

Multi-Axial Testing System User Manual



NCREE Taiwan
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Preface

Before you Begin

Safety first!

Before you attempt to use your MTS product or system, read and understand the *Safety* manual and any other safety information provided with your system.

Improper installation, operation, or maintenance of MTS equipment in your test facility can result in hazardous conditions that can cause severe personal injury or death and damage to your equipment and specimen. Again, read and understand the safety information provided with your system before you continue. It is very important that you remain aware of hazards that apply to your system.

Other MTS manuals

In addition to this manual, you may receive additional MTS manuals in paper or electronic form.

If you have purchased a test system, it may include an MTS System Documentation CD. This CD contains an electronic copy of the MTS manuals that pertain to your test system, including hydraulic and mechanical component manuals, assembly drawings and parts lists, and operation and preventive maintenance manuals. Controller and application software manuals are typically included on the software CD distribution disc(s).

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Conventions

Documentation Conventions

The following paragraphs describe some of the conventions that are used in your MTS manuals.

Hazard conventions

s necessary, hazard notices may be embedded in this manual. These notices contain safety information that is specific to the task to be performed. Hazard notices immediately precede the step or procedure that may lead to an associated hazard. Read all hazard notices carefully and follow the directions that are given. Three different levels of hazard notices may appear in your manuals. Following are examples of all three levels.

Note For general safety information, see the safety information provided with your system.



Danger notices indicate the presence of a hazard with a high level of risk which, if ignored, *will* result in death, severe personal injury, or substantial property damage.



Warning notices indicate the presence of a hazard with a medium level of risk which, if ignored, *can* result in death, severe personal injury, or substantial property damage.



Caution notices indicate the presence of a hazard with a low level of risk which, if ignored, *could* cause moderate or minor personal injury, equipment damage, or endanger test integrity.

Notes

Notes provide additional information about operating your system or highlight easily overlooked items. For example:

Note Resources that are put back on the hardware lists show up at the end of the list.

Special terms

The first occurrence of special terms is shown in *italics*.

Illustrations

Illustrations appear in this manual to clarify text. It is important for you to be aware that these illustrations are examples only and do not necessarily represent your actual system configuration, test application, or software.

Electronic manual conventions

This manual is available as an electronic document in the Portable Document File (PDF) format. It can be viewed on any computer that has Adobe Acrobat Reader installed.

Hypertext links

The electronic document has many hypertext links displayed in a blue font. All blue words in the body text, along with all contents entries and index page

numbers are hypertext links. When you click a hypertext link, the application jumps to the corresponding topic.

Technical Support

How to Get Technical Support

Start with your manuals

The manuals supplied by MTS provide most of the information you need to use and maintain your equipment. If your equipment includes MTS software, look for online help and README files that contain additional product information.

If you cannot find answers to your technical questions from these sources, you can use the internet, e-mail, telephone, or fax to contact MTS for assistance.

Technical support methods

MTS provides a full range of support services after your system is installed. If you have any questions about a system or product, contact MTS in one of the following ways.

MTS web site www.mts.com

The MTS web site gives you access to our technical support staff by means of a Technical Support link:

www.mts.com > Contact Us > Service & Technical Support

E-mail

techsupport@mts.com

Telephone

MTS Call Center 800-328-2255

Weekdays 7:00 A.M. to 5:00 P.M., Central Time

Fax

952-937-4515

Please include "Technical Support" in the subject line.

Before You Contact MTS

MTS can help you more efficiently if you have the following information available when you contact us for support.

Know your site number and system number

The site number contains your company number and identifies your equipment type (material testing, simulation, and so forth). The number is usually written on a label on your MTS equipment before the system leaves MTS. If you do not have or do not know your MTS site number, contact your MTS sales engineer.

Example site number: 571167

When you have more than one MTS system, the system job number identifies which system you are calling about. You can find your job number in the papers sent to you when you ordered your system.

Example system number: US1.42460

**Know information from
prior technical
assistance**

If you have contacted MTS about this problem before, we can recall your file. You will need to tell us the:

- MTS notification number
- Name of the person who helped you

Identify the problem

Describe the problem you are experiencing and know the answers to the following questions:

- How long and how often has the problem been occurring?
- Can you reproduce the problem?
- Were any hardware or software changes made to the system before the problem started?
- What are the model numbers of the suspect equipment?
- What model controller are you using (if applicable)?
- What test configuration are you using?

**Know relevant
computer information**

If you are experiencing a computer problem, have the following information available:

- Manufacturer's name and model number
- Operating software type and service patch information
- Amount of system memory
- Amount of free space on the hard drive in which the application resides
- Current status of hard-drive fragmentation
- Connection status to a corporate network

**Know relevant
software information**

For software application problems, have the following information available:

- The software application's name, version number, build number, and if available, software patch number. This information is displayed briefly when you launch the application, and can typically be found in the "About" selection in the "Help" menu.
- It is also helpful if the names of other non-MTS applications that are running on your computer, such as anti-virus software, screen savers, keyboard enhancers, print spoolers, and so forth are known and available.

If You Contact MTS by Phone

Your call will be registered by a Call Center agent if you are calling within the United States or Canada. Before connecting you with a technical support specialist, the agent will ask you for your site number, name, company, company address, and the phone number where you can normally be reached.

If you are calling about an issue that has already been assigned a notification number, please provide that number. You will be assigned a unique notification number about any new issue.

Identify system type

To assist the Call Center agent with connecting you to the most qualified technical support specialist available, identify your system as one of the following types:

- Electromechanical materials test system
- Hydromechanical materials test system
- Vehicle test system
- Vehicle component test system
- Aero test system

Be prepared to troubleshoot

Prepare yourself for troubleshooting while on the phone:

- Call from a telephone when you are close to the system so that you can try implementing suggestions made over the phone.
- Have the original operating and application software media available.
- If you are not familiar with all aspects of the equipment operation, have an experienced user nearby to assist you.

Write down relevant information

Prepare yourself in case we need to call you back:

- Remember to ask for the notification number.
- Record the name of the person who helped you.
- Write down any specific instructions to be followed, such as data recording or performance monitoring.

After you call

MTS logs and tracks all calls to ensure that you receive assistance and that action is taken regarding your problem or request. If you have questions about the status of your problem or have additional information to report, please contact MTS again and provide your original notification number.

Problem Submittal Form in MTS Manuals

Use the Problem Submittal Form to communicate problems you are experiencing with your MTS software, hardware, manuals, or service which have not been resolved to your satisfaction through the technical support process. This form includes check boxes that allow you to indicate the urgency of your problem and your expectation of an acceptable response time. We guarantee a timely response—your feedback is important to us.

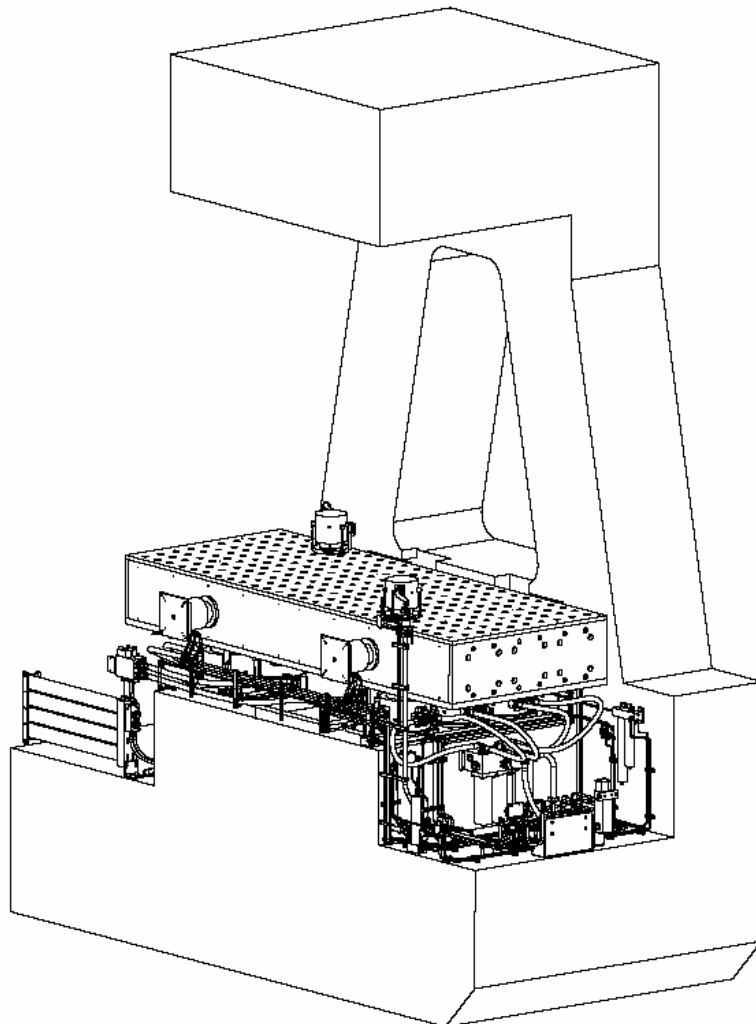
The Problem Submittal Form can be accessed:

- In the back of many MTS manuals (postage paid form to be mailed to MTS)
- www.mts.com > Contact Us > Problem Submittal Form (electronic form to be e-mailed to MTS)

Introduction

This section of the User's Manual provides a brief description of the components and sub-systems designed and provided by MTS Systems Corporation for the NCREE 4000 Ton Multi-Axial Testing System (MATS). The MATS testing system is configured to provide a wide range of testing capabilities that will include evaluations of bearings, dampers and various seismic isolation components on the system.

A partial rendering of the MATS system is shown below. The rendering includes a partial view of the reaction frame and the table/ platen for the system. These elements were designed and provided by others.

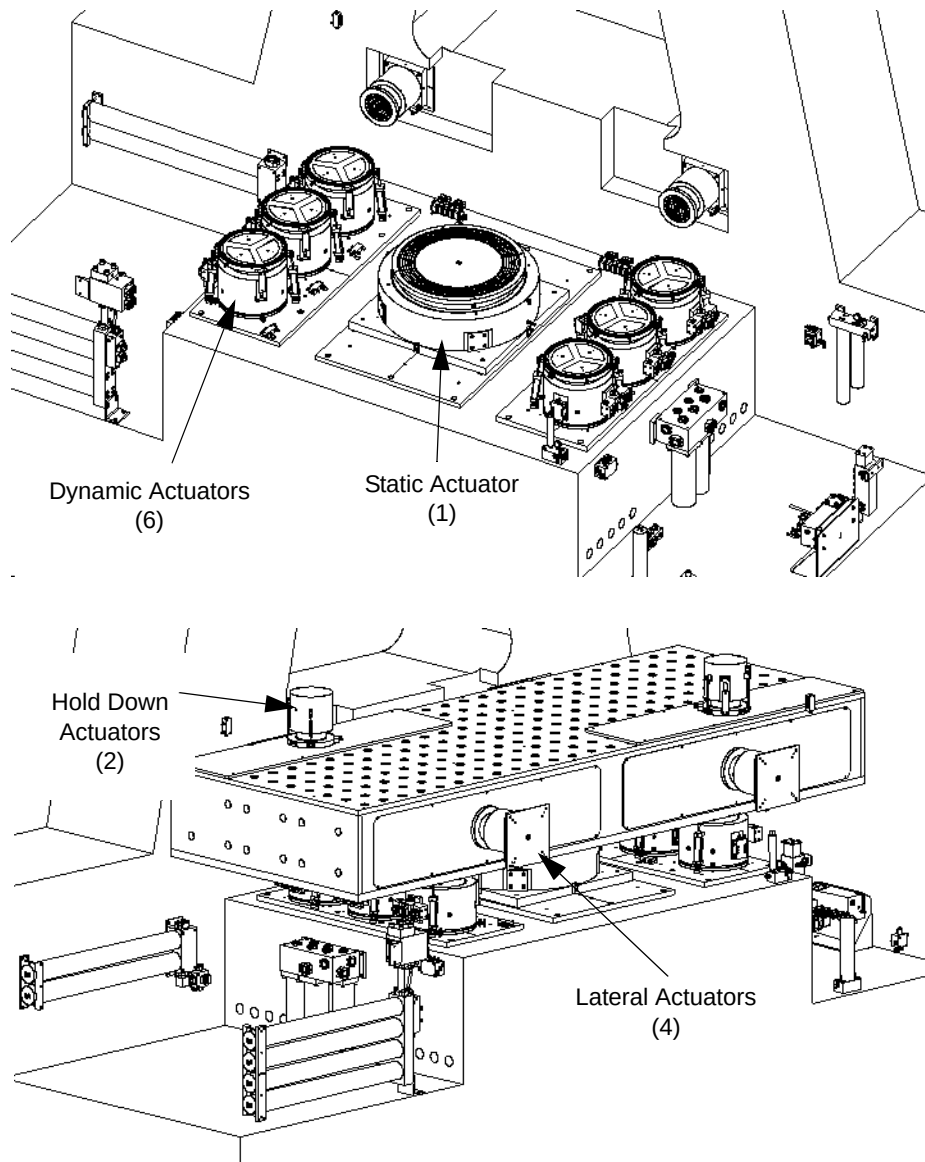


The elements designed and provided by MTS for the system are the vertical and lateral hydraulic actuators, the hydraulic distribution system, digital control system, and control software for operating the system. The following sections provide a further description of the MTS provided elements.

Hydraulic Actuators

The actuators that provide the vertical and lateral control of the MATS system are compact, single ended actuators. These new actuators have been designed to maximize stiffness and to reduce oil compliance/ resonance in the assemblies. The vertical and lateral actuators also incorporate pressure balanced, or hydrostatic bearing features on the end faces of the actuator rods to reduce friction and distortion in the cycling of the table/ platen. Actuator operation is accomplished by porting high-pressure hydraulic fluid into the actuator cylinders through a servovalve. As fluid is ported into the cylinder, pressure is applied to one side of the actuator piston, and fluid on the other side is ported to the return line. This results in a differential pressure across the piston and this will result in a motion of the actuator or an applied force that is equal to the effective piston area times the differential pressure.

The MATS system includes the following vertical and lateral actuators:



- **1 Static 3000 ton actuator (1)**

The static actuator is a vertical single ended pancake type actuator with a pressure balance type bearing at the interface to the table. Two 50 liter accumulators are provided to minimize force variation. Porting is included for future additions of accumulators for higher performance. Force will be measured using a readout pressure transducer.

- **6 Dynamic 500 ton actuators**

The six compression dynamic actuators are vertical single ended pancake type actuators with hydrostatic bearings at the interface to the table. Displacement is measured by a Temposonic displacement type stroke transducer and force is measured by a pressure transducer.

- **2 Hold Down 200 ton actuators (pre-load)**

The two hold down actuators are single-ended pancake type actuators with pressure balance bearings at the interface to the table. External accumulation is provided to minimize force variation in the actuators. Force is measured by using a readout pressure transducer.

- **4 Lateral +/- 100 mm stroke actuators**

The four lateral actuators are single ended pancake type devices with pressure balanced bearings at the interface to the table. The stroke range is +/- 100 mm. One pressure transducer, and one Temposonics stroke transducer are included with each lateral actuator assembly.

For the longitudinal motion of the MATS table/ platen, a combination of different actuator configurations are planned to be used for the displacement or force inputs to the system. The MTS MATS digital controller will operate the longitudinal actuators.

Servovalves

The MTS actuators are equipped with servovalves that control the direction and amount of fluid flow to the actuators. This regulated hydraulic fluid flow controls the force or displacement being applied to the test specimen.

For the bearing system, the following servovalves are used:

Static actuator (1):

- Dual 252 servovalves = 57 lpm rating

Dynamic actuators (6):

- 256 servovalve (three stage) = 340 lpm rating

Hold Down actuators (2):

- 252 servovalve = 57 lpm rating

Lateral actuators (4):

- 252 servovalve = 57 lpm rating

When the servovalve slave stage spool is in the hydraulic null position, the control ports are blocked and fluid is not allowed to flow to the system actuator. When a command signal causes the spool to move off of center, a pressure path is opened at one end of the actuator cylinder and a return path is opened at the opposite end, thereby causing a differential pressure on the piston resulting in actuator force and/or motion.

Hydraulic System

Hydraulic power for the MATS actuators will be supplied from the existing hydraulic distribution pumps and piping system in the lab.

The MATS system includes manifolds and control devices to safely direct the flow of hydraulic oil to the system actuators during normal use or in emergency shut down conditions. The MATS hydraulic distribution system includes boost pump modules (to raise system pressure to 280 bar), control manifolds, local accumulation for critical actuation sub-systems, a sump system, and hydraulic piping, tubing and hoses to direct flow to and from the various components.

MATS Control System

The control of the MATS test system is provided by an MTS Digital Controller. The controller is a real-time, multi degree-of-freedom module that provides the closed loop control of the system. The control hardware architecture is based on Digital Signal Processing technology that optimizes the performance of the embedded control system, and allows for the implementation of advanced control and data filtering operations.

The controller consists of a MTS console assembly, associated cabling and control software. The control software consists of the real-time control software and the control panel software. The real-time control software drives the processor to generate command and error signals. 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 a test.

The Real Time Control Software uses a cascade type loop to maintain pitch, yaw and roll angles (determined from displacement transducers) while achieving the overall desired vertical static force measured at the seven vertical actuator devices. The horizontal driving force is measured by the load cells or pressure transducers mounted on the horizontal actuators depending on the configuration selected.

When multiple actuators are used to meet the force or velocity requirements, the system becomes “over-constrained”. Over-constrained systems are inherently subject to undesirable force imbalances which can seriously limit the performance of the table. **Force Balance Compensation** corrects for this by balancing the force generated by each actuator against a weighted average of the other actuators in the same degree of freedom. This ensures that the force is distributed equally among all driving actuators and that the full force capability of the actuators is available to drive desired table motion.

Structural Controller Upgrade (STS)

In addition to the MATS controller, MTS has also provided an upgrade to an existing MTS FlexTest GT controller at the lab. This FlexTest controller has

been upgraded to incorporate ScramNet shared memory and MTS Real Time Hybrid Control capabilities. The upgrade includes the ability to Dual Boot the FlexTest GT Controller to operate as either a stand alone FlexTest GT using the original features or as a STS Real Time Hybrid Controller.

A ScramNet Card has been added to the existing FlexTest GT Power PC Processor. An additional personal computer with a ScramNet Card is provided which when used with the MathWorks XPC Target software acts as the real time kernel for the computational model interface and a fiber optic cable interface for communications between the Target PC and the FlexTest GT ScramNet card.

A real time host PC is provided for the model development and communication to the Target PC. STS Software package is provided to allow Real Time Hybrid Testing capabilities.

Note *NCREE is to provide all 3rd party Mathworks Simulink Software required for the MTS Real Time Hybrid Solution.*

Scramnet®.

ScramNet interface capability for the MTS and the STS controllers are provided to allow hybrid testing capabilities.

Note *No application programs or specific hybrid examples are provided, only the necessary hardware and software tools to allow the controller to communicate with other MTS hybrid enabled controllers are provided.*

Mathworks' Simulink® dynamic simulation programming environment has been integrated into MTS's controller architecture. Signals pass between MTS's controllers and the Simulink realtime PC in digital form over Scramnet®. This open environment allows you to create Simulink dataflow programs that interact with MTS's control software in realtime. All controller feedbacks are made available for use in Simulink, while commands or controller correction signals generated by Simulink drive MTS's controller command inputs. Some things that you can do with this capability are:

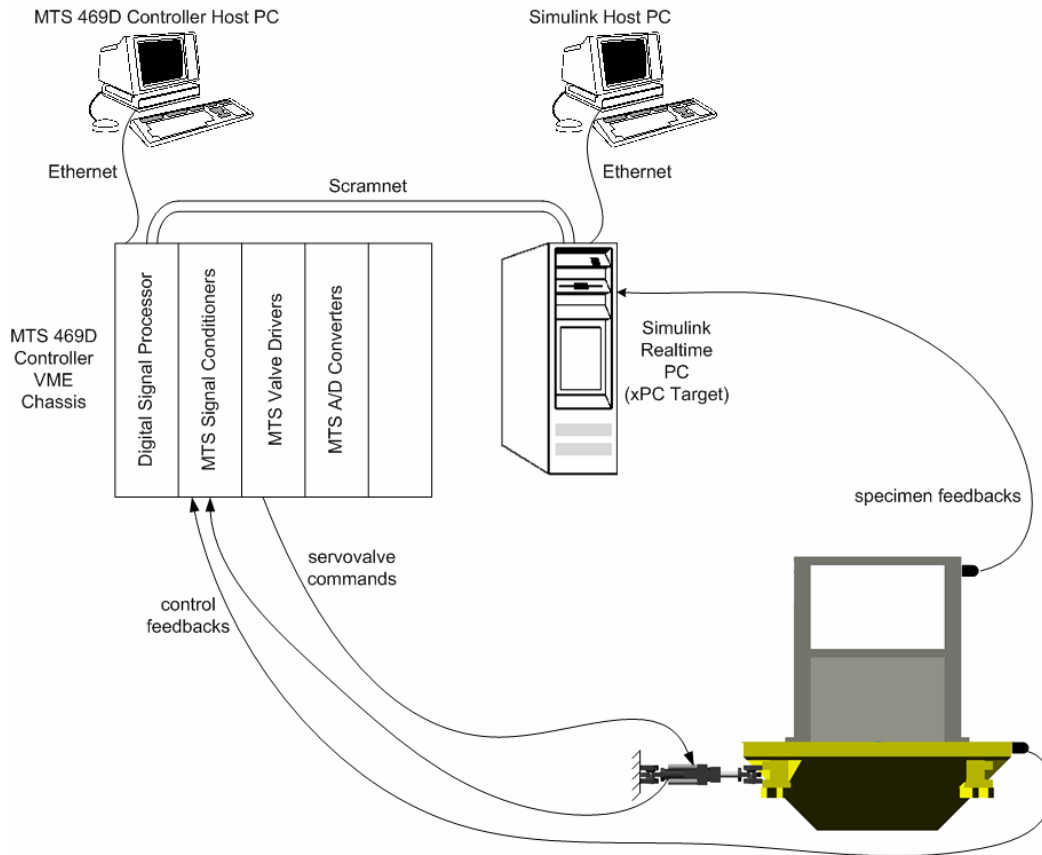
- Develop your own control algorithms to augment or replace MTS's.
- Develop a realtime simulation of your system's dynamics for purposes of algorithm checkout, performance prediction, offline control system tuning, and test rehearsal.
- Test "hybrid" structures, consisting of a real structure on the table and a "virtual" structure in the computer. For example, your real structure can be the lower floors of a multistory building, and the virtual structure the upper floors. As the lower floors are being shaken on the table, the affect of the upper floors on the lower floors can be computed in realtime in Simulink, and a command signal sent back to the MTS controller to drive actuators attached to the top part of the real structure to create those interaction forces.

Hardware

A diagram of a typical control system hardware is shown in the figure below, using a seismic table as an example. MTS's controller consists of a host PC connected to a VME chassis containing signal conditioners, valve drivers, and a high performance digital signal processor. The Simulink realtime model runs on

a high performance PC after being downloaded by its host PC. The Simulink realtime PC is a standard Windows PC that you can easily upgrade to higher performance PCs as they become available. In order to guarantee realtime performance, the PC is booted with a floppy disk containing a special realtime kernel; the Windows operating system does not exist while this kernel is running.

Signals pass between MTS's controller and the Simulink realtime PC in digital form over Scramnet®. Scramnet creates a section of memory that both the MTS controller DSP and the Simulink realtime PC can access, allowing them to pass signals to each other simply by writing and reading this block of shared memory.



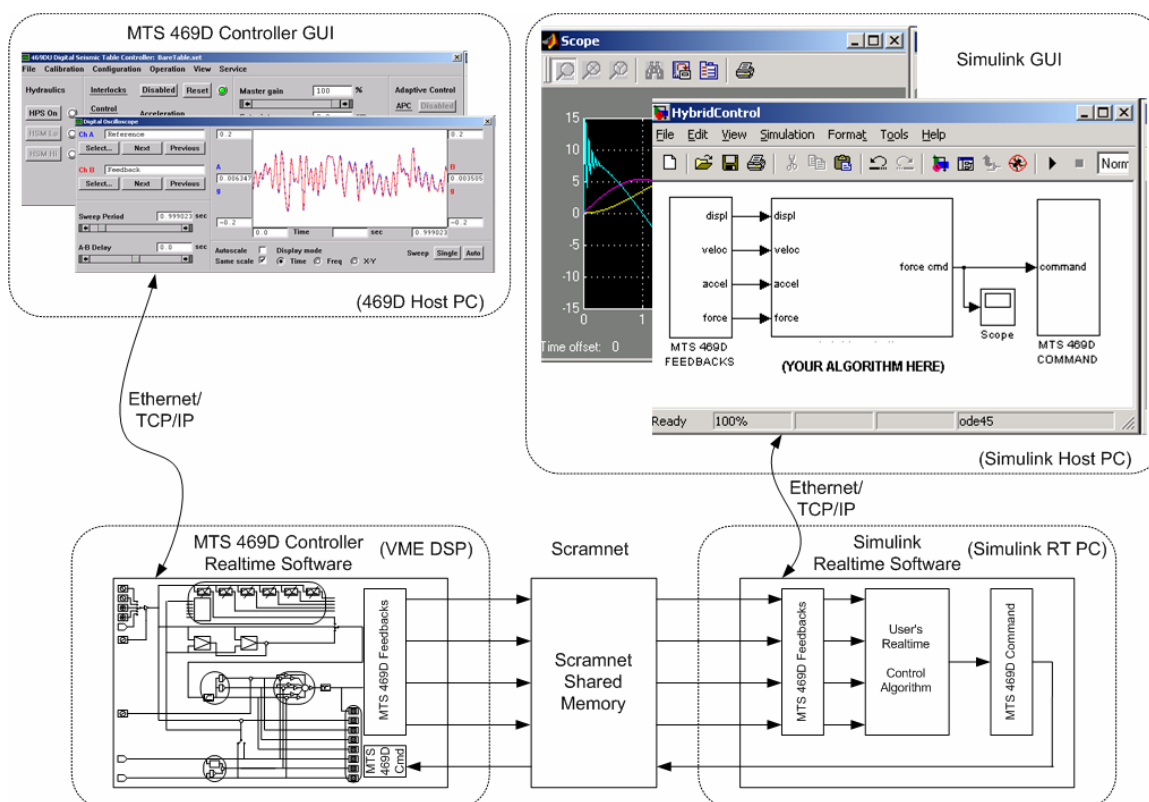
Software

The Real Time Control Software uses a cascade type loop to maintain pitch, yaw and roll angles (determined from displacement transducers) while achieving the overall desired vertical static force measured at the seven vertical actuator devices. The horizontal driving force is measured by the load cells or pressure transducers mounted on the horizontal actuators depending on the configuration selected.

The software will include the ability to run the table in 6 DOF mode.

A diagram of a typical control system from a software standpoint is shown in the figure below. You create your model on the Simulink host PC by drawing a

dataflow diagram that represents your control algorithm, system dynamics, hybrid simulation, or whatever. Then with a click of a button, Simulink will compile your diagram, download it to the Simulink realtime PC, and run it. MTS provides a template model diagram that gives access to all controller feedbacks and command inputs. You insert your model inside the "YOUR ALGORITHM HERE" box. If you add third-party interface hardware to the Simulink realtime PC, Simulink provides software to access a wide range of hardware devices.



Understanding Control Principles

This section contains information on the control principles used in the 469D control system. The following topics are discussed:

- Actuator Control Concepts
 - Basic Closed-Loop Control
 - Inner and Outer Closed-Loop Control
- Table Control Concepts
 - Table Motion
 - Table Polarity
 - Degree of Freedom Control
- Compensation Techniques
 - Force Balance Compensation
 - Differential Pressure Stabilization
- Test Adjustments
 - Master Gain
 - Span
 - Setpoint
- Limit Detection

Before setting up the test system or executing a test, it is important that you fully understand these control elements.

Actuator Control Concepts

Motion of the test system is governed by movement of its collective actuators. Each actuator is controlled through basic closed-loop, inner and outer closed-loop, and three-variable control concepts. These basic servohydraulic control concepts are discussed in the following subsections.

Basic Closed-Loop Control

In general, closed-loop control consists of comparing a command signal with a feedback signal.

Consider the system schematically illustrated in Figure 3-1. In this system, a displacement command signal is generated by a program source that is outside of the control loop. Feedback is generated by a linear variable differential transformer (LVDT).

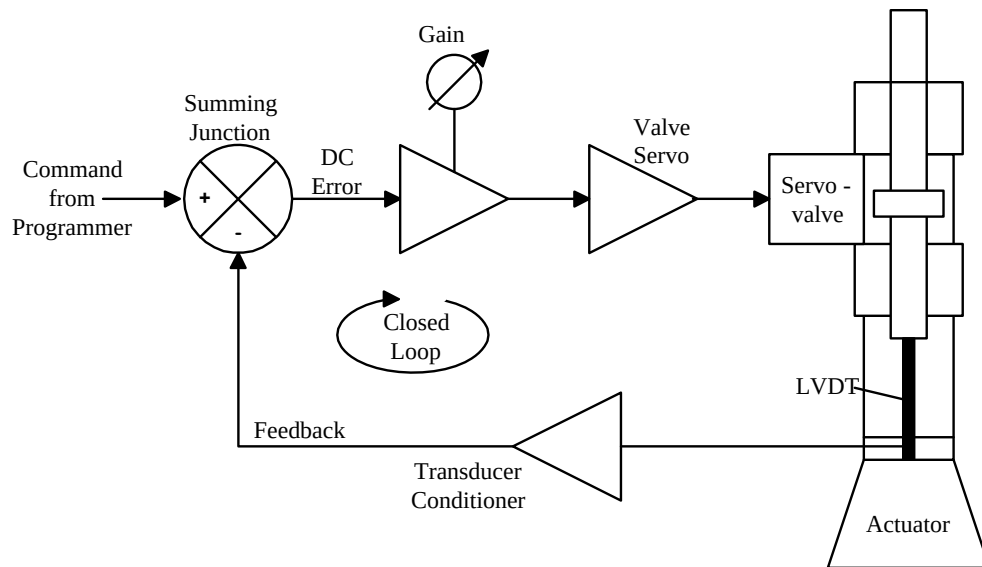


Figure 3-1. Basic Closed-Loop Control

The polarity and magnitude of the dc error signal derived by the command/feedback comparison causes the servovalve spool to open in a direction and by an amount necessary to cause the desired actuator response. As the actuator responds, feedback approaches command. As the program input changes, the command/feedback comparison continuously generates dc error signals that drive the servovalve to create the desired actuator displacement. When command and feedback are equal, the dc error is reduced to zero, the servovalve spool closes, and the actuator does not move. This control method is referred to as "closed-loop control."

Inner and Outer Closed-Loop Control

The simplest form of closed-loop control, as described in the preceding subsection, is used in systems containing a standard one-stage servovalve. However, the large flow and frequency response requirements of seismic testing require the use of a multi-stage servovalve. The multi-stage servovalve (Figure 3-2) contains a spool LVDT that introduces a second loop into the basic closed-

loop control system; the basic closed loop described above becomes an "outer" loop and the second loop becomes an "inner" loop.

The MTS Model 252 servovalve is used solely to drive the slave-stage spool. The spool LVDT provides a signal that is proportional to the position of the spool and that is, therefore, approximately proportional to the output flow of the servovalve.

