www.iotech.com

Materials & Component Failure Testing
using the DaqBoard/2000

Materials Testing Industry

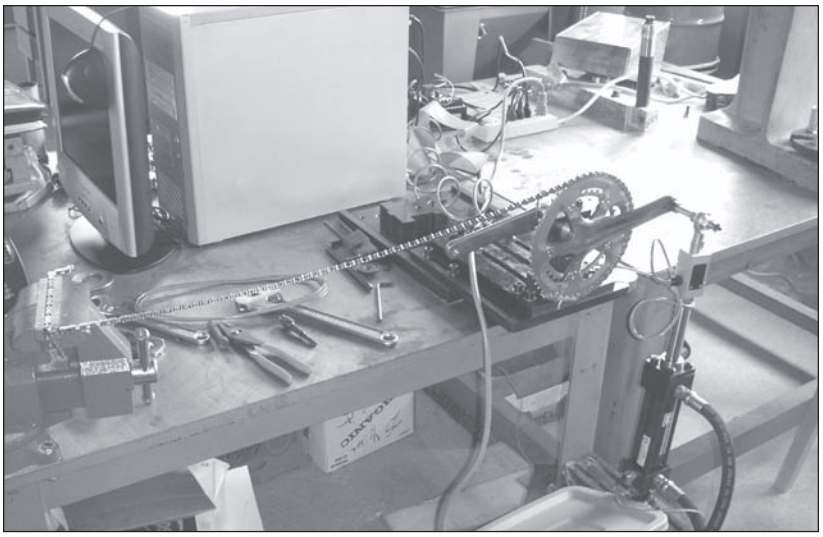
Application Note #100

Application Summary

Imported bicycles and those manufactured and marketed in the US are subject to a number of rigorous testing requirements and safety standards, even though they are basically self-regulated and self-certified. The safety standards used for all types of bicycles conform to ISO, JIS, and ASTM standards as well as the CSPC (Consumer Safety Products Commission); all harmonize with Canadian, German, Asian, and Japanese equivalents. These standards let both consumers and manufacturers within the US and foreign countries import and export these products across borders without extraordinary restrictions.

The standards define test procedures and numerous mechanical parameters that are required to ensure the riders' safety as well as documents to report the findings to the various safety and regulatory agencies such as the CSPC. Some of the parameters include static and dynamic stability, dimensions, strength, flammability, and coefficient of friction for the brakes. Yet other parameters include the types of lights and reflectors needed; fork, handlebar, frame, stem, and wheel strength and deflection; and brake reliability – to name a few.

The standards state that every parameter shall be monitored and measured over a specified time, ambient temperature, and other environmental conditions, depending on the component under test. The method of data collection should be fast, accurate, and reliable. Moreover, with such large amounts of data to be collected, the data acquisition system should be automatic.



The bench test comprises a fatigue-cycling machine for stressing mechanical parts while a variety of sensors located around the bicycle frame or other components under test that can detect a failed critical part. Mobile tests measure mechanical dynamic variables such as acceleration/deceleration, vibration, speed, and distance, as well as other variables.

Potential Solution

Mark Rhomberg of Bicycle Testing, Inc., Boulder, Colorado, has been testing and modifying bicycles for various manufacturers for many years and has been instrumental in implementing the JIS/ISO/ASTM standards since the 1980s.

Rhomberg is responsible for testing various production bikes as well as selected prototypes to ensure conformity to functions, specifications, and standards. He tests all mechanical components to destruction, which includes static and dynamic fatigue tests, and generally runs through entire performance tests according to the published specifications.

Until recently, Rhomberg used individual instruments and an A/D card plugged into a "386" vintage computer to measure temperature, speed, force, torque, acceleration or deceleration, and life cycles. Some of the data were recorded manually. As more data were required, however, and certain critical measurements had to be recorded simultaneously, Rhomberg had to find a better, more automated way to collect data.

IOtech's Solution

Rhomberg selected the IOtech DaqBoard/2000 Starter Kit™ and a few signal conditioning modules to replace the outdated methods that were being used previously. He had been using a combination of automatic data acquisition and manually recording many of the readings from mechanical gages and digital and analog voltmeters into notebooks. This method was wholly inadequate when certain readings had to be correlated in time, particularly force or pressure and displacement. The DaqBoard lets Rhomberg record and store up to 16 dynamic input channels directly and up to 256 channels with expansion modules, although he seldom requires more than four inputs for most tests.

Rhomberg's main function is to test and cycle the sample component and all its attachments in order to validate it according to design specifications. "When something fails outright or does not meet the test specifications," says Rhomberg, "I record the data and ensure that they are as accurate as possible when I return them to the OEM for analysis." Occasionally, when he experiences multiple failures, he determines

the sequence of the failed parts, that is, he finds out which part failed first, and so forth. Since the bicycles are fully instrumented, the DaqBoard records the instant that each part failed and the response of all the sensors immediately before, during, and after the occurrence. This data lets Rhomberg pinpoint the single failure mode or the sequence of multiple failures.

