CHAPTER 2. USING RADAR FOR THE FIRST TIME

This chapter covers basic information and technical terms about radar for those who are using one for the first time.

2.1 What is radar?

RAdio Detecting And Ranging

The word "radar" is an acronym for "RAdio Detecting And Ranging." In very simple terms, this is how it works. A radio transmitter sends a quick microwave pulse, and then a receiver listens for that signal's echo when it is bounced back from something in its path. The returning signal is processed by a computer to determine its relative distance, position and bearing. This information is graphically displayed on a screen for you to see. Other boats or ships, navigational markers, landmasses and such are referred to as targets.

By knowing how long it takes for a signal to return, the distance to a target can be determined. As the radar antenna scans through a 360-degree rotation, it can show where the target is relative to your position. By repeated scans, you can see which direction another vessel is moving.

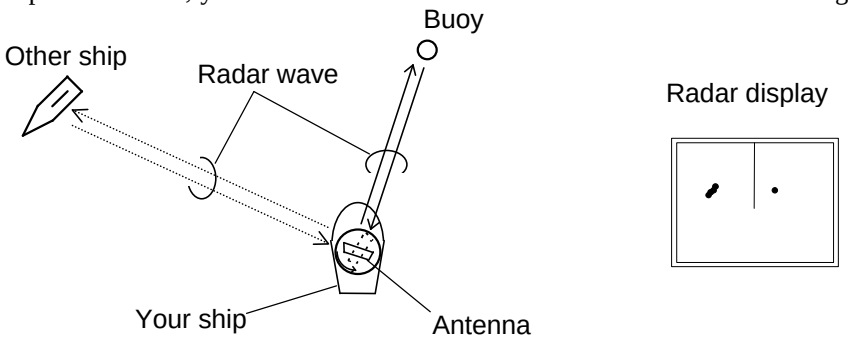

Fig.2-1 What is radar?

Antenna

How radar will perform is largely determined by its antenna or scanner. Increasing the size of the antenna improves long-range performance and target discrimination, or the ability to distinguish two separate targets at a distance. The critical factors are the antenna's beam width and side lobe level. Typically, a radar antenna will radiate a tightly focused beam from the front of the array. The longer the antenna array is, the narrower the beam width will be. Additionally, it will also emit smaller amounts of energy to each side. The lower the side lobe level, the less the effect of a false echo. The RA51 radars are equipped with a closed dome scanner, the RA52/53/54/55 has a larger, open array.

Side lobe

The beam in which the strongest radio signal is radiated from the antenna is called the “main lobe”. Those beams that are radiated in other directions are referred to as the “side lobes”. The side lobe level refers to the difference in level (signal strength) between the largest side lobe and the main lobe.

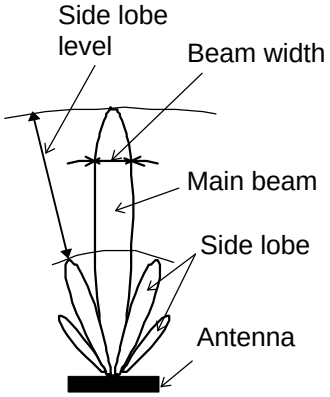

Fig.2-2 Antenna pattern

2.2 Characteristics of Radar Wave

Radio waves travel out from the antenna while bending slightly along the earth's surface. The amount they bend depends on atmospheric conditions. The sight distance of a radar generally is about 6% longer than the optical sight distance and is calculated using this equation:

$$\text{Radar sight distance (NM)} = 2.22\ (\sqrt{\text{antenna height}}\ (\text{m}) + \sqrt{\text{target height}}\ (\text{m}))$$

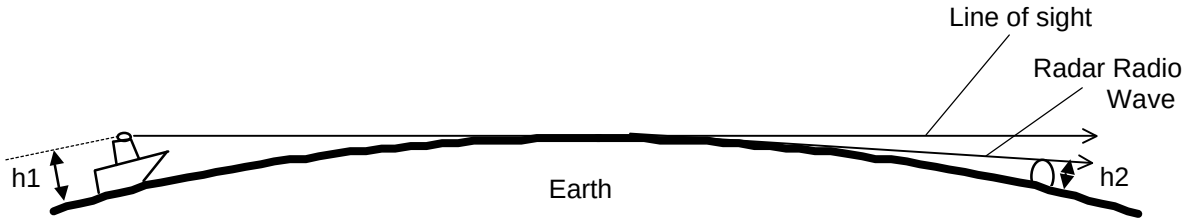

Fig.2-3 Radar wave

Targets difficult to display on screen

The intensity of the reflected radio signal from a target depends on the distance, height, and size of the target, as well as its material and shape, along with the radar's transmitter power output and antenna size. Targets made of fiberglass, wood, or other low-reflectance materials or those that have a small incident angle are difficult to display on a screen. Sandy beaches, and sandy or muddy shallows can be difficult to catch. Because there's not much to reflect a signal back to you, a coastline can actually be closer to your boat than it appears on the screen.

