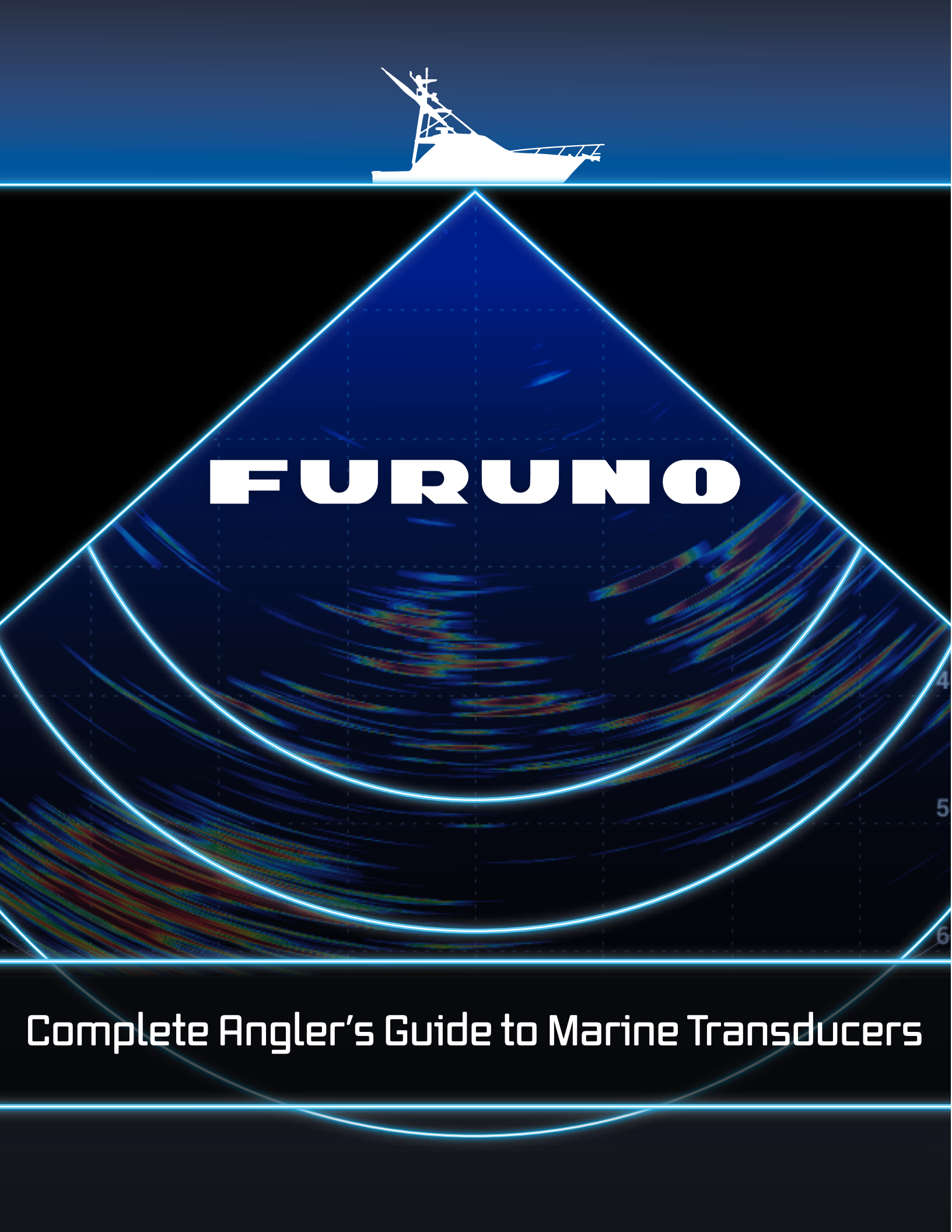
FURUNO
Complete Angler's Guide to Marine Transducers

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Pro anglers often utilize both TruEcho CHIRP and the standard 50/200 kHz frequencies to find their winning catch!

Furuno offers a wide range of matched, high performance transducers for our depth sounders. There are transducers available for virtually every type and size of boat. There are also sensors you can install that will accurately read your boat speed and the surface water temperature. Because there are a number of variables in transducer types that can dramatically affect your fish finder's performance, understanding these variables is the key to selecting the right transducer. This book will help you learn about what makes a transducer 'tick.'

FURUNO

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How it works

There are a wide variety of transducer options available for Furuno fish finders, but all of them operate on the same principle. At it's most basic definition, a transducer is a device that takes energy from one source, converts that energy into some other form and then delivers that energy to a target, such as a PA system converting sound from a microphone into electrical signals and then delivering that energy to the speakers. In the case of marine transducers, imagine that the same device can act as both the microphone and the speaker. Electricity from the fish finder is applied to the transducer, which sends out an acoustic signal - sound waves - into the water column. The transducer receives the reflected echoes from objects that these sound waves encounter and they are sent as an electrical signal to your fish finder. It is the fish finder's job to process this signal into a picture of the underwater world on your screen.

The Essence of a Transducer

The physical device inside a transducer that creates the sound wave is a piezoceramic disc called the element. The element, when voltage is applied, vibrates - it distorts and reforms its shape in very rapid succession. This vibration occurs at a specific frequency and creates compression waves, or acoustic energy - sound waves. These waves travel outward from the element in a vaguely cone-shaped pattern and encounter targets along the way.

As this acoustic energy encounters targets such as fish or bottom structure, some of the beam will be attenuated (absorbed by the target), some will be reflected back at the transducer as an echo and some will be scattered. As the reflected echoes strike the transducer they cause a minuscule distortion in the shape of the crystal. This distortion of the crystal creates a small fluctuation of voltage, which can be detected and processed by the fish finder. The result is an image on your display.

By measuring the time from when the sound wave is generated to when the return echo is received, we can learn the depth at which a target is encountered. The strength of the reflected echo can tell us about the size and density of the target.

Some transducers are referred to as single-element transducers. This means that they contain a single piezoceramic disc that vibrates alternately at 50kHz and 200kHz, utilizing both operating frequencies. Furuno offers a wide range of single-element transducers that are very popular and carry a low price tag.

When greater performance is desired or required, multiple element transducers are available that can significantly enhance the performance and sensitivity of your fish finder. A multiple-element transducer is one in which separate elements vibrate individually at their respective frequencies. Some high-end models utilize seven, nine or even fifteen 50kHz elements along with a large-diameter 200kHz element. The dedicated 200kHz element offers enhanced sensitivity in shallow water, while the greater surface area of the 50kHz array will receive echoes from deeper water with much more clarity and detail.

Many transducers are available with multiple elements for the 50kHz function and a single, large diameter 200kHz element, delivering enhanced performance.

* Shown with High Performance Fairing Block

Frequency and Beamwidth

Frequency demystified

Frequency refers to the number of sound waves that radiate from a transducer each second. Sound waves are made up of high pressure and low-pressure pulses traveling through a given medium. The wavelength of sound is defined as the distance between two successive high-pressure pulses or two successive low-pressure pulses. For example, when an electrical pulse is applied to a 200kHz transducer the element vibrates at a frequency of 200,000 cycles per second – that is, 200,000 individual sound waves are transmitted from the element each second. Short-wavelength, high frequency transducers produce sharp, crisp images on the fish finder display.

Why use two frequencies?

For recreational and sportfishing applications, the 50/200kHz pairing of frequencies offers an ideal balance of both shallow- and deep-water performance. The 200kHz frequency produces sharp, crisp images in shallow water while 50kHz allows you to "see" much deeper.

This image demonstrates the difference in beamwidth of 50kHz and 200kHz. In this example, the wider 50kHz beam will show returns for fish that the narrow 200kHz beam would have missed.

Some frequency pairings are more suited to an individual application than others, and for this reason Furuno has always offered the commercial and serious sport fisherman a choice when it comes to selecting frequency pairs for a commercial fish finder. These include 28, 38, 50, 88, 107 and 200kHz.

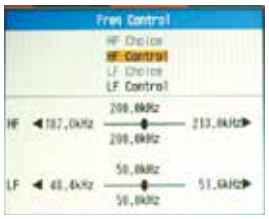
Beamwidth

The beamwidth of a transducer is a numeric value that describes the effective angle of the sound wave. This value is defined as the total angle between the points at which the acoustic energy has been reduced to half its peak value, commonly referred to as -3dB down points. This value is important because it determines the area in which your fish finder will be able to "see."

