Schilling Robotics
Titan 4 Manipulator System
Position-Controlled, 4 Km Submersible

Models:

199-0295
199-0295PAL
199-0296
199-0299
199-0299-1
199-0300
199-0301
199-0307
199-0308-1
199-0308-2
199-0308-3
199-0308-4
199-0308-7
199-0308-81
199-0324

Document No. 011–8239 Rev B.

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TECHNICAL MANUAL REVISION LOG		
Titan 4 Manipulator System, Model Nos. 199-0295, 0295PAL, 0296, 0299, 0299-1, 0300, 0301, 0302, 0307, 0308-1, 2, 3, 4, 7, 8		
TECHNICAL MANUAL: 011–8239		
Description	**Date**	**Rev.**
Manual release	March, 2012	**A**
T4 O7P compatible, 8 pin 20 shell burton connector	June, 2012	**B**

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Safety & Service Summary

Precautionary Notices

This manual provides precautionary notices which carry important information about safety risks to personnel and damage to equipment while installing, operating, servicing, or maintaining this equipment.

The form and significance of the notices are shown below.

⚠ WARNING

A WARNING alerts you to a risk of injury or loss of life. It may also include instructions to help minimize or eliminate the risk.

! Caution

A CAUTION alerts you to a risk of equipment damage or loss. It may also include instructions to help minimize or eliminate the risk.

NOTE: *The absence of WARNING and CAUTION notices does not mean that risk is absent. Always use appropriate safety procedures, equipment, and personal protective equipment (PPE) when operating and servicing this equipment.*

Service Assumption

This manual assumes that service personnel are familiar with the general operating principles, safety guidelines, and service practices associated with the types of equipment represented in this manual.

Security Password

Model No.____________________________

Serial No.____________________________

Level 5 Password

This is your level 5 password: 1357

WARNING

Misuse of the menus accessible with this password can cause malfunctions of the manipulator system, injury to personnel, and/or damage to equipment.

The password for security level 5 is set at the factory and cannot be changed. It provides access to all configurable system menus, including those for setting other security levels and passwords for other operators. See the OPERATION module in your technical manual for complete information on how to use the level 5 password.

Temporary Password, Levels 1-4

The temporary password **0000** is provided for access to security levels 1 through 4 during installation and first startup. This password can be changed to meet your security level requirements.

Security Level 0

Security level 0 is the default level, always available at system startup and requiring no password. While permitting operation, it restricts access to almost all system configuration menus and security features. An operator using a correctly configured manipulator should need no higher privilege level. Levels above 0 require passwords and allow access to specific manipulator system configuration menus.

Specifications

In This Chapter:

- 1 System .... page 9
- 2 Password.. page 9
- 3 Slave Arm .... page 10
- 4 Master Controller... page 11
- 5 Environmental... page 11
- 7 Compensation.. page 12
- 8 Custom Features or Modifications .... page 12

NOTE: *The specifications in this chapter apply to the systems listed on the title page, except as noted. The components specific to each system are itemized in the 199-level part lists at the end of the "Drawings & Part Lists" chapter.*

1 System

1.1 Electrical

System supply at junction box .... 90 to 260 VAC, 50-60 Hz, single-phase

1.2 Telemetry

Default protocol RS-232

User-selectable option ....RS-422/-485 half-duplex 2-wire

NOTE: *RS-485 full-duplex telemetry (4-wire) is not supported.*

Default baud 19200

User-selectable options .... 57600 and 115200 baud

NOTE: *At 57600 and 115200 baud, additional slave arm joint position data is added to each data packet, however third-party software is needed to utilize it.*

2 Password

Access to some master controller menus is password protected. A password information sheet follows the "Table of Contents" section.

3 Slave Arm

3.1 Specifications

Depth rating . . . . 4,000 msw (13,124 fsw)

Maximum reach . . . . 1,922 mm (75.7 in.) (from azimuth to gripper T-bar slot)

Weight in air . . . . 100 kg (221 lb)

Weight in seawater . . . . 78 kg (174 lb)

NOTE: *Performance specifications use the standard system configuration with Shell Tellus Oil 32 hydraulic fluid, input pressure of 207 bar (3,000 psi) and available flow of 19 lpm (5 gpm).*

Lift at full extension, nominal. . . . . 122 kg (270 lb)

Maximum lift, nominal . . . . 454 kg (1,000 lb)

Maximum gripper opening (standard gripper), nominal . . . . 99 mm (3.9 in.)

Grip force, nominal . . . . 4,092 N (920 lbf)

Wrist torque, nominal . . . . 170 Nm (125 ft-lb)

Wrist rotation, continuous . . . . 360°, 6-35 rpm

3.2 Electrical

Connector

The slave arm connector to system power and telemetry varies with the Titan 4 model. See the 199- part list for this system model.

Input power:

Slave arm . . . . 24 VDC

Power consumption:

Slave in-arm controller plus solenoid . . . . 6 W start, 12 W run

Slave arm current draw . . . . 1.875 A, at 24 VDC

3.3 Slave Arm Functions

Function	Actuator	Nominal Range
Azimuth	Rotary	240°
Shoulder pitch	Linear	120°
Elbow pitch	Rotary	270°
Wrist pitch	Rotary	180°
Wrist yaw	Rotary	180°
Wrist rotate	Gerotor	360° continuous
Jaw (standard)	Linear	99mm (3.9-in.)

3.4 Slave Arm Dimensions & Range of Motion

See the slave arm drawing in the “Drawings & Part Lists” chapter for:

- Ranges of motion
- Extended dimensions
- Stow dimensions
- Mounting dimensions

3.5 Sensor

Water detection ....forearm

4 Master Controller

4.1 Specifications

Length .... 470 mm (18.5 in.)
Width .... 177 mm (7.0 in.)
Height .... 67 mm (2.6 in.)
Weight .... 3.7 kg (8.2 lb)

4.2 Electrical

Input power:

Master controller .... 90 to 260 VAC, 50-60 Hz, single-phase

Power consumption:

Master controller .... 6 W start, 3 W run

5 Environmental

Operating temperature .... -2 to +54° C (+28 to +130° F)
Storage temperature .... -15 to +71° C (+5 to +160 ° F)
Humidity .... 0% to 100% condensing

6 Hydraulics

6.1 Fluids

Select a hydraulic fluid based on its maximum temperature during normal operations.

- Lower than 54°C (130°F): Use 22 grade oil.
- Higher than54°C (130°F): Use 32 grade oil.
- For temperatures above 71°C (160°F), below 0°C (32°F), or when in doubt about which fluid to use, contact your regional technical support representative.
- Do not use water-based fluids.
- If a fluid has been specified for this system to meet special environmental or operational requirements, use it and disregard the parameters listed above.

• Specifications

6.2 System Requirements

Viscosity. . . . . 10 - 200 cSt

Available flow . . . . 5.7 - 19.0 lpm (1.5 - 5.0 gpm)

Pressure . . . . .103 bar (1,500 psi) minimum to 207 bar (3,000 psi) maximum

NOTE: *Slave arm performance specifications are determined at maximum pressure and flow. Performance diminishes when pressure or flow are reduced.*

Hydraulic fluid temperature, maximum . . . . .54° C (130° F)

Return pressure, maximum . . . . 34.5 bar (500 psi)

Filtration, hydraulic supply. . . . . 3 microns (10 microns absolute)

NOTE: *Use of the recommended filtration will reduce the need to clean or replace the slave arm's internal hydraulic filter (10 microns, 25 microns absolute).*

Return relief valve cracking pressure, nominal . . . . 500 psi (34.5 bar)

Customer-supplied mating fittings required:

Supply hose fitting -4 JIC female, 1/4-in.

Return hose fitting -6 JIC female, 3/8-in.

7 Compensation

Fluid requirement . . . . Non-conductive, non-water based

Compensator fluid capacity. . . . . 2.2 l (0.58 gal)

Slave arm fluid capacity. . . . . 9.6 l (2.54 gal)

System total fluid capacity. . . . . 11.8 l (3.12 gal.)

Fluid pressure (above ambient) . . . . 0.48 to 0.69 bar (7 to 10 psi)

Relief valve cracking pressure, nominal . . . . .1.4 bar (20 psi)

8 Custom Features or Modifications

Any custom features or modifications present on the supplied Manipulator System are described on the following page(s).

Installation

In This Chapter:

- 1 User-Supplied Equipment .... page 13
- 2 Installation Overview .... page 13
- 3 Mechanical Installation .... page 13
- 4 Electrical Power & Telemetry Connections .... page 16
- 5 Completing the Installation .... page 19

1 User-Supplied Equipment

The following services and equipment are required to complete the installation of the slave arm:

- Electrical and hydraulic power sources. See the “Specifications” chapter for details.
- All hoses and fittings for connecting hydraulic power to the slave controller.
- Topside wiring as needed for integration into long-line system.
- On some systems, the subsea slave cable is supplied by the customer. See the 199-part list for this system.

2 Installation Overview

Long-Line Installation See Figure 3 on page 16.

Deck-Test Installation See Figure 5 on page 19.

3 Mechanical Installation

3.1 Slave Arm

1. Select a suitable mounting **location** (See the slave arm drawing in the Drawings & Part Lists” chapter for information on slave arm dimensions and ranges-of-motion).
2. Create a **mounting platform** with a flat surface. Drill six through-holes as shown in Figure 1 for the 1/2-20 x 1.5-in. mounting screws (supplied).
3. Cut the screws as needed to meet the following thread-engagement requirements:

   Minimum thread engagement into azimuth base. . . . . .12.7 mm (0.5-in.)

   Maximum thread engagement into azimuth base . . . . 15.8 mm (0.625-in.)

• Installation

! Caution

Installing mounting screws that have a thread engagement of more than 15.8 mm (0.625-in.) in the azimuth base will cause damage.

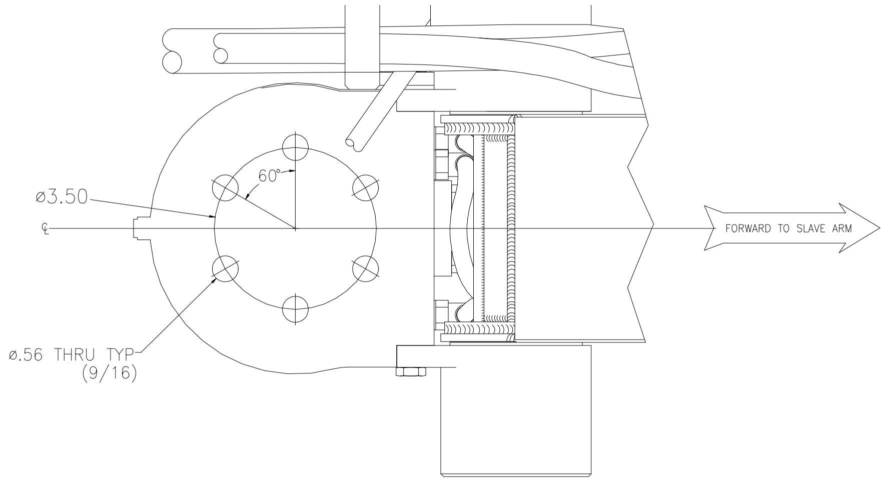
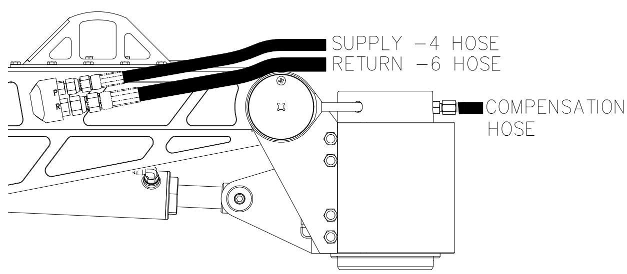


Figure 1 *Azimuth mounting holes*

4. Move the slave arm to the mounting platform, orienting the small arrow on the side of the azimuth base to the center of the desired azimuth travel.
5. Lubricate the screws with Aqua Lube (or equivalent), install, and torque to 108 Nm (80 ft/lbs).
6. Connect the hydraulic supply and return hoses to the slave arm (figure, right).
   — P = Pressure/Supply
   — R = Return



7. Connect the compensation line to the fitting on the slave arm azimuth.
8. The connection of the slave cable is covered in the "Electrical Power & Telemetry Connections" section.

3.2 Compensator

Installation Notes

- See the "Specifications" chapter for fluid requirements.
- Use stainless steel Nylock ("patch") mounting fasteners.
- If a compensator fitting is moved or replaced:
  — Use Teflon tape on the fitting threads. Do not use any form of liquid sealant or thread locker. Apply 1-1/2 to 2-1/2 wraps of Teflon tape to the male threads in a clockwise direction when viewed from the tapered thread end. Do not apply tape to the first one or two threads on the fitting to avoid fluid contamination.
  — Install NPT fittings finger tight, then tighten an additional 1.5 turns.

! Caution

Do not use thread-locking compounds containing bisphenol A fumarate on fittings or hardware contacting the polyurethane compensator housings. This chemical can cause brittleness and micro-cracking.

1. Select a mounting location for the compensator within hose-length of the slave arm.
   — The compensator may be mounted horizontally or vertically (fittings end up). If the compensator is sidewall-mounted horizontally, a 1/4 x 1/2-in. bushing will be required to relocate the bleed/relief valve.
2. Drill mounting holes for 1/4-inch or M6 hardware using the dimensions in Figure 2.

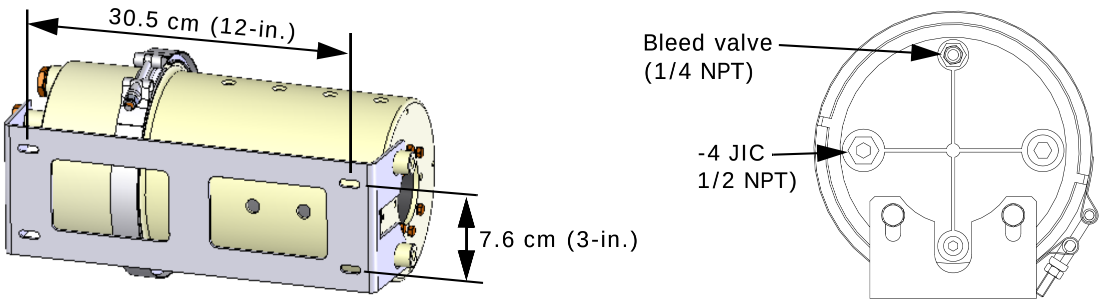


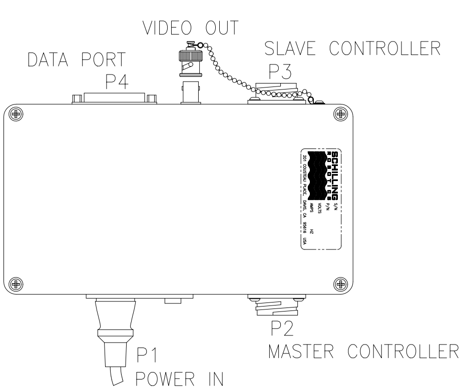
Figure 2

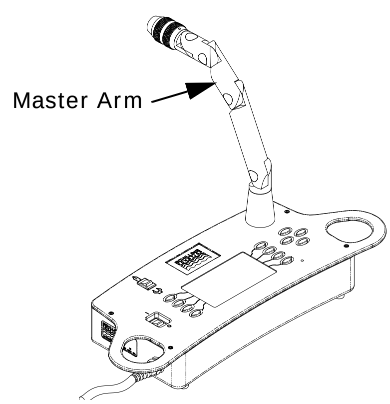
3. Mount the compensator and connect the compensator hose to the -4 JIC male fitting on the compensator.
4. If you want to “dry-test” the compensation system for leaks, charge the compensator half-full with air (the spring-loaded diaphragm will produce a pressure of about 0.7 atmosphere (10 psi).

   Check for leaks by spraying all connections with a mild detergent solution or window cleaner and watching for active bubbles or foam.

3.3 Junction Box

The junction box (below, left) is used for deck testing. It has no mounting hardware and can be placed on any flat, dry surface.





3.4 Master Controller

The master controller (above, right), has no mounting hardware, and can be placed on any flat, dry surface. It is usually located at or near the system control console for use by the pilot or co-pilot.

! Caution

Do not use the master arm to lift or carry the master controller. It is a precision assembly and can be damaged.

4 Electrical Power & Telemetry Connections

4.1 Telemetry Configuration

The default, factory-set telemetry protocol is RS-232. The system can also be configured to RS-485 telemetry. For detailed instructions see “Changing the Communications Protocol” in the “Maintenance and Service” chapter.

4.2 Long-Line Connections

In typical ship-based applications, the Titan 4 Manipulator System is mounted to a remotely operated vehicle (ROV) and connected as shown in Figure 3.

1. Complete the two sections listed below.
   — section 4.2.1, “Subsea Wiring and Connections,” on page 17
   — section 4.2.4, “Topside/Surface Wiring and Connections,” on page 18

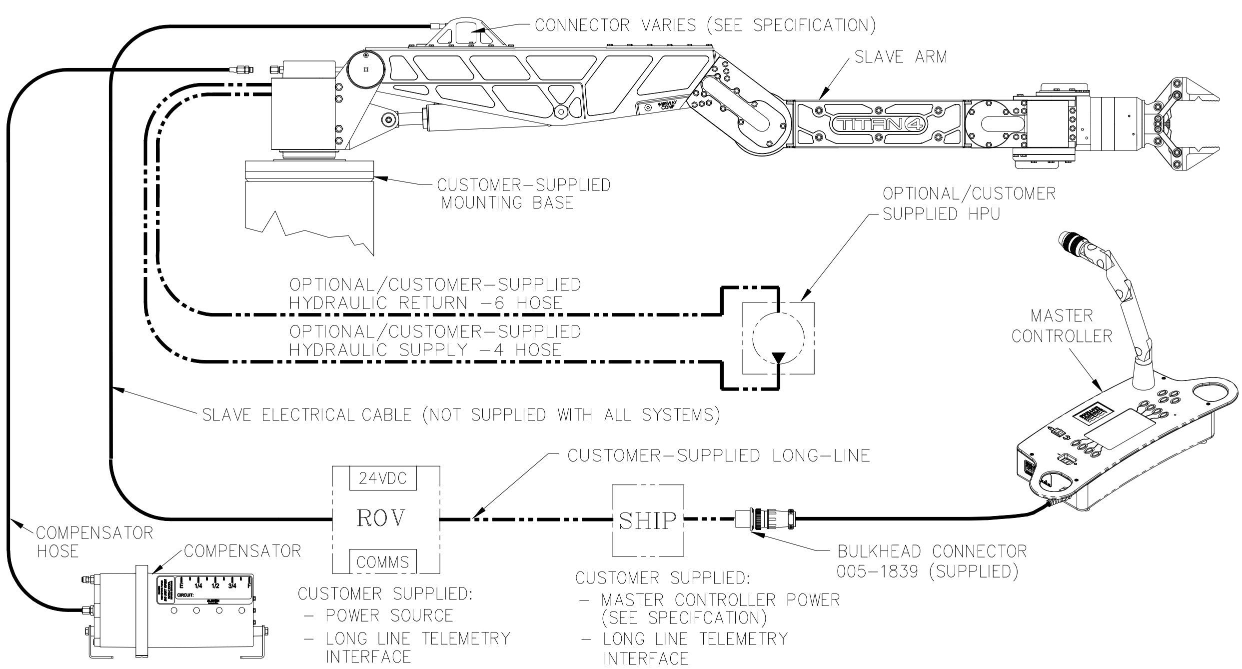


***Figure 3** Long-line power and telemetry connections*

4.2.1 Subsea Wiring and Connections

The wiring schematics helpful for making subsea Titan 4 manipulator system connections are listed below by model number.

Models 199-0295 & 199-0295 PAL
Titan 4 Manipulator System, 199-0295 .... page 254 (dwg sheet 2)
Titan 4 Manipulator System, 199-0295PAL .... page 255 (dwg sheet 2)
Cable Ass'y, Slave Arm, T4 SCE, 101-4839 .... page 176
Cable Ass'y, SeaNet CS-MSAJ9, 101-6778 .... page 217

Model 199-0296
Titan 4 Manipulator System, 199-0296 .... page 259 (dwg sheet 2)
Cable Ass'y, Slave Arm, T4 SCE, 101-4839 .... page 176
SeaNet to CPC Deck Test Cable, 101-4882 .... page 179

Model 199-0299
Titan 4 Manipulator System, 199-0299 .... page 263 (dwg sheet 2)
Cable Ass'y, Slave Arm, T4 SCE, 101-5082 .... page 188
Cable Ass'y, Deck Test, 101-5083 .... page 192

Model 199-0299-1
Titan 4 manipulator System, 199-0299-1 .... page 264 (dwg sheet 2)
Harness, Slave Arm, T4/Camera, 101-5082-1 .... page 189
Cable Ass'y, Deck Test, 101-5083 .... page 192

Model 199-0300
Titan 4 Manipulator System, 199-0300 .... page 268 (dwg sheet 2)
Harness, 6-Pin, 20 Shell, 101-5887 .... page 201
Cable Ass'y, Deck Test, 101-5889 .... page 203

Model 199-0301
Titan 4 Manipulator System, 199-0301 .... page 272 (dwg sheet 2)
Harness, 8-Pin, 20 Shell, 101-6147 .... page 214
Cable Ass'y, Deck Test, 101-6150 .... page 216

Model 199-0307
Titan 4 Manipulator System, 199-0307 .... page 276 (dwg sheet 2)
Harness, SA, T4, Camera, 101-6852 .... page 235
Cable Ass'y, 8-Pin, 15 Shell, 101-6853 .... page 237

Models 199-0308-1, -2, -3, -4, -7, -8
Titan 4 Manipulator System, 199-0308-1 .... page 280 (dwg sheet 2)
Titan 4 Manipulator System, 199-0308-2 .... page 281 (dwg sheet 3)
Titan 4 Manipulator System, 199-0308-3 .... page 282 (dwg sheet 2)
Titan 4 Manipulator System, 199-0308-4 .... page 283 (dwg sheet 3)
Titan 4 Manipulator System, 199-0308-7 .... page 284 (dwg sheet 3)
Titan 4 Manipulator System, 199-0308-8 .... page 285 (dwg sheet 2)
(-1, -3, -8) Cable Ass'y, Deck Test, 101-6926-1 .... page 238
(-1, -3, -8) Harness, 8-Pin, Burton w/Safety,101-6927 .... page 239
(-2, -4, -7) Cable Ass'y, Deck Test, 101-6926-2 .... page 238
(-2, -4, -7) Harness, 8-Pin, Burton,101-6928 .... page 241

Model 199-0324 (Orion compatible)
Titan 4 Manipulator System, BTN 2008 07P Comp, 199-0324... page 290
Harness, T4, BTN 2008, 07P Comp, 101-8357-1 .... page 252
Ca Assy, Power/Telem, CPC/Burton, 101-4018-1 .... page 154

4.2.2 Video

Pin designations for video from slave arm-mounted video cameras can be found on the schematics listed above.

4.2.3 Subsea Cable Installation Recommendations

- Secure cables at regular intervals. Coil and secure any excess cable lengths. Ties must not restrict the flow of fluid in compensated cables.
- Make sure all cables are safely routed to allow full travel of the slave arm and are not kinked, pinched, or in contact with any sharp edges or extremely rough surfaces.
- Maintain the following minimum bend radius dimensions:

  SeaNet Cables:

  Minimum bend radius, static . . . . .50 mm (2-in.)

  Minimum bend radius, dynamic . . . . .75 mm (3-in.)

  Burton Cables:

  Minimum bend radius, static . . . . .100 mm (4-in.)

  Minimum bend radius, dynamic . . . . .150 mm (6-in.)

4.2.4 Topside/Surface Wiring and Connections

Master Controller

1. Mount the supplied bulkhead connector 005-1839 to your control panel where it is convenient to connect the master controller cable.
2. Use pins 005-0239 to wire the connector to system telemetry/comms and to 90-240 VAC power as shown in Figure 4.

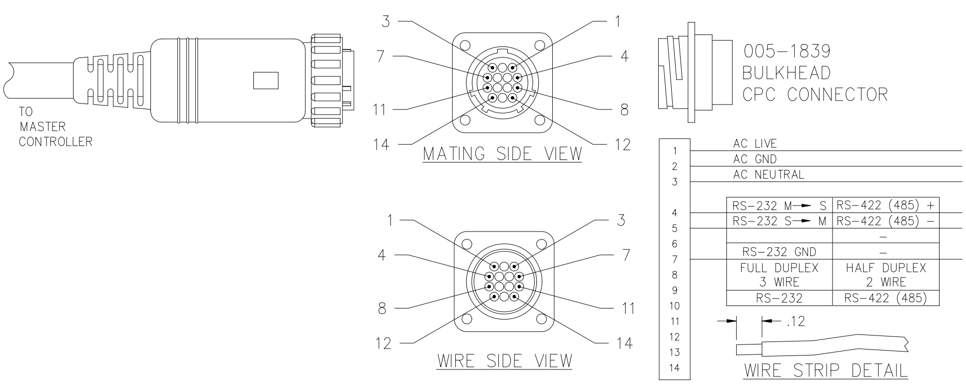


Figure 4 *Bulkhead CPC connector wiring*

3. Connect the master controller whip.

4.3 Deck-Test Connections

The Titan manipulator system includes components needed for deck-testing or local operation (see Figure 5).

> ***NOTE:*** *Manipulator system 199-0302 is not supplied with a junction box.*

1. Connect the junction box AC power cord P1 to a 90-260 VAC power source.
2. Connect the cable from the master controller to connector P2 on the junction box.
3. Connect the deck test cable between connector P3 on the junction box and the connector on the slave arm.
4. If a camera is used on the slave arm, video output is available at the BNC connector on the junction box.
5. Provide a deck cart to power slave arm hydraulics.
6. Proceed to "Completing the Installation" section on page 19.

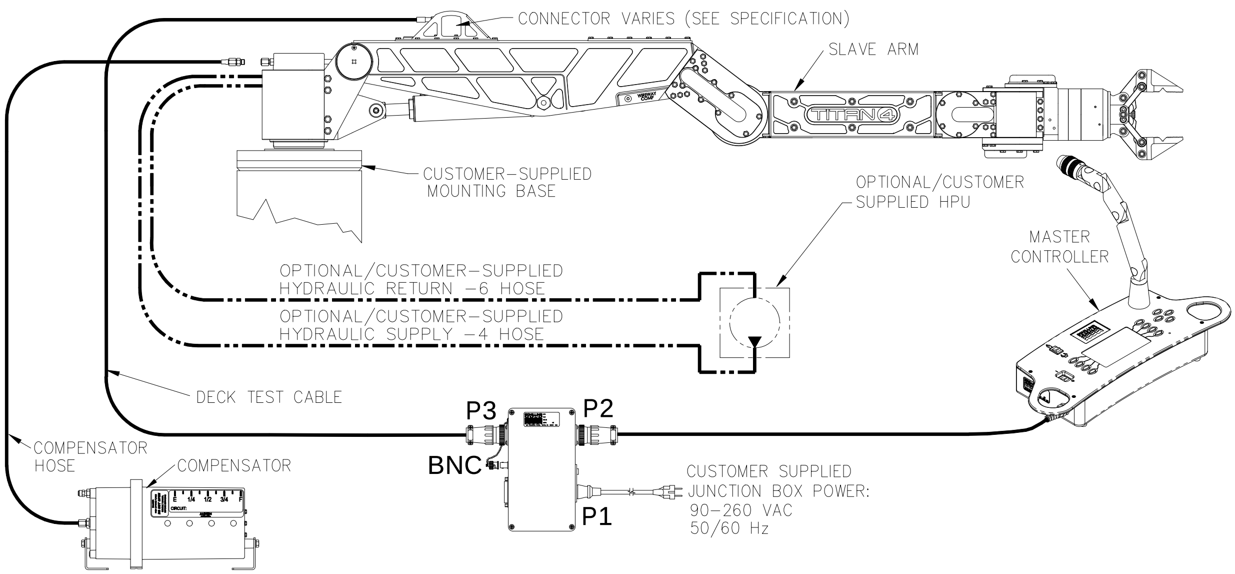


Figure 5 *Typical Deck-test connections*

5 Completing the Installation

After all the components are installed, the manipulator system is connected first in the deck-test configuration and started up to confirm operation, set the Stow In/Stow Out (deploy) and travel limits menus for safe operation, charge/bleed the compensation system, and then test the long-line connections. The four-part process is described below. Refer to the "Operation" chapter, as needed, for additional information.

Part 1: Start System & Test Functions

! Caution

If you are unfamiliar with Titan manipulator systems, please review sections 1 through 3 of the "Operation" chapter before proceeding.

1. Set up the manipulator system for deck-testing (see Figure 5 and section 4.3).
2. Complete the following checks before you start-up the manipulator system.
   - ✔ All system fasteners, fittings, and connectors are correctly installed and properly tightened.
   - ✔ All hoses and cables are safely routed to allow full travel of the slave arm and are without kinks, snagging, and contact with sharp edges or rough surfaces.
3. Move all personnel, equipment, and installation supports outside the range-of-motion of the slave arm.
4. Apply hydraulic power to the Titan 4 Slave Arm supply hose (does not energize arm).
   — Check the hydraulic lines for leaks.
   — Turn on any other hydraulic equipment using the same return line. Confirm that the return pressure does not exceed 500 psi (34.5 bar).

NOTE: *Filters and other hydraulic equipment sharing the return line may cause the return circuit pressure to rise. If pressure exceeds 500 psi (34.5 bar), hydraulic fluid will be released from the return relief valve on the upper arm.*

5. Turn on electrical power to the Titan 4 junction box and master controller.
6. Complete master controller startup.
   — For startup details, see the "Operation" chapter, section 3.2, "Startup," on page 30.

NOTE: *Air in hydraulic lines or components can cause very rapid or jerky slave arm movement upon start-up.*

! Caution

As you proceed, if the response of the slave arm or the master controller does not appear normal, *IMMEDIATELY* disable slave arm hydraulics and refer to the appropriate section of the "Operation" chapter for guidance. Return to this procedure only when you have determined that the system is functioning safely and correctly.

7. From the master controller, turn on hydraulics to the slave arm. Carefully test basic slave arm functions.

Part 2 Set Stow Positions and Travel Limits

8. Set a stow sequence that will allow the slave arm to be safely stowed within its environment.
   — see the "Operation" chapter, section 4.2.4, "Setting the Stow Path," on page 46).

NOTE: *The factory default stowed and deployed slave arm positions are the same: the position of the slave arm in the shipping container.*

9. Set slave arm travel limits that allow safe operation of the slave arm within its environment.

— see the Operation chapter, section 4.2.5, "Setting Slave Arm Travel Limits," on page 48).

NOTE: *The factory default allows full slave arm travel.*

Part 3: Charge the Compensation System

Reference information:

Fluid requirement .... Non-conductive, non-water based

Compensator fluid capacity.................................. 2.2 l (0.58 gal)

Slave arm fluid capacity...................................... 9.6 l (2.54 gal)

! Caution

Compensated components can be damaged if the compensation fluid is conductive or water-based, and if the slave arm is submerged with large amounts of air in the compensation system.

10. Move the slave arm to a wrist-high position (see Figure 6–position 1).

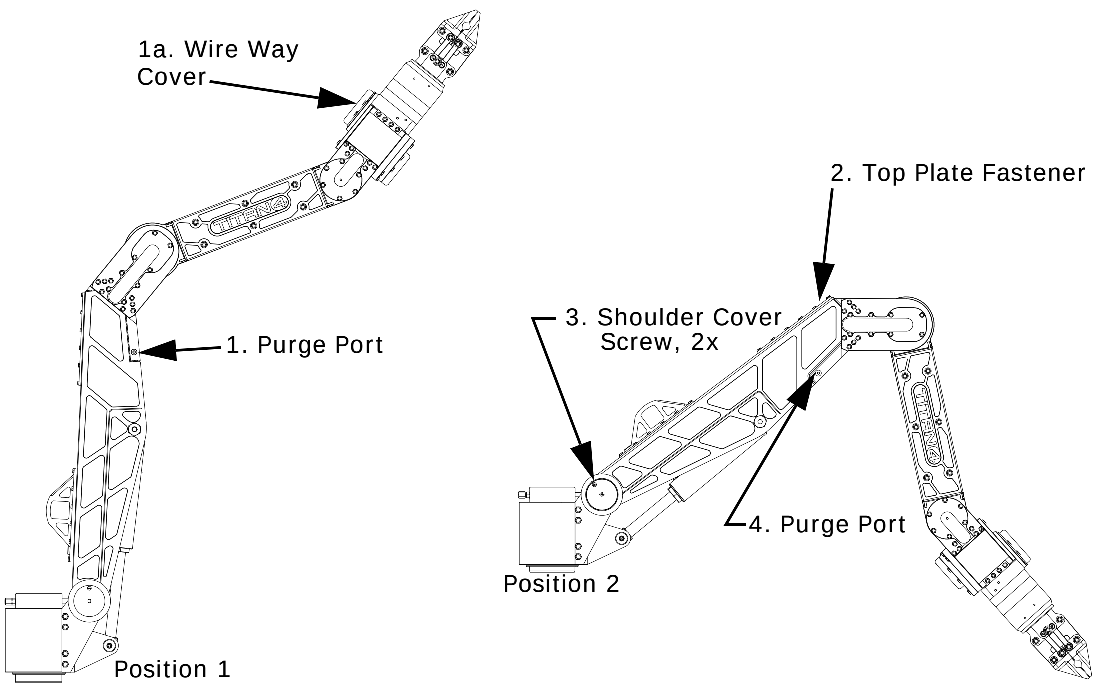


***Figure 6** Bleed positions and bleed points*

11. Open the purge port (Figure 6–point 1).

12. Begin charging the compensator through one of its unused fittings until the yellow band on the piston approaches the "full" band on the housing **- do not overfill**. Crack the fitting seal at the top of the compensator and bleed off any air.

NOTE: Charging pressures above 20 psig (1.4 bar) will cause the discharge of compensation fluid or vapor from the compensator relief valve.

13. Allow the compensator pressure to fill the hose and slave arm cavities.

NOTE: This will take some time as some passages are small and the compensation must travel all the way to the wrist before returning to the purge port near the elbow. You can speed up filling to the wrist by loosening the wrist wireway cover (Figure 6, 1a). Tighten when fluid emerges.

14. Close the purge port when fluid emerges. (add fluid to the compensator as needed.)

15. Move the slave arm to position 2 and remove one top plate fastener (Figure 6, 2). Replace when fluid emerges.

16. Remove the screw from each shoulder cover (Figure 6, 3, 2x) and replace when fluid emerges.

17. Move the slave arm back to position 1 for a few minutes. Open the purge port for final bleed.

18. If the slave arm cable is compensated (SeaNet and SeaNet Adapter cables, etc.), open the bleed screw on the connector farthest from the slave arm until all air is removed.

19. Tighten all bleed point hardware.

20. Bleed any remaining air from the compensator and charge until the yellow band on the piston approaches the “full” band on the housing. **Do not completely fill**. Leave about 6 mm (.25-in.) of diaphragm travel to allow for thermal expansion.

21. Inspect compensation system for leaks and correct as needed.

Part 4: Testing Long-Line Connections

22. After the compensation system has been charged, connect the manipulator system for long-line operation and confirm slave arm functions.

23. Refer to the “Operation” chapter for complete information about system functions, configuration, operation, and diagnostics.

Operation

In this chapter:

- 1 The Master Controller.. page 23
- 2 Using the Master Controller.. page 26
- 3 Operation .... page 30
- 4 Setting Performance Options.. page 41
- 5 System Errors & Warnings .... page 50
- 6 Avoiding Slave Arm Damage .... page 56

1 The Master Controller

Operation of the slave arm is controlled, configured, and diagnosed using the master controller (Figure 1). Slave arm movements are initiated by moving the master arm and observing the slave arm's response, either directly or through a video system.

Performance options and system functions are selected and configured using master controller keys and menus shown on the LCD (liquid crystal display) screen. The LCD screen also displays system status and diagnostic information.

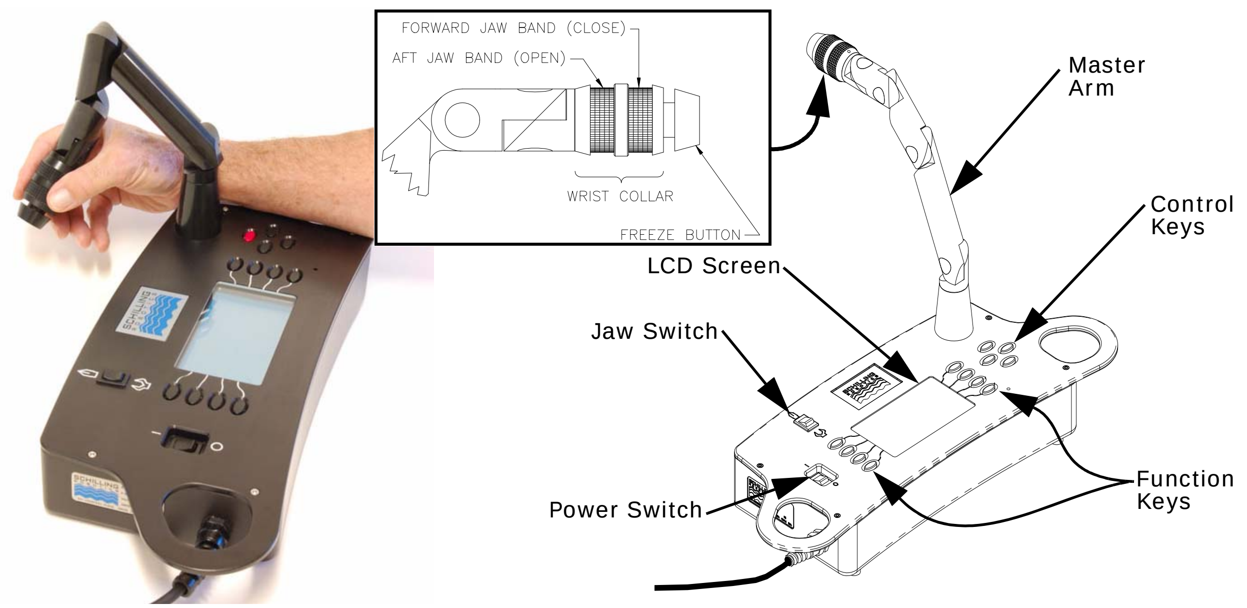


Figure 1 *Master controller features*

• Operation

1.1 Master Arm

The master arm (Figure 1) is a small replica of the slave arm, with equivalent joints, functions, and relative ranges of motion. The small size of the master arm allows you to easily control all functions with your fingers, wrist and forearm.

1.2 LCD Display Screen

The LCD screen on the master controller front panel provides you with information about system status and configuration, operating options, and diagnostic information (see Figure 2). Example screens are used throughout this chapter.

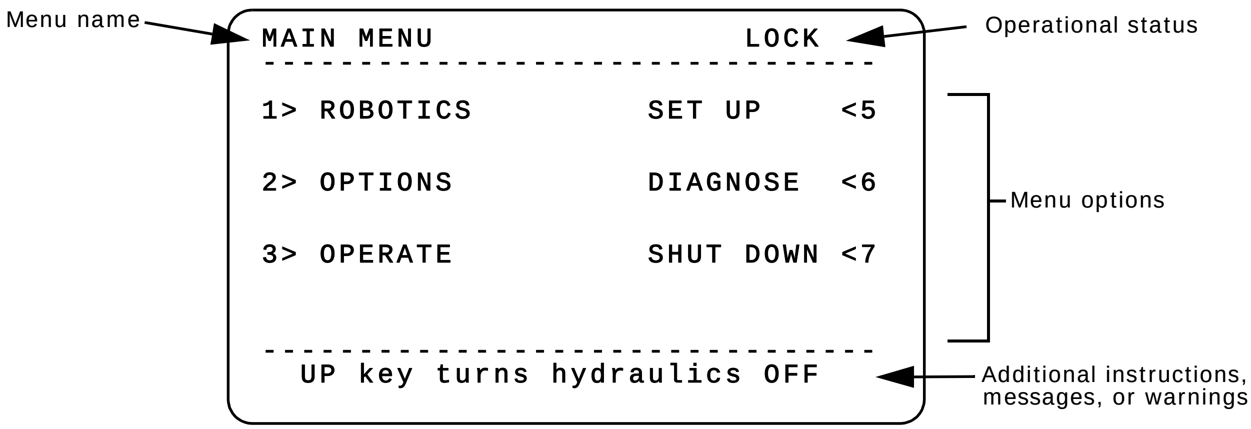


Figure 2 *LCD display screen*

1.2.1 LCD Adjustments

The LCD screen has a temperature sensor and compensator circuit to automatically stabilize the viewing angle across a broad temperature range. However, if the viewing angle is not acceptable, the compensation range can be shifted to suit local viewing or temperature conditions by adjusting a trimmer potentiometer inside the master controller. See the “Maintenance & Service” chapter for details.

