CHAPTER 5 — AUTOMATIC RADAR PLOTTING AIDS (ARPA)

INTRODUCTION

The availability of low cost microprocessors and the development of advanced computer technology during the 1970s and 1980s have made it possible to apply computer techniques to improve commercial marine radar systems. Radar manufactures used this technology to create the Automatic Radar Plotting Aids (ARPA). ARPAs are computer assisted radar data processing systems which generate predictive vectors and other ship movement information.

The International Maritime Organization (IMO) has set out certain standards amending the International Convention of Safety of Life at Sea requirements regarding the carrying of suitable automated radar plotting aids (ARPA). The primary function of ARPAs can be summarized in the statement found under the IMO Performance Standards. It states a requirement of ARPAs....“*in order to improve the standard of collision avoidance at sea: Reduce the workload of observers by enabling them to automatically obtain information so that they can perform as well with multiple targets as they can by manually plotting a single target”*. As we can see from this statement the principal advantages of ARPA are a reduction in the workload of bridge personnel and fuller and quicker information on selected targets.

A typical ARPA gives a presentation of the current situation and uses computer technology to predict future situations. An ARPA assesses the risk of collision, and enables operator to see proposed maneuvers by own ship. While many different models of ARPAs are available on the market, the following functions are usually provided:

1. True or relative motion radar presentation.

2. Automatic acquisition of targets plus manual acquisition.

3. Digital read-out of acquired targets which provides course, speed, range, bearing, closest point of approach (CPA, and time to CPA (TCPA).

4. The ability to display collision assessment information directly on the PPI, using vectors (true or relative) or a graphical Predicted Area of Danger (PAD) display.

5. The ability to perform trial maneuvers, including course changes, speed changes, and combined course/speed changes.

6. Automatic ground stabilization for navigation purposes.

ARPA processes radar information much more rapidly than conventional radar but is still subject to the same limitations. ARPA data is only as accurate as the data that comes from inputs such as the gyro and speed log.

STAND-ALONE AND INTEGRAL ARPA’s

Over the past 10 years, the most significant changes to the ARPA systems has been in their design. The majority of ARPAs manufactured today integrate the ARPA features with the radar display.

The initial development and design of ARPAs were Stand-alone units. That is they were designed to be an addition to the conventional radar unit. All of the ARPA functions were installed on board as a separate unit but needed to interfaced with existing equipment to get the basic radar data. The primary benefits were cost and time savings. This of course was not the most ideal situation and eventually it was the integral ARPA that gradually replaced the stand-alone unit.

The modern integral ARPA combines the conventional radar data with the computer data processing systems into one unit. The main operational advantage is that both the radar and ARPA data are readily comparable.

ARPA DISPLAY

From the time radar was first introduced to the present day the radar picture has been presented on the screen of a cathode ray tube. Although the cathode ray tube has retained its function over the years, the way in which the picture is presented has changed considerably. From about the mid-1980s the first raster-scan displays appeared. The radial-scan PPI was replaced by a raster-scan PPI generated on a television type of display. The integral ARPA and conventional radar units with a raster-scan display will gradually replace the radial-scan radar sets.

The development of commercial marine radar entered a new phase in the 1980s when raster-scan displays that were compliant with the IMO Performance Standards were introduced.

The radar picture of a raster-scan synthetic display is produced on a television screen and is made up of a large number of horizontal lines which form a pattern known as a raster. This type of display is much more complex than the radial-scan synthetic display and requires a large amount of memory. there are a number of advantages for the operator of a raster-scan display and concurrently there are some deficiencies too. The most obvious advantage of a raster-scan display is the brightness of the picture. This allows the observer to view the screen in almost all conditions of ambient light. Out of all the benefits offered by a raster-scan radar it is this ability which has assured its success. Another difference between the radial-scan and raster-scan displays is that the latter has a rectangular screen. The screen size is specified by the length of the diagonal and the width and height of the screen with an approximate ratio of 4:3. The raster-scan television tubes have a much longer life than a traditional radar CRT. Although the tubes are cheaper over their counterpart, the complexity of the signal processing makes it more expensive overall.

Raster-scan PPI

The IMO Performance Standards for radar to provide a plan display with an effective display diameter of 180mm, 250mm, or 340mm depending upon the gross tonage of the vessel. With the diameter parameters already chosen, the manufacturer has then to decide how to arrange the placement of the digital numerical data and control status indicators. The raster-scan display makes it easier for design engineers in the way auxiliary data can be written.

Monochrome and Color CRT

A monochrome display is one which displays one color and black. The general monochrome television uses white as the color. This however is not an appropriate color for the conditions under which a commercial marine radar is viewed. Unlike a television screen, marine radar displays tend to be viewed from the shorter distance and the observer has a greater concentration on the details of the screen and therefore is subject to eyestrain. For this reason the color most common to monochrome raster-scan applications was green. The green phosphor provides comfortable viewing by reducing eye strain and stress.

The color tube CRT differs from its monochrome counterpart in that it has three electron guns, which are designated as red, green, and blue.

FEATURES AND OPERATING INSTRUCTIONS FOR A MODERN RASTER SCAN RADAR AND ARPA

INTRODUCTION

The following paragraphs describe the features and operating instructions of the Furuno Heavy-Duty High Performance Raster Scan Radar and ARPA Model FR/FAR-28x5 series. Only selected portions of the Furuno operating instructions are presented in this manual. For the complete operating instructions you should contact a Furuno dealer or representative.

The purpose of this section is to provide a sample of the technical instructions that should be available to the officer. As a radar observer you should thoroughly read and understand the operating instructions for the radar units that you will be using. Operating instructing will of course differ not only between different radar manufactures' but also with different models for the same manufacturer.

As with all equipment, the operator should be completely familiar with the safety instructions prior to turning on the radar. There are a number of dangers, warnings and cautions that should be followed by those operating these radars. Failure to follow the appropriate safety instructions could result in serious injury or death.

FEATURES

The FR-2805 and FAR-2805 series of Radar and ARPAs are designed to fully meet the exacting rules of the International Maritime Organization (IMO) for installations on all classes of vessels.

The display unit employs a 28 inch diagonal multicolored CRT. It provides an effective radar picture of 360 mm diameter leaving sufficient space for on screen alpha-numeric data.

Target detection is enhanced by the sophisticated signal processing technique such as multi-level quantization (MLQ), echo stretch, echo average, and a built-in radar interference rejector. Audible and visual guard zone alarms are provided as standard. Other ship's movement is assessed by trails of target echoes or by electronic plotting. The FAR-2805 series ARPA further provides target assessment by historical plots, vectors and target data table.

On screen data readouts include CPA, TCPA, range, bearing, speed/course on up to 3 targets at a time. The ARPA functions include automatic acquisition of up to 20 targets, or manual acquisition of 40 targets. In addition, the ARPA features display of a traffic lane, buoys, dangerous points, and other important reference points.

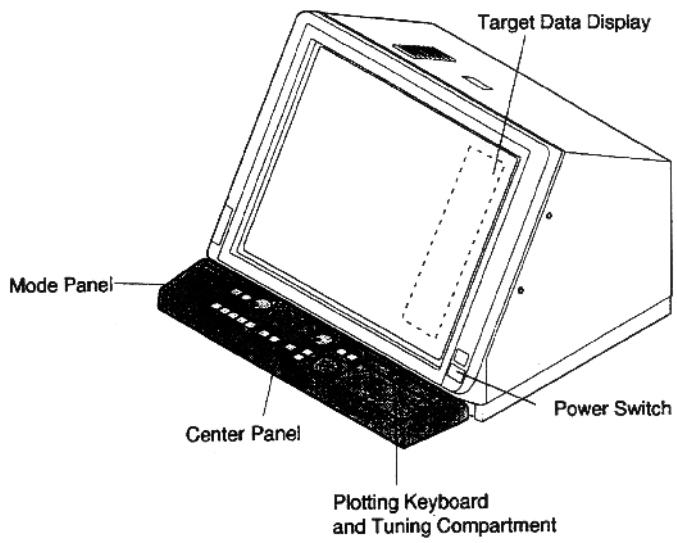


Figure 5.1 - FR-2805 Series Radar Display Unit Overview

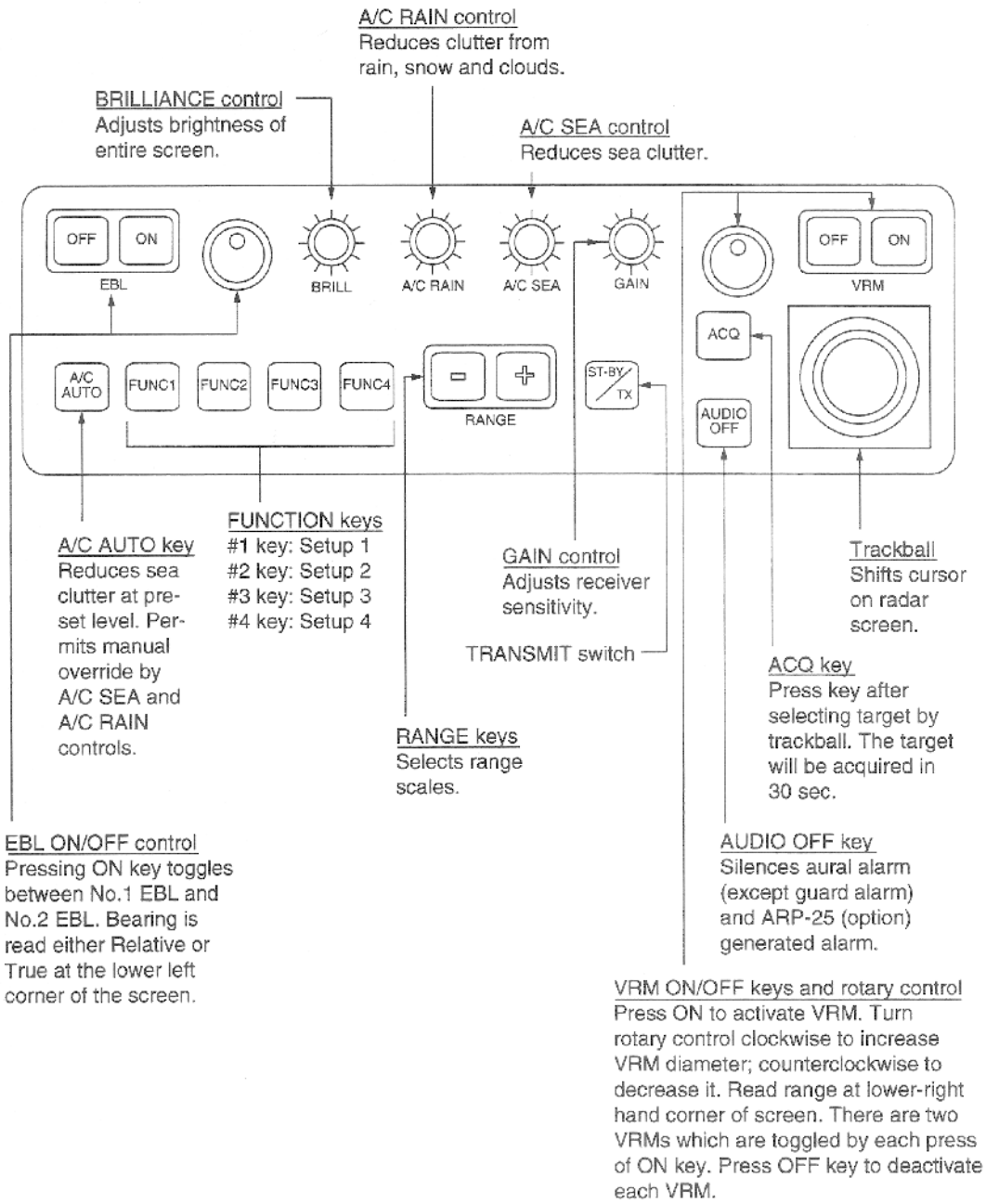
General Features

- Daylight-bright high-resolution display
- 28 inch diagonal CRT presents radar picture of 360 mm effective diameter with alphanumeric data area around it
- User friendly operation by combination of tactile backlit touchpads, a trackball and rotary controls
- Audio-visual alert for targets in guard zone
- Echo trail to assess targets' speed and course by simulated afterglow
- Electronic plotting of up to 10 targets in different symbols (This function is disabled when ARPA is activated)
- Electronic parallel index lines
- Interswitch (optional) built in radar or ARPA display unit
- Enhanced visual target detection by Echo Average, Echo Stretch, Interference Rejector, and multi-level quantization
- Stylish display
- Choice of 10, 25 or 50 KW output for X-band; 30 KW output for S-band, either in the transceiver aloft (gearbox) or RF down (transceiver in bridge)
- Exclusive FURUNO MIC low noise receiver

ARPA Features

- Acquires up to 20 targets automatically
- Movement of tracked targets shown by true or relative vectors (Vector length 1 to 99 min. selected in 1 min steps)
- Setting of nav lines, buoy marks and other symbols to enhance navigation safety
- On-screen digital readouts of range, bearing, course, speed, CPA, TCPA, BCR (Bow Crossing Range) and BCT (Bow Crossing Time) of two targets out of all tracked targets.
- Audible and visual alarms against threatening targets coming into operator-selected CPA/TCPA limits, lost targets, two guard rings, visual alarm against system failure and target full situation
- Electronic plotting of up to 10 targets in different symbols (This function is disabled when ARPA is activated)
- Electronic parallel index lines
- Interswitching (optional) built in radar or ARPA display unit
- Enhanced visual target detection by Echo Average, Echo Stretch, Interference Rejector, and multi-level quantization
- Stylish display
- Choice of 10,25 or 50 kW output for X-band; 30kw output for S-band, either in the transceiver aloft (gearbox) or RF down (transceiver in bridge)
- Exclusive FURUNO MIC low noise receiver

Main control panel



GAIN, A/C RAIN, A/C SEA and BRILL controls are of push-and-rotate type. Push in wanted switch lightly, and it will pop up. Rotate it to the wanted setting and push it in. The retracted position of the controls provides a better protection for water splash.