As the frequency increases the beamwidth will become more narrow, similar to focusing the beam of a flashlight. As you adjust the lens, the beam of light focuses and covers a smaller area, delivering more energy on-target. This is more a function of the design of the transducer rather than an inherent property of frequency.

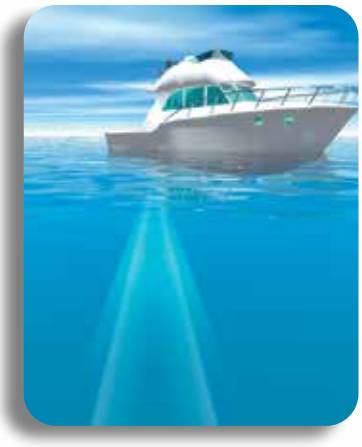
Remember that the lower frequency wavelengths "see" deeper in the water column than higher frequency wavelengths, and so a boost in power is not always necessary to detect fish in deeper water. The lower in frequency that you go, the deeper the echo sounder will see for the same amount of power. You can also increase the fish finders detection range in all frequencies by using a narrower beam transducer. A narrow beam delivers more energy on-target, resulting in stronger echoes, improved target resolution, and the ability to "see" in deeper water.

On some Furuno Fish Finders, you can shift the operating frequency at any time from the menu. For example, with the FCV1150 using the FURUNO 82B-35R transducer, you can select any operating frequency from 65 to 110kHz. This feature is particularly useful for vessels targeting different species, or when Fish Finders of nearby ships may cause interference.



Sidelobes

This image illustrates a typical beam pattern. It is a graphic representation of the pattern the acoustic energy takes as it radiates from the transducer. The center cone represents the energy within the -3db down points, what is referred to as the Mainlobe, and is the focus of the transducers energy. In this image we can see that not all of the energy is concentrated within the Mainlobe. Some of the acoustic energy spills out to the sides in what are referred to as Sidelobes, areas outside of the main beam in which a small level of energy is radiated. Since this energy is capable of producing return echoes from objects it encounters, it is possible to receive weak returns from the Sidelobes in shallow water.



Target Masking

Target masking is a phenomenon where acoustic energy from the transducer encounters a ledge which is only partially within the beam. This produces an echo which is sent back to the transducer sooner than the echo returned by either the sea bottom or fish targets. The result is that these fish targets will not be discernible on the fish finder screen. This phenomenon can occur with trenches as well as when traveling over sloping ground.

It is also possible to pick up a second echo from the sea bed, which will show as an echo on the screen at a greater depth than that of the ledge.

Interference

When two or more echo sounders are operating in close proximity and at the same frequency, it is possible for each to receive false returns from the others transducer. In such cases the operator will see noise and clutter, false returns, multiple bottoms or other video anomalies on the screen. This is most common in and around marinas or harbors where there may be multiple fish finders operating at the same frequencies. Furuno fish finders have interference rejection circuitry which should be used in such instances, but use it sparingly to avoid eliminating small targets. Many boaters have found that adding a Furuno Smart Sensor, operating at 235kHz, will ensure a reliable numeric value for depth when their 50/200kHz fish finder suffers from interference.

Mounting Options

Selecting the mounting location

Although it falls outside the scope of this guide to describe all of the details of installation, there are some important points that are true for every transducer installation. Acoustic noise is always present, and these sound waves can interfere with your transducers operation. Ambient (background) noise from sources such as waves, fish and other vessels cannot be controlled. However, carefully selecting your transducers mounting location can minimize the effect of vessel-generated noise from the propeller(s) and shaft(s), other machinery, and other fish finders. The lower the noise level, the higher the gain setting you'll be able to use effectively on your fish finder.

Always select a location where:

- Water flowing across the hull is smoothest with a minimum of turbulence and bubbles
- The transducer will be continuously immersed in water (not applicable for In-Hull models)
- There is a minimum of deadrise angle
- The transducer beam will not be obstructed by the keel or propeller shaft(s)
- There is adequate headroom inside the vessel for the height of the housing, tightening the nuts, and removing the valve assembly and insert

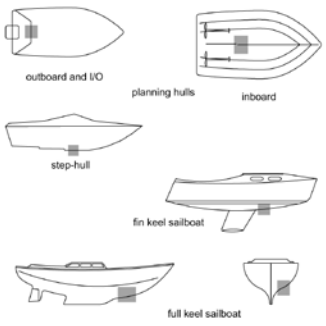
As a rule, no transducer should be located near a water intake or discharge opening, directly aft of any lifting strakes, steps or other obstructions or irregularities in the hull , or behind eroding paint (an indication of turbulence). The flow of water across the transducer face must be as smooth as possible in order to get the best performance while cruising.

Fairing blocks

The purpose of a fairing block is threefold: to compensate for the deadrise of the hull, to reduce drag, and to create a smooth surface for water to flow cleanly and unaerated across the face of the transducer. When a fairing block is correctly installed, boat drag will be minimized and the flow of water over the transducer face will be free of bubbles and turbulence.

A standard fairing is of a similar shape to its companion transducer. By contrast, a high-speed fairing projects a longer, more streamlined form. This elongated wedge shape cuts the water into two streams which flow along its sides towards the tapered end, where they will smoothly rejoin. The result of a well-installed fairing is excellent fish finder performance above 15 knots.

After the fairing is cut, it must be shaped to the hull as precisely as possible with a rasp or power tool. A tight fit will allow water to flow more smoothly over the transducer. If the transducer is recessed more than 0.5 mm (1/64th inch) inside the fairing, you should either shim the transducer or carefully file or sand the fairing until the two are flush.



Through Hull

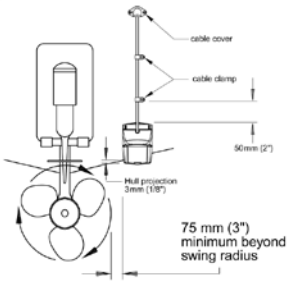
Through-hull transducers require that a hole is cut in the hull, so their installation is more involved than a relatively simple transom mount. They are also more difficult to access for periodic cleaning, which they may require more often than a typical transom mount transducer. Owners of trailerable boats with through-hull transducers must be careful not to damage it when launching or loading the boat.

To keep the transducer facing squarely downward into the water column, a fairing block must be used. The fairing block is installed parallel to the flow of water to ensure proper boat handling, and this will not necessarily be the same from hull to hull.

A fair amount of skill is required to achieve a proper through-hull installation. If in doubt, don't go it alone, but consult your local Furuno dealer for assistance.

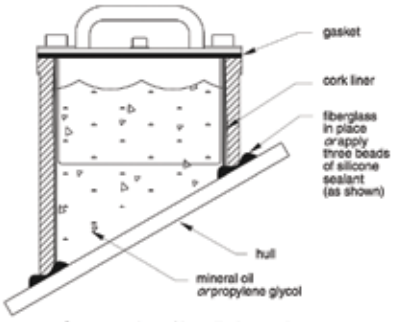
Transom Mount

Transom mounting is the simplest method of transducer installation and is most common among smaller boats. The transducer is installed on the transom, slightly below the waterline. The transducer face should be at a slight angle forward so as to reduce the effects of turbulence and aerated water.



In-Hull or Shoot-Through

A third option when mounting your transducer is referred to as an in- hull, or shoot-through installation. An in-hull transducer is mounted on the inside of the hull. The transducer signal 'shoots through' the fiberglass and so the hull does not require a hole cut in it, although certain hull types may need to be bored out to remove any flotation material. When properly installed the effects of turbulence and aerated water are minimized. Because the transducer face does not touch water, there is no real maintenance involved with an in-hull transducer. These are compelling arguments for shoot-through installations.



Cross section of installed transducer—M260 shown

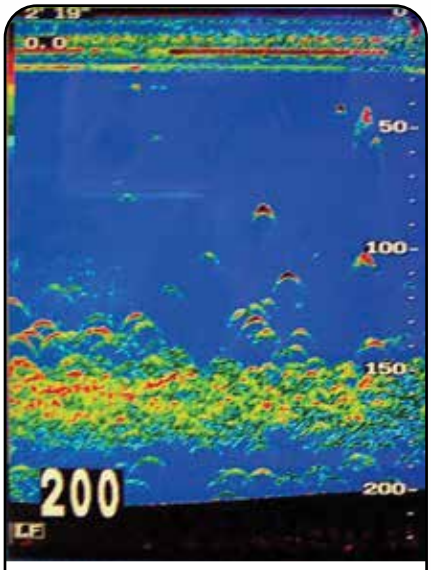
These benefits do not come without a price, and that price is performance. The signal will experience loss when shooting through the hull material. This means that the performance of your fish finder will suffer. Most modern in-hull transducers are designed to compensate for this loss.