1.3 Function Keys

Use the four function keys on each side of the LCD screen to select menus or to control functions. The function of each key is displayed on the LCD screen next to the key.

1.4 Control Keys

The control keys are located to the right of function keys 5-8 and have various uses which are identified in the appropriate menus and the startup or warning screens.

1.5 Power Switch

The power switch, to the right of the LCD display screen, controls electrical power to the master controller.

> ***NOTE:*** *Turn off the master controller power switch only after the slave arm has been moved to a safe position, frozen, and the slave arm’s hydraulics have been disabled.*

1.6 Auxiliary Jaw Switch

The auxiliary jaw switch is located opposite the master arm on single-arm controllers, and adjacent to each master arm on dual-arm controllers. The jaw switch provides the same functions as the jaw bands on the master arm (see section 2.1.3, “Jaw Bands,” on page 26):

- Move switch forward = Jaw closes
- Move switch rearward = Jaw opens

1.7 Menu Structure

The slave arm is controlled and configured through menus displayed on the master controller LCD screen. The menu structure and hierarchy is shown in Figure 3.

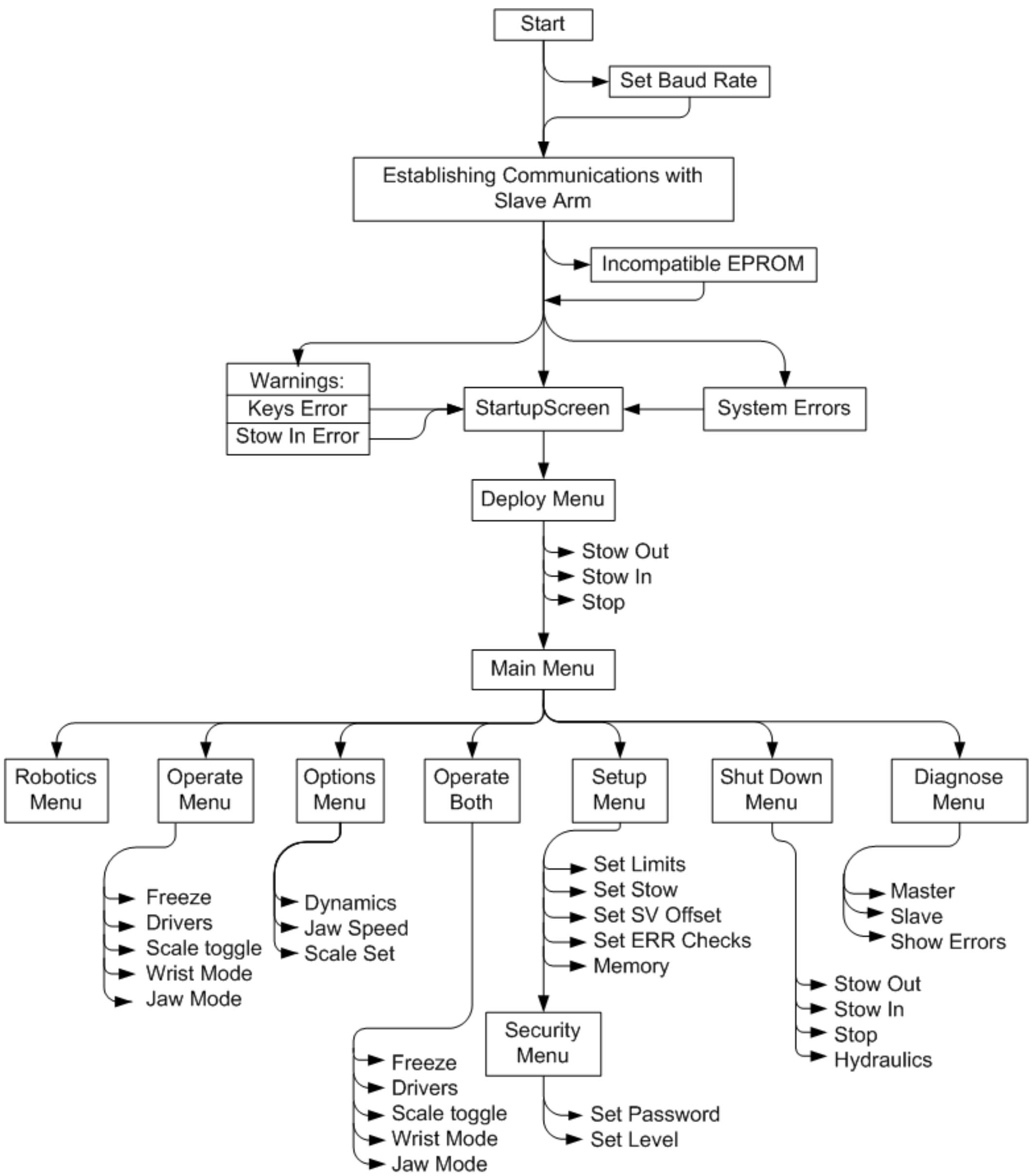


Figure 3 *Menu structure*

• Operation

1.8 Baud Rate

Default data transmission rates:

Single arm Titan 4 system . . . . 19200 baud
(Single arm systems can also be operated at 57600 baud and 115200 baud.)

Dual arm system . . . . 57600 baud
(Dual arm systems can also be operated at 115200 baud.)

At rates higher than the default, additional slave arm joint position data is added to each data packet for creating graphical simulations using third-party software.

Changing the system baud rate requires adjusting the settings of the two Mode switches on the master controller printed circuit board (PCB) and selecting the desired baud rate using the control keys and display.

See “Changing the System Baud Rate,” in the “Maintenance & Service” chapter for details.

2 Using the Master Controller

2.1 Master Arm

2.1.1 Major Master Arm Joints

Moving a master arm joint (azimuth, shoulder, elbow, wrist pitch, wrist yaw) produces an equivalent movement in degree (and speed, subject to hydraulic limitations) of the slave arm joint. When finer control is required, slave arm movements can be scaled down from 100% in the Options menu (see “Scaling Slave Arm Movement (Toggle)” on page 37).

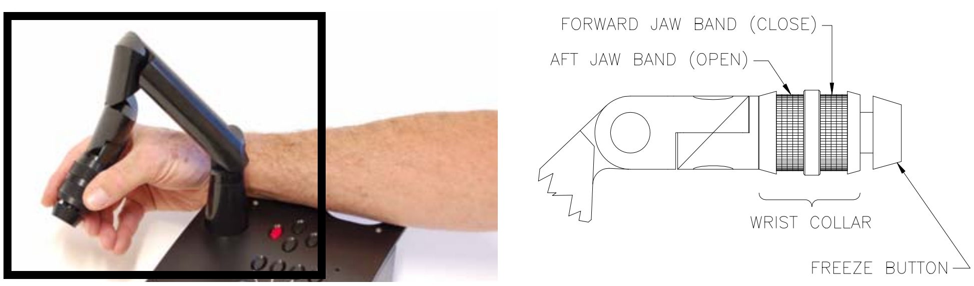


Figure 4 *Master arm and wrist/jaw controls*

2.1.2 Wrist Rotate

The wrist has two operation modes, which are selected in the OPERATE menu (see section 3.6.4, “Selecting the Wrist Mode (Toggle),” on page 38).

- POSITION MODE
  Rotate the wrist collar = slave arm wrist rotates to the position of the collar.
- RATE MODE
  Rotate the wrist collar = slave arm wrist rotates continuously, the speed increasing with the rotation of the collar.

2.1.3 Jaw Bands

Squeezing the textured jaw bands on the master arm wrist activates the jaw. The jaw has three operation modes.

- TOG (toggle): Squeezing the forward jaw band fully opens or closes the jaw.
- POS (position): Moves the jaw in either direction for as long as the appropriate jaw band is squeezed.
  - — Forward band = Jaw closes
  - — Rear band = Jaw opens
- LOCK: Locks the jaw in its current position and prevents the jaw from being operated with the master arm.
  - — Escape from the LOCK mode by using the Jaw Md: key to select the TOG or POS mode.

NOTE: *The jaw relaxes its grip when hydraulics are disabled, whether through operator control or interruption of hydraulic pressure. Objects held by the jaw may be released or dropped.*

2.1.4 Freeze Button

The freeze button is located at the tip of the master arm. Pressing it toggles between enabling and disabling master arm control of the slave arm.

2.2 Slave Arm Status

2.2.1 Operational Status

In most menus the operational status of the slave arm is shown in the upper right hand corner of the MAIN menu screen. Three states are possible:

- **REIN (reindex)**: indicates the master arm is enabled to control the slave arm, starting at their current positions.
  - — Pushing the freeze button (at the tip of the master arm) toggles between REIN and FRZ status (freeze).
- **FRZ (freeze)**: indicates that master arm control of the slave arm is disabled and the slave arm is idled.
  - — Opening most menus automatically engages FRZ status.
  - — Pushing the freeze button (at the tip of the master arm) toggles between REIN and FRZ status (freeze).
- **LOCK**: indicates that master arm control of the slave arm is disabled and cannot enabled in the current menu or state. LOCK status engages automatically:
  - — When opening certain menus or in states where the slave arm should not be operated. To unlock the slave arm, move to another menu where REIN or FRZ is the default status.
  - — When telemetry errors could cause erratic or uncontrolled slave arm movements

2.2.2 Water Detection Status

A grid on the telemetry board detects the presence of water in the low point of the forearm manifold where water is most likely to accumulate. When water is detected in the forearm, the advisory text **[WATER*]** appears in the middle of the top dashed line of all LCD screen menus (see Figure 5, arrow).

```
OPERATE                     FRZ
------------[WATER*]------------
1> FREEZE          Wrs Md:POS  <5

2> DRIVERS         Jaw Md:POS  <6

3> Scale Tog:100%

                          EXIT <8
--------------------------------
```

Figure 5 *Water detected in left forearm*

The detection of water DOES NOT turn off hydraulics or interfere with operation; the warning is advisory only. The asterisk in the text indicates the active detection of water; if water is no longer detected, the asterisk is replaced with an underscore: **[WATER_]**.

Along with this screen warning, the text “Water in slave arm” appears under the **Warnings:** heading in the SHOW ERRORS menu. To clear the warning text in all menus, go to the SHOW ERRORS menu and press the Clr Errs <5 button. If water continues to be detected or is detected again, the warning will reappear.

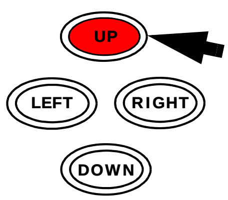
2.3 Controlling Slave Arm Hydraulics

Use the master controller to control hydraulic power to the slave arm.

- Hydraulic (supply) pressure to all slave arm functions is controlled with a single isolation valve located in the upper arm
- The Startup, DRIVERS, and SHOW ERRORS menu screens designate keys for controlling the isolation valve and show hydraulics status:
  - — Hydr: ON = Hydraulics *enabled*
  - — Hydr: OFF = Hydraulics *disabled*

NOTE: *To avoid unexpected movements, always enable slave arm hydraulics before you unfreeze the slave arm.*

2.3.1 Emergency Disable



Hydraulics can be disabled at any time, regardless of menu, by pressing the red UP control key (Figure right, arrow).

If you disable the hydraulics by pressing the UP key, use the DRIVERS menu to re-enable (see “Using the DRIVERS Menu” section on page 37).

2.3.2 Automatic Disable

Some system errors automatically disable the hydraulics. See "Using the SHOW ERRORS Menu" section on page 52 and "Enabling & Disabling System Error Checking" section on page 55.

2.4 Controlling Auxiliary Equipment

Two additional channels are available in the DRIVERS menu for controlling auxiliary equipment such as the optional wrist camera and lights. Contact Customer Service for more information.

2.5 Menu Security

The master controller has three security levels for accessing menus. Two of the levels are password-protected and restrict access to menus that control sensitive or critical system functions.

Level 0 (default level) is available at system startup. No password is required. Full system operation is available at level 0, including access to menus for error-checking, diagnostics, and configuration of some functions. A level 0 operator using a fully configured manipulator system will usually need no higher security level.

Levels 1 through 4 allow access to the SET LIMITS, SET STOW, SET SV (servo valve) OFFSET, and MEMORY menus, and require a password. (Levels 1 through 4 are functionally equivalent.)

Level 5 requires the factory-assigned password, and allows access to all configuration and security menus. Level 5 access is required to set or change passwords for security levels 1 through 4.

2.6 Incompatibility Alert Screens

Incompatibility alert screens are extremely unlikely to occur with a factory-matched slave arm and master controller, but 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 software setting, ID code, or other condition that differs from what it is expecting. This difference may range from unimportant to critical.

- For details, see the Master Controller Service/Incompatibility Alert Screens section of the "Maintenance & Service" chapter.

! Caution

When an incompatibility alert screen appears, use extreme caution if you chose to 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:*
• a component or connection failure.
• a master controller and slave controller/slave arm from different system-types (that is, a Titan-configured master controller has been connected to a Conan or Orion slave controller/slave arm, etc.).

3 Operation

! Caution

Activating hydraulic power without having completed all steps in the pre-start checks and startup sequence can cause injury to personnel and damage to equipment.

3.1 Pre-Start Checks

Each time you prepare to start up the manipulator system, make the following checks:

- All fasteners and fittings are properly tightened and in good condition.
- All hoses and cables are safely routed to allow full travel of the slave arm without producing kinks, snagging, and contact with sharp edges or rough surfaces.
- Hydraulic components, hoses, and fittings are sound and have no leaks.
- All electrical connections between the master controller, junction box or telemetry/control box, and slave arm are secure; electrical cables are safely routed to avoid damage.
- Compensation system is full and bled. (Submersible models only.)

3.2 Startup

To start up the system, follow the steps below.

1. Clear personnel and equipment from the slave arm's range of motion.

   Deck-test: Turn on electrical power to the manipulator system with the switch on the junction box.

   Long-line: Turn on power to the slave arm.

   Non-submersible models: Turn on electrical power to the manipulator system with the switch on the telemetry/control box.

2. Turn on the master controller power switch. The message "Establishing Communications with slave arm" (Figure 6) will appear briefly and, if all system conditions are normal, then default to the Startup screen (Figure 7).

```
     SCHILLING ROBOTICS, INC
   TITAN 4 MANIPULATOR SYSTEM
--------------------------------

Establishing communications with
Slave units...


(Serial port baud rate is 19200
Hold lower-left key at powerup to
adjust the baud rate.)


--------------------------------
```

Figure 6 *Establishing communications message*

NOTE: *If the baud rate is incompatible or if other telemetry issues exist, the message "FATAL TELEMETRY ERROR" will appear on the screen and the keys on the master controller will be unavailable. To change the baud rate, s*ee "Changing the System Baud Rate," in the "Maintenance & Service" chapter for details.

```
SCHILLING ROBOTIC SYSTEMS
TITAN MANIPULATOR SYSTEM
--------------------------------
 Startup Procedure:
 1.Verify arm position.
 2.Turn on HPU power.
 3.Enable arm hydraulics.
 4.Turn hydraulics off if
   the slave arm moves from
   its current position.
 5.Press DOWN key to exit.

                     Hydr:OFF <8
--------------------------------
```

Figure 7 *Startup screen*

3. Abnormal system conditions at startup may result in other message screens:

a. A "WARNINGS" screen appears if the slave arm is **not** near the stow position or if there is a keyboard error.

— The message "***Slave arm is not near the stow position***" is advisory and does not prevent operation. The STOW OUT menu is bypassed and the screen exits to MAIN menu (see "Using the MAIN Menu" section on page 32).

— Keyboard errors need not be corrected if emergency operation of the slave arm is necessary.

— Refer to "Startup with System Warnings" section on page 50.

b. (Submersible models only) If water is detected in the forearm, the warning text [WATER*] will appear in the top dashed line of the screen. The detection of water DOES NOT turn off hydraulics or interfere with operation; the warning is advisory only. See "Water Detection Error (Submersible Models)" on page 52 for details.

c. Other warning screens or the system error screen appear if a communication or system malfunction is present. Refer to"Startup with System Errors" section on page 51 before proceeding.

d. A fatal telemetry error message indicates the master controller and slave controller are unable to communicate. Refer to '"Fatal Telemetry Errors" in the "Troubleshooting" chapter for causes and remedies.

If no warning or error screens are present, proceed to the next step.

4. Proceed with the steps listed in the **Startup Procedure** screen. See Figure 7.

a. Verify the slave arm position (at or near the stow point).

b. Turn on the HPU (hydraulic power unit) to provide pressure up to the slave arm solenoid valve.

5. Enable hydraulic power to the slave arm by pressing the Hydr: field <8 key. The status will change to Hydr: ON <8.

NOTE: *The slave arm should move very little when you enable hydraulics. Disable hydraulics immediately (press the Hydr: field >8 key or the UP control key) if the slave arm moves unpredictably or in a way that endangers itself or other equipment.*

6. Press the **DOWN** control key (see Figure) to exit the startup screen and go to the STOW OUT menu.

3.3 Using the STOW OUT Menu

Use the STOW OUT menu (Figure 8) to automatically move the slave arm to a deployed position or to a compact stowed position.

- Movement of the slave arm to either position follows a set of up to 16 points (positions) that are user programmed in the SET STOW menu (MAIN/SETUP/SET STOW), as described section 4.2.4 on page 46.

```
STOW OUT
--------------------------------
                     STOW OUT <5

                      STOW IN <6

                  pnt:IN STOP <7

                         EXIT <8
--------------------------------
After stowing out press exit KEY
```

Figure 8 *STOW OUT menu*

3.3.1 Command Options

- STOW OUT <5 (deploy): Press the STOW OUT <5 key to deploy the slave arm to the operational position. As the slave arm moves, the **pnt:** field displays the next point in the sequence to which the slave arm is moving.
- STOW IN <6 (stow): Press the STOW IN <6 key to move the slave arm to the stowed position.

NOTE: *The slave arm will move first to the Stow Out (deployed) position before beginning the Stow In sequence. To avoid major automatic movements, position the slave arm at or near the stow out position before pressing the STOW IN <6 key.*

- pnt: ... STOP <7: The next programmed point is displayed the **pnt: ...** field. Press the pnt: ... <7 key to stop the slave arm at the next programmed point.
  — To immediately stop the slave arm in an emergency, press the UP control key to disable hydraulic power.
- EXIT <8: Press the EXIT <8 key to return to the MAIN menu.

3.4 Using the MAIN Menu

Password level: 0 or higher

```
MAIN MENU                    LOCK
--------------------------------
1> ROBOTICS          SET UP    <5

2> OPTIONS           DIAGNOSE  <6

3> OPERATE           SHUT DOWN <7


--------------------------------
  UP key turns hydraulics OFF
```

Figure 9 *MAIN menu*

Use the MAIN menu (Figure 9) to access the menus described below:

1> ROBOTICS

- If your system has optional robotic software, use the ROBOTICS menu to record and play back slave arm movements.
- On systems without robotic software the message NOT AVAILABLE will appear on the screen if you select the 1> ROBOTICS key.

2> OPTIONS

- Configure slave arm and jaw speed.
- Set an alternate scale for slave arm movement relative to master arm movement (toggle-select in the OPERATE menu).
- All menus are accessible at security level 0.

3> OPERATE

- Control normal slave arm operation with the master arm.
- Toggle through jaw and wrist operation modes, and toggle between alternate slave arm scaling values.
- Enter the menu for freezing selected slave arm functions.
- Enter the DRIVER menu to enable/disable hydraulics or operate auxiliary hydraulic equipment.
- All menus are accessible at security level 0.

SET UP <5

- Use to set slave arm travel limits, program stow sequence, set security levels and new passwords, enable/disable error checking functions, adjust servo valve offsets, and edit master controller memory locations.
- These sub-menus require a password or a security level higher than 0 to use.

DIAGNOSE <6

- Diagnose faults in the slave arm position sensors, master arm and master controller.
- Display, reset, and configure system error checking.

- All menus are accessible at security level 0.

SHUT DOWN <7

- Use to activate the pre-recorded automatic Stow In (or Stow Out) sequence for the slave arm and to disable slave arm hydraulics.
- All menus are accessible at security level 0.

3.5 Using the OPERATE Menu

Access path: MAIN/OPERATE
Password level: 0 or higher

```
OPERATE                    FRZ
--------------------------------
1> FREEZE          Wrs Md:POS  <5

2> DRIVERS         Jaw Md:POS  <6

3> Scale Tog:100%

                          EXIT <8
--------------------------------
```

Figure 10 *OPERATE menu*

Use the OPERATE menu for normal operation of the slave arm with the master controller.

1. In the MAIN menu press the 3> OPERATE key to access the OPERATE menu (Figure 10).
   — To prevent unintended operation, the OPERATE menu always opens with the slave arm in the freeze (FRZ) state.
2. Grip the master arm, move it from its parked location, and position it for convenient operation of the slave arm.
3. Press the master arm freeze button (status field changes to REIN) and use the master arm to direct the slave arm.

   NOTE: *The freeze function is also useful when a slave arm task results in an awkward position for holding the master arm. Press the Freeze button, move the master arm to a more comfortable position then press the Freeze button again to resume operations.*

4. Move the master arm to operate the slave arm as desired.
5. Use the SHUT DOWN menu to stow the slave arm and disable hydraulics. (See “Using the SHUT DOWN Menu” on page 40.)

3.5.1 Water Detection

If water is detected in the forearm, the warning **[WATER*]** will appear in the middle of the top dashed line of all LCD screen menus (see Figure 11, arrow). The asterisk in the warning text indicates the active detection of water; if water is no longer detected, the asterisk is replaced with an underscore: **[WATER_]**.

> ***NOTE:*** *The detection of water DOES NOT turn off hydraulics. The warning text is advisory only.*

```
OPERATE                    FRZ
------------[WATER*]------------
1> FREEZE           Wrs Md:POS  <5

2> DRIVERS          Jaw Md:POS  <6

3> Scale Tog:100%

                         EXIT <8
--------------------------------
```

Figure 11 *[WATER*] warning in the OPERATE menu*

Along with this screen warning, the text “Water in slave arm” will appear under the **Warnings:** heading in the SHOW ERRORS menu. To clear the warning text in all menus, go to the SHOW ERRORS menu and press the Clr Errs <5 button. If water continues to be detected or is detected again, the warning will reappear.

3.5.2 Important Steps after Initial Installation

Avoiding Damage

Avoid damage to the slave arm and surrounding equipment. Program travel limits and the Stow In/Stow Out path as soon as possible after installation.

- To program travel limits, see “Setting Slave Arm Travel Limits” section on page 48.
- To program the Stow In/Stow Out path, see “Setting the Stow Path” section on page 46.

Bleeding the Compensator (Submersible Models)

When your system is operational, the slave arm can be positioned for bleeding the compensator system. Refer to “Charging the Compensation System” in the “Installation” chapter.

3.5.3 ERR (Error) Messages

An ERR (Error) message appearing any time during operation (top line, to the left of status field) indicates a system error has been detected and hydraulics are disabled. See *“Using the SHOW ERRORS Menu”* section on page 52 and *“Enabling & Disabling System Error Checking”* section on page 55 for causes and remedies.

3.6 Using OPERATE Menu Options

3.6.1 Freezing Individual Slave Arm Joints

Access path: MAIN/OPERATE/FREEZE
Password level: 0 or higher

Freezing individual joints is useful for tasks where only some joints are required to move and/or where greater stability of specific individual slave arm joints is desired.

```
FREEZE                          FRZ
--------------------------------
1> Azi: FRZ             Yaw: FRZ <5

2> Sho: REIN           Wrs: REIN <6

3> Elb: FRZ             REIN All <7

4> Pit: FRZ                 EXIT <8
--------------------------------
```

Figure 12 *FREEZE menu*

The FREEZE menu (Figure 12) allows the following slave arm joints to be frozen so that they will not respond to master arm movements:

- 1> Azi (azimuth)
- 2> Sho (shoulder)
- 3> Elb (elbow)
- 4> Pit (wrist pitch)
- Yaw <5 (wrist yaw)
- Wrs <6 (wrist rotate)

To freeze individual joints, follow the steps below:

1. From the OPERATE menu press the 1> FREEZE key.
2. From the FREEZE menu, unfreeze the slave arm (using the master arm freeze button) and position each joint where you want it frozen.
3. Press the key next to the joint to toggle the field between FRZ and REIN.
4. After making your selections, press the EXIT <8 key to return to the OPERATE menu.
5. Press the master arm freeze button to unfreeze the slave arm. Joints set to FRZ in the FREEZE menu will remain frozen. Joints set to REIN can be directed with the master arm.
6. To unfreeze all joints, return to the FREEZE menu and press the REIN ALL <7 key.

   NOTE: *All FREEZE menu joint settings return to REIN (active) when power to the master controller is interrupted.*

3.6.2 Using the DRIVERS Menu

Access path: MAIN/OPERATE/DRIVERS
Password level: 0 or higher

The DRIVERS menu (Figure 13) has two main functions.

- Enabling hydraulics if you disabled the hydraulics by pressing the UP control key.
- Controlling auxiliary equipment or tools (camera, lights, etc.) using driver channels #1 through #5.

Pressing the EXIT<8 key returns the screen to the OPERATE menu.

```
DRIVERS                           LOCK
----------------------------------
1> #1: OFF                     #5:OFF  <5

2> #2: OFF                     Hydr:ON <6

3> #3: OFF

4> #4: OFF                        EXIT <8
----------------------------------
```

Figure 13 *DRIVERS menu*

Enabling Hydraulics

1. Press the Hydr: field <6 to ON (enabled).

   ***NOTE:** If the hydraulics are disabled while in REIN (active) status and the master arm is moved to a new position, the slave arm will move automatically to the new master arm position when the hydraulics are enabled.*

Controlling the SR Camera and Light (101-5074 & 101-5074-1)

1. To turn the camera on and off, press key #5.
2. To turn the LED lights on and off at full intensity, press key #4.
3. To turn the LED lights on and off at half intensity, press key #3 (key #4 must be OFF).

   If both #3 and #4 are ON, the LED lights will operate at full intensity.

3.6.3 Scaling Slave Arm Movement (Toggle)

Access path: MAIN/OPTIONS
Password level: 0 or higher

Scaling controls the travel relationship between the master arm and slave arm. The default scale is 100%: slave arm travel matches master arm travel.

To select an alternate scale while in the OPERATE menu:

1. Use the master arm freeze button to freeze the slave arm.
2. Press the 3> Scale Tog: field key to toggle between 100% and a pre-selected lesser scale.

At each startup the selectable scale defaults to 100%. Reset if lesser values are required.

To set an alternate scaling value, follow these steps:

1. From the MAIN menu press the 2> OPTIONS key to display the OPTIONS menu (Figure 14).

```
OPTIONS                    FRZ
--------------------------------
1> Dyn: FAST

2> Jaw Speed:16

3> Scale Set:050%

                        EXIT <8
--------------------------------
```

Figure 14 *OPTIONS menu*

2. Press the 3> Scale Set: field key to change the alternate scale value in 10% increments. (At 100%, the value defaults to 10%.)
   — 100% = the default value producing one-to-one correspondence. For example, rotating the master arm elbow joint 50° causes the slave arm elbow joint to rotate 50°.
   — Less than 100% = reduces the slave arm movement to a percentage of the master arm movement, allowing finer slave arm control. For example, at 50% scale, rotating the master arm elbow joint 90° causes the slave arm elbow joint to rotate 45°.
   — Scaling affects only the azimuth, shoulder, elbow, wrist yaw, and wrist pitch functions. The wrist roll and jaw functions always remain at 100%.
3. When the desired alternate scaling value is displayed, press the EXIT <8 key to save and return to the MAIN menu.

3.6.4 Selecting the Wrist Mode (Toggle)

Access path: MAIN/OPERATE
Password level: 0 or higher

Press the Wrs Md: field <5 key to toggle between POS (position) and RATE modes of control. These options are described below.

RATE

Rotating the collar from its null point (center of travel) initiates continuous slave arm wrist rotation in the same direction, with its speed (rate) increasing with the degree of collar rotation.

- To stop wrist rotation, you can either freeze the master arm or rotate the master arm wrist collar back to its null point (center of travel).

NOTE: When you unfreeze the master arm, the wrist will not rotate until master collar is at or near the null point (center of travel).

POS (position)

The slave arm wrist rotates to the same degree (position) the collar is rotated.

- If one of the collar's mechanical stops prevents achieving the desired wrist position, freeze the slave arm, and rotate the wrist collar away from the mechanical stop until there is adequate travel to direct the wrist as desired. Then unfreeze the slave arm and continue.

NOTE: If the collar is at or near its mechanical limit in position (POS) mode, and you freeze the slave arm and switch to RATE mode, the wrist will not rotate until you first rotate the collar back to the rate mode null point (this prevents immediate full-speed rate rotation when you change modes).

3.6.5 Selecting & Using the Jaw Operating Modes

Access path: MAIN/OPERATE
Password level: 0 or higher

Press the Jaw Md: field <6 key to toggle between the three jaw function modes (POS, TOG, LOCK). These options are described below.

TOG (toggle)

Squeezing the forward jaw band fully opens or closes the jaw.

POS (position)

The jaw moves as long as the jaw band is squeezed

- Forward band = Jaw closes
- Rear band = Jaw opens

LOCK

Disables the master arm input, leaving the jaw in its current position.

- To escape from the LOCK mode, press the JAW Md: field <6 key and toggle between the TOG or POS mode.

NOTE: The jaw relaxes its grip when hydraulics are disabled, either through operator control or hydraulic failure. Objects held by the jaw may be released or dropped.

3.6.6 Auxiliary Jaw Switch

The auxiliary jaw switch is located opposite the master arm (see Figure 1 on page 23) and provides the same functions as the jaw bands on the master arm. See "Selecting & Using the Jaw Operating Modes").

- Move switch forward = Jaw closes
- Move switch rearward = Jaw opens

3.7 Using the SHUT DOWN Menu

Access path: MAIN/SHUTDOWN
Password level: 0 or higher

```
SHUT DOWN                    FRZ
--------------------------------
                     Stow Out <5

                      Stow In <6

                Pnt:OUT  Stop <7

4> Hydr to OFF           EXIT <8
--------------------------------
After stow, turn off hydraulics
```

Figure 15 *SHUT DOWN menu*

To shut down the manipulator system, follow these steps:

1. Release any objects from the jaw.

   NOTE: *The jaw relaxes its grip when hydraulics are disabled, either through operator control or hydraulic failure. Objects held by the jaw may be released or dropped.*

2. Move the slave arm to a position that approximates the STOW OUT position. Exit the OPERATION menu.
3. From the MAIN menu, press the SHUT DOWN <7 key to display the SHUT DOWN menu (Figure 15).

   NOTE: *When you press the Stow In <6 key, the slave arm will first move to the Stow Out position before beginning the Stow In sequence. Be prepared for this movement.*

4. Press the Stow In <6 key to move the slave arm to its stowed position. Note that:
   — Before beginning the stow sequence, the slave arm will first move to the Stow Out position

   — As the slave arm moves towards Stow In, the PNT: field displays each successive point number in the sequence. The final point (01) is displayed as IN.

   — Stop the sequence by pressing the Stop <7 key.

   NOTE: *Pressing the STOP <7 key does not stop the slave arm until it reaches the next stow point. To immediately stop the slave arm, press the UP control key to disables hydraulic power to the slave arm.*

   — Reverse the stow sequence at any time by pressing the Stow Out <5 key.
5. Press the 4> Hydr key to disable hydraulics.
6. Turn off power to the hydraulic power unit.

7. Turn off power to the master controller.
8. Turn off power to the slave arm/controller (if independently supplied).

3.8 Shut Down Maintenance

You can keep your system in good operating condition by performing the following post-operation steps:

All Models

1. Park the master arm on the front panel, above the LCD screen and stow the master controller in a protected location.
2. Check slave arm and hydraulic lines for:
   - Damage
   - Loose or missing fasteners
   - Trapped debris
   - Hydraulic leaks

Submersible Models

1. Hose down the slave arm with clean, fresh water.
2. Check a sample of hydraulic fluid for water contamination.
   - If you find water, flush and refill the system with clean hydraulic fluid
3. Apply a spray lubricant to the slave arm jaw assembly and actuator rods to displace any water.

3.9 Operating the Optional Wrist Camera

Use the master controller DRIVERS menu to operate the camera and LED camera lights.

Access path: MAIN/OPERATE/DRIVERS
Password level: 0 or higher

1. To turn the camera on and off, press key #5.
2. To turn the LED lights on and off at full intensity, press key #4.
3. To turn the LED lights on and off at half intensity, press key #3 (key #4 must be OFF).
   - If both #3 and #4 are ON, the LED lights will operate at full intensity.

4 Setting Performance Options

The Titan 4 can be optimized for a specific task and/or work site by selecting, setting, or configuring system functions using the OPTIONS, SETUP, and other menus.

4.1 Using the OPTIONS Menu

Access path: MAIN/OPTIONS
Password level: 0 or higher

Use the OPTIONS menu (Figure 16) to set slave arm speed and alternate scaling, and set the jaw speed.

```
OPTIONS                   FRZ
--------------------------------
1> Dyn: FAST

2> Jaw Speed:16

3> Scale Set:050%

                         EXIT <8
--------------------------------
```

Figure 16 *OPTIONS menu*

4.1.1 Setting Slave Arm Speed (Dynamics)

Access path: MAIN/OPTIONS
Password level: 0 or higher

Slave arm speed (compared to the speed of master arm movements) can be toggled between FAST and SLOW in the 1> Dyn menu.

- FAST mode = slave arm speed attempts to match movements of the master arm.
  - Use when quick response and close correspondence to rapid movements of the master arm are needed, and in submersible operation where slave arm movements are slowed by water resistance.
- SLOW mode = slave arm speed is limited regardless of master arm movement speed.
  - Use when hydraulic flow is limited to prevent pressure from dropping due to high demand.

To change the slave arm speed, follow these steps:

1. Press the 1> Dyn key to toggle between SLOW and FAST modes.
2. Press EXIT <8 to save setting and return to the MAIN menu.

Slave arm speed defaults to FAST when power to the master controller is interrupted.

> ***NOTE:*** *Avoid rapid movements of the master arm in the SLOW mode. Slave arm response lags and may make it difficult to avoid obstacles or direct the slave arm to an exact position. Slow master arm movements until the slave arm can match them.*

4.1.2 Controlling Jaw Opening & Closing Speed

Access path: MAIN/OPTIONS
Password level: 0 or higher

Jaw speed is functional in POSITION mode only.

- Jaw speeds range from 04 to 32 (slow to fast) in increments of 4.
- Jaw speed defaults to 16 when power to the master controller is interrupted.

To change the jaw speed follow these steps:

1. Press the 2> Jaw Speed key to increase the speed in increments of 4. After 32, the jaw speed value defaults to 04 (Figure 16 on page 42).
2. Press EXIT <8 to save setting and return to the MAIN menu.

4.1.3 Setting an Alternate Slave Arm Scale

Access path: MAIN/OPTIONS
Password level: 0 or higher

You can set an alternate scale of slave arm movement to master arm movement in the OPTIONS menu and use the 3> Scale Tog key in the OPERATE menu to toggle between it and 100% (the default scale value).

- 100% = 1:1 correspondence. For example, 50° master arm elbow joint rotation results in 50° slave arm elbow joint rotation.
- Less than 100% = slave arm movement is a percentage of master arm movement. For example, at 50% scale, a 90° rotation of the master arm elbow joint results in 45° slave arm elbow joint rotation.
- Scaling affects the azimuth, shoulder, elbow, wrist yaw, and wrist pitch functions.
- Wrist roll and jaw functions always remain at 100%.

To set the alternate scaling value, follow these steps:

1. From the MAIN menu (Figure 9 on page 33) press the 2> OPTIONS key.
2. From the OPTIONS menu, press the 3> Scale Set key to select the scaling you want in 10% increments.
3. Press the EXIT <8 key to save the setting and return to the MAIN menu.

The alternate scale value default to 100% when power to the master controller is interrupted.

4.2 Using the SETUP Menu

Access path: MAIN/SETUP
Password level: 1 or higher (level 5 required for MEMORY and SECURITY/SET PASSWORD).

```
SETUP                         LOCK
--------------------------------

1> SET LIMITS               MEMORY <5

2> SET STOW               SECURITY <6

3> SET SV OFFSET

4> SET ERR CHECKS             EXIT <8
--------------------------------
```

Figure 17 *SETUP menu*

The SETUP menu (Figure 17) is used for configuring the following functions:

- 1> SET LIMITS: Set slave arm travel limits.
- 2> SET STOW: Record the Stow In/stow out path.
- 3> SET SV OFFSET: Set servo valve offsets. See “Setting Servo Valve Voltage Offsets” in the “Maintenance & Service” chapter.
- 4> SET ERR CHECKS: Enable/disable system error checking.
- MEMORY <5: Edit master controller memory locations only under direction from Customer Service personnel.
- SECURITY <6: Set and access security levels, set passwords.

To configure the menus within the SETUP menu, except MEMORY<5, you must first access security level 1 or higher by entering a local- (or the factory-assigned level 5) password in the SECURITY menu.

Only the level 5, factory-assigned password will provide access for configuring the MEMORY <5 menu.

Settings in all SETUP submenus are retained even if power to the master controller is interrupted.

4.2.1 SECURITY Menu

Access path: MAIN/SETUP/SECURITY

> ***NOTE:*** *The information sheet for factory-set passwords follows the Table of Contents.*

Entering or changing the passwords for each level is done through the SECURITY menu (Figure 18), which is accessed by pressing the SECURITY <6 key in the SETUP menu.

```
SECURITY                  LOCK
--------------------------------
1> SET LEVEL

2> SET PASSWORD



                          EXIT <8
--------------------------------
```

Figure 18 *SECURITY menu*

The master controller has one unprotected, default access/operation level. Two additional password-protected security levels allow you to access menus and configure sensitive or critical system functions:

- Level 0 is the default level available at system startup. No password is required. Full system operation is available at level 0, including access to error-checking and diagnostic menus. The level 0 operator can access only the 4> SET ERR

CHECKS in the SETUP menu. A level 0 operator using a fully configured manipulator system will usually need no higher security level.

- Levels 1 through 4 require a password, and allow access to the SET LIMITS, SET STOW, SET SV OFFSET, and MEMORY menus. (Levels 1 through 4 are functionally equivalent.)
- Level 5 requires the factory-assigned password, and allows access to all configuration and security menus. Level 5 access is required to set or change passwords.

