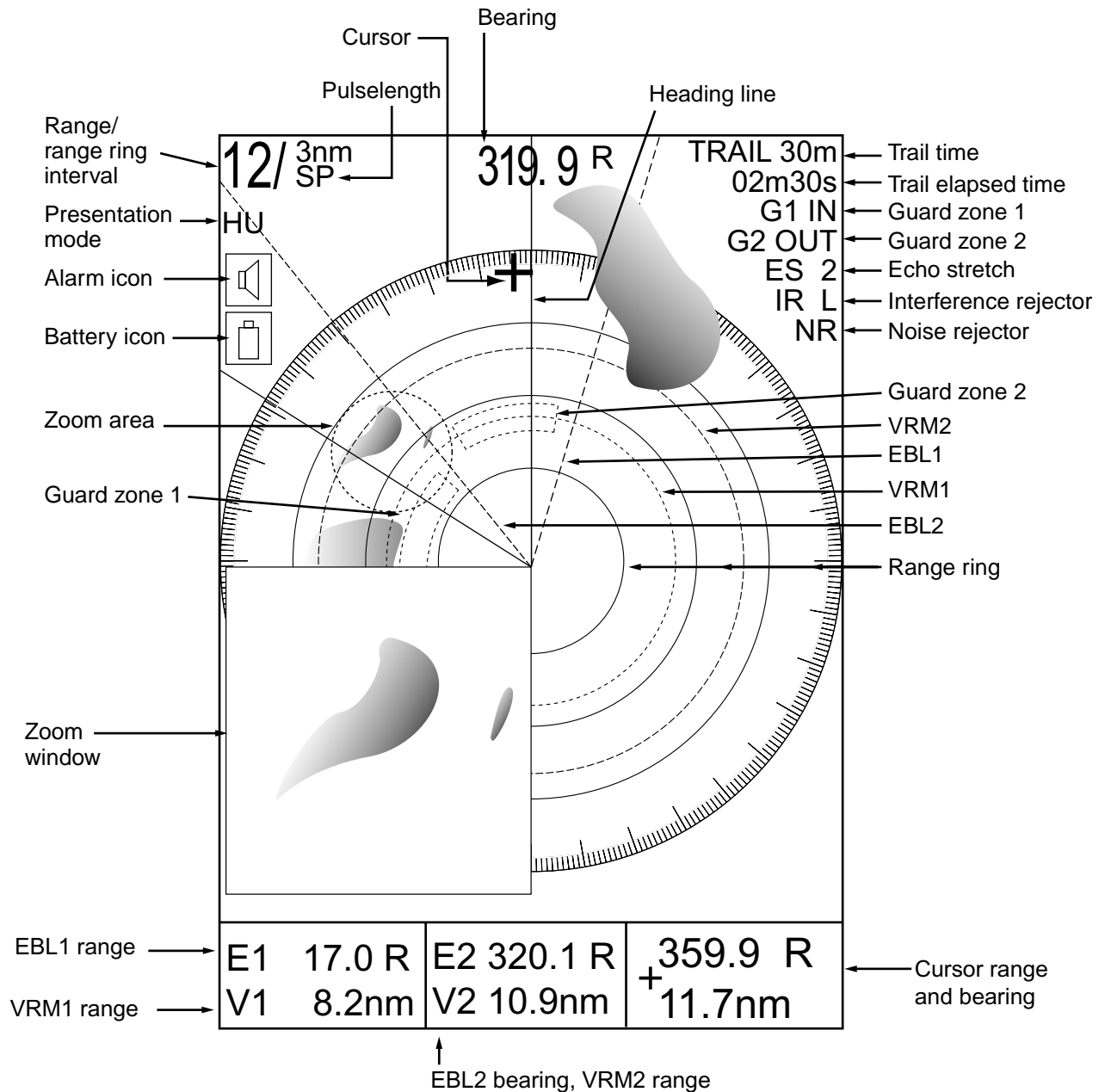


# 2. RADAR OPERATION

This chapter covers radar operation, including the optional ARPA (Automatic Radar Plotting Aid) function. Connection of a 1833/1933/1943 series network radar equipped with the ARPA circuit board is required.

## 2.1 Radar Display



Radar display

## 2.2 Transmitting, Stand-by

1. Press the RADAR TX soft key to show the radar picture.
2. When the radar picture is not required, but you want keep it in a state of readiness, press the RADAR TX soft key to go into the standby mode. ST-BY appears on the display and the RADAR soft key shows STBY as its current option.

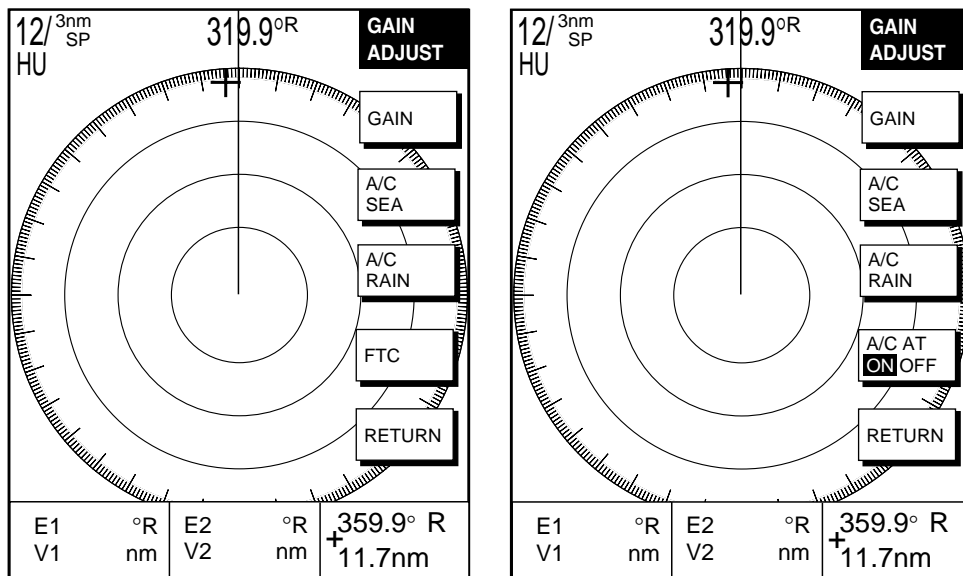
## 2.3 Adjusting the Gain

The gain circuit adjusts the gain (sensitivity) of the radar receiver. It works in precisely the same manner as the volume control of a broadcast receiver, amplifying the signals received.

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

To adjust receiver gain, transmit on long range, and then do the following.

1. Press the [GAIN] key to display the soft key for adjustment of gain.

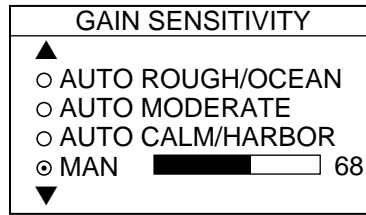


Linear amp

Log amp

*Gain adjust menu*

2. Press the GAIN soft key to show the GAIN SENSITIVITY window.

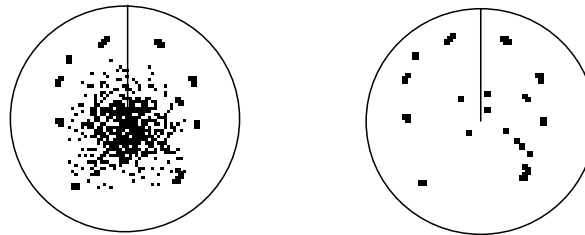


*Gain sensitivity window*

3. Operate the cursor pad to select AUTO ROUGH/OCEAN, AUTO MODERATE, AUTO CALM/HARBOR or MAN (manual) as appropriate.
4. For manual adjustment, rotate the [ENTER] knob to adjust the gain. The adjustable range is 0-100(%)
5. Press the RETURN soft key to finish.

## 2.4 Reducing Sea Clutter

Echoes from waves can be troublesome, covering the central part of the display with random signals known as “sea clutter”. The higher the waves, and the higher the antenna above the water, the further the clutter will extend. Sea clutter appears on the display as many small echoes which might affect radar performance. (See the left-hand figure in the figure below.) When sea clutter masks the picture, adjust the A/C SEA circuit to reduce the clutter.



Sea clutter at  
screen center

A/C SEA adjusted;  
sea clutter suppressed

*Effect of A/C SEA*

### 2.4.1 How the A/C SEA circuit works

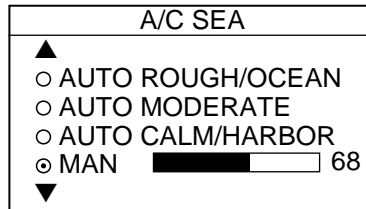
The A/C SEA circuit reduces the amplification of echoes at short ranges (where clutter is the greatest) and progressively increases amplification as the range increases, so amplification will be normal at those ranges where there is no sea clutter.

## 2. RADAR OPERATION

### 2.4.2 Adjusting A/C SEA

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

1. Press the [GAIN] key.
2. Press the A/C SEA soft key to show the A/C SEA setting window.

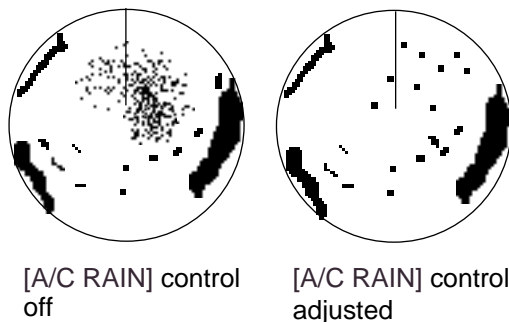


*A/C SEA setting window*

3. Operate the cursor pad to select AUTO LOW, AUTO MEDIUM, AUTO HIGH or MAN (manual).
4. When MAN is selected, rotate the [ENTER] knob to adjust the A/C SEA. The adjustable range is 0-100(%).
5. For the log amp type network radar (MODEL-1833/C, 1933/C, 1943/C), A/C SEA and A/C RAIN can be automatically adjusted. Press the soft key A/C AT to turn automatic adjustment on or off as appropriate.
6. Press the GAIN or RETURN soft key to finish.

## 2.5 Reducing Precipitation Clutter

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

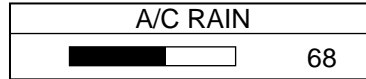


*Effect of A/C RAIN*

### 2.5.1 Adjusting the A/C RAIN

When rain clutter masks echoes, adjust the A/C RAIN circuit. This circuit splits up these unwanted echoes into a speckled pattern, making recognition of solid targets easier.

