Maintenance & Service

In This Chapter:

1 Safety First!

These guidelines, warning, and cautions are a reminder of the safety issues present when maintaining or servicing a slave arm or manipulator system. They do not cover every possible safety risk and are not meant to supersede or replace existing vessel/operator safety policies, standards, processes, and practices.

Please Note:

This slave arm or manipulator system is not an isolated piece of equipment. Be sure to know and use the safety and service guidelines provided in the technical manual for the system or vehicle on which it is used.

1.1 Worksite Safety

WARNING

ELECTRICAL, HYDRAULIC, AND MECHANICAL HAZARDS! Before any contact with this equipment:

- **Notify the appropriate personnel of your activities.**
- **Be sure you have a safe electrical, hydraulic, and mechanical working environment. Turn off, lock out/tag out, and/or isolate surrounding equipment that could be a safety hazard to you.**
- **Observe all safety regulations and procedures in effect at the worksite.**
- **Wear personal protective equipment (PPE) appropriate for the task.**

1.2 Electrical Safety

WARNING

SHOCK HAZARD! Lethal voltages can be present in the manipulator system (see the Specification chapter for specific voltages).

- **Before any contact with this equipment, CONFIRM that it is electrically isolated, locked-out and tagged-out as directed by applicable electrical safety regulations and procedures.**
- **Wear personal protective equipment (PPE) appropriate for the task.**

1.3 Mechanical Safety

WARNING

Slave arm components are heavy and can move, drop, shift, or collapse suddenly when hydraulic pressure is removed or relieved.

- **Support the slave arm at the elbow and jaw when relieving hydraulic pressure or opening any hydraulic connection.**
- **Wear personal protective equipment (PPE) appropriate for the task.**

1.4 Hydraulic Safety

WARNING

Slave arm components are heavy and can move, drop, shift, or collapse when hydraulic pressure is removed or relieved.

- **Support the slave arm at the elbow and jaw when relieving hydraulic pressure or opening any hydraulic connection.**
- **Wear personal protective equipment (PPE) appropriate for the task.**

WARNING

Failure to follow safety procedures for working with high-pressure hydraulic equipment can result in serious injury or death. ALWAYS assume that hydraulic equipment is energized until you have CONFIRMED that it is isolated, locked out, and tagged out as directed by applicable hydraulic safety regulations and procedures, that all pressure gauges indicate zero pressure, and that all stored and residual pressures have been isolated or relieved.

Common causes of serious injury and death from high-pressure hydraulic equipment include:

- Injection of pressurized hydraulic fluid into the body.
- Blunt force trauma to the body from flailing, pressurized hoses and forcefully ejected fittings.
- Bodily contact with hot hydraulic fluids and sprays or ignited fluids, sprays, or mists.
- Falls caused by slipping on spilled fluids.

To prevent injury or death while working with high-pressure hydraulic equipment, always follow all applicable hydraulic safety regulations and procedures. The instructions listed below provide general guidelines and are not meant to replace or modify existing safety regulations and procedures.

- Always lock out and tag out hydraulic equipment **before** it is serviced so that it cannot be accidentally energized.
- Provide support for equipment and components that can move, drop, shift, or collapse when hydraulic pressure is removed or relieved.
- Always wear safety glasses and other required personal protective equipment (PPE).
- Confirm that equipment pressure gauges indicate zero pressure.
- **Before** loosening any fittings, isolate or relieve any stored or residual pressure that remains in components even when the hydraulic system is de-energized.
- Never use any part of your hand or body to check for hydraulic fluid leaks, even if you are wearing personal protective equipment. High-pressure hydraulic fluid injects easily into any body part, and an injection wound, regardless of size, must be evaluated immediately by a physician as a surgical emergency.
- Service hydraulic equipment away from sparks or open flame.
- Immediately clean up spilled hydraulic fluid from floors or other surfaces.
- Before returning the equipment to service, tighten all fittings and connections as specified by the equipment manufacturer.
- Move all personnel away from serviced hydraulic equipment before pressurizing it and testing for safe operation.

Only qualified and authorized personnel should perform hydraulic work on this equipment. A qualified person is one who has the required skills and knowledge to perform hydraulic work safely, even under adverse environmental conditions, and who knows the hazards associated with hydraulic work and the methods for reducing the risk of accidents from those hazards.

1.5 Deck Testing

WARNING

Use extreme caution when testing a slave arm on deck:
• Move all personnel outside the slave arm's range of motion when hydraulic pressure is applied and functions are tested.
• Direct the slave arm to point away from personnel and critical or sensitive areas while testing jaw functions.

2 Service Guidelines

2.1 Service Assumption

Instructions in this manual assume that service personnel are familiar with the general operating principles, safety guidelines, and service practices associated with the types of equipment described in this manual.

2.2 Guidelines

2.2.1 ESD-Sensitive Devices

! Caution

Electrostatic discharge (ESD) can permanently damage sensitive electrical components like printed circuit boards (PCBs), integrated circuits (ICs), and other ESD-sensitive components. To prevent damage, always handle these components according to ESD prevention guidelines.

Microelectronic devices are very susceptible to ESD. Careless handling may cause immediate component failure. It may also make a component more vulnerable to future damage, which can be difficult to detect and often results in faulty performance and intermittent failures. When you handle PCBs, ICs, and other ESD-sensitive components, follow the basic ESD prevention guidelines below.

- Prepare an ESD workstation by grounding all items in the work area (work surfaces, people, equipment, etc.) to the same electrical ground point (called the common point ground). Keep the work area free of nonessential insulators (such as plastic cups, bags, and envelopes).
- If possible, disconnect all power sources, signal sources, and loads connected to the component before you begin maintenance or service.
- Always ground yourself before you touch ESD-sensitive equipment. Discharge any static electricity by touching ground on the workstation each time that you approach and sit at the workbench.
- Ground all tools that may come into contact with the ESD-sensitive equipment.
- Before you handle PCBs, ICs, and other ESD-sensitive components, attach a grounding wrist strap and confirm that the strap is connected to the grounding pad.
- Handle PCBs by the base or edges; always avoid contact with pins.
- Do not unnecessarily pick up, hold, or carry ESD-sensitive devices that are not in shielded packaging.
- Always store and seal ESD-sensitive components in the anti-static packaging in which they were shipped, or in equivalent storage material.

2.2.2 Torque Specifications

See the “Maintenance & Service” section, service or work instructions, and/or drawings in the “Drawings & Part Lists” sections for torque specifications.

- When a torque specification differs between manual text and engineering drawing, use the specification on the drawing.
- When no torque specification is present, use prevailing industry standards and common sense.

2.2.3 Nylock ("Patch") Fasteners

Under ideal conditions, Nylock ("patch") fasteners can be reused up to 5 times. Because tracking their use is difficult and operating conditions are always less than ideal, Nylock fasteners should be replaced whenever they are removed.

! Caution

DO NOT replace Nylock fasteners with standard fasteners. Standard fasteners may loosen and cause component failure or loss.

2.2.4 Fastener Lubrication

- Stainless steel to stainless steel or titanium:
  Apply nickel or molybdenum-based anti-seize compound (Bostik® Never-Seez, or equivalent) when assembling stainless steel fasteners or threading them into stainless steel or titanium components (including nylon-patch/Nylock fasteners).
- Stainless steel to aluminum:
  Apply waterproof grease (Aqua Lube®, or equivalent) when assembling stainless steel fasteners to aluminum IF they are exposed to seawater.
- Do NOT use Aqua Lube on fasteners penetrating hydraulic or compensated areas, unless directed otherwise in a service instruction or engineering drawing.

2.2.5 O-rings

Inspect o-rings for damage during routine maintenance.

- Replace o-rings that are broken, damaged, or hardened.
- Lubricate o-rings prior to installation (Dow Corning® 55 O-ring lube, petroleum jelly, or equivalent).

2.2.6 Connection Identification

Before disconnecting any hose, cable, or conductor, make sure the item and its matching fitting, connector, or terminal are adequately labeled for correct re-assembly.

2.2.7 Drawings & Part Lists

Engineering drawings and part lists are supplied to assist in servicing and maintaining the equipment. They can be a valuable source for determining torque values and the part numbers for serviceable components. Most are located in the "Drawings & Part Lists" section.

3 Maintenance

3.1 Daily Maintenance

Perform the following steps daily, or after every duty cycle:

Submersible Models

1. Thoroughly rinse the slave arm and slave controller with clean, fresh water.
2. Apply a spray lubricant to the slave arm jaw assembly and actuator rods to displace any water.

All Models

Inspect slave arm for:

1. Damage:

If the slave arm has had severe service or a collision, inspect slave arm components,

- — inspect all joints, actuator shaft pivot pins, and joint pivot pins.
- — inspect the linear actuator body and shaft for dents, bends, or damaged components.
- — check all hoses, fittings, and electrical cables.
- — repair or replace damaged components.

2. Loose or missing fasteners
   - — Replace or retighten fasteners, as needed. Vibration and temperature cycles may cause fasteners to loosen.
3. Loose or dirty electrical connectors.
   - — Re-tighten as needed. Clean and lubricate o-rings prior to mating. Vibration and temperature cycles may cause electrical connectors to loosen.
4. Trapped debris
   - — Remove debris and inspect for damage.
5. Hydraulic leaks
   - — Repair any leaks, replace lost fluid, and bleed air, as needed.
6. Damaged hydraulic hoses
   - — Repair or replace hoses, as necessary. If possible, install protection or reroute hoses to prevent future damage.
7. Anode consumption
   - — Inspect all anodes and replace when 2/3 or more is consumed.

3.2 Long Term Periodic Maintenance

Efficient and reliable long-term operation depends on the following three steps:

1. Inspect components and observe performance frequently.
   - — Do this starting with the first use. You will then be able to develop a schedule of inspection, maintenance, and service for hydraulic and mechanical components that meet the needs of the slave arm's operating environment and duty cycles.
2. Perform the inspections, maintenance, or service as scheduled.
   - — Staying with the schedule below will help keep the slave arm in good working condition.
3. Keep a log of all inspection, maintenance, and service actions.
   - — Keeping a log will help you understand when and why problems are occurring. Then you can modify your schedule based on this knowledge.

Table 1 contains a minimum schedule for performing regular long-term maintenance.

Table 1

Recommended Long Term Maintenance Schedule	
Schedule Period	**Maintenance Task**
Every 100 operating hours	Tighten all external slave arm fasteners to the specified torque.
	Check a sample of hydraulic fluid for water and particulates. Replace if contaminated.
	Apply anti-corrosion paint wherever an anodized surface is damaged and aluminum is exposed.
	Submersible: Recoat pivot pins and pivot pin bores with silicone grease such as DC-5.
Every 2000 operating hours	Replace worn or damaged actuator pins and bushings.
Every 2000 operating hours or every 3 years (whichever comes first)	Replace all actuator o-rings and seals. Lubricate with Dow Corning® DC-4. Clean all o-ring grooves and surfaces.

4 Important Service Practices & Procedures

Key practices and procedures for successful manipulator system service:

- Clean, degrease, and inspect disassembled parts before reassembling.
- Replace o-rings that are broken, damaged, or shows signs of wear.
- Lubricate all o-rings with o-ring lubricant (Dow Corning® 55 or petroleum jelly).

  NOTE: *Do not use lubricants that contain suspended particles such as molybdenum or graphite—the particles can be drawn into the hydraulic system and clog filters.*

- Apply Aqua Lube (or equivalent) to all fastener threads, EXCEPT:
  - when threads are exposed to the hydraulic system.
  - when you are directed otherwise by the work instruction or engineering drawing.
- Torque all fasteners as specified. Torque specifications on engineering drawings take precedence over all other text references.

4.1 Protecting PC Boards

! Caution

Electrostatic discharge (ESD) can permanently damage sensitive electrical components like printed circuit boards (PCBs), integrated circuits (ICs), and other ESD-sensitive components. To prevent damage, always handle these components according to ESD prevention guidelines.

Microelectronic devices are very susceptible to ESD. Careless handling may cause immediate component failure. It may also make a component more vulnerable to future damage, which can be difficult to detect and often results in faulty performance and intermittent failures. When you

handle PCBs, ICs, and other ESD-sensitive components, follow the basic ESD prevention guidelines below.

- Prepare an ESD workstation by grounding all items in the work area (work surfaces, people, equipment, etc.) to the same electrical ground point (called the common point ground). Keep the work area free of nonessential insulators (such as plastic cups, bags, and envelopes).
- If possible, disconnect all power sources, signal sources, and loads connected to the component before you begin maintenance or service.
- Always ground yourself before you touch ESD-sensitive equipment. Discharge any static electricity by touching ground on the workstation each time that you approach and sit at the workbench.
- Ground all tools that may come into contact with the ESD-sensitive equipment.
- Before you handle PCBs, ICs, and other ESD-sensitive components, attach a grounding wrist strap and confirm that the strap is connected to the grounding pad.
- Handle PCBs by the base or edges; always avoid contact with pins.
- Do not unnecessarily pick up, hold, or carry ESD-sensitive devices that are not in shielded packaging.
- Always store and seal ESD-sensitive components in the anti-static packaging in which they were shipped, or in equivalent storage material.

4.2 Startup After Maintenance or Service

4.2.1 After Minor Maintenance or Service

1. Follow steps in the “Pre-Start Check” and “Startup” sections of the “Operation” chapter.
2. Be sure to replace hydraulic and compensation fluids lost during maintenance or service.

4.2.2 After Major Service

1. Follow the procedures in “Completing the Installation” in the “Installation” chapter before resuming normal operation.
2. If the hydraulic or compensation fluid has been contaminated, flush the system and refill with fresh fluid.

5 Junction Box Service

This section contains special maintenance and service procedures not covered in the Work Instructions. For additional details, refer to the junction box drawing and part list in the “Drawings & Part Lists” chapter.

Fuse Replacement . . . . . Littlefuse T 6.3AL 250V (SRS P/N 005-0587)

The fuse is located under the fuse symbol, between the power switch and the power-in socket. Use the tab on the fuse cover to pry out the fuse for replacement or inspection.

6 Master Controller Service & Configuration

This section contains special maintenance and service procedures not covered in the Work Instructions. For additional details, refer to master controller, 101-5781 in the “Drawings & Part Lists” chapter.

This section contains special maintenance, service, and configuration procedures not covered in the Work Instructions.

6.1 PCB Features and Functions

The master processor board performs the following functions:

- Communicates with the slave controller.
- Reads master arm potentiometer positions for use by the control algorithm.
- Detects front panel switch inputs for use by the control algorithm.
- Displays operation information on the LCD display.
- Contains the program information for each system.
- Stores system parameters in non-volatile memory for use by the control algorithm.
- Illuminates status LED's to assist troubleshooting and diagnostics.

The master processor board operates on 90-260VAC (standard) or 18-36VDC (optional). Power is supplied by either the supplied AC junction box, or by a user installed CPC connector mounted near the operating station. A 4 pin power connector (P7) plugs into the board. An adjacent 4 pin plug (P2) connects to a SPST on/off switch mounted in the controller faceplate. An in-line fuse (F1) provides over-current protection to the PCB.

Communication between the master processor board and the slave controller board is via RS-232 or RS-485. A 9 pin connector is plugged into the appropriate receptacle (Either P1A or P1B) depending on system requirements. An auxiliary RS-232 connection is also present on both connectors for applications that require an additional serial port connection. (The auxiliary RS-232 is not used for connection to the slave controller board)

A telemetry daughter (inductive isolation) board is plugged into connectors J1 and J2. The purpose of the telemetry board is to provide electrical isolation and protection from over-voltage or voltage spikes between the telemetry conductors and the PCB electronics.

Two hex switches marked “Mode H” (high bit) and “Mode L” (low bit)' are used to select which program to load during startup. This allows the PCB to be pre-loaded with all standard product program software and allows the user to reconfigure the PCB for other systems without the need for additional ICs or programming. A table provides the switch position options.

