

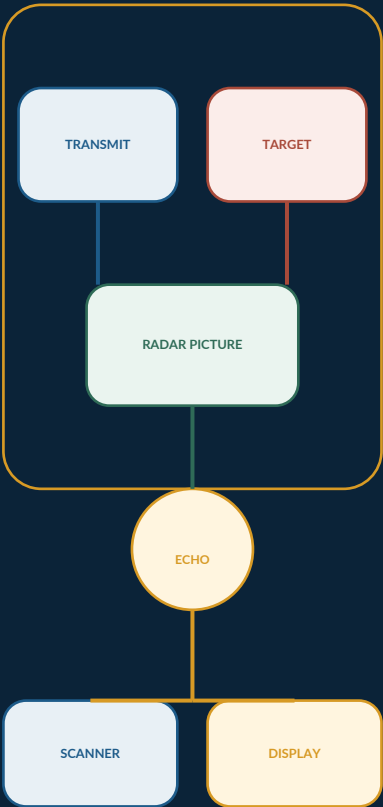
Understanding Radar

An owner's guide to radar detection,
tuning, target tracking and degraded operation

Radar is a physical sensor, not a database.
It detects reflected energy from land, vessels and weather.
Its value depends on installation, tuning, heading data
and a watchkeeper able to interpret an imperfect picture.

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Commercial thinking for private cruising.



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GUIDE OVERVIEW

What understanding radar are designed to do

Marine radar transmits radio energy, receives reflections and presents range and bearing information that can support collision avoidance, coastal navigation, weather awareness and position cross-checking.

SCOPE	This guide covers common pulse and solid-state yacht radar systems, including scanners, displays, heading and speed inputs, tuning controls, target tracking, blind sectors, networks and backup arrangements. It does not replace radar-navigation or collision-avoidance training.
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By the end of this guide, you should be able to:

- Trace the complete path from command or supply to the physical result.
- Identify the principal components, controls, protection and monitoring.
- Recognise common failure modes and early warning signs.
- Understand hidden dependencies and safe degraded operation.
- Ask better questions during purchase, survey, sea trial, refit and offshore preparation.

CORE PRINCIPLE	Radar should be treated as an independent observation tool and continuously compared with visual lookout, charts, AIS, depth and other available information.
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Safety

Radar scanners transmit radio-frequency energy and contain moving or high-energy components. Keep clear of the scanner, comply with safe-distance and service procedures, and isolate all power before work aloft or inside equipment.

SYSTEM ARCHITECTURE

How a radar return becomes a usable picture

The scanner transmits energy, receives echoes and passes processed information to a display. Heading, speed and position inputs then support stabilisation, overlays and target calculations.



Area	Why it matters	Owner focus
Transmission	The radar emits controlled radio energy through the scanner.	Know transmit status, warm-up or standby behaviour and scanner safety.
Reflection and reception	Objects return a small proportion of the transmitted energy.	Expect target strength to vary with material, shape, aspect, sea state and range.
Signal processing	Electronics separate useful echoes from noise and clutter.	Understand automatic and manual processing modes and their limitations.
Presentation	The display plots echoes by bearing and range and may add trails or vectors.	Use suitable range scale, orientation and brightness for the situation.
External inputs	Heading, speed, position and time support stabilisation and target tracking.	Confirm source validity before relying on overlays, vectors or true motion.

CORE PRINCIPLE	Radar detects reflections, not identity or intent. The watchkeeper must decide whether an echo represents land, a vessel, weather, sea clutter or interference.
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MAIN COMPONENTS

What owners should be able to identify

The installation should be traceable from scanner and transceiver to display, heading and speed inputs, network equipment, power supplies, breakers and any independent second radar.



Area	Why it matters	Owner focus
Scanner or antenna	Transmits and receives radio energy while rotating or electronically sweeping.	Mounting, rotation, water ingress, bearing noise, cable and blind sectors.
Transmitter and receiver	Create the signal and detect weak returned energy.	Operating hours, magnetron or solid-state status, alarms and service support.
Display and controls	Present the picture and allow tuning, ranging and target functions.	Keys, touchscreen, daylight visibility, software, cooling and source selection.
Heading and speed inputs	Stabilise the picture and support target vectors and overlays.	Source identity, alignment, latency, validity and independent comparison.
Power and network	Supply the scanner and carry radar data to one or more displays.	Breakers, cable routes, switches, connectors, essential supply and separation.

ACCESS AND LABELLING	A second display is not a second radar if both displays depend on one scanner, one network switch and one heading source.
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SYSTEM ARRANGEMENTS

Pulse, solid-state, X-band and different presentation modes

Radar technology and display modes affect start-up, target discrimination, long-range performance and how the picture responds to vessel movement.

