04
THE MARINE RADAR

Basic terms

radar	***cathode ray tube (CRT)***	***screen***
tracking	***console***	***presentation***
range	***radar repeater***	***bearing cursor***
bearing	***radarscope***	***range***
target	***scope***	***strobe***
reference source	***plan position indicator***	***pip***
echo	***(PPI)***	***readings***
scanner	***LOP***	***tuning of radar***
radar beam	***true motion radar***	***errors***
indirect echo	***relative motion radar***	***bearing resolution***
side-lobe effect	***racon***	***range resolution***
radar range	***CPA***	***radar shadow***
scanning	***TCPA***	***multiple echo***
display		***false echo***

Radar is a word derived from "radio detection and ranging". It is of great practical value to the navigator in the piloting waters. Radars are not only used to locate navigational aids and to perform radar navigation, but they are also used for tracking other vessels in the vicinity so as to avoid risk of collision.

Radar determines distance to an object by measuring the time required for a radio signal to travel from a transmitter to the object and return. Such measurements can be converted into lines of position (LOP's) comprised of circles with radius equal to the distance to the object. Since marine radars use directional antennae, they can also determine an object's bearing. However, due to its design, a radar's bearing measurement is less accurate than its distance measurement. Understanding this concept is crucial to ensuring the optimal employment of the radar for safe navigation.

Insert the missing words
Radar is a word derived from "radio detection and __________". It is of great practical value to the navigator in the __________ waters. Radars are not only used to locate navigational aids and to perform radar navigation, but they are also used for __________ other vessels in the vicinity so as to avoid risk of collision. Radar determines distance to an object by measuring the time required for a radio signal to travel from a __________ to the object and return. Such measurements can be converted into lines of __________ (LOP's) comprised of circles with radius equal to the distance to the object. Since marine radars use directional __________, they can also determine an object's bearing. However, due to its design, a radar's __________ measurement is less accurate than its distance measurement.

Marine Radar FURUNO 1832 :
4 kW output, 36 nm range
3 NMEA 0183 ports (2 inputs and 1 output)
User-programmable function keys
Automatic optimization of radar picture
Newly enhanced short range performance
Cursor position and radar system data output (TTM target data with ARP-10)
Head-up, Course-up, North-up and True Motion
Economy Mode, Guard Zone Alarm and Watch Mode
Optional Autoplotter ARP-10 (10 targets auto/ manual acquisition and auto tracking)

The **basic principle** of radar is to determine the range to an object or "target" by measuring the time required for an extremely short pulse of very high radio frequency, transmitted as a radio wave, to travel from a reference source (own ship) to a target and return as a reflected echo. The radar antenna (called the scanner) rotates to scan the entire surrounding area. Bearings to the target are determined by the orientation of the antenna at the moment when the reflected echo returns.

Supply the appropiate term
The **basic principle** of radar is to determine the ***radius/range/circle*** to an object or "target" by measuring the time required for an extremely short ***post/pump/pulse*** of very high radio frequency, transmitted as a radio wave, to travel from a reference source (own ship) to a ***charge/target/place*** and return as a reflected echo. The radar antenna (called the scanner) rotates to ***see/scan/screen*** the entire surrounding area. Bearings to the target are determined by the orientation of the antenna at the moment when the reflected ***signal/echo/sound*** returns.

Complete the text below

The **basic principle** of radar is to determine the .... or "target" by measuring the time required for an extremely short pulse of very high radio frequency, transmitted as a radio wave, to travel from a reference source (own ship) to a target and return ....
The radar antenna (called the ___________) rotates to scan the entire surrounding area. Bearings to the target are determined by the orientation of the antenna at the moment when ....

The radar incorporates a **display device**, i.e. a cathode ray tube located within a console called a radar repeater. The most common of such displays is called the plan position indicator scope, or PPI. Bearing on the PPI scope is indicated around the periphery of the screen. On ships having a gyro compass the display has a gyro input and the presentation is oriented so that the true north lies under the 000 degrees mark. Most radars are now fitted with bearing cursors and range strobes. As the antenna rotates a thin line sweeps around the center of the screen and illuminates or "paints" any objects within the range of the radarscope. The presentation of objects is called a "pip" or "blip".

Insert the missing term

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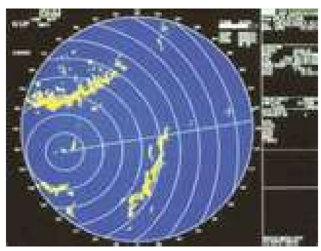


Factors Affecting Radar Interpretation

- Radar's value as a navigational aid depends on the navigator's understanding its characteristics and limitations. Whether measuring the range to a single reflective object or trying to find a shoreline lost amid severe clutter, knowledge of the characteristics of the individual radar used are crucial.

- Marine radars are usually short range radars that are used by ships to pinpoint locations about other ships and land in the area. The frequencies with which these radars are operated are known as x-band or s-band frequencies. The x stands for secret, as the ship radar was mainly a hidden frequency while used for the purpose of tracking ship during the Second World War. The s stands for small range in the second type.

Complete the text below
• *Radar's value as a navigational aid depends on the navigator's understanding its .... and ....* • *Whether measuring the range to a single reflective object or trying to .... lost amid severe clutter, knowledge of the characteristics of the individual radar used are crucial.* • *Marine radars are usually short range radars that are used by ships to .... about other ships and land in the area.* • *The frequencies with which these radars are operated are known as x-band or s-band ___________.* • *The x stands for ___________ , as the ship radar was mainly a hidden frequency while used for the purpose of tracking ship during the Second World War.* • *The s stands for .... in the second type.*

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.

Supply the missing word
Radar Resolution There are two important factors in radar ___________ : bearing resolution and range resolution. **Bearing Resolution** Bearing resolution is the ability of the radar to display as separate pips the ___________ received from two targets which are at the same ___________ and close together.

It is proportional to the antenna length and reciprocally proportional to the ____________.

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.

Read the text below and separatae the words in each sentence
Range Resolution Rangeresolutionistheabilitytodisplayasseparatepipstheechoes receivedfromtwotargetswhichareonthesamebearingandclosetoeach other.Testtargetsfordeterminingtherangeandbearingresolutionareradar reflectorshavinganechoareaof10squaremeters.

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.

TRUE or FALSE?
Bearing Accuracy • One of the most important features of the gyro compass is how accurately the bearing of a target can be measured. • The accuracy of bearing measurement basically depends on how wide the radar beam is. • The bearing is usually taken relative to the ship's course. • So, proper adjustment of the heading marker at installation is an important factor in ensuring range accuracy. • To minimize error when measuring the bearing of a target, put the target echo at the closest position on the screen by selecting a suitable range.

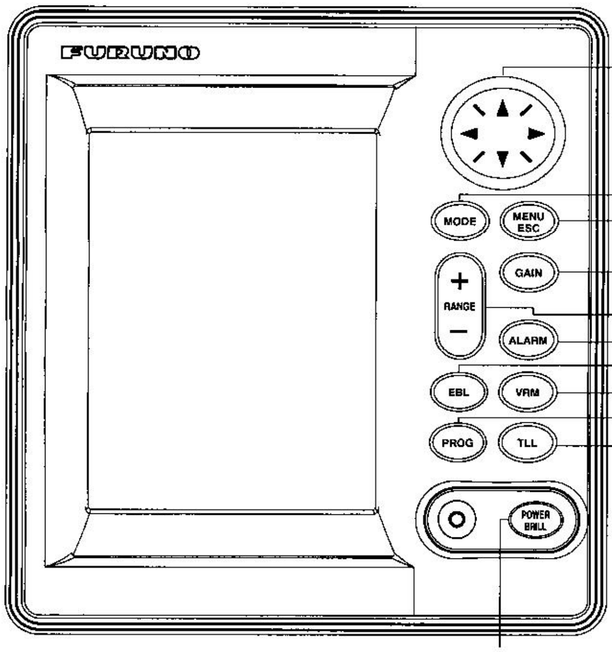
Discussion:

Work in pairs and discuss the above text using the questions above:

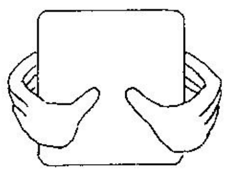
1. What are the main uses of marine radar?
2. Explain the basic principle of the radar function.
3. How does the radar determine distance to an object?
4. What do the directional antennae enable?
5. How are the bearings determined?
6. What is a PPI?
7. How is the presentation oriented in radars with the gyro input?
8. What happens on the radarscope as the antenna rotates?
9. Explain the concepts of difraction, attenuation and refraction.
10. What are the factors affecting the interpretation of the radar picture?
11. What is bearing resolution?
12. What is range resolution?
13. When do the radar shadows occur?
14. What is the cause of the multiple echo?
15. What are the two instances of false echoes?
16. What is the accuracy of the radar bearings and range?
17. Explain the difference between a true and relative motion radar.
18. Explain the difference between an *x-band or s-band* radar.
19. Why is tracking ships compulsory?

1. OPERATION

1.1 Controls

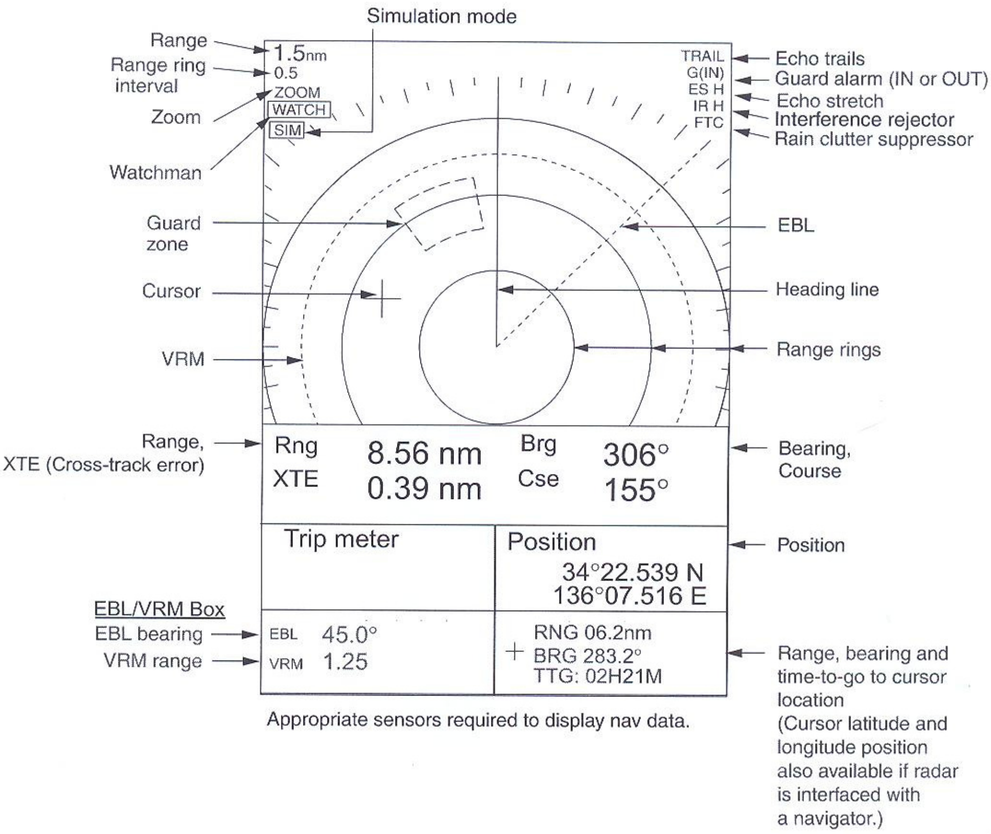


How to remove the hard cover
Place your thumbs at the center of the cover, and then lift the cover while pressing it with your thumbs.



Display unit

1.2 Indications



Indications

About the LCD

The high quality LCD displays better than 99.99% of its picture elements. The remaining 0.01% may drop out or light, however this is not an indication of malfunction; it is a characteristic of the LCD.

Part II.

Operation of the Marine Radars

The operation of the **marine radars** can be explained as follows:

- There is an antenna on the top of the radar that continuously rotates and flashes
- The flashes actually are frequency beams that are transmitted from the radar to find out whether there any objects present in the path of the ship
- The frequency and the time taken by the flashes to return (reflections) to the radar receiver of the ship helps to find out whether the route of the boat can be continued with or not
- On the display screen, the reflections can be seen so that identifying the actual distance of the objects can be even more easy

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Interpretation of information on a radarscope

Interpretation of information on a radarscope is not always easy and requires much skill of the radar operator to obtain correct readings. These are affected by unfavorable meterological conditions, possible component failures, bad tuning errors.

Among the factors producing errors in interpretation are: *bearing resolution, range resolution, radar shadows, multiple echoes* and *false echoes.*

- ***Bearing resolution*** is the minimum difference in bearing between two targets at same range which can be seen clearly. If two objects are close together their pips may merge giving the impression of one target only. Such faulty presentations often appear in coastal areas ("false shoreline").
- ***Range resolution*** is the minimum difference in range between two objects at the same bearing to be clearly distinguished on the radar display. False interpretation may occur if small boats or rocks are merged with the shoreline.
- ***Radar shadows*** occur when a large radar target masks another small object positioned behind it or when an objeet is obscured by the curvature of the Earth.
- ***The multiple echo*** occurs when a radar beam bounces back and forth between the ship and a relatively close-in target, i.e. another ship.
- ***A false echo*** is a type of false pip that appears on the display where there is actually no target at all. It occurs when a part of the energy is reflected to the antenna from a part of the ship's structure (indirect echo) or if energy from side lobes (in addition to the main lobe of the radar beam) is reflected back by a target (side-lobe effect).

In piloting most radar bearings are accurate only to within 3 to 5 degrees. A well-tuned radar gives ranges precise to within ±100 yards out to the radar horizon. Therefore radar range LOP's are preferred over radar bearings.

In a true motion radar, one's own ship and other moving targets move on the PPI in accordance with their true courses and speeds. All fixed targets appear as stationary echoes. It needs own ship's speed and course input. In a relative motion radar the position of one's own ship is usually fixed at the centre of the PPI, and all detected targets move relative to one's own ship.

