1.46.2 How to check the radar's performance

The range scale is automatically set to 24 NM. The radar screen will show arcs. If the radar transmitter and receiver are in good working conditions in as much as the original state when the monitor was turned on, the innermost arcs should appear between 8.0 NM to 19.8 NM. The performance monitor can observe a total of 10 dB loss in transmitter and receiver.

How to set the number of arcs

1. Open the [MAIN MENU].
2. Select [ECHO], then press the **ADJUST** knob.
3. Select [PM ARC], then press the **ADJUST** knob.
4. Select [2], [3], [5] or [6] as appropriate, then press the **ADJUST** knob.
5. Close the menu.

The figure belows shows an example where [PM ARC] is set to [5].

Display	Radar State
	**Transmitter:** normal **Receiver:** normal

Display	Radar State
	**Transmitter and receiver:** No arc indicates 10 dB loss. Contact your dealer for advice. (For magnetron radars, have a technician check the magnetron.

Note 1: The lengths of the arcs can vary according to installation environment. Judge the strength of the echo that appears within 60° from the arc location to confirm if the radar is working properly or not.

Note 2: The location of the arcs changes according to the [PM ARC] setting.

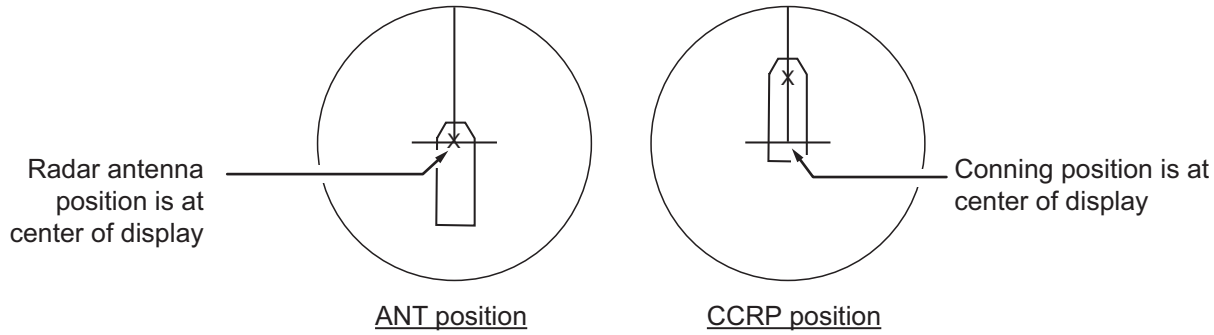
Turn the performance monitor off when finished.

1.47 How to Adjust the Reference Position

The reference position for measurements (range, bearing, etc.) and markers (heading line, stern mark, etc.) can be antenna position or consistent common reference point (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 adjust the reference position, use the touchpad to place the cursor over the "REF POINT" indication at the top of the screen, then press the **left button** to select [ANT] or [CCRP] as applicable. You can also adjust the reference by rotating the **ADJUST** knob when the cursor is placed over the indication.

The position of the own ship marker changes according to reference position as shown below. 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 position as in the table below.

Category	Item	Reference point	
		ANT	CCRP
Range and bearing measurements	EBL	Range and bearing measured from antenna position.	Range and bearing measured from CCRP.
	VRM		
	Cursor		
	PI line		
	Range ring		
	Drop mark		
Graphics	Heading line	Drawn from antenna position.	Drawn from CCRP.
	Stern mark		
	Beam line		
	Own ship vector		
	Own ship track		
Bearing cursor		Drawn with antenna position at center.	Drawn with CCRP at center.
Course, speed		Calculated with antenna position at center.	Calculated with CCRP at center.
CPA, TCPA		Calculated with antenna position at center.	Calculated with CCRP at center.
BCR, BCT		Calculated from bow position.	

Continued on next page

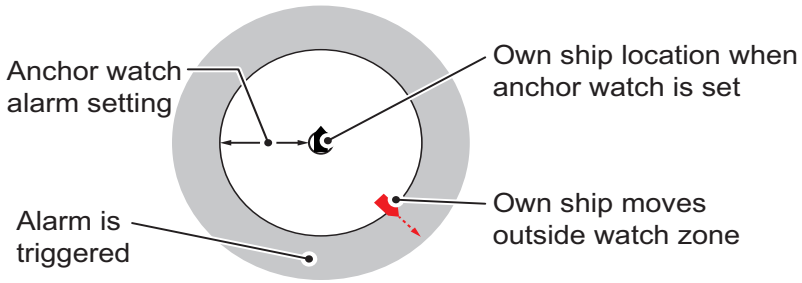
Category	Item	Reference point	
		ANT	CCRP
Own ship data	Heading	Data is taken from respective sensors, regardless of reference point selected.	
	Speed		
	Course over ground		
	Speed over ground		
	Own L/L	Location of the CCRP.	

Note: When the antenna is located some distance from the CCRP, the CCRP can be outside the bearing cursor in true motion or off-center.
Also, when the CCRP is set as reference point, some parts of the bearing cursor are not displayed.

1.48 Anchor Watch

The anchor watch feature alerts you when your ship has traveled a distance greater than a threshold value, when it should be at rest. When the anchor watch is active, an orange dashed circle marks the anchor watch range.

