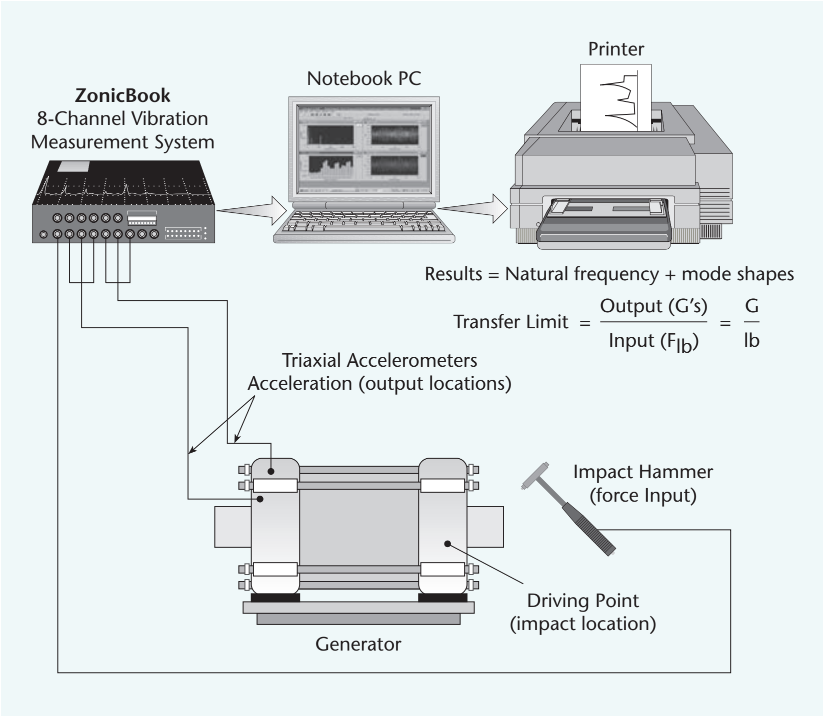
Turbine Generator Vibration Testing

using the ZonicBook

Application Summary

Design calculations for the steam and combustion turbines and electrical power generators that supply international energy needs are typically computer generated. But the calculations are normally verified in a hardware lab with actual component tests. Design and test engineers also use the lab to proof design modifications, fine tune finite-element models, and perform vibration analyses.

The engineers spend most of their time in the lab collecting data on both new and old turbines, generators, and components, but occasionally, they assist the field service group. A Mechanical Test Designer at a large turbine and combustion generator manufacturer, says, "When the field service engineers become unusually concerned about a particular problem, we are called to take a more detailed look. For some, we "rap" out the natural frequencies with an impact hammer and find the mode shapes. Then we can better determine the type of failure that might have occurred and how to modify it." The engineer analyzes the natural frequencies and determines how the driving forces could affect the parts.



Most new turbine component testing is carried out in the lab where engineers use an impact hammer for modal analysis. Although the test engineers occasionally use an exciter to perform a swept-sine test or a white-noise generator, the impact test is quicker and can be done in the field on an operational turbine as well.

Potential Solution

Like many labs performing these types of tests, the manufacturer had, for a number of years, employed two different brands of data acquisition systems. But, although both kinds of analyzers were accurate, they had only two input channels and were too heavy and large to be carried to various sites that needed engineering quality assistance. Moreover, they comprised a cumbersome, three-component system that further limited portability.

IOtech's Solution

The old equipment's limitations prompted the Test Engineer to search for another system that was smaller and more portable but did not sacrifice the accuracy he needed for the shock, vibration, and modal testing that was so critical in both the lab and the field. He evaluated several different data acquisition system manufacturers and selected the IOtech ZonicBook. "Going to 8-channels from a 2-channel instrument housed in a huge and heavy chassis was a big step for us. To have a little black box that weighs less than 5 lbs. with 8-channel capability is a tremendous advantage. Now, I can put it in my briefcase and I'm out of here, and that's exciting. In this business you've got to be ready to go anytime," he says.

He primarily uses the ZonicBook to fine-tune the FE analytical model. Calculations are made on a new design and the part is built. Then he tests it in the lab to see how close the part comes to predicted behavior. Generally, the design engineers are very close, but the additional input that they get from the ZonicBook helps them tune their analytical model even closer, so they can predict better. The engineer and his colleagues have used IOtech ZonicBooks for FFT analysis, but generally they concentrate on the transfer function.

