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Rotating-Shaft Bearing Testing
using the DaqBook

Machine Vibration

Application Note #89

Application Summary

Vibrations generated by rotating machinery or impacts from punch presses can severely reduce the life of factory equipment and affect other apparatus located nearby. The vibrations produced by new machines are generally low in amplitude but increase as the equipment ages, and components that are sensitive to wear begin to develop failures. A point can be reached where bearings become so worn that they damage the machine. But when technicians and maintenance personnel monitor trends and measure the bearing vibration routinely with accelerometers and displacement transducers, they can make timely repairs to avoid severe damage.

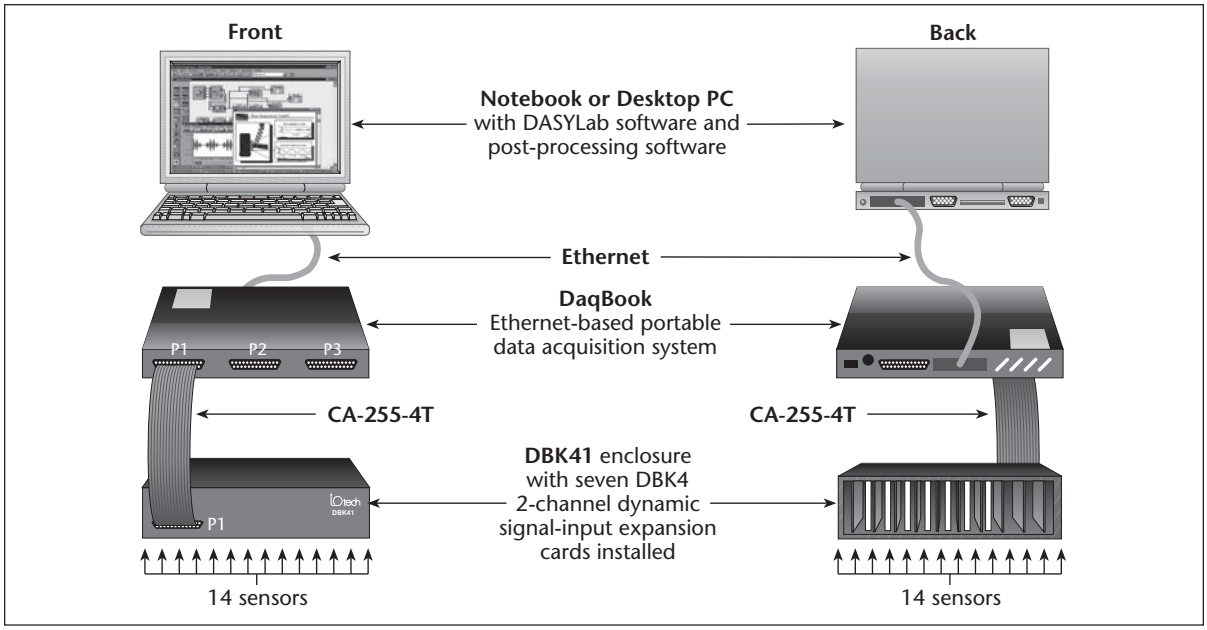
Moreover, certain measuring instruments, Magnetic Resonance Imaging (MRI) equipment, and semiconductor manufacturing equipment, for example, are susceptible to malfunction and low yields when even the smallest outside disturbances are allowed to reach them. Garrett Smith, president of Ball Spin Engineering, Bremerton, Wash., is in the business of measuring and recording such vibrations and recommends a number of solutions. "Low-level vibrations from doors closing or just simple footfalls'" says Smith, "can adversely disturb semiconductor lines. Means must be taken to isolate these production lines and sensitive instruments from extremely small vibrations. Flexible data acquisition equipment is necessary to monitor and record these vibrations."

Potential Solution

Smith had used a variety of data acquisition systems in his career before starting his own business and found many of them to be limited in some respects. Either they had too few input channels or were unable to store a sufficiently large quantity of data for post analysis. Another significant problem relates to proprietary software. Smith prefers to write some of his own software to control, analyze, and display the data, but is unable to do so with the closed software packages.