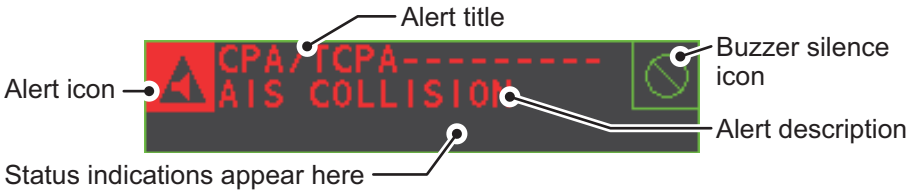
If your ship goes outside the circle, the indication "ANCHOR WATCH" appears in the [ALERT] box.



1. Open the [MAIN MENU].
2. Select [ALERT], then press the **ADJUST** knob.
3. Select [ANCHOR WATCH], then press the **ADJUST** knob.
4. Select [ON] to enable [ANCHOR WATCH].
5. Using the **ADJUST** knob, select the distance for the alert. Press the **ADJUST** knob to apply the setting.
6. Close the menu.

1.49 How to Interpret the ALERT Box

When an alert condition is found, the applicable alert message appears in the [ALERT] box. A buzzer sounds for alarm and warning alerts. The [ALERT] box is composed of three lines of information, and two icons, as shown below.



Silence the buzzer with the ALERT ACK key or select the [ALERT] box then press the **left button**. The buzzer and the flashing stop but the alert indication remains on the display until the reason for the alert is removed.

Status indications are displayed in yellow text. The displayable indications are listed in the table below.

Status indication	Reason for display
AUTO VIDEO ADJ	Video adjust ([VIDEO ADJ]) is set to [AUTO].
PM	Performance Monitor (PM) is ON.
SART	SART is ON.
TUNE INITIALIZE	TUNE INITIALIZE is ON.
VIRTUAL AIS ATON:OFF	[AIS VIRTUAL ATON] is OFF.
WR CARD DATA	Writing data to SD card.
RD CARD DATA	Reading data from SD card.
DELETE CARD DATA	Deleting data from SD card.

1.49.1 Alert descriptions

Alerts which can appear on this radar are listed in the table. The level of priority, from highest to lowest, is ALARM → WARNING → CAUTION. For detailed information regarding specific alerts and alert codes, including possible remedies, see "ALERT CODES, MESSAGES AND MEANINGS" on page AP-7.

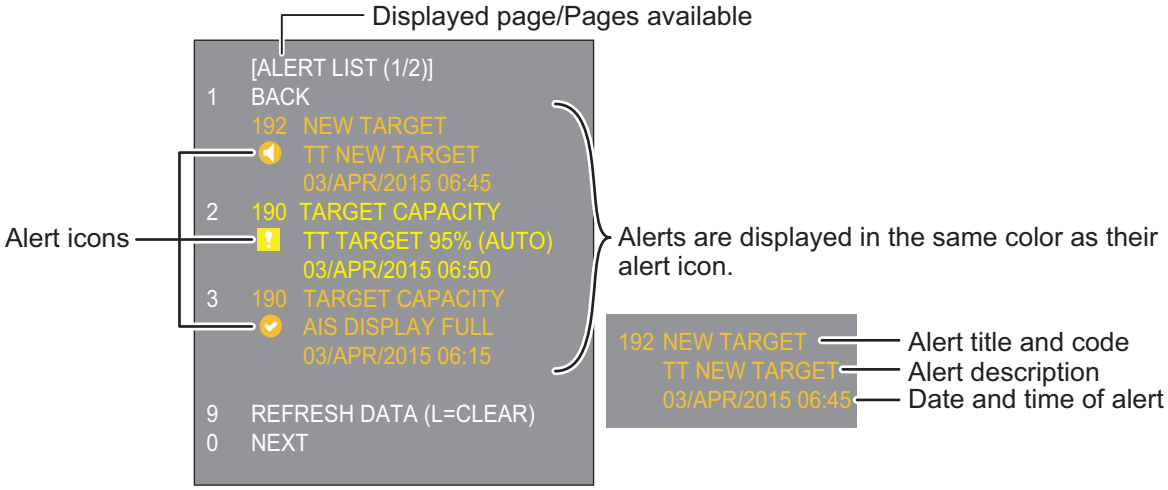
Note: All active-unacknowledged warnings are repeated as warnings after 60 seconds (manufacturer's fixed time period).

1.49.2 Alert list

The alert list displays the names of violated alerts, including the time and date violated. Up to 100 alerts are stored in the internal memory. Unacknowledged alarms are displayed first in the list (in red text), in the order in which they appear in the [ALERT] box. Unacknowledged warnings are displayed in the list (in yellow-orange text), in the order in which they appear in the [ALERT] box.
Cautions are displayed in the list (in yellow text), in the order in which they appear in the [ALERT] box.

An unacknowledged alert can be acknowledged from the list by selecting it, the pressing the **left button**. To erase the data for the number selected, press the **left button** again. To erase all alert indications, select [REFRESH DATA], then press and hold the **left button**.

To display the alarm list, place the cursor in the [ALERT] box and press the **right button**.



To change pages, select Next, then press the **left button**.