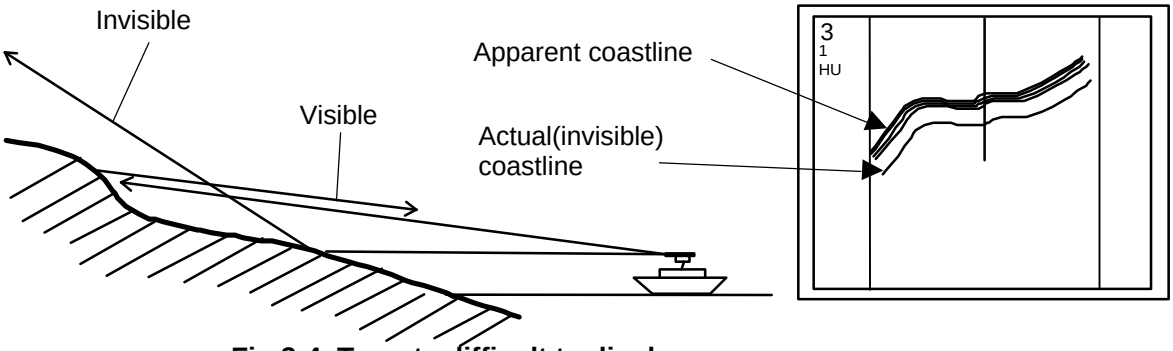

Fig.2-4 Targets difficult to display on screen

Shadow zones of radar

Radar waves propagate in a straight line. A high outcropping of land or a large ship will create a shadow zone behind it and prevent you from seeing targets on the other side. More importantly, if a mast or some part of the boat's superstructure is in the path of the antenna's sweep, this will also create a shadow zone. No targets will be recognized behind it and it could create a dangerous situation.

False echoes

Sometimes radar will display targets on screen that do not exist in the real world. You should be aware of how and why this happens.

A. Ghost echoes

Sometimes one large object very near your boat will appear as two different targets onscreen. One is the actual radar echo. The other is a ghost echo generated by a re-reflection of the original signal. It comes back to your own boat, bounces back to the target, and then is picked up by the

antenna on the second bounce. The actual echo appears at the correct distance and bearing on the screen. The ghost echo appears somewhere behind your boat. This type of false echo is also generated by re-reflection of waves from bridges, quay walls or building along shore.

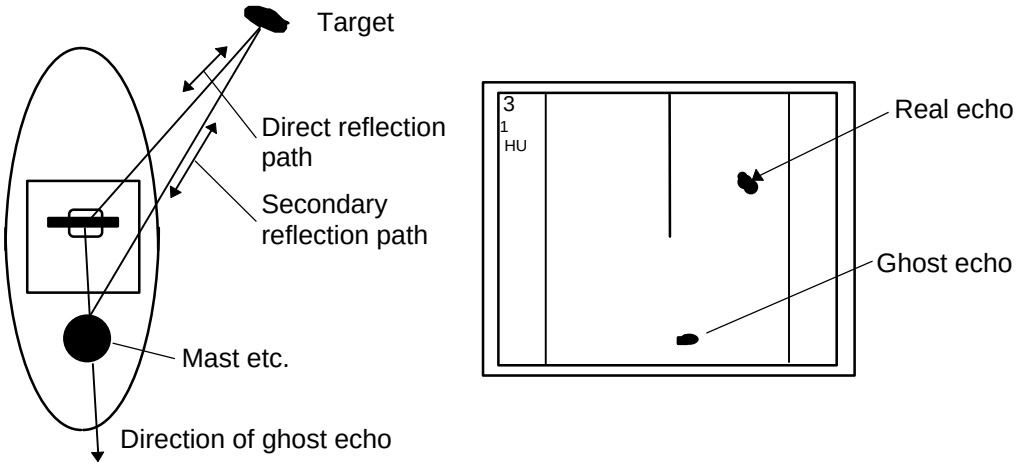

Fig.2-5 False echoes of radar (Ghost echoes)

B. Multiple echoes

If there is a large vertical reflecting surface near your boat, as in the case when you pass alongside a large ship, radar signals are repeatedly bounced back and forth between your boat and the other object. Two to four images appear on the screen at equal intervals in the same bearing. This is called a multiple echo. The image appearing closest to you is the real echo. Multiple echoes will disappear as you move away from the reflecting object or its bearing changes.