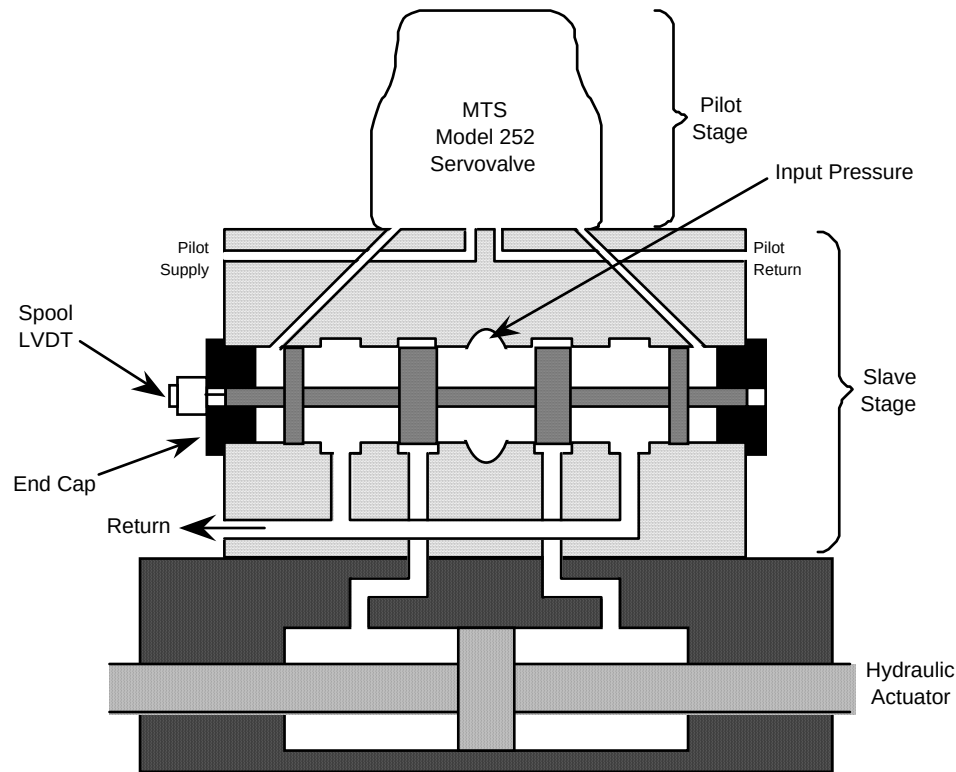


Figure 3-2. Multi-Stage Servovalve

Figure 3-3 schematically illustrates the inner and outer closed-loop control concept. As shown, the outer loop is similar to the basic closed-loop control concept discussed in the previous subsection. The dc error generated in the outer loop is the same as the dc error signal of the basic closed loop illustrated in

Figure 3-1. This dc error signal is then applied to the inner loop as a valve command signal.

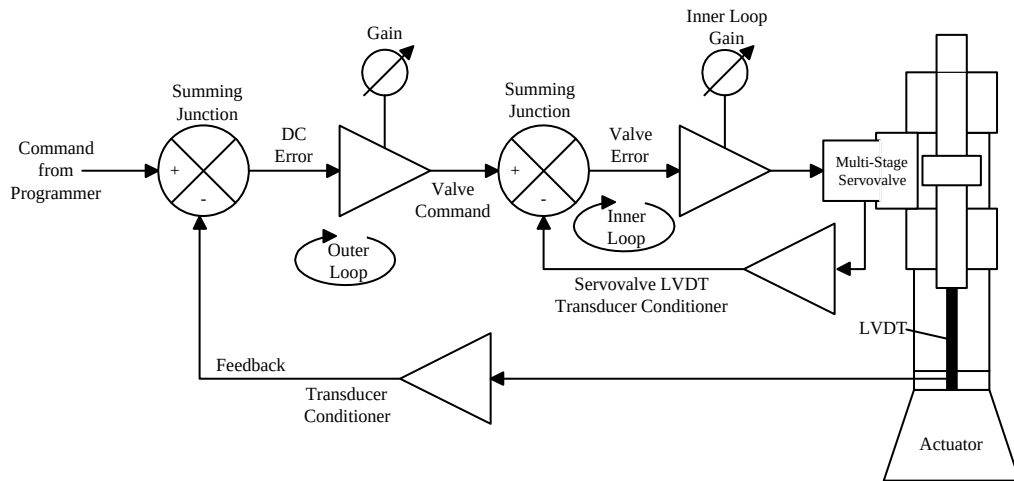


Figure 3-3. Inner and Outer Loop Control

The inner loop controls the position of the slave-stage spool in the same manner that the basic closed-loop concept controls the actuator. The inner loop summing junction produces a dc error signal that drives the slave-stage spool in the desired direction. This second loop enhances closed-loop performance to meet the hydraulic flow and frequency response requirements of the bearing testing.

Table Control Concepts

Motion of a table is governed by the collective movement of all system actuators. To create a desired table motion, the individual actuator control concepts discussed in the previous section must be synchronized. MTS achieves this synchronization through application of the degree of freedom (DOF) control concept.

Understanding standard definitions of table motion, DOF coordinates, and table polarity are critical to understanding DOF control. The following subsections provide these definitions and a description of DOF control.

Table Motion

The unrestrained motions of the seismic table are described by six degrees of freedom. These six degrees of freedom, illustrated in the figure below, are defined as follows:

Translational Degrees of Freedom

Longitudinal - motion along the longitudinal (X) axis

Lateral - Motion along the lateral (Y) axis

Vertical - Motion along the vertical (Z) axis

Rotational Degrees of Freedom

Roll - Rotation about the longitudinal (X) axis

Pitch - Rotation about the lateral (Y) axis

Yaw - Rotation about the vertical (Z) axis

Note that the Dalian system has three unrestrained motions: longitudinal, vertical and pitch. The other three motions (lateral, roll and yaw) are restrained.

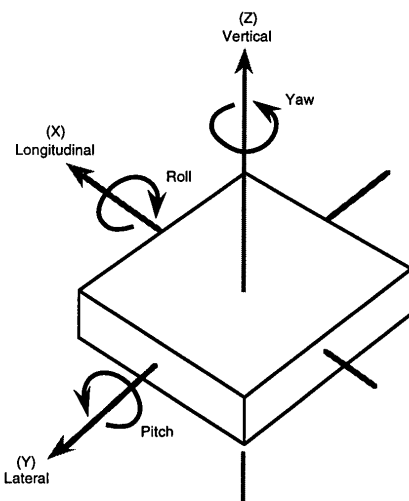
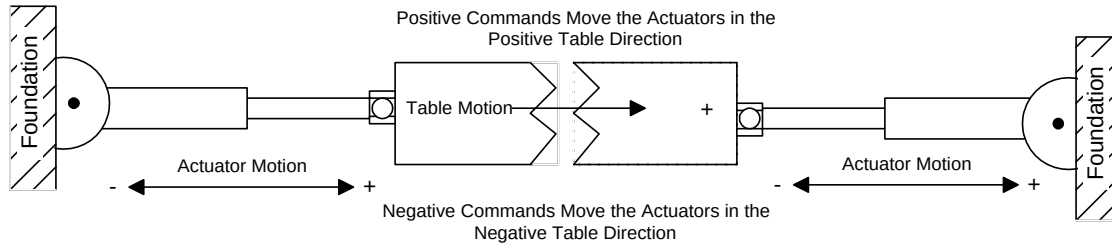


Table Polarity

All actuator movements are defined by positive or negative table movement. As illustrated below, an actuator movement is defined as positive for a motion in the positive direction of table movement.



Although the same DOF coordinate system is applied to most MTS test systems, table and actuator polarity is defined on a system-specific basis.

Degree of Freedom Control

Motion of the multi-axial table is governed by the collective movement of all system actuators. To create a desired table motion, actuator motions must be time synchronized. This synchronization is achieved using the Degree of Freedom (DOF) control concept. This control concept allows the user to control table motion in the coordinate domain rather than the actuator domain.

This concept provides the means to account for and control all actuator movements in a given DOF by transforming the feedback signals from all actuators in that DOF to provide DOF feedback inputs. It then transforms all DOF composite error signals to provide coordinated actuator control signals.

Compensation Techniques

The remaining seismic control concepts are methods of compensation and stabilization techniques that improve the fidelity of system performance. The techniques explained in the following subsections are:

- Force Balance Compensation
- Differential Pressure (ΔP) Stabilization
- Velocity and Acceleration Lead Terms

Force Balance Compensation

Force balance compensation is required in systems where more than one actuator affects the control of any translational or rotational axis (that is, where systems are "over-constrained").

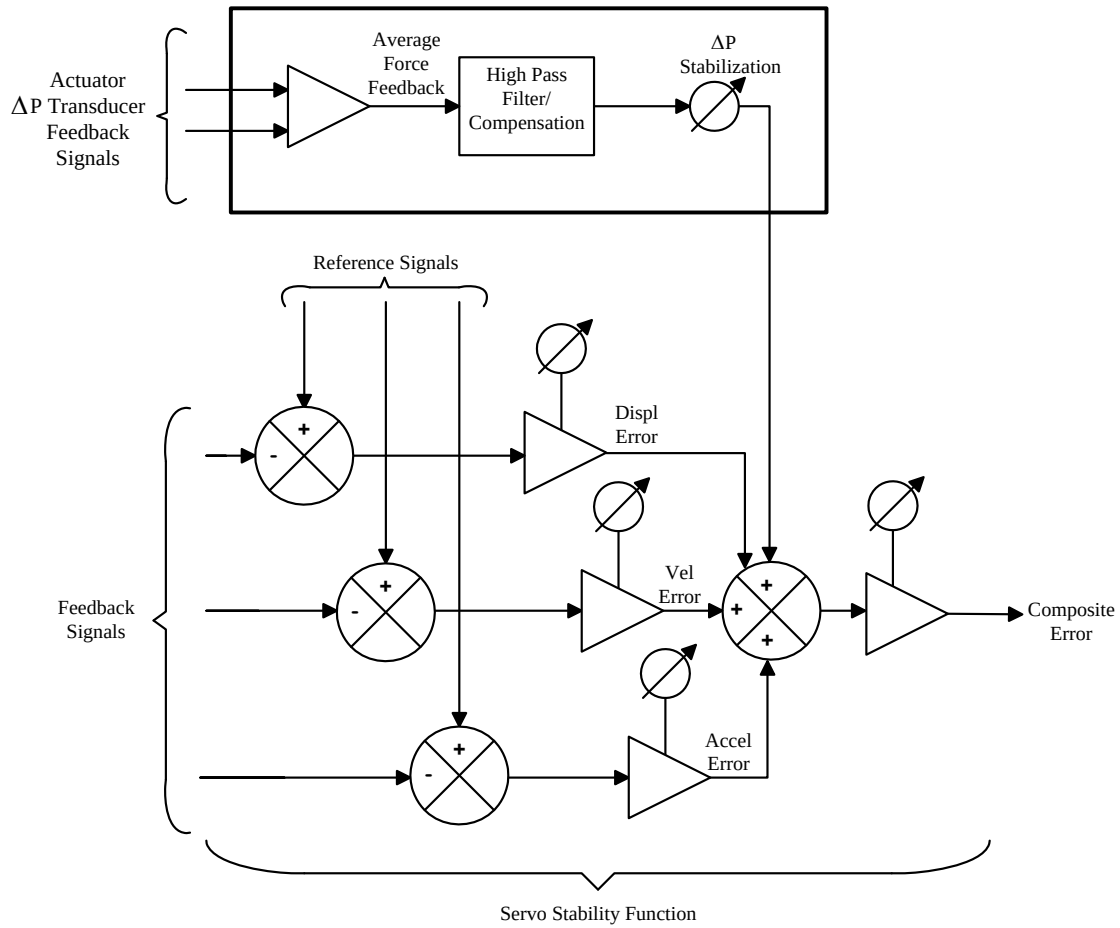
If a table is considered a rigid body, three actuators completely define the plane of the table. A fourth actuator, if not perfectly balanced, may exert large forces to try to distort the stiff table into a shape out of the plane of the other actuators. Therefore, due to the high stiffness of a typical seismic table, small errors in the actuator position can cause large internal table forces to be generated.

This force "imbalance" can seriously limit the force capability of the actuator system. The force balance function compensates for this effect by adding two more degrees of freedom, warp and roll which is controlled to zero using a PID controller.

Differential Pressure Stabilization

Differential pressure stabilization is commonly used in MTS seismic test systems to improve the fidelity of system performance. This function stabilizes the extremely high frequencies encountered during seismic testing to provide more stable acceleration.

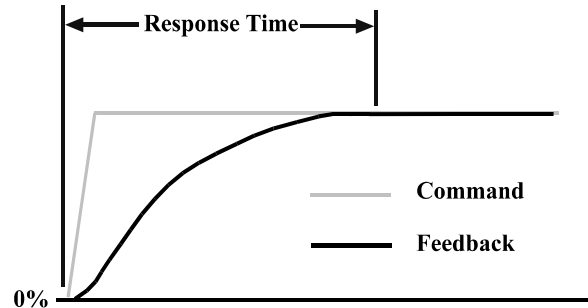
Differential pressure (ΔP) stabilization is applied to all electronically-controlled axes. The functional diagram in the following figure illustrates the application of ΔP stabilization in a single degree of freedom.



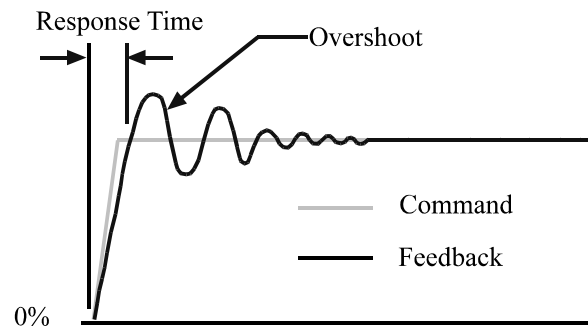
Test Adjustments

Master Gain Adjustment

Master gain is a multiplier applied to the error signal. It determines how quickly the controller responds to error. The greater the gain, the more the servovalve opens for a given error. As master gain is increased, the error decreases, indicating closer tracking of the feedback to the command. The following figure shows a step command and resulting transducer feedback signal with a small gain.



Increasing the master gain decreases the stability margin of the system, increases the frequency of oscillation, and decreases response time. The following figure shows the effect on the transducer feedback of increasing the master gain adjustment.

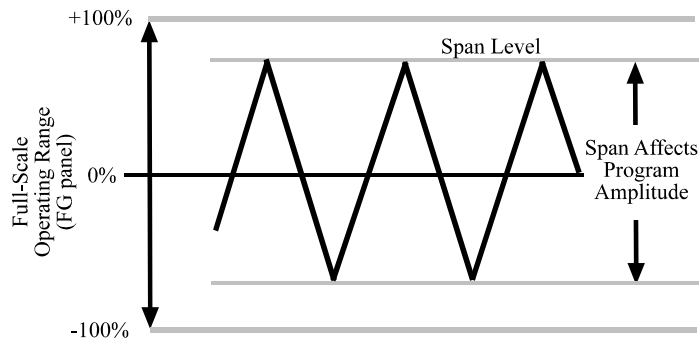


Setting the master gain too high can result in unstable system operation, causing specimen damage. Master gain should be set high enough to achieve an appropriate response time while maintaining stable system operation.

Span Adjustment

The maximum and minimum amplitude of a waveform output by a programmer is ± 10 volts, which represents $\pm 100\%$ of the full-scale operating range. The

master span control determines the amplitude of the command signal that is sent to the servo control process.

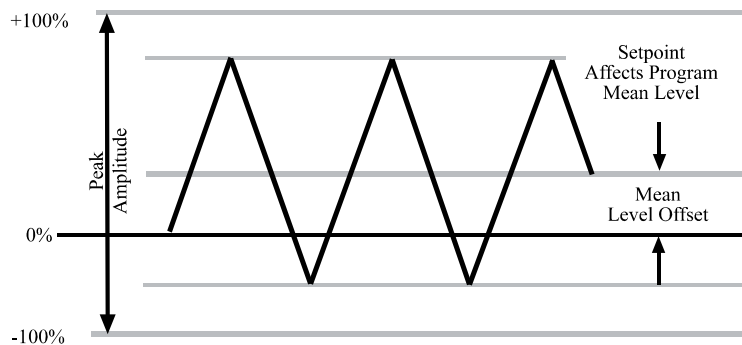


Setting the Span Controls

You set the span controls during test setup to scale the command signal. You can also make minor adjustments to the span control during the test.

Setpoint Adjustment

The maximum and minimum amplitudes of a waveform output by a programmer are ± 10 volts, which represent 100% of the peak amplitude operating range. The local setpoint control changes the mean level offset of that program.



Determining Setpoint Position

The setpoint position is the position about which the actuators will move during testing. For seismic testing, setpoint is typically the actuator midstroke position. If a different position is desired, you must ensure that the position does not limit the program capability.

For example, if you adjust a channel setpoint to +75% of the full-scale operating range, then any command that exceeds +25% of the full-scale range will shut down the test system when a full-scale system limit is encountered.

Setting the Setpoint Controls

You set **Setpoint** control during test setup. Refer to the *Operation* section, for procedures used to adjust the setpoint controls.

Limit Detection

Limit Detectors

Limit detectors can be set to monitor any of the following signals:

- reference signals
- feedback signals
- error signals
- auxiliary signals

Refer to *Control Panel Reference*, for additional information about the signal list.

Limit Detector Settings

You set the following parameters for each limit detector: the operating band and a persistence value. The *operating band* defines the allowable range for the signal. The *persistence* value is a time, in seconds, that the signal can remain outside of the operating range before setting an indicator or interlock.

Limit Detector Actions

You can set an action to be taken when a limit or error is detected. The action can be any of the following:

- turn an indicator on
- stop a program signal
- trip the system interlock

Refer to *Control Panel Reference*, and *Operation*, for additional information about setting the limit detectors.

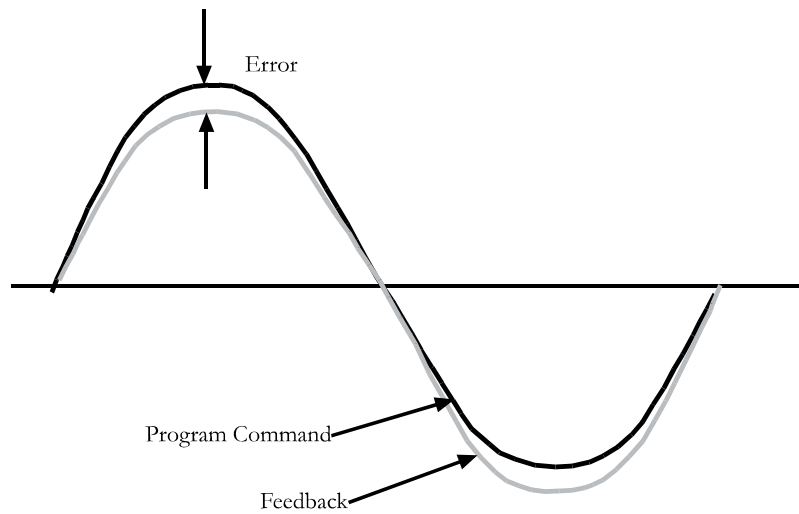
Enabling Limits

After setting limit parameters, you enable the limit detectors and choose an action before running a test.

Error Detector

Error detectors are limit detectors that monitor the error signal, that is, the difference between the command and feedback, as shown in the following figure.

An error detector can stop the test if an error in excess of the preset level is detected.



The level of acceptable error depends directly on the accuracy requirements of each testing situation.

Setting Error Detectors

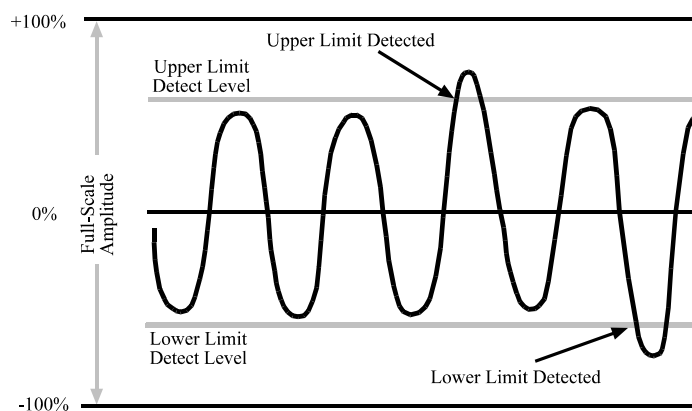
You set the operating band and persistence for the error limit detector.

For static and low frequency testing, the initial error detector levels can be determined before beginning test setup. The level selected should reflect the response requirements of the specific test. For example, if the test can tolerate up to 25% deviation from the program signal, the error detector level can be set to 25%.

The error detector level can also be adjusted during testing if desired. Operator experience is the best guide for adjusting the error detectors for high frequency testing.

Feedback Limit Detectors

Feedback limit detectors monitor the feedback signals. As shown in the following figure, when a feedback signal exceeds its preset upper limit or falls below its preset lower limit, the corresponding limit detector can (if set to hold a program or trip the system interlock) stop the test.



Determining Limit Detector Levels

The limit detectors should be set to minimize the chances of accidental damage to test specimens and test equipment. They are typically set to shut down the system upon specimen failure in order to prevent fixturing or equipment damage. *Under no circumstances should the limit detectors be relied on to protect personnel.*

Setting Limit Detectors

You set the operating band and persistence for each feedback limit detector.

A limit event for a particular signal indicates that the signal has exceeded its upper or lower limit. The selected band establishes a range of values that represent a desired system operating range. This band also represents the range where valid test data can be ensured. The persistence value is a time (in seconds) that an upper or lower out-of-limit condition can persist without causing an interlock.

Safety

Before you attempt to use your MTS equipment, read and understand the information found in this chapter.

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Overview

Important *Make sure you read and understand this entire chapter before attempting to operate the system.*

This chapter contains general safety precautions and practices for the MTS system and describes hazard labeling found in your manuals and on your equipment. The safety practices outlined in this chapter are compiled from known hazardous situations that can result from operator error or negligence, and from the operation of high-pressure hydraulic systems.

Reliable operation of the system depends on correct system setup, a safe operating environment, and an operator who has a thorough knowledge of the system operating characteristics.

Proper safety practices begin with training on similar systems. (MTS offers training classes that include operating theory, system operating procedures, and system maintenance techniques.) In addition, you should gain an understanding of system functions by studying the other manuals supplied with the system.

It is important to study the following safety information while considering your system to ensure that your procedures and the system's operating environment do not contribute to or result in a hazardous situation. In addition, it is important to understand that total elimination of the safety hazards associated with this equipment is not possible. You must, therefore, remain aware of the hazards that apply to your system at all times. Use these safety guidelines to help identify hazards so that appropriate training and operating procedures can be established and desired safety equipment can be acquired.

Before Operating the System

Before you apply hydraulic and drive power to the system, review and complete all of the safety precautions and practices that are applicable to your system as described in the “Maintenance” chapter. The goals in doing this are to improve the safety awareness of all personnel involved with the system and to maintain, through visual inspections, the integrity of specific components.

Read all manuals

Study the contents of this manual and the other manuals provided with the system before attempting to perform any function for the first time. Procedures that seem relatively simple or intuitively obvious may require a complete understanding of system operation to avoid unsafe or dangerous situations.

Locate and read hazard placards

Find, read, and follow the hazard placard instructions located on the equipment. These placards are placed strategically on the equipment to call attention to areas such as known crush points and electrical voltage hazards.

Locate Emergency Stop buttons

Know where all of the system emergency stop (ESTOP) buttons are located so that you can stop the system quickly in an emergency.

Know the controls

Before you operate the system for the first time, do a trial run (with hydraulic and drive power off) through all of the operating procedures. Locate all of the hardware and software controls and know their functions and required adjustments. If any control function or operating adjustment is unclear, review the applicable information until you understand it thoroughly.

Have first aid available

Arrange the work schedule of your facility's personnel so that a properly trained person will be close by at all times to render first aid.

Know potential crush and pinch points

Know where the potential system crush and pinch points are and take the appropriate safety precautions.

When hydraulic power is interrupted on a servohydraulic system, it is likely that gravity will cause portions of the system to sag. Be aware of this and take steps to keep personnel and equipment clear of these areas.

Know electrical hazards

When the system electrical power is turned on, minimize the potential for electrical shock hazards by wearing and using clothes and tools that are properly insulated for electrical work. Avoid touching exposed wires or switch contacts.

Whenever possible, turn the electrical power switches to OFF and lock-out the switches when working with any part of the system. Observe the same precautions as those given for any high-voltage machinery.

Keep bystanders safely away

Keep bystanders at a safe distance from all equipment. Never allow anybody in the test bay while the system is running.

Wear proper clothing

Do not wear neckties, shop aprons, loose clothing, or long hair that could get caught in equipment and create a potentially injurious situation. Remove or restrain all loose clothing and restrain long hair.

Know compressed gas hazards

Your servohydraulic system contains accumulators and nitrogen gas bottles that require high-pressure (pressures that exceed 1 MPa [100 psi]) gas precharging. High-pressure devices are potentially very dangerous because a great amount of energy is available in the event of an uncontrolled expansion or rupture.

Observe the following safety practices when working with high-pressure air or gases:

- Follow all the charging instructions provided in the appropriate product information manuals (for MTS accumulators, see the *Series 111 Accumulator* product information manual). When precharging accumulators and nitrogen gas bottles, properly identify the type of gas to be used and the type of device to be precharged.

When precharging nitrogen-charged accumulators and gas bottles, use only dry-pumped nitrogen. (Dry-pumped nitrogen can also be labeled “oil pumped” or “dry water pumped.”)

Do not use compressed air or oxygen for precharging. The temperature increase caused by rapid gas compression can result in highly explosive conditions when hydraulic fluid is in the presence of oxygen or compressed air.

- Use adequate ventilation. Always follow the recommended procedures to bleed components that contain pressurized gas before you remove or disassemble them. Remember that many of the gases used in pneumatic or gas-charged devices cannot support life. Therefore, as the ratio of released gas to oxygen increases, so does the potential for suffocation.
- Wear appropriate hearing protection. Vented air or gas can create noise levels that can damage hearing.
- Ensure that all pressurized air or gas is bled out of a pneumatic or gas-charged device before you start to disassemble it. A thorough understanding of the assembly and its pressurized areas is necessary before undertaking any maintenance. Refer to the appropriate product information for the proper bleed method (for MTS accumulators, see the *Series 111 Accumulator* product information manual).

It may not be obvious or intuitive which bolts or fittings are used to restrain a pressurized area. On some assemblies, a cover plate must be removed to gain access to the structural bolts.

Sometimes, to protect you from a rapid release of trapped gases, a small port is exposed when you remove the cover plate. Exposing this port ensures that the gas precharge is fully bled before disassembly. However, this is not the recommended bleed procedure for a pneumatic or gas-charged device, because it can expose you to the dangers of escaping compressed gas and particulates that are expelled from the chamber or seal areas. Do not assume that cover plates and ports are installed in all the critical locations.

Consult MTS when in doubt about the safety or reliability of any system related procedure or modification that involves devices containing compressed gas.

Check bolt ratings and torques

To ensure a reliable product, bolts used in MTS-manufactured systems are tightened to specific design requirements. If a bolt is loosened or the configuration of a component within the system is modified, see the system and component assembly drawings (located in the System Reference manual) to determine the correct bolt ratings and torque. Overtorquing or undertorquing a bolt can create a hazardous situation due to the high forces and pressures present in MTS test systems.

On rare occasions, a bolt or tie rod will fail even when correctly installed. Failure usually occurs during torquing, but it can occur at anytime. Due to the stored potential energy, if a torqued tie rod or fastener fails it can become a projectile. Therefore, it is essential that maintenance personnel follow the prescribed schedule for the inspection of fasteners and tie rods.

Practice good housekeeping

Keep work area floors clean. Hydraulic fluid spilled on any type of flooring can result in a dangerous, slippery surface.

Protect hoses and cables

Protect electrical cables from spilled hydraulic fluid and from excessive temperatures that can cause the cables to harden and eventually fail. Ensure that all cables have appropriate strain relief devices installed at the cable and near the connector plug. Do not use the connector plug as a strain relief.

Protect all system hoses and cables from sharp or abrasive objects that can cause the hose or cable to fail. Never walk on hoses or cables or move heavy objects over them. Route hoses and cables away from areas that expose them to possible damage.

Record changes

If you change any operating procedure, note the change and the date of the change in your operating procedures.

While Operating the System

General Precautions

Wear appropriate protection

Wear eye protection when you work with high-pressure hydraulic fluid.

Wear ear protection when you work near electric motors, pumps, or other devices that generate high-level noise.

Wear appropriate protection (gloves, boots, suits, respirators) whenever you work with fluids, chemicals, or powders that can irritate or damage the skin, respiratory system, or eyes. Read the labels on the containers of these products for hazard or contact the manufacturer.

Know system interlocks

Never rely on interlock devices to protect you or any personnel. Interlock devices are designed to minimize the chances of accidental damage to the test specimens or to equipment.

- Test all interlock devices for proper operation immediately before a test.
- Do not use any interlock reset to bypass the interlock chain while you attempt to start the hydraulic power supply. Doing this could cause hydraulic pressure to be applied regardless of the interlock condition.
- Interlock devices should always be used (never disabled) and properly adjusted.

Do not disturb sensors

Do not bump, wiggle, adjust, disconnect, or otherwise disturb a sensor (such as an accelerometer or proximity detector) or its connecting cable when hydraulic pressure is applied.

Know the effect of adjustments

Do not make any adjustments to the system unless you know exactly how the adjustment will affect the operation of the system. If in doubt about any adjustment procedure, consult MTS.

Ensure secure cables

Do not change any cable connections with electrical power or hydraulic pressure applied. Changing cable connections with the system operating can result in an open control loop condition. An open control loop condition can cause rapid unexpected system response resulting in severe personal injury, death, or damage to equipment. Also ensure that all cables are connected if you make any changes in the system configuration.

Stay alert

Avoid long periods of unvarying or monotonous work tasks that can contribute to accidents and hazardous situations. Familiarity with the working environment can lead you to overlook potential hazards in that environment.

Contain small leaks

Do not use your fingers or hands to stop small hydraulic or pneumatic leaks. Substantial pressures can build up, especially if the hole is small. These high pressures can cause the oil or gas to penetrate your skin, causing painful and dangerously infected wounds.

Keep the work area clean	Always keep floors in the work area clean. Hydraulic fluid spilled on any type of flooring presents an extremely slippery surface that can be hazardous.
Stay clear of moving equipment	Locations of crush points vary with the type of system. All areas of movement are potential crush points. The following user practices apply to most systems. Keep clear of moving mechanical linkages. Also, stay clear of connecting cables and hoses that move along with the test vehicle or equipment. Objects can get tangled or dragged along with moving equipment. Serious injury can be inflicted by any high forces that are produced. These forces can pinch, cut, or crush anything in the path of the moving equipment. Never allow bystanders to be near equipment while the system is operating. Be especially careful and alert when you are near rotating or torque generating equipment. Also, do not wear neckties, shop aprons, loose clothing, or long hair that can get caught in equipment and create a potentially injurious situation.
Do not use RF transmitters	Keep radio frequency (RF) transmitters away from the workstation computers, remote terminals, and electronics consoles. Intense RF fields can cause erratic operation of the more sensitive circuits in the system.
Avoid crush points	Stay clear of any potential crush points. Most test systems are capable of producing sudden high-force motion. Never assume that human reaction time is fast enough to escape injury during system failure.
Avoid high voltage areas	Hazardous line voltage potential is present inside all the electronics consoles and all the control enclosures for some self-contained equipment (for example, a hydraulic power unit). To minimize potential electrical shock hazards while the electrical power is turned on, avoid touching exposed wiring or contact points. Keep all console covers securely in place and all enclosure doors closed except as required for service.
Monitor the equipment	While the system is operating, inspect all hoses and cables to ensure that there is no excessive thrashing, bending, or chafing that can cause cable or hose damage. Do not shut off electrical power to the control consoles during system operation. Do not disconnect any hoses or cables while the system is operating. At a minimum use the maintenance schedule provided later in this manual to check the hoses, hard lines, and all connections at each hydraulic power unit, hydraulic control manifold, hydraulic distribution manifold, hydraulic motor, and actuator for signs of leaks. Shut down the system and make all necessary repairs. Listen for unusual sounds such as squeaking or rumbling. Shut down the system and make all necessary repairs.