1.49.3 Alert icons and their meanings

Icon	Status	Visual indication	Audible alert
	Active– unacknowledged alarm	Red, Flashing	3 short audible alerts repeated every 7 seconds.
	Active – silenced alarm	Red, Flashing	Silent
	Active– acknowledged alarm	Red	Silent
	Active – responsibility transferred alarm	Red	Silent
	Rectified – unacknowledged alarm	Red	Silent
	Active – unacknowledged warning	Yellow-orange, Flashing	2 short audible alerts repeated every 60 seconds.
	Active – silenced warning	Yellow-orange, Flashing	Silent
	Active – acknowledged warning	Yellow-orange	Silent
	Active – responsibility transferred warning	Yellow-orange	Silent
	Rectified– unacknowledged warning	Yellow-orange	Silent
	Caution	Yellow	Silent

1.49.4 How to assign alarm priority to an alert

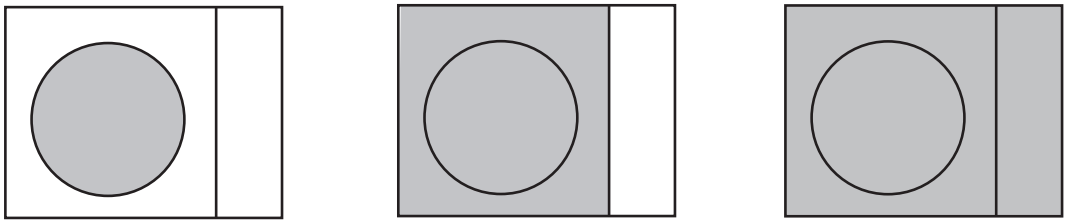
You can assign the same priority as an alarm to an alert, using the following procedure.

1. Open the [MAIN MENU].
2. Select [ALERT], then press the **ADJUST** knob.
3. Select [PRIMARY ALERT], then press the **ADJUST** knob.
4. Select the alert you wish to assign alarm priority to, then press the **ADJUST** knob. Selected items area underlined.
5. Close the menu.

1.50 How to Select a Display Mode

Non-IMO radars in this series have several display options available. For IMO radars in this series, only the standard display mode is available.

- Standard display mode: The operational display area, box functions, data display, etc. are shown in a standard (IMO compliant) manner.
- [CIRCLE] mode: The echoes are displayed inside a circle on the screen.
- [WIDE] mode: The echoes are displayed in a square area, but are not displayed in the data display area.
- [ALL] mode: The echoes are displayed across the entire screen.
- Simple display: The display is echo-focused, menu boxes and the data display are simplified.



CIRCLE WIDE ALL

Follow the procedure below to change display modes.

1. Open the [MAIN MENU].
2. Select [ECHO], then press the **ADJUST** knob. The [ECHO] menu is displayed.
3. Select [ECHO AREA], then press the **ADJUST** knob.
4. Select the appropriate setting, then press the **ADJUST** knob.
5. Close the menu.

1.51 How to Manage SD-Card Data

The following data can be stored on a SD-Card: marks, lines, user settings, installation settings, own track, alert history and some alert logs (for example, the alert log).

1.51.1 How to access the SD-Card menu

Note: This operation is only available when a SD-Card is inserted. When there is no SD-Card inserted, the [FILES] menu is not selectable.

1. Open the [MAIN MENU].
2. Select [FILES], then press the **ADJUST** knob.
3. Select [DRIVE SELECT], then press the **ADJUST** knob.
4. Select [SD-1] or [SD-2] as appropriate, then press the **ADJUST** knob.

1.51.2 How to save data

1. Access the SD-Card menu as shown in paragraph 1.51.1
2. Using the **ADJUST** knob, select [SAVE DATA], then press the **ADJUST** knob.
3. Using the **ADJUST** knob, select the data to be saved, then press the **ADJUST** knob. The software keyboard is displayed.
4. Using the software keyboard, name the file, then select [END]. The file name can be up to 12 characters in length. The indication "WR CARD DATA" appears during the save process.
5. Close the menu.

1.51.3 How to read (load) data

1. Access the SD-Card menu as shown in paragraph 1.51.1
2. Using the **ADJUST** knob, select [REPLAY (READ) DATA], then press the **ADJUST** knob.
3. Using the **ADJUST** knob, select the data to be read, then press the **ADJUST** knob. The indication "RD CARD DATA" appears during the read process.
4. Close the menu.

1.51.4 How to delete data

1. Access the SD-Card menu as shown in paragraph 1.51.1
2. Using the **ADJUST** knob, select [DELETE DATA], then press the **ADJUST** knob.
3. Using the **ADJUST** knob, select the data to be deleted, then press the **ADJUST** knob. The indication "DELETE CARD DATA" appears during the delete process.
4. Close the menu.

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2. RADAR OBSERVATION

2.1 General

2.1.1 Minimum and maximum ranges

Minimum range

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

It is mainly dependent on the pulselength, antenna height, and signal processing such as main bang reduction 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.

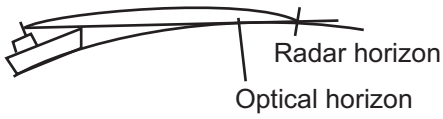
The IMO Resolution MSC.192(79) requires the minimum range to be less than 40 m, respectively. This series of radars satisfy this requirement.

Maximum range

The maximum detecting range of the radar, Rmax, 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 Rmax is given in the following equation.

$R_{max} = 2.2 \times (\sqrt{h1} + \sqrt{h2})$
where R_{max}: radar horizon (nautical miles)
h1: antenna height (m)
h2: target height (m)



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;

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

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

X-band and S-band

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

Radar resolution

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

- Bearing resolution is the ability of the radar to display as separate pips the echoes received from two targets that 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 selected for a bearing resolution better than 2.5° (IMO Resolution). This condition is normally satisfied with a radiator of 1.2 m (4 ft) or longer in the X-band. The S-band radar requires a radiator of about 12 feet (3.6 m) or longer.
- Range resolution is the ability to display as separate pips the echoes received from two targets that are on the same bearing and close to each other. This is determined by pulselength only. Practically, a 0.08 microsecond pulse offers the discrimination better than 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.