Rhomberg uses 1000 or 3000-lb load cells with 0 to 10 Vdc outputs to measure force or torque applied to various parts of the bike. For example, the torque applied to a handlebar stem comes from the product of the force (measured with the load cell) applied to a one-foot lever arm. He also uses an LVDT mounted on a hydraulic actuator with a 4-in. displacement to pull or crush various members during a static head tube test while recording the displacement and the speed of the stroke. The LVDT measures deflection with a resolution of 0.001 mm over a range of -10V to + 10V, which is fed to the DaqBoard analog input.

"The bicycles can be quite complex for such rather simple-looking machines," says Rhomberg. "For example, I run about three different tests in several different configurations and combinations. Some setups are intended solely for static tests, which entails crushing any part of the bike and may take only ten minutes, while other tests measure force and displacement that can take 30 minutes, and finally fatigue tests, which can last for several days," explains Rhomberg. In addition, some bench tests that run under an adjustable cam machine require from 66,000 to 200,000 cycles at 5 Hz, which can take at least two days of uninterrupted testing.

In a portable or mobile test, Rhomberg measures speed, vibration, and forces applied to various members, such as seats, forks, and stems. Four-channel frequency-inputs measure encoder outputs for real-time speed and distance traveled. Also, accelerometers measure forces during acceleration and deceleration.

The DaqBoard is capable of 16 single-ended (8 double-ended) analog inputs and 40 digital I/O, which let Rhomberg perform fatigue tests automatically. Strategically placed sensors and switches can detect failed parts during fatigue cycling and automatically shut down the test when a failure occurs.

Says Rhomberg, "I found the software supplied by IOtech easy to use. I learned how to use it in four to five hours over one day of experiments." The open architecture of the system also gives him the flexibility to select the software he is most familiar with or best suits the application. For example, he can use Excel® spread sheet software to calculate and average data much more accurately and display the test results for reports.

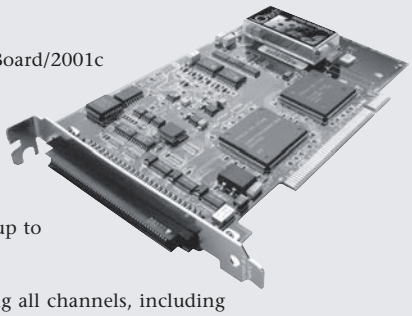
Conclusion

Bicycle Testing, Inc, Boulder, Colorado, a testing lab for bicycle frames and components, currently uses an IOtech DaqBoard for verifying that new products meet specifications and government regulations. The DaqBoard, along with eZ-Analyst™ software, collect data during bench-top fatigue testing as well as during actual, on-the-road operational tests. The systems are totally automatic, and collect data on numerous channels simultaneously to let test technicians precisely determine the root failure of a component and track or identify the sequence of multiple failures.

DaqBoard/2000 Series

The DaqBoard/2000™ series sets the price/performance benchmark for high-speed, multifunction plug-and-play data acquisition for PCI bus computers. The DaqBoard/2000 series hardware design offers all of the features normally found on significantly more expensive boards, including 16-bit, 200-kHz A/D, 100% digital calibration, bus mastering, two or four 16-bit, 100-kHz D/A converters, 40 digital I/O lines, four counters and two timers. DaqBoard/2000 series is supported by a growing family of over 40 signal conditioning and expansion options, offering signal conditioning for thermocouples, RTDs, accelerometers, isolation, high-voltage, strain gages, and much more.

Features



- Five DaqBoard/2000 series PCI boards and the DaqBoard/2001c CompactPCI® version are available
- 16-bit, 200-kHz A/D converter
- 8 differential or 16 single-ended analog inputs (software selectable per channel)
- Expandable up to 256 analog input channels, while maintaining 200 kHz (5 µs per channel) scan rate
- Up to four boards can be installed into one PC for up to 1024 analog input channels
- 100% digital calibration
- 512 location channel/gain FIFO, capable of scanning all channels, including 256 analog expansion channels and digital/counter channels, at 5 µs per channel
- DMA bus mastering for synchronous analog I/O, digital I/O, and counter inputs
- Trigger modes include analog, digital, and software, with <5 µs latency
- Virtually infinite pre-trigger buffer*
- Up to four 16-bit, 100-kHz analog outputs with infinite continuous waveform output capability*
- 40 digital I/O lines, can be scanned synchronously or asynchronously with analog inputs
- Digital I/O is expandable up to 272 lines, including optional isolation and relay closure
- Four counter/pulse input channels can be scanned synchronously or asynchronously with analog inputs
- Two timer/pulse output channels

Software

- Includes DaqView™ *Out-of-the-Box*™ software application for effortless data logging and analysis
- Support for Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- Comprehensive drivers for DASYLab®, MATLAB®, and LabVIEW®
- DaqCal™ software application for easy user calibration

* Limited only by available PC RAM and hard disk space