

Which digital radar is best?



A revolution has come about in marine radar, but are these high-resolution, solid-state digital scanners all they're cracked up to be?

Duncan Kent tries out four of the very latest models



Using menus on some models was not straightforward

What to look for

Finding a radar that is suitable for you and the type of sailing you do depends on four different criteria:

ANTENNA TYPE Sailing yachts up to 60ft LOA usually opt for the radome antennae (where the spinning array is fully enclosed) rather than open array – to avoid any risk of halyards or sails snagging the rotating antenna.

ANTENNA SIZE The bigger the antenna, the narrower the beamwidth and the better the separation between small and nearby targets.

POWER The more powerful the transmitted signal, the greater the attainable range.

PROCESSOR The faster the processor, the more data it can handle from each sweep, thus improving the resolution and clarity of the image.

Radar remains the single most important collision avoidance device for sea-going vessels.

Whether you'll benefit from investing in a radar system depends on the type of sailing you do, and the frequency of other vessels in your area.

In times of restricted visibility, though, every penny spent on a radar suddenly seems like money very well spent.

The march of technology moves ever-onwards and the heavy old power-hungry pulse scanners are being replaced by lightweight, low-power solid-state technology.

With these high-performance, instant-on solid-state radars, the cruising yacht owner now has the ability to purchase extremely high-definition radar at a sensible price and overlay the scan onto a chartplotter for better clarity.

Using sophisticated electronic filters and high-tech features such as CHIRP, Doppler, Beam Sharpening and Target Recognition, the

will get to your vessel, and how long it will be until that point) and warning you if a collision is imminent. Like tracks on a chart plotter, some radars can also be set so that moving vessels leave a trail on the screen to help show you recent direction of travel.

The MARPA/ARPA feature works best with an optional heading sensor.

Guard sectors and alarms

It's possible to set up one or more guard zone sectors ahead of your vessel, as well as an exclusion

ACRONYMS

CHIRP	C ompressed H igh-Intensity R adar P ulse
FMCW	F requency M odulated C ontinuous W ave
CPA	C losest P oint of A pproach
TCPA	T ime of C losest P oint of A pproach
VRM	V ariable R ange M arker
EBL	E lectronic B earing L ine

resolution of these modern radars is actually quite astonishing.

How it works

Older design magnetron radar transceivers fired out a crude, high-power pulse and then waited for it to be partially returned before emitting a second. This time delay leads to a blurred echo being pasted onto the screen and sometimes none at all in rough sea conditions. These traditional radars relied on a narrow beamwidth to 'crisp up'

target echoes as much as possible but this meant bigger was better. Large open-array scanners can afford to rotate slowly and emit a narrower beam for more precise resolution, but these aren't at all suitable for yachts below 60ft.

A modern Frequency Modulated Continuous Wave (FMCW) radar, also known as a Broadband radar, transmits a continuous wave, but with a variable, sometimes stepped, frequency enabling the receiving electronics to identify the signal and to discriminate between each return – even if it comes back after a part of the wave that was transmitted later. This, along with greatly increased processing power, not only enables a much more accurate picture of the target to be drawn at very close range but also provides much improved separation between distant targets, at 15nm or more.

The CHIRP method of radar scanning, as used by Raymarine in its Quantum range, is similar to CHIRP-based sonar technology. A CHIRP radar transmits a pulse,

RADAR FEATURES

Mini-Automatic Radar Plotting Aid (MARPA)

This is one of the most important features of any radar and offers vital assistance with collision avoidance. Moving vessels can be selected manually or automatically within a set range. The radar then tracks the target's position, speed, and direction, giving you the CPA and TCPA (Closest Point of Approach and Time to Close Point of Approach: how close a target

ring around it. In either case, an alarm will sound if any other vessel enters a predetermined guard perimeters.

Radar overlay on chart

All modern MFDs now allow you to overlay a radar scan on your chart, which helps you to differentiate between land, buoys and other moving vessels easily and quickly. As with MARPA, an accurate heading sensor helps (a high-accuracy electronic compass) and initial adjustments are required to ensure both displays are fully synchronised.