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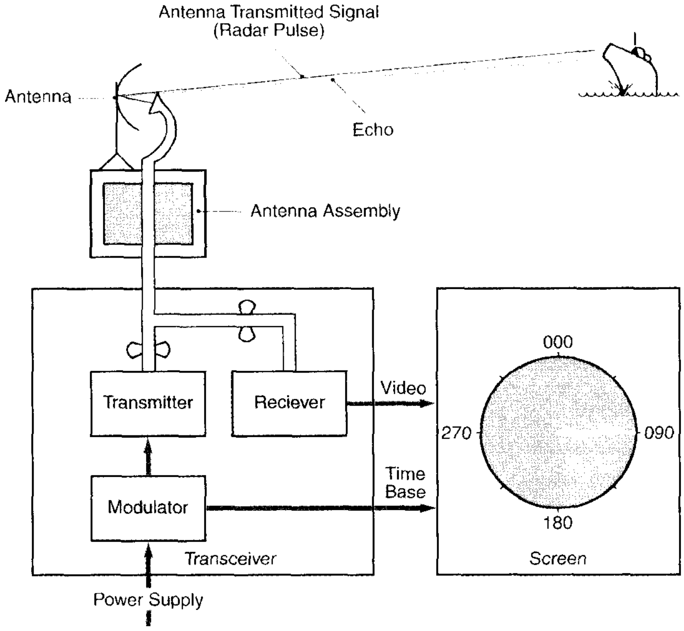
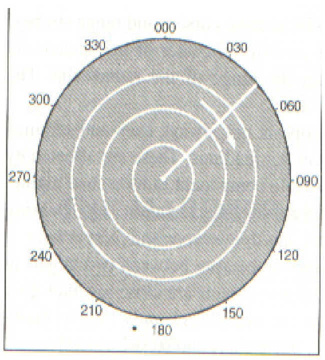
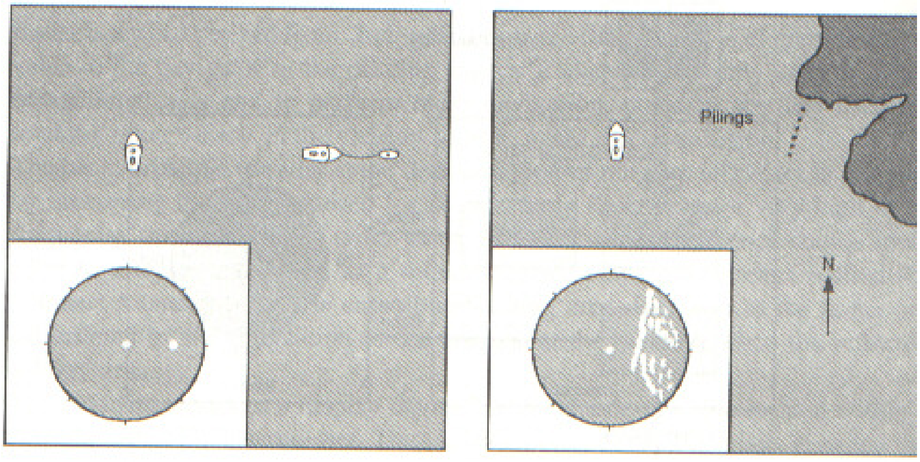
Basic Block Diagram of a Radar



A PPI Radarscope, with Range Rings Illuminated





Tug and Tow Merged Because of Lack of Range Resolution

A False Shoreline Caused by Lack of Bearing Resolution

IMO STANDARD MARINE COMMUNICATION PHRASES

III/6.2.2 - *NAVIGATIONAL ASSISTANCE SERVICE*
6.2.2.1 - *Request, identification, begin and end*

Is shore based radar assistance available?
- **Yes, shore based radar assistance available.**
- **No, shore based radar assistance not available.**
- **Shore based radar assistance available from ... UTC to ... UTC.**

Do you want navigational assistance to reach ... ?
- **Yes, I want navigational assistance to reach ... .**
- **No, I do not want navigational assistance.**

What is your position?
- **My position ... degrees from ... distance ... kilometres/nautical miles.**

How was your position obtained?
- **Position obtained by GPS.**
- **Position obtained by DECCA.**
- **Position obtained by RADAR.**
- **Position obtained by cross-bearing.**
- **Position obtained by astronomical observation.**
- **Position obtained by ... .**

Repeat your position for identification.
I have located you on my radar screen - your position ... degrees from….
I cannot lacate you on my radar screen.
What is your present course and speed?
- **My present course ... degrees, speed ... knots.**

What is course to reach you?
- **Course to reach me ... degrees.**

Is your radar working?
- **Yes, radar working.**
- **No, radar not working.**

What range scale are you using?
- **I am using ... miles range scale.**

Advise you change to larger range scale.
Advise you change to smaller range scale.
You are leaving my radar screen.
Change to radar ... *(name)* ***VHF Channel ... .***
Changing to radar ... *(name)* ***VHF Channel... .***
l have lost radar contact.

A. Comprehension & vocabulary

A.1 Decide whether the following statements are true or false:

1. The pulses transmitted from the ship's antenna are reflected from the targets and are received and displayed on the screen.
2. Radar is based upon the time interval between the transmitting of the pulse and the return of its echo.
3. Range resolution requires two targets to be separated in bearing.
4. CRT is short for Cathode Ray Tube.
5. CPA is short for Closest Point of Approach.
6. TCPA indicates the time of CPA.
7. In the Head up display the radar display bears to the true north.
8. In the North-upward display the north is 0° on the display.

A.2 Explain the terms:

Ramark Racon CPA TCPA gain CRT PPI VRM sea clutter rain clutter

Consult any handbook on marine radars on the web or in your library!

A.3 Complete the text below with the appropriate words:

bearings distance crossing bearings radar landmarks

Determining ship's position by radar

There are three ways, generally, of determining the position of a vessel by 1.__________.
The first is by determining the distances to known 2.__________ . This method is useful when you are not sure of the 3.__________ of these landmarks either because of gyro error or uncertainty of the magnetic compass.
The second is by obtaining the true bearing and 4.__________ from known landmark. In this case you only need one object clearly visible on radar.
The third would be by 5.__________ such as tangent bearings.

A.4 Choose the right answer:

1. The ability of a radar to distinguish separate targets on the same bearing, but having small difference in range, is called:
   a) bearing resolution
   b) range resolution
   c) range elongation
   d) propagation

2. The maximum measurable range of a radar set depends on:

a) peak power in relation to the pulse repetition rate
b) beam width
c) range resolution
d) refraction

3. The common wave length in a marine radar is:
   a) 3 and 10 cm
   b) 3 and 10m
   c) 600 m
   d) 500 kilocycles

4. Of the following the most accurate position by radar fix is:
   a) radar range and visual bearing
   b) intersection of radar range circles
   c) radar range and bearing
   d) intersection of two radar bearings

5. You are observing a pip of a small ship by radar. Between you and the ship is a point of land. You are not able to see the pip because of:
   a) poor bearing resolution
   b) super-refraction
   c) shadow effect
   d) side lobes
6. When the range of a ship is decreasing and its bearing remains constant,the ships are on:
   a) parallel courses
   b) opposite courses
   c) diverging courses
   d) collision courses

A5 . Supply the right term:

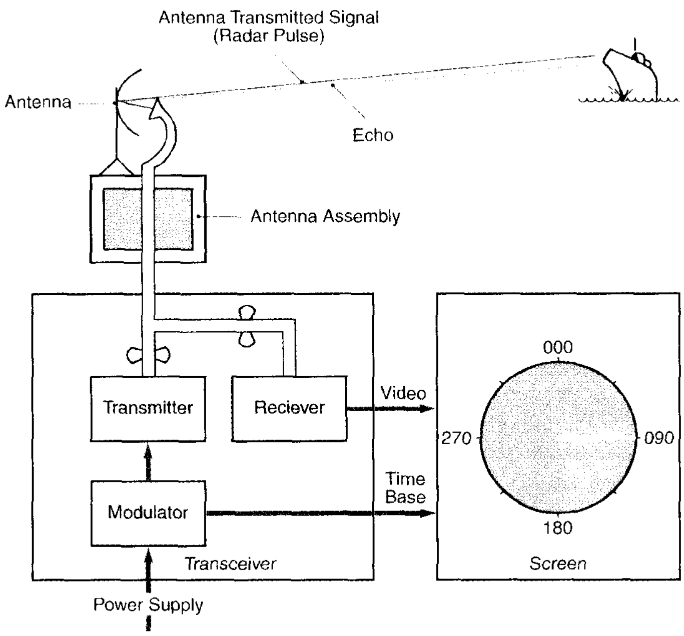
The radar display is often referred to as the ______________ (PPI). On a PPI, the sweep appears as a radial line, centered at the center of the _______ and rotating in synchronization with the antenna. Any returned _______ causes a brightening of the display screen at the bearing and _______ of the object. Because of a luminescent coating on the inside of the tube, the glow continues after the trace rotates past the _______. On a PPI, a target's actual range is proportional to its _______ from the center of the scope. A moveable _______ helps to measure ranges and bearings. In the "headingupward" _______, which indicates _______ bearings, the top of the scope represents the direction of the ship's _______. In this unstabilized presentation, the orientation changes as the ship changes _______. In the _______ "north-upward" presentation, gyro _______ is always at the top of the scope.

A6 Match the term with the right definition:

	multiple echo		the minimum difference in bearing the azimuth two targets at same range which can be seen clearly. If two objects are close together their pips may merge giving the impression of one target only. Such faulty presentations often appear in coastal areas ("false shoreline").
	false echo		the minimum difference in distance between two objects at the same bearing to be clearly distinguished on the radar display. False interpretation may occur if small boats or rocks are merged with the shoreline.
	bearing resolution		These occur when a large radar target masks another small object positioned behind it or when an objeet is obscured by the curvature of the Earth.
	radar shadows		This occurs when a radar beam bounces back and forth between the ship and a relatively close-in target, i.e. another ship.
	range resolution		A type of wrong pip that appears on the display where there is actually no target at all. It occurs when a part of the energy is reflected to the antenna from a part of the ship's structure (indirect echo) or if energy from side lobes (in addition to the main lobe of the radar beam) is reflected back by a target (side-lobe effect).

A7 Writing and speaking skills

Write down the operation of the radar using the Basic Block Diagram of a Radar and then present it orally to the student next to you.



B. Grammar

B.1 Supply the right link word to camplete the sentences below. The meaning of the link word is given in brackets:

Radar provides a means of fixing the ship's position *(time)* 1.__________ other methods may not be available.

(Reason) 2.__________ both range and bearing could be obtained, only one identifiable object is necessary.

(Condition) 3.__________ a visual bearing is available, it is undoubtedly , more reliable than any radar bearing.

(Reason) 4.__________ radar range is more accurate than a radar bearing, the best fix is obtained by two or more ranges.

Fixes *(relative)* 5.__________ are obtained by a bearing and range are less accurate *(comparison)* 6.__________ those obtained by using intersecting range areas.

B.2 Re-write all instances in the reading text where the word radar occurs as a "noun " and as a "noun modifier ":

NOUN	NOUN MODIFIER
true motion radar	radar shadow

B.3 Supply the correct form of the verb in brackets:

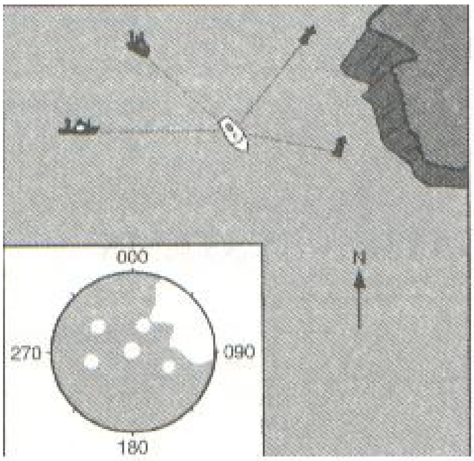
Various aids to radar navigation *(develop)* 1.__________ to aid the navigator in *(search)* 2.__________ for radar targets and in *(amplify)* 3.__________ the echoes. Corner reflectors *(fit)* 4.__________ generally on the tops of buoys or on cornered buoys. Radar beacons are transmitters *(operate)* 5.__________ in the marine radar frequency band. Racon *(provide)* 6.__________ both bearing and range to the target and Ramark *(provide)* 7.__________ bearing information only. However, when the Ramark installation *(delect)* 8.__________ as an echo on the radarscope, the range *(be)* 9.__________ available too.

Writing skills

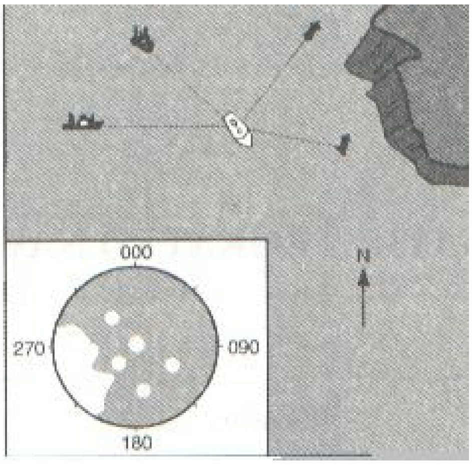
C.1 Summarize the reading text using the answers to the questions below as a guide:

20. What are the main uses of marine radar?
21. Explain the basic principle of the radar function.
22. How are the bearings determined?
23. What is a PPI?
24. How is the presentation oriented in radars with the gyro input?
25. What happens on the radarscope as the antenna rotates?
26. What are the factors affecting the interpretation of the radar picture?
27. What is bearing resolution?
28. What is range resolution?
29. When do radar shadows occur?
30. What is the cause of the multiple echo?
31. What are the two instances of false echoes?
32. What is the accuracy of the radar bearings and range?
33. Explain the difference between a true and relative motion radar.

A PPI Presentation Oriented to True North



A PPI Presentation Oriented Relative to Ship's Head



FURTHER READING

RADAR OBSERVATION
GENERAL

Minimum Range
The minimum range, *Rmin*, 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.

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.

RADAR OBSERVATION - EXERCISES

GENERAL

1. ***Supply the missing terms:***

Minimum Range
The minimum range is defined by the shortest distance at which, using a scale of 1.5 or 0.75 nm, a __________ having an echoing area of 10 square meters is still shown separate from the point representing the __________ position. It is mainly dependent on the __________ length, antenna __________, and signal processing such as main bang suppression and digital quantization. It is good practice to use a shorter range __________ as far as it gives favorable definition or clarity of picture. The IMO Resolution A. 477 (XII) and IEC 936 require the minimum __________ to be less than 50m. All FURUNO radars satisfy this requirement.

