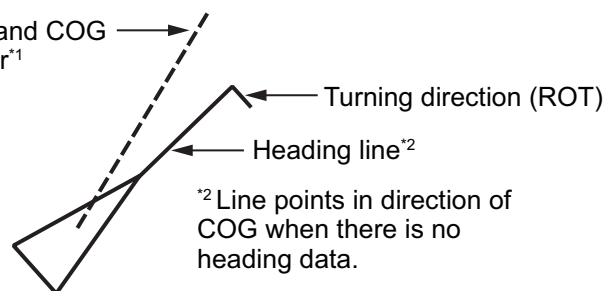
From the Control Unit

Select the target with the cursor then press the **ACQ/ACT** key.

By the trackball module

Click the AIS target symbol.

SOG (Speed Over the Ground) and COG (Course Over the Ground) vector[*1]

[*1] Vector shows STW (speed through the water) and CTW (course through the water) when sea stabilized mode is selected at the radar.

Turning direction (ROT)

Heading line[*2]

[*2] Line points in direction of COG when there is no heading data.

4.5.2 How to automatically activate targets

You can get automatic activation of a sleeping AIS target when its CPA/TCPA are within a preset limit. The CPA/TCPA alarm must be active to use this feature.

How to set conditions for automatic activation of AIS targets

1. Right-click the AIS mode indication then click [AIS Menu] to show that menu.

2. Open the [4 CPA AUTO ACTIVATE] menu.

3. Set each menu item, referring to the description below.
   [1 MAX RANGE]: Set the maximum range to use. Any AIS target at a distance greater than set here will not be activated.
   [2 MIN SHIP SPEED]: Set the minimum speed to use. Any AIS target whose speed is slower than set here will not be activated.
   [3 EXCEPT CLASS B]: Select [ON] to exclude class B AIS targets.

4. Close the menu.
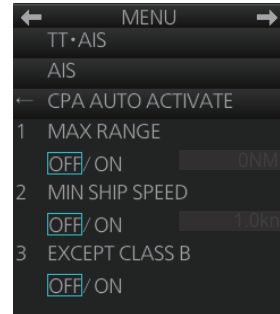
How to enable, disable automatic activation of AIS targets

Click the location circled in the figure below to select one of the following:
[AUTO OFF]: Disable automatic activation of AIS target by CPA.
[AUTO ACT FILT]: Activate AIS targets that fulfil the requirements set on the [CPA AUTO ACTIVATE] menu.
[AUTO ACT ALL]: Activate all AIS targets within the CPA range set.

4.6 How to Sleep Targets

4.6.1 How to sleep an activated AIS target

You can "sleep" an activated AIS target as shown below when the screen becomes filled with targets that might prevent important radar and AIS targets from being identified. The targets that have been activated automatically cannot be "slept."

From the Control Unit

Put the cursor on the AIS target to sleep then press the **TARGET CANCEL** key.

By the trackball module

1. Right-click the screen to show the context-sensitive menu.

2. Select [Target Cancel] and [Any] or [AIS Only] as applicable.

3. Click the AIS target to sleep.

4.6.2 How to sleep all activated AIS targets

Sleep all activated targets from the menu

1. Open the menu then select [2 TT•AIS] and [4 AIS].

2. Select [3 SLEEP ALL TGTS] then [YES].

3. Close the menu.

Sleep all activated targets from the AIS box

Long-click the AIS mode indication at the bottom-right position to display [FUNC OFF] then click [DISP ALL] to sleep all AIS targets redisplayed.

TT		AIS	
OFF		DISP ALL	
Vector		20min	True-G
CPA/TCPA		0.5NM	3min
AIS CPA		AUTO ACT ALL	
Lost TGT		ALL	
Past POSN		OFF	True-G
Trail		OFF	

4.7 How to Display AIS Target Data

You can display an AIS target's data by selecting it on the display.

4.7.1 AIS pop-up information

The AIS pop-up shows abbreviated AIS data (COG, SOG, CPA, TCPA and destination*) for the selected AIS target. Simply put the cursor on the AIS target to show the pop-up. The pop-up can be enabled or disabled with [AIS POP-UP INFO] in the [TT•AIS SYMBOL] menu.

*: Not displayed in chart mode.

