



# Product Manual

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## Model 407 Controller

Version 2.0

June 1994  
119499-00B



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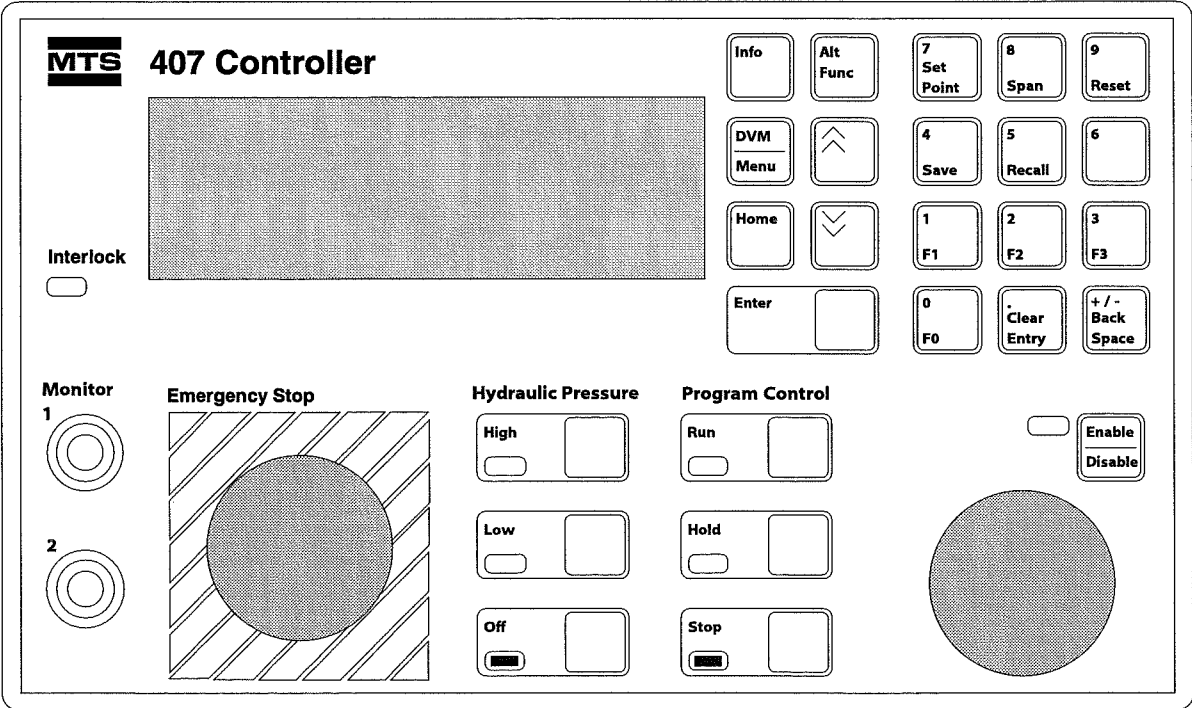




# Chapter 1 Introduction

## Introduction

The MTS Model 407 Controller is a single channel, digitally-supervised Proportional, Integral, Derivative, Feedforward (PIDF) servo controller that provides complete control of one servo hydraulic channel/station in an MTS testing system. This includes ac and dc transducer conditioning, basic function generation (with the capability to accept externally generated command signals), servovalve drive signal generation, and hydraulic pressure control. Multiple 407 Controllers can be interconnected to accommodate multiple-channel testing, and can be quickly configured to accommodate a variety of tests.



VW-0001

Operations are controlled through the 407 Controller front panel. An easy-to-read multi-line display shows the status of the parameter currently being adjusted or monitored. A simple scroll-through menu provides quick access to any parameter or function. All parameters are entered through a keypad or adjusted by a single multi-turn knob. The current settings are saved in battery-backed RAM and are automatically recalled at start up. Two conditioner setups (for each conditioner) can also be stored.

In addition to providing the means to adjust and monitor the test parameters, the front panel also provides program control, system hydraulic pressure control, and an Emergency Stop button that shuts down the system hydraulics in an emergency situation. BNC monitor connectors are also provided to allow you to connect easily to external readout devices.

*Plug-in Modules*

The 407 Controller can accept up to three modular transducer conditioners and one valve driver. Both ac and dc transducer conditioners are available and can be installed in any combination. Valve driver modules are available to accommodate either two-stage or three-stage servovalves. All plug-in modules provide 15-pin D-type cable connectors for compatibility with other MTS electronics.

*Interlocks*

The 407 Controller provides interlocks for adjustable upper/lower limit, underpeak, and error detection for each installed conditioner module, plus an end-of-count interlock. These interlocks can be daisy-chained for multiple controller configurations.

*Function Generation*

A function generator (with a built-in cycle counter) in the 407 Controller provides basic sine, square, and triangle command waveforms. For tests requiring complex waveforms, the 407 provides an external command input to receive externally generated commands.

The function generator waveform can be output to another 407 Controller (or any external device) for synchronization. An external program Run/Stop input can also be set up through the digital inputs.

*Hydraulic Pressure Control*

The 407 Controller provides complete control of the test system hydraulics. The 407 can be used to control a hydraulic power supply and/or a hydraulic service manifold to apply low and high hydraulic pressure to the test system. In multiple Controller configurations, the 407 provides first-on/last-off control of the hydraulic power supply in addition to control of a local hydraulic service manifold.

*Definitions*

Definitions of acronyms and abbreviations used in this manual are provided in Appendix A.

## Conventions Used in This Manual

The following symbol indicates a note that gives you important additional information:

---

### **NOTE**

---

The following symbol indicates that caution must be used to avoid losing valuable data or causing minor equipment damage:

### **CAUTION**

The following symbol indicates that extreme care must be used to avoid causing personal injury or equipment damage:

### **WARNING**

## Software Conventions

407 Controller displays are represented like this:

→Configuration Function Generator Controller Intlk status      ↓
---

When defining a menu item, the following additional information is provided:

Access level: 2      indicates the access security level (in this example, 2). Level 1 items are available to all users. Level 2 and 3 items are restricted for some users by changing the user access level, as described in Chapter 2 under "Enter Lvl."

Inhibit: hyd on      indicates a state that inhibits the use of this item (in this example, the item cannot be used while hydraulic pressure is on).



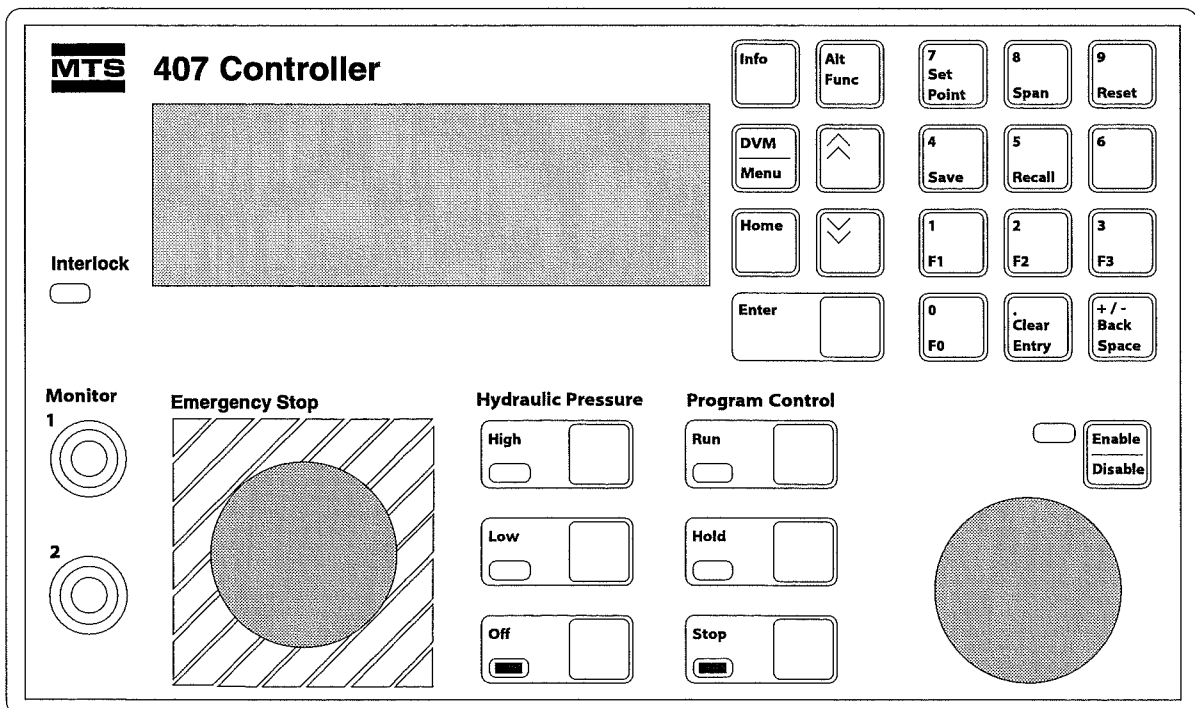
## Chapter 2 Using Panel Controls

407 Controller operations are controlled through the front panel, as described in this chapter.

At power up, the Controller displays the current revision level of the firmware and runs through a self-test. You must supply the firmware revision level when calling for service or when asking questions regarding your 407 Controller.

The front panel features include:

- emergency stop button
- monitor connectors
- an interlock indicator
- hydraulic pressure keys
- program control keys
- menu display screen and controls

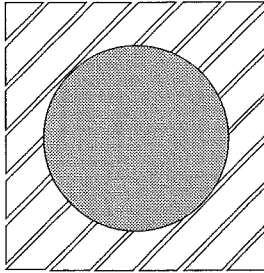


VW-G001

## Direct Controls and Indicators

### Emergency Stop

Emergency Stop



Pressing the Emergency Stop button commands the hydraulic pressure to turn off, removes the program signal, and lights the Interlock indicator. This is a mechanically latching button.

Hydraulic pressure cannot be applied again until the button is returned to its inactive position by turning it clockwise until it unlatches. Press the Alt Func button, then the Reset button to extinguish the Interlock indicator.

If no remote Emergency Stop buttons are connected to the controller, make certain a remote stop jumper connector (MTS part number 491695-01) is connected. Failing to make this connection will cause an interlock.

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### Interlock Indicator

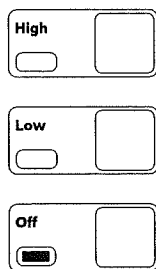
The Interlock LED indicator lights to indicate that an interlock has occurred. It is extinguished only after you eliminate the interlock condition and press the Reset function button. The cause of the interlock is shown on the Intlk Status menu (described later in this chapter).