Doppler

The Doppler Effect has been known and utilised for many years, but until now no-one appears to have realised the beneficial effect for a radar image. Put simply, the radar is capable of distinguishing between vessels approaching and those travelling away from it, so why not put this information to good use and paint all of the former, possibly hazardous targets, in red, leaving the latter in green to indicate their lack of threat? This is exactly what Furuno has done in its DRS4D-



A split-screen page can help see targets that may get lost on a chart overlay

as with a traditional magnetron radar, but the frequency of the pulse wave changes during its transmission – enabling the radar to resolve the target more easily by analysing the full array of the different frequency signals returned simultaneously.

The speed of transmission and detection on modern solid-state antennae is now so fast that it means you can receive recognisable target images right down to 50m away – an impossibility with older style radars where there'd be a noticeable 'hole' in the image surrounding your vessel.

NXT antenna (see below). Garmin has done the same, but currently only with its Fantom 4ft open-array antenna, although rumour has it that it will soon feature in the smaller radomes as well.

Antenna rotation speeds

Modern radars now offer dual- or triple-speed scan rates – usually 24rpm, 36rpm and 48rpm. These can often be selected manually, or set to automatic, when they adjust to suit the selected range. The faster speed gives a much faster refresh rate, which is useful

How we tested them

We tested the radars on land and at sea. We ran them separately, so there was no risk of interference, and they were all connected into a central NMEA2000 network when operating. We used the NMEA2000 Furuno PG700 electromagnetic compass and heading sensor to ensure all the radars had accurate heading data, it's not a

cheap option at £550 (similar NMEA0183-connected devices are closer to £200). The network also contained a McMurdo AIS transponder, as well as data from our ship's other instruments when tested at sea.

All gain and filter adjustments were left in auto mode for ease of comparison, although we did try manually adjusting them at some point to see if we could better the devices' own settings. In every case during our fine weather tests the MFD did as well as, if not better than, our testers.

Each radome was fitted on board, then taken to sea and tested



PHOTOS: GRAHAM SNOOK PHOTOGRAPHY

when in close proximity of an approaching vessel, but in return slightly reduces the resolution. It is primarily helpful at close range when fast vessels are around.

Range and dual-window display

Most traditional 18in radome radars offer a range of operation between 0.5-36nm, while in solid-state radars this often expands to 0.1-48nm. Some also offer dual-range capabilities, whereby the screen can be split into two windows, with each set to a different range.

HINTS AND TIPS

Alignment

When first installed the antenna needs to be aligned properly with the centreline of your boat, otherwise the radar image will be skewed and will not be synchronised with the chart in overlay mode. This is best done by pointing your boat at a known mark and adjusting the relevant offset in degrees.

Also, for accuracy you will need to install a heading sensor in the network to use the MARPA or ARPA function.

Network

Clearly, the more instrument data available to the system, the better each item of navigation equipment will function and the more useful the system becomes. For this reason we believe an MFD/radar installation really should be connected to an on board high-speed instrument network such as NMEA2000 or SeaTalk NG, particularly if a separate heading sensor is included within the network for MARPA operation, AIS and chart overlay.

Products tested

The price shown is for the radar scanner, display not included

Garmin GMR 18xHD £1,499



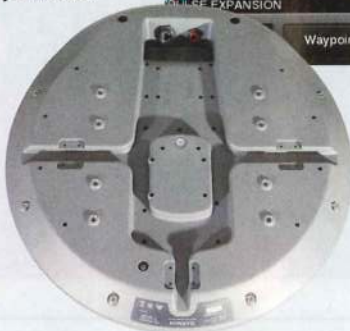
The GMR 18xHD is a 20in radome, not 18in

The only magnetron-based radar scanner in our trials, this is the latest extra high-definition version of Garmin's 4kW/18in radome that boasts an impressive 20m-48nm range and has both 24 and 48rpm rotation speeds that automatically adjust with range selection. Furthermore, a dual range facility allows you to split the screen into two independent windows, each showing a different range scan, which is extremely useful when entering or leaving port.

It also has a more sophisticated automatic dynamic gain and sea filter compensation that continually adjusts to the changing sea conditions, as well as offering the usual manual operation.

