Electric Window Testing
using the DaqBoard/2000™

Automotive Safety

Application Note #65

Application Summary

The design goals for electric-powered windows in automobiles include strict requirements for safety as well as performance. Primarily, a window must be able to stop immediately when it detects an obstruction such as a child's limb, head, or neck. Because of these safety and consequential liability issues, at least one car manufacturer tests every window motor and control module before it goes into a production vehicle. In addition, replacing the module at the dealership or on the production floor can cost up to 100 times its sale price.

Testing 100% of the modules further requires a test stand that can measure the temperature and torque of the drive motor and electronics control package within critical tolerances and guarantee the data. ATI Systems Inc., Warren, Mich., builds such a window motor and module manufacturing cell, specifically designed to ensure that the hardware meets all functional and safety requirements. The system performs the tests and verifies the assembly and functioning of the modules as an integral part of the manufacturing process. In addition, the manufacturing cell programs each control module and collects specific data for auditing and component traceability. The data includes torque, voltage, current, speed, cycle count on each assembly, and the vibration signature of each motor module.
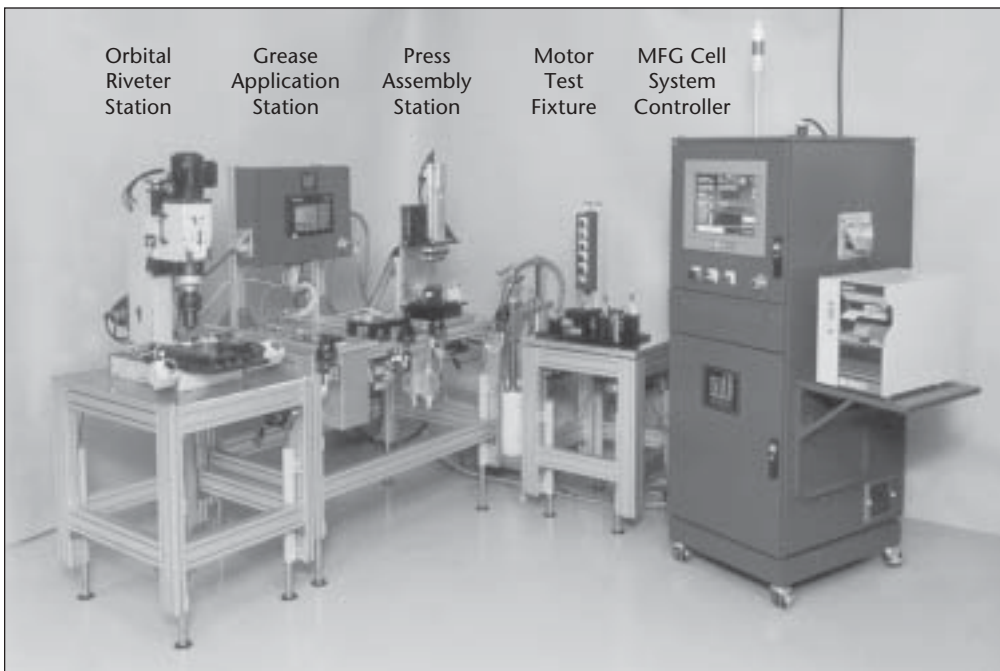
Potential Solution

ATI Systems originally designed and built test stands around a well-known PC-style data acquisition plug-in board. But Jerry Bambach, Test Consultant and Lab Manager, soon discovered a major shortcoming in the equipment that made him doubt the robustness of the data he collected. The problem deals with the issue of a so-called "aperture of uncertainty." Says Bambach, "When the test system commands an event, there are no guarantees (with this data acquisition hardware) that the event will occur in a particular window of time. That is, the predictability of the event is uncertain, and we cannot reliably coordinate events between the analog and digital signal channels."

IOtech's Solution

After evaluating several other data acquisition systems and PC plug-in acquisition boards, Bambach found the IOtech DaqBoard/2000™ to have much more credible predictability, and it eliminated the aperture of uncertainty that plagued the other system. The PC and its operating system now limit the predictability of an event more than the DaqBoard. The DaqBoard has built-in features that allows it to overcome these problems, such as its high bandwidth that lets Bambach look at both analog and digital signals at the same point in time as well as scan them as an increment of time.