The master arm connects to 12-pin circular connector P4 (Standard). In a dual arm system, the additional master arm connects to P5. The master processor board sends a 4VDC reference volt-

age to each of the potentiometers in the master arm. An analog to digital converter interprets the voltage as a numerical value that is used by the control algorithm.

The USB port (J6) can be used in place of the auxiliary RS-232 connector for applications that require serial port connection. (The USB port cannot be used for connection to the slave controller board)

The 20 pin DIP connector (J7) can be used to run legacy LCD displays that have a ribbon cable interconnection. Current displays connect via spring loaded pins onto contacts (J4) on the back side of the PCB. Two additional SIP receptacles marked “LCD backlight” are also used with legacy LCD displays and provide ~80VAC to power the backlight via two wires coming from the legacy display. Two spring loaded pins are used on current displays.

6.1.1 Adjusting the LCD

A potentiometer (VR1) is used to set the optimal contrast between the black text and the blue-gray background at the desired viewing angle. Once the potentiometer is adjusted, it will automatically compensate for changes in temperature so the display remains viewable throughout the operating temperature range. See “Adjusting the LCD Screen Viewing Angle” section on page 63.

6.1.2 Changing the Software Image

Changing software image (Titan to Conan, Orion to Titan, etc.) is accomplished by selecting the appropriate hex switch settings on the PCB and then cycling power to the master processor. See “Selecting Pre-Loaded Software Images” section on page 64.

The master processor can also be run from a legacy EPROM installed in the 28 pin DIP socket (U11). This connector was installed to ensure the master processor board is fully backwards compatible with existing master controllers. See “Installing an EPROM” section on page 65.

The Secure Digital card slot (J5) allows new software, when available, to be loaded into memory on the PCB. See “Installing Images from an SD Card” section on page 65.

For more information on changing the software image, see “Master Controller Software Selection” section on page 64.

6.1.3 Troubleshooting the PCB

Communications

The master controller PCB has seven LEDS to indicate the status of PCB power, master arm reference voltage, image loading, processor function, and communication with the slave controller (TX and RX). See the “Troubleshooting” chapter for details.

Power

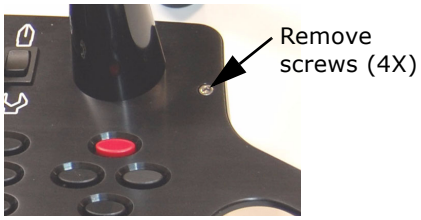
There are test-points on the master controller PCB for -16V, +12V, +5V, +3.3V, +2.5V, +1.2V, and ground. See the “Troubleshooting” chapter for details.

> ***NOTE:*** *There are no user-serviceable parts on the master controller PCB. If the board fails to function, replace it with a spare.*

6.2 Accessing Internal Components

6.2.1 Removing the Faceplate

1. **Turn off** the master controller and disconnect the whip from its power source.
2. Remove the four screws holding the master controller faceplate to the enclosure (Figure, right).
3. Lift the faceplate assembly out of the enclosure. Turn it over to expose the face of the PC board. Take care to immobilize the master arm(s) and avoid stressing the cables connected to the boards in the enclosure.



6.2.2 Installing the Faceplate

4. Carefully swing the faceplate assembly back over and seat it on the enclosure. Reinstall the four mounting screws.

   ✔ Check that no wires or cables are pinched between the faceplate and the enclosure.

6.3 Adjusting the LCD Screen Viewing Angle

The LCD screen comes with a temperature sensor and compensation circuit that keeps the viewing angle stable over a broad temperature range. If you find the viewing angle is not acceptable for your work environment, adjust it as follows:

⚠ WARNING

SHOCK HAZARD! Be aware that potentially lethal voltages are present while adjusting the LCD viewing angle potentiometer. Always observe appropriate safety procedures.

1. While keeping power supplied to the master controller, open the assembly as described in "Removing the Faceplate" section on page 63.
2. Identify the LCD adjustment potentiometer (labeled VR1 on the PC board), located at the bottom right of the board (Figure 1).

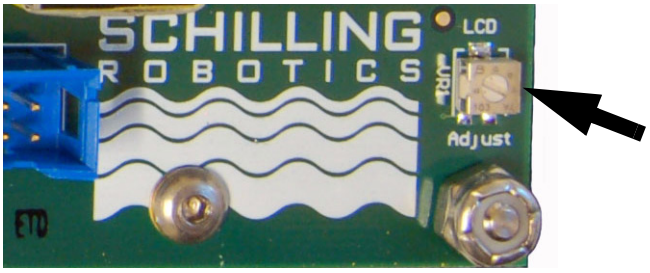


Figure 1 *LCD Adjustment potentiometer*

3. Using a small flat blade screwdriver, adjust this potentiometer for the desired viewing angle.
4. Close the master controller as described in "Installing the Faceplate" section on page 63.

6.4 Master Controller Software Selection

The master processor board is shipped with several pre-loaded software images, allowing the master controller to be used with different Schilling Robotics slave arms. The software is user-selectable by configuring two Mode switches located on the main PC board.

Software can also be loaded from:

- an existing EPROM using the 28-pin connector on the PC board
- a Secure Digital card using slot (J5).

The three methods are described in the following sections.

> ***NOTE:*** The jaw mode POS (position) option is lost when the software image is changed. To re-enable it after a software change, see *section 6.4, "Master Controller Software Selection," on page 64*.

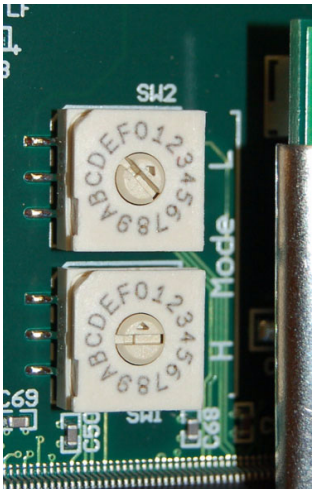
6.4.1 Preparation

1. **Turn off** the master controller and disconnect the whip from its power source.
2. Open the master controller as described in "Removing the Faceplate" on page 63.

> **! Caution**
>
> **PC board components can be damaged by static electricity. Wear a grounded anti-static wrist band handling PC boards or chips.**

6.4.2 Selecting Pre-Loaded Software Images

The two hexadecimal Mode switches (H and L) are located at the top center of the processor board (Figure 3, left). The available software is listed in a table at the right of Figure 3, and the switch settings for the "H" and "L" switches are shown as well.



H	L	Description
0	0	Titan 4, Titan 3, Titan 2
0	1	Orion 7P
0	2	Conan 7P
0	3	Dual T3
0	4	Dual Orion
0	5	Dual Conan
0	6	T3 Spaceball FLX
0	7	T3 Robotics
0	8	Titan 4, Enhanced
0	9	Titan 4, Dual
F	F	EPROM
F	0	SD Card Read
0	F	SD Card Write
4	0	Buzzer Test

Figure 3 *Hexadecimal switch orientation and software values*

1. Using a small, flat head screwdriver, adjust each switch so the "H" and "L" values match those shown for the software you want to use.
2. Close the master controller as described in "Installing the Faceplate" on page 63 and reconnect the whip.

3. Power up the master controller and view the LCD display. If a compatibility issue occurs between the new system parameters and the old software image, a message will appear on the screen asking you to Ignore, Overwrite, or Update the version number only. If in doubt, overwrite; there are no irreparable consequences due to overwriting the image. (Overwriting loads the factory default values for system parameters, gains, limits, and stow positions.)

6.4.3 Installing an EPROM

To install an EPROM chip on the master controller processor board, perform the following steps (also refer to the master controller drawing in the "Drawings & Part Lists" chapter).

The 28-pin connector is located at the lower left corner of the processor board (see Figure 4).

1. Confirm that all pins on the EPROM are aligned and straight. Orient the EPROM with its **notch towards the edge of the PCB** and press it gently into the socket until the locking clips snap into place.

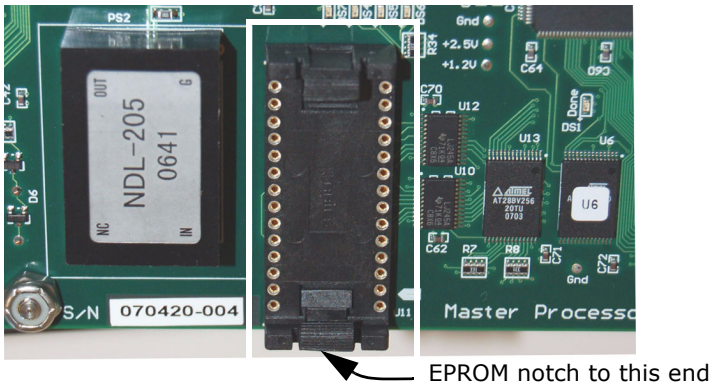


Figure 4 *EPROM 28-pin connector*

Caution

Installing the chip backwards will damage system electronic assemblies. Locate the notch on the chip to the edge of master processor board.

2. Set each hexadecimal switch to "F" (see Figure 3 on page 64 for an example of the hexadecimal switches and the EPROM switch settings).
3. Close the master controller as described in "Installing the Faceplate" on page 63.
4. Power on the master controller to load the new software.

NOTE: *You can also load the EPROM image into the master processor board memory by moving the hex switch to F 0, and then switch to 0 F while the processor board is powered. The EPROM can then be removed from the board and the EPROM image will be available for loading by selecting the hex switch position 0 F. A different EPROM can be installed and the image loaded by selecting hex switch position F F, however if you overwrite the image by selecting F 0 then 0 F, the image from the first EPROM is lost.*

6.4.4 Installing Images from an SD Card

The Secure Digital card slot (J5) allows new software, when available, to be loaded into memory on the PCB. Binary images containing the manipulator programs can be loaded onto the SD cards root directory. When the card in inserted into the slot, changing the hex switch settings

from F 0 then to 0 F while the processor is running loads the images into memory. The program can then be loaded by selecting the appropriate hex switch positions. After loading into memory, the SD card can be removed.

6.4.5 Re-enabling POS (Position) Jaw Control

The jaw mode POS (position) option is lost when the master controller software image is changed by:

- adjusting the PCB mode switches.
- replacing the EPROM (if used).
- loading a new image from an SD card.

To re-enable position jaw control when one of these events has occurred, edit the MEMORY menu as described below.

1. Reconnect the master controller to the manipulator system. Do not provide hydraulic power to the slave controller.
2. Turn on electrical power at the junction box and/or master controller, and the base module.
3. Cycle through the startup menus to the MAIN MENU. Press the 3>SETUP key. Press the SECURITY <6 menu and set the security level to 1 or higher.
4. Press the MEMORY <5 key to enter the MEMORY menu.
   — Use the RT and LF control keys to move the cursor (^) along the address line. Using the UP and DN control keys to select numerals and letters, change the address line from [0:0000-FFFF] to [5:00F0-0000] (FFFF changes to 0000 automatically) as shown in Figure 5.

```
MEMORY EDIT                LOCK
-------------------------------

1> Edit:OFF

2> View:OFF

LF & RT keys control the cursor.
UP & DN keys control the numeral.

[5:00F0-0000]
           ^                EXIT <8
-------------------------------
<CAUTION>-CONSULT MANUAL BEFORE
USING THIS MENU
```

Figure 5 *MEMORY EDIT menu with new address*

5. Press the 1> Edit key to display 1> Edit:0000 (+0000).
   — Use the control keys to change the fourth zero (0) to 1, and the line reads 1> Edit: 0001 (+0001).
6. Press the 1> Edit key to turn the edit function to OFF. The address line now reflects your editing as shown in Figure 6.

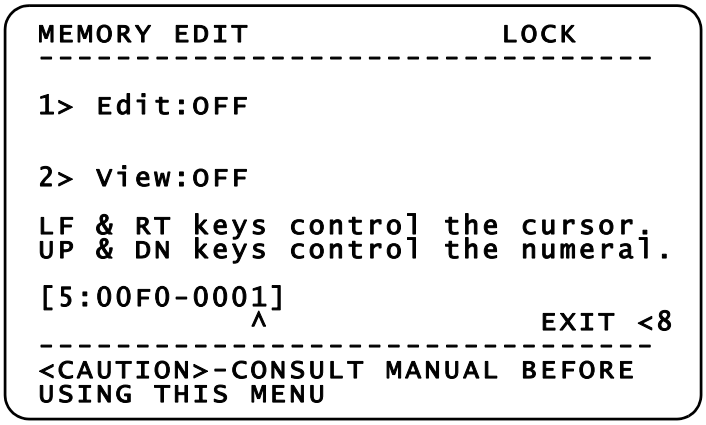


Figure 6 *Address line after editing*

7. Press the EXIT <8 key to return to the SETUP menu. Exit the SETUP menu and shut down the system. The editing changes will not take affect until the master controller has been turned off and restarted.

6.5 Incompatibility Alert Screens

Incompatibility alert screens may occur during startup when (1) a master controller is used as-is to operate a slave arm other than the one it was supplied with, or (2) when the master controller software configuration has been changed to operate a slave arm other than the one it was supplied with, and (3) the software encounters a setting, ID code, or other condition that differs from what it is expecting. This difference may range from unimportant to critical.

The alert screen typically offers an option and the user may have other options for proceeding. These are described in the following sections. ***No matter which option is chosen, proceed with extreme caution during the startup and operation of the slave arm.***

! Caution

When an incompatibility alert screen appears, use extreme caution if you continue operation. Be prepared to quickly disable hydraulics if the slave arm behaves erratically.

NOTE: *A "Fatal Telemetry Error" message at startup is NOT an incompatibility alert screen. It indicates a communications failure caused by component or connection problems, or that the master controller and slave controller/slave arm are completely different models (that is, a master controller configured with Conan software has been connected to an Orion slave controller/slave arm, etc.).*

6.5.1 Incompatible User-Configurable Settings

The user-configurable settings (such as joint travel limits, stow sequence, etc.) remain in non-volatile memory even after the master controller has been configured with new software. If they are not compatible with the software currently loaded, the alert screen in Figure 7 will be displayed.

You have three options.

a. Press the 4> Overwrite EEPROM button to install the default system non-volatile user-settings.

b. Press 3> Ignore to operate the slave arm with the current user-settings. ***Use extreme caution when testing the slave arm for safe and successful operation.*** Note that the alert screen will reappear each time the master controller is turned on.

c. Press the <7 Update EEPROM Version # only button to operate the slave arm with the current user-settings on a continuing basis—the version number is updated to prevent the alert screen from appearing each time the master controller is turned on. ***Use this option only if you have successfully tried option b.***

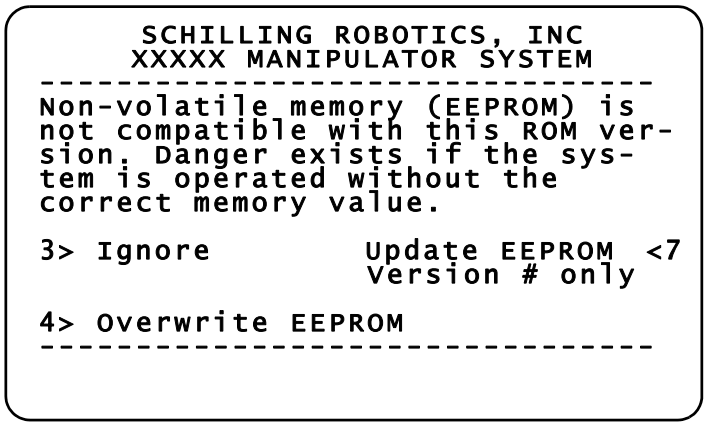


Figure 7 *"Non-volatile memory (EEPROM)..." warning screen*

6.5.2 Incompatible Slave Arms/Controllers

If the master controller is configured for a standard manipulator system and is connected to an incompatible or custom slave arm and slave controller, you may see the alert screen shown in Figure 8.

