CU-NEES-07-7

NEES at CU Boulder

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The George E Brown, Jr. Network for Earthquake Engineering Simulation

FHT Facility
Controller Operations

By

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May 2007

1. FHT Facility

Our fast hybrid testing laboratory consists of a computer network connected to the MTS controller and the three high performance servo-hydraulic actuators through SCRAMnet (Shared Common Random Access Memory Network). Depending on the complexity of the test being run, one to six computers and up to three people are required to operate all aspects of the test. The computer network controls the actuators, runs the simulation part of the test and performs data acquisition. Real time testing is accomplished with the controller synchronizing all the host computers on the network by sending out a system interrupt every millisecond. The diagram below shows how all the various aspects of the system interact.

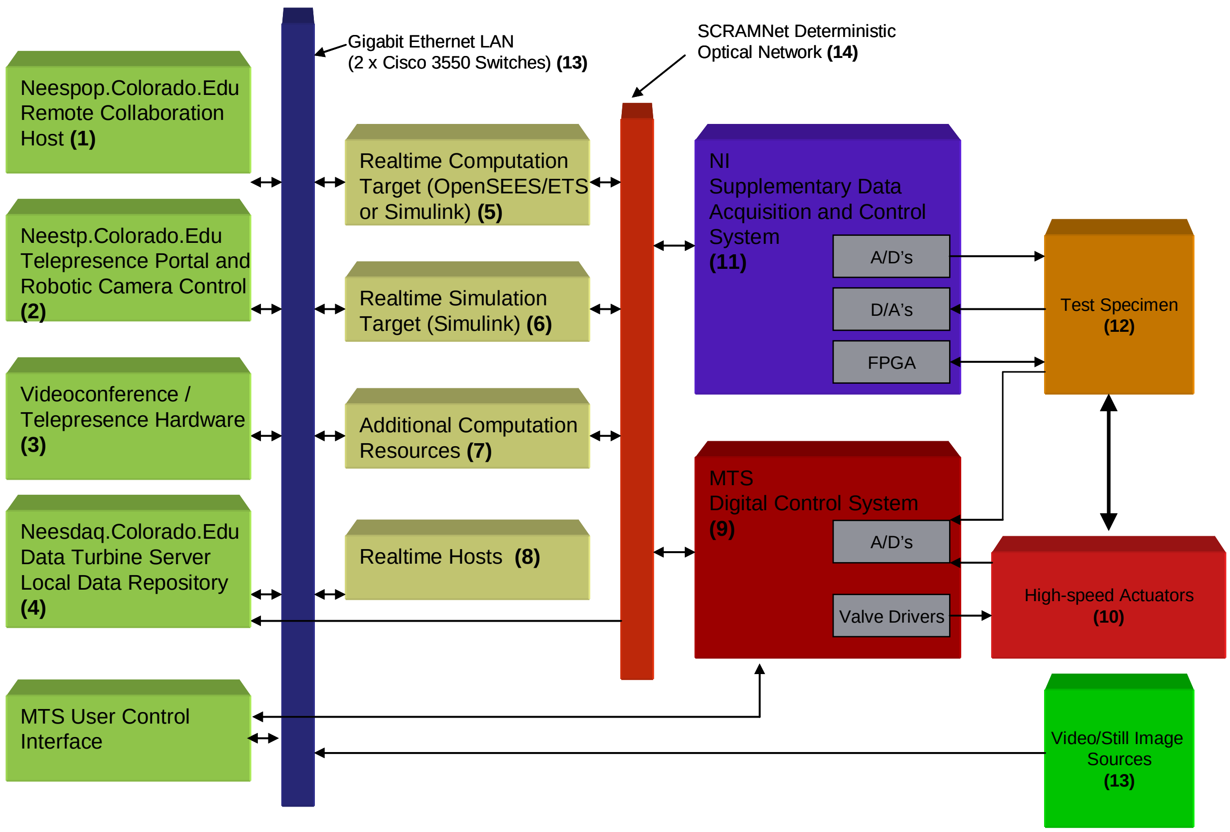

Figure 1: CU FHT Equipment Network

2. MTS Controller

The MTS 493 Controller is a real-time, digital controller that provides closed loop control with a delta-p feedback signal. It provides an operator interface to the real-time hardware from a PC over an Ethernet link. The controller consists of a MTS console assembly, associated cabling, and control software. The control panel software runs on a PC and has a graphical user interface consisting of interactive, modeless dialogs that are used to enter system parameters and execute tests.