1. Press the [GAIN] key to show the GAIN ADJUST menu.
2. Press the A/C RAIN soft key to show the A/C RAIN window.



*A/C RAIN setting window*

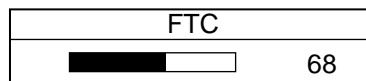
3. Rotate the [ENTER] knob to adjust the A/C RAIN affect. The current level is shown on the A/C RAIN level bar in the A/C RAIN window, and the adjustable range is 0 to 100(%).
4. Press the A/C RAIN or RETURN soft key to finish.

### 2.5.2 Adjusting the FTC (linear amp-type network radar only)

To suppress rain clutter from heavy storms or scattered rain clutter, adjust FTC. The FTC circuit splits up these unwanted echoes into a speckled pattern, making recognition of solid targets easier.

**Note:** In addition to reducing clutter, the FTC can be used in fine weather to clarify the picture when navigating in confined waters. However, with the circuit activates the receiver is less sensitive. Therefore, turn off the circuit when its function is not required.

1. Press the [GAIN] key to show the GAIN ADJUST menu.
2. Press the FTC soft key to show the FTC window.



*FTC setting window*

3. Rotate the [ENTER] knob to adjust FTC circuit affect. The adjustable range is 0-100(%).
4. Press the GAIN or RETURN soft key to finish.

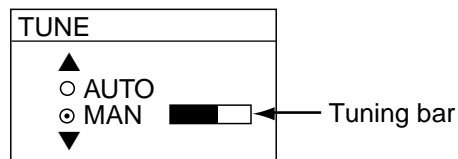
## 2.6 Tuning the Receiver

The radar receiver can be tuned automatically or manually, and the default tuning method is automatic.

### 2.6.1 Manual tuning

If you require manual tuning do the following:

1. Press the [MENU] key to display the main menu.
2. Press the RADAR DISPLAY SETUP soft key.
3. Select TUNING and press the EDIT soft key.



*Tuning window*

4. Choose MAN.
5. Adjust the [ENTER] knob to show the longest tuning bar.
6. Press the RETURN soft key.
7. Press the [MENU] key to close the menu.

## 2.7 Selecting the Range Scale

The range selected automatically determines the range ring interval, the number of range rings, pulselength and pulse repetition rate, for optimal detection capability in short to long ranges.

The range, range ring interval and pulselength appear at the top left-hand corner of the display.

Press the [RANGE (+ or -)] key to change the range scale.

### *Range scales (nm, sm)*

Range	0.125	0.25	0.5	0.75	1	1.5	2	3	4	6	8	12	16	24	36	48	64
Ring Interval	0.0625	0.125	0.125	0.25	0.25	0.5	0.5	1	1	2	2	3	4	6	12	12	16
# of Rings	2	2	4	3	4	3	4	3	4	3	4	4	4	4	3	4	4

### *Range scales (km)*

Range	0.25	0.5	0.75	1	1.5	2	3	4	6	6	8	12	16	24	36	48	64
Ring Interval	0.125	0.25	0.25	0.25	0.5	0.5	0.5	1	1	2	2	3	4	6	12	12	16
# of Rings	2	2	3	4	3	4	3	4	3	4	4	4	4	4	3	4	4

**Note:** Maximum range depends on the network radar connected as below.

1722, 1722C: 24 nm

1732, 1732C, 1752, 1752C, 1833, 1833C; 36 nm

1762, 1762C, 1933, 1933C: 48 nm

1943, 1943C: 64 nm

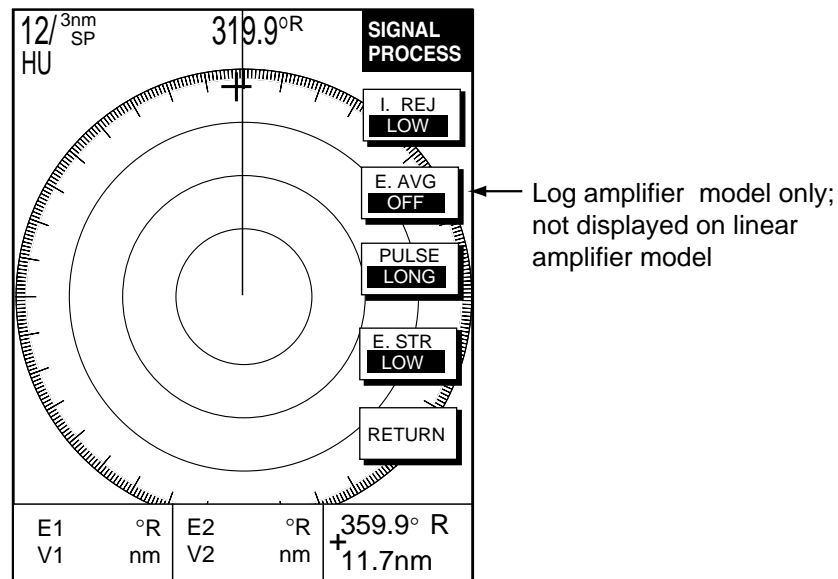
## 2.8 Pulselength

The pulselength in use is displayed at the upper left corner of the display. Appropriate pulselengths are preset to individual range scales and function keys. Therefore, you are not usually required to select them. If you are not satisfied with the current pulselength setting, however, it is possible to change it for the 3 and 6 kilometer ranges as below. Generally, select a long pulse for longer detection range and short pulse for better range discrimination.

1.5 nm (3 km): Short pulse, middle pulse

3 nm (6 km): Middle pulse, long pulse

1. Press the SIGNAL PROC. soft key to show the soft keys for signal processing.



*Signal process soft keys*

2. Press the PULSE SP (MP/LP) soft key to select the pulse width setting. Soft key shows the current setting. (1.5 nm: short pulse and middle pulse, 3 nm: middle pulse and long pulse)
3. Press the RETURN soft key to finish.

**Note:** This function is available only when 3 nm or 1.5 nm is selected.



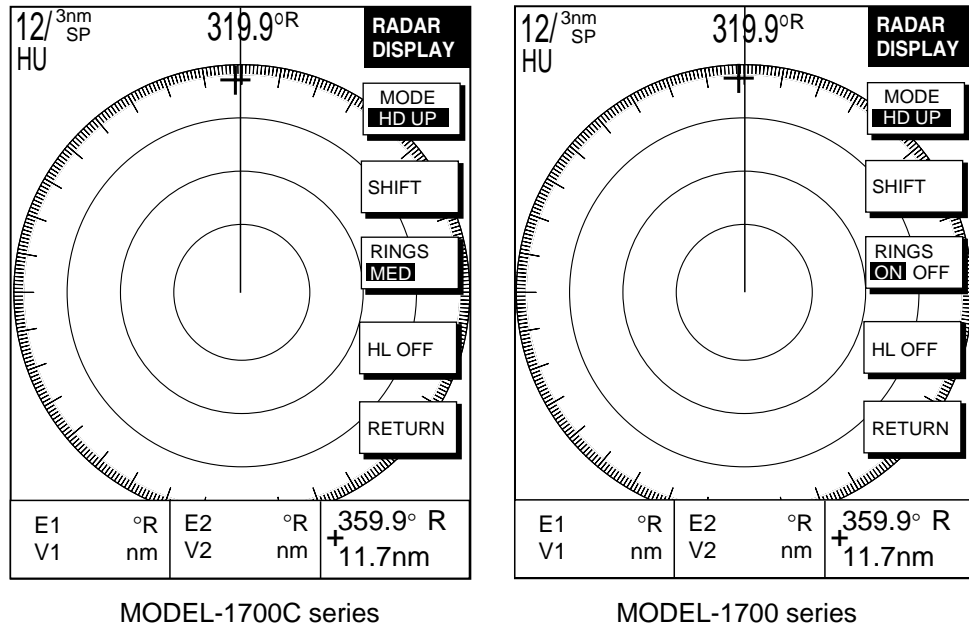
## 2.9 Presentation Mode

This unit provides four presentation modes: head-up, course-up, north-up and true motion.

Heading input required for modes other than head-up.

### 2.9.1 Selecting a presentation mode

1. Press the RADAR DISPLAY soft key to show the radar display soft keys.



2. Press the MODE soft key. Each pressing of the key changes the presentation mode and the presentation mode indication in the sequence of North-up, True Motion, Head-up, and Course-up.

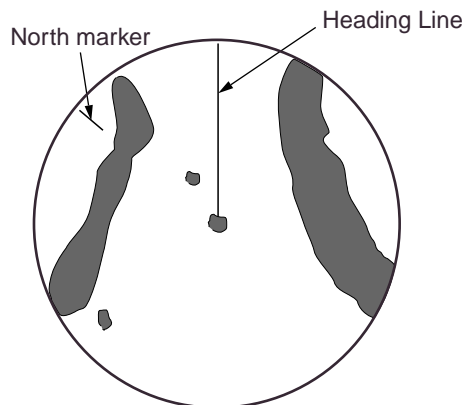
**Note:** When there is no heading data input, the MODE soft key does not appear.

## 2.9.2 Presentation mode overview

### Head-up (HU)

A display without azimuth stabilization in which the line connecting the center with the top of the display indicates own ship's heading. The target pips are painted at their measured distances and in their directions relative to own ship's heading.

A short line on the bearing scale is the north marker indicating compass north.

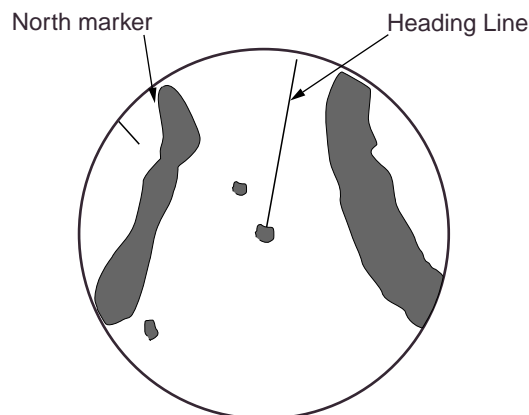


*Head-up presentation mode*

### Course-up (CU)

An azimuth stabilized display in which a line connecting the center with the top of the display indicates own ship's intended course (namely, own ship's previous heading just before this mode has been selected).

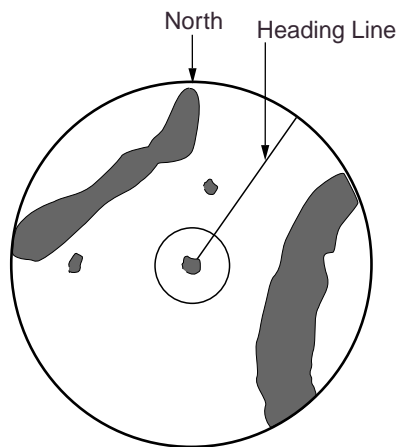
Target pips are painted at their measured distances and in their directions relative to the intended course which is maintained at the 0-degree position while the heading line moves in accordance with ship's yawing and course changes. This mode is useful to avoid smearing of picture during course change. After a course change, press the [CLEAR] key to reset the picture orientation if you wish to continue using the course-up mode.



