# Urethane Shock Absorber Production Testing

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**Category:**
Manufacturing

**Products Used:**
LabVIEW 8.2
LabVIEW RealTime 8.2
cFP-2120
cFP-AI-100
cFP-DIO-550
cFP-RLY-423
Schaevitz HR-5000 LVDT
Strainsert FL75U Load Cell
Schaevitz LDM-1000 Signal Conditioner
Precise Instruments AT10 Signal Conditioner

**The Challenge:**
Developing a data acquisition and control system for a hydraulic press used to test railroad car shock absorbers. The system must retain three months of historical data and provide an easy method to download from the controller. The shock absorbers are cylindrical urethane molds of 5 inches in height and 3 3/8 inches in diameter. One is placed on each corner of rail car frame that transports rail car shipping containers. After the urethane absorbers are produced they need to be tested by applying a typical load to them to ensure they absorb the appropriate amount of force.

**The Solution:**
Developing a LabVIEW RealTime application deployed to a National Instruments Compact Fieldpoint (cFP) controller and displays a user interface through a web browser remote panel. The application would also log test data to a comma separated value (.csv) file which would be easily retrievable thru the conveniently built-in FTP server on the cFP controller.

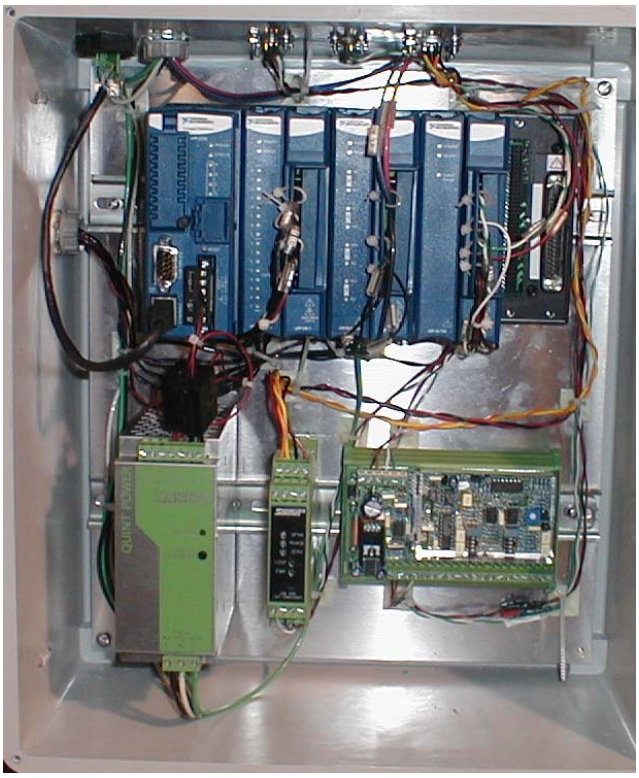

**Figure 1. Controller and Signal Conditioning Modules**



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**Abstract:**
The flexibility of NI's Compact FieldPoint line of products allowed for multiple options in choosing which modules would be best for this application. The cFP-2120 Real-Time Controller was selected because of its storage capabilities and high speed. (See Figure 1) We chose to go use the cFP-AI-100 because of the resolution available for the analog measurements the project called for, the cFP-DIO-550 for flexibility in providing digital inputs and outputs and the cFP-RLY-423 to handle the directional control valve for the hydraulic pump which in turn applies the hydraulic pressure to the cylinder press for testing the urethane shock absorbers.

**The Details:**
The directional control valve is a 3 position value with two solenoids that are energized by 110 VAC signals. When one solenoid is energized the press cylinder retracts, when the other solenoid is energized the press cylinder compresses. When neither solenoid is energized or when they are both energized the cylinder is held at a fixed position.


**Figure 2. Hydraulic Load Frame and Operator Controls**

The LabVIEW RT application reads load cell data, position data from the LVDT and a pressure reading via a pressure transducer on the hydraulic pump output. The position reading is accurate to a one ten thousandth of an inch. During testing, the application monitors the position of the LVDT, which is mounted to the press cylinder. The current position of the LVDT is used to know when the application should stop the cylinder, change direction of the press and/or collect data. The pressure transducer is constantly monitored at a rate of 10Hz and alerts the operator of a lower pressure condition by both a lamp indicator mounted on the front of the machine and an LED on the user interface of the application. The load cell reading is only acquired twice per part tested. The application also constantly monitors an E-Stop button, mounted on the front of the machine, at a rate of 10 Hz. Upon detection of pressing of the E-Stop, the cylinder press would immediately retract to its Home position.




