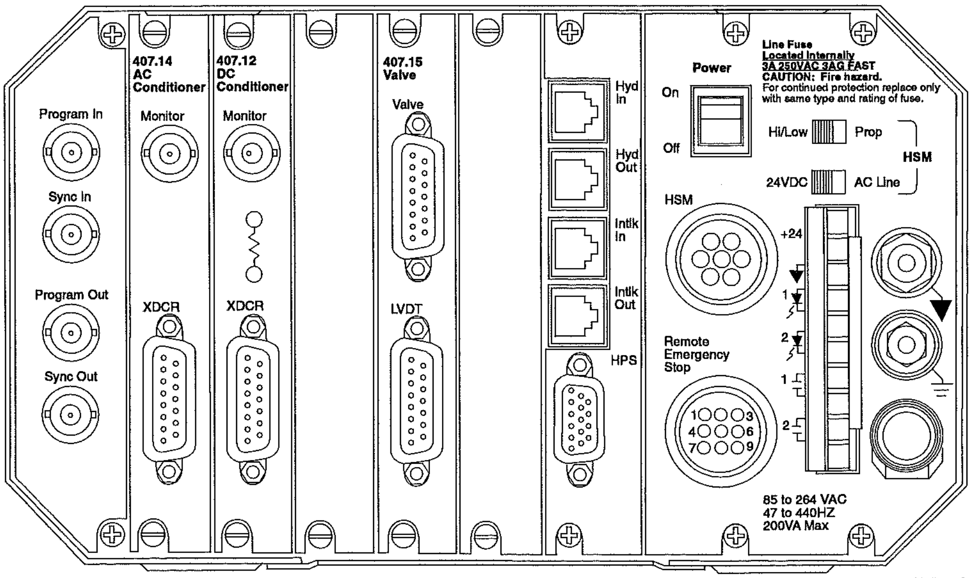
Chapter 4
Installation

Installation Overview

This chapter covers the installation of the 407 Controller, including connections and mounting.

All connections to the 407 Controller are made through the cable connectors on the Controller rear panel. The following figure shows the rear panel of the 407 Controller with a typical set of modules, including the optional 407.15 Three-stage Valve Driver. The rear panel connections include:

- system hydraulic power supply (HPS) and/or hydraulic service manifold (HSM) connections
- external program source connections
- digital input and digital output connections
- connections to other 407 Controllers in the system configuration (hydraulic control, synchronization, and interlock chaining)
- remote emergency stop connections
- system transducer connections
- servovalve connections



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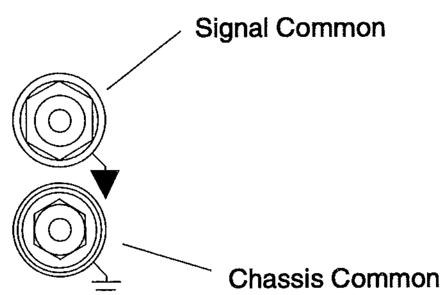
Voltage and Grounding

The 407 Controller receives power from an integral, three-wire power cord. The power switch is on the rear panel.

The Controller can operate using line voltage from most common ac power sources in the range 90 to 250 Vac. Any line frequency in the range 48 to 440 Hz can be used.

The molded plug supplied with the power cord is a standard North American 3-pin plug for use with 115 Vac. To replace this plug with a different type (for European or other line voltages) take the following steps:

1. Cut off the molded plug and prepare the wires for a new plug.
2. Connect the blue wire to the Neutral terminal on the plug.
3. Connect the brown wire to the Live (Line) terminal on the plug.
4. Connect the green-and-yellow wire to the Ground (Earth) terminal on the plug.



The external connections for signal common (black terminal) and chassis common (metallic terminal) are located on the rear panel of the 407 Controller. The Controller is manufactured with both terminals connected together. For tabletop installations, both terminals should remain connected. For equipment rack installations, remove the commoning connection and connect the chassis to the console ground.

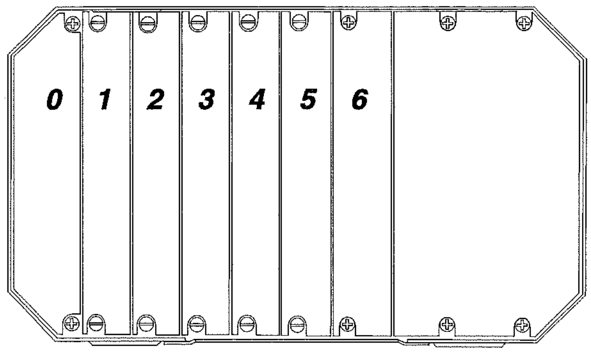
NOTE For European applications, remove the connection between the signal common terminal and the chassis common terminal.

NOTE For areas where power lines are excessively noisy (exceeding IEC 804.1 Level 4 specifications) use an external power line filter (MTS part number 119600-15 is recommended).

Removing and Installing Modules

Slot Positions

Modules must be installed only in certain slots, as shown in the following diagram and table:



Slot	Module
0	407.18 Analog PIDF Controller
1	407.12 DC Conditioner or 407.14 AC Conditioner
2	407.12 DC Conditioner or 407.14 AC Conditioner
3	407.12 DC Conditioner or 407.14 AC Conditioner
4	407.15 Three-Stage Valve Driver or 407.16 Valve Driver
5	(reserved for 407.35 Communications module)
6	407.02 Processor

Removing a Module

The following instructions apply to all modules except the 407.02 Processor module and the 407.18 Analog PIDF Controller module. (The Controller has no serviceable parts. The Processor is removed only for replacing the ROM, as described in Chapter 10 of this manual.)

⚠ CAUTION

Do not work with the power on.

Connecting or disconnecting components while power is applied can cause severe equipment damage.

Make sure the power switch is off before opening the 407 Controller or removing any module.

⚠ CAUTION

Guard against static discharge, which can damage circuit components:

- **If the Controller power cord is plugged in (so the chassis is grounded) you can then touch the chassis before touching any component or conductive path.**
- **Alternatively, you can work at an anti-static work station, or use anti-static wrist or ankle bands.**
- **Do not take a new component out of its anti-static packaging until you are ready to install it.**
- **After removing a component, place it on a non-static surface.**
- **Except where necessary, avoid touching components or conductive paths on the circuit card.**

In general, use all reasonable anti-static precautions.

Take the following steps to remove a module:

1. Turn off power to the 407 Controller.
2. Unplug any connections to the module.
3. Loosen the two captive screws holding the module in place.
4. Slide the module out of the Controller chassis.

Installing a Module

Take the following steps to install a module:

1. Slide the module into the back the Controller chassis.
2. Tighten the two captive screws to hold the module in place.

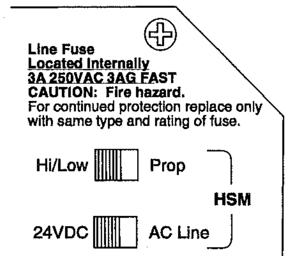
Hydraulic Control Connections

The 407 Controller can be configured to control a hydraulic power supply (HPS), a hydraulic service manifold (HSM), or both.

Hydraulic Service Manifold Connections

The Controller can be set up to control either a high/low solenoid type hydraulic service manifold (such as the MTS Series 290 HSMs) or a proportional type hydraulic service manifold (such as the MTS Series 298 HSMs). The 7-pin HSM connector is used to make connections to the hydraulic service manifold. The HSM Hi/Low - Prop (proportional) switch and 24VDC - AC Line switch are each set up according to the HSM type.

HSM Switches



Set the positions of the HSM Hi/Low - Prop and 24VDC - AC Line switches to match the type of HSM the Controller is being used with.

For Hi/Low solenoid type HSMs, set the switches to Hi/Low and the appropriate 24VDC or AC LINE position. The Controller can be used with either voltage type.

For proportional type HSMs, set the switches to Prop and 24VDC.

NOTE If you select proportional (Prop) you MUST also select 24DC.

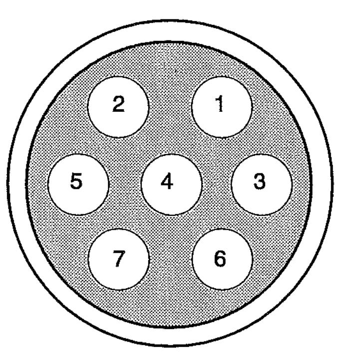
HSM Connector

The positions of the HSM Hi/Low - Prop and 24VDC - AC Line switches apply the appropriate connections to the HSM cable connector pins. Pin assignments are shown below.

HSM

HSM Connector Pin Assignments

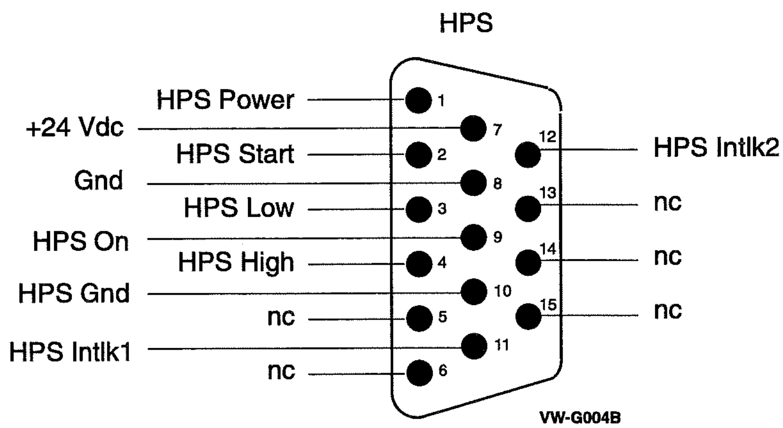
1 HSM Low
2 HSM RTN
3 Protective Earth
4 HSM High
5 nc
6 nc
7 nc



Hydraulic Power Supply Connections

Connections to a hydraulic power supply are made through the 15-pin female, high density, D-type, HPS connector. If you are using the 407 Controller with an MTS hydraulic power supply that has PLC control logic, connections can be made directly from the HPS connector to the hydraulic power supply control box.

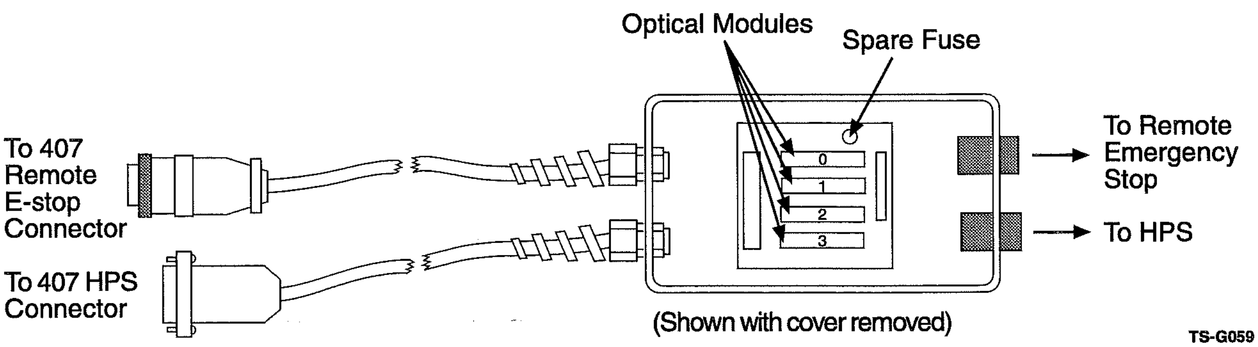
If you are using the 407 Controller with an MTS hydraulic power supply with relay-type control logic, an external driver must be used to provide the drive current required to drive the solenoid coils. The optional 407.05 Hydraulic Pump Interface is available for that purpose. It is described in the following pages.



Model 407.05 Hydraulic Pump Interface

The 407.05 Hydraulic Pump Interface is specifically designed to connect the 407 Controller to a hydraulic power supply (HPS) such as MTS Model 526 HPS or equivalent relay-operated pump. The Pump Interface converts logic-level signals to and from the 407 Controller to relay signals used by the HPS pump.

The Pump Interface includes two 6-ft cables for connection to the 407 Controller. One cable, terminated with a 9-pin female connector, connects to the Controller Remote Emergency Stop connector. The other, a 15-pin (three rows) male, high density, D-type connector, plugs into the Controller HPS connector.



The Pump Interface contains a modular I/O board supporting four optical modules. These modules convert logic-level signals at a Controller into relay signals at the HPS. The set of modules used depends upon whether the Controller is powered by 24 Vdc or 115 Vac.

Module Position	24 Vdc Controller MTS p/n (mfr p/n)	115 Vac Controller MTS p/n (mfr p/n)	Function
0	113791-58 (G4ODC24)	119791-73 (G4OAC24)	HPS HI
1	113791-58 (G4ODC24)	119791-73 (G4OAC24)	HPS LO
2	113791-58 (G4ODC24)	119791-73 (G4OAC24)	HPS START
3	113791-71 (G4IDC24)	119791-72 (G4IAC24)	HPS ON
Spare Fuse	113791-75 (FUSEG4)		

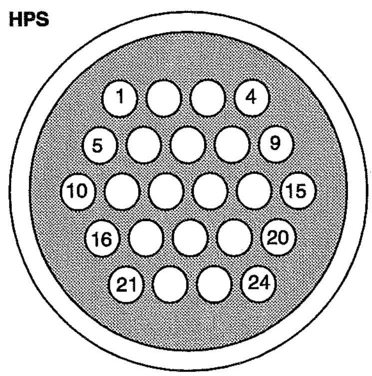
⚠ CAUTION

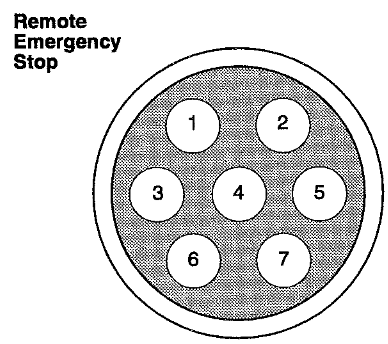
You must configure the 407.05 Hydraulic Pump Interface for the correct voltage before installation.

Connecting an interface configured for 24 Vdc to a 115 Vac pump causes improper operation.

Make sure the 407.05 Hydraulic Pump Interface is configured for the correct voltage before installation.

Connectors on the 407.05 Hydraulic Pump Interface





Connections from the Pump Interface to a hydraulic power supply and a remote emergency stop module are made through two round CPC connectors.

Remote E-Stop

A 7-pin female CPC connector provides connection to the MTS remote emergency stop module. Pin definitions are as follows:

Pin	Definition
1	Low level contact (–)
2	nc
3	Chassis ground
4	nc
5	High level contact (+)
6	Low level contact (+)
7	High level contact (–)

NOTE For more information about the 407.05 Pump Interface with a 9-pin remote emergency stop connector, request MTS Service Bulletin No. 182.