*Course-up presentation mode*

**North-up (NU)**

In the north-up mode, target pips are painted at their measured distances and in their true (compass) directions from own ship, north being maintained UP of the screen. The heading line changes its direction according to the ship's heading.

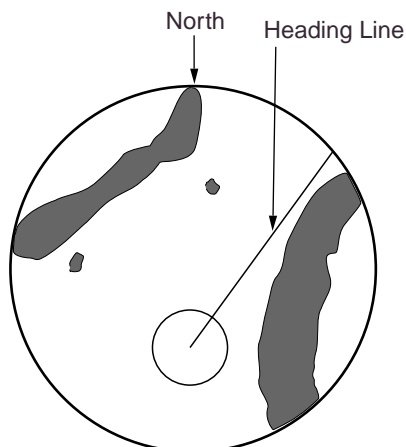


*North-up presentation mode*

**True motion (TM)**

Own ship and other moving objects move in accordance with their true courses and speeds. All fixed targets, such as landmasses, appear as stationary echoes.

When own ship reaches a point corresponding to 75 % of the radius of the display, the own ship is automatically reset to a point of 75 % radius opposite to the extension of the heading line passing through the display center. Resetting can be made at any moment before the ship reaches the limit by pressing the [CLEAR] key. Automatic resetting is preceded by a beep sound.



*True motion presentation mode*

**LOSS OF COMPASS SIGNAL:** When the compass signal is lost, the presentation mode automatically becomes head-up and the compass readout at the screen top shows xxx.x°. Once the compass signal is restored the presentation mode in use when the compass signal was lost is restored.

## 2.10 Measuring the Range

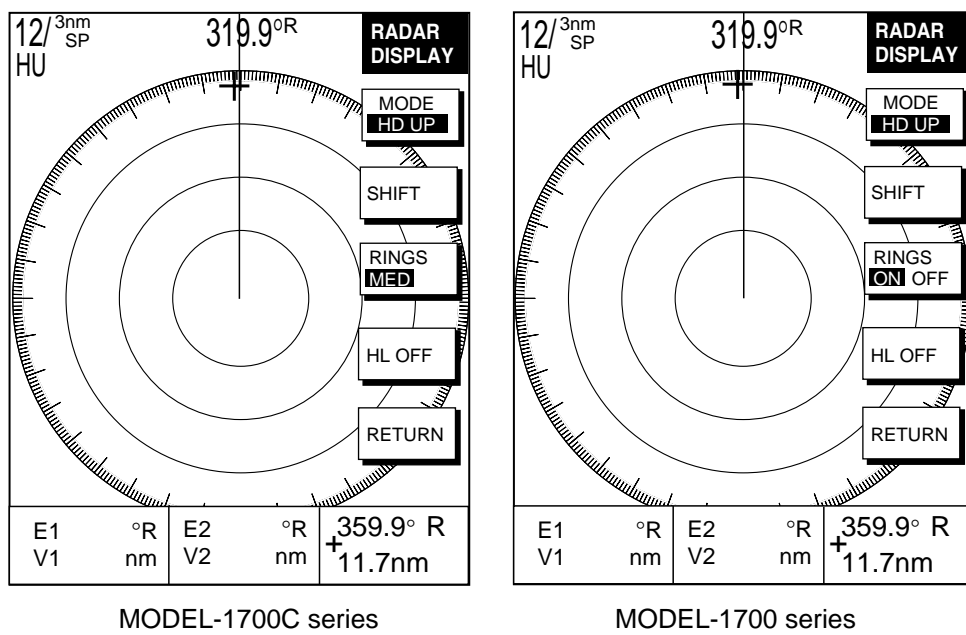
You can measure the range to a target three ways: by the range rings, by the cursor, and by the VRM (Variable Range Marker).

### 2.10.1 Measuring range by range rings

Count the number of rings between the center of the display and the target. Check the range ring interval and judge the distance of the echo from the inner edge of the nearest ring.

To turn the rings on/off, do the following:

1. Press the RADAR DISPLAY soft key.



*View soft keys*

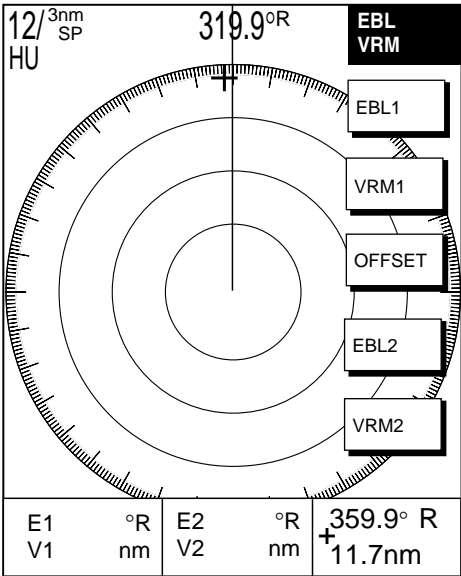
2. Press the RINGS soft key to display the range rings.
3. Press the RETURN soft key to finish.

### 2.10.2 Measuring range by cursor

Operate the cursor pad to place the cursor intersection on the inside edge of the target echo. The range to the target, as well as the bearing, appears to the right of “+” at the bottom of the display.

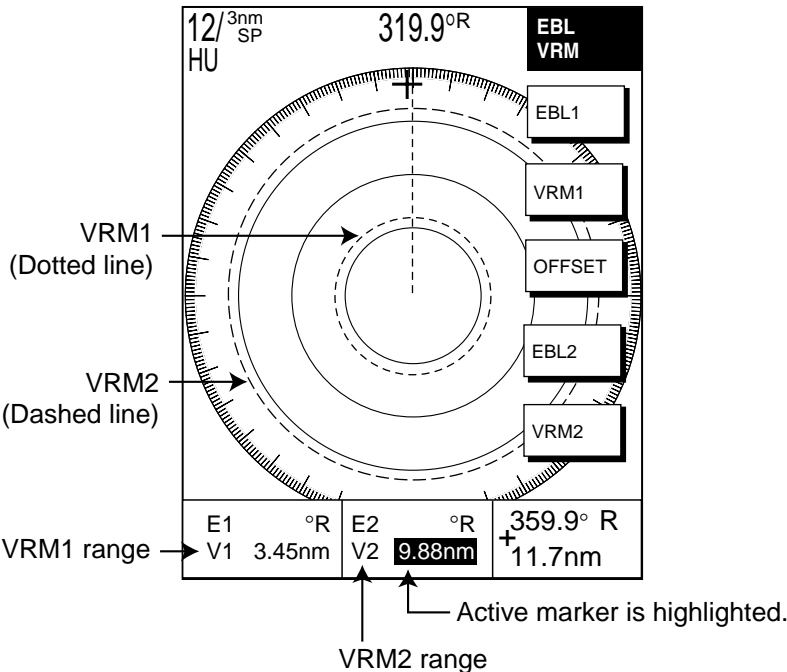
### 2.10.3 Measuring range by VRM

- 1. Press the [EBL/VRM] key to display the EBL and VRM soft keys.



EBL/VRM soft keys

- 2. Press the VRM1 (dotted ring) or VRM2 (dashed line) soft key to select VRM desired. The selected VRM and its indication (at the bottom center) is highlighted.
- 3. Rotate the [ENTER] knob to place the VRM on the inside edge of a target echo. Read the VRM indication to find range.



How to measure range with the VRM

## 2. RADAR OPERATION

### **2.10.4 Erasing a VRM**

Press appropriate VRM soft key and press the [CLEAR] key.

### **2.10.5 Erasing EBL/VRM data boxes**

The EBL/VRM data boxes are automatically erased any time an EBL or VRM is turned off. If you do not require the EBL/VRM data boxes during operation of an EBL or VRM, you can erase them by pressing the [CLEAR] key. The data boxes will be redisplayed when an EBL or VRM is operated or an EBL/VRM data box is moved.

### **2.10.6 Moving EBL/VRM data boxes**

When an EBL/VRM data box is obscuring a wanted target you can move it to another location. Place the cursor in the data box and press the [ENTER] knob. Use the cursor pad to move the box to new location and then press the [ENTER] knob.

## 2.11 Measuring the Bearing

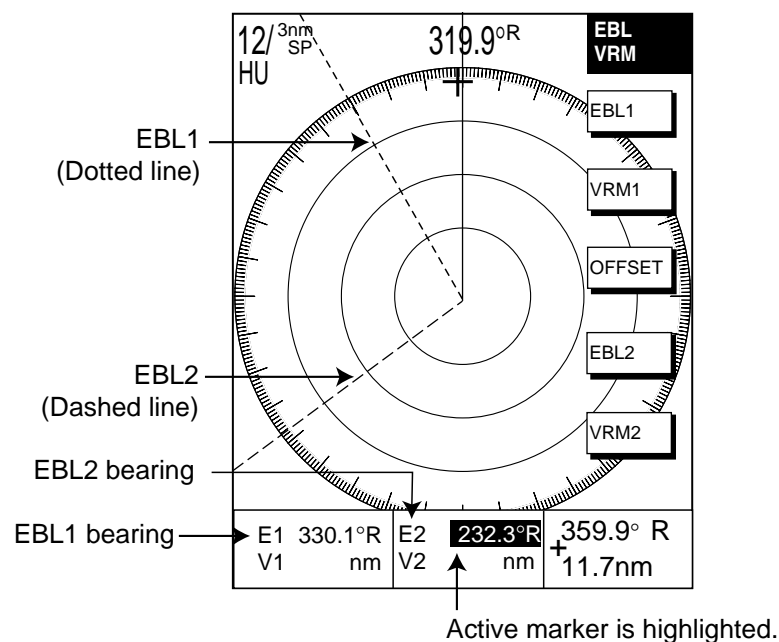
There are two ways to measure the bearing to a target: by the cursor, and by the EBL (Electronic bearing Line).

### 2.11.1 Measuring bearing by cursor

Operate the cursor pad to bisect the target with the cursor intersection. The bearing to the target appears at the bottom to the right of "+" at the bottom of the display.

### 2.11.2 Measuring bearing by EBL

1. Press the [EBL/VRM] key.
2. Press the EBL1 (dotted line) or EBL2 (dashed line) soft key to select EBL desired. The selected EBL and its indication (at the bottom center) is highlighted.
3. Rotate the [ENTER] knob to bisect the target echo with the EBL. Read the EBL indication to find bearing.
4. To erase an EBL, press the EBL1/EBL2 soft key again.



*How to measure bearing with the EBL*

### 2.11.3 Erasing an EBL

Press appropriate EBL soft key and press the [CLEAR] key.