3. Structural Test System

The user interacts with the Structural Test System application on the designated PC. This program contains the control software that communicates with the MTS console assembly. The structural test system operates through a settings file which is loaded at the start of the application and includes all calibration values, safety limits and test parameters. The default settings file must be modified for each individual test.

Shown below in Figure 1 is the main control panel of the structural test system software. The menus from this panel are used to access all other options for calibrating, configuring, setting up tests, and displaying data. You can also use the controls and displays of this panel to set or check functions, control the status of the hydraulics, and to run tests.

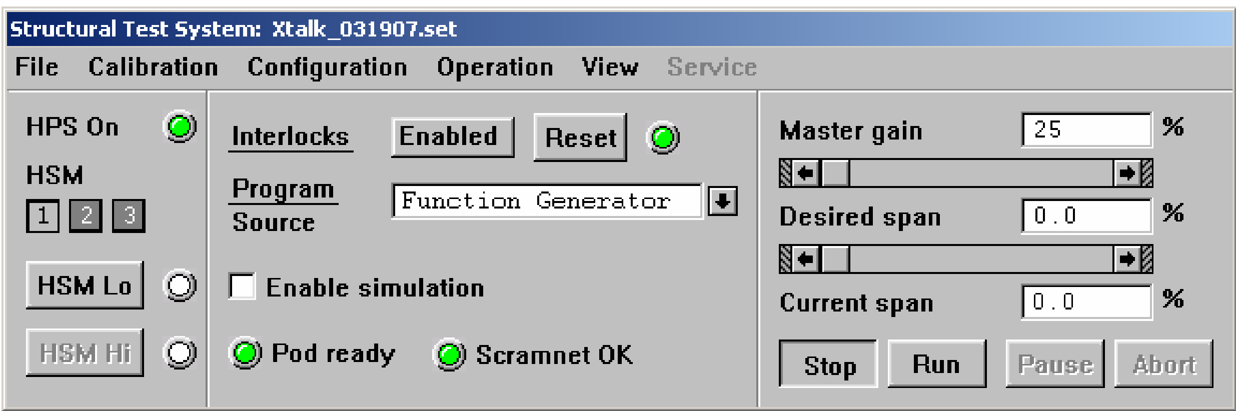

Figure 2. Structural Test System Main Control Panel

3.1 Calibration Settings

The system is calibrated annually and all values are stored in the settings files. The AC/DC Conditioner Panel retains the calibration values for all data collection elements of the system. Data includes displacement and force feedback from all the actuators as well as additional data from strain gauges and LVDTs. Calibration values such as excitation amplitude, phase, gain and delta K can be seen in Figure 2 below.

