

# Comander Control for Natural Gas Liquefaction Process Simulation

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## Category

Control Design/Simulation

## Products Used

National Instruments LabVIEW 7.1  
1 National Instruments GPIB interface  
1 Keithley 2700 DMM

## The Challenge

A leading fuel company needed a reliable process to safely convert large quantities of natural gas products into a liquid, utilizing a liquefaction process. A reliable, automated, small-scale prototype solution was necessary for evaluation prior to deployment in the country of Qatar. This solution had to control elaborate compressor/expander (comander) units and incorporate a multi-screen application that is flexible enough to allow the user to change tests and export data when demanded. It involved very complicated mathematical algorithms for process characterization and verification. Data Science Automation was selected to develop, install, and test the entire system in just three weeks!

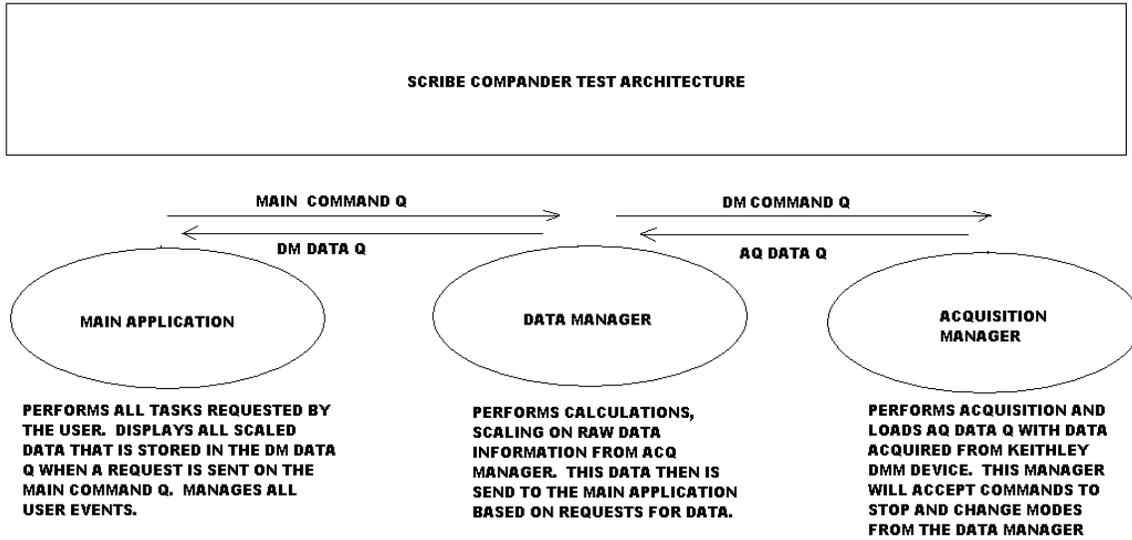
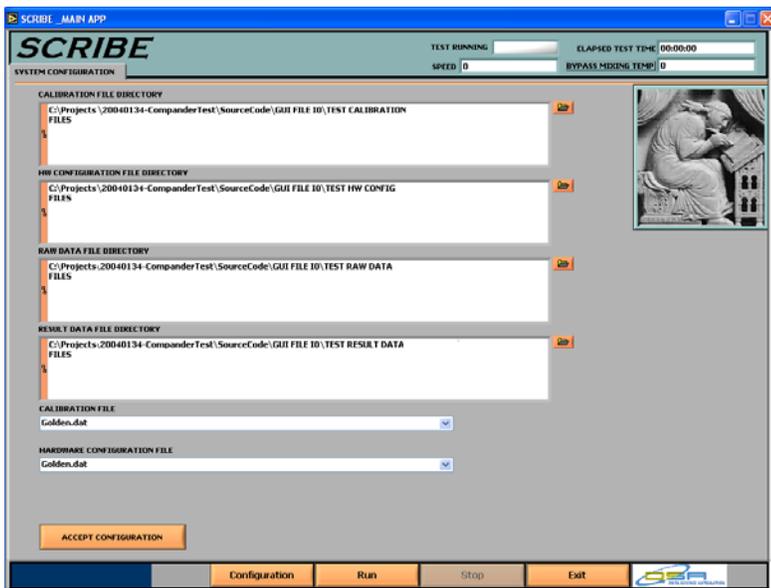


Figure 1. Software System Architecture

## The Solution

Working under such a tight deadline, National Instruments LabVIEW 7.1 was selected as the rapid application development environment. An NI-GPIB interface was used for controlling an existing Keithley 2700 DMM system to acquire data during the testing process. The solution that was created is based on three-module software architecture to isolate the main user interface from the other critical acquisition and data management functions. Figure 1 illustrates the architectural approach.