Hazards Related to Unexpected Actuator Reactions

The high force and velocity capabilities of MTS actuators can be destructive and dangerous (especially if actuator motion is unexpected). The most likely causes of unexpected actuator response are operator error and equipment failure due to damage or abuse (such as broken, cut, or crushed cables and hoses; shorted wires; overstressed feedback devices; and damaged components within the servocontrol loop).

The following special points concern the force-producing characteristics of hydraulic actuators:

- Different operating ranges do not reduce the static force capability of a hydraulic actuator. They only increase the sensitivity of the electronic control and readout components.
- The only effective way to minimize the static force capability of a hydraulic system is to reduce the system hydraulic pressure. Load limiting devices can be added to a hydraulic actuator to limit its force-producing capability. Consult MTS for more information.

The following paragraphs contain examples of some of the most probable causes of an unexpected actuator movement or the application of unexpected forces.

Loss of control loop feedback signal

If the control loop feedback signal is interrupted during operation, the associated servocontroller will sense a large control error and the actuator will attempt to correct the error by moving at maximum velocity or applying maximum force until an interlock is generated or it encounters an obstruction (such as hands or tools). Be aware that the full force of the actuator will be applied to any obstruction.

In most systems, the control loop feedback is supplied through a cable running from a force, displacement, or other transducer to the control console. This transducer cable must be protected from damage to minimize the chance of unexpected actuator reaction. It must never be routed along the floor without protection or be strung overhead under excessive tension. Pad all sharp edges if the cable is routed around corners or through wall openings. Protect cables from exposure to spilled hydraulic fluid or heat that can cause cable failure by hardening the cable's outer protective material.

The error detectors and feedback limit detectors in the servocontrollers minimize the potential for equipment damage caused by loss of feedback or larger-than-normal control errors. Do not rely on these error and limit detectors to protect personnel.

Loss of servovalve control signal

An open control loop results if the cable to the servovalve is disconnected or broken while hydraulic pressure is applied. The actuator response will depend on several factors, such as the piston rod position at the time of the break and the servovalve used. In any event, actuator behavior can be violent.

The error detectors in the servocontrollers can minimize the potential for equipment damage caused by loss of the servovalve control signal. Do not rely on these error detectors to protect personnel.

Change in command signal step functions

The command signal for a control loop usually consists of several inputs; the waveform input from the associated function generator, the associated set point control setting, the master span control setting, and so forth. If one of these inputs is inadvertently removed or suddenly changed while pressure is applied, the control loop will sense a large instantaneous control error and the actuator will respond accordingly. An example would be making a large change to the set point setting.

Make sure you fully understand the effects of changing an input of the command signal before making the change.

Application of hydraulic pressure with a large control error present

When hydraulic pressure is turned off, an actuator piston can drift down to another position unless restrained in some manner. To prevent sudden actuator movement when hydraulic pressure is applied, the servocontrollers for digitally controlled systems will automatically zero errors that are below a predetermined level. If an error is greater, a corresponding message is displayed at the operator workstation and the user must correct the error before applying hydraulic pressure.

Failure or shutoff of electrical power

The failure or shutoff of electrical power to the test system when hydraulic pressure is applied can cause considerable and unpredictable actuator reaction. Under these conditions, loss of electrical power can cause an actuator to move at maximum velocity in either direction or to apply full force (positive or negative acceleration).

This system contains hydraulic accumulators that can store enough energy to temporarily operate an actuator at full force capacity even when the hydraulic pressure is shut off. For this reason, MTS has incorporated features into the system to discharge pressurized hydraulic fluid from the equipment shortly after a loss of electrical or hydraulic power.

Introduction to Control Software

Overview This section contains information on the following topics:

- Setting up your hard disk
- Using the Controller software
- Using the software control panels

This manual does not describe standard PC procedures. Before using the system, you should be familiar with your PC operating system. Of particular importance are the procedures relating to selecting and moving files, opening and closing files, moving windows, and using file folders. For information about the PC, refer to the PC documentation provided with your system.

Setting Up Your Hard Disk

To run the Controller software, the application and support files must be installed on your PC.

Note *The application and support files listed below have already been installed on the computer system by MTS during installation. The following procedure for installing the programs should only be done in the event of a hard disk failure or other event that corrupts the disk or software files.*

Required Files The files named *469D.exe*, *Settings.set*, *Calibration.cal* and *Table.dat* and the folder *bin* must be installed on your hard drive in the folder, “c:\469D”. These files contain the 469DController application software, default setting parameters, calibration parameters and system specific data for your system.

Backup Copies MTS recommends that you make backup copies of the Controller application and support files. Keep this backup copy in a safe place to ensure that, if a file is corrupted during operation, you can restore the file and operate your system.

Using the Controller Software

This section describes how to start the control software, save and load calibration files, and quit the control software.

Starting the Control Software

The 469D Controller application contains the control software, calibration data, and the default setting parameters for your system. Opening this application will load the calibration parameters and open the 469D Controller Main Panel and the default Settings file.

Note *After you use the control software to set up the system for a test, you can save the system settings in a new file. During system startup, the system automatically opens the default Settings file. You can select and use a different "settings" file after system startup.*

The 469D Controller main panel is the control center of this application. You can use the menus of this panel to access all 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, to enable adaptive control, and to run a test.

Calibration Files

The hardware dependant parameters for the system are stored in a calibration file that is automatically loaded when the application is opened. There is only one calibration file for the system and it must be called Calibration.cal. This file contains calibration data for the A/D and D/A Converters, AC and DC Conditioners, Encoder Conditioners, and Valve Drivers. Hardware is calibrated using the panels found under the Calibration menu and new parameters are saved using the Save Calibration option. If needed, you can restore the parameters stored in the calibration file by selecting the Restore Calibration option. This is useful if you change parameters on any of the calibration panels and wish to return to the original values

Save Calibration Files:

1. Select **Save Calibration...** from the main panel Calibration menu. When you select **Save Calibration...**, the system will open a PC Save window.
2. To save system calibrations in the same file you are currently using:
Using standard PC file procedures, select the folder containing the existing calibration file. Do not change the file name.
To save system calibration in a new file:
Using standard PC file procedures, select the folder that you want to save the new calibration file in and change the file name.
3. Click the **OK** button to save the file in the selected folder (or click **Cancel** to cancel the procedure, close the save window, and return to the Controller main panel).

Load Calibration Files

To load a calibration file that has been saved:

1. Select **Open Settings...** from the Controller main panel File menu. The system will open a PC Find window.
2. Using standard PC file procedures, select the file that contains the calibration settings that you want to use.
3. Click the **OK** button to load the selected file (or click **Cancel** to cancel the procedure, close the find window, and return to the Controller main panel).

Saving and Restoring System Settings Files

When you set up your system for a test, you will complete a number of procedures defining the system test settings. These settings include servo control loop adjustments, limit detector settings, function generator settings, and control settings.

Note When you save a system settings file, use the **Save Settings** option from the File menu on the 469D Controller Main Panel.

You can save these settings files and use them when running different types of tests. In this way, you can eliminate the need for re-defining the system parameters when running a different type of test.

You can choose to save system settings for a test in the same file you are currently using to run the software or in a new file. When saving a settings file, you should name the file in a way that makes it easily identifiable.

To save system settings:

1. Select **Save Settings...** from the main panel File menu. When you select **Save Settings...**, the system will open a PC Save window.

2. To save system settings in the same file you are currently using:

Using standard PC file procedures, select the folder containing the existing settings file. Do not change the file name.

To save system settings in a new file:

Using standard PC file procedures, select the folder that you want to save the new settings file in and change the file name.

3. Click the **OK** button to save the file in the selected folder (or click **Cancel** to cancel the procedure, close the save window, and return to the 469D Controller Main Panel).

To restore a system settings file that has been saved:

1. Select **Restore Settings...** from the 469D Controller Main Panel File menu. The system will open a PC Find window.
2. Using standard PC file procedures, select the file that contains the system settings that you want to use.
3. Click the **OK** button to restore the selected file (or click **Cancel** to cancel the procedure, close the find window, and return to the 469D Controller Main Panel).

Changing Access Modes

To change the access mode, select **Change Access** from the main panel File menu and select the desired access level. The current access level will have an *.

The available access modes are:

Basic—The basic user can adjust variables on the main panel and run a test along with setting up the function generators and the data recorder, and using all the display panels. The basic user can only observe the calibration and configuration panels, the controller panels, and the limit detector panel.

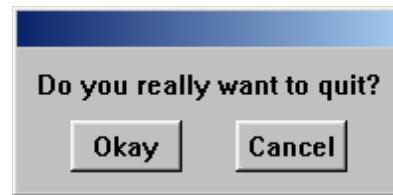
Extended—The extended user is responsible for setting up or designing a test and has access to all the parameters on all the panels.

Service—For MTS service personnel only

Quitting the Control Software

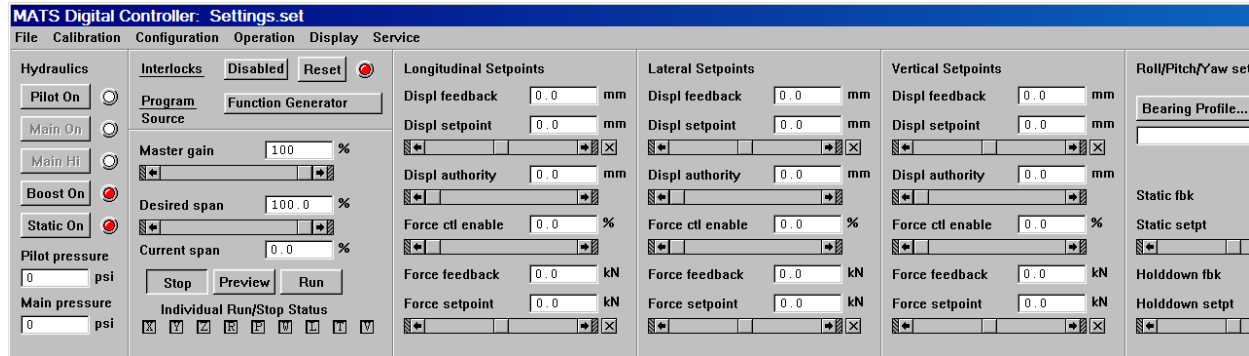
To ensure you do not accidentally close the control software application, the close box on the Controller main panel is not functional. To quit the control software, complete the following steps:

1. Select **Quit** from the File menu on the Controller main panel. When you select **Quit**, the system will open the following window:



2. Select **OK** to quit or **Cancel** to return to the control software without quitting.

Controller Main Panel



As previously described, the 469D Main Panel contains a menu bar, system controls, and indicators. It is opened automatically when you start the control software. You use the menus on the 469D Main Panel to access option panels used to set up the system. The following menus are included on the 469D main panel:

- File
- Calibration
- Configuration
- Operation
- Display

The main panel also has system controls and indicators which allow the user to do the following:

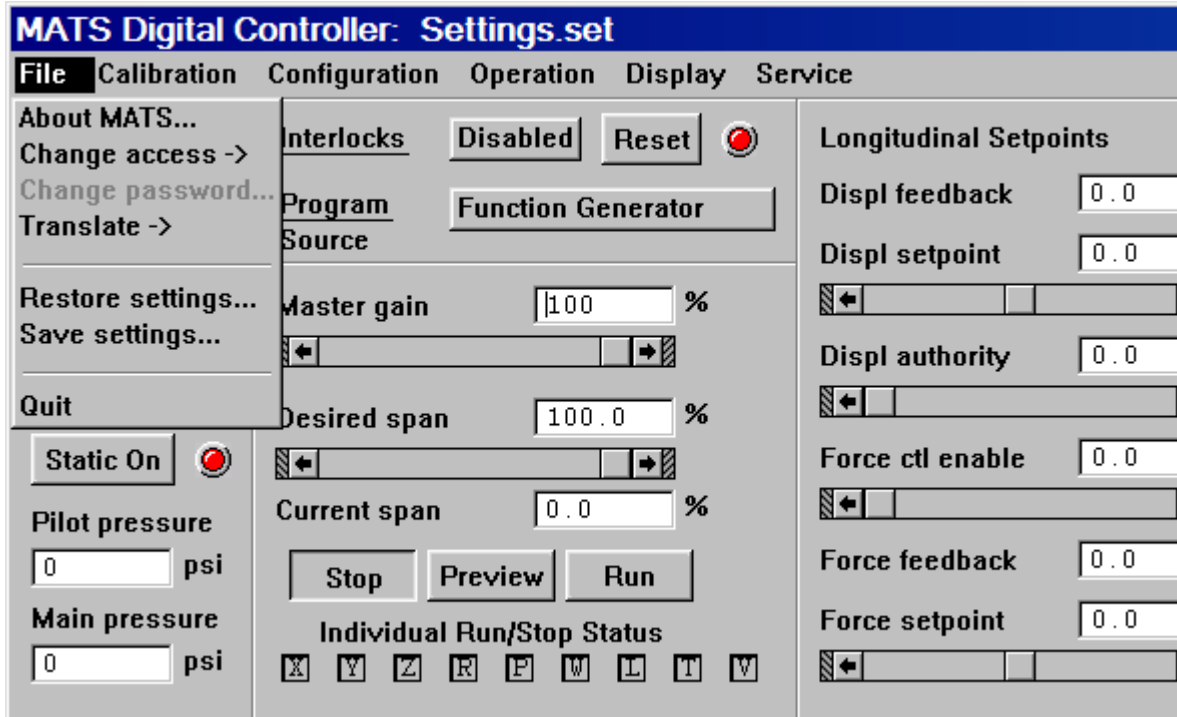
- Enable and monitor hydraulics
- Reset Interlocks
- Enable/disable limits
- Monitor control variable
- Monitor program source
- Set master gain, setpoint and span values
- Monitor current span
- Stop, preview, or run a test
-

Refer to the Main Panel in , *Control Panel Reference*, for more detailed information on how to use the main panel controls and indicators.

Main Panel Menus

Each main panel menu and corresponding commands and control panels are defined below. Refer to the following section, *Control Panel Reference*, for more detailed explanations on how to use each panel.

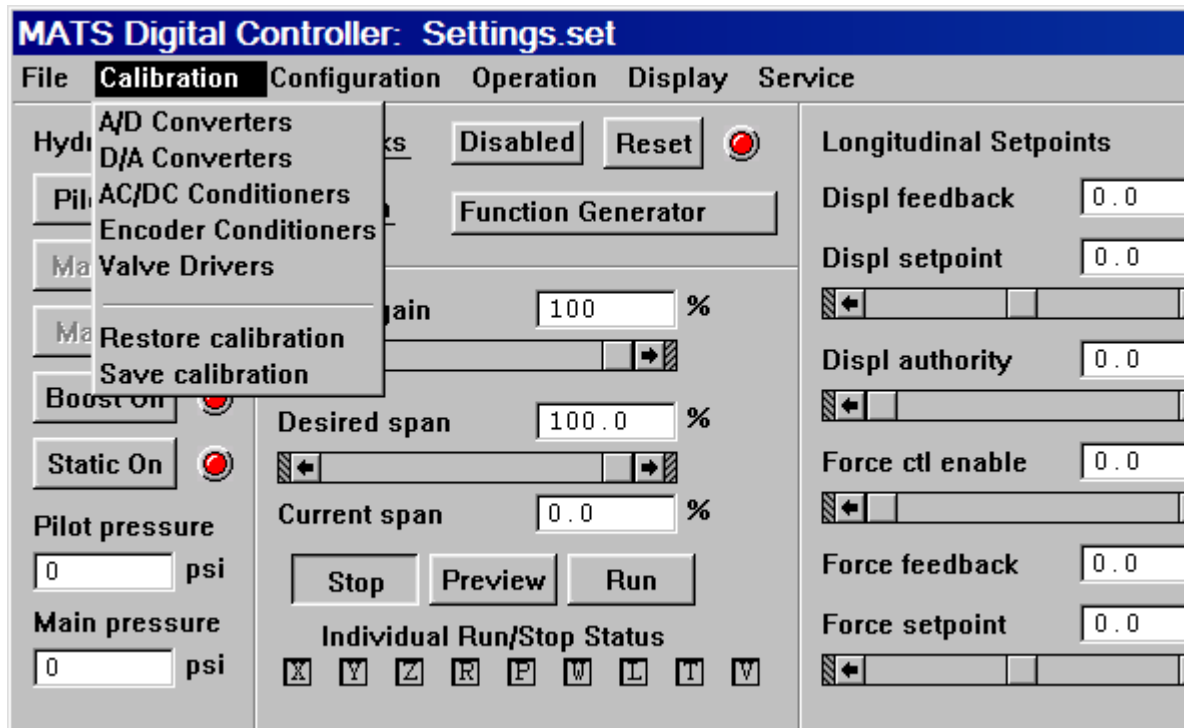
File



Use the commands on this menu to perform the following tasks (tasks marked with an asterisk (*) are available only to users with extended or service access privileges):

- **About BTS**-displays current software version and copy rights
- **Change Access**-change access level (Basic, Extended or Service)
- **Change Password**-create or change the password for access privileges*
- **Translate text to binary**-translates data files from text to MTS binary format. This can be used to translate a playout file. Refer to the Function Generator panel in Section 4 of this manual.
- **Restore settings**-restore Controller settings from an existing disk file*
- **Save settings**-save Controller settings to a disk file*
- **Quit**-quit from Controller application

Calibration

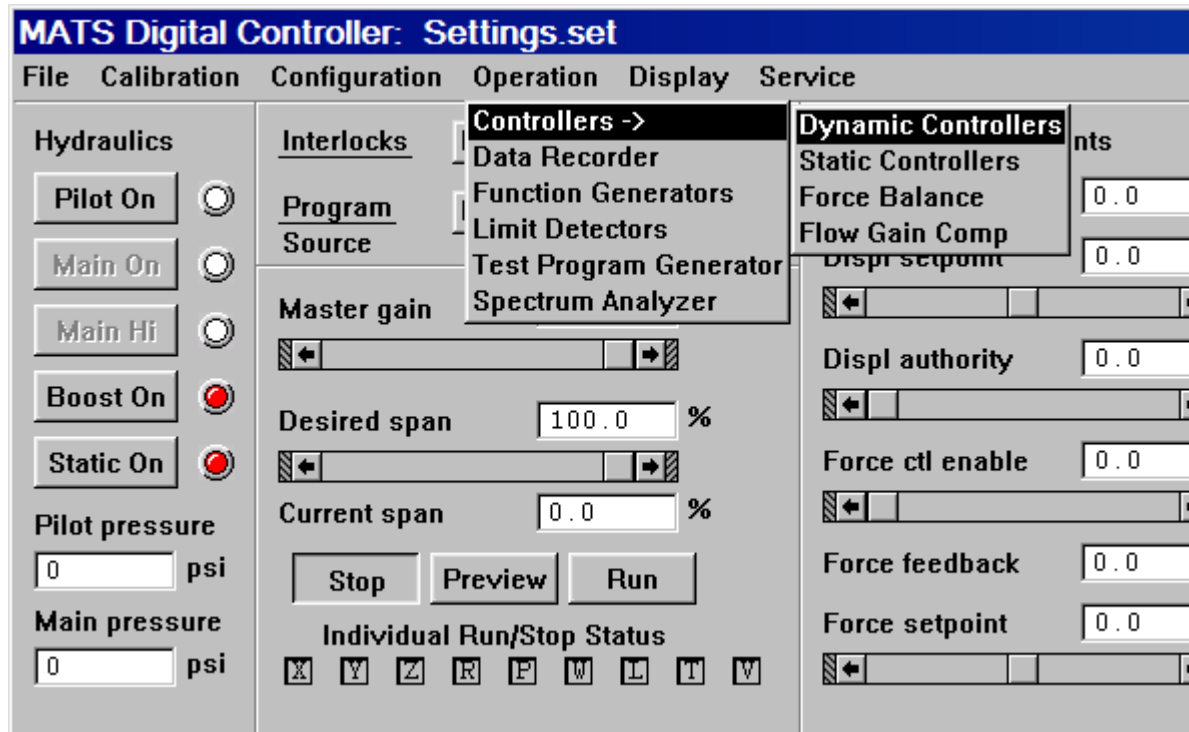


Use the commands on this menu to calibrate the following devices:

- Converters
- AC/DC Conditioners
- Encoder Conditioners
- Valve Drivers

Also use this menu to save/restore the calibration parameters to/from the calibration file.

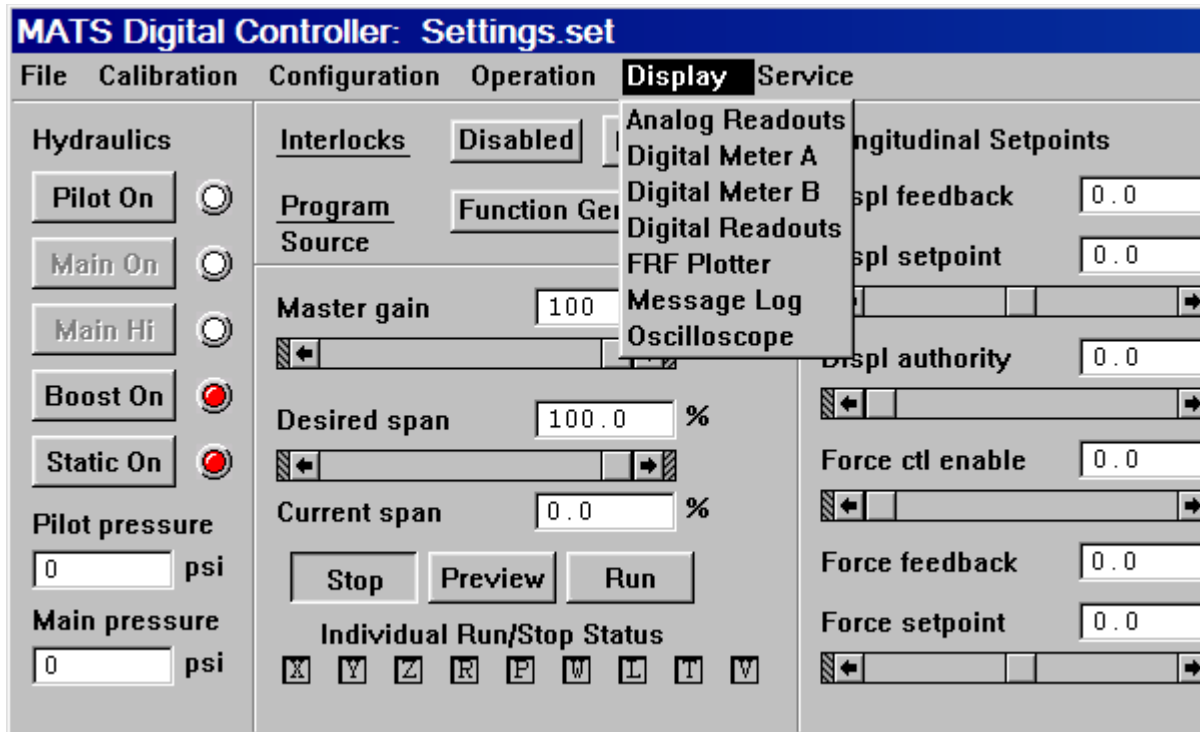
Operation



Use the commands on this menu to perform the following tasks:

- **Controllers**-set parameters for both Three Variable Control and adaptive controllers. A side menu allows you to set parameters for:
 - Dynamic controllers
 - Static Controllers
 - Force balance
 - Flow Gain Compensation
- **Data Recorder**-set up data acquisition to a file
- **Function Generators**-set parameters for function generators
- **Limit Detectors**-setup limit detectors
- **Test Program Generator** - set up parameters for a test program
- **Spectrum Analyzer**-set parameters for spectrum analyzer

Display



Use the commands on this menu to display data on the following types of panels:

- **Analog Readouts**-to route a digital signal to a D/A converter for monitoring by external analog equipment
- **Digital Meters A and B**-to read the present value of a signal and to monitor the maximum/ minimum values, or the peak/valley values over time
- **Digital Readouts**-to display the present value of one or more signals
- **FRF Plotter**-to plot the FRF (frequency response function) to show frequency responses computed by the Spectrum Analyzer
- **Message Log**-display current messages in the message log
- **Oscilloscope**-display oscilloscope traces of various signals

Selecting an Option from a Main Panel Menu

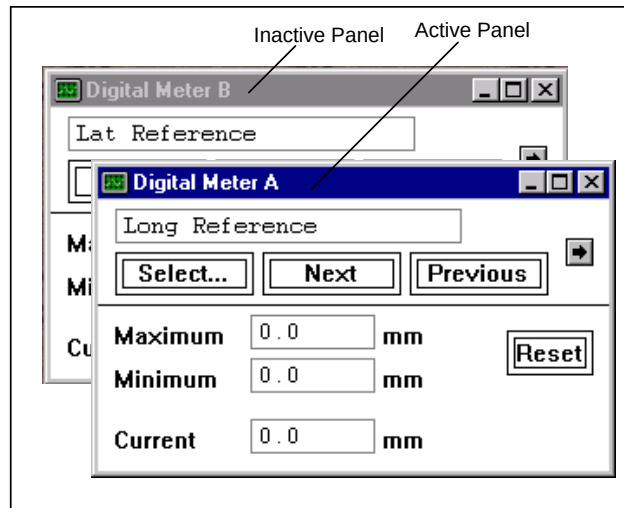
To access a control panel from a main panel menu, complete the following steps:

1. Click and hold on the menu title associated with the option you want to access.
2. While holding down the mouse button, move the mouse to highlight the option you want to access.
3. When the option is highlighted, release the mouse button.

When you release the mouse button, the panel associated with the option will open automatically and become the active panel.

Making a Control Panel Active

Although more than one control panel can be open at the same time, only one panel can be *active* at a time. You can enter information and use the controls only on the active panel.



When you first open a panel, it automatically becomes the active panel and you can use the panel's controls. To make a different panel active, click anywhere on that panel. When you do this, the panel will be redrawn on the top of the other panel(s) and become active.

Note When switching from one panel to another, the first mouse click only activates the panel. The first click is not directed at a control, regardless of the pointer position.

Closing a Control Panel

Each control panel has a close box in its upper right-hand corner. To close a control panel, click on the close box when the panel is active.

Using the Software Panel Controls

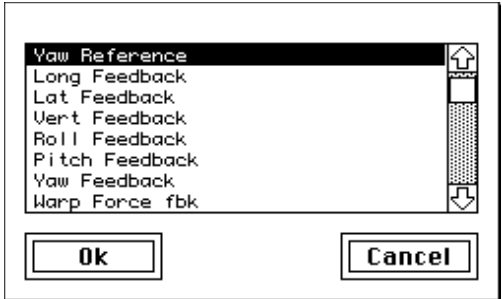
The control panels contain a variety of controls that you use to make selections and enter test parameters. You use the controls by moving and clicking the mouse.

The panel controls are illustrated and described in the following table.

Software Panel Control Descriptions (part 1 of 4)

CONTROL	DESCRIPTION
Check Boxes Autoscale ☒ Same scale ☒	<i>Check boxes</i> are used when you can select any option in a set of options. A selected check box shows an X. Click on a check box to select or deselect its option.
Function Buttons Ok Cancel Select... Next Previous	Click a <i>function button</i> to complete the function associated with the button. Some of the most common function buttons are illustrated at the left. The OK and Cancel buttons are used to enter the information from a selection panel into the system. The Select..., Next, and Previous buttons are used to select a channel or signal for which you want to enter information. Any function button that has an ellipsis (...) following its label accesses a secondary panel. For example, the Select... button shown at the left accesses a selection panel, from which you select a channel or signal.
Indicators Tracking	An <i>Indicator</i> is a small circle that identifies a specific condition in the system. The condition, identified by the label associated with the indicator, exists if the indicator is filled (like the Tracking indicator shown on the left). The indicators in the control panels are set by the control electronics. Refer to the appropriate description in Section 2, <i>Control Panel Reference</i>, for more information about a specific indicator and, if applicable, for instructions on clearing an indicator.
Pulldown Menus Configuration Control Observers Ramp Rates Units	A pulldown menu is used to select one option from a list of options. To display the selections on a pulldown menu, click and hold on the pulldown menu field until the menu appears. Move the mouse to highlight the option you want to select, and then release the mouse button.
Radio Buttons Display mode ☒ Time ☐ Freq ☐ X-Y	<i>Radio buttons</i> are used when you can select only one option in a set of options. The selected radio button is the one with the darkened center. Click on a radio button to select an option. When you select one of the radio buttons in the set, the other button(s) in that set are automatically deselected.

Software Panel Control Descriptions (part 2 of 4)

CONTROL	DESCRIPTION
Scroll Bars  	A <i>scroll bar</i> can be used to view all available selections in a selection box or all available messages in the Message Log. To view selections or messages, use the scroll bar in one of the following ways: - Click and hold or click repeatedly on the scroll bar arrows to “scroll” through the selection/message list. - Click and then drag the box in the scroll bar to move through the selection/message list. - Click on the bar outside of the box to “jump” through the available selections/messages.

Software Panel Control Descriptions (part 3 of 4)

CONTROL	DESCRIPTION
Slide Bars Master gain 100 % 	A <i>slide bar</i> is used to enter numeric values in the system. Each slide bar is associated with a specific signal or value, which is identified by the label on the slide bar. The current value is shown in a text box above the bar. The units associated with the signal or value are also identified on the slide bar. Change the value identified on a slide bar in one of the following ways: - Click and hold or click repeatedly on the slide bar arrows to “scroll” through the range of values. - Click and hold, and then drag the box in the slide bar to change the value. - Click on the arrow on either side of the box to “jump” through the range of values. - Highlight the text box, type in the desired value and then press the return key on the keyboard. A quick double click highlights existing text in the entire box. Typing then replaces the box contents. Each slide bar has a defined range. For example, the range of the Master gain slide bar is 0 to 100%. You can change the range associated with a slide bar by clicking on one of the small striped rectangles at the end of the bar. After clicking on the rectangle, type the value desired and press the return key to enter the new range value in the system. To cancel without entering a new range value, click on the striped rectangle again. One mouse click on the slide bar moves the current value of the adjustment by 1% of the full range. This also affects scrolling resolution. To increase the scrolling resolution, reduce the range.  WARNING If the range is large, small movements of the slide bar can cause large changes in the control loop. Unexpected actuator action could result. Unexpected actuator action can cause injury to personnel or damage to equipment. To avoid injury or damage, use a small enough range to ensure that no major control system motions occur.