Boats with wood, aluminum or steel hulls will not be able to use in-hull transducers, as these materials act as a very effective barrier against the acoustic signal. Sound waves simply will not propagate through these materials. Only fiberglass boats, with no flotation core, can utilize an in-hull transducer. Fiberglass boats with foam or balsa cores or those with air pockets will need to be 'dug out' so that the face of the transducer touches the fiberglass. This can make installing an in-hull transducer a tricky proposition.

Getting the most out of your Fish Finder

Standard vs. High Performance

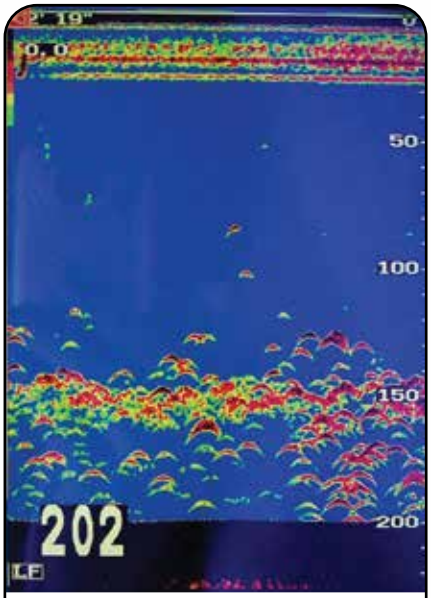
When you purchased your fish finder you made an investment, and to get the most out of that investment you will need to match it with the right transducer. Once you've selected your mounting method (In Hull, Through Hull or Transom Mount), you will need to select the right transducer. The best transducer for your needs will depend on a number of variables but there are some constants that should be considered and we'll go over those now.



Above is an actual screen shot of a 600 watt Furuno sounder utilizing the 525ST-MSD, a standard 50/200 kHz transducer.

Most standard transducers are designed for recreational fish finders and generally have a single element that resonates alternately at 50 and 200 kHz. Although these transducers are effective and inexpensive, greater performance can be had by matching your recreational fish finder with a high-performance transducer. These transducers are rated for a greater power output and contain an array of 50kHz elements along with one or more large-diameter 200kHz elements. An array of 50kHz elements allows for a very tight beam pattern, meaning there will be more energy on-target to produce return echoes. The greater surface area of this array also makes the transducer more sensitive to return echoes, improving target resolution on the screen. The same is true of having one large, dedicated 200kHz element - its tighter beamwidth and greater sensitivity create a better performing transducer at all power outputs.

For example, a typical recreational fish finder will output 600 watts of energy and is designed to function with a matching triducer rated at 600 watts. Pairing this fish finder with a high-performance transducer rated at 1,000 watts will drastically improve the performance of your fish finder.

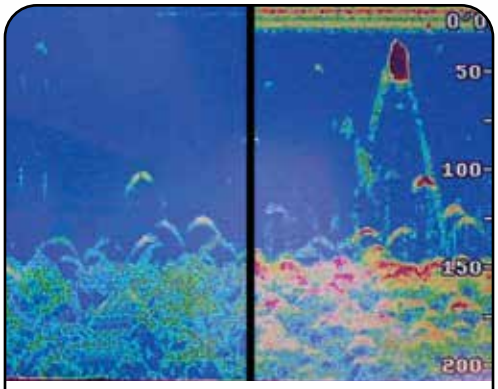


Here is the same 600 watt sounder utilizing the 525T-HDD high performance transducer. The darker color illustrates the enhanced sensitivity available for most sounders.

Smart Sensors connect directly to a variety of Furuno equipment, enabling you to upgrade your transducer without sacrificing speed and temperature information.

Output wattage and performance
Higher output power equates to greater depth range, as well as stronger returns on your fish finder screen. The actual depths you can reach with your fish finder will vary depending on a number of factors including water salinity and temperature, as well as the quality and frequency of the transducer. The following maximum depths are general guidelines:

100W = 400' Max Depth
200W = 500' Max Depth
300W = 600' Max Depth
600W = 800'- 1200' Max Depth
1KW = 1800' - 2500' Max Depth
2KW = 2500' - 4000' Max Depth



Notice the difference in returns between the 600 watt output with the 525ST-MSD (left) and 1,000 watt output 525T-HDD (right) from the GP7000F fish finder.

As we can see in the image at right, your fish finder can benefit from being matched to a transducer rated for a higher output wattage, but remember that the output wattage must always be less than or equal to the wattage of the transducer. If the echosounder has more output wattage than the transducer is capable of handling, the transducer will be damaged.

When to use a matching box
Most recreational fish finders have a single connection for your transducer. Because a standard transducer contains one vibrating element that alternates transmission frequency across a single line, only one line is required to send the electrical signal from the fish finder to the transducer and back. Multiple-element transducers always have separate signals for each frequency, and so some high-performance transducers come with a device called a diplexer installed inside the housing. A diplexer takes the electrical signal from the fish finder and distributes it to the individual 50/200kHz arrays. It then combines the returning 50/200kHz signals so that they can be transmitted together across a single line. The result is a high-performance transducer that is able to connect directly to a recreational fish finder, and one that will outperform a standard transducer matched to an identical fish finder.

Not all high-performance transducers contain an internal diplexer. Matching a high-performance transducer and a recreational fish finder will sometimes require a diplexer-like device called a matching box. This is a simple device that separates and recombines the electrical signal. The result is a lower-wattage recreational fish finder capable of operating with the sensitivity and resolution of a more powerful commercial machine.


The MB1100 Matching Box allows for the use of high-performance transducers with your recreational Fish Finder.

Broadband Technology
"Broadband" is a term used to describe a method for increasing the available bandwidth (range of frequency) of a transducer element without lessening performance. Increased bandwidth allows for the faster rise and fall times of the acoustic pulse, the byproduct of which is referred to as ring. This decreased ringing presents a much crisper image on the fish finder screen, allowing for better discrimination of individual bait fish as well as an increase in the ability of the fish finder to differentiate between the sea floor and fish suspended very near to the bottom. Broadband technology is available in select transducers.

CHIRP, or **Compressed High Intensity Radar Pulse,** has been used by the military, geologists and oceanographers since the 1950's. This technology has become available for widespread use on personal vessels, and it's taken the sport fishing world by storm. CHIRP transducers employ sinusoidal waveforms with a pulse frequency the increases or decreases linearly over time.

Wait, what?

In plain language, this means that the transducer elements vibrate across a range of frequencies. With each pulse, the transducer will begin vibrating at a low frequency, which will then be modulated upwards to a higher frequency throughout the duration of that pulse. Sonic information is sent and received at each individual frequency in the range, which is represented as a single waveform. These waveforms are commonly referred to as linear chirps or simply chirps. So, a single CHIRP sounder will transmit and receive information across as many as 90 different frequencies. CHIRP sounders use a precise sweep pattern modulated within a range of frequencies all within a single long-duration transmit pulse.

Single-Band CHIRP Transducers

CHIRP across a single range of high, medium, or low frequencies.

