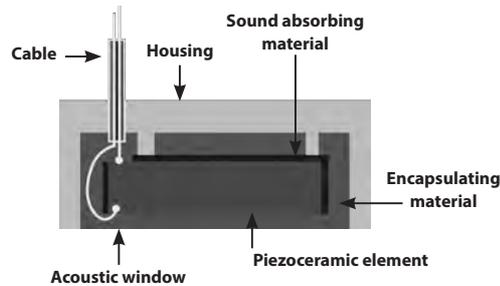


# TRANSDUCERS AN OVERVIEW AIRMAR

## What Goes into the Making of a Transducer?

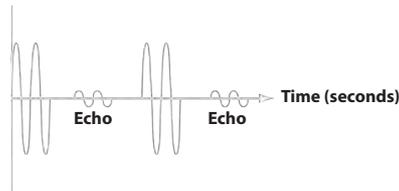
The main component of a depth transducer is the piezoceramic element. It is the part that converts electrical pulses into sound waves, and when the echoes return, the piezoceramic element converts the sound waves back into electrical energy. Piezoceramic elements are most often in a disk form, but they may also be in the shape of a bar or a ring. A transducer may contain one element or a series of elements linked together called an array. A transducer is made up of six separate components:

- Piezoceramic element or an array of elements
- Housing
- Acoustic window
- Encapsulating material
- Sound absorbing material
- Cable



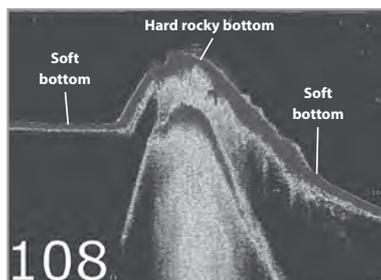
## How Does a Transducer Know How Deep the Water is?

The echosounder measures the time between transmitting the sound and receiving its echo. Sound travels through the water at about 1,463 m/s (4,800 ft/s), just less than a mile per second. To calculate the distance to the object, the echosounder multiplies the time elapsed between the sound transmission and the received echo by the speed of sound through water. The echosounder system interprets the result and displays the depth of the water in feet for the user.



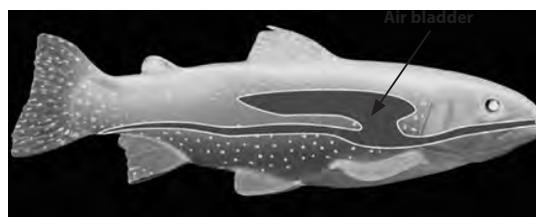
## How Does a Transducer Know What the Bottom Looks Like?

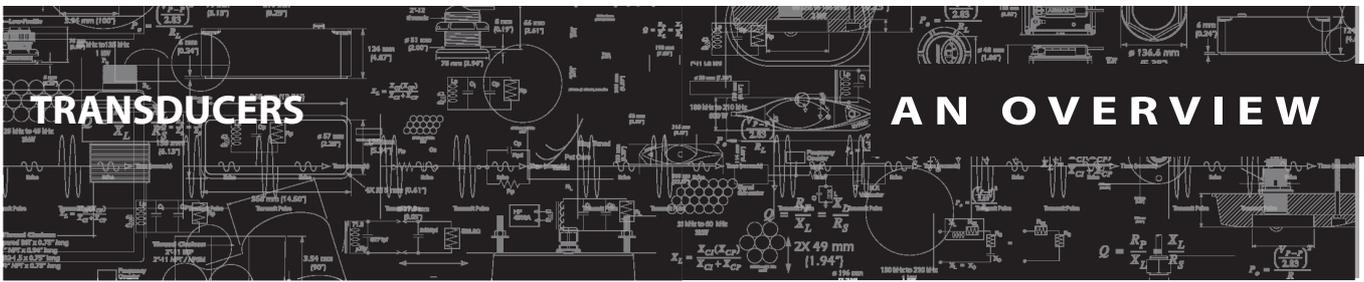
As the boat moves through the water, the echoes of some sound waves return more quickly than others. We know that all sound waves travel at the same speed. When a sound wave in one section of the sound field returns more quickly than another, it is because the wave has bounced off something closer to the transducer. These early returning sound waves reveal all the humps and bumps in the underwater surface. Transducers are able to detect whether a bottom is soft or hard and even distinguish between a clump of weeds and a rock, because the sound waves will echo off of these surfaces in a slightly different manner.