Software Panel Control Descriptions (part 4 of 4)

CONTROL	DESCRIPTION
Status Buttons (with indicator) On	A status button is a function button that is linked to an indicator. The function is selected by the button, and the status of the function is identified by the indicator. For example, the HPS On status button changes the state of the hydraulic service manifolds.
Text boxes ADC/D1 AX1 Acceleration fbk Setpoint rate 25.0 %FS/s Setpoint accel 100.0 %FS/s^2 Span rate 50.0 %FS/s Phase rate 45.0 deg/s	A <i>text box</i> contains current selections, selection information, or alphanumeric data. Some text boxes are editable and some are not editable. To change the entry in a <i>selection text box</i> you have to use functions buttons associated with the field (for example, a Select... button). The name of the entry can be changed by selecting the text in the box, typing the desired name over it, and then pressing the return key. (Double clicking on the text will select all of it). A <i>display text box</i> is not editable, but is updated whenever you change the associated selection. An example of this type of text box is the Chan text box shown on the left. An <i>alphanumeric text box</i> is used to enter data into the system. Examples of this type of text box are the text boxes shown on the left. To change the data in a text box, select the existing text, type the desired information over it, and then press the return key.

Control Panel Reference

Overview

This section contains alphabetically arranged descriptions for each control panel in the MTS Controller software.

WARNING

For most options, a control panel is automatically opened when you select the option. These control panels display current settings.

Before you change a displayed setting, know the effect the change will have on the system. Refer to the Operation section, before adjusting any value or attempting to operate the system.

The following table identifies each panel described in this section, as well as its corresponding option name and menu location. Refer to the Introduction to Control Software section, for information on how to select these menu options.

Panel List (part 1 of 2)

PANEL NAME	MENU	MENU OPTION
AC/DC Conditioners	Calibration	Conditioners
A/D Converters	Calibration	A/D Converters
Analog Inputs	Configuration	User Analog Inputs
Analog Readouts	Display	Analog Readouts
D/A Converters	Calibration	D/A Converters
Data Player	Operation	Data Player
Data Recorder	Operation	Data Recorder
Digital Meter A or B	Display	Digital Meter A Digital Meter B
Digital Readouts	Display	Digital Readouts
Dynamic Controllers	Operation	Controllers: Dynamic Controllers
Encoder Conditioners	Calibration	Encoder Conditioners
Flow Gain Comp	Operation	Controllers: Flow Gain Comp
Force Balance Controllers	Operation	Controllers: Force Balance
Frequency Response Function Plotter	View	FRF Plotter
Function Generator	Operation	Function Generators

Panel List (part 2 of 2)

PANEL NAME	MENU	MENU OPTION
Impulse Response Function Plotter	Display	IRF Plotter
Limit Detectors	Operation	Limit Detectors
Main Panel	--	--
Message Log	Display	Message Log
Observers	Configuration	Observers
Oscilloscope	Display	Oscilloscope
Ramp Rates	Configuration	Ramp Rates
Resonance Compensator	Operation	Controllers: Resonance Comp
Spectrum Analyzer	Operation	Spectrum Analyzer
Static Controllers	Operation	Controllers: Static Controllers
Static Lift	Operation	Static Lift
Table Parameters	Configuration	Table Parameters
Test Program Generator	Operation	Test Program Generator
Units	Configuration	Units
Valve Drivers	Calibration	Valve Drivers

AC/DC Conditioners

Panel Description The Conditioners panel allows you to perform the following tasks:

- Select a specific AC or DC conditioner
- Calibrate the conditioner to its associated transducer
- Select polarity of output
- Select filtering option
- Set hardware limits for the conditioner output (feedback)
- Identify whether an interlock has occurred
- Disable and/or reset interlocks

Access Open the Conditioners panel by selecting the **AC/DC Conditioners** option from the **Calibration** menu on the main panel.

When to Use the Panel

Use the Conditioners panel to calibrate a conditioner with its associated transducer and to identify and reset hardware interlocks. Whenever a transducer is replaced or moved, the associated conditioner should be calibrated. Hardware limits should be checked and reset before starting a test. In addition, MTS recommends verifying calibration values periodically.

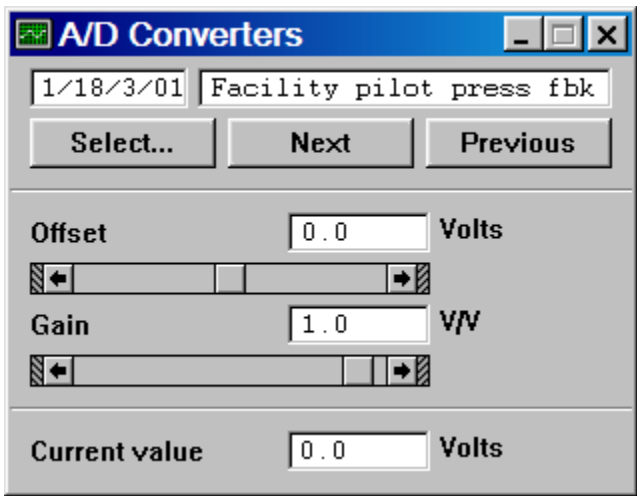
AC/DC Conditioners Control Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Cond text box	Shows the name of the currently selected conditioner. The adjacent conditioner ID box shows the slot number of the selected conditioner. Select a conditioner using the Select... , Next , or Previous buttons.
Select... button	Opens the conditioner selection panel, from which you can select a conditioner.
Next button	Selects the next conditioner in the selection panel list.
Previous button	Selects the preceding conditioner in the selection panel list.
Excitation mode pop-up	Displays the type of conditioner selected; AC or DC.
Excitation slide bar and text box	Sets the level of the excitation signal sent to the transducer. You can use the slide bar to set a value or you can enter it in the text box.
Demod. phase slide bar and text box	(Available for AC excitation mode only) Sets the demodulator phase of the AC conditioner output. You can use the slide bar to set a value or you can enter it in the text box.
Zero slide bar and text box	Sets the dc offset of the conditioner output. You can use the slide bar to set a value or you can enter it in the text box.
Gain slide bar and text box	Sets the total gain of the conditioner. You can use the slide bar to set a value or you can enter it in the text box.
Delta K (+) slide bar and text box	Sets the delta K(+) value for the conditioner. You can use the slide bar to set a value or you can enter it in the text box.
Filter cutoff pop-up menu	Select the desired output filter cutoff frequency.
Invert Polarity checkbox	Selects the polarity of the output signal. The choices are: Inverted or noninverted.
Shunt Cal button	(Available for DC excitation mode only) Closes the shunt calibration relay to complete a shunt calibration of the conditioner and displays the value in the Conditioner Output Value display.
Interlocks	
Disabled check box	When checked, disables hardware interlocks for this channel.
Reset button	When pressed, resets the hardware interlocks for this channel.
Watchdog timer indicator	Indicates the state of the watchdog timer.

AC/DC Conditioners Control Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Excitation fail indicator	Shows whether excitation has failed. This detector is always enabled, both in hardware and software. Excitation failure causes a system interlock because it may indicate a broken, defective or missing conditioner cable.
Limit indicator	Indicates whether the conditioner output has gone outside of the limits set using the Upper and Lower Limit slide bars.
Upper Limit slide bar and text box	Sets the upper limit of the conditioner output. You can use the slide bar to set a value or you can enter it in the text box. If the conditioner output (feedback) has exceeded this limit, the Limit indicator is lit.
Lower Limit slide bar and text box	Sets the lower limit of the conditioner output. You can use the slide bar to set a value or you can enter it in the text box. If the conditioner output (feedback) has fallen below this limit, the Limit indicator is lit.
Conditioner output value text box	Shows the value of the signal output by the selected conditioner. Not editable.

A/D Converters



- Panel Description

The A/D Converters panel allows you to perform the following tasks:
- Select a specific user analog-to-digital (A/D) converter
 - Adjust the offset and gain for the selected converter
 - View the current voltage output value at the selected converter

Access

Open the A/D Converters panel by selecting the **A/D Converters** option from the **Calibration** menu on the main panel.

When to Use the Panel

Use the A/D Converters to periodically calibrate the user A/D converters (or ADCs) in the system to ensure that the input and output voltages are balanced.

Note Both offset and gain are saved in the Calibration file.

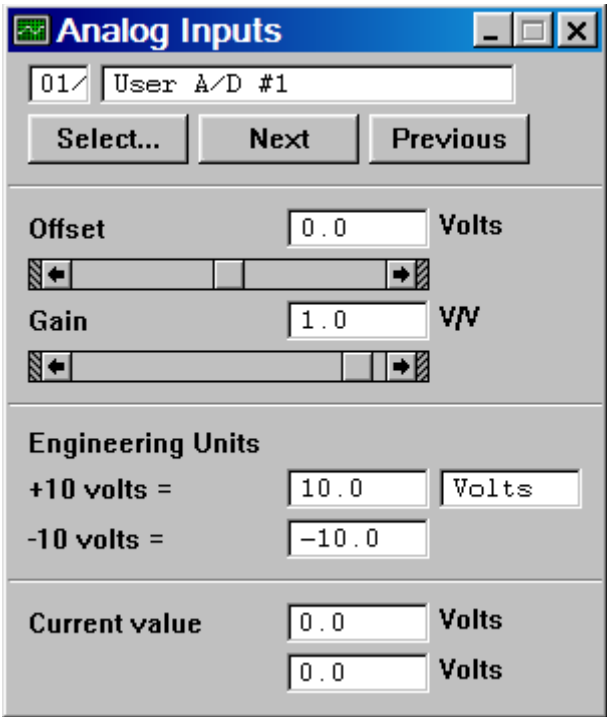
A/D Converters Control Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Conv text box	Shows the name of the currently selected channel. The adjacent channel ID box shows the number of the selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the converter selection panel, from which you can select a converter.
Next button	Selects the next converter in the selection panel list.
Previous button	Selects the preceding converter in the selection panel list.
Offset slide bar and text box	Adjusts the offset of the signal output by the converter. Use the Offset slide bar to set the A/D Converter for a current value of 0.00V. You can use the slide bar to set a value or you can enter it in the text box.

A/D Converters Control Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Gain slide bar and text box	Adjusts the gain of the signal output by the converter. Use the Gain adjustment to set the full-scale range of the A/D Converter. You can use the slide bar to set a value or you can enter it in the text box.
Current value text box	Shows the current value output by the selected converter. Not editable.

Analog Inputs



Panel Description The Analog Inputs panel allows you to perform the following tasks:

- Select a specific analog-to-digital (A/D) converter
- Adjust the offset and gain for the selected converter
- Define engineering units for the selected converter
- View the current voltage output value at the selected converter

Access Open the Analog Inputs panel by selecting the **User Analog Inputs** option from the **Configuration** menu on the main panel.

When to Use the Panel Use the Analog Inputs panel to periodically calibrate the A/D converters (or ADCs) in the system to ensure that the input and output voltages are balanced.

Note Both offset and gain are saved in the *Settings.set* file.

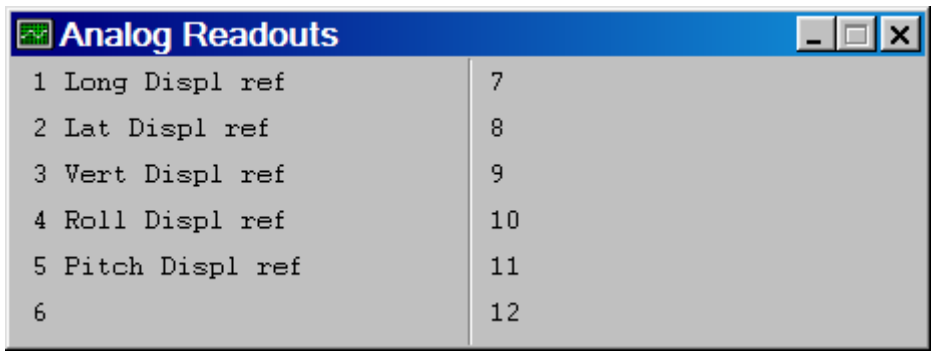
Analog Inputs Control Descriptions (part 1 of 2)

Control	Description
Conv text box	Shows the name of the currently selected channel. The adjacent channel ID box shows the number of the selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the converter selection panel, from which you can select a converter.

Analog Inputs Control Descriptions (part 2 of 2)

Control	Description
Next button	Selects the next converter in the selection panel list.
Previous button	Selects the preceding converter in the selection panel list.
Offset slide bar and text box	Adjusts the offset of the signal output by the converter. Use the Offset slide bar to set the A/D Converter for a current value of 0.00V. You can use the slide bar to set a value or you can enter it in the text box.
Gain slide bar and text box	Adjusts the gain of the signal output by the converter. Use the Gain adjustment to set the full-scale range of the A/D Converter. You can use the slide bar to set a value or you can enter it in the text box.
Engineering Units text boxes	Shows the ± 10 voltage values that equate to the inputted engineering value.
Current value text boxes	Shows the current value output by the selected converter. Not editable.

Analog Readouts



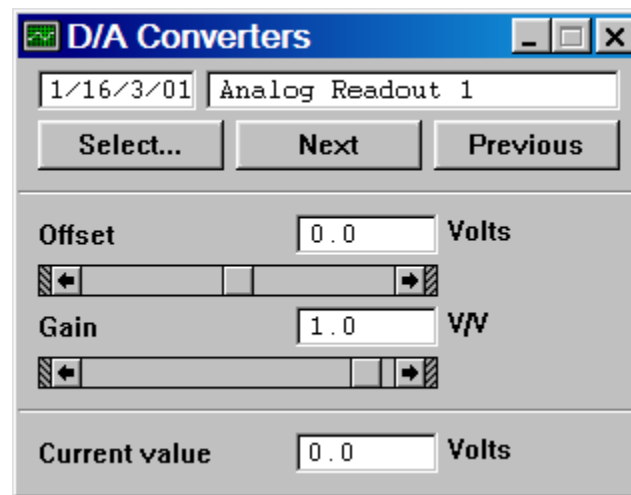
Panel Description The Analog Readouts panel allows you to select a signal to be outputted to a D/A converter.

Access Open the Analog Outputs panel by selecting the **Analog Readouts** from the **Display** menu on the main panel.

When to Use the Panel Use this panel to select a signal to be written to a readout D/A converter.

Analog Readouts Control Description	
CONTROL	DESCRIPTION
Signal Name text box	Click near any number to open a pulldown channel selection box. Select a channel. The name of the selected channel is displayed.

D/A Converters



Panel Description The D/A Converters panel allows you to perform the following tasks:

- Select a specific user digital-to-analog (D/A) converter
- Adjust the offset and gain for the selected converter
- View the current voltage output value at the selected converter

Access Open the D/A Converters panel by selecting the D/A Converters option from the **Calibration** menu on the main panel.

When to Use the Panel Use the D/A Converters to periodically calibrate the **D/A converters** (or DACs) in the system to ensure that the input and output voltages are balanced.

Normally you do not need to calibrate D/A converters (or DACs). Any D/A converter calibration should be completed only by experienced MTS service personnel.

Note Both offset and gain are saved in the Calibration file.

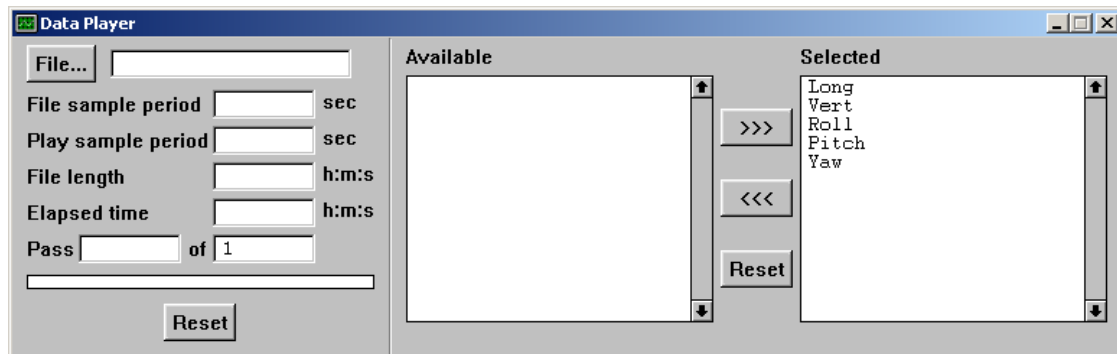
D/A Converters Control Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Conv text box	Shows the name of the currently selected channel. The adjacent channel ID box shows the number of the selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the converter selection panel, from which you can select a converter.
Next button	Selects the next converter in the selection panel list.
Previous button	Selects the preceding converter in the selection panel list.

D/A Converters Control Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Offset slide bar and text box	Adjusts the offset of the signal output by the converter. Use the Offset slide bar to set the D/A Converter for a current value of 0.00V. You can use the slide bar to set a value or you can enter it in the text box.
Gain slide bar and text box	Adjusts the gain of the signal output by the converter. Use the Gain adjustment to set the full-scale range of the D/A Converter. You can use the slide bar to set a value or you can enter it in the text box.
Current value text box	Shows the current value output by the selected converter. Not editable.

Data Player



Panel Description The Data Player panel allows you to list the data channels and select a time history file for the program source.

Access Open the Data Player panel by selecting the Data Player option from the **Operation** menu on the main panel. You can also open this panel by clicking on the **Program Source** icon on the Main panel when Data Player File is selected.

When to Use the Panel Use the Data Player panel to list the data channels and choose a file to be played out as the program source when the Data Player selection is enabled for the program source on the Main panel.

First choose the desired channels and then select the file. It is very important that the number of channels and order of channels selected match the number and order in the selected file.

Tip: Always keep the natural order of channels as they are listed by the software in the Available list.

Playout File Information When using a file for the playout source, the file must be in MTS binary format. The *Translate text to binary* option under the File menu on the Main panel will translate an ASCII text file to MTS binary format.

The text file to be translated must be in the following format:

The first value in the text file must be the time period between samples, followed by the data in engineering units arranged in a single column.

The translator will prompt you for the ASCII text file. The converted file will be given the same name as the text filename but will have a *.bin* extension.

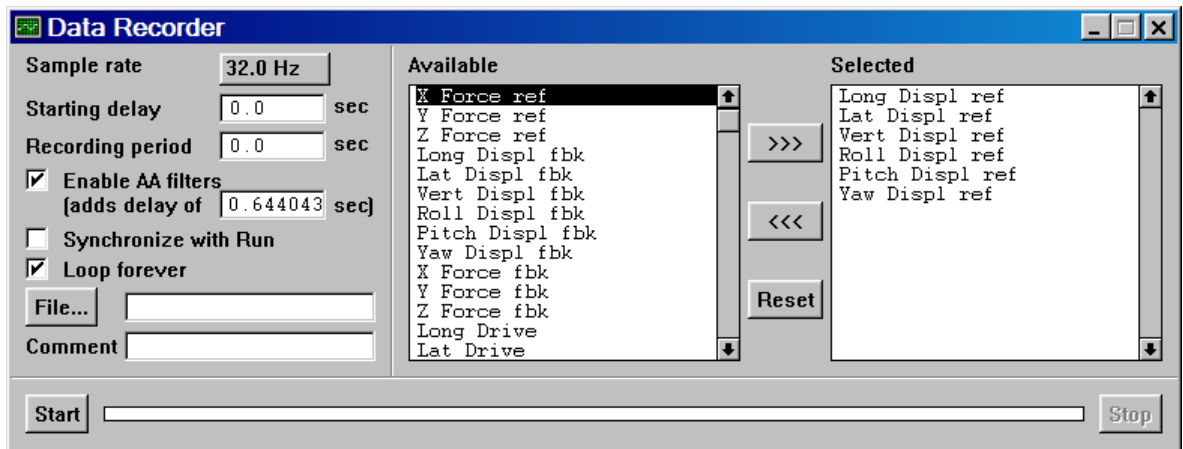
Note that when a file is played out, the system does not automatically ramp up at the beginning of the file. It is assumed the file will contain this ramping data if it is required. The span will jump to 100% at the beginning of the file. The only exception to this is in the middle of the file, if the program is put into Stop mode, then the system will ramp down to 0% and ramp back up to 100% when it starts up again (Run mode enabled).

You can scale the playout file by playing it out at a different sample rate than the recorded rate. The **Play Sample Period** input allows the user to input a playout sample period different from the recorded sample period.

Data Player Control Description

CONTROL	DESCRIPTION
File... button and text box	Selects the file which contains the playout data. The file must be in MTS binary format. The <i>Translate text to binary</i> option under the File menu on the Main panel can be used to convert an ascii text file to MTS Binary format.
File Sample Period text window	Displays the sample period of the recorded file.
Play Sample Period text box	Input the desired sample period for playing out the recorded file. This value will default to the File Sample Period.
File Length text window	Displays the playout file length.
Elapsed Time text window	Displays the amount of time that the file has been played out.
Pass _ of _ text boxes	Input the number if times to play the selected file. The current pass will be displayed.
Reset button	When pressed, resets the playout file to the beginning.
Channel Selection text boxes	Select the channels to be played out. The Available box shows the available channels. The Selected box shows the selected channels. To move a channel between boxes, first highlight the channel by placing the cursor on it and clicking once on the mouse button. Then click on the appropriate arrow to move the channel to the other box.
	Press the Reset button to clear the Selected box of all channels.
	Make sure the number of channels selected and the order of these selected channels matches the number and order in the selected playout file.
Reset button	When pressed, resets the playout file to the beginning.

Data Recorder



Panel Description

The Data Recorder panel allows you to:

- Record data from selected channels and store in a user selected file
- Set the sample rate, starting delay, and recording period
- Choose whether to start recording data when the START button is pushed, or to synchronize the data recording with the RUN button on the main panel

Access

Open the Data Recorder panel by selecting the Data Recorder option from the **Operation** menu on the main panel.

When to Use the Panel

Use the Data Recorder panel to record data from selected channels and store the data in a file. The data in the file will be in MTS binary format. This data file can be converted to an ascii text format file by choosing the *Translate binary to text* option under the File menu option on the Main panel.

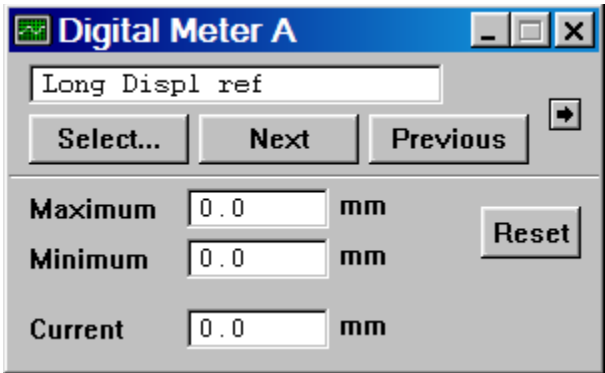
Data Recorder Control Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Sample Rate pulldown menu	Select the recording sample rate. The available sample rates are 32, 64, 128, 256, 512, and 1024 Hz.
Starting delay text box	Input the time delay between when the Start (or Run) button is pressed and data recording begins.
Recording period text box	Input the period of time that the data recorder should run.

Data Recorder Control Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Enable AA Filters check box	When checked, a digital anti-aliasing filter is added to each selected signal. The software will select an appropriate filter type dependant on the sample rate. The frequency response of this AA filter can be viewed using the FRF panel. The AA filter will add a delay which is displayed for your reference. You may need to adjust the starting delay and/or extend the recording period, accordingly.
Synchronize with Run check box	If checked, data recorder will start when the Run button on the main panel is pressed (the Start button on the Data Recorder panel must also be on). If not checked, the data recorder will start as soon as the Start button is pressed.
Loop Forever check box	When checked, will record over and over again.
File... button	Input the filename where the recorded data is to be stored.
Comment text box	Use this text box to input a comment to be stored with the data. This comment box can be used to input information to identify the particular acquisition such as a Serial ID number, etc.
Signal Selection text boxes	Select the signals to be recorded. The Available box shows the available signals. The Selected box shows the selected signals. To move a signal between boxes, first highlight the signal by placing the cursor on it and clicking once on the mouse button. Then click on the appropriate arrow to move the signal to the other box.
Reset button	Pressing this button will clear the Selected box of all signals.
Start/Arm button	Starts data recording. If acquisition is synchronized, the Start button grays out after you click on it. Acquisition is then queued to start with the appropriate event.
Progress bar	After data acquisition starts, the progress bar grows from left to right, showing how much data has been recorded (0 to 100%).
Stop button	Stops data recording.

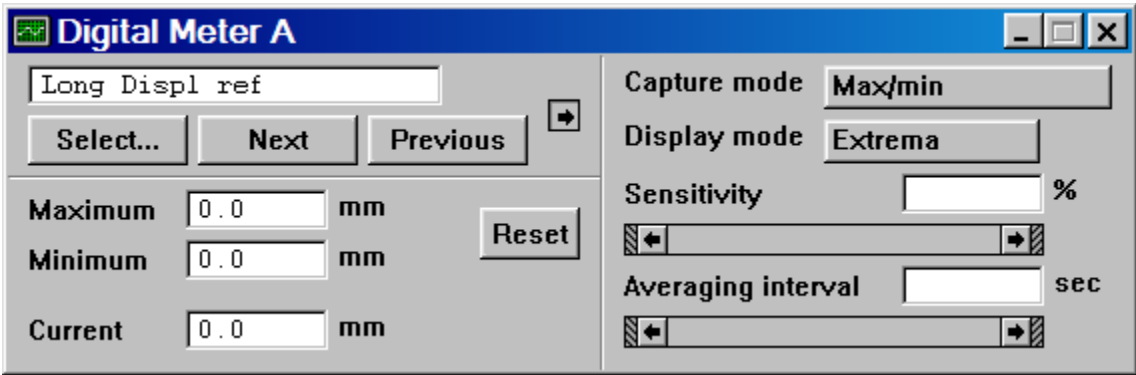
Digital Meter A or B



Panel Description The Digital Meter A or B panel allows you to monitor a signal.

Access Open the Digital Meter A or B panel by selecting the Digital Meter A or Digital Meter B option from the **Display** menu on the main panel.

Toggle the arrow  to display the right side of the display panel as shown below:



When to Use This Panel Use either panel to read the present voltage value of the selected signal.

Background Information The digital meters provide the following signal monitoring modes:

- **Max/min**
Monitors the maximum and minimum signal values since the display session began or the reset button was last selected. Signal values are displayed in the Maximum and Minimum text boxes.
- **Peak/valley (banded)**
Similar to Max/min mode, except the Reset button is automatically pressed after the signal reverses by an amount determined by the sensitivity adjustment. Thus changes in signal peaks and valleys can be continuously monitored. Can be used for cyclic and non-cyclic waveforms.

- **•Peak/valley (timed)**

Similar to Max/min mode, except the Reset button is automatically pressed after the signal reverses a quarter of a cycle as determined by the signal's current frequency. Thus changes in signal peaks and valleys can be continuously monitored. Can be used only for cyclic waveforms.

- **•RMS/mean**

Monitors the RMS and mean of a signal since the display session began or the reset button was last selected. The amount of signal averaging can be adjusted via the *Averaging Interval* sidebar/textbox. Can be used for cyclic and non-cyclic waveforms.

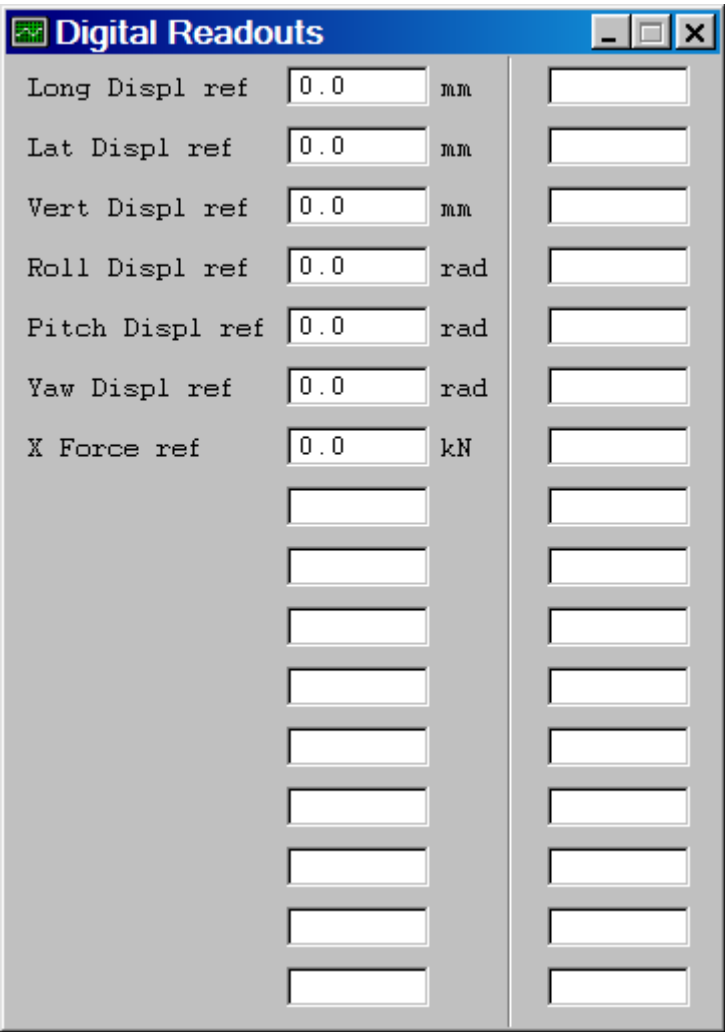
Digital Meter Control Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Signal text box	Shows the name of the current selected signal.
	Select a signal using the Select... , Next , or Previous buttons.
Select... button	Opens the signal selection panel, from which you can select a signal.
Next button	Selects the next signal in the selection panel list.
Previous button	Selects the preceding signal in the selection panel list.
Maximum or Peak or RMS or Amplitude text box	Displays the Maximum value for the signal when Capture Mode is Max/Min and Display Mode is Extrema. Displays the Peak value for the signal when Capture Mode is Peak/valley and Display Mode is Extrema. Displays the RMS value for the signal when Capture Mode is RMS/Mean (Display Mode is grayed out). Displays the Amplitude of the signal when Capture Mode is Max/Min or Peak/valley and Display Mode is Amplitude/Base.
Minimum or Valley or Mean or Base text box	Displays the Minimum value for the signal when Capture Mode is Max/Min and Display mode is Extrema. Displays the Valley value for the signal when Capture Mode is Peak/valley and Display Mode is Extrema. Displays the Mean value for the signal when Capture Mode is RMS/Mean. (display Mode is grayed out) Displays the Base value of the signal when Capture Mode is Max/Min or Peak/valley and Display Mode is Amplitude/Base.
Current value text box	Displays the current value of the selected signal.
Reset button	Clears the Minimum and Maximum text boxes.
 arrow	Toggle the  arrow to open/close the right side of the display panel that contains the options described below.

Digital Meter Control Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Capture Mode pop-up menu	Selects a monitoring mode. The choices are: Max/min—display the maximum and minimum values of the signal in the Maximum and Minimum boxes. Peak/valley (banded)—display the peak and valley values of a signal determined by reversal outside a specified sensitivity band. Peak/valley (timed) – display the peak and valley values of a signal determined by reversal within an amount of time determined by the signal frequency. RMS/Mean – display the RMS and mean values of a signal averaged over a specified sliding time interval.
Display pop-up menu	Selects a display mode. The choices are: Extrema—Displays min/max or peak/valley values. See Capture mode above. Amplitude/Base—Alternative form of displaying extrema, where: $\text{Amplitude} = \frac{\text{max} - \text{min}}{2} \quad \text{and} \quad \text{Base} = \frac{\text{max} + \text{min}}{2}$ NOTE: not available in RMS/mean capture mode
Sensitivity slide bar and text box	For peak/valley detection, sets the sensitivity of detection to a percentage of full-scale band. You can use the slide bar to set a value or you can enter it in the text box.
Averaging interval slide bar and text box	For RMS/Mean capture mode, sets the averaging interval. You can use the slide bar to set a value or you can enter it in the text box.

Digital Readouts



Panel Description The Digital Readouts panel allows you to monitor a signal.

