HA100A Electro-Hydraulic Actuator for hazardous areas

Operations Guide

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Rev. 1

TRICONEX

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REVISION HISTORY

Rev. 0	11/9/99	Initial publication
Rev. 1	1/4/02	Revised per ECO 4043.

Warnings!

READ THIS ENTIRE MANUAL AND ALL RELATED PUBLICATIONS PERTAINING TO THE WORK TO BE PERFORMED BEFORE INSTALLING, OPERATING, OR SERVICING THIS EQUIPMENT.

- **Practice all plant and safety codes and standards. Failure to follow instructions can result in personal injury and/or property damage.**
- To prevent ignition of hazardous atmosphere, do not remove covers of Class I Division I (explosion-proof) units with power applied.
- All servicing should be performed by qualified technicians. Dangerous voltages may be present on the circuit boards.
- Use extreme caution when working around power-input cables. These cables may have potentially lethal voltages on them.
- Be very careful when working on the digital (or discrete) input/output field termination panels. The external devices being controlled can have high, potentially lethal voltages on them. Turn off the power to the external devices before disconnecting or connecting the cable or a wire between the digital (or discrete) input/output field termination panels and the field wiring.
- Replace fuses only with specified parts for continued safe operation.
- **Equip the engine, turbine, or other type of prime mover with an overspeed (overtemperature or overpressure, where applicable) shutdown device that operates totally independently of the prime mover control device. This protects against run-away or damage to the engine, turbine, or other prime mover, or personal injury or loss of life, should the mechanical-hydraulic or electronic governor, actuator, fuel control, driving mechanism, linkage, or controlled device fail.**
- Make sure the charging device is turned off before disconnecting the battery from the system to prevent damage to a control system that uses an alternator or battery-charging device.
- Prior to energizing the equipment, have qualified personnel verify all wiring and connections against vendor drawings. Incorrect wiring and/or connections can result in equipment damage.
- Contact appropriate manufacturer for instructions on operation of engine, turbine, or driven unit. This manual does not contain this information.

If you have questions or need more information on installing and operating Triconex equipment, contact the Triconex Customer Service Department.

Disclaimer

Because of the variety of uses for this equipment, the user of and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and the use of the equipment.

The illustrations in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Triconex cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

In no event will Triconex be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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No patent or copyright liability is assumed by Triconex with respect to use of information, circuits, equipment, or software described in this text.

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Warranty

All Triconex products are warranted to be free of defects in materials and workmanship for a period of one year from date of start-up of our equipment or 18 months from date of shipment, whichever comes first. In case of failure, Triconex liability shall be limited to furnishing, but not installing, necessary repair parts; or at the option of Triconex, to repairing the defective product at its manufacturing location, providing the equipment is returned at purchaser’s expense.

This warranty does not apply to equipment showing abuse or damage or to equipment which has been altered or repaired by others, except as authorized by Triconex. Nor does it extend to products that have been subjected to a corrosive and/or abnormal atmosphere, or to product components (such as batteries, lamps, etc.) which have provided a normal service life.

Triconex will determine if warranty applies when material is received at its manufacturing location. A purchase order and a Returned Merchandise Authorization (RMA) must accompany all returned material. The purchase order number as well as the RMA number should be clearly marked on the outside of the shipping container. Triconex Customer Service Department issues RMA numbers.

In no event will responsibility be assumed or implied for consequential damages arising from interrupted operation or any other causes.

This warranty is in lieu of all other warranties expressed or implied, and no one is authorized to assume any liability on behalf of Triconex, or to impose any liability on behalf of Triconex, or to impose any obligation on it in connection with the sale of any equipment other than as stated above.

Electrostatic Discharge Awareness

Electrostatic discharge can damage or destroy electronic components, assemblies, or systems.

1. Keep the following materials away from components and work area:
   - Styrofoam® (polystyrene): cups, packing material
   - cellophane: cigarette packages or candy wrappers
   - vinyl: books or folders
   - plastic: cups, bottles, ash trays
2. Avoid synthetic clothing. Instead wear cotton or cotton-blend materials. Keep components away from elastics, clothing, and hair.
3. *Before* handling electronic components, discharge static electricity buildup from your body by using a properly connected wrist strap.
4. *Do not handle components in the field unless properly grounded via wrist strap*. If you are not properly grounded:
   - Do *not* pick up components.
   - Do *not* touch the printed circuit board.
   - Do *not* remove components from the chassis.
5. Transport all static-sensitive components only in static-shielding carriers or packages. Place static awareness labels on all components to prevent removal from static-shielding container during transit.
6. Handle all static-sensitive components at a static-safe work area including floor mat, wrist strap, air ionizer, ground cord, and conductive tablemat.
7. *Wear a grounded wrist strap in the field whenever possible*. Where wrist straps are impractical, wear grounded heel straps or special footwear on properly grounded dissipative flooring.
8. Do *not* subject components to sliding movements over any surface at any time.

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Contents

Illustrations

Chapter 1 - Introduction

This manual describes the *HA100A* Electro-Hydraulic Actuator, which is a general-purpose actuator, specifically designed for turbine control applications requiring high performance and the utmost reliability.

About This Manual

As its name implies, this manual is a *guide* to using the *HA100A* actuator. In depth user training is available from Triconex.

This manual contains the following chapters:

- Chapter 1 - Introduction
  This chapter contains information about this document and related reference documents.

- Chapter 2 - Product Description
  This chapter presents an overall description of the *HA100A* and discusses general operation.

- Chapter 3 - Application
  This chapter briefly summarizes various applications for which the *HA100A* is appropriate and gives wiring examples.

- Chapter 4 - Installation
  This chapter explains how to install an *HA100A* including electrical and hydraulic connections and mechanical linkage.

- Chapter 5 - Startup
  This chapter describes how to prepare for and begin operating the *HA100A*.

- Chapter 6 - Maintenance
  This chapter presents testing and maintenance information.

- Chapter 7 - Field Calibration
  This chapter provides instructions for changing the calibration of the *HA100A* for different service than when it was shipped from the factory.

- Chapter 8 - Specifications
  This chapter contains specifications for the *HA100A*.

- Appendix A
  This appendix provides information for operating the *HA100A* with the Triconex M306 Servo-Controller.

- Appendix B
  This appendix discusses ways to correct and/or avoid hydraulic system contamination.

By reading this manual, you will be able to: apply, install, and maintain the *HA100A*. For additional information call Triconex Customer Service.

Documentation Conventions

This manual uses the following typographic conventions:

Example	Description
NOTE	Notes contain supplementary information.
CAUTION	This symbol precedes information about potential equipment damage.
WARNING	**This symbol precedes information about potential personnel hazards.**

User Experience Prerequisites

To effectively use the *HA100A*, users should have some experience with the use of hydraulic and control systems.

Extremely advantageous, though not required, is experience with turbine control systems, and normal operational control procedures within a plant environment.

Reference Documents

- Digital Control System Manual(s); e.g. *TRISEN 310*, etc.
- Documentation provided with other components of a system containing an *HA100A*; e.g., *M306*, etc.

Chapter 2 - Product Description

The *HA100A* is an electro-hydraulic proportional actuator with internal mechanical feedback. It is designed for use with Triconex turbine control systems such as TS310, TS1000, and TS3000. The *HA100A* functions as a signal transducer. It converts an electric current signal into a proportional mechanical position. It is a component part of a larger prime mover control system.

The following is a list of the major features of the *HA100A*:

- Extremely precise mechanical position
- High speed response
- Ability to operate with low hydraulic supply pressure
- The dual coil design can be set up to provide a redundant backup
- The *HA100A* can be configured to provide retract or extend output shaft movement with an increase in current signal
- The *HA100A* is approved for use in Class I, Division 2 hazardous (explosive) environments, if proper installation requirements are followed.

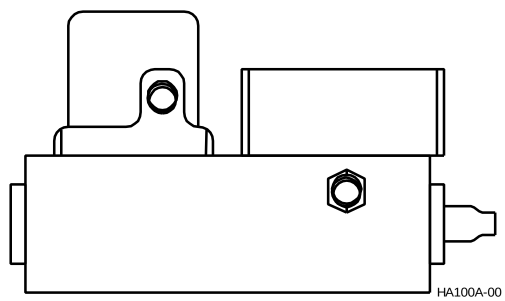

Figure 1. General Appearance of the *HA100A*

The *HA100A* requires a hydraulic supply pressure between 80 and 400 psig. The maximum stroke is 1.00" when driven with a coil current of 2 to 36 mA DC. The unit can be adjusted to either extend or retract the output shaft with an increase in input current. The *HA100A* provides an output thrust of 400 pounds with a 200 psig supply and can actuate small turbine steam and fuel valves directly in many cases.