Figure 5.2 - Main Control Panel

DISPLAY CONTROLS - MODE PANEL

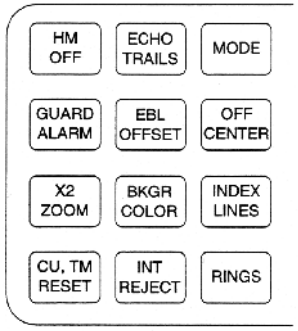


Figure 5.3 - Mode Panel

HM OFF
Temporarily erases the heading marker.

ECHO TRAILS
Shows trails of target echoes in the form of simulated afterglow.

MODE
Selects presentation modes: Head-up, Head-up/TB, North-up, Course-up, and True Motion.

GUARD ALARM
Used for setting the guard alarm.

EBL OFFSET
Activates and deactivates off-centering of the sweep origin.

BKGR COLOR
Selects the background color.

INDEX LINES
Alternately shows and erases parallel index lines.

X2 ZOOM
enlarges a user selected portion of picture twice as large as normal. (R-type only)

CU, TM RESET
Resets the heading line to 000 in course-up mode; moves own ship position 50% radius in stern direction in the true motion mode.

INT REJECT
Reduces mutual radar interference

RANGE RINGS
Adjusts the brightness of range rings.

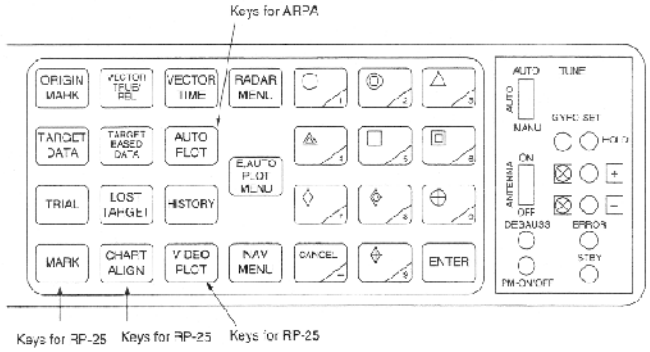


Figure 5.4 - Plotting keypad and tuning compartment

ORIGIN MARK
Show and erases the origin mark (a reference point).

VECTOR TRUE/REL
Selects true or relative vector.

VECTOR TIME
Sets vector length in time.

RADAR MENU
Opens and closes RADAR menus.

E-PLOT, AUTO PLOT MENU
Opens and closes E-plot and AUTO PLT menus.

NAV MENU
Opens and closes NAV menu.

KEYS 0-9
Select plot symbols. Also used for entering numeric data.

CANCEL
Terminates plotting of a specified target or all tracked targets.

ENTER
Used to save settings on menu screen.

TARGET DATA
Displays the acquired target data.

TARGET BASED DATA
Own ship's speed is measured relative to a fixed target.

AUTO PLOT
Activates and deactivates the Auto Plotter.

TRIAL
Initiates a trial maneuver.

LOST TARGET
Silences the lost target audible alarm and erases the lost target symbol.

HISTORY
Shows and erases past positions of tracked targets.

MARK
Enter/erase mark.

CHART ALIGN
Used to align chart data.

VIDEO PLOT
Turns the video plotter on/off.

OPERATION

TURNING ON POWER

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

In warm-up and standby condition, you will see the message BRG SIG MISSING. This is normal because a bearing signal is not yet generated when the antenna is not rotating. ON TIME and TX TIME values shown at the bottom of the screen are the time counts in hours and tenths of hour when the radar has been powered on and transmitted.

TRANSMITTER ON

When the STANDBY status is displayed on the screen, press the Transmit switch labeled ST-BY/TX on the control panel of the display unit.

The radar is initially set to previously used range and pulse width. Other settings such as brilliance levels, VRMs, ELBs and menu option selections are also set to previous settings.

The Transmit switch toggles the radar between STANDBY and TRANSMIT status. The antenna stops in STANDBY status and rotates in TRANSMIT status.

Notes:
1. If the antenna does not rotate in TRANSMIT status, check whether the antenna switch in the tuning compartment is in the OFF position.
2. The magnetron ages with time resulting in a reduction of output power. It is highly recommended that the radar be set to STANDBY status when not used for an extended period of time.

CRT BRILLIANCE

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

Note: The CRT brilliance should be adjusted before adjusting relative brilliance levels on the BRILLIANCE menu to be explained later.

TUNING THE RECEIVER

Auto tune

The radar receiver is tuned automatically each time the power is turned on, thus there is no front panel control for tuning purpose. The tuning indicator and the label AUTO TUNE at the top right corner of the display unit show the tuning circuit is working. If the label AUTO TUNE is not displayed, check that the TUNE selector in tuning compartment is the AUTO position.

Manual tune

If you are not satisfied with the current auto tune setting, follow these steps to fine-tune the receiver:

1. Push the tune control so that it pops up.

2. Set the TUNE selector in the tuning compartment to MAN for manual tuning.

3. While observing the picture on the 48 mile scale, slowly adjust TUNE control and find the best tuning point.

4. So the TUNE selector to AUTO and wait for about 10 seconds or four scanner rotations.

5. Make sure that the radar has been set to the best tuning point. This condition is where the tuning indicator lights to about 80% of its total length.

6. Push the TUNE control into the retracted position.

Video Lockup Recovery

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

1. Turn off the power switch and turn it on again within five seconds.

2. Push the ST-BY switch in the tuning compartment.

3. Push the Transmit switch labeled ST-BY/TX for Transmit status.

ON-SCREEN LEGENDS AND MARKERS

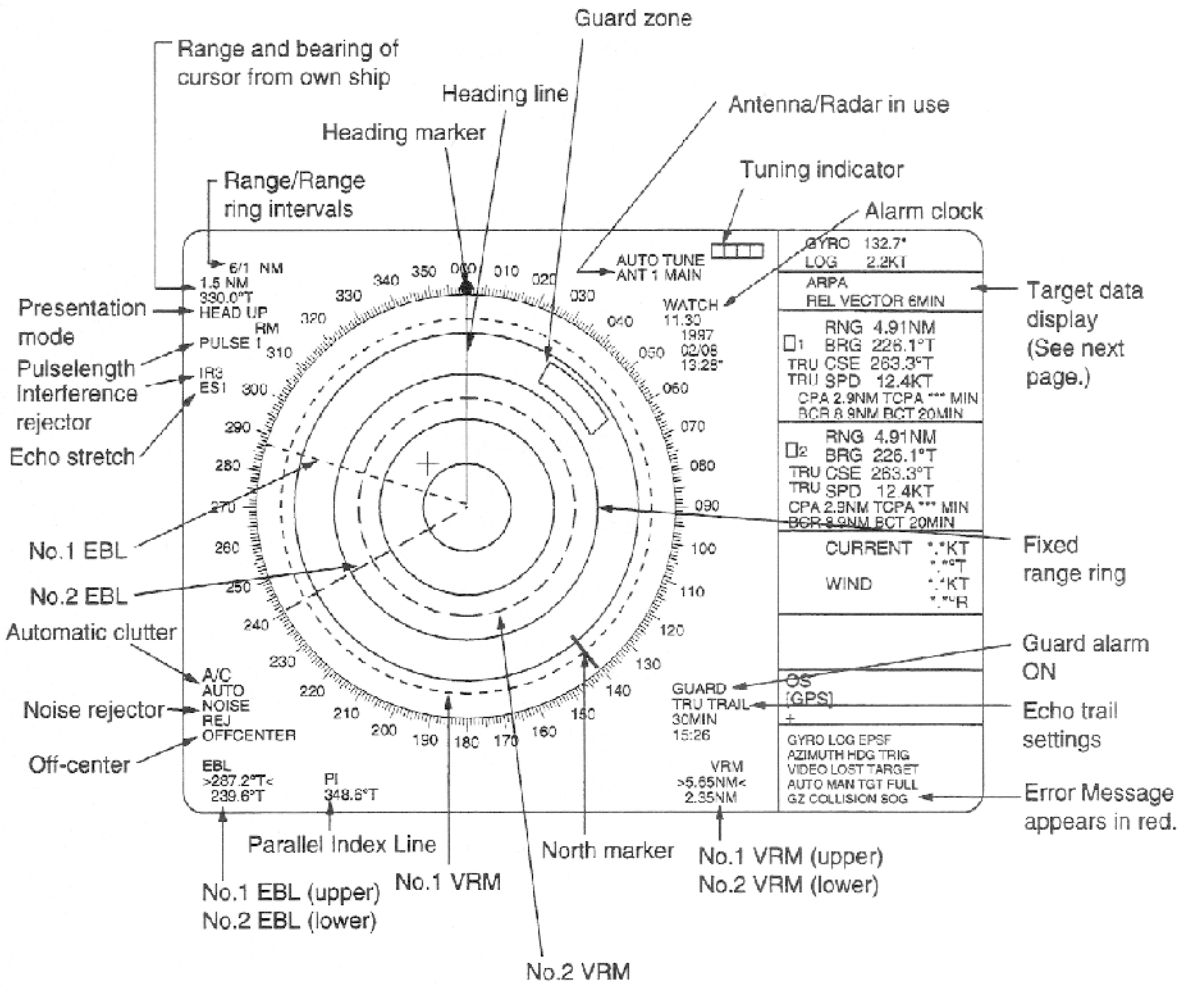


Figure 5.5

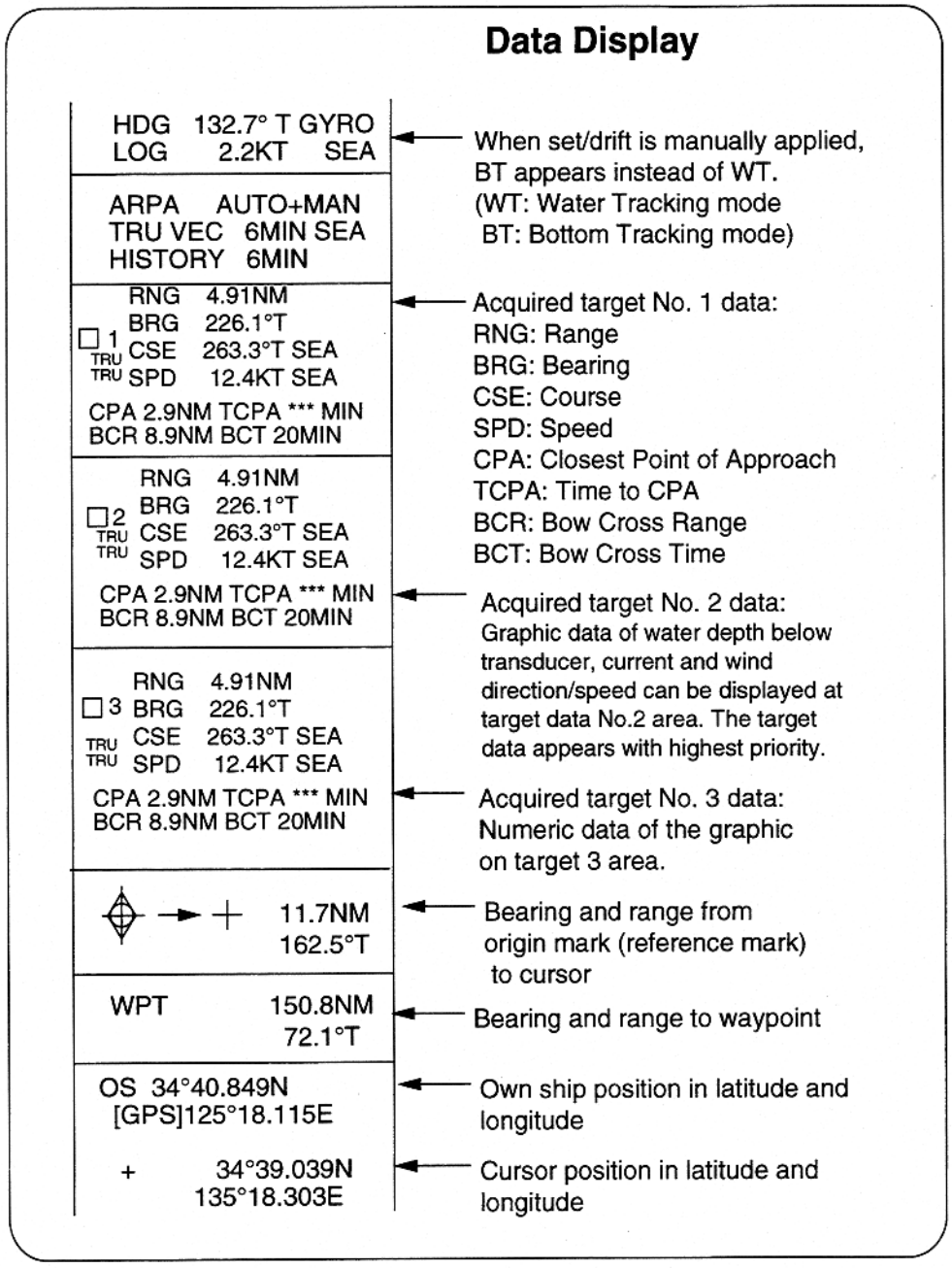


Figure 5.6 - Data display

DEGAUSSING THE CRT SCREEN

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

The screen is also degaussed automatically when own ship has made a significant course change. While being degaussed, the screen may be disturbed momentarily with vertical lines. If you wish to degauss by manual operation at an arbitrary time, open and press the Degauss switch in the tuning compartment.

