

High-Q AE Sensors

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AE Sensors According to Frequency Response

The shape of the overall frequency curve is often the first deciding factor in choice for AE sensors. Traditionally, there have been two types: resonate AE sensors, the main workhorse for practical AE, and broadband AE sensors have been the main alternative providing some desirable features for waveform analysis, for instance. Recently, DECI has been building and customizing sensors with much stronger resonance than the typical resonate sensors. These “high-Q” sensors have specialized uses.

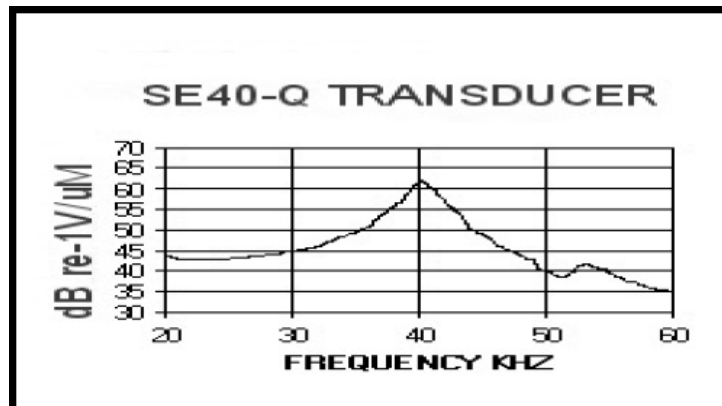
	Resonate	Broadband	High-Q
Examples	SE150-M SE650-P	SE1000-H SE900-MWB	SE40-Q SE32-Q
Selection Criteria	Frequency Range	Degree of Linearity	Center Frequency
Main advantages	High Signal/Noise Ratio	Most accurate reproduction of wave shapes	Highly focused response with respect to frequency spectrum

Characteristics of Hi-Q Sensors

Both the resonate and high-Q sensor resonate. So where is the difference?

- High-Q sensors often have stronger frequency drop off than the electronic filters in use
- High-Q sensors are tuned to a much more narrow frequency spectrum
- The signal-noise ratio at the selected frequency is very high

For example, the popular SE150-M provides an extra 20-30 dB of sensitivity in the range of 50 to 200 kHz, but also has extended broad sensitivity above 200 kHz. The SE40-Q provides a peak energy over 30-50 kHz. The sensor is also calibrated according to NIST traceable displacement procedure, with a peak at 1V/nm. For most AE applications, a resonate sensor is advised. But in niche applications, high-Q sensors can be used to tune into specific frequencies, to extend detection range in noisy environments and to support portability properties in AE hand held AE systems.



Uses of Hi-Q Sensors

For portable (Handheld) instruments, both weight and power consumption are much more important than with desktop systems. Filtering and amplification are two important features of devices that define the design of the box. Since AE sensors are piezoelectrics, the sensors provide small level signal before amplification, and the resonant AE sensors already provide some limited filtering. But with the high-Q sensors, the signal-to-noise coming directly from the sensor is much stronger, greatly reducing the amount of amplification and filtering required by the system. DECI's Termite Tracker takes advantage of the SE40-Q to make a portable device with long battery lifetime and 1 V/nm sensitivity.

Some AE applications require high noise rejection at low frequency (Below 100 kHz). Tank bottom leak testing is one of these applications. At higher frequencies, such as 300 and 650 kHz, noise rejection can often be accomplished nicely with simple resonance sensors and conventional filtering. The SE5650-P is an example of a sensor which is popular in laboratory environments, where signals do not have to propagate far. The resonance of the SE650-P works very well to limit lower frequency noise. But in tank bottom testing, both high sensitivity (or more properly, signal-to-noise ratio) and long detection range are desired. The detection range is best extended by using lower frequency sensors, typically below 50 kHz. At these frequencies, background noise is significant and limiting the detection bandwidth is the most effective way to achieve higher signal-to-noise for AE detection. Strong resonate sensors are typically employed for this application, but high-Q sensors perform this task even better. It should be cautioned that even high-Q AE sensors, by themselves, can never limit noise enough. Further noise isolation, such as provided by the AESmart's Modal ratio filter is warranted in AE testing.

Detecting forced oscillation (often continuous) is an application area where AE sensors can function, even if the source does not follow the classic definition of AE: a transient elastic wave generated by local energy release. When an oscillator is driven continuously at a specific frequency, the waves source is external (not a local energy release) and the resulting wave can be better described as a steady-state wave than a transient. One approach to monitoring this force vibration is to use a small aperture sensor, such as the SE1000-H, while another is to apply a high-Q sensor tuned to the desired frequency. Both sensors have had success. The small aperture approach is better suited to forced oscillation applications where the frequency can vary. DECI has customized sensors to specific frequencies upon request. The high-Q can provide exceptional strong coupling to a particular frequency, but the sensor is then dedicated to that frequency.

Closing

Most AE sensors are either resonate or broadband varieties, and this will continue to be the case. But specific niche applications can exploit the unique features that high-Q sensors provide. DECI can and has provided support for these applications by applying its 40+ years of AE sensor design.