Utilizing queue technology native to LabVIEW, an elaborate system was designed to send messages/requests back and forth to control the three independently-operating modules. The main application will request data from the data manager. The data manager will execute complex equations, and condition the raw data that is being acquired by the acquisition manager. The data manager will also service all requests by the main application such as logging to files and controlling the actions of the acquisition manager. The acquisition manager strictly acquires data and publishes the data to the data manager. This three module architecture is flexible enough to account for any issues in the acquisition process and without affecting the main application.



Shown in Figure 2, the main application, called Scribe, allows the user to define, save, and load file configurations, including all output paths for the raw data files, result data files, hardware configurations, and the calibration files.

**Figure 2. System Configuration Screen**

When the user initially wants to configure this application they must either use a previous configuration or create a new configuration. The first step in setting up the new configuration is configuring the high channel count Keithley DMM for native settings such as Temp Scale, Polarity, Auto Zero, etc. The second part to the hardware configuration is to setup each data acquisition channel and their associated transducer inputs. During this configuration the user must specify the type of measurement, scaling, filtering, tag names, and a serial number. This information is stored in the hardware configuration files for future use. This configuration is shown below in Figure 3.

The next step in the configuration process is to setup the measurement names for everything from simple temperature and voltage readings, to outputs from complex equations. These measurement names are aliases for the actual hardware channels

or calculations resulting from one or multiple channel inputs. Multiple aliases can be given to a channel for use in multiple calculations. Each of these measurement names are used in calculations during the running stage of the application. Due to the complexity of the liquefaction process multiple calculations must be done to verify the process was successful. The measurement configuration screen is shown in Figure 4.

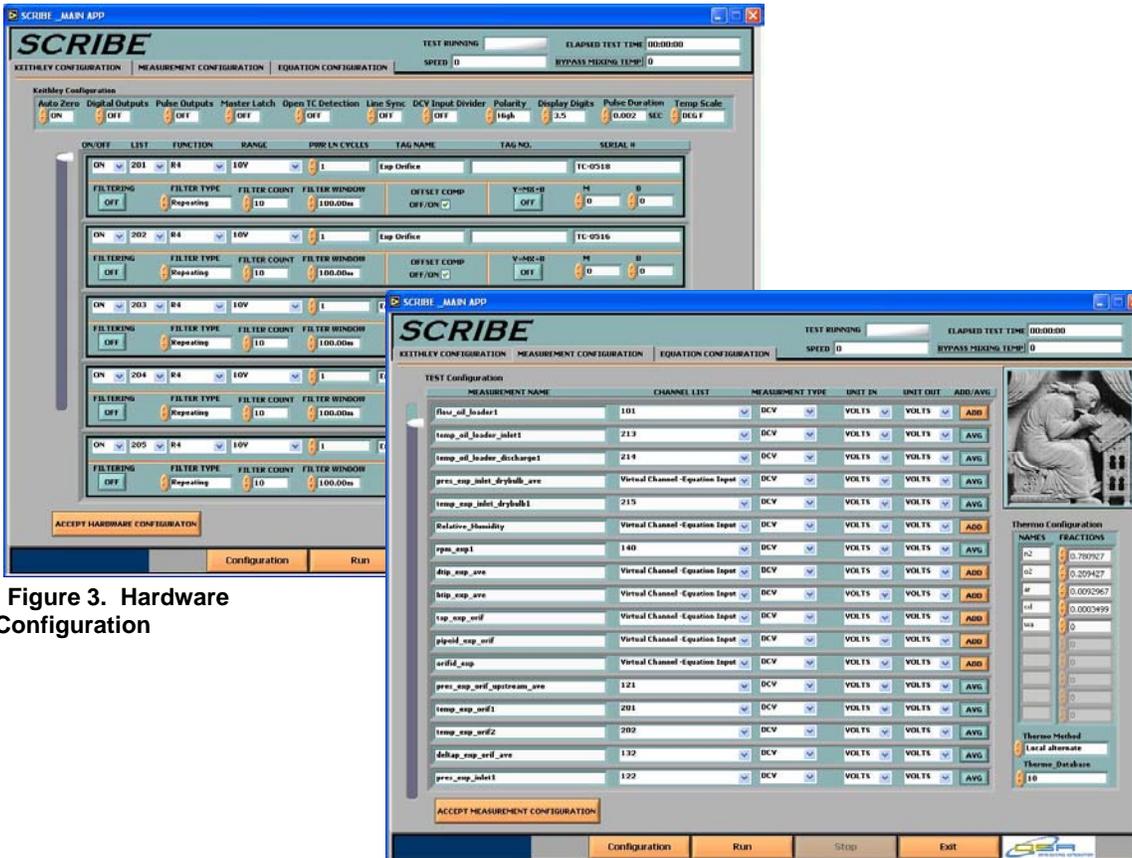


Figure 3. Hardware Configuration

Figure 4. Measurement Configuration

Once all measurement names and variables have been created, the user can configure the proprietary equations based on the measurement names. Each of these equations will be evaluated each iteration of the acquisition process. This will allow the user to view all calculated data without having to post process results. This real-time approach significantly increased the throughput of the combined research and analysis procedures.