INITIALIZING THE GYRO READOUT

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

1. Open the tuning compartment and press the HOLD button. The Gyro LED lights.

2. Press the UP or DOWN button to duplicate the gyrocompass reading at the on screen GYRO readout. Each press of these buttons changes the readout by 0.1-degree steps. To change the readout quickly, hold the UP or DOWN button for over two seconds.

3. Press the HOLD switch when the on screen GYRO readout has matched the gyrocompass reading. The Gyro LED goes out.

Note: The HOLD button is used to disengage the built-in gyro interface from the gyrocompass input in the event that you have difficulty in fine-adjusting the GYRO readout due to ship's yawing, for example. When initializing the GYRO readout at a berth (where the gyrocompass reading is usually stable), you may omit steps 1 and 3 above.

PRESENTATION MODES

This radar has the following presentation modes:

Relative Motion (RM)

Head-up:	Unstabilized
Head-up TB:	Head-up with compass-stabilized bearing scale (True Bearing)
Course-up:	Compass-stabilized relative to ship's intended course
North-up:	Compass-stabilized with reference to north)

True Motion (TM)

North-up:	Ground or sea stabilized with compass and speed inputs

SELECTING PRESENTATION MODE

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

Loss of Gyro Signal: When the gyro signal is lost, the presentation mode automatically becomes head-up and the GYRO readout at the screen top shows asterisks(***.*). The message SET HDG appears at the upper of the screen. This warning stays on when the gyro signal is restored, to warn the operator that the readout may be unreadable. Press the MODE key to select another presentation mode (the asterisks are erased at this point). Then, align the GYRO readout with the gyrocompass reading and press the CANCEL key to erase the message SET HDG.

Head-up Mode (Figure 5.7)

A display without azimuth stabilization in which the line connecting the center with the top of the display indicates own ship's heading.

The target pips are painted at their measured distances and in their directions relative to own ship's heading.

A short line on the bearing scale is the north marker indicating compass north. A failure of the gyro input will cause the north marker to disappear and the GYRO readout to show asterisks (***.*) and the message SET HDG appears on the screen.

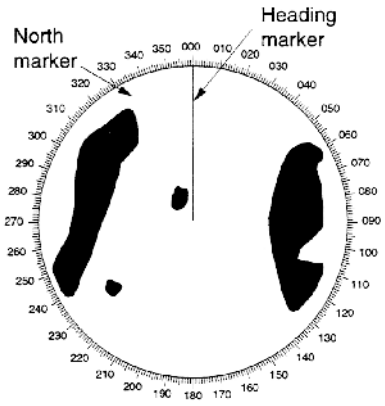


Figure 5.7 - Head-up Mode

Course-up Mode (Figure 5.8)

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 position while the heading marker 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 (CU, TM RESET) key to reset the picture orientation if you wish to continue using the course up mode.

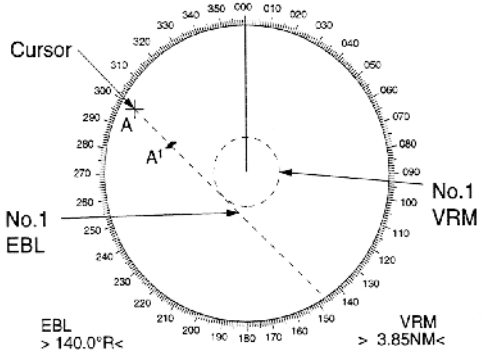


Figure 5.8 - Course-up Mode

Head-up TB (True Bearing) Mode (Figure 5.9)

Radar echoes are shown in the same way as in the head-up mode. The difference from normal head-up presentation lies in the orientation of the bearing scale. The bearing scale is compass stabilized, that is, it rotates in accordance with the compass signal, enabling you to know own ship's heading at a glance.

This mode is available only when the radar in interfaced with a gyrocompass.

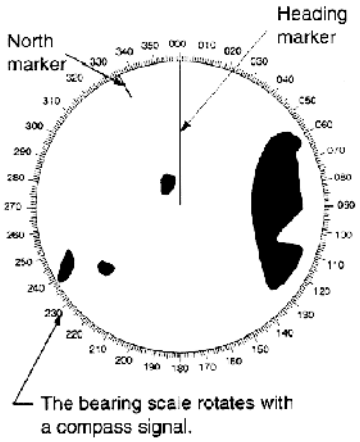


Figure 5.9 - Head-up TB (True Bearing) Mode

North-up Mode (Figure 5.10)

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 marker changes its direction according to the ship's heading.

If the gyrocompass fails, the presentation mode changes to head-up and the north marker disappears. Also, the GYRO readout shows asterisks (***.*) and the message SET HDG appears on the screen.

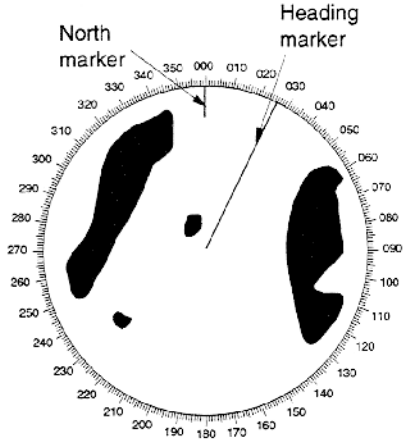


Figure 5.10 - North-up Mode

True Motion Mode (Figure 5.11)

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 50% radius opposite to the extension of the heading marker passing through the display center. Resetting can be made at any moment before the ship reaches the limit by pressing the (CU, TM RESET) key. Automatic resetting is preceded by a beep sound.

If the gyrocompass fails, the presentation mode is changed to the head-up mode and the north marker disappears. The GYRO readout at the top of the screen shows asterisks (***.*) and the message SET HDG appears on the screen.

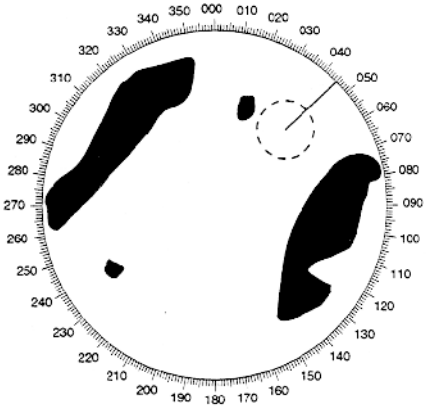


Figure 5.11 - True Motion Mode

SELECTING THE RANGE SCALE

The display range scale is changed in 13 steps on the R-type (11 steps on the IMO-type) by pressing the (+) and (-) keys. The selected range scale and range ring interval are shown at the upper left corner on the screen.

The display range can be expanded by 75% (100% in R-type) in any direction by using the off-centering control.

SELECTING THE PULSEWIDTH

The pulse width in use is displayed at the upper-left position of the screen using the abbreviations shown in the table above.

Appropriate pulse widths are present to individual range scales and function keys. Therefore, you are not usually required to select them. If you are not satisfied with the current pulsewidth settings, however, it is possible to change them by the radar menu operation shown below.

You can choose the pulsewidth 1 or 2 on the scales 0.5 to 24 nm ranges on X-band models and 0.75 to 24 nm ranges on S-band models.

The display range can be expanded by 75% (100% in R-type) in any direction by using the off-centering control.

Selecting Pulsewidth 1 or 2

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTION menu.

2. Press the (1) key to select (or highlight) PLUSEWIDTH 1 or 2 as appropriate.

3. Press the (1) key to select menu item 1 PULSEWIDTH.

4. Press the ENTER key to conclude your selection followed by the RADAR MENU key to close the FUNCTION menu.

Presetting Pulsewidths 1 and 2

Pulsewidth 1 and 2 can be preset on the Pulsewidth 1 and 2 menus. Shown below are examples of the pulsewidth setup procedure:

1. To enable selection of S1 (0.07 microseconds) and S2 (0.15 microseconds) pulsewidth on the 0.5 nm range on an X-band model, select S1 at 0.5 nm on the PULSEWIDTH 1 menu and M1 at 3 nm on the PULSEWIDTH 2 menu.

2. To enable selection of S2 (0.15 microseconds) and M1 (0.3 microseconds) pulsewidth on the 3 nm range on an X-band model, select S2 at 3 nm in the PULSEWIDTH 1 menu and M1 at 3 nm in the PULSEWIDTH 2 menu.

A longer pulse provides an increased detection range, but with reduced discrimination. If you need discrimination in preference to detection, choose a shorter pulse.

Example: To select S1 (0.07us) as Pulsewidth 1 for the 0.5 nm range, display the PULSEWIDTH 1 menu following the steps shown above and hit the (2) key to choose “2 0.5 NM>” Further hit the (2) key until the menu option “S1” is highlighted to the right of “2 0.5” NM.”

ADJUSTING THE SENSITIVITY

The GAIN control (see Figure 5.14) is used to adjust the sensitivity of the receiver, and thus the intensity of echoes as they appear on the screen. It should be adjusted so that speckled background noise is just visible on the screen.

To become acquainted with the way the GAIN control works, try rotating it between fully counterclockwise and clockwise positions while observing the radar picture. You will notice that clockwise rotation increases the echo intensity level. A low gain setting results in the loss of weak echoes and a reduced detection range. If you turn the GAIN control too far clockwise for an excessive gain setting, desired echoes will be masked in the strong background noise.

SUPPRESSING SEA CLUTTER

In rough weather conditions returns from the sea service are received over several miles around own ship and mask close targets. This situation can be improved by properly adjusting the A/C SEA (Anti-clutter sea) control (see Figure 5.15).

Automatic anti-clutter control

The easiest way to suppress the service clutter is to use the automatic control. Press the A/C AUTO key (see Figure 5.15) next to the EBL rotary control at the left corner on the control panel. Use of a function key is also a good method for reducing sea clutter. For this purpose, presetting is required. Consult a Furuno representative.

Manual anti-clutter control

From the fully counterclockwise position, slowly turn the A/C SEA control clockwise. For optimum target detection, you should leave speckles of the surface return slightly visible.

The ant-clutter sea control is often referred to as STC (Sensitivity Time Control) which decreases the amplification of the receiver immediately after a radar pulse id transmitted, and progressively increases the sensitivity as the range increases.

A common mistake is to over adjust the A/C SEA control so that the surface clutter is completely removed. By rotating the control fully clockwise, you see how dangerous this can be; a dark zone is created near the center of the screen and close-in targets can be lost. This dark zone is even more dangerous if the gain has not been properly adjusted. Always leave a little surface clutter visible on the screen. If no surface clutter is observed (on very calm water), set the control at the fully counterclockwise position.

SUPPRESSING PRECIPITATION CLUTTER

In adverse weather conditions, clouds, rain, or snow produce a lot of spray-like spurious echoes and impairs target detection over a long distance. This situation can be improved by using a function key provided that it is programmed. If the function key fails to offer a favorable suppression of the rain clutter, adjust the A/C RAIN control (see Figure 5.16) on the front control panel.

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

INTERFERENCE REJECTOR

Mutual radar interference may occur in the vicinity of another shipborne radar operating in the same frequency band (9GHz for X-band, 3 GHz for S-band). It is seen on the screen as a number of bright spikes either in irregular patterns or in the form of usually curved spoke-like dotted lines extending from the center to the edge of the picture. The type of interference can be reduced by activating the interference rejector circuit.

The interference rejector is a kind of signal correlation circuit. It compares the received signals over successive transmissions and suppresses randomly occurring signals. There are three levels of interference rejection depending on the number of transmissions that are correlated. These are indicated by the legends lR1, lR2 and lR3 at the upper left position of the screen.

Press the INT REJECT key to activate the interference rejector circuit. Successive presses of the key increase the effect of interference rejection, up to level 3. A fourth press deactivates the interference rejector. Switch off the interference rejector when no interference exists; otherwise weak targets may be lost.

Note: For stable reception of certain types of radar beacons (racons) or SART (Search and Rescue Radar Transponder) as required by SOLAS 1974 as amended 1988 (GMDSS), it is recommended to turn the interference rejector off.

MEASURING THE RANGE (FIGURE 5.12)

Use the fixed range rings to obtain a rough estimate of the range to the target. They are concentric solid circles about own ship, or the sweep origin. The number of rings is automatically determined by the selected range scale and their interval is displayed at the upper left position of the screen. Press the RINGS key on the mode panel to show the fixed range rings if they are not displayed. Successive presses of the RINGS key gradually increase their brightness in 4 steps and fifth press erases the range rings.

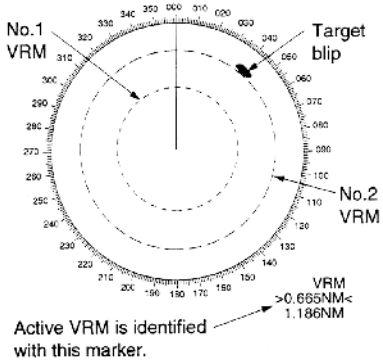


Figure 5.12 - Measuring the range

Use the Variable Range Markers (VRM) for more accurate measurement of the range of the target. There are two VRMs, No.1 and No.2, which appear as dashed rings so that you can discriminate them from the fixed range rings. The two VRMs can be distinguished from each other by different lengths of dashes.

Press the VRM ON key to display either of the VRMs. Successive presses of the VRM ON key toggle the active VRM between No.1 and No.2 and the currently active VRM readout is circumscribed by >.....<.

Align the active VRM with the inner edge of the target of interest and read its distance at the lower right corner of the screen. Each VRM remains at the same geographical distance when you operate the RANGE+ or RANGE- key. This means that the apparent radius of the VRM ring changes in proportion to the selected range scale. Press the VRM OFF key to erase each VRM.

