

Microturbine Testing

using the ZonicBook

Microturbines are increasingly being used at various consumer sites to generate 480 VAC, three-phase electrical power, typically in the range of 25 to 500 kW. They are relatively small, combustion-gas turbines that run on natural gas, hydrogen, propane, diesel fuel, landfill gas (methane), and even some bio-diesel fuels. The turbines come in two varieties, simple-cycle and recuperated-cycle. Simple-cycle turbines are about 15% efficient, compared

to turbines with reliable recuperators (that is, no moving parts) that double efficiencies to nearly 33%. They reintroduce exhaust heat energy into the cycle instead of wasting it. Better yet, system efficiency can reach 85% with an integrated combined heating and power (ICHP) installation.

Because they are about the size of an industrial refrigerator, microturbines can easily be installed on site and power a modest-sized building such as a convenience store. When multiple units are interconnected, they can offset the energy expenses and demands of larger facilities such as motels or large apartment buildings. Moreover, some users can sell their excess power back to the grid.

Exceptional Efficiency

Microturbines are self-contained, integrated systems. They are economical to run, cost little to maintain over long intervals, and are designed for long life. They contain microcomputer-based electronic controls that let them operate automatically at the highest possible efficiencies. Also, the modular nature of the microturbine and its controller let more than one microturbine run in parallel (multi-pack), but act as a single unit for larger installations. Some installations contain as many as 50 microturbines connected in parallel and reduce methane emissions by operating on landfill gas. Here, the microturbines provide maximum power and efficiency at full-load demands, or the multipack can shed individual turbines one at a time while maintaining the overall installation efficiency as load requirements decrease. Compare this to conventional megawatt turbines that drop dramatically in efficiency when their load demands decrease; they must operate well below the peak design point.

A large market for the generated power and clean exhaust heat includes hotels and other installations that consume both power and heat, known as Combined Heating and Power (CHP) applications. This is the most efficient system. A typical installation employs a heat exchanger on the microturbine's exhaust, which preheats water for a boiler. Less fuel is then needed for the boiler, and the microturbine system efficiency can reach 70 to 90%. Because of this, new, green energy-efficient buildings are increasingly using microturbines and have been working extremely well with remarkably



The ZonicBooks are superior to the test equipment used before: The first equipment that was considered had a top measurement speed of only 60,000 rpm, while the ZonicBook easily measures speeds higher than the required 96,000 rpm. Also, the early FFT analyzers were implemented in hardware only and difficult to use, as compared to the ZonicBook's FFTs in software — much easier to use.

low emissions. For example, one greenhouse application feeds the exhaust directly to the plants to supply warm, CO₂-rich air. Other applications include hybrid-electric city busses, offshore oil-drilling platforms, and farms where fermenting waste tanks provide the fuel gas for operating the microturbines.

Vibration Testing

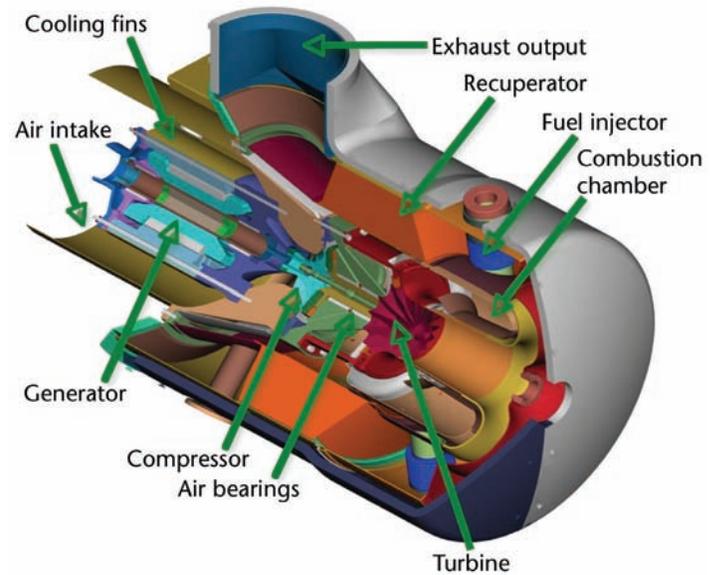
An engineering team consisting of a Principal Turbomachinery Engineer, and a Senior Rotordynamics Engineer at a leading microturbine manufacturer, use IOtech ZonicBooks with eZ-TOMAS to monitor and record the microturbines' vibration levels during both production and development testing to ensure they remain within the design envelope. They also test production units in such a unique way that only the eZ-TOMAS software can satisfy their needs for analyzing rotating machines. Because the microturbines run at extremely high speeds, acquiring test data is critical to ensure that vibrations are not dangerously out of tolerance and cause the microturbines to fail. The ZonicBook measures and records synchronous, sub-synchronous, and super-synchronous vibration, which is at, above, and below running speed. The eZ-TOMAS has a built-in feature for condition monitoring alarm levels. It contains a unique, complex speed-vibration matrix, which applies constantly changing pass/fail criteria based upon the speed and time-at-speed operating point of the engine. A "Production Test Report" provides a final look at the engine as the data are summarized on a formatted output page. No further data processing is needed.

IOtech ZonicBooks were selected over another stand-alone system that the engineers were already familiar with, initially because the other instrument was unable to measure turbine speed over 60,000 rpm. "In the beginning," says the Principal Turbomachinery Engineer, "we had to use some basic FFT analyzers in the test cell, and a person had to manually set up the instrument and watch it constantly; they were essentially stand-alone units with no software capability. We decided to upgrade the setup and find a new solution. In contrast to basic FFT analyzers, the ZonicBook records continuous vibration data, contains built-in FFT software, easily records the turbines' top vibration levels, provides the added safety of an automatic shutdown, and prints out a record, all for one-half the price. We found the system to exceed our expectations."