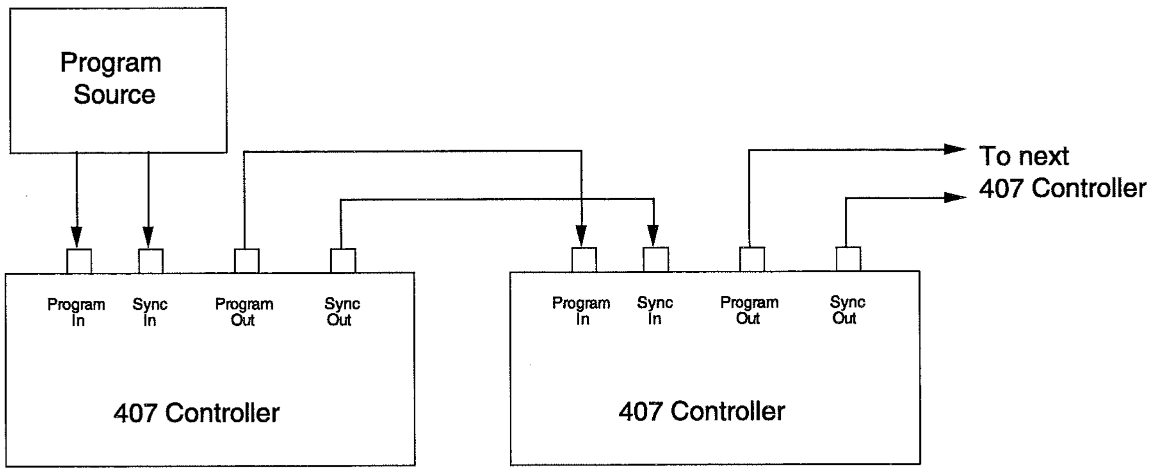
HPS

A 24-pin male CPC connector provides connection to the HPS. Pin definitions are as follows:

Pin	Definition
1	nc
2	Overtemperature (HPS error)
3	Low level
4	Protective earth
5	nc
6	nc
7	Interlock common
8	nc
9	Power from pump
10	Low
11	Start
12	E-stop chain
13	nc
14	nc
15	High
16	E-stop chain
17	Common
18	Defeat common
19	Defeat power
20	nc
21	nc
22	nc
23	nc
24	nc

External Program Connections

BNC connectors are provided for connections to an external program source. The Program In and Sync In connectors receive program input and synchronization signals from an external program source or another 407 Controller in a multiple Controller configuration. The Program Out and Sync Out connectors are used to pass the program and synchronization signal on to the next 407 Controller in a multiple Controller configuration. External program connections are shown in the following figure.

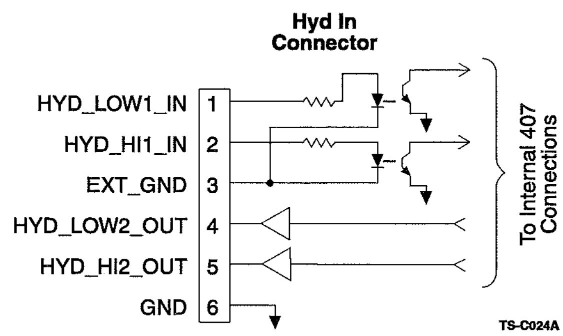


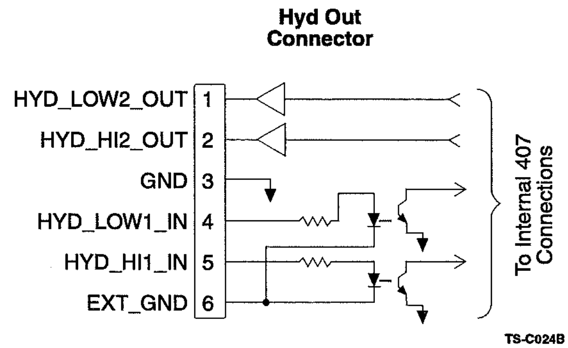
Hyd In and Hyd Out Connectors

In a multiple 407 configuration, hydraulic connections are daisy-chained from one 407 Controller to another, using the Hyd In and Hyd Out connectors.

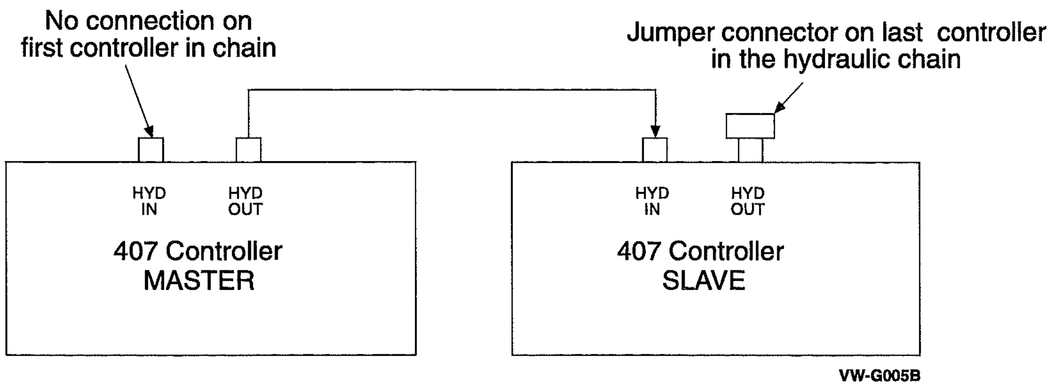
Notice that the Hyd Out connector of every 407 Controller must either be cabled or jumpered. It can be cabled to the Hyd In connector of another 407 Controller, or it can be jumpered with a jumper plug (MTS part number 496359-01). A jumper plug must be installed in the Hyd Out connector of:

- the last controller in a multiple 407 Controller chain, or
- a stand-alone 407 Controller





The following figure shows the daisy-chain connections.

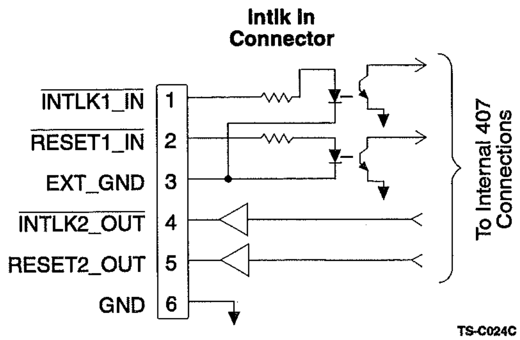


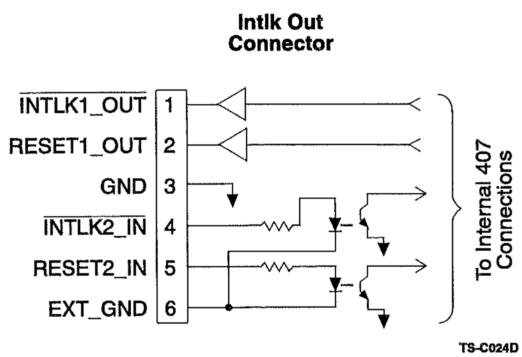
External Interlock Connections

In a multiple 407 configuration, interlock connections must be daisy-chained from one 407 to another, using the Intlk In and Intlk Out connectors.

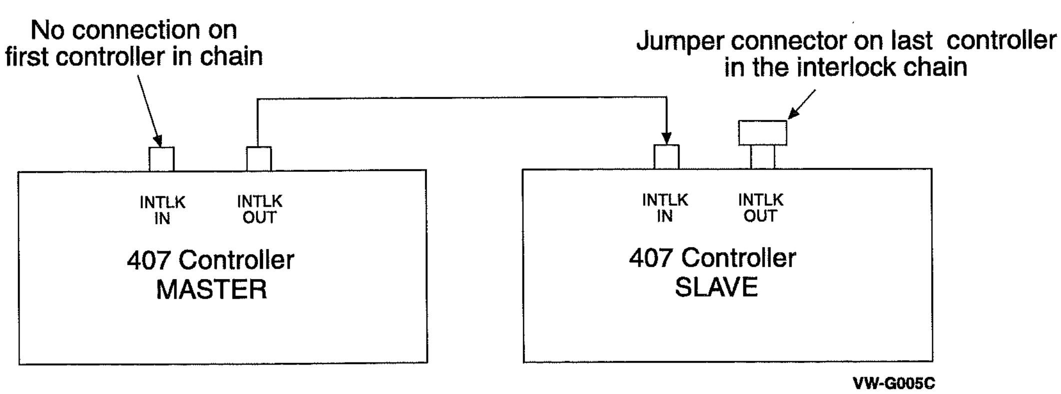
Notice that the Intlk Out connector of every 407 Controller must either be cabled or jumpered. It can be cabled to the Intlk In connector of another 407 Controller, or it can be jumpered with a jumper plug (MTS part number 496359-01). A jumper plug must be installed in the Intlk Out connector of:

- the last controller in a multiple 407 Controller chain, or
- a stand-alone 407 Controller





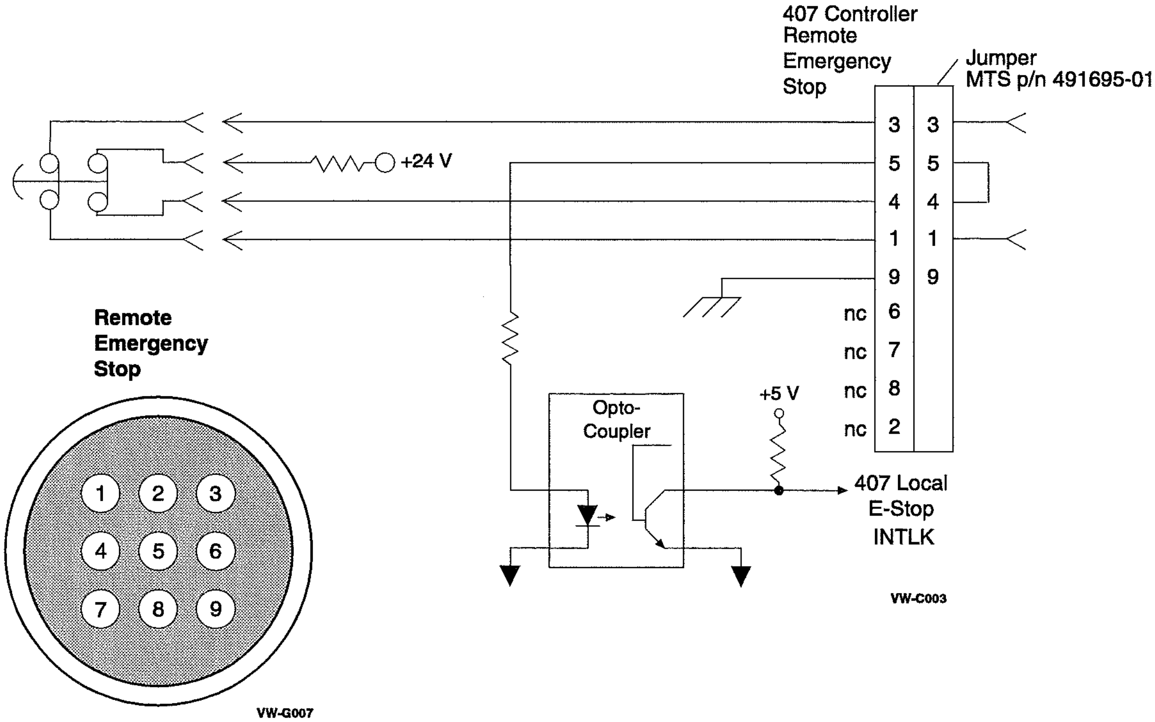
The following figure shows the daisy-chain connections.



Remote Emergency Stop Connections

The following figure shows the connections at the Remote Emergency Stop connector on the 407 Controller. If no remote emergency stop connections are used, the Controller must have a remote stop jumper connector (MTS part number 491695-01), connected to the Remote Emergency Stop connector. If a jumper connector is not connected, the interlock indicator will light and it will not be possible to reset the ESTOP interlock.

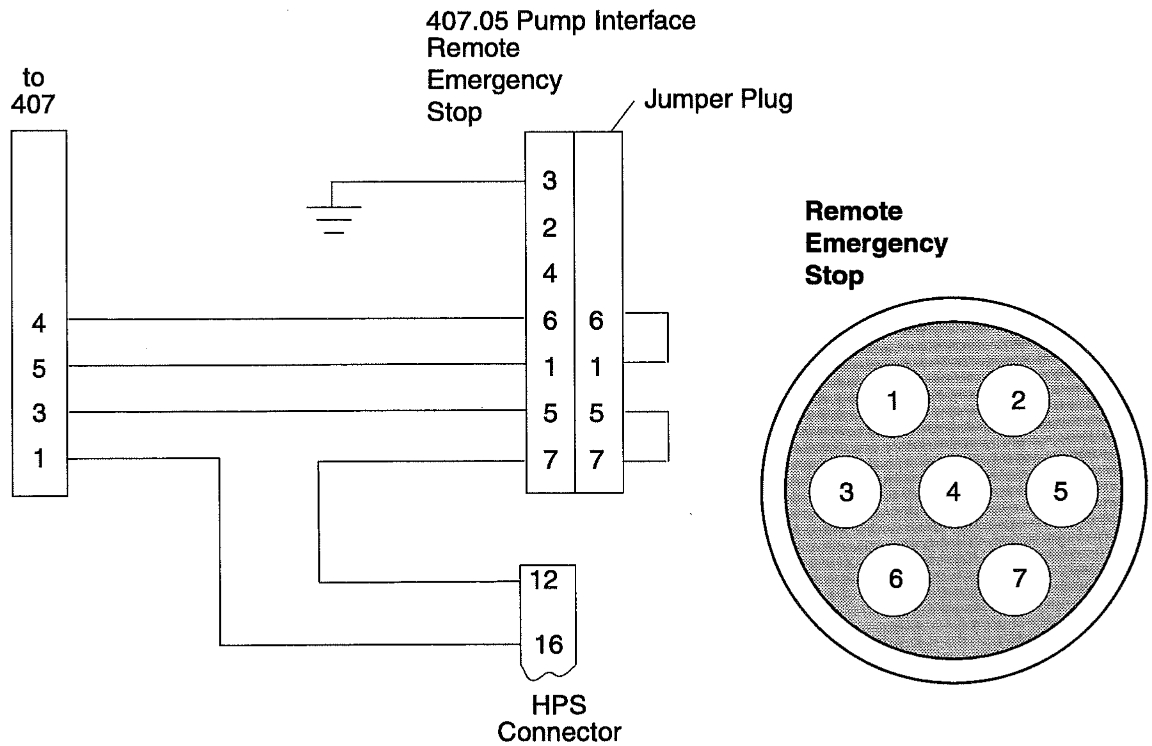
Remote E-Stop to Controller



If the 407.05 Hydraulic Pump Interface is not required, a pair of user E-stop contacts are available for special use on pins 1 and 3 of the Remote Emergency Stop connector. (If the 407.05 Hydraulic Pump Interface is used, these contacts are not available.)

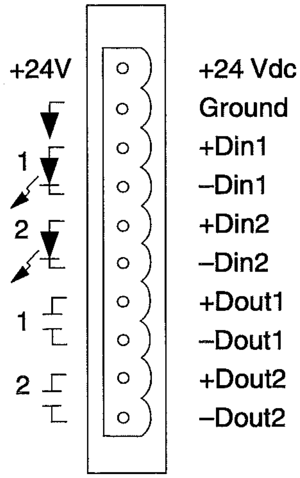
Remote E-Stop to 407.05 Pump Interface

The following figure shows the connections at the Remote Emergency Stop connector on the 407.05 Hydraulic Pump Interface. If no remote emergency stop connections are used, the Controller must have a remote stop jumper connector (MTS part number 491695-01), connected to the Remote Emergency Stop connector. If a jumper connector is not connected, the interlock indicator will light and it will not be possible to reset the ESTOP interlock.



User Digital Input/Output

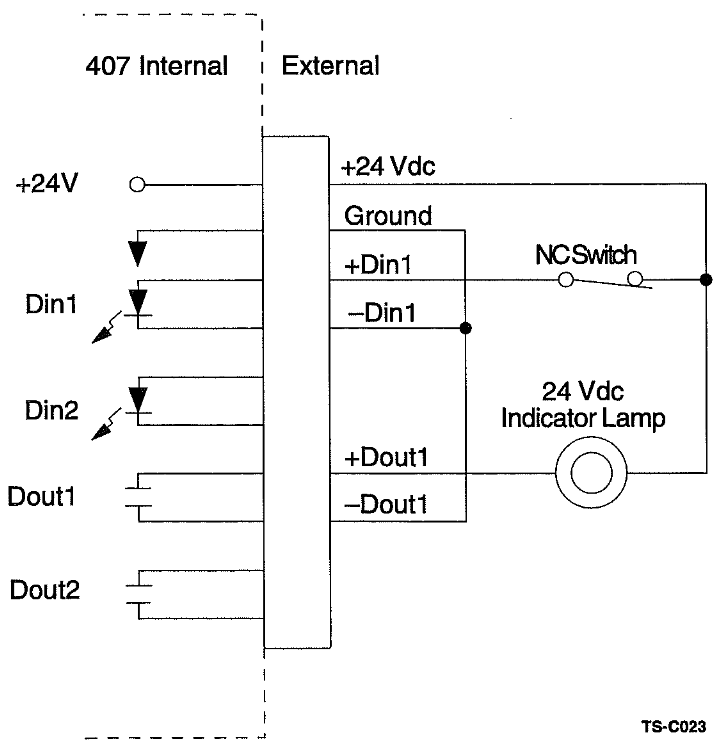
The following figure shows user digital input/output connections. These can be used for special inputs (such as proximity switches or optical sensors) or outputs (such as indicator lights, horns, or relays).