Larger loads require the *HA100A* to be used as a pilot actuator to control a larger actuator using electrical or mechanical position feedback techniques. Refer to Chapter 3 for typical application information and examples.

The *HA100A* is typically used in conjunction with an M306 Servo-Controller which can be configured as a current amplifier or a closed loop servo-controller. The M306 will accept a 4-20 mA position command signal from the turbine controller and output the required 2-36 mA drive to the *HA100A* coils. It also provides adjustable dither to improve resolution.

Redundant coils are a standard feature of the *HA100A* and various arrangements can be used to provide protection against a failed coil or current driver. Refer to Chapter 3, Application, for additional information.

The *HA100A* housing and output shaft are made of stainless steel. Internal wetted parts are stainless steel, brass or aluminum. Hydraulic valve parts are through-hardened stainless steel. All O-rings are Viton®. Seals are nitrile, urethane, or Teflon®.

General Operation

The *HA100A* is a mechanical feedback, electro-hydraulic actuator which produces a linear 1.00" output shaft stroke proportional to a 2 to 36 mA current input. The unit consists of 3 subassemblies:

- A Torque Motor
- A Hydraulic Power Stage
- A 2 square-inch Piston Actuator

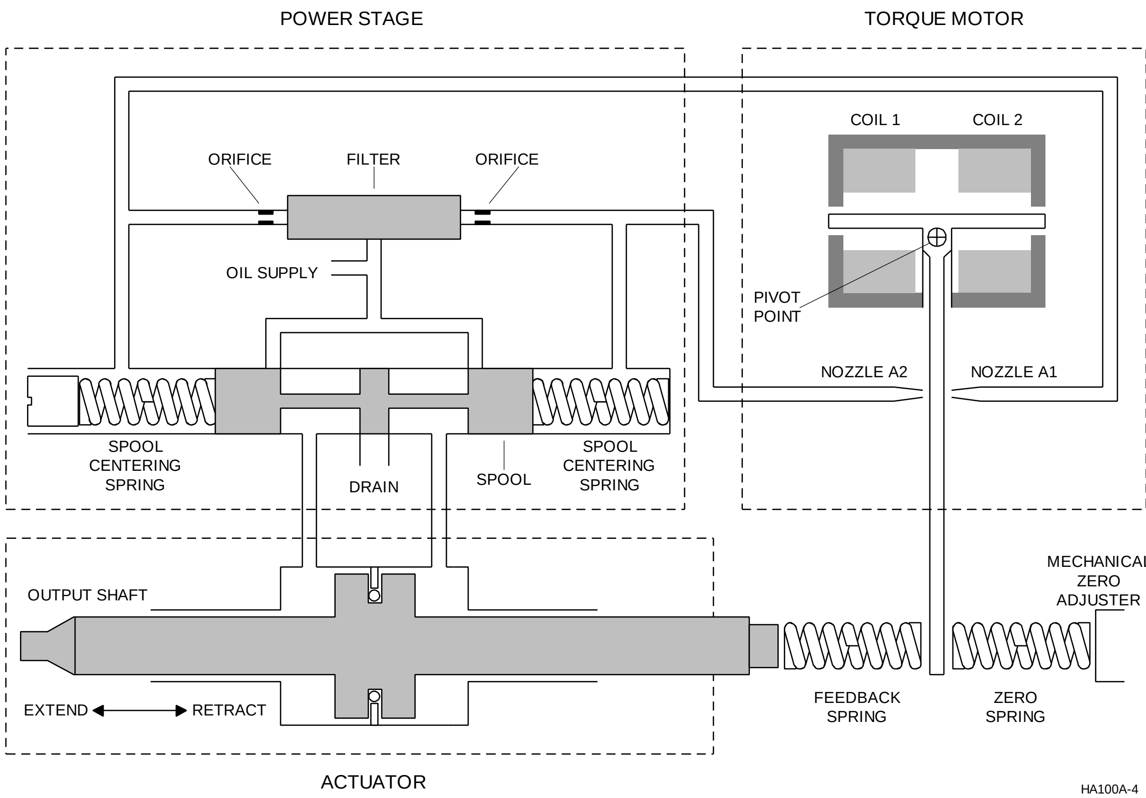

Figure 2. Overall Function Diagram

The *HA100A* can be calibrated to either retract or extend the output shaft with an increase in input current. A description of operation for each option follows. Refer to Chapter 7 for a description of how to calibrate the actuator for each direction of motion. When supplied from the factory, the actuator is initially calibrated according to customer specifications.

Increasing Current to Retract Actuator

In operation, the actuator position is constant whenever the forces balance around the torque motor pivot point.

- An increase in input current causes an imbalance at the pivot point and the feedback arm to move to the left.
  Simultaneously, nozzle A2 is closing and nozzle A1 is opening which creates a differential pressure.
- The differential pressure is applied to the power stage spool, resulting in spool movement to the left.
- Supply pressure is ported to the left side of the power piston and the right side is ported to drain.
- The piston moves to the right, compressing the feedback spring and pushing the feedback arm to the right until the forces are again balanced around the pivot point. The feedback arm is then recentered between the nozzles, differential pressure reduces to zero, the powerstage spool recenters, and piston motion stops.

Increasing Current to Extend Actuator

- An increase in input current causes an imbalance at the pivot point and the feedback arm to move to the right.
  Simultaneously nozzle A2 is opening and nozzle A1 is closing which creates a differential pressure.
- The differential pressure is applied to the power stage spool, resulting in spool movement to the right.
- Supply pressure is ported to the right side of the power piston and the left side is ported to drain.
- The piston moves to the left, extending the feedback spring and allowing the zero spring to push the feedback arm to the left until the forces are again balanced around the pivot point. The feedback arm is then recentered between the nozzles, differential pressure reduces to zero, the powerstage spool recenters, and piston motion stops.

Chapter 3 - Application

Safety Considerations

By specifying the correct actuator action, the *HA100A* can be configured to fail in a safe direction upon electrical current failure. The failure direction upon loss of hydraulic pressure is not predictable because the *HA100A* has no internal bias spring. The actuator will initially fail in place, but will then tend to move slowly in the direction of least resistance. A separate means of safety shutdown, such as a steam trip and throttle valve or a fuel shutoff valve, is required to protect against hydraulic supply failure. In addition, pressure switches should be installed to prevent starting and to safely shutdown the machine upon hydraulic pressure failure.

Some failure conditions, such as plugging due to oil supply contamination, can produce an unpredictable failure direction; so system safety, again, dictates the requirement for a separate, independent shutdown means.

WARNING **The turbine or engine should always be equipped with a separate safety shutdown system to protect against equipment damage and injury to personnel in the event of a control system or actuator failure.**

Application Examples

WARNING **Improper actuator application can result in loss of control of the turbine or engine, possibly causing equipment damage and injury to personnel.**

General Application Considerations

- Make certain that the actuator has enough force to operate the valve at the minimum supply pressure available.
- Align the actuator and install a *flexible* coupling or linkage.

  NOTE*:* *A hard coupling introduces side loads which can damage the valve stem and the actuator. Triconex recommends a Parker, Linear Alignment Coupler (PN 1347570038), or equivalent, for applications requiring a flexible stem coupling.*
- Allow additional force for friction.
- Allow at least a 30% force margin.
- Make the actuator fail-safe by specifying *HA100A* action (Extend or Retract) so that loss of coil current reduces steam or fuel to minimum flow. To change between extend and retract operation, reverse the polarity of the electrical connections and re-zero the mechanical zero adjustment. See Chapter 7 for information regarding field calibration.
- Utilize as much of the 1.00" stroke as possible.

Direct Application

The *HA100A* can be mounted directly on small fuel and steam valves as shown in the figure below. A stem coupling should be used which will compensate for axial misalignment between the *HA100A* actuator and the valve. A direct connection without a stem coupling is not recommended due to the side loading of the actuator and valve shafts which may result.

NOTE: *Choose a balanced valve to reduce actuator force requirements.*

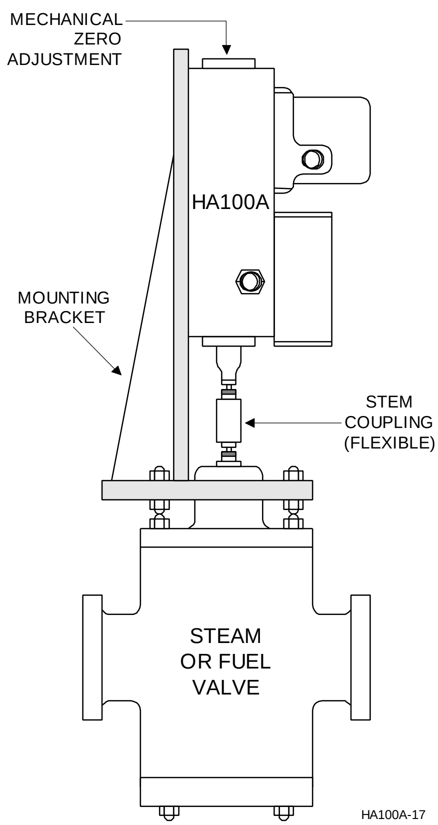

Figure 3. Direct Application

Mechanical Pilot Application

The *HA100A* can be used to operate a larger hydraulic actuator with a mechanical feedback pilot arrangement as shown in the figure below.