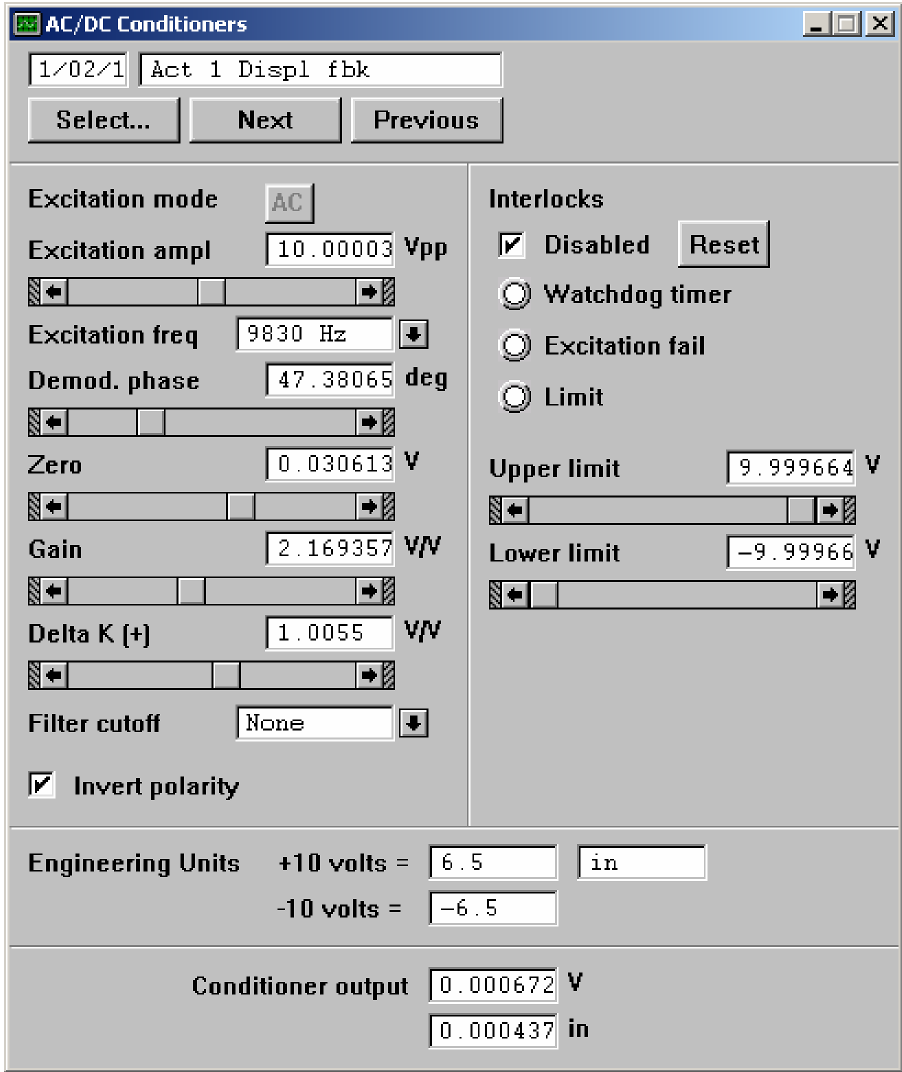

Figure 3. Conditioners

The calibration data for the actuators and the LVDTs is obtained from the yearly MTS calibration visit, and is not altered until the next calibration date. There are approximately 100 of these values that must be correct in each settings file in order to ensure accurate data. There are additional strain and other gauges that amount to additional 100+ calibration values. When a new settings file is created or an old settings file is used for a test, all the calibration values must be checked and corrected if necessary.

The one calibration value that can change as often as the system is used, although it is not always necessary, is the zero number. This is applicable when a feedback signal can experience an offset from a command signal.

3.2 Test Settings

Settings associated with individual tests will determine which actuators are active, how the actuators behave, whether they are force or displacement driven, their motion and the types of data that will be recorded as part of the test.

The source command is chosen off the main control panel. Each option provides for a different type of test to be run. For a fast hybrid test the source is always the SCRAMNET system. The figure below shows the pull down menu on the main control panel where the source choices are found.