TS-G058

This connector mates with a plug (MTS p/n 113282-47, Phoenix p/n 1764303). It provides 24 Vdc to power external switching devices.

Example Configuration for User Digital Input/Output



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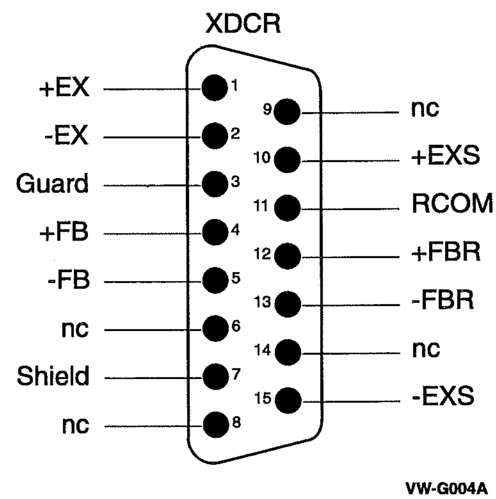
Transducer Connections

Transducer connections are made to the 15-pin, female, D-type, XDCR cable connectors on the 407.14 AC Conditioner module, the 407.12 DC Conditioner modules, or the optional 407.15 Three-stage Valve Driver module installed in the Controller. The following figures show the pin assignments for these cable connectors.

Each conditioner module (except the 407.15 Three-stage Valve Driver) also provides a BNC Monitor connector on its rear panel for connections to an external readout device. The signal available on the Monitor connector is selected through the user interface display. The 407.15 Three-stage Valve Driver monitor signals are available on the two BNC connectors (Monitor 1 and 2) on the 407 Controller front panel.

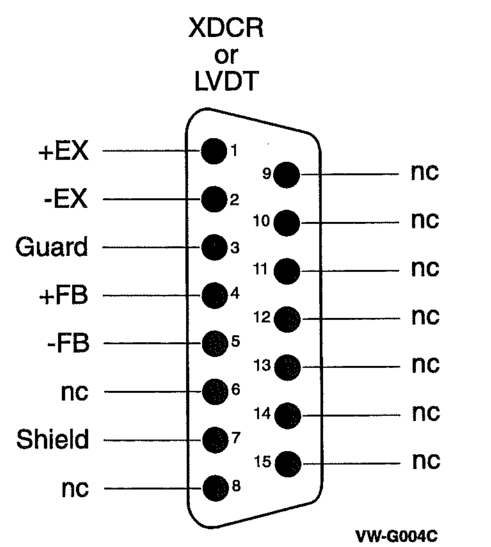
407.12 DC Conditioner module



407.14 AC Conditioner module

or

407.15 Three-stage Valve Driver module



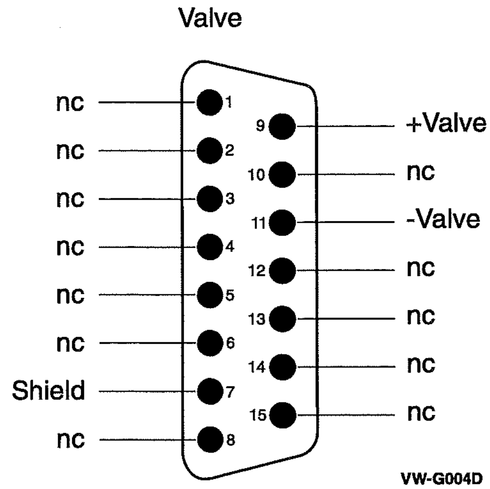
Servovalve Connections

Connections to the associated servovalve are made through the 15-pin female, D-type, Valve cable connector located on the rear of the 407.16 Valve Driver module or the optional 407.15 Three-stage Valve Driver module installed in the Controller.

407.16 Valve Driver Module

or

407.15 Three-stage Valve Driver module



The 407.16 Valve Driver module also provides a BNC Monitor connector on its rear panel for connections to a readout device. The signal available on the Monitor connector is selected through the user interface display.

Handle Kit Installation

The following procedure provides complete assembly and installation instructions for the 407 handle kit. The figure following this procedure shows the handle kit assembly components described.

1. Place one support arm (1) into one handle side leg (2), as shown in the handle kit assembly figure.

2. Set one of the clips (3) in place over the slender, straight portion of the support arm (1), just behind the circular end of the support arm.

3. Insert two washers (4) and a screw (5) through the mounting hole in the handle side leg (2).

4. Insert a spring (6) and a button (7) into the handle side leg mounting hole, over the screw (5) and washers (4).

5. Press the button (7) into the handle side leg, as far as you can and push a ratchet (8) over the button (7) leg detents, until it snaps into place over the first set of detents. Make certain the burred or sharper edges of the ratchet are pointing toward the handle side leg.

6. Hold a ratchet housing (9) in place over the ratchet (8) and press the posts on the back side of the ratchet housing (9) into the mounting holes on the side panel of the 407 Controller.

7. Insert a Phillips screwdriver through the hole in the button (7) and lightly tighten the screw (5).

8. Assemble the remaining handle kit components to the other handle side leg (2) according to steps 1 through 7 and mount the side leg to the mounting holes on the opposite side of the 407 Controller.

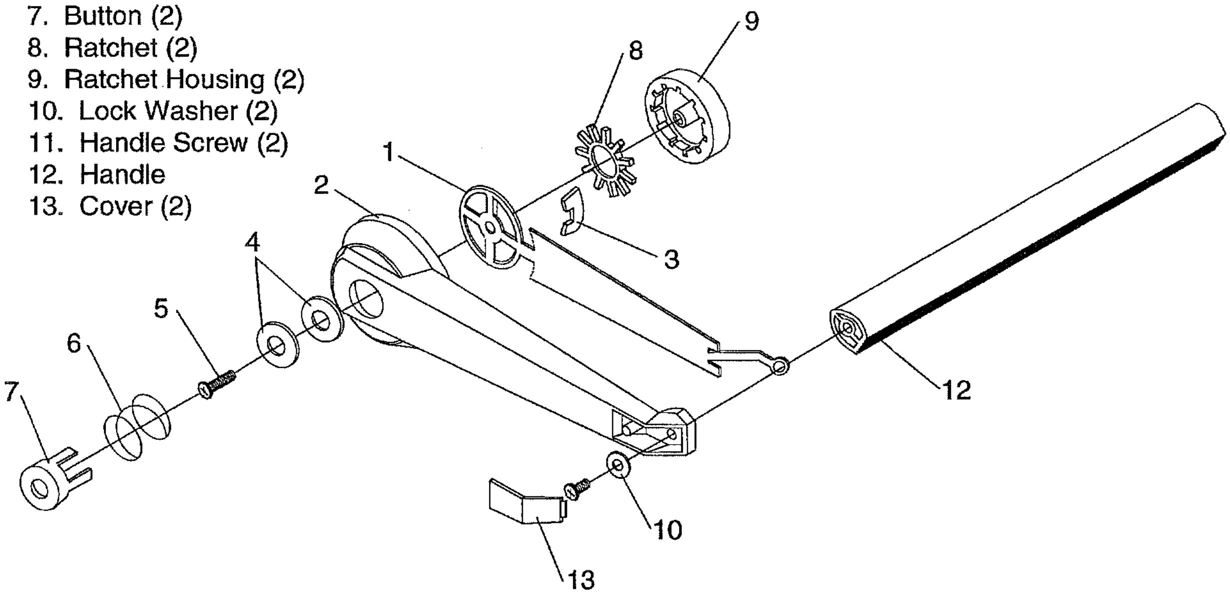
9. Insert a lock washer (10) and handle screw (11) through the mounting hole at the end of one handle side leg (2) and lightly tighten to handle (12). Repeat this step for the other handle side leg, then secure both screws (11). (The mounting screw for the first handle side leg may have to be loosened slightly to allow the second handle side leg to be mounted.)

10. Snap cover (13) in place over the handle screw (11) and lock washer (10).

11. Secure mounting screws (5) on each side of the 407 Controller.

12. Press in both buttons (7) and rotate the handle assembly. The assembly should rotate up and down easily. When the buttons (7) are released, the handle should lock into a detent position and remain there. If the handle does not move easily, or if it does not lock into a detent position, an error may have been made during the assembly. Take a small straight blade screw driver and carefully remove the covers (13), loosen all screws and remove the handle assembly from the 407 Controller. Reassemble the handle side leg assemblies according to steps 1 through 7.

1. Support Arm (2)
2. Handle Side Leg (2)
3. Clip (2)
4. Washer (4)
5. Screw (2)
6. Spring (2)
7. Button (2)
8. Ratchet (2)
9. Ratchet Housing (2)
10. Lock Washer (2)
11. Handle Screw (2)
12. Handle
13. Cover (2)



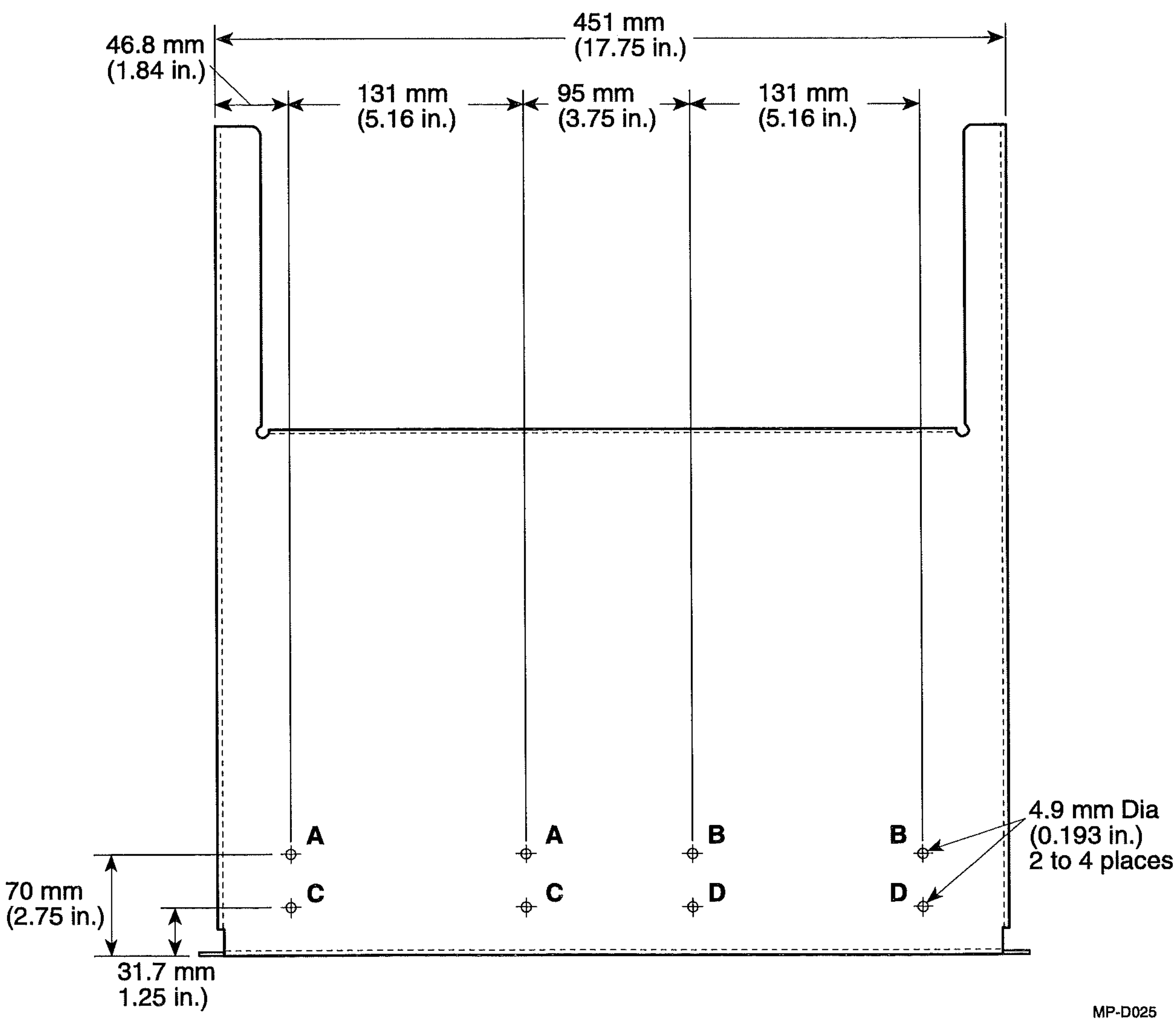
Mounting the 407 Controller

The following procedures provide complete instructions for mounting the 407 Controller on either a 406-style fixed shelf or an MTS slide-mounted writing top.

NOTE Rack-mounting large numbers of 407 Controllers in a small console space may require additional ventilation, such as a fan inside the console.

Mounting to the Fixed Shelf

Refer to the following figure while modifying a 406 Fixed Shelf to mount a 407 Controller.



To mount Controller in this position:	**FLUSH** With the Controller front panel flush with the front edge of the fixed shelf...	**FORWARD** With the Controller front panel(s) approximately one inch forward of the front edge of the fixed shelf...
LEFT One Controller on the left side of the fixed shelf...	Measure and mark the holes A.	Measure and mark the holes C.
RIGHT One Controller on the right side of the fixed shelf...	Measure and mark the holes B.	Measure and mark the holes D.
BOTH Two Controllers on the fixed shelf..	Measure and mark the holes A and B.	Measure and mark the holes C and D.