VESSEL B	
COG:	090.0° T
SOG:	14.00kn
CPA:	57.06NM
TCPA:	76:36
DEST:	DESTIN...

4.7.2 Basic AIS target data

From the Control Unit

1. Use the trackball to put the cursor on the activated AIS target symbol you want to know its data.

2. Press the **TARGET DATA** key.

3. The selected target is marked with a broken square and AIS data is shown in the AIS data box when the target is correctly selected.
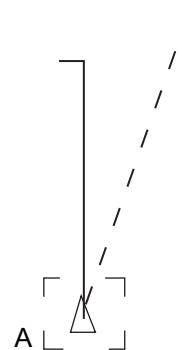
By the trackball module

Click the activated AIS target symbol. The selected target is marked with a broken square and AIS data is shown in the AIS data box when the target is correctly selected.

AIS no. (information display order) →

Vessel name →

Bearing →

Range →

Course over ground →

Speed over ground →

CPA →

TCPA →

Bow crossing range →

Bow crossing time →

Position →

AIS A

FURUNO

BRG 136.4°T HDG ← Heading

RNG 8.576NM 040.0°T

COG 040.0°T ROT ← Rate of turn

SOG 10.00kn +000.0°/min

CPA 5.726NM

TCPA -32:59

BCR -11.88NM STATUS

BCT -20:12 Underway

50°58.8600' N using ← Navigation status*

001°30.3181' E engine

*: Where the selected AIS target is an aircraft, the STATUS box shows the aircraft's altitude.

Note 1: AIS is not available in dead reckoning when the radar type is selected to [IMO] on the [INSTALLATION] menu.

Note 2: If the TCPA value is negative, this means that you have already passed the closest point and the AIS target is going away from your ship.

Note 3: For the maximum displayable number of TT•AIS boxes, see section 3.8.1.

4.7.3 Expanded AIS data

The expanded AIS data display provides additional information about an AIS target, including call sign, MMSI No., IMO No., etc. To display expanded AIS data, show the basic data for a target, right-click the target data display then select [Expanded AIS Data].

Title bar →	**Target Information** ✕
Vessel name →	Name: FURUNO
Call sign →	Call: WG27CQ
Position →	L/L: 50° 57.198' N
	001° 28.104' E
Type of position sensor →	POS sensor: missing
Position accuracy → (HIGH or LOW)	POS ACC.: HIGH
Navigation status* →	NAV status: Underway using engine
MMSI No. →	MMSI No.: 2324433222
IMO No. →	IMO No.: 0023555552
Length of vessel →	Length: 180m
Width of vessel →	Width: 32m
Draught of vessel →	Ship draught: 8.0m
Destination →	DEST.: ROTTERDAM
ETA at destination →	ETA: 20/JUL 19:20
Version of AIS transponder →	AIS version: 0
Association (On or Off) →	Association: Off
Ship and cargo type →	Ship & Cargo type: Tanker(s) All ships of this type

*: Where the selected AIS target is an aircraft, the STATUS box shows the aircraft's altitude.

If data for an item is unknown, "missing" appears. In the example above, the name of the position sensor is "missing".

4.8 AIS CPA/TCPA Alarm

This radar calculates CPA and TCPA by using own ship and relative target positions. An AIS dangerous target is one whose CPA and TCPA are within the range of the CPA and TCPA limits set in the TT/AIS box. The AIS symbol of an AIS dangerous target is red and flashing, and is announced with the Alert 536 (ALF format: 191,2) "AIS CPA/TCPA". After the alert is acknowledged the target symbol is displayed in red color.

To set the CPA and TCPA ranges, do the following:

1. If the CPA and TCPA settings are not shown, click [CPA/TCPA].
   Note: When clicking [CPA/TCPA], the CPA/TCPA alarm function is off.
2. Click the CPA indication to select desired CPA range.
3. Click the TCPA indication to select desired TCPA setting.
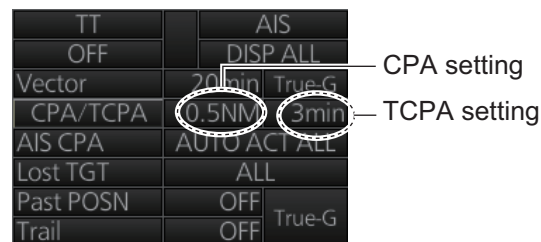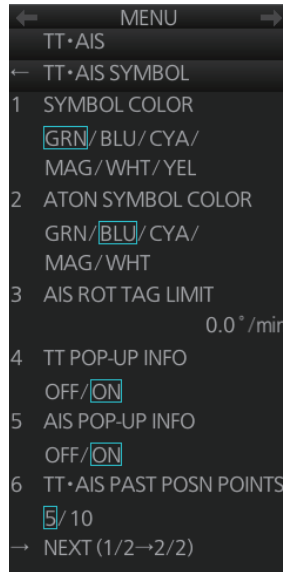