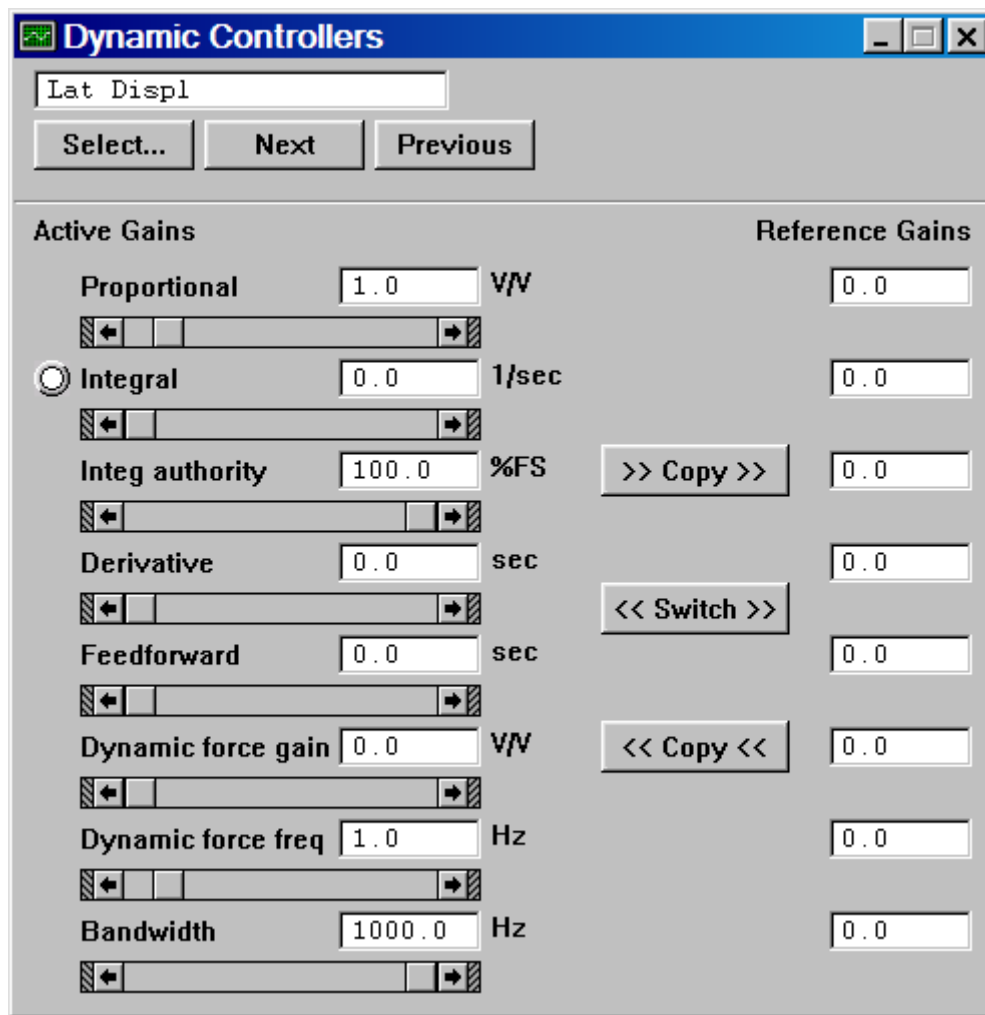
Access Open the Digital Readouts panel by selecting the **Digital Readouts** option from the **Display** menu on the main panel.

When to Use the Panel Use this panel to read the present voltage value of a selected signal.

Digital Readouts Control Panel Description

CONTROL	DESCRIPTION
Numerical text box	Click near any display box to open a pulldown channel selection box. Select a channel. The selected channel and its value (in engineering units) are displayed.

Dynamic Controllers



Panel Description The Dynamic Controllers panel allows you to set up and tune the PID servo control loops.

Access Open the Dynamic Controllers panel by selecting the **Controllers** option from the **Operation** menu on the main panel.

When to Use the Panel You can use the Dynamic Controllers panel to set up or adjust parameters for a PIDF controller, including the following:

- Gain (P)
- Reset (I)
- Rate (D)
- Integ Authority
- Dynamic force gain

- Dynamic force frequency
- Bandwidth

Before making any adjustments, you may wish to use the >>**Copy**>> command to copy the current stable settings to the reference gains. If the system then becomes unstable, you can immediately click on the <<**COPY** button and restore the stable setting to current gains. You can also switch between reference and current gains via the <<**Switch**>> button for quick comparisons.

Background Information

Each of the controls on the Dynamic Controllers panel affects the system in a distinct way. It is important to understand these effects before attempting to tune the system.

Servo Controller Error

The servo control process sums feedback and command signals to generate an error signal, which is sent to the valve driver to generate the servovalve control signal.

The command and (conditioned) feedback signals are summed to create an initial error signal. That signal is gain-adjusted and summed with integral and derivative factors before a bandwidth adjustment is made to the signal. The resulting error signal is sent to the valve driver (or valve controller).

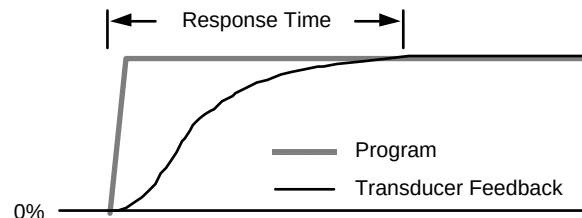
The servo loop adjustments establish the response and stability of the servo control loop. Servo loop adjustments are experimental and you should become familiar with the effects of these adjustments while using dummy specimens during both dynamic and static system operation.

Because each adjustment can have some effect on the other adjustments, adjustments to the servo loop should be made iteratively.

The following paragraphs explain how the servo loop controls affect the error signal.

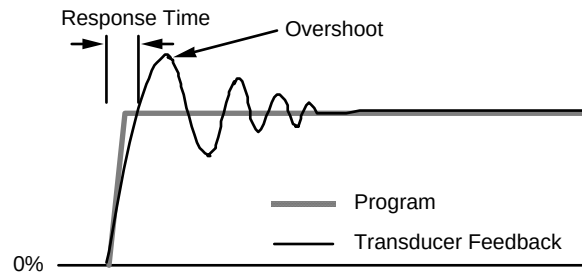
Proportional Gain

Proportional gain adjustments affect how well the error signal will follow the program. The greater the proportional gain, the more the servovalve opens for a given error. As proportional gain is increased, the error decreases, indicating closer tracking of the feedback to the command. The following figure illustrates the program and resulting transducer feedback signal with a small proportional gain.



Increasing the gain decreases the stability margin of the system, increases the frequency of oscillation, and decreases response time. The following figure

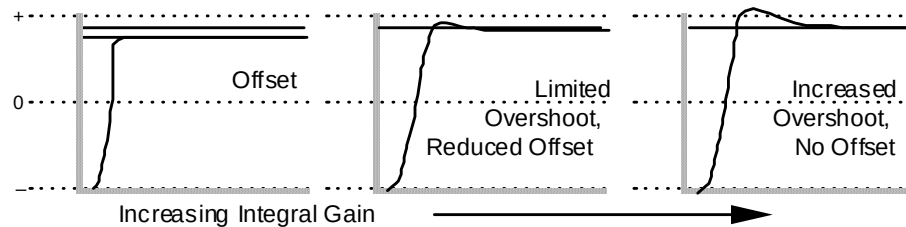
illustrates the effect that increasing the proportional gain has on the transducer feedback.



If the proportional gain is set too high, unstable system operation and "ringing" can result. This instability may cause specimen damage. Consequently, proportional gain should be set as high as possible while maintaining stable system operation.

Integral

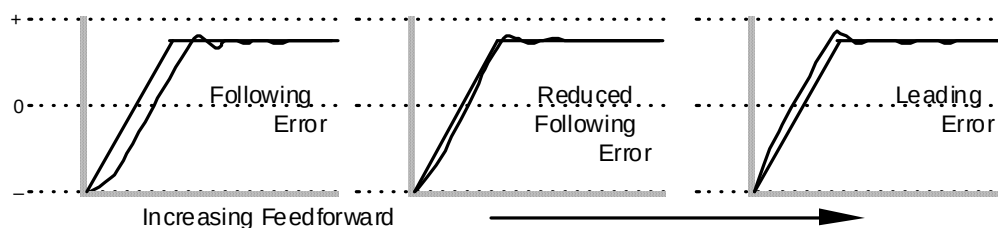
Integral adjustments affect system accuracy during static or low-frequency operation when the actuator cannot keep the commanded position. Increasing the Integral adjustment reduces the error between command and feedback by integrating out offsets in the dc portion of the feedback.



Because the integrator can integrate to large or even infinite values, a limit is placed on how much correction the integrator can apply. This limit is called "Integrator Authority".

Feedforward

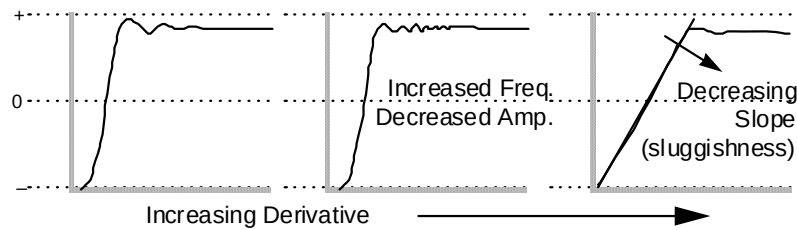
Feedforward effectively alters loop response by introducing a derivative of the command signal. The feedforward component is used to minimize following errors or phase lag. It is especially useful because it does not affect the control loop stability. As illustrated, higher settings reduce following error during a ramp command, ultimately producing a leading error.



Derivative

Derivative adjustments affect the servo control loop dynamic stability. You can use derivative to reduce overshoot at higher proportional gain settings. In

addition, it can reduce the system bandwidth, closing the servovalve in anticipation of achieving the commanded position through the rate of change in feedback. The following figure shows the effect of adding derivative to a transducer feedback signal that has already been adjusted for proportional gain.



Bandwidth

The bandwidth adjustment is used to filter the drive signal to the servovalve and can be used to remove frequency content that can make the system become unstable.

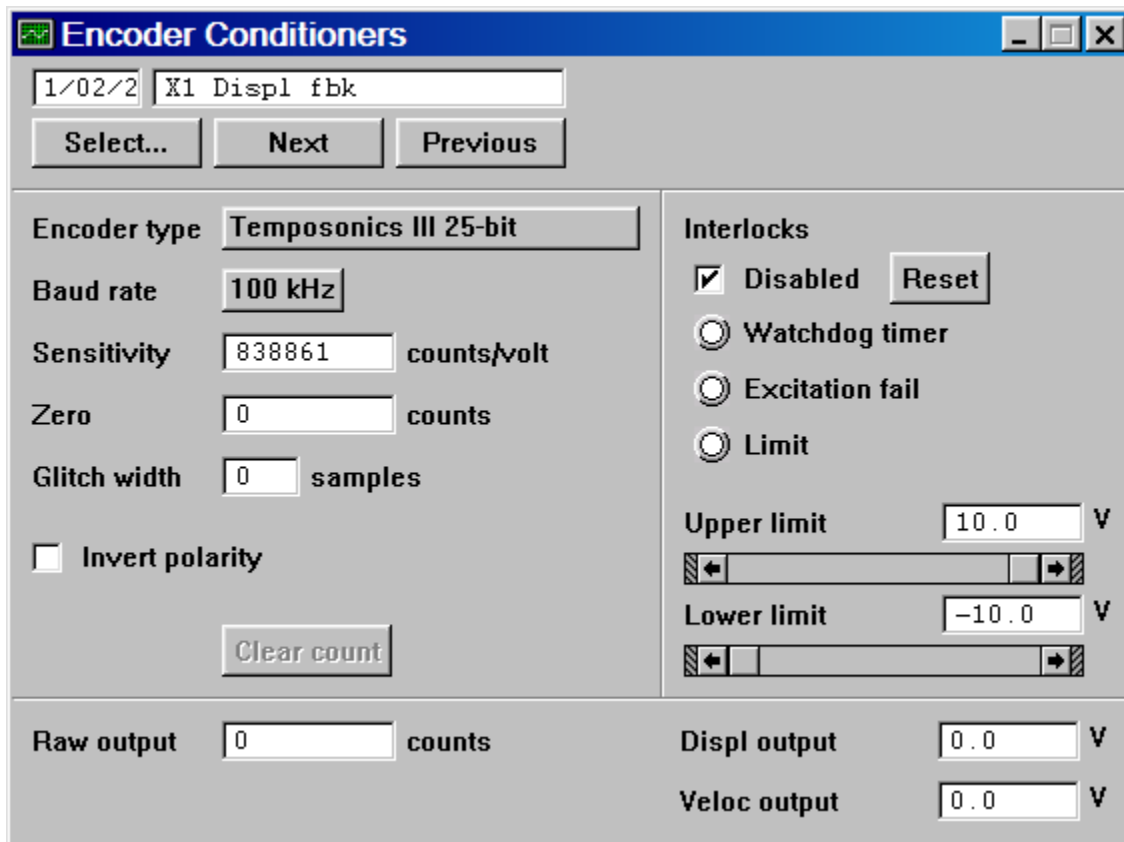
Dynamic Controllers Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Channel text box	Shows the name of the current selected signal. Select a signal using the Select... , Next , or Previous buttons.
Select... button	Opens the signal selection panel, from which you can select a signal.
Next button	Selects the next signal in the selection panel list.
Previous button	Selects the preceding signal in the selection panel list.
Apply button	Pressing this button will apply the controller settings on this panel to selected modules.
Current gains and Reference gains	A gain parameter can be entered as Current gains, which go into effect immediately. Current gains can be copied to Reference gains, which are kept in memory but not used. The <<Copy<<, <<Switch>> and >>Copy>> buttons are used to move the complete set of gain parameters between Current and Reference. >>Copy>>Copies all current gain parameters to their corresponding reference gains. <<Switch>>Swaps all current gain parameters with their corresponding reference gains. <<Copy<<Copies all reference gain parameters to their corresponding current gains.
Proportional slide bar and text box	Adjusts the gain value. You can use the slide bar to set a value or enter it in the text box.
Integral slide bar and text box	Adjusts the reset value. You can use the slide bar to set a value or enter it in the text box.

Dynamic Controllers Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Integral indicator	Indicates the state of the reset integrator. White – not integrating Green – integrating Red – has integrated up to maximum integral authority. You should review whether to increase the integral authority.
Integ Authority slide bar and text box	Adjusts the limit for the reset integrator control authority. Input the value in % of full-scale output. You can use the slide bar to set a value or enter it in the text box.
Derivative slide bar and text box	Adjusts the rate value. You can use the slide bar to set a value or enter it in the text box.
Feedforward slide bar and text box	Adjusts the amount of the differentiated program signal summed with gain, reset, and rate to create the valve command signal for the selected channel. You can use the slide bar to set a value or enter it in the text box.
Dynamic Force Gain slide bar and text box	Adjusts the gain applied to the dynamic force feedback, which is a highpassed version of the regular force feedback. It provides damping of the oil column resonance. You can use the slide bar to set a value or enter it in the text box.
Dynamic Force Frequency slide bar and text box	Adjusts the cut-in frequency of the highpass filter applied to the force feedback. A value of 0.5 to 1.0 Hz is recommend for most systems. You can use the slide bar to set a value or enter it in the text box.
Bandwidth slide bar and text box	Adjusts the bandwidth of the low pass filter. You can use the slide bar to set a value or enter it in the text box.

Encoder Conditioners



Panel Description

The Encoder Conditioners panel allows you to perform the following tasks:

- Select a specific encoder conditioner
- Calibrate the conditioner to its associated transducer
- Select polarity of output
- Select filtering option, baud rate, and sensitivity
- Set hardware limits for the conditioner output (feedback)
- Identify whether an interlock has occurred
- Disable and/or reset interlocks

Access

Open the Encoder Conditioners panel by selecting the **Encoder Conditioners** option from the **Calibration** menu on the main panel.

When to Use the Panel

Use the Encoder Conditioners panel to calibrate a conditioner with its associated transducer and to identify and reset hardware interlocks. Whenever a transducer is replaced or moved, the associated conditioner should be calibrated. Hardware limits should be checked and reset before starting a test. In addition, MTS recommends verifying calibration values periodically.

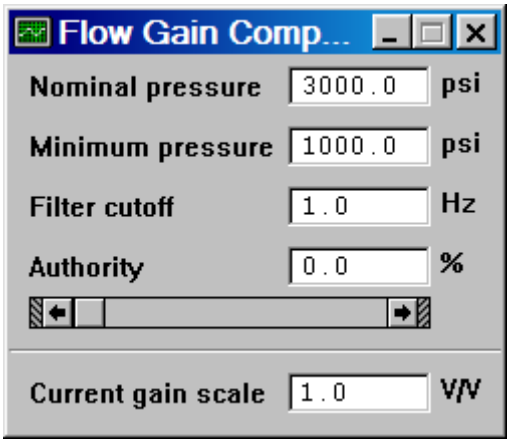
Encoder Conditioners Control Panel Descriptions

CONTROL	DESCRIPTION
Cond text box	Shows the name of the currently selected conditioner. The adjacent conditioner ID box shows the slot number of the selected conditioner.
	Select a conditioner using the Select... , Next , or Previous buttons.
Select... button	Opens the conditioner selection panel, from which you can select a conditioner.
Next button	Selects the next conditioner in the selection panel list.
Previous button	Selects the preceding conditioner in the selection panel list.
Encoder Type pop-up	Displays the type of encoder selected. The choices are:
Baud rate button	Sets the baud rate of the excitation signal sent to the encoder. You can use the slide bar to set a value or you can enter it in the text box.
Sensitivity text box	Sets the counts/volts.
Zero text box	Sets the home position for the encoder.
Glitch width text box	Sets the # of samples of dropout expected. NOTE: Output deglitcher: Because this conditioner is often used for conditioning Temposonics transducers which are prone to dropouts and glitches, the output is run through a deglitching filter in the form of a median filter. Set "glitch width" to the number of samples of dropout expected. Setting "glitch width" to zero turns the filter off (default).
Invert Polarity check box	Selects the polarity of the output signal. The choices are: Inverted or noninverted.
Clear count button	Clears the count.

Encoder Conditioners Control Panel Descriptions

CONTROL	DESCRIPTION
Interlocks	
Disabled check box	When checked, disables hardware interlocks for this channel.
Reset button	When pressed, resets the hardware interlocks for this channel.
Watchdog timer indicator	Indicates the state of the watchdog timer.
Excitation fail indicator	Shows whether excitation has failed. This detector is always enabled, both in hardware and software. Excitation failure causes a system interlock because it may indicate a broken, defective or missing conditioner cable.
Limit indicator	Indicates whether the conditioner output has gone outside of the limits set using the Upper and Lower Limits slide bars.
Upper Limit slide bar and text box	Sets the upper limit of the conditioner output. You can use the slide bar to set a value or you can enter it in the text box. If the conditioner output (feedback) has exceeded this limit, the Limit indicator is lit.
Lower Limit slide bar and text box	Sets the lower limit of the conditioner output. You can use the slide bar to set a value or you can enter it in the text box. If the conditioner output (feedback) has exceeded this limit, the Limit indicator is lit.
Raw output value text button	Shows the value of the signal output in counts by the selected conditioner. Not editable.
Displ output value text button	Shows the value of the displacement output by the selected conditioner. The value is in volts. Not editable.
Veloc output value text button	Shows the value of the velocity output by the selected conditioner. The value is in voltss. Not editable.

Flow Gain Compensators



Panel Description The Flow Gain Compensators panel allows you to adjust the amount of correction applied to the servovalve command signal to compensate for main pressure flow losses.

Access Open the Flow Gain Compensators panel by selecting the **Controllers** option from the **Operation** menu on the main panel, then dragging right to open the Controllers submenu and selecting Flow Gain Comp.

When to Use the Panel Use this panel to adjust the amount of servovalve signal correction. This value will nominally be 1.0. Setting the gain to 0 will remove the correction completely.

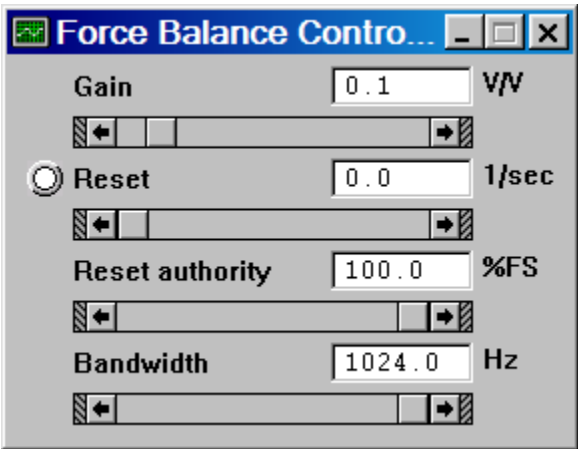
Flow Gain Compensators Control Descriptions

CONTROL	DESCRIPTION
Nominal pressure text box	Sets the nominal pressure
Minimum pressure text box	Sets the minimum pressure
Filter cutoff text box	Sets the filter cutoff
Authority slide bar and text box	Sets the authority. You can use the slide bar to set a value or you can enter it in the text box.
Current gain scale	Sets the amount of signal correction added to the valce driver signal to compensate for nonlinearities in the servovalve pressure switching.
Offset slide bar and text box	Adjusts the offset of the signal output by the converter. Use the Offset slide bar to set the D/A Converter for a current value of 0.00V. You can use the slide bar to set a value or you can enter it in the text box.

Flow Gain Compensators Control Descriptions

CONTROL	DESCRIPTION
Gain slide bar and text box	Adjusts the gain of the signal output by the converter. Use the Gain adjustment to set the full-scale range of the D/A Converter. You can use the slide bar to set a value or you can enter it in the text box.
Current value text box	Shows the current value output by the selected converter. Not editable.

Force Balance Controllers



Panel Description The Force Balance Controllers panel allows you to setup and tune the force balance servo control loops. All current and reference gains are included in the parameters saved to a settings file.

Access Open the Force Balance Controllers panel by selecting the **Controllers** option from the **Operation** menu on the main panel, then dragging right to open the Controllers submenu and selecting **Force Balance**.

When to Use the Panel You can use the Force Balance Controllers panel to set up and adjust parameters for the Warp PID controllers.

Before making any adjustments, you may wish to use the **>>Copy>>** command to copy the current stable settings to the reference gains. If the system then becomes unstable, you can immediately click on the **<<Switch>>** button and restore the stable setting to current gains. You can then examine the gains that caused the instability.

Background Information Each of the controls on the Force Balance Controllers panel affects the system in a distinct way. It is important to understand these effects before attempting to tune the system. Refer to Chapter 3, Understanding Control Principles, for more detailed information about the control system and servo control adjustments.

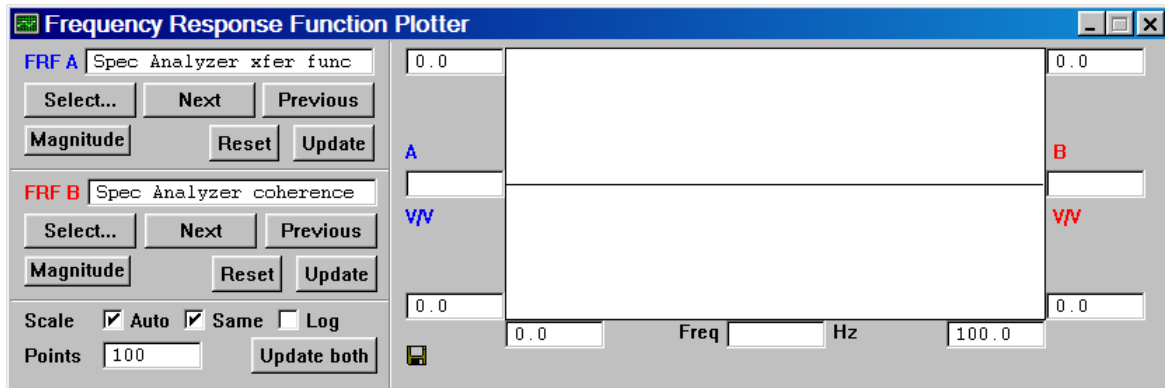
Force Balance Controllers Control Panel Description (part 1 of 2)

CONTROL	DESCRIPTION
Gain text box and slide bar	Adjusts the proportional gain for the selected channel. You can use the slide bar to set a value or enter it in the text box.

Force Balance Controllers Control Panel Description (part 2 of 2)

Reset indicator	Indicates the state of the reset integrator. White – not integrating Green – integrating Red – has integrated up to maximum integral authority. You should review whether to increase the integral authority.
Reset text box and slide bar	Adjusts the reset (integral) gain for the selected channel. You can use the slide bar to set a value or enter it in the text box.
Reset Authority text box and slide bar	Adjusts the limit for the reset integrator. Input the value in % of full scale output. You can use the slide bar to set a value or enter it in the text box.
Bandwidth slide bar and text box	Adjusts the bandwidth of the low pass filter. You can use the slide bar to set a value or enter it in the text box.

FRF Plotter



Panel Description

The FRF (frequency response function) Plotter panel is used with adaptive inverse control and adaptive harmonic control. It allows you to display the frequency response characteristics of the selected channels. This panel is also used to display the forward FRF determined by the spectrum analyzer. The display plots magnitude or phase vs. frequency.

Access

Open the FRF Plotter panel by selecting the FRF Plotter option from the **Display** menu on the main panel.

When to Use the Panel

Use this panel to display the FRF for one or two channels. It allows you to identify cross coupling between channels. Before using this panel, use the Function Generator panel to set a random drive signal for the channel(s).

Background Information

The frequency response function, or FRF, is a mathematical model that accounts for the effects of a system on a signal.

It provides a linear approximation of the changes in phase and amplitude that occur in the frequencies making up a signal as that signal passes through a system. It is used within a component test to compensate for those changes.

The system that the signal is played through contains the electronic and hydromechanical parts of the testing equipment, the transducers, and the test specimen. The response collected shows all the changes in phase and amplitude that the system produces in the signal. These changes are calculated and used to compensate for the effects of the system on the signal.

If any system component is significantly changed (for example, if a test specimen accelerometer is replaced) a new FRF should be measured for the system.

An FRF is measured by exciting the test system with a shaped random drive signal (whose frequency content is similar to the desired drive signal) and collecting responses to the excitation.

FRF Plotter Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Channels select controls	
FRF A or FRF B text box	Shows the name of the selected channel.
	Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the channel list box, from which you can select a channel. You can also select a channel by clicking in the appropriate box in the cross-coupling configuration diagram.
Next button	Selects the next channel in the list.
Previous button	Selects the preceding channel in the list.
Cross-coupling configuration diagram	This diagram shows how each command signal is coupled to a feedback signal for adaptive control. The rows correspond to command signals, and the columns correspond to feedback signals.
Magnitude/Phase pop-up menu	Selects the type of Y-axis data to be displayed. The choices are: Magnitude (in V/V) Phase (in degrees)
Reset button	The Reset button when activated is used with the spectrum analyzer. It resets the spectrum analyzer averaging to zero count and starts averaging again.
Update and Update both buttons	The Update button for each signal updates the display of adaptive control for that signal. The Update both button updates the display of adaptive control for both.
Scale checkboxes:	
Auto	Selects independent autoscaling. In this mode, the two signals are scaled to fill the entire display area, regardless of their relation to each other. Even if Auto scale is selected, you can change the frequency range of interest using the text boxes on the X axis.
Same	If this box is checked, the same scaling is applied to both signals
Log	If checked, plots on a logarithmic scale. Unchecked, plots on a linear scale.
Points text box	Selects and shows the number of points displayed at the selected scale. You can enter a number of points in this box (range 32 to 384).

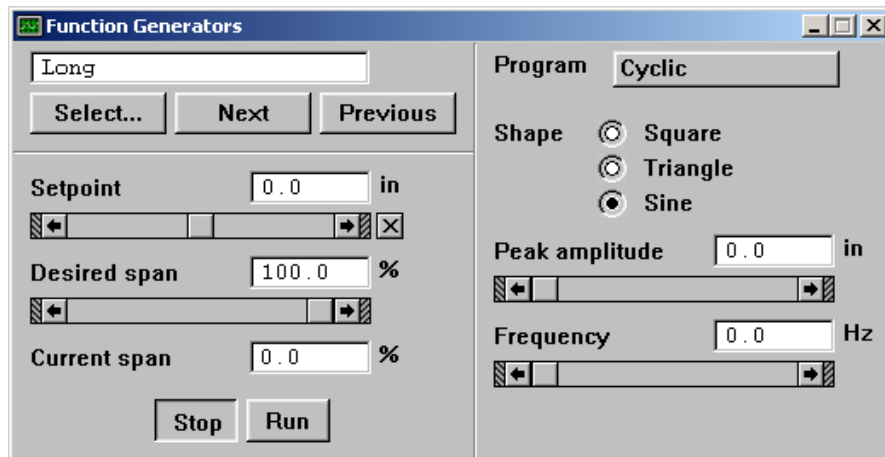
FRF Plotter Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Display area text boxes	The text boxes surrounding the display area show the values of the upper and lower ranges currently displayed. •The top and bottom text boxes on the right and left sides show the minimum and maximum values of the A and B traces (respectively); the right and left text boxes on the bottom of the monitor show frequency. •If you click on a specific point in the display area, a line appears, and the corresponding X and Y values will be shown in the text boxes in the right center, bottom center, and left center.
Save 	Click to save plotted values to a text file. A dialog box will appear to ask for a file name.