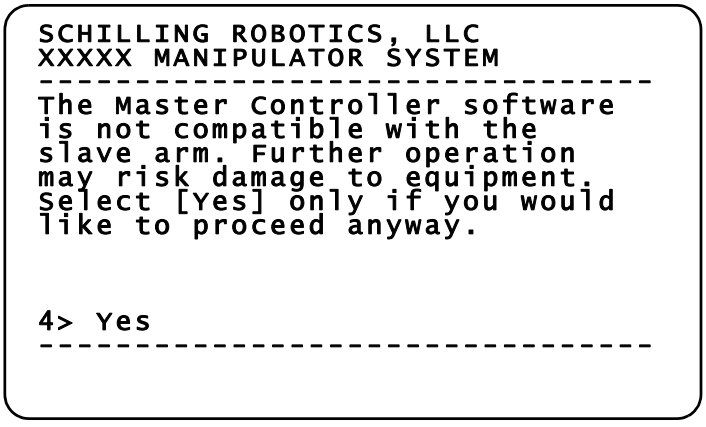


Figure 8 *Incompatibility screen*

You have three options.

a. Recommended: Do not use the master controller with this slave arm. Connect a compatible model instead.

b. Operate the slave arm with the software on its original EPROM: if the original EPROM ("PROM") used with the slave arm is available, install it in the master controller as described in section 6.4.3, "Installing an EPROM," on page 65.

c. Pressing the 4> Yes key updates the user-configurable memory with the factory default settings for the currently loaded software. ***Use extreme caution when testing the slave arm for safe and successful operation.***

6.5.3 Incompatible Systems

A master controller configured for use with one type of manipulator system (Titan, Conan, or Orion) cannot communicate with a slave arm of a different type system, and if connected, will display a "Fatal Telemetry Error" screen at startup.

7 Base Module Service

This section contains special maintenance and service procedures not covered in the Work Instructions. For additional details, refer to the drawing and part list 101-3655 in the "Drawings & Part Lists" chapter.

7.1 Fuse Replacement

Base module circuits are protected by self-resetting, non-replaceable fuses.

7.2 Servicing the Hydraulic Filter

The base module contains a tubular, mesh-screen hydraulic filter which can be removed for cleaning. The most common symptom of a clogged filter is sluggish operation of all slave arm functions despite adequate hydraulic pressure and flow from the HPU.

Refer to drawing and the parts list for 101-3655 for this procedure.

WARNING

Bleed off all pressure to all slave arm hydraulic lines before continuing. Hydraulic fluid is under high pressure and may cause injury.

1. Disable electrical power and hydraulic power to the base controller.
2. Remove the hydraulic pressure hose from the -4 hydraulic fitting (34).
3. Remove the reducer fitting (35) from the manifold block (1). Pull the filter from the manifold block.
4. Remove the filter (11) from the filter base (12). You may install a new filter or replace the original filter after cleaning it with ultrasound. Remove the two o-rings (14 & 15) from the filter base.
5. Lubricate two new o-rings with o-ring lube and install onto the filter base. Insert the filter into the manifold block.
6. Install the reducer fitting, with the -4 hydraulic fitting, onto the manifold block.
7. Install the hydraulic pressure hose.

7.3 Accessing Internal Base Module Components

The base module must be opened to perform the following procedures:

7.3.1 Opening the Base Module

Refer to drawing and the parts list for 101-3655 for this procedure. To access internal base controller components, follow the procedure below:

1. Disable hydraulic power to the manipulator system.
2. Disable power by turning off the power switch on the junction box or disconnecting local power to the base module.
3. Isolate the compensation system and drain the compensation fluid from the base module.
4. Remove the four HHCS (13) and washers (17) and separate the power supply cover (4) and manifold cover (power supply atmospheric container) (2) from the base module case. Disconnect the wiring harness coming from the power supply (21).

! Caution

When you handle the PC boards or other electronic components, wear an anti-static wrist band attached to earth ground or a large metal object.

7.3.2 Closing the Base Module

To reinstall the power supply cover (4) and manifold cover (2) follow the procedure below:

1. Check that all wire harnesses are connected and that no wires will be pinched when the covers are reinstalled.
2. Lubricate two new o-rings (26) with o-ring lube and install onto the power supply cover and the manifold block.
3. As you lower the manifold cover into place, connect the wiring harness to the power supply.
4. Install the power supply cover. Install the four HHCS and washers. Torque to 9 ft/lb (12Nm).

7.4 Replacing the Jaw/Wrist Actuator Controller PCB

Refer to drawing and the parts list for 101-3655 for this procedure.

1. Open the base module as described in “Opening the Base Module” section on page 70.
2. At the controller board (3), remove the wire harness coming from the servo valve (7). Remove the five wires going to J4 from the base module board (36).
3. Remove the three SHCS (37) and washers (38) that hold the actuator control board in place.

! Caution

When any actuator controller board is replaced, the new board’s DIP switch must be set with the address of the actuator it will control. If the controller board has the wrong address, the actuator may not respond to commands or may respond to commands intended for a different actuator.

4. Set the DIP switches on the replacement controller board as outlined below:

The DIP switch unit is shown in Figure 9 on page 71. The individual switches are labeled, left to right, with numbers from 1 through 8 across the bottom of the switch unit. Each switch contains a sliding tab. The switch is in the ON position when the sliding tab is moved towards the ON label. The switch is in the OFF position when the sliding tab is moved closest to its number.

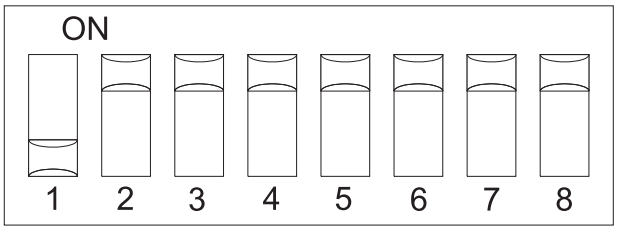


Figure 9 *Setting controller board address switches*

Switch settings for each joint are shown in Table 2 and Table 3. Use a non-conducting tool for moving switches.

Table 2

DIP Switch Settings, Right-Hand Slave Arm									
Joint No.	**Joint Name**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
5	Wrist	Off	On	Off	On	On	On	On	Off
6	Jaw	On	Off	Off	On	On	On	On	Off

Table 3 **Left-hand Slave Arm DIP Switch Settings**

DIP Switch Settings, Left-Hand Slave Arm									
Joint No.	**Joint Name**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
5	Wrist	Off	On	Off	Off	On	On	On	Off
6	Jaw	On	Off	Off	Off	On	On	On	Off

5. Install the replacement controller board. While installing the board, be careful not to damage the pins that the boards seats on.
6. Install the three SHCS (37) and washers (38) that hold the actuator control board in place.
7. Install the five wires going to J4 from the base module board and secure them with a harness tie. Install the wire harness coming from the servo valve.
8. Close the base module as described in “Closing the Base Module” on page 70.

7.5 Servicing the Jaw or Wrist Servo Valve

Refer to drawing and the parts list for 101-3655 for this procedure.

1. Open the base module as described in “Opening the Base Module” on page 70.
2. At the controller board (3), remove the wire harness coming from the servo valve (7).
3. Remove the four SHCS (8) from the servo valve.

4. Remove the four o-rings (49) from beneath the servo valve.
5. Lube four new o-rings (49) with o-ring lube and install to the underside of the servo valve.
6. Place the new servo valve in position and install with four SHCS. Torque to 9 ft/lb (12Nm).
7. Connect the wire harness to the controller board.
8. Close the base module as described in "Closing the Base Module" section on page 70.

7.6 Removing the Jaw Bypass Valve

When hydraulics are disabled, because of operator control or hydraulic failure, a bypass valve in the base module causes the jaw to relax its grip. Objects held by the jaw may be released or dropped. If you prefer that the jaw lock when hydraulic power is disabled, the bypass valve must be removed. To service the jaw bypass valve, complete the steps in "Accessing Internal Base Module Components" section on page 69. Then proceed to the steps below:

Refer to drawing and the parts list for 101-3655 for this procedure.

! Caution

This procedure requires four new SHCS, 10-24 x 1-1/2-in (manufacturer P/N 002-0197, and cannot be completed without them (see Conan Spares Kit 008-0090, item 7-37).

NOTE: *It is not necessary to separate the servo valve from the lock valve for this procedure.*

1. Open the base module as described in "Opening the Base Module" section on page 70.
2. Locate the jaw servo valve.
3. Remove the four SHCS (46) that secure the servo valve/lock valve assembly (7 & 31) and the jaw bypass valve to the manifold block (1).
4. Carefully lift the servo valve/lock valve assembly and remove the bypass valve block (81) and four o-rings (47).
5. Lubricate four new o-rings with o-ring lube and install to the bottom of the servo valve/lock valve assembly. Place the servo valve/lock valve assembly onto the base controller manifold and align the mounting holes.
6. Install the four new SHCS 10-24 x 1-1/2-in (P/N 002-0197) and torque to 45 in/lb (5.1Nm).
7. Close the base module as described in "Closing the Base Module" section on page 70.

8 Slave Arm Service

This section contains special maintenance and service procedures not covered in the Work Instructions. For additional details, refer to the slave arm drawing and part list in the "Drawings & Part Lists" chapter.

8.1 Servicing Slave Arm Servo Valves

To replace the azimuth, shoulder, elbow, pitch, or yaw actuator servo valve, you will need to gain access to the control module (containing the servo valve).

1. Position the slave arm or disconnect slave arm components as needed to allow the control module cover to be removed.
2. Remove the four SHCS (5) from the cover (2).
3. Gently remove the cover. Try to leave the base of the control module attached to the actuator. This will retain the o-rings located between the control module and the actuator. As you remove the cover, disconnect the five wires from J4 on the controller board (9). Remove the o-ring (12) from the cover (2).
4. Disconnect the wire harness that leads from the servo valve (4) to the controller board at J5.
5. Remove the four nuts (8) holding the servo valve in place. Lift the servo valve off the manifold (1).
6. Lubricate four new o-rings (004-0561) with o-ring lube and install to the bottom of the replacement valve.
7. Install the valve. Install the four nuts that hold the valve in place.
8. Install the wire harness from the valve to the controller board (J5).
9. Lubricate a new o-ring with o-ring lube and install into the cover. As you install the cover, connect the five wires to J4 on the controller board. Note that the wires are color coded to the J4 connector.
10. Install the four SHCS to hold the cover in place.
11. Reconnect slave arm components disconnected to gain control module access.

8.2 Servicing Slave Arm Actuator Boards

To service the azimuth, shoulder, elbow, pitch, or yaw actuator board, you will need to gain access to the control module (containing the actuator board).

! Caution

When you handle the PC boards or other electronic components, wear an anti-static wrist band attached to earth ground or a large metal object.

1. Position the slave arm or disconnect slave arm components so the control module cover can be removed.
2. Remove the four SHCS (5) from the cover (2).
3. Gently remove the cover. Try to leave the base of the control module attached to the actuator. This will retain the o-rings located between the control module and the actuator. As you remove the cover, disconnect the five wires from J4 on the controller board (9). Remove the o-ring (12) from the cover (2).
4. Disconnect the wire harness that leads from the servo valve (4) to the controller board at J5.
5. Remove the three SHCS (14) and washers (15) that hold the controller board in place. Remove the controller board.

NOTE: *When an actuator controller board is replaced, the new board's DIP switch must be set with the address of the actuator/function it will control. If the controller board has*

the wrong address, the actuator may not respond to commands or may respond to commands intended for a different actuator.

6. Set the address on the replacement controller board as outlined below:

   The DIP switch unit is shown Figure 10. The individual switches are labeled, left to right, with numbers from 1 through 8 across the bottom of the switch unit. Each switch contains a sliding tab. The switch is in the ON position when the sliding tab is moved towards the ON label. The switch is in the OFF position when the sliding tab is moved closest to its number.

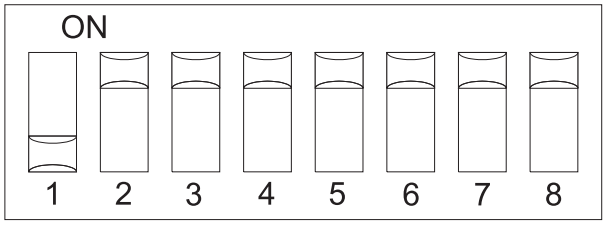


Figure 10 *Setting controller board address switches*

Switch settings for each joint are shown in Table 4 and Table 5. Use a non-conducting tool for moving switches.

Table 4

Switch Settings, Right-Hand Slave Arm									
Joint No.	**Joint Name**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
0	Azimuth	On	On	On	On	On	On	On	On
1	Shoulder	Off	On	On	On	On	On	On	On
2	Elbow	On	Off	On	On	On	On	On	On
3	Pitch	Off	Off	On	On	On	On	On	On
4	Yaw	On	On	Off	On	On	On	On	On

Table 5

Switch Settings, Left-Hand Slave Arm									
Joint No.	**Joint Name**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
0	Azimuth	On	On	On	Off	On	On	On	On
1	Shoulder	Off	On	On	Off	On	On	On	On
2	Elbow	On	Off	On	Off	On	On	On	On
3	Pitch	Off	Off	On	Off	On	On	On	On
4	Yaw	On	On	Off	Off	On	On	On	On

7. Install the controller board using the three SHCS and washers.
8. Install the wire harness from the valve to the controller board (J5).

9. Lubricate a new o-ring with o-ring lube and install into the cover. As you install the cover, connect the five wires to J4 on the controller board. Note that the wires are color coded to the J4 connector.
10. Install the four SHCS to hold the cover in place.
11. Reconnect slave arm components that were disconnected to gain control module access.

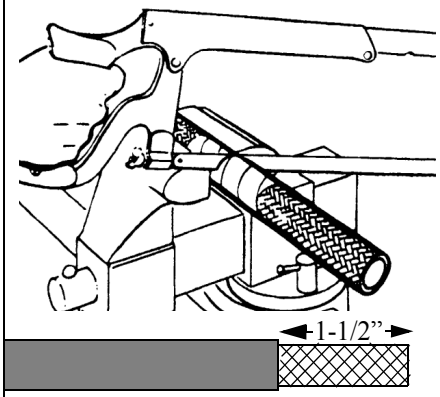
8.3 Wrist Pitch/Yaw Hose Fittings

Wrist pitch and yaw hoses are supplied with reusable fittings at the ends connected to the base module. These fittings must be removed to extract the hoses from the slave arm. Replacement wrist pitch and wrist yaw hydraulic hoses are supplied without the fittings installed so they can be installed through the pitch and yaw structural segments. See the fitting installation instructions below.

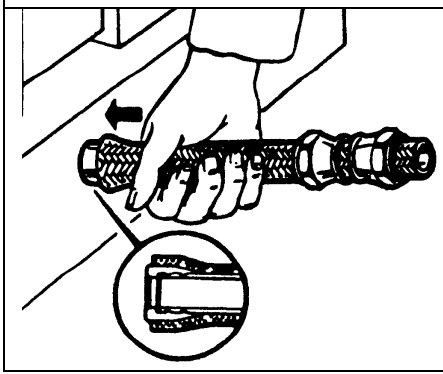
Installing Reusable Fitting 006-1205

The following instructions describes how to shorten a hydraulic hose and/or terminate it with reusable fitting 006-1205 (OEM Aeroquip 63-190600-4).

1. Determine the required hose length and mark the hose at the cut-off point. Disconnect both ends of the hose from components.



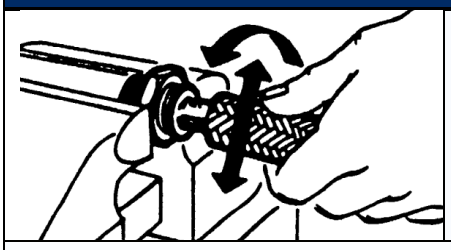
2. Wrap the hose with masking tape at the cut-off point and cut square through the taped area using a cut-off saw fitted with an abrasive blade (you can also use a fine-tooth hacksaw, as shownin figure, left). Remove the tape and trim any loose wires flush with the tube stock. Remove any burrs on the bore of the tube stock with a knife.
3. Trim the hose jacket back about 1-1/2 in. from the end, exposing the braid, as shown at left.