### 2.11.4 Erasing EBL/VRM data boxes

The EBL/VRM data boxes are automatically erased any time an EBL or VRM is turned off. If you do not require the EBL/VRM data boxes during operation of an EBL or VRM, you can erase them by pressing the [CLEAR] key. The data boxes will be redisplayed when an EBL or VRM is operated or an EBL/VRM data box is moved.

### 2.11.5 Moving EBL/VRM data boxes

When an EBL/VRM data box is obscuring a wanted target you can move it to another location. Place the cursor in the data box and press the [ENTER] knob. Use the cursor pad to move the box to new location and then press the [ENTER] knob.

## 2.12 Erasing the Heading Line, North Marker

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

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

To temporarily erase the heading line and north marker, press the VIEW soft key followed by the HL OFF soft key. Release the key to redisplay the markers.

## 2.13 Reducing Noise Interference

White noise, appearing on the displays as random "speckles," can be rejected as follows:

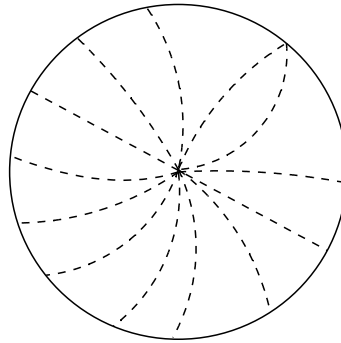
1. Press the [MENU] key to open the menu.
2. Press the RADAR DISPLAY SETUP soft key.
3. Select NOISE REJECTION and press the EDIT soft key.
4. Select ON or OFF as appropriate.
5. Press the RETURN soft key.
6. Press the [MENU] key to close the menu.



## 2.14 Reducing Radar Interference

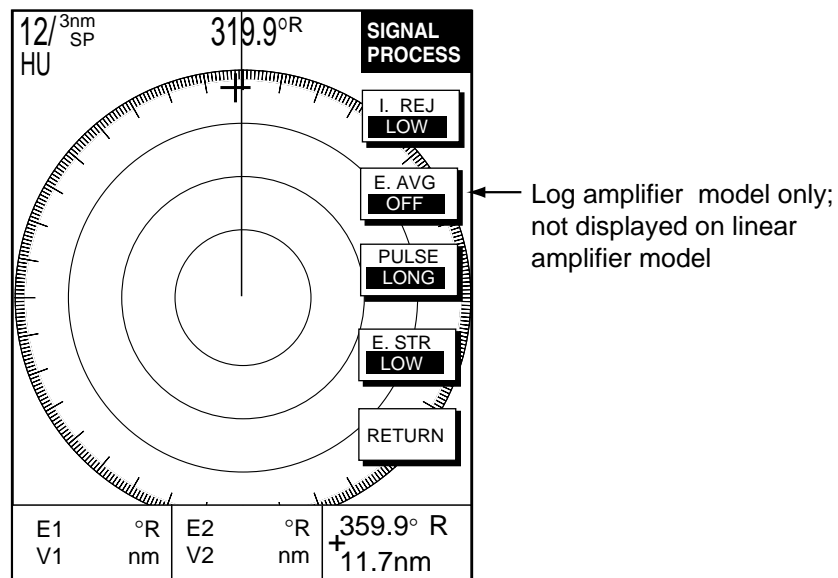
Radar interference may occur when near another shipborne radar is operating in the same frequency band as your radar. Its on-screen appearance is many bright dots either scattered at random or in the form of dotted lines extending from the center to the edge of the display. Interference effects are distinguishable from normal echoes because they do not appear in the same place on successive rotations of the scanner.

Be sure to turn off the interference rejection circuit when no interference exists – weak targets may be missed.



*Radar interference*

1. Press the SIGNAL PROCESS soft key to show the signal process soft keys.



*Signal process soft keys*

2. Press the I. REJ. soft key to set the interference rejection level.
3. Press the RETURN soft key to finish.

The display shows IRL (Low), IRM (Medium), IRH (High) when the interference rejector is on.

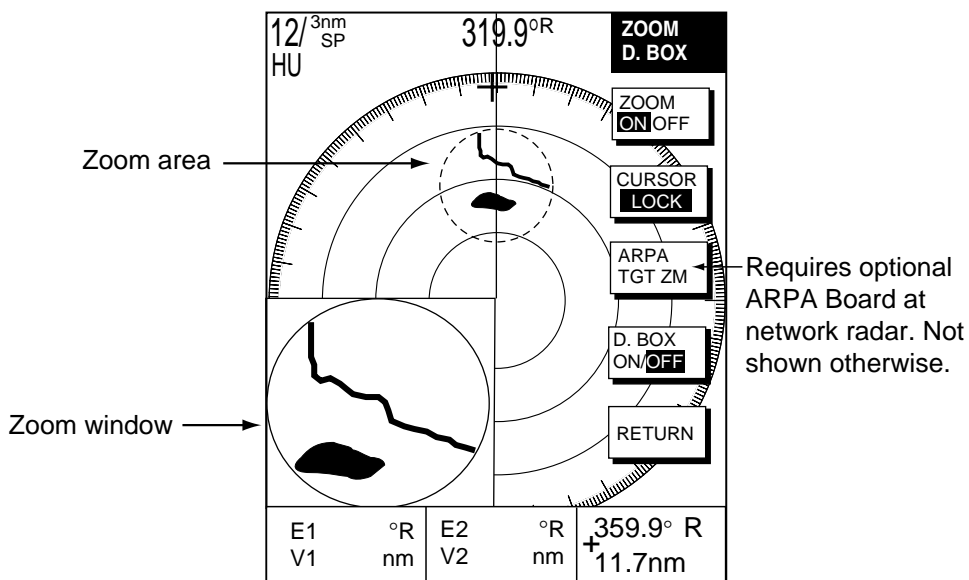
## 2. RADAR OPERATION

### 2.15 Zoom

The zoom feature allows you to double the size of the area selected. The zoom window appears at the bottom right (or left) 1/4 of the display. Note that the zoom function is available on the 0.25 nm range and above.

#### 2.15.1 Zooming radar targets

1. Press the ZOOM/D.BOX soft key to show ZOOM/D.BOX soft keys.
2. Press the ZOOM ON/OFF soft key to highlight ZOOM ON. A solid circle appears on the display.
3. Operate the cursor pad to locate the circle where you want to zoom.
4. Press the CURSOR FLOAT soft key. The solid circle changes to a dashed one.
5. To change the area, press the CURSOR LOCK soft key.

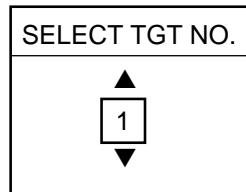


*Zoom*

### 2.15.2 Zooming ARPA, TTM targets

If TTM data sentence is input to the equipment, you can magnify corresponding tracked targets as follows:

1. Press the ZOOM/D.BOX soft key to show ZOOM/D.BOX soft keys.
2. Press the ZOOM ON/OFF soft key to highlight ZOOM ON.
3. Press the ARPA TGT ZM soft key. Target no. selection window appears.



*ARPA target no. selection window*

4. Use the rotary encoder to select number and press the [ENTER] knob. If the target could not be magnified the audio alarm sounds and the zoom function is cancelled.

To cancel, press the CURSOR FLOAT soft key.

## 2.16 Shifting the Picture

Own ship position, or sweep origin, can be displaced manually or automatically to expand the view field without switching to a larger scale.

### **Manual shift**

The sweep origin can be shifted in any presentation mode to a point specified by the cursor, up to 75% of the range in use in any direction.

### **Automatic shift**

The sweep origin is automatically shifted sternwise, the amount of shift dependent on the automatic shift maximum speed. The formula for determining amount of shift is as below.

When the ship's speed is lower than the automatic ship speed setting:

Temporary shift amount = effective radius dot X 0.75 X speed/auto shift speed setting

- Absolute position (previous shift amount – interim shift amount) ≥ judged shift amount

Shift amount = interim shift amount

- Absolute position (previous shift amount – interim shift amount) < judged shift amount

Shift amount = previous shift amount

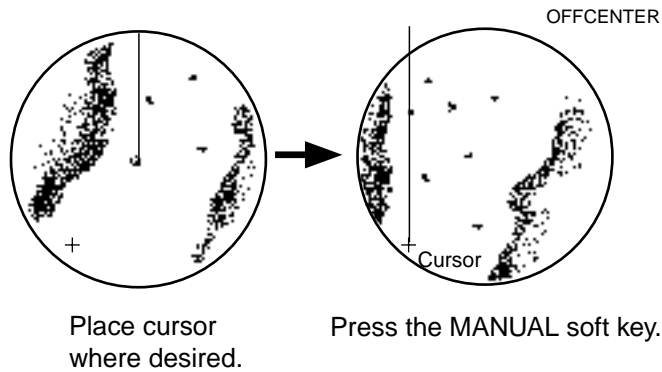
When the ship's speed is higher than the automatic ship speed setting

Shift amount = effective radius X 0.75

## 2. RADAR OPERATION

### 2.16.1 Manual shift

1. Locate the cursor anywhere within the effective radius of the display.
2. Press the RADAR DISPLAY soft key.
3. Press the SHIFT soft key.
4. Press the MANUAL soft key to shift. The heading line shifts to the cursor location.
5. To cancel shift, press the OFF soft key.



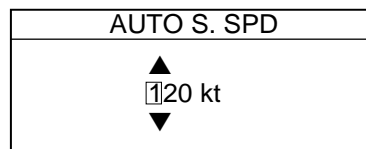
*Shifting the picture manually*

### 2.16.2 Automatic shift

The automatic shift mode is only available in the heading up mode.

#### **Setting automatic shift maximum speed**

1. Press the RADAR DISPLAY soft key.
2. Press the SHIFT soft key to show the shift soft keys.
3. Press the AUTO S.SPD soft key to display the AUTO S. SPD setting window.



*AUTO S.SPD setting window*

4. Rotate the [ENTER] knob to enter the maximum ship's at which the display is automatically shifted. The setting range is 1-999 kt and the default setting is 15 kt.
5. Press the ENTER soft key to close the window.

#### **Automatic shift**

Press the AUTO key to automatically shift the display. To cancel shift, press the OFF soft key.