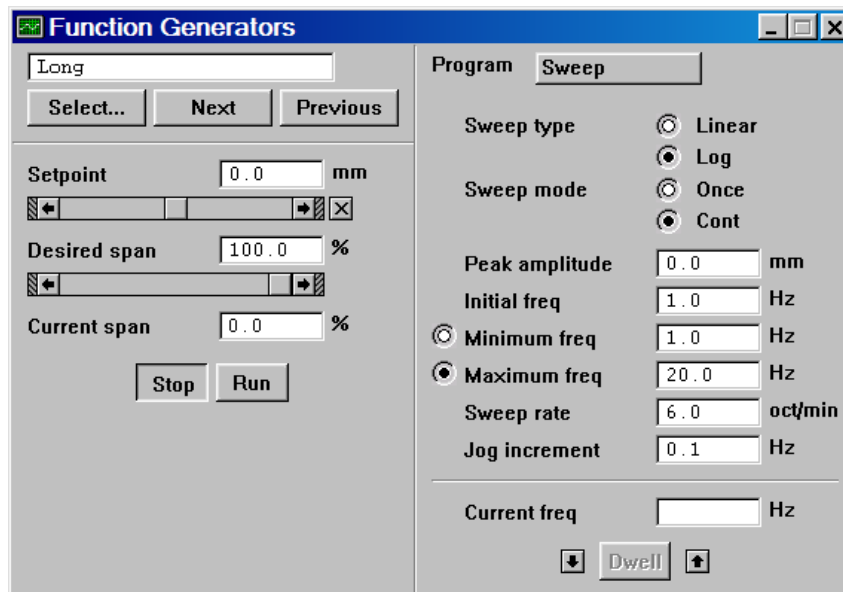
Function Generators

The following Function Generators are available:

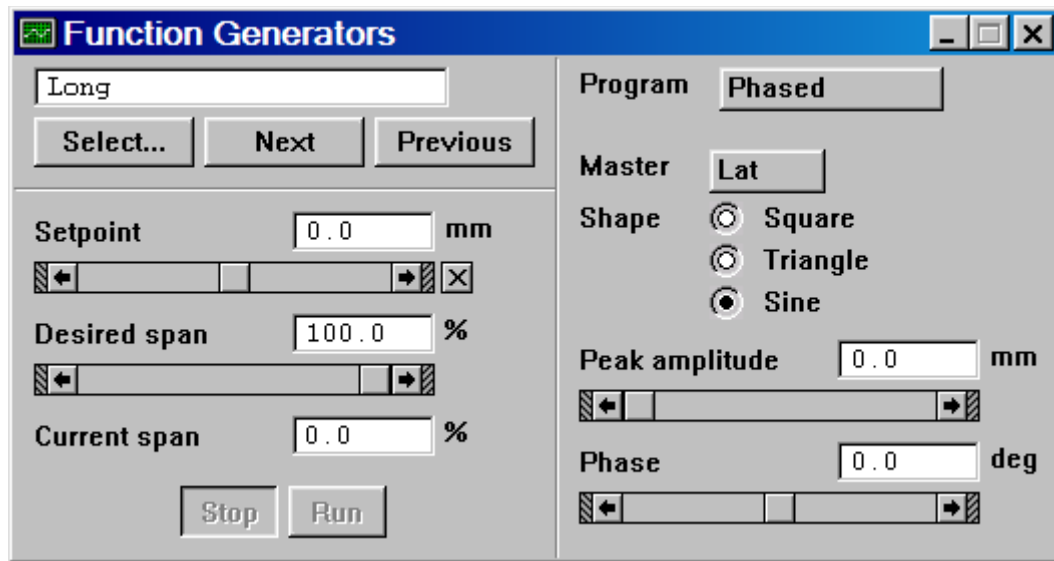
Cyclic



Sweep



Phased



Function Generators

Long

Select... Next Previous

Setpoint 0.0 mm

Desired span 100.0 %

Current span 0.0 %

Stop Run

Program **Phased**

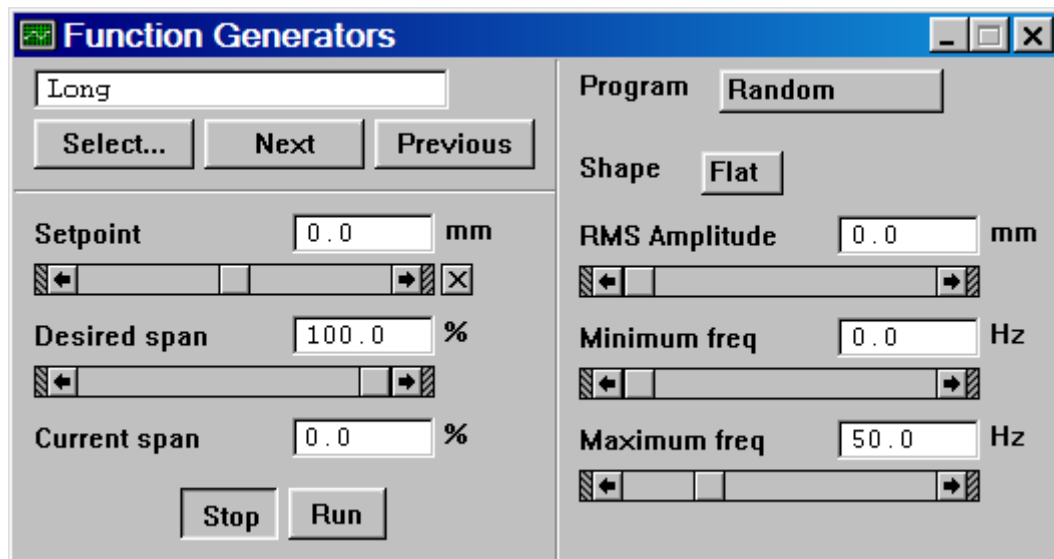
Master Lat

Shape ☐ Square ☐ Triangle ☒ Sine

Peak amplitude 0.0 mm

Phase 0.0 deg

Random



Function Generators

Long

Select... Next Previous

Setpoint 0.0 mm

Desired span 100.0 %

Current span 0.0 %

Stop Run

Program **Random**

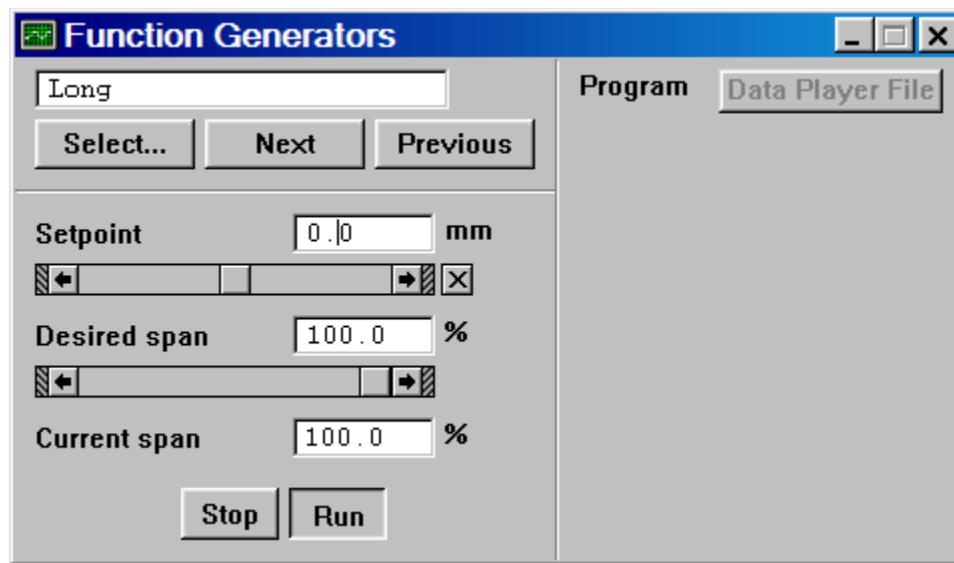
Shape Flat

RMS Amplitude 0.0 mm

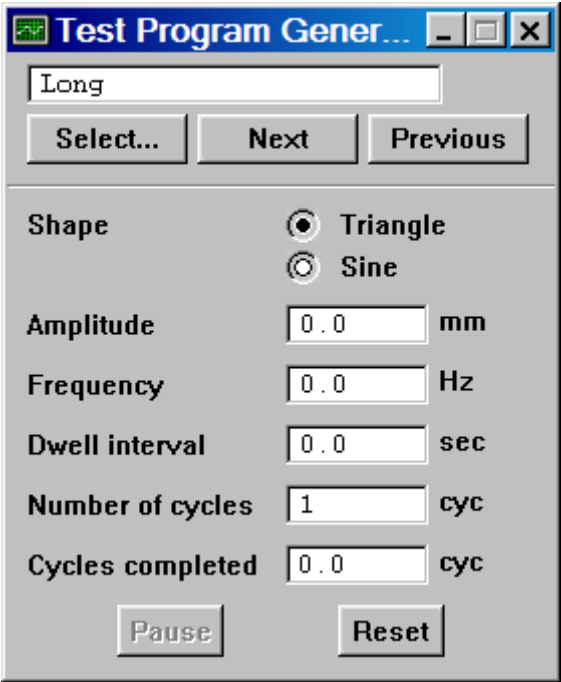
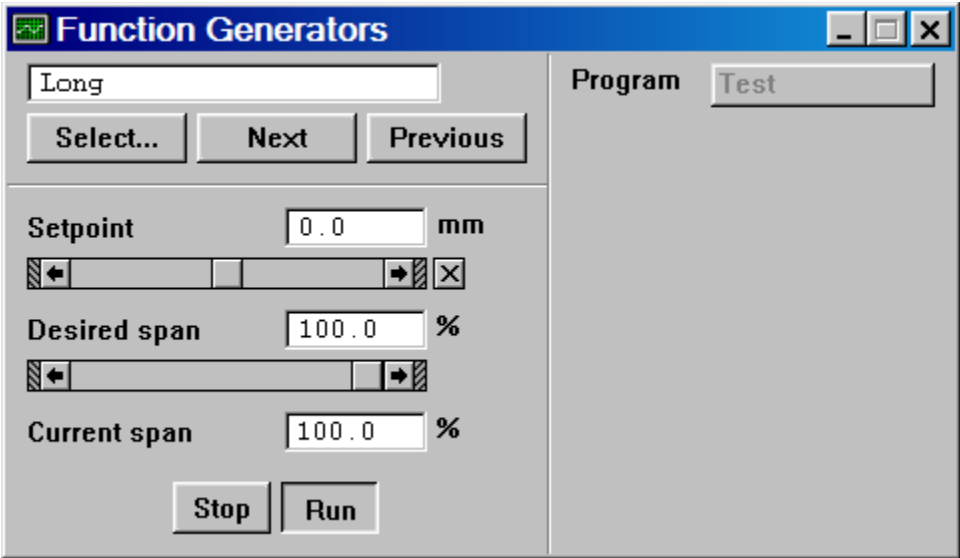
Minimum freq 0.0 Hz

Maximum freq 50.0 Hz

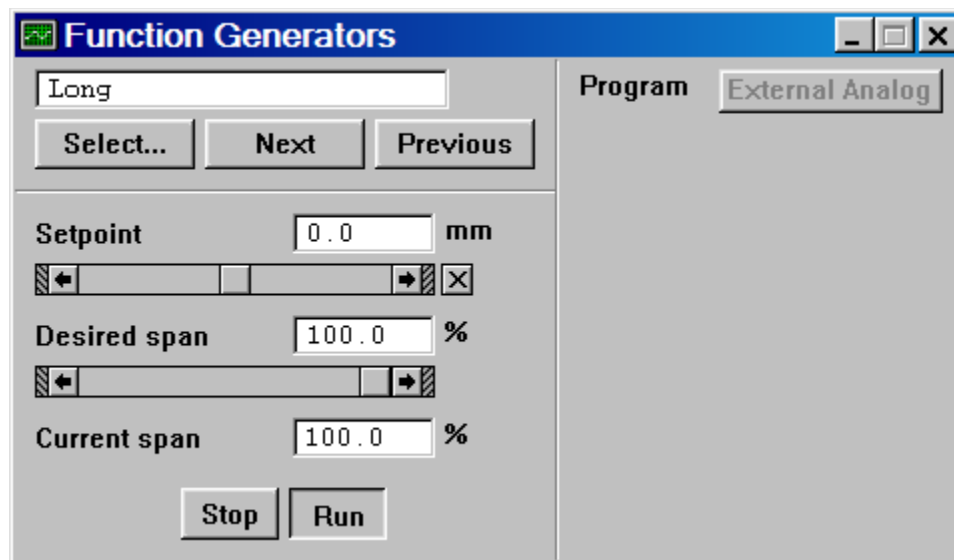
Data Player File



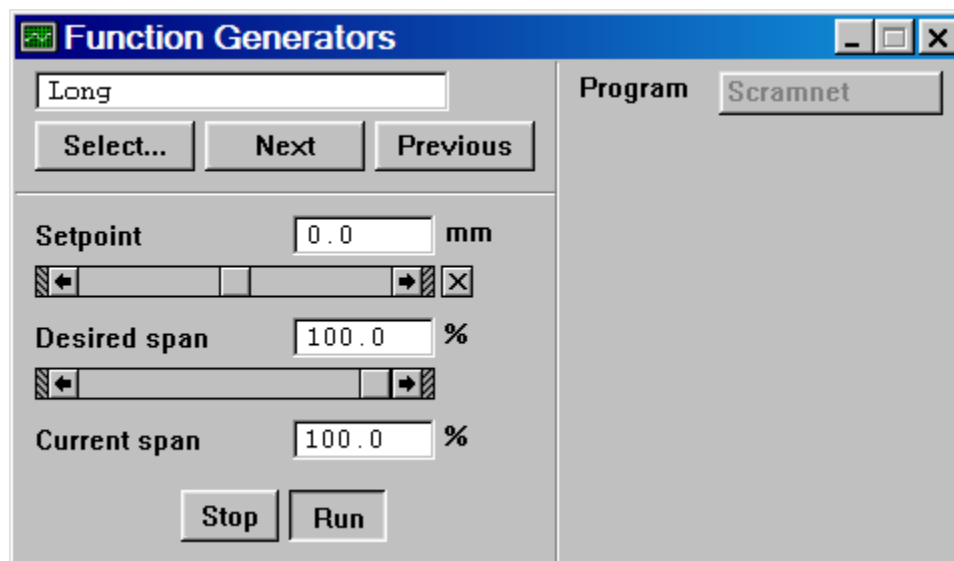
Test Program
Generator



External Analog



Scramnet



Panel Description The Function Generator panel allows you to select the program source and set the appropriate parameters.

Access Open the Function Generator panel by selecting the Function Generator option from the **Operation** menu on the main panel. You can also open this panel by clicking on the **Program Source** icon on the Main panel when Function Generator is selected.

When to Use the Panel You can use this panel to generate and apply a program to the test system. Typically, you will want to use the function generator when you are tuning the servo control loops during test setup, but it can also be used for testing.

Important Information



Whenever hydraulic pressure is applied, adjustment of the controls on the Function Generator panel can cause actuator movement.

Unexpected actuator movement can result in personal injury or equipment damage.

Ensure that all personnel are clear of the actuators, fixturing, and specimen before adjusting any Function Generator control. In addition, make sure that all operators know the effect of control adjustments before they make any adjustments.

Controls for all sources

Control Panel Descriptions for all sources (part 1 of 2)

CONTROL	DESCRIPTION
Chan text box	Shows the name of the currently selected channel. The adjacent channel ID box shows the number of the selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the channel selection panel, from which you can select a channel.
Next button	Selects the next channel in the selection panel list.
Previous button	Selects the preceding channel in the selection panel list.
Setpoint slide bar and text box	Sets the setpoint position for the channel. You can use the slide bar to set a value or you can enter it in the text box. If hydraulic pressure is not applied, this setting identifies the position to which the actuator will ramp when hydraulic pressure is turned on. If hydraulic pressure is applied, adjustment of this control ramps the actuator to the specified position.
Desired Span slide bar and text box	Scales the amplitude of the command applied to the channel (regardless of selected source). You can use the slide bar to set a value or you can enter it in the text box. - If a program is currently running, it will be ramped to the new amplitude within 2 seconds. - If no program is currently running, the program will be ramped to the amplitude set by this control within 2 seconds when it is started. The Span value is multiplied by the Desired Span value (from the main panel, applied to all channels) to obtain the <i>channel span</i>. Refer to the main panel description for further information. Notice that if Span is set to a negative value, the signal will start in the opposite direction.
Current span text box	Not editable. Displays the current span of the function generated for the selected channel.

Control Panel Descriptions for all sources (part 2 of 2)

CONTROL	DESCRIPTION
Stop/Run buttons	Pressing the Run button starts the program on the selected channel. Ramps to the amplitude level set on the Span control within 2 seconds. Pressing the Stop button stops the program for the selected channel. Internally ramps the local span level to zero, but the value set on the Span control does not change. Notice that this does not start or stop a test program; use the Run/Stop on the main panel. Refer to the main panel description for information on starting or stopping a test program. If another channel is selected as the source, the Run/Stop button on this channel cannot be used. The master channel will control Run/Stop.
Program pop-up menu	Selects the programming source. The choices are: • Cyclic • Sweep • Phased • Random • Data Player File* • Test Program Generator* • External Analog* • Scramnet*
	Note <i>*If the main panel buttons are set for Data Player File, Test Program Generator, External Analog, or Scramnet all function generators are set to that same source. This menu is then grayed out and cannot be changed.</i>

Cyclic

Control Panel Descriptions for Cyclic Source

CONTROL	DESCRIPTION
Shape radio buttons (Square, Triangle, Sine)	Selects the shape of the function to be generated for the selected channel by the <i>cyclic</i> function generator.
Peak amplitude slide bar and text box	Sets the peak amplitude of the function to be generated for the selected channel by the <i>cyclic</i> function generator. You can use the slide bar to set a value or enter it in the text box. Ramps to new amplitude at the rate entered in the Ramp Rates panel.
Frequency slide bar and text box	Sets the frequency of the function to be generated for the selected channel by the <i>cyclic</i> function generator. You can use the slide bar to set a value or enter it in the text box. Ramps to new frequency at the rate entered in the Ramp Rates panel.

Sweep

Control Panel Descriptions for SweepSource

CONTROL	DESCRIPTION
Sweep type pop-up menu	Selects the type of sweep (linear or logarithmic). The choices are: • linear • log
Sweep mode pop-up menu	Selects the sweep mode (one-time or continuous). The choices are: • once • cont If once is selected, the function generator sweeps to the end of its sweep range, then dwells.
Peak amplitude text box	Sets the peak amplitude of the function to be generated for the selected channel by the sweep function generator. You can enter a value in the text box.
Initial freq text box	Sets the initial frequency of the sweep function for the selected channel. You can enter a value in the text box.
Minimum freq radio button and text box	Sets the minimum frequency of the sweep function for the selected channel. You can enter a value in the text box. Click on this radio button if you wish to make the sweep first start moving from the initial frequency towards the minimum frequency.
Maximum freq radio button and text box	Sets the maximum frequency of the sweep function for the selected channel. You can enter a value in the text box. Click on this radio button if you wish to make the sweep first start moving from the initial frequency towards the maximum frequency.
Sweep rate text box	Selects the sweep rate of the function to be generated for the selected channel by the sweep function generator. You can enter a value in the text box. Units are defined as dec/min for the log sweep and Hz/sec for the linear sweep.
Jog increment	Sets the amount by which the dwell frequency can be raised or lowered by pressing the up or down jog arrows on the panel. For example if the jog increment is 0.1, pressing the down arrow lowers the dwell frequency by 0.1 Hz. You can enter a value in the text box.
Current freq text	Displays the current frequency of the sweep function generator. Not editable while sweeping but you can enter the desired frequency when in Dwell mode.
Dwell button	Stops the sweep and maintains the current frequency.
Jog arrow buttons	Jog the dwell frequency up or down. The Jog increment text box specifies how much the dwell frequency is raised or lowered. Use the up arrow button to raise the frequency by the Jog increment amount. Use the down arrow button to lower the frequency by the Jog increment amount.

Phased

Control Panel Descriptions for Phased Program Source

CONTROL	DESCRIPTION
Controls for Phased channel source:	Note <i>This can be considered a master/slave channel relationship. This source can only be selected if the master channel has a cyclic or sweep source. The master channel determines the frequency. The shape, amplitude and phase lag between the master/slave channels is selectable.</i>
Master: pop-up menu	Selects the master actuator.
Shape radio buttons (Square, Triangle, Sine)	Selects the shape of the function to be generated for the slave channel.
Peak amplitude slide bar and text box	Sets the peak amplitude of the function to be generated for the slave channel. You can use the slide bar to set a value or enter it in the text box.
Phase slide bar and text box	Sets the phase lag between the master channel and the slave channel. You can use the slide bar to set a value or enter it in the text box.

Random

Control Panel Descriptions for Random Program Source (part 1 of 2)

CONTROL	DESCRIPTION
	Because TVC tuning is done almost exclusively in the frequency domain, the Random Function Generator is used to excite the system so that good transfer function estimates can be obtained. The Random Function Generator consists of a uniform distribution random number generator followed by a bandpass filter. This filter has four parameters adjustable from the Random Function Generator Panel:
Shape pop-up menu	Selects the shape of the function to be generated for the selected channel by the random function generator. This is the shape of the bandpass filter's magnitude response as a function of frequency between minimum and maximum frequencies. Five shapes are available: $1/F^2$, $1/F$, Flat, F, and F^2, where "F" denotes frequency. $1/F^2$ – signal energy decreases with frequency as $1/f^2$ $1/F$ - signal energy decreases with frequency as $1/f$ Flat - signal energy constant for all frequencies F - signal energy increases with frequency as f F^2 - signal energy increases with frequency as f^2 The primary consideration in selecting the shape is to get the most energy into the system across the frequency band of interest without damaging the system by excessive velocity or acceleration. In acceleration control, "Flat" works well, but in displacement control, "Flat" will result in excessive velocity and acceleration at high frequencies; "$1/F$" or "$1/F^2$" is much gentler on the system in that case. Shapes "F" and "F^2" accentuate acceleration at high frequencies and so should not be used. Note that theoretically a shape of "$1/F$" or "$1/F^2$" results in a filter magnitude response that tends toward infinity as the frequency tends toward zero. This is neither desirable nor practical, so the filter response is rolled off to zero as the frequency approaches the minimum frequency. In addition, for technical reasons the minimum frequency is not allowed to be less than 1% of the maximum frequency when "$1/F$" and "$1/F^2$" shapes are selected.
RMS Amplitude slide bar and text box	Selects the root mean square amplitude for the function to be generated for the selected channel by the random function generator. You can use the slide bar to set a value or enter it in the text box. Adjust the RMS amplitude to the minimum value possible to prevent damage to the test specimen. Keep in mind, however, that using too low of an amplitude will result in inaccurate estimates of the transfer function. If your system is significantly nonlinear, try to use an RMS amplitude similar in amplitude to the test waveform if possible, because in such systems the transfer function is a strong function of signal amplitude. Also, keep in mind that you are setting RMS amplitude, not peak amplitude; peak amplitude will be somewhat higher than RMS amplitude.

Control Panel Descriptions for Random Program Source (part 2 of 2)

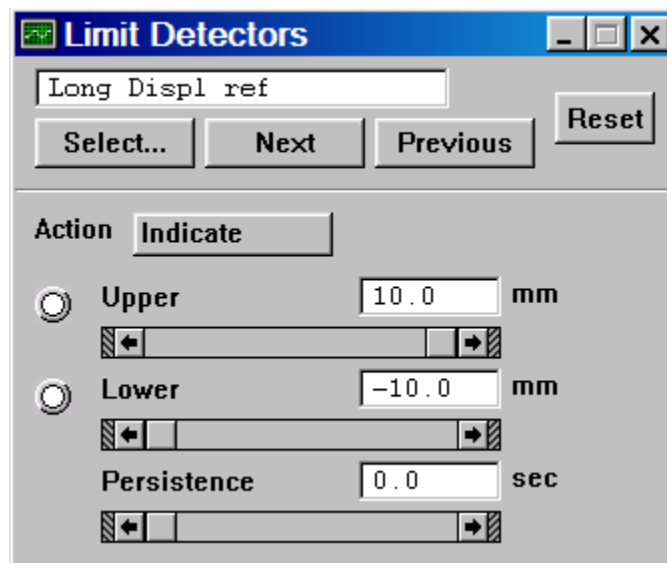
CONTROL	DESCRIPTION
Minimum freq slide bar and text box	Selects the minimum frequency content for the signal to be generated for the selected channel by the random function generator. You can use the slide bar to set a value or enter it in the text box. This is the cut-in frequency of the bandpass filter. Set this according to the lowest frequency expected in your test waveform. A minimum frequency of zero is allowed. In velocity and acceleration control modes, this frequency should match the cut-in frequency of the Reference Generator. NOTE: For $1/f^2$ or $1/f$, minimum frequency cannot be zero. If zero, it will automatically be set to same scale non-zero frequency value.
Maximum freq slide bar and text box	Selects the maximum frequency content for the signal to be generated for the selected channel by the random function generator. You can use the slide bar to set a value or enter it in the text box. This is the cutoff frequency of the bandpass filter. Set this according to the highest frequency to which you expect to control.

Control Descriptions
for others

Control Panel Descriptions for Others

CONTROL	DESCRIPTION
	Note <i>The following controls are not selectable via the Function Generator panel. They are for display purposes only and are selected via the Main panel.</i>
Data Player File	This option indicates that the program command to the selected actuator comes from playing a data file. Refer to Data Player panel information.
Test Program Generator	This option indicates that the program command to the selected actuator comes from the Test Program Generator panel. Refer to Test Program Generator panel information.
External Analog	This option indicates that the program command to the selected actuator is generated by an external data payout system.
Scramnet	This option indicates that the program command to the selected actuator is generated by scramnet.

Limit Detectors



Panel Description The Limit Detector panel allows you to:

- Select a specific software signal for which a limit can be set
- Choose the action to be taken if a limit is exceeded
- Set an allowable operating range and persistence value for the signal
- Identify if an upper or lower out-of-limit has occurred
- Reset the software limit detector circuit

Access Open the Limit Detector panel by selecting the Limit Detectors option from the **Operation** menu on the main panel. You can also open this panel by clicking on the **Limits** icon on the Main panel.

When to Use the Panel Use the panel to set safety limits for the test system during test specification. This panel can be used to set software limits for the following signals:

- displacement reference
- velocity reference
- displacement feedback
- velocity feedback
- force feedback

Important Information The limit detectors are designed to protect equipment from damage. They are not designed, and should not be used, to protect personnel from injury.

The limit detectors are enabled and disabled from the main panel. If not enabled, they will not set an indicator or interlock.

Background Information

A limit event for a particular signal indicates that the signal has exceeded its upper or lower limit. The upper and lower limits establish a range of values that represent a desired system operating range. This band also represents the range where valid test data can be ensured. The persistence value is a time (in seconds) that an upper or lower out-of-limit condition can persist without causing an interlock.

When an out-of-limit condition occurs, the Message Log panel identifies the specific out-of-limit condition.

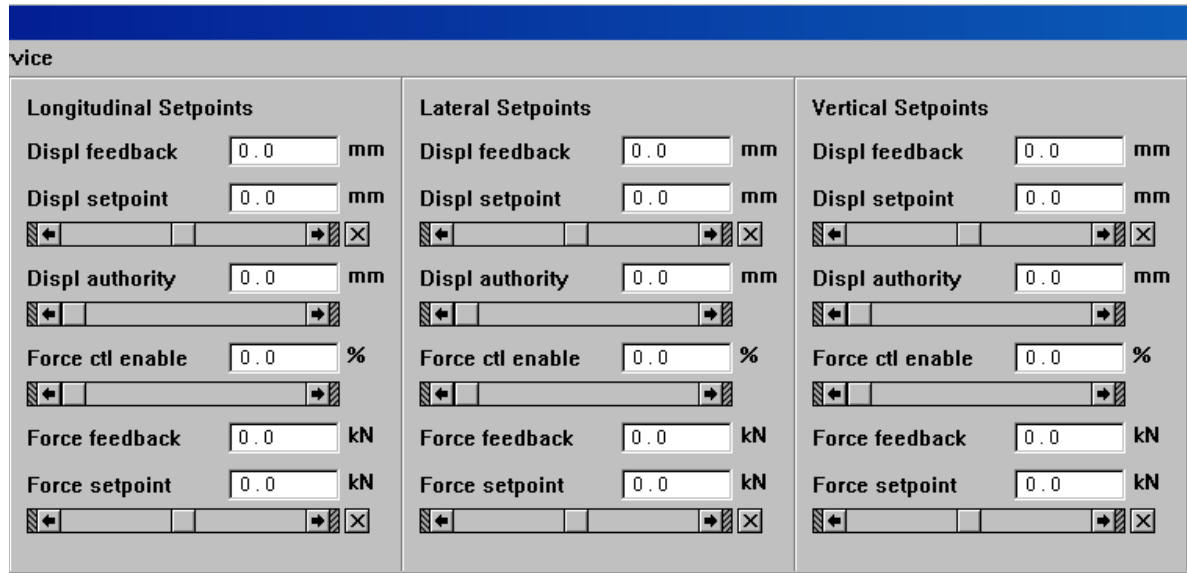
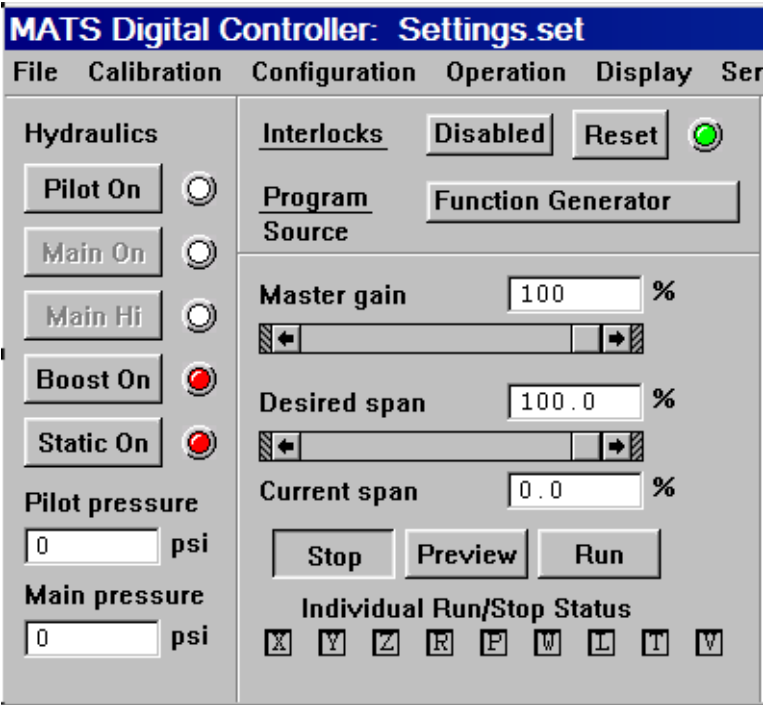
Limit Detectors Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Det text box	Shows the name of the current selected signal. Select a signal using the Select... , Next , or Previous buttons.
Select... button	Opens the signal selection panel, from which you can select a signal.
Next button	Selects the next signal in the selection panel list.
Previous button	Selects the preceding signal in the selection panel list.
Reset button	When pressed, clears the Upper and Lower indicators and any software interlocks generated by the out-of-limit condition, if the channel is within limits.
Action pop-up menu	Select the result of an out-of-limit condition. Selections are: • Indicate – This selection causes the indicator to light only while the signal is outside of the limit. When the signal returns inside the limit, the indicator goes out. • Alert – This selection causes the indicator to light and latch. When the signal returns inside the limit, the indicator remains lit until the Reset button is used. The out-of-limit condition will be recorded in the message log. • Program Abort– This selection causes the system to trigger a program abort if the signal goes outside the limit where the master span will be ramped to zero at a rate entered in the Ramp Rates panel. The Reset button is required to reset the system. The out-of-limit condition will be recorded in the message log. • Interlock – This selection causes the system to trigger an Emergency Stop if the signal goes outside the limit. The Reset button is required to reset the system. The out-of-limit condition will be recorded in the message log.
Upper slide bar and text box	Sets the upper limit of the selected signal. Note that when you set the upper limit value, the lower limit is automatically set to the negative of the upper limit value. If you desire a different lower limit value, you should change it using the lower slide bar after setting the upper limit.
Upper indicator	Lights when an out-of-limit condition occurs for the upper limit.
Lower slide bar and text box	Sets the lower limit of the selected signal. Setting this value does not affect the upper limit value.

Limit Detectors Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Lower indicator	Lights when an out-of-limit condition occurs for the lower limit.
Persistence slide bar and text box	Sets the time, in seconds, that an upper or lower out-of-limit condition can persist without causing an interlock.

Main Panel



The screenshot shows the Main Panel interface with the following elements:

- Roll/Pitch/Yaw setpoints:** A button labeled "Zero".
- Bearing Profile...:** A button with a text input field below it.
- Static fbk:** A numeric input field set to "0.0" with a "kN" unit label.
- Static setpt:** A numeric input field set to "0.0" with a "kN" unit label and a range slider below it.
- Holddown fbk:** A numeric input field set to "0.0" with a "kN" unit label.
- Holddown setpt:** A numeric input field set to "0.0" with a "kN" unit label and a range slider below it.
- Total compression:** A numeric display showing "-33.8477 kN" with a list of components: "= dynamic force", "+ static force", "- holddown force", and "- tare weight".
- Tare weight:** A numeric display showing "33.84772 kN" and a "Measure" button.
- Calibration buttons:** Three buttons labeled "Zero AC/DC Conditioners", "Zero Encoder Conditioners", and "Zero Valve Drivers".
- Status:** A label "Scramnet OK" next to a green indicator light.

