



Certified Experts in Automation Engineering to Design, Control, Test & Adapt

Digital Pressure Gauge Calibrator

Authors:

Jeff Scott, Senior Project Manager, Data Science Automation, McMurray PA
Paul Tortora, Senior Automation Engineer, Data Science Automation, McMurray PA

NI Products Used:

LabVIEW 2012
cDAQ-9178
NI 9205
NI 9472

Category:

Automated Test

The Challenge

Calibrate multiple digital pressure gauges over multiple ranges in an automated test sequence by controlling a temperature chamber and several pressure controllers. Software should also open certain pressure controllers to a high pressure source periodically to maintain pressure.

The Solution

NI-VISA was used to identify and communicate with up to 28 pressure gauges simultaneously. The pressure controllers, temperature chamber, and pressure valve were also controlled in a single application that automates the calibrations and data logging process.

Gauging the Gauges

Data Science Automation (DSA) is a premier National Instruments (NI) Alliance Partner that specializes in automating and educating the world leading companies. Clients choose DSA because of DSA's deep knowledge of National Instruments products, disciplined project development process, its staff of skilled Certified LabVIEW Architects and Certified Professional Instructors, and its unique focus on empowerment through education and co-development.

Our customer is designing a new line of digital pressure gauges, and had the foresight to begin designing a calibration system to be ready when the products start rolling off the production line. This kind of device improves accuracy with a temperature correction, so they procured a temperature-controlled chamber and decided to simultaneously calibrate as many gauges as they could fit into the chamber at one time. The gauges would all be connected to a common manifold and pressure provided by one of several pressure controllers – each designated to provide a particular pressure range.

Having recently attended an NI seminar and with some prior experience with NI products, the customer came to DSA to provide software for an automated calibration system. The system needs to interact with four types of hardware:

- The temperature chamber via MODBUS.
- Several pressure controllers via serial communication. Fortunately they all use the same communication syntax.
- The gauges themselves. They also use serial communication via a custom protocol, but they are connected to the test computer via USB adapters and two large USB hubs. In total there may be up to 28 units connected. That's a lot of COM ports!
- Finally, a solenoid must be operated based on feedback from an inlet pressure transducer attached to certain pressure controllers. The highest range pressure controllers need to be periodically opened to a high pressure source to maintain the controlled pressure.

Make it Simple

Although the application needs to control several pieces of hardware to perform a calibration sequence, the user interface is kept simple and straightforward. The user is first presented with a configuration screen (Figure 1) where pressure and temperature set points are listed along with the number of gauges being calibrated. These test templates can be saved to and loaded from files.

The templates also include the selection of pressure and temperature controllers and the parameters for interacting with them. For each controller the user may enter a time period to allow the controller to reach its set point, as well as the acceptable deviation from that set point. If the wait time or deviation is exceeded, the software alerts the user and gives the option to continue testing or abort the sequence.

After a configuration is selected the user may switch to a "Run" tab (Figure 2) and trigger the test to start. A pre-test option which verifies communication with all gauges is also available. This screen shows a simple table of all temperature and pressure combinations. During testing, the table shows which tests have completed ("Done"), which are pending, and which is underway ("Testing").

The user can stop the test early and view the partially collected data set, or wait until the test is completed. In either case, the data is displayed on a separate dialog for review (Figure 3), and automatically saved to a log file. Gauges are identified by a serial number, which is obtained over the serial interface. An E-Stop button is also available which deactivates the pressure and temperature controllers and stops the test.

Let LabVIEW do the Rest

That is the extent of the user's experience. Everything else is automated through the use of software modules in LabVIEW. A few hours of work with the customer's hardware was all that was needed to create a set of modules to control the hardware. The temperature controller utilizes MODBUS and a driver set available on NI's IDNET. The pressure controllers require some custom serial interaction but LabVIEW's VISA API makes this straightforward. The same goes for the serial interface to the gauges and the VISA functions also make it possible to discover all of the COM ports that the gauges are connected to.