2. ***Rearrange the chunks below to make sensible sentences:***

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

the maximum range is equal to
the radar horizon or a little shorter
under normal atmospheric conditions,

the optical one about 6%
The radar horizon is longer than
because of the diffraction property of the radar signal

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

3. Match the terms with the corresponding definitions:

	Range Resolution	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.	
	Bearing Resolution	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.	
	X-BAND and S-BAND	the ability to display as separate pips the echoes received from two targets which are on the same bearing and close to each other.	
	Range Measurement	One of the most important features of the radar is how precisely the bearing of a target can be measured. This 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 preciseness. 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.	
	Bearing Accuracy	Measurement of the distance 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.	

4. *Put the slash marks between the words in the text below and the read the txt aloud.*

FALSEECHOES

Occasionallyechosignalsappearonthescreenatpositionswherethereis Notargetordisappeareveniftherearetargets.Theyare,however,recognizedifyouunderstandth ereasonwhytheyaredisplayed.Typicalfalseechoesareshownbelow.

5. *Write down question-word questions (i.e those beginning in Who, Which, Whose, What, Why, How, When, Where, etc.?) to which the following sentences are responses:*

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.

e.g. *When do multiple echoes occur?*
Multiple echoes occur when a transmitted pulse returns from a solid object like a large ship, bridge, or breakwater.

____ ?
____ ?
____ ?
____ ?
____ ?
____ ?

6. *Match the parts of the sentences on the right with the ones on the left:*

Sidelobe echoes

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

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 XBand (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.

Search and Rescue Transponder (SART)

SART or Search and Rescue Transponder, is an extremely vital equipment on the ship as it performs the job of a signal-man. It is a vital machine during distress for it helps in locating the position of the vessel in case it goes off-track. SARTs are made of water proof components which protects it against damage by water. SARTs are essentially battery-operated, hence can be operative for a long time, as long as 100-hours if need arises in case of emergencies.

SARTs are of use in ships, lifeboats and life rafts. They are the most supportive machines in case of an unprecedented emergency. SARTs are designed to remain afloat on water for a long time in case the vessel finds itself submerged in water. The bright color of SARTs enables their quick detection, whereas the combination of transmitter and receiver enables it to transmit as well as receive radio signals. SART machines have been instrumental in rescuing several crafts and ships by reacting to the search signal sent from an X-band radar, typically of 9 GHz. These signals are known as homing signals. The response is usually displayed on radar screens as a sequence of dots on a S band-radar, which helps rescuers reach the vessels in time.

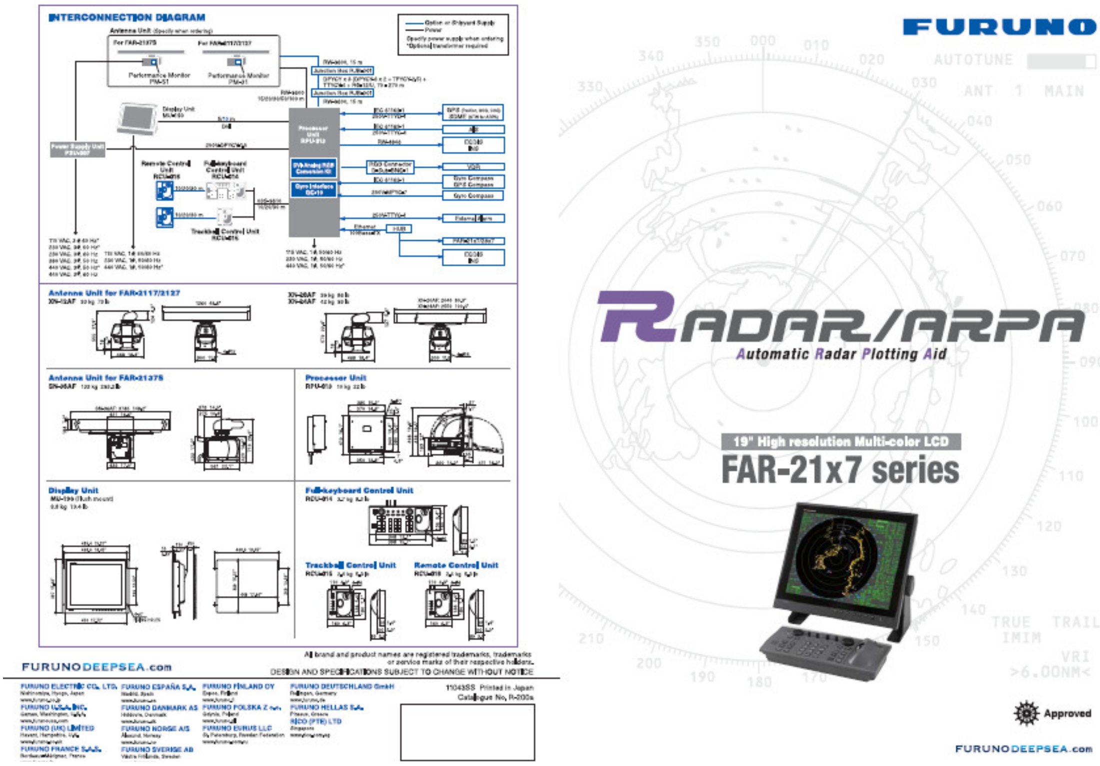
The battery of SART is kept safe and can last long because it lies dormant when not needed. The equipment is activated only when it needs to be, like when it comes in contact with water. Standard vessels of 500 tons or less are not supposed to go in the sea without a SART, whereas vessels above 500 tons are not supposed to venture out in the seas without two transponders. This signifies the importance of a SART on a ship.
The device remains dormant until an emergency switch is on. This way, it saves on several watts of power, crucial for other equipments. It turns itself on, when it gets signals emitted by the radar of a vessel passing by. The crew on the ship is thus alerted that another vessel in the vicinity of 100 meters requires assistance. Audio and visual signals do the trick in most cases.
SARTs find themselves useful in rescue operations involving airplanes or ships stranded by air and sea accidents. They are designed to survive the toughest conditions and stay active on elevated positions like on a pole so that they could cover a diverse range. Talking of heights, a SART transponder on an airplane could have a range of 30 to 40 miles. This helps to scrutinize a huge range and huge area.
SART emits a sequence of 12 dots, the first dot represents the starting point, and the rest would simply rush to the ends. As the rescuing vessel or individual approaches the SART, the circumference of the arc would go up. The pattern differentiates it from that of a RADAR, which simply reflects the signals.
Looking at the facts, one can determine that SARTs are a marvel of human engineering, making them significant equipments on the ship venturing out in deep oceans.

Radar Reflectors

Marine radar reflectors are an important device that are fitted in boats especially in today's times when there is a constant threat of boats, ships, and yachts entering unknown water borders. Boats that are made of fibreglass do not reflect the radar pulses; this could cause unwanted collisions between boats or with ships. For this reason radar reflectors are designed specifically to help boats get located and avert any untowardly accident.

In order to understand how a radar reflector works, it is important to understand how the system of radar works. The Radar (Radio Detection and Ranging) system basically involves sending electromagnetic pulses or waves across in an intended direction. The difference in the time it takes for these pulses to reach back to the point from where they were emitted proves whether there are any objects that are moving or not.

-


INTERCONNECTION DIAGRAM
Antenna Unit for FAR-2117/2127
Antenna Unit for FAR-2137S
Processor Unit
Display Unit
Full-keyboard Control Unit
Trackball Control Unit
Remote Control Unit
FURUNODEEPSEA.com
All brand and product names are registered trademarks, trademarks or service marks of their respective holders.
DESIGN AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
FURUNO
RADAR/ARPA
Automatic Radar Plotting Aid
19" High resolution Multi-color LCD
FAR-21x7 series
Approved
FURUNODEEPSEA.com

▶**Advanced signal processing for improved detection in rough sea**

▶**LCD display providing crisp radar images**

▶**Designed to comply with SOLAS carriage requirements for ships below 10,000 GT**

▶**Up to four radars can be interswitched in the network without an extra device**

▶**Automatic plotting/tracking of 100 targets manually or automatically acquired**

▶**Low spurious magnetrons meeting ITU-R unwanted emission standards**

▶**Displays 1000 AIS-equipped targets**

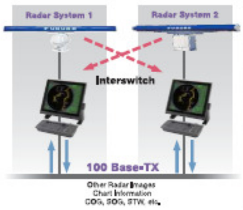
This series of radar comply with the latest IMO and IEC standards:
• IEC 60945 • IEC 62388 • IEC 61162 • IEC 61993
• IMO MSC.191(79) • IMO MSC.192(79) • IMO A.694(17)
• IMO A.813(19) • IMO SN/Circ.243

▶**Easy operation by customizable function keys, trackball/wheel palm module and rotary controls**

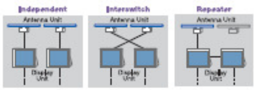
Full-keyboard Control Unit
The control head has logically arranged controls in a combination of push keys and trackball. Well organized menu ensures that all operations can be done by trackball.

Palm Control Unit
Alternative to the Full-keyboard Control Unit or additional as a remote operation.

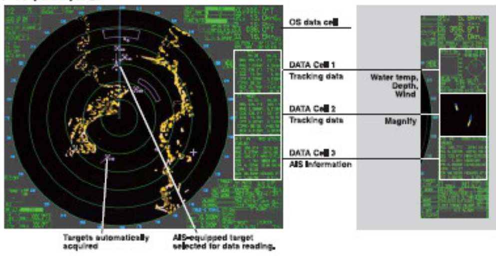
▶**100 Base-TX Ethernet Network System**



The radar can be connected to an Ethernet network for a variety of user requirements, SOLAS Chapter V as amended requires X- and S-band radar for ships 3000 GT and over. Each of X- and S-band radar can be interswitched without using an extra device. Up to four sets of radar can be interchanged in the network. In addition, the essential navigational information including the electronic chart, L/L, COG, SOG, STW, etc. can be shared in the network.



▶**TT (ARPA) /AIS**



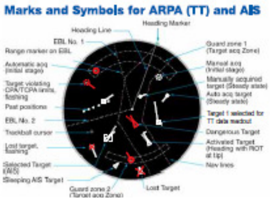
Data Display

A variety of navigational information, own ship status, radar plotting data, wind, water temperature and information from other shipborne sensors are displayed on the cells. These selected targets are marked with a square symbol on the radar display. Magnify is a special feature of the FURUNO radars FAR-21x7 series. This looks like a delayed-sweep zoom which IMO strictly prohibits, but where Administration accepts, the Magnify feature enlarges part of radar display for special maritime activities.

Target Association (Fusion)

An AIS-equipped ship may be displayed by both AIS and TT symbols. This is because the AIS position is measured by a GPS in L/L while the TT symbol blip and data are measured by range and bearing from own ship and located on the radar PPI.
When the symbols are within an operator-set criteria, the TT symbol is merged in the AIS symbol. The criteria are determined by the differences in range, bearing, course, speed, etc.

Marks and Symbols for ARPA (TT) and AIS



AIS information

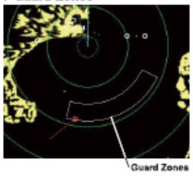
Static Data
MMSI (Maritime Mobile Service Identity)
IMO number (Where available)
Call sign & name
Length and beam
Type of ship
Location of position-fixing antenna on the ship

Voyage related data
Ship's draught
Hazardous cargo (type)
Destination and ETA
(at masters discretion)

Dynamic data
Ship's position with accuracy indication and integrity status
UTC
Course over ground (COG)
Speed over ground (SOG)
Heading
Navigation status (manual input)
Rate of turn (where available)
Update rates dependent on speed and course alternation (2 s – 3 min)

Short safety-related messages
Free messages

▶**Guard Zones**

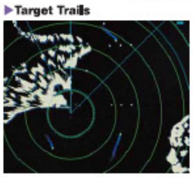


Automatic Acquisition Zone
Two automatic acquisition zones may be set in a sector or any form. They also act as suppression zones, avoiding unnecessary overloading to the processor and clutter by disabling automatic acquisition and tracking outside them. Targets in an automatic acquisition zone appear as inverse triangles.
The operator can manually acquire important targets without restriction.

CPA Alarm Zone
Target tracking symbol changes to a triangle when its predicted course (vector) violates the operator set CPA/TCPA. The operator can readily change the vector lengths to evaluate target movement trend.

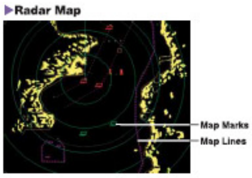
Guard Zones and Anchor Watch Zone
Guard Zones generate visual and audible alarms when targets enter the operator set zones. One of Guard Zones may be used as an anchor watch to alert the operator when own ship or targets drift away from the set zone.

▶**Target Trails**



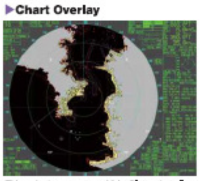
The target trails feature generates monotone or gradual shading afterglow on all objects on the display. The shading afterglow paints the display just like on an analog PPI. The monotone trails are useful to show own ship movement and other ship tracks in a specific fishing operation. The trail time is adjustable for 15, 30 s, 1, 3, 6, 15, 30 min or continuous. The target trails are indicated in a different color from background. The unique feature in this radar is a choice of True or Relative mode in Relative Motion (only True in TM).

▶**Radar Map**



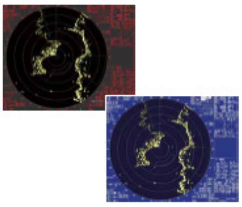
Up to 200 waypoints and up to 30 routes can be stored. Each route may contain up to 30 waypoints. A radar map is a combination of map lines and marks whereby the user can define and input the navigation area, route planning and monitoring data. The radar map has the capacity of 3,000 points for lines and marks. The map data can be stored and recalled for repeated use on a routine navigation area.