4. Install the socket onto the hose end. Push the new sleeve over the end of the tube and under the wire braid by hand (figure left, arrow). Complete positioning of the sleeve by pushing the hose end against a flat surface.

   It is critical that the tube stock butts against the inside shoulder of the sleeve (nearly flush with the flat end-face of the sleeve). Visually confirm this orientation.

Installing Reusable Fitting 006-1205 (cont.)

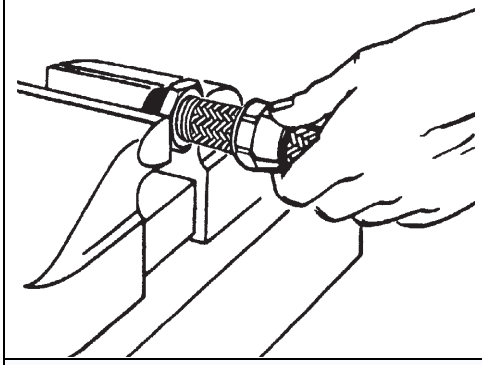


5. Clamp the hex of the nipple in a vise (male fitting shown). Push the hose and sleeve over nipple as shown in Figure, left. Work the hose with twisting motion until it is seated against the nipple chamfer (at the base of the nipple).

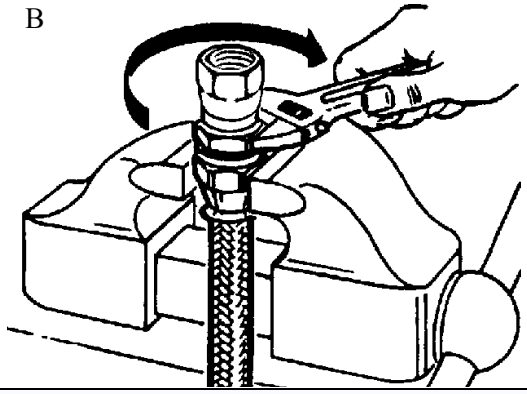
6. As shown in Figure A, below, push the socket forward on the hose and thread onto the nipple.

7. As shown in Figure B, below, use a wrench to tighten the nipple hex until it bottoms on the socket hex and the corners of nipple and socket hexes align.

A



B



8. Clean interior of hose assembly with compressed air or flush with mineral spirits or hot water (65°C/150° F max.). If the hose will not be reconnected immediately, cap or plug end fittings.

9. Inspect the fitting assembly. The gap between the nipple hex and the socket should be 1/32-in. or less. The nut on a female fitting should swivel freely.

10. Proof testing:

! Caution

Conduct hose tests with adequate safeguards to protect personnel in the test area.

Test the hose assembly at 6000 psi (twice the recommended working pressure of the hose). Hold the test pressure for not more than one minute and not less than 30 seconds. When test pressure is reached, visually inspect hose assembly for any leaks, bulges, or any movement of the hose in relation to the hose fitting. Correct any defects before placing the hose into service.\

11. Install the hose between the slave arm and base module, matching the hose and fitting codes.

12. When hose installation is completed, apply hydraulic pressure to the slave arm, operate the affected slave arm joint, and inspect the new fitting for leaks or any movement of hose within the hose fitting.

9 System Configuration

9.1 Adjusting Servo Valve Offsets

Access path: MAIN/SETUP/SET SV OFFSET
Security level: 1 or higher

The servo offset adjustment balances the response of a servo valve to control input so the speed of actuator movements is consistent in both directions of travel. Correct adjustment also keeps the actuators without lock valves (wrist pitch/yaw, wrist, jaw) immobile when the servo valve is inactive (no control input pending) and reduces sag and/or drift when hydraulics are disabled. The key physical symptoms indicating the need for adjustment are:

- A joint that moves faster in one direction than the other (given similar control inputs). This is most noticeable following a high speed movement of the master arm, when the servo valve is fully driven.
- Spontaneous joint drift in the wrist pitch/yaw, wrist, or jaw functions
- An increase in the sag or drift of the wrist pitch/yaw, wrist, or jaw functions when hydraulics are disabled.

The servo valve offset for each function is set at the factory but should be checked and adjusted when a servo valve, control module, actuator, or other control software or hardware within the master controller, base module, or control module has been serviced or replaced. Component wear, temperature, and other environmental factors may also affect the servo valve response and initiate the need for offset adjustment.

The servo offset for each joint (including the wrist and jaw) is set independently, and does not affect the offset for any other joint. The goal is to equalize the servo valve's null position so that when it is activated the servo can provide an equivalent hydraulic flow to either port of the actuator. This will ensure balanced travel rates and minimize sagging and drift in the functions without lock valve.

To set the slave arm servo offsets, follow these steps:

1. Set the current privilege level to 1 or higher. (If you aren't sure what the current level is, display the SET LEVEL menu, as described in the Operation chapter, and note the level displayed on the screen). Enter the password and change to a higher privilege level if necessary.
2. From the OPERATE menu toggle the jaw mode to POS. Make sure hydraulics are enabled (ON).
3. From the MAIN menu, select the 3> SETUP menu. From the SETUP menu, select the SET SV OFFSET <7 menu (Figure 11).

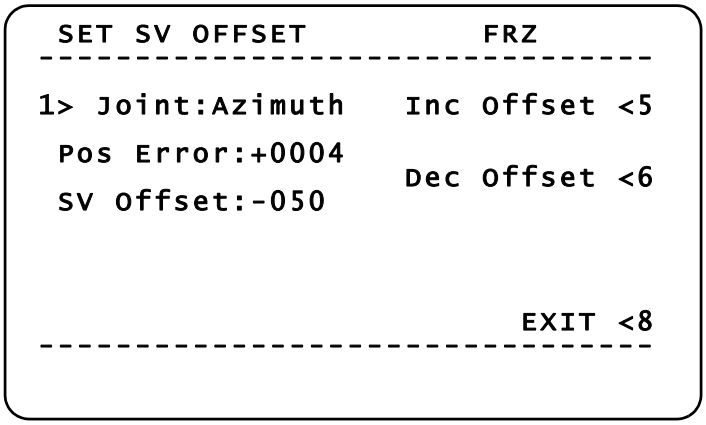


Figure 11 *Setting servo offsets*

4. The slave arm should be positioned so that all joints are near the centers of their ranges of motion. If any of the joints are at or near their limits, unfreeze the arm and reposition it, then freeze it again.
5. The joint for which servo offset is being set will appear in the 1> Joint: field. You can cycle through the joints by pressing 1> Joint.
6. For each joint, a value will appear in the Pos Error: field. The goal is to get this value as close to zero as possible. (In practice, the lowest absolute value between +0009 and -0009 is acceptable.) If the displayed value is not near-zero, press the 5> Inc Offset and 6> Dec Offset keys to adjust the value in the SV Offset: field until the Pos Error: field value is lowest.

   NOTE: *The slave arm will move slightly after each increment or decrement of the servo offset. You should wait a few seconds after each change for the arm, and the values, to stabilize.*

7. Press 1> Joint: to move to the next joint. Repeat steps 6 and 7 until the servo offsets for all joints except the wrist and jaw (azimuth, shoulder, elbow, pitch and yaw) have been nulled.
8. Wrist offset adjustment: If necessary, reposition the arm so that you can see the wrist, and freeze the arm again.

   The wrist does not have position feedback, so adjustment of its servo offset is less precise. Normally, you will need to adjust the wrist servo offset only if the servo valve has been serviced, or if the wrist rotates spontaneously. To null the wrist servo offset, perform the following adjustment procedure:

   a. Press 1> Joint until the adjacent field reads WRI.
   b. Press 5> Inc Offset until the wrist begins rotating slowly. Note the SV Offset value (it may be relatively large).
   c. Press 6> Dec Offset until the wrist begins rotating slowly in the opposite direction. Again note the SV Offset value.
   d. Add the two offset values algebraically (that is., include the plus or minus signs). If, for example, the positive offset value was +260 and the negative offset value was -60, their algebraic sum is +200. Divide this value by 2. Increment or decrement the SV offset to match this result (+100, in the example).

9. Jaw offset adjustment: If necessary, reposition the arm so that you can see the jaw, and freeze the arm again. The jaw mode must be set, in the OPERATE menu, to POS for this step.

   The jaw does not have position feedback, so adjustment of its servo offset is less precise. Normally, you will need to adjust the jaw servo offset only if the servo valve has been serviced, or if the jaw slowly opens or closes spontaneously. To null the jaw servo offset, perform the following adjustment procedure:

   a. Press 1> Joint until the adjacent field reads JAW.

   b. Press 5> Inc Offset until the jaw begins closing slowly. Note the SV Offset value (it may be relatively large). (Allow the jaw to close all or most of the way.)

   c. Press 6> Dec Offset until the jaw begins opening slowly. Again note the SV Offset value.

   d. Add the two offset values algebraically (that is, include the plus or minus signs). If, for example, the positive offset value was +500 and the negative offset value was -240, their algebraic sum is +260. Divide this value by 2. Increment or decrement the SV offset to match this result (+130, in the example).

10. Press 8> EXIT to exit the SET SV OFFSET menu and save the new settings.

! Caution

Changes to the servo offsets can change the positioning response of the slave arm joints. Reset the slave arm movement limits and/or stow sequence immediately if their settings are needed to prevent damage to the slave arm or work area (see "Setting Slave Arm Movement Limits" and "Setting the Stow In/Stow Out Sequence" in the "Operation" chapter for details).

9.2 Changing the Communications Protocol

This manipulator system can be operated using RS-232 (factory default) or RS-485 protocol. To change the telemetry configuration you must move a connector on the master controller master processor PC board and change jumper settings on the Base Module PC board.

9.2.1 Configuring the Master Processor Board

1. Open the master controller as described in "Removing the Faceplate" section on page 63.

   The RS-232 (P1A) connector (default) and the RS-485 (P1B) connector are located at the upper right side of the processor board (Figure 12).

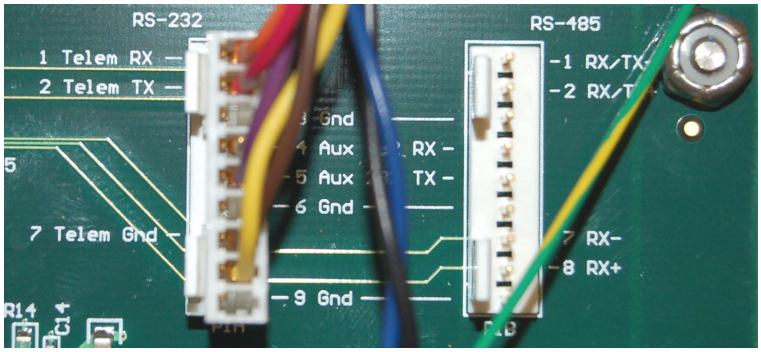


Figure 12 *RS-232 / RS-485 connection points*

2. To select RS-232 or RS-485 protocol in the master controller, install the J1 connector (terminating the power/telemetry wire bundle) to the appropriate connector on the PC board. In Figure 12, the J1 connector is connected to the RS-232 (P1A) connector.
3. Swing the faceplate assembly back over and seat it on the enclosure. Make sure that no wires or cables are pinched between the faceplate and the enclosure.
4. Do not install the four cover mounting screws at this time.

9.2.2 Configuring the Base Module PC Board

Refer to the base module drawing in the "Drawings & Part Lists" chapter. To access the base module/SCU PC board, perform the following steps:

1. Open the base module as described in section 7.3.1, "Opening the Base Module," on page 70.
2. Remove the three SHCS (37) and washers (38), and separate one of the actuator controller boards from the base module/SCU PC board (36). Repeat for the second board.
3. Set the jumpers on the base module/SCU PC board for the desired telemetry option using Table 6 and Figure 13. This telemetry option must match the telemetry option set on the master controller PCB (RS-232 or RS-485).

Table 6

Base Module Jumper Settings		
Jumper Number	**RS-422(-485) HALF DUPLEX**	**RS-232 (DEFAULT)**
JP1	1-2	1-2
JP2	1-2	1-2
JP3	2-3	2-3
JP4	1-2	2-3
JP5	1-2	2-3
JP6	1-2	1-2
JP7	1-2	1-2
JP8	1-2	2-3
JP9	1-2	2-3

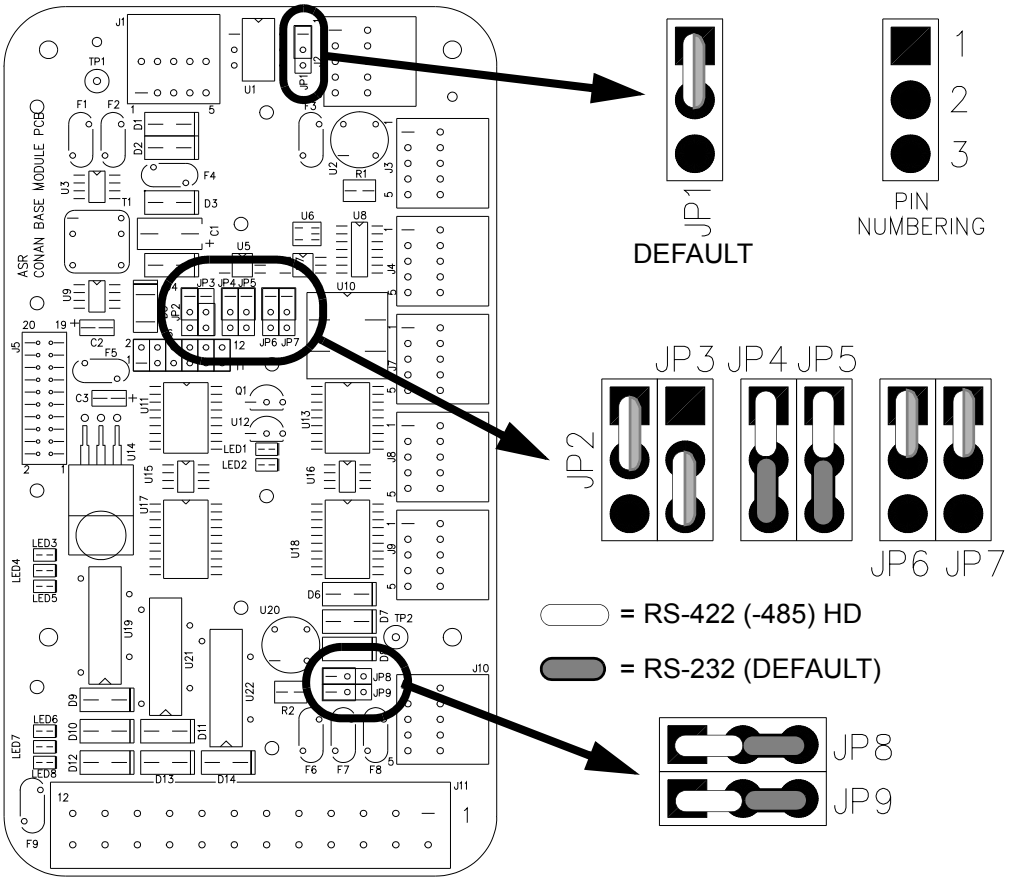


Figure 13 *Telemetry jumper settings*

4. Return one of the actuator controller boards to the standoffs (39) on the base module/SCU PC board (36). Install the three SHCS (37) and washers (38). Repeat for the second board.
5. Do not close up the base module. Proceed to the sext section.

9.2.3 Testing the Protocol Configuration

1. Before closing up the master controller and base module, connect all manipulator system components and confirm system operation. If the system starts and operates correctly, proceed to the next step.