MEASURING THE BEARING (FIGURE 5.13)

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

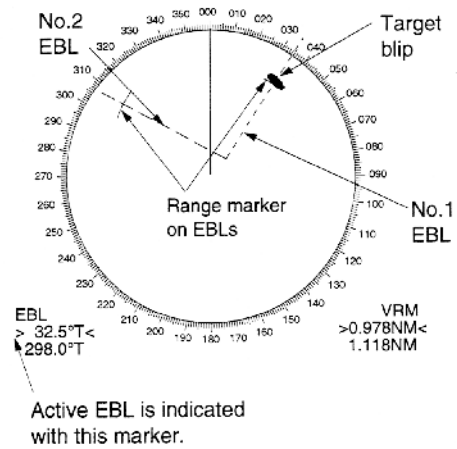


Figure 5.13 - Measuring the bearing

Press the ELB ON key to display either of the EBLs. Successive presses of the EBL ON key toggle the active ELB between No.1 and No.2 and the currently active EBL readout is circumscribed by >... <.

Rotate the EBL rotary control clockwise or counterclockwise until the active EBL bisects the target of interest, and read its bearing at the lower left corner of the screen. The EBL readout is affixed by “R” (relative) if it is relative to own ship’s heading, T (true) if it is referenced to the north, as determined by RADAR 2 menu settings.

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

Press the EBL OFF key to erase each EBL.

COLLISION ASSESSMENT BY OFFSET EBL

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

1. Press the EBL ON key to display or activate an EBL (No.1 or 2).

2. Place the cursor (+) on a target of interest (A in the illustrated example) by operating the trackball.

3. Press the EBL OFFSET key on the mode panel, and the origin of the active EBL shifts to the cursor position. Press the EBL OFFSET key again to anchor the EBL origin.

4. After waiting for a few minutes (at least 3 minutes), operate the EBL control until the EBL bisects the target at the new position (A'). The EBL readout shows the target ship's course, which may be true or relative depending on the settings on the RADAR 2 menu.

If relative motion is selected, it is also possible to read CPA by using a VRM as shown in figure 5.14. If the EBL passes through the sweep origin (own ship) as illustrated in figure 5.15, the target ship is on a collision course.

5. To return the EBL origin to the own ship's position, press the EBL OFFSET key again.

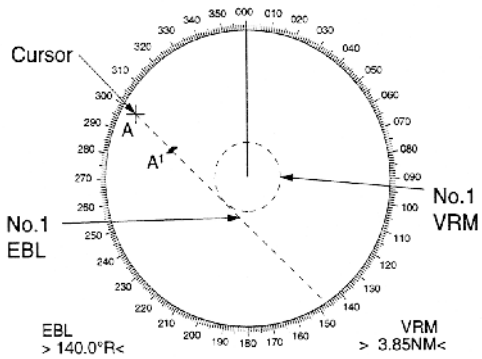


Figure 5.14 - Evaluating target ship's course and CPA in relative motion mode

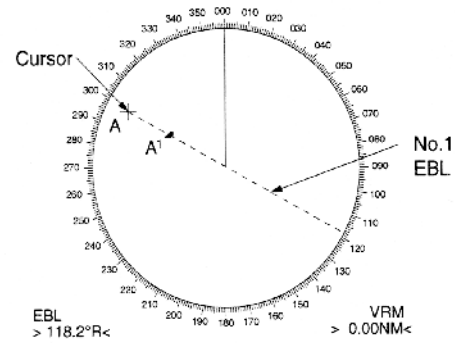


Figure 5.15 - Target ship on collision course

MEASURING RANGE AND BEARING BETWEEN TWO TARGETS

Press the EBL OFFSET key, and place the origin of No.1 EBL, for example, on a target of interest (target 1 in figure 5.16) by operating the trackball.

Turn the EBL control until the EBL passes through another target of interest (target 2).

Turn the VRM control until the range marker aligns with target 2. The active VRM readout at the lower right corner of the screen indicates the distance between the two targets.

You can repeat the same procedure on third and fourth targets (targets 3 and 4) by using No.2 EBL and No. 2 VRM.

Bearing is shown relative to own ship with suffix “R” or as a true bearing with suffix “T” depending on EBL relative/true settings on the RADAR 2 menu. To return the EBL origin to the own ship position, press the EBL OFFSET key again.

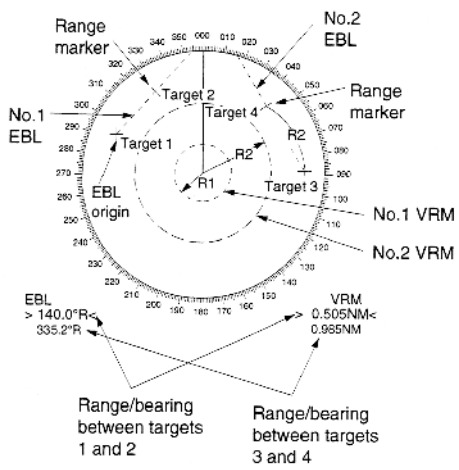


Figure 5.16 - Measuring range and bearing between two targets

SETTING A GUARD ZONE (GUARD ALARM)

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

A guard zone (guard alarm) may be set to alert the navigator to targets (ships, landmasses, etc.) entering a certain area with visual and audible alarms.

The guard zone (guard alarm) has a fixed width of 0.5 nm in the radial direction and is adjustable only within 3.0 to 6.0 nm from own ship. The guard zone (guard alarm) can be set to any sector angle between 0 and 360 in any direction.

To set the guard zone (guard alarm):

1. Place the cursor (+) at point “A” using the trackball and press the GUARD ALARM key on the mode panel (left key group). The message SET GUARD appears at the bottom right corner of the screen.

2. Move the cursor (+) to point “B” and press the GUARD ALARM key. Then, a guard zone (guard alarm) as illustrated is created and the label GUARD appears instead of SET GUARD at the lower right corner of the screen.

Note: If you wish to create a guard zone (guard alarm) having a 360 coverage around own ship, set point “B” in almost the same direction (approx. +/-3) as point “A” and press the GUARD ALARM key.

SILENCING AUDIBLE ALARM, REACTIVATING GUARD ALARM

A target entering the guard zone produces both visual (flashing) and audible (beeping) alarms. To silence the audible alarm, press the GUARD ALARM key, and the label GUARD ACK replaces GUARD on the display.

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

DISABLING GUARD ZONE (GUARD ALARM)

Hold the GUARD ALARM key depressed for at least 3 seconds.

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

INWARD AND OUTWARD GUARD ALARMS

On the R-type, an inward or outward guard alarm can be selected on the RADAR 2 menu. On the IMO type, only the inward guard alarm is available. The inward guard alarm generates visual and audible warnings when a target enters the guard zone from any direction. The outward guard alarm is produced when a target leaves the guard zone.

OFF-CENTERING

Own ship position, or sweep origin, can be displaced to expand the view field without switching to a larger range scale. On the R-type, the sweep origin can be off centered to a point specified by the cursor, up to 100% of the range in use in any direction. On the IMO type, the sweep origin can be off centered to the cursor position, but not more than 75% of the range in use; if the cursor is set beyond 75% of the range scale, the sweep origin will be off centered to the point of 75% of the limit. This feature is not available on the longest range scale.

To off center the radar picture:

1. Place the cursor at a position where you wish to move the sweep origin by operating the trackball.

2. Press the OFF CENTER key. Then, the sweep origin is off centered to the cursor position.

3. To cancel off centering, press the OFF CENTER key again.

The picture cannot be off centered in the true motion mode.

ECHO STRETCH

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

To activate the echo stretch:

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (2) key to select 2 ECHO STRETCH.

3. Press (2) until Echo Stretch option 1, 2 or OFF as desired is highlighted.

4. Press the ENTER key to conclude your selection followed by the RADAR MENU key to close the FUNCTIONS menu.

Notes:
1. If the 1.5 nm range is preset for pulsewidth of S1 (0.08 microseconds) or S2 (0.2 microseconds), and the 3nm scale for S2 (0.2), the echo stretch function is not available on these range scales.
2. The echo stretch function magnifies not only small target pips but also returns from sea surface, rain and radar interference. For this reason make sure these types of interference have been sufficiently suppressed before activating this function.

ECHO AVERAGING

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

To distinguish real target echoes from sea clutter, this radar 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 to do the following:

1. Press the RADAR MENU key on the plotting keypad to show the functions menu.

2. Press the (3) key to select 3 ECHO STRETCH.

3. Press (3) until echo average option 1, 2 or OFF as desired is highlighted.

OFF: No averaging effect
- Helps distinguish targets from sea clutter and suppresses brilliance of unstable echoes
- Distinguishes small stationary targets such as navigation buoys
- Stably displays distant targets

4. Press the ENTER key to conclude your selection followed by the RADAR MENU key to close the FUNCTIONS menu.

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

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

Manual speed entry is done at menu item 6 SHIP'S SPEED on the FUNCTIONS menu which is accessed by pressing the RADAR MENU key.

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

ELECTRONIC PLOTTING AID (E-PLOT)

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

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

Alphanumeric readouts at the upper right hand corner of the screen show range, bearing, course, speed, CPA, and TCPA of the last plotted target.

It should be noted that the vector and alphanumeric data are not updated in real time, but only when you enter a new plot.

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

Plotting a target

To perform electronic plotting:

1. Place the cursor (+) on a target of interest by operating the trackball.

2. Select a desired plot symbol by pressing one of the plot symbol keys on the plotting keypad.

3. Press the ACQ key on the operator control panel, and the selected plot symbol is marked at the cursor position.

4. Watching the EPA time (TIM xx:xx) shown at the upper right margin of the screen, wait for at least 30 seconds. Place the cursor (+) on the target at its new location, select the same plot symbol for the target and press the ACQ key. The plot symbol moves to the new target position and previous position is marked by a small dot.

5. To acquire other targets, repeat the above steps selecting different plot symbols.

Note: If a target once plotted is not plotted again within 10 minutes, the warming “UPDATE PLOT NO” will appear on the upper right margin of the screen and the plot symbol of the target flashes. If you want to continue plotting this target, reacquire it within five minutes. Otherwise, the target will be regarded as a “lost target” and its plot symbol and target data will be erased. The larger the plotting interval, the less accurate the plotted target data. Plotting of each target should normally be made every 3 or 6 minutes as far as possible.

When a target has been plotted more than once, the radar calculates its motion rend and automatically displays a vector on the target.

True or relative vector

True vectors can be displayed relative to own ship’s heading (Relative) or with reference to the north (True). Press the VECTOR TRUE/REL key to select the proper indication. This feature is available in all presentation modes (gyrocompass must be working correctly). The current vector mode is indicated at the upper right corner of the screen.

Vector time

Vector time (or the length of vectors) can be set to 30 sec, 1, 2, 3, 6, 12, 15 or 30 minutes and the selected vector time is indicated at the upper right corner of the screen. Press the VECTOR TIME key until the desired vector time is reached. The vector tip shows an estimated position of the target after the selected vector time elapses. It can be valuable to extend the vector length to evaluate the risk of collision with any target.

Target data

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

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

Reading the target data

Press the corresponding plot symbol key, and the following target data is displayed.

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

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

CPA/TCPA: CPA is a closest range the target will approach to own ship. TCPA is the time to CPA. Both are automatically calculated. TCPA is counted up to 99.9 minutes and beyond this., it is indicated as TCPA >*99.9 MIN.

BCR/BCT: BCR (Bow Cross Range) is the range at which target will cross own ship’s bow. BCT (Bow Cross Time) is the estimated time at which target will cross own

Terminating target plotting

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

By Symbol: To terminate plotting of a certain target, press the corresponding plot symbol key. Then press the CANCEL key.

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

All Targets: To terminate plotting of all targets at once, press and hold the CANCEL key until all plot symbols and marks disappear in about 3 seconds.

Entering own ship’s speed

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

Automatic speed input

1. Press the RADAR MENU key on the plotting keypad to show the functions menu,

2. Press the (6) key to select menu item 6 SHIP'S SPEED.

3. Press the (6) key to select (or Highlight) LOG option.

4. Press the ENTER key to confirm your selection followed by the RADAR MENU key to close the FUNCTIONS menu. The ship's speed readout at the screen top shows own ship's speed fed from the speed log preceded by the label "LOG".

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

Manual speed input

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

1. Press the RADAR MENU key on plotting keypad to show the FUNCTIONS menu.

2. Press the (6) key to select menu 6 SHIP'S SPEED.

3. Press the (6) key to select menu 6 SHIP's SPEED.

4. Press the ENTER key to confirm selection. At this point, "MAN+XX.KT" appears at the bottom of the FUNCTIONS menu.

5. Enter the ship speed by hitting corresponding numeric keys followed by the ENTER without omitting leading zeros, if any. As an example, if the ship speed is 8 knots, punch (0) (8) (ENTER).

6. Press the RADAR MENU key to close FUNCTIONS menu. The ship speed displayed at the screen top shows own ship speed entered by the label "MAN".

TARGET TRAILS (ECHO TRAILS)

Echo trails are simulated afterglow of target echoes that represent their movements relative to own ship or true movements with respect to true north in a single tone or gradual shading depending on the settings on the RADAR 1 menu.

True or relative trails

You may display echo trails in true or relative motion. Relative trails show relative movements between targets and own ship. True motion trails require a gyrocompass signal and own ship speed input to cancel out own ship's movement and present true target movements in accordance with their over the ground speeds and courses.

Refer to the automatic and manual speed input procedures for entering own ship's speed information.

Note: When true trail is selected on the RM mode, the legend TRUE TRAIL appears in red. No true relative selection on TM, it is only TRUE TRAIL on TM mode.

To select true or relative echo trail presentation:

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (0) key to show the SYSTEM SETTING 1 menu.