▶**Chart Overlay**



This radar incorporates a VideoPlotter that allows to display electronic charts, plot own and other ship's track, enable entry of waypoints/routes, and make a radar map. Chart is displayed in combination of radar images. (For non-SOLAS ships only)

▶**Presentation Colors**



Antenna Radiators

1. Type
Slotted waveguide array

2. Beamwidth and sidelobe attenuation

	X-Band			S-Band
Radiator Type	XN-12AF	XN-20AF	XN-24AF	SN-36AF
Length	4 ft	6.5 ft	8 ft	12 ft
Beamwidth(H)	1.9	1.23	0.95	1.8
Beamwidth(V)	20	20	20	25
Sidelobe (within 10°)	-24 dB	-28 dB	-28 dB	-24 dB
Sidelobe (outside 10°)	-30 dB	-32 dB	-32 dB	-30 dB

3. Rotation

	X-Band		S-Band	
Rotation	24 rpm	42 rpm	21/26 rpm	45 rpm
Gear Box	RSB-096	RSB-097	RSB-098 RSB-099	RSB-100 RSB-101 RSB-102

RF Transceiver

1. Frequency
X-band: 9410 MHz 30 MHz
S-band: 3050 MHz 30 MHz

2. Output power

	FAR-2117	FAR-2127	FAR-2137S
Output Power	12 kW	25 kW	30 kW
Transceiver	RTR-078	RTR-079	RTR-080

3. Pulselength/PRR

Range scale (nm)	Pulselength (s)	PRR (Hz)
0.125, 0.25	0.07	3000
0.5	0.07, 0.15	3000
0.75, 1.5	0.07, 0.15, 0.3	3000, 1500
3	0.15, 0.3, 0.5, 0.7	3000, 1500, 1000
6	0.3, 0.5, 0.7, 1.2	1500, 1000, 600
12, 24	0.5, 0.7, 1.2	1000, 600
48, 96	1.2	600

4. I.F.
60 MHz, Logarithmic

5. Bandwidth
Short pulse: 40 MHz
Middle pulse: 10 MHz
Long pulse: 3 MHz

Radar Display

1. Display
19" color LCD (SXGA 1280 x 1024 pixels),
376.3 (H) x 301.1 (V) mm.
Effective display diameter: 281 mm
Echo Color: Yellow, green or white in 32 levels

2. Range scales and ring intervals (nm)
Range: .125, .25, .5, .75, 1.5, 3, 6, 12, 24, 48, 96
Ring: .025, .05, .1, .25, .25, .5, 1, 2, 4, 8, 16

3. Minimum range
22 m

4. Range discrimination
26 m

5. Range ring accuracy
0.2 %

6. Presentation modes
Head-Up, Cursor-gyro, Course-Up, North-Up, North-Up True Motion (sea or ground stabilization)

7. Heading Information
Furuno GPS compass is a recommendable heading sensor as a backup of a gyrocompass.
Confirm with your Administrations.

8. Parallel index lines
1, 2, 3 or 6 lines (menu selectable)

9. Radar map
20,000 points to create coastlines, own ship safety contour, isolated underwater dangers, buoys, traffic routing systems, prohibited areas, fairways as required by IMO.

Target Tracking

1. Acquisition
100 targets (e.g. manually 50, automatically 50) in 0.2–24 nm

2. Tracking
Automatic tracking of all acquired targets

3. Guard zone
Two zones, one of them 0.5 nm depth

4. Past positions
5 or 10 past positions on all targets

5. Collision warning
CPA limit: 0.2 - 10 nm, TCPA limit: 0 - 99 min.

6. Trial maneuver
Dynamic or static, with selected delay time.

AIS Display (Data input from AIS is required)

1. Symbols
Sleeping, Activated, Dangerous, Selected, Lost targets

2. Number of targets
1,000 targets max.

3. Data indication
Basic and expanded data

Power Supply (specify when ordering)

1. Processor Unit
100-115/220-230 VAC, 1φ, 50/60 Hz.
FAR-2117: 7.8 A (8.5 A for HSC application) at 24 VDC,
FAR-2127: 8.8 A (9.7 A for HSC application) at 24 VDC
FAR-2137S: 3.0 A for 100–115 VAC
1.5 A for 220-230 VAC
440 VAC, 1φ, 50/60 Hz with optional transformer RU-1803

2. Display Unit
100-230 VAC, 1φ, 50/60 Hz, 0.7 A
440 VAC, 1φ, 50/60 Hz with optional transformer RU-1803

3. Antenna Unit
FAR-2137S:
200/380 VAC, 3.0/1.5 A, 3φ, 50 Hz; 220/440 VAC, 3.0/1.5 A (3.5/1.7 A for HSC application), 3φ, 60 Hz
115 VAC, 3φ, 60 Hz with optional transformer RU-5693
230 VAC, 3φ, 50 Hz with optional transformer RU-6522
440 VAC, 3φ, 50 Hz with optional transformer RU-5466-1

EQUIPMENT LIST

Standard
1. Display Unit MU-190
2. Processor Unit RPU-013
3. Full-keyboard Control Unit RCU-014
   Trackball Control Unit (Palm Control Unit)
   RCU-015 (Specify when ordering)
4. Antenna Unit with cable, 15/20/30/50/100 m
   (Specify when ordering)
5. Power Supply unit PSU-007 for FAR-2137S
6. Standard Spare Parts and Installation Materials

Option
1. Performance Monitor PM-31 for FAR-2117/2127
   PM-51 for FAR-2137S (Specify when ordering)
2. Remote Control Unit RCU-016
3. Gyro Interface GC-10 (built in Processor Unit)
4. DVI-Analog RGB Conversion Kit (Buffer board built in) OP-03-180
5. RGB Connector DSUB-BNC-1 (for VDR)
6. Card Interface Unit CU-100
7. Transformer RU-1803/5466-1/5693/6522
8. Rectifier RU-3424/1746B
9. Junction Box RJB-001
10. Antenna Cable RW-9600
11. External Alert Buzzer OP03-21
12. Hand Grip FP03-09840
13. Bracket FP03-09820
14. Hub HUB-100

ffers unmatched
rface

S-band antenna

10 ft antenna
(12 ft also available)

FAR-2137S-BB: *S-band, 30 kW, TR up*

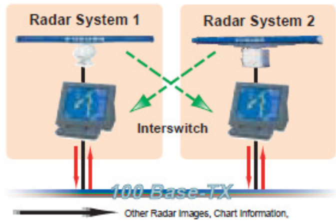
X-band antenna

8 ft antenna
(4 or 6.5 ft also available)

FAR-2117-BB: *X-band, 12 kW, TR up*
FAR-2127-BB: *X-band, 25 kW, TR up*

100 Base-TX Ethernet Network System

The radar can be connected to an Ethernet network for a variety of user requirements. Each of X- and S-band radars can be interconnected without requiring extra options. Up to four radar sets can be interchanged in the network. In addition, the essential navigational information including the electronic chart, L/L, COG, SOG, STW, etc., can be shared in the network.



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S-band antenna

10 ft antenna
(12 ft also available)

FAR-2137S-BB: *S-band, 30 kW, TR up*

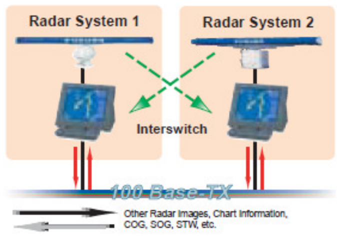
X-band antenna

8 ft antenna
(4 or 6.5 ft also available)

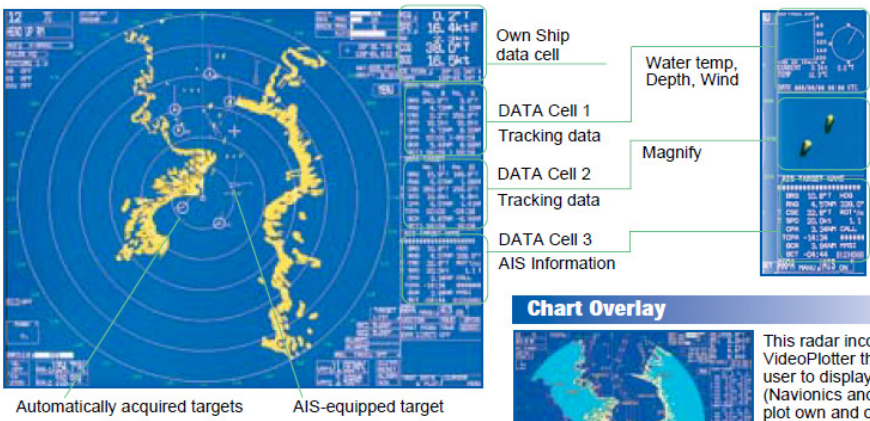
FAR-2117-BB: *X-band, 12 kW, TR up*
FAR-2127-BB: *X-band, 25 kW, TR up*

100 Base-TX Ethernet Network System

The radar can be connected to an Ethernet network for a variety of user requirements. Each of X- and S-band radars can be interconnected without requiring extra options. Up to four radar sets can be interchanged in the network. In addition, the essential navigational information including the electronic chart, L/L, COG, SOG, STW, etc., can be shared in the network.



AIS/ARPA



A variety of navigational information, own ship status, radar plotting data, wind, water temperature and information from other shipborne sensors are displayed in the cells.

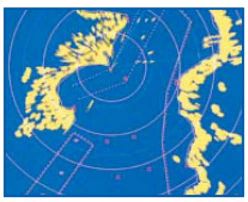
Chart Overlay

This radar incorporates a VideoPlotter that allows the user to display electronic charts (Navionics and Furuno Charts), plot own and other ship's track, enable entry of waypoints/ routes, and make a radar map. A chart may be overlaid with the radar image. Optional card reader required.

Target Trails

The target trails feature generates monotone or gradual shading afterglow on all objects on the display. This feature is useful to show own ship movement and other ship tracks in a specific fishing operation. The trail time is adjustable at 30 seconds intervals or continuous.

Radar Map



Up to 200 waypoints and up to 30 routes can be stored. Each route may contain up to 30 waypoints. A radar map is a combination of map lines and marks. The radar map has the capacity of 20,000 points for lines and marks.

SPECIFICATIONS OF FAR-21x7-BB Series

Antenna Radiators
1. Type Slotted waveguide array
2. Beamwidth and sidelobe attenuation

	X-Band			S-Band	
Radiator Type	XN-12AF	XN-20AF	XN-24AF	SN-30AF	SN-36AF
Length	4 ft	6.5 ft	8 ft	10 ft	12 ft
Beamwidth(H)	1.9°	1.23°	0.95°	2.3°	1.8°
Beamwidth(W)	20°	20°	20°	25°	25°
Sidelobe (within ± 10°)	-24 dB	-28 dB	-28 dB	-24 dB	-24 dB
Sidelobe (outside ± 10°)	-30 dB	-32 dB	-32 dB	-30 dB	-30 dB

S-band 10 ft radiator usable for a HSC

3. Rotation

X-Band

Rotation	24 rpm	42 rpm
Gear Box	RSB-096	RSB-097

S-Band

Rotation	21/26 rpm		45 rpm		
Gear Box	RSB-098	RSB-099	RSB-100	RSB-101	RSB-102

RF Transceiver
1. Frequency
   X-band: 9410 MHz ± 30 MHz
   S-band: 3050 MHz ± 30 MHz
2. Output power

	FAR-2117	FAR-2127	FAR-2137S
Output Power	12 kW	25 kW	30 kW
Transceiver	RTR-078	RTR-079	RTR-080

3. Pulselength/PRR

Range scale (nm)	Pulselength (μs)	PRR (Hz)
0.125, 0.25	0.07	3000
0.5	0.07, 0.15	3000
0.75, 1.5	0.07, 0.15, 0.3	3000, 1500
3	0.15, 0.3, 0.5, 0.7	3000, 1500, 1000
6	0.3, 0.5, 0.7, 1.2	1500, 1000, 600
12, 24	0.5, 0.7, 1.2	1000, 600
48, 96	1.2	600

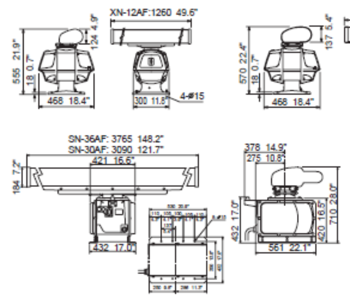
4. I.F. 60 MHz, Logarithmic
5. Bandwidth
   Short pulse: 40 MHz
   Middle pulse: 10 MHz
   Long pulse: 3 MHz

Radar Display
1. Display Unit (Locally arranged)
   Type: Non-interlaced, Multi-sync monitor (DVI-D)
   Resolution SXGA (1280 x 1024 pixels)
2. Range scales and ring intervals (nm)
   Range: .125, .25, .5, .75, 1.5, 3, 6, 12, 24, 48, 96
   Ring: .025, .05, .1, .25, .25, .5, 1, 2, 4, 8, 16
3. Minimum range 30 m on 0.75 nm range scale
4. Range discrimination 30 m on 0.75 nm range scale
5. Range ring accuracy +0.2 %
6. Presentation modes Head-Up, Course-Up, North-Up, North-Up TM
7. ARPA
   Acquisition: 100 targets
   Tracking: Automatic tracking of all acquired targets in 0.1 to 32 nm
8. AIS Display (Data input from AIS is required)
   Targets: 1,000 targets

Power Supply (specify when ordering)
1. Processor Unit
   24 VDC or 115/230 VAC, 1ø, 50/60 Hz,
   7.6 A (FAR-2117-BB: 24 rpm at 24 VDC),
   8.8 A (FAR-2127-BB: 24 rpm at 24 VDC)
   440 VAC, 1ø, 50/60 Hz with RU-1803
2. Antenna Unit
   FAR-2137S-BB:
   200 VAC, 3ø, 50 Hz; 220 VAC, 3ø, 60 Hz; 380 VAC, 3ø, 50 Hz;
   440 VAC, 3ø, 60 Hz; 110 VAC, 3ø, 60 Hz with RU-5693;
   220 VAC, 3ø, 50 Hz with RU-6522;
   440 VAC, 3ø, 50 Hz with RU-5466-1

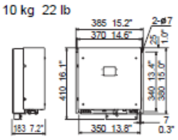
EQUIPMENT LIST
Standard
1. Processor Unit RPU-013 — 1 unit
2. Control Unit RCU-014 or Trackball Control Unit RCU-015 (Specify when ordering) — 1 unit
3. Antenna Unit with cable, 15/30/40/50 m — 1 pc
4. Power Supply unit PSU-007 for FAR-2137S — 1 unit
5. Standard Spare Parts and Installation Materials

Option
1. Performance Monitor PM-31 for X-band, PM-51 for S-band
2. Remote Control Unit RCU-016
3. Gyro Interface GC-10
4. DVI-Analog RGB Conversion Kit OP03-180
5. RGB Connector DSUB-BNC-1 (for VDR)
6. Chart/Memory Card Interface Unit CU-200-FAR
7. Transformer RU-1803/5466-1/5693/6522
8. Rectifier RU-3424/1746B
9. Junction Box RJB-001 (for expanded antenna cable, 100-300 m)
10. Antenna Cable RW-9600
11. Switching Hub HUB-100

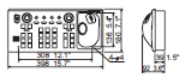
Antenna Unit


XN12AF:	33 kg	73 lb
XN-20AF:	39 kg	86 lb
XN-24AF:	42 kg	93 lb
SN-30AF:	135 kg	298 lb
SN-36AF:	142 kg	313 lb