Range measurement

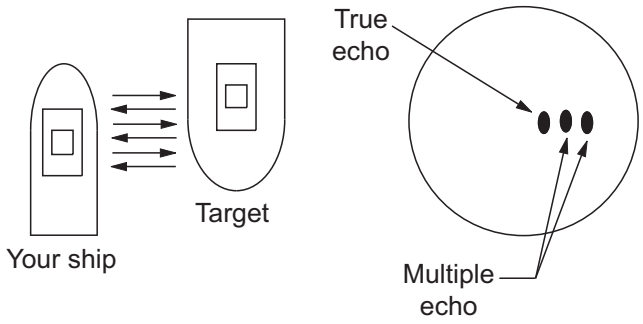
Measurement of the range to a target is also a very important function of the radar. Generally, there are two means of measuring range: the fixed range rings and the variable range marker (VRM). The fixed range rings appear on the screen with a pre-determined interval and provide a rough estimate of the range to a target. The variable range marker's diameter is increased or decreased so that the marker touches the inner edge of the target, allowing the operator to obtain more accurate range measurements.

2.2 False Echoes

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

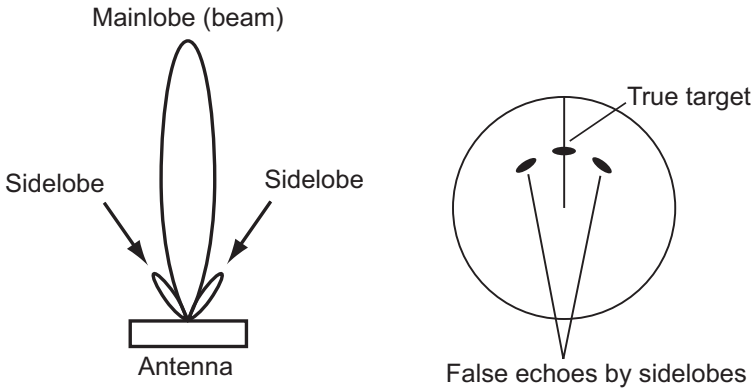
Multiple echoes

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



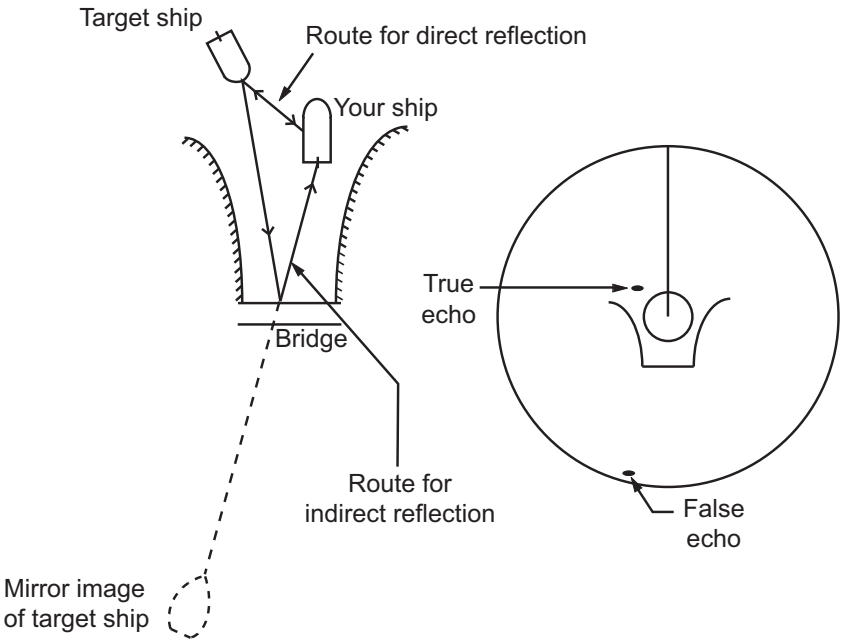
Sidelobe echoes

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



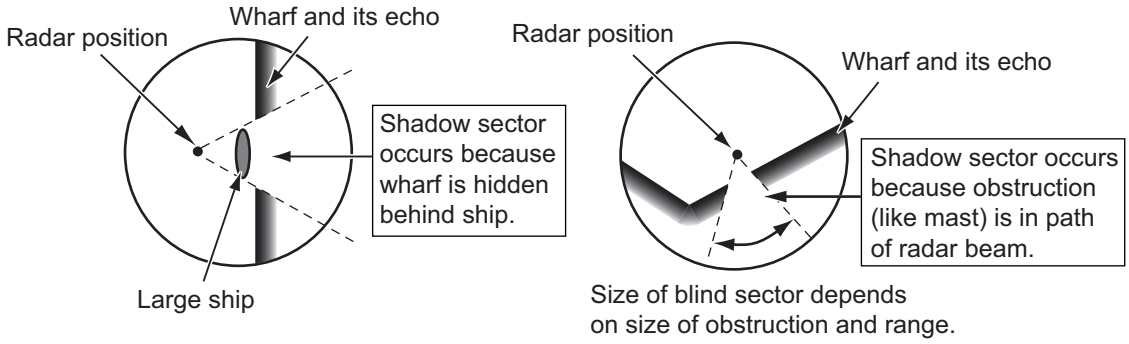
Virtual image

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.