   If the system fails to start or the message “FATAL TELEMETRY ERROR” appears on the display, check for the following problems and correct them before proceeding:

   a. Are the settings in the master controller or base module for the same protocol?

   b. Has a jumper or pin been damaged or bent?

   c. Does the manipulator system operate correctly when connected for deck-testing (long lines bypassed)?

   d. Are the connections to multiplexed long lines consistent, end to end, for slave>master/master>slave or RS-485/RS-232 communications.

2. If the system is operating correctly, close the master controller as described in “Installing the Faceplate” on page 63
3. Close the base module as described in “Closing the Base Module” on page 70.

4. Charge and bleed the base module compensation system (see the “Installation” chapter for details).

10 Instructions for Serviceable Components

- **Service instructions** are written specifically to repair or overhaul a component, and describe the complete disassembly and reassembly processes.
- **Work instructions** are written for factory assembly and some steps do not apply to field service or maintenance. Disregard the steps under Initial Preparation and the quality control (QC) tests. To disassemble a component for service or maintenance, perform the steps in reverse order until the desired parts are exposed.
- Service and work instructions are supported by their associated part lists and drawings in the “Drawings & Part Lists” chapter.

10.1 Startup Following Maintenance or Service

Startup After Minor Maintenance or Service

1. Follow steps in the “Pre-Start Checks” and “Startup Sequence” sections of the “Operation” chapter.
2. Be sure to replace hydraulic and compensation fluids lost during maintenance or service

Startup After Major Service

1. Follow the procedures in “Completing the Installation” in the “Installation” chapter before resuming normal operation.
2. If the hydraulic or compensation fluid has been contaminated, flush the system and refill with fresh fluid.

10.2 Work & Service Instruction List

See the following page.

Use the list below to find the work or service instruction that you need.

Work Instructions

Assembly Number: 101-3299 Description: Jaw Kit, 6 Inch
Product Family: Conan

Job Number:	Qty:	Date:	Dwg Rev:
Tech:		Due Date:	BOM Rev:

Process Specifications, Procedures or Remarks:

Work Instructions:	Drawing:	BOM:
☐ Do not revise	☐ Do not revise	☐ Do not revise
☐ Revise	☐ Revise	☐ Revise

Materials Required:

Adhesives:
Loctite® 271 002-0795
Chemicals:
AquaLube

Tools:

Bench Vise
1/8 inch dia. punch
Hammer

Initial Preparation:

Serialization:
Serialization is not required.

Workmanship:
For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces; that there are no missing parts; and that all hoses, cables, or wires are routed correctly. Determine that all threaded fasteners have been torqued to the correct values. Record your findings on the data sheet.

Completeness of assembly:
Verify that all assembly components listed on the bill of material are in the kit. Record your findings on the data sheet.

Assembly:

[ ]1. Using Loctite #271, glue bearings (1-2), (2-2), and (3-2) into rocker links (1-1), (2-1) and (3-1) respectively.

[ ]2. Insert rocker link (3) and two bearings (14) into jaw (1) as shown. Insert the .499" pin (7) through jaw flanges, bearings, and rocker link. Align the .125" diameter hole in pin with hole in rocker link. Press, or drive, the spring pin (17) into the .125" diameter hole until flush with rocker link surface.

[ ]3. Insert the .499" diameter pin (8) into jaw (1) as shown. Install thrust washer (15), idler link (2) with chamfer facing away from jaw, thrust washer (15), jaw washer (12), and HHCS (11) onto both ends of pin (8). Torque the HHCS (11) as indicated on the assembly drawing.

[ ]4. Q.C. Point 1. Verify bearings (1-2), (2-2), (3-2) and (14), spring pin (17), thrust washers (15) have been installed and torque of HHCS (11). Record your findings on the data sheet.

[ ]5. Install bearing (19) and shafts (6) into rocker link (3). Slide the thrust washer (13) and spacer (5) over each end of the shaft (6). Also install the thrust washers (15) over each end of the two idler plates (4).

[ ]6. Install the idler plate (4) through the two idler links (2) and onto the two shafts (6) as shown on the assembly drawing. Repeat the process on the opposite side of the unit.

[ ]7. Install HHCS (9) and washer (10) onto each end of the shafts (6).

[ ]8. Q.C. Point 2. Verify that the bearings (19), shafts (6) and rocker links (3) have been assembled correctly. Also check that the spacer (5) and thrust washer (15) have been installed over the shaft (6) and that the thrust washers (15) have been installed over the idler plates (4). Verify that the idler plates (4) were installed correctly and the HHCS (9) and washer (10) are installed correctly. Record your findings on the data sheet.

Remarks:
Record any pertinent findings or information not directly called for on the data sheet. For example: corrective action that may have been taken for the assembly to pass any of the above tests, failed tests, or problems encountered during assembly or testing.

Acceptance:
Record the name of person inspecting the assembly and affix the acceptance tag.
Record Military Specification (as required) to which the assembly was tested, and date that the test was completed.

Work Instructions

Assembly Number: 101-3372 Description: Wrist Motor Assembly
Product Family: Conan/RigMaster

Materials Required:

Chemicals:

Aqua Lube (002-0805)	O-ring lubricant (Dow Corning® 55)	Never-Seez® (002-1925)
Petroleum jelly	Valvoline® Val-plex EP® grease	

Miscellaneous:

Nitrile gloves	Safety glasses	Paper towels

Tools:

010-0173	010-0175	010-0557
010-0174	010-0804	010-0991

Initial Preparation:

Serialization:

Serialize, using steel stamps, in location shown on the assembly drawing, using the last five digits of the job number, the assembly number and BOM revision letter. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. (i.e. 101-3372 X__XXXXX-X) Record the serial number of each assembly at the top of it data sheet.

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces; that no parts are missing; and that all hoses, cables, or wires are routed correctly. Verify that all threaded fasteners have been torqued to the correct values. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are in the kit. Record your findings on the data sheet.

> Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor

Assembly:

[ ]1. Install the two rod bearings (7-8) into the noseblock (7-5).

[ ]2. Install the seals (7-9) into the noseblock (7-5). See the assembly drawing for the correct orientation and placement of the seals.

[ ]3. Install the backup ring (7-7) and then the o-ring (7-6) into the groove in the nose block (7-5) as shown on the assembly drawing.

[ ]4. Install the jaw bolt (7-13) into the counterbore of the T-bar plate (7-12) per note 9, as shown on the assembly drawing.

[ ]5. Q.C. Point 1. Verify that the bearings (7-8) and the backup ring (7-7) are installed.

Check that the seals (7-9) and o-ring (7-6) are installed. Verify the orientation and installation of the T-bar plate (7-12). Record your findings on the data sheet.

[ ]6. Apply anti-seize (7-11) to the threads and under bolt head of jaw bolt (7-13).

[ ]7. Install the piston (7-2) into the nose block (7-5) using tool 010-0804 and then install the jaw bolt (7-13) into the piston. Place the assembly onto the fixture 010-0991 and torque as indicated as shown on the assembly drawing. Ensure that the T-bare plate does not damage the noseblock when torqueing by placing a protective layer (popsicle stick) between T-bare plate and noseblock on both sides.

[ ]8. Install the bearings (7-3) and then the seal (7-4) onto the jaw piston (7-2) using tool 010-0174 as shown on the assembly drawing. Remove the bearings and then resize the seal with tool 010-0175. Reinstall the bearings.

[ ]9. Q.C. Point 2. Verify the correct assembly of the nose block unit (7) and that the bearings (7-3) and the seal (7-4) are installed. Record your findings on the data sheet.

[ ]10. Using the four HHCS (7-14) and washers (7-16) install the nose block unit (7) onto the wrist motor (2) as shown on the assembly drawing. Torque the HHCS (7-14) as indicated on assembly drawing.

[ ]11. Test 1. Jaw Functionality Test: Use compressed air to extend and retract the jaw rod several times. Apply pressure to the C1 port and observe that there is no pressure leaking from the C2 port. Record your findings on the data sheet.

[ ]12. Q.C. Point 3. Verify the torque of the HHCS (7-14). Verify the results of Test 1. Record your findings on the data sheet.

[ ]13. Affix acceptance tag and route to stock.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record on the data sheet your name and the date on which the test was completed. Record the inspector's name on the data sheet, and affix the appropriate acceptance tag. Record the Military Specification (as required) that the assembly was tested to and the date on which the test was completed.

Work Instructions

Assembly Number: 101-3657 Description: Control Module, Actuator, Bidirection
Product Family: Conan

Materials Required:

Adhesives:

Loctite® 271	002-0795	Epoxy 2043 (90 sec.)	002-1509

Chemicals:

O-ring lubricant (Dow Corning® 55)		Aqua Lube	002-0805

Tools:

Initial Preparation:

Serialization:

Serialize the actuator control module in the location shown on the assembly drawing, with the vibro engraver, using the last five digits of the job number. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. Record the serial number of each assembly at the top of its individual data sheet.
Also record the serial numbers of the servo valve (4) and PCB (9) subassemblies in the spaces provided on the data sheet.

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces, that there are no missing parts, and that any cables or wires are routed correctly. Check for the presence of any foreign matter. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are present in the kit. Record your findings on the data sheet.

Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor

[ ]1. Press the spiral pin (10) into the manifold (1) until it bottoms out in the hole.

[ ]2. Apply Loctite 271 (24) to the male end of the three standoffs (13) and install them into the manifold as shown on the assembly drawing.

[ ]3. Q.C. Point 1. Ensure the spiral pin protrudes approximately .295 inch (max). Record your findings on the data sheet.

Assembly:

[ ]1. Use the four SHCS (8) to secure the servo valve (4) to the manifold (1). Make sure that the servo valve is correctly oriented and that all o-rings are present in the grooves on the bottom of the servo valve.

[ ]2. Secure the PC board (9) to the three standoffs (13) using the three SHCS (14), five washers (15), and two SHCS (16) as shown on the assembly drawing. The connector from the PC board must seat in the large bore of the manifold (1). Do not over tighten screws and ensure that the nylon washers (15) do not deform.

[ ]3. Connect the whip from the servo valve (4) to the PC board (9), and secure it to the body of the servo valve with a cable tie (27). Make sure that the whip is not routed over the top of the servo valve and that the cable tie end is toward the PC board. Trim the excess cable tie with flush cutters.

[ ]4. Secure the cable tie (26) to the inside of the cover (2) with the SHCS (18) as shown in section A-A of the assembly drawing. Install the cable tie so that it does not hit or rub against the inside of the cover (2) when it is installed.

[ ]5. Install the self-sealing screw (22) with the orange o-ring, in the cover (2) as shown on the assembly drawing.

[ ]6. Q.C. Point 2. Check the installation of the servo valve (4) and the PC board (9). Ensure that the cable tie (27) is securing the whip from the servo valve that is connected to the PC board. Verify installation and orientation of cable ties (26), and (27) and SHCS (18). Check the installation of the self-sealing screw (22). Record your findings on the data sheet.

[ ]7. Slide the cover (2) over the unit. Bag items (6),(12),(5),(20),(19),(3),(21) and send to stock in a small cardboard box.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record your name and the date that the test was completed.
Record the name of person inspecting the assembly and affix the acceptance tag.
Record the military specification (as required) to which the assembly was tested, and the date that the test was completed.

Work Instructions

Assembly Number: 101-3658 Description: Linear Actuator, 2.6" X 1.75"
Product Family: Conan

Job Number:	Qty:	Date:	Dwg Rev:
Tech:		Due Date:	BOM Rev:

Process Specifications, Procedures or Remarks:

Work Instructions:	Drawing:	BOM:
☐ Do not revise	☐ Do not revise	☐ Do not revise
☐ Revise	☐ Revise	☐ Revise

Materials Required:

Adhesives:
Loctite® 271 (002-0795)
Loctite® PST Nuclear grade (002-1618)

Chemicals:
O-ring Lubricant (Dow Corning® 55) petroleum jelly
Valvoline® Val-plex EP® grease

Tools:

010-0184 010-0185 010-0203 010-0236 010-0523 010-0563

Initial Preparation:

Serialization:
Serialize the actuator body, using the stamp and ink, as shown on the assembly drawing. Use the last five digits of the job number for the serial number. Add a designation of -1, -2, -3, etc. for jobs consisting of more than one assembly. Record the serial number of each assembly at the top of its respective data sheet.

Workmanship:
For the duration of the assembly process verify that there are no sharp edges or scratches on any exposed surfaces, and that there are no missing parts. Check that all threaded fasteners are torqued correctly. Record your findings on the data sheet.

Completeness of assembly:
Verify that each of the components of the assembly called for on the bill of material are present, and record findings on the data sheet.

[ ]1. Install the composite bearing (12) in the rod end (11). Clean the parts well and use Loctite® 271 (16) when pressing the bearing into the bore.

[ ]2. Install the two Cv plugs (15) into the actuator body (1) using Loctite® PST (18), and tool #010-0523 (23), as described in SRS specification 130-0098-1.

Assembly:

[ ]1. Install the bearings (7) in its groove in the nose nut (6).

[ ]2. Install the seals (8) and scraper (9) in their grooves in the nose nut (6).

[ ]3. Install o-ring (10) into the groove on the outside diameter of the nose nut (6).

[ ]4. Use tool #010-0563 (24) to install o-ring (13) onto the rod end (11).

[ ]5. Q.C. point 1. Verify that the Cv plugs (15) have been installed correctly. Check to see that the bearings (7) and (12), seals (8) and (9) and o-rings (10) and (13) are installed correctly. Record your findings on the data sheet.

[ ]6. Use tool 010-0203 (19) to resize the seals and bearing strips in the nose nut (6). Screw the tool into one end of the shaft (2) and lube both the shaft and the tool well. Carefully slide the bullet shaped tool through the nose gland making sure the orientation is as shown on the assembly drawing.

[ ]7. Unscrew the tool and apply Loctite® 271 (16) to the male threads of the rod end (11). Thread the rod end (11) into the end of the piston (2). Using tool #010-0238 (24) to clamp the piston, torque the piston/shaft/rod end unit to 60 ft-lb.

[ ]8. Install the bearing (4) into its groove on the piston (2). Using tool # 010-0184 (20) install the o-ring (3) and the seal (17) into its groove on the piston. Use tool # 010-0185 (21) to resize the seal (17).

[ ]9. Q.C. point 2. Check that the seal (17) and the bearing (4) are installed on the piston (2). Record your findings on the data sheet.

[ ]10. Apply a film of petroleum jelly to the inner surfaces of the body (1). Also apply a film of petroleum jelly or o-ring lube to the bearings and seal on the piston. Apply a light film of EP® lube to the threads of the actuator housing.

[ ]11. Carefully slide the piston (2) into the bore of the actuator body (1) until it is about half way down the bore. Slide the nose nut (6) down the piston rod and down into the bore of the body. You will feel the o-ring slide past the chamfer in the bore, continue to thread the gland down until it bottoms out on the step in the bore. Torque the nose nut (6) to 100 ft-lb.

[ ]12. Q.C. point 3. Check the final configuration on the assembly. Record findings on data sheet, affix acceptance tag, bag and return to stock.

Remarks:

Record any pertinent findings or information not directly called for on the data sheet. For example: corrective action that may have been taken for the assembly to pass any of the above tests, failed tests, or problems encountered during assembly or testing.

Work Instructions

Assembly Number: 101-3659 Description: Linear Actuator, 2.25" X 6"
Product Family: Conan

Job Number:	Qty:	Date:	Dwg Rev:
Tech:		Due Date:	BOM Rev:

Process Specifications, Procedures or Remarks:

Work Instructions:	Drawing:	BOM:
☐ Do not revise	☐ Do not revise	☐ Do not revise
☐ Revise	☐ Revise	☐ Revise

Materials Required:

Adhesives:
Loctite® 271 (002-0795)
Loctite® PST Nuclear grade (002-1618)

Chemicals:
O-ring lubricant (Dow Corning® 55) petroleum jelly
Valvoline® Val-plex EP® grease

Tools:

010-0523	010-0546	010-0236
010-0563	010-0203	010-0173/010-0218
010-0174	010-0175/010-0217	010-0486

Initial Preparation:

Serialization:
Serialize the linear actuator body, using the stamp and ink, as shown on the assembly drawing using the last five digits of the job number, the assembly number and BOM revision letter. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. (i.e. 101-XXXX X__XXXXX-X) Record the serial number of each assembly at the top of its individual data sheet.