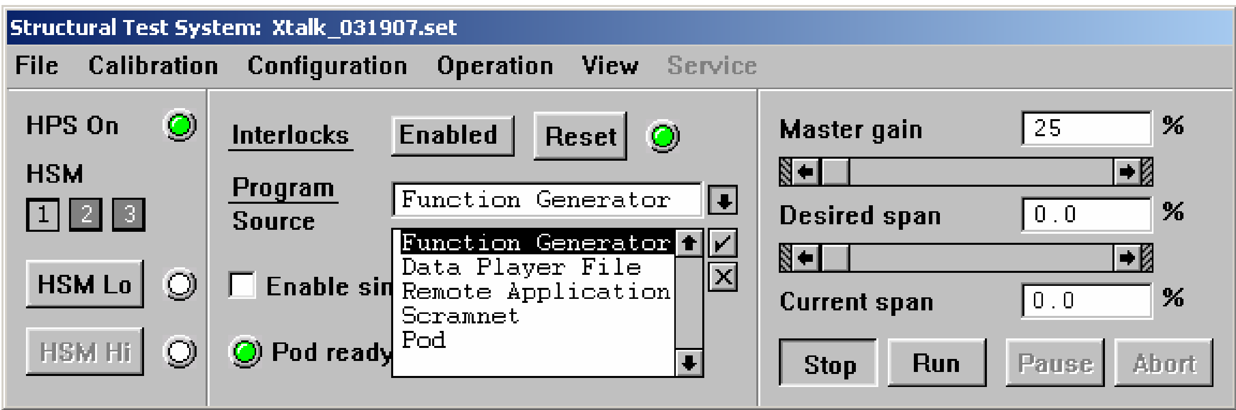

Figure 4. Source Options

The Data Recorder can collect and record data for any test. This information provides an important means of checking accuracy and identifying problems. For each test the channels of data of interest must be selected so that the only data collected is that which is relevant to the test. Sample rate, starting delay and the recording period are other important factors that are set in the Data Recorder as shown below.

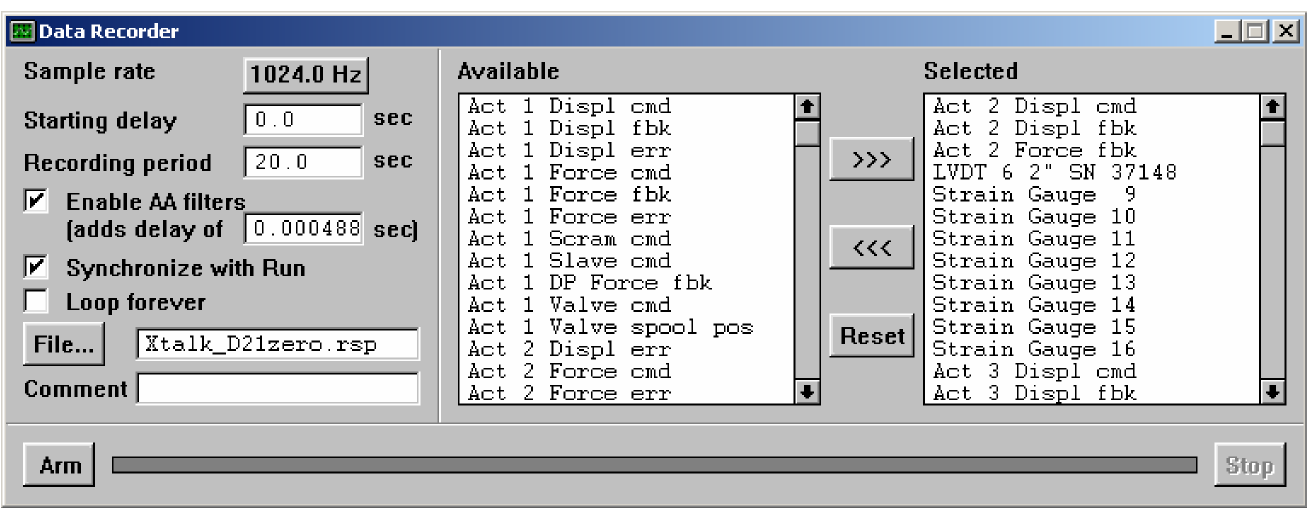

Figure 5. Data Recorder

3.3 Safety Settings

Besides specifying the characteristics of a test, the controller also provides an important safety function for the entire hydraulic actuator system. These safety function are accomplished through data viewing applications and limit settings.

The Digital Readouts window provides a way to simultaneously view values of multiple selected channels. The condition of the system can be determined from the data seen below. If any of the values need to be zeroed or in another way altered before testing, the digital readout window shows this. Before starting up the hydraulics and allowing pressure to the actuators, this information is used as part of an important check to be sure the system ready. Any of the viewed channels can be changed to suit the needs of a particular setup or test, and be stored as part of the settings file.