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.



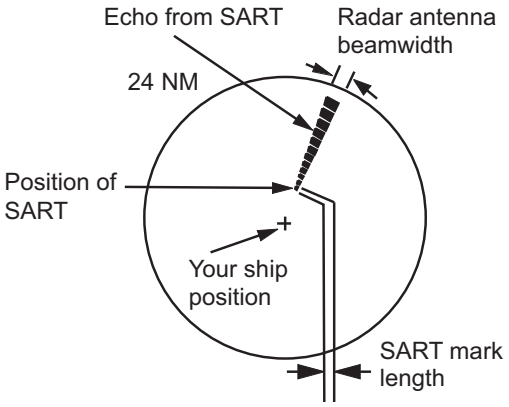
2.3 SART (Search and Rescue Transponder)

2.3.1 SART description

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

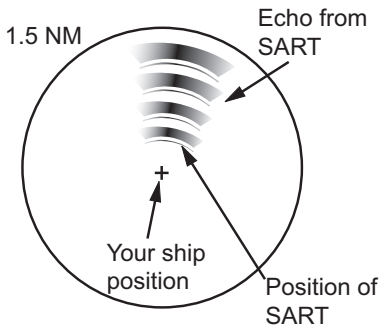
When the radar to the SART is reduced to about 1 nm, the radar display my show also the 12 responses generated during the fast sweeps. These additional dot responses, which also are equally spaced by 0.64 nautical miles, will be interspersed with the original line of 12 dots. They will appear slightly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

Screen A: When SART is distant



Screen B: When SART is close

Lines of 12 dots are displayed in concentric arcs.



2.3.2 How to show SART marks on the radar display

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.

1. Open the [MAIN MENU].
2. Select [ECHO], then press the **left button**.
3. Select [SART], then press the **left button**.
4. Select [ON] to show SART marks on the radar display, then press the **left button**. Select [OFF] to hide SART marks.
   When the SART function is active, the following setting changes are automatically made to radar functions:

Setting	Changed to
Range	12 NM
Pulselength	Long
Echo Stretch	Off
Noise Rejector	Off
Echo Averaging	Off
Interference Rejector	Off
Performance Monitor	Off
A/C RAIN	Off

5. Close the menu.

The indication "SART" appears at the bottom of the alert box, in yellow text, when this feature is active. Be sure to turn this feature off when SART detection is no longer your objective.

2.3.3 General remarks on receiving SARTs

SART range errors

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

Radar bandwidth

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

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

Radar side lobes

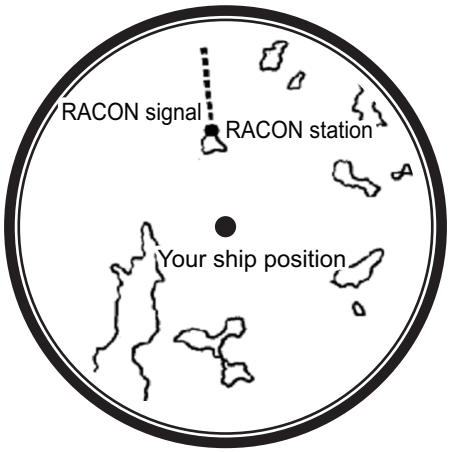
As the SART is approached, side lobes from the radar antenna can show the SART responses as a series of arcs or concentric rings. These can be removed by the use of the anti-clutter sea control although it can be operationally useful to observe the side lobes as they may be easier to detect in clutter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

Note: SART information excerpted from IMO SN/Circ 197 OPERATION OF MARINE RADAR FOR SART DETECTION.

2.4 RACON

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

Echoes on the radar screen



Echo description

2.5 Radar Target Enhancer (RTE)

An RTE is a radar transponder 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. The RTE is available in X-band and S-band types.

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3. TARGET TRACKING (TT)

3.1 Precautions for Target Tracking Usage

⚠ WARNING

No one navigational aid should be relied upon for the safety of vessel and crew. The navigator has the responsibility to check all aids available to confirm position. Electronic aids are not a substitute for basic navigational principles and common sense.

- This TT automatically tracks automatically or manually acquired radar targets and calculates their courses and speeds, indicating them by vectors. Since the data generated by the auto plotter are based on what radar targets are selected, the radar must always be optimally tuned for use with the auto plotter, to ensure required targets will not be lost or unwanted targets such as sea returns and noise will not be acquired and tracked.

- A target does not always mean a land-mass, reef, ships or other surface vessels but can imply returns from sea surface and clutter. As the level of clutter changes with environment, the operator should properly adjust the A/C SEA, A/C RAIN and GAIN controls to be sure target echoes are not eliminated from the radar screen.

⚠ CAUTION

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

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

- The amount of tracking delay is inversely proportional to the relative speed of the target. Delay is on the order of 15 - 30 seconds for high relative speed; 30 - 60 seconds for low relative speed.