Workmanship:
For the duration of the assembly process verify that there are no sharp edges or scratches on any exposed surfaces, and that there are no missing parts. Check that all threaded fasteners are torqued correctly. Record your findings on the data sheet.

Completeness of assembly:
Verify that each of the components of the assembly called for on the bill of material are present, and record findings on the data sheet.

[ ]1. Install the composite bearing (14) in the rod end (13). Clean the parts well and use Loctite® 271 (25) when pressing the bearing into the bore.

[ ]2. Install the eight Cv plugs (21) and the Cv plug (22) into the actuator body (1) using Loctite® PST (26) and tools 010-0523 (30) and 010-0546 (31) to install Cv plugs per SRS specification 130-0098-1.

[ ]3. Place two of the thrust bearings (2) into the bottom of the side bores of the actuator body (1) and then press the two bearings (3) into those same bores.

Assembly:

[ ]1. Install the bearing (9) in the shallower, wider groove in the nose nut (8).

[ ]2. Install the seals (10) and scraper (11) in their grooves in the nose nut (8).

[ ]3. Install o-ring (12) into the groove on the outside diameter of the nose nut (8).

[ ]4. Use tool 010-0563 (32) to install o-ring (15) onto the rod end (13).

[ ]5. Install the two fittings (24) as shown on the assembly drawing.

[ ]6. Q.C. point 1. Verify that the Cv plugs (21) and (22) are installed. Check to see that the bearings (2), (3), (9) and (14), the seals (10) and (11), the o-rings (15) and (12) and the fittings (24) are installed correctly. Record your findings on the data sheet.

[ ]7. Use tool 010-0203 (29) to resize the seals and bearing strips in the nose nut (8). Screw the tool into one end of the piston shaft (4). Carefully slide the bullet shaped tool through the nose gland making sure the orientation is as shown on the assembly drawing.

[ ]8. Unscrew the tool and apply Loctite® 271 (25) to the male threads of the rod end (13). Thread the rod end (13) into the end of the piston shaft (4). Using tool # 010-0173/010-0218 (33) to clamp the piston, torque the piston/shaft/rod end unit, using tool #010-0486, to 60 ft-lb.

[ ]9. Install the bearing (6) into its groove on the piston (4). Use tool 010-0174 (27) to install the o-ring and seal (5) into the smaller groove on the piston (4).

[ ]10. Use tool # 010-0175/010-0217 (28) to resize the seal (5).

[ ]11. Q.C. point 2. Check that the seal (5) and the bearing (6) are installed on the piston (4). Record your findings on the data sheet.

[ ]12. Apply a film of petroleum jelly to the inner surfaces of the body (1). Also apply a film of petroleum jelly or o-ring lube to the bearings and seal on the piston. Apply a light film of EP® lube to the threads of the actuator housing.

[ ]13. Carefully slide the piston (4) into the bore of the actuator body (1) until it is about half way down the bore. Slide the nose nut (8) down the piston rod and down into the bore of the body. You will feel the o-ring slide past the chamfer in the bore,

continue to thread the gland down until it bottoms out on the step in the bore. Torque the nose nut (8) to 100 ft-lb.

[ ]14. Q.C. point 3. Check the final configuration on the assembly. Record findings on data sheet, affix acceptance tag, bag and return to stock.

Remarks:
Record any pertinent findings or information not directly called for on the data sheet. For example: corrective action that may have been taken for the assembly to pass any of the above tests, failed tests, or problems encountered during assembly or testing.

Acceptance:
Record your name and the date that the test was completed.
Record the name of person inspecting the assembly and affix the acceptance tag.

Work Instructions

Assembly Number: 101-3665-4 Description: Slave Arm, 7P, PA Jaw, SMD
Product Family: Conan 24V

Materials Required:

Adhesives:

Loctite® Black Max 38050	002-0814	Loctite® 290	002-0796

Chemicals:

O-ring lubricant (Dow Corning® 55)	002-0359
Aqua Lube	002-0805
Dow Corning® DC-5 Silicon Grease	002-0799

Tools:

1 5/8" socket, machined.

Initial Preparation:

Serialization:

If sold without a control system, stamp the serial number of the slave arm onto the serial number label (12) using the last five digits of the job number, the assembly number and BOM revision letter. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. (i.e. 101-3665-4 X__XXXXX-X) Otherwise, bag serial label (12) and drive screws (15) for later assembly. Record the serial number of each assembly at the top of its individual data sheet if needed.
Also record the serial numbers of the wrist, linear actuator, base module actuator module and transducer subassemblies in the spaces provided on the data sheet.

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces, that there are no missing parts, and that any hoses, cables, or wires are routed correctly. Check for the presence of any foreign matter. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are present in the kit. Record your findings on the data sheet.

Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor

Assembly:

[ ]1. Install the magnets from the transducer assemblies (8), (9) into the pistons of the five linear actuators (1-5), (2-2), (3-3). The white polarity mark on each magnet should be visible after installation. Reassemble the actuators and torque the nose nuts to 100 ft-lb. Retract each actuator to the hard stop prior to step 2.

[ ]2. Install the five transducer assemblies (8), (9) into the five actuators (1-5), (2-2), (3-3) using the two FHMS from each transducer assembly. Orient the transducer connector so that the small notch in the transducer is aligned with the arrow and

"ALIGN" marked in the back of each actuator. Extend each actuator to approximately mid stroke prior to step 3. Pack the connector with DC5.

[ ]3. ***Q.C. Surveillance Required for Step 3.*** Install the three "lock valve kits" (7) [consisting of parts (7-1), (7-2), (7-3), (7-4) and (7-5)] into the three linear actuators (1-5) as shown on sheet 5 of the assembly drawing. Note the orientation of the lock valve (7-1) and the flow spacers (7-3). Torque the SHSS (7-5) to 64 in-lb.

[ ]4. Q.C. Point 1. From Q.C. surveillance in step 3, verify the installation of the o-rings (7-4), orientation of lock valves (7-1), orientation of flow springs (7-3), and spacers (7-2). Verify torque of SHSS (7-5). Record your findings on the data sheet.

[ ]5. Install the ten relief valves (17) as shown on sheet 6 of the assembly drawing. Torque the SHSS to 30 in-lb. Apply a single drop of Loctite 290 to each SHSS.

[ ]6. Install the hoses from the coax hose assembly (10) into the adapters from the control modules (6) as shown on sheet 7 of the assembly drawing. Note the orientation of each of the hose/adapter units (on sheet 7 of the assembly drawing) and then attach each adapter to a cover. Use the cable tie secured to the inside of the cover to route the colored wires.

[ ]6. Set the DIP switches on each actuator controller PCB as shown on the graph below or the wiring diagram (29). *****In-Process Q.C. Point.***

Joint	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8
0. Azimuth	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
1. Shoulder	**OFF**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
2. Elbow	**ON**	**OFF**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
3. Pitch	**OFF**	**OFF**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
4. Yaw	**ON**	**ON**	**OFF**	**ON**	**ON**	**ON**	**ON**	**ON**
5. Wrist	**OFF**	**ON**	**OFF**	**ON**	**ON**	**ON**	**ON**	**OFF**
6. Jaw	**ON**	**OFF**	**OFF**	**ON**	**ON**	**ON**	**ON**	**OFF**

[ ]7. Connect the color-coded wires from the coax hose to the color-coded connector on the actuator control PCB. Install **YAW** coax to **YAW** controller PCB etc. Pack the electrical components of each actuator control PCB with Dow Corning® DC-5 silicon grease. Install the twenty o-rings on the bottom of the manifolds. Use the SHCS supplied with the control module assemblies to secure each assembly to the actuators. Torque the SHCS to 8 ft-lb.

[ ]8. Install the markers (11-21), the backups (11-19) and the o-rings (11-18) onto the hoses (11-1),(11-2),(11-3),(11-4),(11-5),(11-6),(11-7),(11-9),(11-12),(11-15) and (11-16) as shown on sheet 8 of the assembly drawing. Install the hose assemblies onto the three actuators (1-5), into the forearm (1-4), the yaw (3-1), onto the wrist (4) and onto the two manifolds (11-10) as shown on sheet 9 of the assembly drawing. Install the four fittings (11-17) onto the hoses (11-4) and (11-5) per SRS specification 130-0082. Record the actuator serial numbers on the data sheet.

[ ]9. Install the shoulder bumper (1-21) onto the hard stop plate (1-11) using the two FHMS (1-22). Torque the FHMS to 2 ft-lb. Install the hard stop plate onto the shoulder actuator using the four washers (1-19) and the four HHCS (1-18) as shown on sheet 2 of assembly drawing. Torque the HHCS to 35 ft-lb.

[ ]10. Install the linear slides (2-10) and (3-12) onto the forearm (1-4) and the yaw (3-1) using the four FHMS (2-11) and (3-13) as shown on sheets 3 and 4 of the assembly drawing. Torque the FHMS to 8 ft-lb.

[ ]11. Attach the hose guard (21) to the forearm (1-4) using the two HHCS (22), the two washers (24) and the two nuts (23) as shown on sheet 1 of the assembly drawing. Torque the nuts to 8 ft-lb.

[ ]12. Install the anodes (13) onto the base (1-1), the azimuth (1-2), the upper arm (1-3), the forearm (1-4) and the yaw (3-1). Install the anodes (16) onto the wrist (4) and the three actuators (1-5) as shown on sheet 1 of the assembly drawing. Torque "hand tight" with pliers.

[ ]13. Install the spring pins (1-24) into the center of the two conterbores on the azimuth. Install the upperarm bumpers (1-25) onto the ends of the spring pins and into the counterbores.

[ ]14. Attach the yaw (3-1) to the forearm (1-4) using two of the pivot pins (2-6), two of the thrust bearings (2-4), two of the retainers (2-12) and four of the HHCS (2-14) as shown on sheet 3 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]15. Install the serial number label (12) onto the base using the two drive screws (15).

[ ]16. Q.C. Point 2. Check the installation of the shoulder bumper (1-21), hard stop plate (1-11), the two linear slides (2-10),(3-12), the hose guard (21), the two pivot pins (2-6) and the two retainers (2-12). Verify the torque of the six FHMS (1-22), (2-11), and (3-13) and the four HHCS (2-14). Check the installation of the four o-rings (11-18) and the backups (11-19). Check that all hose assemblies have been properly marked, and have been installed as shown on sheets 7, 8 and 9 of the assembly drawing. Check that the anodes (13) & (16) have been installed. Check the installation of the spring pins (1-24) and upperarm bumpers (1-25). Check that the actuator, transducer, base module and actuator module serial numbers have been recorded. Check that the serial number label (12) is stamped and installed. Record your findings on the data sheet.

[ ]17. Install the pitch actuator (2-5) onto the forearm using the four washers (2-16) and the four HHCS (2-17) as shown on sheet 3 of the assembly drawing. Torque the HHCS to 60 ft-lb.

[ ]18. Install the yaw actuator (3-7) onto the yaw using the four washers (3-19) and the four HHCS (3-20) as shown on sheet 4 of the assembly drawing. Torque the HHCS to 60 ft-lb.

[ ]19. Install the azimuth actuator (0P, 0R) onto the base using two of the pivots (1-6), twenty of the washers (1-16) and HHCS (1-20) as shown on sheet 2 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]20. Install the remaining two actuators (1P, 1R) and (2P, 2R) into the upper arm (1-3) using the remaining forty washers (1-16) and HHCS (1-20) as shown on sheets 2 and 9 of the assembly drawing. Torque the HHCS to 8 ft-lb. Route the elbow hoses into the upper arm as shown on sheet 9 of the assembly drawing.

[ ]21. Attach the azimuth (1-2) to the base using two of the pivot pins (1-8), two of the retainers (1-14), and four of the HHCS (1-17) as shown on sheet 2 of the assembly drawing. Attach the rod end of the azimuth actuator to the azimuth using one of the pins (1-7), one of the retainers (1-14), and two of the HHCS (1-17). Torque all six HHCS to 8 ft-lb.

[ ]22. Attach the upper arm to the azimuth using two of the pivot pins (1-8), two of the retainers (1-14), and four of the HHCS (1-17) as shown on sheet 2 of the assembly drawing. Attach the rod end of the shoulder actuator to the azimuth using one of the pins (1-7), one of the retainers (1-14), and two of the HHCS (1-17). Torque all six HHCS to 8 ft-lb.

[ ]23. Attach the forearm (1-4) to the upper arm using the two remaining pivot pins (1-8), two of the retainers (1-14), and four of the HHCS (1-17) as shown on sheet 2 of the assembly drawing. Attach the rod end of the elbow actuator to the forearm using the remaining pin (1-7), one of the retainers (1-14), and two of the HHCS (1-17). Torque all six HHCS to 8 ft-lb.

[ ]24. Attach the wrist (4) to the yaw using the two remaining pivot pins (3-8), two of the thrust bearings (3-6), two of the retainers (3-14), and four of the HHCS (3-15) as shown on sheet 4 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]25. Route the pitch, yaw, wrist, jaw, comp and coax hoses through the slave arm as show on sheets 7 and 9 of the assembly drawing. Connect the hydraulic hoses to the manifold (11-10) and the base module (5) and connect the coax hoses to the base module as shown on sheet 7 and 9 of the assembly drawing.

[ ]26. Install the base module (5) onto the base using the HHCS and washers supplied with the base module. Torque the HHCS to 8 ft-lb. Assembly tip: Attach the nylon washers to the base module with Loctite Black Max.

[ ]27. Install the four side plates (2-2), (2-3), (3-3), (3-4) onto the two top plates (2-1), (3-2) using the sixteen HHCS (2-4), (3-5) as shown on sheets 3 and 4 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]28. Install one of the link assemblies onto the yaw using the bearings (2-9), the spacer (2-7), the retainers (2-12), the HHCS (2-14), and the pivot pins (2-8),(2-15) as shown on sheet 3 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]29. Install the remaining link assembly onto the wrist base using the bearings (3-6), the spacer (3-9), the retainers (3-14), the HHCS (3-15), and the pivot pins (3-10), (3-18) as shown on sheet 4 of the assembly drawing. Torque the HHCS to 8 ft-lb.

[ ]30. Remove the cover and intermediate block from the base module (5) to expose the PC board. Connect the color-coded wires to the color-coded connectors on the PC board inside the manifold according to the wiring diagram (29). Start with the

wires from azimuth function on the lowest connector, shoulder function on the next connector up, and so on, until all coax wires are connected.

[ ]31. Q.C. Point 3. Check that the pitch and yaw actuators (2-5) and (3-7) have been properly installed. Check the installation of the six pivots (1-6), the eleven pivot pins (1-7), (1-8), (3-8) and the eleven retainers (1-14), (3-14). Check the torque of the ninety HHCS (1-17), (1-20), (2-17), (3-15) and (3-20). Check that the actuators have been properly oriented and the hoses have been properly routed and connected as shown on sheet 7 and 9 of the assembly drawing. Check that the HHCS securing the base module are torqued. Check the proper installation of the pitch and yaw links. Check the torque of the HHCS (2-4), (2-14), (3-5) and (3-15). Check the DIP switch settings on the Wrist and Jaw actuator controller PCB (the two smaller PCBs). Verify that they match the appropriate table on wiring diagram (29). Record your findings on the data sheet.

[ ]32. Test 1. {Note: If sold without control system, perform a manipulator functionality test. Otherwise test completed at next level.} Make the appropriate electrical and hydraulic connections to power up the system. Operate the manipulator for approximately one half hour, making sure to run all joints throughout their respective range of motion. Verify that all functions are operating correctly and that there are no hydraulic leaks. Record your findings on the data sheet.