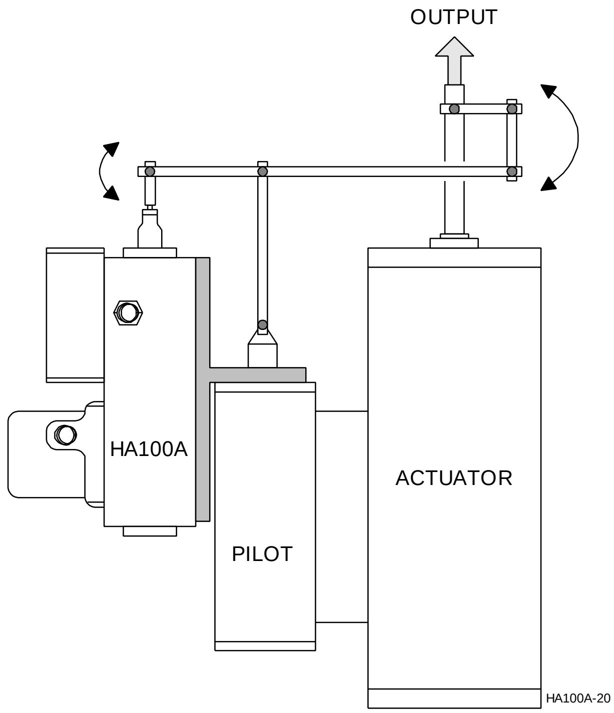

Figure 4. Mechanical Pilot Application

Electrical Feedback Application

The *HA100A* can be used with an electrical position feedback device (usually an LVDT) and a servo amplifier such as the M306 to provide very accurate closed loop position control of a large actuator.

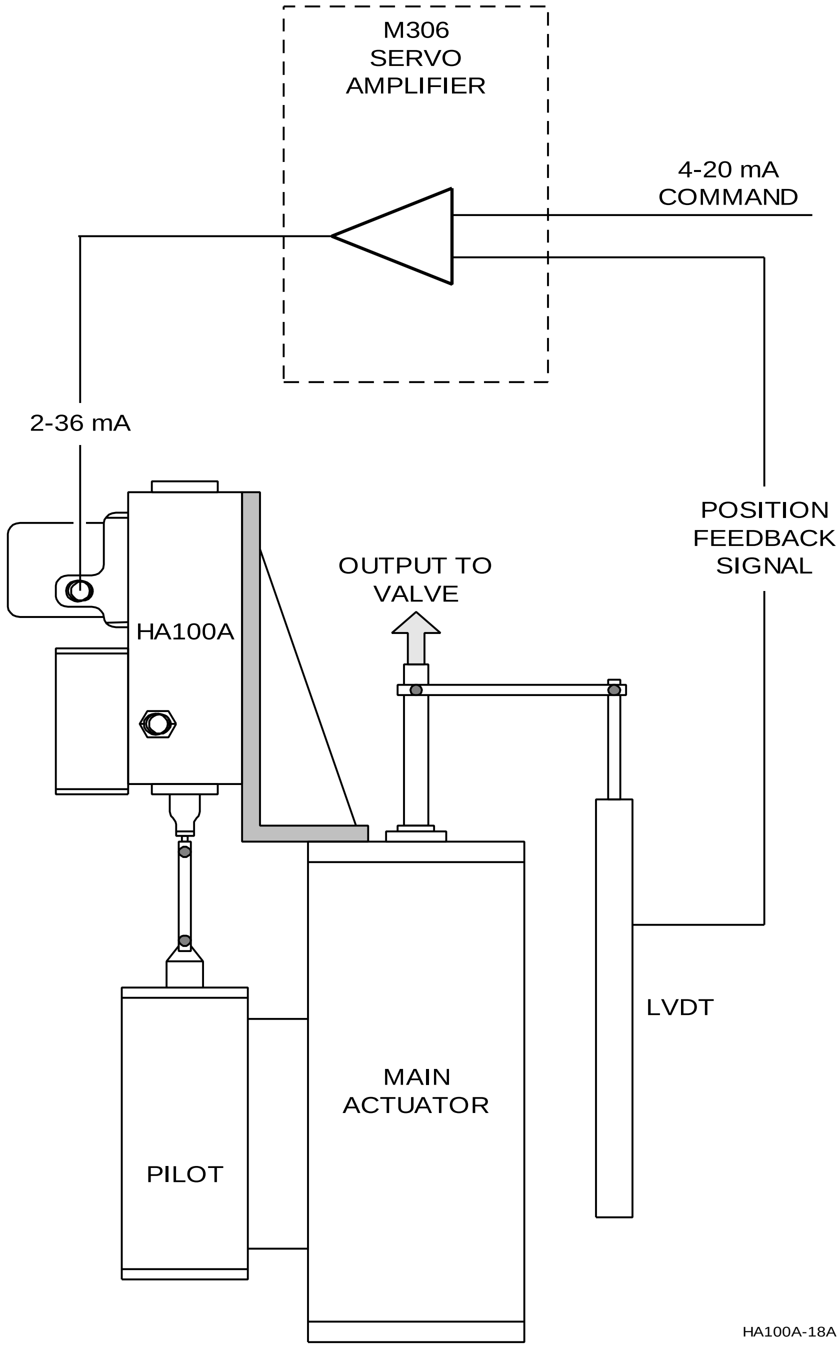

Figure 5. Electrical Feedback Application

Electrical Wiring

The *HA100A* torque motor has two, 170 ohm coils. These can be wired in series, parallel, or individually depending on current source characteristics and redundancy requirements.

NOTE: *In the discussions that follow, it is assumed, that the coils are driven by a current regulated source, not a voltage. This is required because the copper wire in the coils change resistance considerably with temperature variation.*

NOTE: *Polarity shown represents operation for retract with an increase in current.*

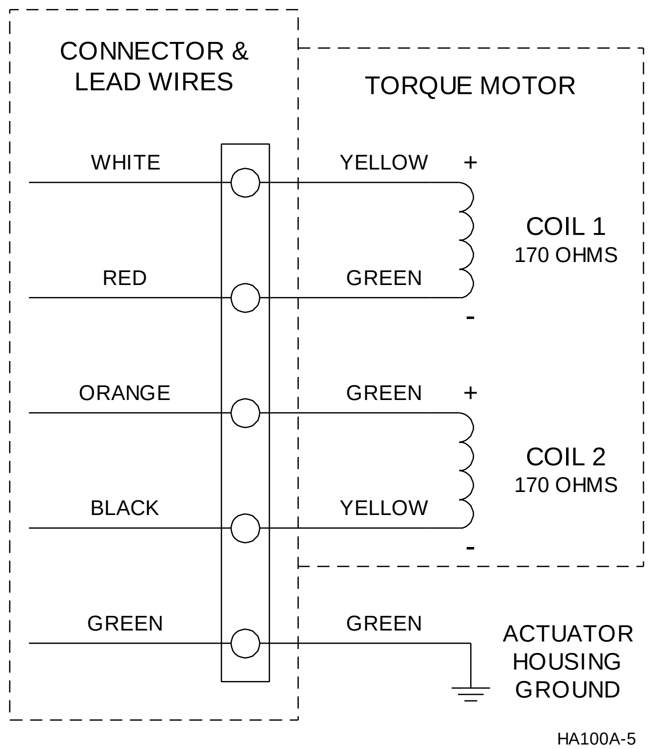

Figure 6. Connector-to-Coil Wiring

Coil Wiring for Simplex Operation

Coils can be wired either in series, in parallel, or individually. If wired individually, either coil can be used alone with the unused coil not connected. The two coils can be operated simultaneously at different current levels. The effective current will be the sum of the current to both coils. See the following figures.