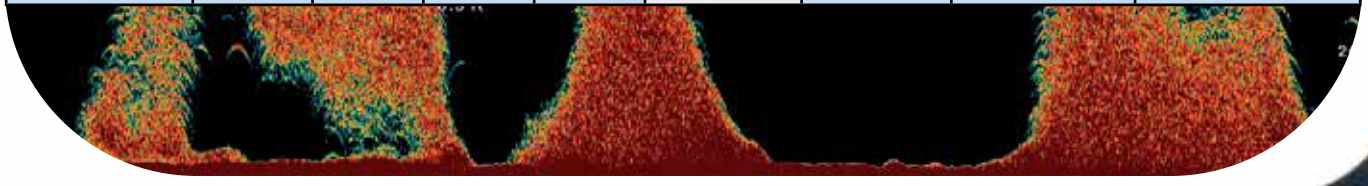
Transducer Part numzber	Housing Type	Mount Type	Temp Sensor	Power Rating	Frequency Range	Fairing Block	Compatible Models
B175H	Bronze	TH-LP	Yes	1kW	130-210 kHz	NA	GP1871F GP`1917F TZT9F
B75H	Bronze	TH-LP	Yes	600W		NA	
B175HW	Bronze	TH-LP	Yes	1kW	150-250 kHz	NA	
B175HW/12	Bronze	TH-LP	Yes	1kW		NA	
B175HW/20	Bronze	TH-LP	Yes	1kW		NA	
B285HW	Bronze	TH	Yes	1kW		NA	
TM185HW	Plastic	TM	Yes	1kW		NA	
B175L	Bronze	TH	Yes	1kW	40-60 kHz	NA	
B75L	Bronze	TH	Yes	300W	40-75 kHz		
B75M	Bronze	TH-LP	Yes	600W	80-130 kHz	NA	
B785M	Bronze	TH	Yes	600W		Hi-Speed	
B175M	Bronze	TH-LP	Yes	1kW	85-135 kHz	NA	
B175M/12	Bronze	TH-LP	Yes	1kW		NA	
B175M/20	Bronze	TH-LP	Yes	1kW		NA	
B285M	Bronze	TH	Yes	1kW		Hi-Speed	
TM185M	Urethane	TM	Yes	1kW		NA	
B150M	Bronze	TH-LP	Yes	300W	95-155 kHz	NA	
TM150M	Plastic	TM	Yes	300W		NA	
SS75H	Stainless	TH-LP	Yes	600W	130-210 kHz	NA	
SS75M	Stainless	TH-LP	Yes	600W	8-130 kHz	NA	
SS75L	Stainless	TH-LP	Yes	300W	40-75 kHz	NA	
TH = Thru Hull, LP = Low Profile, TM = Transom Mount, IH = In Hull							

Typical Non-CHIRP Fish Finders operate with a maximum duty cycle of 1%, meaning they transmit a voltage to the transducer no more than 1% of the time. The rest of the time, they are listening for return echoes. Consequently the transmit pulse can be high power but of very short duration, limiting the total energy that is transmitted into the water column. Because the CHIRP transmission lasts for a longer amount of time, more energy is directed into the water column. The equivalent energy transmitted into the water can be up to 1,000 times greater than a conventional Fish Finder, resulting in more energy on target. Because of these two factors, greater energy over a wide frequency range, a CHIRP Fish Finder can effectively deliver up to 5x greater resolution and depth capability than standard Fish Finders.

Dual-Band CHIRP Transducers

CHIRP across a combination of two distinct ranges of high, medium, or low frequencies..

Transducer Part number	Housing Type	Mount Type	Temp Sensor	Power Rating	Low Frequencies	High Frequencies	Fairing Block	Compatible Models
CM599LHG	Urethane	Pocket	Yes	2-3kW	28-60 kHz	130-210 kHz	NA	FCV1900, FCV1900B, FCV1900G, FCV295, FCV1150, DI-FFAMP
R509LH	Urethane	TH	Yes	2-3kW			Hi-Speed	FV295, FCV1150, FCV1900, DFF3-UHD, DI-FFAMP
R599LH	Urethane	IH	No	2-3kW			NA	DFF3, DFF3-UHD, DI-FFAMP
CM599LHW	Urethane	Pocket	Yes	3kW	28-60 kHz	150-250 kHz	NA	FCV1900B, DFF3-UHD, DI-FFAMP
CM599LM	Urethane	Pocket	No	3kW	28-60 kHz	80-130 kHz	NA	FCV1900, FCV1900B, DFF3-UHD, DI-FFAMP
PM111LHG	Urethane	Pocket	Yes	2kW	38-75 kHz	130-210 kHz	NA	FCV1900, DI-FFAMP, DFF3-UHD
PM111LM	Urethane	Pocket	Yes	2kW	38-75 kHz	80-130 kHz	NA	FCV1900, FCV1900B, DFF3-UHD, DI-FFAMP
PM411LWM	Urethane	Pocket	Yes	2kW	40-60 kHz	80-130 kHz	NA	DFF3-UHD
B265LH	Bronze	TH	No	1kW	42-65 kHz	130-210 kHz	Hi-Speed	FCV1900B, DFF1-UHD
B265LHG	Bronze	TH	No	1kW			Hi-Speed	FCV1900, FCV1900G, DFF1-UHD
CM265LHG	Urethane	Tank	No	1kW			NA	
PM265LH	Bronze	Pocket	Yes	1kW				DFF1-UHD
PM265LH-12P	Bronze	Pocket	Yes	1kW				TZT12F, TZT16F, TZT19F
B275LHW	Bronze	TH	Yes	1kW		150-250 kHz	Hi-Speed	DFF1-UHD
B275LHW-12P	Bronze	TH	Yes	1kW			Hi-Speed	TZT12F, TZT16F, TZT19F
CM275LHW	Urethane	Tank	No	1kW			NA	FCV1900, FCV1900B
CM275LHW-12P	urethane	Tank	No	1kW				TZT12F, TZT16F, TZT19F
PM275LHW	Bronze	Pocket	Yes	1kW				DFF1-UHD
PM275LHW-12P	Bronze	Pocket	Yes	1kW				TZT12F, TZT16F, TZT19F
TM275LHW	Plastic	TM	Yes	1kW				DFF1-UHD
TM275LHW-12P	Plastic	TM	Yes	1kW				TZT12F, TZT16F, TZT19F
CM265LM	Urethane	Pocket	Yes	1kW		85-135 kHz	NA	FCV1900



What is the DFF3D, and how does it work?

The DFF3D is a Multibeam Sonar designed for NavNet TZtouch, TZtouch2, and TZtouch3 series MFDs. The DFF3D transmits 41 individual beams, covering a 120° water column between port and starboard. The DFF3D is very effective in analyzing a wide area, detecting bottom contours and targets that otherwise might have been missed with a conventional Fish Finder.

The DFF3D offers four presentations: Cross Section, Multi-Sounder, 3D Sounder History, and Side Scan, as well as a Personal Bathymetric Generator (PBG) function for NavNet TZtouch3.

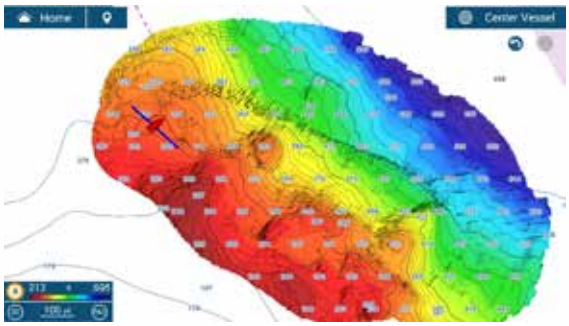
Cross Section: Conventional Fish Finders show echoes, but you cannot see whether the fish is located on the port side, starboard side, or right below. The Cross Section screen shows the water under the boat in a 120° range. In the example at right, you can easily see a fish school on the port side of the boat. Think of this mode as an extremely wide A-scope. Just like a conventional A-scope, targets are real time, not historical.

Multi-Sounder: The Multi-Sounder screen shows triple beams for port (left), center (down), and starboard (right). In the above example, the port side has more fish targets than the center or starboard side. To focus on the center only, the single beam window is also available that operates as a conventional 40° Fish Finder. The beam angle of triple beam and the beam width of triple and single beams can be adjusted.

3D Sounder History: The 3D Sounder History screen shows the bottom shape and fish location in 3D. The view angle can be adjusted by dragging the screen so that you can easily analyze the bottom shape and the location of fish targets. In the 3D Sounder History screen, the bottom image is drawn in a single line at the same picture advance speed regardless of boat heading and speed. When the boat rotates rapidly, the 3D image on the screen may look different from the actual one.