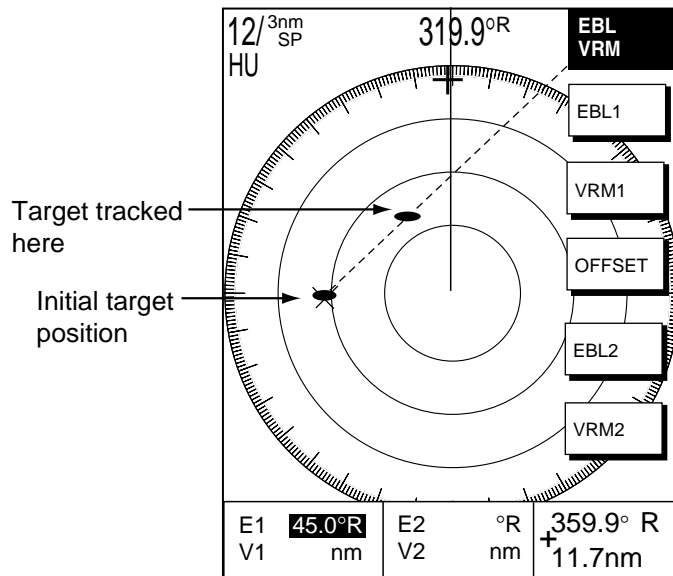
## 2.17 Using the Offset EBL

The offset EBL functions to predict collision course and measure the range and bearing between two targets.

### 3.17.1 Predicting collision course with the Offset EBL

The procedure below checks if the target echo shown in below is on a collision course.

1. Use the cursor pad to place the cursor on the target which looks like it might be on a collision course with your vessel.
2. Press the [EBL/VRM] key to show the EBL and VRM soft keys.
3. Press the OFFSET soft key. The origin of EBL1 moves to the cursor position and an "X" appears at the cursor position.
4. Press the [ENTER] knob to fix the origin position.
5. After waiting for a few minutes (at least three minutes), rotate the [ENTER] knob so the EBL bisects the target at the new position. If the target tracks along the EBL towards the center of the display (your ship's position), the target may be on a collision course.
6. To cancel the offset EBL, press the OFFSET soft key.

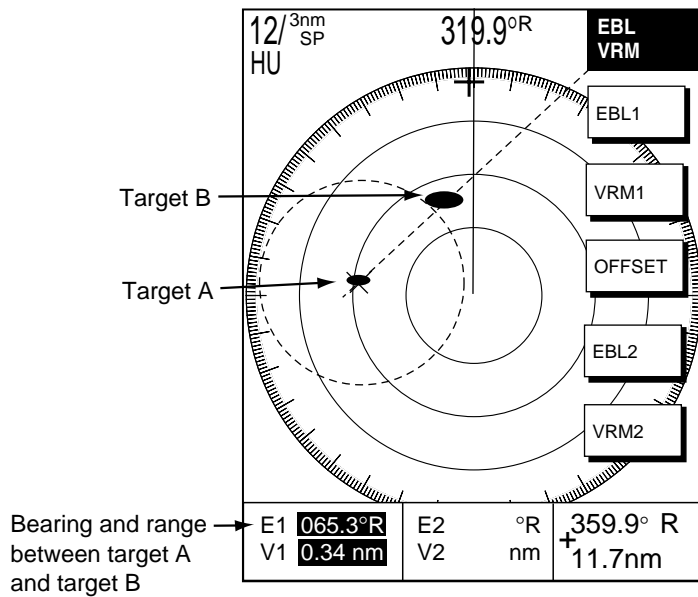


*Predicting collision course with the offset EBL*

### 2.17.2 Measuring range & bearing two targets

The procedure which follows shows how to measure the range and bearing between target “A” and target “B” in the figure below.

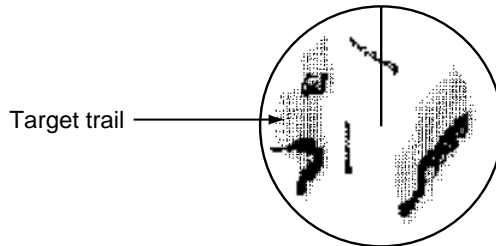
1. Operate the cursor pad to place the cursor on the target “A”.
2. Press the [EBL/VRM] key to show the EBL and VRM soft keys.
3. Press the OFFSET soft key. The origin of EBL1 and VRM1 moves to the cursor position and an “X” appears at the cursor position.
4. Rotate the [ENTER] knob so the EBL bisects the target “B”.
5. Press the VRM1 soft key and then rotate the [ENTER] knob to place the VRM1 on the inner edge of the target “B”.



*Measuring bearing between two targets*

## 2.18 Target Trails

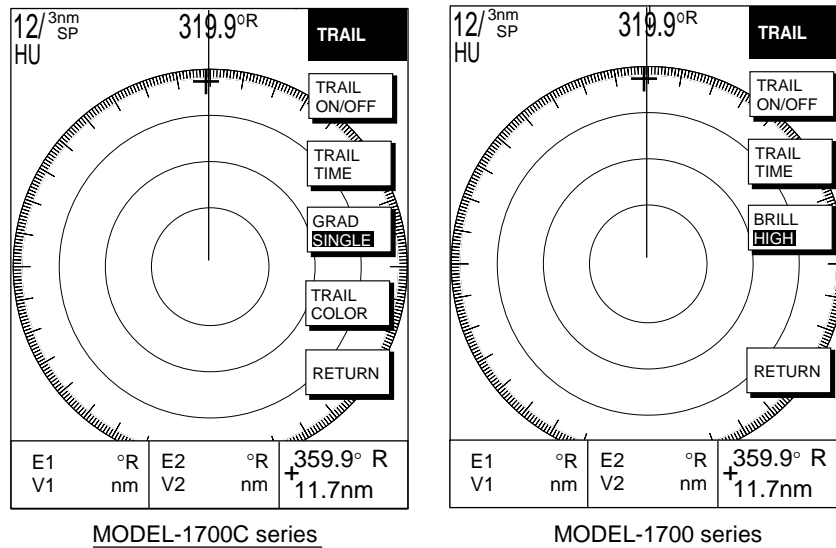
Target trails are simulated afterglow of target echoes that represent their movements relative to own ship in a single tone depending on menu setting. This function is useful for altering you to possible collision situations.



Sample target trails

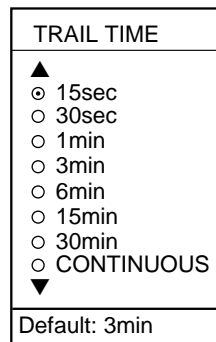
### 2.18.1 Selecting trail time

1. Press the TARGET soft key.
2. Press the TRAIL soft key to show the trail menu.



Trail soft keys

3. Press the TIME soft key to show the TRAIL TIME window.



Trail time window

4. Use the cursor pad to select time desired, and then press the ENTER key.

## 2. RADAR OPERATION

### 2.18.2 Starting target trail

1. Press the [MENU] key.
2. Press the TARGET and TRAIL soft keys.
3. Press the TRAIL soft key to show ON.

TRAIL, the echo trail time selected and elapsed time appear at the top right-hand corner of the display. Then afterglow starts extending from all targets. Trails are restarted when the range or mode is changed or zoom or shift is turned on. For continuous trails the maximum continuous trail time is 99 minutes and 59 seconds. When the elapsed time clock counts up to that time the elapsed time display resets to zero and trail begins again.

4. To turn off echo trail, press the TRAIL soft key to select OFF.

### 2.18.3 Trail brilliance (MODEL-1700 series only)

Trail brilliance can be selected to high or low as below.

1. Press the [MENU] key.
2. Press the TARGET and TRAIL soft keys.
3. Press the BRILL soft key to select HIGH or LOW.

### 2.18.4 Trail gradation (MODEL-1700C series only)

The echo trails can be shown in single or multiple gradations. Multiple gradation paints the trails getting thinner with time, like the afterglow on an analog PPI radar. Press the GRAD soft key to show GRAD SINGLE or GRAD MULTIPLE as appropriate.



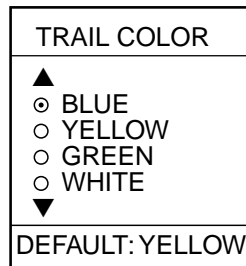
*Multitone and monotone trails*



### 2.18.5 Trail color (MODEL-1700C series) only

The MODEL-1722C series can show trails in colors

1. Press the [MENU] key.
2. Press the TARGET, TRAIL and TRAIL COLOR soft keys.

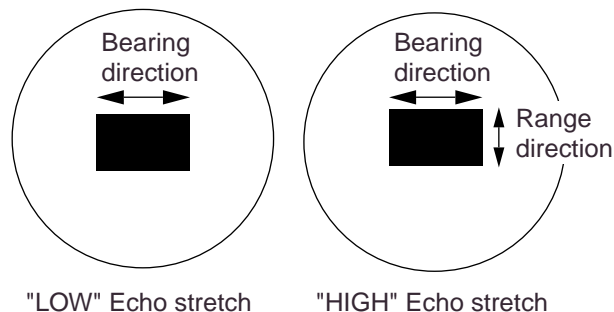


*Trail color window*

3. Use the cursor pad to select color desired.
4. Press the RETURN soft key to quit.

## 2.19 Magnifying Long Range Echoes (echo stretch)

Normally, the reflected echoes from long range targets appear on the display as weaker and smaller blips even though they are compensated by the radar's internal circuitry. The echo stretch function magnifies these small blips in all ranges. Two types of echo stretch are available: ES LOW which stretches echoes in bearing direction and ES HIGH which stretches them in both range and bearing directions.



*Types of echo stretch*

This function magnifies not only targets but also sea clutter and radar interference. For this reason be sure sea clutter and radar interference are properly suppressed before activating the echo stretch.

1. Press the SIGNAL PROCESS soft key.
2. Press the E. STR soft key to select E. STR HIGH or E. STR LOW as appropriate.
3. Press the RETURN soft key to finish.

The display shows ES H (High) or ES L (Low) when the echo stretch is on.

## 2.20 Echo Averaging (log amp only)

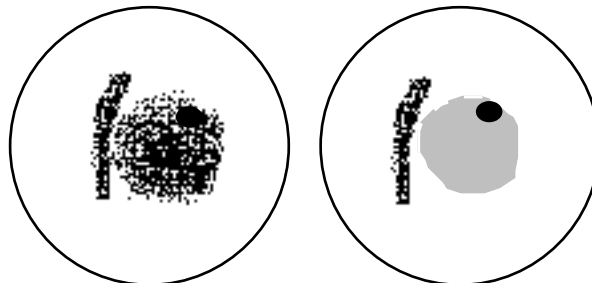
The echo average feature effectively suppresses sea clutter. Echoes received from stable targets such as ships appear on the screen at almost the same position every rotation of the scanner. On the other hand, unstable echoes such as sea clutter appear at random positions.

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

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

1. Press the SIGNAL PROCESS soft key.
2. Press the E. AVG key to select desired averaging.
  - OFF: No averaging effect
  - 1: Helps distinguish targets from sea clutter and suppresses brilliance of unstable echoes.
  - 2: Distinguishes small stationary targets such as navigation buoys.
  - 3: Stably displays distant targets.