An interlock stops the test and turns off the hydraulic power supply if undesirable conditions occur. You can use the 407 software to set interlock conditions, such as end of count, error detection, and limit detection.

---

### Hydraulic Pressure Control Keys

Hydraulic Pressure



The Hydraulic Pressure keys control the hydraulic power supply (HPS) and the hydraulic servo manifold (HSM). In practice, the functions of these buttons depend upon the hydraulic configuration in software. The following are typical functions:

- High—turns on high hydraulic pressure.
- Low—turns on low hydraulic pressure.
- Off—turns off hydraulic pressure.

## Program Control Keys

### Program Control



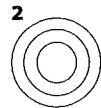
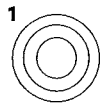
Program Control keys control the running program directly.

- Run—applies the program signal to the system and lights the Run indicator.
- Hold—reserved for future use.
- Stop—removes the program signal from the system and lights the associated indicator.

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## Monitor 1 & 2 Connectors

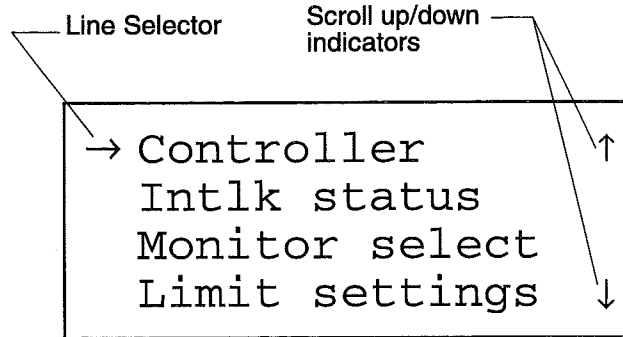
### Monitor



These BNC connectors allow you to easily make connections to external monitor devices. You can use the software menus to select the signal for each connector.

Refer to the Monitor Select menu later in this chapter for information on signal monitoring.

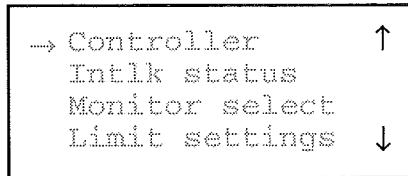
## Menu Display Screen



The menu display screen can show four lines of a menu.

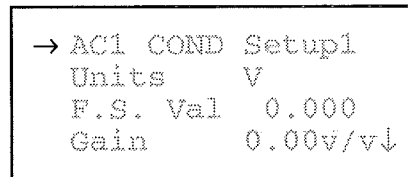
The screen may also show some of the following symbols:

### Scroll Arrows



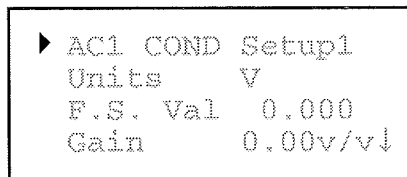
Arrows (↑↓) indicate that more lines are available on this menu. You can use the up and down keys (↑ and ↓) to view more menu lines.

### Line Selector



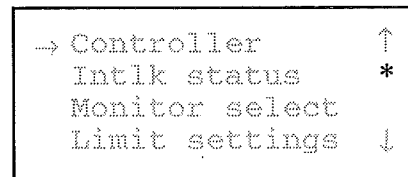
The selected line is indicated by a right arrow (→). You can use the up and down keys (↑ and ↓) to select a different line.

While a line is selected, you can change a parameter or enter another menu.



When you do not have access to a line (because of the security level), the line selector is a triangle (▶).

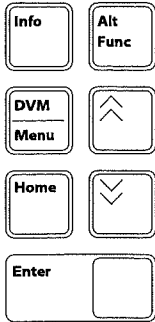
### Alt Func Symbol



When you press the Alt Func key, an asterisk (\*) appears on the second line. It is a reminder that the alternate key functions are now active. The asterisk remains until you press another key.

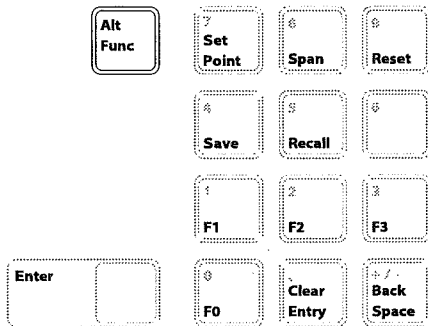


## Menu Keys



- Arrows—(⤴ and ⤵) move the line selector up or down on the menu.
- Enter—In a menu, pressing Enter activates the selected item. If the item is another menu, Enter opens that menu. If the item is a parameter with a value, pressing Enter confirms the value displayed. If the item is a parameter with choices, pressing Enter repeatedly cycles through the list of choices.
- Home—moves to the next higher menu level. In the main menu, pressing Home moves you to the first line of the menu.
- DVM/Menu—toggles the screen between the menu display mode and the digital voltmeter (DVM) mode. You can switch to or from the DVM mode at any time without changing any parameters.
- Info—displays information about the currently selected parameter on the user interface display. Pressing Info a second time returns to the original display.

## Alt Func Key



The Alt Func key gives you access to alternate functions on the numeric keypad. Press the Alt Func key, then press the key for the alternate function.

An asterisk (\*) appears on the screen while the alternate functions are active. Pressing a key selects the function, turns off the asterisk, and returns all keys to their numeric functions. Pressing the Alt Func key repeatedly toggles the asterisk on and off.

## Alternate Functions

- Set Point—displays the setpoint value on the screen, no matter where you are in the menu hierarchy. To return to the previous location, press the Home key.
- Span—displays the span value on the screen, no matter where you are in the menu hierarchy. To return to the previous location, press the Home key.
- Reset—resets any interlocks (providing the interlock condition has been removed) and turns off the Interlock indicator.
- Save—saves the setup for the selected feedback conditioner.
- Recall—reserved for future use.
- F0, F1, F2, F3—function keys defined by a screen instructions.
- Clear Entry—clears a value entered by the numeric keys.
- Back Space—clears the last digit entered by the numeric keys.
- Enter—pressing Alt Func, then Enter, returns to a previous choice when selecting from a list of choices.

## How to Use the Menus

### Moving Around in the Menus

Use the up and down arrow keys ( $\wedge$  and  $\vee$ ) to move to an item in a menu.

Use the Enter key (after selecting a menu name) to open a menu.

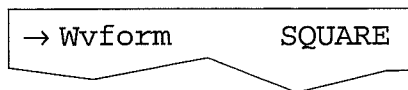
Use the Home key to move to the next higher menu level. In the main menu, pressing Home moves you to the first line.

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### Selecting from a List of Choices

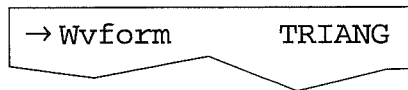
An item may offer a list of choices. In this case, only one choice is visible. You press Enter to display the next choice. Pressing Enter repeatedly cycles through the list of choices.

To display the *previous* choice, press Alt Func, then Enter.



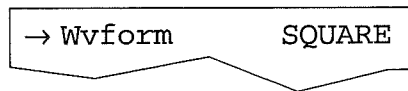
→ Wvform      SQUARE

For example, the item Wvform (in the Function Generator menu) offers the choices SQUARE, TRIANG, SINE, and EXTRNL.



→ Wvform      TRIANG

If SQUARE is displayed, press Enter to change the choice to TRIANG.

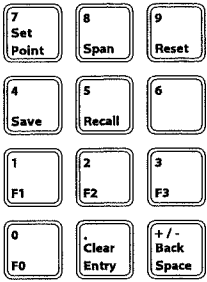
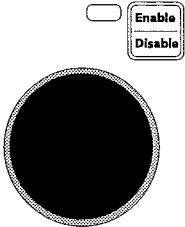


→ Wvform      SQUARE

If TRIANG is displayed, press Alt Func, then Enter to change the choice to SQUARE.

## Entering a Numeric Value

An item may require a numeric value. In this case, use the numeric keys or the adjustment knob to enter the number.

Numeric Keys	Adjustment knob
 <p>0-9 type numerals on the screen.</p> <p>. types a decimal point.</p> <p>+/- changes the sign of the value being entered.</p> <p>Entries outside the acceptable range are ignored.</p> <p>If you make a mistake, use Back Space to erase the last digit or use Clear Entry to erase all of the digits you have typed.</p> <p>Press Enter to confirm the value.</p>	 <p>The adjustment knob is especially useful for making small adjustments in a value.</p> <p>First press the Enable key to enable the knob. (The Enable LED indicator lights while the knob is enabled.)</p> <p>Then turn the knob to increment or decrement the value.</p> <p>When you press any other key (except the DVM/Menu key) the knob is once more disabled.</p>

### NOTE

If you are making adjustments (such as gain) while the hydraulics are on, MTS recommends using the adjustment knob, rather than the numeric keys. Using the numeric keys can cause a slight bump in the actuator movement, due to the sudden change in value. For a smoother transition, use the adjustment knob.

# Menu Summary

The following menu summary shows each conditioner as ACx or DCx, where x is the number of the slot (1, 2, or 3) in which the conditioner is installed. Your screen will show the slot numbers. Both two-stage and three-stage valve driver menus are shown. Your Controller has one type of driver only, and its associated menu.