NOTE: *Polarity shown represents operation for retract with an increase in current.*

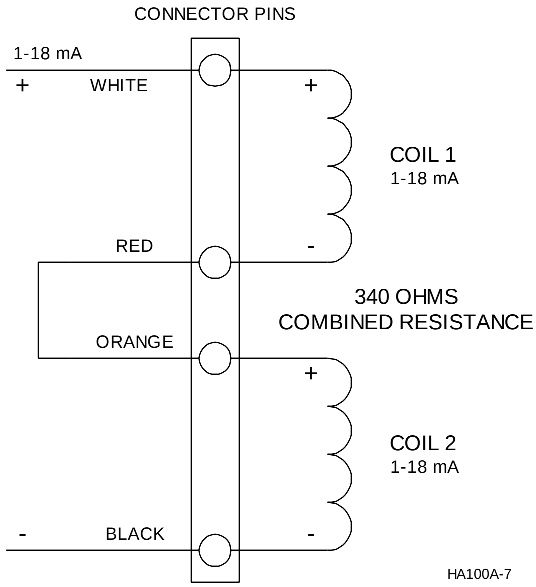

Figure 7. Coils Wired in Series

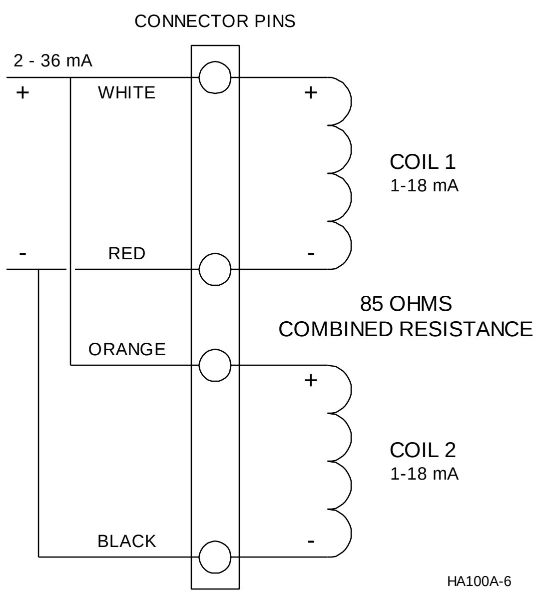

Figure 8. Coils Wired in Parallel

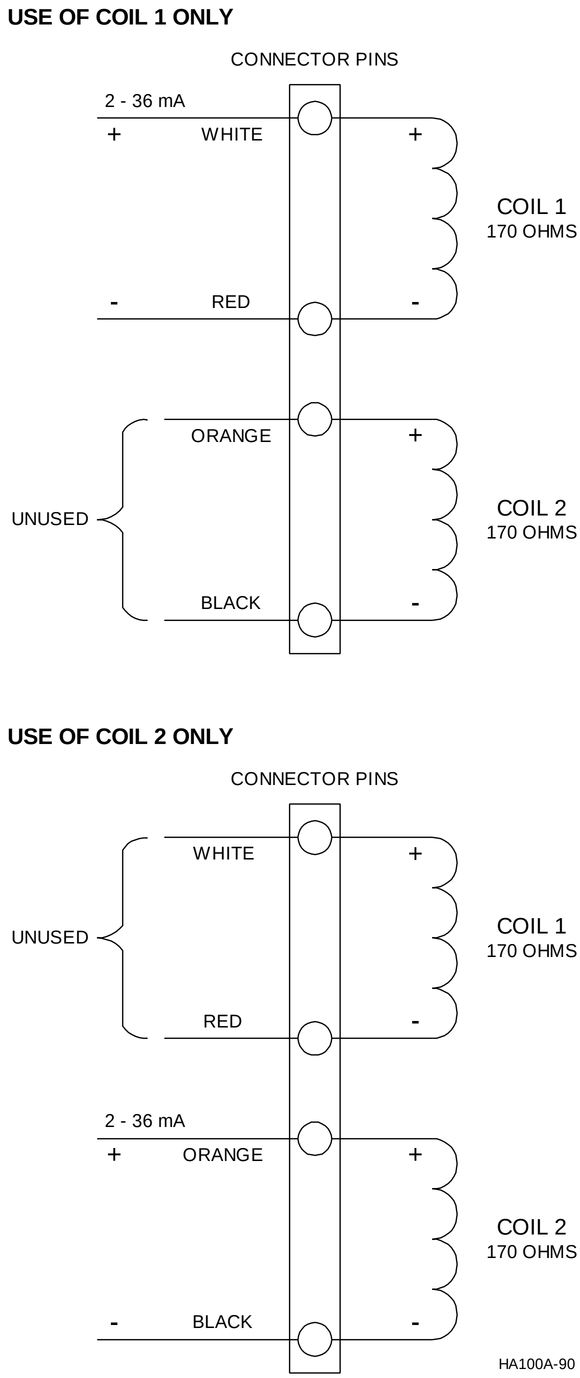

Figure 9. Either Coil Wired Individually

Chapter 4 - Installation

Unpacking

Upon receipt of the *HA100A*, unpack it carefully and visually check for damage. If everything appears to be in order, proceed to the instructions in the following chapters. If the unit is damaged, contact the factory prior to returning equipment to Triconex for repair. Information for contacting Triconex is provided at the front of this document.

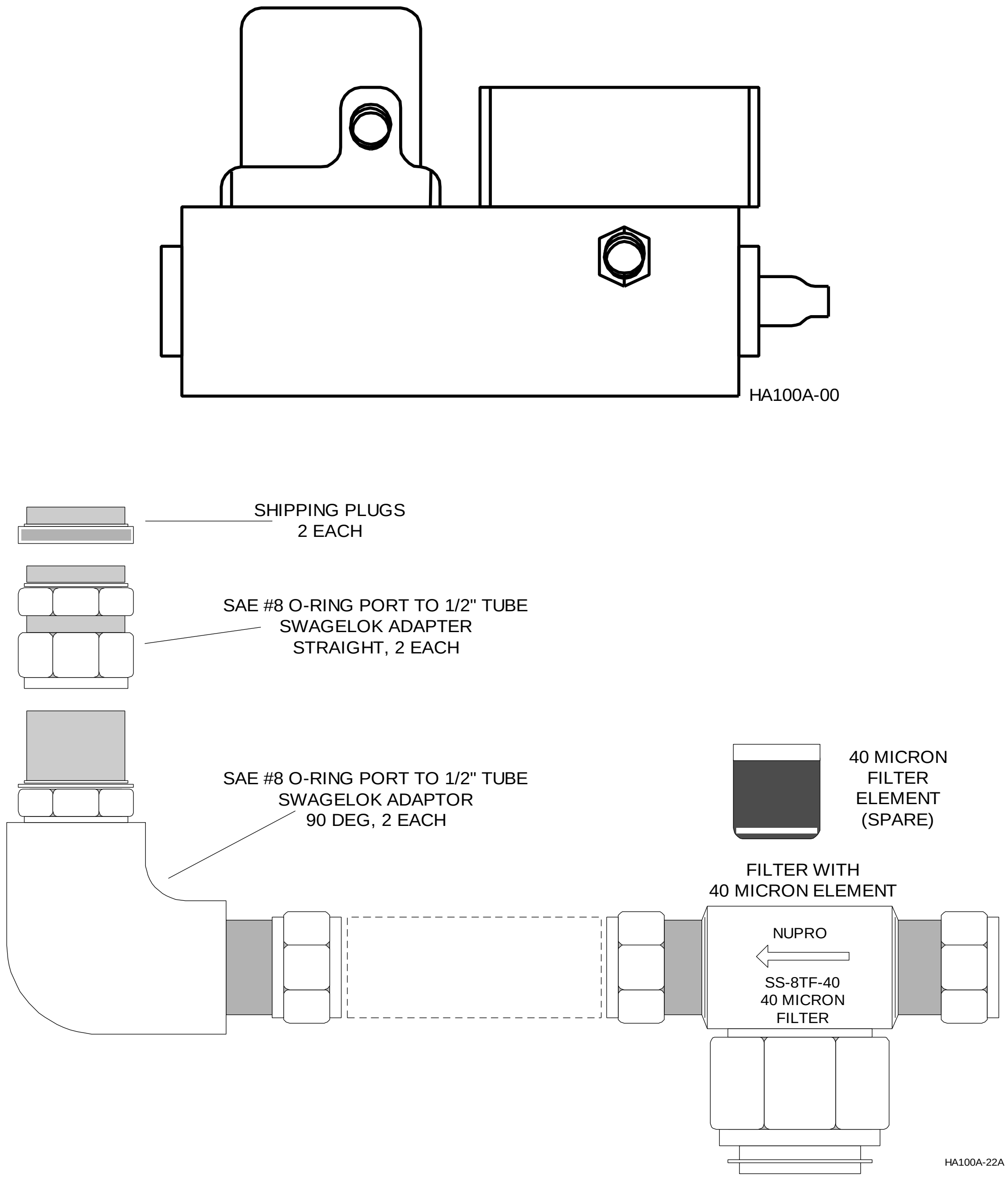

Figure 10. *HA100A* Delivered Items

Mounting

The *HA100A* has four, 3/8" x 24 UNF-2B tapped holes on the bottom for mounting.