Installation

The 18xHD dome has a larger diameter (20in) than its '18' tag and it's a tad heavier than the others, but it's by no means cumbersome. Two cables are

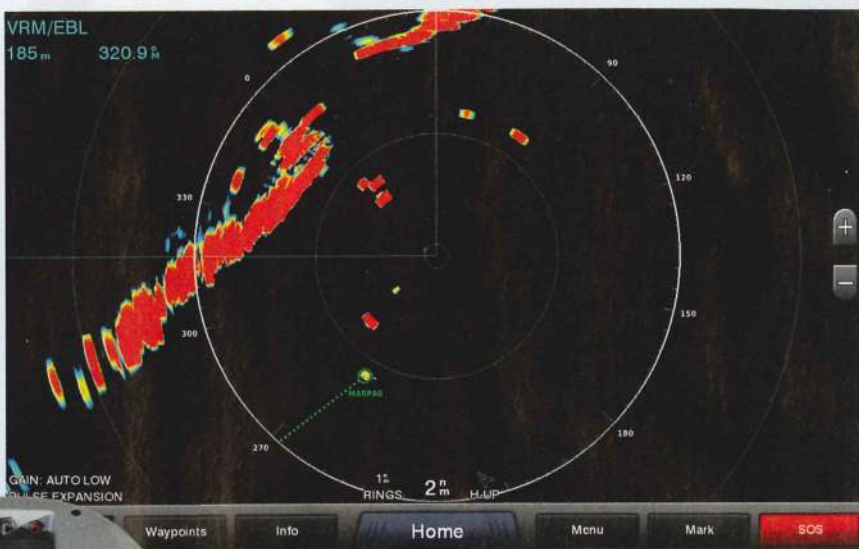


There are a number of cable routing options beneath

provided, one power and one data, the latter connecting directly to the MFD via an Ethernet port.

Display

The xHD dome is compatible with all current Garmin MFDs and many discontinued models too. Its eight-colour, high-resolution (0.25° discrimination) display makes the targets stand out more clearly. It uses red for strong echoes, fading down through blue and then yellow for weaker returns, facilitating shape recognition at a glance.



ABOVE: A safe MARPA target is shown in green on the Garmin

Your current route and its waypoints can be shown on the radar screen as well, so you can see of what's along your course.

In 3D chart mode using radar overlay accentuates the land by giving it relief.

Operation

The operation is straightforward. It has all the common radar features such as MARPA, guard zones, VRM/EBL, chart overlay etc., and the display is clear.

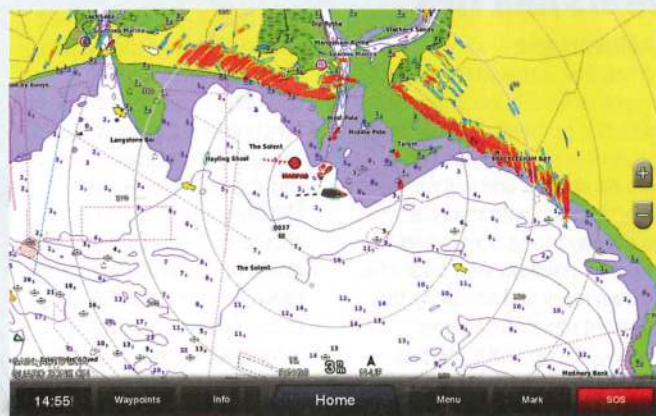
Nearly all the features offer an auto setting for beginners who are not yet totally au fait with radar, yet they also allow the more experienced user to refine many of the settings to suit their own particular preferences. Users can simply select between Harbour or Offshore modes to allow the device to adjust its own filter settings, depending on whether you're sailing along a busy coastline or you're out at sea where there are fewer ships but more chance of sea clutter. Alternatively, you can go into the Sea Clutter adjustment and select the button that most resembles the current sea state – Calm,

Medium or Rough.

The menus are intuitive – so selecting Orientation brings up individual keys for Head-up, North-up or Course-up, along with the range setting and the distance between rings (not always obvious on some other makes). Simple + and – keys enable the range to be decreased/increased quickly, without pulling up a menu.

Touching the screen brings up a menu with several options. You can measure the distance between two points, or between a target and your own vessel. You can request a VRM/EBL on a target, which will show up in a data box top left, or you can go the whole hog and 'Acquire' a MARPA target, which then activates target tracking giving you a display of its speed, course and relative bearing to you. If the target becomes dangerous the MFD will beep loudly and the target will change from green to red.