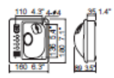
Processor Unit RPU-013
10 kg 22 lb

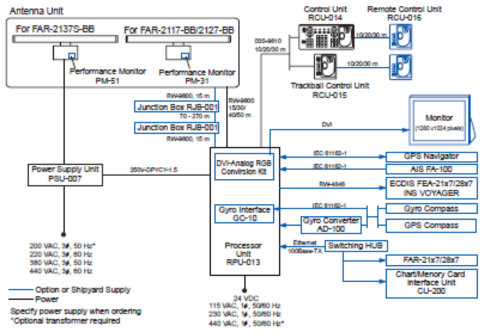


Control Unit RCU-014
3.7 kg 8.2 lb



Trackball Control Unit RCU-015
2.4 kg 5.3 lb



INTERCONNECTION DIAGRAM


SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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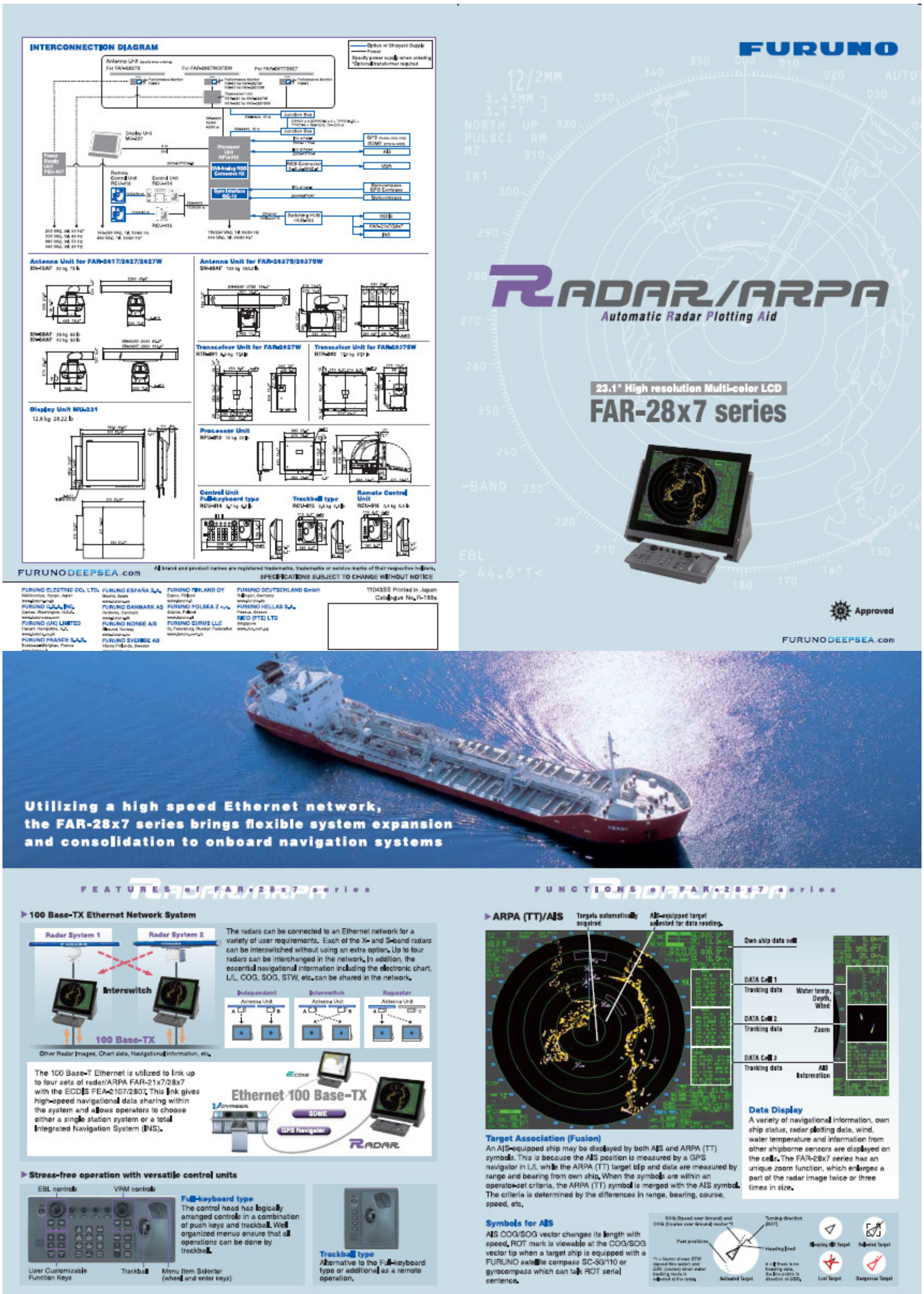
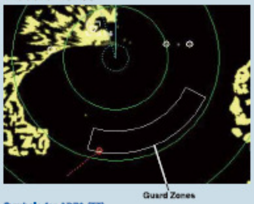

FURUNO
RADAR/ARPA
Automatic Radar Plotting Aid
23.1" High resolution Multi-color LCD
FAR-28x7 series
Approved
FURUNODEEPSEA.com
INTERCONNECTION DIAGRAM
Display Unit MU-231
Processor Unit
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
Utilizing a high speed Ethernet network, the FAR-28x7 series brings flexible system expansion and consolidation to onboard navigation systems
FEATURES of FAR-28x7 series
100 Base-TX Ethernet Network System
Radar System 1
Radar System 2
Interswitch
100 Base-TX
Other Radar Images, Chart data, Navigational information, etc.
The radars can be connected to an Ethernet network for a variety of user requirements. Each of the X- and S-band radars can be interswitched without using an extra option. Up to four radars can be interchanged in the network. In addition, the essential navigational information including the electronic chart, L/L, COG, SOG, STW, etc. can be shared in the network.
Independent
Interswitch
Repeater
Antenna Unit
The 100 Base-T Ethernet is utilized to link up to four sets of radar/ARPA FAR-21x7/28x7 with the ECDIS FEA-2107/2807. This link gives high-speed navigational data sharing within the system and allows operators to choose either a single station system or a total Integrated Navigation System (INS).
Ethernet 100 Base-TX
SDME
GPS Navigator
RADAR
Stress-free operation with versatile control units
EBL controls
VRM controls
User Customizable Function Keys
Trackball
Menu Item Selector (wheel and enter keys)
Full-keyboard type
The control head has logically arranged controls in a combination of push keys and trackball. Well organized menus ensure that all operations can be done by trackball.
Trackball type
Alternative to the Full-keyboard type or additional as a remote operation.
FUNCTIONS of FAR-28x7 series
ARPA (TT)/AIS
Targets automatically acquired
AIS-equipped target selected for data reading.
Own ship data cell
DATA Cell 1
Tracking data
Water temp. Depth, Wind
DATA Cell 2
Tracking data
Zoom
DATA Cell 3
Tracking data
AIS Information
Target Association (Fusion)
An AIS-equipped ship may be displayed by both AIS and ARPA (TT) symbols. This is because the AIS position is measured by a GPS navigator in L/L while the ARPA (TT) target blip and data are measured by range and bearing from own ship. When the symbols are within an operator-set criteria, the ARPA (TT) symbol is merged with the AIS symbol. The criteria is determined by the differences in range, bearing, course, speed, etc.
Data Display
A variety of navigational information, own ship status, radar plotting data, wind, water temperature and information from other shipborne sensors are displayed on the cells. The FAR-28x7 series has an unique zoom function, which enlarges a part of the radar image twice or three times in size.
Symbols for AIS
AIS COG/SOG vector changes its length with speed. ROT mark is viewable at the COG/SOG vector tip when a target ship is equipped with a FURUNO satellite compass SC-50/110 or gyrocompass which can talk ROT serial sentence.
Past positions
Heading line
Activated Target
Lost Target
Dangerous Target

FUNCTIONS of FAR-28x7 series — RADAR/ARPA

▶ Guard Zones



Automatic Acquisition Zone
Two automatic acquisition zones may be set in a sector or any form. They also act as suppression zones, avoiding unnecessary overloading to the processor and clutter by disabling automatic acquisition and tracking outside them. Targets in an automatic acquisition zone are shown with an inverse triangle. The operator can manually acquire important targets without restriction.

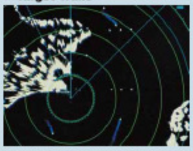
Guard Zones and Anchor Watch Zone
Guard Zones generate visual and audible alarms when targets enter the operator set zones. One of the Guard Zones may be used as an anchor watch to alert the operator when own ship or targets drift away from the set zone.

CPA Alarm
The target tracking symbol changes to a triangle when its predicted course (vector) violates the operator set CPA/TCPA. The operator can readily change the vector lengths to evaluate the target movement trend.

Symbols for ARPA (TT)

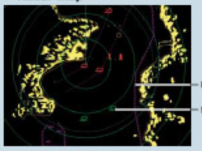
Past Position Display
The ARPA (TT) displays equally time-spaced dots marking the past positions of any targets being tracked. A new dot is added during preset time intervals until the preset number is reached. AIS also displays past position dots.

▶ Target Trails



The target trails feature generates a monotone or gradual shading afterglow on all objects on the display. The trails are useful in showing own ship movement and other ship tracks in a specific fishing operation. The unique feature in this radar is a choice of True or Relative mode in Relative Motion (only True in TM). When changing modes, trails remain on the screen.

▶ Radar Map

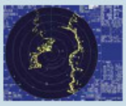


A radar map is a combination of lines and marks whereby the user can define and input the navigation area, route planning and monitoring data. The radar map can include up to 20,000 points for lines and marks. The map data can be saved to facilitate repeated use on a routine navigation area. Planned routes created on ECDIS can be transferred onto a radar display when interfaced with ECDIS.

▶ Chart Overlay

This radar incorporates a VideoPlotter that displays electronic charts, plots own and other ship's track, enables entry of waypoints/routes, and makes a radar map. The Radar targets are overlayed on the chart. (For non-SOLAS ships only)

▶ Presentation Colors

Antenna Radiators
1. Type Slotted waveguide array
2. Beamwidth and sidelobe attenuation

	X-Band			S-Band
Radiator Type	XN-12AF	XN-20AF	XN-24AF	SN-36AF
Length	4 ft	6.5 ft	8 ft	12 ft
Beamwidth(H)	1.9	1.23	0.95	1.8
Beamwidth(V)	20	20	20	25
Sidelobe (within 10°)	-24 dB	-28 dB	-28 dB	-24 dB
Sidelobe (outside 10°)	-30 dB	-32 dB	-32 dB	-30 dB

3. Rotation

X-Band		
Rotation	24 rpm	42 rpm
Gear Box	RSB-096/103	RSB-097
S-Band		
Rotation	21/26 rpm	45 rpm
Gear Box	RSB-098/099/104/105	RSB-100/101/102

RF Transceiver
1. Frequency
X-band: 9410 MHz 30 MHz
S-band: 3050 MHz 30 MHz

2. Output power

	FAR-2817	FAR-2827	FAR-2827W	FAR-2837S	FAR-2837SW
Output Power	12 kW	25 kW	25 kW	30 kW	30 kW
Transceiver	RTR-078	RTR-079	RTR-081	RTR-080	RTR-080

3. Pulselength/PRR

Range scale (nm)	Pulselength (s)	PRR (Hz)
0.125, 0.25	0.07	3000
0.5	0.07, 0.15	3000
0.75, 1.5	0.07, 0.15, 0.3	3000, 1500
3	0.15, 0.3, 0.5, 0.7	3000, 1500, 1000
6	0.3, 0.5, 0.7, 1.2	1500, 1000, 600
12, 24	0.5, 0.7, 1.2	1000, 600
48, 96	1.2	600

4. I.F. 60 MHz, Logarithmic
5. Bandwidth Short pulse: 40 MHz
Middle pulse: 10 MHz
Long pulse: 3 MHz

RADAR DISPLAY
1. Display
23.1" color LCD (UXGA 1600 x 1280 pixels),
470 (H) x 353 (V) mm,
Effective display diameter: 341 mm
Echo Color: Yellow, green or white in 32 levels

2. Range scales and ring intervals (nm)

Range	.125, .25, .5, .75, 1.5, 3, 6, 12, 24, 48, 96
Ring	.025, .05, .1, .25, .25, .5, 1, 2, 4, 8, 16

3. Minimum range
22 m
4. Range discrimination
26 m
5. Range ring accuracy
Within ±1 % of the current range scale or 10 m, whichever the greater
6. Presentation modes
Head-Up, Course-gyro, North-Up, Course-Up, True Motion (sea or ground stabilization)
7. Heading Information
GPS compass SC-60/110 is a recommended heading sensor as a backup for a gyrocompass. Confirm if your Administrations permit its use.
8. Parallel index lines
1, 2, 3 or 6 lines (menu selectable)
9. Radar map
20,000 points to create coastlines, own ship safety contour, isolated underwater dangers, buoys, traffic routing systems, prohibited areas and fairways as required by IMO.

Target Tracking
1. Acquisition
Auto or manual acquisition: 100 targets in 0.2-24 (32) nm
2. Tracking
Auto tracking on all acquired targets
3. Guard zone (Target Acquisition Area)
0.5 nm width sector, within 3-6 nm, desired bearing
1 nm width sector or polygon, desired range and bearing
4. Past positions
5 or 10 past positions on all targets
5. Collision warning
CPA Limit: 0.1-20 nm, TCPA Limit: 1-60 minutes
6. Trial maneuver
Dynamic or static, with selected delay time.