IOtech's Solution

After evaluating a few new data acquisition systems, Smith purchased an IOtech DaqBook® to measure a variety of vibration sources, from hydroturbines to semiconductor wafer furnaces. He monitors and records the vibrations continuously with single-channel and triaxial accelerometers. Smith uses seven DBK4™ dual input, dynamic signal input cards with



Garrett Smith at Ball Spin Engineering uses a variety of sensors for measuring relatively large vibrations and displacements in heavy equipment such as hydroturbines and much smaller vibrations in semiconductor processing facilities. The IOtech DBK4 signal conditioners, DaqBook data acquisition system, and DASYLab software let Smith measure these data in real time and record them for subsequent post processing.

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100 mV/g accelerometers. He also uses DASYLab® software to control the DaqBook, and a variety of programmable sampling rates and filters to customize the data acquisition system. This arrangement provides Smith with 14 input channels. The DBK4's input range of 50 mV to 5V coupled with the DaqBook's ADC programmable input range allows Smith to use virtually any commercially available transducer. He can measure 50 gs generated by a punch press or just a few µgs in the semiconductor furnace environment with the same set of accelerometers. In addition, he uses proximity sensors to measure shaft-bearing displacements on a turbine and optical tachometers to monitor rotational speed. Four triaxial sensors occupy 12 of the 14 channels when used for vibration analysis.

Smith also performs modal analysis using the IOtech instruments with DASYLab software. He uses this analysis method to find where resonant patterns or standing waves might develop in structures and machinery. Forced vibrations at resonant frequencies can severely damage equipment, often by fatiguing and cracking metal structures or accelerating wear in gears, bearings, and seals in rotating machinery.

Smith particularly likes the open software feature. He can use DASYLab software and other sources — or he can write his own programs to handle unique applications. "The open-source software feature makes the instrument extremely useful and flexible," says Smith. And because he uses the equipment at different locations in a wide variety of applications, Smith finds the product modularity, size, and weight a definite advantage. Moreover, Smith says the DaqBook is inexpensive and very easy to use while providing precisely the flexibility he needs for analyzing equipment vibration problems.

Conclusion

Ball Spin Engineering uses the IOtech DaqBook to measure and monitor a wide variety of vibrations in rotating and reciprocating types of machinery at numerous locations around the country. Hydroturbines, shipping cranes, freight engines, and ships are among the larger equipment analyzed, and small vibrations in semiconductor processing environments that can reduce yield are also measured with the same proficiency. The small size, flexibility, portability, and modularity add up to make the DaqBook data acquisition system most suitable to Ball Spin Engineering's vibration analysis needs.

DaqBook/2000 Series

The DaqBook/2000® series of portable data acquisition devices can synchronously measure analog inputs, frequency inputs, and digital inputs. The 16-bit/200-kHz DaqBooks come equipped with built-in signal I/O capability, which can be further expanded and enhanced with over 40 DBK series expansion and signal conditioning options.

The DaqBook/2000 series includes a built-in 10/100BaseT Ethernet interface capable of transferring acquired data back to the PC at the full 200 Kreading/s measurement rate of the DaqBook. Multiple DaqBooks can be attached to a single PC via an Ethernet hub or switch, and are capable of being synchronized and of transferring data continuously at full speed into the PC. Up to 10 DaqBooks can be transferring 200 Kreading/s back to a PC concurrently, with no loss in data.

Features

- Analog input, analog output, frequency input, timer output, and digital I/O; all in one compact and portable enclosure
- Built-in Ethernet connection provides continuous streaming to the PC with no data loss
- 16-bit, 200-kHz A/D converter
- Operates from -30˚ to +70˚C
- Powerable from 10 to 30 VDC, or with included AC adapter
- Synchronous analog, digital, and frequency measurements
- Trigger modes include analog, digital, frequency, and software
- Virtually infinite pre-trigger buffer
- 4 channels of 16-bit, 100-kHz analog output (models /2001 and /2020)
- DaqBook/2020 offers convenient front panel connectors for thermocouple, voltage and frequency measurements all in one box
- DaqBooks attach to over 40 DBK signal conditioning options to assemble a low-cost system, customized to your particular application

Signal Conditioning Options

- Signal conditioning and expansion options for thermocouples, strain gages, accelerometers, isolation, RTDs, etc. — over 40 DBK I/O expansion options are available

Software

- DaqView™ software included for effortless data logging
- Includes support for Visual Basic®, C/C++, ActiveX/COM, LabVIEW®, MATLAB®, and DASYLab®