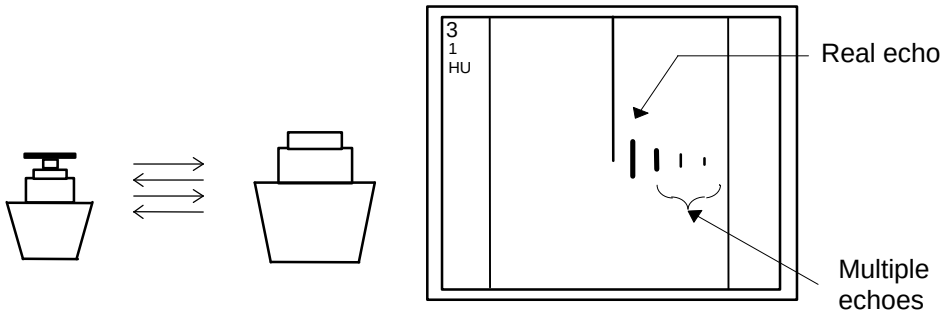

Fig.2-6 False echoes of radar (Multiple echoes)

C. False echoes caused by side lobe

An antenna's side lobe emissions are low power, and will not register distant targets. However, if there is a strong reflecting target near your boat, it sometimes may appear as a circular-arc false echo on the screen.

⚠ CAUTION

When near large targets or land, your boat's mast may sometimes appear as a circular-arc shaped false echo.

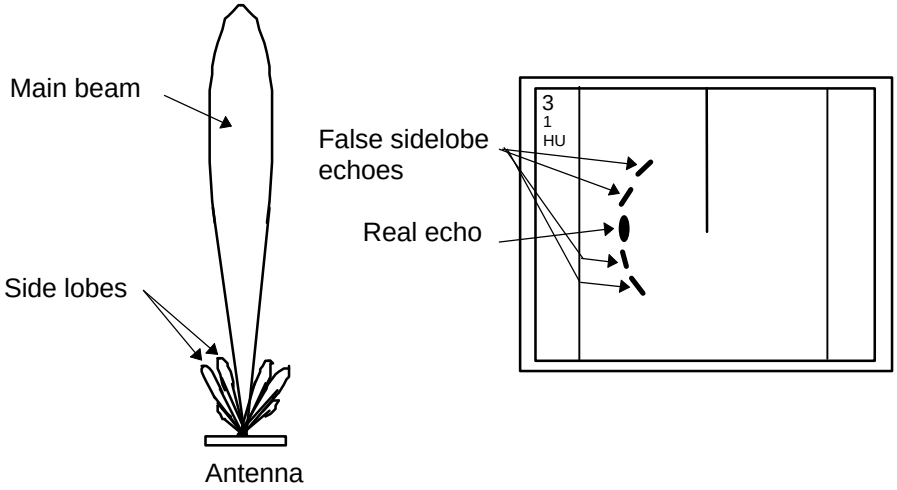

Fig.2-7 False echoes of radar (Caused by side lobe)

D. Distant false echoes caused by duct phenomenon

The duct phenomenon sometimes occurs when meteorological conditions create a temperature inversion between layers of air. When this happens, radar waves propagate erratically and can reach a location considerably farther away from your boat than the radar's maximum distance range. What appears onscreen is a false echo that looks to be nearer than the actual target. Since the true echo from the distant target is outside the measurement capabilities of the radar, its apparent distance will change when you change ranges, and you can conclude that it's a false echo.

Radar interference

If another boat's radar is operating on the same frequency as yours, it can create interference on your display. The interference usually appears as spiral or radial patterns. The RA51/52/53/54/55 radar has two levels of interference rejection control to eliminate interference. Turn it on to reduce or eliminate the interference.