Panel Description

The main panel allows access to all other parts of the Digital Seismic Table Controller application. It includes both menus and system controls. The following menus are provided:

- **File**—allows you to add comments to the message log, change passwords for access privileges, close windows, restore or save settings, convert files from binary to text format or visa versa, and quit the application
- **Calibration**—allows you to calibrate A/D and D/A converters, AC conditioners, DC conditioners, encoders and valve drivers, and save or restore the calibration values.
- **Configuration**—allows you to configure units, observers, ramp rates, table parameters, and analog inputs.
- **Operation**—allows you to setup dynamic, static, force balance, and flow gain controllers; function generators, data recorders, limit detectors, spectrum analyzers, and test program generators.
- **Display**—allows you to use digital meters and readouts, read the message log, use FRF plotter, and the digital oscilloscope.

Note You can click on an underlined icon on the main panel to open the associated panel for that item.

System controls on the main panel allow you to perform the following tasks:

- Monitor the current settings file
- Enable and monitor hydraulics
- Enable or disable limits

- Reset limit/interlock conditions
- Monitor the control mode
- Monitor the program source
- Set the master gain and setpoint
- Set the desired span and monitor current span
- Stop, run or preview a program
- Enable/disable Adaptive Control
- Enable/disable Online Iteration

Access The main panel opens when you start the application. It cannot be closed except by quitting the application.

When to Use the Panel Use this panel to set system controls and to access all other panels.

Main Panel Control Descriptions (part 1 of 4)

CONTROL	DESCRIPTION
Hydraulics	
Pilot On button and status indicator	Turns the pilot pressure on. The status indicator will turn green when the pumps reach the system pilot pressure.
Main On button and status indicator	Turns the main pressure on. The status indicator will turn green when the pumps reach the system operating pressure.
Main Hi button and status indicator	Turns the high pressure on. The status indicator will turn green when the pumps reach the system high pressure.
Boost On button and status indicator	Turns the boost pump on. The boost pump can only be used in high pressure. If pressure is 3000 psi, you can enable the boost pump to increase pressure to 4200-4500 psi. Green light indicates boost pump is active and running in high pressure. Yellow light indicates the boost pump is enabled but not active. Red light indicates boost pump is OFF.
Static On button and status indicator	Enables or disables the Static Actuator. Green light indicates Static Actuator is active. Yellow light indicates the Static Actuator is enabled but not active. Red light indicates Static Actuator is OFF.
Pilot pressure display box	Displays the system pilot pressure.

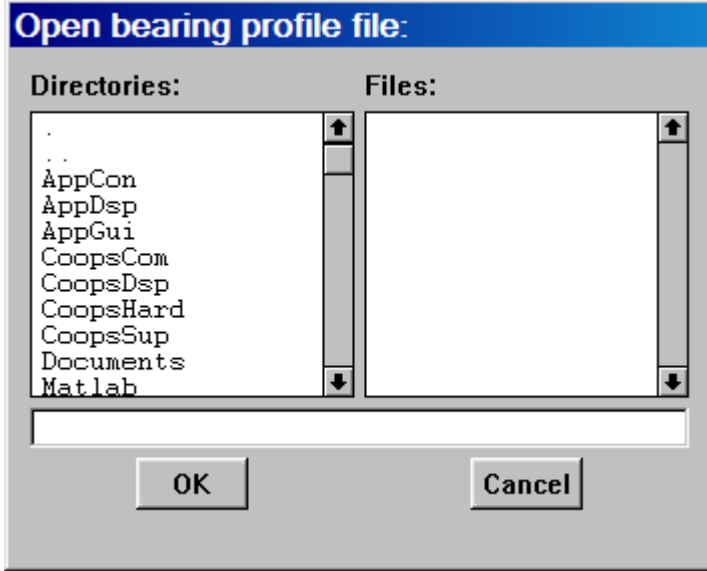
Main Panel Control Descriptions (part 2 of 4)

CONTROL	DESCRIPTION
Main pressure display box	Displays the system main pressure.
Interlocks pop-up menu	Enables/disables the software and hardware limit detectors. The hardware limit detectors are only enabled if the "hardware limits" disable control is not checked on the AC/DC Conditioner panels.
Interlocks Reset button	Use the Interlocks Reset button to clear the hardware and software limit status indicators located on the Conditioners and Limit Detector panels and the system E-STOP chain.
Program Source display	Select the desired function generator program source. Function Generator - setup function using Function Generator panel Test Program Generator - setup function using Function Generator panel Data Player File - select file using Data Player panel External Analog- the program command to the selected actuator is generated by an external source. Scramnet- the program command to the selected actuator is generated by Scramnet.
Master Gain slide bar and text box	Adjusts the master gain. You can use the slide bar to set a value or enter it in the text box.
Desired span slide bar and text box	Adjusts the desired span of the command signal. You can use the slide bar to set a value or enter it in the text box.
Current span display	Shows the current value of the span. The master span may take time to ramp up to its set value. This shows the actual value, at any moment.
Stop/Preview/Run buttons	Controls the program. Stop - stops the test program. Span will ramp to zero. System returns to setpoint levels Preview— allows user to evaluate (preview) command time history while hydraulic power is on. The program runs without commands being sent to the servo controller. Active only in velocity or acceleration control modes. Use Preview to verify that the program will not exceed the mechanical limits. Run - enables and runs the program.

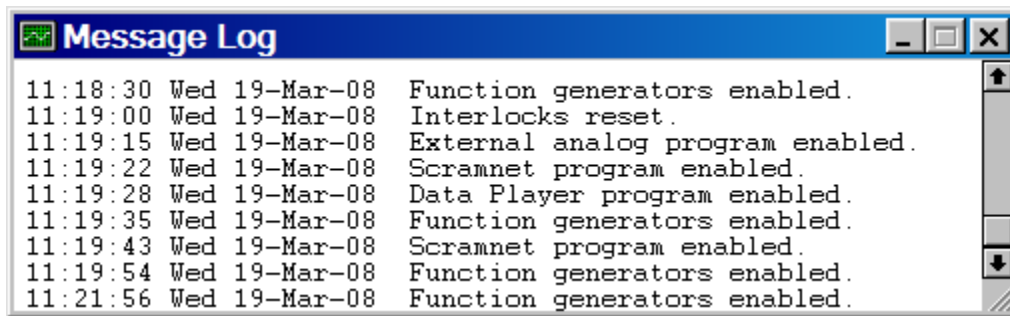
Main Panel Control Descriptions (part 3 of 4)

CONTROL	DESCRIPTION
Individual Run/Stop Status X, Y, Z, R, P, W, L, T, V	Green light indicates which function generators are in run. condition. The following axis and control modes are available: X - Longitudinal displacement Y - Lateral displacement Z - Vertical displacement R - Roll displacement P - Pitch displacement Y - Yaw displacement L - Longitudinal force T - Transverse force V- Vertical force
Longintudinal Setpoints	
Displ Feedback display box	Displays the longitudinal displacment feedback in engineering units.
Displ setpoint slide bar and text box	Adjusts the desired longitudinal setpoint of the command signal. You can use the slide bar to set a value or enter it in the text box.
Displ authority slide bar and text box	Adjusts the desired longitudinal displacement authority of the command signal. You can use the slide bar to set a value or enter it in the text box.
Force ctl enable slide bar and text box	Adjusts the desired longitudinal force control percentage. You can use the slide bar to set a value or enter it in the text box.
Force feedback display box	Displays the longitudinal force feedback in engineering units.
Force setpoint slide bar and text box	Adjusts the desired longitudinal force setpoint. You can use the slide bar to set a value or enter it in the text box.
Roll/Pitch/Yaw setpoints Zero button	Press Zero to zero out the command to roll, pitch, and yaw axes.

Main Panel Control Descriptions (part 4 of 4)

CONTROL	DESCRIPTION
Bearing Profile button	Press Bearing Profile to open a bearing profile dialog box. Select
	
Static fbk display box	Displays the static feedback in kN.
Static setpt slide bar and text box	Adjusts the static setpoint. You can use the slide bar to set a value or enter it in the text box.
Holddown fbk display box	Displays the holddown feedback in kN.
Holddown setpt slide bar and text box	Adjusts the holddown setpoint. You can use the slide bar to set a value or enter it in the text box.
Total compression display box	Displays the total compression of the vertical actuators in kN. Total compression is automatically recalculated and updated continually.
Tare weight display box	Displays the tare weight in kN.
Measure button	Press the Measure button to calculate the Tare weight in kN
Zero AC/DC Conditioners button	Press Zero AC/DC Conditioners button to zero the pressure and load cell readouts.
Zero Encoder Conditioners button	Press Zero Encoder Conditioners button to zero the encoder outputs.
Zero Valve Drivers button	Press Zero Valve Drivers button to zero the valve driver feedback error.
Scramnet OK	Indicates that Scramnet is connected and functioning properly.

Message Log



Panel Description The Message Log panel allows you to read messages generated by system events. Messages are saved to a file called **message.log**. This file records many system actions automatically.

Access Open the Message Log panel by selecting the Message Log option from the **Display** menu on the main panel.

In this view, the message log can be read but not changed. To add data to the message log, use the Add comment... option on the **File** menu.

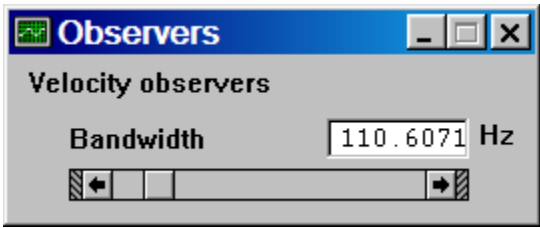
When to Use the Panel Use this panel to read the message log. Only messages from the current session are displayed. The file **message.log**, however, keeps a running list of all messages from all sessions.

Note This file must periodically be deleted to prevent it from growing large and affecting performance. (Although it would take a very long time.)

Message Log Control Description

CONTROL	DESCRIPTION
Scroll bar	Use the scroll bar to scroll through messages in the message log.

Observers



Panel Description The Observers panel allows you to configure the Velocity Observer. (The term "observer" is control theory terminology for a special-purpose filter that computes a feedback signal)

Access Open the Observers panel by selecting the Observers option from the **Configuration** menu on the main panel.

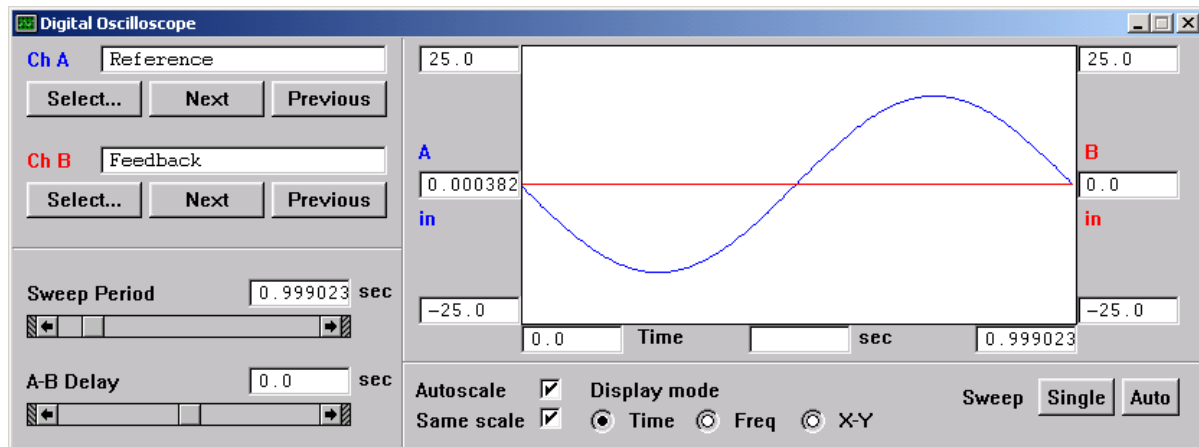
When to Use the Panel Use this panel to do the following:

- Create velocity from displacement for both command and feedback.

Observer Control Panel Descriptions

CONTROL	DESCRIPTION
Bandwidth slide bar and text box	Adjusts the bandwidth of the low pass filter. You can use the slide bar or set a value or enter it in the text box.

Oscilloscope



Panel Description

The Oscilloscope panel shows oscilloscope traces for one or two signals. This panel allows you to perform the following tasks:

- Select one or two signals to be monitored.
- Set the sweep period and delay for the display of the selected signals.
- Select the scaling mode of the selected signals.
- Select the display mode for the monitor.
- Select the sweep mode for the monitor.

Access

Open the Oscilloscope panel by selecting the Oscilloscope option from the **Display** menu on the main panel.

When to Use the Panel

Use this panel at any time to monitor system signals.

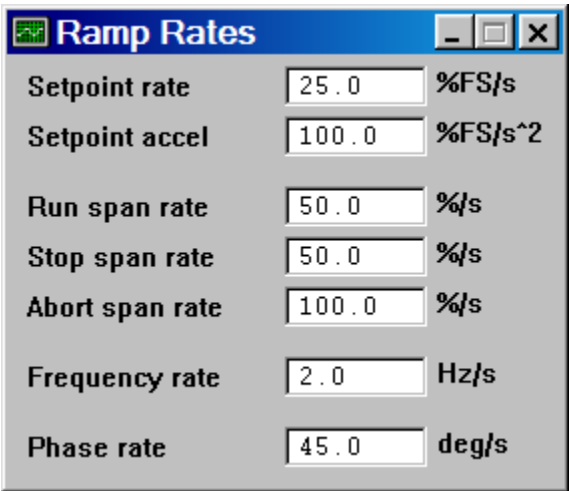
Oscilloscope Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Channels select controls	
Ch A or Ch B text box	Shows the name of the currently selected signal. Select a signal using the Select... , Next , or Previous buttons. You can select NONE from the Select... list (or a blank from Next or Previous) to remove a channel from the display.
Select... button	Opens the signal selection list, from which you can select a signal.
Next button	Selects the next signal in the list.
Previous button	Selects the preceding signal in the list.

Oscilloscope Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Sweep Period slide bar and text box	Sets the sweep period in seconds, for a trace on the oscilloscope display. You can use the slide bar to set a value or enter it in the text box.
A–B Delay slide bar and text box	Sets the time by which the Channel B trace follows the Channel A trace. (If the value is negative, B precedes A.) You can use the slide bar to set a value or enter it in the text box.
Autoscale check box	Selects independent autoscaling. In this mode, the two signals are scaled to fill the entire scope display area, regardless of their relation to each other.
Same scale check box	If this box is checked, the same scaling is applied to both signals.
Display mode radio buttons	Select a relation for the A and B traces: Time - time is displayed along the X axis, amplitude along the Y axis Freq - frequency is displayed along the X axis, amplitude along the Y axis X–Y - signal A amplitude is displayed along the X axis, signal B amplitude along the Y axis
Scope display area text boxes	The text boxes surrounding the scope display area show the values of the upper and lower limits currently displayed. - If in Time display mode, the top and bottom text boxes on the right and left sides show the minimum and maximum values of the A and B traces (respectively); the right and left text boxes on the bottom of the monitor show time. - If in Freq display mode, the top and bottom text boxes on the right and left sides show the minimum and maximum values of the A and B traces (respectively); the right and left text boxes on the bottom of the monitor show frequency. - If in X–Y display mode, values of A and B are shown on the left and bottom (respectively), and nothing is displayed in the text boxes on the right. - If you click on a specific point in the scope display area, a line appears, and the corresponding X and Y values will be shown in the text boxes in the right center, bottom center, and left center.
Sweep Single and Auto buttons	Select single sweep or automatically updated sweeps for display. - If in Single mode, only one sweep will be displayed. To update the display, use the Single button again. - If in Auto mode, the display will be updated when one sweep period (as set on the Sweep Period slide bar) of new data is available. To return to the single mode from the automatic mode, use either the Single or Auto button.

Ramp Rates



Panel Description The Ramp Rates panel allows you to set maximum values for the setpoint generator velocity and acceleration, the span ramp rate and phase rate.

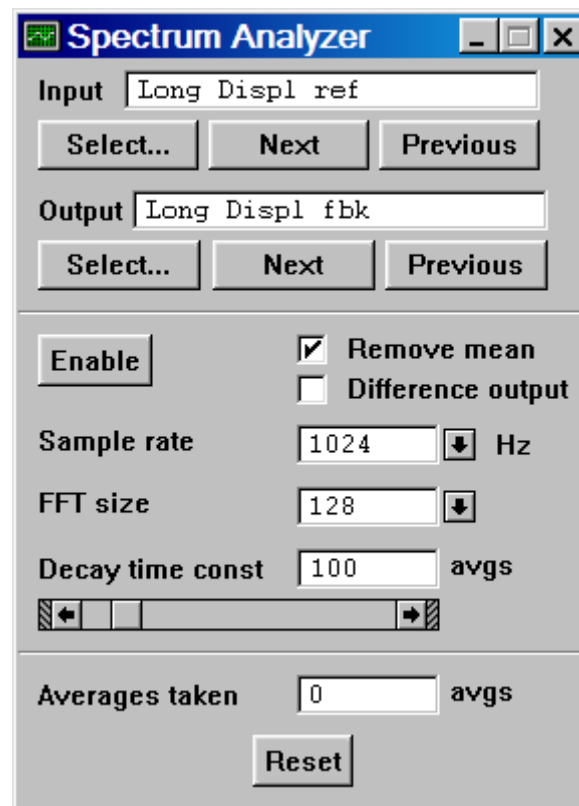
Access Open the Ramp Rates panel by selecting the Ramp Rates option from the **Configuration** menu on the main panel.

When to Use the Panel Use this panel to set limits on how fast the system can reach the displacement setpoint and how fast it can ramp up or down. Note that these values are % of full scale, not engineering units.

Ramp Rates Control Panel Descriptions

CONTROL	DESCRIPTION
Setpoint rate input	Input the maximum velocity that the system is allowed to achieve while trying to reach the displacement setpoint value set on the main panel.
Setpoint accel input	Input the maximum acceleration the system is allowed to achieve while trying to reach the displacement setpoint value set on the main panel.
Run span rate input	Input the maximum rate that the span function generator is allowed to ramp up when starting a program.
Stop span rate input	Input the maximum rate that the span function generator is allowed to ramp down when stopping a program.
Abort span rate input	Input the maximum rate that the span function generator is allowed to ramp down when aborting a program (abnormal stop). The limit detector will use this rate.
Frequency rate input	Input the rate that the program will ramp to a new frequency when the program cyclic generator frequency is changed.
Phase rate input	Input the rate that the phase lag between a master and slave channel can be changed.

Spectrum Analyzer



Panel Description

The Spectrum Analyzer panel allows you to set up the spectrum analyzer to measure the forward transfer function between two channels. Use the FRF Plotter panel to display the transfer functions.

Access

Open the Spectrum Analyzer panel by selecting the Spectrum Analyzer option from the **Operation** menu on the main panel.

When to Use the Panel

Use the Spectrum Analyzer when tuning the system to monitor signals for frequency content and to check for system resonances.

The Spectrum Analyzer produces a true FFT transfer function with input and output PSDs and coherence functions. It uses hanning windows, 50% frame overlaps, and exponential averaging to minimize leakage effects and to smooth spectral estimates.

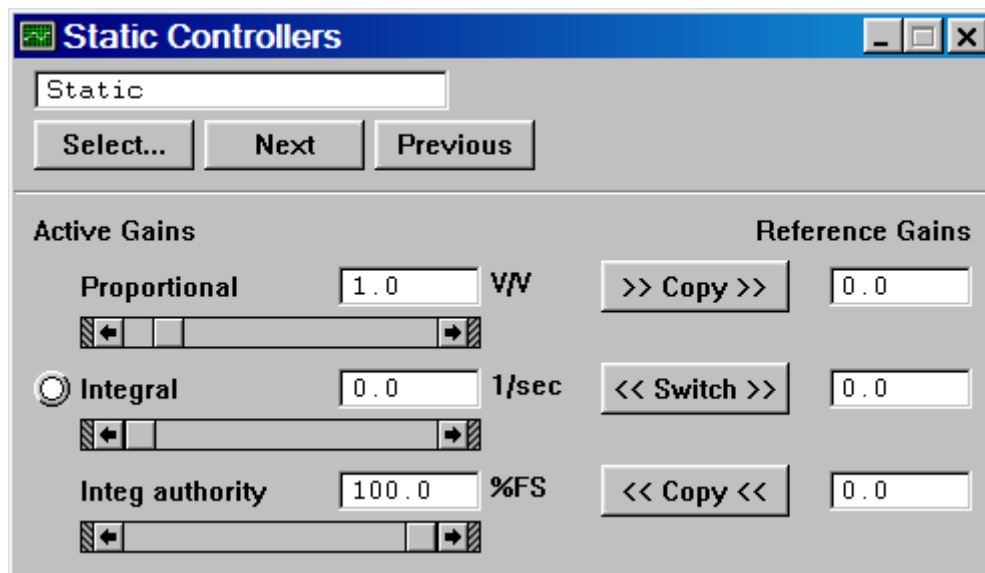
Spectrum Analyzer Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Input and Output text boxes	Shows the name of the selected input channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the channel list box, from which you can select a channel.

Spectrum Analyzer Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Next button	Selects the next channel in the list.
Previous button	Selects the preceding channel in the list.
Enable button	Use to enable/disable the spectrum analyzer.
Remove mean check box	When checked, removes the dc content of the signal by adding a hi-pass filter (with an extremely low cut-in frequency) to the input of the analyzer.
Difference output check box	When checked, the software will differentiate the output signal to remove any integrator between the input and output.
Sample rate selection box	Use to select the desired sample rate of the spectrum analyzer.
FFT size selection box	Use to select the FFT size. The FFT size determines the frequency resolution of the analyzer ($\text{Resolution} = \text{Sample Rate} \div \text{FFT size}$).
Decay time constant slide bar and text box	Use to adjust the decay time constant which determines how long the analyzer keeps data before discounting it. A lower average will allow the analyzer to track better but spectral estimates will be noisier.
Averages taken display box	Displays how many averages have been taken by the analyzer. Can be reset to zero using the Reset button.
Reset button	Use to reset the averaging process.

Static Controllers



Panel Description The Static Controllers panel allows you to set up and tune the PI servo control loops.

Access Open the static Controllers panel by selecting the **Controllers** option from the **Configuration** menu on the main panel, then dragging right to open the controllers menu and selecting Static Controllers.

When to Use the Panel You can use the Static Controllers panel to set up or adjust parameters for a PI controller, including the following:

- Gain (P)
- Reset (I)
- Integ Authority

Before making any adjustments, you may wish to use the **>>Copy>>** command to copy the current stable settings to the reference gains. If the system then becomes unstable, you can immediately click on the **<<Copy<<** button and restore the stable setting to current gains. You can also switch between reference and current gains via the **<<Switch>>** button for quick comparisons.

Background Information Each of the controls on the Static Controllers panel affects the system in a distinct way. It is important to understand these effects before attempting to tune the system.

Servo Controller Error The servo control process sums feedback and command signals to generate an error signal, which is sent to the valve driver to generate the servovalve control signal.

The command and (conditioned) feedback signals are summed to create an initial error signal. That signal is gain-adjusted and summed with integral factors. The resulting error signal is sent to the valve driver (or valve controller).

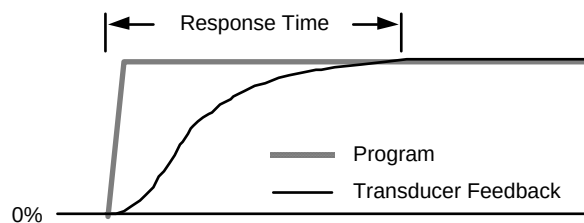
The servo loop adjustments establish the response and stability of the servo control loop. Servo loop adjustments are experimental and you should become familiar with the effects of these adjustments while using dummy specimens during both dynamic and static system operation.

Because each adjustment can have some effect on the other adjustments, adjustments to the servo loop should be made iteratively.

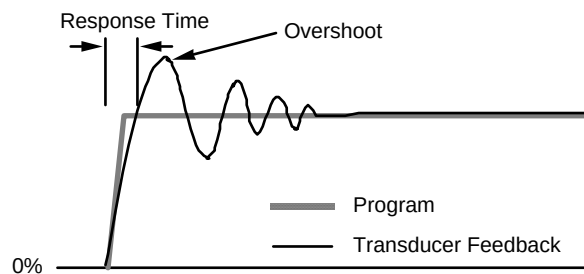
The following paragraphs explain how the servo loop controls affect the error signal.

Proportional Gain

Proportional gain adjustments affect how well the error signal will follow the program. The greater the proportional gain, the more the servovalve opens for a given error. As proportional gain is increased, the error decreases, indicating closer tracking of the feedback to the command. The following figure illustrates the program and resulting transducer feedback signal with a small proportional gain.



Increasing the gain decreases the stability margin of the system, increases the frequency of oscillation, and decreases response time. The following figure illustrates the effect that increasing the proportional gain has on the transducer feedback.

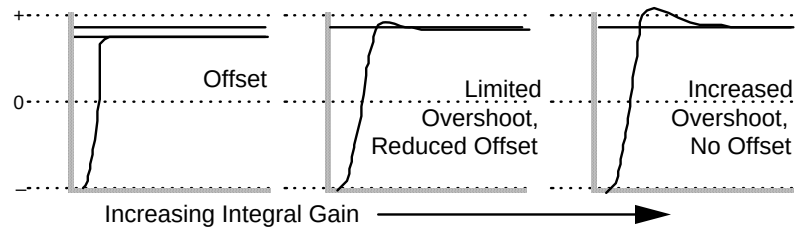


If the proportional gain is set too high, unstable system operation and "ringing" can result. This instability may cause specimen damage. Consequently, proportional gain should be set as high as possible while maintaining stable system operation.

Integral

Integral adjustments affect system accuracy during static or low-frequency operation when the actuator cannot keep the commanded position. Increasing the

Integral adjustment reduces the error between command and feedback by integrating out offsets in the dc portion of the feedback.



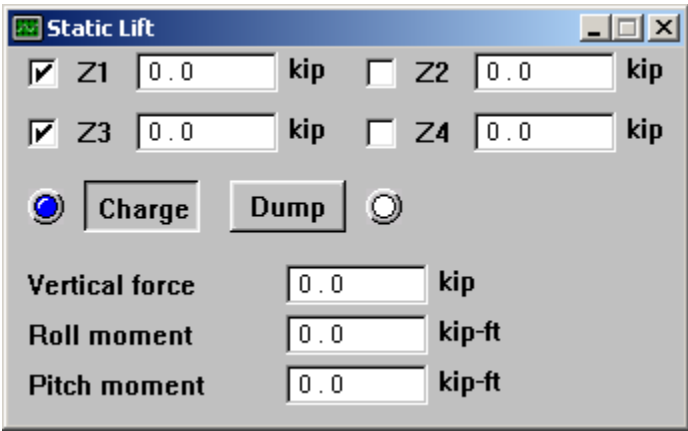
Integrator Authority

Because the integrator can integrate to large or even infinite values, a limit is placed on how much correction the integrator can apply. This limit is called *integrator authority*.

Static Controllers Control Panel Descriptions

CONTROL	DESCRIPTION
Channel text box	Shows the name of the current selected signal. Select a signal using the Select... , Next , or Previous buttons.
Select... button	Opens the signal selection panel, from which you can select a signal.
Next button	Selects the next signal in the selection panel list.
Previous button	Selects the preceding signal in the selection panel list.
Active gains and Reference gains	A gain parameter can be entered as Active gains, which go into effect immediately. Active gains can be copied to Reference gains, which are kept in memory but not used. The <<Copy<<, <<Switch>> and >>Copy>> buttons are used to move the complete set of gain parameters between Active and Reference. >>Copy>> Copies all current gain parameters to their corresponding reference gains. <<Switch>> Swaps all current gain parameters with their corresponding reference gains. <<Copy<< Copies all reference gain parameters to their corresponding current gains.
Proportional slide bar and text box	Adjusts the gain value. You can use the slide bar to set a value or enter it in the text box.
Integral slide bar and text box	Adjusts the reset value. You can use the slide bar to set a value or enter it in the text box.
Integ authority slide bar and text box	Adjusts the limit for the reset integrator control authority. Input the value in % of full-scale output. You can use the slide bar to set a value or enter it in the text box.

Static Lift



- Panel Description

The Static Lift panel allows you to activate the static lift support cylinders for purposes of compensating for table and specimen tare weight.
- Access

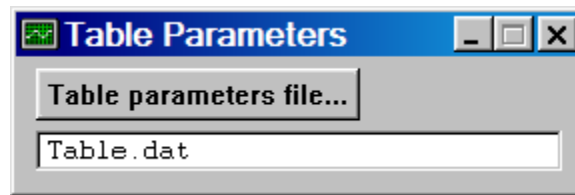
Open the Static Lift panel by selecting the Static Lift option from the **Operation** menu on the main panel.
- When to Use the Panel

Use this panel when the table is in test position prior to test execution and before parking the table after test execution.

Static Lift Control Panel Description s

CONTROL	DESCRIPTION
Static Lift Z1, Z2, Z3 or Z4 checkboxes and display boxes	Select the appropriate static lift position(s) based on the location of your specimen mass. The current value of the appropriate static lift cylinder force will be displayed.
Charge button/indicator	Pumps oil into the selected static lift cylinder. The indicator turns blue when charge is selected.
Dump button/indicator	Dumps oil out of the selected static lift cylinder. The indicator turns blue when the dump is selected.
Vertical force text box	Displays the current value of the vertical force feedback.
Roll moment text box	Displays the current value of the roll moment feedback.
Pitch moment text box	Displays the current value of the pitch moment feedback.

Table Parameters



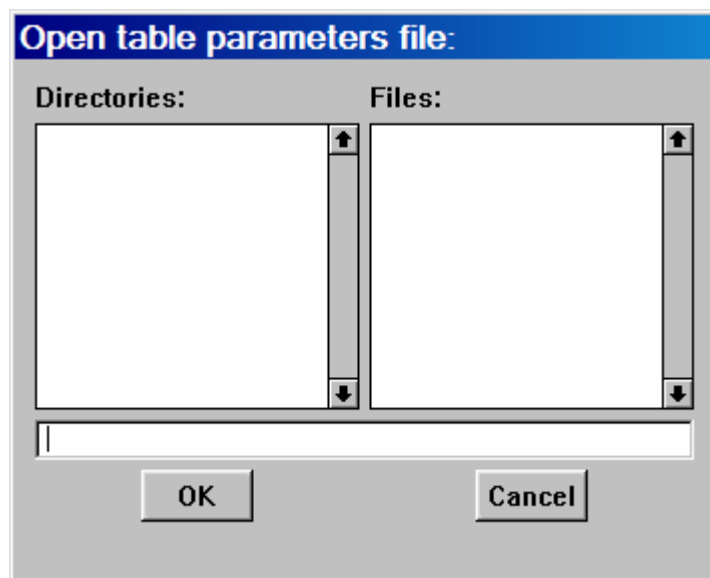
Panel Description The Table Parameters panel allows you to select a table parameters file.

Access Open the Table Parameters panel by selecting the Table Parameters option from the **Configuration** menu on the main panel.