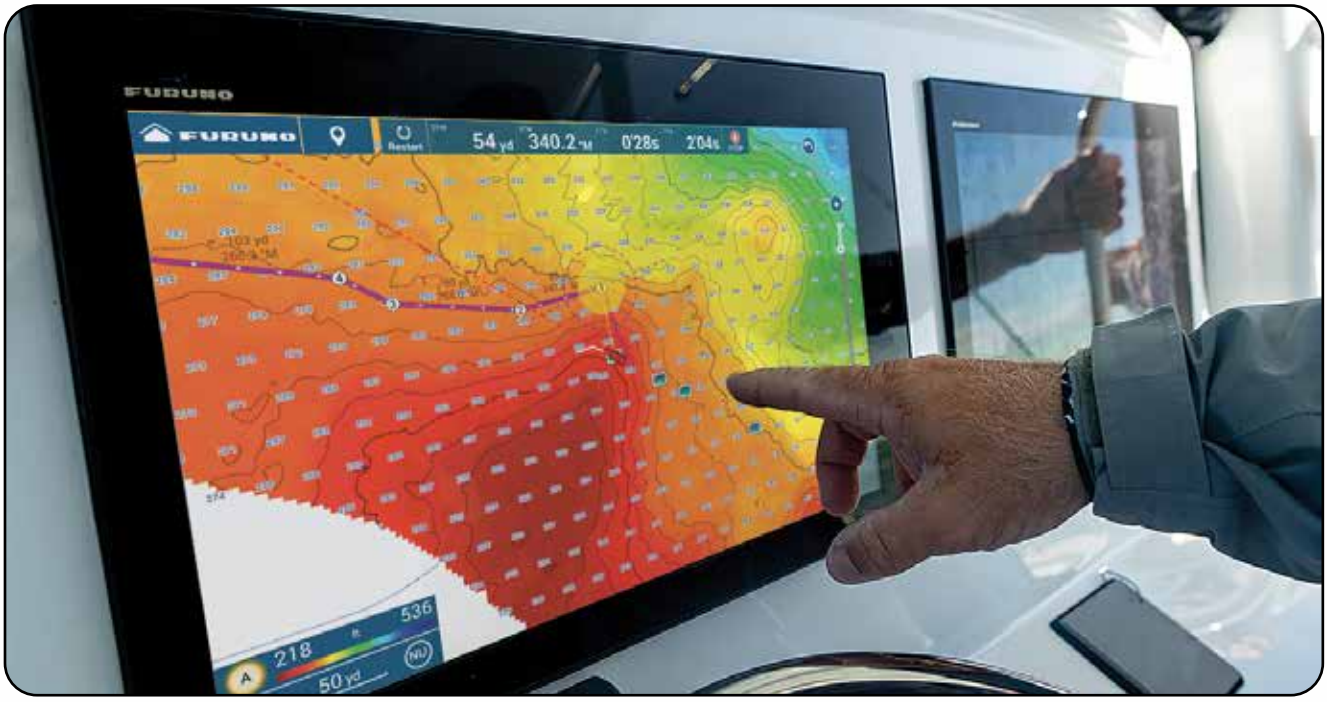
Side Scan: In the Side Scan screen, the seabed is drawn at both sides of the screen to focus on port and starboard images. This mode is suitable to analyze detailed bottom structures such as a reef.

PBG: The DFF3D's PBG (Personal Bathymetric Generator) function for NavNet TZtouch3 and NavNet TZtouch2 TZTBB lets you leverage the Multibeam Sonar's wide detection range to quickly generate your own shaded relief bathymetric charts as you navigate. Bottom images are drawn with shaded relief, depth contours, and variable colors, making it easy to identify hidden structure and ridges that hold fish in a simple, easy-to-interpret presentation. The area each ping covers is approximately twice the depth at the time of recording, so at a depth of 100', a 200' wide area is displayed and recorded to your MFD, complete with spot soundings for at-a-glance knowledge of depths. Your custom bathymetric charts are stored on your MFD, which comes with enough memory to save a lifetime of PBG data.



Follow-It instantly creates a constant-depth route!

The amazing Follow-It feature leverages the power of the DFF3D's PBG (Personal Bathymetric Generator) function to instantly create a constant-depth route so you can easily navigate a specific contour on your PBG chart. With just a swipe and tap, Follow-It creates a white line on the PBG chart indicating the constant depth. Tapping the line instantly transforms it to an active route, sent directly to your NavPilot Autopilot. Your NavPilot will follow the depth route all the way around a ridge or trough. By following specific depth contours, you can keep your baits at the same level as the fish while trolling withouthaving to constantly adjusting the reels. Keeping your bait at the correct depth is critical to catching fish in areas where tide and currents flow along structure where gamefish concentrate.



DFF3D Multibeam Sonar Transducers

A motion sensor that stabilizes the display is built in to every Furuno DFF3D transducer.

Transducer Part number	Housing Type	Mount Type	Power Rating	Frequency	Fairing Block	Compatible Models
Combination DFF3D / Fish Finder Transducers						
165T-50/200-TM260	Bronze	TH	1kW	165 kHz and 50/200 kHz	Hi-Speed	DFF3D and TZT12F, TZT16F, TZT19F
165T-50/200-SS260	Stainless	TM	1kW		NA	
165T/275LHW	Urethane	IH	1kW	165 kHz and CHIRP 42-65 / 150-250 kHz	NA	DFF3D and DFF1-UHD
165T/275LHW-12P	Urethane	IH	1kW		NA	DFF3D and TZT12F, TZT16F, TZT19F
165T/265LH-PM488	Urethane	IH	1kW	165 kHz and CHIRP 42-65 / 130-210 kHz	NA	DFF3D and DFF1-UHD
165T/265LH-PM488-12P	Urethane	IH	1kW		NA	DFF3D and TZT12F, TZT16F, TZT19F
165T-PM542LM	Urethane	IH	2kW	165 kHz and CHIRP 30-60 / 80-130 kHz	NA	DFF3D and DFF3-UHD
165T-PM542LHW	Urethane	IH	2kW	165 kHz and CHIRP 30-60 / 150-250 kHz	NA	
DFF3D Transducers						
165T-B54	Bronze	TH		165 kHz	Hi-Speed	DFF3D
165T-CM54	Urethane	IH			NA	
165T-SS54	Stainless	TH			Hi-Speed	
165T-TM54	Plastic	TM			NA	

What is Side-Scan?

A standard Fish Finder scans directly beneath your vessel. Side-Scan shows you what is out there on both the port and starboard sides of the boat. Side-Scan allows you to see the shape of structures for fishing inshore or along the coast, identify bottom structure not shown on your navigation charts, and avoid the risk of collision by unintentionally drifting into shallow areas. You can also easily identify the presence of fish targets around structures before casting your lure or jig, which is game-changing information for any fishermen used to being able to detect fish targets only once they're on top of them!

CHIRP SIDE-SCAN

Side-Scan has a reputation for producing near-photo-quality images, making it simple to instantly identify what you see on the screen. This hightened resolution is due to the very high frequency range that most Side-Scan systems on the market operate in. As shown in the previous section on Frequency, remember that the cost for those high resolution images is range, and most Side-Scan equipment available for the fisherman are effective only at very short ranges and very slow speeds. This is why Furuno has specifically selected a CHIRP frequency range that is lower than most other Side-Scan equipment, but higher than standard Fish Finders. This allows you to see targets at the furthest Side-Scan distance possible while maintining remarkable image clarity, helping you understand what is around your vessel at distances up to 750 feet.

TruEcho CHIRP Side-Scan Transducers

TruEcho CHIRP Side-Scan is a built-in feature of NavNet TZtouch3 TZT12F/TZT16F/TZT19F and NavNet TZtouchXL TZT10X/TZT13X/TZT16X MFDs.

Transducer Part number	Housing Type	Mount Type	Power Rating	Frequency	Fairing Block	Compatible Models
225T-PR904	Urethane	TH	150 Watts Each Side	220-240 kHz	Included	NavNet TZtouch 3 TZT12F/TZT16F/TZT19F NavNet TZtouchXL TZT10X/TZT13X/TZT16X
225T-SS904	Urethane	Paired TH			Optional	
225T-TM904	Urethane	TM			NA	
455T-PR903	Urethane	TH		445-465 kHz	Included	NavNet TZtouchXL TZT10X/TZT13X/TZT16X
455T-SS903	Urethane	Paired TH			Optional	
455T-TM903	Urethane	TM			NZ	

Some Furuno features require a dual frequency transducer

There are features of some Furuno Fish Finders that require specific CW 50/200 kHz transducers to operate. When selecting a transducer for these Fish Finders, select from the list of what we call 'Bottom Discrimination Transducers' in order to take advantage of these useful features.

RezBoost

RezBoost™ is a revolutionary signal processing technology that improves resolution and target separation when using conventional narrowband transducers. With RezBoost™ technology, not only can you expect higher resolution and crisper visuals, but also improvements in the ACCU-FISH™ function. You'll be able to spot individual game fish surrounding bait balls, as well as pick out fish close to the seabed

ACCU-FISH

ACCU-FISH is a revolutionary fish size assessment function. In order to assess individual fish size, the echo strength from the fish needs to be computed and turned into fish size display on the screen. It can detect fish size of 4" to 80", in depths of 7 to 300 feet.