## How Does a Transducer Detect Fish?

The transducer can detect fish, because it senses the air bladder. Almost every fish has an organ called an air bladder filled with gas that allows the fish to easily adjust to the water pressure at different depths. The amount of gas in the air bladder can be increased or decreased to regulate the buoyancy of the fish. Because the air bladder contains gas, it is a drastically different density than the flesh and bone of the fish as well as the water that surrounds it. This difference in density causes the sound waves from the echosounder to bounce off the fish distinctively. The transducer receives the echoes and the echosounder is able to recognize these differences. The echosounder then displays it as a fish.





## Broadband versus Non-Broadband

Airmar achieves superior results by using a unique ceramic material. It lets transducers operate over a broad range of frequencies while maintaining sensitivity. These Broadband Transducers are, by definition, low-Q devices (refer to “Q” paragraph). In other words, they exhibit very low ringing. There is little variation from transducer to transducer. Additionally, Broadband Transducers are relatively immune to the effects of aging, so their frequency range remains stable over time.

Airmar is the first to introduce affordable Broadband Transducers. This is an enabling technology that provides better fish detection today and will lead to dramatic advances in echosounder performance in the future. While these transducers are more costly to manufacture, the present and future benefits are huge.

Broadband Transducers enhance fish detection on virtually all of today’s fishfinders. They give better definition; it is far easier to distinguish among individual fish and between fish and the bottom.

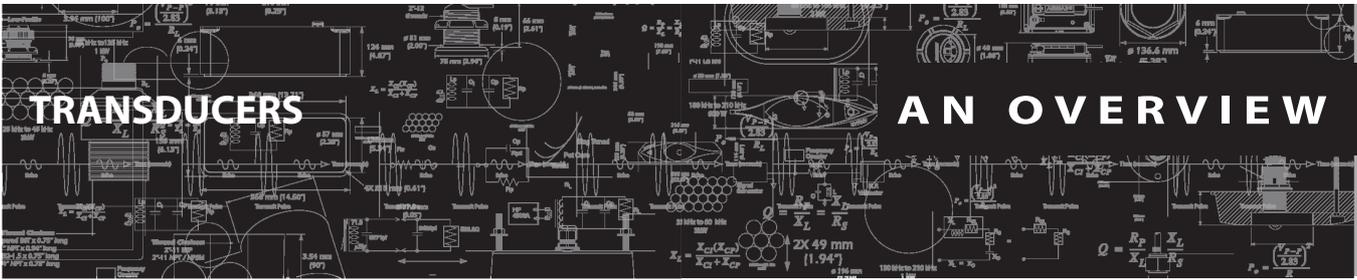
## Broadband Benefits Today

Manufacturers now market echosounders that can adjust operating frequency and power output. While these are premium products, the designs are a precursor of things to come. With the ability to adjust frequency, an echosounder can operate Airmar’s broadband ceramics anywhere in the 160 kHz to 260 kHz band. By selecting different operating frequencies, two or more sounders can work simultaneously without interference. The frequency can also be adjusted to the mission. Lowering the operation frequency increases the beamwidth and depth capability; raising the frequency narrows the beamwidth, increases echo definition, and improves high-speed performance.

## Broadband Future Benefits

Here is where it gets really exciting. In today’s fishfinders, good fish detection is obtained by transmitting a long pulse. This puts more energy on the target. With a long pulse, closely-spaced fish cannot be separated—you get a big blob. Fish close to the bottom appear attached to the bottom and are difficult or impossible to detect.

Airmar’s broadband transducers enable frequency modulated (FM) transmissions; a.k.a. CHIRP or coded transmissions. Using FM transmissions, you can achieve both the benefits of long pulse, more energy on target, and short pulse, segregation of closely-spaced fish and identification of fish on or close to the bottom. This is because the coding of the transmission is known and the return echoes are similarly coded. The technique is also known as pulse compression. In summary, fishfinders of the future with FM transmissions will have dramatically improved target resolution and signal-to-noise ratio. Airmar’s broadband transducer will enable this to happen.