## Configuration

- Eng Units
- EOC Act
- Cyc Src
- SetPt R
- Span R
- Hyd Config
- Intlk Cnfg
- P/V Sens
- Ampl Cntrl
- Enter Lvl
- Chng Pswd

## Function Generator

- Wvform
- Freq
- Setpnt
- Span
- Preset

## Controller

- FdBack
- P Gain
- I Gain
- D Gain
- D src
- F Gain
- dP Cond
- dP Gain

## Intlk Status

- ESTOP
- EOC
- Error
- ACx Up
- ACx Lo
- DCx Up
- DCx Lo
- HPS1
- HPS2
- UpkPeak
- UpkVly
- Extern
- DigIn

## Monitor Select

- Mon1
- Mon2

## Limit Settings

- ACx Up
- ACx Lo
- DCx Up
- DCx Lo
- ErrLim
- UPk Sig
- Min Pk
- Max Val

## Digital I/O

- Din1
- Din1Pol
- Din2
- Din2Pol
- Dout1
- Dout1Pol
- Dout2
- Dout2Pol

## ACx Conditioner

- ACx Cond Setup
- Units
- F.S. Val
- Gain
- Delta K
- C Zero
- F Zero
- Excit
- Phase
- Polarity
- Monitor

## DCx Conditioner

- DCx Cond Setup
- Units
- F.S. Val
- Gain
- Delta K
- C Zero
- F Zero
- Excit
- Polarity
- Monitor

## DCx Shunt Cal Chk

- DCx Shunt F1=+FB
- F2=-FB, F3=RELEASE
- Pre-Shunt
- Delta

## 2-Stage Valv Drv

- Dither
- Balance
- Polarity
- Monitor

## 3-Stage Valv Drv

- Gain
- C Zero
- F Zero
- Excit
- Phase
- Fdbk Pol
- P Gain
- D Gain
- Dither
- Balance
- Vlv Pol
- Monitor

## DVM (Press DVM/Menu key)

- ACx or DCx Cond
- ACx or DCx Cond Pk/Vly
- ACx or DCx Cond Max/Min
- Cmd
- Cmd Pk/Vly
- Cmd Max/Min
- Error
- Error Pk/Vly
- Error Max/Min
- Vlv Cmd
- Vlv Cmd Pk/Vly
- Vlv Cmd Max/Min
- Vlv Mon
- Vlv Mon Pk/Vly
- Vlv Mon Max/Min
- Cyc Cnt
- Preset

## Configuration menu

Use the Configuration menu to select basic 407 Controller definitions.

```
→Configuration
  Function Generator
  Controller
  Intlk status      ↓
```

Press the Enter key to display the Configuration menu:

```
→Eng Units OFF
  EOC Act  NONE
  Cyc Src  SYNC
  SetPt R  77.8%/s↓
```

The Configuration menu choices are:

- **Eng Units**—engineering units
- **EOC Act**—end-of-count action
- **Cyc Src**—cycle counter source
- **SetPt R**—setpoint ramp rate
- **Span R**—span ramp rate
- **Hyd Config**—hydraulic configuration
- **Intlk Config**—interlock configuration
- **P/V Sens**—peak/valley sensitivity level
- **Ampl Cntrl**—external amplitude control
- **Enter Lvl**—enter a security level
- **Chng Pswd**—change password

Use the up or down arrow key to scroll through the choices.

---

### Eng Units

Access level: 1

Use this to turn the engineering units feature on or off. When on, all channels are displayed in the engineering units assigned to them. When off, all channels are displayed in volts (but setpoint and span are displayed in%). Choices are ON or OFF.

## Configuration menu (continued)

---

### EOC Act

Access level: 1

Use this to define the action to be taken when an end of count (EOC) condition occurs. Choices are:

- NONE—no action.
  - PGM STOP—stops the program.
  - INTLK—trips the interlock.
- 

### Cyc Src

Access level: 2

Use this to define the cycle counter source. Choices are:

- OFF—no source.
- SYNC—use the external signal from the Sync In input (TTL signal). The internal counter is incremented by 1 every full cycle of Sync In input. The Sync In input must be a square wave with a minimum pulse width of 5 ms.
- PROGRAM—use the program source (zero crossings of the signal).

When the cycle counter is set to PROGRAM, the Sync Out signal is related to zero crossings of the program signal (square, sine, triangle or external). For the internal program signals, this is a 50% duty cycle square wave.

---

### SetPt R

Access level: 2

Use either the keypad or the adjustment knob to adjust the setpoint ramp rate in %/s.

The setpoint ramp rate controls the rate at which the setpoint can change. When you use the keyboard or knob to enter a new setpoint value, this setpoint ramp rate determines how quickly the setpoint reaches the new value. For example, a ramp rate of 10%/s takes 5 seconds to go from 0% to 50%.

---

**NOTE** Use a low setpoint rate ( $\approx 10\%/s$ ) for applications that are sensitive to jumps in the command signal.

---

## Configuration menu (continued)

### Span R

Access level: 2

Use either the keypad or the adjustment knob to adjust the span ramp rate in %/s.

The span ramp rate controls the rate at which the span can change. Span changes occur when the Program Run or Program Stop buttons are pressed, or when you enter a new span value. This span ramp rate determines how quickly the span reaches the new value. For example, a ramp rate of 10%/s takes 5 seconds to go from 0% to 50%.

---

**NOTE** Use a low span rate ( $\approx 10\%/s$ ) for applications that are sensitive to jumps in the command signal.

---

### Hyd Config

Access level: 2  
Inhibit: hyd on

Defines the hydraulic configuration. Choices are:

- HSM—Hydraulic Service Mamifold control (no HPS)
- HPS—Hydraulic Power Supply control (no HSM)
- HPSHSM—both HPS and HSM control.
- NONE

The Hyd Config mode determines the interaction between the Hydraulic Pressure keys on the front panel (High, Low, or Off) and the HPS and HSM, in either a single-Controller or multiple Controller configuration. In a multiple 407 configuration, hydraulic connections are daisy-chained from one 407 Controller to another, using the Hyd In and Hyd Out connectors.

### HSM

The front panel Hydraulic Pressure keys set the HSM and Hyd Out outputs to the state indicated (High, Low, or Off). Changes in the hydraulic state, including off to low, happen immediately.

The local HPS controller is disabled. All HPS contacts remain inactive and the HPS on signal is ignored.

Single 407 Controller set to HSM		
Front Panel LED	HPS State	HSM State
Off	off	off
Low	off	low
High	off	high

## Configuration menu (continued)

### Hyd Config (continued)

Access level: 2  
Inhibit: hyd on

#### HPS

The front panel Hydraulic Pressure keys set Hyd Out outputs to the state indicated (High, Low, or Off). The HSM remains inactive.

The local HPS controller monitors the HydIn signal (logical OR of all units) and is set to the highest state indicated by these lines. In going from off to low there is a 10-second delay while the HPS start contact is energized. If the HPS is turned off remotely, it uses the "HPS on" signal to inform the 407 Controller that it is off. This signal causes the 407 to turn off its HPS control signals and turn off the local HSM. *Loss of the HPS on signal only changes the state of the unit connected to the HPS. All other units remain in the same state and should be turned off manually.*

Single 407 Controller set to HPS		
Front Panel LED	HPS State	HSM State
Off	off	off
Low	low	off
High	high	off

#### HPSHSM

In the HPS-HSM mode, the front panel Hydraulic Pressure keys set the local HSM to the level indicated (High, Low, or Off). They also set the HydOut outputs (HSM demand). If the HPS is not already on, the HSM off to low is delayed 10 seconds to allow the HPS to start.

The local HPS controller monitors the HydIn signal (the logical OR of all units). When an HSM demand is detected (low or high) it activates the start contact for 10 seconds and then cycles to a high pressure. When the HSM demand signal goes inactive, the HPS is turned off. If the HPS is turned off remotely, it uses the "HPS on" signal to inform the 407 Controller that it is off. This signal causes the 407 to turn off its HPS control signals and turn off the local HSM. *Loss of the HPS on signal only changes the state of the unit connected to the HPS. All other units remain in the same state and should be turned off manually.*

Single 407 Controller set to HPS-HSM		
Front Panel LED	HPS State	HSM State
Off	off	off
Low	high	low
High	high	high

#### NONE

The front panel Hydraulic Pressure keys and LED indicators are disabled, along with the HSM and HPS controllers. The HydIn input is used for the enable/disable features of the servocontroller (i.e. shunt cal is disabled when hydraulics are low or high, and the 407 controller integrator is enabled when hydraulics are high).



## Configuration menu (continued)

---

### Intlk Config

Access level: 2  
Inhibit: hyd on

Designates the 407 as either an interlock master or slave. Choices are:

- MASTER—the first unit in an interlock chain. There is no connection to IntlkIn.
  - SLAVE—Other than the first unit in an interlock chain. A cable must be plugged into Intlk In.
- 

### P/V Sens

Access level: 1

Defines the voltage level change that is required to count as a peak or valley (P/V). Choices are:

- 50 mV
  - 100 mV
  - 250 mV
  - 500 mV
  - 1.0 V
  - 2.0 V
- 

### Ampl Cntrl

Access level: 2  
Inhibit: hyd on

Makes the necessary setup changes for external amplitude control, using the Program In and Program Out signals. Choices are:

- NONE—The program signal selected in the controller (before span and setpoint are applied) becomes the Program Out signal.
- EXTERN—The Program In signal, scaled to one-fifth, becomes the Controller command signal. The internal function generator signal, scaled by span and setpoint, becomes the Program Out signal.

## Configuration menu (continued)

---

### Enter Lvl

Access level: 1

Provides the means to change the access security level and displays the existing security level. Choices are:

- LVL 1—user can access only Level 1 menu items.
- LVL 2—user can access Level 1 and Level 2 menu items.
- LVL 3—user can access all menu items.

Press Enter to begin changing the security level, then follow the prompts to set the desired level. When you attempt to access a higher security level, you are asked for the password for that level. The default passwords are "2" for level 2 and "3" for level 3. It is suggested that you change these default passwords to establish controller security.

---

### Chng Pswd

Access level: 1

Allows you to change the access level password. The password is a number of one or more digits. You must already know the existing password for a level in order to change it.

No password is required for level 1. The default passwords are "2" for level 2 and "3" for level 3. It is suggested that you change these default passwords to establish controller security.

Press Enter to begin changing the password, then follow these prompts:

- You are asked to enter the old (existing) password. Type the numeric password and press Enter.
- You are asked to enter the new password. Type a new password and press Enter.
- You are asked to verify password. Again, type the new password and press Enter.

---

#### **NOTE**

Be sure you remember or make a note of your passwords. If you forget a password, the BRAM must be reset. Resetting the BRAM erases all saved parameters.

If you forget a password, consult MTS for help.

---

## Function Generator menu

Use the Function Generator menu to select parameters for the internal function generator.

```
Configuration
→Function Generator
Controller
Intlk status ↓
```

Press the Enter key to display the Function Generator menu:

```
→Wvform    SQUARE
Freq       0.000Hz
Setpnt     -0.002%
Span       0.000% ↓
```

The Function Generator menu choices are:

- **Wvform**—Selects a wave shape.
- **Freq**—Adjusts the function generator frequency.
- **Setpnt**—Adjusts the mean level (setpoint) of the waveform.
- **Span**—Adjusts the amplitude (span) of the waveform.
- **Preset**—Adjusts the maximum cycle count.

Use the up or down arrow key to scroll through the choices.