PULSE RADAR
Magnetron or pulsed transmission

SOLID STATE
Broadband or pulse compression technology

RELATIVE MOTION
Own vessel remains fixed on the display

TRUE MOTION
Own vessel moves across chart-referenced picture

Area	Why it matters	Owner focus
Conventional pulse radar	Strong peak transmission and established long-range performance.	Warm-up, magnetron age, pulse length and service history.
Solid-state radar	Fast start, lower peak power and strong short-range discrimination.	Software, proprietary scanner compatibility and model-specific limitations.
X-band installation	Common yacht radar frequency with good target definition.	Rain and sea clutter can be significant; installation height affects horizon.
Relative-motion presentation	Shows target movement relative to own vessel.	Understand whether vectors are relative or true and what heading mode is active.
True-motion presentation	Shows own vessel moving over a stabilised reference.	Requires trustworthy position, heading and speed inputs and sensible reset limits.

PRACTICAL DISTINCTION	Newer radar technology can improve usability, but a well-installed and competently operated system matters more than the marketing label.
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OPERATION AND CONTROL

Tuning gain, sea clutter, rain clutter and range

Automatic controls are useful, but the watchkeeper should understand how to obtain a clear picture manually and how excessive filtering can remove real targets.

SELECT RANGE

Use several scales and look beyond the immediate area

SET GAIN

Raise sensitivity until background speckle appears

CONTROL CLUTTER

Reduce sea and rain echoes without erasing targets

CHECK TARGETS

Use EBL, VRM, trails and visual comparison

Area	Why it matters	Owner focus
Range scale	Controls displayed area and target detail.	Use more than one scale and avoid remaining zoomed too close or too far out.
Gain	Controls receiver sensitivity to weak echoes.	Too low removes targets; too high masks them in noise.
Sea-clutter control	Reduces returns from waves near the yacht.	Apply only enough suppression; small craft can disappear with aggressive settings.
Rain-clutter control	Reduces echoes from precipitation.	Rain may hide vessels behind it; compare settings and ranges.
EBL, VRM and guard zones	Support bearing, range and early warning.	Set deliberately, verify alarm coverage and continue visual and radar watch.

OPERATOR FOCUS	The strongest owner skill is being able to return the radar to a useful manual picture after automatic tuning has produced something misleading.
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DEPENDENCIES AND RESILIENCE

What can remove apparently independent capability

Radar capability may be lost or degraded by one shared power supply, network switch, heading sensor, GNSS source, display processor or scanner cable.

SHARED POWER
One bus or breaker
removes scanner and display

SHARED HEADING
One compass error affects
overlay and tracking

SHARED NETWORK
One switch or gateway
removes several displays

SHARED MOUNTING
One mast fire or damage
removes both scanners

Area	Why it matters	Owner focus
Heading source	Target bearings, overlays and vectors may depend on one compass.	Compare radar coastline and target bearings with independent heading.
Speed and position	True vectors and motion modes need valid own-ship movement data.	Know source, water or ground speed selection and low-speed limitations.
Electrical supply	Scanner, processor and display may share one distribution path.	Trace essential supply, UPS or emergency source and restart behaviour.
Network and software	Modern scanners may send all radar data through Ethernet and proprietary protocols.	Keep switch, cable, licence and software compatibility information.
Physical installation	One mast, arch or cable route may expose all sensors to fire, lightning or damage.	Assess separation and practical portable or second-system alternatives.

COMMON-MODE RISK	Radar redundancy should be judged by independent scanner, processing, power, heading and display paths - not by the number of screens.
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MONITORING AND NORMAL VALUES

Recognising a healthy radar picture and trustworthy target data

Useful evidence includes repeatable coastline shape, correct range and bearing, stable heading alignment, expected scanner behaviour and target vectors that agree with observation.

PICTURE QUALITY

Background noise, coastline and small target visibility

ALIGNMENT

Heading line and radar overlay agreement

TARGET DATA

Range, bearing, trail, CPA and TCPA behaviour

SCANNER STATUS

Rotation, temperature, alarms and output

Area	Why it matters	Owner focus
Coastline or buoy appears offset	Heading alignment, position, timing or chart-reference error.	Compare non-overlay radar, visual bearing and independent position.
Small targets appear and disappear	Range, gain, clutter, sea state, aspect or scanner fault.	Try manual tuning, alternate range and repeated scans.
Target vector changes implausibly	Own-ship heading or speed error, poor acquisition or manoeuvre.	Use raw range and bearing trend and continue visual assessment.
Scanner noise or intermittent rotation	Bearing, motor, cable, power or water-ingress problem.	Move to standby if overheating or abnormal mechanical behaviour develops.
Picture weakens over time	Magnetron ageing, radome contamination, low voltage or receiver deterioration.	Record comparable targets and arrange performance testing.