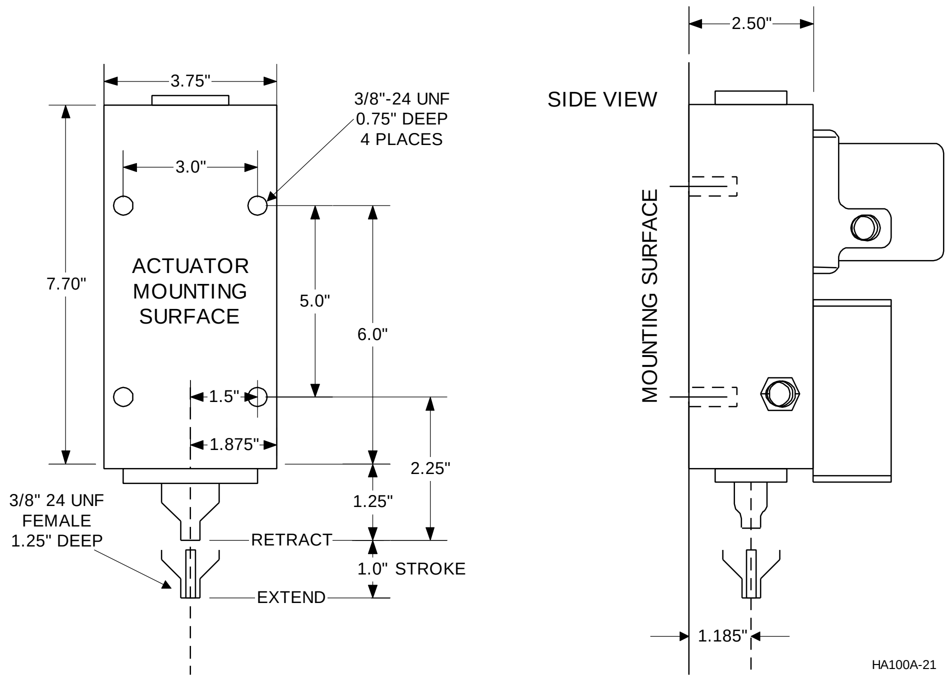

Figure 11. Mounting Footprint

A simple steel bracket of the type shown below is required for mounting.

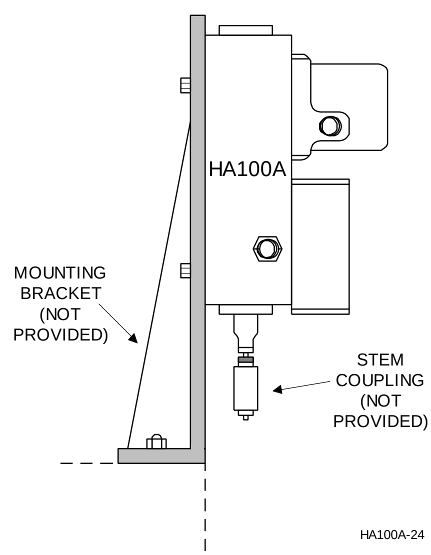

Figure 12. Typical Mounting Arrangement

Electrical Connections

Electrical connection to the *HA100A* is made with five 18 AWG lead wires passing through a 1/2 NPT conduit connector. Connection can be accomplished in an adjacent or nearby conduit or junction box for connection to extended wiring to the control system. Refer to the figure below for wiring to the *HA100A*.

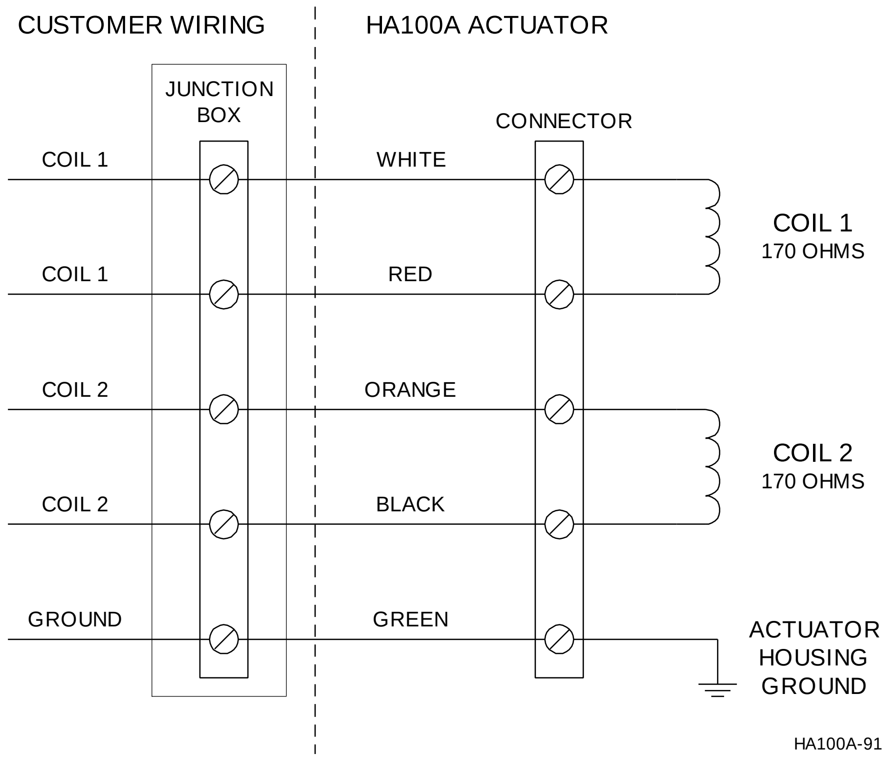

Figure 13. *HA100A* Cable Wiring

Installation of customer field wiring shall be in accordance with the National Electrical Code (ANSI-NFPA 70) as it pertains to Class I, Division 2 hazardous areas; maximum voltage is equal to 9.1 VDC, maximum current is equal to 40 mA DC.

Wiring between the junction box and the control system should be 18 AWG or larger shielded instrumentation cable or pairs, separated from power wiring. Total field wiring resistance should not exceed 5 ohms per pair. Conduit installed between the junction box and the HA100A shall be metallic to provide shielding of the actuator lead wires.

External Wiring Polarity for Retract/Extend

External wiring polarity, in addition to adjustment of the zero spring, determines the direction of the actuator output shaft motion. Refer to the table below to determine the correct coil wire polarity required to provide retract or extend motion with an increase in current to the torque motor.

***NOTE**: The* HA100A *is calibrated initially for retract or extend operation according to user specifications.*

Wire Color	Coil #	RETRACT with increase in current	EXTEND with increase in current
White	1	+	-
Red	1	-	+
Green	GND	NA	NA
Orange	2	+	-
Black	2	-	+

Hydraulic Connections

3/4" stainless steel tubing is recommended for supply lines. The oil supply system should be as close as possible to the actuator. The final connections to the actuator should be 1/2" stainless steel tubing (flex hose optional). Observe the following:

- The hydraulic system should be flushed or otherwise cleaned to remove contamination prior to installing the *HA100A*. A bypass line and valve around the actuator can be installed from the supply line to the drain line to isolate the actuator from the supply flow and to facilitate flushing.
- The port shipping plugs should remain installed in the actuator until ready for final piping tie-ins to prevent contamination.
- Slope horizontal tubing runs to prevent air pockets from developing during a non-operating condition. It is recommended that the HA100A not be installed at the highest point in the system in order to maintain the actuator filled with oil during non-operating periods.
- Make certain the oil supply filter system is in good order and that 10 micron or better filter elements are installed.

CAUTION *Absolute* cleanliness is essential. Thread burrs, weld slag, Teflon® tape and other debris can cause the actuator to malfunction, and can permanently damage precision internal parts. Refer to Appendix C.

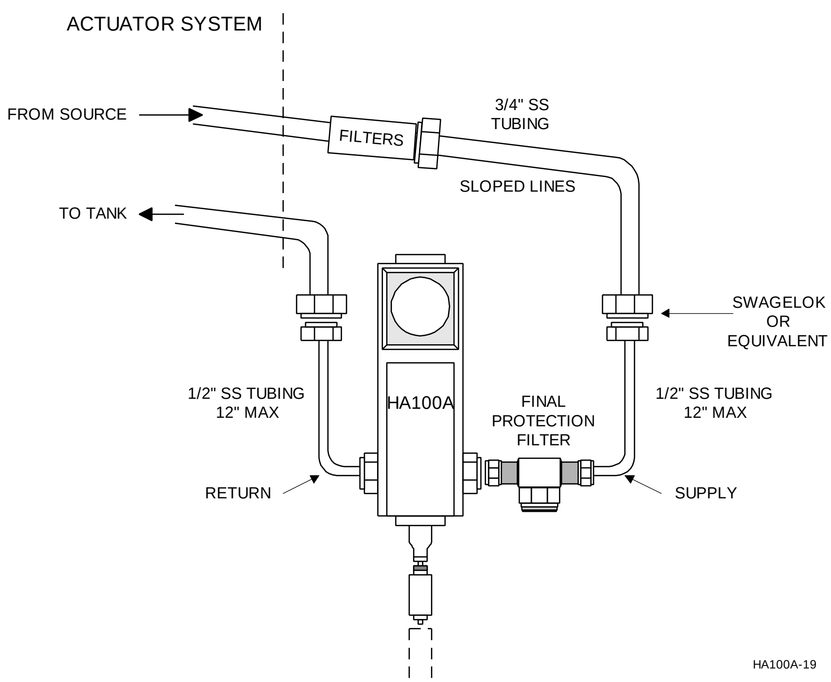

Figure 14. Hydraulic Connections

Mechanical Linkage

The connection between the *HA100A* output rod and the load can be accomplished in a number of ways. These are described in the following paragraphs. The stem coupling and other linkage hardware discussed are not provided with the *HA100A*.