4.9 AIS Symbol Brilliance

1. Right-click the [BRILL] button on the InstantAccess bar™ then select [Brill Menu].
2. Go to page 2, select [5 AIS SYMBOL] then spin the scrollwheel to adjust the brilliance.
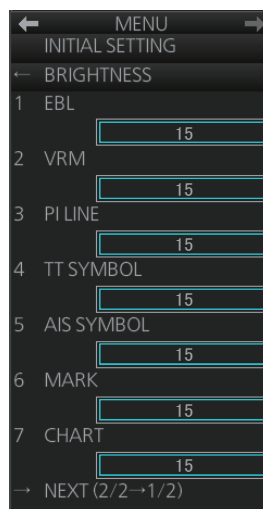
3. Close the menu.

4.10 AIS Symbol Color

1. Right-click the AIS mode indication then click [Symbol Menu] to show that menu.

```
←           MENU           →
    TT·AIS
←   TT·AIS SYMBOL
1   SYMBOL COLOR
    GRN/ BLU/ CYA/
    MAG/ WHT/ YEL
2   ATON SYMBOL COLOR
    GRN/ BLU / CYA/
    MAG/ WHT
3   AIS ROT TAG LIMIT
                    0.0˚/min
4   TT POP-UP INFO
    OFF/ ON
5   AIS POP-UP INFO
    OFF/ ON
6   TT·AIS PAST POSN POINTS
    5/ 10
→   NEXT (1/2→2/2)
```

2. Select [1 SYMBOL COLOR] and desired color. (Yellow is not available with the IMO type.)

3. Close the menu.

4.11 AIS Lost Targets

An AIS target is declared a lost target when it fails to produce data for intervals which are based on the table on page 4-1. When this occurs, the target is marked with the lost target symbol (flashing), shown in the right figure, the buzzer sounds (for activated targets only) and the Alert 537 (ALF format: 193,3) "AIS Lost" appears.
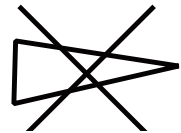
To acknowledge a lost target, push the **ALARM ACK** key or click the [Alert] box.

Note: The AIS data transmission interval depends on target's speed. For example, the data is transmitted every 10 seconds on the ship speed of 0 to 14 kn and every two seconds on the ship speed of more than 23 knots. For details, see the owner's manual of the AIS transponder.

4.11.1 How to enable, disable the AIS lost target alert

The[Lost TGT] indication (at the bottom-right position) enables, disables the lost target alert. Click the indication to select [OFF], [FILT] or [ALL] as appropriate.

[OFF]: Disable the lost target alert.
[FILT]: Get the alert against the targets whose criteria meet the settings made in section 4.11.2.
[ALL]: Get the alert against all lost targets.

TT		AIS	
OFF		DISP ALL	
Vector		20min	True-G
CPA/TCPA		0.5NM	3min
AIS CPA		AUTO ACT ALL	
Lost TGT		ALL	
Past POSN		OFF	True-G
Trail		OFF	

Note: The [Lost TGT] setting is shared commonly between TT and AIS.

4.11.2 How to set the AIS lost target filter

If you are in an area where AIS targets often become lost, the lost target alert may activate frequently. In this case, you may want to specify which targets to classify as lost targets, to prevent frequent triggering of the lost target alert.