4.2.2 Entering Passwords: the SET LEVEL Menu

Access path: MAIN/SETUP/SECURITY/SET LEVEL
Password level: 1 or higher

To enter a password for a higher security level, perform the following steps:

1. From the SETUP menu, press the SECURITY <6 key.
2. From the SECURITY menu, press the 1> SET LEVEL key to display the SET LEVEL menu (Figure 19). The current security level is displayed at the bottom of the screen.
3. The cursor appears in the Level: field. Press the Inc <5 or Dec <6 keys until the desired level (number) is displayed. Press the Select <7 key to enter the setting.
4. The cursor drops to the first digit of the Password: field, changing the first asterisk (*) to a zero (0). Press the Inc <5 or Dec <6 keys until the first number of the four-digit password appears. Press the Select <7 key to enter the number and repeat until all four numbers of the password have been entered.
5. When the level and password have been correctly entered, DONE will appear at the bottom of the screen.
6. Press the EXIT <8 key to exit.

```
SET LEVEL
--------------------------------
 Level:0                  Inc <5
 Password:####
                          Dec <6

                       Select <7

 Current user's
 Privilege Level:0       EXIT <8
--------------------------------
```

Figure 19 *SET LEVEL menu*

4.2.3 Setting & Changing Passwords

Access path: MAIN/SETUP/SECURITY/SET PASSWORD
Password level: 5

Use the SET PASSWORD menu (Figure 20) to set or change passwords for security levels 1 through 4. The password for security level 5 cannot be changed.

```
SET PASSWORD                    LOCK
--------------------------------
 Level:0                         Inc <5
 Password:####
                                 Dec <6

                              Select <7

 Current user's
 Privilege Level:5              EXIT <8
--------------------------------
```

Figure 20 *SET PASSWORD menu*

To set or change a password, follow these steps:

1. Set the security level to 5 (see “Entering Passwords: the SET LEVEL Menu” section on page 45).
2. From the SETUP menu, press the SECURITY <6 key.
3. From the SECURITY menu, press the 2> SET PASSWORD key.
4. In the SET PASSWORD menu, the cursor appears in the Level: field. Press the Inc <5 or Dec <6 key until the desired level is displayed. Press the Select <7 key to enter.
5. The cursor drops to the first digit of the Password: field. Press the Inc <5 or Dec <6 key to set the first number of the new password. Press the Select <7 key to enter the number. Repeat until all numbers of the new password have been entered.
6. When the level and password have been correctly entered, the message DONE will appear at the bottom of the screen.
7. Press the EXIT <8 key to exit.

4.2.4 Setting the Stow Path

Access path: MAIN/SETUP/SET STOW
Password level: 1 or higher

The stow path is a pre-recorded sequence of 2 to 16 points (positions) that the slave arm automatically travels to and passes through when the STOW IN or STOW OUT (deploy) key is pressed in the STOW OUT or SHUT DOWN menus. Use the SET STOW menu (Figure 21) to create or change the stow path and stowed/deployed positions for your slave arm.

> ***NOTE:*** *The SET STOW and SET LIMIT menus are interrelated:*
> *1. Current travel limits (set in the SET LIMITS menu) also apply while you are in the SET STOW menu.*
> *2. The current stow sequence cannot be limited or affected by new changes in the SET LIMIT menu.*
>
> *If you want to set new stow points outside the current travel limits, you must first extend the limits in the SET LIMITS menu. Then return to the SET STOW menu to set the stow*

points. If desired, restore the original travel limits using the SET LIMITS menu (the stow sequence, including the points outside the limits, will not be affected).

Other Considerations

- Pressing the Stop <7 key while the slave arm is performing a Stow In or Stow Out action will not halt the slave arm until the next point in the sequence is reached. A Stow In/Stow Out path with more points allows the slave arm to be stopped sooner.
- The control system calculates how to move the slave arm between points. If only a few points are points are programmed, the slave arm will travel directly to them, as directed by the control system. If the slave arm must avoid specific obstacles or equipment while being stowed or deployed, create as many travel points as needed (up to 16) for the slave arm to avoid them.

To change the stow path for your slave arm, following these steps:

1. Set the security level to 1 or higher.
2. Access the SET STOW menu (Figure 21): MAIN/SETUP/SET STOW.

```
  SET STOW                 FRZ
--------------------------------
  POINT:01               Last <5

                         Next <6

                        Teach <7
    Last Stow
4>  Point:08             EXIT <8
--------------------------------
```

Figure 21 *SET STOW menu*

The POINT field opens to the 01 (Stow In) point.

3. Press the 4> Last Stow Point:... key to change the number of points you want to use for the path sequence.

- POINT 01 = the Stow In position.
- Last Stow Point = the final Stow Out position.
- Select any number of points between 2 and 16 to reach the Stow Out point.

4. Unfreeze the arm.
5. Move the arm to the desired Stow In point (01). Press Teach<7 to record the position. The POINT: field will increment to the next point.

NOTE: *Slave arm travel limits set in the SET LIMITS menu will apply to and limit future changes to settings in the SET STOW menu. Existing stow settings are not affected.*

6. Move the slave arm to the next position and press Teach<7. Repeat this step to record each point in the stow sequence.

- — Last<5 key = return to a previous point and reteach.
- — Next<6 key = skip ahead. Skipped points retain existing settings.
- — The last point taught = the final Stow Out point.

7. After recording the last point, press the EXIT <8 key to save the recorded path.

4.2.5 Setting Slave Arm Travel Limits

Access path: MAIN/SETUP/SETLIMITS
Password level: 1 or higher

Limit the range of motion of each slave arm joint (except wrist and jaw) by entering travel limits in the SET LIMITS menu (Figure 22).

> ***NOTE:*** *The SET STOW and SET LIMIT menus are interrelated:*
> *1. Current travel limits (set in the SET LIMITS menu) also apply while you are in the SET STOW menu.*
> *2. The current stow sequence cannot be limited or affected by new changes in the SET LIMIT menu.*
>
> *If you want to set new stow points outside the current travel limits, you must first extend the limits in the SET LIMITS menu. Then return to the SET STOW menu to set the stow points. If desired, restore the original travel limits using the SET LIMITS menu. The stow sequence, including the points outside the limits, will not be affected.*

```
SET LIMITS                  FRZ
--------------------------------
 COUNT:01                Last <5

 LIMIT:                  Next <6
  AZI LEFT
                        Teach <7

                         EXIT <8
--------------------------------
```

Figure 22 *SET LIMITS menu*

To set travel limits for individual slave arm joints, follow these steps:

1. Set the security level to 1 or higher: MAIN/SETUP/SECURITY/SET LEVEL.
2. Access the SET LIMITS menu: MAIN/SETUP/SET LIMITS.

> ***NOTE:*** *While the SET LIMITS menu is open, slave arm joints are capable of full mechanical travel. Limits will NOT engage until you have exited from the SET LIMITS menu.*

3. The COUNT: field and LIMIT: field identify each slave arm function. Refer to Table .

Table 1

SET LIMITS Menu		
(Menu) COUNT:	**(Menu) LIMIT:**	**Joint Function**
01	AZI LEFT	Azimuth Yaw
02	AZI RIGHT	
03	SHO DOWN	Shoulder Pitch
04	SHO UP	
05	ELB DOWN	Elbow Pitch
06	ELB UP	
07	PIT DOWN	Wrist Pitch
08	PIT UP	
09	YAW LEFT	Wrist Yaw
10	YAW RIGHT	

4. The menus default is COUNT: 01 and LIMIT: AZI LEFT.

5. Unfreeze the arm by pressing the master arm freeze button.

6. Move the slave arm to the desired left azimuth travel limit.

7. Press the Teach <7 key to enter the position as the limit. The COUNT: field will automatically increase to 02, for setting the AZI RIGHT limit.

8. Repeat steps 6 and 7 to set limits for the remaining joints.

— Press the Last <5 key to return to a previous function.

— Press the Next <6 key to skip a function and keep the existing setting.

9. To save all settings, move the arm to any position inside the new limits, freeze the slave arm, and press the EXIT <8 key.

NOTE: *If you have positioned any joint outside its limits, the arm will move to a position within the new limits the next time the arm is unfrozen.*

10. You should immediately test the new limits to ensure that the slave arm's range of motion is acceptable. Use caution near equipment until you are certain that the new limits prevent collisions.

NOTE: *The slave arm will not respond normally to master arm input if contradictory travel limits have been set. For example: a right azimuth limit that is set to the left of the left azimuth limit. If the slave arm does not respond as expected after setting travel limits, re-enter the menu and set new limits, paying careful attention to the function and direction being set.*

4.2.6 Set ERR Checks Menu

For configuring system error-checking and emergency operation when a system error cannot be cleared, see “Enabling & Disabling System Error Checking” section on page 55.

4.2.7 Set SV Offset Menu

Use of this menu is described in the “Setting Servo Valve Voltage Offsets” in the “Maintenance & Service” chapter.

4.2.8 Memory Menu

! Caution

The MEMORY menu should only be used under direction from Customer Service personnel.

4.3 Enhancing the Slave Arm Position Data Stream

Default data transmission rates:

Single arm Titan 4 system . . . . 19200 baud
(Single arm systems can also be operated at 57600 baud and 115200 baud.)

Dual arm system . . . . 57600 baud
(Dual arm systems can also be operated at 115200 baud.)

At rates higher than the default, additional slave arm joint position data is added to each data packet for creating graphical simulations using third-party software.

Changing the system baud rate requires adjusting the settings of the two Mode switches on the master controller printed circuit board (PCB) and selecting the desired baud rate using the control keys and display.

See “Changing the System Baud Rate,” in the “Maintenance & Service” chapter for details.

5 System Errors & Warnings

5.1 Startup with System Warnings

```
SCHILLING ROBOTIC SYSTEMS
TITAN MANIPULATOR SYSTEM
--------------------------------
 WARNINGS:
   Arm not near STOW point
   (STOW OUT will be bypassed)
   Keys Error(0000000001000)



                         Exit <8
--------------------------------
```

Figure 23 *Startup with warnings screen*

The Startup with Warnings screen (Figure 23) appears under the conditions described below.

Arm not near STOW (In) point

For this condition follow the steps below:

1. Press the EXIT <8 key to exit to the Startup menu.
2. Clear personnel from the slave arm's range of motion. Follow the steps in "Startup" section on page 30 and exit to MAIN menu.
3. Access the OPERATE menu and test operation of the slave arm.

5.1.1 Keys Error

A 1 in the Keys Error field indicates a depressed or malfunctioning key (or freeze button). In many cases, the cause is:

- An object or the master arm is depressing a key.
- The key itself is stuck.
- The master arm is resting on the freeze button (freeze button depressed).

If the keys error appears, follow these steps:

If a key or the freeze button is depressed:

1. Remove the pressure from the key or freeze button.
2. Turn power to master controller off and on. Watch for the warning screen.
3. If there are no keys errors, proceed to step 4. If the key error remains, refer to "Diagnosing Key and Freeze Button Failures" in the "Troubleshooting" chapter.
4. Press the EXIT<8 key to exits to the Startup menu.
5. Proceed with normal startup. See "Startup" section on page 30, beginning with step 5.

If a key or the freeze button is not depressed:

1. Note the position of any 1 numbers in the Keys Error field.
2. DO NOT proceed with startup. Refer to "Diagnosing Key and Freeze Button Failures" in the "Troubleshooting" chapter.

   NOTE: *In an emergency, the slave arm may be operated with keys errors. Exit the warning screen and proceed with the startup. Use caution until safe operation of the slave arm is verified.*

5.2 Startup with System Errors

A Startup with System Errors screen (Figure 24) is displayed when error-checking software detects a problem.

If this screen appears, follow these steps:

1. Press the EXIT <8 key to exit to the MAIN menu. DO NOT proceed with startup.
2. Press the DIAGNOSE <6 key to access the DIAGNOSTICS menu.
3. See "Using the SHOW ERRORS Menu" on page 52 of this chapter and "System Errors" in the "Troubleshooting" chapter to diagnose system errors.

```
SCHILLING ROBOTIC SYSTEMS
TITAN MANIPULATOR SYSTEM
--------------------------------
 System errors were detected!

 Diagnose errors before starting
 hydraulics. Press EXIT key to
 view the next menu.


                        EXIT <8
--------------------------------
```

Figure 24 *System errors screen*

5.3 ERR (Error) Message During Operation

An ERR (error) message in the top line (left of the status field) during operation indicates a system error has been detected and hydraulics have been disabled. See “Using the SHOW ERRORS Menu” section on page 52 and “Enabling & Disabling System Error Checking” section on page 55.

5.4 Using the SHOW ERRORS Menu

Access path: MAIN/DIAGNOSE/SHOW ERRORS
Password level: 0 or higher

5.4.1 Water Detection Error (Submersible Models)

You are alerted to a water detection error when the warning text **[WATER*]** appears in the middle of the top dashed line of all LCD screen menus (see Figure 25, arrow).

```
OPERATE                   FRZ
------------[WATER*]------------
1> FREEZE          Wrs Md:POS  <5

2> DRIVERS         Jaw Md:POS  <6

3> Scale Tog:100%

                        EXIT <8
--------------------------------
```

Figure 25 *[WATER*] warning in the OPERATE menu*

The asterisk indicates the active detection of water; if water is no longer detected, the asterisk is replaced with an underscore: **[WATER_]**.

Along with this screen warning, the text “Water in slave arm” will appear under the **Warnings:** heading in the SHOW ERRORS menu.

To clear the warning text in all menus, go to the SHOW ERRORS menu (Figure 26) and press the Clr Errs <5 button. If water continues to be detected or is detected again, the warning will reappear.

> ***NOTE:*** *The detection of water DOES NOT turn off hydraulics. The warning is advisory only.*

5.4.2 System Errors

```
SHOW ERRORS                 LOCK
--------------------------------
ERRORS:
 Master Range           Clr Errs <5

Warnings:
 Hydr OFF               Hydr OFF <6




                            EXIT <8
--------------------------------
```

Figure 26 *SHOW ERRORS menu*

You are alerted to system errors by:

- A System Errors screen during startup.
- An ERR message in the top line of a menu at any time during operation.

Use the SHOW ERRORS menu (Figure 26) to:

- View a list of errors detected by the system.
- Identify which joint caused the error.
- Reset error conditions that have been corrected.
- After correcting error, re-enable slave arm hydraulics.
- See “System Errors” in the “Troubleshooting” chapter for a description of error types and a list of causes and remedies.

The system errors are described in Table 2.

Table 2

System Errors		
Error No.	**Error Name**	**Description**
01	Slave range	Feedback information from the slave arm indicates that the slave arm is outside of its factory set travel limits. This means that the system is reporting that the arm is in a position that it cannot actually attain.
02	Slave continuity	Feedback information from the slave arm indicates that the slave arm position is changing at a faster rate than is actually possible.

03	Slave control	Feedback information from the slave arm indicates too large a difference between command and actual position.
04	Slave telemetry	Indicates that communications from the master controller to the slave controller have been halted, interrupted, or fatally corrupted.
05	Slave CPU reset	Indicates that the slave controller has reset. This occurs if the slave controller loses power or the slave controller CPU board fails.
06	Master range	Feedback information from the master arm indicates that the master arm is in a position that it cannot actually attain.
07	Master telemetry	Indicates that communications from the slave controller to the master controller have been halted, interrupted, or fatally corrupted.

5.4.3 Show & Clear System Errors

To show and clear system errors, follow these steps:

1. Access the SHOW ERRORS menu: MAIN/ DIAGNOSTICS/SHOW ERRORS (Figure 26 on page 53).
2. Detected errors or warnings will appear In the upper left corner of the display in the ERRORS: and Warnings: fields.
3. See Table 2, above, for error descriptions and “System Errors” in the “Troubleshooting” chapter for more information on diagnosing and correcting errors.

Intermittent or Transient Errors

Some conditions causing error messages can be corrected and cleared immediately, allowing normal operation to resume. For example:

- Pushing the slave arm against an immovable object or lifting too heavy an object.
- Transient or intermittent cable/connector malfunction.

Correct these conditions and press the Clr Errs <5 key to clear the ERRORS: field. Note that:

- The ERRORS: field is completely updated when you press the Clr Errs <5 key. Uncorrected error conditions will still be displayed.
- An error disabling hydraulics must be corrected and cleared before hydraulics can be enabled.

4. When ALL errors have been corrected and cleared, press the Hydr On <6 key to enable the hydraulics.
5. Press the EXIT<8 key and return to the OPERATE menu.

Uncleared Errors Requiring Service

6. Shut down system and correct error conditions. See Table 2, above, for error descriptions and “System Errors” in the “Troubleshooting” chapter for more information on diagnosing and correcting errors.
7. Restart the system. Verify that no error messages are present. Proceed with normal startup and operation.

Emergency Operation

For emergency operation when an error cannot be cleared or reoccurs frequently during operation, see “Enabling & Disabling System Error Checking” below.

5.5 Enabling & Disabling System Error Checking

Access path: MAIN/SETUP/SET ERR CHECKS
Password level: 1 or higher

Error checking detects malfunctions or dangerous conditions and automatically disables hydraulics to prevent damage.

! Caution

• An automatic shut down due to a system error protects the slave arm and its surroundings from risk of damage.

• Disabling error checking to resume operation indicates the operator’s awareness and acceptance of increased risk.

• The safety features that result from error-checking (such as automatically disabling hydraulics) will no longer be in effect.

• The condition causing the error may result in limited or erratic operation of the slave arm

Use the Set Error Checks menu (Figure 27) to selectively disable error checking:

- When collisions or extreme loads are likely to cause repeated error messages.
- For emergency operation.
- For diagnosing a fault or malfunction.

```
SET ERR CHECKS              LOCK
--------------------------------
[01] Slave Range       Change <5
   Check ENA State:OFF
2> Last           Disable all <6
3> Next            Enable all <7
4> Save as default       EXIT <8
--------------------------------
```

Figure 27 *SET ERR CHECKS menu*

To enable and disable system error checks, follow these steps:

1. Review system errors or determine error status. See “Using the SHOW ERRORS Menu” section on page 52.
2. Access the SET ERR CHECKS menu: MAIN/SETUP/SET ERR CHECKS.

3. In the SET ERR CHECKS menu (Figure 27), the error type and its current status will appear in the upper left of the screen. For example:
   - [01] = Error number
   - Slave Range = Error type
   - Check ENA = error checking enabled (DIS = error checking disabled)
   - State: OFF = no error detected (ON = error detected)
4. Press the 2> Last and 3> Next keys to review the other error types and their status.
5. Press the Change <5 key to toggle the Check: field between ENA and DIS.
   - To disable checking for all error types, press the Disable all <6 key.
   - To enable checking for all error types, press the Enable all <7 key.
6. Your settings can be saved two ways:
   - Temporary (until the master controller is turned off) press the EXIT <8 key.
   - Default (until changed again) press the 4> Save as default key. Then press the EXIT <8 key.

5.6 Diagnosing Master/Slave Problems

See “Diagnosing Master/Slave Joint Problems” in the “Troubleshooting” chapter for information about using the DIAGNOSTICS menu to view to screens that display joint position data for the master arm or slave arm.

5.7 Fatal Telemetry Errors

A fatal telemetry error occurs when communication between the master controller and slave controller is interrupted for more than several seconds. See “Fatal Telemetry Errors” in the “Troubleshooting” chapter for causes and remedies.

6 Avoiding Slave Arm Damage

The Titan 4 is designed with safety factors well in excess of its rated capacities. However, situations can occur in operation where safety factors may be exceeded, placing the slave arm and surrounding equipment/personnel at risk. These situations include:

- Collisions
- Collisions while manipulating extreme loads
- Collisions and/or extreme loads while at the slave arm’s mechanical limits

The best protection is **anticipating** risky situations and **planning** slave arm operations to avoid or minimize them.

> ***NOTE:*** *Collisions and extreme loads can cause unusual joint movements (reversed, overly slow or accelerated) that may trigger automatic system shutdown by error-checking software.*
> *If necessary, error checking can be disabled in order to assure uninterrupted operation. However, you should be aware that disabled error checking puts the slave arm at greater risk. (For details see “Enabling & Disabling System Error Checking” on page 55.)*

Troubleshooting

In This Chapter:

- 1 Preliminary Fault Isolation Procedures .... page 57
- 2 Diagnosing Master/Slave Joint Problems .... page 58
- 3 Diagnosing Key and Freeze Button Failures .... page 62
- 4 Troubleshooting Tables .... page 63
- 5 Using the Status Indicator LEDs .... page 72
- 6 Master Controller Voltage Test Points.............................. page 73
- 7 Factory Assistance .... page 74

NOTE: *Before starting any troubleshooting, maintenance, inspection, service procedure, or deck operation, please read and apply the information provided in the "Safety First!" and "Service Guidelines" sections of the "Maintenance & Service " chapter.*

1 Preliminary Fault Isolation Procedures

Eliminate the obvious causes of a fault or malfunction. Check the following:

- The master controller is receiving electrical power.
- The slave arm/controller is receiving electrical power.
- The junction box (if used) is receiving electrical power and the fuse is intact.
- The electrical power and hydraulic inputs are correct as described in the "Specifications" and "Installation" chapters.
- All telemetry conductors between the master controller and slave arm show continuity and connectors are secure.
  - — Isolate cable malfunctions by testing the cables for continuity and insulation resistance, or by substituting spare cables.

If the fault or malfunction persist, use the following sections and troubleshooting tables to isolate the fault.

1.1 Definitions

The following terms are used to describe slave arm performance:

- **Unresponsive** = No response to commands
- **Sluggish** = Responds predictably, but slowly, to commands
- **Erratic** = Responds unpredictably to commands
- **Sagging** = Joint that should be rigid sags instead

- **Hard over** = A slave arm joint moves abruptly to its hardware limit

2 Diagnosing Master/Slave Joint Problems

Although a malfunction of the slave arm is often the first sign of a problem, the cause may be elsewhere in the manipulator system. Strategies to help isolate the cause of a malfunction are described in the following sections.

2.1 Uncontrolled Operation

If a manipulator exhibits uncontrolled movement, freeze the slave arm by pressing the freeze button on the master arm, or by pressing the EXIT key to go to FRZ menu. When the manipulator is frozen, no updated commands are sent to the slave controller; the slave arm is running on a closed control loop and maintains the last commanded position.

- If the slave arm maintains position after being frozen, the problem is probably in the master arm or master controller. Problems associated with the master controller are often only apparent when the slave arm is in a particular position. You can test this theory by using the Freeze/Reindex button to orient the master arm away from the defective range, or by deliberately moving the slave arm into the defective range to induce the fault.
- If the slave arm behaves erratically even when frozen, the problem is probably in the slave controller, slave cable, or slave arm.

  If at least one joint/function is operating correctly, you can use that function to test the others by swapping the known-good resolver and servo valve connectors with the faulty one. Be sure to change both the resolver and the servo valve connector, or you will create another problem called “hard-over.”

  — If the known-good resolver reports bad feedback when plugged into the faulty function, the problem is somewhere upstream, such as the wiring harness, slave cable, or slave controller. If the known-good resolver reports good feedback when plugged into the faulty function, the problem is with the resolver.

  — If the resolver is reporting no feedback, then that joint function is running “open-loop” and control may be limited: if the master arm is moved a little bit, a small differential is generated, and the slave arm will move slowly to “close the loop.” If the master arm is moved back to its original position, the arm will stop moving. However, if you start the joint moving and do not return the master arm to its original position, the differential will become greater, the signal to the servo will become greater, and eventually the slave arm will go “hard over.”

! Caution

If possible, do not allow the slave arm to go “hard-over” as the slave arm and its surroundings could be damaged.

2.2 The Stow In/Stow Out Test

When the slave arm malfunctions during operation with the master arm, using the Stow Out or Stow In command in the STOW OUT or SHUT DOWN menu can help isolate the cause:

- If a single slave arm joint was malfunctioning but accurately follows the stow path, the fault is most probably in the corresponding master arm joint potentiometer. To test it, see "Diagnosis with the MASTER TEST Screen" below.
- If the entire slave arm was malfunctioning but accurately follows the stow path, the cause is most probably in the master controller PC boards. See "Slave Arm Symptoms (Entire Arm)" section on page 66.
- If the single joint still malfunctions following the stow path, the cause is most probably in the joint's slave arm wiring, resolver, or servo valve. See "Diagnosis with the Slave Test Screen" section on page 60 and "Slave Arm Symptoms (Individual Joints)" section on page 67.
- If the entire slave arm still malfunctions following the stow path, other diagnostic tests may be more helpful. See "Diagnosis with the Slave Test Screen" section on page 60 and "Slave Arm Symptoms (Entire Arm)" section on page 66.

2.3 Diagnosis with the MASTER TEST Screen

The MASTER TEST screen displays joint position output values from position-sensing potentiometers in the master arm. These output values are helpful in diagnosing problems exhibited by the slave arm and isolating the cause to the master arm or slave arm.

Note the following:

- Displaying the MASTER TEST screen locks the slave arm.
- The MASTER TEST screen displays position values for:
  - — each master arm joint.
  - — jaw bands/auxiliary jaw rocker switch.
- Moving the master arm changes the output values.
- A 1 in the Keys: field indicates a key or freeze button error. See "Diagnosing Key and Freeze Button Failures" section on page 62.

2.3.1 Diagnosing with Master Arm Position Values

1. Access the MASTER TEST screen (Figure 1): MAIN/ DIAGNOSTICS/MASTER TEST.

```
MASTER TEST                LOCK
--------------------------------

Command:      Jaw Bands:

Azi: -0743     -0000
Sho: -0516     +2044
Elb: +0128
Pit: -0022
Yaw: +0231
Wrs: -0967

 Keys:00000000000000     EXIT <8
--------------------------------
```

Figure 1 *MASTER TEST screen*

2. Move the master arm and observe the position values from each joint:

— If a specific slave arm joint is malfunctioning, check the matching master arm joint:

a. If the joint is stable, the position value should be stable (an unstable value for a stable joint indicates a possible failure of its potentiometer or a master controller analog PC board).

b. If a small movement of the master arm joint causes a large or erratic change in its position value, this may indicate a failure to that joint's master arm potentiometer.

— If the values for all joints are unresponsive or erratic, a master controller board failure may be the problem.

3. If all values, and value changes in response to master arm movement, appear normal, proceed to "Diagnosis with the Slave Test Screen" section on page 60.

2.4 Diagnosis with the Slave Test Screen

The SLAVE TEST screen displays joint position output values from position-sensing resolvers in the slave arm. These position values are helpful in diagnosing problems exhibited by the slave arm and isolating the cause.

Note:

- In the SLAVE TEST menu, you can unfreeze the slave arm and control it with the master arm while observing the command and position values.
- Command: values = Generated by computer, based on movement of master arm
- MASTER TEST Command: values = generated by movements of the master arm
- Position: values = position values sensed by slave arm joint resolvers

— ~0 values = Approximate middle of range of motion

— + values = Movement up or right

— - values = Movement down or left

2.4.1 Diagnosing SLAVE TEST Position Values

1. Access the MASTER TEST screen (Figure 2): MAIN/ DIAGNOSTICS/SLAVE TEST.

```
SLAVE TEST                 FRZ
--------------------------------

Command:    Position:

Azi: -0250  -0250
Sho: -0516  -0516
Elb: +0128  +0128
Pit: -0057  -0057
Yaw: +0231  +0230
Wrs: -0967  -0967
Jaw: +1600  +1600
                          EXIT <8
--------------------------------
```

Figure 2 *SLAVE TEST screen*

2. While in FRZ status, with master arm and slave arm at rest, observe the Command: and Position: values.

   — If Command: values are unstable refer to "Diagnosing with Master Arm Position Values" section on page 59. Correct any malfunction before proceeding.

   — If a specific slave arm joint is malfunctioning, check its Position: value. If the Position: value is unstable, the most probable cause is its resolver, followed by resolver to slave controller wiring, or the slave controller PC board.)

3. Unfreeze the slave arm and move the master arm as directed:

   — If a small movement of the master arm joint causes a large or erratic change in its Command: value, refer to "Diagnosing with Master Arm Position Values" section on page 59. Correct any malfunction before proceeding.

   — Use the master arm to move each slave arm joint to its travel limits. The Position: values noted at the limits should fall within the ranges shown in Table 1.

Table 1

Travel Limits		
Joint	**Limit**	**Value Range**
Azimuth	Left	-6500 to -5700
	Right	+6600 to +5800
Shoulder	Down	-2300 to -1500
	Up	+3800 to +3000
Elbow	Down	-6500 to -5700
	Up	+6500 to +5700
Pitch	Down	-4500 to -3700
	Up	+4500 to +3700
Yaw	Left	-4500 to -3700
	Right	+4500 to +3700
Jaw	Completely open	+3400 to +2600
	Completely closed	+1700 to +0900

   — A value range that is skewed higher or lower may be caused by an incorrect SV (servo valve) offset (see "Setting Servo Valve Voltage Offsets" in the "Maintenance & Service" chapter).

   — An erratic or widely varying value range may be caused by the joint's resolver.

- If a specific slave arm joint is malfunctioning, check its Position: value.

   — If slight movement of the master arm joint causes erratic slave arm movement and a large change in the slave arm joint's position value, the cause may be the joint's resolver.

— If movement of the master arm joint produces no change in the slave arm joint or its Position: value, the cause may be the slave controller board, resolver to slave controller wiring, or the joint's servo valve.

- If general movement of all master arm joints produces either erratic slave arm movement and Position: values for all joints ***or*** no slave arm movement and no change in Position: values for all joints, the cause may be the slave arm cabling/to the slave controller board.
- If general movement of all master arm joints produces sluggish slave arm movement and normal Position: value responses for all joints, the cause may be the solenoid valve, blockage of hydraulic supply/return lines, or inadequate hydraulic pressure.

4. For transient and intermittent slave arm malfunctions, unfreeze the slave arm and use the master arm to produce movement in all slave arm joints:

- Observe each pair of Command: and Position: values. Watch for unusual or abnormal jumps in values and lack of change in values that might allow you to isolate the cause to either a single joint (resolver, potentiometer, servo valve) or a more global malfunction (cabling, PC board, solenoid valve.

3 Diagnosing Key and Freeze Button Failures

The status of each key and the freeze button is shown in a specific character in the Keys: field at the bottom of the MASTER TEST screen (see Figure 1 on page 59). The status characters are:

- 1 **=** Key/button pressed
- 0 **=** Key/button not pressed

Each character represents a specific key or the freeze button as shown in Table 2.

Table 2

Key Identification	
Keys Field (from left)	**Function**
1	Function key 1
2	Function key 2
3	Function key 3
4	Function key 4
5	Up key
6	Left key
7	Left master arm freeze button (dual-arm systems **only**)
8	Master arm freeze button (std. and right in dual-arm systems)
9	Function key 5
10	Function key 6
11	Down key

12	Up key
13	Function key 8
14	Function key 7

When no keys or the freeze button are pressed, all characters in the Keys: field should show 0 status:

- Key/button failure = A “1” is present in the field (identify using Table 2.)
- Key/button failure = The number does not change when key/button is pressed (identify using Table 2.) If a key/button failure is confirmed, replace the faulty component.

4 Troubleshooting Tables

Since manipulator system components are interactive, the component that displays a fault (typically the slave arm) may not be the cause of it.

To isolate and correct the cause of a fault:

1. Go to the section for the component that displays the fault or symptom that alerts you to the problem.
2. Remedy the most likely cause first and continue until you have eliminated the fault.

The troubleshooting sections are organized as follows:

- section 4.1, “Screen-Displayed Symptoms,” on page 63
- section 4.2, “Master Arm Symptoms,” on page 65
- section 4.3, “Slave Arm Symptoms (Entire Arm),” on page 66
- section 4.4, “Slave Arm Symptoms (Individual Joints),” on page 67
- section 4.5, “Jaw Symptoms,” on page 68

Other sections explain how to diagnose and troubleshoot:

- System errors
  — section 4.6, “System Errors,” on page 69
- Fatal telemetry errors
  — section 4.7, “Fatal Telemetry Errors,” on page 71

4.1 Screen-Displayed Symptoms

The master controller display presents diagnostic data, warning, and error screens to help you diagnose symptoms, and alerts you to other abnormal conditions.

Use Table 3 to troubleshoot screen-displayed symptoms.

• Troubleshooting

Table 3

Screen-Displayed Symptoms		
Symptom	**Possible Cause**	**Remedy**
Master controller power is on, but the screen display is blank.	Transient electrical problem.	Turn master controller power switch off, then on.
	Loose connection to the faceplate assembly.	Secure connection.
	LCD display screen failure.	Replace display.
	Master processor PCB failure.	Replace board.
	Master controller display board failure.	Replace board.
Error flag appears on the screen.	(see "System Errors" section on page 69)	
Message Fatal telemetry error appears on the screen.	(see "Fatal Telemetry Errors" section on page 71)	
Pressing a key does not execute the appropriate function; master arm data screen confirms that key failure has occurred (see "Diagnosing Key and Freeze Button Failures" section on page 62).	Contaminated key switch contacts.	Clean key switch contacts.
	Master processor PCB failure.	Replace board.
	Keypad gasket failure.	Replace keypad gasket.
	Keypad switch board failure.	Replace board.
On MASTER TEST screen, position data for one joint changes even though the joint is not moving (also see "Diagnosis with the MASTER TEST Screen" section on page 59).	Master processor PCB failure.	Replace board.
	Master arm potentiometer failure.	Replace master arm.
On MASTER TEST screen, position data for multiple joints changes even though the joints are not moving (also see "Diagnosis with the MASTER TEST Screen" section on page 59).	Master processor PCB failure.	Replace board.
	Defective master arm.	Replace master arm.
On SLAVE TEST screen, position data for one or more joint changes even though the slave arm is frozen (also see"Diagnosis with the Slave Test Screen" section on page 60).	Loose resolver connection.	Secure connection.
	Resolver failure.	Replace resolver.
	Slave controller PC board failure.	Replace board.
On SLAVE TEST screen, position data for all joints changes even though the slave arm is frozen (also see"Diagnosis with the Slave Test Screen" section on page 60).	Slave controller PC board failure.	Replace board.

Screen-Displayed Symptoms		
Symptom	**Possible Cause**	**Remedy**
On SLAVE TEST screen, position data for one joint at its hard stop is not within range of the corresponding value in Table 1 on page 61 (also see Table 2.4, "Diagnosis with the Slave Test Screen," on page 60).	Mechanical interference with joint.	Inspect joint and remove debris.
	Loose resolver connection.	Secure connection.
	Resolver failure.	Replace resolver.
	Slave controller PC board failure.	Replace board.
On SLAVE TEST screen position data for multiple joints at their hard stops are not within ranges of the corresponding values in Table 1 on page 61 (also see Table 2.4, "Diagnosis with the Slave Test Screen," on page 60).	Slave controller analog board failure.	Replace board.
	Slave controller PC board failure.	Replace board.

4.2 Master Arm Symptoms

Use Table 4 to troubleshoot master arm problems.

- If the problem affects one or more master arm joints, see "Diagnosing Master/ Slave Joint Problems" section on page 58 to determine whether a master arm or slave joint is at fault.
- If you identified a joint problem using the MASTER TEST screen, also see "Screen-Displayed Symptoms" section on page 63 to isolate the fault.

Table 4

Master Arm Symptoms		
Symptom	**Possible Cause**	**Remedy**
Master arm freeze button works intermittently or not at all (also see "Diagnosing Key and Freeze Button Failures" section on page 62).	Master arm wiring failure or freeze button failure.	Replace master arm.
	Master processor PCB failure.	Replace board.
Wrist collar does not actuate slave arm wrist (also see"Diagnosis with the MASTER TEST Screen" section on page 59).	Master processor PCB failure.	Replace board.
	Wrist collar failure.	Replace master arm.
	Slave controller board failure.	Replace board.
	Slave arm wrist resolver failure.	Replace resolver.
	Slave arm wrist servo valve failure.	Replace servo valve.

Master Arm Symptoms		
Symptom	**Possible Cause**	**Remedy**
Pressing jaw bands/jaw switch does not actuate slave arm jaw (also see"Diagnosis with the MASTER TEST Screen" section on page 59).	Master processor PCB failure.	Replace board.
	Jaw band failure.	Replace master arm.
	Jaw switch failure.	Replace jaw switch.
	Slave controller board failure.	Replace board.
	Jaw LVDT failure.	Replace jaw LVDT assembly.
	Jaw servo valve failure.	Replace servo valve.

4.3 Slave Arm Symptoms (Entire Arm)

Use Table 5 to troubleshoot symptoms affecting all slave arm joints/functions. If not all joints are affected, see "Slave Arm Symptoms (Individual Joints)" section on page 67.

Table 5

Slave Arm Symptoms (Entire Arm)		
Symptom	**Possible Cause**	**Remedy**
Slave arm is unresponsive.	Loose connection in any cable section between master controller and slave arm.	Secure connection.
	Damaged cable in any section between master controller and slave arm.	Replace cable.
	Master arm or master controller board failure.	(see Table 3 on page 64)
	Slave controller PC board failure.	Replace board.
	Slave arm hydraulics solenoid valve failure.	Replace solenoid valve.
Slave arm is sluggish.	Low hydraulic pressure.	Repair hydraulic power unit.
		Replace slave arm hydraulic fluid filter.
		Clear clogged hydraulic lines.
		Repair solenoid valve.
	Master arm or master processor PCB failure.	(see Table 3 on page 64)
	Dynamics option set to SLOW.	Toggle to FAST.
Slave arm is receiving hydraulic power even though power is disabled; immediately turn off user's hydraulic power.	Slave arm hydraulics solenoid valve failure.	Replace solenoid valve.
	Slave controller PC board failure.	Replace board.

Slave Arm Symptoms (Entire Arm)		
Symptom	**Possible Cause**	**Remedy**
Slave arm is erratic (also see "Diagnosis with the Slave Test Screen" section on page 60).	Master arm or master processor PCB failure.	(see Table 3 on page 64)
	Damaged slave arm wiring harness.	Replace wiring harness.
	Slave controller PC board failure.	Replace board.

4.4 Slave Arm Symptoms (Individual Joints)

Use Table 6 to troubleshoot slave arm joint symptoms.

- Also see "Diagnosing Master/Slave Joint Problems" section on page 58 for some simple tests to determine causes.
- See "Master Arm Symptoms" section on page 65 and "Diagnosis with the MASTER TEST Screen" section on page 59 to determine whether a slave arm joint symptom is actually being caused by the master arm.
- If you have identified a joint problem using the SLAVE TEST screen ("Diagnosis with the Slave Test Screen" section on page 60), also see "Screen-Displayed Symptoms" section on page 63 to isolate the fault.
- For jaw problems, see "Jaw Symptoms" section on page 68.

Table 6

Slave Arm Symptoms (Individual Joints)		
Symptom	**Possible Cause**	**Remedy**
Joint leaks hydraulic fluid.	Actuator leak (from any slave arm actuator).	Replace actuator seals.
	Joint slip ring leak.	Replace slip ring seals.
One or more joints are hard over.	Servo valve failure.	Replace servo valve.
	Master arm problem.	Replace master arm.
	Slave controller board failure.	Replace board.
	Joint resolver failure.	Replace resolver.
One joint is unresponsive.	Slave controller PC board failure.	Replace board.
	Master arm joint potentiometer or master processor PCB problem.	Replace potentiometer or controller board.
	Servo valve failure.	Replace servo valve.
	Joint resolver failure.	Replace resolver.
	Joint is frozen in FREEZE menu.	Toggle to REIN.

Slave Arm Symptoms (Individual Joints)		
Symptom	**Possible Cause**	**Remedy**
One joint is erratic.	Slave controller PC board failure.	Replace board.
	Servo valve failure.	Replace servo valve.
	Contaminated hydraulic fluid.	Replace fluid.
	Joint resolver failure.	Replace resolver.
	Master arm problem.	Replace master arm.
One joint is sluggish.	Servo valve failure.	Replace servo valve.
	Low hydraulic pressure.	Repair hydraulic power unit.
		Replace slave arm hydraulic fluid filter.
		Clear clogged hydraulic lines.
	Slave controller PC board failure.	Replace board.
	Master arm problem.	Replace master arm.
Multiple joints unresponsive.	Slave controller PC board failure.	Replace board.
	Master processor PCB failure.	Replace board.
Shoulder moves freely when hydraulics are off.	Lock valve failure.	Replace lock valve.

4.5 Jaw Symptoms

Use Table 7 to troubleshoot jaw problems. Also see “Diagnosing Master/Slave Joint Problems” section on page 58.

Table 7

Jaw Symptoms		
Symptom	**Possible Cause**	**Remedy**
Jaw is erratic.	Slave controller PC board failure.	Replace board.
	Jaw servo valve failure.	Replace servo valve.
	Jaw LVDT* failure.	Replace LVDT.
Jaw is sluggish or unresponsive.	Jaw servo valve failure.	Replace servo valve.
	Slave controller PCB failure.	Replace board.
	Master processor PCB failure.	Replace board.
	Jaw LVDT failure.	Replace LVDT assembly.

* An LVDT is the jaw position sensor

4.6 System Errors

When an error is detected, the display may show a Startup with System Errors screen (at startup) or an ERR message (during operation).