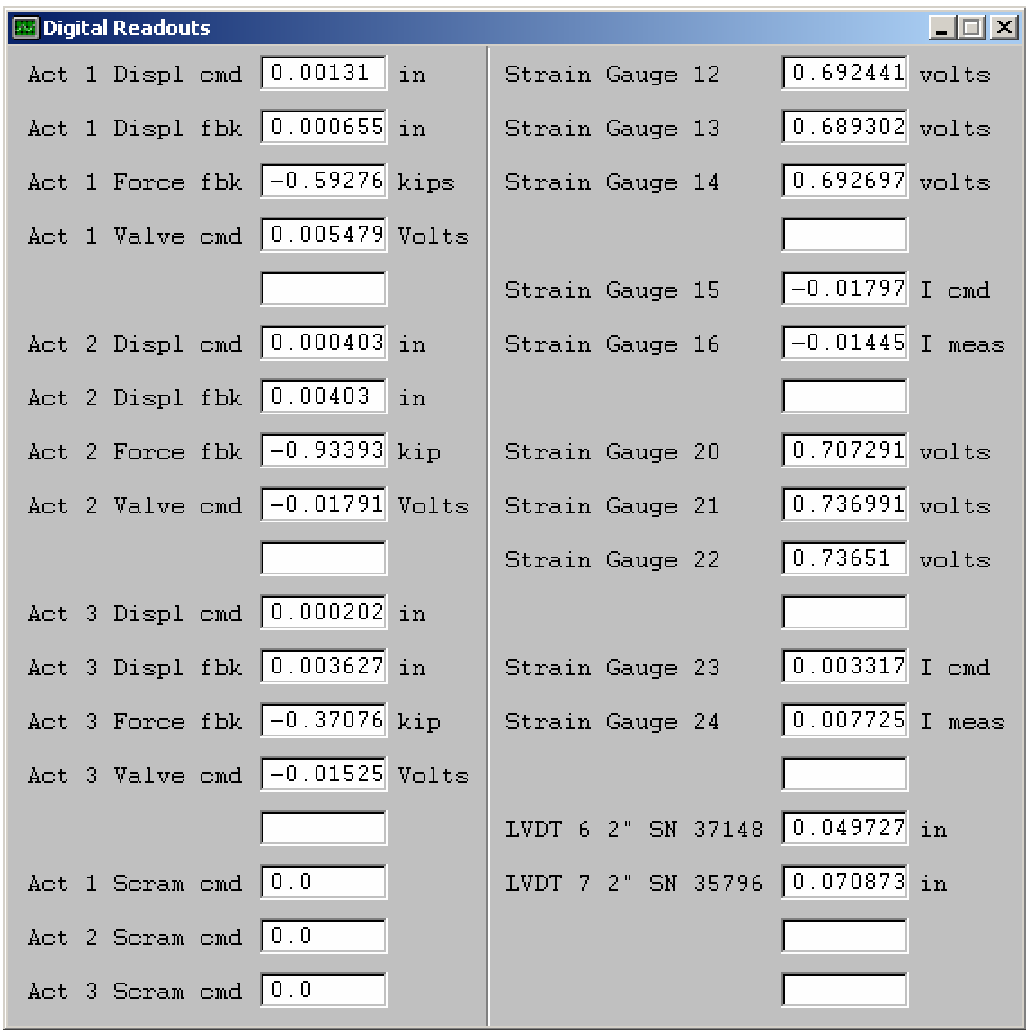

Figure 6 Digital Readouts

As a part of every Level 4 test that occurs, the displacement and force experienced by all applicable actuators is first estimated. These estimates are used to set safety limits on the actuators, thus providing a means of protecting the equipment from damage. These safety limits are defined in the Limit Detectors panel. A limit event can be set on upper and/or lower limits for any signal of data collected by the controller. The lowest setting of a limit event is 'Indicate' which causes an indicator light to come on when the signal is outside the allowable range. The most firm limit event is 'Interlock' which causes the system to trigger an Emergency Stop if the signal goes outside the allowable limits. The more uncertain the predictions of a test are, the tighter the limits will be set on the system when the test is run. For each signal the values of the limits as well as the type of limit event must be defined, as shown below in the Limit Detectors panel. These limits must be defined, prior to testing, for every applicable signal in use for a particular test and are saved in the settings file for that test.