Direct Coupling

This is the simplest connection method as it requires only a threaded coupling connecting the *HA100A* to the load shaft. Because of the difficulty in achieving exact alignment, a stem coupling should be used which will compensate for axial misalignment between the *HA100A* actuator and the valve. Without a stem coupling, side loading can damage the actuator and the load shaft.

***NOTE**: This type coupling cannot be used on pivoted linkage that moves in an arc.*

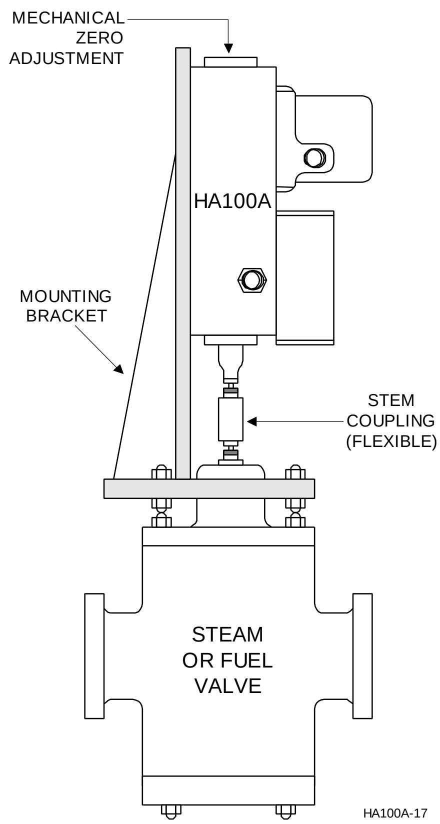

Figure 15. Direct Coupling

Rod-End Coupling

This is the preferred method for coupling the actuator to a variety of loads. The use of readily available rod-end bearings reduces the need for exact alignment and can be used on pivoted linkages that move in an arc.

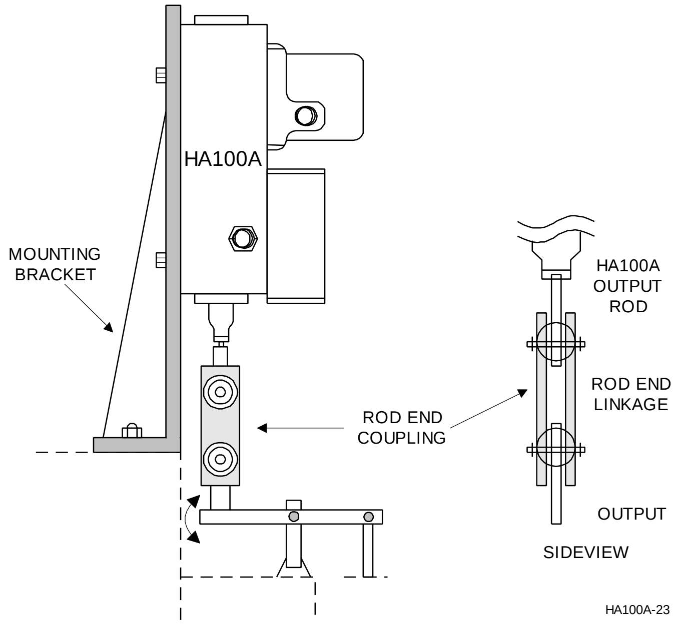

Figure 16. Rod-End Coupling

Chapter 5 - Startup

WARNING Improper actuator installation and/or application can result in erratic control of the machine. This can result in damage to equipment and danger to personnel.

For this reason, it is imperative that system operations are thoroughly tested before commissioning, and that certain precautions are taken during initial test running. Refer to Chapter 3 of this manual for information on application. Refer to the remainder of this section for instructions to verify installation and placing the system in service.

Starting the Hydraulic System

CAUTION To avoid damage to the valves, disconnect linkage prior to starting the hydraulic system.

- Verify that the hydraulic system is suitable for use with the *HA100A*:
  - Must supply at least 3.5 gpm per *HA100A* with minimal pressure drop.
  - Should have 10 micron or better filtration.
  - Supply is pressure regulated at ±20% of the nominal operating pressure and is always in the 80-400 psig range.
- Make sure the oil is clean. Perform a test to verify oil purity. (Refer to Appendix C)
  - Install a bypass around the *HA100A* in order to isolate it from the supply flow and flush the lines for at least 4 hours.
- Inspect the installation. Verify that:
  - Hydraulic lines are correctly sized. A 3/4" line is installed to the machine and a 1/2" line is connected to the actuator.
  - Supply and Return lines are correctly connected.
  - Lines are sloped to avoid air pockets.
- Turn on the oil system:
  - Check for leaks.
  - The *HA100A* should move to its minimum position.
  - Initial erratic operation of the actuator is usually due to air in the piping. It will stabilize after a short period of operation.

Inspecting the Actuator Installation

To verify that the actuator is correctly applied and installed, follow the instructions below.

- Make sure the actuator is correctly mounted for the corresponding mechanical output (i.e., retract or extend with an increase in current).
- Verify that the mechanical output coupling is correct for the particular application. Refer to Chapter 3 for examples of the proper way to couple to different types of loads.
- If direct coupling to the output is used, verify that a coupling is used which compensates for axial mis-alignment to avoid side loads on the actuator and load shafts.
- Verify that all linkage pivots are free from friction and are tight.
- Verify that the actuator is solidly mounted on its bracket. Make sure the mounting bolts are tight and that they are fitted with lock washers.
- If the load, linkage, or pilot can be damaged or caused to malfunction by overstroking make certain that mechanical stops are installed to safely limit stroke.
- Verify that the linkage system is designed to use as much of the 1.00" *HA100A* stroke as possible. Resolution is best if at least 3/4" of the total 1.00" stroke can be utilized.

Testing and Adjustment

There are no required field adjustments on the *HA100A* actuator itself. Adjustment of the coupling or linkage, or the minimum calibrated current from the current driver may be required. Span or stroke is adjusted at the current driver by limiting the output drive current to less than 36 mA (18 mA series coils).

After oil is applied to the actuator:

- Apply 2 mA (minimum stroke) to the actuator. The actuator will move slightly from its minimum position (fully extended or fully retracted).
- Adjust the mechanical linkage or the coupling to position the load at the desired minimum position.
- Apply maximum current to the *HA100A* and verify that it moves quickly and precisely to maximum position.
- If the *HA100A* operates a larger actuator through a hydraulic pilot then calibrate linkage and/or current driver to set the main actuator for desired starting and final stroke position.

For some applications, it may be desirable to limit the HA100A stroke to less than the available one-inch. This is accomplished as follows:

With hydraulic pressure applied:

- Set zero mA current to the coils.
- Turn the zero spring adjustment screw, at the end of the actuator opposite the output shaft, until the shaft moves to the desired minimum position.

An increase in current will cause the output shaft to move with the resulting stroke, and the maximum amount of current required to reach the end of stroke, to both be reduced.

If the current is reduced to zero mA, the actuator will move to the new minimum controlled position.

***NOTE**: If hydraulic pressure is removed, the actuator can be moved beyond the new minimum controlled position by an external load.*

Pre-Startup Checks

Perform the following checks before attempting to test run the machine:

- Make certain steam or fuel is blocked to the machine.
- With the oil system on and the control system tripped, verify that the *HA100A* is in the *minimum* position.
- Simulate a machine start (steam/fuel still blocked) and verify that the steam or fuel valve moves in the proper direction and has the correct stroke.
- Verify operation of the independent shutdown system.

CAUTION Do not test run the machine until the control system, the actuator, and the shutdown system have been thoroughly tested.