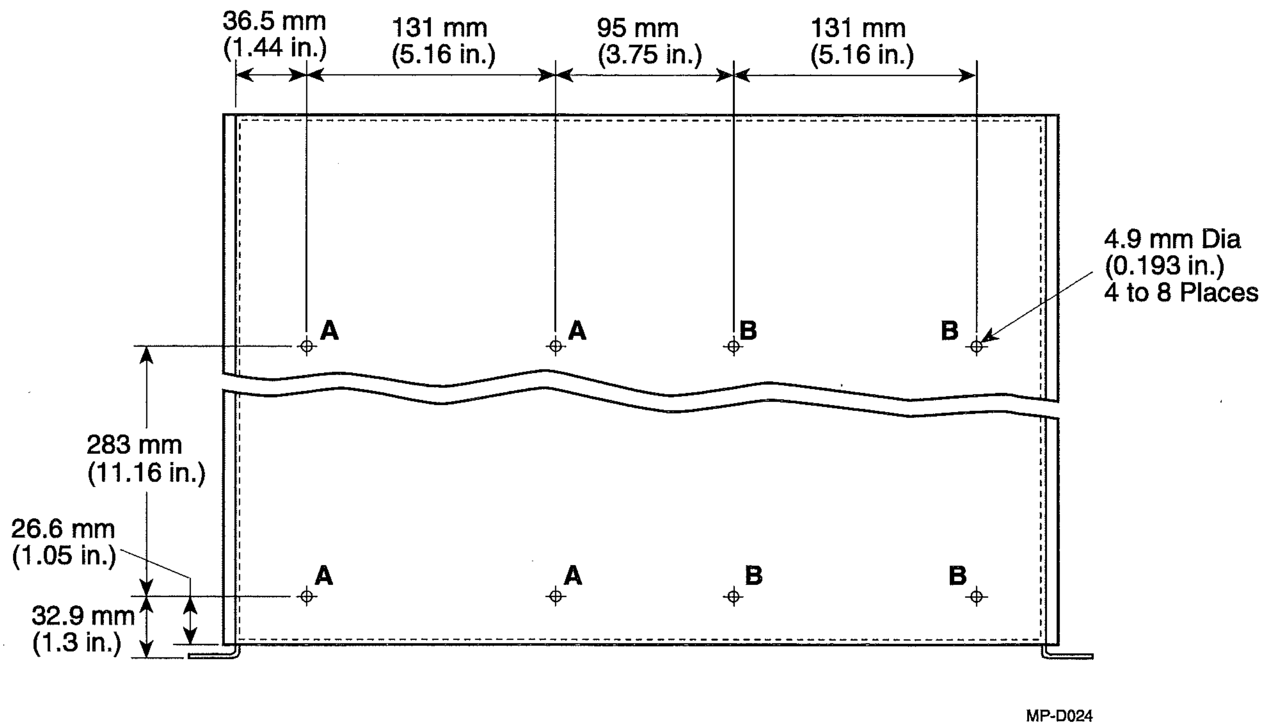
1. Drill at the marks (two holes for a single installation or four holes for a dual installation) using a 0.193 inch diameter drill (a #10 drill).

2. Remove the front feet of each Controller to be mounted (retaining the screws).

3. Insert the screws, upward, through the drilled holes and refasten them to the front foot mounting holes in each Controller.

Mounting to the Slide Mounted Writing Top

Refer to the following figure while modifying an MTS slide-mounted writing top to mount a 407 Controller.



1. To mount the 407 Controller(s) on the writing top, determine whether you want to install:

   a. one Controller on the left side of the writing top

   b. one Controller on the right side of the writing top

   c. two Controllers on the writing top

2. For a single left installation, measure and mark the first set of four holes (A) from the left edge of the writing top.

3. For a single right installation, measure and mark the last set of four holes (B) from the left edge of the writing top.

4. To install two Controllers, measure and mark all sets of holes (A and B) from the left edge of the fixed shelf.

5. Drill four holes, for a single installation or eight holes for a dual installation, using a 0.193 inch diameter drill (a #10 drill).

6. Remove all four feet from each Controller to be mounted (retaining the screws).

7. Insert the screws, upward, through the drilled holes and refasten them to the foot mounting holes in each Controller.

NOTE When mounting the Controller(s), it may be desirable to have a more finished appearance. Additional parts are available through MTS for a more finished appearance. A dress kit, part number 495624-01 is available to finish off the full 19-inch rack width.

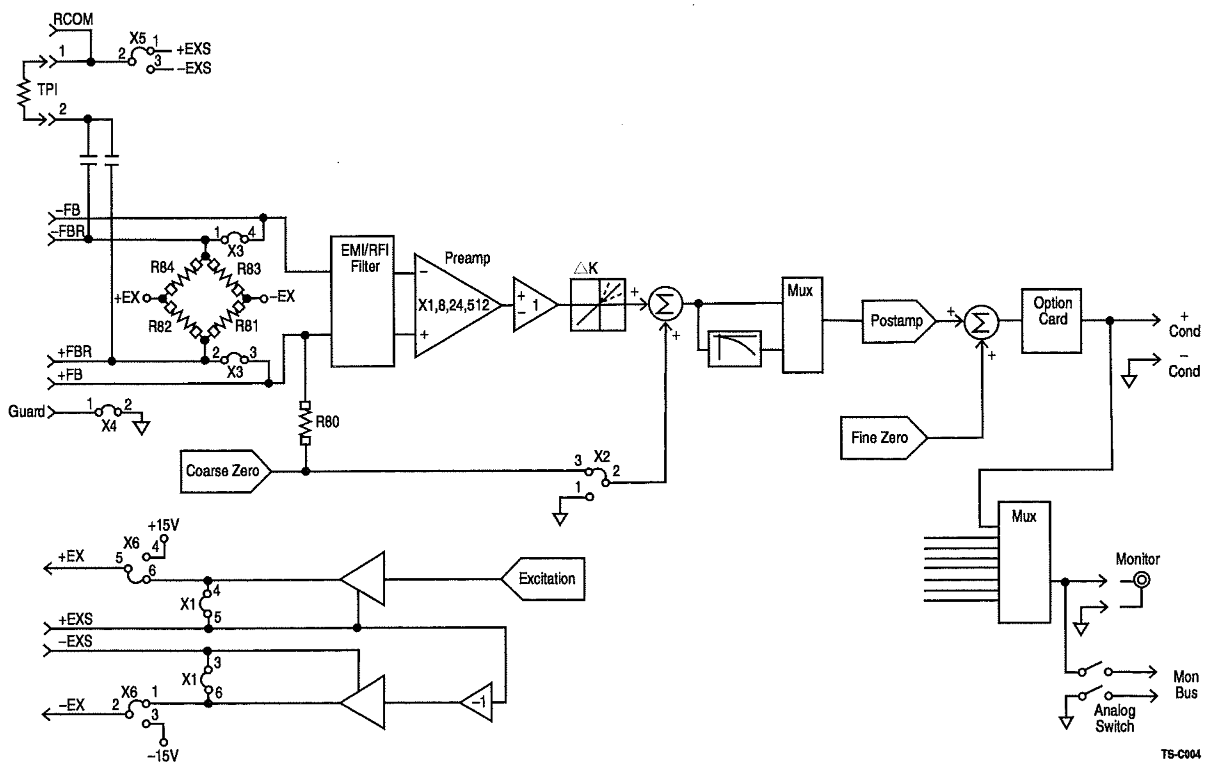
Chapter 5
Model 407.12 DC Conditioner

Description

The 407.12 DC Conditioner is a single-channel dc transducer conditioner module specifically designed for use in the 407 controller. The DC Conditioner provides transducer excitation and output signal amplification for a wide variety of transducer types including both low level transducers (such as load cells, strain gages, and ΔP cells) and high level transducers (such as DCDTs and ADTs). The following is a simplified block diagram of the DC Conditioner circuitry.

The module provides the following features:

- adjustable gain
- adjustable excitation
- output zeroing
- bridge balancing



Monitor Output

The conditioner output circuitry provides selectable monitor output signal selection. Any of the following signals can be selected for the monitor output:

- GND—ground
- FDBK—feedback
- PREAMP—pre-amp
- C ZERO—coarse zero value
- F ZERO—fine zero value
- +EXCIT—plus excitation output
- –EXCIT— minus excitation output
- 5.00 V—on-board reference

Gain and Zero Offset

The DC Conditioner can be programmed to provide transducer output signal amplification within a range of 0 to 5120. This provides compatibility with both low level and high level transducers. A programmable zero offset voltage provides a dc offset of the conditioner output. An offset can be introduced either before or after the gain stage.

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.

The following table shows the relationship between overall gain and maximum voltage offset, Vos.

Gain (V/V)	max Vos (V)
0–10	5.000
10–80	0.625
80–640	0.078
640–5120	0.010

Gain and Zero Offset (continued)

Offsets can be applied to the DC Conditioner circuitry in three areas:

- the positive feedback line (for bridge balancing)
- the conditioner preamp (for a preamp offset)
- the final output stage (as a zero offset)

Two offset sources are available on the DC Conditioner: coarse zero and fine zero. The functions of these sources are determined by the installation of jumpers on the board.

Transducer Excitation

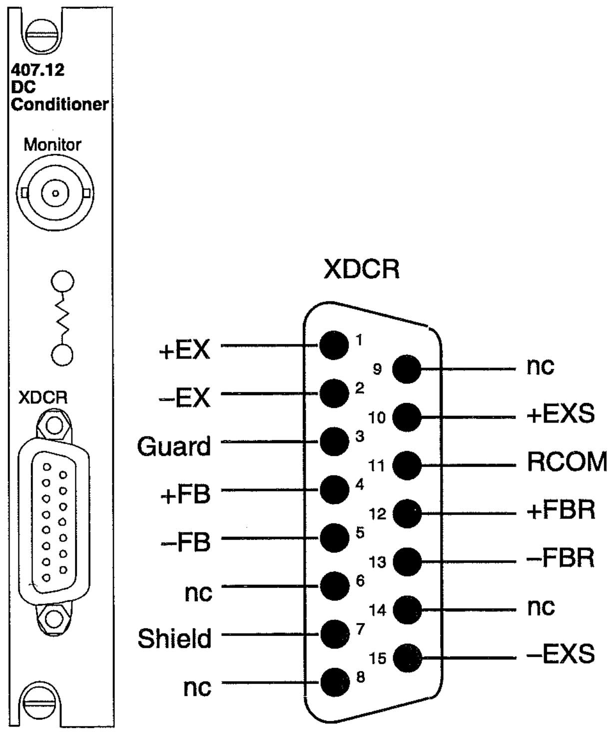
The DC Conditioner provides a programmable excitation source that can be configured for either voltage or current excitation. This source provides a differential output that is programmable within a range of 0 to 20 Vdc (±10Vdc) and can supply up to 100 mA of current.

Calibration Checks

The DC Conditioner contains a selectable shunt calibration relay to perform shunt calibration checks on the transducer. Either a rear panel resistor or a remote resistor can be used for both positive and negative shunt calibration checks.

DC Conditioner Panel

The DC Conditioner panel includes a BNC connector for signal monitoring, a 15-pin, female, D-type transducer connector, and tip jacks for the insertion of an external shunt calibration resistor.



Shunt Cal Resistor tip jacks

The shunt calibration resistor tip jacks are used to insert an external shunt calibration resistor for shunt calibration checks.

Monitor BNC connector

The BNC Monitor connector provides connections to a readout device. The signal available on the Monitor connector is selected through the user interface display.

XDCR connector

The XDCR 15-pin, female, D type connector provides connections to the associated system transducer.

Board Configurations

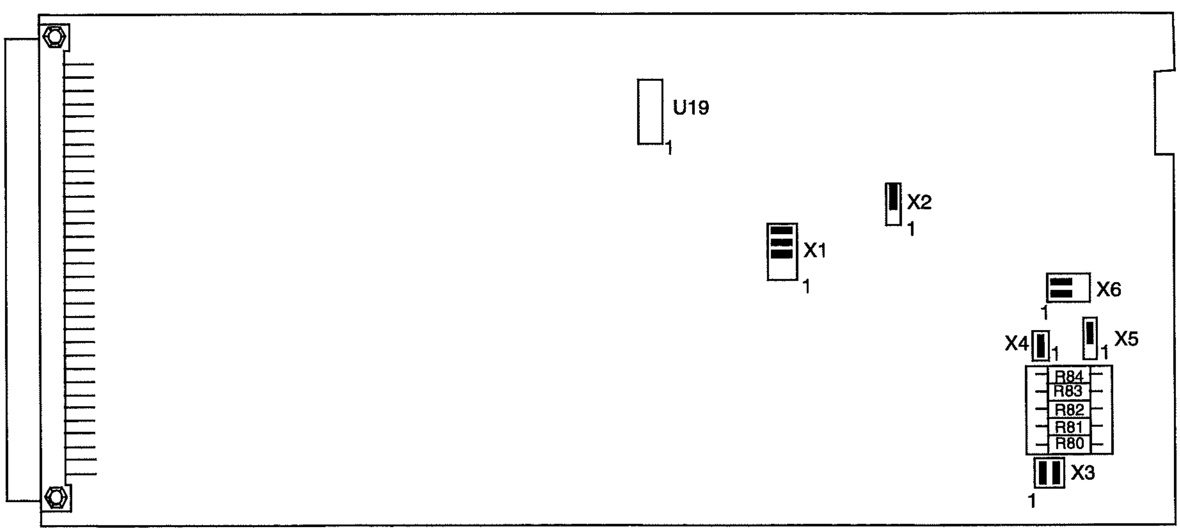
NOTE The following information is intended for *qualified service personnel* only.

The DC Conditioner contains a number of on-board jumpers that are used to configure the module specifically for your application. These jumpers are typically installed by MTS prior to system installation for proper operation in your application. *Do not change the position of any of these jumpers unless system requirements have changed.*

The following information is necessary only if you intend to change the operating configuration of the module from its original setup or if the module was not set up by MTS prior to shipment.

Jumper and Resistor Locations

The following figure shows the jumper and resistor locations on the DC Conditioner circuit board.



407.12 DC Conditioner Jumper Summary

On-board jumpers are used to establish certain parameters and make use of various functions on the DC Conditioner board. These include:

- shunt calibration check options
- bridge balance options
- establishing the preamp reference
- adapting the conditioner for various transducer configurations

The following table provides a summary of the DC Conditioner jumper functions. Those that need further definition are described in detail later in this chapter.

CAUTION

Check jumper X4 before connecting this Conditioner to cables intended for a 406 or 458 product.

The standard position of X4 (1–2) connects pin 3 to analog ground. When used with 406 or 458 product cables, this shorts the –Excitation signal to ground.

When replacing a 406 or 458 product and retaining the original product cable, remove jumper X4.

407.12 DC Conditioner Jumper Summary (continued)

Jumper	Setting	Function
X1		Internal/external excitation sensing and voltage/current excitation selection
	2–7 3–6 4–5	Voltage excitation, internal sense (default)
	2–7	Voltage excitation, external sense
	1–8 3–6 4–5	Current excitation
X2		Preamp zero reference. Connects coarse zero or ground (guard) into summation amplifier, or is used for bridge balancing in conjunction with R80
	2–3	Coarse zero (default)
	1–2	Analog ground (guard)
X3		Shunt calibration resistor selection
	1–4 2–3	Internal (4-wire, default)
	nc	External (7- or 8-wire);shunt cal resistor, external
X4		Guard connection. Configures the dc conditioner cable guard for either an internal or external guard. (See CAUTION on previous page)
	1–2	Internal (analog ground) guard (default)
	nc	External guard
X5		Bridge arm selection. Determines the polarity of the shunt calibration (+EX or –EX) by selecting a bridge arm across which the shunt cal resistor is placed.
	2–3	–EX (default)
	1–2	+EX
X6		Excitation selection. Selects voltage excitation source.
	1–2 5–6	Adjustable excitation
	2–3 4–5	Fixed ±15 Vdc excitation
U19		Conditioner output filter header (200 Hz default)

Excitation Sensing and Mode Selection (X1 and X6)

Transducer Excitation

The DC Conditioner provides a programmable excitation source that can be configured for either voltage or current excitation. This source provides a differential output that is adjustable within a range of 0 to 20 Vdc (±10Vdc) and can supply up to 100 mA of current. Loads from 200 Ω to 1000Ω are supported over the full excitation range and loads less than 200Ω are supported over a reduced excitation range. For example, when used with a 120Ω load, the excitation driver is limited to 12 V (±6 V) to limit the current to 100 mA.

The excitation driver supports excitation sense lines to eliminate inaccuracies that may be caused by IR drop in long cables. This feature can be used with six-, eight-, and nine-wire bridge configurations.

Excitation Sensing

The conditioner can be configured for internal excitation sensing (when long transducer lines are not a factor) or external excitation sensing (when long transducer lines may present a problem). Jumpers must be installed for one configuration or the other for proper operation of the excitation circuitry.

Jumper block X1 is used to establish the excitation sensing configuration. Install jumpers as follows:

Internal excitation sensing:

X1: pins 3-6 jumpered
pins 4-5 jumpered

External excitation sensing:

X1: pins 3-6 open
pins 4-5 open

Excitation Mode Selection

Jumper block X1 is also used to select the excitation mode (voltage or current). Select the excitation mode as follows:

Voltage mode:

X1: pins 1-8 open
pins 2-7 jumpered

Current mode:

X1: pins 1-8 jumpered
pins 2-7 open

NOTE In the current excitation mode, only *internal* excitation sensing is valid.

