

ULTRASONIC LEAK DETECTION

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Pressurized gas leaks emit an audible high-frequency hiss but have even more energy at ultrasonic frequencies. Small leaks give off detectable ultrasound long before they become large enough to be heard by the human ear. The difficulty of locating audible leaks is compounded by the fact that most competing noise sources also are audible, not ultrasonic. By specifically detecting ultrasonic emissions, leaks can be "heard" even in noisy industrial environments.

Ultrasonic leak detectors are available from several manufacturers. All use the same basic principle but their features, prices and user operation vary widely. This paper is based on a design I did in 1993 for a product which is no longer available.

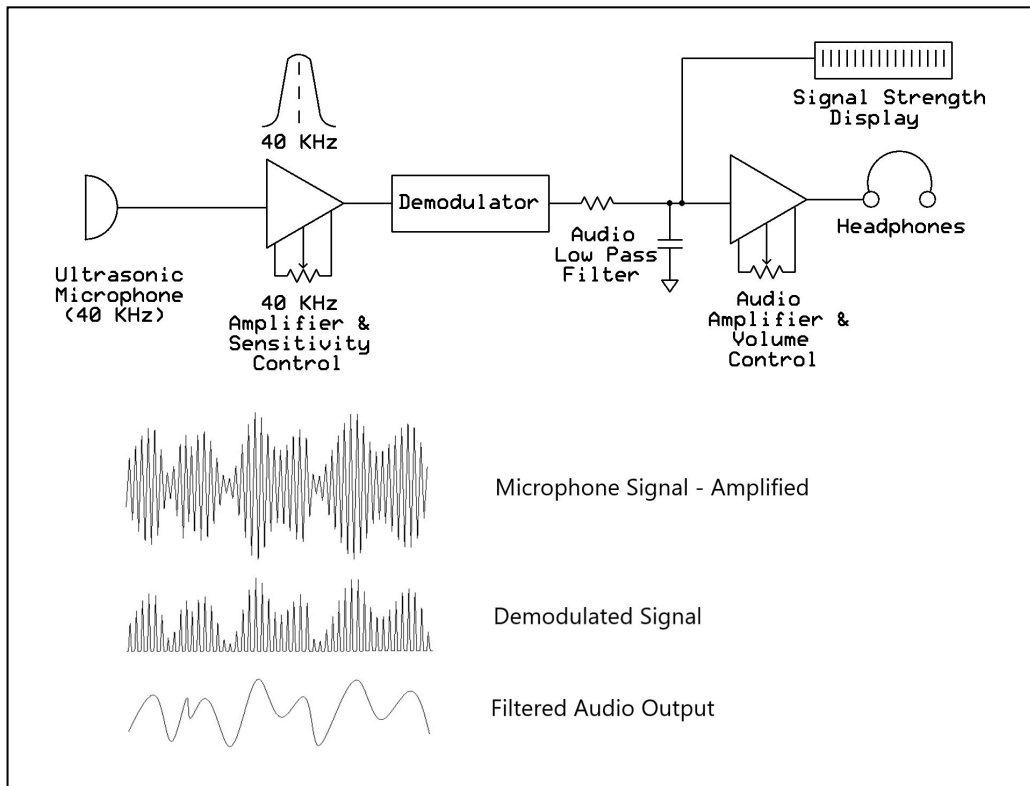
How does it work?

Detection begins with an ultrasonic microphone. Microphones sensitive to a narrow band of frequencies around 40 kHz (kilohertz) are available for

just a few dollars. (See note, next page.) The signal is amplified greatly, converted to audio and sent to headphones and a signal strength display. The user simply points the leak detector, sweeps it around and listens for leaks.

The block diagram illustrates the concept. A narrow-band microphone is used, sensitive only to frequencies between about 35 and 45 kHz. The microphone's signal can be very small, so it is greatly amplified by a bandpass filtered 40 kHz amplifier. Sensitivity can be adjusted higher for distant leaks, lower for close work.

The output resembles a modulated 40 kilohertz carrier. It is demodulated to detect the audio portion, similar to the function of an AM radio. Filtering removes the 40 kHz portion and presents the audio to an amplifier and the user's headphones. A signal strength display helps to aim the detector in the direction of the leak.



The results.

Leaks are heard as a noisy, rushing sound in the headset. Only ultrasound is detected: if someone speaks into the microphone you will not hear it in the headset. Leaks can be detected even when surrounded by audio-frequency noises. Of course, it responds to all ultrasound sources, not just leaks.

A well-designed leak detector can hear leaks up to 30-40 feet (9 to 12 meters) away, depending on the characteristics of the leak. The user starts with the sensitivity set high, sweeping it around to find the general direction of a leak. As he or she closes in the sensitivity is reduced until eventually the exact location of the leak is found.

There is a limitation. Some mechanical systems, and electronics, produce ultrasound. If present, it may mask the sound of the leak.

Typical uses.

The obvious use is finding leaks in pressurized air and gas systems, slow leaks in fittings as well as pinhole leaks. Air conditioning is another. Leak detectors commonly used in A/C detect the coolant gas and so work only if right next to the leak. An ultrasonic detector can hear the leak from a distance.

Non-pressurized leaks? Some manufacturers offer an ultrasound generator as an accessory. The generator is placed into a sealed system and the detector used to hear any ultrasound leaks. Examples include refrigerators or freezers and vacuum chambers.

Note—Ultrasonic microphones – available but tricky to find. Some distributors categorize them under ultrasonic proximity detectors, but this also includes complete proximity detectors along with microphones. Not all distributors carry the microphones. There are “send” and “receive” transducers. Microphones are, of course, “receive”. Manufacturers include MuRata and Pro Wave Electronics. Distributor Jameco carries Jameco Valuepro brand. Single piece prices typically are between US \$5 and \$10.

High voltage systems! Arcing and corona discharge creates ultrasound. Leaks and insulation breakdown in panels and power distribution can be found from a safe distance. Problems in high voltage overhead wiring often can be detected from the ground.

Products.

Various manufacturers offer a wide variety of products, ranging from a few hundred to several thousand dollars. Their features and accessories vary. I’ve not tested them but would guess their sensitivities vary also. Some low-end devices do not actually let you hear the sound. Instead, they produce a tone which rises or falls with signal strength, sort of an audio signal strength indicator. Some manufacturers include parabolic or other focusing accessories. Some also offer contact probe “stethoscope” accessories which let you hear mechanical defects such as broken or out-of-round bearings.

Summary.

Listening for ultrasound is a sensitive way of finding pressurized air and gas leaks at a distance. It also can hear high voltage arcing and corona discharge. Non-pressurized leaks can be found using an ultrasound generator. A variety of products is available.

This paper is based on an all-analog design done in 1993. Today, digital techniques such as digital signal processors probably would be used. The principles remain the same, however.