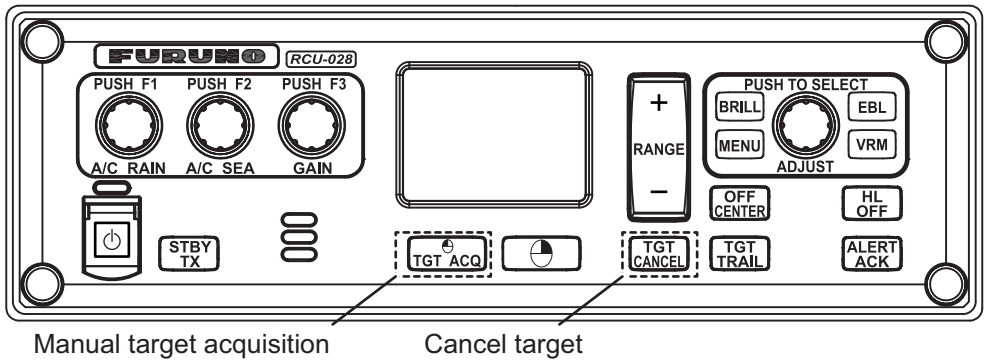
- Display accuracy is affected by the following:
  - Echo intensity
  - Radar transmission pulsewidth
  - Radar bearing error
  - Gyrocompass error
  - Course change (own ship and target)

The data generated by TT, AIS and video plotter are intended for reference only.

Refer to official nautical charts for detailed and up-to-date information.

3.2 TT Controls

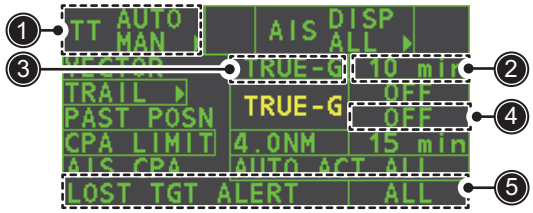
The control unit has two keys which you can use during target tracking mode. The keys are indicated in the figure below.



- **TGT ACQ**: Acquires the selected echo as a target.
- **TGT CANCEL**: Deactivates tracking for the cursor-selected target.

These functions, along with other TT functions, can also be accessed from the [CURSOR] menu (See section 1.7).

3.3 TT Box Overview



No.	Indication name	Description/remarks
1	TT acquisition mode	Shows current TT mode (AUTO, AUTO/MAN, MAN)
2	Vector time	Adjusts the vector time for the selected target
3	Vector reference	True, Relative referencing for this target's vector
4	Past position time	Sets the interval for the target's trail
5	Lost TGT Alert	Display/hide the alert when a target is lost

3.4 How to Select the TT mode

Target tracking is available in three modes: [MANUAL 50] (up to 50 targets, selected manually), [MANUAL 25•AUTO 25] (up to 50 targets, 25 selected automatically, 25 selected manually) and [AUTO 50] (up to 50 targets, selected automatically). To select a target tracking mode, do the following:

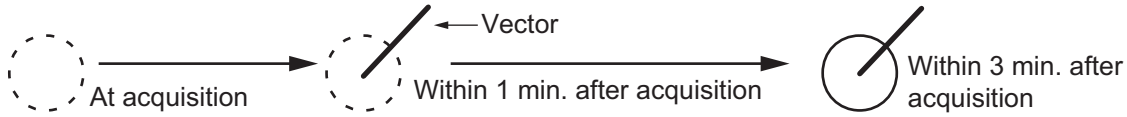
1. Select the [TT] box, then press the **right button**. The [TT TARGET MENU] is displayed.
2. Select [TT SELECT], then press the **ADJUST** knob.
3. Select the appropriate mode, then press the **ADJUST** knob.
4. Close the menu.

3.5 How to Activate/Deactivate Target Tracking

Place the cursor on the TT acquisition mode indicator, then press the **left button**. The indication changes, depending on the TT mode selected (See section 3.4). The table below shows the indication changes based on mode selection.

TT mode selected	Indication change
[Manual 50]	"OFF" → "MAN" → "OFF"...
[MANUAL 25•AUTO 25]	"OFF" → "MAN/AUTO" → "OFF"...
[AUTO 50]	"OFF" → "AUTO" → "OFF"...

The plotting symbol is drawn by broken lines during the initial acquisition stage. A vector appears in about one minute after acquisition indicating the target's motion trend. If the target is consistently detected for three minutes, the plotting symbol changes to a solid circle. If acquisition fails, the target plotting symbol blinks and disappears shortly.



3.5.1 How to manually acquire targets

Manual target acquisition can be done with one of two methods:

Using the control unit

1. Place the cursor on the target to be acquired.
2. Press the TGT ACQ key.

Using the menu

1. Select the operational display area, then press the **right button**. The [CURSOR] menu is display.
2. Select [TARGET DATA/ACQ], then press the **ADJUST** knob.
3. Place the cursor on the target to be acquired, then press the **ADJUST** knob.

Note 1: For successful acquisition, the target to be acquired should be within 0.1 to 24 nm (or 32 nm, depending on initial setting) from own ship and not obscured by sea or rain clutter.

Note 2: When the capacity for manual acquisition is reached, the message "TT TARGET FULL(MAN)" is displayed at the screen bottom. Cancel tracking of non-threatening targets if you wish to acquire additional targets manually.

⚠ CAUTION

Target Swap

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. Should this happen, manual re-acquisition of the Lost Target may be required after the two have separated.

3.6 How to Enter Own Ship 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). Manual input is also possible.

For automatic or manual input, see section 1.12. For echo-referenced speed input follow the procedure below.

3.6.1 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 (doppler sonar, speed log, etc.) that can measure ship's bow-stern, port-starboard movement.

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 R1, R2 or R3. When a plural of objects are selected, the mean value is used, for stabilization and speed.