1. Right-click the AIS mode indication then click [AIS Menu] to show that menu.
2. Open the [6 LOST FILTER] menu.
3. Set each menu item, referring to the description below.
[1 MAX RANGE]: Set the maximum range to use. Any AIS target at a distance greater than set here will not trigger the lost target alert.
[2 MIN SHIP SPEED]: Set the minimum speed to use. Any AIS target whose speed is slower than set here will not trigger the lost target alert.
[3 EXCEPT CLASS B]: Select [ON] to exclude class B AIS targets from the lost target alert.
4. Close the menu.
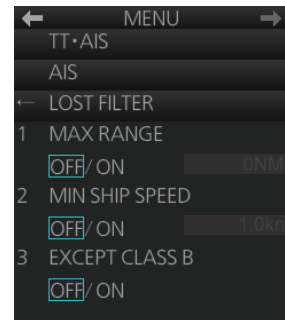
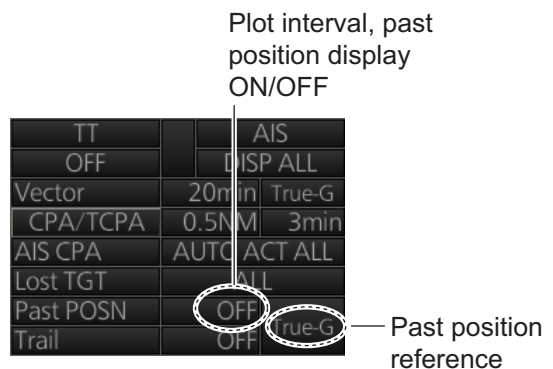# 4.12 How to Display AIS Target Past Positions

The past position display shows equally time-spaced dots marking past positions of activated AIS targets. If a target changes its speed, the spacing will be uneven. If it changes course, its plotted course will not be a straight line.

Below are sample past position displays.
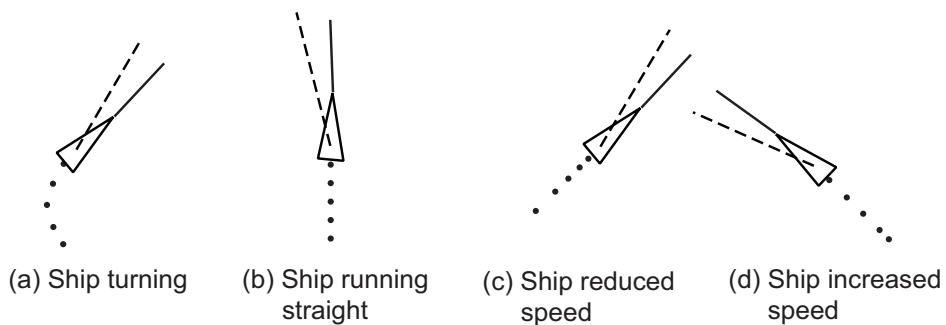
(a) Ship turning   (b) Ship running straight   (c) Ship reduced speed   (d) Ship increased speed

4.12.1 How to enable/disable the past position display, select past position reference

Click the indications circled in the figure below to set the plot interval (or disable the display) and the past position reference (true or relative).

Plot interval, past position display ON/OFF

Past position reference

4.12.2 Past position points

You can show 5 or 10 past position points per AIS target. Right-click the past position indication then click [Past POSN Menu] to show that menu. Set [6 TT•AIS PAST POSN POINTS] to [5] or [10].

4.13 How to Display True or Relative Speed Vectors

AIS targets vector can be displayed relative to your ship's heading (relative) or with reference to the North (True).

Vector time (or the length of vectors) and presentation mode can be set at the bottom-right position on the screen. For further information, see section 3.9.

4.14 Association of TT and AIS Targets

An AIS-equipped ship is usually displayed by two symbols on the radar display. This is because the AIS ship position is measured by a GPS navigator (L/L) whereas the radar detects the same ship by PPI principle (range and bearing relative to own ship radar antenna).

To avoid the presentation of two target symbols for the same physical target, use the "association" function. If target data from both AIS and TT are available and if the association criteria are fulfilled, either the AIS or TT symbol is presented according to the association method selected.

Association will not happen between AIS and TT if the AIS target is sleeping or the AIS target is lost.

All association settings, including ON/OFF, can also be controlled from the chart radar mode, with the [TT/AIS] page in the [Overlay/NAV Tools] box. All settings are mutually shared.

4.14.1 How to select association method

Click the location circled below to show "<" to select AIS symbol for associated target, or ">" to select TT symbol for associated target. This setting overrides the corresponding item on the [TT•AIS] menu. To turn off association, click the location to remove the arrow.

Note: You can also select the method by right-cllcking the location. Click desired association method.