High Level Excitation

Some transducers contain internal conditioning electronics and require a supply voltage greater than can be achieved by the 407 adjustable supply. For those transducers, the excitation output can be wired directly to the 407 power supply (±15V) through X6.

Adjustable excitation:

X6: pins 1-2
pins 5-6

Fixed ±15V excitation:

X6: pins 2-3
pins 4-5

Preamp Zero Reference Selection (X2)

The preamp zero reference can be either coarse zero or ground (guard).

Jumper block X2 is used to configure the preamp zero reference. Install jumpers as follows:

Coarse zero (default):

X2: pins 2-3 jumpered

Analog ground (guard)

X2: pins 1-2 jumpered

Bridge Balancing

The coarse zero output can be applied to the +Feedback line through resistor R80 for bridge balancing. When R80 is installed, all jumpers in X2 must be removed.

The bridge balance resistor (R80) must be present to use the bridge balance voltage as a feedback offset. The offset voltage applied to the selected feedback line is calculated as follows:

$$V_{OS} = V_{BB}\left(\frac{R}{R+2R_{BB}}\right)$$

or

$$R_{BB} = \frac{R}{2}\left(\frac{V_{BB}}{V_{OS}}-1\right)$$

where:

V_{OS} = offset voltage applied to the feedback line
V_{BB} = bridge balance output voltage
R_{BB} = value of the bridge balance resistor in Ω
R = bridge resistance in Ω

Preamp Zero Reference Selection (X2, continued)

NOTE All zeroing, except bridge balancing through R80, is done after the ΔK gain adjustment. (Bridge balance and ΔK may produce unexpected results.)

Shunt Calibration Configuration (X3 and X5)

The configuration of the shunt calibration is controlled by X3 and X5. The X3 jumpers are installed for four-wire bridge connections and are removed when a remote shunt resistor is used. X5 is used to control which arm of the bridge the shunt calibration resistor is to be placed across.

Local R-Cal connection	X3:	pins 1-4 and 2-3 installed
Remote R-Cal connection	X3:	no connection
R-Cal to +EXS	X5:	pins 1 - 2
R-Cal to –EXS	X5:	pins 2 - 3

Guard Connection (X4)

The dc conditioner cable shield guard can be either internal or external.

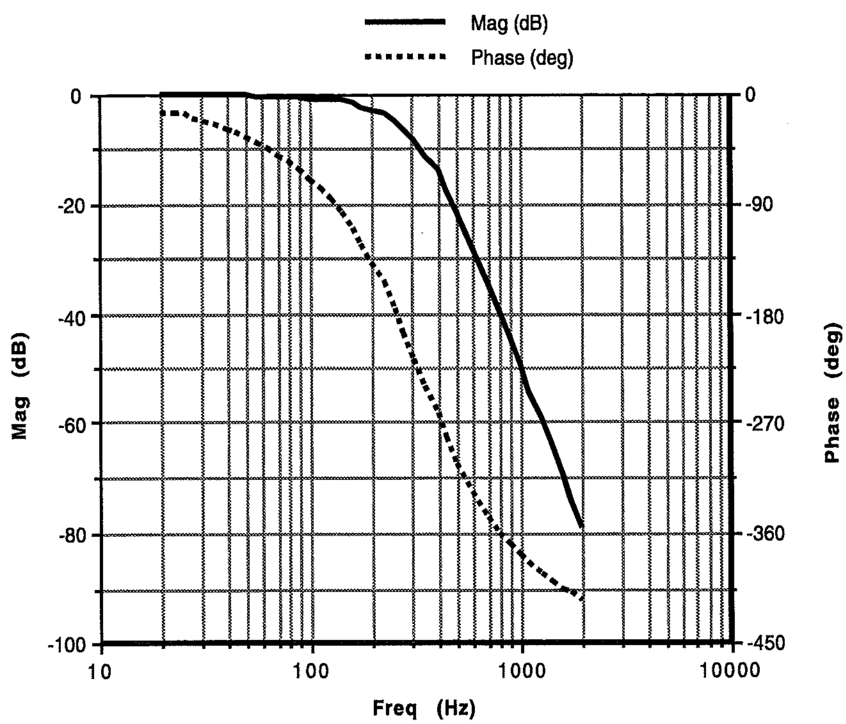
X4 is used to select the cable shield guard configuration. When using this module with 406 or 458 product cables, you MUST remove jumper X4. (See CAUTION earlier in this chapter.)

Internal (analog ground) guard (default)	X4:	pins 1-2 installed
External guard	X4:	no connection

Filtration (U19)

The DC Conditioner contains a low pass 200 Hz filter that can support up to 5th order Butterworth, Chebychev, Linear-Phase Elliptic, and Bessel responses. The filter type and cutoff frequency can be changed by the insertion of a SIP filter module. The filter can be used to reduce unwanted high frequency noise when necessary.

The following figure shows the cutoff frequency for the standard 200 Hz Bessel filter.



The available filter modules, with their MTS part numbers and characteristics, are listed in the Service chapter of this manual. The SIP filter module is installed in U19. The default filter is 200 Hz.

Resistor Summary

The DC Conditioner uses "select" resistors for various board functions. These resistors are installed on mounting posts in the locations shown in the figure at the beginning of this chapter. The functions provided by these resistors include:

- bridge completion
- bridge balancing
- external shunt calibration resistor

The following table provides a summary of the resistor functions. The functions that require further explanation are described later in this chapter.

Resistor	Function
External Shunt Cal Resistor	The external shunt calibration resistor is externally mounted to the tip jack connections on the DC Conditioner panel. A resistor mounted in this position should be a 1/10 W, 0.1%, RN55E (25 ppm/°C) precision resistor. The system configuration dictates its value.
R81, R82, R83, R84 Bridge Completion	Bridge completion resistors.
R80 Bridge Balance	Resistor R80 is installed when the bridge balance signal is used for bridge balancing. R80, along with the coarse zero signal, determines the amount of bridge balancing applied to the circuit.

Shunt Calibration

The conditioner can be set up to apply a shunt calibration resistor across any leg of a transducer bridge by the installation of jumpers on the DC Conditioner circuit board.

Shunt Cal Config

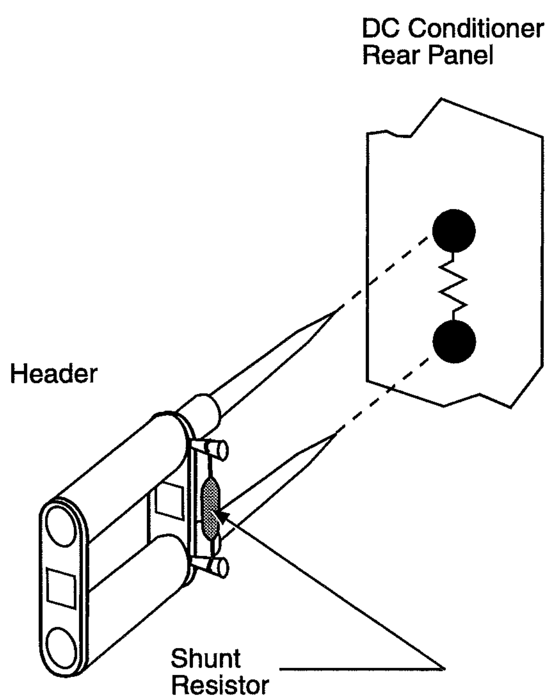
The configuration of the shunt calibration is controlled by X3 and X5. The X3 jumpers are installed for four-wire bridge connections and are removed when a remote shunt resistor is used. X5 is used to control which arm of the bridge the shunt calibration resistor is to be placed across.

Local R-Cal connection	X3:	pins 1-4 and 2-3 installed
Remote R-Cal connection	X3:	no connection
R-Cal to +EXS	X5:	pins 1 - 2
R-Cal to –EXS	X5:	pins 2 - 3

Shunt Cal Header

The shunt calibration header is a mini tip plug with two pins that fit into sockets on the panel of the DC Conditioner. Its MTS part number is 118719-14 (ITT Pomona part number 3545-0).

A resistor is soldered in place on the shunt calibration header, which can then be plugged into the DC Conditioner.



Determining the Resistor Value

The following table lists the shunt resistor values for standard ranges using 350Ω, 2 mV/V transducers.

Range	Resistor Value *	MTS Part Number
100%	49.9 kΩ	113407-22
50%	100.0 kΩ	113407-28
20%	249.0 kΩ	113407-29
10%	499.0 kΩ	113407-30
5%	1.0 MΩ	113407-31

* All resistors listed are rated at 0.1%, RN55E (25 ppm/°C).

Use the following formula to calculate the shunt cal resistor for resistive bridge transducers with a known sensitivity:

$$R_{SH} = R_0\left[\frac{1}{4 \times S \times (F_R/F_{FS})} - \frac{1}{2}\right]$$

where:

R_{SH} = shunt resistance in Ω
R_0 = nominal bridge resistance in Ω
F_R = desired simulated force
F_{FS} = full scale force rating of transducer
S = transducer sensitivity (volts out/volts excitation)

Example:

R_0 = 350 Ω
F_R = 80 lb
F_{FS} = 100 lb
S = 2 mV/V

$$R_{SH} = 350\left[\frac{1}{4 \times 0.002 \times (80/100)} - \frac{1}{2}\right]$$

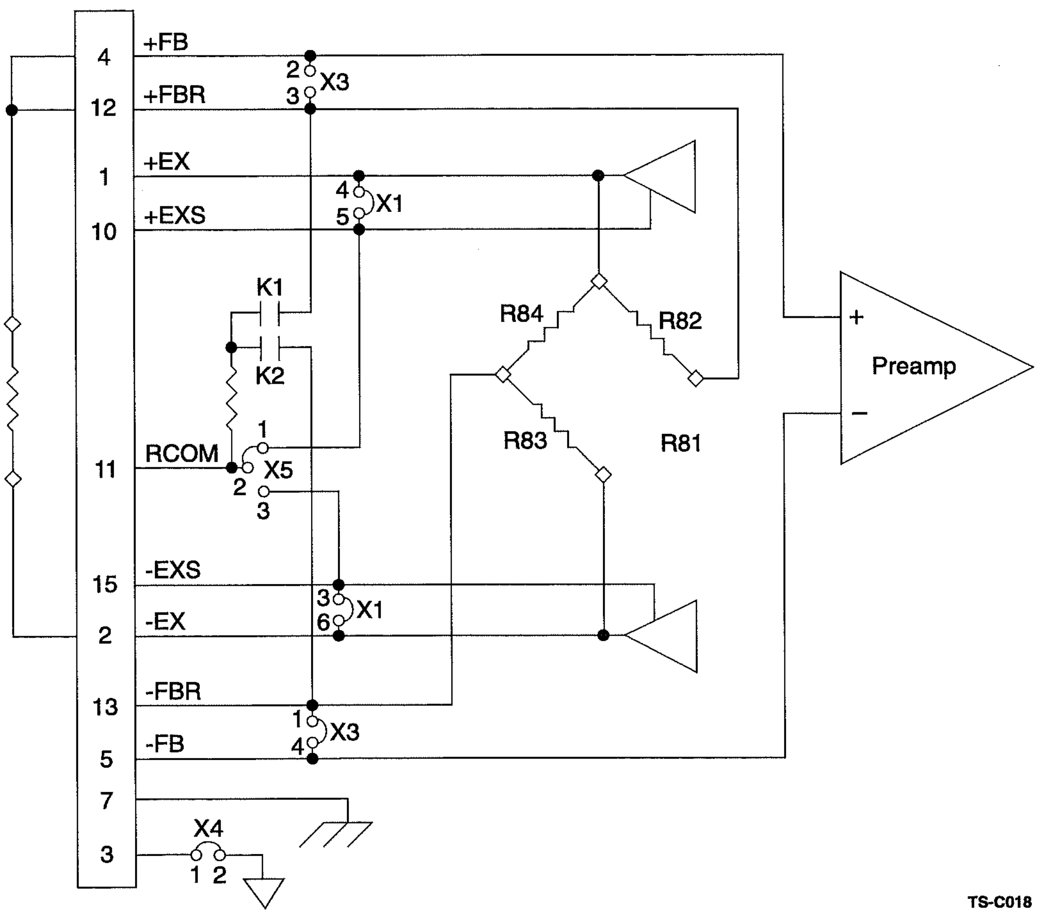
R_{SH} = 54.5 kΩ

Bridge Completion Configurations

The DC Conditioner provides a completion resistor network (resistors R81, R82, R83, and R84) to allow you to configure the board for specific transducer types. The completion resistor values are dependent on the transducer and must be calculated according to the application. Transducer types that can be accommodated by the conditioner include:

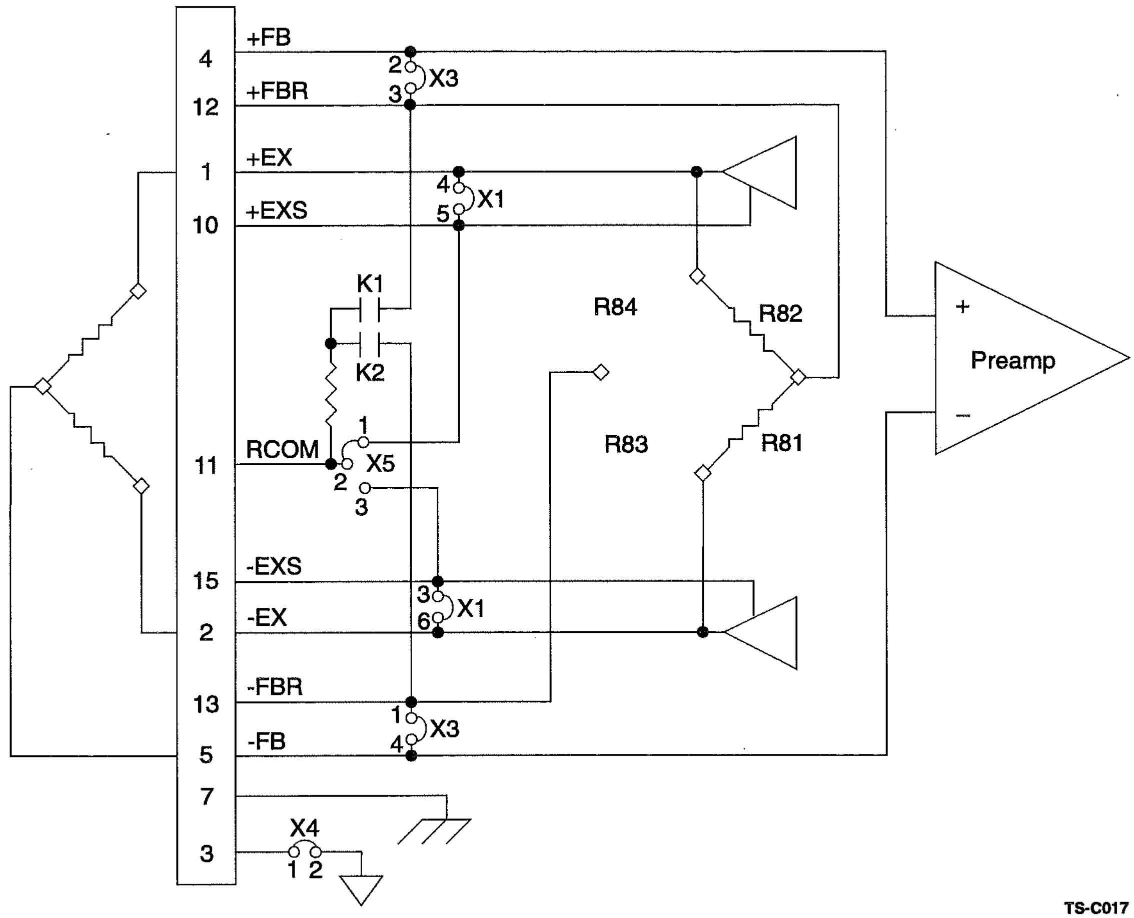
- quarter bridge (three-wire configuration)
- half bridge (three-wire configuration)
- full bridge transducers (four-through nine-wire configurations)