TREND, DO NOT GUESS

A radar picture should be compared with known land, buoys and visible vessels. Familiar reference targets make gradual deterioration easier to detect.

FAILURE AWARENESS

Common weaknesses and warning signs

Radar faults often begin with intermittent network loss, weak echoes, heading offsets, scanner noise, frozen pictures, repeated restarts or target tracking that no longer agrees with observation.

NO TRANSMIT
Power, warm-up, interlock
or transmitter fault

POOR PICTURE
Tuning, weather, scanner
or receiver problem

WRONG ORIENTATION
Heading or position
input fault

LOST TRACKING
Data, network or target
processing problem

Area	Why it matters	Owner focus
Scanner will not transmit or rotate	Power, interlock, motor, cable, software or transmitter fault.	Primary detection capability is lost.
Picture is weak or noisy	Low voltage, gain setting, water ingress, ageing transmitter or receiver fault.	Small and distant targets may be missed.
Heading line or overlay is misaligned	Compass error, installation offset, latency or network source change.	Bearings, overlays and tracked vectors become misleading.
Display freezes or loses scanner	Network switch, cable, software, processor or power fault.	A convincing stale picture may remain briefly visible.
Blind sector is larger than expected	New mast equipment, tender, crane or structural obstruction.	Targets can remain hidden in critical approach sectors.

**DO NOT NORMALISE
CHANGE**

A frozen or stale radar picture can be more dangerous than a blank screen because it may still look credible.
Confirm sweep, time and target movement.

FAILURE RESPONSE

Continuing safely after radar degradation or loss

The immediate response is to increase lookout, reduce speed and create sea room while switching to an independent radar or alternative observations.

RECOGNISE

Confirm blank, stale, misaligned or degraded picture

REDUCE RISK

Slow, post lookout and increase separation

SELECT BACKUP

Second radar, visual, AIS and navigation references

DECIDE

Continue, divert or wait for safer conditions

Area	Why it matters	Owner focus
Primary radar lost in clear weather	Use visual lookout, second radar if fitted and AIS as supporting information.	Treating AIS as a complete radar substitute.
Radar lost in fog or darkness	Reduce speed, increase sound and visual watch, use independent systems and consider stopping or diverting.	Continuing a confined approach at normal speed.
Heading input fails	Use head-up unstabilised radar and magnetic compass if the equipment permits.	Relying on overlay, true vectors or autopilot using invalid heading.
Picture becomes cluttered by weather	Use range, gain and clutter controls and compare both radars or frequencies where available.	Applying so much suppression that small craft disappear.
Scanner fault or abnormal heat/noise	Place in standby or isolate according to procedure and use the alternate system.	Repeatedly restarting a mechanically damaged scanner.

PROTECT THE WIDER YACHT

Loss of radar should change the operating plan. More lookout, lower speed and greater sea room are often more valuable than hurried troubleshooting.

TESTING AND DEMONSTRATION

Testing range, bearing, alignment and target tracking

A meaningful test uses known targets and sea-trial manoeuvres to demonstrate picture quality, alignment, range accuracy, tracking and independent operation.

STATIC CHECK

Power, scanner, controls
and source status

KNOWN TARGETS

Compare range and bearing
with chart and visual

SEA TRIAL

Turns, target tracking
and clutter response

FAIL / TRANSFER

Isolate source, display or
network under control

Area	Why it matters	Owner focus
Scanner and control test	Confirms standby, transmit, rotation and control response.	Does not prove detection performance at range.
Range and bearing check	Compares known fixed targets with expected position.	Use suitable references and account for antenna position.
Heading-line alignment	Shows whether radar bearing agrees with vessel heading.	Repeat after compass, mast or scanner work.
Target-tracking test	Shows acquisition, vectors, CPA and response during own-ship manoeuvre.	Use several targets and competent interpretation.
Independent-system test	Shows what remains after one scanner, display, network or power source is isolated.	Maintain safe navigation throughout the test.

MEANINGFUL EVIDENCE

A marina picture full of strong nearby echoes is not a complete performance test. Sea trial should include small, distant and moving targets.

MAINTENANCE STRATEGY

Keeping the scanner, data inputs and controls dependable

Maintenance should preserve clean and dry scanner hardware, secure mounting, sound cabling, stable power, accurate heading data and current software or service support.

SCANNER

Mounting, seals, motor and transmitter condition

CABLING

Power, network and connector integrity

NAV INPUTS

Heading, speed and position validity

SOFTWARE

Configuration, charts, licences and backups

Area	Why it matters	Owner focus
Radome or open array	Clean exterior, secure fasteners, sound seals and unobstructed rotation.	Protects output, bearing life and water exclusion.
Scanner internals	Motor, gearbox, magnetron or solid-state module and ventilation serviced as specified.	Maintains transmit and receive performance.
Power and network	Breakers, voltage, connectors, cable strain and switches inspected.	Prevents intermittent loss and resets.
Heading and speed sources	Alignment, source priority and validity checked after refit.	Protects overlays and target calculations.
Displays and software	Cooling, controls, configuration backup and compatible versions maintained.	Supports reliable operation and future replacement.