1. Select the operational display area, then press the **right button**. The [CURSOR] menu is displayed.
2. Select [REF MARK], then press the **ADJUST** knob. The cursor is highlighted.
3. Place the cursor on the location to be used as a reference, then press the **ADJUST** knob. The cursor changes from the highlighted cross to a circle with dashed lines, indicating that the reference location is now set. See section 3.8 for more information on TT symbols and their attributes.
   The dashed lines of the reference point change to a solid line over time, as shown in the figure above.

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, that reference target mark blinks and the indication "REF TARGET LOST" appears in the alert box. If all reference targets are lost, the speed indication reads "*.*" Select a different reference target if currently selected one is lost.
- When all targets are deleted, the reference target mark is also deleted and the target-based speed becomes invalid. The speed is indicated as "BTREF" where BT means Bottom Track (speed over ground).
- Reference targets can be marked with a vector.
  This can be done with [REF TARGET VECTOR] on the [TT TARGET] menu.
- 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

1. Open the [MAIN MENU].
2. Select [SHIP SPEED MENU], then press the **ADJUST** knob.
3. Select [SHIP SPEED], then press the **ADJUST** knob.
4. Select any option, other than [REF] or [MANUAL], then press the **ADJUST** knob.
5. Close the menu.

3.7 Lost Target

Targets not detected in five consecutive scans become “lost targets”. A lost target is shown in the display with flashing red "X". Flashing stops after lost target alert is acknowledged.

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

3.7.1 How to set the lost target filter

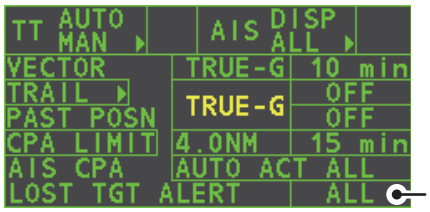
You can set the lost target alert to sound against lost targets that are within a specific range. To set the criteria, use the procedure below.

1. Open the [MAIN MENU].
2. Select [TT•AIS], then press the **ADJUST** knob.
3. Select [TT LOST FILTER], then press the **ADJUST** knob.
4. Select [MAX RANGE], then press the **ADJUST** knob.
5. Select [ON], then press the **ADJUST** knob. The settings can now be adjusted.
6. Rotate the **ADJUST** knob to adjust the setting as required, then press the **ADJUST** knob to apply the setting.
7. Close the menu.

Note: Reference targets are not affected by this filter.

3.7.2 How to enable/disable the lost target alert

The [LOST TARGET ALERT] box at the bottom right corner enables and disables the lost target alert. Select the box with the cursor, then press the **left button** to select [OFF], [ALL] or [FILT] as appropriate.



- [OFF]: Disable the alert.
- [ALL]: Enable the alert for all lost targets, including filtered targets.
- [FILT]: Enable the alert for all lost targets, excluding filtered targets.

3.8 TT Symbols and Attributes

3.8.1 TT symbols

Item	Symbol	Status	Remarks
Automatically acquired targets Manually acquired targets (the width of the line for "steady tracking" TT is thicker than that of the auto-matically acquired target)		Initial stage	Broken circle around an echo to indicate the target under acquisition and initial stage of tracking, before steady-state tracking.
			Within one minute after acquisition (vector still unreliable).
		Steady tracking	Solid circle with vector indicating steady state tracking (within three minutes after acquisition).
	 (flashing)	CPA alarm	Plotting symbol (red) flashes to indicate the target is predicted to come into CPA or TCPA.
		CPA alarm acknowledge	Shown in red, and flashing stops after CPA/TCPA alarm is acknowledged.
	 (flashing)	Lost target	A red X is crossed through the TT symbol to indicate that it is a lost target. Flashing stops after lost target alert is acknowledged.
Acquisition zone	 (flashing)	On target passing through operator-set acquisition zone	Symbol is red and flashing.
Target selected for data readout		On selected target	Target data (range, bearing, course, speed, CPA, TCPA, BCR, BCT, etc.).
Reference target	 After three minutes, changes to	On reference target	Used to calculate own ship's over-the-ground speed (echo-referenced speed) for ground stabilization.

3.8.2 How to adjust symbol brilliance

1. Place the cursor on the [BRILL] box, then press the **right button**. The [BRILL] menu is displayed.
2. Select [TT SYMBOL], then press the **ADJUST** knob. The settings can now be adjusted.
3. Rotate the **ADJUST** knob to select the desired brilliance, then press the **ADJUST** knob to apply the setting.
4. Close the menu.

3.8.3 How to set the symbol color

1. Open the [MAIN MENU].
2. Select [TT•AIS], then press the **ADJUST** knob.
3. Select [TT•AIS SYMBOL], then press the **ADJUST** knob.
4. Select [SYMBOL COLOR], then press the **ADJUST** knob. The settings can now be adjusted.
5. Select the appropriate color, then press the **ADJUST** knob.
6. Close the menu.

3.9 How to Display/Remove Target Data

The TT mode provides the full functionality of TT as required by the IMO Resolution A.823(19) and IEC 62288, including display of range, bearing, course, speed, CPA and TCPA of all tracked targets.

The target bearing is shown 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.

3.9.1 How to display target data

Place the cursor on a desired tracked target and press the TGT ACQ key. The target's shape changes to a square and the selected TT target's data is shown in the data display area.

