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Slip Ring Testing

using the DaqBoard/2000

Industrial

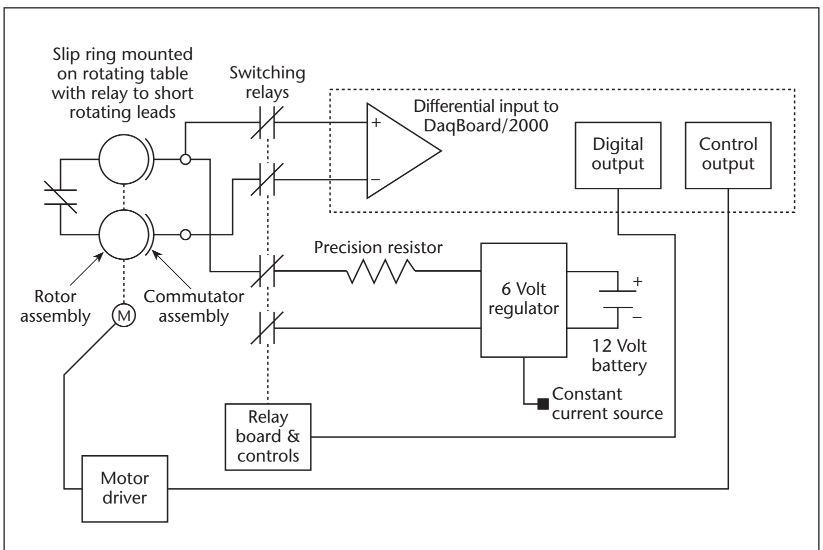
Application Note #67

Application Summary

Electromechanical devices and motion-control components such as slides and torque motors typically travel over mutually perpendicular X-Y-Z-axes or curvilinear paths and return directly to their starting point. Such components usually revolve or rotate less than 360˚ because the flexible cables that provide power and signals limits their range of motion. Except for motors, most motion-control equipment and instruments intended to move through more than 360˚ are prime candidates for slip rings.

Slip rings are basically circular, electrical "switches" and provide continuous signals and power to the rotating or revolving module, motor, or subassembly. They come in diameters ranging from only fractions of an inch to a few inches for small appliances such as game controllers and security cameras in casinos, or four or more feet in diameter for missiles, smart bombs, helicopters, and windmill-driven electrical generators. Each part usually contains from about 6 to more than 100 circuits.

One inherent property of the rings is their propensity to generate electrical noise. Multiple conducting rings and commutator fingers maintain electrical connection over the sliding interface. Sometimes, dirt and other non-conducting or semi-conducting particles adhere to the electrical contacts and interfere with circuit conductivity, intermittently making and breaking the circuit or changing its resistance. Because of this, all slip rings must be 100%-tested for resistance and the level of noise they generate.



The block functional diagram illustrates the DaqBoard/2000's ability to both acquire data and provide motor control. Each DaqBoard's analog input port handles up to 16 slip-ring/commutator measurement channels, one DAC output drives a servomotor on the slip ring assembly, and some of the digital inputs are used for discrete-signal monitoring.

Potential Solution

Poly Scientific, Blacksburg, Va., a leading manufacturer of slip rings, makes them in a wide variety of sizes. Every ring is tested to ensure that it meets stringent performance specifications and passes under a guaranteed noise threshold. The traditional test method comprised an oscilloscope connected across the slip rings and commutators to measure the noise amplitude generated as an operator manually turned the assembly on a fixture. The contacts were fed with a constant-current source, and voltage spikes were visually measured and hand recorded on a data sheet. Slip rings that generated voltage spikes exceeding the maximum allowable amplitude were returned for rework. Sometimes the problem was as simple as a small foreign particle captured between the ring and the commutator. Unfortunately, such manual measurement and record keeping procedures seriously limited throughput on production lines, and occasionally, technicians would overlook a failure. Moreover, the procedure did not sufficiently characterize the true operation of slip rings nor guarantee their future performance because a waveform signature was impossible to obtain and store for subsequent evaluation.