Quarter Bridge Three-wire Configuration



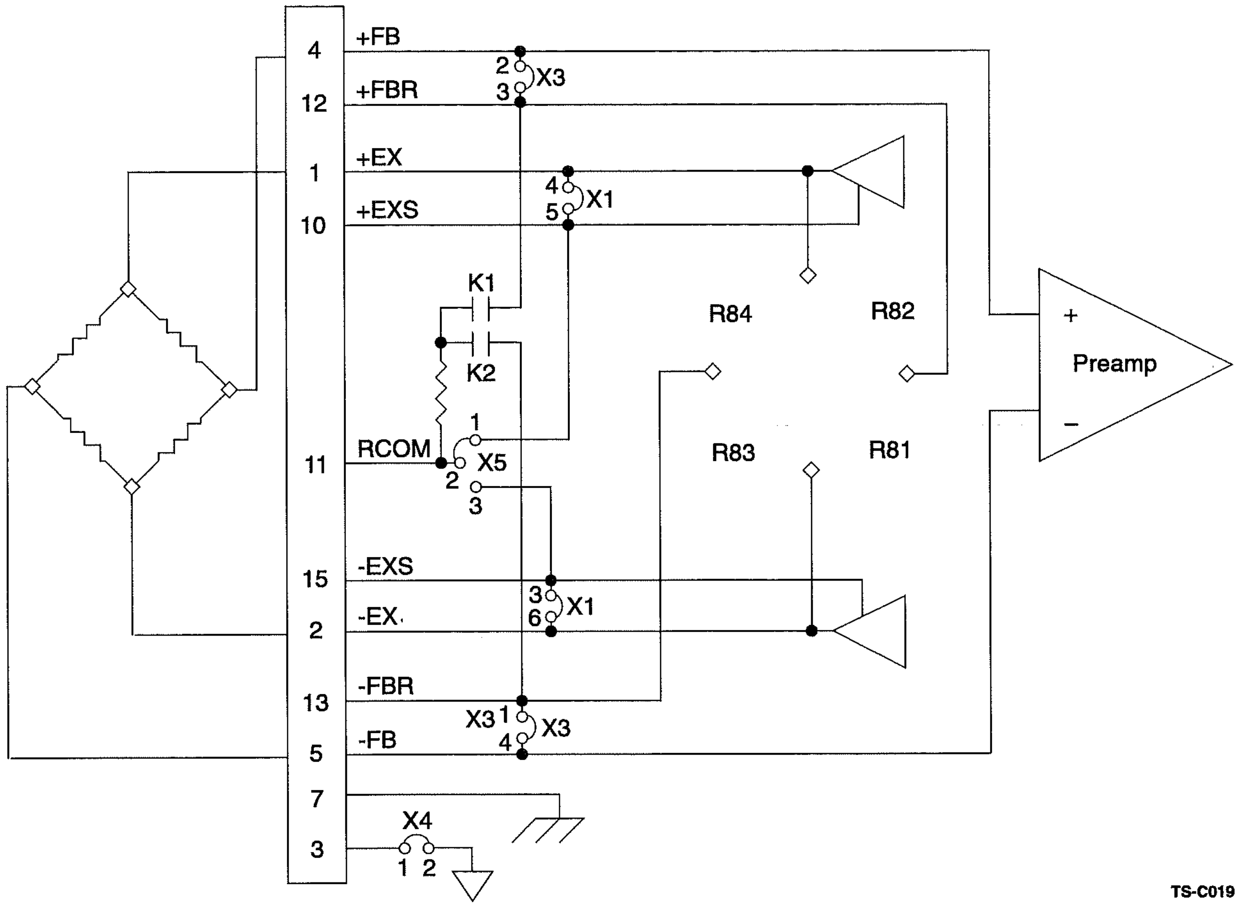
TS-C018

Half Bridge Three-wire Configuration

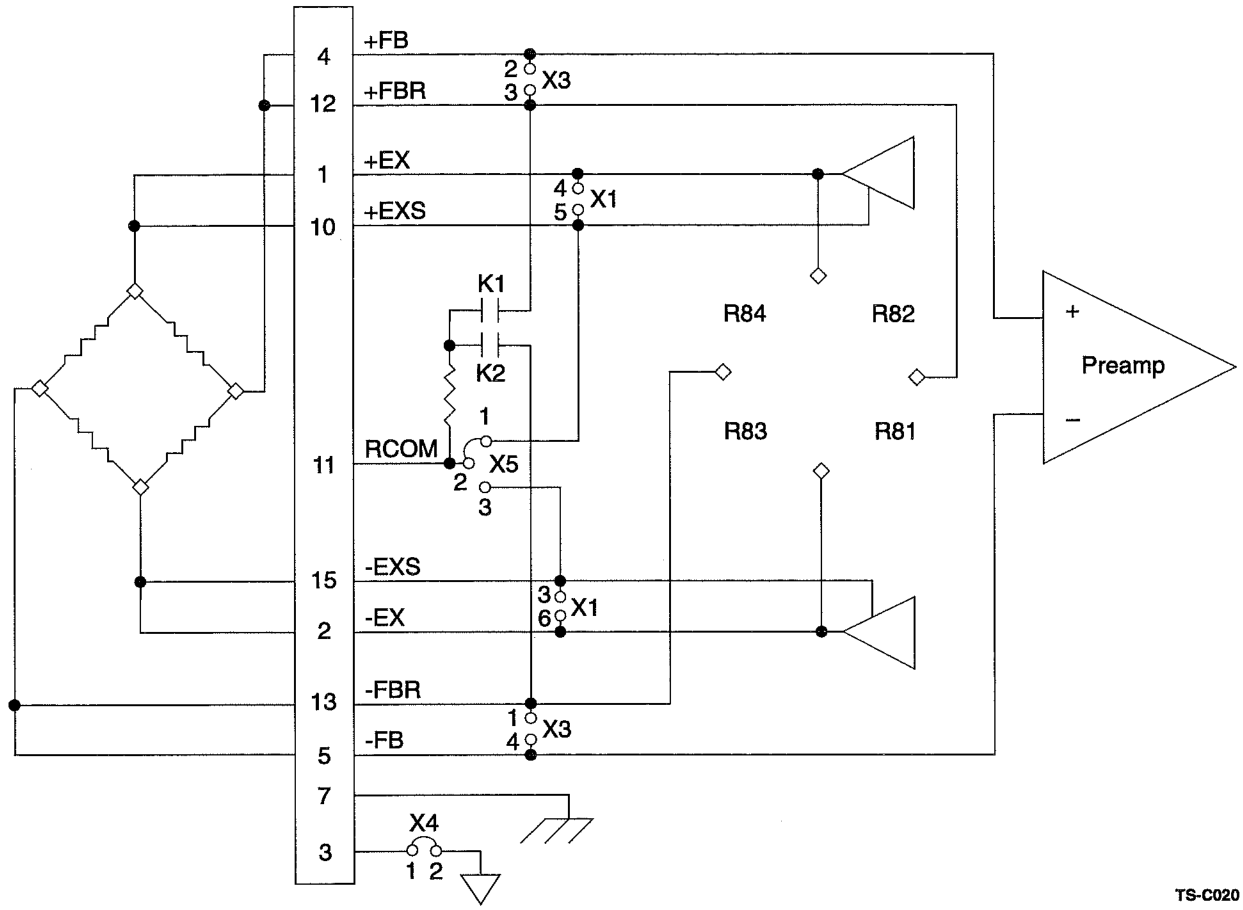


TS-C017

Full Bridge Four-wire Configuration

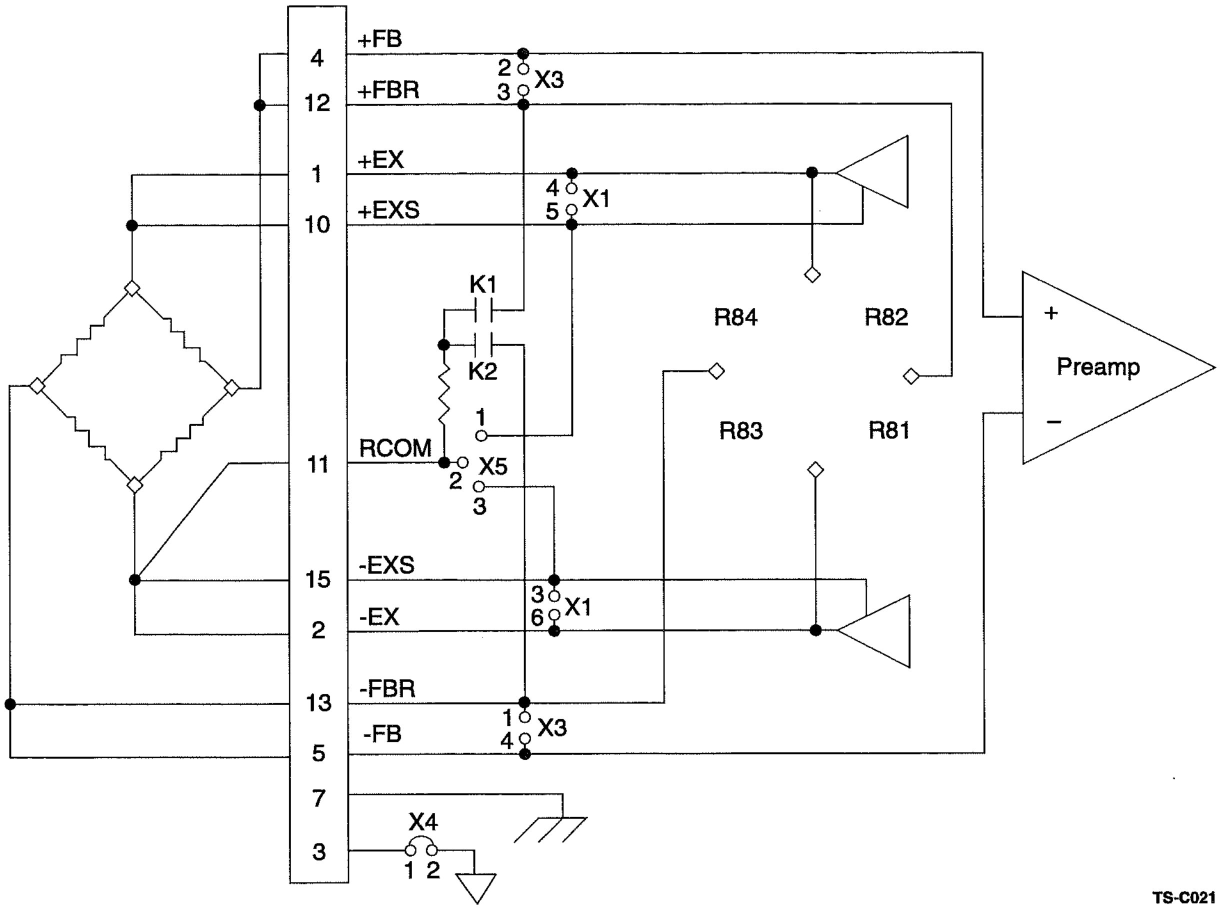


Full Bridge Eight-wire Configuration



TS-C020

Full Bridge Nine-wire Configuration



TS-C021

Typical Force Transducer Calibration

Load cells, torque cells, and differential pressure transducers measure force for servo loop control and readout purposes. Calibration should be performed with hydraulic pressure applied to the actuator. A force standard with direct readout—mounted in series between the actuator and transducer—is the equipment required for this procedure.

The following procedure gives a general outline for calibrating a load cell at –80%, 0%, and +80% of full scale. It does not specify further details and standards that might be used. In practice, use a more detailed procedure, (for example, MTS Calibration Procedure 1234). Some of the following considerations might improve the accuracy of the calibration:

- Environment—try to calibrate the transducer where it will be used, and at typical temperature and atmospheric conditions.
- Linearity—to make sure of linearity, check the calibration at more points (–100%, –80%, –60%, –40%, –20%, 0%, 20%, 40%, 60%, 80%, 100%)
- Repeatability—to check repeatability, run the calibration twice.

Use this formula to determine the actuator maximum force capability at a given pressure:

$$F = A_p \times P$$

where:

F	=	maximum force capability of the actuator in kip (kN)
Ap	=	effective piston area in in.^{2} (cm^2)
P	=	supply pressure in psi (MPa)(normally 3000 psi or 21 MPa)

To protect the transducer, F must be limited to a value 110% of the force transducer rating. If F is greater than this value, reduce the supply pressure.

This procedure uses the following menus: DCx Conditioner, Function Generator, and Controller.

1. Check the valve and feedback phasing for proper polarity. (Refer to "Valve and Feedback Polarity" in the Operation chapter of this manual.) Proper polarity is necessary to achieve control of the hydraulic actuator and for correct readout values.

2. Find the full scale force (F_{FS}) and sensitivity (S) for the force transducer from the manufacturer's specification sheet.

3. Determine the desired operating force range (F_R).

4. Select a conditioner setup (Setup1 or Setup2) for storing the calibration parameters. Note that any changes will overwrite existing values for that setup.

Typical Force Transducer Calibration (continued)

5. (*optional*) Set the conditioner Units to the desired engineering units for readout. (For example, Units = lb)

6. (*optional*) Set the conditioner F.S. Val to the desired full scale value of the engineering units. When engineering units are turned on, the full scale value entered here will be displayed when the conditioner is at 10.0 V. (For example, F.S. Val = 100)

7. Set the excitation voltage (V_{EX}) of the conditioner. A typical value for V_{EX} is 10.000 V for 350 Ω force transducers. Make sure not to exceed the maximum excitation voltage rating of the force transducer.

8. Use the following formula to compute an approximate conditioner gain (G) and enter it for the conditioner being calibrated:

$$G \approx \frac{10}{V_{EX} \times S \times (F_R / F_{FS})}$$

Example:

$$F_{FS} = 100 \text{ lb}$$
$$S = 2 \text{ mV/V}$$
$$F_R = 100 \text{ lb}$$
$$V_{EX} = 10.000 \text{ V}$$

$$G \approx \frac{10}{10.00 \times 0.002 \times (100/100)}$$

$$G \approx 500.0$$

9. In the DCx Conditioner menu, set Delta K to 1.000V/V.

10. In the Controller menu, set the PIDF control parameters to initial values that will not cause large or unstable actuator movements. Example:

FdBack	=	DCx (conditioner being calibrated)
P	=	1.0 (this is a good starting point, but some systems may need even lower gains to achieve stability)
I	=	0.0
D	=	0.0
F	=	0.0
ΔP	≈	0.0

11. While one end of the force transducer is free, adjust the coarse zero (C Zero) and fine zero (F Zero) offsets until the output is 0.000 V.

12. Press the Hydraulic Pressure Low key. Make sure the system is "incontrol" and stable, then press High.

Typical Force Transducer Calibration (continued)

13. Make sure the system is "incontrol" and stable at high pressure. If not, adjust the PIDF controller tuning parameters. For calibration it is desirable to tune the loop for an overdamped response. This will help ensure that the control loop remains stable if the conditioner gain needs to be increased later.

NOTE	When the controller gain is lower than the optimal setting you may not be able to achieve higher loads because of a large static error. In that case, increasing the integral (I) gain can help eliminate the static error. Typically the derivative (D) and feedforward (F) gains are set to zero during calibration. For more information on gains, refer to Appendix B of this manual.

⚠ WARNING

Installing or removing the force standard can involve working near pinch points while equipment is under pressure.

High pressure at pinch points can cause personal injury.