---

### Wvform

Access level: 1  
Inhibit: program running

Selects the function generator waveform. Choices are:

- **SQUARE**—square waveform, useful for tuning.
- **TRIANG**—triangular waveform.
- **SINE**—sine waveform.
- **EXTRNL**—external program.

---

### Freq

Access level: 1

Adjusts the function generator frequency. Use either the keypad or the adjustment knob to adjust this value.

---

### Setpnt

Access level: 1

Adjusts the mean level (setpoint) of the function generator waveform. Use either the keypad or the adjustment knob to adjust this value.

## Function Generator menu (continued)

---

### Span

Access level: 1

Adjusts the amplitude (Span) of the function generator waveform. Use either the keypad or the adjustment knob to adjust this value.

---

### Preset

Access level: 1

Adjusts the maximum function generator cycle count. Use either the keypad or the adjustment knob to adjust the preset. The action defined by the EOC Act menu will be executed when this count is reached.

## Controller menu

Use the Controller menu to select PIDF control parameters for closed-loop control.

```
Configuration
Function Generator
→Controller
Intlk status ↓
```

Press the Enter key to display the Controller menu:

```
→FdBack AC1 COND
P Gain 0.00V/V
I Gain 0.00rps
D Gain 0.00ms ↓
```

The Controller menu choices are:

- **FdBack**—Selects a feedback signal for control.
- **P Gain**—Adjusts the proportional gain.
- **I Gain**—Adjusts the integral gain.
- **D Gain**—Adjusts the derivative gain.
- **D Src**—Selects the input to the differentiator.
- **F Gain**—Adjusts the feedforward gain.
- **dP Cond**—Selects the input to the delta P gain.
- **dP Gain**—Adjusts the delta P gain.

Use the up or down arrow key to scroll through the choices.

---

### FdBack

Access level: 2  
Inhibit: hyd on

Selects a conditioner to provide the feedback signal for the control loop.  
Choices are:

- Conditioner 1 (AC1 COND or DC1 COND)
- Conditioner 2 (AC2 COND or DC2 COND)
- Conditioner 3 (AC3 COND or DC3 COND)

---

### P Gain

Access level: 2

Adjusts the Proportional Gain. Use either the keypad or the adjustment knob to adjust this value, in volts per volt (V/V).

## Controller menu (continued)

---

### I Gain

Access level: 2

Adjusts the Integral Gain (reset). Use either the keypad or the adjustment knob to adjust this value, in repetitions per second (rps).

The integrator is enabled only when hydraulic pressure is set to High.

---

### D Gain

Access level: 2

Adjusts the Derivative Gain (rate). Use either the keypad or the adjustment knob to adjust this value, in ms.

---

### D Src

Access level: 2

Differentiator Source. Selects the input to the differentiator. Choices are:

- Error
  - Feedback
- 

### F Gain

Access level: 2

Adjusts the Feedforward Gain. Use either the keypad or the adjustment knob to adjust this value, in ms.

---

### dP Cond

Access level: 2  
Inhibit: hyd on

Selects a conditioner to provide input to the differential pressure (delta P) Gain circuit. Choices are:

- Conditioner 1 (AC1 COND or DC1 COND)
  - Conditioner 2 (AC2 COND or DC2 COND)
  - Conditioner 3 (AC3 COND or DC3 COND)
  - NONE
- 

### dP Gain

Access level: 2

Adjusts the delta P gain. Use either the keypad or the adjustment knob to adjust delta P gain, in V/V.

---

## Intlk Status menu

Use the Intlk Status menu to check or change the status of various interlocks.

```

Configuration
Function Generator
Controller
→Intlk status ↓
    
```

Press the Enter key to display the Intlk Status menu:

```

→ESTOP    ENABLED
EOC        DISABLED
Error      ENABLED
AC1 Up     ENABLED ↓
    
```

The Intlk Status menu choices are:

- **ESTOP**—Emergency stop
- **EOC**—End-of-count
- **Error**—Error
- **ACx Up or DCx Up**—Conditioner x upper limit (x = 1, 2, or 3)
- **ACx Lo or DCx Lo**—Conditioner x lower limit (x = 1, 2, or 3)
- **HPS1**—Typically, low hydraulic fluid level
- **HPS2**—Typically, overtemperature hydraulic fluid
- **UpkPeak**—Underpeak peak
- **UpkVly**—Underpeak valley
- **Extern**—External interlock (from another 407 Controller)
- **DigIn**—User digital input

Use the up or down arrow key to scroll through the choices.

For most items in this menu, pressing Enter toggles between Enabled and Disabled. Depending upon the interlock condition, the screen shows one of the following messages:

	Message	
	If the interlock has not occurred:	If the interlock has occurred:
While the interlock is <i>enabled</i>	ENABLED	TRIPPED
While the interlock is <i>disabled</i>	DISABLED	WARNING

## Intlk Status menu (continued)

---

### ESTOP

Access level: 1

Shows the status of the Emergency Stop interlock. The Emergency Stop interlock cannot be disabled.

---

### EOC

Access level: 1

Shows the state of the EOC (end of count) interlock. The action defined by the EOC Act (described earlier in the Configuration menu) automatically enables or disables EOC.

---

**NOTE** You cannot manually enable or disable the EOC interlock from this menu item.

---

You can reset an end-of-count (EOC) interlock in one of the following ways:

- Press the DVM/Menu key. Select the cycle count line (Cyc Cnt) and press the Alt Func key, then the Reset key. This sets the cycle count to zero and clears the EOC interlock.

To prevent inadvertent resetting of the cycle count, be sure to move the line selector away from the Cyc Cnt line before leaving this menu.

#### CAUTION

**Do not reset interlocks while the selected line is Cyc Cnt, unless you wish to reset the cycle count to zero.**

**While the selected line is Cyc Cnt, pressing Alt Func-Reset resets the cycle count to zero. The previous cycle count value is lost.**

If you do not wish to reset the cycle count to zero, move the line selector away from the Cyc Cnt line before using Alt Func-Reset.

---

- Select Preset in the Function Generator menu. Set the preset to a number larger than the present cycle count, and press the Alt Func key, then the Reset key. This is useful when stopping at intervals for service inspection.



## Intlk Status menu (continued)

---

### Error

Access level: 1

Enables/disables the error interlock and displays its status.

---

### ACx Up DCx Up

Access level: 1

Enables/disables the Conditioner x upper limit interlock and displays its status, where x represents a slot number (1, 2, or 3) in the 407 Controller chassis.

This item refers to a 407.12 DC Conditioner or 407.14 AC Conditioner installed in a specified slot. For example, DC2 Up refers to a 407.12 DC Conditioner in slot 2. If no conditioner is installed for a slot, no interlock reference appears for that slot.

---

### ACx Lo DCx Lo

Access level: 1

Enables/disables the Conditioner x lower limit interlock and displays its status, where x represents a slot number (1, 2, or 3) in the 407 Controller chassis.

This item refers to a 407.12 DC Conditioner or 407.14 AC Conditioner installed in a specified slot. For example, DC2 Lo refers to a 407.12 DC Conditioner in slot 2. If no conditioner is installed for a slot, no interlock reference appears for that slot.

---

### HPS1

Access level: 1

Enables/disables the HPS1 interlock (typically low hydraulic fluid level in the HPS reservoir) and displays its status. When the status is Disabled, an HPS1 interlock condition nevertheless prevents the HPS from being restarted after it has been turned off. The low level interlock condition must then be corrected before the HPS can start.

## Intlk Status menu (continued)

---

### **HPS2**

Access level: 1

Enables/disables the HPS2 interlock (typically over-temperature hydraulic fluid) and displays its status. When the status is Disabled, an HPS2 interlock condition nevertheless prevents the HPS from being restarted after it has been turned off. The overtemp interlock condition must then be corrected before the HPS can start.

---

### **UpkPeak**

Access level: 1

Underpeak Peak. Enables/disables the upper underpeak level (minimum peak) interlock and displays its status.

---

### **UpkVly**

Access level: 1

Underpeak Valley. Enables/disables the lower underpeak level (maximum valley) interlock and displays its status.

---

### **Extern**

Access level: 1

External interlock input. Enables/disables an external interlock from another 407 Controller and displays its status.

---

### **DigIn**

Access level: 1

User digital input. Enables/disable the user digital input interlock and displays its status.

Two user digital inputs (Din1 and Din2) are available on the 407 Controller rear panel. These can be used for special inputs, such as proximity switches or optical sensors. For more information, refer to "User Digital I/O" in the Installation chapter of this manual.

## Monitor Select menu

Use the Monitor Select menu to select the signals that are routed to the front panel BNC connectors.

```
Function Generator↑  
Controller  
Intlk status  
→Monitor Select ↓
```

Press the Enter key to display the Monitor Select menu:

```
→Mon1      AC1 COND  
Mon2       AC1 COND
```

---

### Mon1

Access level: 1

Defines the signal that is routed to the Monitor 1 connector on the front panel. Choices are:

- ACx COND or DCx COND—feedback signal from conditioner in slot x (1, 2, or 3) in the 407 Controller chassis.
- CMD—command signal
- ERROR—error signal
- VLV CMD—valve command signal
- VLV MON—valve monitor signal selected in valve driver menu (2-Stage Valv Drv or 3-Stage Valv Drv )

---

### Mon2

Access level: 1

Defines the signal that is routed to the Monitor 2 connector on the front panel. Choices are:

- ACx COND or DCx COND—feedback signal from conditioner in slot x (1, 2, or 3) in the 407 Controller chassis.
- CMD—command signal
- ERROR—error signal
- VLV CMD—valve command signal
- VLV MON—valve monitor signal selected in valve driver menu (2-Stage Valv Drv or 3-Stage Valv Drv )

## Limit Settings menu

Use the Limit Settings menu to define the various limit settings.

Controller	↑
Intlk status	
Monitor Select	
→Limit Settings	↓

Press the Enter key to display the Limit Settings menu:

→AC1 Up	0.000V	↑
AC1 Lo	0.000V	
DC2 Up	0.000V	
DC2 Lo	0.000V	↓

Choices are:

- **ACx Up or DCx Up**—Conditioner x upper limit (x = 1, 2, or 3)
- **ACx Up or DCx Lo**—Conditioner x lower limit (x = 1, 2, or 3)
- **ErrLim**—Error limit
- **UPk Sig**—Selects the conditioned signal for underpeak detection
- **Min Pk**—Defines the minimum value that can be detected as a peak
- **Max Val**—Defines the maximum value that can be detected as a valley

---

### ACx Up DCx Up

Access level: 1

Defines the upper limit for conditioner 1, 2 or 3. Use either the keypad or the adjustment knob to adjust this value.