Indication	Description
BRG	Bearing from own ship to target in relative (R) or True (T) reference.
RNG	Range from own ship to target.
T COG	Relative (R) or True (T) Course Over Ground of target. Displayed as "T CTW" where speed input is set to [LOG(WT)]. Displayed as "R CRS" where speed data is not available.
T SOG	Relative (R) or True (T) Speed Over Ground of target. Displayed as T STW where speed input is set to [LOG(WT)]. Displayed as R SPD where speed data is not available.
CPA	Closest Point of Approach of target to own ship.
TCPA	Time to CPA of target to own ship.
BCR	Bow crossing range of target.
BCT	Bow crossing time of target.

	TT TARGET No:07	TT TARGET No:09
BRG	056.6°R	056.4°R
RNG	2.749NM	3.386NM
T COG	303.6°T	097.5°T
T SOG	13.1kn	31.2kn
CPA	1.699NM	2.776NM
TCPA	05:43	-05:29
BCR	-5.378NM	<-99.9NM
BCT	19:15	<-99:59

You can display the target data for two targets in one data box and the data for as many as six targets can be displayed.

3.9.2 How to remove target data

Place the cursor on a desired tracked target and press the TGT CANCEL key. The select target's data is no longer displayed in the data display area.

3.9.3 How to display, hide and sort the target list

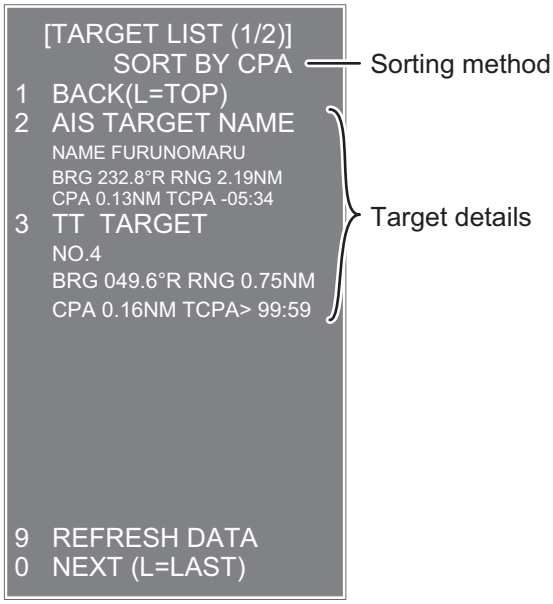
The target list provides a comprehensive data display of all TT (and AIS) targets being tracked.

How to display/hide the target list

1. Select the [Target List] menu item at the bottom-right of the screen, then press the **left button**. The target list is displayed inside the information box.

2. Select the [Target List] menu item at the bottom-right of the screen, then press the **left button** to hide the target list.

How to sort the target list



1. With the target list displayed, select [Sort by], then press the **ADJUST** knob.
2. Select the sort method, referring to the table below, then press the **ADJUST** knob.

Sort method	Description
[CPA]	Targets are sorted in order from closest to farthest CPA.
[TCPA]	Targets are sorted in order from shortest to longest TCPA.
[BCR]	Targets are sorted in order from closest to farthest BCR.
[BCT]	Targets are sorted in order from shortest to longest BCT.
[RANGE]	Targets are sorted in order from closest to farthest range.
[SPEED]	Targets are sorted in order from fastest to slowest.
[NAME]	Targets are sorted in Alphabetical order. Unknown names are displayed last.

3. Select the appropriate filter option, if required, then press the **ADJUST** knob.

Note: Targets with no data are sorted to the back of the list, regardless of filter setting.

3.10 Vector Modes

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

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

To change the vector mode, do the following:

Place the cursor on the vector reference indication in the [Vector] box, then press the **left button**. The vector reference cycles through the following settings with each press of the **left button**.

[REL] → [TRUE-G/TRUE-S] → [REL]...

3.10.1 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 in the True Motion mode. 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

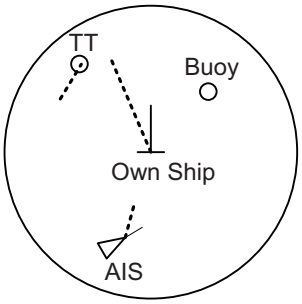
In the true motion mode, all fixed targets such as land, navigational marks and ships at anchor remain stationary on the radar screen with vector length zero. But in the presence of wind and/or current, the vectors appear on fixed targets representing the reciprocal of set and drift affecting own ship 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 from the [SPD] menu at the top-right of the screen.

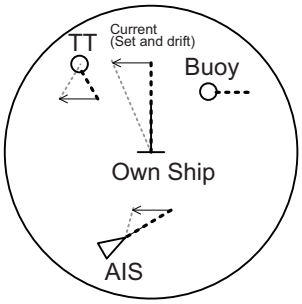
Speed selection	True vector mode
LOG(WT)	TRUE-S
LOG(WTC)	TRUE-G
LOG(BT)	TRUE-G
GPS(BT)	TRUE-G
REF(BT)	TRUE-G
MAN(WT)	TRUE-S
MAN(WTC)	TRUE-G

Relative vector

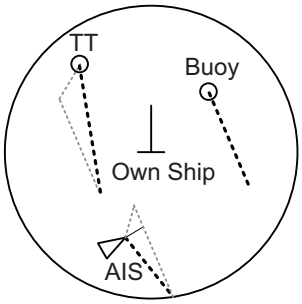
Relative vectors on targets that are not moving over the ground such as land, navigational marks and ships at anchor will represent the reciprocal of own ship's ground track. A target whose vector passes through own ship is on a collision course. (Dotted lines in the figure are for explanation only.)



True vectors in ground stabilization



True vectors in sea stabilization



Relative vectors