# TRANSDUCERS

# AN OVERVIEW

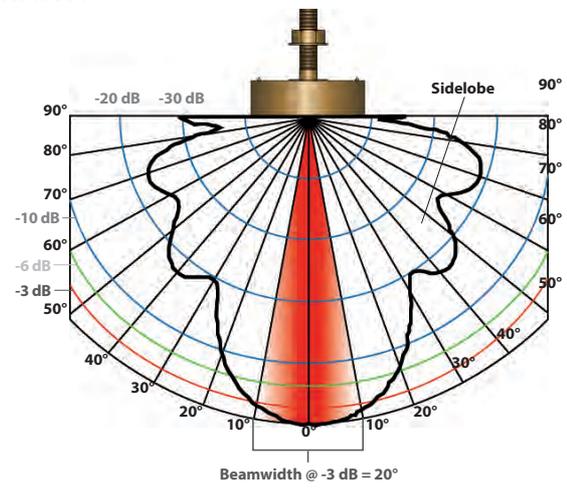
## RMS Power versus Peak-To-Peak Power

All Airmar transducers are measured in RMS power as opposed to peak-to-peak power ratings. Peak-To-Peak power ratings are eight times higher than RMS power, which can trick the consumer into thinking that their echosounder and transducer are more powerful than they really are. For example, if a transducer manufacturer L advertises 4,000 Watts peak-to-peak power, this is only 500 Watts RMS power. See the chart below for typical Airmar transducers and their power ratings in both RMS and Peak-To-Peak.

RMS Power	=	Peak-To-Peak Power
250 W RMS	=	2,000 W Peak-To-Peak
600 W RMS	=	4,800 W Peak-To-Peak
1,000 W RMS	=	8,000 W Peak-To-Peak
2,000 W RMS	=	16,000 W Peak-To-Peak

## Beamwidth

Airmar measures transducer beamwidth at -3 dB. Other transducer manufacturers measure their beams at -6 dB and -10 dB, stating the beam is wider than it really is at -3 dB. For example, the image below shows a beamwidth of 20° at -3 dB. If the same transducer is measured at -6 dB, the beamwidth increases to 30°.



## “Q”

A Transducer’s quality factor, “Q” describes the amount of ringing the ceramic element or elements undergo when power is applied to the transducer. Think of a church bell analogy—as the bell is struck it vibrates rapidly and then the vibration will gradually stop. Most competitor’s recreational transducers have an average Q between 25 and 35. Airmar Q values range from 1 to 30, depending on models. The lower the “Q” number the less ringing in the transducer and the better the performance. Less ringing greatly improves individual fish separation along with bottom imaging in rapidly changing water depths such as ledges and offshore canyons.

## Transmitting Voltage Response

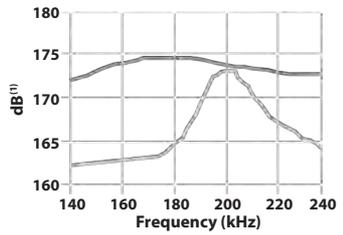
Transmitting Voltage Response (TVR) is computed using Receiving Voltage Response and Impedance. The unit of measure for TVR is dB relative to 1 micropascal per volt at a distance of 1 meter (3’).

## Receiving Voltage Response

Receiving Voltage Response (RVR) is measured typically by applying 200 V peak-to-peak to the transducer under test, pointing it at a nearly perfect reflector, and measuring the echo amplitude as a function of frequency. The unit of measure is dB relative to 1 Volt per micropascal.

## Figure of Merit

This graph is a summation of TVR and RVR and provides a measure of two-way performance. A transducer whose figure of merit response has a wide bandwidth is generally preferred over a transducer with a narrow bandwidth. The former usually rings less and offers most consistent performance over the transducer’s range of frequency tolerance.



This Broadband transducer has a flat response and can run across the entire frequency range.

This Non-Broadband transducer peaks its performance at 200 kHz and drops off sharply at frequencies before and after.