---

### ACx Lo DCx Lo

Access level: 1

Defines the lower limit for conditioner 1, 2, or 3. Use either the keypad or the adjustment knob to adjust this value.

---

### ErrLim

Access level: 1

Defines the error limit. Use either the keypad or the adjustment knob to adjust this value.

## Limit Settings menu (continued)

---

### UPk Sig

Access level: 1  
Inhibit: hyd on

Selects the conditioned signal for underpeak detection. Choices are:

- AC1 COND or DC1 COND
- AC2 COND or DC2 COND
- AC3 COND or DC3 COND
- NONE

---

**NOTE** The signal selected for Upk Sig will be displayed on the second channel of the DVM (on the DVM menu). No other signal can be selected for that channel. If you wish to use the second channel of the DVM for another signal, you must select NONE for UPk Sig

---

---

### Min Pk

Access level: 1

Defines the minimum value that can be detected as a peak. A peak less than this value trips the minimum peak interlock (UpkPeak). Use either the keypad or the adjustment knob to adjust this value.

Refer to Appendix B of this manual (Understanding Control Principles) for more information on peak-valley detection.

---

### Max Val

Access level: 1

Defines the maximum value that can be detected as a valley. A valley greater than this value trips the maximum valley interlock (UpkVly). Use either the keypad or the adjustment knob to adjust this value.

Refer to Appendix B of this manual (Understanding Control Principles) for more information on peak-valley detection.

## Digital I/O menu

Use the Digital I/O menu to define actions the 407 Controller will take according to the states of digital inputs, the events that will activate digital outputs, and the polarities of both inputs and outputs.

Intlk status	↑
Monitor Select	
Limit Settings	
→Digital I/O	↓

Press the Enter key to display the Digital I/O menu:

→Din1	NONE
Din1Pol	ACT HI
Din2	NONE
Din2Pol	ACT HI ↓

The Digital I/O menu choices are:

- **Din1**—defines action for digital input 1 active.
- **Din1Pol**—defines the polarity for digital input 1.
- **Din2**—defines action for digital input 2 active.
- **Din2Pol**—defines the polarity for digital input 2.
- **Dout1**—defines an event to activate digital output 1.
- **Dout1Pol**—defines the polarity for digital output 1.
- **Dout2**—defines an event to activate digital output 2.
- **Dout2Pol**—defines the polarity for digital output 2.

Use the up or down arrow key to scroll through the choices.

### Background

Two user digital inputs (Din1 and Din2) and two digital outputs (Dout1 and Dout2) are available on the 407 Controller rear panel. These can be used for special inputs, such as proximity switches or optical sensors, or special outputs, such as indicator lights or warning horns. For more information, refer to "User Digital I/O" in the Installation chapter of this manual.

---

### Din1

Access level: 2

Defines the action the Controller takes when digital input 1 is asserted (active). Choices are:

- NONE—no action.
- INTLK—interlock activated. (The status of this interlock can be checked using the Interlock Status menu.)
- RUN/STOP—the program is started or, if running, the program is stopped.
- HYD OFF—hydraulic pressure is turned off.
- PGM INHB—the program is stopped and cannot be started.

## Digital I/O menu (continued)

---

### Din1Pol

Access level: 2

Sets the polarity of digital input 1 by defining its active state. Choices are:

- ACT LOW—active low
  - ACT HI—active high
- 

### Din2

Access level: 2

Defines the action the Controller takes when digital input 2 is asserted (active). Choices are:

- NONE—no action.
  - INTLK—interlock activated. (The status of this interlock can be checked using the Interlock Status menu. )
  - RUN/STOP—the program is started or, if running, the program is stopped.
  - HYD OFF—hydraulic pressure is turned off.
  - PGM INHB—the program is stopped.
- 

### Din2Pol

Access level: 2

Sets the polarity of digital input 2 by defining its active state. Choices are:

- ACT LOW—active low
  - ACT HI—active high
- 

### Dout1

Access level: 2

Defines an event to activate digital output 1. Choices are:

- NONE—no event.
- INTLK—any interlock interrupt.
- RUN/STOP—the program is started or stopped. (This can be caused by the Run/Stop keys or by a digital input. )
- HYD OFF—hydraulic pressure is turned off. (This can be caused by the Hydraulic Pressure Off key or by a digital input.)
- HYD LO—the Hydraulic Pressure Low key is pressed.
- HYD HI—the Hydraulic Pressure High key is pressed.
- EOC—the end-of-cycle count reaches a preset value.

## Digital I/O menu (continued)

---

### Dout1Pol

Access level: 2

Defines the polarity of digital output 1 when activated. Choices are:

- ACT LOW—active low (relay open)
  - ACT HI—active high (relay closed)
- 

### Dout2

Access level: 2

Defines an event to activate digital output 2. Choices are:

- NONE—no event.
  - INTLK—any interlock interrupt.
  - RUN/STOP—the program is started or stopped. (This can be caused by the Run/Stop keys or by a digital input.)
  - HYD OFF—hydraulic pressure is turned off. (This can be caused by the Hydraulic Pressure Off key or by a digital input.)
  - HYD LO—the Hydraulic Pressure Low key is pressed.
  - HYD HI—the Hydraulic Pressure High key is pressed.
  - EOC—the end-of-cycle count reaches a preset value.
- 

### Dout2Pol

Access level: 2

Defines the polarity of digital output 2 when activated. Choices are:

- ACT LOW—active low (relay open)
- ACT HI—active high (relay closed)



## ACx or DCx Conditioner menus

Use the ACx Conditioner menu to select parameters for the 407.14 AC Conditioner installed in slot x of the 407 Controller (where x= 1, 2, or 3).

Use the DCx Conditioner menu to select parameters for the 407.12 DC Conditioner installed in slot x of the 407 Controller (where x= 1, 2, or 3).

Monitor Select	↑
Limit Settings	
Digital I/O	
→AC1 Conditioner	↓

Limit Settings	↑
Digital I/O	
AC1 Conditioner	
→DC2 Conditioner	↓

Press the Enter key to display the ACx or DCx Conditioner menu:

→AC1 COND	Setup1
Units	V
F.S. Val	0.000
Gain	0.000V/V↓

→DC2 COND	Setup1
Units	V
F.S. Val	0.000
Gain	0.000V/V↓

The ACx or DCx Conditioner menu choices are:

- **ACx COND Setup or DC COND Setup**—selects a conditioner setup (a stored set of parameters).
- **Units**—defines the engineering units for display.
- **F.S. Val**—defines the conditioner full scale value.
- **Gain**—adjusts the conditioner gain.
- **Delta K**—adjusts the delta K compensation.
- **C Zero**—adjusts the coarse zero.
- **F Zero**—adjusts the fine zero.
- **Excit**—adjusts the amplitude of the conditioner excitation output.
- **Phase**—(ac conditioner only) adjusts the phase (in degrees) of the ac conditioner demodulator.
- **Polarity**—selects the feedback polarity.
- **Monitor**—selects the monitor signal.

Use the up or down arrow key to scroll through the choices.

## ACx or DCx Conditioner menus (continued)

---

### ACx COND Setup DCx COND Setup

Access level: 2  
Inhibit: hyd on

Selects a conditioner setup (a stored set of parameters). Pressing Enter allows you to switch from one of the two setups (Setup1, Setup2) to the other. You are offered a choice of saving or discarding the existing data for the selected setup:

```
→Save cal and control  
loop settings?  
F1 = Save  
F2 = Discard
```

Press Alt Func, then F1 to save the latest setup data.  
Press Alt Func, then F2 to discard the latest setup data (and revert to the previous setup data).

#### CAUTION

**Saving a setup overwrites prior data in that setup.**

**If you change controller or conditioner parameters before saving a setup, the changes you make will be saved, overwriting any prior data for the same setup. If you run a test, then change some settings before saving, the settings for the test run will be lost when the setup is saved.**

Before switching setups, make certain that all settings, including the control gains, are those that you wish to save.

---

#### CAUTION

**Changes made to one setup do not affect the other setup.**

**Data from one setup is NOT copied to the other setup.**

After switching setups, make certain that all settings in the active setup are correct for your application.

---

## ACx or DCx Conditioner menus (continued)

### ACx COND Setup DCx COND Setup (continued)

The setup data saved includes values for both conditioner and PIDF controller parameters. The following table lists these parameters and shows the default values for each. These default values are valid for both setups when the BRAM of a new 407 Controller is initialized.

Parameter	Definition	Default Value
Units	engineering units for display	V
F.S. Val	conditioner full scale value	10
Gain	conditioner gain	1.0
Delta K	delta K compensation	1.0
C Zero	coarse zero offset	0.0
F Zero	fine zero offset	0.0
Excit	excitation output amplitude	0.0
Phase	(ac conditioner only) phase of the ac conditioner demodulator	0.0
Polarity	feedback polarity	NORMAL
P Gain	controller proportional gain	1.0
I Gain	controller integral gain	0.0
D Gain	controller derivative gain	0.0
D Src	source of input to the differentiator	ERROR
F Gain	feedforward gain	0.0
dP Cond	conditioner input to the delta P gain	NONE
dP Gain	delta P gain	0.0

#### Example

The following example shows how changing setups (or using the Save key) affects the displayed and stored values. Values shown are for one parameter, such as gain.

After you:	The displayed and stored values are:		
	Display	Saved in Setup1	Saved in Setup2
power-up new 407 Controller	1.0	1.0	1.0
change setting	500.0	1.0	1.0
press Alt-Save while Setup1 is displayed	500.0	500.0	1.0
switch from Setup1 to Setup2	1.0	500.0	1.0

## ACx or DCx Conditioner menus (continued)

---

### Units

Access level: 2

Defines the conditioner engineering units to be displayed. Choices are:

- V—volts
- lb—pounds force
- kip—thousand pounds force
- MT—metric tons
- kg—kilograms
- N—Newtons
- kN—kiloNewtons
- ue—microstrain units ( $\mu\epsilon$ )
- in—inches
- mm—millimeters
- cm—centimeters
- m—meters
- m/s—meters per second
- G—gravitational accelerations
- ilb—inch-pounds torque
- N-m—Newton-meters
- kgm—kilogram-meters (torque)
- deg—degrees of arc
- rad—radians
- %—percent
- F—degrees Fahrenheit
- C—degrees Celsius
- Pa—Pascals
- bar—bar (pressure)
- psi—psi (pressure)
- EU—undefined engineering units

---

### F.S. Val

Access level: 2

Defines the conditioner full scale value. Use either the keypad or the adjustment knob to adjust this value. If engineering units are turned on, this value is displayed when the conditioner output is at 10.0 V.