The display shows EAVL, EAVM or EAVH when echo averaging is on.



(a) Echo average OFF

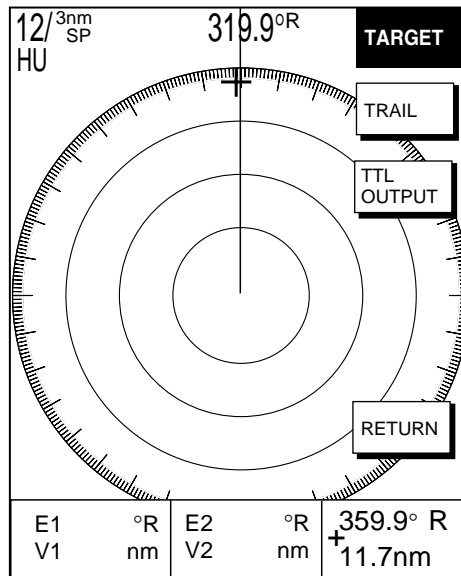
(b) Echo average ON

*Effect of echo averaging*

## 2.21 Outputting TLL Data

Target position data can be output to a navaid, in IEC 61162 (NMEA 0183) format. This function requires position data and heading data.

1. Operate the cursor pad to place the cursor on the target to output.




*TARGET soft keys*

2. Press the TLL OUTPUT soft key to output target position data.

## 2.22 Guard Alarm

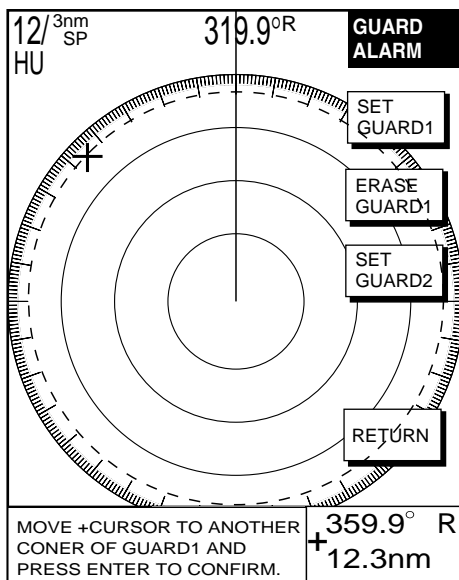
The guard alarm allows the operator to set the desired range and bearing for a guard zone. When ships, islands, landmasses, etc. violate the guard zone an audible alarm sounds and the offending target blinks to call the operator's attention.

 <b>CAUTION</b>
<ul style="list-style-type: none"> <li>• The alarm should not be relied upon as the sole means for detecting possible collision situations.</li> <li>• A/C SEA, A/C RAIN and GAIN controls should be properly adjusted to be sure the alarm system does not overlook target echoes.</li> </ul>

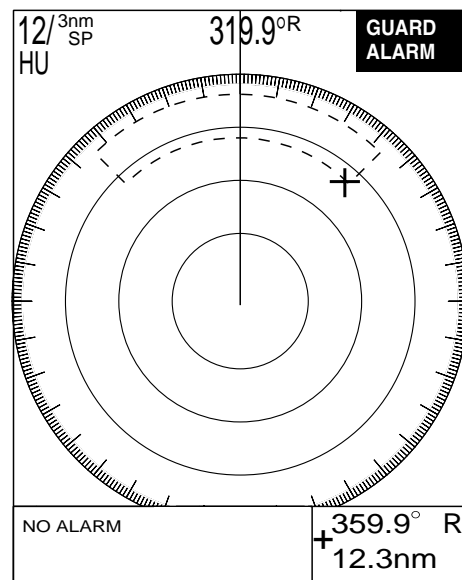
### 2.22.1 Setting a guard alarm zone

To set a guard alarm zone transmit and do the following:

1. Press the [ALARM] key.
2. Use the cursor pad to set the cursor on the top left (or top right corner) of the guard zone to set and press the SET GUARD 1 or SET GUARD 2 soft key.
3. Use the cursor pad to set the cursor on the bottom right (or top left corner) of the guard zone and press the [ENTER] knob.



(1) Drag cursor to top (or bottom) corner for guard zone and press the SET GUARD 1 or SET GUARD 2 soft key.

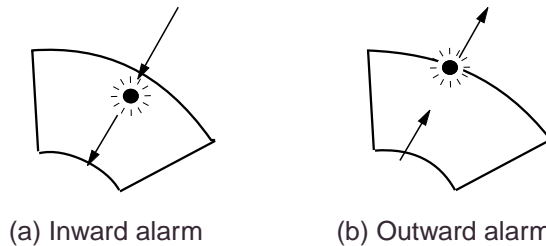


(2) Drag cursor diagonally to bottom (or top) corner for guard zone and press the [ENTER] knob.

*How to set a guard alarm zone*

### 2.22.2 Guard zone type

After the guard zone is set, the radar searches for targets inside the guard zone to determine guard alarm type. If no targets are found the guard zone type is “inward” and the guard zone indication is G1(G2) OUT. The “inward” alarm is triggered when a target enters the guard zone. If a target is found the guard zone type is “outward” and the guard zone indication is G1(G2) IN. The “outward” alarm is triggered when a target exits the guard zone.



*How the inward and outward alarms work*

- Note 1:** When the radar range is less than the guard zone range, the alarm icon is displayed in reverse video, the audio alarm sounds and the message “GUARD 1(2) IS OUTSIDE RADAR RANGE” appears. Press the [ALARM] key to silence the alarm and erase the message. Reselect appropriate range.
- Note 2:** If the network radar is set to standby while the guard alarm is active, the guard alarm is cancelled and the radar goes into standby. The guard alarm is redisplayed when radar pulses are again transmitted.
- Note 3:** If the network radar is set to standby while the radar picture is not displayed, the alarm icon appears in reverse video and the alarm sounds. Further, the message “STBY MODE HAS BEEN SELECTED. GUARD/WTCHMN CANCELED.” or GUARD/WATCHMAN CANCELED. STBY/TX SELECTED.

### 2.22.3 When the alarm is violated...

Any radar target violating the guard zone will flash, the audio alarm sounds, the alarm icon appears, and the message “TARGET HAS ENTERED G1(G2)” or “TARGET HAS LEFT G1(G2)” is displayed at the bottom of the screen. Press the [CLEAR] key to silence the alarm and erase the alarm icon. When this is done, “G1(G2) ACK” replaces G1(G2) IN(OUT) at the top right corner of the display. This means the alarm is temporarily deactivated. Press the SETGUARD1 or SETGUARD2 soft key again to reactivate the alarm.

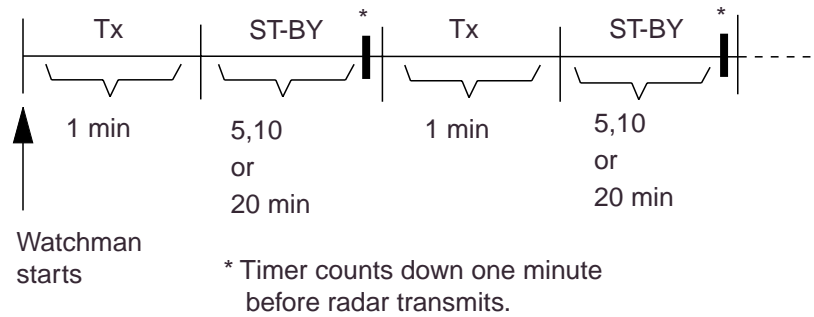
### 2.22.4 Cancelling the guard alarm

1. Press the [ALARM] key to show the ALARM menu.
2. Press the SET GUARD1 or SET GUARD2 soft key as appropriate.
3. Press the RETURN soft key to finish.

## 2.23 Watchman

### 2.23.1 How watchman works

The watchman function periodically transmits radar pulses for one minute to check for targets in a guard zone. If a target is found in the zone, watchman is cancelled, the audio alarm sounds and the radar continues transmitting. If no target is found the radar goes into standby. This feature is useful when you do not need the radar's function continuously but want to be alerted to radar targets in a specific area.



*How watchman works*

### 2.23.2 Turning on/off watchman

1. Press the NAV FUNC soft key to show the NAV FUNC soft keys.
2. Press the W. MAN ON/W. MAN OFF soft key to highlight ON or OFF as appropriate.

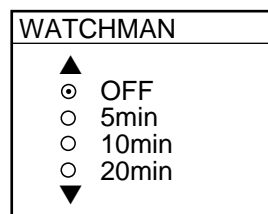
**To cancel watchman,** press any key.

**Note:** When the watchman is activated and no guard zone is active, the message "PLEASE SET GUARD ZONE. PRESS ANY KEY TO CONTINUE." appears. Press any key and then set a guard zone.

### 2.23.3 Setting watchman stand-by interval

The watchman standby interval can be set to 5, 10 or 20 minutes as follows:

1. Press the [MENU] key.
2. Press the RADAR DISPLAY SETUP soft key.
3. Select WATCHMAN and press the EDIT soft key.

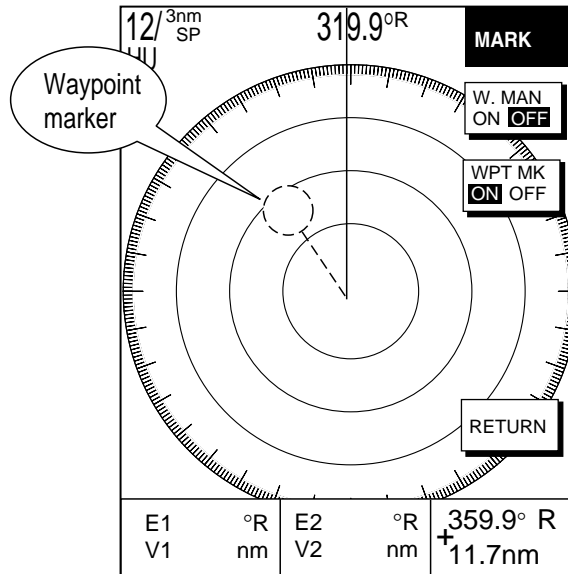


*Watchman window*

4. Select option desired and press the RETURN soft key.
5. Press the [MENU] key to close the menu.

## 2.24 Turning Waypoint Marker On/Off

A waypoint marker, showing waypoint position output from a navigation device, may be inscribed on the radar display. You may show or hide this mark as desired.



*Waypoint marker*

1. Press the NAV FUNC soft key.
2. Press the WPT MK ON/OFF to highlight ON or OFF as appropriate.
3. Press the RETURN soft key to finish.

## 2.25 ARPA Operation

The network radar model 1800/1900 series equipped with the optional ARPA circuit board can manually and automatically acquire and track 10 targets. Once a target is acquired automatically or manually it is automatically tracked within 0.1 to 32 nm, whether inside or outside the automatic acquisition area.