1. Use the SHOW ERRORS menu (Figure 3) to identify the error.

```
SHOW ERRORS                 LOCK
--------------------------------
ERRORS:
 Master Range           Clr Errs <5

Warnings:
 Hydr OFF               Hydr OFF <6




                            EXIT <8
--------------------------------
```

Figure 3 *SHOW ERRORS menu*

2. Use Table 8 and Table 9 to troubleshoot system errors.
   — Table 8 describes the error.
   — Table 9 identifies possible causes and remedies.

Table 8

System Errors		
Error	**Error Name**	**Description**
01	Slave range	Feedback information from the slave arm indicates that the slave arm is outside of its factory set movement limits. This means that the system is reporting that the arm is in a position that it cannot actually attain.
02	Slave continuity	Feedback information from the slave arm indicates that the slave arm position is changing at a faster rate than is actually possible.
03	Slave control	Feedback information from the slave arm indicates too large a difference between command and actual position.
04	Slave telemetry	Indicates that communications from the master controller to the slave controller have been halted, interrupted, or fatally corrupted.
05	Slave CPU reset	Indicates that the slave controller has reset. This occurs if the slave controller loses power or the slave controller PC board fails.
06	Master range	Feedback information from the master arm indicates that the master arm is in a position that it cannot actually attain.
07	Master telemetry	Indicates that communications from the slave controller to the master controller have been halted, interrupted, or fatally corrupted.

Table 9

Error Causes & Remedies		
Listed Error	**Possible Cause**	**Remedy**
Slave range	Slave arm resolver failure.	Replace resolver.
	Loose resolver connection.	Secure connection.
	Slave controller PC board failure.	Replace board.
Slave continuity	Slave arm resolver failure.	Replace resolver.
	Loose resolver connection.	Secure connection.
	Slave controller PC board failure.	Replace board.
Slave control	During operations, pushing hard against an immovable object.	Cease activity.
	During operations, lifting too heavy an object.	Cease activity.
	Slave arm actuator failure.	Replace actuator.
	Slave controller PC board failure.	Replace board.
Slave telemetry	Slave controller PC board failure.	Replace board.
	Loose connection at any point between slave arm and master controller.	Secure connection.
	Damaged cable at any point between slave arm and master controller.	Replace cable.
	Connections to multiplexed long lines are inconsistent (see “Factory Assistance” section on page 74).	Match telemetry functions at both ends.
Master range	Master arm potentiometer failure.	Replace master arm.
	Master processor PCB failure.	Replace board.
Master telemetry	Loose connection at any point between the master controller and slave controller.	Secure connection.
	Master processor PCB failure.	Replace board.
	Connections to multiplexed long lines are inconsistent (see “Factory Assistance” section on page 74).	Match telemetry functions at both ends.
Slave CPU reset	Loose connection at any point between the slave controller and the user’s electrical power source.	Secure connection.
	Interruption of user’s electrical power.	Restore continuous power.
	Voltage outside of specified range, or noise in the supplied power.	Supply correct power.
	Damaged cable at any point between the slave controller and the user’s electrical power source.	Replace cable.
	Slave controller PC board failure.	Replace board.

4.6.1 Disabling Error Checking

All system errors disable the hydraulics. You can disable error checking for any of the system errors in order to keep the slave arm operational for emergencies and diagnostic testing (see "Enabling & Disabling System Error Checking" in the "Operation" chapter).

! Caution

1. An automatic shutdown due to a system error protects the slave arm and its surroundings from the risk of damage. Disabling error checking to resume operation indicates the operator's awareness and acceptance of increased risk.

2. The safety features that result from error-checking (such as automatically disabling hydraulics) will no longer be in effect.

3. The condition causing the error may result in limited or erratic operation of the slave arm.

4.7 Fatal Telemetry Errors

A fatal telemetry error occurs when communication between the master controller and slave controller cannot be enabled or is interrupted for more than several seconds. When this occurs, a fatal telemetry error message appears on the screen.

- A fatal telemetry error can appear at start up or during operation.
- If a fatal telemetry error occurs during operation, hydraulic power is disabled and the master controller command loop is idled.

To resume operation after a fatal telemetry error:

1. **Turn off** power to the master controller.
2. Diagnose and correct the problem that caused the error.
3. Restart the system.

Use Table 10 to troubleshoot fatal telemetry errors.

Table 10

Fatal Telemetry Errors	
Possible Cause	**Remed6y**
Faulty telemetry connection or cable at any point between the master controller and slave controller.	Secure connection / Replace cable.
Master controller opto or CPU board failure.	Replace board.
Slave controller PC board failure.	Replace board.

• Troubleshooting

5 Using the Status Indicator LEDs

5.1 Slave Controller PCB LEDs

Figure 4

The slave controller PCB has five diagnostic LEDs (Figure 14).

PWR Lit when 24 VDC is present. If not, confirm power source is on; check all cabling, connectors between source and PCB.

PROC Flashes when the slave controller PCB processor is active. If communications are normal, the LED flashes about once per second. Four to five flashes per second indicate the detection of an error. Go to the SHOW ERRORS menu and troubleshoot. If the LED does not light when the system is powered, replace the PCB.

VALVE Lit when slave arm hydraulics are enabled. If not, check cabling between the slave controller PCB and the solenoid (assumes power and telemetry are present).

TX Lit when slave controller is transmitting data. If not, confirm that the master controller is producing master arm position values/commands. Check all connections between master controller and slave controller, mux/demux configuration, and so on.

RX Lit when slave controller is receiving data. If not, confirm that the slave arm resolvers are returning position values. Check all connections between master controller and slave controller, mux/demux configuration, and so on.

5.2 Master Controller PCB Status LEDs

The master controller processor board has seven diagnostic LEDs (Figure 5).

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

5.2.1 Power

Pwr When the master processor is turned on, the “Pwr” (power) LED will illuminate and the program image will load according to the position of the hex switches.

Vref LF and RF LEDs Vref RF and Vref LF, adjacent to master arm connectors P4 and P5 (top of Figure 5), illuminate when the 4VDC reference is present. Failure of either LED to light could indicate a short circuit in the master arm (disconnect the master arm connector to check) or a failure of the A/D converter.

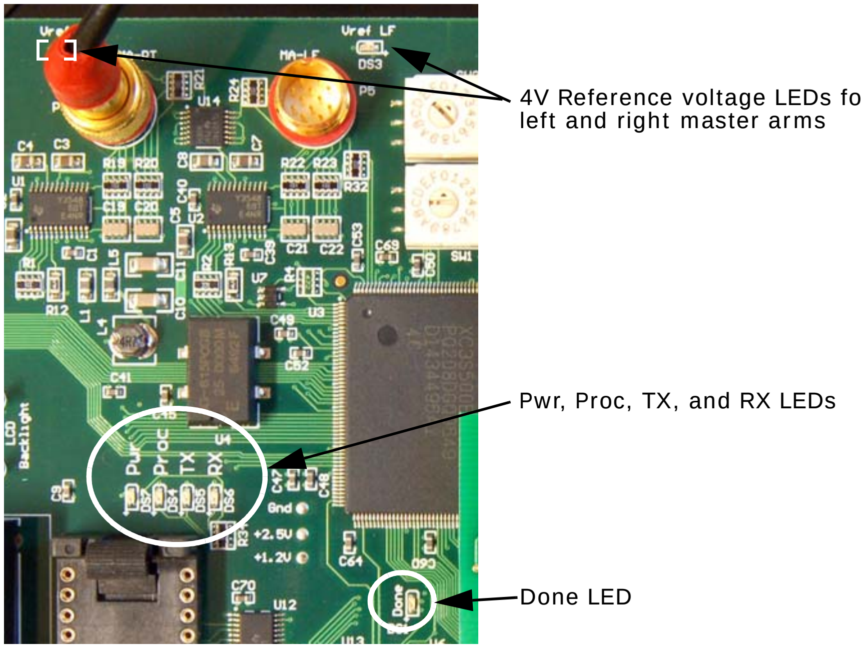


Figure 5

5.2.2 Communications

Done The “Done” LED lights when the program successfully loads. Observing the operation on the LCD while turning on power to the master controller, the LCD will indicate which image is being loaded (“Loading master.001” for example—additional LCD text will be dependent on the type of manipulator being operated).

Proc The “Proc” (processor) LED (“heartbeat”) will blink at 1 Hz to indicate the master processor is functioning correctly. If no software image is installed, the LED is continuously lit. If the LED does not illuminate, the board is either damaged or has not been programmed.

TX The TX LED will blink each time a packet is sent to the slave controller.

RX If a response is received from the slave controller, the RX LED will illuminate. Check all connections between master controller and slave controller, mux/demux configuration, and so on.

Associated LED's are present on the slave controller (see “Slave Controller PCB LEDs” section on page 72). Observing LED function between master processor and slave controller will often point to a problem with the system. Ensuring continuity between master and slave is the next step in troubleshooting communications problems. This is best performed by directly connecting the system using the supplied Junction Box and eliminating all external lines and equipment.

6 Master Controller Voltage Test Points

The first step in troubleshooting is to ensure that the correct voltages are present at all test points. There are test-points on the master processor board for -16V, +12V, +5V, +3.3V, +2.5V, +1.2V, and ground (Figure 6). The power LED should be illuminated whenever +5V is available to the board from the AC-DC or DC-DC converter.

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

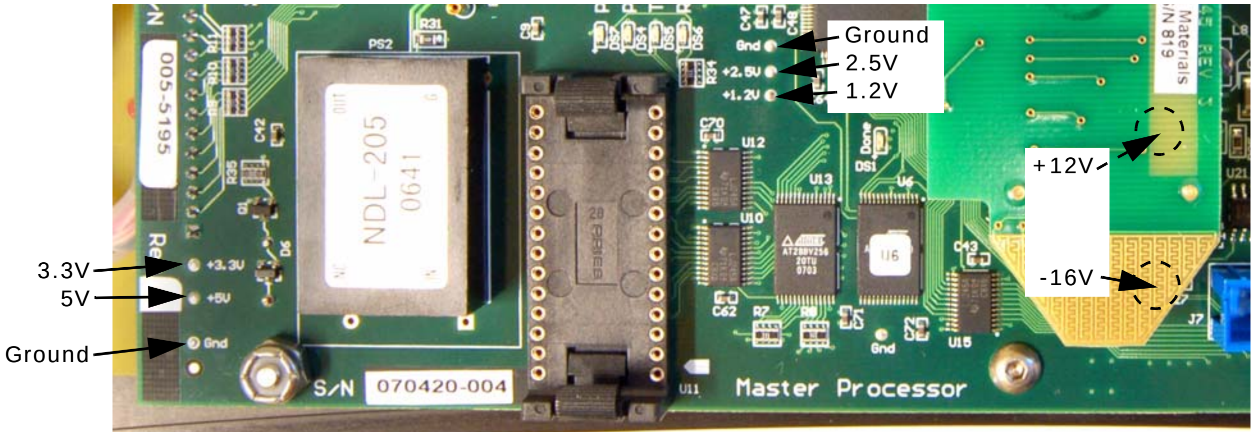


Figure 6 *Voltage and ground test points*

7 Factory Assistance

To help speed diagnosis and problem resolution, please have the following information available when you contact Customer Service.

1. What are the symptoms of the problem?
2. Is the problem intermittent or constant?
3. If the problem is intermittent, under what conditions does it occur?
4. Was the affected part of the manipulator system subjected to excessive loads or adverse conditions (such as vibration, heat, or shock)?
5. Did the problem occur suddenly or gradually?
6. Does the problem appear to affect other functions?
7. What system functions are still operable?
8. Has anyone tried to fix the problem? If so, what components have been installed. Were they swapped from a similar unit or from spares?
9. What is the system serial number? (You can find the serial number on the slave arm upper arm segment.) If the problem appears to be electrical or software-related, what is the part number of the master controller software shown on the startup screen, which starts with the numbers “014?”
10. Are there other relevant details?

Maintenance & Service

In This Chapter:

- 1 Safety First .... page 75
- 2 Service Guidelines .... page 77
- 3 Maintenance .... page 80
- 4 Junction Box Service .... page 82
- 5 Master Controller Service & Configuration .... page 82
- 6 Slave Arm Service .... page 89
- 7 System Adjustments & Configuration .... page 97
- 8 Service & Work Instructions .... page 100

NOTE: *Before starting any troubleshooting, maintenance, inspection, or service procedure, or deck operation, please read and apply the information provided in the "Safety First!" and "Service Guidelines" sections below.*

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.

2.3 Startup After Maintenance or Service

2.3.1 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.

2.3.2 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.

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 joint actuators, 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 can cause fasteners to loosen.
3. (Position-controlled models only) Loose or dirty electrical connectors.
   - Vibration and temperature cycles may cause electrical connectors to loosen. Retighten as needed. Clean and lubricate o-rings prior to mating.
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. Develop schedules of inspection, maintenance, and service that fit your slave arm's operating environment and duty cycles. Harsh service environments require more frequent intervals of attention.
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.
   — Besides confirming that all actions were performed, keeping a log can 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

Long Term Maintenance Schedule	
Period	**Task**
Every 100 operating hours	Tighten all external slave arm fasteners to the specified torque.
	Test a sample of the hydraulic fluid for water and particulates. Replace the fluid if it is contaminated.
Every 500 operating hours	Drain Azimuth return circuit.
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. Replace all slave arm o-rings and seals. Clean all o-ring grooves and surfaces.

3.3 Cable & Penetrator Maintenance

The following recommendations can help to get the best performance and longest life from the slave arm cables and penetrators, particularly after the initial installation.

3.3.1 Seanet Cables & Penetrators

- Do not connect or disconnect a SeaNet cable when electrical power is present. The power supply or penetrator ring traces can be damaged.
- Before connecting a SeaNet cable, remove any water/condensation from both the connector and SeaNet penetrator, and apply contact cleaner/lubricator to the traces.
- Apply a light coating of o-ring lubricant to the SeaNet penetrator and connector to make mating and demating easier.

- To prevent compensation leaks and/or water intrusion when a SeaNet connector or penetrator is disconnected or unused while submerged, seal the connector with plug 001-5959 and the penetrator with cap 101-5791 (figure, right).

  To minimize compensation leaks on deck, disconnect the compensators to eliminate circuit pressure.

! Caution

SeaNet connectors MUST BE PLUGGED and SeaNet penetrators MUST BE CAPPED if they will not be connected when submerged.

3.3.2 Proprietary Connectors & Penetrators

- Remove, clean, and inspect o-rings. Replace if damaged. Lightly lubricate the o-ring with Dow Corning 55, Dow Corning 111, or petroleum jelly, and install into the 0-ring groove.
- A cleaner and connector lubricant, such as Pro-Gold G5 (002-2402), is recommended for use on connector pins and sockets.

4 Junction Box Service

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

4.1 Fuse Replacement

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 remove the fuse for replacement or inspection.

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

5 Master Controller Service & Configuration

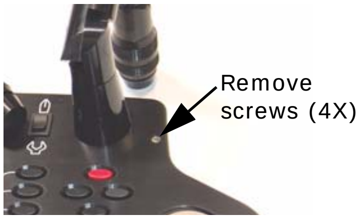
This section contains special maintenance, service, and configuration procedures not covered in the Work Instructions.

• 5.1 Accessing Internal Components .... page 82
• 5.2 Adjusting the LCD Screen Viewing Angle .... page 83
• 5.3 Changing the System Baud Rate .... page 83
• 5.4 Master Controller Software Selection .... page 84
• 5.5 Incompatibility Alert Screens .... page 86

5.1 Accessing Internal Components

5.1.1 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.

5.1.2 Installing the Faceplate

4. Carefully turn the faceplate over and seat it on the enclosure.

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

5. Reinstall the four mounting screws.

5.2 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:

1. **Before** changing the LCD screen angle, check the current angle:

a. Turn on power to the master controller under work environment conditions.

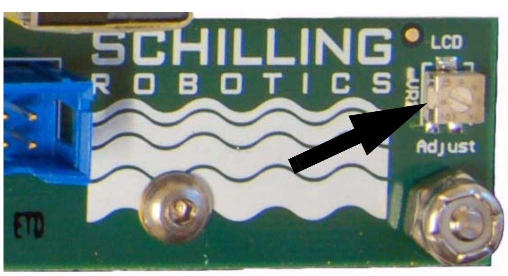
— The slave controller and slave arm need **do not** need to be powered up for this test.

b. Allow the master controller to reach its normal operating temperature (5-10 minutes). It is not unusual for the viewing angle to be unacceptable for the first few minutes of operation.

⚠ **WARNING**

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

2. While keeping power supplied to the master controller, open the assembly as described in "Removing the Faceplate" on page 82.



3. Locate the LCD adjustment potentiometer (labeled VR1 on the PC board), located at the bottom right of the board (Figure, right).

4. Using a small flat blade screwdriver, adjust the potentiometer for the desired viewing angle.

5. Close the master controller as described in "Installing the Faceplate" on page 83.

5.3 Changing the System Baud Rate

Default data transmission rates:

Single arm Titan 4 system . . . . 19200 baud
(Single arm systems can also be operated at 57600 baud and 115200 baud.)

Dual arm system . . . . 57600 baud
(Dual arm systems can also be operated at 115200 baud.)

At rates higher than the default, additional slave arm joint position data is added to each data packet for creating graphical simulations using third-party software.

Changing the system baud rate requires adjusting the settings of the two Mode switches on the master controller printed circuit board (PCB) and selecting the desired baud rate using the control keys and display.

The process is described below.

Set the PCB Mode Switches

1. Configure the master controller PCB Mode switches using steps 1 through 4 in section 5.4.1, “Selecting Pre-Loaded Software Images,” on page 85. Set the switches to: H = 0 and L = 8 (Titan 4, Enhanced)

Set Baud Rate

2. Hold down the lower left function key on the master controller. Turn on power. This opens the SERIAL PORT BAUD SETUP screen (Figure 1),

```
SERIAL PORT BAUD SETUP
--------------------------------

1> Change Baud Rate: 115200

2> Save to EEPROM



                     Continue <8
--------------------------------
```

Figure 1 *Master Controller baud rate setup screen*

3. Press the 1> Change Baud Rate key until the desired rate appears.
4. Press the 2> Save to EEPROM key to save the new setting.
5. Press the Continue <8 key to exit.
6. To enable the new baud rate, turn off power to the master controller, then turn it on. Next, turn on power to the slave arm (the slave arm PCB will auto-detect and adjust itself to the new baud setting).

   NOTE: *If this Titan 4 is used on an ROV system, the Node port to which it is connected must also be set to the same baud rate using the Config App (configuration application). See your ROV manual for details.*

5.4 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 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 and from a Secure Digital card using slot (J5). The three methods are described in the following sections.

! Caution

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

5.4.1 Selecting Pre-Loaded Software Images

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 82.

   The two hexadecimal Mode switches (H and L) are located at the top center of the processor board (Figure 2). The available software and the “H” and “L” switch settings are listed in the table.

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

Figure 2 *Hexadecimal switch orientation and software values*

3. 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.
4. Close the master controller as described in “Adjusting the LCD Screen Viewing Angle” on page 83 and reconn3ect the whip.
5. 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.)

5.4.2 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).

1. Open the master controller as described in “Removing the Faceplate” on page 82.

   The 28-pin connector is located at the lower left corner of the processor board (see Figure 3).

2. 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.

! Caution

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

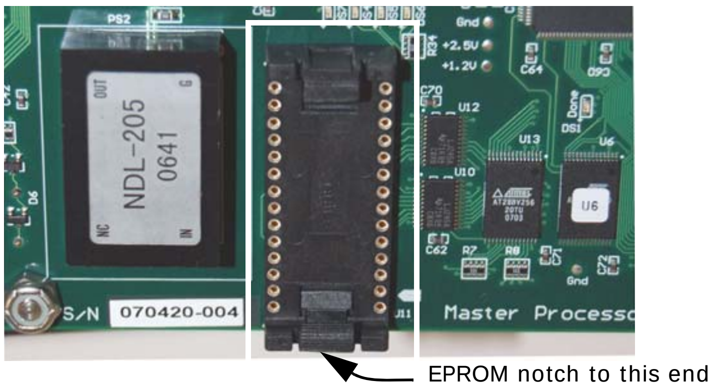


Figure 3 *EPROM 28-pin connector*

3. Set each hexadecimal switch to “F” (see Figure 2 on page 85 for an example of the hexadecimal switches and the EPROM switch settings).
4. Close the master controller as described in “Adjusting the LCD Screen Viewing Angle” on page 83.
5. 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.*

5.4.3 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.

5.5 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 Titan-configured master controller has been connected to an Orion slave controller/slave arm, etc.).

5.5.1 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 Titan software currently loaded, the alert screen in Figure 4 will be displayed.

```
     SCHILLING ROBOTICS, INC
    TITAN MANIPULATOR SYSTEM
--------------------------------
Non-volatile memory (EEPROM) is
not compatible with this ROM ver-
sion. Danger exists if the sys-
tem is operated without the
correct memory value.

3> Ignore         Update EEPROM  <7
                  Version # only

4> Overwrite EEPROM
--------------------------------
```

Figure 4 *"Non-volatile memory (EEPROM)..." warning screen*

You have three options.

a. Press the 4> Overwrite EEPROM button to install the default Titan 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.***

5.5.2 Incompatible Titan Slave Arms/Controllers

If the master controller is configured for “Titan 4, Titan 3, Titan 2” operation and connected to an incompatible Titan slave arm and slave controller, you may see the alert screen shown in Figure 5.

```
SCHILLING ROBOTICS, LLC
TITAN MANIPULATOR SYSTEM
--------------------------------
The Master Controller software
is not compatible with the
slave arm. Further operation
may risk damage to equipment.
Select [Yes] only if you would
like to proceed anyway.



4> Yes
--------------------------------
```

Figure 5 *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 5.4.2, “Installing an EPROM,” on page 85 of the “Maintenance & Service” chapter.

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.***

5.5.3 Incompatible ID Code

The system ID and user-configurable settings for the previous system remain in non-volatile memory even after the master controller has been configured with new software. If the detected ID is for a non-Titan system, the alert screen in Figure 6 will be displayed.

```
SCHILLING ROBOTICS, LLC
TITAN MANIPULATOR SYSTEM
--------------------------------
The ID Code indicates that
this Master Controller may
have been configured for a
non-Titan manipulator.
Select [Yes] only if you would
like to change ID Code to T4
and to overwrite saved values
for joint limits and stow.

4> Yes
--------------------------------
```

Figure 6 *Alert screen, with Titan 4 software detected (arrow)*

You have two options:

a. If the master controller software configuration and slave arm/slave controller match the suggested ID code change, press the 4> Yes key. This action will update the user-configurable memory with the factory default settings and ID code for the currently loaded software. ***Use extreme caution when testing the slave arm for safe and successful operation.***

b. If you do not want to lose the existing, non-Titan user-configurable settings, set the Mode switches for use with the non-Titan system.

5.5.4 Incompatible Titan Models

When the master controller software is configured for one Titan model (Titan 2, 3, or 4) and the ID code for a different model of Titan slave arm/slave controller is detected, the alert screen in Figure 7 will be displayed.

```
SCHILLING ROBOTICS, LLC
TITAN MANIPULATOR SYSTEM
--------------------------------
The ID Code indicates that
this Master Controller has been
used with a T(#) slave arm, but
now a T4 slave arm is detected.
Select [Yes] only if you would
like to change ID Code to T4
and continue operation.

4> Yes
--------------------------------
```

Figure 7 *Alert screen, with Titan 4 detected (arrow)*

You have two options:

a. Use the master controller with the Titan model for which the software is configured.

a. Press the 4> Yes key to change the ID code to match the detected slave arm. ***Use extreme caution when testing the slave arm for safe and successful operation.***

5.5.5 Non-Titan Systems

A master controller configured for Titan operation cannot communicate with a non-Titan Slave Arm and, if connected, will display a “Fatal Telemetry Error” screen at startup.

6 Slave Arm Service

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

- 6.1 Slave Arm Filter Replacement and Cleaning .... page 89
- 6.2 Emergency Manual Slave Arm Manipulation .... page 91
- 6.3 Recovery from Water Intrusion .... page 92

6.1 Slave Arm Filter Replacement and Cleaning

The slave arm supply filter is located in the upper arm (see Figure 8).

Filtration . . . . 10 microns (25 microns absolute)

Replacement filter part number:

P/N. 006-1517

OEM P/N. . . . . 411G-10VL (Norman Filter Co.)

NOTE: *To avoid frequent replacement or cleaning of this filter, the supply line to the slave arm should be filtered to 3 microns (10 microns absolute).*

Recommended Service

- Clean and inspect the filter when performance of all slave arm functions is reduced or sluggish, and/or when filter is accessible due to other service.
- Replace a damaged filter. Inspect the filter for damage if other components under repair show evidence of media contamination (media accumulation, abnormal wear, scoring, etc.).

Follow the steps below to clean or replace the hydraulic filter. Replace all o-rings that have been disturbed. See drawing 101-5977 for details.

1. Disconnect the compensator and drain the upper arm volume as needed to access the cover plate closest to the elbow on the topside of the upper arm (see Figure 8).
2. Disconnect the pressure and return lines. Open the return line to the atmosphere.
3. Remove the cover plate closest to the elbow on the topside of the upper arm.

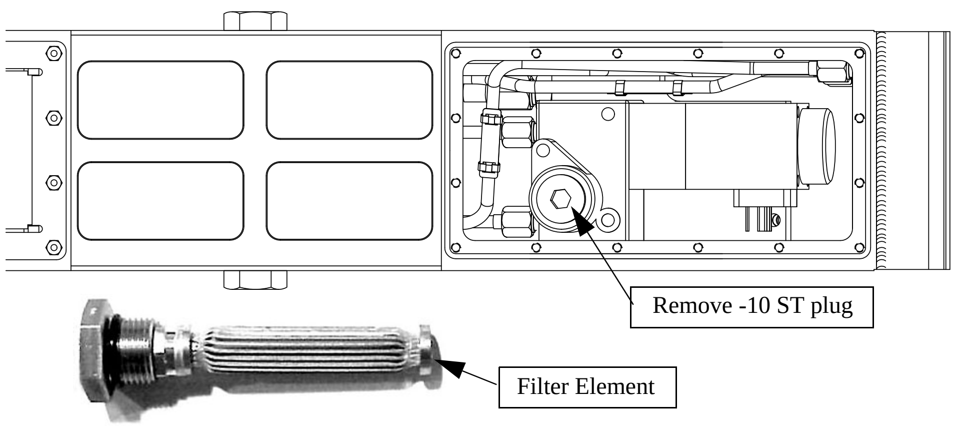


Figure 8 *Accessing the filter assembly*

4. Remove the -10 ST plug to access the filter (see Figure 8).
5. Clean or replace filter, as needed.
6. Reinstall the filter assembly (torque to 50 in-lb/5.7 Nm) and install the -10 ST plug (torque to 35 ft-lb/47.4 Nm).
7. Pressurize the supply line and check all filter connections for leaks.
8. Replace the upper arm cover.
9. Connect compensation. Charge and bleed the slave arm’s compensated volumes.

6.2 Emergency Manual Slave Arm Manipulation

Collision, hydraulic or electrical power failure, or component malfunction may leave a slave arm joint actuator frozen. Once the slave arm is on deck, a frozen azimuth, shoulder, or elbow actuator and the related joint can usually be manually moved by opening its bleed ports.

This is an **emergency procedure** for the following reasons:

- When a joint is manually moved, the actuator draws in air through one of its bleed ports, and forces hydraulic fluid out of the other port into the environment.
- The joint will lose all rigidity. For example, opening the shoulder bleed ports will cause the slave arm to drop suddenly.

WARNING

Opening the bleed ports will cause the affected joints to drop suddenly. Provide support for the joint to avoid injury to people or damage to equipment.

2. Wear safety goggles while working on or near the lave arm bleed ports. Pressure may be present in many slave arm components even with the HPU turned off. Opening the bleed ports will cause the release of hydraulic fluid, at varying pressures, into the environment.

There are two bleed ports each for the azimuth, shoulder, and elbow actuators and all are located on the forearm, just below the elbow. See the slave arm drawings for port locations.

Azimuth = Port 0	Shoulder = Port 1	Elbow = Port 2

To use the bleed functions, follow these steps:

1. **Turn off** the hydraulics and electrical power to the manipulator system.
2. Inspect the slave arm as outlined in “Daily Maintenance” section on page 80 and make any other repairs as needed.
3. Install supports to prevent the slave arm and joints from collapsing.
4. Remove the two bleed screws for the actuator you want to move.
5. Manually move the related joint.
   — Note that movement will cause the actuator to draw in air through one of the bleed ports and force hydraulic fluid out of the other port into the environment.
   — If you suspect that water has entered an actuator, manually move the affected joint back and forth to the full extent of its travel to force the water from the actuator cavities and journals. Inspect the fluid. If the water intrusion includes other slave arm components, see “Recovery from Water Intrusion” section on page 92.
6. Bleed the air and any residual water from the hydraulic system and reinstall the bleed port screws. Also see section 6.3, “Recovery from Water Intrusion,” on page 92.

6.3 Recovery from Water Intrusion

6.3.1 Water in Hydraulic Circuits

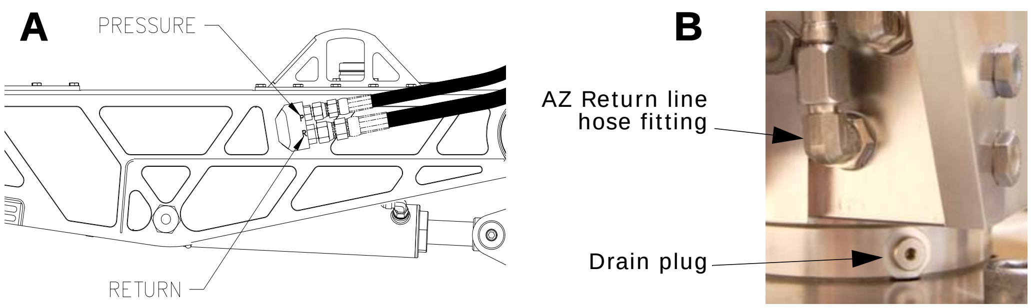


Figure 9 *Azimuth drain fitting (A) and slave arm return line (B)*

If water has entered the hydraulic circuits of the slave arm, most can be flushed by connecting the return line (Figure 9A) to a fluid storage container and operating the slave arm throughout its range of motion. Discard flushed fluid. Some water can also collect in the return circuit at the base of the azimuth actuator. This water can be flushed by removing the -2 drain plug located on the azimuth base and the return line hose connected to the azimuth (Figure 9B). Apply compressed air to the return port fitting to flush water out the drain port.

6.3.2 Water in Compensation Circuits

If you suspect that water has entered the Titan slave arm compensation system, or if “WATER*” appears in the top dashed line of the display (Titan 4 only), take quick action as described below to minimize damage.

This procedure applies to Titan 2, 3, and 4 Manipulator Systems.

1. Turn power off to the manipulator system as quickly as possible to minimize damage to electrical assemblies.
2. When the Titan slave arm can be serviced, turn off/lock out the hydraulic power. Place a receptacle to catch oil under the slave arm.
3. Remove all resolver covers, upper arm cover plates, forearm manifold cover, and wireway covers, shoulder pivot covers, azimuth lid.

   NOTE: *Do not disconnect any electrical connectors at this point.*

4. Fill a squirt bottle with alcohol and wash out the entire inside of the slave arm. Pay special attention to the difficult to clean areas under the resolvers.
5. The wrist requires some additional attention as it is not easy to reach the voids around the wrist and jaw resolver. By hand, position the wrist pointing down. Fill the wireway leading to the wrist with alcohol. Point the wrist back towards the azimuth to allow the alcohol to drain. Perform this step 2-3 times; more if the system was severely flooded.
6. Remove the drain screw on the upper arm (Figure 10, arrow) to drain the fluid that accumulates in the low points near the filter.

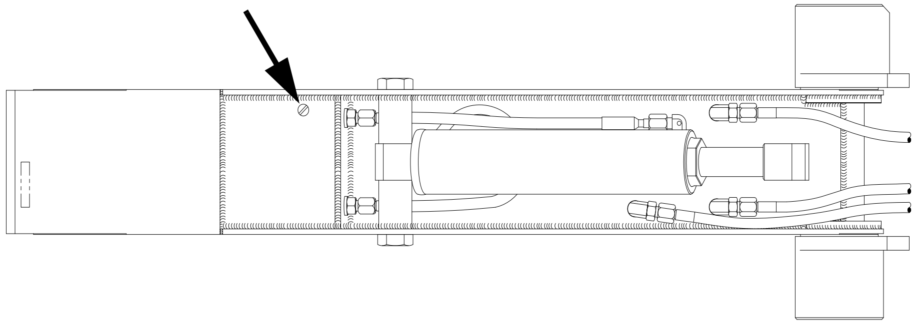


Figure 10 *Upper arm drain screw*

7. At the shoulder pivots, there will likely be grease on the bearings that was applied in the manufacturing process. Since this area will be filled with comp oil, it is not necessary to re-grease the bearings; the comp oil will act as the lubricant. Pay particular attention to rinsing the right side of the slave arm as this is where the shoulder resolver sits.

8. Wipe the entire inside of the slave arm as dry as possible with clean cloths or paper towels.

9. Disconnect each electrical connector (resolvers, servos, solenoid) and spray with Contact Cleaner. If the system was severely flooded, remove each connector backshell and spray with contact cleaner. The backshells have been filled with DC5 silicone grease at the factory as a water barrier. If the grease is removed in the cleaning process, it should be replaced. DC5 is a very stiff grease that does not wash away easily. DC4 or other silicone grease can be used if DC5 is not available, but will not be as effective.

10. When all electrical connections have been cleaned, put a small (pea sized) drop of DC5 in each connector interface. Slowly mate each connector to allow the grease to displace and create a water barrier.

11. (Titan 4 and Titan 3 with in-arm slave controller) Remove the back cover from the main circuit board. Clean the board with contact cleaner paying special attention to connectors. Carefully inspect the board for any corrosion damage. If any conformal coating has come off, re-spray the board with a Urethane protective coating (TechSpray UR or MIL-I-46058C, Type UR equivalent).

12. Perform an electrical test before replacing the cover plates. Turn on electrical power to the slave controller and master controller. When communications are established, go to the SLAVE TEST screen (Figure 11) (path: MAIN/DIAGNOSTICS/.

(Titan 4 and Titan 3 with in-arm slave controller) If you are unable to establish communications, replace the circuit board in the slave arm.

```
SLAVE TEST                    FRZ
---------------------------------

Command:     Position:

Azi: -0250   -0250
Sho: -0516   -0516
Elb: +0128   +0128
Yaw: +0231   +0230
Pit: -0057   -0057
Wrs: -0967   -0967
Jaw: -0064   -0064
                          EXIT <8
---------------------------------
```

Figure 11 *Titan SLAVE TEST screen*

13. The “Position” values should be stable (within 2 or 3 digits) while the arm is motionless. If any joint shows excessive noise (unstable values), disconnect and clean it's resolver connector again. Swap functions to ensure the noise is coming from the connector wiring and not the circuit board.

NOTE: *Resolvers are resistant to short-term contact with water and not usually a noise source unless corroded from long-term exposure to water.*

14. Move each slave arm function by hand and ensure that the values go up when the arm is moving right or up, and down when the arm is moved left or down.

15. When all functions report stable position values (less than 2-3 digit change) while the arm is motionless, enable hydraulic power and test all functions.

! Caution

Do not enable hydraulics to the slave arm if position values are not stable. Unstable values produce uncontrolled slave arm movements.

16. When all functions are confirmed, turn off the slave arm and replace all resolver covers, upper arm cover plates, forearm manifold cover, and wireway covers, shoulder pivot covers, azimuth lid, etc. Make sure all o-rings are in place; replace all damaged o-rings.

17. Charge and bleed the slave arm compensation system as described in the technical manual. The slave arm takes about 10 liters (2.5 gal) of comp oil, so make sure you completely fill the arm and remove all air.

18. Once the arm is filled and bled of air, operate it throughout it's range of motion and look for any errors. Before submerging the arm, bleed all high points again and top off the compensator.

6.4 Remove & Install Optional Camera

6.4.1 Remove

1. Remove the four wire cover screws, 002-0038P, from the camera assembly (Figure 12, A) and save for step 8.
2. Remove the four manifold plate screws (Figure 12, A). These screws will **not** be reused.

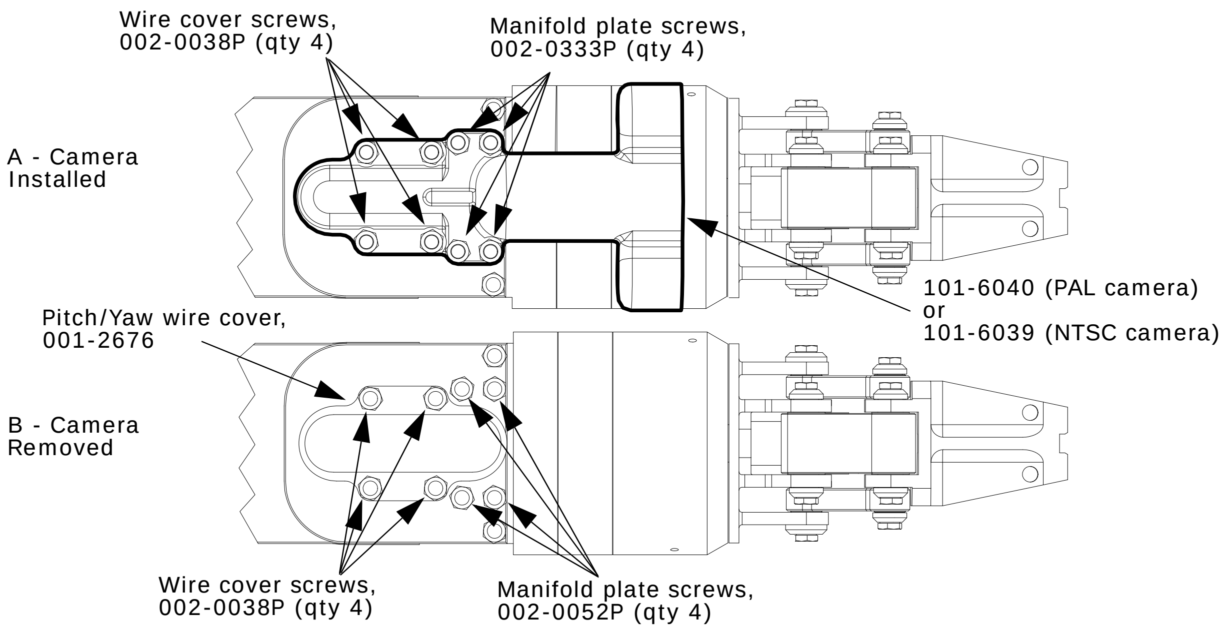


Figure 12

3. Cut off the shrink tubing from the coax cable connector and disconnect from the PCB camera board. See Figure 13.
4. Install a piece of heat shrink (005-1706) onto the coax cable connector to prevent a ground fault.
5. Disconnect the white harness cable connector from the PCB camera mount. See Figure 13.

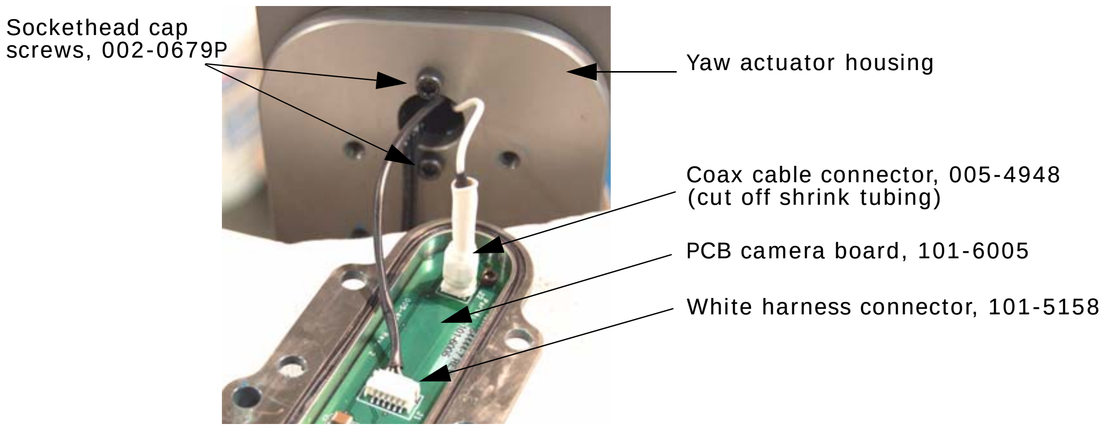


Figure 13

6. Tuck the coax cable and white harness cable into the yaw actuator housing for future camera installation.
7. Before installing the pitch/yaw wire cover (Figure 12, B):
   — Inspect the O-ring (004-0139) and replace if necessary.
   — Check the two sockethead cap screws, 002-0679P, (Figure 13) and confirm they are torqued to 7.3 Nm (65 lbf/in).