## ACx or DCx Conditioner menus (continued)

---

### Gain

Access level: 3

Adjusts the conditioner gain to match the associated transducer. Use either the keypad or the adjustment knob to adjust this value.

---

**NOTE**

The actuator may exhibit a slight bump as the gain adjustment passes through the values 10, 80, or 640. This unavoidable effect is caused by near-simultaneous changes in two internal values.

---

---

### Delta K

Access level: 3

Delta K is a gain used to compensate for non-symmetrical transducer outputs by affecting the positive transducer output. For positive inputs, the conditioned signal is multiplied by the delta K gain. The delta K default value is 1.0.

---

### C Zero

Access level: 2

Provides coarse adjustment of the conditioner zero offset. Use either the keypad or the adjustment knob to adjust this value.

---

**NOTE**

The final effect of the coarse zero setting on the output depends upon the conditioner gain. This is because coarse zero is applied to the signal before the signal is amplified by the gain.

---

---

### F Zero

Access level: 2

Provides fine adjustment of the conditioner zero offset. Use either the keypad or the adjustment knob to adjust this value.

---

### Excit

Access level: 3

Adjusts amplitude of the conditioner excitation output. Use either the keypad or the adjustment knob to adjust this value.

---

**Phase**

Access level: 3

**For the ac conditioner only.** Adjusts the phase of the ac conditioner demodulator. Use either the keypad or the adjustment knob to adjust this value, in degrees.

---

**Polarity**Access level: 3  
Inhibit: hyd on

Selects the conditioner feedback polarity. Choices are NORMAL or INVERTED.

---

**Monitor**

Access level: 2

Selects the monitor signal on the conditioner rear panel BNC connector. Choices are:

- GND—ground
- FDBK—feedback
- DEMOD—demodulator (ac conditioner only)
- PREAMP—pre-amp (dc conditioner only)
- C ZERO—coarse zero value
- F ZERO—fine zero value
- +EXCIT—plus excitation output
- -EXCIT— minus excitation output
- 5.00 V—on-board reference

## DCx Shunt Cal Chk

Access level: 1  
Inhibit: hyd on

Use this function to perform a shunt cal check.

```
Digital I/O      ↑
AC1 Conditioner
DC2 Conditioner
→DC2 Shunt Cal Chk ↓
```

Pressing Enter displays the following lines:

```
DC2 Shunt F1=+FB
F2=-FB, F3=RELEASE
Pre-Shunt 0.000V
Delta 0.000V
```

Press F1 to activate +FB shunt.

Press F2 to activate -FB shunt.

Press F3 to deactivate a shunt and release the channel.

---

**NOTE** The shunt cannot be activated while hydraulic pressure is on.

---

The at sign (@) appears on the screen to indicate that a shunt is active. It remains visible until you release the channel by pressing F3:

```
DC2 Shunt F1=+FB @
F2=-FB, F3=RELEASE
Pre-Shunt 0.000V
Delta 0.000V
```

The displayed values are:

- Pre-Shunt—This shows the output (in volts) from the conditioner before the shunt is activated (i.e., the operating point where shunt is applied).
- Delta—This shows the difference (in volts) between the conditioner output (at the instant F1 or F2 is pressed) and the pre-shunt value.

***Background***

Shunt calibration sets up the conditioner to apply a resistor (the shunt calibration resistor) across one leg of a transducer bridge on the DC Conditioner circuit board. For more information on hardware changes, refer to "Shunt Calibration" in the 407.12 DC Conditioner chapter of this manual.



## 2-Stage Valv Drv menu

Use the 2-Stage Valv Drv menu to establish parameters for the 407.16 Valve Driver.

AC1 Conditioner	↑
DC2 Conditioner	
DC2 Shunt Cal Chk	
→2-Stage Valv Drv	

Press the Enter key to display the 2-Stage Valv Drv menu:

→Dither	0.000%	↑
Balance	0.00%	
Polarity	NORMAL	
Monitor	GND	

The 2-Stage Valv Drv menu choices are:

- **Dither**—adjusts the dither signal.
- **Balance**—adjusts the valve balance signal
- **Polarity**—selects the valve command polarity
- **Monitor**—selects the monitor signal.

---

### Dither

Access level: 2

Adjusts the amplitude of the dither signal. Use either the keypad or the adjustment knob to adjust this value.

---

### Balance

Access level: 2

Adjusts the valve balance signal. Use either the keypad or the adjustment knob to adjust this value.

Valve balance is used to compensate for any mechanical imbalance in the servovalve. Mechanical imbalance can cause the actuator to move even though the servovalve command is zero. The balance signal is a dc offset added to the servovalve command to compensate for mechanical imbalance.

For more information, refer to the 407.16 Valve Driver chapter of this manual.

## 2-Stage Valv Drv menu (continued)

---

### Polarity

Access level: 2  
Inhibit: hyd on

Selects the valve command polarity. Choices are:

- NORMAL
- INVERTED

---

### Monitor

Access level: 1

Selects the monitor signal on the valve driver rear panel BNC connector. Choices are:

- GND—valve ground
- CUR—current
- VLV CMD—valve command signal
- VLV BAL—valve balance
- DITHER—dither amplitude
- +10.00 V—on-board reference

## 3-Stage Valv Drv menu

Use the 3-Stage Valv Drv menu to establish parameters for the 407.15 Three-stage Valve Driver.

AC1 Conditioner	↑
DC2 Conditioner	
DC2 Shunt Cal Chk	
→3-Stage Valv Drv	

Press the Enter key to display the 3-Stage Valv Drv menu:

→Dither	0.000%	↑
Balance	0.00%	
Vlv Pol	NORMAL	
Monitor	GND	

The 3-Stage Valv Drv menu choices are:

- **Gain**—adjusts the conditioner gain.
- **C Zero**—adjusts the conditioner coarse zero.
- **F Zero**—adjusts the conditioner fine zero.
- **Excit**—adjusts the amplitude of the conditioner excitation output.
- **Phase**—adjusts the phase of the demodulator.
- **Fdbk Pol**—adjusts the conditioner feedback polarity.
- **P Gain**—adjusts the proportional gain.
- **D Gain**—adjusts the derivative gain.
- **Dither**—adjusts the dither amplitude.
- **Balance**—adjusts the valve balance signal.
- **Vlv Pol**—selects the valve command polarity.
- **Monitor**—selects the monitor signal.

---

### Gain

Access level: 3

Adjusts the conditioner gain to match the associated transducer. Use either the keypad or the adjustment knob to adjust this value.

---

### C Zero

Access level: 2

Provides coarse adjustment of the conditioner zero offset. Use either the keypad or the adjustment knob to adjust this value.

---

### F Zero

Access level: 2

Provides fine adjustment of the conditioner zero offset. Use either the keypad or the adjustment knob to adjust this value.

## 3-Stage Valv Drv menu (continued)

---

### Excit

Access level: 3

Adjusts amplitude of the conditioner excitation output. Use either the keypad or the adjustment knob to adjust this value.

---

### Phase

Access level: 3

Adjusts the phase of the ac conditioner demodulator. Use either the keypad or the adjustment knob to adjust this value, in degrees.

---

### Fdbk Pol

Access level: 3  
Inhibit: hyd on

Selects the conditioner feedback polarity. Choices are:

- NORMAL
  - INVERTED
- 

### P Gain

Access level: 3

Adjusts the Proportional Gain. Use either the keypad or the adjustment knob to adjust this value, in volts per volt (V/V).

---

### D Gain

Access level: 3

Adjusts the Derivative Gain. Use either the keypad or the adjustment knob to adjust this value, in ms.

---

### Dither

Access level: 2

Adjusts the amplitude of the dither signal. Use either the keypad or the adjustment knob to adjust this value.

## 3-Stage Valv Drv menu (continued)

---

### Balance

Access level: 2

Adjusts the valve balance signal. Use either the keypad or the adjustment knob to adjust this value.

Valve balance is used to compensate for any mechanical imbalance in the servovalve. Mechanical imbalance can cause the actuator to move even though the servovalve command is zero. The balance signal is a dc offset added to the servovalve command to compensate for mechanical imbalance.

For more information, refer to the 407.15 Three-stage Valve Driver chapter of this manual.

---

### Vlv Pol

Access level: 2  
Inhibit: hyd on

Selects the valve command polarity. Choices are:

- NORMAL
  - INVERTED
- 

### Monitor

Access level: 1

Selects the monitor signal on the Monitor 1 or Monitor 2 front panel BNC connector. Choices are:

- DEMOD—demodulator
- IL FDBK—inner loop feedback
- F ZERO—fine zero
- IL CMD—inner loop command
- IL ERR—inner loop error
- VLV BAL—valve balance
- VLV CUR—valve current
- GND—ground

## DVM menu

The internal DVM can be monitored at any time during Controller operation by pressing the DVM/Menu key. The DVM simultaneously allows you to monitor two different conditioner signals plus the preset and current cycle count.

→AC1 Cond	1.000	V
DC2 Cond	1.000	V
Cyc Cnt	0	
Preset	0	

Press the DVM/Menu key again (or the Home key) to leave the DVM menu. The top two lines of this menu provide the following choice of signals:

- ACx Cond—Conditioner x output
- ACx Cond Pk/Vly —Conditioner x peak/valley settings
- ACx Cond Max/Min—Conditioner x max/min limits
- DCx Cond—Conditioner x output
- DCx Cond Pk/Vly—Conditioner x peak/valley settings
- DCx Cond Max/Min—Conditioner x max/min limits
- Cmd—command
- Cmd Pk/Vly—command peak/valley settings
- Cmd Max/Min—command max/min limits
- Error
- Error Pk/Vly—error peak/valley settings
- Error Max/Min—error max/min limits
- Vlv Cmd—valve command
- Vlv Cmd Pk/Vly—valve command peak/valley settings
- Vlv Cmd Max/Min—valve command max/min limits
- Vlv Mon—valve monitor signal selected in valve driver menu (2-Stage Valv Drv or 3-Stage Valv Drv )
- Vlv Mon Pk/Vly—valve monitor peak/valley settings
- Vlv Mon Max/Min—valve monitor max/min limits

For the third and fourth lines, the DVM menu can select only two choices:

- Cyc Cnt—function generator cycle count.
- Preset—maximum function generator cycle count. The action defined by the EOC Act menu will be executed when this count is reached.