AIS FUNCTIONS (Data input from AIS is required)
1. Number of Targets
1,000 targets max.
2. Past Position Plot Intervals
OFF, 30 s, 1-60 minutes

POWER SUPPLY (specify when ordering)
1. Processor Unit
FAR-2817
100-115 VAC: 2.6 A (3.0 A for HSC), 220-230 VAC: 1.6 A (1.7 A for HSC), 1 ø, 50/60 Hz
FAR-2827
100-115 VAC: 3.0 A (3.4 A for HSC), 220-230 VAC: 1.8 A (1.9 A for HSC), 1 ø, 50/60 Hz
FAR-2827W
100-115 VAC: 3.2 A, 220-230 VAC: 1.6 A, 1 ø, 50/60 Hz
FAR-2837S/2837SW
100-115 VAC: 3.0 A, 220-230 VAC: 1.5 A, 1 ø, 50/60 Hz
2. Display Unit
100-230 VAC, 0.9 A, 1 ø, 50/60 Hz
440 VAC, 1 ø, 50/60 Hz with optional transformer RU-1803
3. Antenna Unit
FAR-2837S/2837SW:
200 VAC, 3.0 A, 3ø, 50 Hz; 220 VAC, 3.0 A (3.5 A for HSC*), 3ø, 60 Hz; 380 VAC, 1.5 A, 3ø, 50 Hz; 440 VAC, 1.5 A (1.7 A for HSC*), 3ø, 60 Hz
* for FAR-2837S only
110 VAC, 3ø, 60 Hz with RU-5693; 220 VAC, 3ø, 50 Hz with RU-6522; 440 VAC, 3ø, 50 Hz with RU-5466-1

EQUIPMENT LIST
Standard
1. Display Unit MU-231
2. Processor Unit RPU-013
3. Full-keyboard Control Unit RCU-014
   Trackball Control Unit RCU-015
   (Specify when ordering)
4. Antenna Unit with cable (15/30/40/50 m)
5. Power Supply Unit PSU-007 for FAR-2837S
6. Standard Spare Parts and Installation Materials

Option
1. Performance Monitor PM-31 for X-band, PM-51 for S-band
2. Remote Control Unit RCU-016
3. Gyro Interface GC-10
4. DVI-Analog RGB Conversion Kit OP03-180 (SXGA output)
5. RGB Connector DSUB-BNC-1 (for VDR)
6. Memory Card Interface Unit CU-200
7. Transformer RU-1803/5466-1/5693/6522
8. Rectifier RU-3424/1746B
9. Junction Box RJB-001
10. Antenna Cable RW-9600
11. Hand Grip FP03-09840
12. Bracket FP03-09820
13. Switching Hub HUB-100

FURUNO

SPECIFICATIONS

Radar/ARPA

FAR-28x7 series

Display Unit	23.1" color LCD, UXGA (1600 x 1200 pixels)
ARPA	100 targets (manually 50, automatically 50)
AIS	1000 targets
Data from ECDIS	Planned route, User customizable chart, Pilot data
Other Functions	Performance monitoring, Interswitched up to four sets of X- and S-band radar by menu operation, Echo trail

ECDIS

FEA-2107/2807

Display Unit	FEA-2107: 20.1" color LCD, SXGA (1280 x 1024 pixels) FEA-2807: 23.1" color LCD, UXGA (1600 x 1200 pixels)
Usable Charts	IHO/S-57 ed3 vector chart, ARCS raster chart, C-MAP CM93 ed3* (* available in the near future)
Voyage Calculation	Range/Bearing to destination, TTG, ETA, Fuel consumption
Route Navigation Monitoring	Off track, Waypoint, Arrival, Grounding, Depth
Other functions	Nighttime/daytime display, ARPA/AIS target display, Radar overlay, User chart, Position optimization, MOB, Log book, Pilot data, Track control system (TCS)*

* Please contact the local dealers in your area for details.

Conning Information Display

Display Unit	Choice of 20.1" or 23.1" color LCD, SXGA (1280 x 1024 pixels)
Display of navigational information	Planned route, Waypoint data, Ship's Speed, Heading, Rudder angle, Rate of turn, Wind speed/direction, Depth, Propeller rpm/pitch, Thruster status

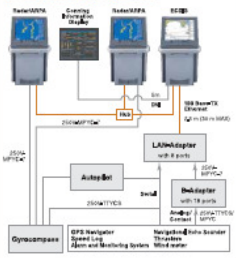
Track Control System

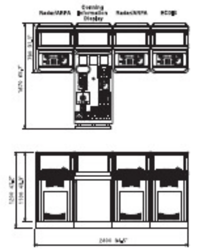
Tracking function	Automatic Waypoint approach maneuver planned by ECDIS, Automatic turning by dedicated radius
Alarms	Off-track, Off-course

Steering

Manual steering, Heading control system (Automatic track control), Waypoint approach maneuver, Track control system, Radar/ARPA approach maneuver.

INTERCONNECTION DIAGRAM





The dimensions vary depending on the system configuration

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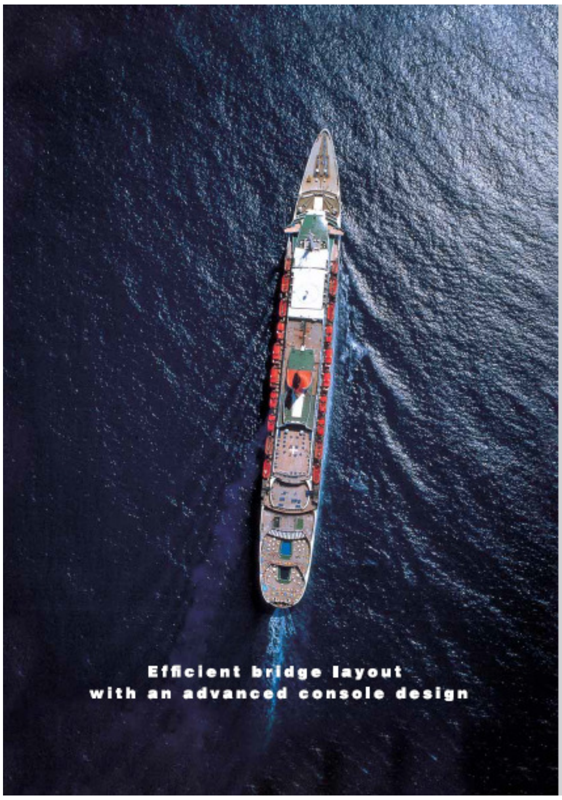
Catalogue No. L-180c
100PDF Printed in Japan

VOYAGER
Integrated Navigation System

FURUNODEEPSEA.com



FURUNO's navigation equipment is designed to fully meet the latest standards set by IMO, IEC, ISO and other international industrial organizations. All FURUNO equipment is developed by our unparalleled R & D Department, which is staffed with the premier engineers in the marine electronics industry. Their expertise in the fields of sensor devices and software development allows FURUNO to construct equipment that is reliable and will perform in a variety of environmental conditions.

Working from this technological foundation, FURUNO's integrated navigation system (INS VOYAGER) was created. The system consists of a Radar/ARPA*, an ECDIS** and an autopilot to facilitate the Track Control System. All of these components fully comply with the latest standards set by the IMO and IEC.

VOYAGER's streamlined design matches modern cruise ships, super yachts and other ocean-going commercial vessels. With its sleek design, VOYAGER can fit right into the most up-to-date bridge area where the operation of the vessel is performed. A simple but efficient bridge layout allows for all of the navigation information to be easily accessible.

VOYAGER's unparalleled navigation system employs seamless operational control throughout the entire system, as if it were a single device.

* ARPA: Automatic Radar Plotting Aid
** ECDIS: Electronic Chart Display and Information System

VOYAGER
Integrated Navigation System

FURUNO's software interface makes operating the entire system seamless

FEATURES of VOYAGER

Streamlined route planning

The ECDIS FEA-2107/FEA-2807, which come with the standard configuration of VOYAGER, fully meets the quality standards set by IMO and IEC. This is compatible with an ENC (S57 Edition 3) chart, an ARCS chart and C-MAP CM93 ed3 and C-MAP CM-ENC.

The operators can conduct route planning, while taking into account the waypoints and destinations shown on the screen. Its sophisticated screen layout and graphic processing techniques allow the operator to observe the performance of all the functions including the route planning. Moreover, the ECDIS can share navigation information with radar and vice versa. The planned routes produced in the ECDIS can be transferred onto the radar screen, and the electronic chart can be overlaid with the data from radar.

Comfortable and intuitive operation

The ergonomic design of the control panel of VOYAGER provides comfortable operation. The whole operation of the system can be done solely with the use of the trackball and the thumbwheel.

Networked information handling

Thanks to its up-to-the-minute data communications technology, VOYAGER offers the possibility of interswitching radar images amongst the radar networked within the system. Also, it enables the radar and ECDIS to share a variety of navigation information obtained from a variety of navigation sensors.

The Ethernet-based network offers enhanced stability in data management. It also streamlines the wiring of the whole system, hence simplifying installation and maintenance.

Track Control System permits automatic navigation

VOYAGER features the Track Control System through the combination of ECDIS and an autopilot. The Track Control System enables the automatic navigation to the destination in a variety of situations ranging from sailing through narrow straits to ocean-crossing. This has been achieved with the help of flexible steering control together with route-planning in minute detail. Moreover, area data for possible danger as well as important warning for navigation can be registered in the system. Important information can be displayed before the vessel reaches the areas.

A variety of navigation information including vessels' heading, rate of turn, planned route and drift is graphically displayed on the conning screen. Waypoint data and navigational warnings are also shown on the screen.

Module design facilitates flexible installation

VOYAGER is a combination of individual modules comprising of radar, ECDIS, etc. Therefore, the system configuration can be customized for almost any bridge environment. VOYAGER can be installed on both existing and newly built vessels.

Its streamlined design makes it ideal for an operation-oriented bridge area.

X-/S-band radar with TT function

The FAR-28x7 series radar, which utilizes a high-definition UXGA LCD, is employed in VOYAGER. Whether it is X-band or S-band radar, the FAR-28x7 series provides a sharp and clear presentation of radar images, TT and AIS symbols and markers.

With the latest signal processing technology, a variety of functions including: the echo trail, echo stretch and anti-clutter rain/sea are available. These functions allow the operator to observe the targets' movement in different sea conditions, and assist the operator in obtaining even the smallest of the targets.

Bridge Navigational Watch Alarm System (BNWAS)

BNWAS can be incorporated into VOYAGER INS to monitor fitness of Officer of the Watch (OOW). Also, it can collectively monitor the status of the bridge equipment as well as various navigation alarms to help facilitate safety and efficiency at seas.

FUNCTIONS of VOYAGER

ECDIS (Electronic Chart Display and Information System)

- Fully complies with standards by IMO/IEC
- Compatible with ENC (IHO S57 Edition 3), ARCS chart and C-MAP CM93 ed3*
  * available in the near future
- User-updateable chart plotting
- Radar image overlay
- Presents data from ARPA and AIS
- Track Control System when connected with autopilot

RADAR/ARPA (Automatic Radar Plotting Aid)

- Fully meets the standards set by IMO/IEC
- Plots and tracks* up to 100 targets
  * Target tracking is conducted both manually and automatically.
- Displays up to 1,000 AIS targets
- Sets up the specific guard zones
- Various alarm functions to alert of hazardous objects, objects entering the guard zones as well as CPA and TCPA
- Displays the data from ECDIS such as the planned routes and user charts and others
- Enhanced detection capability for the targets in the short range, thanks to the most up-to-the-minute signal processing technology

Conning Information Display

- Works out the precise position of the vessels through the data from a Gyrocompass, positioning equipment and Speed and Distance Measuring Equipment.
- The heading and rate of turn can be input and displayed
- Navigation mode and berthing mode

Route planning / Route monitoring

- Track Control System using combination of ECDIS and autopilot
- Flexible route planning in minute detail
- Optimization of the routes taking into account the running cost
- Pilot data display
- Antigrounding alarm function

Bridge Navigational Watch Alarm System BR-500/1000

BR-1000 BNWAS

- Meets IMO resolution MSC.128(75) for "Bridge Navigational Watch Alarm System"
- Collectively manages and presents the alarm information on the display unit
- Alarm information is sorted and displayed according to the set priority
- Watch Safety System to monitor the watch officer's presence to minimize failure at avoiding approaching danger
- Transmits alarm to the backup officer in accommodation, if watch officer fails to respond to the active alarm or emergency call

RADAR/ARPA | Conning Information Display | RADAR/ARPA | ECDIS

VOYAGER offers a multitude of functions that solidly support navigation safety

ARPA

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.

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.

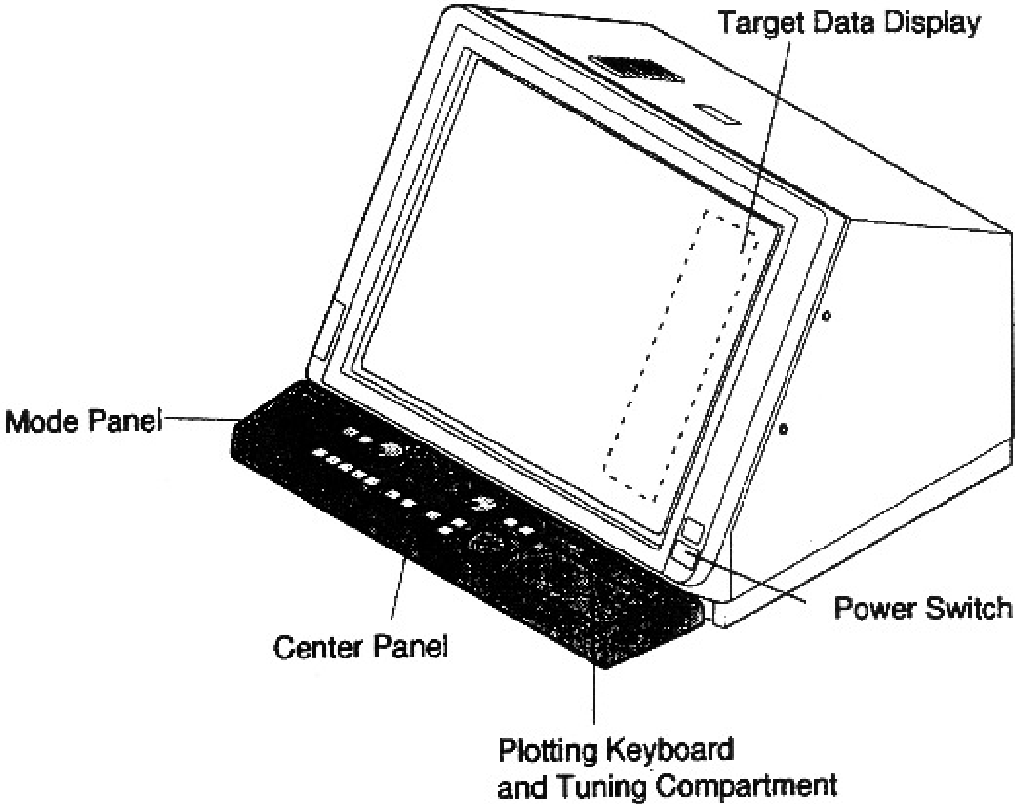
ARPA DISPLAY

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 rasterscan 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

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.