8. Secure the pitch/yaw wire cover with the four wire cover screws removed in step 3. Lubricated the bolts with AquaShield and torque to 28.5 Nm (21 lbf/ft). See Figure 12, B.
9. Re-install four new manifold plate screws (002-0052P) to the yaw actuator (Figure 12, B). Do not use old screws. Lubricated the bolts with AquaShield and torque to 28.5 Nm (21 lbf/ft).
10. The slave arm is ready for normal operation.

6.4.2 Install

1. Remove the four wire cover screws securing the top yaw wire cover and save. See Figure 14.
2. Remove the four manifold plate screws securing the manifold plate. These screws will **not** be reused for camera installation.

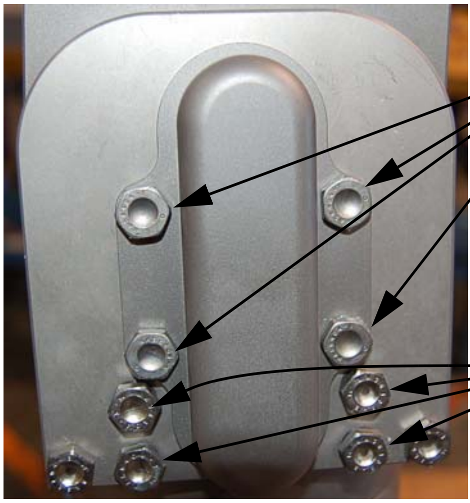


Figure 14 *Yaw wire cover plate and manifold plate screws*

NOTE: *Retain the original yaw wire cover, o-ring, and manifold screws for re-installation if the camera is removed.*

3. Apply o-ring lube and install o-ring, 004-0139, to the channel in the mounting face of the camera housing. See Figure 13.
4. Pull the coax cable and white harness cable out of the yaw actuator housing.
5. Install a piece of heat shrink (005-1706) onto the coax cable.
6. Connect the white harness connector and coax cable connector to the connectors in the camera housing as shown in Figure 13. Heat-shrink the tubing over the coax connectors.
7. Before securing the camera to the yaw plate, check that the two sockethead cap screws (Figure 13) are torqued to 7.3 Nm (65 lbf/in).
8. Install the camera to the yaw actuator housing using the four wire cover screws removed in step 1. Lubricate the bolts with AquaShield and torque to 28.5 Nm (21 lbf/ft).
9. Using four new manifold plate screws (002-0333P), secure the manifold to the yaw actuator housing. Lubricate the bolts with AquaShield and torque to 28.5 Nm (21 lbf/ft).

NOTE: *Be sure all wires and coax are clear of mating faces before you tighten the bolts.*

7 System Adjustments & Configuration

- 7.1 Setting Servo Valve Voltage Offsets .... page 97
- 7.2 Changing the Communication Protocol .... page 98
- 7.3 Changing the System Baud Rate .... page 100

7.1 Setting Servo Valve Voltage Offsets

Servo valves control the hydraulics to the actuators in your salve arm. Individual servo valves vary slightly in their response to a given voltage and work environment. You may need to set voltage offsets so that voltage sent to the servo valves provides the proper slave arm action.

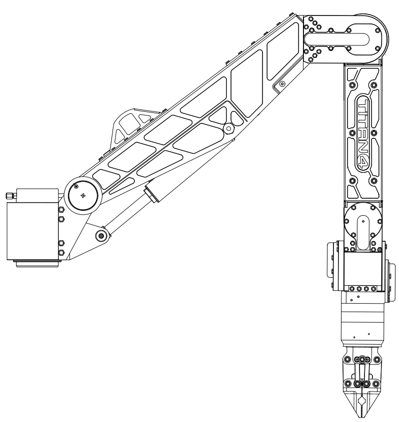
- Correct adjustment keeps the actuators without lock valves (all except the shoulder) immobile when the servo valve is inactive (no control input pending) and reduces sag and/or drift when hydraulics are disabled.
- Once voltage offsets have been set, you should not need to change the offsets.
- If you replace a servo valve, you will need to reset the voltage offsets.

The key 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.
- Small movements of a joint at the moment when the slave arm is frozen and unfrozen.

To set the servo valve voltage offset:

1. Start up the manipulator system.
2. Enable slave arm hydraulics.
3. From the MAIN menu, select 3>OPERATE. Set jaw and wrist to POS mode.
4. Adjust the slave arm to the position shown in Figure 15, left.



```
SET SV OFFSET                    FRZ
--------------------------------
OFFSETS:
  Azi: +0000                  Set <5
  Sho: +0000
  Elb: +0000
  Pit: +0000                Clear <6
  Yaw: +0000
  Wrs: +0000
  Jaw: +0000


                             EXIT <8
--------------------------------
```

Figure 15 *SET SERVO OFFSET screen*

5. Press EXIT<8.
6. From the MAIN menu, select SETUP<5, then select SET SV OFFSET<7 (Figure 15, right).

! Caution

Clear slave arm range of motion of personnel and equipment. Pressing SET<5 or CLEAR<6 on the SET SV OFFSET menu may cause slave arm joints to move a small amount. Be prepared to immediately disable slave arm hydraulics (UP key) if there are greater movements.

7. Press CLEAR<6 to reset all servo valve offsets to zero.
   - The numbers next to each joint should change to zero.
   - Be prepared for the slave arm to move slightly.
8. Press SET<5. The proper servo valve offsets will be calculated for your slave arm.
   - Be prepared for the slave arm to move slightly.
9. Press SET<5. Joint movement of one or two degrees is acceptable. Wait 5-10 second before moving to the next step.

   NOTE: *If one or more joints moves more than one or two degrees, contact the* Customer Service *department.*

10. To exit, press EXIT<8.

The servo valve offset values are automatically saved for your next slave arm use.

7.2 Changing the Communication Protocol

Two communications protocols are available on the Titan 4 Manipulator System:

- RS-232 (factory default)
- RS-485 half duplex

NOTE: *RS-485 full-duplex telemetry (4-wire) is not supported in this system.*

The telemetry protocol is set in two places:

- Forearm: See “Configuring the Forearm Protocol Connection” below.
- Master controller processor board: See “Configuring the Master Processor Board” section on page 99.

7.2.1 Configuring the Forearm Protocol Connection

Telemetry protocol is configured in the forearm and on the master controller processor board. The protocol default is set to RS-232 at the factory. To change the protocol to RS-485, complete the forearm harness configuration as described below.

1. Access the slave controller board in the forearm by loosening the six HHCS and removing the forearm cover (drain slave arm compensation if already filled).
2. Connect the lead for the desired system protocol (RS-232 or RS-485) to the harness connector in the forearm (see Figure 16).

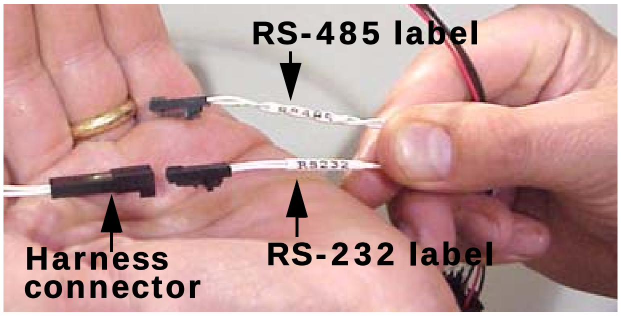


Figure 16 *Configuring protocol, part 1 (forearm)*

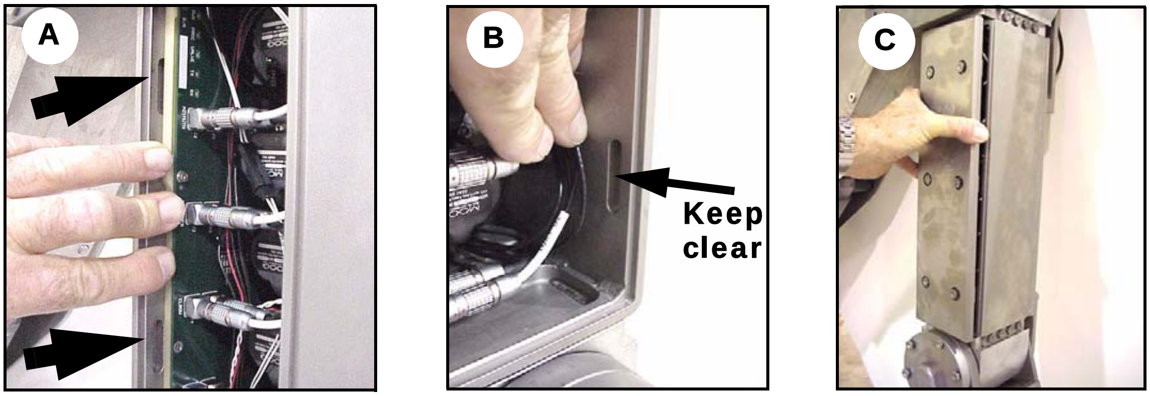


Figure 17 *Seating forearm PC board*

3. Fully seat the PC board to the rear of the forearm cavity until center cover slot is exposed and upper/lower cover slots are half exposed (Figure 17A, arrows).
4. Form all loose cables in forearm to the rear of the forearm cavity and away from the cover slots (Figure 17B).
5. (Assumes the forearm is hanging vertically, as shown) Fit the cover plate tabs to the slots in the left side of the forearm cavity (the upper and lower tabs must flex the strip at the edge of the PCB in order to seat in the slots) (Figure 17C). Then mate the cover to the right side. Make sure the o-ring remains in place and no cables or wires are caught between the cover and forearm.
6. Loosely install the cover HHCS. Do not tighten at this time.

7.2.2 Configuring the Master Processor Board

RS-232 protocol is set as the factory default. To change to RS-485:

1. Open the master controller as described in "Removing the Faceplate" section on page 82.

   The "P1A" connector for RS-232 communications (Default) and "P1B" for RS-485 communications are located at the upper right side of the processor board. In Figure 18 below, the J1 connector terminating the power/telemetry bundle is connected to P1A (RS-232).

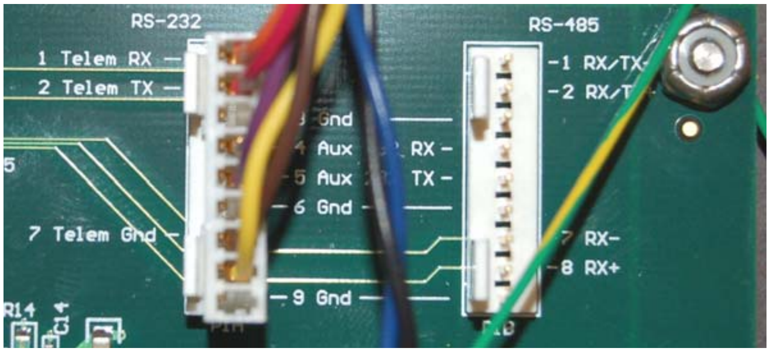


Figure 18 *RS-232 / RS-485 connection points*

2. To relocate the J1 connector, grasp the connector with needle-nosed pliers, pull it straight out of the P1A plug, and carefully reinstall it into the P1B plug.
3. Verify that the protocol selected on the forearm harness connection and the master processor board are the same (RS-232 or RS-485).
4. 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.
5. Do not install the four cover mounting screws at this time.

7.2.3 Final Steps

1. Before closing up the master controller and forearm, connect all manipulator system components and test 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 the following:

   a. Protocol setting for the master processor board and forearm are the same.

   b. Connections to multiplexed long lines are consistent, end to end, for slave>master/ master>slave or RS-485/RS-232 communications.

   c. Manipulator system operates correctly when connected for deck-testing (long lines bypassed).
2. Install the four mounting screws securing master controller faceplate.
3. Torque the forearm cover HHCS to 28.5 Nm (21 ft/lbs).
4. Charge and bleed the slave arm compensation system (see the “Installation” chapter for details).

7.3 Changing the System Baud Rate

See section 5.3, “Changing the System Baud Rate,” on page 83.

8 Service & Work Instructions

See the following page.

8.1 Index

- 2.2-Liter Compensator Diaphragm: Remove & Install.......... page 102
- 2.2-Liter Compensator Oil-Side Housing: Remove & Install.. page 104
- Linear Actuator, 101-2354 .... page 105
- Wrist Actuator, 101-6789 .... page 107
- Pitch-Yaw Actuator, 101-4821 .... page 114
- Pitch/Yaw, 101-4182 .... page 120
- Elbow Actuator, 101-4077 .... page 122
- Forearm, 101-5723 .... page 127
- Upper Arm, 101-5977 .... page 129
- Azimuth Actuator, 101-4042 .... page 133
- Slave Arm, 101-5976 (also used for 101-6790, -6792) .... page 138

8.2 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.

8.3 Startup Following Maintenance or Service

Startup After Minor Maintenance or Service

1. Follow steps in the “Pre-Start Checks” and “Startup” sections of the “Operation” chapter.
2. 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.

! Caution

Leave covers open after servicing the slave arm and inspect for internal leaks *before* installing the cover plates.

SERVICE INSTRUCTION

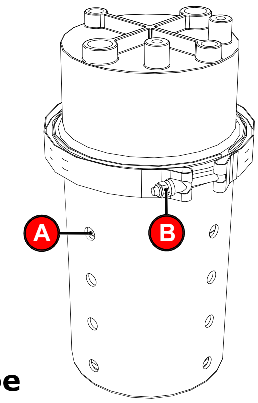
2.2-LITER COMPENSATOR DIAPHRAGM

REMOVE AND INSTALL (NON-UCM COMPENSATOR)

! Warning

Do not loosen or remove the central housing clamp unless the spring and piston have been restrained as directed in a service instruction. Uncontrolled release of the spring can cause serious personal injury and damage to surrounding equipment.

REMOVE

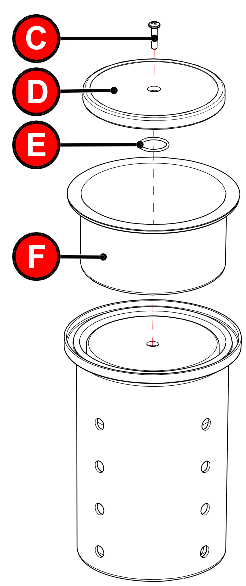


1. Remove and drain the compensator (see the 2.2L Compensator: Remove, Install, Dry-test, Fill instruction). Thoroughly wash out the water-side housing to remove all internal debris.
2. Restrain the piston and spring by inserting a 12mm (0.5-in.) diameter bolt or pin through both sides of the water-side **housing and piston skirt holes (A)**. Secure in place with tape or a nut.

Caution!

If threaded bolts are used to restrain the piston and spring, tape the threads to prevent damage to the plastic coating on the spring. If the plastic coating is damaged, the spring can corrode and fail.

3. Mark the orientation of the housings and housing clamp with a felt pen so they can be replaced in the same positions.
4. Slowly loosen and remove the **housing clamp (B)** without distorting its shape by opening it too wide. (It is normal for spring pressure to separate the oil and water-side housing flanges by 2-3 mm/0.062-0.125-in. when the housing clamp is removed.) Separate the oil and water-side housings.



NOTE: Press and hold the bleed while pulling the oil-side housing to ease removal.

5. Remove the M6 x 25 **sealing screw (C)** and separate the **diaphragm guide (D)**, **o-ring (E), and diaphragm (F)** from the piston.
6. Remove and discard the damaged diaphragm.
7. Thoroughly clean all components.

INSTALL NEW DIAPHRAGM

1. Install the replacement diaphragm, seating the D-profile lip into the flange of the water-side housing (with the flat side facing out). Form and smooth the diaphragm over the piston.

2. Apply o-ring lubricant to the mating surfaces of the sealing screw and diaphragm guide o-ring 004-0015. Install the diaphragm guide and o-ring to the diaphragm and piston.

3. Install the M6 x 25 sealing screw. *[3.4 Nm / 35 lbf-in]*

4. Install the oil-side housing to the water-side housing, aligning marks and making sure that the D-profile bead on the diaphragm remains seated in the flange of the water-side housing.

5. Apply DC-55 o-ring lube to the inner faces of the clamp and the outer flanges of the housings that contact the clamp.

6. Use clamps or the assistance of another person to press the housings together. Make sure the oil-side housing is seated within the perimeter of the water-side flange. Install the housing clamp to the position marked with the felt pen.

NOTE: To help the clamp seat fully and draw the housings together, tap lightly around its perimeter with a rubber mallet while tightening the clamp nut.
[Housing clamp; 7.3 Nm / 65 lbf-in]

7. Inspect the assembly and confirm that the:

- Oil-side housing is seated within the water-side flange.
- Housing clamp is fully and correctly seated.
- Clamp torque is correct.

8. Remove the bolt or pin securing the piston in the compensator.

SERVICE INSTRUCTION

2.2-LITER COMPENSATOR OIL-SIDE HOUSING

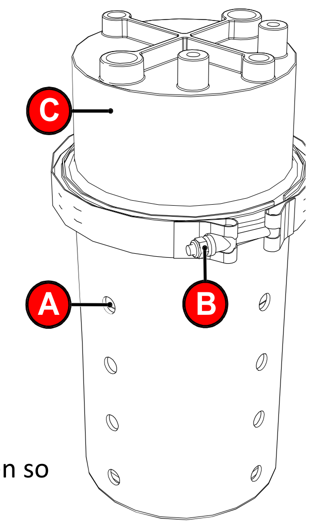
REMOVE AND INSTALL

WARNING

Do not loosen or remove the central housing clamp until the spring is restrained as directed. Uncontrolled release of the compensator spring can cause serious personal injury and damage to surrounding equipment.

REMOVE

1. Remove and drain the compensator (see the 2.2L Compensator: Remove, Install, Dry-test, Fill instruction). Thoroughly wash out the water-side housing to remove all internal debris.
2. Remove all fittings from the oil-side housing, noting their locations.
3. Restrain the piston and spring by inserting a 12mm (0.5-in.) diameter bolt or pin through both sides of the water-side **housing and piston skirt holes (A)**. Secure in place with tape or a nut.



! Caution

If threaded bolts are used to restrain the piston and spring, tape the threads to prevent damage to the plastic coating on the spring. If the plastic coating is damaged, the spring can corrode and fail.

4. Mark the orientation of the water-side housing and housing clamp with a felt pen so they can be replaced in the same positions.
5. Slowly loosen and remove the **housing clamp (B)** without distorting its shape by opening it too wide (It is normal for spring pressure to separate the oil and water-side housing flanges by 2-3 mm/0.062-0.125-in. when the housing clamp is removed.) Separate the oil and water-side housings.
6. Remove and discard the **oil-side housing (C)**.

INSTALL

1. Inspect and clean the diaphragm. Replace as needed.
2. Install the replacement oil-side housing diaphragm, making sure that the D-profile bead on the diaphragm remains fully seated in the flange of the water-side housing.
3. Apply DC-55 o-ring lube to the inner faces of the clamp and the outer flanges of the housings that contact the clamp.
4. Use clamps or the assistance of another person to press the housings together. Make sure the oil-side housing is seated within the perimeter of the water-side flange. Install the housing clamp to the position marked with the felt pen.

Work Instructions

Assembly Number: 101-2354 Description: Linear Actuator
Product Family: T3

Materials Required:

Adhesives:

Loctite® 7649 Primer (002-0291) Loctite® 271 (002-0795)

Chemicals:

DC55 O-ring Lube (002-0359) EP Grease (002-3051)

Tools:

010-0184 010-0185 010-0203 010-1457 010-0759

Initial Preparation:

Serialization:

Serialize the linear actuator body, with metal hand stamp, as shown on the assembly drawing, using the last six digits of the job number, add the designation –1, -2, -3 etc. for jobs consisting of more than one assembly. In second location stamp the assembly number and BOM revision letter. (i.e. 101-2354 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 no parts are missing. 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. Apply primer (23) to the outside surface of the bearing (6) and to the inside of the bearing bore in actuator housing (13). Apply Loctite (21) to the outside surface of the bearing (6) and install into (13) using tool (28).

[ ]2. Install the rod bearings 2x(10) into the shallow, wide grooves in the nose gland (4).

[ ]3. Lubricate the seals 2x(11) and (12) with DC55 and install into the grooves of the nose gland (4) as shown on the assembly drawing.

[ ]4. Lubricate the o-ring (9) with DC55 and install into the groove on the outside diameter of the nose gland (4), being careful not to twist the o-ring.

[ ]5. Install a piston bearing (7) into the shallow, wide groove on the non-threaded side of the piston (1). Lubricate the inner and middle rings of the piston seal (8) with DC55. Slide tool (25) over the piston (1) and bearing (7) and install the inner and middle rings of the piston seal (8). Remove installed piston bearing (7) and slide tool (26) over the installed inner and middle rings of piston seal (8) to resize the seal. Install piston bearings 2x(7) into the shallow, wide grooves of the piston (1). Again, slide tool (25) over the piston (1) and bearing (7). Lubricate the outer ring of seal (8) with DC55 and install into the groove of the middle ring of seal (8), being careful not to twist the outer ring.

[ ]6. Q.C. Point 1. Verify that bearings (6), 2x(7), 2x(10), o-ring (9) and the seals (8), 2x(11), and (12) have been correctly installed. Also ensure that the outer ring of piston seal (8) and the external nose gland o-ring (9) are not twisted. Record findings on data sheet.

[ ]7. Screw tool (27) into one end of the shaft (2) and lubricate the shaft and tool with EP grease. Carefully slide the tool and shaft (2) through the nose gland (4) to install nose gland (4) onto shaft (2). Unscrew and remove the tool.

[ ]8. Apply primer (23) to the threads of the shaft (2), rod end (3), and piston (1). Apply Loctite (21) to the threads of the rod end (3) and piston (1). Thread piston (1) on the end of the shaft where the tapered end of the nose gland (4) is pointing. Thread the rod end (3) on the opposite end of the shaft. Place the rod end (3) in a vise and use a 1/2-inch drive to torque the piston/shaft/rod end unit as specified on the assembly drawing. ***** In-Process Q.C. Point***

[ ]9. Apply EP grease to the inner surfaces of the body (13) and to the bearings 2x(7) on the piston (1).

[ ]10. Carefully slide the piston (1) into the bore of the actuator body (13) until it is about halfway down the bore.

[ ]11. Slide the nose gland (4) down the piston rod and thread it into the end of the actuator body (13). Torque the nose nut (4) per assembly drawing specification using tool (29).

[ ]12. Apply EP grease to the threads of the JIC fittings 2x(15) and install into the threaded ports of the body (13). Orient the fittings as shown in the assembly drawing. Torque fittings 2x(15) per assembly drawing specification.

[ ]13. Q.C. point 2. Verify the nose gland (4) is properly torqued and the fittings (15) are installed and oriented properly. Record findings on data sheet.

[ ]14. TEST 1. Use a rubber tipped air nozzle to pressurize the actuator through the fitting closest to the nose gland. Check to see that there is no leakage through the opposite fitting by actuating actuator in both directions. Record your findings on the data sheet. Cap the ends of the fittings.

Work Instructions

Assembly Number: 101-6789 Description: Wrist Actuator, T4
Product Family: T4

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:

010-0185	010-0184	010-0194	010-0220	010-0236
010-0474	010-0523	010-0577	010-0989	

Initial Preparation:

Serialization:

Serialize the wrist base (1), as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last six digits of the job number for the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-6789 X XXXXXX-X). Record the serial number of each assembly at the top of its individual data sheet.

In addition, record the serial number of the resolver/LVDT subassembly in the space 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 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.

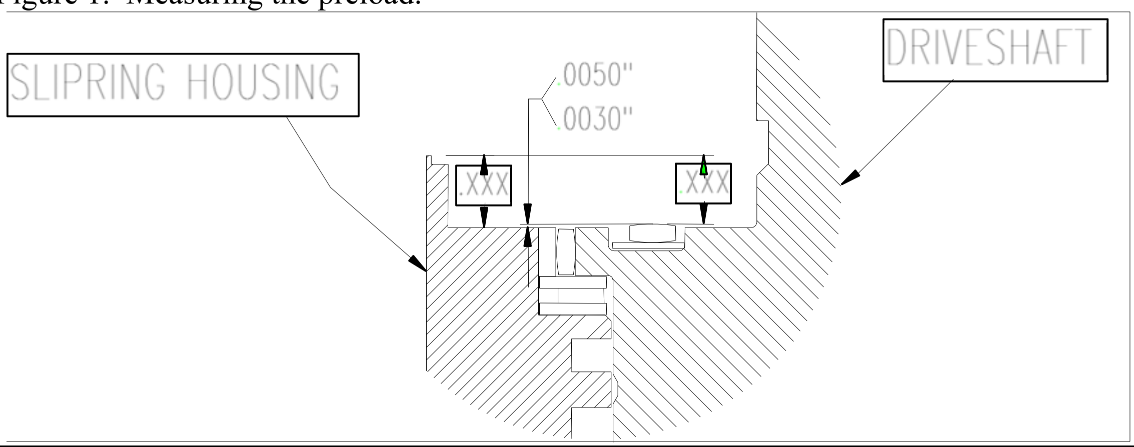
> Follow all standard Shop Practices during assembly process. If unsure of what the practices are, see the Manufacturing Supervisor.

[ ]1. Set the pre-load on the thrust bearing. Thoroughly degrease all parts: the housing (8), the drive shaft (7), the two bearing races (thrust washers) (40), the bearing race (thrust washer) (38), and the two thrust bearings (37) and (39). Place one of the bearing races (thrust washers) (40) and one of the thrust bearings (39) into the housing (8). Place another bearing race (40) on top of the thrust bearing (39). Carefully install the drive shaft (7) into the housing. Install the bearing race (thrust washer) (38) and the thrust bearing (37) into the groove on the drive shaft. Take the unit to the arbor press and, while supporting the slip ring housing only, (and allowing the drive shaft to protrude slightly from other side of housing), lightly load the drive shaft into the housing to make sure it is fully seated while you

measure the preload. Use a depth micrometer to measure the distance between the edge of the housing to the top of a single roller bearing. Then measure from the edge of the housing to the bottom of the counterbore area (see Figure 1). The top of any single roller should be between 0.0030 inch/. 076mm and 0.0050 inch / .127mm above the counterbore area of the housing. If the measurement does not fall between these values, note the variance and select the proper shims (see below) in order to achieve the correct preload. Add .003-.005 inch shim to your measured difference for correct preload. Disassemble all parts and set them aside. Record the shims required and bearing pre-load on the data sheet.

Shim P/N	Thickness
001-2202	.002"
001-2203	.003"
001-2204	.005"

Figure 1. Measuring the preload.



[ ]2. Q.C. Point 1. Verify that the bearing preload has been set correctly.

[ ]3. Install two of the Cv plugs (64) per SRS specification 130-0098 into the face of the drive shaft (7) using tool 010-0523 (171).

[ ]4. Install the remaining five Cv plugs (64) per SRS specification 130-0098 into the outside diameter of the wrist housing (8) using tool 010-0523 (171).

[ ]5. Use tool #010-0236 to press the bearing (36) (with the printed edge visible) into the centerbore of the wrist manifold (4) until it seats on the bottom of the counterbore. Lubricate bearing with Valvoline EP grease.

[ ]6. Use Loctite® 271 to secure the LVDT core support (21) and the LVDT core (69) together. Then thread the LVDT core support/core unit into the plunger (20).

[ ]7. Install the two spirol pins (83) using tool number 010-0989, one each into the wrist manifold (4) and the driveshaft (7) as shown on the assembly drawing. Carefully get the pin started in the hole, use the resolver (68) to hand press the pin into item (4) & (7). You must use this technique or you risk pressing the pin too far in the hole.

Assembly:

[ ]1. Install the four o-rings from the roto-glyd rings (60) into the four grooves of the slip ring housing (8) and then install the roto-glyd rings. Use tool #010-0220 to resize the seals.

[ ]2. Install the o-ring (71) onto the LVDT liner (24).

[ ]3. Install one of the o-rings (45) and the o-rings (47), (48), and (49) into the grooves on the valve plate (6).

[ ]4. Install the o-ring (43) into the groove on the cover (2).

[ ]5. Use tool #010-0194 to install the five small o-rings (52) into the grooves on the ends of the five bolts (5).

[ ]6. Install the o-ring (10-8) onto the groove in the nose block (10-1).

[ ]7. Install the rod bearing (10-4) into the center groove of the bore in the nose block (10-1). Then install the seals (10-3) into the outer grooves of the bore as shown on the assembly drawing.

[ ]8. Install the o-ring (10-6) into the narrow groove of the jaw piston (10-2).

[ ]9. Install the eight crush washers (63) onto the five SHCS (5) and three SHCS (33).

[ ]10. Install the five SHCS (5) through the holes in the manifold (4), as shown on the assembly drawing (the holes correspond to the pin plug holes on the outside of the wrist housing (8)). Install the three SHCS (33) into the vacant holes.

[ ]11. Install the eight bushings (73) onto the SHCS (5) and (33) as shown on the assembly drawing. Install the eight o-rings (50) onto the SHCS (5) and (33).

[ ]12. Install the seven o-rings (79) and the remaining o-ring (45) onto the wrist manifold (4) as shown on the assembly drawing.

[ ]13. Retrieve the slip ring housing (8) and remove the resize tool. Lightly lubricate the thrust bearing (39) with Valvoline® Val-plex EP® grease. Install one of the thrust washers (40), the thrust bearing (39) and then the remaining thrust washer (40) into the slipring housing (8) as shown on the assembly drawing.

[ ]14. Install the bearing race (26) into the slipring housing. (With a rubber mallet if necessary.) Using EP grease as an adhesive install the 119 needle rollers (41) into the race (26).

[ ]15. Install the shims (80),(81) and (82) if necessary, and then the thrust washer (38) onto the driveshaft (7) as shown on the assembly drawing. Lubricate the thrust bearing (37) with EP grease and install it onto the thrust washer (38).

[ ]16. Install the seal (62) onto the driveshaft (7) as shown on the assembly drawing.

[ ]17. Q.C. Point 2. Check that the pin plugs (64) and the spirol pins (83) have been installed. Check that the core (69), the core support (21) and the plunger (20) are

assembled together. Check the installation of the o-rings (10-6),(43),(45),(47),(48),(49),(50),(52),(10-8),(71) and (79). Check the installation of, the seals (10-3),(60),(62), the bearings (36),(37),(39),(41),(10-4), the bearing races (26),(38),(40), the crush washers (63) and the bushings (73). Check the installation and orientation of the SHCS (5) and (33). Record your findings on the data sheet.

[ ]18. Apply liberal amounts of EP grease to the seals in the housing (8) and the slip ring portion of the drive shaft (7). Slide the drive shaft down into the slip ring housing until you feel it seat on the bearing race (40). It may be necessary to use the arbor press to "gently force" the drive shaft past the last couple of seals.

[ ]19. Apply generous amounts of Dow Corning® 55 o-ring lubricant to the eight threaded holes of the wrist housing (8).

[ ]20. Apply o-ring lube to the inside diameter of the wear plate (9) and install it into the slip ring housing (8) and onto the seal (62).

[ ]21. Install one of the o-rings (51) into the groove on the outer edge of the slip ring housing (8).

[ ]22. Apply a thin film of petroleum jelly to all of the gerotor (65) parts, and then place the inner rotor on the splines onto the drive shaft (7) and slide it down to the wear plate (9).

[ ]23. Place the outer element down around the inner rotor and onto the wear plate (9).

Note: Install with the narrow grove facing up and large groove down.

[ ]24. Place the locating ring down around the outer element and onto the wear plate (9). Make sure the bolt holes line up.

[ ]25. Install the larger diameter, sharp cornered sealing rollers into the spaces between the outer element and the inner rotor.

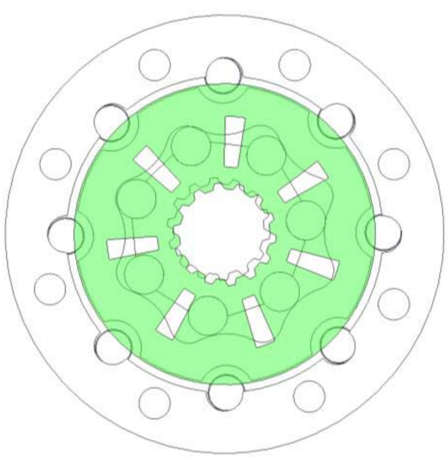


Figure 1

[ ]26. Install the smaller diameter anti-rotation rollers into the spaces between the outer element and the locating ring.

[ ]27. Install the valve plate on the drive shaft splines. The slots go between the rollers with the T-shape facing upward. (See Fig. 1)

[ ]28. Q.C. Point 3. Verify the correct orientation of the motor valve plate and Gerotor (65).

[ ]29. Install the seal (61) onto the diameter of the drive shaft (7). Make sure it is oriented with the cupped portion of the seal facing the gerotor assembly (65).

[ ]30. Install the wrist valve plate (6) onto the gerotor assembly (65) with the o-ring grooves facing upward.

[ ]31. Install the remaining o-ring (51) around the valve plate (6).

[ ]32. Q.C. Point 4. Check the installation of the o-rings (51), the seal (61) and the valve plate (6). Record your findings on the data sheet.

[ ]33. Install the wrist manifold (4) down onto the wrist motor stack. Check to see that the five ported o-ring bolts (5) are in the holes corresponding to the pin plug holes that are visible on the outside diameter of the slip ring housing (8). Hold the slipring housing and torque the SHCS (5) and (33) per assembly drawing.

[ ]34. Install the core from the resolver assembly (68) onto the end of the drive shaft (7) while indexing it on the spirol pin and then install the retaining ring (30) into the groove in the drive shaft.

[ ]35. Install the jaw piston into the nose block (10-1). Ensure that the jaw piston is oriented as shown on the assembly drawing.

[ ]36. Place pin (10-10) thru hole at the end of the piston (10-2) and center it forming a "T". Orient the pin by rotating it until the tick mark on the end or the pin is pointing up to the threaded hole at the end of the piston. Install the retaining bolt (10-11) into the threaded hole at the end of the piston (10-2). Torque the retaining bolt as specified on drawing.

[ ]37. Install the piston bearing (10-7) onto the jaw piston. Install the jaw piston seal (10-5) onto the jaw piston (10-2) with tool # 010-0184 and resize it using tool #010-0185.

[ ]38. Q.C. Point 5. Check that the SHCS (5) and (33) are torqued. Insure the correct assembly of the resolver core/retaining ring (30). Insure the installation of the wrist base (1) onto the wrist manifold (4). Insure the correct assembly of the nose block/T-bar piston and the retaining bolt (10-11) is torqued. Check that the seal (10-5) and bearing (10-7) are installed. Record your findings on the data sheet.

[ ]39. Using the five SHCS (27), install the wrist base (1) onto the wrist manifold (4). Torque the SHCS (27) to the value specified on the assembly drawing.

[ ]40. Q.C. Point 6. Check that the SHCS (27) are installed and torqued. Record your findings on the data sheet.

[ ]41. Test 1. Wrist functionality test: Install the o-rings into each of the wrist and jaw ports and then fasten the test manifold to the top of the wrist base with the six screws. Use the hydraulic test bench to operate the wrist function. Connect a servo valve to the bench and operate the wrist at 3000 psi/20.68 MPa in both directions for several minutes to see if it is operating correctly. Stop the wrist from rotating and then gradually drive the servo valve until the wrist <u>just</u> 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. Repeat this process in the opposite direction for no more than four RPMs. You may adjust the preload/shims to achieve proper wrist operation.

[ ]42. Test 2. Wrist torque test. Test the wrist torque using tool 010-0577. The wrist torque shall be a minimum of 90 ft*lb in both directions. You may adjust the preload/shims to achieve proper wrist torque.

[ ]43. Thread the Lemo connectors and associated cables through the holes in the wrist base (1).

[ ]44. Apply Loctite® 271 to the SHCS (28), and using the clamps (29) and SHCS secure the resolver/LVDT assembly (68) onto the wrist manifold (4) while indexing it on the spirol pins. Torque the SHCS (28) per assembly drawing.

[ ]45. Install the LVDT liner (24) into the hole in the drive shaft (7). Push the LVDT liner down into the bore until it bottoms out. Be careful not to damage the o-ring on the very sharp corner that it must slide by.

[ ]46. Place the plunger unit into the sleeve (23) until it bottoms out on the step in the bottom of sleeve. Place the spring (31) into the sleeve until it bottoms out on the plunger.

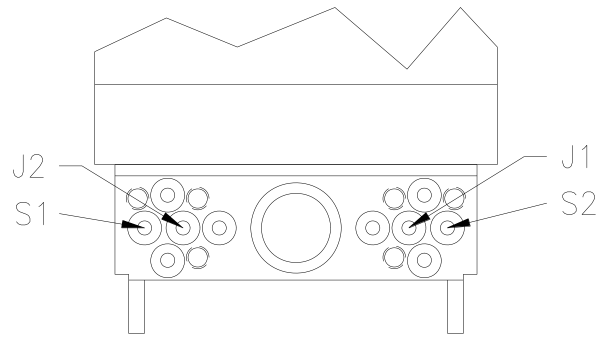
[ ]47. Install the unit into the LVDT liner (24), making sure that the LVDT core goes into the hole in the LVDT liner. Slide the sleeve down, against the force of the spring, and into the hole in the drive shaft (7) using a suitable tool. Install the retaining ring (32) onto the top of the sleeve and into the groove in the hole of the drive shaft. Check that the plunger moves up and down freely in the LVDT sleeve.

[ ]48. Q.C. Point 7. Check the installation of the resolver/LVDT assembly (68), the clamps (29), and the torque of SHCS (28). Insure the LVDT plunger assembly operates correctly. Record your findings on the data sheet.

[ ]49. Install the back cover (2) into the shallow, counterbored area on the wrist base (1).

[ ]50. Install the nose block/T-bar piston unit into the bore of the drive shaft (7). First, slide the jaw rod piston (10-2) into the bore, then seat the o-ring onto the nose block (10-1) and into its bore. Line up the six holes in the nose block with the holes in the drive shaft and then screw the bolts (10-9) into the holes after applying Aqua Lube to the threads. Torque the screws to the value specified on the assembly drawing.

[ ]51. Test 3. Jaw Functionality Test: Use compressed air to extend and retract the jaw rod several times. Plug the S1 port while applying the pressure to the J1 port and observe that there is no pressure leaking from the S2 and J2 ports. See detail below. Record your findings on the data sheet.



[ ]52. Q.C. Point 8. Check that the cover (2) is installed. Check that the HHCS (10-9) are torqued. Verify the results of Test 1, 2 and 3. Check that the assembly is properly serialized. Record your findings on the data sheet.

[ ]53. Install the port plugs and affix an acceptance tag. Return assembly 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. Affix the acceptance tag to the assembly.

Work Instructions

Assembly Number: 101-4821 Description: Actuator, Rotary, Pitch, w/Flats, T3
Product Family: T3, T4

Materials Required:

Adhesives:

Loctite® 271 Red (002-0795) Loquic® Primer 'N' (002-0291)
Loctite® 609 Green (002-1032) Loctite® 620 Green (002-0873)

Chemicals:

Aqua Lube (002-0805) O-ring lubricant (Dow Corning® 55)
Petroleum jelly Valvoline® Val-plex EP® grease

Miscellaneous:

Razor Blades

Special Tool:

010-0474 010-0801 010-0819 010-1927

Initial Preparation:

Serialization:

Serialize the actuator housing (1) , as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last six digits of the job number. Add a designation of -1, -2, -3, etc. for jobs consisting of more than one assembly. (i.e. 101-4821 X XXXXXX-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 any 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 Loctite® 271 (45) to secure the sleeve (42) into the flush port of the drive shaft (3) as shown on the assembly drawing. Make sure that the top of the sleeve is flush with the top of the drive shaft.