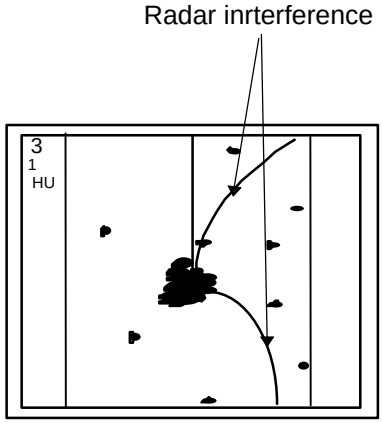

Fig.2-8 Radar interference

2.3 Terms Specific to Radar

HM (Heading Marker)

This is a line-shaped marker used to indicate the forward direction of your boat.

North Mark

The marker to indicate the direction North is a short line approximately 1/6 of the screen size. It only appears when the radar is connected to a suitable heading source provided through NMEA, 10/12 bit serial or sin/cos.

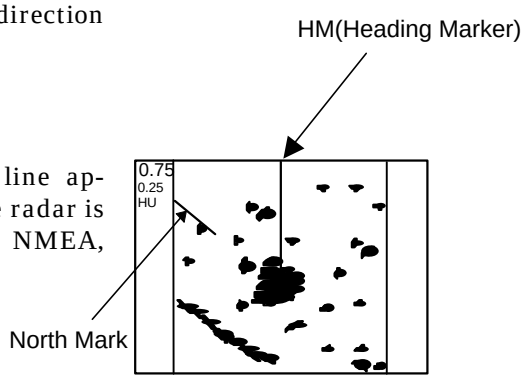

Fig.2-9 Heading Marker and North Mark

Display modes five (+HS)

The RA51/52/53/54/55 has four display modes. Each refers to the top of the screen as it relates to the direction of your boat's travel.

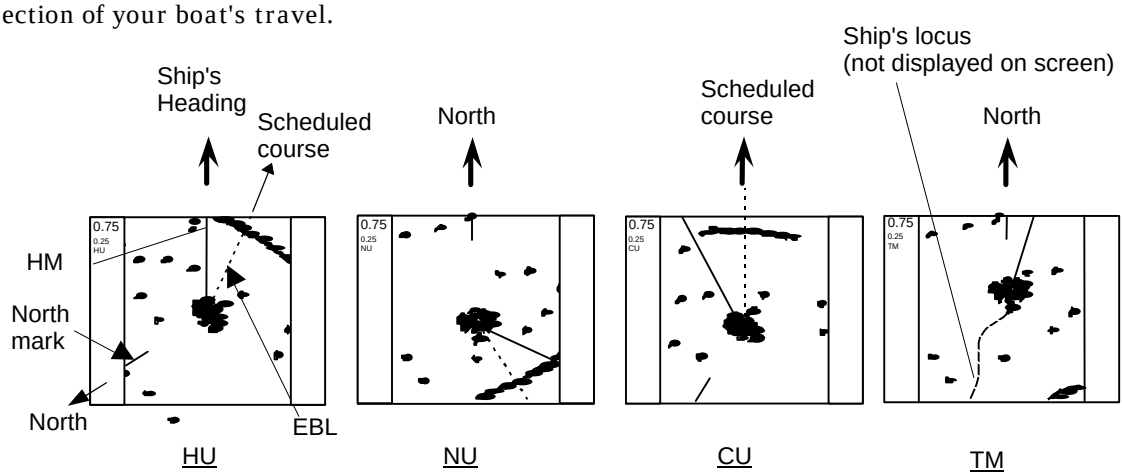

Fig.2-10 Display modes

Head Up (HU)

The heads up mode corresponds with your current heading and shows what's directly in front of you at the top of the screen. It gives you the position of other targets around you relative to your boat.

North Up (NU)

In this mode, North is at the top of the screen. This allows you to compare your position with a chart as you navigate. Heading data input is required for this mode to function.

Course Up (CU)

This is similar to North up except that your boat's destination is at the top of the screen. A straight line from the bottom to top of the screen is your course bearing.

True Motion (TM)

In this mode, the boat icon is displayed as if it is moving on a marine chart while targets such as islands and seashores are fixed in position. When the icon reaches a certain position on the screen (approx. 2/3 of screen size), it is placed back on the opposite side on the screen. North is at the top of the screen. External heading and speed data are needed for this mode.

VRM (Variable Range Marker)

This adjustable circular-shaped marker can be used to determine the distance of a target from your boat. When measuring be certain to move the VRM to a point close to the center of the echo image on the screen.