WORK TO REFER	Internal scanner repair, transmitter work, performance measurement aloft and radar-alignment commissioning should be completed by competent marine electronics specialists.
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RECORDS, SPARES AND SUPPORTABILITY

Preserving configuration, baseline performance and supportability

Useful records show scanner model and hours, software versions, heading offsets, blind sectors, target-test results, power architecture and the steps needed to restore configuration.

SYSTEM DRAWING

Scanner, display, power and network paths

BASELINE

Known target range, bearing and picture quality

CONFIGURATION

Heading offset, sources and display settings

SUPPORT

Parts, software, licence and technician details

Area	Why it matters	Owner focus
System and network diagram	Shows scanners, processors, displays, heading sources, switches and breakers.	Makes common dependencies visible.
Alignment and performance record	Known-target checks, offsets, blind sectors and sea-trial observations.	Provides a comparison when performance changes.
Configuration backup	Source priority, display setup, alarms and software settings.	Speeds recovery after reset or replacement.
Service history	Transmitter hours, scanner work, cable faults and software changes.	Supports condition and supportability decisions.
Selected spares and support	Fuses, network hardware, display power supply and supplier contacts as practical.	Improves recovery without unsafe internal repair.

SUPPORTABILITY	For older systems, confirm whether scanners, displays and processors can still be replaced as a compatible set rather than assuming any new screen will connect.
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BUYER AND SURVEY PERSPECTIVE

Assessing detection performance rather than screen appearance

A buyer should see each radar operate independently at sea, compare known targets, review installation geometry and understand every shared heading, power and network dependency.

INSTALLATION
Height, obstruction and scanner separation

PERFORMANCE
Range, bearing, small targets and clutter

INTEGRATION
Heading, speed, overlay and target tracking

SUPPORTABILITY
Age, parts, software and replacement path

Area	Why it matters	Owner focus
Scanner installation	Are height, blind sectors, cable route and structural mounting suitable?	Inspect mast changes, cranes, tenders and radome condition.
Sea-trial performance	Are coastline, buoy and moving-target returns clear at several ranges?	Test manual tuning and both radars separately.
Heading and target data	Do bearing, overlay and vectors agree with independent observations?	Investigate offsets rather than recalibrating casually.
Power and network resilience	What remains after one breaker, switch, display or heading source fails?	Request an architecture diagram and controlled test.
Age and support	Are magnetrons, scanner motors, displays and software still supported?	Include replacement, mast work and integration cost.
BUYER FOCUS	A bright modern multifunction display can conceal an old unsupported scanner, poor mast installation or one heading source shared by every navigation function.	

OFFSHORE READINESS

Questions before relying on radar offshore

A ready radar system detects expected targets, remains correctly aligned, can be tuned manually and retains a usable alternative after one scanner, display or data-source failure.

Area	Question to resolve
Detection	Can small, fixed and moving targets be seen at useful ranges in representative conditions?
Tuning	Can more than one watchkeeper set range, gain, sea clutter and rain clutter manually?
Alignment	Do radar bearings and overlays agree with independent heading and position references?
Redundancy	Which scanner, display, heading source and power path remain after one common failure?
Blind sectors	Which directions are obscured by mast, tender, crane or structure?
Degraded operation	How will the yacht proceed safely if radar is lost in fog, darkness or confined water?

Quick readiness check

	Readiness statement
☐	Scanners, processors, displays, heading inputs, networks and breakers are identified.
☐	Known-target range, bearing and alignment checks are current.
☐	Manual gain, sea-clutter and rain-clutter tuning has been practised.
☐	Blind sectors and scanner limitations are documented.
☐	There are no unresolved weak echoes, freezes, offsets, scanner noise or repeated resets.
☐	Independent radar or alternative navigation and lookout arrangements are realistic.
☐	Target tracking, guard zones and alarm settings are understood.
☐	Configuration backups, selected spares and electronics contacts are available.

KEY TAKEAWAY

Dependable radar operation combines sound scanner installation, correct tuning, trustworthy heading data, independent comparison and watchkeepers able to continue safely when the electronic picture is incomplete.

Guidance to consult

Use the current vessel navigation, mast, electrical and network drawings and the installed radar, heading-sensor and display manufacturers' instructions, together with official navigation guidance, collision regulations and appropriate radar training.

Understanding Yacht Systems

Practical guides for owners, buyers
and offshore cruising crews.

AMTG-041

Understanding Radar

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