[ ]33. Reassemble the base module using the supplied HHCS and washers. Torque the HHCS to 8 ft-lb.

[ ]7. Q.C. Point 4. Check installation of base module and block and verify torque of HHCS (5). Record your findings on the data sheet.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.
Acceptance:
Record your name and the date that the test was completed.
Record the name of person inspecting the assembly and affix the acceptance tag.
Record the military specification (as required) to which the assembly was tested, and the date that the test was completed.

Work Instructions

Assembly Number: 101-3683 Description: Wrist, w/PA Jaw
Product Family: Conan

Job Number:	Qty:	Date:	Dwg Rev:
Tech:		Due Date:	BOM Rev:

Process Specifications, Procedures or Remarks:

Work Instructions:	Drawing:	BOM:
☐ Do not revise	☐ Do not revise	☐ Do not revise
☐ Revise	☐ Revise	☐ Revise

Materials Required:

Chemicals:

Aqua Lube	002-0805
Dow Corning® DC 5 (Silicon Grease)	002-0799
O-ring Lube (Dow Corning® 55)	002-0359

Tools:

No special tools are required.

Initial Preparation:

Serialization:

Serialize the wrist base using the stamp and special ink as shown on the assembly drawing using the last five digits of the job number. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. Record the serial number and part number with revision of each assembly at the top of its individual data sheet.

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces, that there are no missing parts, and that any hoses, cables or wires are routed correctly. Check for the presence of any foreign matter. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are present in the kit. Record your findings on the data sheet.

Assembly:

[ ]1. Record the serial number of the wrist module (2) on the data sheet prior to step 2.

[ ]2. Install the jaw assembly (44), using the special vise jaws, onto the wrist assembly (2) as shown on the assembly drawing. Torque the four HHCS (44-11) to 21 ft-lb. Torque the four HHCS (44-9) to 40 ft-lb.

[ ]3. Install the five fittings (50) into the wrist base (1). Torque the fittings to 15 ft-lb.

[ ]4. Install the five o-rings (48) into the wrist base as shown on the assembly drawing.

[ ]5. Install the o-ring (49) into the groove on the wrist manifold as shown on the assembly drawing.

[ ]6. Q.C. Point 1. Check that the serial number of wrist module (2) is recorded. Check that the jaw assembly (44) is correct and its eight HHCS (44-9),(44-11) are torqued. Check that the five fittings (50), five o-rings (48) and the o-ring (49) have been installed. Record your findings on the data sheet.

[ ]7. Install the wrist base (1) onto the wrist assembly (2) using the four HHCS (12) and washers (45) as shown on the assembly drawing. Note that the orientation of these parts is critical. Torque the HHCS to 25 ft-lb.

[ ]8. Test 1. Using compressed air, operate the jaw function. Insure that there is no port to port leakage. Record your findings on the data sheet.

[ ]9. Cap the wrist fittings.

[ ]10. Q.C. Point 2. Check the correct orientation of the wrist base (1). Check the torque of the HHCS (12). Check results of Test 1. Check that the final assembly is complete and correct. Record your findings on the data sheet.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record your name and the date that the test was completed.
Record the name of person inspecting the assembly and affix the acceptance tag.
Record Military Specification (as required) to which the assembly was tested, and date that the test was completed.

Work Instructions

Assembly Number: 101-3786 Description: Wrist, Orion
Product Family: Orion

Materials Required:

Adhesives:
Loctite® 271 (002-0795) Loctite® Primer 'N' (002-0291)
Chemicals:
Aqua Lube (002-0805) O-ring lubricant (Dow Corning® 55)
Petroleum jelly Valvoline® Val-plex EP® grease
Miscellaneous:
Nitrile gloves Safety glasses Cotton swabs Paper towels

Tools:

010-0194 010-0236 010-0525 010-0613

Initial Preparation:

Serialization:
Serialize in location shown on the assembly drawing with the ink and rubber stamp, using the last five digits of the job number, the assembly number and BOM revision letter. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. (i.e. 101-3786 X__XXXXX-X) Record the serial number of each assembly at the top of its individual data sheet.

Workmanship:
For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces; that no parts are missing; and that all hoses, cables, or wires are routed correctly. Verify that all threaded fasteners have been torqued to the correct values. Record your findings on the data sheet.

Completeness of assembly:
Verify that all assembly components listed on the bill of material are in the kit. Record your findings on the data sheet.

Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor

[ ]1. Use tool 010-0236 to press the needle roller bearing (21), with the printed edge visible, into the centerbore of the wrist manifold (20) until it seats on the bottom of the counterbore. Degrease and pack the bearing with Valvoline® Val-plex EP® grease.

[ ]2. Press the caged needle roller bearing (4), with the printed edge visible, into the housing (2). Degrease and pack the bearing with Valvoline® Val-plex EP® grease.

Phantom Assembly:

[ ]3. Verify installation of inserts (2-5) and CV plugs (2-2) into slip ring (2-1) per SR spec 130-0098 and phantom assembly 101-3784.

[ ]4. Verify installation of CV plug (1-2) into drive shaft (1-1) per SR spec 130-0098 and phantom 101-3785.

[ ]5. Verify installation of CV plug (20-2) into wrist manifold (20-1) per SR spec 130-0098 and phantom 101-3782.

Assembly:

[ ]6. Install the roto glyd seals (5) into the three grooves of the housing (2) as shown on the assembly drawing.

[ ]7. Lightly lubricate the bearing (7) and install into the housing (2).

[ ]8. Install the eight crush washers (27) onto the five SHCS (29), the two oil supply bolts (22), and the oil return bolt (23). Slide the crush washers down to the bolt heads.

[ ]9. Use tool 010-0194 to install the two o-rings (24) into the grooves on the tips of the two oil supply bolts (22).

[ ]10. Slide the two oil supply bolts (22) into the wrist manifold (20) at the locations that correspond to the outside pin plug holes located on the outside of the wrist manifold, and slide the oil return bolt (23) into the hole that corresponds to the middle pin plug on the outside of the manifold. Slide the five SHCS (29) into the remaining five holes of the wrist manifold.

[ ]11. Install the two bushings (25) and then the two o-rings (26) over the oil supply bolts (22) already placed in the countersunk locations on the wrist manifold (20).

[ ]12. Install the o-ring (19) into the groove in the wrist manifold (20).

[ ]13. Install the o-rings (16), (17), and (18) into the grooves of the valve plate (14) as shown on the assembly drawing.

[ ]14. Loosely install the SHCS (33) into the clamp nut (32).

[ ]15. Degrease the thrust washer (8) and thrust bearing (9). Using Valvoline® Val-plex EP® grease as an adhesive, install the thrust washer, thrust bearing and the seal backup (10) onto the drive shaft (1) as shown on the assembly drawing.

[ ]16. Install the lip seal (12) onto drive shaft (1) as shown on the assembly drawing.

[ ]17. Use o-ring lubricant to lubricate the bores below the heli-coils in the housing (2).

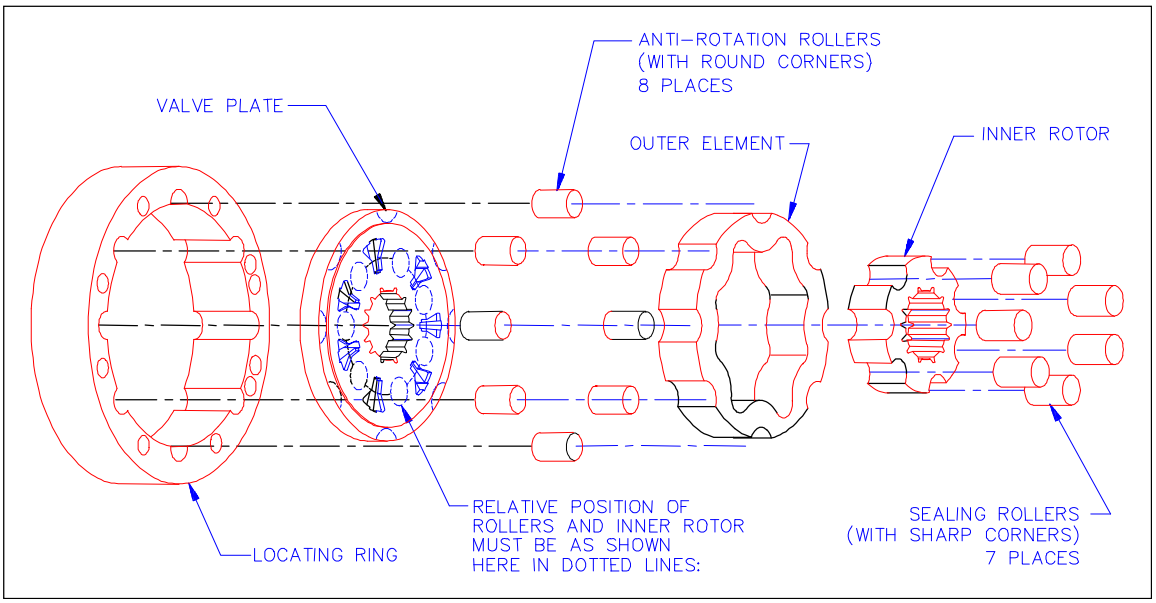
[ ]18. Q.C. Point 1. Verify that the bearings (4),(7),(8),(9),(21) and the backup (10) are installed. Check that the seals (5),(12) , and o-rings (16),(17),(18),(19),(24),(26) are correctly installed. Check that the crush washers (27) have been installed. Verify the orientation and installation of the SHCS (22),(23),(29),(33) and bushings (25). Record your findings on the data sheet.

[ ]19. Lightly lubricate the sealing surfaces of the driveshaft (1) and then orient it with the splined end upward. Install the housing (2) onto the driveshaft as shown on the assembly drawing.

[ ]20. Install the wear plate (11) onto the drive shaft (1). You may need an arbor press to fully seat the wear plate over the seal and onto the bearing. Align the eight bolt holes to the eight threaded holes of the housing.

[ ]21. Lightly lubricate the pieces of the gerotor assembly (13) (shown in figure 1 below) and install it onto the driveshaft (1) as shown on the assembly drawing. Note: install the locating ring with the "funnels" or the "small groove" up. Gerotor valve plate should be installed with "T" shaped ports up and "bell" shaped ports down. The bearings should not be visible through the "T" shaped port.

Figure 1.



[ ]22. Install the lip seal (15) onto the drive shaft (1) using tool 010-0525 as shown on the assembly drawing.

[ ]27. Degrease and then install the two thrust washers (30) and the thrust bearing (31) onto the wrist manifold (20) as shown on the assembly drawing. Lubricate the bearing with Valvoline® Val-plex EP® grease.

[ ]28. Install the clamp nut (32), with the three threaded holes facing up, onto the drive shaft (1). Torque the nut to 75 ft-lb. Loosen the nut and then retorque to 10 ft-lb. Torque the SHCS (33) to 5 ft-lb.

[ ]29. Install the lip seal (3) into the housing (2) as shown on the assembly drawing.

[ ]30. Q.C. Point 3. Verify the correct installation of the seal (3). Check the torque of the SHCS (22),(23),(29),(33).

[ ]31. Install test plate 010-0613 onto wrist using HHCS (73). Torque HHCS to 73 ft-lbs.

[ ]32. Test 1. Wrist functionality test. Connect the wrist assembly to the servo C1 and C2 ports of the hydraulic test bench and operate the wrist at 3000 psi in both directions for several minutes to see if it is operating correctly. You may adjust the clamping nut (32) to achieve proper wrist operation. Do not lower the torque of the clamping nut below 10 lb-ft or any higher than 110 lb-ft. Stop the wrist from rotating and then gradually drive the servo valve until the wrist just begins to rotate. This is the "breakaway RPM," or the lowest speed at which the motor will operate. Observe the number of revolutions in one minute and record the reading on the data sheet. The value should be no more than 6 RPM. Repeat this process for the opposite direction.

[ ]33. Test 2. Wrist torque test. Test the wrist torque using tool 010-0577. The wrist torque shall be a minimum of 75 ft. Lb in both directions. You may adjust the clamping nut (32) to achieve proper wrist torque. Do not lower the torque of the clamping nut below 10 lb-ft or any higher than 110 lb-ft. Record the final clamping nut torque value on the data sheet and stamp the value on the face of the nut itself.

[ ]34. Q.C. Point 4. Verify the results of Test 1 and 2 and that the torque value of the clamping nut (33) has been stamped into its face. Record your findings on the data sheet.

[ ]35. Affix acceptance tag and route to stock.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record on the data sheet your name and the date on which the test was completed. Record the inspector's name on the data sheet, and affix the appropriate acceptance tag. Record the Military Specification (as required) that the assembly was tested to and the date on which the test was completed.

Work Instructions

Assembly Number: 101-5781 Description: Master Controller, Universal Input, Gen II

Product Family: Titan

Materials Required:

Test Equipment:

- 101-1780: Junction box T3
- 005-3600/101-3242 test box

Chemicals:

- 002-1839: Loctite ® 242 (or equivalent)

Initial Preparation:

Prepare Documentation Package:

The assembly technician shall print a copy of the Test Data Sheet for the purpose of recording the serial number, traceability of components (where applicable) and step-by-step conformance with the procedure. The technician shall check off each step as they are completed. The technician shall initial and date the last page of the Test Data Sheet upon completion of the procedure. The Test Data Sheet shall remain with the assembly at all times. The Assembly Steps is a technical reference document that does not need to be retained after the build is complete.

BOM Required for Assembly

Print BOM(s): 101-5781

General Notes:

1. The following steps may be performed out of sequence.
2. Install components and hardware in accordance with posted shop standards.
3. Record QC acceptance details on the Test Data Sheets pertaining to each sub-assembly. Completed TDS documents for each sub-assembly shall be combined with the top level TDS document for this procedure

Serialization:

Serialize item 33 of the assembly drawing, using the last five digits of the job number. Add a designation of -1, -2, -3, etc. for jobs consisting of more than one assembly. Record the serial number of each assembly at the top of its individual data sheet.

In addition, record the serial numbers of the faceplate (1), the master control arm (3), the processor (2), and the telemetry board (5) in the spaces provided on the data sheet.

Label Information:

Add the part number (P/N) followed by a space and the BOM revision to the label (33). Also add the following voltage input data to the label:

Volts:	90-260VAC
Amps:	1
Hz:	50/60

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces; that no parts are missing; and that cables and wires are routed correctly. Verify that all threaded fasteners have been torqued to the correct values. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are in the kit. Record your findings on the data sheet.

Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor

Assembly:

[ ]1. Stick the four rubber feet (17) to the four corners on the bottom of the housing (16).

[ ]2. Install label (51) onto housing (16) as per the drawing.

[ ]3. Install the MCA (3) to the faceplate assembly (1) using the four screws (11), (32) and the clamp (10) as shown on the assembly-drawing. *Be careful* not to over-tighten the screws (11) because the Delrin threads in the MCA can easily be stripped.

[ ]4. Connect the jaw switch three-wire connector to the three-wire connector of the MCA.

[ ]5. Install item (56) onto the face plate assembly (1) per detail F.

[ ]6. Install the telemetry board (5) onto the processor boards' (2) J1 and J2 connector. Secure the telemetry board per the drawing.

[ ]7. Align the SIP connectors to the processor board (2) with the sip connectors of the display (56) and secure the processor board to the faceplate, using the four nuts (39) and two screws (32) as per the drawing.

[ ]8. Insert the power switch connector from the faceplate assembly (1) into the processor board's (2) P2 connector.

[ ]9. Connect the cable from the MCA (3) to P4 on the motherboard (2).

[ ]10. Connect Wire 1 (53) and (54) to the face plate assembly (1) per the drawing at location F using screw (9).

[ ]11. Feed the wires of cable (7) through the hole in the housing (16) as shown in the drawing and secure the cable to the housing.