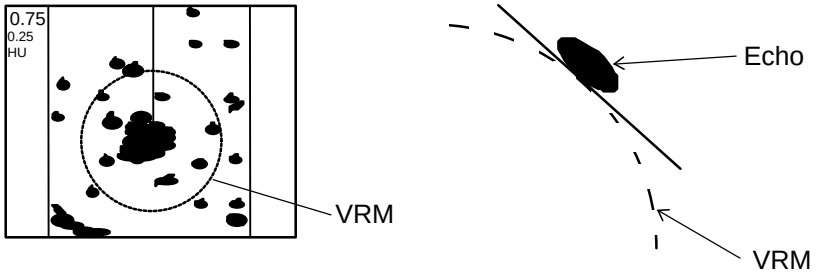

Fig.2-11 VRM

EBL (Electronic Bearing Line)

This straight-line marker can be rotated in any direction centered on your boat's position. Use the EBL to indicate the advancing direction of your boat and its relative angle with a target.

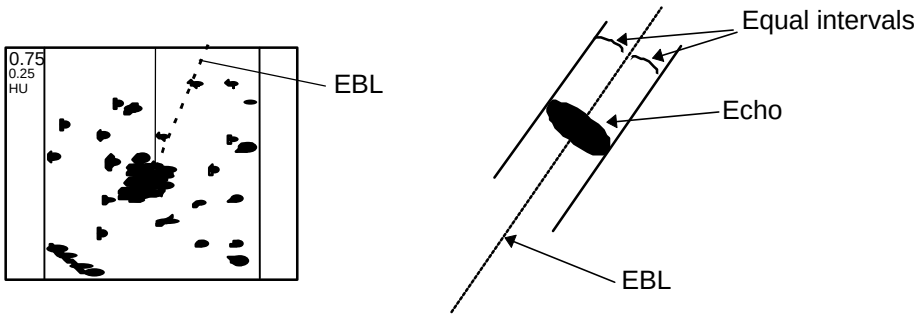

Fig.2-12 EBL

STC (Sensitivity Time Control)

Since echo signals received by the radar are stronger when they are coming from a short distance, it's difficult to compare signal strength between each reflected signal. To overcome this, signal strength is adjusted in such a way that the received signal levels coming from a short distance are lowered. This is helpful when there are large reflected waves from sea surfaces during rough weather.

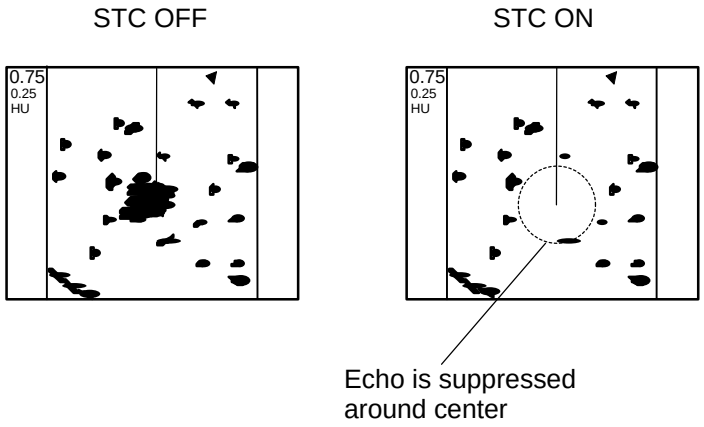

Fig.2-13 STC

FTC (Fast Time Constant)

When it rains or snows, fine noise may appear over the entire screen, making it difficult to identify echoes. In such a case, echo images on the screen can be made easily distinguishable by adjusting FTC.

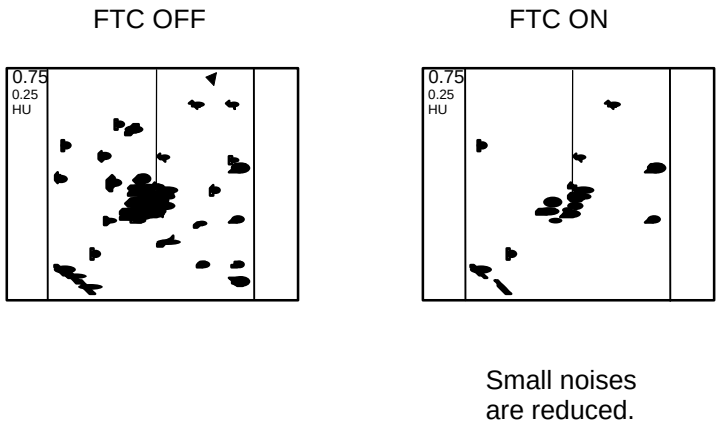

Fig.2-14 FTC

PPI (Plan Position Indicator)

A display system of radar. Reflected radar signal is displayed in plan.