Keep clear of pinch points. If possible, keep the system at LOW pressure only during the installation or removal of the force standard.

14. Press the Hydraulic Pressure Low key.

15. Install a force standard. If the system must be at high pressure to install the force standard, then press the Hydraulic Pressure High key.

16. Adjust the setpoint (Setpnt) between –10% and –100% three times to reestablish the transducer hysteresis pattern. Readjust Setpnt until the force transducer output indicates 0.000 V.

NOTE	If you wish to use the keys, rather than the knob to change the setpoint, first set the setpoint ramp rate (Setpt R) in the Configuration menu to something slow (for example, 5%/s for a 20s ramp).

16. Adjust the force standard amplifier zero until the force standard reads zero.

17. Adjust the setpoint (Setpnt) until the force transducer output indicates –8.000V. Go to the DCx Conditioner menu and slowly adjust Gain, using the knob, until the force standard reads the equivalent of –80%.

Typical Force Transducer Calibration (continued)

18. Adjust the setpoint (Setpnt) until the force transducer output indicates 0.000V. Recheck the zero value on the force standard.

19. If the force transducer and force standard outputs differ significantly, readjust C Zero and F Zero (with one end of the force transducer free) until the output is 0.000 V . Then go back to Step 15.

NOTE A significant difference between force transducer and force standard outputs means that the force transducer zero may have been affected by the gain change. This phenomenon is more pronounced in force transducers that have large offsets at zero load.

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20. Adjust the setpoint (Setpnt) between +10% and +100% three times to reestablish the transducer hysteresis pattern. Readjust Setpnt until the force transducer output indicates 0.000 V.

21. Adjust the setpoint (Setpnt) until the force transducer output indicates +8.000 V. Go to the DCx Conditioner menu and slowly adjust Delta K, using the knob, until the force standard reads the equivalent of +80%.

22. Set the setpoint (Setpnt) to 0%. Turn off hydraulics.

23. Press the Hydraulic Pressure Low key.

24. Remove the force standard. If the system must be at high pressure to remove the force standard, then press the Hydraulic Pressure High key.

25. Turn off hydraulics.

26. Plug the appropriate shunt calibration resistor into the DC Conditioner panel. Apply shunt calibration and record the value. (The ideal value should be about 80%).

27. If the system was in operation before this calibration procedure, restore the original system parameters. Otherwise set hydraulics to high pressure, then tune the servoloop for an optimum response. (Do not use the force standard as a specimen for tuning.)

28. Turn off hydraulics.

29. Make a record of the conditioner and controller settings. Press Alt Func-Save (or switch setups) to save the conditioner setup settings. These settings will remain in battery-backed memory until they are overwritten with new values.

NOTE Switching setups can change all conditioner parameters and PIDF gains.

Strain Gage Calibration

The following procedure gives a general outline for calibrating a strain gage at –80%, 0%, and +80% of full scale. It does not specify further details and standards that might be used. Some of the following considerations might improve the accuracy of the calibration:

- Environment—try to calibrate the gage where it will be used, and at typical temperature and atmospheric conditions.
- Linearity—to verify linearity, check the calibration at more points (–100%, –80%, –60%, –40%, –20%, 0%, 20%, 40%, 60%, 80%, 100%)
- Repeatability—to check repeatability, run the calibration twice.

This procedure is for a single-element strain gage arranged as shown in the figure "Quarter Bridge Three-wire Configuration" earlier in this chapter. This procedure will automatically compensate for the wire resistances of the cable between the conditioner and strain gage.

1. Determine the gage factor (GF) and nominal gage resistance (R_0) for the strain gage from the manufacturer's data sheets. The resistance of the gage (R_S) is a function of the strain (ε) on the gage and is governed by the equation:

$$R_S = R_0\,(1 + GF \times \varepsilon)$$
$$= R_0 + \Delta R$$

2. Determine the full scale strain (ε_{FS}) for the calibration setup.

3. Compute the change in gage resistance (ΔR) at full scale strain (ε_{FS}):

$$\Delta R = R_0 \times GF \times \varepsilon_{FS}$$

Example:

$$R_0 = 350\ \Omega$$
$$GF = 2$$
$$\varepsilon_{FS} = 5000\ \mu\varepsilon$$

$$\Delta R = 350 \times 2 \times (5000 \times 10^{-4})$$
$$\Delta R = 3.5\ \Omega$$

4. Neglecting wire resistance, the output from the quarter bridge circuit is governed by:

$$V_0 = \left(\frac{\Delta R}{2R_0 + \Delta R}\right) \times \frac{V_{EX}}{2}$$

Compute the gain needed to amplify the bridge output so that the conditioner output is -8.0 V at -80% of full scale strain:

$$G = \frac{-8.0}{V_0(-80\%)}$$

Strain Gage Calibration (continued)

Example:

$R_0 = 350\ \Omega$
$\Delta R_{-80\%} = -2.8\ \Omega\ (-0.8 \times \Delta R)$
$V_{EX} = 10.0\ V$

$$G = \frac{-8.0}{\dfrac{-2.8}{2(350)+(-2.8)} \times 10/2}$$

$$G = 398.4 V/V$$

5. Compute the shunt cal resistance (R_{SH}) that would produce the same output as computed in step 4:

$$R_{SH} = -R_0\left(\frac{\Delta R + R_0}{\Delta R}\right)$$

Example:

$R_0 = 350\ \Omega$
$\Delta R_{-80\%} = -2.8\ \Omega$

$$R_{SH} = -350 \times \frac{-2.8+350}{-2.8}$$

$$R_{SH} = 43.4\ K\Omega$$

6. Select a shunt cal resistor with a standard value close to the R_{SH} computed in Step 5. Compute the equivalent strain:

$$\varepsilon_{SH} = \frac{\Delta R_{SH}}{GF \times R_0}$$

$$= \frac{1}{GF}\left(\frac{R_0}{R_0 + R_{SH}}\right)$$

Example:

$GF = 2$
$R_0 = 350\ \Omega$
$R_{SH} = 43.2\ K\Omega$ (standard 1% resistor value)

$$\varepsilon_{SH} = \frac{1}{2}\left(\frac{350}{350+43200}\right)$$

$$\varepsilon_{SH} = 4018.4\ \mu\varepsilon$$

Strain Gage Calibration (continued)

7. Initially set the conditioner gain and excitation values to those used in Step 4, and the coarse zero (C Zero) and fine zero (F Zero) to zero. When setting the excitation, make sure not to exceed the voltage ratings of the strain gage or completion resistors. With the gage unstrained and unshunted, check the initial zero. Extremely large offsets may be an indication of a bad gage or one that has been improperly pasted to the specimen. Zero the conditioner output using the coarse and fine zeroes.

   Example:

initial gain	=	398.4 V/V
initial coarse zero	=	0.0 V
initial fine zero	=	0.0 V
initial excitation	=	10.0 V (usually smaller for 120 Ω gages)

   Due to the nominal gage resistance tolerance (typically 1%) offsets as large as 100% could be possible.

8. Set the ΔK (Delta K) gain by the following equation to compensate for nonlinearities in the single element bridge:

   $$\Delta K = \left[1 + \left(\frac{GF}{2}\right)\varepsilon_{+80\%}\right]^2$$

   Example:

   $$GF = 2$$
   $$\varepsilon_{+80\%} = 4000\ \mu\varepsilon$$
   $$\Delta K = \left[1 + \left(\frac{2}{2}\right)4000 \times 10^{-4}\right]^2$$
   $$\Delta K = 1.008$$

9. Use DC Shunt Cal Chk to activate the positive (+FB) shunt. Adjust DCx Conditioner Gain until the conditioner output is equal to the output computed below. Although the gain (G) computed in Step 4 will be close to the necessary value, any wire resistance will desensitize the strain gage. For this reason, Gain must be increased slightly to compensate.

   $$V_{OUT} = 10\left(\frac{\varepsilon_{SH}}{\varepsilon_{FS}}\right)(\Delta K)$$

   Example:

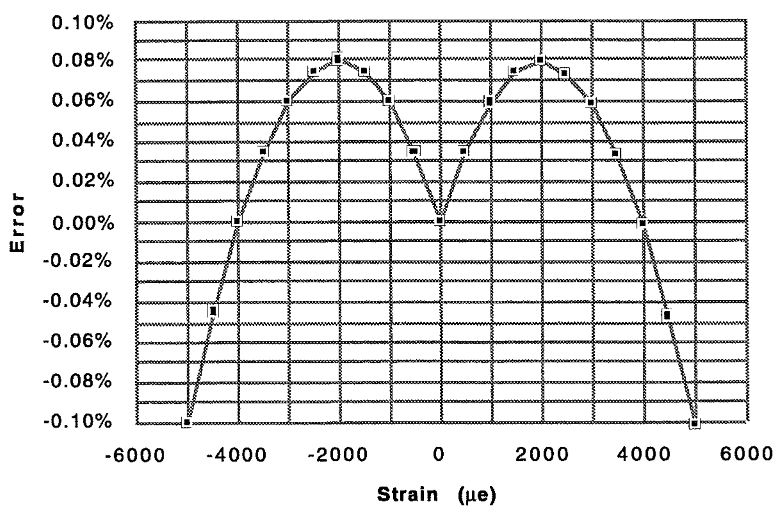
   $$\varepsilon_{SH} = 4018.4\ \mu\varepsilon$$
   $$\varepsilon_{FS} = 5000\ \mu\varepsilon$$
   $$\Delta K = 1.008$$

   $$V_{OUT} = 10\left(\frac{4018.4}{5000}\right)(1.008)$$
   $$V_{OUT} = 8.101\ V$$

Strain Gage Reference Information

The following table and figure show data for the "ideal" output from the strain gage conditioner setup with the above procedure. Actual accuracies will depend on factors not considered here such as the accuracy of the gage factor (GF).

Strain (με)	Rg (Ω)	V_{OUT} desired	V_{OUT} w/ΔK	Error (%)
−5000	346.50	−10.00	−10.010	−0.10
−4500	346.85	−9.00	−9.005	−0.05
−4000	347.20	−8.00	−8.000	0.00
−3500	347.55	−7.00	−6.997	0.03
−3000	347.90	−6.00	−5.994	0.06
−2500	348.25	−5.00	−4.993	0.08
−2000	348.60	−4.00	−3.992	0.08
−1500	348.95	−3.00	−2.993	0.07
−1000	349.30	−2.00	−1.994	0.06
−500	349.65	−1.00	−0.996	0.04
0	350.00	0.00	0.000	0.00
500	350.35	1.00	1.003	0.03
1000	350.70	2.00	2.006	0.06
1500	351.05	3.00	3.007	0.07
2000	351.40	4.00	4.008	0.08
2500	351.75	5.00	5.007	0.07
3000	352.10	6.00	6.006	0.06
3500	352.45	7.00	7.003	0.03
4000	352.80	8.00	8.000	0.00
4500	353.15	9.00	8.995	−0.05
5000	353.50	10.00	9.990	−0.10



Ideal Error Curve for Three–wire Single-element Strain Gage Using ΔK Linearization

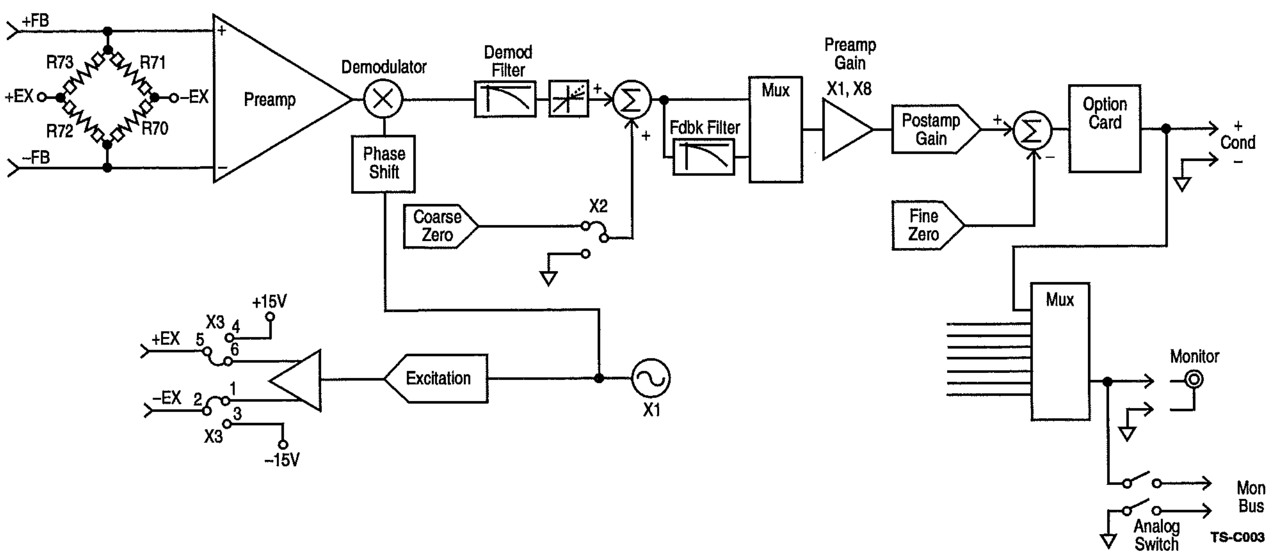
Chapter 6
Model 407.14 AC Conditioner

Description

The 407.14 AC Conditioner is a single-channel ac transducer conditioner module specifically designed for user interactive applications using MTS Series 407 electronics. The AC Conditioner provides transducer excitation and output signal amplification for a wide variety of ac transducers. The following is a simplified block diagram of the AC Conditioner circuitry.

The module provides the following features:

- adjustable gain
- adjustable excitation
- adjustable output zeroing
- adjustable demodulator phase adjustment
- adjustable output selection



Monitor Output

The conditioner output circuitry provides selectable monitor output signal selection. Any of the following signals can be selected for the monitor output:

- GND—ground
- FDBK—feedback
- DEMOD—demodulator
- C ZERO—coarse zero value
- F ZERO—fine zero value
- +EXCIT—plus excitation output
- –EXCIT— minus excitation output
- 5.00 V—on-board reference

Gain and Zero Offset

The AC Conditioner can be programmed to provide transducer output signal amplification within a range of 1 to 80. This provides compatibility with both low-level and high-level transducers. An adjustable zero offset voltage provides a dc offset of the conditioner output. This offset can be introduced either before or after the gain stage.

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

Two offset sources are available on the AC Conditioner: coarse zero and fine zero. The functions of these sources are determined by the installation of jumpers on the board.

Demodulator Phase

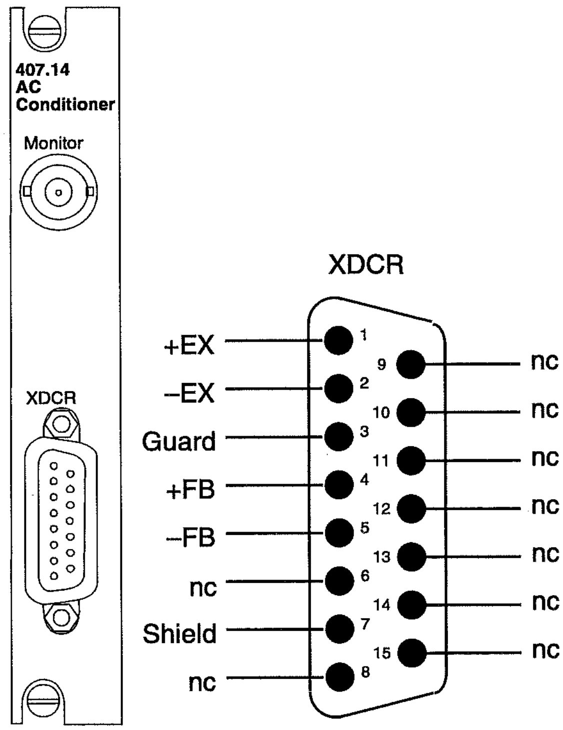
The AC Conditioner provides a demodulator phase adjustment within a range of ±90°.