The top-level program uses the tried-and-true state machine architecture to make decisions and calls the hardware modules when needed. A separate thread handles the actuation of a valve that opens and closes a path to the high pressure source. Our customer fortunately had the NI hardware available to accomplish this, which — although originally used for a different purpose — was easily adapted to the task. An NI 9205 analog input module is used to monitor a pressure transducer connected to the inlet of the pressure regulators. When the pressure drops below a certain level, the valve is opened to expose the high pressure source required to maintain pressure. Feedback is provided by an NI 9472 which has 24 V digital sourcing output that is perfect for driving a solenoid attached to the valve.

The customer now has an automated gauge calibration system that will allow them to move hundreds of units per week. The software is also scalable to other temperature and pressure controllers that use the same communications protocols. If the user wants to add or remove any, modifying an INI file with the necessary specifications is all that is required.

Contact Information

Jeff Scott, jjscott@DSAAutomation.com

Paul Tortora, prt@DSAAutomation.com

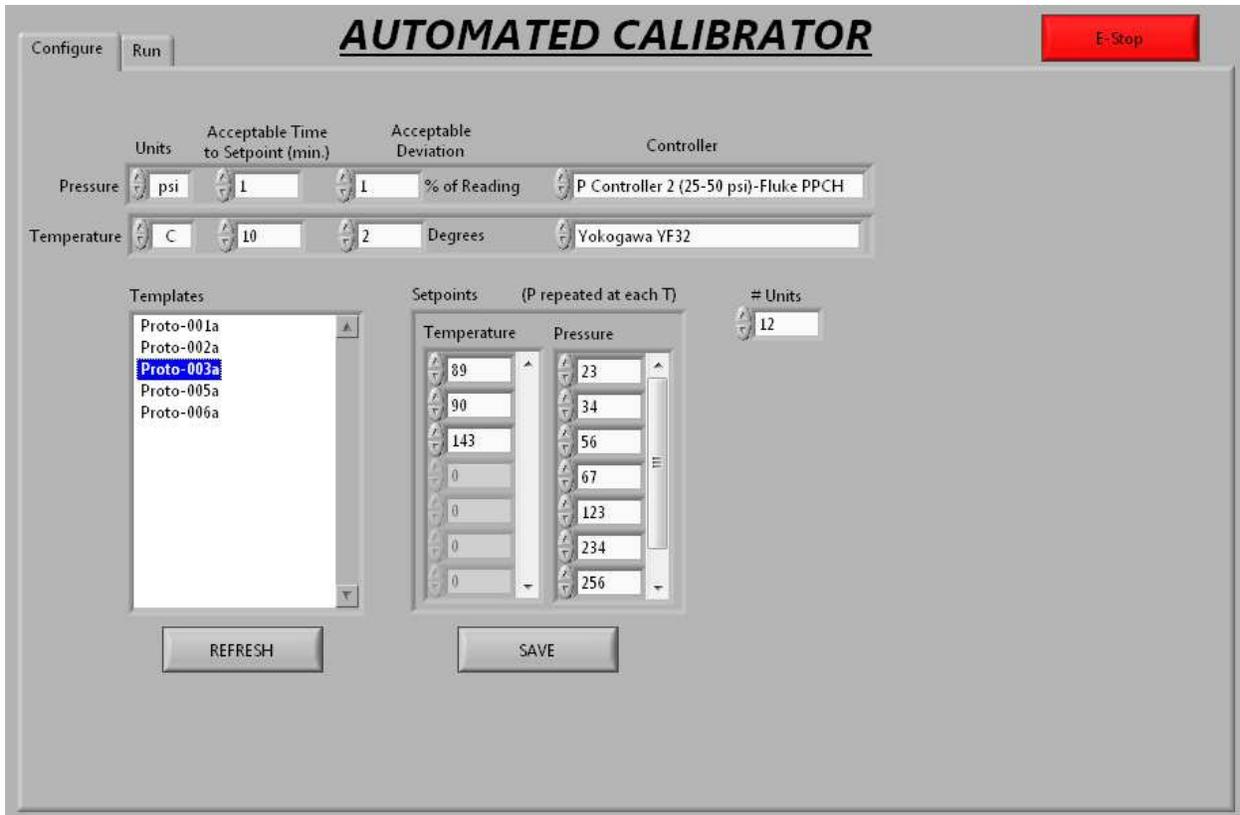


Figure 1. The configuration screen allows users to select pressure and temperature calibrations points and the hardware that will be used during the calibration session.

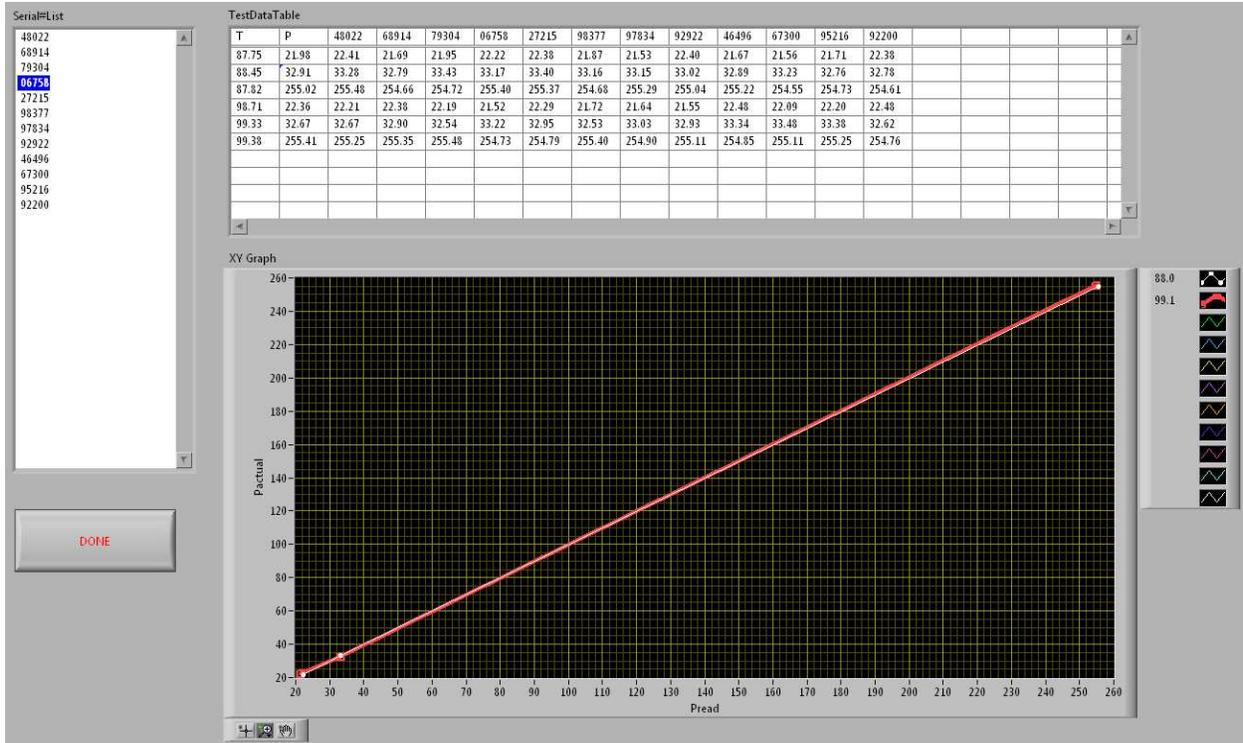


Figure 3. At the conclusion of testing the user may review the calibration data and later recover it from a log file.