Contact Garmin
Tel 0370 850 1242
Web www.garmin.com



Radar overlaid onto a chart with a dangerous MARPA target in red

OUR VERDICT

An intuitive and logical system with an excellent range of automatic filter settings and adjustments; making set-up dead simple. We also liked the simplicity of operation. The display wasn't the sharpest, but target discrimination is good and the multi-colour echoes help to differentiate echo types.

RATING
6/10

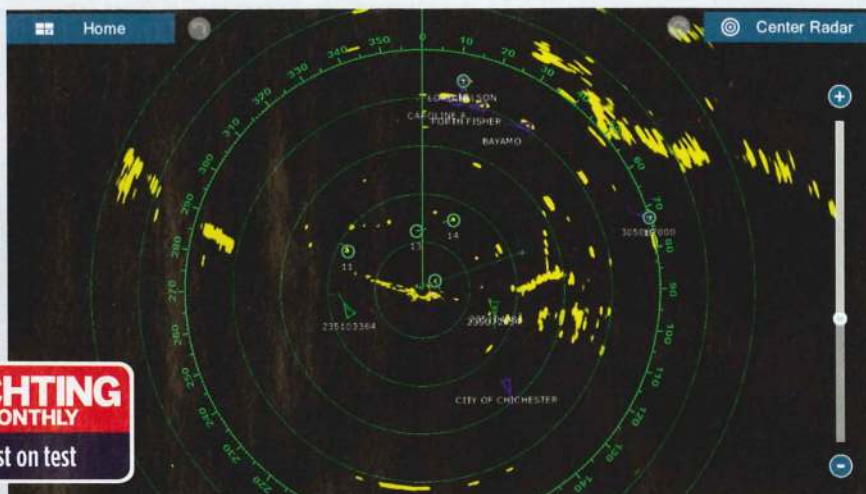
PHOTOS: COLIN WORK

Furuno DRS4D-NXT £2,122



The 24in radome was the largest, but also the second lightest on test

**YACHTING
MONTHLY**
Best on test



ABOVE: Tracking five ARPA targets. It is possible to track 100

Compatible with all NavNet TZtouch and TZtouch 2 MFDs, this is Furuno's first solid-state, pulse compression radar that puts the well-known Doppler Effect to good use. This proven technology enables Target Analyzer and Fast Target Tracking, to provide accurate and rapid vessel monitoring.

The DRS4D-NXT is only available in a 24in radome, which, though it makes it a little more awkward to install on a sailing yacht, actually weighs less than the Garmin and B&G models we tested.

Installation

It comes with a single cable containing both power and data wires, with the latter connecting onto a short tail at the dome and then plugging into an Ethernet port at the back of the NavNet TZtouch MFD. If you wish to use the ARPA tracking features you'll need to add a NMEA2000-compatible heading sensor, like the Furuno PG700 we used.

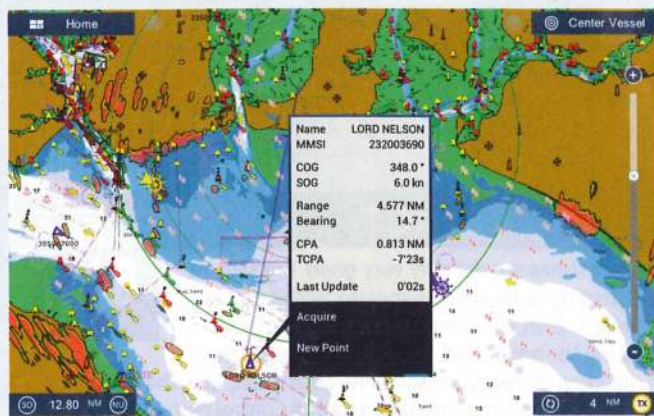


There is just a single cable to install for both data and power

Display

The Doppler-assisted Target Analyzer function is a quick and easy way to identify targets that might present an imminent risk of collision. Put simply, any vessel travelling towards you is painted in red, while those going away from you are shown in green.

Another great feature is RezBoost, which increases the image resolution by giving the antenna the equivalent of up to a 2° horizontal beam width, ie. similar to an open array antenna. This greatly improves separation between smaller targets and helps with identification.