Alternatively, you can display the tracks of other ships by receiving the data sentence TTM via a network radar. Targets cannot be acquired in this case.

### **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 auto plotter automatically tracks an automatically or manually acquired radar target and calculates its course and speed, indicating them by a vector. 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 auto plotter 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.

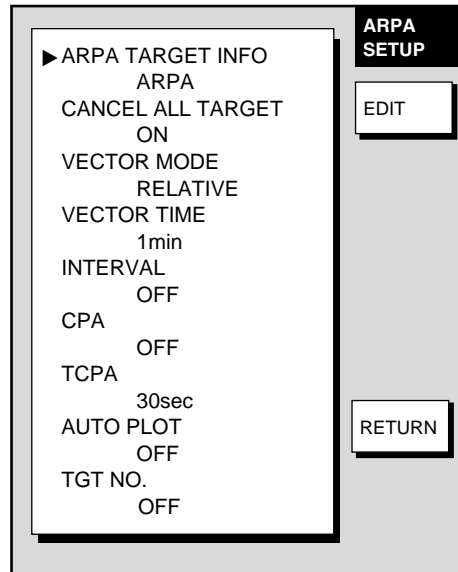
**Display accuracy is affected by the following:**

- Echo intensity
- Radar transmission pulsewidth
- Radar bearing error
- Gyrocompass error
- Course change (own ship or target)



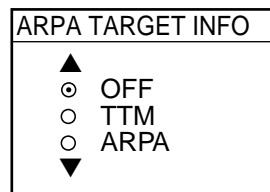
### 2.25.1 Activating/deactivating ARPA

1. Press the [MENU] key followed by the ARPA SETUP soft keys to show the ARPA SETUP menu.



*ARPA SETUP menu*

2. Select ARPA TARGET INFO, and then press the EDIT soft key to show the ARPA TARGET INFO window.



*Plot window*

3. Select ARPA, TTM or OFF as appropriate. For TTM, targets cannot be acquired.
4. Press the ENTER soft key.
5. Press the [MENU] key to close the menu.

## 2.25.2 Acquiring and tracking targets

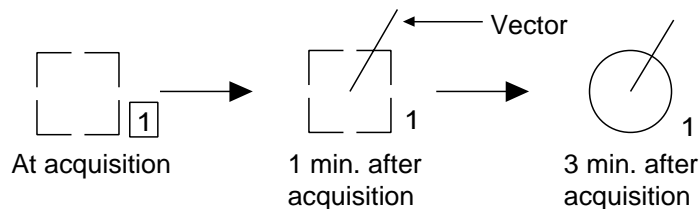
When selecting ARPA on the ARPA SETUP menu, targets can be acquired.

### Manual acquisition

10 targets can be manually acquired and automatically tracked.

1. Place the cursor on the target to acquire.
2. Press the ACQ soft key.

The plot symbol changes its shape according to the status as below. 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 plot symbol blinks and disappears shortly. When all 10 targets have been acquired the message ARPA TGT FULL-TRACKING 10 TARGETS appears. To acquire another target, terminate tracking of an unnecessary target.

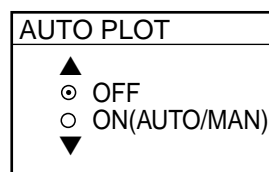


*Plot symbols*

### Automatic acquisition

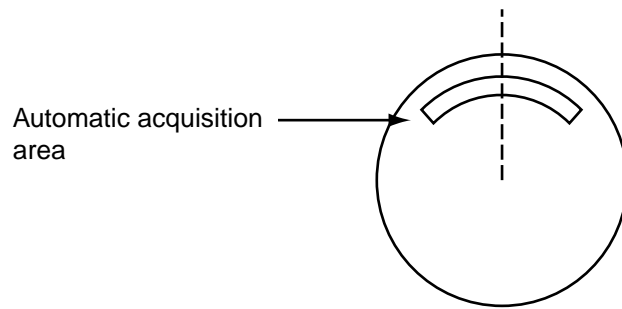
The ARPA automatically acquires up to 10 targets which come into the acquisition area.

1. Press the [MENU] key to show the main menu.
2. Press the ARPA SETUP soft key to show the ARPA SETUP menu.
3. Operate the cursor pad to select AUTO PLOT.
4. Press the EDIT soft key to show the AUTO PLOT window.



*Auto plot window*

5. Select ON. An acquisition area of 2.0 to 2.5 miles in range and  $\pm 45^\circ$  on either side of the heading line appears.



*Automatic acquisition area*

When the automatic acquisition capacity is reached the message ARPA TARGET FULL-TRACKING 10 TARGETS appears.

### 2.25.3 Terminating tracking of targets

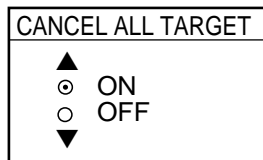
When 10 targets have been acquired, no more acquisition occurs unless targets are lost. Should this happen, cancel tracking of individual targets or all targets by the procedure described below.

#### Terminating tracking of selected targets

1. Place the cursor on the target to terminate tracking.
2. Press the [CLEAR] key to erase.

#### Terminating tracking of all targets

1. Press the [MENU] followed by the ARPA SETUP soft keys.
2. Select CANCEL ALL TARGET, and then press the EDIT soft key.



*Cancel all target window*

3. Select YES and press the ENTER soft key.
4. Press the [MENU] key to close the menu.

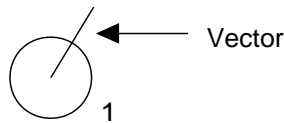
## 2.25.4 Vector attributes

### True or relative vector

Target vectors display speed and course of tracked targets. You may reference the vectors to North (True) or ship's heading (relative) as desired. Own ship does not have a vector in relative mode.

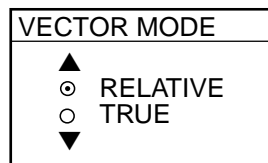
### Vector time

Vector time can be set to 30 seconds, 1, 3, 6, 15 or 30 minutes and the selected vector time is indicated on the screen. The vector tip shows an estimated position of the target after the selected vector time elapses. It can be valuable to extend the vector length to evaluate the risk of collision with any target.



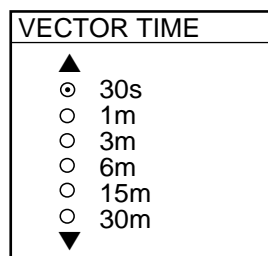
*Vector*

1. Press the [MENU] key followed by the ARPA SETUP soft keys to show the ARPA SETUP menu.
2. Operate the cursor pad to select VECTOR MODE.
3. Press the EDIT soft key to show the VECTOR MODE window.



*Vector mode window*

4. Select TRUE or RELATIVE as appropriate.
5. Press the ENTER soft key.
6. Select VECTOR TIME, and then press the EDIT soft key to show the VECTOR TIME window.



*Vector time window*

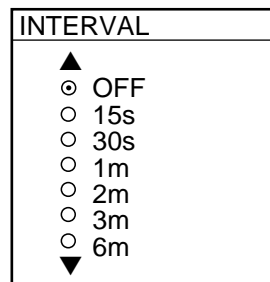
7. Operate the cursor pad to select vector length among 30 sec, 1 min, 3 min, 6 min, 15 min and 30 min.
8. Press the ENTER soft key.
9. Press the [MENU] key to close the menu.

### 2.25.5 Past position display

This ARPA displays equally time-spaced dots (maximum 10 dots) marking the past positions of any targets being tracked. If a target changes its speed, the spacing will be uneven. If it changes the course, its plotted course will not be a straight line in TM mode.

To turn the past position display on/off:

1. Press the [MENU] key followed the RADAR and ARPA SETUP soft keys in order.
2. Operate the cursor pad to select INTERVAL.
3. Press the EDIT soft key to show the INTERVAL window.



*Interval window*

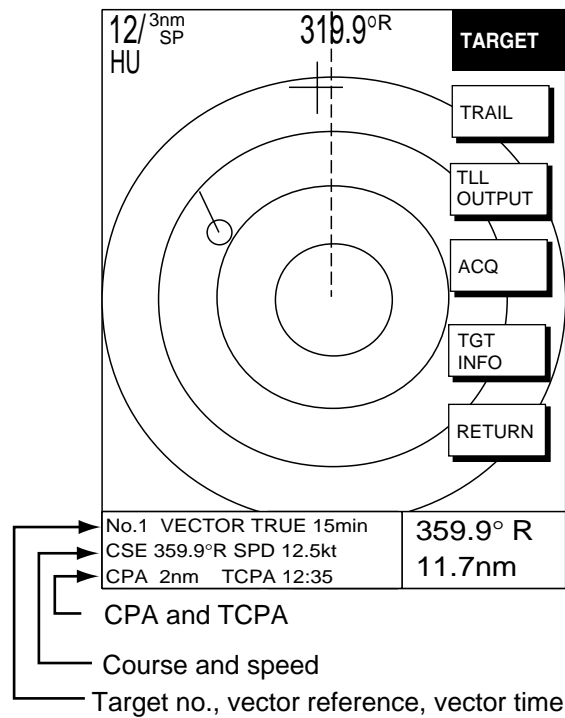
4. Operate the cursor pad to select plotting interval among 15 sec, 30 sec, 1 min, 2 min, 3 min and 6 min. (OFF turns off the past position display.)
5. Press the ENTER soft key.
6. Press the [MENU] key to close the menu.

## 2. RADAR OPERATION

### 2.25.6 Displaying target data

This ARPA calculates motion trends (range, bearing, course, speed, CPA and TCPA) of all targets under tracking, and displays data of selected target at the bottom of the screen.

1. Place the cursor on the target you want to see its data.
2. Press the TARGET INFO soft key. The data of the selected target appears



*ARPA target data*

#### Displaying the target number

You can turn the acquired target number display on or off as follows:

1. Press the [MENU] key followed by the RADAR MENU and ARPA SETUP MENU soft keys.
2. Operate the cursor pad to select TARGET NO.
3. Press the EDIT soft key.
4. Select YES or NO as appropriate.
5. Press the ENTER soft key.
6. Press the [MENU] key to close the menu.

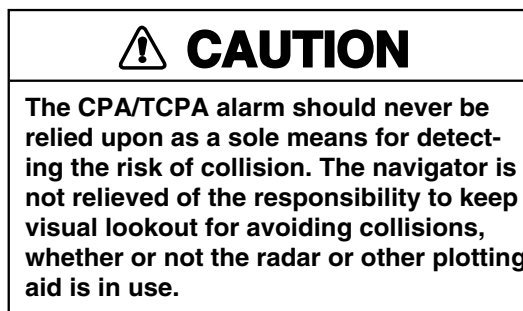
### 2.25.7 CPA/TCPA alarm

Visual and audible alarms are generated when the predicted CPA and TCPA of any target become less than their preset limits. Press the [CLEAR] key to acknowledge and silence the CPA/TCPA audible alarm. This ARPA continuously monitors the predicted range at the Closest Point of Approach (CPA) and predicted time to CPA (TCPA) of each tracked to own ship.