Test Running the Machine

Observe the following precautions during the initial test run of the machine:

- Do not open the fuel or steam block valve fully. Allow only enough fuel or steam to achieve minimum governing speed.
- Perform a shutdown test as soon as the machine is rolling to verify operation of the shutdown system.
- Closely monitor speed and valve position for erratic operation or instability.
- Be prepared to manually trip the machine if any unusual condition develops.
- Thoroughly test the machine under various load and operating conditions to verify control and actuator tuning and integrity.

Chapter 6 - Maintenance

Because of its rugged construction and simple design, the *HA100A* will give long trouble-free service. If problems do occur, most will be caused by oil contamination. The importance of maintaining cleanliness of the hydraulic supply cannot be over-stressed. Maintenance can be performed in the field by trained personnel, but wherever possible it is recommended that, via the Triconex exchange program, the unit be returned to the factory for service.

Refer to Appendix C of this manual for helpful information on hydraulic system maintenance and monitoring.

To return a unit for service, please contact Triconex; listings are provided in the front of this document.

Troubleshooting

Problems in the actuator and linkage system can be isolated using a 2 to 36 mA variable current source and accurate milliammeter.

⚠ **CAUTION** If the actuator is mounted in a hazardous (explosive) area, make sure the proper precautions are taken before testing.

- Verify that hydraulic oil, at the correct pressure, is present at the actuator before performing any tests.
- Vary the current to the actuator from 2 to 36 mA, and verify that the output shaft moves quickly and precisely. Hysteresis should be minimal.
- If the *HA100A* is connected to a pilot or linkage, verify that the main actuator follows the *HA100A* movement.
- If the actuator does not function correctly disconnect the load or linkage and retest according to the previous steps.
- If the actuator operates when disconnected from the load, then the problem is a frozen valve stem, pivot, pilot, etc. – not the *HA100A*.
- If the actuator still does not move, or moves sluggishly with the load disconnected, the most likely cause is plugging due to oil contamination.
- Refer to instructions on cleaning, or replace the unit and send it to Triconex for repair.

⚠ **CAUTION** A plugged actuator indicates a contaminated oil supply. Replace or install filters and clean up the oil to rectify the problem. Continued operation with dirty oil will lead to further plugging and can result in shaft and spool scoring which will require a complete overhaul of the actuator.

Oil Filters & Cleaning

The *HA100A* Actuator requires that clean oil be used in order to provide long-term reliable operation. Therefore, the hydraulic system should be filtered to a 10-micron cleanliness level.

Two filters are provided with the *HA100A* Actuator for additional protection:

- A 40-micron in-line barrier filter screen is supplied and should be installed near the actuator in the oil supply line. The purpose of this filter is to collect any contamination that may pass through the 10-micron filters in the event of an unexpected bypass of fluid around the element. It will also collect particles that may be generated if a line connection is opened for service.

- In addition, a 70-micron filter screen is mounted in the powerstage body. This filter protects the torque motor orifices and nozzles from contamination that may pass through the other filters or that was not removed during system flushing.

During normal operation with proper hydraulic system filtration, the internal 70-micron filter requires no service. However, if this filter becomes plugged, it is an indication that the oil is very contaminated, and that the 10-micron filters and the 40-micron inlet screen have been damaged.

If actuator operation becomes sluggish, and it is suspected that oil contamination is the cause, the 10-micron filters should be replaced to ensure that they are not restricting oil flow to the actuator. In addition, the 40-micron in-line filter element should be cleaned by removing and back-flushing it, or it can be replaced. Actuator operation can then be re-evaluated. If operation is restored to normal, action should be taken to determine what caused the system to become contaminated, and to prevent it from reoccurring.

If the 10- and 40-micron filters were heavily contaminated, and after being cleaned or replaced operation of the actuator remains sluggish, then the internal 70-micron filter may be plugged with contamination. If this is the case, and after other potential causes of sluggish operation have been eliminated, the *HA100A* Actuator should be returned to the factory for cleaning and inspection by trained service personnel.

Other Maintenance

Other than cleaning of the 40-micron barrier filter, the only maintenance that may be required is replacement of the internal shaft seals and bushings. Shaft misalignment, damage to the shaft where it enters the bushing and seal, and oil contamination are the common causes of bushing and seal failure.

Seal and bushing replacement in the field is not recommended, as special tools are required.

Chapter 7 - Field Calibration

The *HA100A* is shipped from the factory pre-calibrated for a particular actuator stroke direction (or action), as specified by the user. In order to accommodate changing circumstances in the field, the *HA100A* can be re-calibrated for different service, as described in the paragraphs below.

Changing Actuator Stroke Direction

Actuator stroke direction can be changed in the field, as described in the following paragraphs.

Stroke direction is determined by:

- The polarity of the external wiring to the actuator
- The adjustment of the zero spring preload

The torque motor is stamped with A1 and A2 to indicate the internal nozzle porting. The side stamped A2 is installed closest to the power stage for both retract and extend versions.

Extend Operation

The calibration procedure, for the shaft to extend with an increase in current, is as follows:

- Refer to the table below for external wiring polarity required.

Wire Color	Coil #	RETRACT with increase in current	EXTEND with increase in current
White	1	+	-
Red	1	-	+
Green	GND	NA	NA
Orange	2	+	-
Black	2	-	+

- Apply hydraulic pressure to the actuator.
- Turn the zero spring adjustment screw, at the end of the actuator opposite the output shaft, until the output shaft position is 0.012” to 0.028” from the fully retracted position with 2 mA applied to parallel wired coils (1 mA for series wired coils). The adjustment screw will be approximately 0.375” below the outside surface of the end cap.

Retract Operation

The calibration procedure, for the shaft to retract with an increase in current, is as follows:

- Refer to the table above for external wiring polarity required.
- Apply hydraulic pressure to the actuator.
- Turn the zero spring adjustment screw, at the end of the actuator opposite the output shaft, until the output shaft position is 0.012” to 0.028” from the fully extended position with 2 mA applied to parallel wired coils (1 mA for series wired coils). The adjustment screw will be approximately 0.05” below the outside surface of the end cap.

Chapter 8 - Specifications

Performance:

Stroke:	Maximum 1.0"
Thrust:	2 times the supply pressure 200 pounds at 100 psig supply 400 pounds at 200 psig supply
Stroking Speed:	5 inches/second with a 200 psig supply
Control Resolution:	Less than 0.5% with dither
Linearity:	Better than 5%
Supply Sensitivity:	Less than 1% for a ±20% change in supply pressure

Electrical:

Coil Resistance:	2 coils, each 170 ohms at 70° F
Current:	2 to 36 mA summed total current (parallel or independent coil operation) for 1.0" stroke (1 to 18 mA for coils wired in series)
Coil Matching:	Less than 1% position difference between coils at 18 mA input
Connections:	18 AWG lead wires from 1/2 NPT female conduit opening

Mechanical:

Size:	Actuator Body:	8.00" long 3.75" wide 5.50" high	
Weight:	30 lbs		
Materials:	Actuator Body:	303 Stainless Steel	
	Piston:	17-4 PH Stainless Steel, through hardened	
	O-Rings:	Viton®	
	Seals:	Nitrile, Urethane, Teflon®	
	Power Stage:	Body:	303 SS
		Spool:	440 SS, through hardened
		Sleeve:	440 SS, through hardened
Effective Piston Area:	2.00 square inches		
Shaft Diameter:	0.625"		
Output Connection:	3\8" x 24 UNF female, 1.25” deep		

Hydraulic:

Connections:	Supply:	#8 O-ring port, per SAE J1926/1 (with 40 micron barrier filter supplied with fitting kit)
	Return:	#8 O-ring port, per SAE J1926/1
Supply Pressure:	80 to 400 psi	
Flow Required:	3.5 gpm at full stroking speed; < 0.5 gpm static	
Fluid:	Petroleum based fluid	
Filtration:	70 micron internal for the pilot stage 40 micron barrier filter provided for supply line 10 micron external required	
Recommended Viscosity:	100 to 300 SUS (20 to 65 cSt)	
Allowed viscosity:	50 to 1000 SUS (8 to 220 cSt)	

Adjustments:

Span:	None on the actuator Adjust current drive or mechanical linkage

Environmental:

Ambient Temperature Range for non-hazardous areas:	0 to 200° F
Hazardous areas:	FM approved and CSA certified for use in Class I, Division 2, Groups A, B, C, and D hazardous areas as classified by the National Electric Code (ANSI-NFPA 70) T-Code T6 @ maximum ambient temperature of 40°C (104°F) T-Code T4A @ maximum ambient temperature of 85°C (185°F)

Appendix A - Calibrating an M306 for use with the *HA100A*

If the *HA100A* is used in an LVDT feedback configuration with an M306 or similar servo-amplifier, then calibration should be performed in two steps:

- Adjust the *HA100A* independently to stroke the pilot over its specified range.
- Calibrate the servoamplifier to stroke the main actuator over the desired range.