Touch a target, then select Acquire to activate ARPA target tracking

Operation

We found the radar features of the Furuno easy to find, use and operate, although there are things in the deeper set-up menus that went entirely over my head! If you are a radar expert and like to set all your own parameters, then this one's for you. Otherwise setting up the basics such as heading alignment, guard zones, exclusion sectors etc. is straightforward. You can switch it on and off, alter orientation and change range easily using icons on the screen, without going into a menu. You can also pinch to zoom and swipe to pan as per any modern touchscreen device.

In addition to the green/red Target Analyzer feature, the Doppler Effect is also used to improve the radar's ARPA tracking ability. You can use the ARPA function manually, by simply touching a particular moving target and selecting 'Acquire' from the drop-down menu. After a few seconds a circle appears around the ship to show it is being tracked, along with a number and a short heading vector. Alternatively,

you can activate Fast Target Tracking, which will monitor up to 100 moving targets simultaneously, plotting their course and speed just as an AIS receiver does, displaying them with a dotted heading vector to give an immediate idea of their course and audibly warning you if an approaching vessel enters your predetermined guard zone.

The NXT radar also offers a clever dual-range display facility, which allows the user to split the screen into two windows, each with a radar image, but at two different range levels. This is similar to the dual-chart display found on most MFDs these days, but this is a first for radar and allows you to locate channel buoys close up while keeping an overall picture of your wider surroundings. It does have some limitations: the range for each window is limited to 12nm max and the antenna rotation speed to 24rpm.

Contact Furuno
Tel 02392 441000
Web www.furuno.co.uk

OUR VERDICT

Despite being the largest radome, the Furuno was in fact the second lightest. We liked all the innovative features such as Target Analyzer, which greatly improve your ability to see what's happening at a glance, and we found the set-up and operation fairly straightforward if you stick to the basics and let the micro-processors do the rest.

RATING
9/10

Products tested

Prices include VAT
The price shown is for the radar scanner

B&G 4G Broadband £1,995.00



At 19in, this was the smallest radome

Navico/B&G's 4G model boasts features designed to offer the user better resolution and target separation, specifically its Target Separation Control method of beam sharpening, which halves the effective horizontal beamwidth from 5.2 to 2.6° and raising its target discrimination abilities closer to a 4ft open-array antenna.

Other features include Target Boost and Expansion, to enlarge specific targets, better filtering and noise rejection, and dual-range split screens.

Installation

Although the radome uses a 20m-long single cable for power and data, you need to install the supplied Radar Interface Module (RIM) to the system, to which the radome then connects. The module is then linked to the MFD via an Ethernet cable, which seems an unnecessary complication as all the other MFDs have this interface built in. If you want to



The radome connects to a Radar interface module

use the chart overlay and MARPA functions then you'll also need a SimNet-to-NMEA2000 converter cable connected between the RIM and your NMEA2000 network, in order to share heading/compass data. After the initial straightforward setup, the MFD detected everything automatically, including the Furuno electronic compass on the NMEA2000 network. Like all modern radars the 4G sets up many of the parameters automatically, which are hard to better unless you're an expert.



ABOVE: Tracking multiple MARPA and AIS targets on one screen

If you are there's plenty of opportunity for fine-tuning.

Display

The 4G radar will connect to any of B&G's Zeus MFDs (or Simrad NSE/NSS), which automatically activates the radar options, after which you simply press transmit to start up the antenna. The screen is clear and well-defined and we liked the direct on-screen access to the clutter filters, gain and range. There are plenty of information panels available as well, including a comprehensive window showing current MARPA and AIS vessel data, guard zone setting and alarms, and VRM/EBL information.

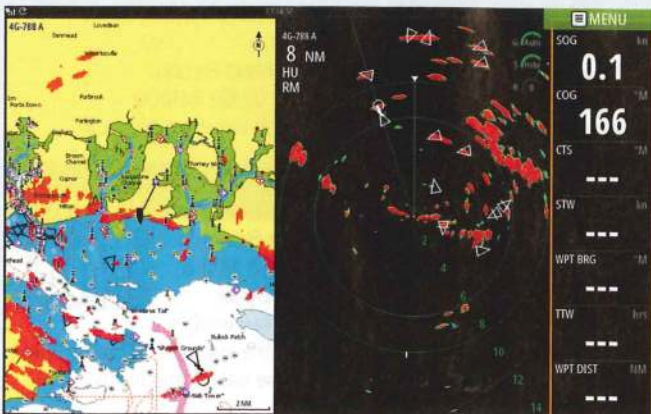
Operation

On the radar screen all the options are available on a drop-down Radar menu, including the settings for gain and filters, MARPA target acquisition, Target Boost control and more. When in chart overlay mode there are basic radar options under the Chart drop-down menu, but you need the radar menu for full reconfiguration.