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

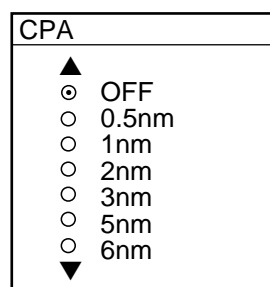
Provided that this feature is used correctly, it will help prevent the risk of collision by alerting you to threatening targets. It is important that gain, A/C SEA, A/C RAIN and other radar controls are properly adjusted and the ARPA is set up so that it can track targets effectively.

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



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

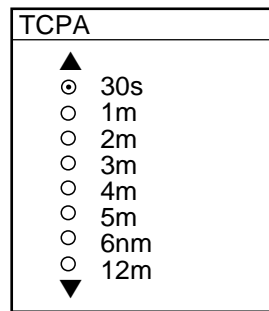
1. Press the [MENU] key followed by ARPA SETUP soft keys in order.
2. Operate the cursor pad to select CPA.
3. Press the EDIT soft key to show the CPA window.



*CPA window*

4. Select a CPA limit desired among 0.5 nm, 1 nm, 2 nm, 5nm and 6 nm by the cursor pad.
5. Press the ENTER soft key. The ARPA SETUP menu reappears.
6. Press the cursor pad to select TCPA.
7. Press the EDIT soft key to show the TCPA window.

## 2. RADAR OPERATION



*TCPA window*

8. Select a TCPA limit among 1 min, 2 min, 3 min, 4 min, 5 min, 6 min and 12 min.
9. Press the ENTER soft key.
10. Press the [MENU] key to close the menu.

### 2.25.8 Lost target alarm

When the system detects a lost target, the target symbol becomes a diamond (◊) and tracking is discontinued one minute later. The normal plotting symbol is restored to the target when the target is manually acquired.



## 2.26 Interpreting the Radar Display

### 2.26.1 General

#### Minimum and maximum ranges

##### Minimum range

The minimum range is defined by the shortest distance at which, using a scale of 1.5 or 0.75 nm, a target having an echoing area of 10 m<sup>2</sup> 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 suppression and digital quantization. It is a good practice to use a shorter range scale as far as it gives favorable definition or clarity of picture. The IMO Resolution A. 477 (XII) and IEC 60936 require the minimum range to be less than 50 m. All FURUNO radars satisfy this requirement.

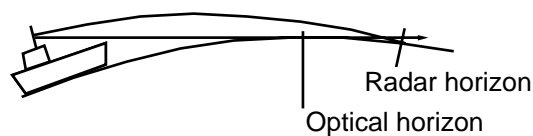
##### Maximum range

The maximum detecting range of the radar,  $R_{max}$ , 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.

$$R_{max} = 2.2 \times (\sqrt{h_1} + \sqrt{h_2})$$

where  $R_{max}$ : radar horizon (nautical miles)  
 $h_1$ : antenna height (m)  
 $h_2$ : target height (m)



*Radar horizon*

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

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

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

## 2. RADAR OPERATION

### **X-band and S-band**

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

### **Radar resolution**

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

#### **Bearing resolution**

Bearing resolution is the ability of the radar to display as separate pips the echoes received from two targets which are at the same range and close together. It is proportional to the antenna length and reciprocally proportional to the wavelength. The length of the antenna radiator should be chosen for a bearing resolution better than  $2.5^\circ$  (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**

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 35 m as do so with all FURUNO radars.

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

### **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 marker at installation is an important factor in ensuring bearing accuracy. To minimize error when measuring the bearing of a target, put the target echo at the extreme position on the screen by selecting a suitable range.

### **Range measurement**

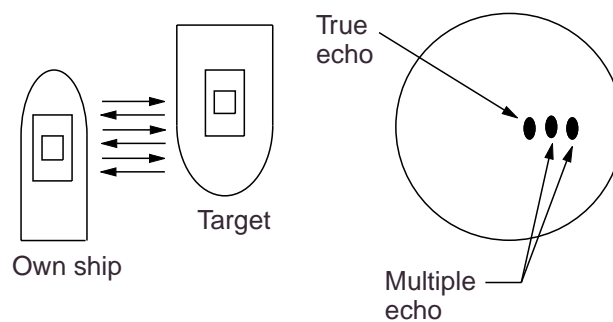
Measurement of the range to a target is also a very important function of the radar. Generally, there are two means of measuring range: the fixed range rings and the variable range marker (VRM). The fixed range rings appear on the screen with a predetermined interval and provide a rough estimate of the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

## 2.26.2 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

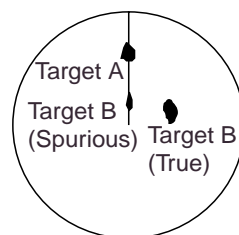
Multiple echoes occur when a transmitted pulse returns from a solid object like a large ship, bridge, or breakwater. A second, a third or more echoes may be observed on the display at double, triple or other multiples of the actual range of the target as shown below. Multiple reflection echoes can be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



*Multiple echoes*

### Sidelobe echoes

Every time the radar pulse is transmitted, some radiation escapes on each side of the beam, called sidelobes. If a target exists where it can be detected by the side lobes as well as the main lobe, the side echoes may be represented on both sides of the true echo at the same range. Sidelobes 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.

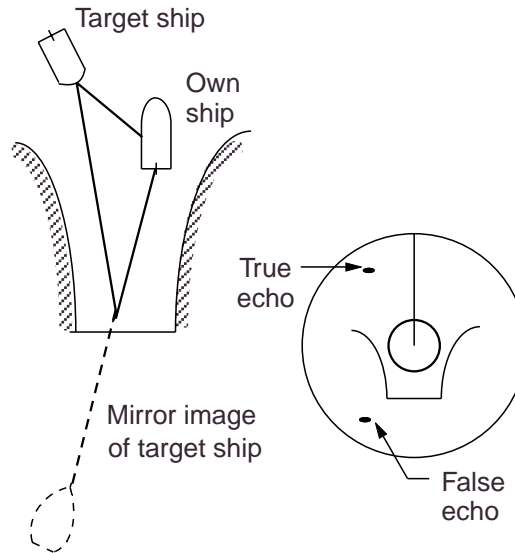


*Sidelobe echoes*

## 2. RADAR OPERATION

### **Virtual image**

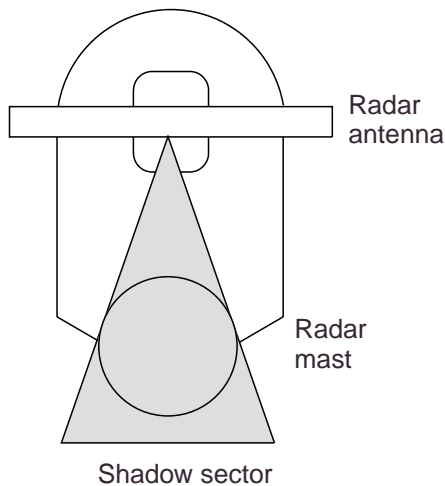
A relatively large target close to your ship may be represented at two positions on the screen. One of them is the true echo directly reflected by the target and the other is a false echo which is caused by the mirror effect of a large object on or close to your ship as shown in the figure below. If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



*Virtual image*

### **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.

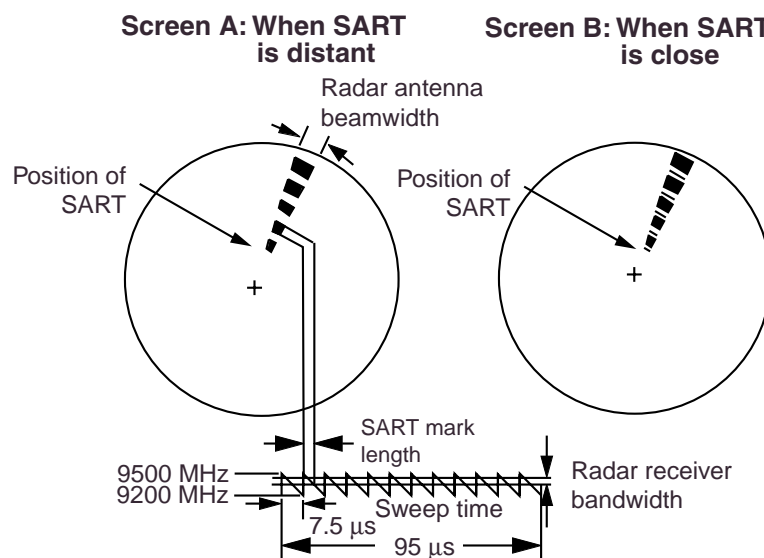


*Shadow sectors*

### 2.26.3 SART (Search and Rescue Transponder)

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

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



*Appearance of SART signal on the radar display*

## 2. RADAR OPERATION

### **General procedure for detecting SART response**

1. Use the range scale of 6 or 12 nm as the spacing between the SART responses is about 0.6 nm (1125 m) to distinguish the SART.
2. Turn off the automatic clutter suppression.
3. Turn off the Interference Rejector.

### **General remarks on receiving SART**

#### **SART range errors**

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

#### **Radar bandwidth**

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

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

#### **Radar side lobes**

As the SART is approached, sidelobes from the radar antenna may show the SART responses as a series of arcs or concentric rings. These can be removed by the use of the [A/C SEA] control although it may be operationally useful to observe the sidelobes as they may be easier to detect in clutter conditions and also they will confirm that the SART is near to the ship.

#### **Gain**

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

**A/C SEA control**

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

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

**A/C RAIN control**

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

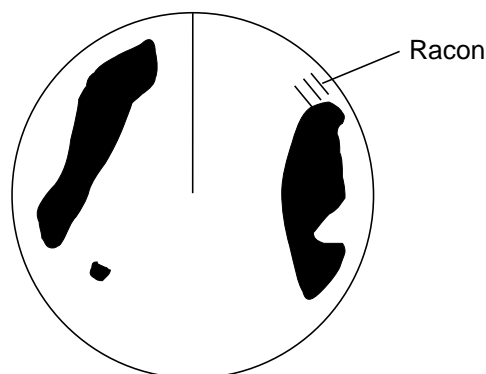
Some sets have automatic/manual anti-clutter rain control facilities in which case the operator should switch to manual.

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

#### 2.26.4 Racon (Radar Beacon)

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

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



*Appearance of racon signal on the radar display*