[ ]2. Degrease the two bearing rings (41), the output flange (7), and the stator manifold (30). Apply Loctite® 609 (44) to the inside diameter of the two bearing rings and

install them on the output flange and the stator manifold. Use the arbor press, as necessary, to force the bearing rings onto the diameter of the output flange and stator manifold. Refer to the assembly drawing while you perform this step.

[ ]3. Degrease the two thrust bearings (16), the four thrust washers (17), the drive shaft (3), rotor vane (2), needle bearings (14) and the six SHCS (43).

Assembly:

[ ]1. Install one backup plate (26) into the groove in the stator vane (8) and push it to one side. Then install one o-ring (21) into the same groove and stretch a vane seal (20) over o-ring. Snap second backup (26) into groove to sandwich the vane seal. Align radius cutouts of stator, vane seal and backups together.

[ ]2. Repeat previous step for rotor vane (2) using backup (25), o-ring (21) and vane seal (20).

[ ]3. Install the four o-rings (22) onto the shanks of the four HHCS (12).

[ ]4. Install the two o-rings (23) into the grooves in the pitch housing (1).

[ ]5. Install o-rings 20x(24) onto SHCS 10x(9) and 10x(49).

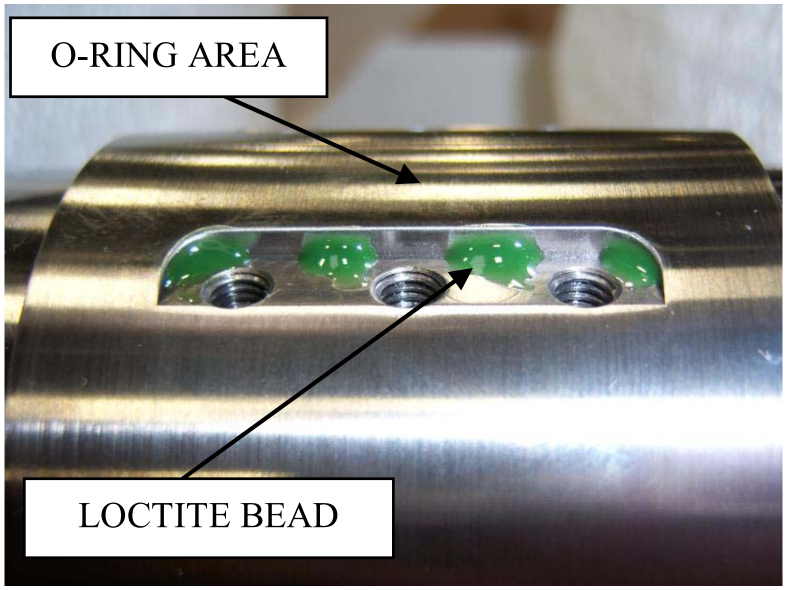
[ ]6. Stretch the two UHMW backup rings (32) and place inside of housing (1). The backup rings should be loaded against housing in groove. Ensure the backup ring is above the o-ring (23) in the housing groove.

[ ]7. Use liberal amounts of petroleum jelly to “glue” the needle roller bearings (14) to the inside walls of the end plates (4). Load sixty-two of the rollers into each end plate.

[ ]8. Apply a film of Valvoline® Val-plex EP® grease to the threads of the thirty-two SHSS (18) and thread them into the two torque rings (5). Thread the screws in until they are flush with the top and bottom faces of the torque rings.

[ ]9. Slightly stretch and lubricate the two o-rings (19) and install into the grooves of the driveshaft (3) as shown on the assembly drawing.

[ ]10. Apply small beads of Loctite #620 along the back edge of each of the flats cut in the drive shaft.



[ ]11. Place rotor vane (2) onto drive shaft and tighten down using two SHCS (43). Remove SHCS and rotor vane and wipe off all Loctite that is not in the flat area. **NOTE:** It is VERY important that there is no Loctite under o-rings.

[ ]12. Place six of the SHCS (43) through the rotor vane (2) and apply Loctite #271 (46) onto the threads of each bolt and place a drop into each threaded hole. Then install the rotor vane onto the driveshaft and torque the SHCS as indicated on the assembly drawing. **NOTE:** Make sure SHCS and threaded holes in driveshaft are clean or Loctite will not adhere to them.

[ ]13. Q.C. Point 1 Check the installation of the sleeve (42) into the drive shaft. Ensure that the bearing rings (41) have been installed on the output flange (7) and the stator manifold (30). Check the installation of the o-rings (22) onto the HHCS (12). Ensure the installation of the o-rings (21), the vane seals (20) and backups (25), (26) onto the stator vane (8) and rotor vane (2). Check the installation of the o-rings (23) and backups (32) into the pitch housing (1). Verify the installation of the needle roller bearings (14) into the end plates (4). Check the installation of the SHSS (18) into the torque rings (5). Check the installation of the two o-rings (19) and torque of SHCS (43) onto the drive shaft (3). Verify installation of o-rings 20x(24) onto SHCS 10x(9) and 10x(49). Record your findings on the data sheet.

[ ]14. Place the stator vane (8) into the bore of the actuator housing (1) so that the four holes in the stator vane line up with the four holes in the housing. Screw the four HHCS (12), with the o-rings already installed on them, through the housing and into the stator vane. Make sure the stator vane is tight up against the inner wall of the actuator but <u>do not</u> torque the bolts at this time.

[ ]15. Use generous amounts of petroleum jelly and apply a film over the inside diameter of the pitch housing (1) and the outside diameter of the driveshaft (3).

[ ]16. Make sure you have the orientation (or clocking) of the rotor correct by installing it as it is shown in the assembly drawing.

[ ]17. Place both end seals (6) down over o-rings (19) on driveshaft. End seals must be seated on driveshaft before drive shaft installation into housing. Ensure that o-rings are staying under end seals. NOTE: There are sharp edges on the seal required for sealing.

[ ]18. Insert the driveshaft (3) into the actuator housing (1) with the rotor vane oriented 90 degrees from the stator vane. Once the rotor is centered on the actuator surface, carefully rotate the rotor so that the rotor vane is now oriented 180 degrees from the stator vane. Make sure that the rotor is centered on the actuator surface.

[ ]19. Q.C. Point 2. Check to see that the end seals (6) have been installed on the driveshaft (3). Verify that the orientation of the rotor in the housing (1) is correct. Record your findings on the data sheet.

[ ]20. Reseat end seals prior to installing end plates, if necessary.

[ ]21. Apply petroleum jelly to the bottom and side of both end plates (4). Slide end plates into actuator until they rest against the UHMW backup rings. Using tool 010-0801 (48) carefully seat both end plates in housing.

[ ]22. Slide one torque ring (5) down into the housing (1) until it bottoms out on the top of the end plate (4). Install the retaining ring (10) into the groove located just above the torque ring. Position the gap of the retaining ring so that it is centered over the area of the actuator where the stator vane (8) is located. Repeat for second torque ring.

[ ]23. Use a T-handle Allen driver to lightly tighten the sixteen setscrews (18). This will lock the torque ring (5) in place between the end plate (4) and the retaining ring (10). Follow same pattern and torque the setscrews as indicated on assembly drawing. Repeat for second torque ring.

[ ]24. Torque the four HHCS (12) that hold the stator vane (8) in place, as indicated on the assembly drawing.

[ ]25. Using tool 010-1927, zero the dial indicator of this tool by installing on the fixture block.

[ ]26. Place the tool with the dial indicator on the stator side of the actuator and record dimension "A."

[ ]27. Place the tool with the dial indicator on the stator manifold and record dimension "B."

[ ]28. Subtract dimension B from A to calculate the shim required.

[ ]29. The goal is to end up with zero gap and zero driveshaft movement when the stator manifold is torqued to its final value.

[ ]30. Repeat the four previous steps for the output flange (7) side of the actuator.

[ ]31. Lightly lubricate thrust bearing (16) and place between thrust washers (17), with any shims between thrust washer and stator manifold or output flange.

[ ]32. **Temporary non patch SHCS, in place of items (9),(49), may be used for testing purposes only**.
Notice the small tick-mark in the end of the drive shaft (3) and line it up with the small tick-mark that can be found on the bottom side of the stator manifold (30). Place the stator manifold down onto the end of the drive shaft and use the ten SHCS (temporary test bolts) to secure the drive shaft to the stator manifold. Torque the ten SHCS (temporary test bolts) as indicated on the assembly drawing.

[ ]33. Place the output flange down onto the end of the drive shaft and use the ten SHCS (temporary test bolts) to secure the output flange to the drive shaft as shown on the assembly drawing. Torque the ten SHCS (temporary test bolts) as indicated on the assembly drawing.

[ ]34. Test 1. At the hydraulic test bench, connect the two appropriate ports on the actuator to a servo valve. Operate the valve for 10 to 20 cycles. Check to see that the actuator is operating smoothly and that there are no external leaks. Perform both breakaway pressure and port-to-port leakage test per SR spec 130-0323. Record the results on the data sheet. Return the assembly to the assembly bench.

[ ]35. Loosen and remove the ten SHCS (test bolts) and remove the output flange (7) from the drive shaft (3).

[ ]36. Loosen and remove the ten SHCS (test bolts) and remove the stator manifold (30) from the drive shaft (3).

[ ]37. Place ten o-rings (24) into the ten counterbores in the end of the drive shaft (3).

[ ]38. Q.C. Point 3. Ensure that the retaining ring (10) has been fully seated and that the SHSS (18) have been torqued to the correct value. Check to see that the thrust washers (17) and bearings (16) have been installed in both the output flange (7) and the stator manifold (30). Ensure that the four stator bolts (12) have been torqued to the correct value. Check the installation of o-rings 10x(24) onto the drive shaft (3). Review the data from Test 1 and record your findings on the data sheet.

[ ]39. Install the two fluorocarbon lip seals (28) into the opposite bores of the actuator housing (1), as shown in the assembly drawing.

[ ]40. Q.C. Point 4. Ensure that the two lip seals (28) have been properly installed per the assembly drawing.

[ ]41. Notice the small tick-mark in the end of the drive shaft (3) and line it up with the small tick-mark that can be found on the bottom side of the stator manifold (30). Place the stator manifold down onto the end of the drive shaft and use the ten SHCS (49), with the o-rings (24) installed on the shanks, to secure the drive shaft to the stator manifold. Torque the ten SHCS (49) as indicated on the assembly drawing.

[ ]42. Place the output flange down onto the end of the drive shaft, making sure that the orientation is the same as the stator manifold (30). Use the SHCS (9), with the o-rings (24) installed on the shanks, to secure the output flange to the drive shaft (3),

and snug the screws. (This flange will need to be loosened during the building of the pitch/yaw assembly.)

[ ]43. Plug or cover the hydraulic ports on the assembly. Bag the assembly, affix an acceptance tag to it, and return it to stock.

[ ]44. Q.C. Point 5. Verify torque of SHCS (49) per assembly drawing. Verify installation and orientation of output flange (7) with SHCS (9), snugged.

Remarks:
Record any pertinent findings or information not directly called for on the data sheet. 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 date on which the test was completed
Record the inspector's name on the data sheet and affix the appropriate acceptance tag to the assembly.
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: 101-4182 Description: Pitch/Yaw
Product Family: T3

Materials Required:

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

Tools:

010-0195 Seal installation tool 010-0196 Seal resize tool

Initial Preparation:

Serialization:
Serialize the manifold block (1) as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last five digits of the job number, as the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-4182 X XXXXX-X). Record the serial number of each assembly at the top of its individual data sheet. In addition, record the serial numbers of the pitch and the yaw actuator and resolver 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 no parts are missing, and that any 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. Use the seal installation tool #010-0195 to install the twenty-four o-rings (29) and the seals (16) onto the two slip ring manifolds (2). Use the resizing tool #010-0196 to resize the seals. Install the four slydring bearings (17) onto the two slip ring manifolds (2). Note: It helps to squeezing seal back into shape in groove prior to resizing.

[ ]2. Place the twenty o-rings (18) and the two larger o-rings (19) into the counterbores on the stator manifolds that are assembled to the actuators (20).

[ ]3. Install the two o-rings (15) into the counterbores of both of the rotor manifolds (23).

[ ]4. Q.C. Point 1. Check to see that all the seals (16) and the o-rings (15), (18), (19), and (29) have been installed. Also, verify that the four bearings (17) have been installed on the slip ring manifolds (2) and are free of defects and irregularities.

Verify the serialization of the manifold block (1). Record your findings on the data sheet.

[ ]5. Loosen the twenty SHCS that hold the output flanges onto the drive shafts enough so that the manifold block (1) can be installed between the faces of the output flanges and the stator manifolds.

[ ]6. Use the assembly drawing to make sure the orientation between the actuators (20) and the manifold block (1) is correct. Use the twelve HHCS (27) to secure the manifold block to the rotor manifolds of the actuators. Tighten the SHCS in driveshaft to ensure end gap goes back to zero. Using eight of the HHCS (11), secure the output flanges to the manifold block. Torque the HHCS to 21 ft-lb/28.47 N-m and the twenty SHCS to 76 in-lb/8.6 N-m.

[ ]7. Carefully slide the slip ring manifold (2) down into the bore of the drive shaft. Because of the force of friction, it may be necessary to use the arbor press after a few of the seals have been seated to complete the installation of the slip ring manifold. Use the assembly drawing to determine the orientation of the slip ring with respect to the drive shaft. Repeat the process for the remaining manifold.

[ ]8. Install the thrust race (26) down over the slip ring manifold (2). Install the retaining ring (25) into the groove. Repeat the process for the remaining actuator.

[ ]9. Torque HHCS (27) and (11) to 21 ft/lbs.

[ ]10. Torque SHCS (9) from the 101-4821 assembly to 76 in/lbs.

[ ]11. Install the twenty o-rings (14) into the counterbores in the ends of the slip ring manifolds (2).

[ ]12. Q.C. Point 2. Check the orientation and assembly of the actuators (20) to the manifold block (1). Check the installation of the slip rings (2), the thrust races (26), and the retaining rings (25). Verify that the o-rings (14) have been installed. Verify torque on HHCS (27) and (11). Verify torque on SHCS (9) on 101-4821 assembly. Record your findings on the data sheet.

[ ]13. Install rotor manifolds (23) onto slip ring manifolds (2) using SHCS (7). Tighten only hand tight.

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.*This page not used.*

Work Instructions

Assembly Number: 101-4077 Description: Elbow Actuator
Product Family: T3/T4

Materials Required:

Adhesives:

Loctite® 609 (002-1032)	Loctite® 271 (002-0795)

Chemicals:

Aqua Lube (002-0805)	O-ring lubricant (Dow Corning® 55)
Petroleum jelly	Valvoline® Val-plex EP® grease

Miscellaneous:

Razor blade

Tools:

010-0197	010-0198	010-0474	010-1856	010-1926
010-0254	010-0803 (Optional)			

Initial Preparation:

Serialization:

Serialize the actuator housing as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last five digits of the job number, as the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-4077 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. Degrease the two bearing rings (52), the output flange (13), and the stator manifold (43). Check the fit between the bearing rings and the output flange and the stator manifold. It may be necessary to put the rings in the oven and the output flange and the stator manifold in the freezer to ease the installation. Apply Loctite® 609 (63) to the inside diameter of the two bearing rings, and install them on the output flange and the stator manifold. If necessary, use the arbor press to press the bearing rings onto the diameter of the output flange and the stator manifold, as shown in the assembly drawing.

[ ]2. Use Loctite® 271 (73) to secure the sleeve (61) into the flush port of the rotor body (3), as shown on the assembly drawing. Make sure that the top of the sleeve is flush with the top of the drive shaft.

[ ]3. Degrease the four bearing races (24) and the two thrust bearings (25).

Assembly:

[ ]1. Install the six o-rings (46) onto the shanks of the six HHCS (47).

[ ]2. Install twenty of the o-rings (34) over the shanks of ten each of the SHCS (18) and (62).

[ ]3. Install the eleven o-rings (59) and the seals (28) onto the slip ring spool (4), as shown in assembly drawing, and using the special tools 010-0197 (75), 010-0198 (76) and 010-0254. Install and resize each seal, one seal at a time, until they are all installed.

[ ]4. Install the slip ring bearings (27) onto the slip ring shaft.

[ ]5. Place one back-up plate (31) onto each stator vane halves (10) and rotor vane halves (2) aligning the radius cuts together.

[ ]6. Place one of the seal carriers (65) onto one of the stator vane halves (10) and the other onto one of the rotor vane halves (2). Place the o-rings (66) over the seal carrier (65), and then place the vane seals (32) over the o-rings aligning the radius cuts together.

[ ]7. Use the four SHCS (64) and Loctite 271 (73) to secure the two stator vane halves together. Torque the SHCS (64) as indicated on the assembly drawing.

[ ]8. Use the four SHCS (70) and Loctite 271 (73) to secure the two rotor vane halves together. Torque the SHCS (70) as indicated on the assembly drawing.

[ ]9. Apply Loctite 271 (73) to six SHCS (50) and install the rotor vane seal unit onto the rotor body (3). Torque the SHCS (50) as indicated on the assembly drawing.

[ ]10. Install the two o-rings (67) into the grooves in the driveshaft (3) as shown on the assembly drawing.

[ ]11. Install the two o-rings (39) into the grooves in the elbow housing.

[ ]12. Test fit the two UHMW backup rings (48) on the outside diameter of the end plates (5). The rings should be slightly loose around the diameter. If the rings are not loose, stretch them slightly. When the rings are installed in the grooves of the elbow housing above the o-ring, they should be loaded against the inside wall of the groove.

[ ]13. Use liberal amounts of petroleum jelly or Valvoline® Val-plex EP® grease to "glue" the needle roller bearings (22) to the inside wall of the end plates (5). Load 75 of the rollers into each end plate.

[ ]14. Apply a film of Valvoline® Val-plex EP® grease to the threads of the forty set screws (40), and thread them into the two torque rings (6). Thread them in until they are flush with the top and bottom faces.

[ ]15. Q.C. Point 1. Insure that the bearing rings (52), the sleeve (61) and the o-rings (67) are all installed. Verify that the o-rings (34),(46),(59),(66) and (67) have been installed. Check to see that the stator and rotor vane seals (32) and back-up plates (31) have been correctly installed. Ensure that the two o-rings (39) and backups (48) have been properly installed into housing (1). Check to see that the slip ring seals (28) and the bearings (27) have been installed on the slip ring shaft (4). Ensure that the roller bearings (22) have been installed in the end plates (5). Check the torque of the SHCS (50),(64),(70). Record your findings on the data sheet.

[ ]16. Place end seals (7) down over o-rings (67) on drive shaft (3). You should feel the end seal engage over the drive shaft all the way around. NOTE: There are sharp edges on the seal required for sealing.

[ ]17. Use the six HHCS (47) to secure the stator vane seal unit to the inside of the housing. Torque the HHCS to 3 ft-lb/4.06 N-m, or just enough to tighten the vane seals up against the housing.

[ ]18. Use generous amounts of petroleum jelly to apply a film over the inside diameter of the elbow housing and the outside diameter of the rotor.

[ ]19. Make sure you have the orientation (or clocking) of the rotor correct by installing it as it is shown in the assembly drawing. The hydraulic ports of the rotor body should be opposite of the transfer tubes of the housing.

[ ]20. Insert the rotor body into the actuator housing with the rotor vane oriented 90 degrees from the stator vane. Once the rotor body is centered in the actuator, carefully rotate the rotor body so that the rotor vane is now oriented 180 degrees from the stator vane. Recheck your work to ensure that the rotor is centered in the actuator and end seals are still engaged on drive shaft.

[ ]21. Q.C. Point 2. Ensure that the stator vane seal unit and the end seals (7) have been installed correctly. Check the orientation of the rotor unit in the housing and verify that the orientation is correct. Record your findings on the data sheet.

[ ]22. Apply petroleum jelly to the bottom and side of both end plates (5). Install the end plates into the actuator until they rest against the UHMW backup ring (48). Carefully seat the endplates past the UHMW backup rings, may use tool 010-0803.

[ ]23. Slide one of the torque rings (6) down into the housing until it bottoms out on the top of the end plate. Install the retaining ring (14) in the groove just above the torque ring. Position the gap of the retaining ring so that it is centered over the area of the actuator where the stator vane is located. Repeat for other torque ring.

[ ]24. Use a T-handle Allen driver to snug the forty SHSS (40) to JUST SEAT the end plates. Then torque the forty SHSS (40) as indicated on the assembly drawing. Repeat for other torque ring.

[ ]25. Finally, torque the six HHCS (47) as indicated on the assembly drawing.

[ ]26. Using tool 010-1926, zero out the dial indicator of this tool by installing it on the fixture block.

[ ]27. Place the tool with the dial indicator on the stator side of the actuator and record dimension "A."

[ ]28. Place the tool with the dial indicator on the stator manifold and record dimension "B."

[ ]29. Subtract dimension B from A to calculate the shim required.

[ ]30. The goal is to end up with zero gap and zero driveshaft movement when the stator manifold is torqued to its final value.

[ ]31. Repeat the five previous steps for the output flange (13) side of the actuator.

[ ]32. Lubricate thrust-bearing (25) with Valvoline grease.

[ ]33. Q.C. Point 3. Verify that the retaining rings (14) are fully seated. Check the torque of the HHCS (47). Insure that shims (if any) are installed first, then a bearing race (24), a thrust bearing (25) and another bearing race (24) into the grooves of the stator manifold (43) and the output flange (13).

[ ]34. Line up the tick marks of the stator manifold and the driveshaft and install the stator manifold using ten of the SHCS from the test fixture hardware in the work cell. Torque fasteners as indicated for SHCS (62).

[ ]35. Orient the output flange to the stator manifold and install it using the SHCS from the test fixture hardware in the work cell. Torque fasteners as indicated for SHCS (18).

[ ]36. Test 1. At the hydraulic test bench, connect the two appropriate ports on the actuator to a servo valve. Operate the valve for 10 to 20 cycles. Check to see that the actuator is operating smoothly and that there are no external leaks. Perform both breakaway pressure and port-to-port leakage test per SR spec 130-0323. Record the results on the data sheet. Return the assembly to the assembly bench.

[ ]37. Remove the output flange and remove the drive shaft/stator manifold unit from the actuator.

[ ]38. Install the two lip seals (33) into the actuator housing, as shown in the assembly drawing.

[ ]39. Install the ten o-rings (36) into the counterbores of rotor body.

[ ]40. Q.C. Point 4. Verify installation of lip seals (33) into housing and o-rings (36) into counterbores of the driveshaft. Record your findings on the data sheet.

[ ]41. Line up the tick marks of the stator manifold and the driveshaft and re-install the stator manifold. Torque the SHCS (62) as indicated.

[ ]42. Install the slipring shaft (4) into the rotor body as shown on the assembly drawing.

[ ]43. Orient the output flange to the stator manifold and re-install. Only snug down the SHCS (18) this makes the slave arm assembly easier.

[ ]44. Q.C. Point 5. Verify installation of slipring shaft (4) and orientation of output flange to stator manifold. Confirm torque of SHCS (62) on the stator manifold. Record your findings on the data sheet.

[ ]45. Install the thrust washer (26) and then the retaining ring (15) onto the slipring shaft.

[ ]46. Plug the hydraulic ports of the actuator. Attach the o-rings (35) to the assembly, they will not be used until the slave arm assembly.

[ ]47. Q.C. point 6. Verify the installation of the thrust washer (26) and the retaining ring (15). Check the general configuration of the assembly. Verify that the serial number has been stamped on the actuator housing. Record your findings on the data sheet. Issue an acceptance tag and attach the tag to the assembly.

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. Affix the acceptance tag to the assembly. Record the Military Specification to which the assembly was tested (if necessary), and the date on which the test was completed.

Work Instructions

Assembly Number: 101-5723 Description: Forearm
Product Family: T4

Materials Required:

O-ring Lubricant (Dow Corning® 55)

Tools:

No special tools are required.

Initial Preparation:

Serialization:
Use a vibro engraver to serialize the forearm weldment (8), as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last five digits of the job number, as the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-5723 XXXXX-X). Record the serial number of each assembly at the top of its individual data sheet. In addition, record the serial numbers of the servo valves and the lock valve 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, and that there are no missing parts. Check all threaded fasteners to determine that they 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. Unpack the servo valves (9) and remove the protective covers from the bottoms of the valves. Note that all o-rings (27) are present. Locate the seven adapter plates (24) and the twenty-eight o-rings (22). Use o-ring lubricant to "glue" the o-rings to the bottoms of the adapter plates.

[ ]2. Install the o-rings (13) into the two oval-shaped grooves on the bottom of the lock valve assembly (10). Place the two smaller o-rings (5) into the round grooves on the bottom of the lock valve. Install the four o-rings (5) in the bottom of the lock relief valve (28).

[ ]3. Install the o-ring (6) into the groove of the lid (1).

[ ]4. Place the two o-rings (25) onto the two BHCS (26).

[ ]5. Place the six o-rings (7) onto the six HHCS (3).

[ ]6. Q.C. Point 1. Verify that all the o-rings (5), (6), (7), (13), (22), (25), and (27) have been installed. Record your findings on the data sheet.

[ ]7. Using the twenty-eight SHCS (23), secure each servo valve (9) to its adapter plate (24). Install the adapter plates with their flush sides facing the o-rings (27) in the servo. Attach the adapter plates to the bottoms of the valves.

[ ]8. Place the servo valve/adapter plate unit onto the locations in the forearm manifold (8) representing the azimuth, elbow, pitch, yaw, wrist, and tool/jaw functions, as shown on the assembly drawing. Make sure the "P" mark on the servo valve lines up with the "P" mark on the lockvalve. Secure each unit to the manifold with the four SHCS (4).

[ ]9. Place the servo valve/adapter/lock valve/relief valve unit with the o-rings facing down, over the location representing the shoulder function as shown in the assembly drawing. Secure the adapter plate (24), lock valve (10) and relief valve (28) to the forearm manifold (8) with the four SHCS (11).

[ ]10. Install the two BHCS (26) into the ports labeled "2."

[ ]11. Install the six HHCS (3) through the holes in the lid (1) and into the three cover clamps (2), as shown in the assembly drawing. Loosely thread the bolts into the clamps.

[ ]12. Q.C. point 2. Ensure that the fasteners (4), (11), (23), and (26) have been securely fastened. Determine if the lock valve (10) and the servo valves (9) have all been installed correctly. Ensure that the HHCS (3) have been installed through the lid (1) and into the clamps (2). Record your findings on the data sheet.

[ ]13. Angle the lid (1) so that you can place one end of the three clamps (2) into the grooves on the inside of the forearm manifold (8) walls. Tilt the lid so that it rests flat on the manifold and the lip around the top of the manifold is fully seated into the lid groove. Torque the six HHCS (3) loosely as the lid will be removed later.

[ ]14. Install plastic cap plugs into the two ports on both ends of the forearm manifold (8). Tag the assembly and return it 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' name on the data sheet and affix the acceptance tag to the assembly.

Work Instructions

Assembly Number: 101-5977 Description: Upperarm, T4
Product Family: T4

Materials Required:

Adhesives:
Loctite® 271 (002-0795)
Chemicals:
Aqua Lube (002-0805)
Valvoline® Val-plex EP® grease
O-ring lubricant (Dow Corning® 55)
Nickel based Anti-Seize

Tools:

Spring scale 010-0629 010-0475

Initial Preparation:

Serialization:
Serialize the upper arm weldment (5), with metal stamps, as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last six digits of the job number, as the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-4841 X XXXXXX-X). Record the serial number of each assembly at the top of its individual data sheet. In addition, record the serial numbers of the linear actuator (15) subassembly in the space 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 no parts are missing; and that all hoses, cables, or wires have been routed correctly. Verify that all the threaded fasteners have been torqued to the correct values.

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. Use Loctite 271 (111) to secure the races from the bearing (12) into the shoulder housings (3) and (4) as shown on the assembly drawing. Use an arbor press to make sure the bearings bottom out on the shoulders of the housings. Be careful to remove all excess Loctite .

[ ]2. Thoroughly degrease the four bearings (12).

Assembly:

[ ]1. Install the o-rings (63) into the shoulder housings (3) and (4) as shown on the assembly drawing.

[ ]2. Install two of the fittings (106) and two of the fittings (85) into the main hydraulic mount as shown on the assembly drawing.

[ ]3. Install the three plugs (43) the two fittings (85) and (106) into the valve plate (35) as shown in the assembly drawing. Note: Leave the pressure port next to the return fitting empty for the time being.

[ ]4. Install the three o-rings (50) and o-ring (47) into the bottom of the valve plate (35).

[ ]5. Install the remaining o-ring (47) onto the relief valve (31) as shown on the assembly drawing.

[ ]6. Install the remaining fittings (85), (99) and self-sealing screws (87) into the upper arm (5) as shown in the assembly drawing.

[ ]7. Install the remaining self-sealing screws (87) into each of the shoulder lids (32) as shown on the assembly drawing

[ ]8. Install the o-rings (7) onto the HHCS (6).

[ ]9. Install o-ring (121) onto cover (124).

[ ]10. Thoroughly pack bearings (12) with Valvoline® Val-plex EP® greases.

[ ]11. Install the Hawe valve (36) onto the valve block (39) with the four SHCS supplied with the valve, tightening to the torque as per assembly drawing.

[ ]12. Cut and heat shrink tubing (126) onto threaded rod (57), leaving 1/2" of exposed thread on each end of the rod.

[ ]13. Q.C. Point 1. Verify the installation of the plugs (43), the races (12), the o-rings (7),(47),(50),(63),(121) the self-sealing screws (87), fittings (85),(99),(106), and shrink tubing (126). Verify bearings (12) are packed with grease. Verify the valve (36) is installed correctly and fasteners are torqued. Record your findings on the data sheet.

[ ]14. Install tubes (18), (19), and (21) into the upper arm as shown on the assembly drawing.

[ ]15. Without fully torqueing the fasteners or using loctite, install the valve plate (35) with the two SHCS (34) and two washers (110) into the upper arm weldment (5). They will be torqued later.

[ ]16. In the following sequence, install tubes (66), (17) and (62) as shown in the assembly drawing.

[ ]17. Now install fitting (85) into the pressure port of the valve plate (35) next to the return fitting.

[ ]18. Install the pressure tube (20) as shown on the assembly drawing. **Make sure there is adequate space between all of the tubes – any tubes touching one another will cause vibration and noise.**

[ ]19. Remove the two SHCS (34) holding down the valve plate (35) and apply Loctite (111) and reinstall the fastener to the torque specified on the assembly drawing.

[ ]20. Install the o-rings (107), (50), and (108) into the top of the valve plate (35).

[ ]21. Q.C. Point 2. Verify the installation of o-rings (107), (108), (50) and torque of fastener (34).

[ ]22. Install the block assembly onto the valve plate (35) using the three SHCS (40) and three of the washers (110) and loctite (111). Note: one of the washers will need to be filed down in order to fit next to the filter housing. Torque the SHCS (40) per assembly drawing.

[ ]23. Install the filter element (117) and torque very carefully – torque to 50 in lbs.

[ ]24. Onto the left shoulder spindle, install a flange (60), a bearing (12), the housing (3) and another bearing (12).

[ ]25. Using shims {(70),(71),(72)}install .030" of shims and the retainer (61) and hand tighten six of the SHCS (25). Use a rubber mallet to "dead blow" the housing to make sure it is completely seated. Then torque the SHCS (25) per assembly drawing.

[ ]26. Install the spring scale in the last hole of the shoulder housing and measure the drag. A drag measuring between 2 to 5 lb (9 to 22 N) should be attained. If drag is too low, remove shims and if drag is too high, add shims.

[ ]27. Repeat the previous steps for the right shoulder spindle using the housing (4) and adapter (11). Note that the orientation of the adapter (11) is critical.

[ ]28. Measure the distance between the inside faces of the shoulder housings. The nominal dimension on the azimuth housing is 5.060 inches/128.524 mm. (If possible, check the azimuth that will be used in the final assembly. Check them both in a couple of places.) Subtract the width of the azimuth flange to determine the total amount of shimming required.

Inside Face distance _________" - 5.060" = ________" total shims

[ ]29. Remove the bearing assembly from one side and install half the shim distance {(73),(74),(75)} under the flange (60). Repeat under other side.

[ ]30. Install the o-rings (65) and seals (64) onto the flanges (60) as shown on the assembly drawing. **IN PROCESS QC**.

[ ]31. Reinstall flange (60) bearings (12) and housings (3 & 4). Add equal amount of shims {(73),(74),(75)} (as added under the flange in step 28) under the retainers (61) and then torque SHCS (25) as indicated on the drawing. Repeat under other side.

[ ]32. Install the two shoulder hoses (53) onto the fittings (85) as shown on the assembly drawing.

[ ]33. Lightly lubricate the tail bearing of the linear actuator assembly (15) and install the stepped pin (8) through the bore.

[ ]34. Install the bushing (9) over the stepped pin (8).

[ ]35. Connect hoses (53) to the appropriate ports of the linear actuator (15) and place it inside the upper arm. Apply anti-seize to HHCS (10) and secure the linear actuator in the upper arm. The HHCS will be torqued at the next assembly level.

[ ]36. Install the hose (51) and two hoses (52) onto the three fittings (85) in the upper arm (5) as shown on the assembly drawing.

[ ]37. Install the relief valve (31) in the side of the upper arm (5) using the retaining ring (42) as shown on the assembly drawing.

[ ]38. Assemble the wireway relief valve assembly (121),(123),(124) onto the cover (122) using adhesive (111), as shown in detail D of the assembly drawing.

[ ]39. Q.C. Point 3. Verify the complete and correct assembly of the pivot joints. Verify the shimming and friction results on the data sheet. Verify the proper installation of the hose/tube assemblies (17),(18),(19),(20),(21),(51),(52),(53),(62),(66), the retaining ring (42),the seals (64), o-rings (65) the linear actuator (15), the filter element (117) and the wireway relief valve assembly (121),(123),(124). Installation of the filter (117). Check the torque of the fasteners (25). Record your findings on the data sheet.

[ ]40. Install the plug (109) into the filter block assembly.

[ ]41. Q.C. Point 4. Verify installation of plug (109), the gap between flanges is at 5.060" and that the remaining parts have been bagged or boxed, to be returned to stock with the assembly.

Remarks:
Record on the data sheet any pertinent findings or information not directly called for. For example, record any corrective action 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 on which the test was completed.
Record the inspector's name and affix the acceptance tag to the assembly.
Record the Military Specification (as required) to which the assembly was tested, and date on which the test was completed.

W o r k   I n s t r u c t i o n s

Assembly Number: 101-4042 Description: Actuator, Azimuth One Piece Spindle
Product Family: T3/T4

Materials Required:

Chemicals:

Aqua Lube	002-0805	O-ring lube (Dow Corning® 55)	002-0359
Petroleum jelly		Valvoline® Val-plex EP® grease	
Loctite 271 Red	002-0795	002-1032 Loctite 609 Green	

Tools:

Torqo-meter Snap-On tool	#QJFR275E	Snap-On tool extension	010-0459
CV Installation tool	010-0629	O-ring Installation Tool	010-0672
Installation tool	010-0178	Endplate Installation Tool	010-0802
Installation tool	010-0591		

Initial Preparation:

Serialization:

Serialize the actuator housing (1) as shown on the assembly drawing, using the assembly part number, the BOM revision letter and the last five digits of the job number, as the serial number. Add a designation of -1, -2, -3 for jobs consisting of more than one assembly. (i.e. 101-4042 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. 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.

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

[ ]1. Degrease the thrust bearings (30), thrust washers (31), end plates (5), needle bearings (29) and driveshaft (71).

Assembly:

[ ]1. Place one back-up plate (79) onto one of the stator vane halves (10) orientating the radius cutouts per the assembly drawing. Place one seal carrier (64), o-ring (69) over the seal carrier, and then place the vane seal (66) over o-ring, onto the stator vane half with the back-up plate. Orienting the radius cutouts of the vane seal to the back-up plate.

[ ]2. Place another back-up plate (79) on the other stator vane half (10) orienting the radius cutouts per the assembly drawing.

[ ]3. Slide the six HHCS (25) through the clevis (17). Slide the six o-rings (39) over the threads of the bolts and down onto the back face of the clevis bracket.

[ ]4. Install the six o-rings (83) onto the six twelve-point fasteners (74) using tool 010-0672 (85).

[ ]5. Install the two o-rings (35) into the grooves in the azimuth housing (1).

[ ]6. Test fit the two UHMW backup rings (52) on the outside diameter of the end plates (5). The backup rings should be slightly loose around the diameter. If they are not, stretch them slightly. When the backup rings are installed in the grooves of the azimuth housing (1) above the o-rings (35), they should be loaded against the inside wall of the groove.

[ ]7. Use liberal amounts of Valvoline® Val-plex EP® grease to "glue" the needle roller bearings (29) to the inside walls of the end plates (5). Load fifty of the rollers into each end plate.

[ ]8. Apply a film of Valvoline® Val-plex EP® grease to the threads of the thirty-two SHSS (23) and install the screws in the two torque rings (6). Thread the screws in until they are flush with the top and bottom faces of the torque rings.

[ ]9. Install the o-ring (34) and the lip seal (38) into the base flange (15) as shown in the assembly drawing.

[ ]10. Loosely install the three threadlock pins (51) and the three SHSS (20) into the three threaded holes in the spindle nut (8).

[ ]11. Using the arbor press, if necessary, press bearing retainer block (55) into the spindle end cap (72). Use item (91) as needed.

[ ]12. Using Valvoline EP grease to lightly lubricate thrust washers (31) so that they adhere to the spindle nut (8) and bearing retainer block (55). Lightly lubricate the thrust bearings (30) and set them with the thrust washers on spindle nut (8) and bearing retaining block (55).

[ ]13. Apply loctite 271 (90) to the eight SHCS (80) and install the rotor vanes (73) onto driveshaft (71). Use a small clamp seat the rotor vanes together tightly in the driveshaft. Torque SHCS (80) as indicated on assembly drawing and in the sequence shown in Fig. 1.

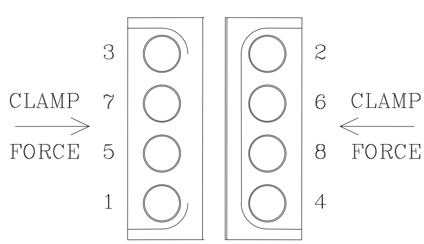


Fig. 1

[ ]14. For the rotor vane seal pack, place the filler plate (78) into one of the back-up plate (79). Slide the seal carrier (64) over the filler plate and seat it against the back-up plate. Place o-ring (69) over seal carrier, and then place remaining vane seal (66) over the o-ring, orienting all the radius cutouts together.

[ ]15. Install the two o-rings (81) into driveshaft (71) as indicated on the assembly drawing.

[ ]16. Q.C. Point 1. Verify the installation of the back-up plates (79), vane seal carriers (64), o-rings (69) and vane seals (66) onto the stator vane (10) and the filler plate (78). Check the installation of the o-rings (39) on the HHCS (25), o-rings (83) onto twelve-point fasteners (74) and o-ring (81) onto driveshaft (71). Verify torque of rotor vane fasthеners (80). Check that the bearing retaining block (55) is seated into spindle end cap (72) and thrust washers (31) and bearings (30) are lubricated. Verify that the o-rings (35) and the back-ups (52) have been installed in the housing. Ensure that the bearings (29) have been installed in the end plate (5). Check the installation of the SHSS (23) into the torque ring (6). Verify that the o-rings (34) and the lip seal (38) have been installed in the base flange (15). Verify that the actuator housing has the correct serial number. Record your findings on the data sheet.

[ ]17. Apply loctite #271 (90) to two SHCS (70) to secure the two stator vane halves (10) together and torque them as indicated on the assembly drawing.