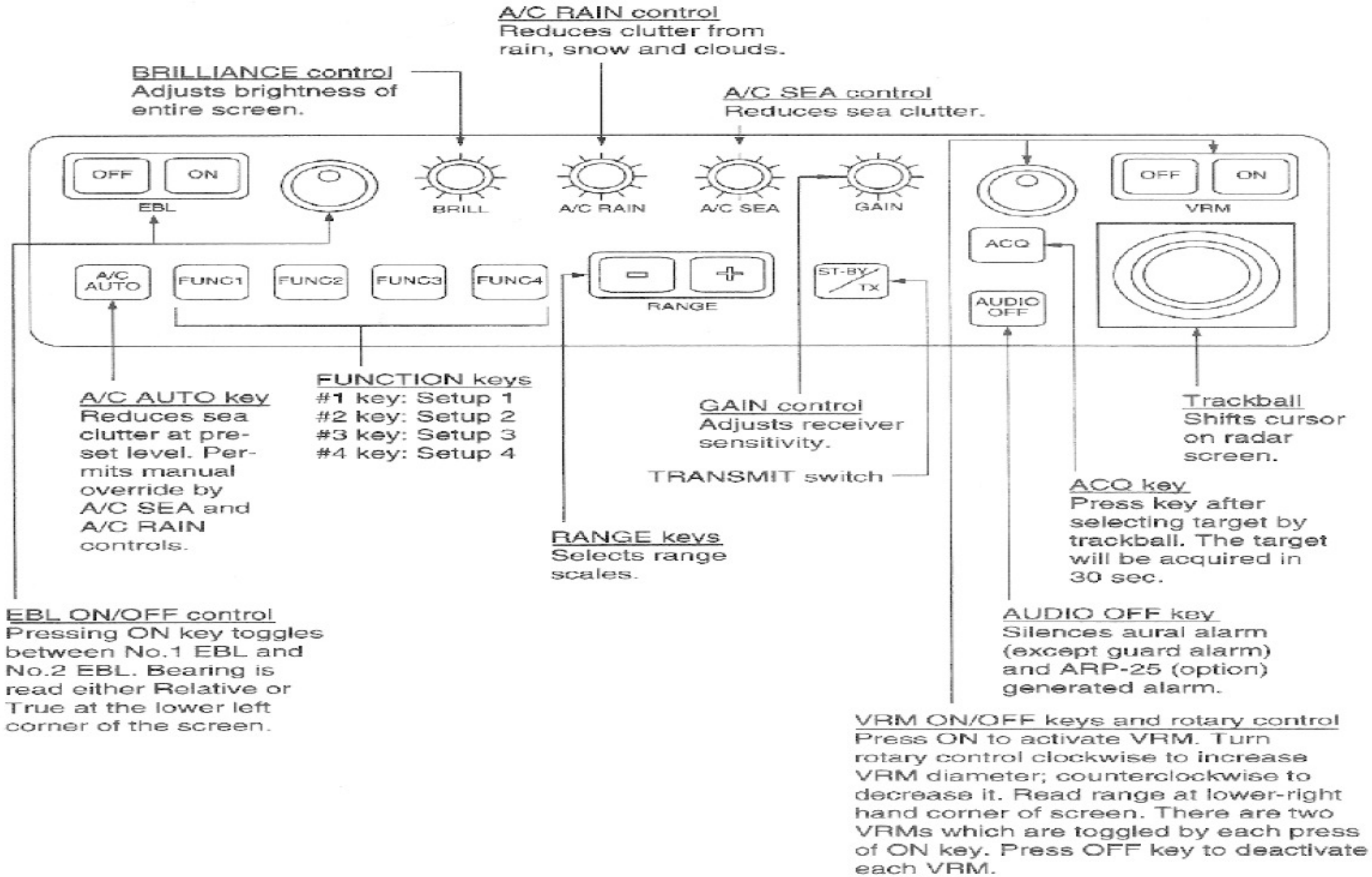
General Features

• 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

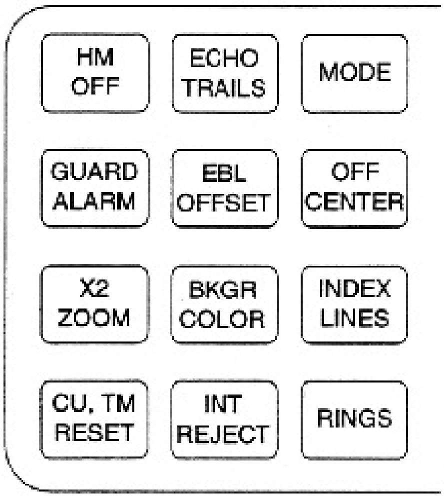
• Acquires up to 20 targets automatically
• Movement of tracked targets shown by true or relative vectors (Vector length 1 to 99 min. selected in 1 min steps)
• Setting of nav lines, buoy marks and other symbols to enhance navigation safety
• On-screen digital readouts of range, bearing, course, speed, 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

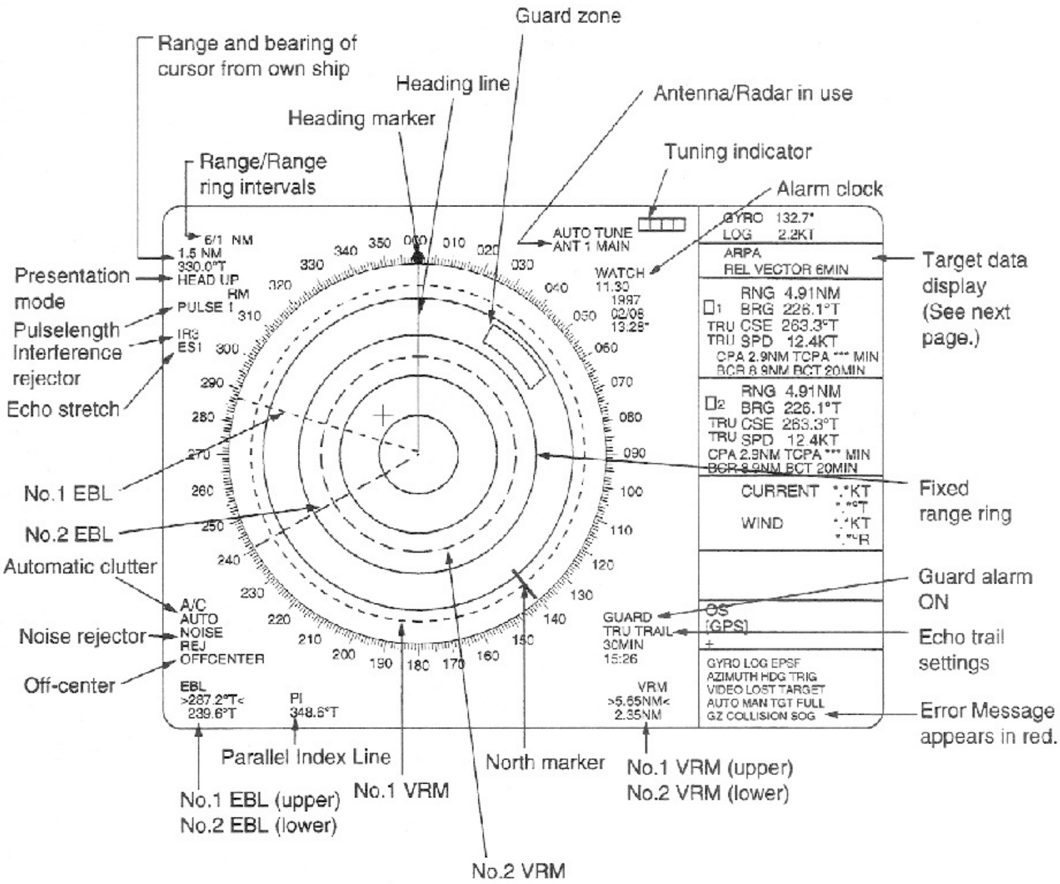


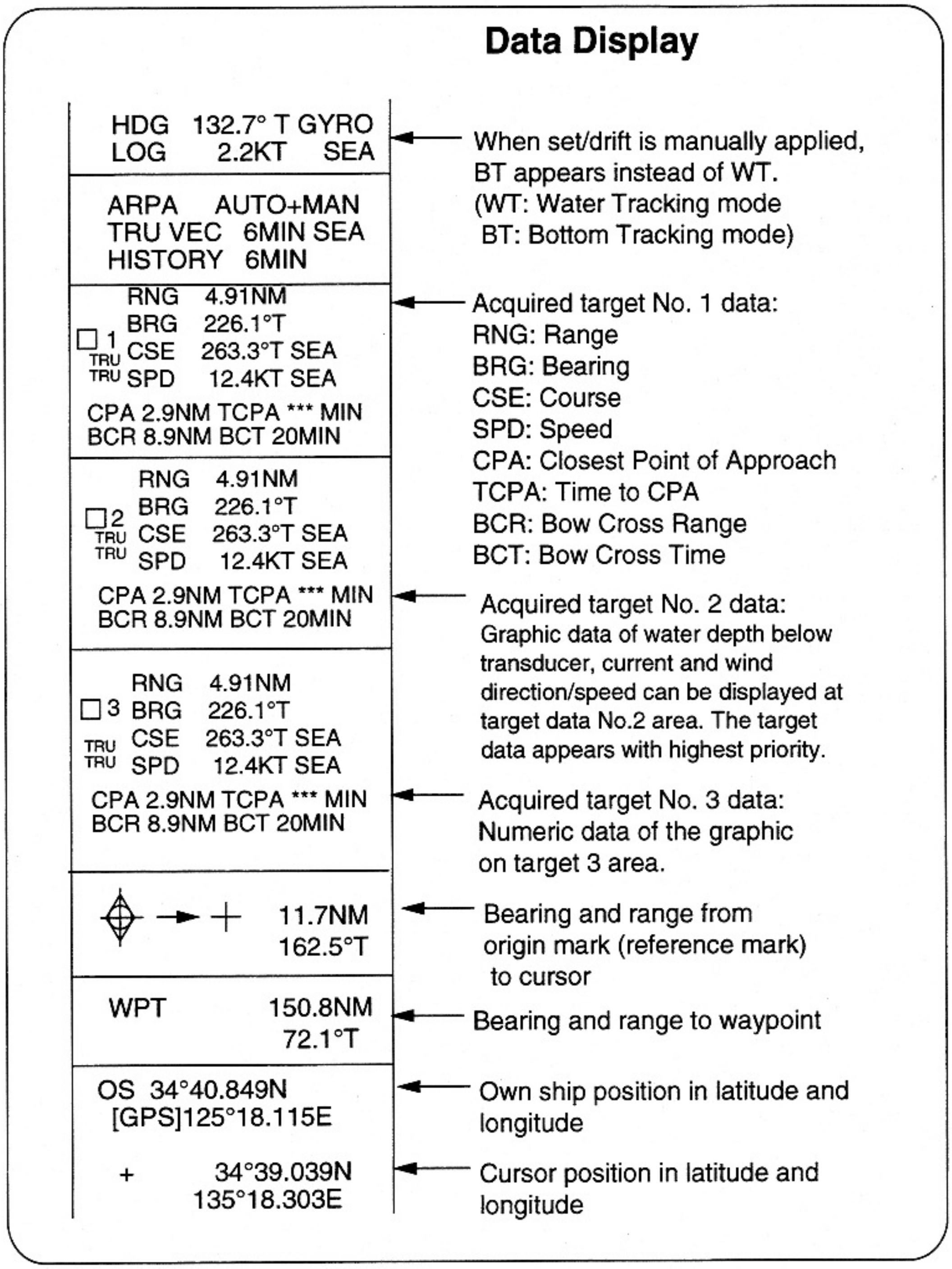
GAIN, A/C RAIN, A/C SEA and BRILL controls are of push-and-rotate type. Push in wanted switch lightly, and it will pop up. Rotate it to the wanted setting and push it in. The retracted position of the controls provides a better protection for water splash.

DISPLAY CONTROLS - 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.


Guard zone
Range and bearing of cursor from own ship
Heading line
Antenna/Radar in use
Heading marker
Tuning indicator
Range/Range ring intervals
Alarm clock
Target data display (See next page.)
Presentation mode
Pulselength
Interference rejector
Echo stretch
No.1 EBL
No.2 EBL
Fixed range ring
Automatic clutter
Guard alarm ON
Noise rejector
Echo trail settings
Off-center
Error Message appears in red.
Parallel Index Line
North marker
No.1 VRM (upper)
No.2 VRM (lower)
No.1 EBL (upper)
No.2 EBL (lower)
No.1 VRM
No.2 VRM



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 onscreen 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)

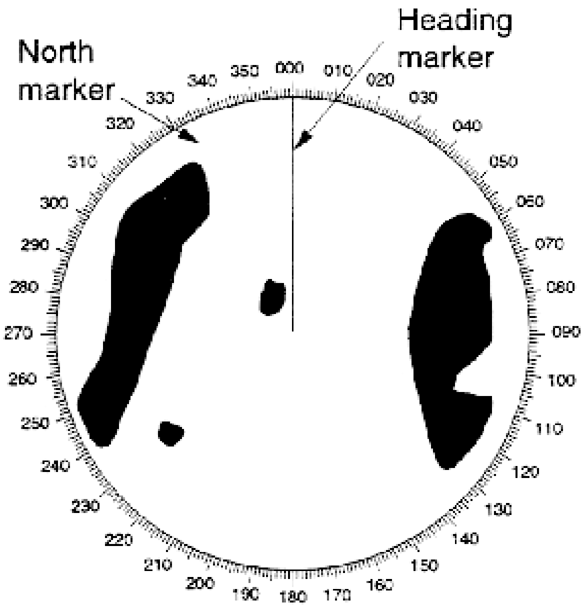
North-up: Ground or sea stabilized with compass and speed inputs

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.