3. Press the (2) key to show the RADAR 1 menu.

4. Press the (6) key to select menu item 6 TRAIL REF.

5. Press the (6) key to select (or highlight) REL (Relative) or TRUE option.

6. Press the ENTER key to confirm your selection followed by the RADAR MENU key to close the menu.

Trail gradation

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

Selection of monochrome or gradual shading requires almost the same operation as for true or relative trails setup procedure described above except that you should:

- Press the (7) key to select menu item 7 TRAIL GRAD (graduation) in step 4, and

- Press the (7) key to select (or highlight) GGL (single tone) or MULT (multiple shading) option in step 5.

Displaying and erasing echo trails

Press the ECHO TRAILS key to activate or deactivate the echo trails feature.

Each press of the ECHO TRAILS key within 5 seconds cyclically changes echo trail length (time) to 30 seconds, 1, 3, 6, 15, and 30 minutes, continuous echo trailing and OFF. The current echo trail setting is displayed at the lower right corner of the screen.

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

Note: Holding the ECHO TRAILS key depressed for about 3 seconds will cause a loss of echo trail data so far stored in an in memory.

Resetting echo trails

To reset (or clear) the echo trail memory, hold the ECHO TRAILS key depressed for about 3 seconds. Echo trails are cleared and the trailing process restarts from time count zero at current echo trail plot interval. When memory assigned to echo trailing becomes the echo trail timer at the lower right corner of the screen freezes and the oldest trails are erased to show the latest trails.

PARALLEL INDEX LINES

Parallel index lines are useful for keeping a constant distance between own ship and coastline or a partner ship when navigating. Index lines are drawn in parallel with the No. 2 EBL (no. 2 EBL must be active). The orientation of the index lines is controlled with the EBL control and the intervals between the lines adjusted with the VRM rotary control (provided that No. 2 VRM is active).

Maximum number of the index line can be set the initial Setting menu: 2, 3, or 6.

Displaying and erasing the index lines

1. Press the INDEX LINES key if the index lines are not already shown.

2. Make sure that the No. 2 EBL is active and orient the index lines in a desired direction with the EBL rotary control.

3. To erase the index lines, press the INDEX LINES key again.

Adjusting index line intervals

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (7) key to select menu item 7 INDEX LINES.

3. Press the (7) key to select or (highlight) No. 2 VRM or MAN (manual) option.

4. Press the ENTER key to conclude your selection.

5. If you have selected MAN in step 3 above, “MAN=XX.XX NM” appears at the bottom of the functions menu. Enter a desired line interval by hitting numeric keys followed by the ENTER key without omitting leading zeroes, if any. There are six index lines but the number of lines visible on the screen may be less than six depending on the line setting interval.

6. If you have selected NO. 2 VRM in step 3 above, make sure that the No. 2 VRM is active and adjust the spacing between the index lines by operating the VRM control.

7. Press the RADAR MENU key to close the functions menu.

ANCHOR WATCH

The anchor watch feature helps you monitor whether own ship is dragged by wind and/or tide while at anchor. This feature requires ship position data from a suitable radio navigational aid. Provided that own ship’s physical data has been entered, an own ship mark can be displayed when the anchor watch feature is activated. The message “ANCHOR WATCH ERR” appears in red when position data is not inputted.

Notes:
1. The own ship mark is available on the R-type radar only; unavailable on the IMO type.
2. The own ship mark is created with data on own ship’s length, width, radar antenna location, etc. To display an own ship mark, ask your nearest Furuno representative.

Activating anchor watch

To set up the anchor watch feature:

1. On the ANCHOR WATCH menu, press the (2) key to select menu item 2 ANCHOR WATCH OFF/ON.

2. Further press the (2) key to select (or highlight) ON, followed by the ENTER key to conclude your selection. The label WATCH appears at the lower left corner of the screen.

3. Press the (3) key to select menu item 3 ALARM OFF/ON. Further press the (3) key to select (or highlight) ON or OFF, followed by the ENTER key to conclude your selection. (This operation determines whether to activate the anchor watch audible alarm).

Alarm range setting

Press the (4) key to select menu item 4 ALARM RANGE on the ANCHOR WATCH menu. Enter a desired alarm range between 0.1 and 9.999 nautical miles with numeric keys and press the ENTER key to conclude your key input.

An anchor watch alarm circle thus established shows up as a red circle on the screen. When own ship is dragged out of this alarm circle, an audible alarm is generated and the on screen label ANCHOR WATCH turns red.

To silence the audible alarm, press the AUDIO OFF key on the control panel.

Showing drag line

Press the (5) key to select menu item 5 HISTORY on the ANCHOR WATCH menu. Further press the (5) key to select ON, followed by the ENTER key to conclude your selection.

A drag line, or a series of dots along which own ship was carried by wind and water current, appears as illustrated below. During the first 50 minute period, dots or own ship's past positions are plotted every minute. When 50 dots have been plotted in 50 minutes, the plot interval becomes 2 minutes and up to 25 dots are plotted during the succeeding 50 minute period. Next, the dot interval becomes 4 minutes and the maximum number of dots will be 12.

Anchor watch in standby or transmit status

On the R-type the anchor watch feature is available in either STANDBY or TRANSMIT status.

On the IMO type the anchor watch feature is available only in STANDBY status.

Origin Mark

You can mark any dangerous point, prominent target or a particular reference point using the origin mark feature. This mark is geographically fixed.

To use the origin mark:

1. Place the cursor (+) at a point where you want to place a reference mark by operating the trackball.

2. Press the ORIGIN MARK key on the plotting keypad. The origin mark appears at the cursor position of which range and bearing are indicated at the lower left section of the screen.

3. To measure the range and bearing to a target of interest from the origin mark, move the cursor to the target of interest. Then, the range and bearing from the origin mark to the target are shown at the target data display.

4. To erase the origin mark, press the ORIGIN MARK key once again.

Zoom

The zoom function is available on the R-type radar only to enlarge an area of interest.

1. Place the cursor (+) close to the point of interest by operating the trackball.

2. Press the X2 ZOOM key. The area around the cursor and own ship is enlarged twice as large as the original size and the label ZOOM appears at the lower left corner of the screen.

3. To cancel zoom, press the X2 ZOOM key again.

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

MARKERS

Heading marker

The heading marker indicates the ship's heading in all presentation modes. It appears at zero degrees on the bearing scale in head up mode, in any direction depending on the ship orientation in north up and true motion modes.

Temporarily erasing heading marker

To temporarily extinguish the heading marker to look at targets existing dead ahead of own ship, press the HM OFF key on the mode panel. This heading marker reappears when the key is released.

North marker

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

Stern marker

The stern marker (a dot-and-dash line) appears opposite to the heading marker. This marker can be displayed on the R type only provided that the STERN MARK ON is selected on the RADAR 2 menu.

Menu Keys

Three menu keys are provided on the plotting keypad: RADAR MENU, E-AUTO PLOT MENU and NAV MENU keys.

RADAR MENU: Permits setting of basic radar parameters.

E, AUTO PLOT MENU: Provides a choice of standard or large size of plotting symbols for plot.

NAV MENU: Provides a choice of navigation data for on screen display. Also select display for the Video Plotter.

FUNCTION KEYS

The four function keys (#1-4) on the control panel (figure 5.17) work like the auto dialing feature of a telephone, instantly calling out desired settings to perform specially assigned functions. The function keys provide optimum radar settings for a specific purpose with a single key operation.

Each function key can be assigned a combination of particular radar settings that will be most suited to your specific navigating purpose, and an adhesive label (such as BUOY, HARBOR, COAST or the like) is usually attached to the key top for easy identification of the assigned purpose.

The individual function keys are preset, or programed, for the following purposes by qualified service personnel at the time of installation using the procedures described in the succeeding paragraphs;

Function key #1: Picture setup
Function keys #2 and #3: Picture setup and specific operation
Function key #4: Specific operation or watch alarm

Suppose that you have been navigating along a coast for hours and now you are approaching a harbor, your final destination. You will have to adjust your radar to change from the settings for coastal navigation to those for harbor approach. Every time your navigating environment or task changes, you must adjust the radar, which can be a nuisance in a busy situation. Instead of changing radar settings case by case, it is possible to assign the function keys to provide optimum settings for often encountered situations.

The radar's internal computer offers several picture setup options to be assigned to each function key for your specific navigating requirements. For instance, one of the functions keys may be assigned the buoy detecting function and labeled BUOY on the key top. If you press this key, the radar will be instantly set for optimum detection of navigation buoys and similar objects and the label BUOY is shown at the left margin of the screen. If you re-press the same key, the radar returns to the previous settings.

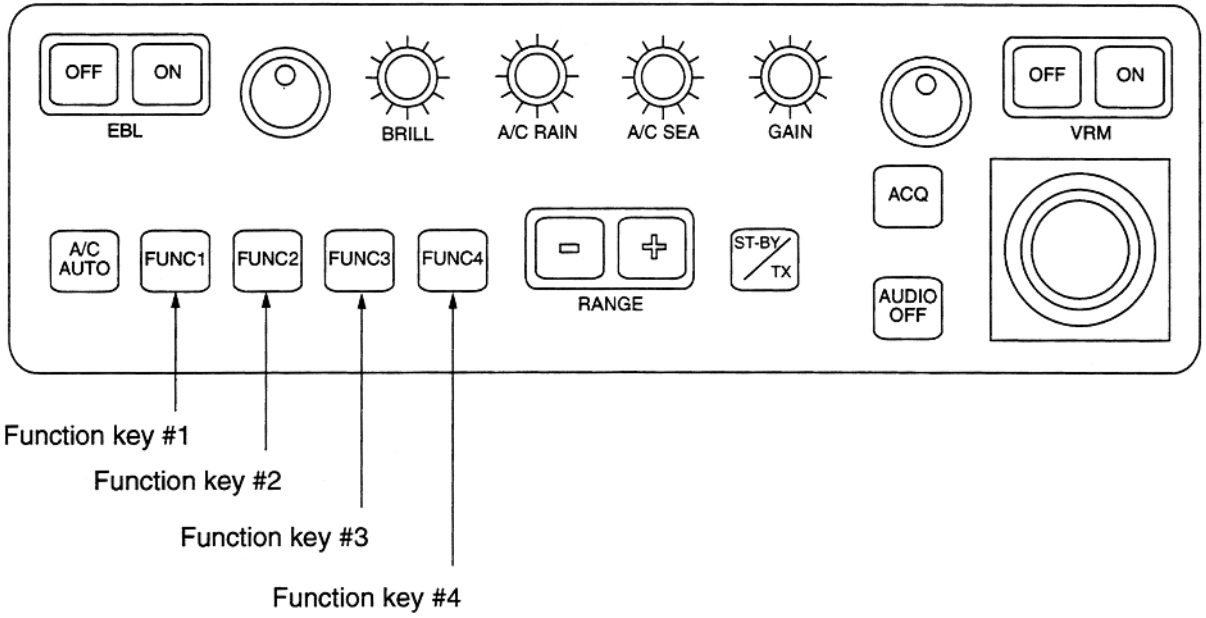


Figure 5.17 - Function keys

The radar's internal computer offers several picture setup options to be assigned to each function key for your specific navigating requirements. For instance, one of the functions keys may be assigned the buoy detecting function and labeled BUOY on the key top. If you press this key, the radar will be instantly set for optimum detection of navigation buoys and similar objects and the label BUOY is shown at the left margin of the screen. If you re-press the same key, the radar returns to the previous settings.

The picture setup options assignable to any of the function keys are shown in the table below.

LABEL	DESCRIPTION
RIVER	Optimum setting for navigation on river.
BUOY	Optimum setting for detecting navigation buoys, small vessels and other small surface objects.
SHIP	Optimum setting for detecting vessels.
SHORT	Optimum setting for short range detection using a range scale of 6 nm or larger.
CRUISING	For cruising using a range scale of 1.5 nm or larger.
HARBOR	Optimum setting for short range navigation in a harbor area using a range scale of 1.5 nm or less.
COAST	For coastal navigation using a range of 12 nm or less.
OCEAN	Transoceanic voyage using a range scale of 12nm or larger.
ROUGH SEA	Optimum setting for rough weather or heavy rain.

Each picture setup option defines a combination of several radar settings for achieving optimum setup for a particular navigating situation. Those involved are interference rejector, echo stretch, echo average, automatic ant clutter, pulsewidth and noise rejector settings.

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

Note: Function key presetting requires a good knowledge of optimum radar settings. If you want to change the original function key settings, consult your Furuno representative or dealer.

Watch alarm

The watch alarm sounds an external buzzer selected time intervals to help you keep regular watch of the radar picture for safety or other purposes. This feature can be assigned to function key #4 with a choice of alarm intervals of 3, 6, 10, 12, 15 and 20 minutes.

Provided that function key #4 is assigned the watch alarm feature, just press function key #4 to activate the feature. The label WATCH appears at the lower left corner of the screen associated with a watch alarm timer counts down from the initial value (namely, "12:00").

When an audible watch alarm is released the preset time interval has elapsed, the screen label WATCH turns red and the watch alarm timer freezes at "0:00".

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

If you press the AUDIO OFF key before the selected time interval is reached, the watch alarm timer is reset to the initial value and starts the countdown sequence again.

EPA Menu

EPA menu appears by pressing the E, AUTO PLOT MENU key. You can set the following items.

1. COLLISION ALARM: You can set CPA and TCPA for the tracked target. Refer to 2.12 setting CPA/TCPA alarm range. Note that TCPA setting is available over one minute.

2. MARK SIZE: Change the size of the plotting.

3. PLOT NO.: Displays or hides plot number inside of the plot symbol (circle and square).

4. TARGET DATA: Selects target vector mode between TRUE or REL. Selection of REL provides the target mode in REL on HU and HU TB.