The engineers use from one to eight channels to monitor very high-frequency rotor vibration levels that could reach several thousandths of an inch on each microturbine. Proximity probes are located near each oil-free air bearing that supports the rotor. The eZ-TOMAS software for monitoring and recording multiple channel vibration lets them analyze the proximity probes' output amplitude, frequency, and phase in real time and compare both synchronous and asynchronous peak amplitudes in different locations to the complex pass/fail criteria, as well as the automatic shutdown limits.



Typical Array of Microturbines



Microturbine Diagram

Hands-Off Testing

The microturbines are tested in unattended cells according to an acceptance test procedure also known in the industry as a “green run.” Says the Principal Turbomachinery Engineer, “The ZonicBook helps us with two functions; it monitors the running engine for both the pass/fail and self-protection criteria, and it uses IOtech NDT relay boxes to safely and automatically shut down the engine if the vibration level should exceed preprogrammed limits. Many of the test cells run unattended during most of the test time, so automatically protecting the engine from damage recovers more than the cost of a single ZonicBook. In fact, over several years, each ZonicBook has saved at least one engine from a high-cost failure.

“When we first started looking for equipment like this, I bought one of the earliest model ZonicBooks, tested it with the eZ-TOMAS software, and I found that it did more than the other instruments I had worked with and new ones that I evaluated. However, over time, we came up with some ideas that would help us even more — to enable a higher quality process — and we passed them on to the IOtech software engineers. They are very supportive. We would make a request for a new feature, and they would provide it in a couple of weeks, or sometimes just in hours. We are confident now that we can run the tests in an unattended cell because of all these improvements and upgrades. We are very pleased because we got the product we needed when no one else had it.”

ZonicBook/618E

Vibration analysis and monitoring has never been easier than with the ZonicBook/618E and eZ-Series analysis and monitoring software. The ZonicBook leverages 30+ years of experience providing vibration measurement solutions. The ZonicBook hardware is the signal conditioning and acquisition engine, while the eZ-Series software in the PC defines the specific analysis and monitoring features of the system. The ZonicBook’s architecture makes expansion beyond the eight built-in channels less expensive than other suppliers. You can expand the ZonicBook in 8-channel increments up to 56 channels, and each additional 8 channels are approximately one third the cost of the first 8 channels. All channels in a ZonicBook system are measured synchronously, providing 1 degree phase matching between channels.

Features

- 8 dynamic input channels, expandable up to 56 channels
- 4 tachometer channels for rotational measurements
- High-speed Ethernet connection to the PC for continuous recording
- Four eZ-Series software packages address a wide variety of vibration monitoring and analysis applications
- TEDS support for accelerometers

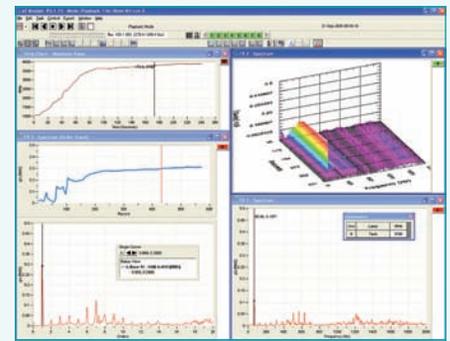


The ZonicBook/618E with eZ-Series software and your PC makes a real-time, portable vibration analysis monitoring system

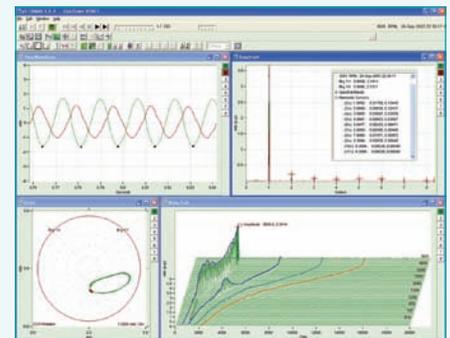
Software Overview

Four software packages are available for the ZonicBook, each tailored to a particular vibration measurement and analysis application. Choose the package that suits your application now, and upgrade to additional packages as your requirements evolve.

- **eZ-Analyst** provides real-time multi-channel vibration analysis, including overlay of previously acquired data while acquiring new data, strip charts of the throughput data files, cross channel analysis, and direct export to the most popular MODAL analysis packages, ME Scope and Star Modal.
- **eZ-TOMAS** provides on-line vibration recordings, limit checking, storage, and analysis of rotating machinery. Order track, Waterfall, Orbit, Polar, Bode, Spectrum, and Trend displays show machine startup or shutdown events, as well as diagnose long-term changes in machine health.
- **eZ-Balance** is used to balance rotating machinery with up to seven planes. A balance toolkit, including Split Weight calculations, supports the balance process. The balance vectors are displayed on a polar plot so the user has a visual indication of the improvement. Time and spectrum plots show detailed vibration measurement during the balance process.
- **eZ-NDT** package is exclusively used in production applications to determine the quality of composite-metal products at production rates of 1 part per second.



eZ-Analyst adds real-time continuous and transient data acquisition in the time, frequency, or order domain



View Time-Domain, Spectrum, Waterfall, and Trend simultaneously on one screen with eZ-TOMAS

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