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From time to time, the engineer uses a shaker or an exciter to do a swept-sine analysis or a large speaker to inject "white noise" into a component such as a combustion turbine transition. Most often in the field, however, he uses an impact hammer as an exciter. The shaker or noise injection procedure is considered a lab test, not a field test. "We are usually under a time constraint too, so obviously impact tests go a lot faster than swept sine."

The engineer likes the ZonicBook's small size the best, but another handy feature is the 8-channel input. He uses two triaxial accelerometers and runs them both at the same time while using one channel for another input. When using 7 channels his data acquisition time is cut in half. "That's a tremendous advantage," he says. "A multi-channel system for this particular kind of field application isn't necessary because I don't acquire all the signals simultaneously." Basically, he excites one point and then runs the accelerometers over the geometry of the part.

The frequency range covered is 0 to 5 kHz, which pretty much handles most of the testing. "Sometimes the engineers want data at 10 kHz, and I ask why. Not much happens at 10 kHz on a mechanical structure, and I am reluctant to take unnecessary

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

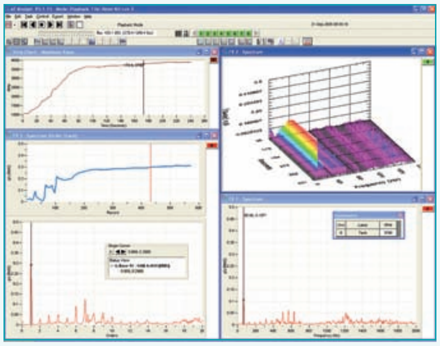
- 8 dynamic input channels, expandable up to 56 channels
- 4 tachometer channels for rotational measurements
- High-speed Ethernet connection to for continuous recording
- eZ-Series software packages address a wide variety of vibration monitoring and analysis applications
- TEDS support for accelerometers

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

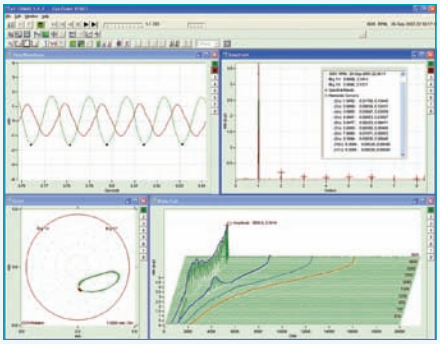
Software Overview

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 & eZ-TOMAS Remote** are highly sophisticated, yet easy-to-use tools for the monitoring and analysis of single or multiple machines, which allows the user to assess the reliability and operation of his process, and the critical machines pertaining to his process. Notification of faults are displayed locally, but can also be sent via text message or email, allowing the user to be notified of any problem regardless of his location.
- **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 data." At the other end of the spectrum, no one really measures 5 Hz or less. And if they did they would probably not be satisfied with the resolution. The engineer says he would have to do something differently, but he is rarely concerned about anything in that range.

ZonicBooks are rugged. "We try to be careful with them," he says, "but sometimes we work in the middle of a generator stator frame where it is quite dark. We try to put our ZonicBook in a safe place, and just when we think we have, it slips to the level below. So I can tell you that it does withstand some pretty good g forces."

The data the engineer collects is more than satisfactory, and he has had no hardware problems. The only thing seen are the classical signal acquisition problems that everyone deals with such as cable routing, connector integrity, electrical noise tables, and so forth. Also, he doesn't usually have a problem with electromagnetic fields interfering with the accelerometers, because most often, the equipment is not running when acquiring data. However, when he does an operating deflection shape, the machine would be running, and the only worry is whether 60 or 120-Hz signals are being picked up. If they are, he shields the sensors, and that generally takes care of the problem. Or he might add a ground wire from the box itself to some external ground. That usually takes care of the noise, but interference is certainly something the engineers always look at very closely.

Conclusion

Turbine and combustion generator manufacturers test component parts such as rotating blades, stationary blades, or an entire segment of a generator frame in the lab. At a large manufacturer, these measurements are collected by an IOtech ZonicBook data acquisition system. It helps engineers verify their design calculations and lets them fine tune their finite element models so they can run even more accurate calculations on the following design job. Part of the testing includes rapping the component with a hammer and recording the vibrations for analyzing vibration modes, frequency response, and coherence. This allows them to determine the natural frequencies, modal shapes, and numerous other signal components needed to ensure a safe, robust MW turbine generator.