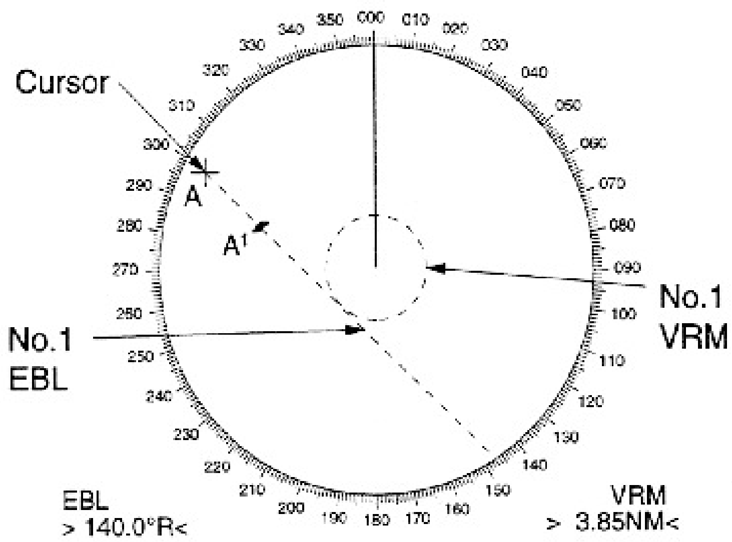
Loss of Gyro Signal: When the gyro signal is lost, the presentation mode automatically becomes head-up and the GYRO readout at the screen top shows asterisks(***.*). The message SET HDG appears at the upper of the screen. This warning stays on when the gyro signal is restored, to warn the operator that 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)



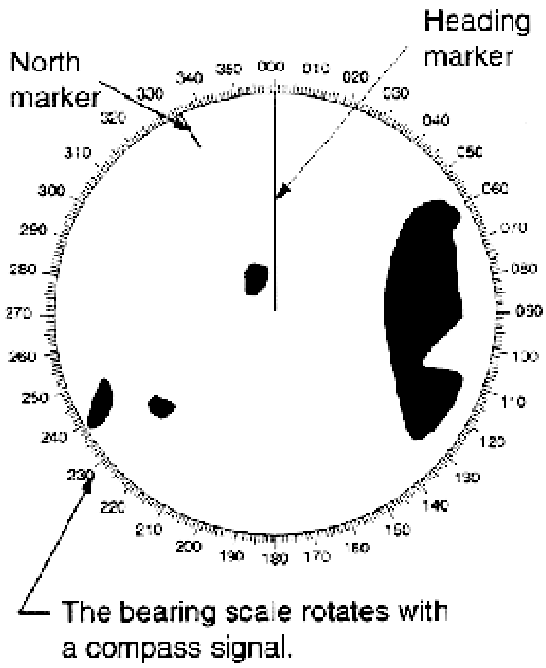
A display without azimuth stabilization in which the line connecting the center with the top of the display indicates own ship's heading.
The target pips are painted at their measured distances and in their directions relative to own ship's heading.
A short line on the bearing scale is the north marker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

Course-up Mode (Figure 5.8)



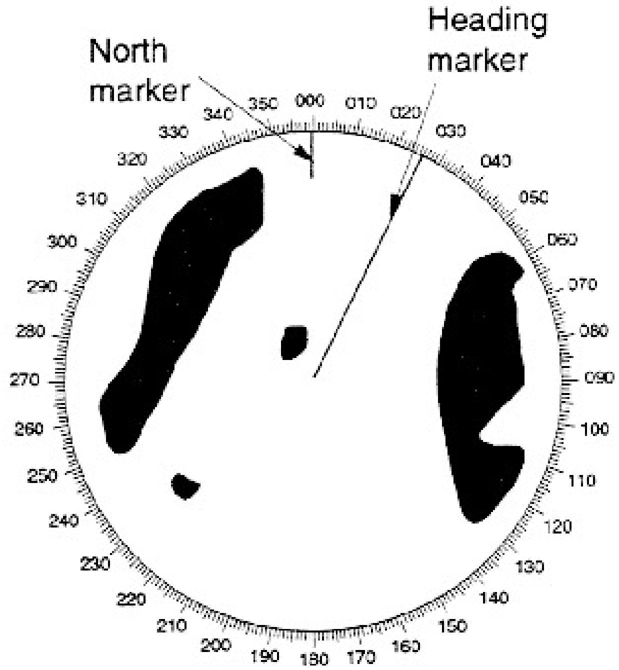
An azimuth stabilized display in which a line connecting the center with the top of the display indicates own ship's intended course (namely, own ship's previous heading just before this mode has been selected). Target pips are painted at their measured distances and in their directions relative to the 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.

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



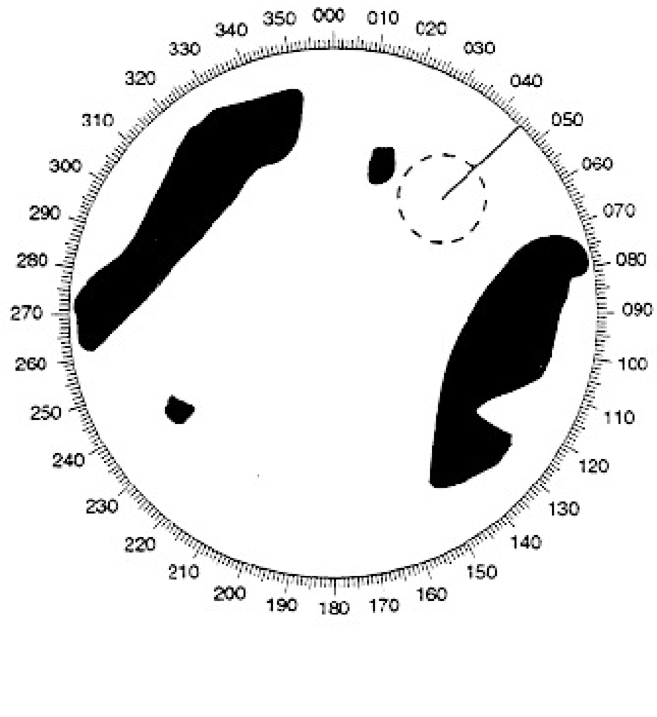
Radar echoes are shown in the same way as in the head-up mode. The difference from normal head-up presentation lies in the orientation of the bearing scale. The bearing scale is compass stabilized, that is, it rotates in accordance with the compass signal, enabling you to know own ship's heading at a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

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.

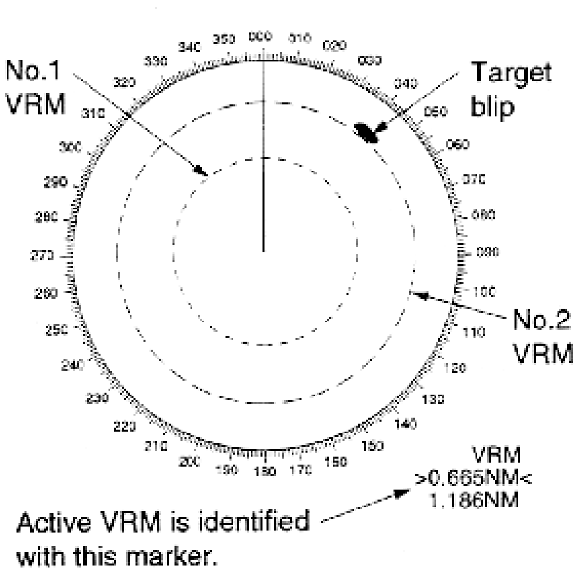
True Motion Mode (Figure 5.11)



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.

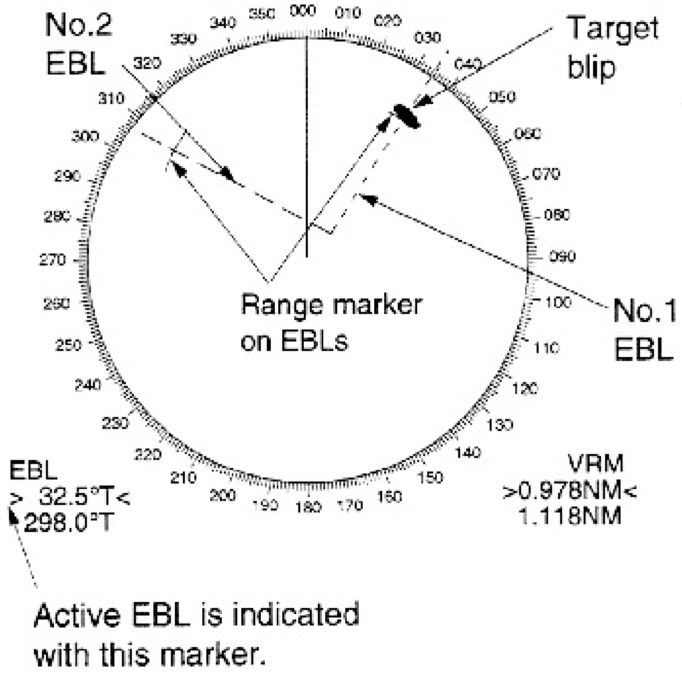
MEASURING THE RANGE (FIGURE 5.12)

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.



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 RANGEkey. 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.
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.

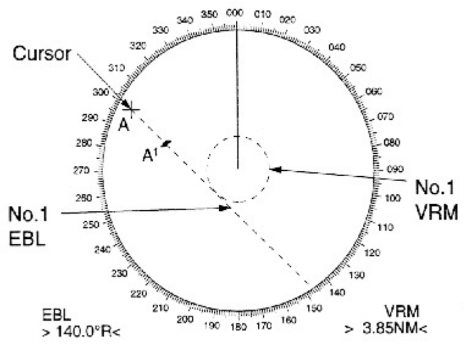


Figure 5.14 - Evaluating target ship's course and CPA in relative motion mode

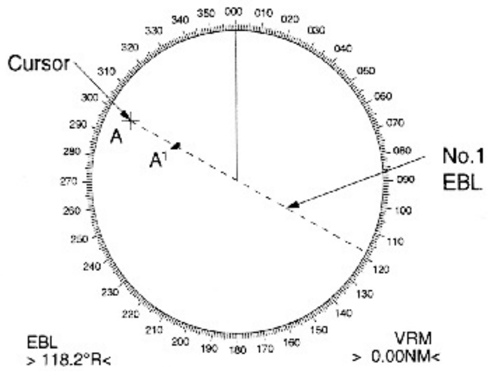


Figure 5.15 - Target ship on collision course

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.

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 10targets 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):

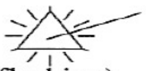
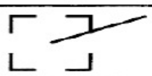
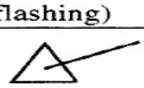
1. Press the E, AUTO PLOT MENU key to show the ARPA 1 menu.
2. Press the (2) key to select menu item 2 AUTO ACQ AREA.
3. Further press the (2) key to select (or highlight) menu option 3, 6 nautical miles.
4. Press the ENTER key to confirm your selection followed by the E, AUTO PLOT MENU key to close the ARPA 1 menu.

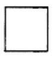
To set auto acquisition areas with trackball:

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.

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).

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).

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.

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.

INTEGRATED NAVIGATION SYSTEMS (INS)

MantaDigital™ Integrated Bridge Systems - At the forefront of navigation technology.

MantaDigital™ Multi-functionality

MantaDigital™ Bridges provides multi-function displays which are able to access information from any processor connected to the system. Each display can show ARPA, ECDIS, CAAS/HAP conning, AIS, VDR real time recording or auxiliary data from engine, fire or cargo control systems. TFT high resolution displays are available in 17" diagonal size (MANTA 1700), 20" diagonal size

MantaDigital™ provides wide-screen bridge operation with screen sizes of 20" and 26". It is available in pedestal, console and desktop mountings with a range of control options. It can provide the following functionality: Radar, Chart-Radar, ECDIS, Conning Display, Machinery/Engine Monitoring, BNWAS and alarm transfer system, Platform Management, DP and much more Bridge Features

Commercial Vessels

Navigation Solutions

With solutions ranging from complete integrated bridge packages to retrofit Radar aimed at vessels from cruise liners to fishing boats, Kelvin Hughes state of the art bridge equipment offers the ultimate in terms of performance and reliability. Mantadigital™ is at the core of our product range, this is a multi-function display platform which can host Radar, ECDIS and conning functionality on a wide-screen display surface. SharpEye™ solid-state Radar transceivers complete the picture giving the ultimate in radar performance combined with lowest through-life costs. The combination has to be the "best Radar in the world".

Combined with an unrivalled product offering, our global service network ensures that you can get the service you need wherever you need it.

We can supply the following solutions:

Radar - X-band, S-band both magnetron based and SharpEye™ based all using the MantaDigital™ wide-screen display platform.

ECDIS - The latest wide-screen ECDIS systems together with the ECDISplus equipment and data package designed to make ECDIS compliance easy...

VDR - Voyage data recorders for all types of vessels with options of fixed and float-free data storage options, replay kits and global Annual Performance Testing.

Integrated Bridge Systems - Design, manufacture and implementation of complete integrated bridge systems including the latest MantaDigital™ wide-screen workstation and SharpEye™ solid-state radar.

The radar display is often referred to as the **plan position indicator** (PPI). On a PPI, the sweep appears as a radial line, centered at the center of the scope and rotating in synchronization with the antenna. Any returned echo causes a brightening of the display screen at the bearing and range of the object. Because of a luminescent coating on the inside of the tube, the glow continues after the trace rotates past the target. On a PPI, a target's actual range is proportional to its distance from the center of the scope. A moveable cursor helps to measure ranges and bearings. In the "headingupward" presentation, which indicates relative bearings,

the top of the scope represents the direction of the ship's head. In this unstabilized presentation, the orientation changes as the ship changes heading. In the stabilized "north-upward" presentation, gyro north is always at the top of the scope.

Diffraction is the bending of a wave as it passes an obstruction. Because of diffraction there is some illumination of the region behind an obstruction or target by the radar beam. Diffraction effects are greater at the lower frequencies. Thus, the radar beam of a lower frequency radar tends to illuminate more of the shadow region behind an obstruction than the beam of a radar of higher frequency

or shorter wavelength.

Attenuation is the scattering and absorption of the energy in the radar beam as it passes through the atmosphere. It causes a decrease in echo strength. Attenuation is greater at the higher frequencies or shorter Wavelengths.

Refraction

If the radar waves traveled in straight lines, the distance to the radar horizon would be dependent only on the power output of the transmitter and the height of the

antenna. In other words, the distance to the radar horizon would be the same as that of the geometrical horizon for the antenna height. However, atmospheric density gradients

bend radar rays as they travel to and from a target. This bending is called refraction.

Factors Affecting Radar Interpretation

Radar's value as a navigational aid depends on the navigator's understanding its characteristics and limitations. Whether measuring the range to a single reflective object or trying to discern a shoreline lost amid severe clutter, knowledge of the characteristics of the individual radar used are crucial.

Marine radars are usually short range radars that are used by ships to pinpoint locations about other ships and land in the area. The **frequencies** with which these radars are operated are known as *x-band* or *s-band* frequencies. The *x* stands for secret, as the ship radar was mainly a hidden frequency while used for the purpose of tracking ship during the Second World War. The *s* stands for small range in the second type.

The Display