Dither is required to eliminate dead-band due to internal friction. The amount of dither required can vary between actuators and is dependent on supply pressure. At 80 psig minimum pressure, approximately 1.0 to 2.0 mA may be required. At 200 psig, 0.2 mA usually is sufficient.

Dither Adjustment Procedure

NOTE: *Excessive dither produces no increase in performance and can result in increased wear on the actuator's components.*

- Connect a frequency meter to TP-10 and GND.
- Adjust DHz (R209) for 10 Hz.
- Adjust Dither (R212) for a barely noticeable dither (Approximately 0.001" to 0.003") on the output shaft.
- Repeat Offset and Span adjustments if necessary.

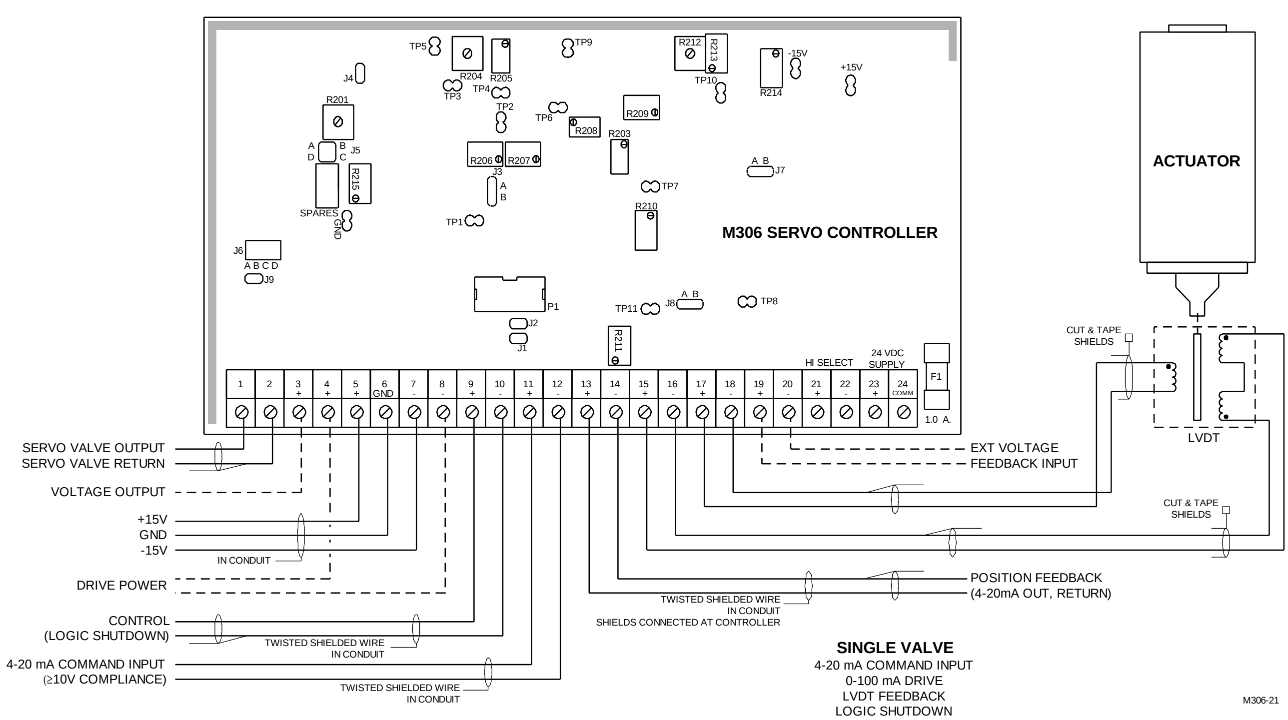

Figure 17. Setup with an M306

4934-0075 R/A
Hyd Note R/A

Appendix B - Controlling Hydraulic System Contamination

Triconex hydraulic components are designed to give long life and trouble-free service provided the hydraulic fluid is maintained at an adequate cleanliness level. For Triconex hydraulic components, we recommend that hydraulic fluid be filtered to 10 microns or better. Triconex recognizes the practical constraints of plant environment and economics. This appendix is intended to assist you in attaining maximum service within those constraints.

Contaminated hydraulics can shut down and damage expensive equipment. Dirty hydraulic fluid will eventually be costly in terms of lost production and repairs.

The Problem

The basic problem is unwanted particles in your hydraulic fluid which:

- Clog screens and filters
- Migrate between moving parts causing scratches and excessive wear

You may believe that you are protected from dirty hydraulics. Let's look at a typical situation.

An existing turbine lube oil system is protected by an in-line 10-micron filter. You wish to use this oil as the hydraulic fluid for a newly installed Triconex actuator. The actuator requires 10 micron filtering, so you conclude that the actuator is adequately protected. Unfortunately, this conclusion proves incorrect when, three weeks after installation, the actuator inlet screen plugs with particles considerably larger than 10 microns.

***NOTE**:* *If a particle is visible to the human eye, it is at least 40 microns in size.*

What went wrong?

There are several possibilities.

First, many filters have a built-in bypass set to open on a specified differential pressure. The bypass protects the system from filter collapse and inefficiencies resulting from excessive differential pressure. Your bypass may simply be opening and allowing contaminants to pass through.

Second, lines likely accumulated some debris along the inside diameter. This contaminating debris may consist of welding residue, cutting and grinding residue, and just plain dirt. Even after a system is flushed, there is still a small percentage of the original contamination in the line. This material may be caught in flanges, elbows, bends, or cracks in the line. It may not wash out for days or even months. Vibration and other disturbances, such as a startup or surge, can shake this debris loose at any time, dumping it into the fluid stream. In fact, you should expect the first filter installed after a retrofit to clog rather quickly. The next filter will have longer life.

Third, your existing filters may be leaking past or through the element for these reasons.

- Filter elements can fatigue and crack with cyclic flow unless they are internally supported.
- If the filter element fiber is of the non-fixed pore variety, it can degrade as it becomes loaded and pressure differential increase deforms the fiber lattice.
- Seals may be incompatible with the fluid, causing the seal to degrade.

- The seal may be worn or deformed.

Fourth, you must look at the efficiency of the filter element. Filter manufacturers use the term *beta ratio* to indicate filter efficiency for a particular particle size. A beta ratio of 75 corresponds to about 98.6% efficiency for filtering particles. A lower beta ratio indicates lower filtering efficiency for a given particle size.

Finally, the hydraulic fluid must be compatible with the filter element and seals. If you use paper elements and water gets in the fluid, the element will swell, allowing particles through. Also, certain fluids can cause seals to swell. In addition, the element can disintegrate.

The Solution

The most practical solution is to assure that your hydraulic fluid is clean. This is achieved through:

- Optimal filter selection
- Fluid and filter monitoring

Again, the solution must be practical given plant constraints. The more fluid contamination you can remove, the longer the actuator service life.

Selecting a Filter System

Ideally, the hydraulics system for an *HA100A* consists of a sealed, stand-alone unit. In this case, Triconex recommends a 3-micron filter with a beta ratio of 75. Triconex provides hydraulic skids, individual filter assemblies, and replacement filters.

However, 3-micron filtering may be impractical when the fluid is shared, since the filter element would clog too frequently. That is the situation when a lube oil system is used as the source of hydraulic fluid and economics are such that a program to upgrade the lube oil system is not justified. Here, Triconex recommends a 10 micron filter with a beta ratio of 75.

Whether the hydraulic system is sealed or shared, Triconex recommends a separate filter for control oil. It should have the following specifications:

- Dual parallel filters, with valves to permit alternate use and maintenance with uninterrupted service
- Non-bypass filter elements
- Filter element collapse rating well above maximum system differential pressure
- High differential pressure switch for remote alarm annunciation
- Viton 0-ring seals
- Inorganic, fixed pore, resin impregnated filter element fibers

Monitoring the Fluid and Filter System

Once a filter is installed, there is no way to predict its service life. Likewise, it is impossible to predict whether the fluid is being maintained clean enough for reliable operation.

The solution is some form of filter and fluid monitoring. As already mentioned, Triconex recommends providing an alarm annunciator for monitoring filter differential pressure as an indicator of current filter performance. This alarm, coupled with dual filtration, provides a straightforward method of assuring clean filters and uninterrupted service. Fluid contamination monitoring is normally accomplished in one of two ways:

- On-site test
- Mail-in sample test

In either case, a valve is required in your system for sample collection. The on-site test allows a quick microscopic look at contaminant levels.

The mail-in sample test requires a longer turn-around time, but provides a quantitative analysis of contaminants. This requires an on-going test program in association with a specific test lab.

Triconex recommends that a weekly test be performed and that a mail-in sample test be used as warranted by test results.