Acquiring a MARPA target requires a single tap on the screen and another on the menu. At any time you can check that target's details and nav data just by tapping on the tracked target. The split display is a real boon – especially when you can monitor up to 10 MARPA targets on each. It's a bit like having two entirely separate antennae, although there are limitations – only ranges between 3nm-36nm can be used. Nevertheless, while you're looking ahead at ships up to 36nm away you can clearly make out buoys close by. We found the close-up detection of channel buoys was excellent, with a clear distinction between buoys and moored boats.

The guard zone feature allows you to set up one or two zones ahead of you, or within a range ring when anchored, and the alarm sensitivity can be set to ignore small vessels.

Contact Navico
Tel 01794 518448
Web www.bandg.com



It's possible to orientate the split screens in different directions

OUR VERDICT

Its features are not only very good, but they're also easy to locate and operate, which, to our minds, is vitally important when you're not using the equipment regularly. The split screen function allowing two zoom levels is great, as is the beam sharpening of the Target Separation Control feature.

RATING
8/10

Raymarine Quantum £1,545



At 5.6kg the Quantum was the lightest on test

Raymarine's most recently launched, lightweight Quantum radar is its first leap into CHIRP-based, Wi-Fi enabled, magnetron-free radar. The Quantum uses CHIRP pulse compression and its own Advanced Target Separation (ATX) technology to produce quality imaging at both long and short range.

The radar is designed to interact with all the features of its latest user interface, LightHouse II, enabling easy access to this high-performance radar technology.

Installation

The test unit arrived with a standard, 'fully wired' 0m-long mast cable. With power and data in this one cable and with the latter using a simple Ethernet connection directly into the back of the eS12 MFD we were using, there hardly seemed any point in using the Quantum's much flaunted Wi-Fi capabilities. If you want to use Wi-Fi,

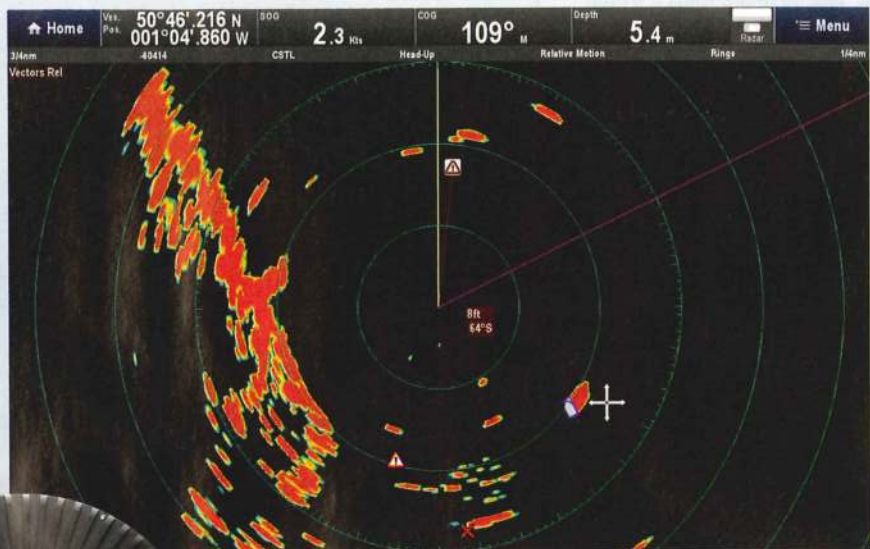


Although data can use Wi-Fi you'll still need a power cable

remember to jot the serial number and Wi-Fi password down from the base of the radar before installing it (we didn't!).

The Quantum is some 2kg lighter than the other radomes and, though it actually measures 21in in diameter, it retains the same bolt-hole centres as the company's standard radome so it should retrofit easily onto an original 18in mast bracket.