More details of using the DVM/Menu key are explained in the Operation chapter of this manual.

## Chapter 3 Operation

---

This chapter provides operating information about the 407 Controller. Definitions of terms, acronyms, or abbreviations used in this manual or on the Controller screen can be found in Appendix A. The following operating information is described in this chapter:

- using the internal DVM (digital voltmeter)
- saving setup information
- a typical operating sequence for setting up a test on the 407 Controller

Further operations involving specific 407 modules are described in later chapters of this manual. For example,

- Shunt calibration of a DC conditioner is described in the 407.12 DC Conditioner chapter of this manual.
- Tuning the three-stage valve drive inner loop is described in the 407.15 Three-stage Valve Driver chapter of this manual.

## Using the DVM (Digital Voltmeter)

The internal DVM can be monitored at any time during Controller operation by pressing the DVM/Menu key. The DVM simultaneously allows you to monitor two different conditioner signals plus the preset and current cycle count.

→AC1 Cond	1.000	V
DC2 Cond	1.000	V
Cyc Cnt	0	
Preset	0	

Press the DVM/Menu key again (or the Home key) to leave the DVM menu.

Each line of the display shows a signal that can be checked by the DVM. The bottom two lines show either Cyc Cnt or Preset. Move the cursor to the line and press Enter to select a signal.

The top two lines display a choice of signals. The choice depends upon which types of conditioners have been installed in positions 1 to 3 in the Controller chassis. The following typical list shows an ac conditioner in position 1, a dc conditioner in position 2, and nothing in position 3:

- AC1 Cond—Conditioner 1 output
- AC1 Cond Pk/Vly —Conditioner 1 peak/valley settings
- AC1 Cond Max/Min—Conditioner 1 max/min limits
- DC2 Cond—Conditioner 2 output
- DC2 Cond Pk/Vly—Conditioner 2 peak/valley settings
- DC2 Cond Max/Min—Conditioner 2 max/min limits
- Cmd—command
- Cmd Pk/Vly—command peak/valley settings
- Cmd Max/Min—command max/min limits
- Error
- Error Pk/Vly—error peak/valley settings
- Error Max/Min—error max/min limits
- Vlv Cmd—valve command
- Vlv Cmd Pk/Vly—valve command peak/valley settings
- Vlv Cmd Max/Min—valve command max/min limits
- Vlv Mon—valve monitor signal selected in valve driver menu (2-Stage Valv Drv or 3-Stage Valv Drv )
- Vlv Mon Pk/Vly—valve monitor peak/valley settings
- Vlv Mon Max/Min—valve monitor max/min limits

For the third and fourth lines, the DVM menu can select only two choices:

- Cyc Cnt—function generator cycle count.
- Preset—maximum function generator cycle count. The action defined by the EOC Act menu will be executed when this count is reached.



In some cases, the information assigned to a line does not fit on one line of the display. In that case, the information is carried over to the next line, while other lines are pushed down. For example:

→AC1	Cond	Pk/Vly	
	-15.000/	15.000	V
DC2	Cond	1.000	V
Cyc	Cnt		0

### CAUTION

Do not reset interlocks while the selected line is Cyc Cnt, unless you wish to reset the cycle count to zero.

While the selected line is Cyc Cnt, pressing Alt Func-Reset resets the cycle count to zero. The previous cycle count value is lost.

If you do not wish to reset the cycle count to zero, move the line selector away from the Cyc Cnt line before using Alt Func-Reset.

---

## Monitoring Adjustments

You can use the DVM with the adjustment knob. Pressing the DVM/Menu key does not disable the knob. The knob also remains enabled while you select a line or a signal within the DVM menu.

For example, you can take the following steps to adjust the setpoint to zero the dc error:

1. Press Alt Func and then Set Point to select the setpoint adjustment.
2. Enable the adjustment knob,
3. Press the DVM/Menu key and press Enter repeatedly until you select Error.
- 4.. Turn the adjustment knob until the error reads 0.0.

## Resetting Max/Min Limits

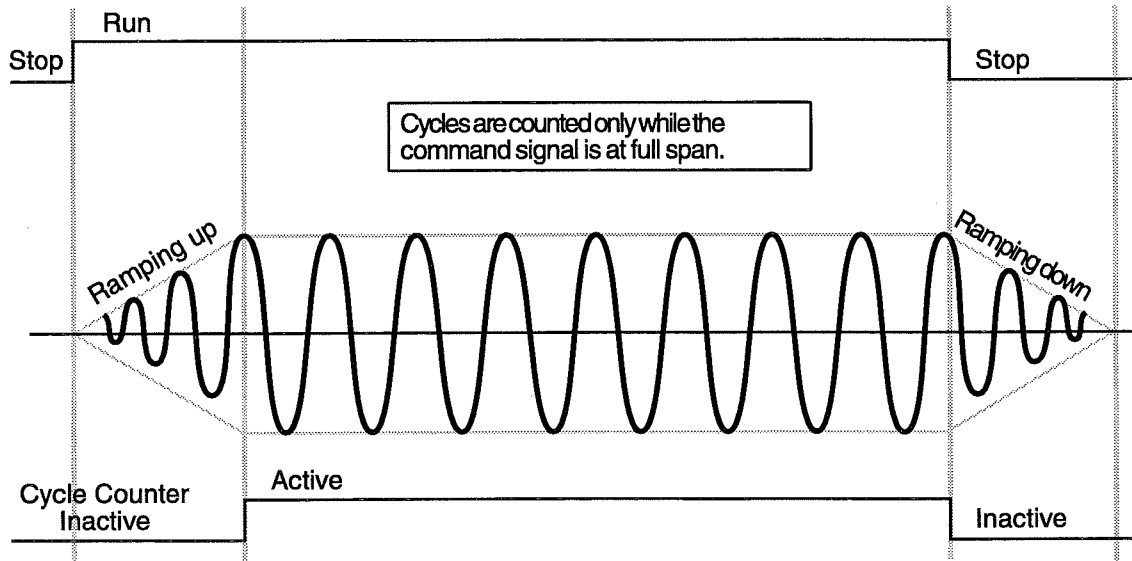
While any line showing max/min limits is selected, you can press Alt Func-Reset to reset the max/min values. This is useful for updating a limit after a span has changed, for example.

## Using the Cycle Counter

### Background

The cycle counter counts the cycles of a program signal from a selected source, up to a maximum of 9,999,999 cycles. Only cycles at full span are counted. While Span is ramping up or down, the cycle counter is disabled.

You can set a preset maximum count. When the cycle count reaches this preset, the EOC (end-of-count) interlock is tripped. The EOC interlock can trigger a pre-defined action.



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## Selecting the Cycle Source

Use *Cyc Src* (on the Configuration menu) to define the source of the cycle to be counted. Choices are:

- OFF—no source.
- SYNC—use the external signal from the Sync In input (TTL signal). The internal counter is incremented by 1 every full cycle of Sync In input. The Sync In input must be a square wave with a minimum pulse width of 5 ms.
- PROGRAM—use the program source (zero crossings of the signal.)

## Selecting the End-of-count (EOC) Action

Use *EOC Act* (on the Configuration menu) to define the action to be taken when an end-of-count (EOC) condition occurs. Choices are:

- NONE—no action.
- PGM STOP—stops the program.
- INTLK—trips the interlock.

## Setting a Preset Maximum Count

Use Preset (on the Function Generator menu) to set a value for the preset (maximum cycle count). The action defined by the EOC Act menu will be executed when this count is reached.

## Viewing the EOC Interlock

Use EOC (on the Intlk Status menu) to show the state of the EOC interlock. The action defined by the EOC Act (described earlier in the Configuration menu) automatically enables or disables EOC. Otherwise you can use the DVM to reset an end-of-count (EOC) interlock as described below.

## Viewing the Preset and Cycle Count

Use the DVM (press the DVM/Menu key) to view the preset or the cycle count.

### CAUTION

**Do not reset interlocks while the selected line is Cyc Cnt, unless you wish to reset the cycle count to zero.**

**While the selected line is Cyc Cnt, pressing Alt Func-Reset resets the cycle count to zero. The previous cycle count value is lost.**

If you do not wish to reset the cycle count to zero, move the line selector away from the Cyc Cnt line before using Alt Func-Reset.

---

## Resetting the EOC Interlock

You can reset an end-of-count (EOC) interlock in one of the following ways:

- Press the DVM/Menu key. Select the cycle count line (Cyc Cnt) and press the Alt Func key, then the Reset key. This sets the cycle count to zero and clears the EOC interlock.
- Select Preset in the Function Generator menu. Set the preset to a number larger than the present cycle count, and press the Alt Func key, then the Reset key. This is useful when stopping at intervals for service inspection. It does not set the cycle count to zero.

## Saving or Changing Setup Information

You can save setup data by using the Save key (Alt Func-Save) or by switching to another setup. Setup data includes values for both conditioner and PIDF controller parameters.

### CAUTION

Saving a setup overwrites prior data in that setup.

If you change controller or conditioner parameters before saving a setup, the changes you make will be saved, overwriting any prior data for the same setup. If you run a test, then change some settings before saving, the settings for the test run will be lost when the setup is saved.

Before switching setups, make certain that all settings, including the control gains, are those that you wish to save.

### CAUTION

Changes made to one setup do not affect the other setup.

Data from one setup is NOT copied to the other setup.

After switching setups, make certain that all settings in the active setup are correct for your application.

Save Setups This Way	NOT This Way
<p>A desirable sequence example would be:</p> <ul style="list-style-type: none"><li>• Calibrate (i.e., set up conditioner parameters).</li><li>• Tune the servo loop (i.e., set controller parameters).</li><li>• <i>Save the setup.</i></li><li>• Run the test.</li><li>• Switch setups.</li></ul>	<p>An undesirable sequence would be:</p> <ul style="list-style-type: none"><li>• Calibrate (i.e., set up conditioner parameters).</li><li>• Tune the servo loop (i.e., set controller parameters).</li><li>• Run the test.</li><li>• Readjust the controller or conditioner parameters. (Thus overwriting parameters used in the test).</li><li>• Switch setups.</li></ul>
Result: the test parameters are saved.	Result: the test parameters are lost.