NAVIGATION INFORMATION

Menu and Navigation Data Display

Various navigation data can be displayed on the radar screen. The data includes, depending on whether appropriate information is fed into the radar, own ship position, cursor position, waypoint data, wind data, water current data, depth data, water temperature, rudder angle, rate of turn and navigation lane.

Note that data not directly related with the radar presentation is not available. Shown below id a typical navigational data display.

1. Press the NAV MENU key on the plotting keypad to show the NAV INFORMATION menu.

2. Select navigation data input device and press the ENTER key to confirm your selection.

3. Also, set other nav data parameters as appropriate referring to the operation flow diagram (not shown).

4. Press the NAV MENU key to close the NAV INFORMATION menu.

Notes:
1. Own ship position display requires an input from an EPFS (elest rouis position fixing system) such as a GPS receiver or a Loran-C receiver. Such an EPFS should be of the type which provides output data in accordance with IEC 1162.
2. When the sensor in use changes (ex. from GPS or DGPS), the name of sensor in the own ship call turns red, and EPFS label appears. To erase, press the CANCEL key.

Suppressing Second-trace Echoes

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

To activate or deactivate the second trace echo rejector:

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (8) key to select menu item 8: 2ND ECHO REJ.

3. Further press the (8) key to activate (ON) or deactivate (OFF) the second trace echo rejector.

4. Press the ENTER key to conclude selection followed by the RADAR MENU key to close the FUNCTIONS menu.

Adjusting Relative Brilliance Levels of Screen Data

You can adjust relative brilliance levels of various marks and alphanumeric readouts displayed on the screen by following the steps shown below:

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (9) key to show the BRILLIANCE menu.

3. Select a desired menu item by pressing the corresponding numeric key. As an example, press (4) if you want to change the brilliance of echo trails.

4. Further press the same numeric key as you pressed in step 3 above to select or highlight a desired brilliance level.

5. Press the ENTER key to conclude your selection followed by the RADAR MENU key to close the FUNCTIONS menu.

Set and Drift (Set and Rate)

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

Set and drift corrections are beneficial for increasing the accuracy of the vectors and target data. The correction is best made in the head up mode with true vector, watching landmasses, or other stationary targets. If they have vectors, set and drift values should be adjusted until they lose vectors.

Note: Set and drift correction is available on selecting the water tracking mode only.

Proceed as follows to enter set and drift (rate):

1. Press the RADAR MENU key on the plotting keyboard to show the FUNCTIONS 1 menu.

2. Press the (8) key to select menu item 8; SET, DRIFT.

3. Further press the (8) key to select OFF or MAN option.

OFF: No correction against set and drift.
MAN: Manual entry of set and drift data.

4. If OFF is selected, press the ENTER key.

5. If you have selected MAN in step 3 above, the highlight cursor will advance one line down requesting you to enter SET xxx.x .Enter the value of set in degrees by hitting numeric keys without omitting leading zeroes, if any, and press the ENTER key.

6. The highlight cursor will then advance to the next line DRIFT xx.x KT. Enter the value of drift in knots by hitting numeric keys without omitting leading zeroes, if any, and press the ENTER key. Set and drift have the same effect on own ship and all targets.

7. Press the RADAR MENU key to close the menu.

OPERATION OF ARPA

GENERAL

The FAR-2805 series with ARP-25 board provide the full ARPA functions complying with IMO A. 823 and IEC-60872-1 as well as complying with the radar performance MSC.64(67) Annex 4.

PRINCIPAL SPECIFICATIONS

Acquisition and tracking

Automatic acquisition of up to 20 targets plus manual acquisition of 20 targets, or fully manual acquisition of 40 targets between 0.1 and 32 nm (0.1 and 24 nm depending on initial setting)

Automatic tracking of all acquired targets between 0.1 and 32 nm (0.1 and 24 nm depending on initial setting)

Vectors

Vector length:	30 sec, 1, 2, 3, 6, 12, 15, 30 min.
Orientation:	True velocity or relative velocity
Motion trend:	Displayed within 20 scans, full accuracy within 60 scans after acquisition.
Past positions:	Choice of 5 or 10 past positions at intervals of 30 sec, 1,2,3 or 6 min.
Alarms:	Visual and audible alarms against targets violating CPA/TCPA limits, lost targets, targets crossing guard zone (guard ring), system failure and target full status.
Trial maneuver:	Predicted situation appears in 1 min after selected delay (1-60 minutes).

KEYS USED FOR ARPA

The Auto Plotter uses the keys on the plotting keypad on the right side of the radar screen and two keys on the control panel. Below is a brief description of these keys.

CANCEL: Terminates tracking of a single target specified by the trackball if the key is pressed with a hit-and-release action. If the key is held depressed for about 3 seconds, tracking of all targets is terminated.

ENTER: Registers menu options selected.

VECTOR TRUE/REL: Selects a vector length of 30s 1, 2, 3, 6, 12, 15 or 30min.

TARGET DATA: Displays data on one of tracked targets selected by the trackball.

TARGET BASED SPEED: Own ship's speed is measured relative to a fixed target.

AUTO PLOT: Activates and deactivates the ARPA functions.

TRIAL: Shows consequences of own ship's speed and course against all tracked targets.

LOST TARGET: Silences the lost target aural alarm and erases the lost target symbol.

HISTORY: shows and erases pat positions of tracked targets.

ACQ: (on control panel): Manually acquires a target.

AUDIO OFF: (on control panel): Silences aural alarm.

ARPA MENU OPERATION

Various parameters or the Auto Plotter are set on the ARPA 1 and ARPA 2 menus. To do this, follow the steps shown below:

1. Press the AUTO PLOT key if the Auto Plotter is not yet activated. Note that the label ARPPA appears in the upper right box on the screen.

2. Press the E, AUTO PLOT MENU key to show the ARPA 1 menu.

3. Press the (0) key once if you wish to go to the ARPA 2 menu.

4. Select a desired menu item by pressing the corresponding numeric key.

5. Select a menu option by pressing the same numeric key as pressed in step 3 above. If there is more than one option on the current menu item, you may need to press the numeric key several times. Press it until the desired option is highlighted. (Note that certain menu items will prompt you to enter numeric data or to define points on the radar screen with the trackball).

6. Press the ENTER key to register settings.

7. Press the E, AUTO PLOT MENU key to close the menu.

START UP PROCEDURE

Activating the ARPA

To activate the ARPA:

1. Adjust the A/C RAIN, A/C SEA and GAIN controls for proper radar picture.

2. Press the AUTO PLOT key. The label ARPA appears in the box at the upper right on the screen.

Entering own ship's speed

The ARPA requires own ship's speed and heading data. Of these, the speed data can be entered automatically from a speed log, navaid, or manually through the numeric keys or based on a selected reference target (such as a buoy or other prominent stationary target).

Automatic Speed Input

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (6) key to select menu item 6 SHIP'S SPEED.

3. Press the (6) key to select (or highlight) LOG option.

4. Press the ENTER key to conclude your selection followed by the RADAR MENU key to close the FUNCTIONS menu. The ship's speed readout at the top of the screen shows own ship's speed fed from the speed log preceded by the label "LOG".

5. When the speed log is used, select speed reference to either of SEA or GND (ground) on the ARPA 2 menu.

Notes:
1. IMO Resolution A.823:1995 for ARPA recommends that a speed log to be interfaced with an ARPA should be capable of providing through the water speed data rather than over the ground speed.
2. Be sure not to select LOG when a speed log is not connected. If the log signal is not provided, the ship speed readout at the top of the screen will be blank. In the event of a log error, you can continue plotting by entering a manual speed.
3. If a log signal interval becomes more than 30 seconds with the ship's speed 5 knots or more, the radar regards the speed log is in trouble and LOG FAIL appears, reading xx.xKT. For R-type, if no speed input is present for 3 minutes at below 0.1 knots, the radar regards the log is in failure.

Manual Speed Input

To manually enter the ship's speed with the numeric keys:

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the key (6) to select menu item 6 SHIP'S SPEED.

3. Press the key (6) to select (or highlight) MAN option.

4. Press the ENTER key to conclude your selection. At this point, "MAN=xx.xKT" appears at the bottom of the FUNCTIONS menu.

5. Enter the ship speed by hitting corresponding numeric keys followed by the ENTER key without omitting leading zeroes, if any. As an example, if the ship speed is 8 knots, press (0)(8) ENTER. For 4.5 knots, (0)(4)(5) ENTER.

6. Press the RADAR MENU key to close the FUNCTIONS menu. The ship speed readout at the screen top shows own ship's speed you entered preceded by the label "MANU".

Target based speed

The use of target based speed is recommended when:

1. The speed log is not operating properly. or not connected to the radar.

2. The vessel has no device which can measure ship's leeward movement (doppler sonar, speed log, etc.) though leeward movement cannot be disregarded.

If you select target based speed, the Auto Plotter calculates own ship's speed relative to a fixed reference target.

Note: When the target based speed is adopted, automatically or manually entered ship's speed is disregarded.

To establish target based speed:

1. Select a small fixed island or any radar prominent point located at 0.2 to 24 nm from own ship.

2. Place the cursor (+) on the target by operating the trackball.

3. Press the TARGET BASED SPEED key. the reference target mark appears at the cursor position and the own ship data label changes from "LOG", "NAV" or "MENU" to "REF". Note that it takes one minute before a new speed is displayed.

Notes:
1. When the reference target is lost or goes out of the acquisition range, the reference target mark blinks and the speed reads "xx.x."
2. When all targets are deleted, the reference target mark is also deleted and the target based speed becomes invalid. the speed is indicated in KTBT where BT means Bottom Track (speed over ground).
3. The vector of the reference target can be displayed by menu operation (Auto Plot 1 menu).

Cancelling target based speed

To cancel the target based speed, just press the TARGET BASED SPEED key. The speed is shown by LOG, NAV* or MANUAL as selected previously. (NAV only on R-type).

Deactivating the ARPA

To deactivate the ARPA, just press the AUTO PLOT key. Target plotting symbols and the on-screen label ARPA will disappear.

Note: Even when the ARPA is turned off, target tracking still goes on until the radar id turned off.

AUTOMATIC ACQUISITION

The ARPA can acquire up to 40 targets (20 automatically and 20 manually or all 40 manually). If AUTO ACQ is selected after more than 20 targets have been manually acquired, only the remaining capacity of targets can be automatically acquired. For example, when 30 targets have been acquired manually, then the ARPA is switched to AUTO ACQ. Only 10

targets can be acquired automatically. A target just acquired automatically is marked with a broken square and a vector appears about one minute after acquisition indicating the target's motion trend. Three minutes after acquisition, the initial tracking stage is finished and the target becomes ready for stable tracking. At this point, the broken square mark changes to a solid circle. (Targets automatically acquired are distinguished from those acquired manually, displayed by bold symbol).

Enabling and disabling auto acquisition

1. Press the E, AUTO PLOT key if the ARPA is not yet activated. Note that the label ARPA appears in the box at the upper right on the screen.

2. Press the E, AUTO PLOT MENU key to show the ARPA 1 menu.

3. Press the (1) key to select menu item 1 AUTO ACQ.

4. Further press the (1) key to select (or highlight) ON (enable auto acquisition) or OFF (disable auto acquisition) as appropriate.

5. Press the ENTER key to conclude your selection followed by the E, AUTO PLOT MENU key to close the AUTO PLOT 1 menu. Note that the label AUTO+MAN is displayed in the box at the upper right on the screen when auto acquisition is enabled; MAN when auto acquisition is disabled.

Note: When the ARPA has acquired 20 targets automatically, the message AUTO TARGET FULL is displayed in the box at the right hand side of the screen.

Setting auto acquisition areas

Instead of limits lines, auto acquisition areas are provided in the system. There are two setting methods:

3, 6 Nautical Miles: Two predefined auto acquisition areas; one between 3.0 and 3.5 nautical miles and the other between 5.5 and 6.0 nautical miles.

SET: Two sector shaped or full circle auto acquisition areas set by using the trackball.

To activate two predefined auto acquisition areas (3 & 6 NM):

1. Press the E, AUTO PLOT MENU key to show the ARPA 1 menu.

2. Press the (2) key to select menu item 2 AUTO ACQ AREA.

3. Further press the (2) key to select (or highlight) menu option 3, 6 nautical miles.

4. Press the ENTER key to confirm your selection followed by the E, AUTO PLOT MENU key to close the ARPA 1 menu.

To set auto acquisition areas with trackball:

1. Press the E, AUTO PLOT MENU key to show the ARPA 1 menu.

2. Press the (2) key to select menu item 2 AUTO ACQ AREA.

3. Further press the (2) key to select (or highlight) SET option.

4. Press the ENTER key to conclude your selection. At this point the AUTO ACQ SETTING menu is displayed at the screen bottom.

5. Press the (2) key to select menu item 2 1/2 and press the ENTER key.

6. Place the cursor at the outer counterclockwise corner of the area and press the ENTER key.

7. Place the cursor at the clockwise edge of the area and press the ENTER key.

Note: If you wish to create an auto acquisition area having a 360 degree coverage around own ship, set point B in almost the same direction (approx. +/-3) as point A and press the ENTER key.

8. Repeat steps 5 and 7 above if you want to set another auto acquisition area with the trackball.

9. Press the (1) key followed by the E, AUTO PLOT MENU key to close the ARPA 1 menu.

An auto acquisition area like the example shown above appears on the display. Note that each auto acquisition area has a fixed radial extension width of 0.5 nautical miles.

Note that the auto acquisition areas are preserved in an internal memory of the ARPA even when auto acquisition is disabled or the ARPA is turned off.

Terminating tracking of targets

When the ARPA has acquired 20 targets automatically, the message AUTO TARGET FULL is displayed in the box at right hand side of the screen and no more auto acquisition occurs unless targets are lost. You may find this message before you set an auto acquisition area. Should this happen, cancel tracking of less important targets or perform manual acquisition.