It also has the lowest power consumption of all, at just 17W (1.4A @ 12v) on transmit and 7W (0.6A @ 12v) at standby.



ABOVE: Identifying and analysing hazardous targets using MARPA

Display

As we mentioned in our review of MFDs last month, the eS12 has a superb non-reflective display that is easy to read in sunlight and thereby enhances the radar image no end. The iconography is also clear and the touchscreen responsive, even with cold hands.

Setting up the windows and split screen was a doddle, too.

The Quantum is excellent at close range, picking out the smallest buoys and RIBS, but the level of separation at maximum range wasn't the best.

Operation

By the end of these trials we were not great fans of the LightHouse II operating system. Yes, some aspects are good and the iconography clear, but the same problems arise with using radar as with charting – menus that are too short to include all the function buttons being the most frustrating.

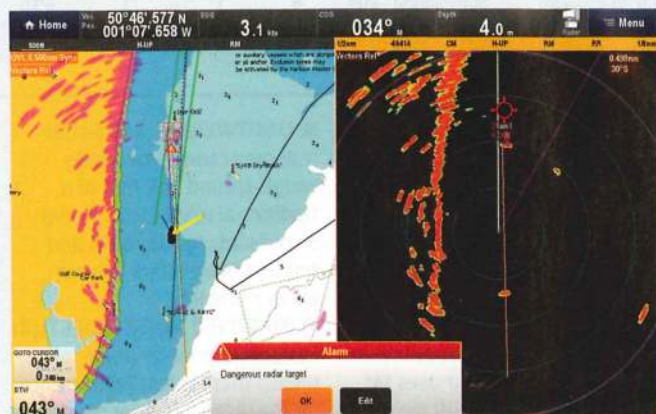
We liked some of the filter functions – especially the weather button, which adjusts

the rain clutter filter to allow rain-bearing squalls to appear more clearly without having to play around manually with the filter controls.

The range and rotation speeds are limited to 24nm and 24rpm. The former isn't really a problem, but the latter means you won't have the benefit of higher rpm in close-encounter situations with fast vessels that others have. Also, the lack of a dual-range split window option that all the other radars we tested boast about could lose some sales.

The Wi-Fi function might be useful for racing boats, where even the weight of the data cable up the mast might be detrimental to stability and speed, but for the cruising yachtsman we don't feel it's worth the risk of Wi-Fi interference disabling your radar when most needed.

Contact Raymarine
Tel 01329 246700
Web www.raymarine.co.uk



If a MARPA target becomes dangerous, the unit alerts the user

OUR VERDICT

The Quantum CHIRP radar is definitely a leap into the future, although we're not convinced of the need for its Wi-Fi capabilities, being that a power cable needs to be run anyway. The image is crisp and clear, and target discrimination very good, but it's let down a little by the LightHouse user interface, which needs fine-tuning. It's a shame it's lacking a dual-range facility, though, which can be very useful when entering a channel.

RATING
7/10

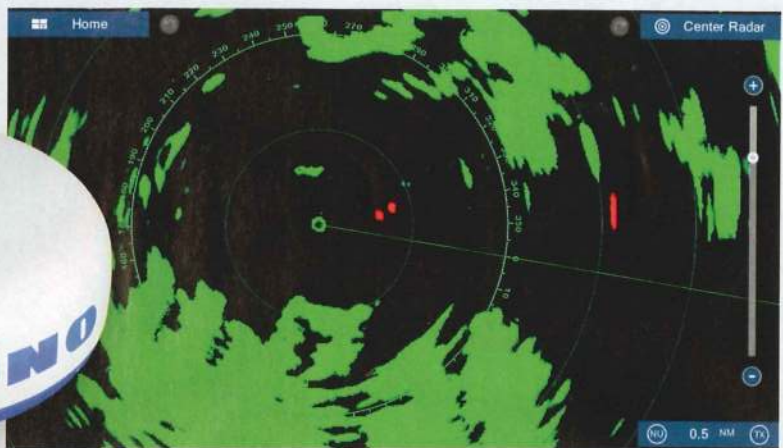
Conclusions – How do they compare?