## Saving or Changing Setup Information (continued)

The setup data saved includes values for both conditioner and PIDF controller parameters. The following table lists these parameters and shows the default values for each. These default values are valid for both setups when the BRAM of a new 407 Controller is initialized.

Parameter	Definition	Default Value
Units	engineering units for display	V
F.S. Val	conditioner full scale value	10
Gain	conditioner gain	1.0
Delta K	delta K compensation	1.0
C Zero	coarse zero offset	0.0
F Zero	fine zero offset	0.0
Excit	excitation output amplitude	0.0
Phase	(ac conditioner only) phase of the ac conditioner demodulator	0.0
Polarity	feedback polarity	NORMAL
P Gain	controller proportional gain	1.0
I Gain	controller integral gain	0.0
D Gain	controller derivative gain	0.0
D Src	source of input to the differentiator	ERROR
F Gain	feedforward gain	0.0
dP Cond	conditioner input to the delta P gain	NONE
dP Gain	delta P gain	0.0

## Valve and Feedback Polarity

### *Background*

The valve command signal and the conditioned feedback signal are compared to produce a dc error signal. The polarity and magnitude of the dc error signal causes the valve driver circuit to change the valve command signal, opening the servovalve spool in a direction and by an amount necessary to allow fluid to flow into the actuator and cause the desired actuator displacement. As the actuator approaches its commanded position, the error decreases. (For more information on control loops, see the appendix "Understanding Control Principles" in this manual.)

In some cases, the control system cannot work because the polarity of the valve command signal does not match that of the feedback signal. This causes the error to increase (instead of decreasing) until the control system "runs away," moves "hard over," or otherwise fails to exert control.

The solution is to change either the valve polarity or the feedback polarity.

In some cases, the control system is "in control" but you wish to change the reading of feedback polarity from an ac or dc conditioner. The solution is to change both the valve polarity and the feedback polarity.

### Two-stage Valve Polarity

Take the following steps to change the polarity of the two-stage valve:

1. Open the 2-Stage Valv Drv menu.
2. Select Polarity. Change the polarity by pressing Enter. (Hydraulics must be off to this function.)
3. Check the valve balance (Balance) and zero it if necessary.

### Three-stage Valve Polarity

For the three-stage valve driver, if the inner loop is "in control," you may wish to keep it in control while changing valve polarity. In that case, change both valve command and valve conditioner feedback polarity. Take the following steps:

1. Open the 3-Stage Valv Drv menu.
2. Select the valve polarity (Vlv Pol). Change the valve polarity by pressing Enter. (Hydraulics must be off to this function.)
3. Select the feedback polarity (Fdbk Pol). Change the feedback polarity by pressing Enter.
4. Check the valve balance (Balance) and zero it if necessary.

## Valve and Feedback Polarity (continued)

### Feedback Polarity

In some cases, you may wish to change the reading of feedback polarity from an ac or dc conditioner. Take the following steps:

1. Open the ACx Conditioner or DCx Conditioner menu.
2. Select Polarity. Change the feedback polarity by pressing Enter. (Hydraulics must be off to this function.)

If the system was "in control" before this change, or if it is now "hard over" after this change, you must also change the valve polarity.

#### CAUTION

**Changing feedback polarities can affect the calibration.**

**Because of interactions between coarse zero and fine zero settings, changing the feedback polarity can introduce an unexpected offset which affects previous calibrations.**

If you switch polarities, you must then recalibrate.

---

## Typical Operating Sequence

The following steps provide a typical stroke control operating sequence for systems using a 407 Controller.

1. **Turn on electrical power.**
2. **Configure the system.** Open the Configuration menu and set the following:
  - A. Set the engineering units feature (Eng Units) to OFF.
  - B. Set the end-of-count action (EOC Act) to INTLK.
  - C. Set the cycle source (Cyc Src) to PROGRAM or OFF.
  - D. Set the hydraulic configuration (Hyd Config) to HPSHSM.
  - E. Set the interlock configuration (Intlk Cnfg) to MASTER.

---

**NOTE** A stand-alone unit or the first unit in an interlock chain (no cable connected to Intlk In) is configured as MASTER. Other units must be configured as SLAVE.

---

3. **Set the servo loop controls to values that will ensure actuator stability.** These will be readjusted later in the procedure. Open the Controller menu and set the following:
  - A. Use FdBack to select the feedback conditioner for the required type of control (e.g., stroke).
  - B. Set the proportional gain (P Gain) to 1.0 V/V.
  - C. Set the integral gain (I Gain) to 0.0 rps.
  - D. Set the derivative gain (D Gain) to 0.0 ms.
  - E. Set the derivative source (D Src) to FDBK (feedback) or ERROR.
  - F. Set the feedforward gain (F Gain) to 0.0 ms.
  - G. Set the delta P conditioner (dP Cond) to NONE.
  - H. Set the delta P gain (dP Gain) to 0.0 V/V.



4. **Adjust the Upper and Lower Limit detectors.** Open the Limit settings menu. For each conditioner:
  - A. Set the upper limit. Use the parameter ACx Up or DCx Up (where x represents the chassis slot in which the conditioner is installed). Use the keypad to set a value, and press Enter.
  - B. Set the lower limit. Use the parameter ACx Lo or DCx Lo (where x represents the chassis slot in which the conditioner is installed). Use the keypad to set a value, and press Enter.
5. **Adjust the setpoint to zero dc error.** Press Alt Func and then Set Point to select the setpoint adjustment.
  - A. Enable the adjustment knob,
  - B. Press the DVM/Menu key and press Enter repeatedly until you select Error.
  - C. Turn the adjustment knob until the error reads 0.0.
6. **Clear interlocks.** Press Alt Func and then Reset to clear any active interlocks.

If required, calibrate the stroke actuator, using the LVDT calibration procedure described in Chapter 6 of this manual.

**⚠ WARNING**

The following procedure produces immediate and unexpected actuator movement.

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

Clear all personnel from the area before tuning the servo loop. Uncouple any equipment that can be damaged by extreme movements.

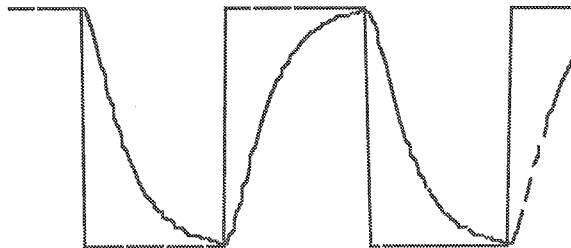
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**NOTE** If the actuator moves towards one end, increasing the error signal, the system may be phased wrong. Turn off the hydraulics, change the valve driver polarity and repeat Steps 5 and 6

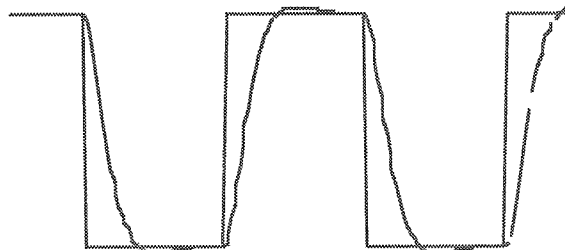
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7. **Install the specimen.**
  - A. Press the Hydraulic Pressure Low key to apply low hydraulic pressure to the test system.
  - B. Enable the adjustment knob and use it to adjust the setpoint, positioning the actuator for installing the specimen.

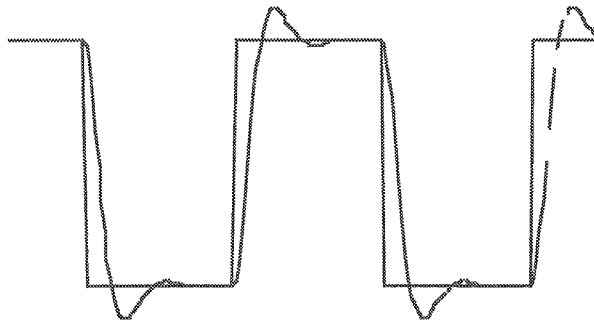
8. **Apply pressure.** Press Hydraulic Pressure High to apply full hydraulic pressure to the test system.
9. **Apply a low frequency, low amplitude square wave command to the test system.** In the Function Generator menu, set the following:
  - A. Set the waveform (Wvform) to SQUARE.
  - B. Set the frequency (Freq) to a low frequency value ( $\approx 1$  Hz).
  - C. Set Span to a small percentage value ( $\approx 5$  to 10%).
  - D. Press Program Run to apply the command to the test system.
10. **Adjust the servo control loop.**
  - A. Connect an oscilloscope to the Monitor 1 BNC connector to monitor the feedback signal.
  - B. Open the Monitor select menu. Set the Monitor 1 signal (Mon1) to the name of the conditioner feedback signal (for example, AC1 COND).
  - C. Open the Controller menu and select P Gain. Enable the adjustment knob. The waveform displayed should resemble this:



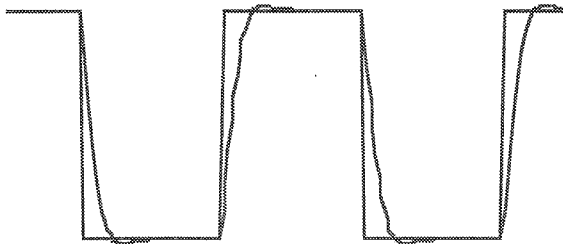
- D. Increase the P gain until the waveform resembles this:



- E. Increase the proportional gain (P gain) further to achieve an overshoot:



- F. Select D Gain. Enable the adjustment knob. Adjust the derivative gain (D Gain) to stabilize the waveform and eliminate ringing without excessive overshoot, as in this waveform shape:



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**NOTE** The above figures show typical responses from a simple system. Actual responses may vary slightly.

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- G. Open the Function Generator menu. Select Span. While you increase the span setting, check the system response at various amplitude levels. Readjust the servo loop settings as necessary.
11. Press Program Stop to stop the program. Monitor the ERROR signal. (The stroke error should be near zero).

12. **Adjust Balance to minimize the outer loop error.**

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**NOTE**

If the valve cannot be balanced electrically, check the mechanical balance of the valve. You may need to make mechanical adjustments to zero the valve spool position. (See the MTS product manual for an MTS valve, or the manufacturer's manual for other valves). For MTS valves, the adjustments are called mechanical LVDT null and mechanical pilot stage null.

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13. **Set up the program generation device to be used for the test.**
14. **Set the span and setpoint values for the test.**
15. **Press Program Run to start the test.**