Before starting the test and controlling the compander units, the application initializes queues to start the Keithley Manager and the Data Manager based on configuration and setup information saved in files. Once all parameters and hardware configuration information has been sent, the user will have the ability to calibrate the RTD and non-RTD devices before logging data.

After all calibration has been completed, the test will begin. During the test execution the user will have the ability to view real-time results from the Keithley device and from the sophisticated equation calculations. These results can be exported to file during run time or can be viewed on charts, or tables shown in Figure 5. Data can be saved at automatic intervals or upon user activation.

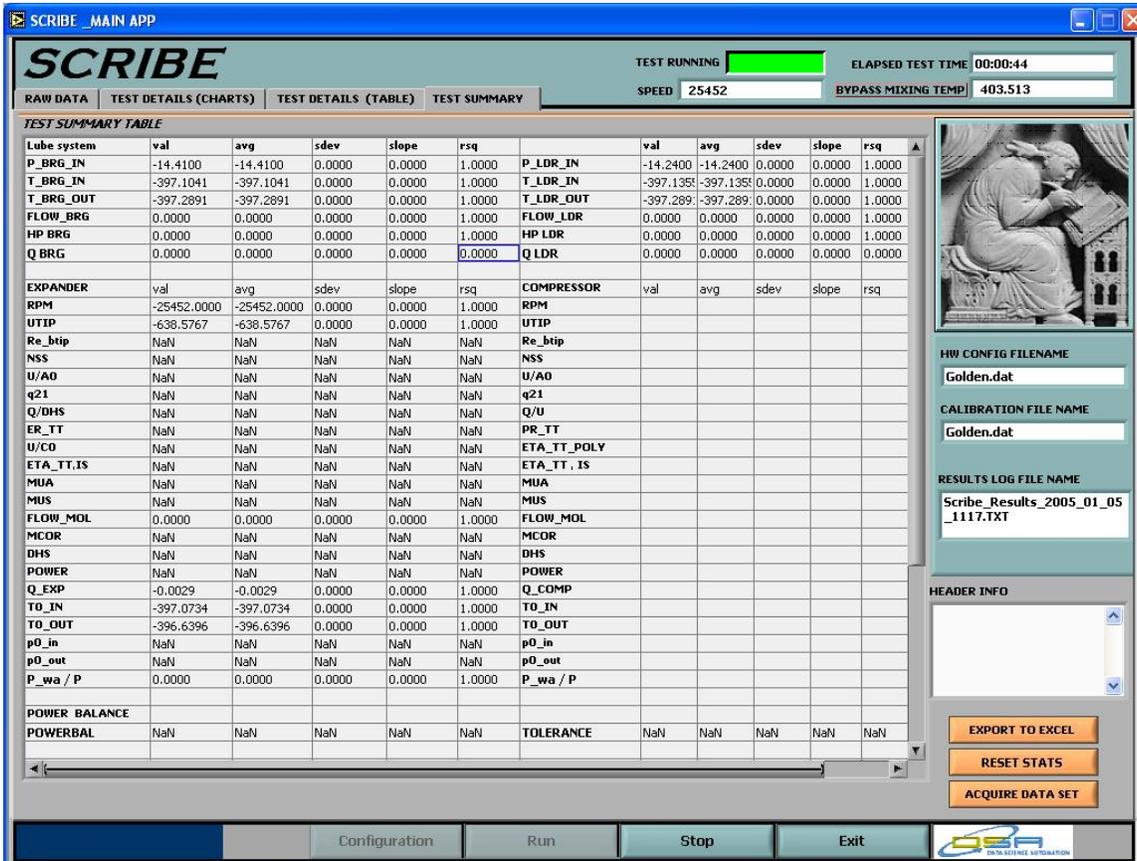


Figure 5. Test Results

Summary

Data Science Automation’s prototype solution created to automate the liquefaction process using commercial compander units. The advanced data acquisition and data analysis techniques were successfully used to simulate the future deployment of large scale natural gas liquefaction processes. This solution leveraged National Instruments LabVIEW 7.1 software, and the GPIB interface to the Keithley DMM. It has saved countless hours of planning, and eliminated costly field testing by simulating the real world deployment on a smaller scale.