Activating the **ACCU-FISH** from the menu, the display will show fish size on the individual fish echo. When the **ACCU-FISH** is used concurrently with fish marks, it greatly helps anglers to identify fish targets on the display. You may also select and display the target depth instead of fish size, which helps to see how far the fish is from the boat.

The fish mark can be utilized to display on individual fish echoes when detected. It helps beginners to identify the fish targets on the display for a more fun fishing experience. Fish mark is selectable from two types of fish symbol, circle and square. The fish symbol, displayed in two different sizes (Large: over 10" , Small: 4" to 9"), is a great help for anglers to identify fish targets. Circle and square marks are used to identify targets without hiding fish echo.

BOTTOM DISCRIMINATION

The **Bottom Discrimination** feature enables the fish finder to indicate if the major component of the bottom is rocks, gravel, sand or mud.

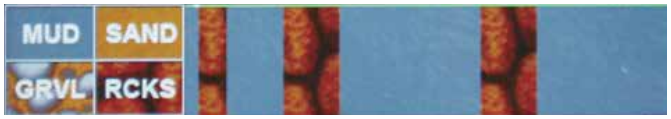
The **Bottom Discrimination** Function provides you with valuable information to locate rich fishing grounds, while boosting your catch of the day.

Keep the following in mind when using a **Bottom Discrimination** Sounder:

1. Use at a depth of 16 - 325 feet
2. Use a transom or thru-hull mounted transducer
3. To show a consistent display, set the range of the fish finder to "auto"
4. Enter your ship's draft value
5. Use a ship speed of 10 knots or less

Probability Mode:

Standard Mode:



Transducers - 50/200kHz

Transducer Part number	Power Rating	Beam Angle	Housing Type	Plug Type	Mount Type	Temp	Fairing Block	Compatible Models
520-5MSD	600W	46/10	Bronze	10 Pin	TH	NO		BBDS1, FCV628, FCV588, GP1871F, GP1971F, TZT9F, TZT12F, TZT16F, TZT19F, TZT2BB, GP3700F, FCV295, FCV1150, FCV1900
520-5PSD	600W	46/10	Plastic	10 Pin	TH	NO		
525-5PWD	600W	46/10	Plastic	10 Pin	TM	NO		
525T-PWD	600W	40/10	Plastic	10 Pin	TM	YES		
525T-PPD	600W	45/11	Plastic Puck	10 Pin	TM	YES		
520-BLD	600W	45/12	Bronze	10 Pin	TH-LP	NO		
520-IHD†	600W	45/11	Plastic	10 Pin	IH	NO		
520T-BLD	600W	45/15	Bronze	10 Pin	TH-LP	Yes		
520-PLD	600W	45/12	Plastic	10 Pin	TH-LP	NO		
525TID-BHD	1KW	50 = 3x5 200 = 15x21	Bronze	10 Pin	TH	YES	AIR-033-523**	
525T-BSD	600W	45/12	Bronze	10 Pin	TH	YES	AIR-033-351 AIR-033-352**	
525T-LTD/12 or 525T-LTD/20	600W	45/12 Tilted	Bronze	10 Pin	TH-LP	YES		
526TID-LTD/12 or 526TID-LTD/20	1KW	20/6 Tilted	Bronze	10 Pin	TH-LP	YES		
555-SLTD/12 or 555-SLTD/20	600W	20/6 Tilted	SS	10-Pin	TH-LP	YES		
556TID-LTD/12 or 556TID-LTD/20	1KW	20/6 Tilted	SS	10-Pin	TH-LP	YES		
SS60-SLTD/12 or SS60-SLTD/20	600W	45/12	SS	10 Pin	TH-LP	YES		
CA50/200-12M *	1KW	28/8.5	Bronze	NC	TH	NO		
CA50/200-1T *	1KW	28/8.5	Rubber	NC	C, H, T	NO		
526TID-HDD **, ***	1KW	19/6	Bronze	10 Pin	TH	YES	AIR-033-391**	
526TID-HDN *, **, ***	1KW	19/6	Bronze	NC	TH	YES	AIR-033-391**	
525TID-TMD	1KW	19/6	Urethane	10 Pin	TM	YES		
527ID-IHD ***	1KW	19/6	In Hull	10 Pin	IH	NO		
527ID-IHN*, ***	1KW	19/6	In Hull	NC	IH	NO		
556TID-HDD **, ***	1KW	19/6	SS/Urethane Broadband	10 Pin	TH	YES	(TBA, included)	
556TID-HDN*, **	1KW	19/6	SS	NC	TH	YES	(TBA, included)	

* Must connect to MB1100 to use with: BBDS1, FCV628, FCV588, GP1871F, GP1971F, NavNet TZtouch3, TZT2BB, or GP3700F
** High Performance Fairing Block included;
*** Broadband Transducer (200 kHz function only)
† Includes connector for optional Speed/Temp

Legend: W=Watts, KW = Kilowatts, SS = Stainless Steel, NC = No Connector, TH - Thru Hull, TM = Transom Mount, IH = In Hull, LP = Low Profile,
Some of these transducers are available with 8-Pin connectors for use with older Furuno CRT model sounders. See your Furuno dealer for availability.

High-Power Transducers - 50 or 200 kHz

Furuno offers a wide selection of multi sensors for use with our recreational fish finders. Multi sensors, also referred to as triducers, combine standard 50/200 kHz transducers with speed and temperature functions into a single package. The benefit of having a multi sensor is ease of installation, since there is only one unit to be installed that provides depth, speed and temperature functions. Furuno offers a variety of multi sensors that are cost-effective and very efficient for most recreational applications.

Transducer Part number	Power Rating	Beam Angle	Housing Type	Plug Type	Mount Type	Compatible Models
Single Frequency, High Power 200 kHz						
CA200B-5S**	1kW	8.5	Rubber	NC	C, H, T	BBDS1, FCV628, FCV588, GP1871F/GP1971F, TZT12F, TZT16F, TZT19F, TZT2BB, GP3700F, FCV295, FCV1150, FCV1900
CA200B-8B**	2kW	5.5	Rubber	NC	C, H, T	BBDS1, DFF3, FCV628, FCV588, GP1871F/GP1971F, TZT12F, TZT16F, TZT19F, TZT2BB, GP3700F, FCV295, FCV1150, FCV1900
CA200B-12H**	2kW	16 x 16	Rubber	NC	T	
Single Frequency, High Power 50 kHz						
SS264W-50/12*	1 kW	25	SS	10 P	TH-LP	BBDS1, FCV628, FCV588, GP1871F/GP1971F, TZT12F, TZT16F, TZT19F, TZT2BB, GP3700F, FCV295, FCV1150, FCV1900
SS264W-50/20*	1 kW	25	SS	10 P	TH-LP	
CA50B-6B**	1kW	28	Rubber	NC	C, H, T	
CA50B-9B**	1kW	12 X 28	Rubber	NC	C, H, T	
CA50B-6G**	1kW	28	Rubber	NC	T	
CA50BL-12HR	2kW	14 X 18.5	Rubber	NC	T	DFF3, DFF3-UHD, DI-FFAMP, FCV295, FCV1150, FCV1900
CA50BL-24HR	3kW	9 X 14	Rubber	NC	T	
CA50F-38	5 kW	8	Rubber	NC	T	
CA50F-70	10kW	6	Rubber	NC	T	
* 12-degree or-20 degree tilted element with temperature sensor * Must connect to MB1100 to use with: BBDS1, FCV628, FCV588, GP1871F, GP1971F, NavNet TZtouch3, TZT2BB, or GP3700F						

Multi Sensors - 50/200kHz

Furuno offers a wide selection of multi sensors for use with our recreational fish finders. Multi sensors, also referred to as triducers, combine standard 50/200 kHz transducers with speed and temperature functions into a single package. The benefit of having a multi sensor is ease of installation, since there is only one unit to be installed that provides depth, speed and temperature functions. Furuno offers a variety of multi sensors that are cost-effective and very efficient for most recreational applications.

