

# Test Instrumentation for Nuclear Power Plants

## using USB-2533

### Introduction

According to the US Department of Energy, 104 commercial reactors at 65 nuclear power plants currently produce one-fifth of the energy used in the United States. While some advocates see nuclear power as an option to lessen dependency on foreign oil, others are concerned with safety and environmental issues from radioactive waste. In either case, most of today's nuclear plants, which were originally designed for 30 or 40 year operating lives, undergo routine facility and systems maintenance to extend the operational life to over 60 years.

**“Using the advanced functionality of the Measurement Computing USB-2533 saved our time and development resources.”**

### Challenge

Predictive and scheduled maintenance programs at these facilities are mandated by the Nuclear Regulatory Commission (NRC). These programs not only assure operational excellence, but also ensure safeguards are in place for public safety. Seeking a means to streamline testing, a US nuclear power plant operator engaged InHand Electronics, Inc. to design and deploy a portable solution for energy technicians to test valves, sensors, and various control points during a plant's refueling process. The custom designed solution not only had to meet the customer's technical specifications but also achieve certification by the NRC and guarantee a 10 year product life span.

### Background

InHand Electronics was contracted to design and build the next generation of test instrumentation for nuclear power plants. The instrumentation presented many challenges that could not be met with commercially available solutions; however, time-to-market pressures required some form of reuse of existing solutions.

For the safety of everyone, it is not acceptable to let any part of the nuclear power plant to fail. Regular testing is designed to identify the earliest signs of cracks or degraded operation so that infrastructure can be replaced before a key function fails.



*The reactor containment area undergoes scheduled testing on a regular basis. Photo: Courtesy of NRC File Photo*

The testing is substantial. It involves using dozens of different kinds of sensors, and since every sensor is different, it is not as simple as just plugging in the sensor to an A/D converter. Some sensors are analog voltage, while others are analog current. Some sensors have ranges of  $\pm 10$  V which is relatively straightforward to measure, while other sensors require measurements in the micro-volt range, with accuracy better than 0.01%. Similarly with current sensing, many of the 4-20 mA sensors need to be measured with  $\pm 1$   $\mu$ A resolution. Quadrature encoder inputs were also needed to measure distance travel down to the micro-meter.

Today's generation of test equipment used in plants requires a suitcase of hardware because each sensor or actuator requires a different interface to the computer. The equipment is hard-wired and requires Ethernet and power connections to every corner of the nuclear plant

which involves laying hundreds of feet of temporary cabling. This testing approach is often impractical, difficult, and takes longer than the two week shutdown required for refueling. The test system needed to be able to handle more than the 16 differential channels on a typical COTS DAQ board. Aggregate sampling rates could reach 200 kS/s, with a need to sample various sensors at different rates.

InHand searched the market to find a COTS solution to leverage. Dozens of vendor products were considered, but most products only supported 8 to 16 differential inputs. Having to put several of these cards in a hand-held device was impractical and costly. Many devices were eliminated because they did not meet the 16-bit resolution requirement, or could not sample at rates of 200 kS/s or faster.

## Solution

A single commercial offering stood out as providing the best solution. The Measurement Computing USB-2533 using MCCs Windows® CE deployment platform allows for 64 single-ended or 32 differential, 16-bit ADC channels. This board supports gains of 1x to 100x, and can sample data up to 1 MS/s. It also includes 4 quadrature encoder inputs, and 24 digital I/O channels.

InHand provided Measurement Computing with a Windows® CE platform enabling MCC to port the driver to this real-time operating system. InHand leveraged its own expertise in real-time performance optimization and collaborated with MCC to optimize the driver to meet the necessary requirements. Together, InHand and MCC now have a solution to stream the high precision, real-time data on the Windows® CE platform.

The system needed fault and overload protections, had to monitor one channel, and within 5 mS, shut off a control signal that was connected to one of the other ports. A key feature in the USB-2533, the setpoint feature, enabled real-time monitoring of one channel while allowing one of the digital ports to toggle anytime a preset threshold was reached. This signal was then routed to the analog front end, so that if the signal was toggled, any control port tagged as requiring an emergency shutoff in case of a fault, could then be deactivated. With the analog front end acquiring data at a 1 mS response time, a 3 mS debouncing algorithm was used, and the 5 mS requirement for shutoff achieved.

## Summary

InHand Electronics, Inc. successfully delivered the certified nuclear test bed. Measurement Computing worked with InHand Electronics throughout the development process, including building custom drivers for the application. The partnership, responsiveness, and technical expertise of the Measurement Computing engineers and application engineering teams ensured the best possible testing procedure utilizing the USB-2533 based solution.

## Author Information

Author: Dr. Dave Stewart  
Director of Software Engineering  
info@inhand.com  
www.inhand.com  
Phone: (240) 558-2014

## MCC Product used in this application:



### **HIGH-SPEED MULTIFUNCTION OEM BOARDS** **USB-2500 Series**

- 8 to 64 analog inputs
- 1 MS/s sampling
- 16-bit resolution
- 24 digital I/O, counters/timers (including quadrature encoders)
- Up to 4 analog outputs
- Ideal for OEM and embedded applications