Says Bambach, "When I scan at a 1-kHz rate, for instance, I can mix both analog and digital signals as part of that function, and I can scan 100 events in a 1 msec timeframe with a known figure of uncertainty. I know that I will be looking at 100 events with an aperture of 10 microsec between points, both analog and digital. So while looking at multiple events, I can acquire a lot of specific data in parallel."

Moreover, Bambach offloads some of the functions that would usually be done in the PC program. For example, in a normal acquisition

| Orbital Riveter Station | Grease Application Station | Press Assembly Station | Motor Test Fixture | MFG Cell System Controller |

The ATI Systems window motor-module manufacturing cell comprises an orbital riveter, grease application, and press assembly station, as well as a motor test fixture for testing and verification. The IOtech DaqBoard resides in the panel mounted PC within the manufacturing cell system controller. The DaqBoard lets ATI Systems customers improve their reporting, data logging, and analytical capabilities; track warranty related problems; and implement corrective actions during manufacturing.

board, a command to execute a measurement requires at least one line of code. Instead, he creates an array of measurements with one line of code and commands that to execute. The approach limits the total amount of code needed, and because the board is actually doing it, not the PC, it relieves the operating system of that task. It lets the PC communicate with a programmable logic controller (PLC) or another item during that time frame.

The DaqBoard also integrates well with the PLC/PC's semiautomatic, controlled routine in an unpredictable environment. Although the PLC and PC are independent, they work together via two-way communications. The PC oversees the operation of the PLC and allows independent control of each station's task, which is to run continuously without waiting a predetermined amount of time.

The test and manufacturing system uses Visual Basic® and C in a Windows® environment. Windows is a customer requirement along with a keyboard, but the keyboard is limited to set up only. Operators do not interface with any function of the PC other than the display, which is also there only for convenience. Pushbuttons engage all operations, and colored lights indicate machine functions. Additional I/O from the DaqBoard operates the lights while its digital I/O communicates with the PLC.

"A real big advantage of the DaqBoard," says Bambach, "is the fact that it uses only one slot in the controlling PC. The one board replaces a timer/counter board, digital I/O board, and an analog board." Also, he can scan all functions as one scan list, one line of code to execute his timer/counter, digital I/O, and analog channels. That simplifies the code and uses only one board driver instead of multiple drivers, which makes it a more durable system. "One of the most daunting things you can run into in software is an incompatibility of drivers from different boards," says Bambach, "so any time you add more drivers to a system, you start running into a larger risk of them competing with one another, or a possible error in

the C code that overwrites the particular segment of the code being used by the other board. The DaqBoard totally eliminates that problem."

Conclusion

ATI Systems designs and builds a PLC/PC-based, semi-automated manufacturing and test cell for motor-driven automobile

windows that includes a DaqBoard in the PC controller. The system verifies the assembly and performs a final test of the motor module. The DaqBoard handles some of the functions that would ordinarily be assigned to the PC, and teamed with Visual Basic software, the system reduces system test time and makes it possible for one operator to run tests and keep up with production.

DaqBoard/2000 Series

The new DaqBoard/2000™ series sets the price/performance benchmark for high-speed, multi-function 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. The DaqBoard/2000 series is supported by a growing family of over 30 signal conditioning and expansion options, offering signal conditioning for thermocouples, RTDs, accelerometers, isolation, high-voltage, strain gages, and much more.

Features
- Six PCI (DaqBoard/2000) and six CompactPCI® (DaqBoard/2000c) versions 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, & 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
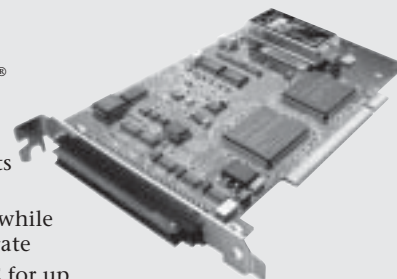
Software
- Included DaqX API library, drivers for Visual Basic®, C++, and Delphi™ for Windows® 95 and higher; C++ for Linux, DASYLab®, TestPoint®, and LabVIEW®
- Optional DaqView2000™ software package
- Optional DaqCOM™ ActiveX/COM-based applications program interface, including network capability

Limited only by available PC RAM and hard disk space

DaqBoard/2000™, DaqCOM™, DaqView™, DaqView2000™, and *Out-of-the-Box*™ are the property of IOtech; all other trademarks and tradenames are the property of their respective holders. 030405.