Transducer Part number	Power Rating	Beam Angle	Housing Type	Plug Type	Mount Type	Temp	Speed	Fairing Block	Compatible Models
Dual Frequency 200 & 50 kHz Multi Sensors									
525STID-PWD	600W	45/11	Plastic	10 Pin	TM	YES	YES	na	BBDS1, FCV628, FCV588, GP1871F/ GP1971F, TZT9F, TZT12F, TZT16F, TZT19F, TZT2BB, GP3700F
525STID-MSD	600W	45/12	Bronze	10 Pin	TH	YES	YES	AIR-033-428 AIR-033-476** (HSFB included)	
525STID-MSD7	600W	45/12	Bronze 7" Stem	10 Pin	TH	YES	YES	AIR-033-080**	

Speed & Temp Sensors

Furuno speed and temperature sensors offer highly accurate data for your fish finder or digital temperature display. Unlike Smart Sensors, these sensors require a connection to specific equipment, either as an insert for a matching transducer or as a component of a dedicated system, such as the T-2000 Digital Temperature Display.

Model	Functions	Housing Style
ST-01PTB	Speed and Temperature (+/ - 1 degree)	S63 Plastic Clip On (requires Transom Mount Bracket, part # AIR-020-058)
ST-02MSB	Speed and Temperature (+/ - 1 degree)	B17 Bronze Thru-Hull
ST-02PSB	Speed and Temperature (+/ - 1 degree)	P17 Plastic Thru-Hull
T-04MSB	Temperature (+/ - 1 degree)	Bronze Thru-Hull

Transducers - Other frequencies

Commercial transducers such as these are generally mounted in tanks or sea chests that are custom-built into the ships hull. Some transducers are designed exclusively for use with Net Sounders, while others are used by commercial fishermen or other high seas vessels that require the most reliable depth sounders available.

Transducer Part number	Frequency	Power Rating	Beam Angle	Housing Type	Plug Type	Mount Type	Compatible Models
CA28BL-6HR	28kHz	2kW	22 x 32	FRP	NP	Tank	DFF3, DI-FFAMP, FCV295, FCV1150,
CA28BL-12HR	28kHz	3kW	16 x 21.5	FRP	NP	Tank	
CA28F-38M	28kHz	5kW	14	Rubber Coated	NP	Tank	
CA28f-72	28kHz	10kW	12 x 16	Rubber Coated	NP	Tank	
CA28F-8	28kHz	1kW	31 x 34	Rubber Coated	NP	Tank	DFF3, FCV295, FCV1150
CA38BL-9HR	38kHz	2kW	20.5 x 20.5	FRP	NP	Tank	DFF3, DI-FFAMP, FCV295, FCV1150,
CA38BL-15HR	38kHz	3kW	12.5 x 21	FRP	NP	Tank	
CA88F-126H	88kHz	5kW	4 x 5	Rubber Coated	NP	Tank	
CA88B-10	88kHz	2kW	8	Rubber Coated	NP	Tank	
CA88B-8	88kHz	1kW	11	Rubber Coated	NP	Tank	DFF3, DI-FFAMP, FCV295, FCV1150,
CA100B-10R	107kHz	3kW	8 x 13	Rubber Coated	NP	Tank	DFF3, DI-FFAMP, FCV295, FCV1150,
CA82B-35R	65k or 88 kHz or 110kHz	2kW	12.5 or 9,6 or 7.7	Rubber Coated	NP	Tank	

Variable Frequency Transducers

The variable frequency of these transducers allows you to change the beamwidth and depth capabilities. If you are bottom fishing in 200' of water, the narrow high-frequency beam will display extreme bottom detail and fish holding tight to structure. If you are fishing in deep blue water, the wider, low-frequency beam will not only give deep-water bottom detail, but more importantly show you more of what is around your vessel, including bait which may attract game fish. Because the bandwidth covers a continuous frequency spectrum, next generation Fish Finders utilizing Furuno Free Synthesizer (FFS) technology can be made "tunable", so you can "dial-in" the best frequency for the target fish species or conditions.

Transducer Part number	Power Rating	Beam Angle	Housing Type	Plug Type	Mount Type	Temp	Speed	Compatible Models
Variable Frequency, High Power								
R209TIDN	2/3KW	*	Urethane	NC	TH	YES	NO	DFF3, DFF30UHD, FCV295, FCV1150, FCV1900, DI-FFAMP
R299ID-IHN	2/3KW	*	Urethane	NC	IH	NO	NO	
R309TIDN	2/3KW	*	Urethane	NC	TH	YES	NO	
R399ID-IHN	2/3KW	*	Urethane	NC	IH	NO	NO	DFF3, FCV295, FCV1150, FCV1200 and BB Models
CA82B-35R	2KW	*	FRP	NC	T	NO	NO	DFF3, FCV295, FCV1150, FCV1200 and BB Models
*Beam Angle varies with frequency - higher frequency = narrower beam angle								

Smart Sensors

If you are looking for a solution to show you precision depth in water as shallow as 2 feet and temperature changes as minute as 2/100^{ths} of a degree, then the Furuno Smart Sensor is the answer.

What is a Smart Sensor?

Furuno Smart Sensors are transducers specifically designed to give an accurate numerical value for depth instead of painting an image on the screen. Smart Sensors are available in a variety of housing styles and can be transom or thru-hull mounted on the vessel. Processing of the return echoes is accomplished by circuitry within the transducer housing and then output as NMEA0183 or NMEA2000 information - electronic text that can be interpreted and displayed by a variety of Furuno electronics such as GPS, chart plotters, NavNet, FI70 Series Instruments, or our popular RD33 NMEA data repeater. Molded, waterproof 7-pin or 10-pin connectors connect directly to these and many other Furuno products.

P17 Plastic Thru-Hull

NMEA0183 Models	Functions	Housing Style
235DT-PSE	Depth and Temperature (+/ - 1 degree)	P17 Plastic Thru-Hull
235DST-PSE	Depth, Speed and Temperature (+/ - 1 degree)	P17 Plastic Thru-Hull
235DT-MSE	Depth and Temperature (+/ - 1 degree)	B17 Bronze Thru-Hull
235DST-MSE	Depth, Speed and Temperature (+/ - 1 degree)	B17 Bronze Thru-Hull
235DHT-MSE	Depth and Precision Temperature (+/- 0.02 degree)	B17 Bronze Thru Hull
235DHT-LMSE	Depth and Precision Temperature (+/- 0.02 degree)	B122 7" Bronze Thru Hull

NMEA2000 Models	Functions	Housing Style
DST-810PSF	Depth, Speed and Temperature (+/ - 1 degree)	P17 Plastic Thru-Hull
DST-800PWF	Depth, Speed and Temperature (+/ - 1 degree)	P17 Plastic Thru-Hull
DT-800PSF	Depth and Temperature (+/ - 1 degree)	P66 Plastic Transom Mount
DST-810MSF	Depth, Speed and Temperature (+/ - 1 degree)	B17 Bronze Thru-Hull
DT-800MSF	Depth and Temperature (+/ - 1 degree)	B17 Bronze Thru Hull
235-MSLF	Depth and Temperature (+/ - 1 degree)	B122 7" Bronze Thru Hull
235-IHF	Depth only	P79 Plastic In Hull

All Smart Sensors operate at 235 kHz, so they will never interfere with your Fish Finder.

B17 Bronze Thru-Hull

B122 7" Bronze Thru-Hull

Transducer FAQ's

We've gathered a short list of frequently asked questions about transducers and provided the answers in this section. If you have a question that is not answered in this book, you can visit us on the web at www.FurunoUSA.com and click on Support. You can browse through our comprehensive library of answers to questions, or search for your answer by model, topic or keyword. If you can't find the answer you're looking for, you can always send an Email directly from our web site to our technical support staff. A knowledgeable technician will respond with your answer, generally within 48 hours.

Q: My transducer needs to be cleaned frequently. Is there any type of paint I can use to prevent barnacles, algae and marine growth from fouling it?
A: There are several manufacturers of anti-fouling marine paint. Furuno recommends the use of "Foul Free" by Airmar.

Q: What type of housing should I choose for my transducer?
A: The type of housing you select depends on the hull where it will be installed:

- A plastic housing is recommended for fiberglass or metal hulls only. Never install a plastic thru-hull sensor in a wood hull, since swelling of the wood may overstress the plastic and cause a fracture.
- A bronze housing is recommended for fiberglass or wood hulls only. Never install a bronze housing in a metal hull, because electrolytic corrosion will occur.
- A stainless steel housing is recommended for metal hulls to prevent electrolytic corrosion.
- Never install a metal housing in a vessel with a positive ground system.