You might think it a little unfair to include the Garmin magnetron-based radar in our trials, but we felt it made sense to check out the most current offerings from the big four, especially as the Garmin 18xHD supports a good number of very innovative features. In many ways the xHD is pretty much solid-state anyway, in the true meaning of the term, so it shares the low weight advantage of the others. Furthermore, its high processing capacities and smart circuitry mean it probably offers the best resolution and separation of any small radome system available. It isn't quite up to the others when it comes down to short range performance, however, and it's a little more power hungry.

Raymarine's new Quantum is the first of its kind in that it introduces CHIRP technology into small craft radar. It works extremely well, giving the user a surprisingly good picture of the sub-200m range situation, considering it doesn't share the ability of the others to up its scan speed. The company argues that it makes far less difference in CHIRP radar.

The B&G 4G broadband radar is a further improvement on its 3G model, but not massively. That said, we all thought it probably

Which digital radar do we recommend?



The Doppler Target Analyzer makes it obvious which targets pose a risk

YACHTING MONTHLY
Best on test

Furuno DRS4D-NXT

Although the most expensive, the Furuno was an impressive, all-round performer with a wealth of features. We loved the Doppler Target Analyzer feature and its automatic filter setting makes image configuration easy.

PHOTO: COLIN WORK

'The very latest leisure radar from Furuno is mightily impressive'

scored equal first with Furuno when it came to identifying clearly the difference between buoy, kayak, small boat and large ship, and it gave us all the confidence to navigate a narrow congested channel using radar alone.

We also thought the radar operating system of the Zeus married extremely well with the

4G radar, making it easy and less daunting to use in anger.

Finally, the very latest leisure radar launched by Furuno is mightily impressive all round, although some might say it's a little too much for the small craft user. We might have agreed initially, but very soon realised that the sheer number-crunching power of the DRS4D-NXT enabled it to analyse and continually adjust the automatic filters so well that there was never a time we could better its settings manually. When you see its Doppler-derived

Target Analyzer feature in action, changing a safe green plot into a red one when the vessel is creates a collision risk, you wonder why no-one else has thought of it.

Okay, so it has a 24in radome, which gives it a slight beamwidth advantage and sharpens echoes a touch more, and if you think it's too big, it's only 3in larger in diameter than the Quantum and it weighs less than the B&G. We all thought the Furuno was the best in class, but, if size is king, then you wouldn't regret choosing B&G's excellent 4G radar. ▲

Specifications of the units on test

Make/Model	Price	Dia	Type	Tx power	Weight	RPM	H-beam	V-beam	Range	Power draw	Dopp	MARPA	Dual range	W-prf
Garmin 18xHD	£1,499.99	20in	Magnetron	4kW	7.7kg	24/48	5.2°	25°	20m-48nm	48W	N	Y	Y	IPX7
Furuno DRS4D-NXT	£2,122.00	24in	FMCW	25W	7.3kg	24/36/48	2.0°/3.9°	25°	115m-36nm	30W	Y	Y	Y	IPX6
B&G Broadband 4G	£1,995.00	19in	FMCW	24W	7.4kg	24/36/48	2.6°-5.2°	25°	50m-36nm	18W	N	Y	Y	IPX6
Raymarine Quantum	£1,545.00	21in	CHIRP	20W	5.6kg	24	4.9°	20°	115m-24nm	17W	N	Y	N	IPX6

What the new radar technology offers

Solid-state radar can benefit owners of sailing yachts in many ways. Here are a few reasons why you should consider upgrading

■ **BETTER SHORT-RANGE TARGET DISCRIMINATION** FMCW radar achieves greatly increased clarity of nearby objects, in some cases down to a range of 60m, which is ideal for pilotage assistance

in limited visibility allowing channel markers and buoys to be identified more easily.

■ **INSTANTLY ON** No more lengthy wait for the radar to warm up, all the features of solid-state radar are ready

to use almost the instant you power it up and press transmit.

■ **GREATLY REDUCED POWER CONSUMPTION** Older pulse radars often consumed 120W-plus when transmitting, which could only be mitigated by putting it into standby, resulting in a wait for it to warm-up. FMCW radar uses far less power, around 25W max; far better for a sailing yacht.

■ **LIGHTWEIGHT** Solid-state radome scanners generally weigh around half that of a traditional magnetron model so puts less weight aloft and has less of an effect on your yacht's stability.

■ **IMPROVED NOISE REJECTION** Reduced signal-to-noise ratios means there is less interference on the display in poor weather conditions.