Individual targets

Place the cursor (+) on a target to cancel tracking by operating the trackball. Press the CANCEL key.

All targets

Press and hold the CANCEL key down more than 3 seconds. In the automatic acquisition mode, acquisition begins again.

Discrimination between landmass and true targets

A target is recognized as a landmass and thus not acquired if it is 800 meters or more in range or bearing direction.

MANUAL ACQUISITION

In auto acquisition mode (AUTO ACQ ON), up to 20 targets can be manually acquired in addition to 20 auto acquired targets. When auto acquisition is disabled (AUTO ACQ OFF), up to 40 targets can be manually acquired and automatically tracked.

To manually acquire a target:

1. Place the cursor (+) on a target of interest by operating the trackball.

2. Press the ACQ key on the control panel. The selected plot symbol is marked at the cursor position.

Note that the plot symbol is drawn by broken lines during the initial tracking 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 plot symbol changes to a solid mark. If acquisition fails, the target plot symbol blinks and disappears shortly.

Notes:
1. For successful acquisition, the target to be acquired should be within 0.1 to 32 nautical miles from own ship and not obscured by sea or rain clutter.
2. When you have acquired 40 targets manually, the message MAN TARGET FULL is displayed at the screen bottom. Cancel tracking of non threatening targets if you wish to acquire additional targets manually.

CHANGING PLOT SYMBOL SIZE

You may also choose plot symbol size. To choose a large or standard size for all plot symbols:

1. Press the E, AUTO PLOT MENU key on the plotting keypad followed by the keys (0) to show the ARPA 2 menu.

2. Press the (3) key to select 3 MARK SIZE.

3. Further press the (3) key to select (or highlight) STANDARD or LARGE as appropriate.

4. Press the ENTER key to conclude your selection followed by the E, AUTO PLOT MENU key to close the ARPA 2 menu.

ADJUSTING BRILLIANCE OF PLOT MARKS

1. Press the RADAR MENU key on the plotting keypad to show the FUNCTIONS menu.

2. Press the (9) key to show the BRILLIANCE menu.

3. Press the (7) key to select 7 PLOT BRILL.

4. Further press the (7) key to select (or highlight) a desired brilliance level.

5. Press the ENTER key to confirm your selection followed by the RADAR MENU key to close the FUNCTION menu.

Item	Symbol	Status	Remarks
Automatically acquired targets		Initial stage EPVS symbol NO. 3	Broken square around an echo to indicate the target under acquisition and initial stage of tracking, before steady-state tracking.
		EPVS symbol NO. 3	Between 20 and 60 scans of antenna after acquisition (vector still unreliable)
		Steady tracking EPVS symbol NO. 4a	Solid circle with vector indicating steady state tracking (60 scans after acquisition)
	(flashing)	CPA alarm EPVS symbol NO. 8	Plot symbol changes to an equilateral triangle flashing to indicate the target is predicted to come into CPA or TCPA.
		CPA alarm acknowledge EPVS symbol NO. 8	Flashing stops after CPA/TCPA alarm is acknowledged.
	(flashing)	Lost target EPVS symbol NO. 9	Lost target is indicated by flashing diamond symbol. The diamond is formed from two equal triangles.
Manually acquired targets		Initial stage EPVS symbol NO. 3	Plot symbol selected for a target acquired manually is shown in bold broken lines.
		EPVS symbol NO. 3	Bold broken square for 20 - 60 scans of antenna after acquisition.
		Steady tracking EPVS symbol NO. 4a	Manual plot symbol in a bold solid circle (60 scans after acquisition)
	(flashing)	CPA alarm (collision course) EPVS symbol NO. 8	Plot symbol changes to an equilateral triangle flashing if a target is predicted to come into the preset CPA or TCPA.
		EPVS symbol NO. 8	Flashing stops after CPA/TCPA alarm is acknowledged.
	(flashing)	Lost target EPVS symbol NO. 9	Lost target is indicated by flashing diamond symbol. The diamond is formed from two equal triangles (one apex up and the other apex down).

Figure 5.18 - ARPA Symbols

Item	Symbol	Status	Remarks
Guard zone	(flashing)	On target passing through operator-set guard zone EPVS symbol NO. 7	Plot symbol changes to an equilateral triangle apex down, flashing together with vector if target entering guard zone (guard ring).
Automatic acquisition area		5.5-6.0 nm, 3-3.5 nm or anywhere EPVS symbol NO. 2	Sector or full circle as selected by the operator.
Target selected for data readout	1	On selected target EPVS symbol NO. 12	Target data (range, bearing, course, speed, CPA and TCPA).
Reference target	R (In 60 scans, change to R)	On reference target	Used to calculate own ship's over-the-ground speed (target-based speed) for ground stabilization. Note: Only one point is useable.
Trial maneuver	T (flashing)	Bottom center EPVS symbol NO. 10	Appears during execution of a trial maneuver.
Auto Plotter performance test	XX (flashing)	Bottom center EPVS symbol NO. 11A	Appears during execution of a performance test (Track Test).

Figure 5.19 - ARPA Symbols (continued)

DISPLAYING TARGET DATA

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

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

Place the cursor on the desired target and press the TARGET DATA key on the plotting keypad. Data on the selected target is displayed at the upper right corner of the screen. A typical target data display is shown in figure 5.20.

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

CSE/SPD: Course and speed are displayed for the selected target with suffix “T” or “R”.

CSE/SPD: CPA (Closest Point of Approach) is the closest range a target will approach to own ship. TCPA is the time to CPA. Both CPA and TCPA are automatically calculated. When a target ship has passed clear of own ship, CPA is prefixed with an asterisk such as, CPA * 1.5NM. TCPA is counted to 99.9 min and beyond this, it reads TCPA.*99.9MIN.

BCR/BCT: Bow crossing range is a range of a target which will pass dead ahead of own ship at a calculated distance. BCT is the time when BCR occurs.

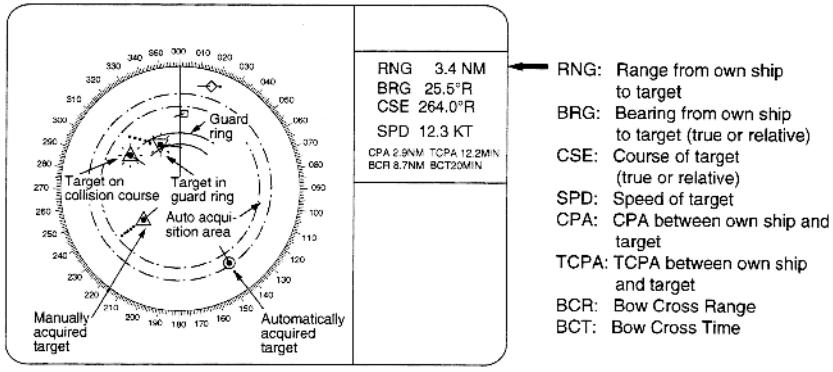


Figure 5.20 - Target Data

MODE AND LENGTH OF VECTORS

True or relative vector

Target vectors can be displayed relative to own ship's heading (relative) or with reference to the north (true).

Press the VECTOR TRUE/REL key to select true or relative vectors. This feature is available in all presentation modes (gyrocompass must be working correctly). The current vector mode is indicated at the upper right corner of the screen.

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, true vectors appear on fixed targets representing the reciprocal of set and drift affecting own ship unless set and drift values are properly entered (see figure 5.21).

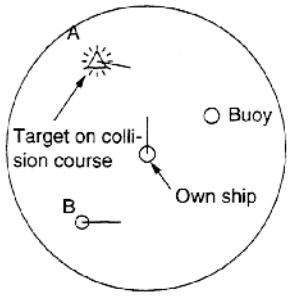


Figure 5.21 - True vectors in head-up mode

Relative vector

Relative vectors on targets which 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 of which vector extension passes through own ship is on the collision course. (See figure 5.22 - dotted lines are for explanation only).

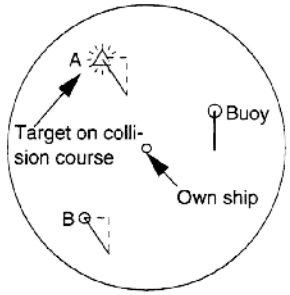


Figure 5.22 - Relative vectors in head-up mode

Vector time

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

Press the VECTOR TIME key to select desired vector time. 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.

PAST POSITIONS

The ARPA displays equally time spaced dots marking the past positions of any targets being tracked.

A new dot is added every minute (or at preset time intervals) until the present number is reached. If a target changes it speed, the spacing will be uneven. If it changes the course, its plotted course will not be a straight line.

Displaying and erasing past positions

To display past positions, press the HISTORY key to display past positions of targets being tracked. The label HISTORY appears at the upper right corner of the screen.

To erase past positions, press the HISTORY key again.

Selecting the number of dots and past position intervals

1. Press the E, AUTO PLOT MENU key on the plotting keyboard to show the ARPA 1 menu.

2. Press the (7) key to select menu item 7 HISTORY POINTS.

3. Further press the (7) key to select a desired number of past positions (5, 10, 20, 30, 100, 150 or 200). The IMO-type has the selection of only 5 or 10.

4. Press the ENTER key to confirm your selection.

5. Press the (8) key to select menu item 8 HISTORY INTERVAL.

6. Further press the (8) key to select a desired past position plot interval (30 seconds, 1, 2, 3 or 6 minutes).

7. Press the ENTER key to conclude your selection.

8. Press the E, AUTO PLOT MENU key to close the menu.

SETTING CPA/TCPA ALARM RANGES

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

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

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

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

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

To set the CPA/TCPA alarm ranges:

1. Press the E, AUTO PLOT MENU key on the plotting keypad to show the ARPA 1 menu.

2. Press the (6) key to select menu item 6 CPA, TCPA SET. At this point, a highlight cursor appears at the “CPAx.xNM” field.

3. Enter the CPA alarm range in nautical miles (max 9.9 min) without omitting leading zeroes, if any, and press the ENTER key. The highlight cursor now moves to the:TCPAxx.xMIN” field.

4. Enter the TCPA alarm limit in minutes (max.99.0 min) without omitting leading zeroes, if any, and press the ENTER key.

5. Press the E, AUTO PLOT MENU key to close the menu.

Silencing CPA/TCPA aural alarm

Press the AUDIO OFF key to acknowledge and silence the CPA/TCPA aural alarm.

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

Setting a Guard Zone

When a target transits the operator-set guard zone, the buzzer sounds and the indication GUARD RING appears at the screen bottom. The target causing the warning is clearly indicated with an inverted flashing triangle.

CAUTION: The Guard Zone (Guard Ring) should never be relied upon as a sole means for detecting the risk of collision. The navigator is not relieved of the responsibility to keep a visual lookout for avoiding collisions, whether or not the radar or other plotting aid is in use.

Activating the guard zone

No. 1 Guard Zone is available between 3 and 6 nm with a fixed range depth of 0.5 nm. No. 2 GZ may be set anywhere when No. 1 GZ is valid.

To set and activate the guard zone:

1. Press the E, AUTO PLOT MENU key on the plotting keyboard to show the ARPA 1 menu.

2. Press the (3) key to select menu item 3 GUARD RING.

3. Further press the (3) key to select (or highlight) ON to activate the guard zone.

4. Press the ENTER key to conclude your selection.

5. Press the (4) key to select menu item 4 GUARD RING SET. At this point the GUARD SETTING menu is displayed at the screen bottom.

6. Press the (2) key and enter key. (2) (2) (ENTER) when setting the no. 2 ring.

7. Place the cursor at the outer left corner of the area (point 1) and press the ENTER key.

8. Place the cursor at the right edge of the area (point 2) and press the ENTER key.

Note: If you wish to create a guard zone having a 360-degree coverage around own ship, set point 2 in almost the same direction (approx. +/- 3) as point 1 and press the ENTER key.

9. Press the (1) key followed by the E, AUTO PLOT MENU key to close the ARPA 1 menu.

Deactivating the guard zone (guard ring)

1. Press the E, AUTO PLOT MENU key on the plotting keyboard to show the ARPA 1 menu.

2. Press the (3) key to select menu item 3 GUARD RING.

3. Further press the (3) key to select (or highlight) OFF to deactivate the guard zone.

4. Press the ENTER key to conclude your selection followed by the E, AUTO PLOT MENU key to close the ARPA 1 menu.

Silencing the guard zone (guard ring) audible alarm

Press the AUDIO OFF key to acknowledge and silence the guard zone audible alarm.

Operational Warnings

There are six main situations which cause the Auto Plotter to trigger visual and aural alarms:

- CPA/TCPA alarm
- Guard zone alarm
- Lost target alarm
- Target full alarm for manual acquisition
- Target full alarm for automatic acquisition
- System failures

The audible alarm can be set to OFF through the AUTO PLOT 2 menu.

CPA/TCPA alarm

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

Guard zone (guard ring) alarm

Visual and audible alarms are generated when a target transmits the operator-set guard zone. Press the AUDIO OFF key to acknowledge and silence the guard zone audible alarm.

Lost target alarm

When the system detects a loss of a tracked target, the target symbol becomes a flashing diamond. and the label “LOST” appears at the screen bottom. At the same time, an aural alarm is produced for one second.

Press the LOST TARGET key to acknowledge the lost target alarm. Then, the lost target mark disappears.

Target full alarm

When the memory becomes full, the memory full status is indicated and the relevant indication appears on the screen and a short beep sounds.

Manually acquired targets

The indication “MAN TARGET FULL” appears at the screen bottom and a short beep tone sounds when the number of manually acquired targets reaches 20 or 40 depending on whether auto acquisition is activated or not.

Automatically acquired targets

The indication “AUTO TARGET FULL” appears at the screen bottom and a short beep tone sounds when the number of automatically acquired targets reaches 20.