Q: Will a fairing affect the performance and top-speed of my boat?
A: The size of the transducer will have some affect on the top-speed of the boat. However if you use a high-performance fairing, the loss will be minimal. Some people report a decrease of one or two knots. Generally, a 30 foot (10m) or longer boat will see almost no speed loss.

Q: Can I cut my transducer cable?
A: Yes, the transducer cable can be cut. However, if the transducer came with a connector do not cut it off. The molded on connector is waterproof. You need to cut and splice the cable away from the connector using Airmar's splash-proof Junction Box. The connections will not corrode and the strain relief grommets are water resistant and have excellent cable retention. Please note that cutting the cable or removing the connector, except when using Airmar's junction box, will void the sensor warranty. You can buy a junction box and splice kit from Gemeco.

Phone: (803) 693-0777 Email: info@gemeco.com

Q: Why does my depth sounder fail when I reach moderate speed?
A: If a sounder works fine at slow speeds but gradually loses the bottom as the vessels speed increases, it is an indication that aerated water is flowing over the transducer. Rather than relocate a thru-hull transducer, try installing it with a high-performance fariring. High-performance fairings are designed to improve a sounder's performance at speeds above 17MPH (15kn). It is much longer than its companion transducer. The elongated streamlined shape cuts smoothly through the water, so there is less aerated water flowing over the transducer's face.

Q: Can I upgrade my CRT Fish Finder display to an LCD display but keep my transducer?
A: Most Furuno's LCD Fish Finders use a 10-pin transducer, while our older CRT models use an 8-pin transducer. Use the adapter part # AIR-033-204 to connect your 8-pin transducer to a newer, 10-pin Furuno LCD Fish Finder or combo unit.

For more FAQ information, visit our web site at www.FurunoUSA.com/Support

Definitions

Acoustic: Relating to sound and sound waves.

Acoustic Property: The ability of a material to carry sound through it.

Acoustic Window: That part of the transducer through which the ultrasonic vibrations from the piezoceramic assembly travel to water.

Air Bladder: An organ in a fish which allows it to adjust to changes in water pressure at different depths.

Amplitude: The degree of intensity (pressure) of a sound wave. If we could hear the sound wave, amplitude would be it's 'loudness.'

Array: A series of elements in a transducer.

Beamwidth: The diameter of a circle in which 50%-70% of the sound waves emitted by the transducer are concentrated.

CHIRP: Compressed High Intensity Radar Pulse. CHIRP transducers vibrate across a range of frequencies within each 'pulse.' Sometimes referred to as 'Broadband.'

Cone Angle: The measurement of beamwidth in degrees. indicates how large an area is covered by a transducer's soundbeam.

dB: Abbreviation for decibel, a unit for measuring the power of a sound wave.

Echosounder: An instrument comprised of a display screen and electronic circuitry used to interpret information from the transducer and display it in a readable format.

Frequency: The number of complete cycles or vibrations that occur within a specific time frame, typically one second. Usually measured in Hertz.

Hertz: A measure of one cycle or complete vibration per second.

In-Hull: The method of installing a transducer by attaching it to the inside of the hull.

Multisensor: A combination of three sensing devices (depth, speed and temperature) in a single housing.

Phased Array: A series of piezoceramic elements in a transducer, typically wired to allow them to fire in time delayed sequence so the echosounder can electronically steer the array.

Piezoceramic Element: A material made of crystals with positive and negative charges.

Resolution: The sounders ability to show fine detail and to discriminate between individual objects.
Sidelobes: Portion of the acoustic image that lies outside of the main sound beam.

Sonar: Derived from the words Sound Navigation and Ranging. An apparatus that uses reflected sound waves to detect and locate objects underwater.

Thru-Hull: A method for installing a transducer through a hole in the hull.

Transducer: A device that changes electrical energy to acoustic energy and back again.

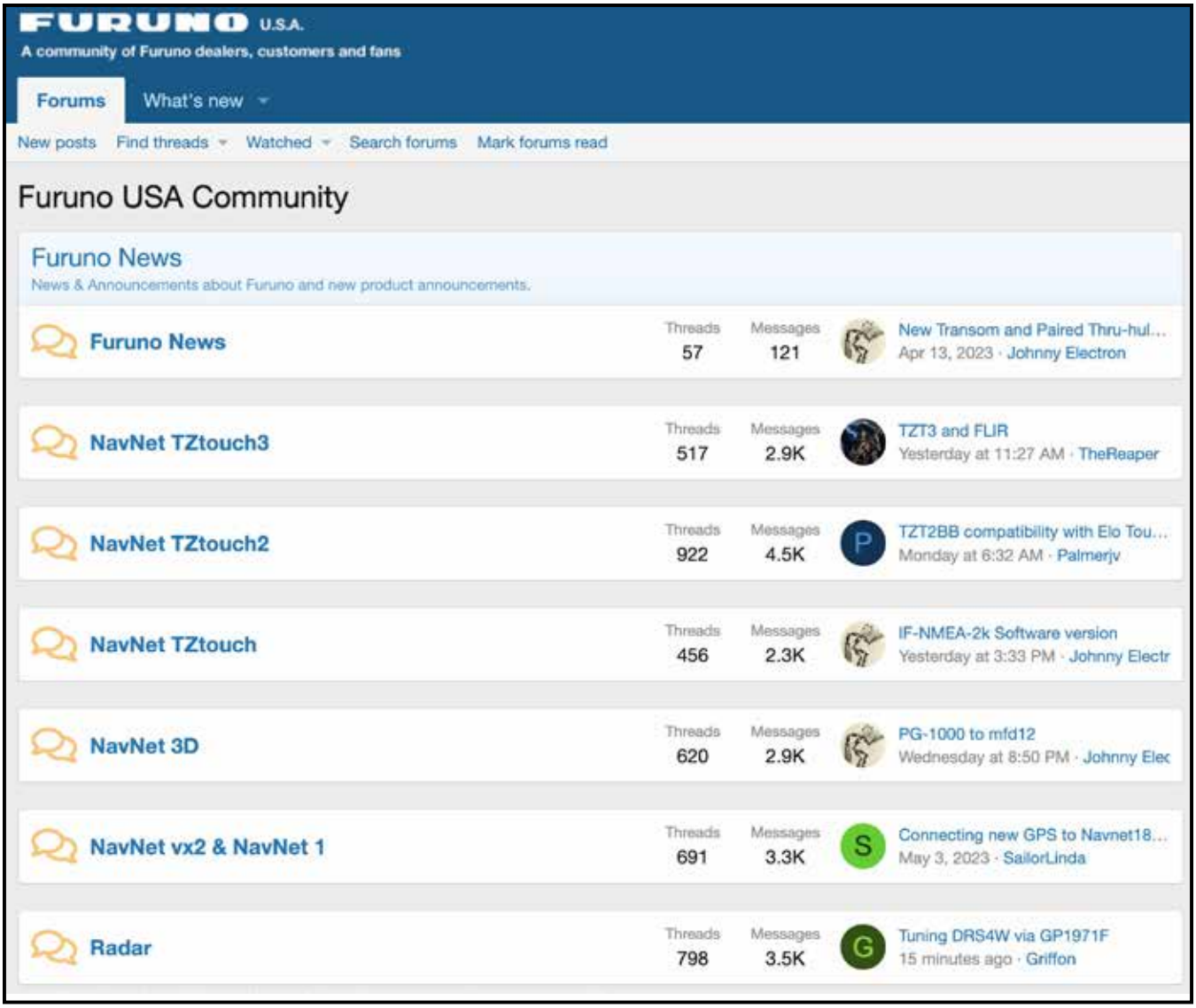
Transom Mount: A method of installing a transducer on the back (transom) of the boat.

Ultrasonic: Sound waves of high frequency (above 20,000 Hertz) that cannot be heard by humans.

Additional Resources

www.FurunoUSAForum.com:

The Furuno USA Forum is the place to get all of your technical questions answered by our own factory-trained technicians as well as industry professionals and end users alike. The free Furuno Forum is a fantastic resource for getting quick answers to all of your questions about the operation, installation, and maintenance of your Furuno electronics.



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[1] TZT9F is a Single-Channel 1kW TruECHO CHIRP™ [2] Compatible with TZT12F/16F/19F only [3] Requires external sensor

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