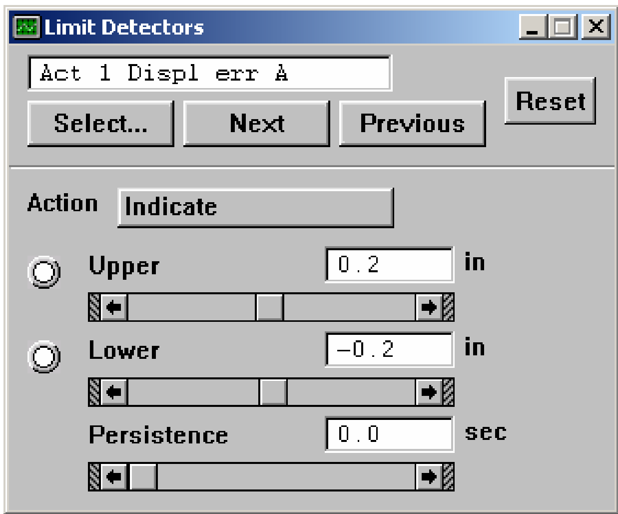

Figure 7. Limit Detectors

The Oscilloscope panel allows for one or two signals to be viewed graphically. This function is particularly important for analyses while a test is running in order to identify any problems or inconsistencies that may be occurring. The channels being viewed, their respective scaling factors, and the sweep period of displaying data are some of the functions available on the oscilloscope.

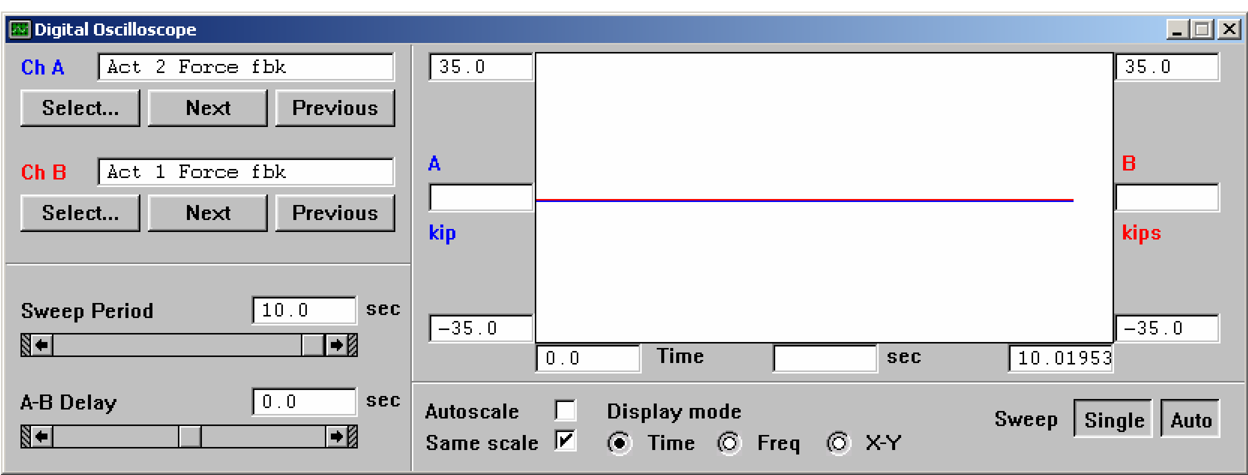

Figure 8. Oscilloscope

The functions described above represent only the basics required to run a test using the MTS controller and actuators. There are as many more applications for resolving any number of individual situations one might face when operating the system.