IOtech's Solution

Bill Scott, a software engineer for Poly Scientific, was recently assigned the task of upgrading an aging test system to substantially increase its throughput and make it more repeatable and automatic. The approach required a data acquisition system to handle the increased number of units that could be tested in a fixed time frame. Scott evaluated a number of possible data acquisition boards and systems. He selected the IOtech DaqBoard/2000™ because it has the capacity to both acquire data and provide motor control.

The new test system comprises two test stations and one DaqBoard in a single PC located under the operator's table. The operator loads one station with a slip ring assembly while the computer tests a slip ring in the other. The operator energizes a button after loading a station, and it waits in standby mode until the previous slip ring finishes the test. Then the second assembly automatically goes into test mode.

A test station consists of the ring under test mounted on a wheel that contains a bank of relays wired to normally closed contacts across two adjacent rotating rings. For example, ring 1 is shorted to ring 2 through a normally closed relay. As the servomotor rotates the wheel at 10 to 11 rpm, Scott measures the voltage drop from ring 1 to ring 2 for 10 sec at a 1-kHz sample rate, ensuring that the slip ring rotates more than 2 revolutions. Then he looks for a change in voltage that represents a change in resistance as a 50 mA constant current passes through the virtual short circuit. He measures the maximum to minimum voltage drop across the two pins for two rotations. "The DaqBoard has 16 analog inputs that I use as 8 differential inputs, says Scott. "This lets me test 16 ring pairs at the same time using the 0 to 312 mV input of the DaqBoard. I look for peak-to-peak voltage changes under 20 milliohm, where 1 milliohm equals 50 μV."

Sealed, rechargeable lead-acid batteries provide the constant current source. Eight 50-mA power supplies output 12V at 15A and continuously charge the batteries. When Scott engages the noise test, he disconnects the charger to fully isolate the batteries. "Originally I was given a small but expensive 6V, 50 mA power supply to use for the constant current," says Scott, "but I was getting more noise out of that than I was supposed to be measuring on the slip ring. I was trying to measure 4 to 5 milliohms."

Scott also built an interface composed of several hundred relays for automatically sequencing through as many as 124 rings and leads. He can control the relays individually or in banks and switch them between the two test stations. Some of the DaqBoard/2000's digital inputs are used for discrete monitoring, and digital outputs for controlling the relay boards.

The entire application is written in LabVIEW®, and Scott has had exceptional success with the IOtech LabVIEW drivers. He started using LabVIEW before using the IOtech DaqBoard, so he had some previous experience. Says Scott, "Now we really love it because of what it can do for us. We soon learned that it does a lot more than we initially expected."

Scott dumps the acquired data into LabVIEW and calculates the mean value to use as a reference point. It also provides the maximum and minimum values to calculate the noise level. "What's really neat for the operators, says Scott, " is that they can click a button and actually see the graph of the ring that generates the noise. And that's really helpful because they can see the effect of some contamination once per revolution. It certainly helps engineering when they want to analyze the different failure modes, something they never had before. And it's particularly valuable when we have serialized and more expensive parts to track."

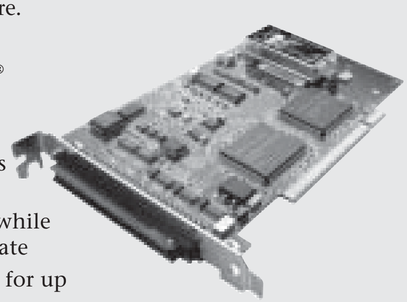
Conclusion

Poly Scientific selected a DaqBoard/2000 for its slip ring testing machines because it contains all the analog and digital I/O ports needed for both control and data acquisition. Mounted in a PC, the DaqBoard drives a servomotor in a slip ring test station, measures the voltage drop across the rings while moving, operates up to 124 control relays, and logs the data for analysis with LabVIEW software. Furthermore, the new test set substantially increases throughput, more accurately measures voltage drops, and captures the voltage signature for further analysis.

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

* Limited only by available PC RAM and hard disk space