Transducer Excitation

The AC Conditioner provides an amplitude-adjustable 10 kHz excitation signal to the transducer. The excitation amplitude is adjustable within a range of 0 to 40 Vp-p (or ±20 V differential at the transducer).

AC Conditioner Panel

The AC Conditioner panel includes a BNC connector for signal monitoring and a 15-pin, female, D-type connector for transducer connections.



Monitor BNC connector

The BNC Monitor connector provides connections to a readout device. The signal available on the Monitor connector is selected through the user interface display.

XDCR connector

The XDCR 15 pin, female, D type connector provides connections to the associated system transducer, ususally an LVDT (linear variable differential transformer).

Board Configurations

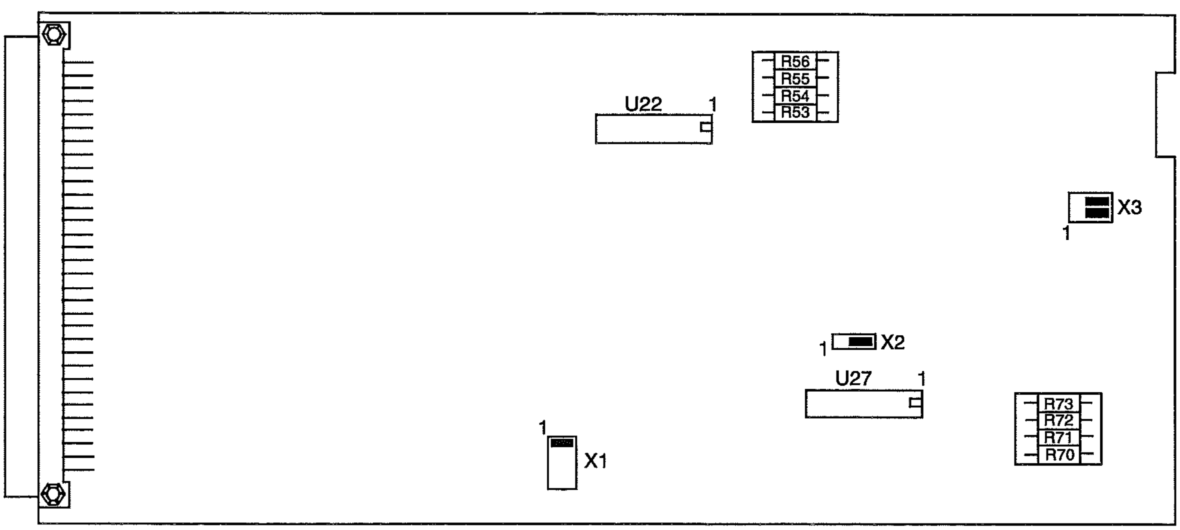
NOTE The following information is intended for *qualified service personnel* only.

The AC Conditioner contains a number of on-board jumpers that are used to configure the module specifically for your application. These jumpers are typically installed by MTS prior to system installation for proper operation in your application. *Do not change the position of any of these jumpers unless system requirements have changed.*

The following information is necessary only if you intend to change the operating configuration of the module from its original setup or if the module was not set up by MTS prior to shipment.

Jumper and Resistor Locations

The following figure shows the jumper and select resistor locations on the conditioner circuit board.



407.14 AC Conditioner Jumper Summary

On-board jumper blocks and "select" resistors are used to establish certain parameters and make use of various functions on the AC Conditioner board. The following table provides a summary of the AC Conditioner jumper blocks and resistors. Those that need further definition are described in detail later in this chapter.

Jumper	Setting	Function
X1		Excitation frequency selection
	1–8	10 kHz (default)
	2–7	5 kHz
	3–6	2.5 kHz
	4–5	1.25 kHz
X2		Preamp zero reference. Connects coarse zero or ground (guard) into summation amplifier.
	2–3	Coarse zero (default)
	1–2	Analog ground (guard)
X3		Excitation selection. Selects voltage excitation source.
	1–2 5–6	Adjustable excitation
	2–3 4–5	Fixed ±15 Vdc excitation
U22		Conditioner output filter header (200 Hz default)
U27		Demodulator filter. 2 kHz default (MTS part number 477744-06). Should be changed if X1 is changed from 10kHz. The available filters are described later in this chapter.

Excitation Frequency and Mode Selection (X1 and X3)

Transducer Excitation

The AC Conditioner provides an amplitude-adjustable 10 kHz excitation signal to the transducer. The excitation amplitude is adjustable within a range of 0 to 40 Vp-p (±20 V differential at the transducer).

Excitation Frequency

Jumper block X1 is used to select the excitation frequency as follows:

10 kHz (default)	X1:	pins 1-8 installed
5 kHz	X1:	pins 2-7 installed
2.5 kHz	X1:	pins 3-6 installed
1.25 kHz	X1:	pins 4-5 installed

High Level Excitation

Some transducers contain internal conditioning electronics and require a supply voltage greater than can be achieved by the 407 adjustable supply. For those transducers, the excitation output can be wired directly to the 407 power supply (±15V) through X3.

Adjustable excitation:

X3: pins 1-2
pins 5-6

Fixed ±15V excitation:

X3: pins 2-3
pins 4-5

Preamp Zero Reference Selection (X2)

The preamp zero reference can be either coarse zero or ground (guard).

Jumper block X2 is used to configure the preamp zero reference. Install jumpers as follows:

Coarse zero (default):

X2: pins 2-3 jumpered

Analog ground (guard)

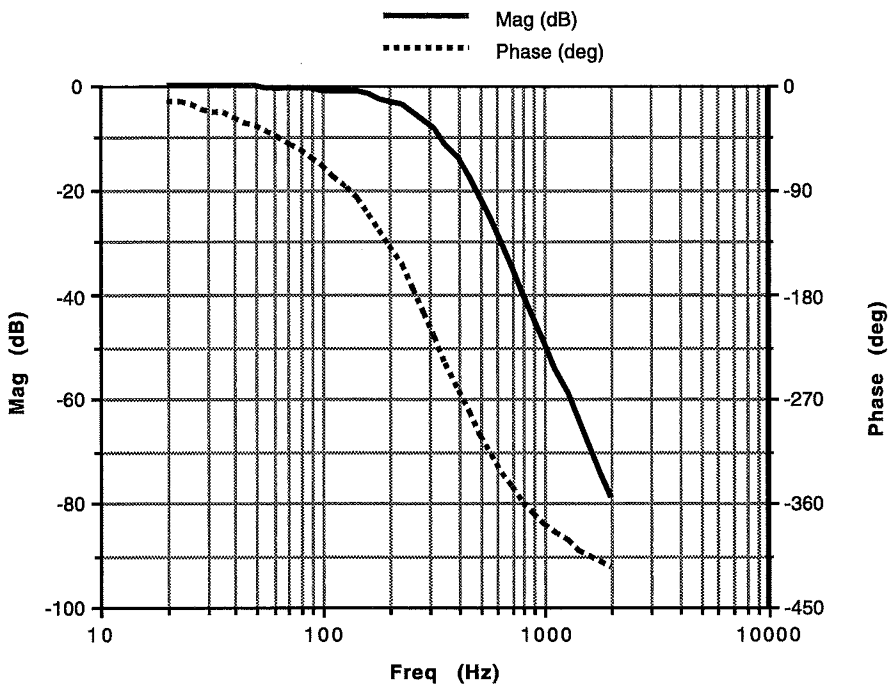
X2: pins 1-2 jumpered

Filtration (U22 and U27)

The AC Conditioner contains a low pass filter (U22) and a demodulator filter (U27). Either filter can support up to 5th order Butterworth, Chebychev, Linear-Phase Elliptic, and Bessel responses.

The filter type and cutoff frequency can be changed by the insertion of a Single In-line Package (SIP) module containing the appropriate component configuration. The filter can be used to reduce unwanted high frequency noise when necessary.

The following figure shows the cutoff frequency for the default 200 Hz Bessel filter.



The available filter modules, with their MTS part numbers and characteristics, are listed in the Service chapter of this manual. The SIP filter module is installed in U22 (low pass filter) or U27 (demodulator filter). The standard for either filter is 200 Hz.

Demodulator Filter (U27)

The demodulator is a synchronous demodulator with a software-controlled ±90° phase adjustment and a five-pole Bessel filter. The filter characteristics are determined by an SIP filter module installed on the board. The default module is suitable for demodulation of a 10 kHz carrier frequency. To lower the high frequency noise, the filter cutoff frequency can be lowered (at the expense of decreased control bandwidth).

For optimum operation, the SIP filter module should be changed to match the carrier frequency whenever that frequency has been changed from the default (10 kHz).

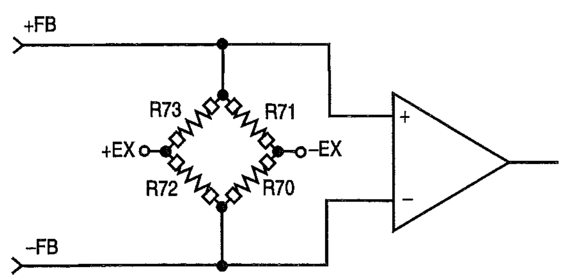
The following table lists the recommended demodulator filter cutoff frequency for various excitation frequencies.

Recommended Demodulator Filter Frequencies

Excitation Freq	Cutoff Freq
10 kHz	2000 Hz
5 kHz	1000 Hz
2.5 kHz	500 Hz
1.25 kHz	200 Hz

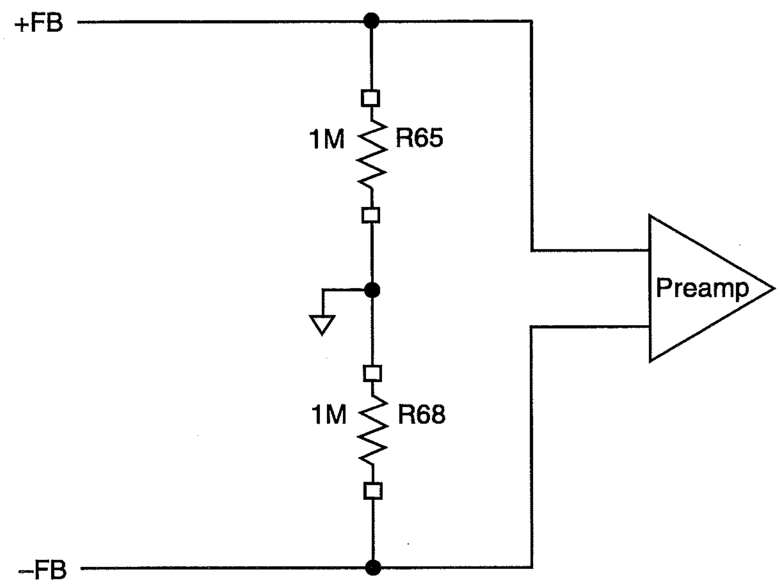
Completion Resistors

The standard AC Conditioner has no completion resistors installed. Some applications may require this option. For example, some Hottinger LVDTs require completion resistors. This is accomplished by installing resistors R70 to R73.



Floating Source Reference

When the AC Conditioner is used with a transducer configuration that uses an external floating excitation source instead of the on-board excitation, an ac path to ground must be established for the conditioner preamp. This is accomplished by resistors provided between the positive and negative feedback lines to ground.



LVDT Calibration

The following procedure gives a general outline for calibrating an LVDT at –80%, 0%, and +80% of full scale. It does not specify further details and standards that might be used. Some of the following considerations might improve the accuracy of the calibration:

- Environment—try to calibrate the LVDT where it will be used, and at typical temperature and atmospheric conditions.
- Linearity—to make sure of linearity, check the calibration at more points (–100%, –80%, –60%, –40%, –20%, 0%, 20%, 40%, 60%, 80%, 100%)
- Repeatability—to check repeatability, run the calibration twice.

This procedure uses the following menus: ACx Conditioner, Function Generator.

1. Find the full scale stroke (L_{FS}) and sensitivity (S) for the LVDT from the manufacturer's specification sheet.

2. Determine the desired operating stroke range (L_R).

3. Select a desired conditioner setup (Setup1 or Setup2) to store the calibration parameters. Note that any changes will overwrite existing values for that setup.

4. *(optional)* Set the conditioner units (Units) to the desired engineering units for readout.

   Example:

   Units = mm

5. *(optional)* Set the conditioner full scale value (F.S. Val) to the desired full scale value of the engineering units. When engineering units are turned on, the full scale value entered here will be displayed when the conditioner is at 10.0V.

   Example:

   F.S. Val = 100

6. Set the excitation voltage (V_{EX}) of the conditioner. A typical value for V_{EX} is 20.000 V_{PP} for an LVDT. Make sure the value does not exceed the LVDT maximum excitation voltage rating.

7. Compute an approximate conditioner gain (G) and enter it for the conditioner being calibrated.

$$G \approx \frac{10\pi}{V_{EX} \times S \times (F_R / F_{FS})}$$

LVDT Calibration (continued)

Example:

π	=	3.1416
F_{FS}	=	100 mm
S	=	0.5 V/V
F_R	=	100 mm
V_{EX}	=	20.000 V_{PP}

$$G \approx \frac{10 \times 3.1416}{20 \times 0.5 \ \times (100/100)}$$

$$G \approx 3.14$$

8. Check the valve and feedback phasing for proper polarity. (Refer to "Valve and Feedback Polarity" in the Operation chapter of this manual.) This is necessary to achieve control of the hydraulic actuator and for proper readout polarity.

9. In the Controller menu, set the PIDF control parameters to initial values that will not cause large or unstable actuator movements.

   Example:

FdBack	=	ACx COND (the stroke control channel)
P	=	1.0 (this is a good starting point, but some systems may need lower gains to achieve stability)
I	=	0.0
D	=	0.0
F	=	0.0
ΔP	≈	0.0

10. Set the conditioner ΔK (Delta K) to 1.000V/V, coarse zero (C Zero) to 0.000V and fine zero (F Zero) to 0.000V.

11. Adjust the setpoint (SetPnt) until the error signal is close to zero and then turn the hydraulics on. Low pressure should be sufficient to move the actuator through its full range.

12. Check the PIDF controller tuning parameters. For calibration it is desirable to tune the loop for an overdamped response. This will help ensure that the control loop remains stable if the conditioner gain needs to be increased later.

13. Adjust the setpoint (Setpnt) to fully retract the actuator without positioning it in the end cap.

14. Mount a dial indicator between the actuator rod and a stationary point such as the actuator upper end cap. Zero the dial indicator.

LVDT Calibration (continued)

15. Adjust the conditioner demodulator phase (Phase) to obtain maximum actuator extension.

16. Set the setpoint (Setpnt) to 0%. Adjust the conditioner zero offsets (CZero and F Zero) to position the actuator at its reference "home," usually mid-displacement.

17. Adjust the setpoint (Setpnt) until the conditioner output is –8.000 V. Adjust the conditioner gain (Gain) until the dial indicator shows the actuator at –80% of its full scale displacement.

18. Set the setpoint (Setpnt) to 0% and recheck the zero. If the actuator is not at its reference position, repeat from Steps 16. Note that the overall zero will change as the conditioner gain is changed if the coarse zero is not set to zero.

19. Adjust the setpoint (Setpnt) until the conditioner output is +8.000 V. Slowly adjust the conditioner ΔK (Delta K) with the knob until the dial indicator shows the actuator at +80% of its full scale displacement.

20. Set hydraulics to high pressure. Tune the servo loop for an optimum response.

21. Make a record of the gain and settings. Press Alt Func-Save (or switch setups) to save the conditioner settings. These settings will remain in battery-backed memory until they are overwritten with new values.

NOTE Switching setups can change all conditioner parameters and PIDF gains.