[ ]12. Connect the wires of cable (7) to the J1 and J2 connector supplied with cable (7) per the drawing detail G.

[ ]13. Connect the ground wire from J2 of cable (7) and Wire 1 (53) (54) onto the housing (16), using the washer (23) and the screws (24) as shown on the assembly drawing.

QC Point 1:

[ ]14. Check the rubber feet (17), the MCA (3), the clamp (10), the processor board (2), the telemetry board (5), and the cable (7) have been properly installed and wired to the J1 and J2 connector. Verify that the fasteners (9), (11), (24), (32), and (38) have been tightened. Record your findings on the test datasheet.

[ ]15. Connect cable A to the P7 connector of the processor board (2). Connect cable B to the P1B connector of the processor board (2) (RS-485).

Note: Reference the processor board's (2) drawing for locations of P1 and P7.

[ ]16. Install the faceplate (1) onto the housing (16) using the four screws (8) as shown on the assembly drawing. Tighten the screws hand tight.

[ ]17. Attach the nameplate (19) to the center of the faceplate as shown on the assembly drawing.

NOTE: Clean the area under label with alcohol and Q-tip to ensure good adhesion.

[ ]18. Apply the voltage label (33) as shown on the assembly drawing.

NOTE: Clean the area under label with alcohol and a Q-tip to ensure good adhesion.

Test 1:

Note: For service or used units, document the following communications and software configuration of the consolette:

- *Communications configuration of cable B (J1) to the P1A or P1B connector on the 005-5195 processor board.*
- *Switch position on the hex switches SW1 and SW2.*

19. Set the hex switch setting as follows:
    - SW1 0
    - SW2 2 (Conan)

20. Plug consolette into J-box. Plug 005-3600 test box into J-box.
21. Ensure Conan base module is plugged in to fixture.

22. Set the base module up for RS-485 communications on the 005-3600 base module in the test box as follows:

Jumper	Pin connection
JP1	1 to 2
JP4	1 to 2
JP5	1 to 2
JP6	1 to 2
JP7	1 to 2
JP8	1 to 2
JP9	1 to 2

23. Ensure at least one of the 101-3656 actuators, on the test set up has a pot and servo LED assembly installed (see 101-3656 test procedure for configuration).
24. Power on J-box.
25. Power on master consolette.

Note: The power button should be oriented such that power is on when the switch is toggled down towards the top of the master controller (away from the operator) and powered off when the switch is toggled down towards the bottom of the master controller (towards the operator).

26. Adjust pot VR1 on 005-5195 processor board so that vertical lines just barely appear on the display.

Note: The lines will fade as the assembly warms up. Readjust the pot if necessary when testing is complete.

27. Check the back-light of the display by cupping your eyes over the display with your hands. The display should still be visible in darkness.
28. Select “Overwrite EEPROM”. Select “Diagnose/Show Errors”. Verify there are no errors.
29. Select “Diagnose/Master”. Rotate each joint through its motion of travel. All joint maximum values should be within the tolerances listed below.

Titan Arm

	Positive Value Tol.	*Negative Value Tol.*
Azimuth	1931 to 1370	-1931 to -1370
Shoulder	679 to 400	-679 to -400
Elbow	1524 to 950	-1500 to -950
Pitch	1346 to 900	-1889 to -1137
Yaw	1200 to 900	-1200 to –900 (for arm serial # >699)
	1317 to 915	-1317 to –915 (for arm serial # <700)
Wrist	2047 to 1488	-2047 to -1488

30. Squeeze the bands at the end of the arm. The band closest to the end of the arm should initiate the jaw close value (the top right screen number). The inner band should initiate the jaw open value (the number just below the jaw open value). Pressing the bands should indicate a value of at least +1850 counts when initiated.

31. On the controller face plate assembly, test the jaw switch by pressing on the jaw switch to the jaw close position. Rocking the switch to the jaw close position should indicate a jaw close condition (the top right screen number). Depressing the jaw switch to the jaw open position should indicate a jaw open condition (the number just below jaw open). Both jaw open and close values should indicate at least +1850 counts when initiated.

32. Test all buttons for proper functionality. There are 16 buttons on the faceplate. There is also a button on the end of the arm. Press each button and verify bit operation at the bottom of the display screen of the consolette.

Bit #	**Button Function**
0	Left top (#1) function button
1	Left #2
2	Left #3
3	Left #4
4	Right side top keypad button
5	Right side left keypad button
6	No function
7	Button on end of arm.
8	Right side top (#1) function button
9	Right side #2
10	Right side bottom keypad button
11	Right side right key pad button
12	Exit button (Right #4)
13	Right side #3

33. Select the “Diagnose” menu.
34. Select the “Slave” menu.
35. Adjust the pot on actuator board and verify position feedback for the joint changes relative to the rotation of the resistor pot attached to the actuator board.
36. Power off consolette and J-box.
37. Set the base module up for RS-232 communications on the 005-3600 base module in the test box as follows:

Jumper	**Pin connection**
JP1	1 to 2
JP4	2 to 3
JP5	2 to 3
JP6	1 to 2
JP7	1 to 2
JP8	2 to 3
JP9	2 to 3

38. Set up the consolette for RS-232 communications by connecting the J1 connector of the 101-5992 cable to P1A on the 005-5195 processor board.
39. Power on J-box.
40. Power on master consolette.
41. Go to the “Diagnose” menu.
42. Select “Show Errors”. Verify there are no errors.
43. Exit from the “Show Errors” menu and select the “Slave” menu.
44. Adjust the pot on the actuator board of the test set up. Verify that there is positional feedback from the corresponding joint attached to the actuator board. Verify that as the pot is rotated that changes occur in the “Fdbk” (Feedback) numbers.
45. Power off consolette and J-box.
46. Disconnect consolette from J-box.
47. Set the SW1 and SW2 hex switch settings on the 005-5195 processor board as follows:
    - SW1 0
    - SW2 0 (Titan 4)

Note: For Service or used- units, reconfigure the consolette communications system to the original configuration documented at the start of the test procedure.

[ ]50. Reinstall the faceplate (1) onto the housing (16) using the four face plate screws (8) as shown on the assembly drawing. Tighten the screws hand tight.

Q.C. Point 2:

[ ]51. Check that the screws (8) are installed and not loose tight. Verify that the name plate (19) and the voltage label (33) have been installed and are correct. Verify the results of Test 1 and check the general configuration of the assembly. Record your findings on the datasheet.

[ ]52. Place the assembly into its shipping case (50).

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record on the data sheet your name and the date on which the test was completed.
Record the inspector’s name on the data sheet and affix the acceptance tag to the assembly.
Record the Military Specification (as required) to which the assembly was tested, and the date on which the test was completed.

Work Instructions

Assembly Number: 101-7854 Description: Base Module Control SMD

Product Family: Conan

Materials Required:

Adhesives:

Locktite® 271	002-0795
Locktite PST® pipe sealant 56747	002-0797

Chemicals:

Aqua Lube	002-0805
O-ring Lube (DC 55)	002-0359

Electrical Related Items:

Cable Tie 3"	002-0524
Cable Tie 8"	002-0846

Initial Preparation:

Prepare Documentation Package:

The assembly technician shall print a copy of the Test Data Sheet for the purpose of recording the serial number, traceability of components (where applicable) and step-by-step conformance with the procedure. The technician shall check off each step as they are completed. The technician shall initial and date the last page of the Test Data Sheet upon completion of the procedure. The Test Data Sheet shall remain with the assembly at all times. The Assembly Steps is a technical reference document that does not need to be retained after the build is complete

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BOM Required for Assembly

Print BOM(s): 101-7854

General Notes:

1. The following steps may be performed out of sequence.
2. Install components and hardware in accordance with posted shop standards.
3. Record QC acceptance details on the Test Data Sheets pertaining to each sub-assembly. Completed TDS documents for each sub-assembly shall be combined with the top level TDS document for this procedure

Serialization:

Serialize the block (1), with label (45), as shown on the assembly drawing using the last five digits of the job number. Add the designation -1, -2, -3, etc. for jobs consisting of more than one assembly. Record the serial number of each assembly at the top of its individual data sheet.
Also record the serial numbers of the base module PC board (36), the two actuator control PC boards (3), lock-valve (31), and the two servo valve subassemblies (7) in the spaces provided on the data sheet.

Label Information:

Add the part number (P/N) followed by a space and the BOM revision to the label (45).
Also add the following voltage input data to the label (45):
Volts: 18-36 VDC
AMPS: 1.5
HZ: N/A

Workmanship:

For the duration of the assembly process, verify that there are no sharp edges or scratches on any exposed surfaces, that there are no missing parts, and that any hoses, cables or wires are routed correctly. Check for the presence of any foreign matter. Record your findings on the data sheet.

Completeness of assembly:

Verify that all assembly components listed on the bill of material are present in the kit. Record your findings on the data sheet.

Assembly:

[ ]1. Install the backup ring (15) and o-ring (14) onto filter base (12). Make sure the orientation of the backup ring is correct.

[ ]2. Install the filter (11) into the filter base (12).

[ ]3. Install the solenoid cartridge (17) into the manifold block (1) as shown on the assembly drawing. Torque to cartridge (17) as indicated on assembly drawing.

[ ]4. Apply Locktite 271 (65) to six SHCS (37) and secure the six standoffs (39) to the base module PC board (36), and then install the four threaded standoffs (40) into the manifold block (1) as shown on the assembly drawing.

[ ]5. Install the solenoid coil (18) onto the solenoid cartridge (17) as shown on the assembly drawing. Connect the two leads to pins 7 and 8 of J11 on the base module PCB (36) as shown in section B-3 of the wiring diagram (56). Torque cartridge nut (17) as indicated on assembly drawing.

[ ]6. Install the wiring harness (5) into the manifold block (1) as shown on the assembly drawing, and then terminate to J11 pins 1 to 6 of the base module PC board (36) as shown in section C-3 of the wiring diagram (56).

[ ]7. Install the base module PC board (36) onto the four standoffs (40) with three SHCS (41). Verify that the communication setting for the base module board (36) is properly set for jumpers JP1 to JP9. Refer to the sales order for configuration and the chart on the wiring diagram (section A/B-2) for verification. Reconfigure as necessary.

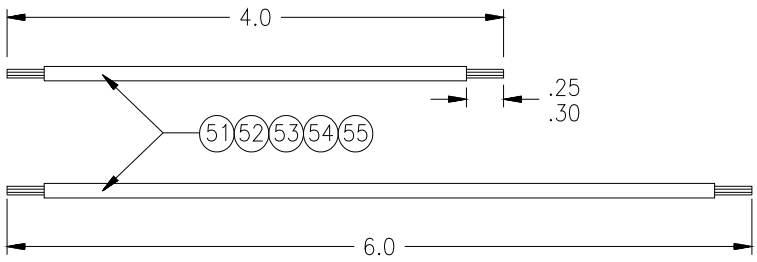
Note: the lower left hole is not filled with a SHCS to allow more room for the wires entering through the bulkhead.

[ ]8. *Q.C. Point 1.* Verify the setting of the JP1 to JP9 jumpers on the base module board (36). Verify installation of solenoid coil (18). Indicate the communication setting for the base module board on the test datasheet.

[ ]9. Install the two actuator controller PC boards (3) onto the six standoffs (39) using the remaining six SHCS (37) and the six nylon washers (38) as shown on the assembly drawing. Then set the DIP switches in the default “right hand” setting as shown in section B-4 of the wiring diagram (56).

[ ]10. Cut and strip the colored wires (51), (52), (53), (54), and (55), as shown in figure 1.

Figure 1. Wire detail.



In Process QC Req: Tin and inspect all wire ends by a qualified electrical tech.

Use the wires to terminate the actuator controller boards (3) to J1 and J2 of the base module PC board (36) as shown in sections A/B-3 of the wiring diagram (56).

[ ]11. Install the seven fittings (10) onto the manifold block (1) as shown on the assembly drawing.

[ ]12. Install fittings (22) and (44), the two fittings (24), the three fittings (42) and the five fittings (59) onto the manifold block (1) as shown on the assembly drawing. Install the fitting (34) into fitting (35) and the two fittings (43) as shown on the assembly drawing. Torque fittings (42) as indicated on assembly drawing.

[ ]13. Apply Locktite PST (66) to relief valve (19) and install into manifold (1) as show on assembly drawing.

[ ]14. Loosely install the four HHCS (28), four of the washers (27), and the four nylon washers (25) onto the manifold block (1) as shown on the assembly drawing.

[ ]15. Use the two SHCS (83) to secure the 24V converter (21) to the adapter plate (84).

[ ]16. Use the four SHCS (82) to secure the adapter plate (84) in the cover/mount (2).

[ ]17. Install the penetrator wiring harness (6) in the cover/mount (2) and retain it with the two washers (9) and two of the SHCS (8). Connect the leads of the wiring harness to the power supply (21) as shown in section C/D-3 of the wiring diagram (56).

[ ]18. Using the remaining eight SHCS (8), install the two servo valves (7) onto the adapter plate (29) and the lock valve assembly (31).

[ ]19. Install the o-rings (30), (32) into the grooves on the bottom of the adapter plate (29). Install four o-rings (47) into the counter-bores of the lock valve assembly (31). Install the remaining four o-rings (47) into the counter-bores of the bypass valve assembly (81).

[ ]20. Install the two o-rings (26) in the groove in the manifold block (1) and cover/mount (2).

[ ]21. *Q.C. Point 2.* Check the backup ring (15) and the o-rings (14), (26), (30), (32) and (47). Check that the filter base (12) is on the filter. Check the installation of the cartridge (17), the base module PCB (36), the two actuator PC boards (3), the wiring harness (5), the fittings (10),(19),(22),(24),(34),(42),(43),(44) and (59), the 24V converter (21) and the adapter plate (84), the penetrator (6), and the two servo valves (7) onto the adapter plate (29) and lock valve (31). Verify that the DIP switches are set correctly. Verify that the wiring harness (5) and the two actuator controller PC boards (3) are properly wired to the base manifold PC board (36). Check that the penetrator (6) is correctly wired to the power supply (21). Record your findings on the data sheet.

[ ]22. Install the servo/adapter plate, servo/lock valve and bypass valve units onto the manifold block (1) using the four SHCS (33) and the four SHCS (46). Note the orientation and the placement of each unit on the assembly drawing.

[ ]23. Install the filter (11) into the manifold block (1) as shown on the assembly drawing.

[ ]24. Connect the six-pin connector of the penetrator (6) to its mate on the wiring harness (5).

[ ]25. *Q.C. Point 3.* Verify the correct orientation and placement of the servo/adapter and servo/lock valve unit. Check installation of filter (11). Check that the penetrator (6) and the wiring harness (5) are connected. Record your findings on the data sheet.

[ ]26. Using the four HHCS (13) and the remaining washers (27), install the cover (4) and the cover/mount (2) onto the manifold block (1). Torque the HHCS to 9 ft-lb.

[ ]27. Install the fitting (35) onto the manifold block (1) as shown on the assembly drawing.

Note: Skip Step 28 if this assembly is going directly into an in house system.

[ ]28. Test 1. Cap the fittings (59) and install the compensation pressure test tool in the open -4 port in the side of the manifold block. Pressurize to 15 psi for at least 30 minutes and check for leaks. Record your findings on the data sheet.

[ ]29. Install the fitting (23) as shown on the assembly drawing.

[ ]30. *Q.C. Point 4.* Check the harness (5) for pins to case short circuits. Check the final configuration of the assembly. Record your findings on the data sheet along with the results of the pressure test.

[ ]31. Bag the remaining wire ties (57) and (58) and route to stock.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record failed tests, problems encountered during assembly or testing, or corrective action taken for the assembly to pass any of the tests.

Acceptance:
Record your name and the date that the test was completed.
Record the name of person inspecting the assembly and affix the acceptance tag.
Record the military specification (as required) to which the assembly was tested, and the date that the test was completed.