System failure alarm

When the ARP board receives no signal input from the radar or external equipment, the screen shows both “SYSTEM FAIL” associated with an indication denoting offending equipment, also releasing an aural alarm. The missing signals are denoted as shown below:

TRIAL MANEUVER

Trial simulates the effect on all tracked targets against own ship's maneuver without interrupting the updating of target information.

There are two types of trial maneuvers: STATIC and DYNAMIC.

Dynamic trial maneuver

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

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

Note that once a dynamic trial maneuver is initiated, you cannot alter own ship's trial speed, course or delay time until the trial maneuver is terminated.

Static trial maneuver

A static trial maneuver displays only the final situation of the simulation. If you enter the same trial speed, course and delay time under the same situation as in the aforementioned example of dynamic trial maneuver, the screen will instantly show position OS7 for own ship, position A7 for target A and position B7 for target B, omitting the intermediate positions. Thus, the static trial maneuver will be convenient when you wish to know the maneuver result immediately.

Note: For accurate simulation of ship movements in a trial maneuver, own ship's characteristics such as acceleration and turning performance should be properly set in initial settings at the time of installation.

To perform a trial maneuver:

1. Press the E, AUTO PLOT MENU key on the plotting keypad followed by the (0) key to show the ARPA 2 menu.

2. Press the (2) key to select 2 TRIAL MANEUVER.

3. Further press the (2) key to select (or highlight) STATIC or DYNAMIC trial maneuver option as appropriate.

4. Press the ENTER key to conclude your selection followed by the E, AUTO PLOT MENU key to close the ARPA 2 menu.

5. Press the VECTOR TRUE/REL key to select true or relative vector.

6. Press the TRIAL key. The TRIAL DATA SETTING menu appears at the screen bottom associated with the current own ship's speed and course readouts.

Note: The second line reads (STATIC MODE) in the event of a static trial maneuver.

7. Enter own ship's intended speed, course and delay time in the following manner:

Speed:	Set with the VRM control.
Course:	Set with the EBL control.
Delay time:	Enter in minutes by hitting numeral keys. This is the time after which own ship takes a new situation, not the time the simulation begins. Change the delay time according to own ship loading condition, etc.

8. Press the TRIAL key again to start a trial maneuver.

Trial maneuver takes place in three minutes with the letter "T" displayed at the bottom of the screen. If any tracked target is predicted to be on a collision course with own ship (that is, the target ship comes within preset CPA/TCPA limits), the target plot symbol changes to a triangle and flashes. If this happens, change own ship's trial speed, course or delay time to obtain a safe maneuver. The trial maneuver is automatically terminated and the normal radar picture is restored three minutes later.

Terminating trial maneuver

Press the TRIAL key again at any time.

CRITERIA FOR SELECTING TARGETS FOR TRACKING

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

When a target is first displayed, it is shown as having zero true speed but develops a course vector as more information is collected. In accordance with the International Maritime Organization Automatic Radar Plotting Aid requirements, an indication of the motion trend should be available in 1 minute and full vector accuracy in 3 minutes of plotting. The FURUNO ARPAs comply with these requirements.

Acquisition and tracking

A target which is hit by 5 consecutive radar pulses is detected as a radar echo. Manual acquisition is done by designing a detected echo with the trackball. Automatic acquisition is done in the acquisition areas when a target is detected 5-7 times continuously depending upon the congestion. Tracking is achieved when the target is clearly distinguishable on the display for 5 out of 10 consecutive scans whether acquired automatically or manually. Targets not detected in 5 consecutive scans become “lost targets”.

Quantization

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

The digital radar signal is then analyzed by a ship sized echo discriminator. As the antenna scans, if there are 5 consecutive radar pulses with l’s indicating an echo presence at the exact same range, a target “start” is initiated. Since receiver noise is random, it is not three bang correlated, and it is filtered out and not classified as an echo.

RADAR OBSERVATION

GENERAL

Minimum Range

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

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

Maximum Range

The maximum detecting range of the radar, Rmax, varies considerably depending on several factors such as the height of the 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 about 6% because of the diffraction property of the radar signal. It should be noted that the detection range is reduced by precipitation (which absorbs the radar signal).

X-BAND and S-BAND

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

Radar Resolution

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

Bearing Resolution

Bearing resolution is the ability of the radar to display as separate pips the echoes received from two targets which are at the same range and close together. It is proportional to the antenna length and reciprocally proportional to the wavelength. The length of the antenna radiator should be chosen for a bearing resolution better than 2.5 (IMO Resolution). This condition is normally satisfied with a radiator of 1.2 meters (4 feet) or longer in the X band. The S band radar requires a radiator of about 12 feet (3.6 meters) 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 pulselength only. Practically, a 0.08 microsecond pulse offers the discrimination better than 25 meters as do so with all Furuno radars.

Test targets for determining the range and bearing resolution are radar reflectors having an echo area of 10 square meters.

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.

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. 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 lobe 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. 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 scanner is more than a few degrees, a non-detecting sector may be produced. Within this sector targets cannot be detected.

SEARCH AND RESCUE TRANSPONDER (SART)

A Search and Rescue Transponder (SART) may be triggered by any X-Band (3 cm) radar within a range of approximately 8 nautical miles. 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 microseconds) through the band before beginning a relatively slow sweep (7.5 microseconds) through the back band 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 STRT is within range, the frequency match during each of the 12 slow sweeps will produce a response in the radar display, thus a line of 12 dots equally spaced by about 0.64 nautical miles will be shown.

POST-IT NOTE METHOD OF RADAR CONTACT THREAT AND ASPECT ASSESSMENT

Contributed by Mr. Eric K. Larsson

Rapid radar plotting has been useful for the ocean mariner, but has always been viewed as a burden by the coastal or inland mariner. Some common complaints are listed below:

- I don't have a reflection plotter!
- I don't stay on course long enough to plot a target!
- I don't have time to plot - I'm the only one in the wheelhouse and I have to steer!

Many of these statements are valid, but if one does not use radar plotting or some other form of systematic observation, as required by the Rules of the Road, that person is missing out on vital information and they are putting themselves and their vessel in an unfavorable position. When the U.S. Coast Guard N-VIC on radar training for tugboat captains, mates and pilots was issued, it was felt that some sort of useful, practical training should be added to the plotting requirements that have always been part of radar courses. Because most of the individuals affected by the N-VIC were on tugs or towboats, that practical method of plotting or observation had been geared to the equipment found on board those vessels.

Radar on tugs have small screens and are usually a raster scan head up unstabilized type display. there is no reflection plotter. Because of limited space and time constraints, transfer plotting is not practical. Experience shows that without use, plotting skills deteriorate. To keep these skills sharp, post-it notes and the use of echo trails or the plot feature on certain radar units can be used to substitute for plotting with pencils and rulers. Other variations have been utilized in the past such as tongue depressor or a plastic overlay but the post-it note method seems to be quicker and easier to use. It also deals with the four complaints stated above.

"*I don't have a reflection plotter.*" In exchange for a reflection plotter, the plot feature on certain small screen radars allows the operator to view the relative track of the target at selected intervals of 15, 30 or 60 seconds or more A continuous track of the target with a timer that counts up in seconds can also be selected. In figure 5.23, a continuous echo trail has been selected and allowed to run for 3 minutes. This is the equivalent of a three minute

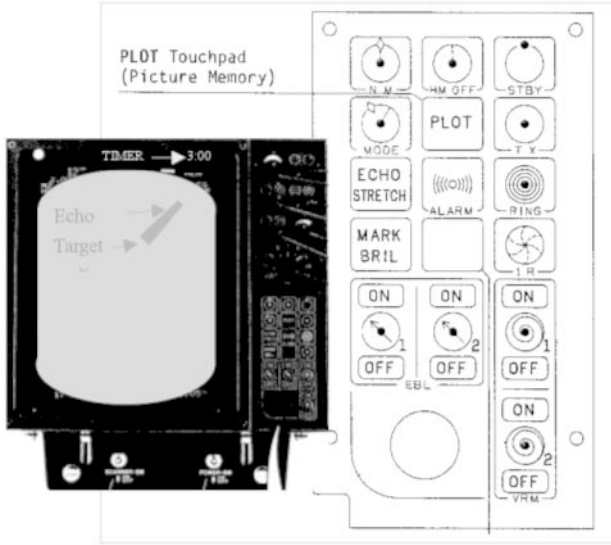


Figure 5.23

"*I don't stay on course long enough to plot a targets* this statement the question is asked, "Do you stay on course for 3 minutes?" The answer is usually "Yes." The plot feature allows the operator to note the time the target began tracking and choose a time interval that is appropriate for the vessel, the range scale used on the radar and the speed of the vessel.

In figure 5.24, our vessel is moving at a speed of 8 knots. A time interval of 3 minutes is selected. Using the 6 minute rule, a vessel moving 8 miles in 60 minutes will move 0.8 miles in 6 minutes (1/10 the time and 1/10 the distance). In order to find the distance traveled in 3 minutes, the distance for 6 minutes is cut in half and a vessel moving 0.8 miles in 6 minutes will move 0.4 miles in 3 minutes (1/2 the time and 1/2 the distance).

The radar range scale in use is 3 miles. A distance of 0.4 miles is measured on the radar using the Variable Range Marker (VRM). Place the post-it note parallel to the heading flasher and the upper left or right corner touching the 0.4nm VRM. Mark the post-it note at the corner and at the start point of the heading flasher. This measured distance on the pot-it note is the equivalent of a 3-minute segment of our vessel's movement. It is the equivalent of the "er" vector in rapid radar plotting.

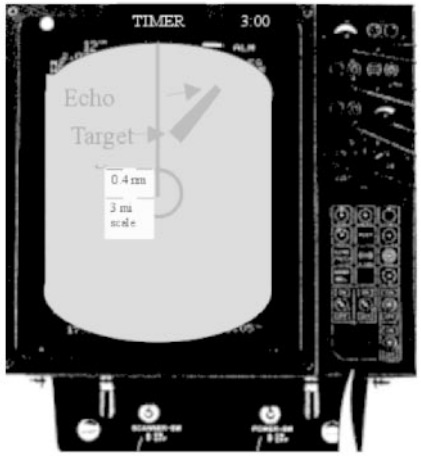


Figure 5.24

Repeat the process for the other corner/side of the post-it note. Once made, the post-it note will work for that range scale and speed, and can be stuck to the side of the radar ready for use at any time. Other scales can be mode for different speeds or ranges as needed. This process only takes a few seconds and can be done "on the spot."

"*I don't have time to plot - I'm the only one in the wheelhouse and I have to steer*!" The echo trail allows the single officer in the wheelhouse to "systematically observe" the movement of vessels. The echo trails alone, however will not give the officer much more information than which targets are collision threats. The post-it note will allow the officer to obtain more information. This includes the aspect of the target as well as the ability to obtain the approximate course and speed of the target.

Assume in this example (figure 5.25) that our course is 270 degrees at a speed of 8 knots. To obtain the course and speed of the target place the corner with the first mark on the post-it note at the beginning of the target trail or plot echo parallel to the heading flasher. Observe the direction of a line that would connect the second mark on the post-it note with the target. This line indicates the course of the target (indicated by a red line). The speed of the target over the 3-minute time period can be compared with the distance we would travel over 3 minutes as indicated by the two marks on the post-it note.

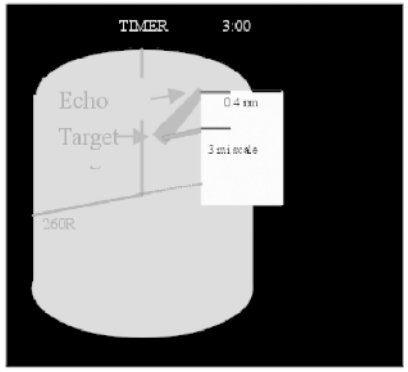


Figure 5.25

If you drew a line drawn from the second mark to the target at the end of a 3 minute interval you can determine the targets course relative to our heading of 270 degrees. The dashed EBL line shown above is parallel to the line drawn from the post-it note to the target position at minute 3.00. It has to be read in the direction from the post-it note to the target (hence the solid line in the direction of 260). With our heading of 270 degrees the relative bearing will read 260 degrees. If you add 260 and 270 (530) and then subtract 360 the target's true course is found to be 170 degrees.

This is shown on the compass rose in figure 5.26.

The length of the line is a little shorter than the distance between marks on the post-it note. This length could be measured at about 0.35nm in three

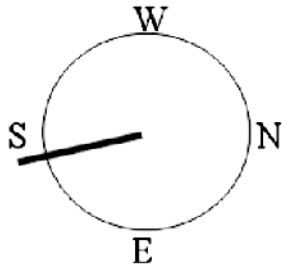


Figure 5.26

minutes which translates to about 7 knots. This line is the equivalent of the target course and speed vector “em” in rapid radar plotting.

A second example is shown in figure 5.27 for a target on a reciprocal course at a speed approximately equal to our own.

Because of the valid statements listed above about the ability to reflection plot, and rules of the road requirement to plot, a practical method of plotting needs to be used. It is hoped the pot-it method will assist the mariner in his efforts to “systematically observe” all targets.

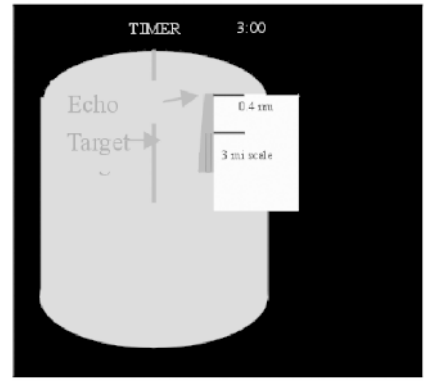


Figure 5.27