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The test procedure is the following: a part is seated in the machine and the operator simultaneously presses two run push buttons. (See Figure 2) This is a safety requirement to ensure the operator's hands are free from the machine when the cylinder activates. After the run buttons are pressed the cylinder compresses the urethane part to the specified "Solid Height" then retracts to the specified "Free Height". Typically, the application cycles this process three times and collects data on the third, final cycle. However the Cycle Count and Data Collect Cycle are configurable by the user. These height and cycle count settings can be modified on the user interface and stored to a .cfg file. Load cell data is collected twice on the Data Collect Cycle: once when the cylinder is compressing the part at the Data Collect Height position and then again at the same position when the cylinder is retracting on the way back up. The two load cell readings are then averaged together and compared to upper and lower limits. If the average falls outside of the configurable limits, the application illuminates a "Part Fail" lamp indicator on the front of the machine. This indicator is also a push button and upon a part fail condition, the operator must press the illuminated push button to acknowledge the part has failed before proceeding with the testing of the next part. After every part is tested, data is logged to a .csv file on the cFP-2120 controller. The averaged load cell reading and time and date are logged as well as the different set heights and cycle settings. The built-in FTP server on the cFP-2120 allows for easy retrieval of the data file from the controller to a networked computer. Once a file was copied over from the controller to the networked PC a new file is automatically created on the cFP-2120.

The application is a producer-consumer architecture with two additional parallel loops. The producer loop is a state machine that handles the cycle testing, updating of config.cfg file, manual mode and all other user interface actions. (Figure 3) The consumer loop displays test data to the user interface and handles the logging of data to the .csv file. The two additional loops are a loop dedicated to monitoring the E-Stop and monitoring the hydraulic pressure and LVDT and Load Cell voltages.




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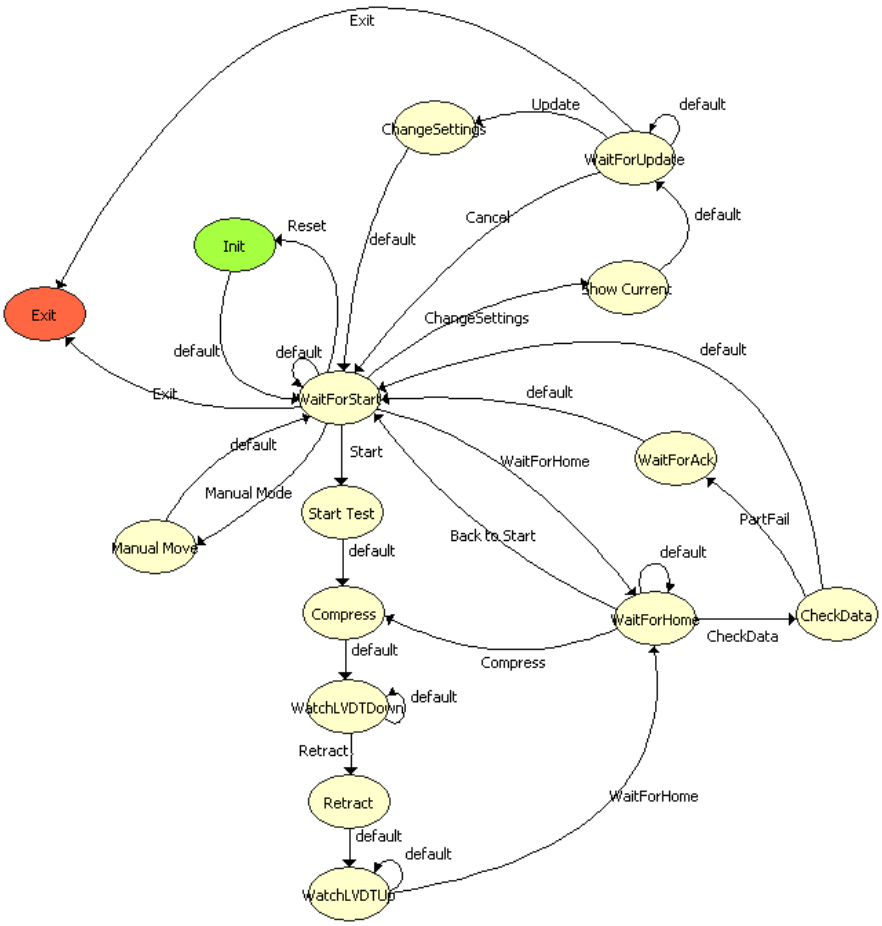


**Figure 3. State Diagram for Producer**

A manual mode is present to help in the calibration of the LVDT and Load Cell. In manual mode, the operator is able to command the cylinder press to move to any fixed height by inputting a set height in inches. The raw, un-scaled voltages for the LVDT and Load Cell are continuously displayed to aid in the calculation of scaling factors.

The application runs on the cFP-2120 completely headless and the user interface of the application can be accessed through NI's built in web browser remote panel so that any networked PC is able to simply open up a Web browser to monitor the testing progress or change settings.




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