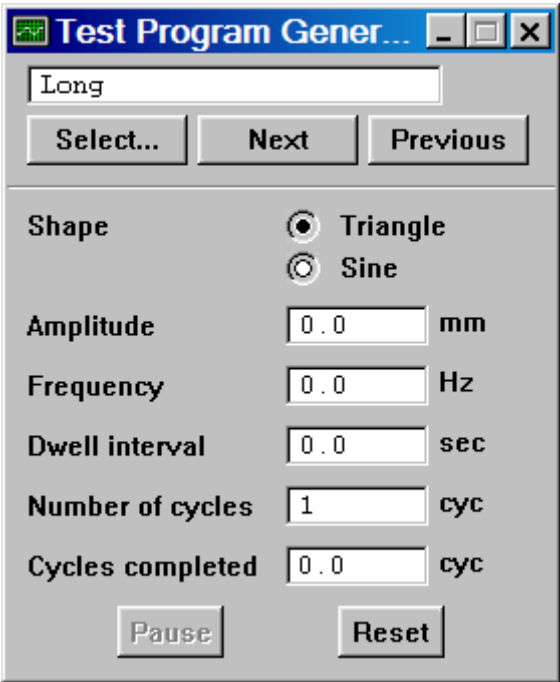
When to Use the Panel Use this panel to select a desired table parameters file.

Table Parameters Control Panel Descriptions

CONTROL	DESCRIPTION
Table parameters file button	Press to open a dialog box. Select the desired file and press OK . Press Cancel to close the box without making a selection.



Test Program Generator



Panel Description The Test Program Generator panel allows you to chose a specific program and to set up the parameters for that program.

Access Open the Test Program Generator panel by selecting the Test Program Generator option from the **Operation** menu on the main panel. You can also open this panel by clicking on the **Program Source** icon on the Main panel when Test Program Generator is selected.

When to Use the Panel You can use this panel to generate and apply a program to the test system. Typically, you will want to use the Test Program Generator when you are testing.

Important Information



Whenever hydraulic pressure is applied, adjustment of the controls on the Function Generator panel can cause actuator movement.

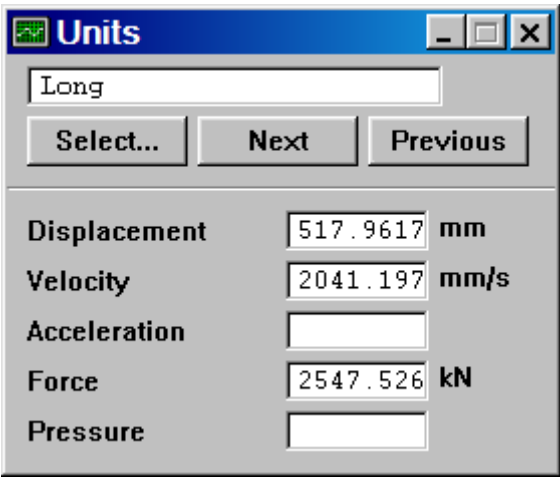
Unexpected actuator movement can result in personal injury or equipment damage.

Ensure that all personnel are clear of the actuators, fixturing, and specimen before adjusting any Function Generator control. In addition, make sure that all operators know the effect of control adjustments before they make any adjustments.

Test Program Generator Control Panel Descriptions

CONTROL	DESCRIPTION
Chan text box	Shows the name of the currently selected channel. The adjacent channel ID box shows the number of the selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the channel selection panel, from which you can select a channel.
Next button	Selects the next channel in the selection panel list.
Previous button	Selects the preceding channel in the selection panel list.
Shape radio buttons (Triangle, Sine)	Selects the shape of the function to be generated for the channel.
Amplitude text box	Sets the amplitude of the function to be generated by the test function generator. You can enter a value in the text box. Ramps to new amplitude at the rate entered in the Ramp Rates panel.
Freq text box	Sets the frequency of the function to be generated. You can enter a value in the text box. Ramps to frequency at the rate entered in the Ramp Rates panel.
Dwell interval text box	Sets the time to stay at peak amplitude for each step.
Number of cycles text box	Set the number of cycles.
Cycles completed display box	Displays the current number of cycles completed.
Reset button	Resets the step function to the minimum frequency.

Units



- Panel Description

The Units panel displays the system full scale units.
- Access

Open the Units panel by selecting the **Units** option from the **Configuration** menu on the main panel.
- When to Use the Panel

This panel displays the full-scale units for system feedback signals.

You can use this panel to determine scaling for BNC inputs and outputs, and when using the external analog program option.

Units Control Panel Descriptions

CONTROL	DESCRIPTION
Channel text box	Shows the name of the current selected channel. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the channel selection panel, from which you can select a channel.
Next button	Selects the next channel in the selection panel list.
Previous button	Selects the preceding channel in the selection panel list.
Displacement display box	Displays the full scale value for displacement.
Velocity display box	Displays the full scale value for velocity.
Acceleration display box	Displays the full scale value for acceleration.
Force display box	Displays the full scale value for force.
Pressure display box	Displays the full scale value for pressure.

Valve Drivers

Valve Drivers

1/02/4 X1 Valve driver

Select... Next Previous

☒ Enabled

Balance 0.0 V

Dither amplitude 0.0 V

☐ Invert polarity

Readout
Spool position

Interlocks

☒ Disabled Reset

☐ Watchdog timer

☐ Excitation fail

Valve driver input 0.0 V

Inner Loop Tuning

Proportional gain 1.0 V/V

Rate gain 1.0 msec

Rate input Spool position

Spool Conditioner Calibration

Excitation ampl 0.0 Vpp

Demod. phase 0.0 deg

Spool zero 0.0 V

Conditioner gain 1.0 V/V

☐ Invert polarity

Spool position 0.0 V

Panel Description

For three-stage valves, the Valve Drivers panel allows you to perform the following tasks:

- Select a specific valve driver channelsAdjust the dither amplitude and balance for the selected valve driver channel
- View the value input to the valve driver by the servocontroller
- Insert the valve phase
- Disable and/or reset interlocks
- Monitor interlocks
- Tune the inner loop
- Make spool conditioner adjustments

Access

Open the Valve Drivers panel by selecting the **Valve Drivers** option from the **Calibration** menu on the main panel.

When to Use the Panel

Use the Valve Drivers panel when adjusting the valve balance and dither amplitude during test setup. If three-stage valves are being used, the Valve Drivers panel also allows you to tune the inner loop and make spool conditioner adjustments.

Valve Drivers Control Panel Descriptions (part 1 of 2)

CONTROL	DESCRIPTION
Driver text box	Shows the name of the selected valve driver. The adjacent driver ID box shows the chassis location, slot location, and channel of the selected driver. Select a channel using the Select... , Next , or Previous buttons.
Select... button	Opens the valve driver list box, from which you can select a channel.
Next button	Selects the next valve driver in the list.
Previous button	Selects the preceding valve driver in the list.
Enabled check box	When checked, sets input of valve driver to zero. (For tuning purposes only).
Balance slide bar and text box	Adjusts the electrical balance of the servovalve.
Dither amplitude slide bar and text box	Adjusts the dither applied to the servovalve. You can use the slide bar to set a value or enter it in the text box.
Invert polarity check box	Selects inverted or non-inverted valve phasing.
Readout pop-up menu	Selects a function for direct readout. The choices are: • Valve current • Spool command • Demodulator filter input • Spool zero output • Spool position • Preamplifier output • Post-gain amplifier out • 5 Volt reference
Interlocks	
Disabled check box	When checked, disables hardware interlocks for the selected channel.
Reset button	When pressed, resets the hardware interlocks for the selected channel.
Watchdog Timer indicator	Indicates the status of the watchdog timer.
Excitation fail indicator	Shows whether excitation has failed. This detector is always enabled, both in hardware and software. Excitation failure causes a system interlock because it may indicate a broken, defective or missing conditioner cable.

Valve Drivers Control Panel Descriptions (part 2 of 2)

CONTROL	DESCRIPTION
Inner Loop Tuning	These adjustments are for three-stage valves only.
Proportional gain slide bar and text box	Adjusts the proportional gain for the selected valve driver. You can use the slide bar to set a value or enter it in the text box.
Rate gain slide bar and text box	Adjusts the derivative rate gain for the selected valve driver. You can use the slide bar to set a value or enter it in the text box.
Rate input radio buttons	Sets the signal source for rate input as spool position or spool.
Spool Conditioner Calibration	
Excitation amplitude slide bar and text box	Sets the level of the excitation signal sent to the transducer. You can use the slide bar to set a value or enter it in the text box.
Demode. phase slide bar and text box	Sets the demodulator phase of the conditioner output. You can use the slide bar to set a value or enter it in the text box.
Spool zero slide bar and text box	Sets the spool position zero offset. You can use the slide bar to set a value or enter it in the text box.
Conditioner gain slide bar and text box	Adjusts the conditioner gain for the selected valve driver. You can use the slide bar to set a value or enter it in the text box.
Invert polarity check box	Selects inverted or non-inverted spool conditioner polarity.
Valve driver input display box	Shows current value input to the valve driver by the servocontroller. Not editable.
Spool position display box	Displays the current spool position.

Operation

This section contains the most commonly used operating procedures. These procedures should serve as a guideline and reminder of the critical adjustments and checks to be made for each operation. Execution of these procedures requires that the operator be familiar with the reason for the adjustment as well as the method of adjustment. The operating procedures detailed here are:

- Pre-Test Adjustments
- Hydraulic Turn On
- Warmup
- Test Execution
- Hydraulic Shutdown
- Emergency Shutdown

As familiarity with the system is gained, these procedures can be altered to suit specific test requirements.

WARNING

The test system is capable of causing personal injury and damage to the test specimen and/or test facility.

Injury or damage can result from attempting to operate the system and disregarding system safety precautions, warnings, and cautions.

It is imperative that you read and understand all safety precautions and procedures before attempting to operate this test system.

Before You Start the System

Safety Precautions and Requirements

Before applying any electrical, hydraulic, or pneumatic power to the system, perform a check to ensure that the following system conditions exist:

- test transducers are properly mounted
- hoses and cables are properly routed and secured
- no loose nuts or bolts or leaking fittings
- tools and other materials are removed from the system
- HPS hydraulic fluid reservoir is at proper level
- accumulator elements are sufficiently charged
- all personnel are clear of the test area

Pre-Test Adjustments

The NCREE MATS Start-Up and Shut-Down sequences will be slightly different when using the large central Static actuator.

Before applying hydraulic pressure, complete the following adjustments.

Specimen Preparation

- Securely mount the test specimen
- Attach the specimen transducers and cables (if applicable)
- Calibrate the specimen transducers (if required)

Activate the Control System

Turn on electrical power to the PC computer. After the PC has completed booting, turn on the 469D and then wait one minute before double clicking on the 469D.exe icon located on your PC desktop. The Calibration parameters and default Settings file, *Settings.set*, will be loaded and the main panel will appear.

If *Settings.set* does not exist, you will be prompted for a settings file.

Initial Start Condition

Before the MATS is started, ensure the initial state of the digital logic to the mechanical/hydraulic system, referred to as the **Start Condition**, are met. Refer to the table below.

Start Conditions

PARAMETER	CONDITION	DIGITAL OUTPUT
Horizontal Axis Actuators	All HSM's OFF	Digital Outputs #3-#6 and #9-#12 are ALL turned OFF.
Pilot Pressure	Enable is OFF	Digital Output #1
Lateral Side A and Lateral Side B Actuator	Enables are OFF	Digital Outputs #13 and #14
Dynamic Actuator	Enable is OFF	Digital Output #18
Static Lift and Static Main	Enables are OFF	Digital Outputs #19 and #20
Static Actuator Accumulator	Accumulator is ISOLATED	Digital Output #21 OFF
Hold-Down Actuator	Enable is OFF	Digital Output #2
BTS High Pressure	Enable is OFF	Digital Output #17
BTS Return DUMP to Drain	DUMP to Drain is ON	Digital Output #22 OFF
Dynamic Actuators DUMP to Drain	DUMP to Drain is ON	Digital Output #25 OFF
Static Actuator DUMP to Drain	DUMP to Drain is ON	Digital Output #26 OFF

Initial Test Parameter Adjustments

If you wish to use a settings file that you have saved earlier, use the Restore Settings option under the File menu. This option restores all settings except the following:

Settings not Restored

PARAMETER	DISPOSITION
Transient values (such as the current value of a program)	Not saved or restored
Display menu value (such as oscilloscope or digital meter)	Not saved or restored
Message log	Not saved in Settings file (message log has its own file)
Access privilege	Always set to BASIC
Displ setpoint	Always set to 0%
Limits	Always disabled
Hydraulics	Always off
Stop /Run button	Always Stop
Adaptive Control	Always disabled

The HSM must be off before you can save settings, restore settings, or quit the application. Note that you can perform these functions when the HPS is on.

Select the Program source

Select the Program source using the **Function Generator** panel.

Use the Function Generators panel under the Operation menu to set up the parameters.

Readout Adjustments

Setup and enable the desired readout devices using the **Display** menu.

System Limit Adjustments

- Adjust limit detector levels.

Use the **Limit Detectors** panel under the Operation menu to set limit detector levels that ensure the safety of the system components.

- Enable the limit detectors.

Select the **(Interlocks) Enabled** button on the main panel.

Hydraulic Turn On Procedure

Complete the following adjustments to ensure a safe start-up of the test system.

Final Safety Checks

- Read the operating safety practices detailed in the Safety section of this Operation Manual.
- Verify the Pre-test adjustments made in the preceding subsection.

Interlocks

Reset any interlocks generated during test setup procedures.

- Press the main panel (**Interlock**) **Reset** button to clear interlock and limit detection indicators.
- If the **Interlock** indicator does not clear, a hardware interlock or a software limit remains uncleared in the system.

If you suspect a hardware interlock:

- A. Check the **AC/DC Conditioner** panel to see if a red fault indicator has been set. If a fault has occurred, select the correct conditioner, move the limits outside of the current signal value, and press the Conditioners **Reset** button.
- B. Press the main panel (**Interlock**) **Reset** button to clear the hardware interlock indicators.

If you suspect a software limit detector is set:

- A. Open the Message Log panel from the **Display** menu to see if a software limit detector remains uncleared. The message will identify the limit.
 - B. Open the Limit Detectors panel from the **Operation** menu, and select the associated signal. Make a note of the limit value. Then, move the limits outside of the current signal value and press the main panel (**Interlock**) **Reset** button to clear the software interlock indicators.
 - C. Open the Limit Detectors panel from the **Operation** menu, and set the limit detector you adjusted in step D back to its original value.
- Enable the limit detectors.
Enable the limit detectors on the main panel.
 - Make sure system is in Stop mode.
Click on the **Stop** button on the main panel.

Hydraulic Start-up



Actuator movement may occur when the Main ON button is pressed.

Actuator movement can result in injury to personnel or damage to the specimen.

Ensure that all personnel are clear of the test area before pressing the **Main On** button.

1. Click on the **Zero AC/DC Conditioners** and **Zero Encoder Conditioners** buttons on the Main panel to zero the encoder outputs, and the pressure and load cell readouts.
2. Click on the **Pilot ON** button on the Main panel to apply pilot pressure to the servovalves. The Pilot On indicator will turn green indicating the pilot solenoid is on.
 - Allow the oil to circulate through the pilot circuit until the normal hydraulic fluid operating temperature is achieved.
 - Check the E-Stop status. If the E-Stop status is OK, Digital Inputs for HSM Dirty Filters are checked and the controller will inform the operator if any of the Longitudinal HSMs has a dirty filter. A dirty filter will NOT stop the Pilot Pressure On process.
3. Cycle the 3rd stage with the DOF function generators to warm up the 3-stage servovalves.
4. If necessary, click on the **Zero Valve Drivers** panel to zero the valve drive-feedback error.
5. Click the **Static On** button to select or de-select the Static Actuator. This will enable the Static Actuator and turn ON the Static Lift Enable (Digital output #19).
 - Green light indicates the static actuator is active
 - Yellow light indicates the static actuator is enabled but not active
 - Red light indicates the static actuator is disabled

Note The Static Actuator CANNOT be selected after main hydraulics are ON.
6. Press the **Main ON** button. Light will turn green when 210 bar pressure is achieved. The following will occur:
 - the servo-controlled channels (except the static actuator) will be nulled
 - the static actuator setpoint will set to -5000 kN (if this function is not enabled)
 - The hold-down actuators will be enabled (Digital Output #2 is turned ON) and the hold-down setpoint will set to 500 kN.
 - the horizontal HSMs will turn on to low pressure (Digital Outputs #3, #5, #7 and #9 are turned ON).

- Once the actuator and servovalve bodies have reached normal operating temperatures, (40⁰ C or above) the system can be run.

Note *Optimum system response is achieved when the hydraulic fluid is at its normal operating temperature of 40⁰ C or above.*

Turn on Hold-Down Actuators and Load the Specimen

The MATS is now ready to turn on the hold-down actuators (setpoint > 500 kN) and to move the platen vertically to contact the specimen in vertical displacement control. The specimen can be loaded to the first vertical load desired.

WARNING

DO NOT put the MATS in Vertical Load control PRIOR to specimen contact.

DO NOT turn on the Static Actuator (setpoint > 0 kN) until the Dynamic Actuators are generating some vertical load.

7. Set the hold-down actuators to the desired setpoint using the **Holddown setpt** control. This will usually be the maximum load possible.
8. Click on **Main Hi** to turn on the high pressure. Indicator will turn green when high pressure is achieved.
9. Click on Roll/Pitch/Yaw setpoints **Zero** button to zero the roll, pitch, and yaw setpoints.
10. Move the platen vertically off the end position (at 0 mm) using the Vertical **Displ setpoint** control until the platen is a few mm above zero, but not yet loading the specimen.
11. Push the **Tare Weight Measure** button. This will compute the force to subtract for the platen and fixture and specimen weight.
12. Move the platen vertically in displacement control until some vertical load greater than the weight of the platen is generated.
13. Set the **Vertical Force setpoint** to a value slightly larger than the vertical load achieved by initial contact displayed in the Vertical **Force feedback** control box. (Ex: If feedback is 200 kN then input 250 kN in setpoint)
14. Set some **Vertical Displ authority**. (Ex: 70 mm) The authority is the maximum displacement command generated by the cascade load control loop for 10 volts error.
15. Once in cascade load control make sure the vertical displacement control loop integrator, **Integral** on the **Dynamic Controllers** panel, is set to 0.
16. Slowly move the **Vertical Force ctl enable** slider from 0% to 100%. The system then is in Cascade load control for the vertical axis.

Note *Once in cascade load control, DO NOT turn ON the vertical displacement control loop integrator.*

17. Raise the **Vertical Force setpoint** to the desired force level.

18. IF the Static Actuator is enabled, set a **Static setpt** for this actuator. As the static load increases, the DComp loop will advance the Dynamic Actuators as required to maintain the **Vertical Force setpoint**.

Warmup Procedure

- Place the controller in displacement control, either by using the control variable selector on the Main panel or by restoring a pre-saved settings file configured for displacement control (preferred).
- Return positive depth notch filter values to original values slowly.
- Run a low frequency, low amplitude sine wave until oil temperature is at or above 40° C.

Test Execution Procedure

After applying hydraulic pressure to the actuator, complete the following procedure to execute a test.

Verification and Safety Checks

Note *Optimum system response is achieved when the hydraulic fluid is at its normal operating temperature of 40 °C or above.*

- Ensure that the hydraulic system is at its normal operating temperature before proceeding with testing. Allow the HSM to run at low pressure until the normal hydraulic fluid operating temperature is achieved.
- Check the program input and pre-test adjustments completed in the preceding subsections.
- Clear all personnel from the test area.

Starting the Program



When adjusting the SPAN and SETPOINT controls, ensure that the test program does not exceed 100% of the full-scale limits.

The SPAN and SETPOINT controls can cause the program to exceed 100% of the system full-scale limits.

If the program exceeds 100% of full-scale, the limit detector interlocks will activate causing a program interlock. A program interlock may invalidate the test data because the test will stop abruptly.

- Verify that the **Desired Span** control (program amplitude) on the main panel is set to a known safe operating level or 0%.
- Verify the program source selection and parameters.
- Verify the correct control variable is selected.
- Use the **Preview** option to verify that the program does not exceed mechanical limits. This button only available in velocity and acceleration control modes.



Immediate and unexpected actuator response is possible when a Run command is applied to the system.

Unexpected actuator response can result in personal injury or equipment damage.

Clear all personnel from the test system before running a test.

Press the **Run** button on the main panel to begin the test.

Adjustments During a Test

- Make adjustments to the readout devices as desired.
- Minor adjustments to the **Desired Span** control can be made at this time.
- While constantly checking for system stability, slowly adjust the main panel **Desired Span** control towards 100%.
- If the system becomes unstable, immediately remove hydraulic pressure by pressing any **Emergency Stop** buttons. Identify the cause(s) of the instability before attempting the test again.

Hydraulic Shutdown Procedure

After the completion of a test, the following procedure should be completed to ensure safe shutdown of

Note *Do not use the EMERGENCY STOP (or E-STOP) buttons during routine system shutdown. An emergency shutdown bypasses normal shutdown control sequences and, if used for routine shutdown, will place unnecessary mechanical strain on the system.*

System Shutdown

1. If necessary, press the **Stop** button on the main panel to stop the test.
2. If the static actuator is being used, unload the Static Actuator to no load:
 - A. Set the **Static setpoint** to -5000 KN and wait for the static load feedback to get very low
 - B. Select the **Static ON** button to **OFF**. Indicator will turn red. This will dump the remaining pressure to the drain line.

Note *Oil flow out of the Static Actuator is due to specimen load, platen weight, and hold-down actuator force.*

3. Once the Static Actuator is turned OFF and the Static Load is not on the system, the **Vertical Force setpoint** is reduced to the level where the Dynamic Comp Gain was turned on to 100%. Do NOT go below this load level. Switch back to displacement control near the point where you entered the vertical cascade control mode. Next, move the **Vertical Force ctrl enable** slider from 100% back to 0%. Note: Dynamic Actuator movement and load change should be minimal.
4. The BTS will be in vertical displacement control and just making contact with the specimen. PRIOR to lowering to the bottom of stroke, make sure that the Lateral and Longitudinal axes are commanded to ZERO displacement. The platen can now be lowered to the bottom of the vertical stroke.
5. Click on the **Main HI** button to **OFF** to return the horizontal axis HSMs to Low Pressure. Indicator light will turn white.
6. Click on the **Main On** button to **OFF**. Indicator light will turn white. The Digital Outputs all go to the Start Condition EXCEPT that Pilot Pressure is still ON (Digital Output #1).
7. Click on **Pilot On** to turn **OFF** the Pilot Pressure. Indicator light will turn white. The BTS is now in the Start Condition.

Emergency Shutdown Procedure

The following actions should be taken if an emergency arises during operation of the test system.

Note *If the system electronics senses and exceeded limit or open interlock condition, a system shutdown will be activated automatically.*

If an emergency situation occurs, activate an emergency shutdown by pressing one of the large red EMERGENCY STOP (or E-STOP) buttons. These E-Stop buttons are located:

- On the control desk
- On pedestals (2) adjacent to the reaction frame

Use one of the E-Stop buttons to shutdown the system if you need to quickly shutdown the hydraulics to the MATS system.

- Correct the condition that caused the emergency shutdown.
- Execute the Hydraulic Turn On Procedure.

Maintenance

The MATS system demands periodic, routine maintenance to continue to provide optimum performance. This section contains lists of recommended preventive maintenance schedules for the system components supplied by MTS, and a system maintenance log. For corrective maintenance information, refer to the Maintenance Procedures section or contact MTS Systems Corporation.

A thorough understanding of the system's nature should be achieved by reading the system manuals and studying the equipment before any maintenance procedure is begun.

Some repair or maintenance procedures may require the use of heavy machine rigging techniques. This manual is not intended to be a primer in this area and assumes knowledge of such techniques and the use of personnel skilled in rigging.

General Inspection Criteria

Before performing any maintenance routine, read the safety practices in this manual and the maintenance procedures in the applicable product manuals. Any system component not specifically discussed in this section or in other sections should not be adjusted or tampered with. Consult MTS Systems Corporation about any problems concerning adjustment of such components.

WARNING

The Safety Practices section of this manual contains information that can help maintenance personnel minimize hazards which can be encountered during system maintenance.

Failure to observe the Safety Practices described in this manual prior to attempting the following maintenance procedures can result in injury to personnel and/or damage to equipment.

Ensure that all persons involved in the maintenance of the equipment read the Safety Practices section of this manual.

In order to maintain a safe system, it is very important to contact the MTS Service Department immediately if any of the following conditions are noted:

- Excessive nitrogen leakage.
- Any bolt or nut fastener failure or any sign of loss of bolt preload, even if the bolt appears to be defective or if the system has been operated with insufficient torquing through oversight.
- Any operation or maintenance procedure that may have accidentally overloaded any structural component.
- Any loss of system control or unexplained tripping of the limit detector interlocks.
- Any unexplained loss of hydraulic fluid from the hydraulic distribution sub-system.

System Operating Inspections

Check for normal system operation whenever the system is run. In addition to the maintenance safety checks, routine operation inspections should consist of checks for the following:

- Fluid level in the hydraulic power supply reservoir is normal (as indicated on the reservoir fluid level gage).
- Nitrogen precharge in the accumulators is within $\pm 20\%$ of posted pressure.

Preventive Maintenance Checklist

Most system maintenance is limited to routine inspections for signs of obvious component damage or failure and maintenance of the correct nitrogen precharge for the accumulators. The following subsections briefly describe specific maintenance tasks. Refer to the appropriate Product Manuals, for detailed maintenance procedures.

WARNING

The hydraulic pump must be turned off before any maintenance procedure is begun. Follow established company safety procedures to assure that the unit cannot be operated while maintenance is being performed.

The time between maintenance intervals may require re-evaluation and may change from the specified interval due to experience gained after the system has been in operation.

Before Starting a Test

General inspection before starting a test. Inspect the test area for damage or obstruction (e.g., forgotten tools, etc).

Check oil temperature. Ensure that the hydraulic system is at its normal operating temperature (at or above 40° C) before proceeding with a test.

After Completing a Test

General inspection after completing a test. Inspect the system for obvious signs of cracking, buckling, loose bolts, leaks, or other conditions requiring maintenance or repair. If any of these conditions are found, contact MTS Systems Corporation.

As Required

Replace table actuator seals. Replace the actuator face or rod seals if excessive leakage occurs or whenever the actuator has been disassembled. A decrease in system performance can be an indication of seal damage or wear.

Replace longitudinal actuator seals. Replace the piston rod seals when leakage occurs or whenever the actuator has been disassembled.

Replace accumulator seals. Replace accumulator seals whenever leakage occurs.

[Reference Manual- Accumulator Product Manual]

Check Servovalves. The servovalves should have a periodic checkup and possible reconditioning. MTS has a valve exchange program to facilitate this. The actual running time of the system will determine the replacement interval for the servovalves.

[Reference Manual- Servovalves (252 & 256 Series) Product Manual]

Each Shift

Check hydraulic fluid level, color and odor. Check the fluid level to ensure that it is within the correct operating range. A below normal level would indicate a loss of hydraulic fluid. If below normal, inspect the system for leakage, correct the problem, and refill it to the proper level. Check the fluid color and compare it to the first test sample taken after initial system installation. Check the smell of the hydraulic fluid. If necessary, replace the hydraulic fluid.

Weekly

Inspect all safety devices. It is important to inspect all safety devices to ensure operator safety.

Refer to Product Manuals for specific safety precautions and features.

Inspect hydraulic components. Inspect the hoses, hard line, pressure sensors, gages, and hose connections for signs of damage, wear or leakage. Correct any problem that exists.

Clean longitudinal actuator piston rods. Clean the exposed area of the hydraulic actuator piston rods.

Check actuator and attachment hardware. Check the actuator and attachment hardware for any sign of damage. Correct any problem that exists.

Clean exposed areas. Clean all exposed areas of the test system including transducers and servovalves.

Check E-Stop safety devices. It is important to check the E-Stops to ensure operator safety. The E-Stops should be tested for proper operation. Run a “dummy” test, hit the E-Stop, and ensure that the system operation stops.

Monthly

Inspect all bolts. Inspect bolts for obvious signs of looseness or structural failure. Correct any problem that exists.

Check hoses. Check hoses for wear or damage.

Check accumulator precharge levels. Check precharge of all accumulators. If the accumulator pressures are outside of the accepted levels, charge or discharge the accumulators.

Run the system. Start the system and allow it to reach operating temperature on a monthly basis. This action drives moisture out of the system and lubricates components that may have drained while inactive.

Every 6 Months

Check accessible cap screws. Check the torque of all accessible cap screws of size M16 or larger. Tighten if necessary. Reference torque tables or appropriate drawings.

[Reference Manual, Actuator Assemblies for the 244.xxx]

Check HSM pilot operated pressure reducing valves. Check the setting of the pressure reducing valves and adjust if necessary. Adjust as follows:

- Reduce pressure on both valves by loosening lock nut and turning counter-clockwise.
- Turn one valve clockwise to raise pressure to desired output. Then, adjust second valve with clockwise motion to a pressure greater than the desired output.
- Reduce pressure of second valve until setting of each valve is equal.
- Lock valves in place with lock nuts.

Analyze hydraulic fluid sample. Take a sample of the hydraulic fluid and have it analyzed. Replace the fluid if necessary. Oil condition is critical for servovalve and internal cylinder component life.

[Reference Manual- Hydraulic Fluid Care Guide]

Yearly

Replace actuator seals (low pressure). Replace the low pressure actuator seals whenever leakage occurs or whenever the actuator has been disassembled. A decrease in system performance can also be an indication of seal wear.

[Reference Manual- Actuator Product Manual]

Check calibration. Check calibration of the feedback devices, re-tune if necessary.

[Operation Manual– Calibration]

Every 5 Years

Replace hoses. Replace any hoses that show signs of wear or damage immediately. Even with no apparent flaws the hoses should be replaced every 5 years due to natural aging of the hose material.

System Maintenance Log

The system maintenance log is a tool to use for recording and tracking maintenance. The maintenance interval/date of maintenance entries should be made when the maintenance is actually performed. An example maintenance log is illustrated in the Figure below.

SYSTEM MAINTENANCE LOG																	
System <u>#2</u> Page <u>1</u> of <u>3</u>		Instructions: When maintenance is performed, fill in date, operating hours (from running time meter), and/or other appropriate maintenance interval															
PROCEDURE	RECOMMENDED INTERVAL	MAINTENANCE INTERVAL / DATE OF MAINTENANCE															
Check hyd. grip pressure supply	Weekly	-	9-9	-	9-16	-	9-23	-	9-30	-	10-7	-	10-14	-	10-21	-	10-28
}	}	-	11-4	-	11-11	-	11-18	-	11-25	-	12-2	-	12-9	-	12-16	-	12-23
		-	12-30	-	1-6	-	1-13	-	1-20	-	1-27	-	2-3	-		-	
Check s/v balance	100 operating hours	0	9-9	100	9-23	200	10-9	292	10-21	380	11-4	500	11-24	590	12-4	685	12-23
}	}	800	1-8	900	1-17	994	1-27										
Check hydraulic hoses	Monthly	-	9-9	-	10-7	-	11-4	-	12-2	-	1-6	-	2-3	-			
Clean air filter	Monthly	-	9-9	-	10-7	-	11-4	-	12-2	-	1-6	-	2-3	-			
Check HSM accum. precharge	Monthly	-	9-9	-	10-7	-	11-4	-	12-2	-	1-6	-	2-3	-			
Purge air from hyd. lifts	As req'd	-	9-9	-	9-23	-	10-21	-	12-2	-		-		-			
Clean actuator rods	As req'd	-	9-9	-	9-23	-	10-7	-	10-21	-	11-4	-	11-18	-	12-2	-	12-6
}	}	-	12-30	-	1-13	-	1-27	-		-		-		-			
Check HPS fluid	500 operating hours	0	9-9	500	11-24	994	1-27										

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Example System Maintenance Log

It may be helpful to maintain separate logs for maintenance procedures that are required weekly, monthly, yearly, etc.