[ ]18. Apply a small amount of EP grease to the six-bolt/clevis unit and slide them into the six holes in the front of the azimuth housing (1). Orient the bracket as it is shown in the assembly drawing. Then, use the six HHCS (25) to secure the stator vane unit to the inside of the housing and seat the six stator bolts. Tightening these screws will secure the stator vane unit up against the housing. Final torqueing of the fasteners will be done late.

[ ]19. Install both end seals (76) onto drive shaft as shown on the assembly drawing. Ensure they slide down onto the drive shaft.

[ ]20. Apply generous amounts of petroleum jelly over the inside diameter of the azimuth housing (1) and the outside diameter of the driveshaft (71).

[ ]21. Orient (or clock) the driveshaft (71) by installing it into the housing as it is shown in the assembly drawing.

[ ]22. Insert the drive shaft (71) into the actuator housing (1) with the rotor lobe oriented 90 degrees from the stator vane (10). Once the rotor is centered on the actuator surface, carefully rotate the rotor so that the lobe is now oriented 180 degrees from the stator vane. Recheck your work to ensure that the rotor is centered on the actuator surface.

[ ]23. Q.C. Point 2. Verify that the clevis/stator unit has been installed in the housing (1) and is in the correct orientation. Check that rotor seal package has two back-up plates (79). Verify that the end seals (76) have been installed and that the

orientation of the rotor vanes (73) in the housing (1) is correct. Record your findings on the data sheet.

[ ]24. Apply petroleum jelly to the bottoms and sides of both end plates (5). Slide both endplates into housing until they rest against the UHMW back-up rings (52). Using tool 010-0802 (88) carefully seat both endplates in housing (1).

[ ]25. Slide one torque ring (6) down into the housing (1) until it bottoms out on the top of the end plate (5). Install the retaining ring (22) in the groove just above the torque ring. Position the gap of the retaining ring so that it is centered over the area of the actuator where the stator vane (10) is located. Ensure that the lock tabs do not get flattened. (If your are unsure how to perform this step, ask an experienced technician for guidance.) Repeat this installation process for the torque ring on the opposite side of the assembly.

[ ]26. Locate the 1/8-inch/3.175 mm diameter hole in the top torque ring (6). Use a pair of calipers to rotate the ring until it is centered with respect to the front of the actuator and is positioned directly over the stator vane (10).

[ ]27. Tighten the sixteen screws (23) to lock the torque ring (6) in place between the end plate (5) and the retaining ring (22). Repeat this process for the other torque ring.

[ ]28. Following the same pattern, torque the setscrews (23) according to the torque specification on the assembly drawing. Repeat the process for the other side.

[ ]29. Use the Torqo-meter Snap-On tool #QJFR275E (or equivalent) with the Snap-On tool extension 010-0459 to torque the six stator HHCS (25) to a reading of 60.8 ft-lb/82.43 N-m on the meter. Because of the extension, this will actually torque the bolts to 73 ft-lb/98.97 N-m.

[ ]30. Using the six twelve-point fasteners (74) install the end cap and bearing unit onto the driveshaft (71). Place the engraved arrow on the end cap (72) in line with the clevis/pin assembly (17) on the housing (1). Torque the twelve-point fasteners (74) as indicated on the assembly drawing.

[ ]31. Thread the spindle nut and bearing unit onto the driveshaft threads and ensure that the thrust washer (31) and the bearing (30) seat correctly in the step on the spindle nut (8). After you have tightened the nut, use the spindle nut wrench #010-0178 to torque the nut to 5 ft-lb/6.78 N-m. After you have torqued the nut, tighten the three setscrews (20) in the side of the spindle nut.

[ ]32. Q.C. Point 3. Check the orientation of the torque rings (6). Verify that the six HHCS (25) have been installed and torqued to the correct value. Check orientation of end cap (72) and torque of twelve-point fasteners (74). Verify that the spindle nut (8) has been installed properly and that the three SHSS (20) have been tightened.

[ ]33. Install the three fittings (44) into the housing (1) as shown in the assembly drawing.

[ ]34. Test 1. At the hydraulic test bench, connect the two appropriate ports on the actuator to a servo valve. Avoid coming against the hard stops while operating the valve for 10 to 20 cycles. Check to see that the actuator is operating smoothly and that there are no external leaks. Perform both breakaway pressure and port-to-port leakage test per SR spec 130-0323. The spindle nut (8) may be tightened to a maximum of 50 ft-lb/67.79 N-m to achieve the best test results. Record the results on the data sheet. Return the assembly to the assembly bench.

[ ]35. Q.C. Point 4. Verify the results of Test 1. Ensure that the fittings (44) have been installed correctly. Record your findings on the data sheet.

[ ]36. Use the installation tool 010-0591 (87) to slide the base flange/lip seal/o-ring over the spindle base and into the actuator housing (1) until it bottoms out on the previously installed retaining ring (22).

[ ]37. Install the retaining ring (21) into the groove just above the base flange (15). (Orientation of the "gap" is <u>not</u> critical on the installation of this retaining ring.)

[ ]38. Install the –2 plug (100) into the port in the azimuth base as shown on the assembly drawing.

[ ]39. Q.C. Point 5. Ensure that the base flange (15), the retaining ring (21) and the –2 plug (100) have been installed. 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 any required corrective action taken for the assembly to pass any of the above tests, failed tests, or problems encountered during assembly or testing.

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.

Work Instructions

Assembly Number: 101-5976 Description: Slave Arm, In Arm SCE, T4, Hawe
Product Family: T4

Materials Required:

Loctite 271 Red	002-0795	O-ring Lube (Dow Corning 55)	002-0359
Aqua Lube	002-0805	EP Grease	
Acetone		Sealant (730 RTV)	002-0801

Tools:

No special tools are required.

Initial Preparation:

Serialization:
Serialize the slave arm, using hand stamps, in location 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 the slave arm at the top of its individual data sheet. In addition, record the serial numbers of the azimuth, azimuth resolver, upper arm, shoulder resolver, elbow, elbow resolver, forearm, pitch/yaw, pitch resolver, yaw resolver and wrist subassembly 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 pitch (11), the yaw (12), and the elbow resolvers onto their respective actuators: the pitch/yaw (5) and the elbow (3). Use the three spacers (60). Six of the SHCS (47), three of the clamps (46), three wire guides (87), three of the retaining rings (48), and three of the wire guides (47) as indicated on the assembly drawing.

[ ]2. Install the six o-rings (15) onto the transfer couplings of the elbow (3) and the pitch/yaw assembly (5).

[ ]3. Install eight of the o-rings (17), one of the o-rings (18), and the four o-rings (30) into the elbow block (21).

[ ]4. Install on of the o-rings (22) into the groove of the rotor manifold of the elbow (3).

[ ]5. Install eighteen of the o-rings (17), one of the o-rings (22), one of the o-ring (26), and on of the o-ring (18) into the forearm manifold (4).

[ ]6. Install the two o-rings (35) onto the shoulder tube (34).

[ ]7. Install the remaining ten o-rings (17) and the remaining o-rings (26) into the counterbores of the wrist assembly (6).

[ ]8. Install the eight o-rings (43) into the counterbores of the stator manifold and the output flange of the elbow (3).

[ ]9. Install the remaining o-ring (18), the eight o-rings (41), the o-ring (62), and the remaining o-ring (22) into the stator manifold of the elbow (3).

[ ]10. Install the o-ring (71) into the grooves of the stator manifolds of the pitch/yaw (5) as shown on the assembly drawing.

[ ]11. Install the o-ring (61) into the cover (65) and the two o-rings (70) into the grooves of the covers (67).

[ ]12. Install the o-rings (55) and (56) and the lip seal (57) into the appropriate grooves of the azimuth lid (52).

[ ]13. Press, DO NOT hammer, to install the roll pin (58) into the top torque ring of the azimuth (1).

[ ]14. Q.C. Point 1. Check the installation of the resolvers (10), (11) and (12), the spacers (60), the wire guides (45), (87), the clamps (46), the SHCS (47) and the retaining rings (48). Check the installation of o-rings (15), (17), (18), (22), (26), (30), (35), (41), (43), (55), (56), (61), (62), (70), (71). Check the installation and orientation of the lip seal (57). Ensure the proper installation of the roll pin (58). Record your findings on the data sheet.

[ ]15. Mount the azimuth actuator (1) to a test stand.

[ ]16. Install the azimuth lid (52) into the azimuth actuator and secure it with the retaining ring (37). Be careful to align the pin to the slot in the lid.

[ ]17. Support the upper arm assembly (2) while connecting the azimuth return, C1, and C2 hoses to the fittings on the azimuth assembly (1), as shown (partially) on the assembly drawing.

[ ]18. Install the shoulder tube (34) into the left side pivot of the upper arm (2) and then slide the tube (and upper arm) into the hole in the azimuth lid (52). Secure the pivot to the azimuth assembly (1) with four of the HHCS (25). Tighten these fasteners to hand tightness.

[ ]19. Swing the right side pivot into place and secure it to the azimuth assembly (1) with the four remaining HHCS (25). Torque the six HHCS (25) as indicated on the assembly drawing.

[ ]20. Insert shear pin shaft (79) into upper arm linear actuator rod end. Line the rod end up between the holes in the clevis, on the azimuth (1), and insert the shear pin ends (80) into the clevis holes. Apply Loctite #271 (82) to both SHCS (81) ad insert through shear pin ends (80) and into shear pin (79). Torque both SHCS (81) as indicated on the assembly drawing.

[ ]21. Install the elbow assembly (3) onto the end of the upper arm (2). Loosen the ten SHCS on the output flange on the elbow to allow the plates to separate just enough to slip the elbow on to the upper arm. Secure the elbow assembly to upper arm with eight HHCS (16) on the ported side of the assembly, and eight of the HHCS (27) on the other side of the assembly, as shown on the assembly drawing. Once installed, re-torque the ten SHCS on the output flange to 15 ft-lb/20.33 N-m. Torque the HHCS (16) and (27) as indicated on the assembly drawing.

[ ]22. Use eight of the HHCS (19) to install the forearm manifold (4) onto the elbow housing. Torque the HHCS (19) as indicated on the assembly drawing.

[ ]23. Install the four BHCS (31) into the ports of the elbow block (21) and tighten them as indicated on the assembly drawing.

[ ]24. Line up the tick mark on the elbow slip ring (3-4) with the tick mark on the elbow slip ring manifold (3-42). Use the six HHCS (23) and the two SHCS from the elbow assembly (3) to secure the slip ring manifold and elbow block (21) to the forearm (4) and elbow assembly. Torque the two SHCS to 19 ft-lb/25.76 N-m and the six HHCS as indicated on the assembly drawing.

[ ]25. Use eight of the HHCS (19) to install the pitch/yaw assembly (5) onto the forearm (4). Torque the HHCS (19) as indicated on the assembly drawing.

[ ]26. Use eight of the HHCS (19) to install the wrist assembly (6) onto the pitch/yaw assembly (5). Torque the HHCS (19) as indicated on the assembly drawing.

[ ]27. Line up the tick mark on the pitch slip ring (5-3) with the tick mark on the pitch slip ring manifold (5-49). Install the slip ring manifold from the pitch/yaw (5) onto the forearm (4) and the pitch actuator. Secure it with the two SHCS (from the pitch/ yaw assembly) and six of the HHCS (27). Torque the two SHCS to 65 in-lb/7.34 N-m and the six HHCS (27) as indicated on the assembly drawing.

[ ]28. Line up the tick mark on the yaw slip ring (5-3) with the tick mark on the yaw slip ring manifold (5-49). Install the slip ring manifold from the pitch/yaw (5) onto the wrist (6) and the yaw actuator. Secure it with the two SHCS (from the pitch/ yaw assembly) and six of the HHCS (27). Torque the two SHCS to 65 in-lb/7.34 N-m and the six HHCS (27) as indicated on the assembly drawing.

[ ]29. Disassemble the Lemo connector on the azimuth resolver (9) cable and feed the cable through the shoulder tube and pivot and into the upper arm (2). Re-assembly the Lemo connector. Use the two clamps (46, the two SHCS (47) and one retaining ring (48) to secure the resolver (9) in the azimuth assembly (1). Install on of the wire guide (45) as shown on the assembly drawing.

[ ]30. Use the remaining retaining ring (48), the spacer (51), the retaining ring (50) and the wire guide (45) to install and secure the shoulder resolver (13) in the right shoulder pivot of the upper arm (2).

[ ]31. Feed the resolver cables from the wrist (6) and the pitch/yaw (5) through the wire guides (87) and into the forearm (3).

[ ]32. Make the appropriate connections in the forearm manifold (4) between each of the labeled Lemo connectors.

[ ]33. Install one small wire tie (75) around each bundle of resolver wires just below the wire guide at the elbow, pitch and yaw. Be sure the small colored wires can not get caught in the slot of the wire guide.

[ ]34. Install the o-rings from the upper arm (2) assembly into the appropriate locations on the upper arm.

[ ]35. Torque the two linear actuator pivots bolts (2-10) of the upper arm assembly (2) as indicated on the assembly drawing.

[ ]36. Q.C. Point 2. Check the installation of the azimuth (1), the lid (52) and the retaining ring (37). Ensure the installation of the shoulder tube (34). Verify the installation of the upper arm (2) and check the connections of C1 and C2 return lines. Check installation of the elbow (3). Check installation of the forearm (4) and the elbow block (21). Check the installation of the pitch/yaw (5). Verify the correct orientation of the elbow and pitch/yaw slip ring manifolds. Check the installation of the wrist assembly (6). Check the installation of the azimuth resolver (9), the wire guide (45), the clamp (46), the SHCS (47) and the retaining ring (48). Check the installation of the shoulder resolver (13), the wire guide (45) the retaining ring (48), the retaining ring (50) and the spacer (51). Check the installation of fasteners (16), (19), (23), (25), (27), (31) and (81). Check the routing and connection of the resolver cables. Record your findings on the data sheet.

[ ]37. Install the jaw kit (7) onto the wrist (6) a shown on sheet 4 of the assembly drawing. Torque the jaw bolts (7-77) as indicated on the assembly drawing.

[ ]38. Install the SCE assy (29) into the forearm.

[ ]39. Ensure that all electrical connectors are packed with DC-5.

[ ]40. Use the retaining ring (49) to secure the azimuth cover (53) in the azimuth lid (52).

[ ]41. Install fittings (54) and (73) into the back of the azimuth lid (52).

[ ]42. Use the double side tape (94) to secure the logo plate (89) to the lid and back of forearm (4) as shown on the assembly drawing. Use alcohol to clean all surfaces prior to installation. To ensure good adhesion, use clamps for 5-10 minutes to apply pressure between the logo plates and lid and forearm.

[ ]43. Q.C. Point 3. Verify the correct installation of the jaw kit (7), SCE assy (29), retaining ring (49), the azimuth cover (53) and the relief valve (54) into the azimuth lid (52). Ensure logo plates (89) have been oriented correctly. Record your findings on the data sheet.

[ ]44. Secure the upper arm covers with the HHCS from the upper arm (2). Install all remaining wireway covers, as shown on the assembly drawing, and secure all the covers by torquing the supplied 10-32 HHCS to 8 ft-lb/10.85 N-m and the ¼-28 HHCS (64) as indicated on the assembly drawing.

[ ]45. Install shoulder lids into the housings using the threaded heat shrinked rod.

[ ]46. Install bag bumpers (90) and (91) for the shoulder pivot housings.

[ ]47. Q.C. Point 4. Verify the final configuration of the assembly. 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.

Drawings & Part Lists

1 Organization

The drawings and part lists in this chapter are in numerical order, ordered first by the three digit prefix, then by the following numbers.

- The drawing and part list for a component are located together.
- Drawing and part list revisions (“Rev X”) are not linked and can differ.
- Parts identified with a numbered bubble on a drawing are referenced to their “Item” number on the part list.
- Electrical schematics (prefix 035-) and hydraulic schematics (prefix 025-) do not have part lists.

2 Index

Where the page number is followed by an asterisk (*), a larger paper copy of the drawing is provided at the end of the chapter.

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- Drawings & Part Lists

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Slave Arm

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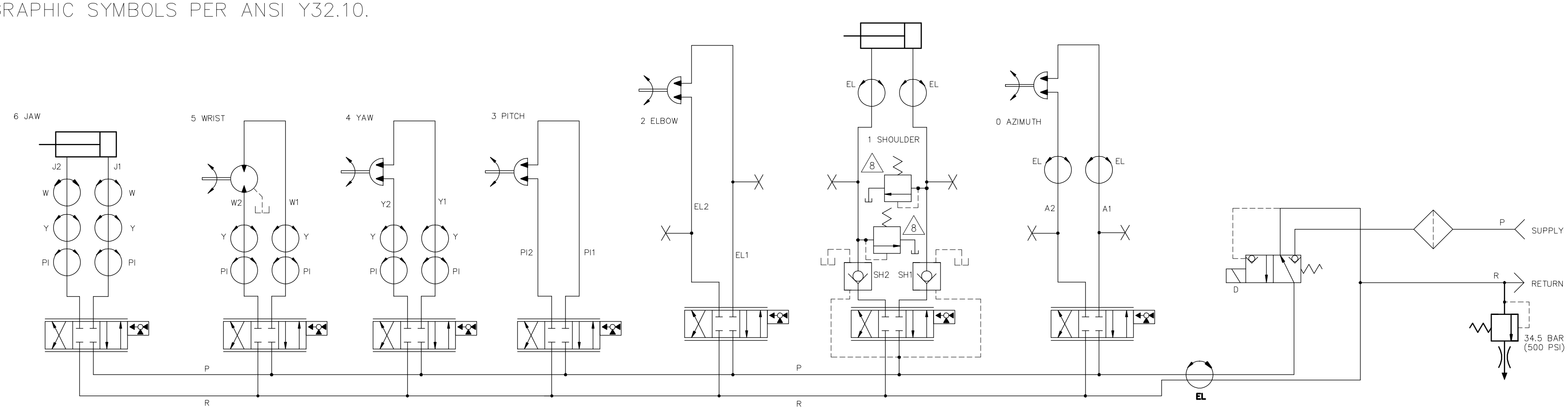
3 Reference Drawings

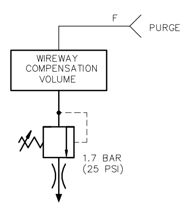
The B-size (11 x 17-in.) paper Reference Drawings section follows this printed chapter.

NOTES:

1. SUPPLY PRESSURE 3000 PSI. [207 Bar]
2. PROOF PRESSURE:
   SUPPLY 4500 PSI [310 Bar]
   RETURN 1000 PSI (R ≤ S) [31 Bar]
   WIREWAY COMPENSATION 38 PSI [2.6 Bar]
3. BURST PRESSURE:
   SUPPLY 9000 PSI [621 Bar]
   RETURN 3000 PSI (R ≤ S) [207 Bar]
   WIREWAY COMPENSATION 200 PSI [14 Bar]
4. FILTRATION:
   10 MICRON NOMINAL
   25 MICRON ABSOLUTE
5. VISCOSITY RANGE 10 CS TO 110 CS.
6. GRAPHIC SYMBOLS PER ANSI Y32.10.
7. ALL OVERALL DRAWING DIMENSIONS ARE FOR REFERENCE ONLY. METRIC EQUIVALENTS SHOWN IN BRACKETS [ ].
8. RELIEF VALVE SETPOINT IS 3600 ±500 PSI.

REV	SHT	ZONE	DESCRIPTION	DATE	BY	APPR
A	–	–	RELEASED FOR PRODUCTION	7/23/07	CRL	SLW
B	1	B1	1000 PSI WAS 450 PSI	11/21/07	NLH	SLW
C	–	–	UPDATED DRAWING WITH PROPER SYMBOLS, CHANGED SHT SIZE FROM "C" TO "B" ON ALL SHTS.	10/17/08	NLH	AH
D	2	A2	REVISED UPPER ARM HYDRAULIC DETAIL	5/5/09	RDJ	WK





PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

NEXT ASSEMBLY

101–2250	101–3126
101–2920	101–3136
101–2926	101–3171
101–3109	101–3214

	SIGNATURE	DATE
DRAWN	CRL	7/23/07
DESIGNED	TL	7/16/07
CHECKED		
LEAD	SLW	

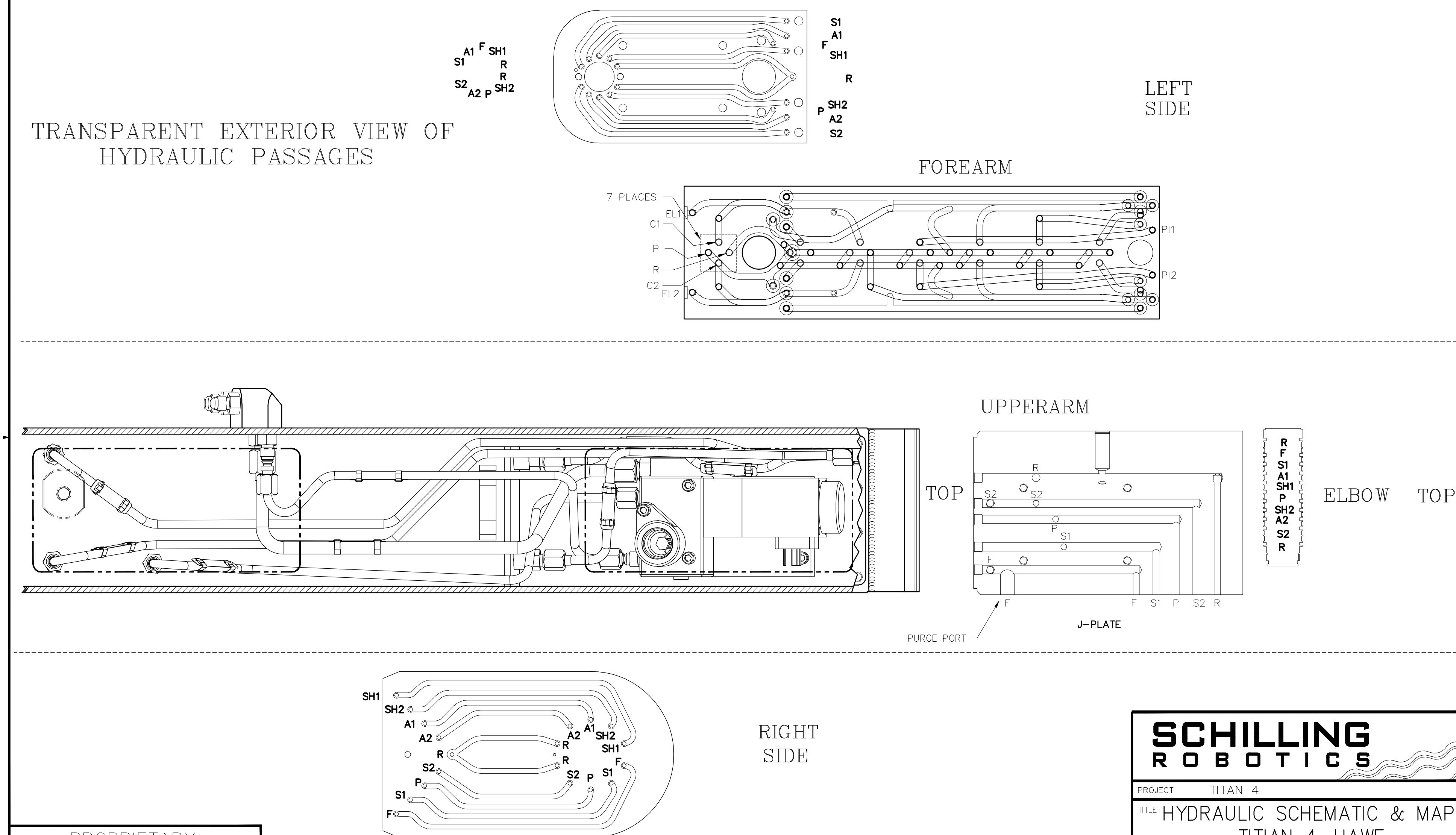
SCHILLING ROBOTICS

PROJECT TITAN 4

TITLE HYDRAULIC SCHEMATIC & MAP, TITAN 4, HAWE

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=2.50	025–0102	B	1 OF 3	D

TRANSPARENT EXTERIOR VIEW OF HYDRAULIC PASSAGES



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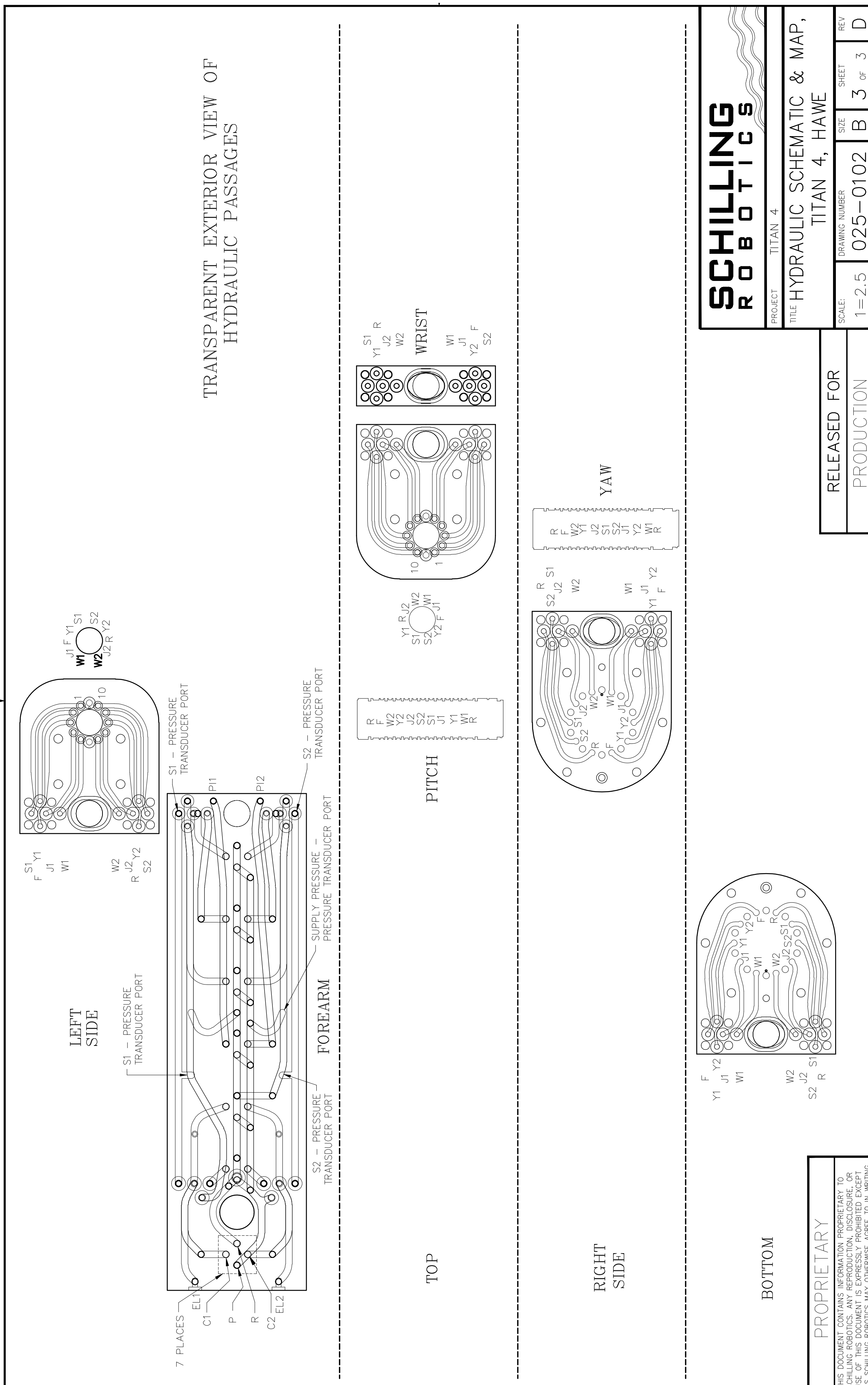
SCHILLING ROBOTICS

PROJECT	TITAN 4
TITLE	HYDRAULIC SCHEMATIC & MAP, TITIAN 4, HAWE

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=2.75	025–0102	B	2 OF 3	D


TRANSPARENT EXTERIOR VIEW OF
HYDRAULIC PASSAGES
LEFT SIDE
FOREARM
TOP
PITCH
WRIST
RIGHT SIDE
YAW
BOTTOM
S1 - PRESSURE TRANSDUCER PORT
S2 - PRESSURE TRANSDUCER PORT
SUPPLY PRESSURE - PRESSURE TRANSDUCER PORT
7 PLACES
EL1
C1
P
R
C2
EL2
PI1
PI2
RELEASED FOR
PRODUCTION
SCHILLING
ROBOTICS
PROJECT TITAN 4
TITLE HYDRAULIC SCHEMATIC & MAP, TITAN 4, HAWE
SCALE: 1=2.5
DRAWING NUMBER 025-0102
SIZE B
SHEET 3 OF 3
REV D
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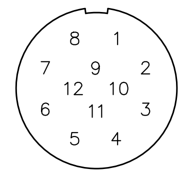
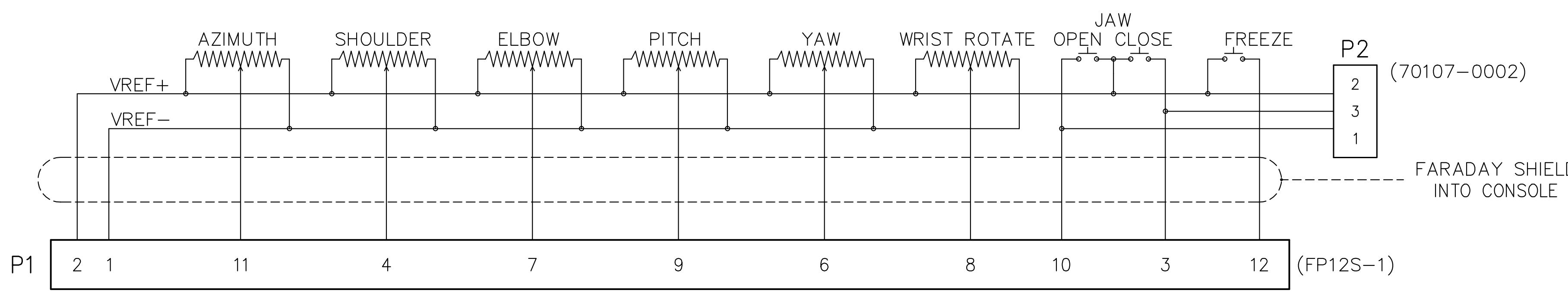
REV	ZONE	DESCRIPTION	DATE	BY	APPR
A	–	ADDED NEW BORDER	5/14/96	DD	RJ
B	B1	ADDED CONNECTOR P2	9/1/99	PN	SLW



VIEW OF MATING SURFACE
OF MICROTECH FP–12S–1 PLUG.

ALL POTENTIOMETERS = 3000 OHMS +/– 30 PERCENT
VREF+ = 5 VDC +/– 5 PERCENT
VREF– = –5 VDC +/– 5 PERCENT



GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±0.1 .XX ±0.02 .XXX ±0.005	±1/16	.X ±30' .XX ±15'

NEXT ASSEMBLY

	SIGNATURE	DATE
DRAWN	RS	5–15–96
DESIGNED	RS	5–15–96
CHECKED		
LEAD	PW	

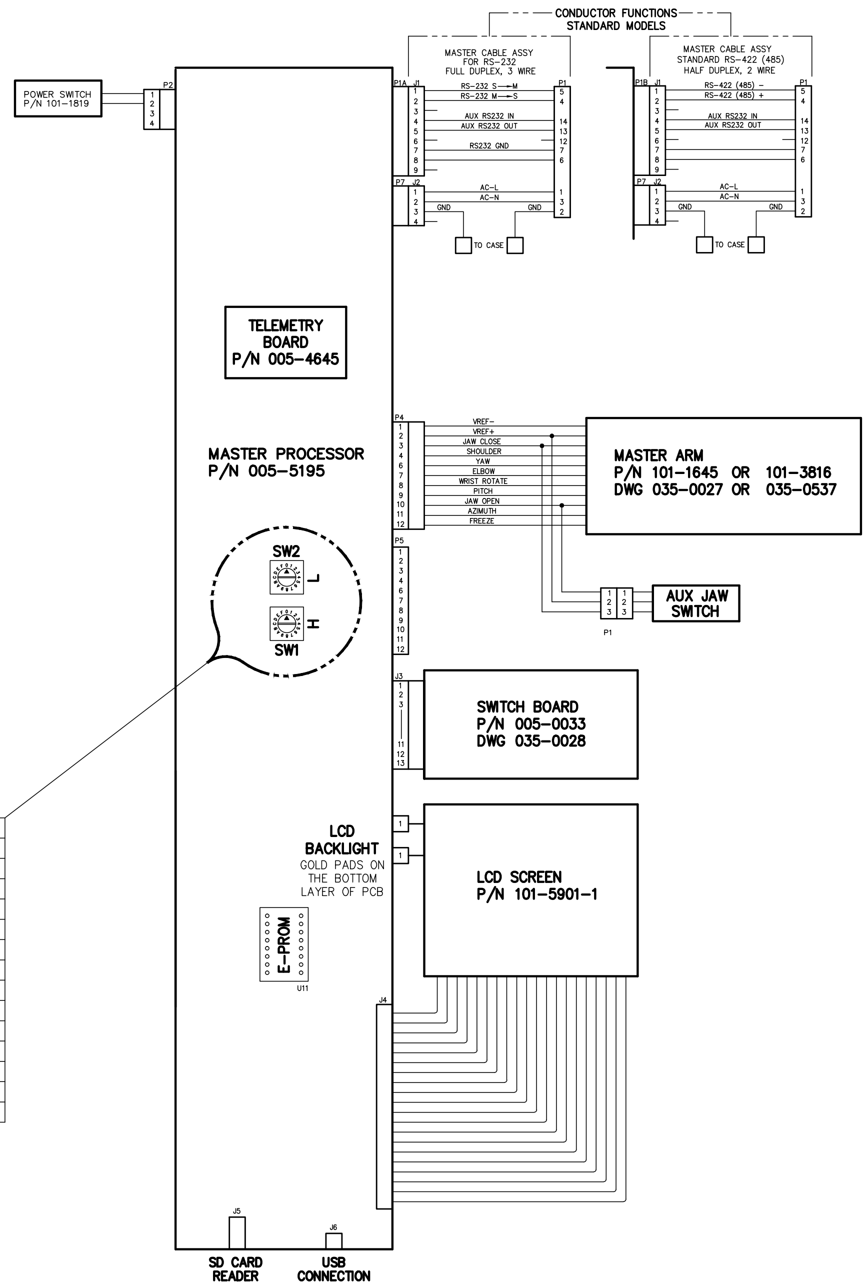
ALSTOM
AUTOMATION
Schilling Robotics

PROJECT TITAN

TITLE MASTER ARM WIRING

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	035–0027	B	1 OF 1	B

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	RELEASED FOR PROTOTYPE	1/15/07	GD	SLW
–	1	–	ADDED ORION MCA P/N TO DWG, AND NOTES	8/31/07	VDM	SLW
–	A	–	RELEASED FOR PRODUCTION	9/17/07	JG	SLW
–	B	–	UPDATED CONDUCTOR FUNCTIONS	9/24/08	DI	SLW
1199	C	2D, 4A, B2, B3	UPDATED CONDUCTOR FUNCTIONS, UPDATED HEX SWITCH SETTINGS, P/N 101-5901-1 WAS P/N 101-3821, J4 WAS J7, ADDED GOLD PADS NOTE TO LCD BACKLIGHT	6/03/10	SWR	TL



HEX SWITCH SETTINGS

H	L	DESCRIPTION
0	0	TITAN 4
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	E-PROM
F	0	SD CARD READER
0	F	SD CARD WRITER
4	0	BUZZER TEST

PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	JSH	7/10/97
DESIGNED	DB	7/10/97
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

PROJECT T4 07P

TITLE WIRING DIA, MASTER CONSOLETTE, 85-264VAC, MASTER PROCESSOR

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:2.25	035-0731	C	1 OF 1	C

Linear Actuator, 101-2354

Rev. D

Item	P/N	Description	Qty
1	001-1777	PSTN,LIN ACTR 1.75	1
2	001-1778	SFT,LIN ACTR,8 IN	1
3	001-12676	ROD END, TITAN 4, DRILLED	1
4	001-2703	GLAND,NOSE,LIN ACTR	1
6	003-0114	BRG,PVT,LIN ACTR,T2 GAMMA	2
7	003-0115	BRG,PSTN,LIN ACTR,T2 GAMMA	2
8	004-0649	SEAL,PSTN,LIN ACTR,T2/3,GAMMA	1
9	004-0669	O-RING,2-031,BUNA 90	1
10	001-0893	BRG,ROD	2
11	004-0650	SEAL,ROD,LIN ACTR,GAMMA	2
12	004-0651	SCRAPER,ROD,LIN ACTR,T2 GAMMA	1
13	007-0199	BODY,LIN ACT.,1.75X8,PORTS,55	1
14	004-0082	O-RING,3-904 BUNA 90	0
15	006-0108	FIT,HYD,-4,JIC,-4 ST,ELB,MALE	2
21	002-0795	ADH,#271 RED LOCTITE 50ML	0
23	002-0291	PRIMER,~N~,LOCTITE,1.75 OZ BTL	0
25	010-0184	TOOL,INSTL,M,1.75	0
26	010-0185	TOOL,SIZING,F,1.75	0
27	010-0203	TOOL,SIZING,M,1.0	0
28	010-1457	TOOL,BEARING INSTL & RMV	0
29	010-0759	CROWSFOOT,OPEN END,1 5/8	0
1000	101-2354-WI	WORK INSTRUCTIONS	0

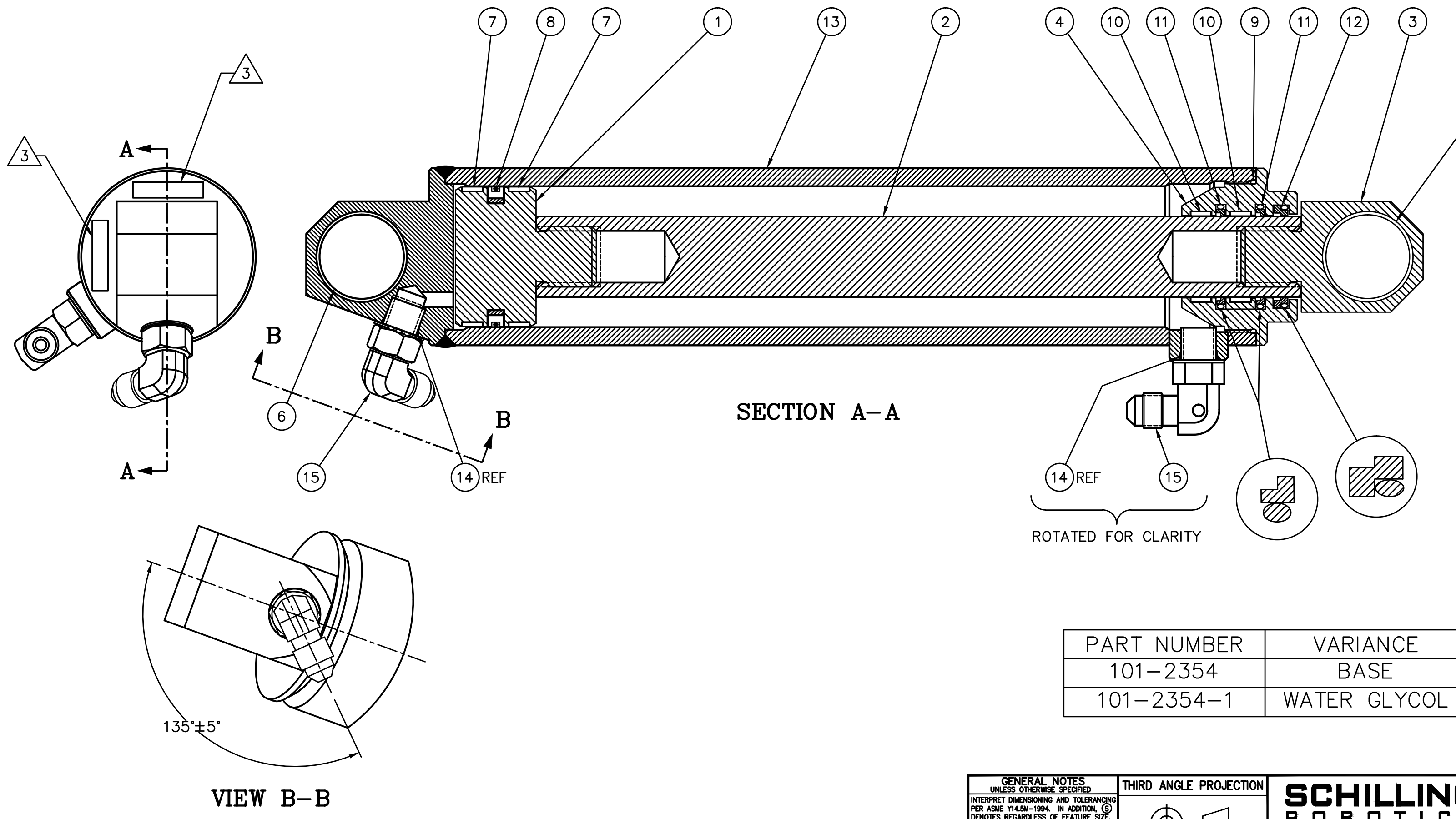
NOTES:

1. FOR 101–2354–1 ASSEMBLY, USE WATER GLYCOL (ITEM 22) IN PLACE OF LUBRICANTS CALLED OUT BY THE SHOP STANDARD
2. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
1 & 3	75 FT–LBS [101.7 N–m]
4	240 FT–LBS [325.4 N–m]
15	21 FT–LBS [28.5 N–m]

3. (△3) STAMP SERIAL NUMBER AND PART NUMBER PER SHOP STANDARD

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	A		AS RELEASED	12/21/94	SS	LC
–	B		ADDED NOTE 3 & CHANGED SHAPE OF ITEMS 11 & 12	6/1/95	DD	LC
–	C	A4	ADDED METRIC EQUIVALENTS AND NOTE 4	9/17/97	DM	LC
–	D	C1,D1	MOVED SERIAL TAG LOCATION	6/30/04	RJ	WK
–	E	C1,D1	ADD PART NUMBER & SERIALIZATION TAG	4/21/05	KJ	WK
–	F	C4,C3	ROTATED ITEM 15 135°	9/21/07	NLH	WK
1731	G	–	ADDED VARIANCE TABLE, UPDATED SHEET FORMAT TO NEW STANDARDS	9/9/10	NLH	JAK



SECTION A–A

VIEW B–B

PART NUMBER	VARIANCE
101–2354	BASE
101–2354–1	WATER GLYCOL

PROPRIETARY

RELEASED FOR **PRODUCTION**

GENERAL NOTES
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INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

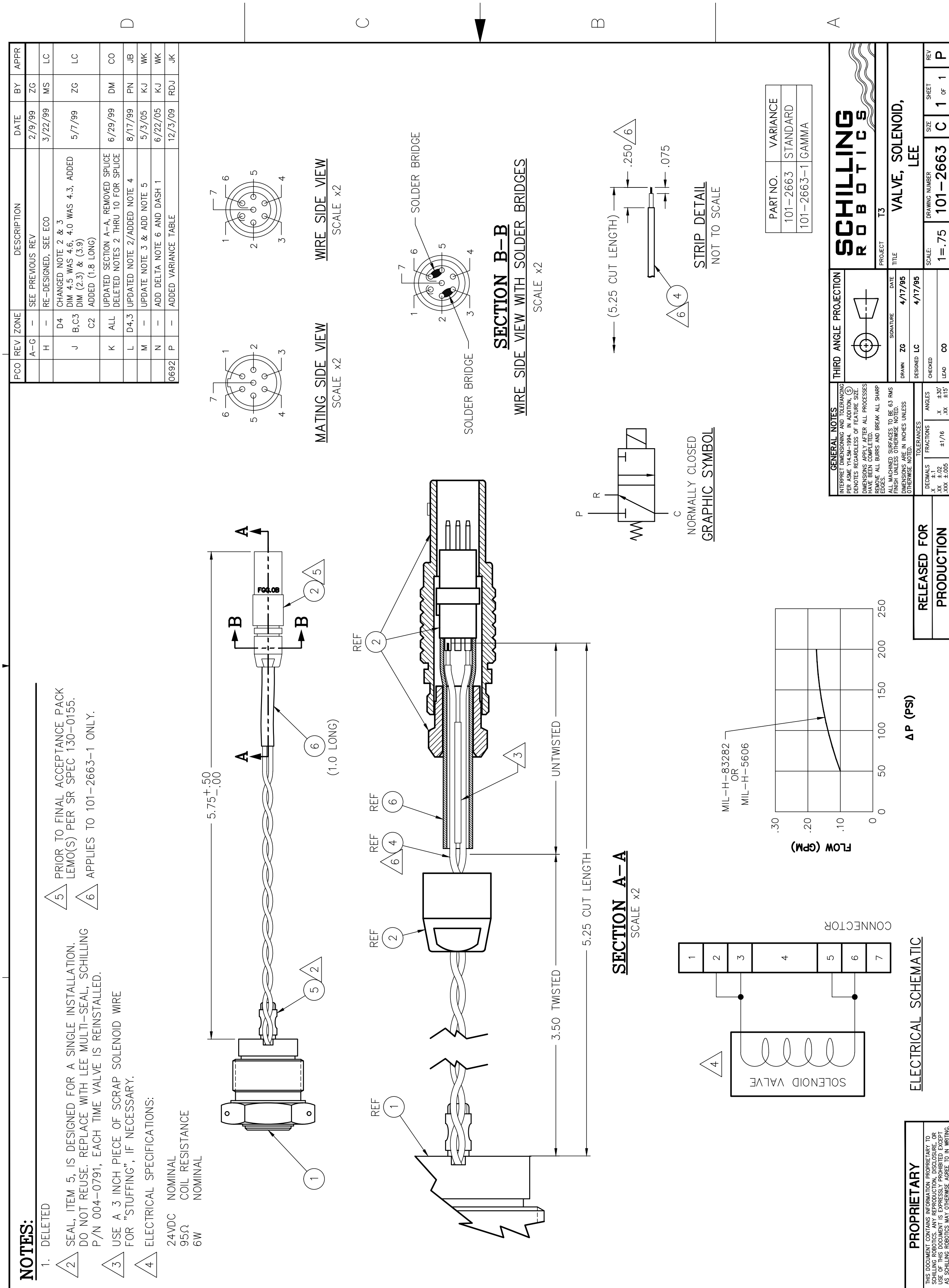
	SIGNATURE	DATE
DRAWN	S. SAUER	12/21/94
DESIGNED	G. COLLIER	12/21/94
CHECKED		
LEAD	LC	

SCHILLING ROBOTICS

PROJECT T3

TITLE LINEAR ACTUATOR,

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1	101–2354	C	1 OF 1	G



NOTE: Drawing only

Ca Assy, Power/Telem, CPC/Burton, 101-4018-1

Rev. D

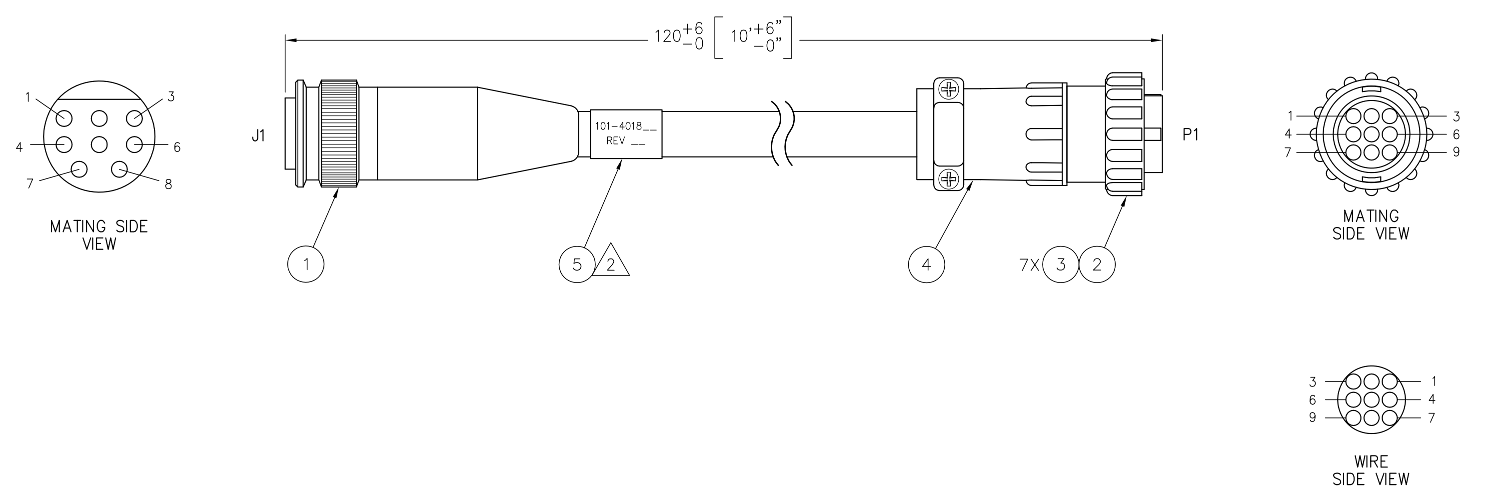
Item	P/N	Description	Qty
1	005-2059	CONN,8 PIN,BURTON SUBSEA,10 FT	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	7
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-3094	SHRINK,TBG,3/4~,WHT,PRINTABLE,	0
1000	101-4018-WI	WORK INSTRUCTIONS	0

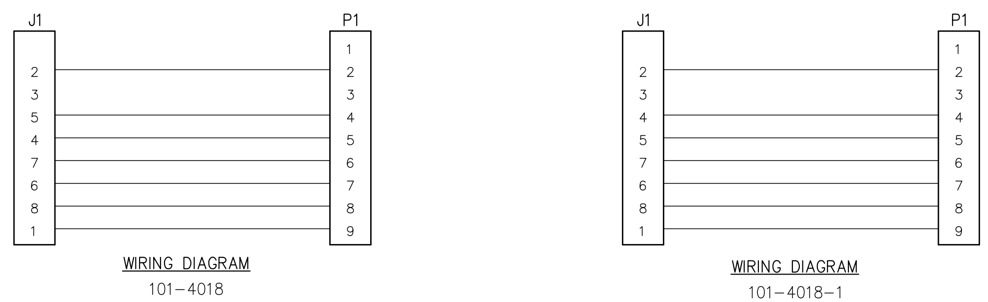
NOTES:

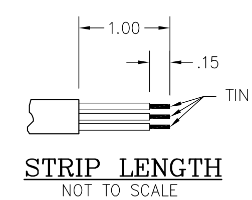
1. DELETED

2. LABEL SHRINK TUBING WITH PART NO. AND CURRENT BOM REVISION.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	PRELIMINARY	2/9/98	DM	
–	1–E	–	SEE PERVIOUS ECO'S	1/21/01	ZG	CM
–	F	A2	1.00 STRIP LENGTH WAS .700	7/23/01	DM	SLW
–	G	–	+VDC WAS +12V & –VDC WAS –12V	5/2/05	KJ	WK
–	H	–	UPDATED WIRING DIAGRAM	3/2/07	JG	WK
–	J	–	ADDED –1 VARIANT	9/25/08	RDJ	SLW
–	K	–	SWAP PINS 6 & 7 ON 101–4018–1 SCHEM ADDED VARIANCE TABLE	11/18/08	PK	WK
2514	L	A2	CHANGED DASH 1 WIRING DIAGRAM AND DRAWNG SIZE FROM B TO C DELETED NOTE 1	3/15/11	TF	SS
3781	M	–	UPDATED BOTH WIRING DIAGRAMS; UPDATED –1 VARIANCE TABLE NAME.	12/15/11	JB	TR







PART NO.	VARIANCE
101–4018	STANDARD WIRING
101–4018–1	NULL MODEM

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TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	D. MAYNE	2/9/98
DESIGNED	C. PERKINS	2/4/98
CHECKED		
LEAD	P. WAGNER	

SCHILLING ROBOTICS

PROJECT: ORION 7P

TITLE: CABLE ASSEMBLY 07P SCU TO J–BOX

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1	101–4018	C	1 OF 1	M

Azimuth Actuator, 101-4042

Rev. N

Item	P/N	Description	Qty
1	001-5127	HOUSING,AZIMUTH,T3	1
5	001-1816	PL,END,AZ,T2	2
6	001-1817	RING,TRQ,AZ,T2	2
8	001-1819	SPDL,NUT,AZ	1
10	001-5311	STATOR,VANE,T3	2
15	001-1824	FLG,BASE,AZ,T2	1
17	001-2472	CLEVIS,SHLDR,T2/SP	1
20	002-0703	SCR,SET,1/4-28X.312,FLAT POINT	3
21	002-0705	RING,RETING,INTL,SMALLEY WH562	1
22	002-0880	RING,RETING,INTL,W/LOCKING TAB	2
23	002-0707	SCR,SET,3/8-24 X.5,FLAT POINT	32
25	002-1541P	NAS 6406PU14,NLK	6
29	003-0018	TORRINGTON,C436Q	100
30	003-0071	BRG,THR,NEEDLE RLR,NTA 5266	2
31	003-0072	WSHR,THR,NEDDLE RLR,TRA 5266	2
34	004-0563	O-RING,2-160 BUNA 70	1
35	004-0564	O-RING,2-161 BUNA 90	2
38	004-0610	SEAL,FLUROCARBON #AR10400-348-	1
39	004-0190	O-RING,2-012 BUNA 90	6
44	006-0108	FIT,HYD,-4,JIC,-4 ST,ELB,MALE	3
45	010-0629	TOOL,INSTL,CV PLUG,281,SHORT	0
51	002-5473	PIN,DWL,3/16X1/2,DELRIN	3
52	001-2173	RING,BACK-UP,AZ,T2	2
55	001-5302	BLK,BRG RETER,AZ	1
64	001-5324	CARR,VANE SEAL,AZ	2
66	001-5309	SEAL,VANE,AZ,T3	2
69	004-0542	O-RING,2-034 BUNA 70	2
70	002-0440	SHCS,3/8-24X1.0,SS	2
71	001-5291	DRIVE SFT,RTRBODY,AZ,T3	1
72	001-5292	END CAP,RTR BODY,AZ,T3	1
73	001-5293	ROTOR VANE,AZIMUTH,T3	2
74	001-5440P	NAS 1275-8,1/2-20X1.25 12PT	6
76	001-5308	SEAL,END,AZ,T3	2
78	001-5312	PL,FILLER,VANE SEAL,AZ,T3	1
79	001-5313	SEAL,BACK-UP,VANE,AZ,T3	4
80	002-1892	SHCS,7/16-20X1.25,ASTMA574	8
81	004-0697	O-RING,2-041,BUNA 90	2
83	004-0115	O-RING,.492x.039 BUNA 90 APPLE	6
84	006-0096	FIT,HYD,-4,JIC,CAP-SS(4-FNTX-S	3
85	010-0672	O-RING INSTL TOOL,T3	0
86	010-0178	TOOL,SPDL NUT,WR,T2/3	0
87	010-0591	TOOL,INSTL,SEAL,AZIM,T2/T3	0
88	010-0802	TOOL,END PL,INSTL,AZ	0

Azimuth Actuator, 101-4042 (cont.)

Rev. N

Item	P/N	Description	Qty
89	010-0459	WRENCH,EXT.,MOD	0
90	002-0795	ADH,#271 RED LOCTITE 50ML	0
91	002-1032	ADH,LOCTITE 609,RETING CMPD	0
100	006-1304	FIT,PLUG,2HP5ONSS,-2 HOL,HEX/S	1
110	101-4042-WI	WORK INSTRUCTIONS	0

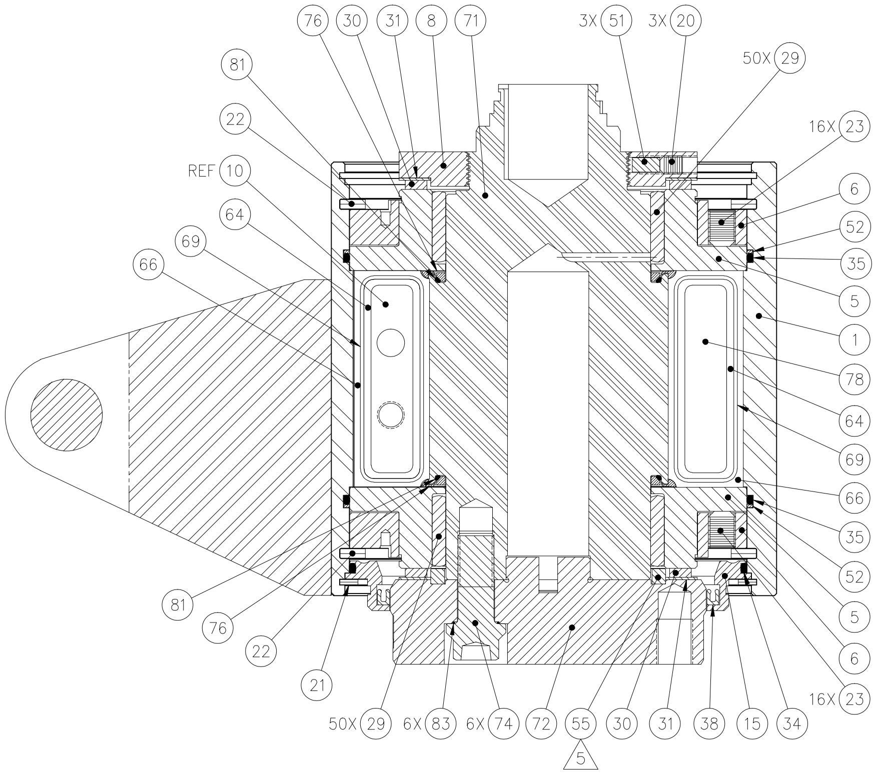
NOTES:

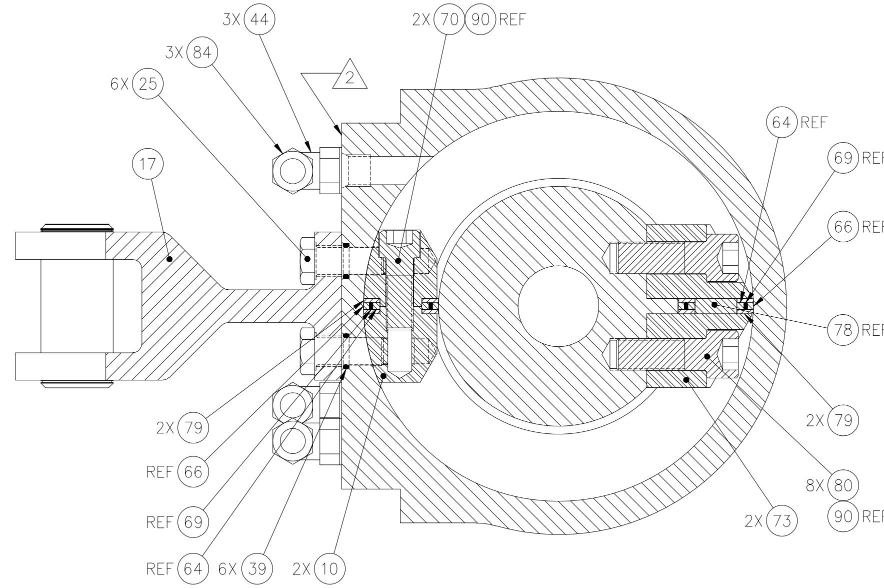
1. DELETED
2. (△2) SERIALIZE IN LOCATION SHOWN AS DESCRIBED IN WORK INSTRUCTIONS.
3. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
8	5 FOOT LBS. [6.8 N–m]
23	15 FOOT LBS. [20.3 N–m]
25	73 FOOT LBS. [99.0 N–m]
70	44 FOOT LBS. [59.7 N–m]
74	175 FOOT LBS. [236.8 N–m]
80	75 FOOT LBS. [101.7 N–m]

4. ALL OVERALL DRAWING DIMENSIONS FOR REFERENCE ONLY. METRIC EQUIVALENTS SHOWN IN BRACKETS [ ].
5. (△5) USE ITEM 91 AS NEEDED.

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	–	PRELIMINARY	6/18/98	PN	LC
	1	1 2	D3,4 C1,3	DELETED ITEM 20 FROM TORQUE SPEC, DELETED NOTE 4, NOTE 5 NOW 4 ADDED ITEM 90 2X, MOVED ITEM 55	5/24/99	DM	CO
	2	ALL	A1	UPDATED TITLE BLOCK	10/23/99	MS	CO
	A	–	–	RELEASED FOR PRODUCTION	10/27/99	LD	CO
	B	1 2 2	B–C1 D2 B1	ADDED ITEM 90 REF TO ITEMS 70, 80 ADDED 90 REF TO ITEM 70 DELETED 90 REF FROM ITEM 74	9/13/00	MS	SLW
	C	ALL	–	UPDATE ITEMS 15, 72 & ADD ITEM 100	4/19/05	KJ	
	D	–	–	DELETED ITEM 43, REMOVED CV PLUG HOLES OF ITEM 1.	4/24/06	GD	GJC
	E	–	–	ADDED DELTA NOTE 5	4/14/08	NLH	SLW
0692	F	–	–	ADDED VARIANCE TABLE	12/3/09	RDJ	JK





PART NO.	VARIANCE
101–4042	STANDARD
101–4042–1	GAMMA

PROPRIETARY

RELEASED FOR
PRODUCTION

GENERAL NOTES
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

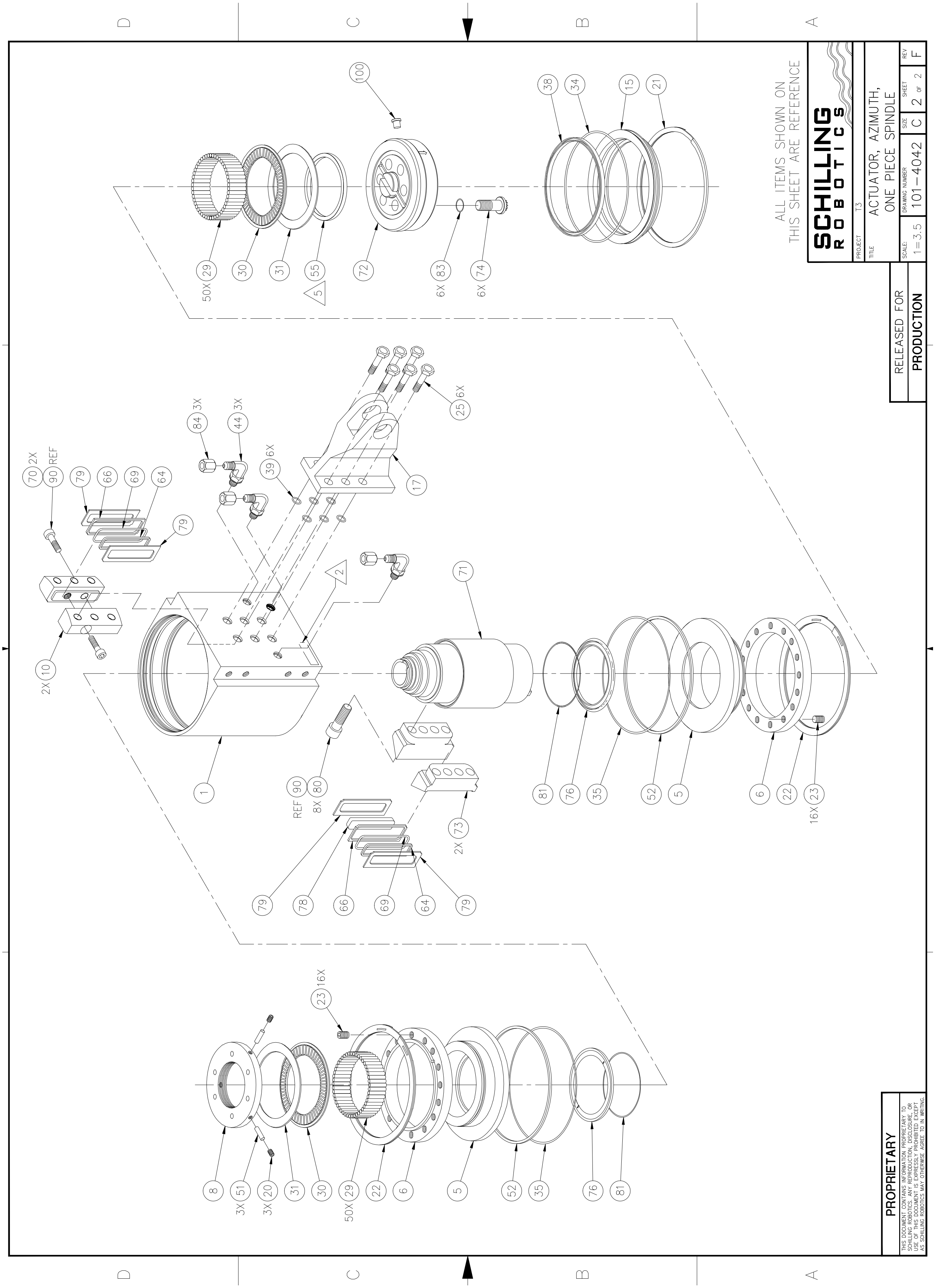
THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	PN	6/12/98
DESIGNED	SW	5/22/98
CHECKED		
LEAD	CO	

SCHILLING ROBOTICS

PROJECT: T3
TITLE: ACTUATOR, AZIMUTH, ONE PIECE SPINDLE

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.25	101–4042	C	1 OF 2	F

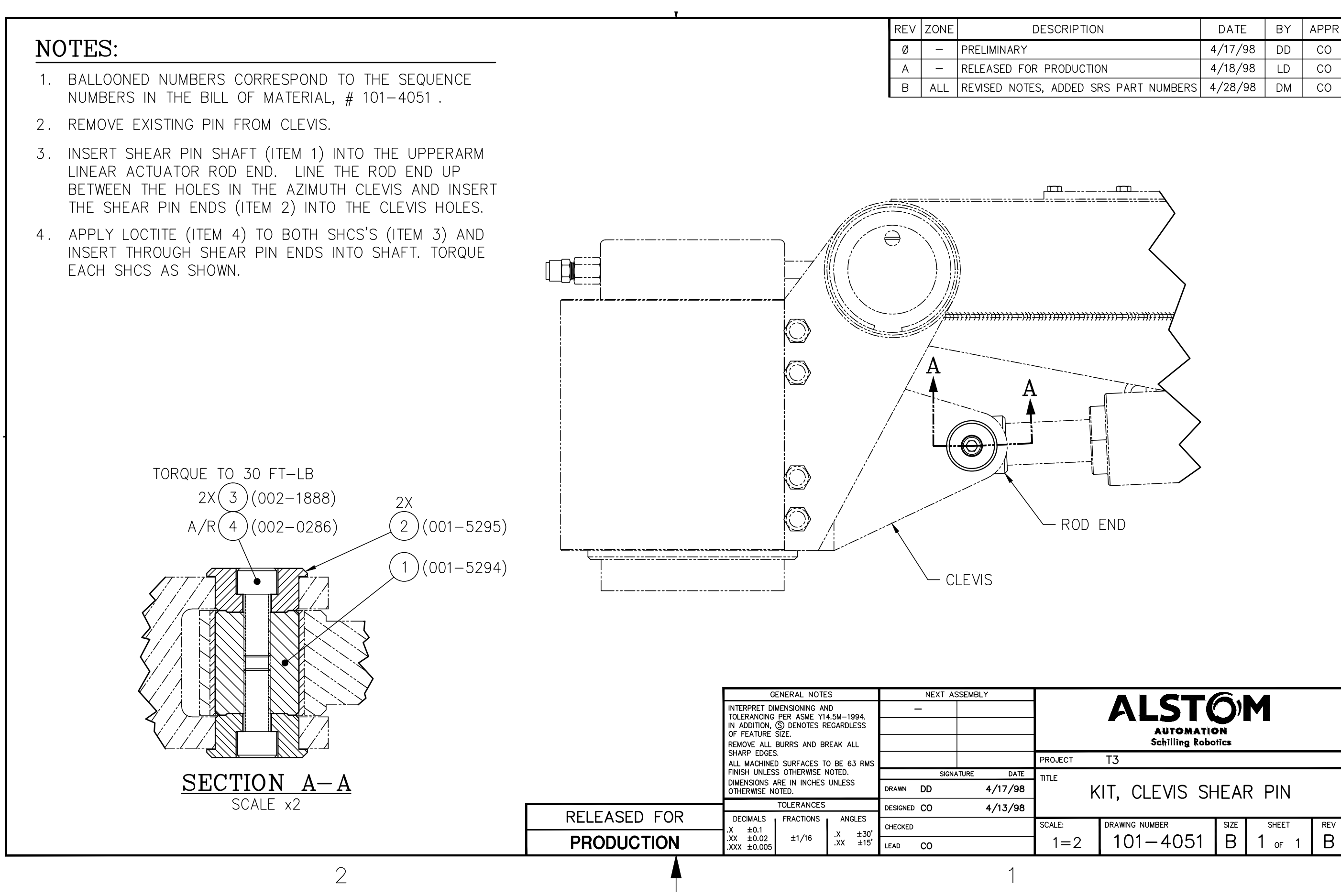


ALL ITEMS SHOWN ON THIS SHEET ARE REFERENCE
SCHILLING ROBOTICS
PROJECT T3
TITLE ACTUATOR, AZIMUTH, ONE PIECE SPINDLE
SCALE: 1=3.5
DRAWING NUMBER 101-4042
SIZE C
SHEET 2 OF 2
REV F
RELEASED FOR PRODUCTION
PROPRIETARY
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO SCHILLING ROBOTICS; ANY REPRODUCTION, DISCLOSURE, OR USE OF THIS DOCUMENT IS EXPRESSLY PROHIBITED EXCEPT AS SCHILLING ROBOTICS MAY OTHERWISE AGREE TO IN WRITING.

Clevis Kit, Shear Pin, 101-4051

Rev. B

Item	P/N	Description	Qty
1	001-5294	SHAFT, SHEAR PIN	1
2	001-5295	END,SHEAR PIN	2
3	002-1888	SHCS,5/16-24X3/4L,120K-150K	2
4	002-0286	ADH,LOCTITE 271(RED 10CC BTL)	1



Elbow Actuator, 101-4077

Rev. M

Item	P/N	Description	Qty
1	001-5128	HOUSING,ELBOW,T3	1
2	001-5362	VANE,RTR,ELB,T3 1/2	2
3	001-5361	DRIVESFT,RTRBODY,ELB,T3 1/2	1
4	001-12480	SLIP RING, HYDRAULIC, ELBOW	1
5	001-3750	END PLATE, ELBOW, T3	2
6	001-2054	RING,TRQ,ELB T2	2
7	001-5366	SEAL,END,ELB,T3 1/2	2
10	001-5363	VANE, STATOR, ELBOW, T3	2
13	001-1804	FLG,OUT,ELB,T2	1
14	002-0879	RING,RETING,INTL,W/LOCKING TAB	2
15	002-0700	RING,RETING,SMALLEY #WSM150	1
18	002-0935P	SHCS,1/4-28x1/2,A286,SLVR,NLK	10
22	003-0012	TORRINGTON,Q11406	150
24	003-0067	BRG,THR,TORRINGTON TRB 4860	4
25	003-0030	BRG,THR,TORRINGTON,NTA-4860	2
26	003-0068	RACE,THR,TORRINGTON,TRA2435	1
27	003-0069	SLYDRING,BRG	2
28	004-0556	SEAL,SLIPRING,ELB,T2 (PER SDI	11
31	001-5365	BACK-UP,VANE SEAL ELB,T3 1/2	4
32	001-5364	SEAL,VANE,ELB,T3 1/2	2
33	004-0610	SEAL,FLUROCARBON #AR10400-348-	2
34	004-0561	O-RING,.228X.040,BUNA 70	20
36	004-0627	O-RING,.189X.039,BUNA 90	10
39	004-0562	O-RING,2-158 BUNA 70	2
40	002-0703P	SCR, SET, 1/4-28X.312,FLAT,NLK	40
43	007-0204	MANIFOLD,STATOR ELBOW,T3	1
46	004-0137	O-RING,.244x.039 BUNA 90 APPLE	6
47	002-0052P	NAS 6404PU3,NLK	6
48	001-2174	RING,BACK-UP,ELB	2
50	002-1132	SHCS,1/4-28X3/4 UNBRAKO ONLY	6
52	001-2215	RING,ELB BRG	2
54	001-2197	SHIM,ELB,.001THK,T2	0
55	001-2198	SHIM,ELB,.003THK	0
56	001-2199	SHIM,ELB,.005THK,T2	0
57	001-2200	SHIM,ELB,.007THK	0
58	001-2201	SHIM,ELB,.008THK,T2	0
59	004-0210	O-RING,2-128 BUNA 70	11
61	001-2729	SLEEVE	1
62	002-0727P	SHCS,1/4-28X1/2,ALLOY, NLK	10
63	002-1032	ADH,LOCTITE 609,RETING CMPD	0
64	002-1816	SHCS,10-32X7/8,ALLOY STL	4
65	001-5367	CARR,VANE SEAL,ELB,T3 1/2	2
66	004-0111	O-RING,2-032 BUNA 70	2

Elbow Actuator, 101-4077 (cont.)

Rev. M

Item	P/N	Description	Qty
67	004-0697	O-RING,2-041,BUNA 90	2
70	002-1133	SHCS 10-32 X 5/8,UNBRAKO	4
73	002-0795	ADH,#271 RED LOCTITE 50ML	0
75	010-0197	TOOL,INSTL,MALE,1.8,T2/3	0
76	010-0198	TOOL,SIZING,FEM,1.8,T2/3	0
78	010-0611	TOOL,ALIGN SCR,ELB VANE,T3	0
79	010-1116	ELBOW ASSEMBLY TOOL	0
90	101-4077-WI	WORK INSTRUCTIONS	0

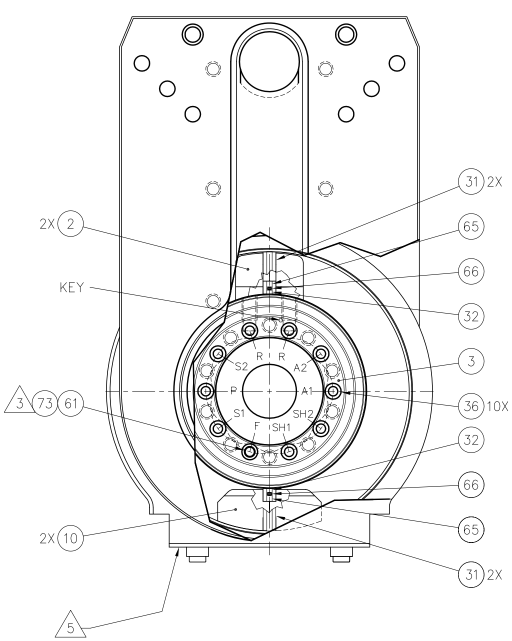
NOTES:

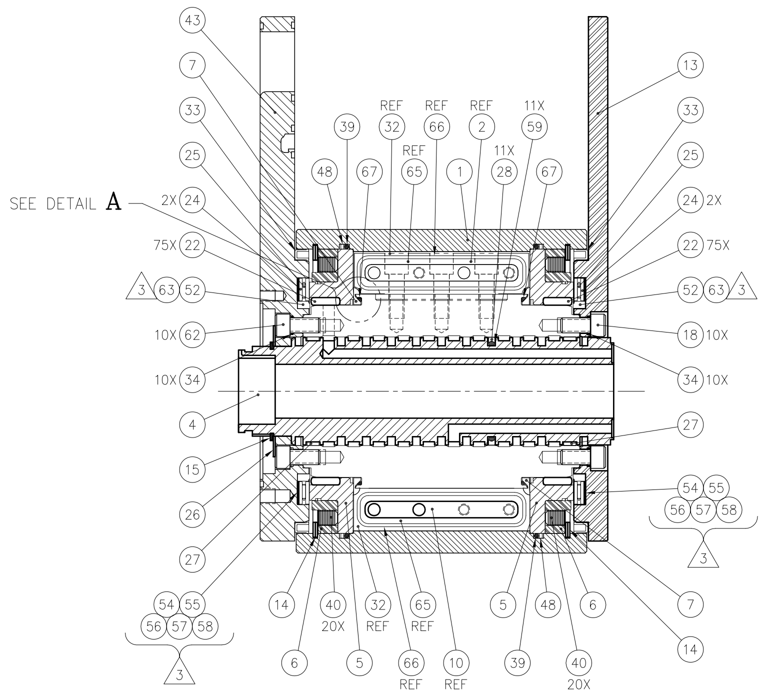
1. DELETED
2. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

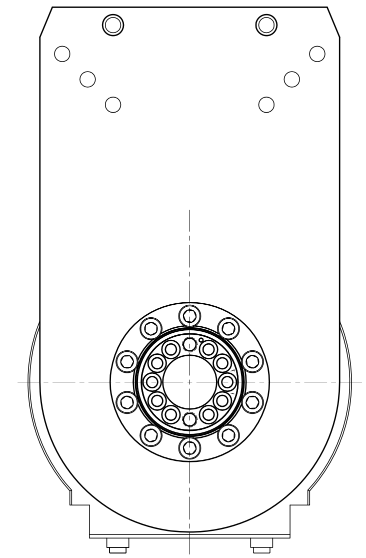
ITEMS:	TORQUE:
18	14.5 FOOT LBS. [19.66 N–m]
50	21 FOOT LBS. [28.5 N–m]
62	19 FOOT LBS. [25.8 N–m]
47	21 FOOT LBS. [28.5 N–m]
64,70	9 FOOT LBS. [12.2 N–m]
40	50 INCH LBS. [5.6 N–m]

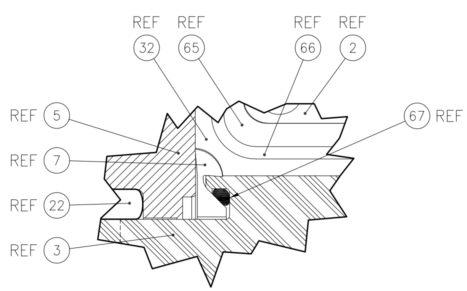
3. QUANTITY AS NEEDED.
4. SERIALIZE IN INDICATED AREA PER WORK INSTRUCTIONS.
5. ITEMS 46 6X, 47 6X, 50 6X, 64 4X, 70 4X NOT SHOWN ON SHEET 1.

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	–	PRELIMINARY	8/4/98	PN	LC
	1	ALL	CB-23	UPDATED ROTOR VANE & DRIVE SHAFT	5/21/99	PN	CO
	A	–	–	RELEASED FOR PRODUCTION	6/14/99	LD	CO
	B	ALL	ALL	UPDATED END PLATES ITEM 5	7/21/99	ZG	CO
	C	ALL	A1	UPDATED TITLE BLOCK	10/23/99	MS	CO
	D	1	D4	TORQUE ON ITEM 40 WAS 40 INCH LBS	2/28/02	DM	LC
	E	1	D4	TORQUE ON ITEM 74 WAS 11 FOOT LBS	11/20/03	SLW	WK
	F	1	B1	SHOWED ITEM 41 ON OPPOSITE VIEW	11/4/05	PK	WK
	G	1	B1	DELETE BROKEN VIEW AND ADD NOTES	7/23/07	VDM	SLW
0692	H	–	–	ADDED VARIANCE TABLE	12/3/09	RDJ	JK
3376	J	–	–	DELETE ITEMS 42, 49 & 74	11/17/11	PK	TR
4130	K	1	D4	REMOVED ITEM 74 FROM TORQUE TABLE	3/2/12	CRL	JAK









DETAIL A
SCALE x4

PART NO.	VARIANCE
101–4077	STANDARD
101–4077–1	GAMMA

PROPRIETARY

RELEASED FOR
PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±10' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

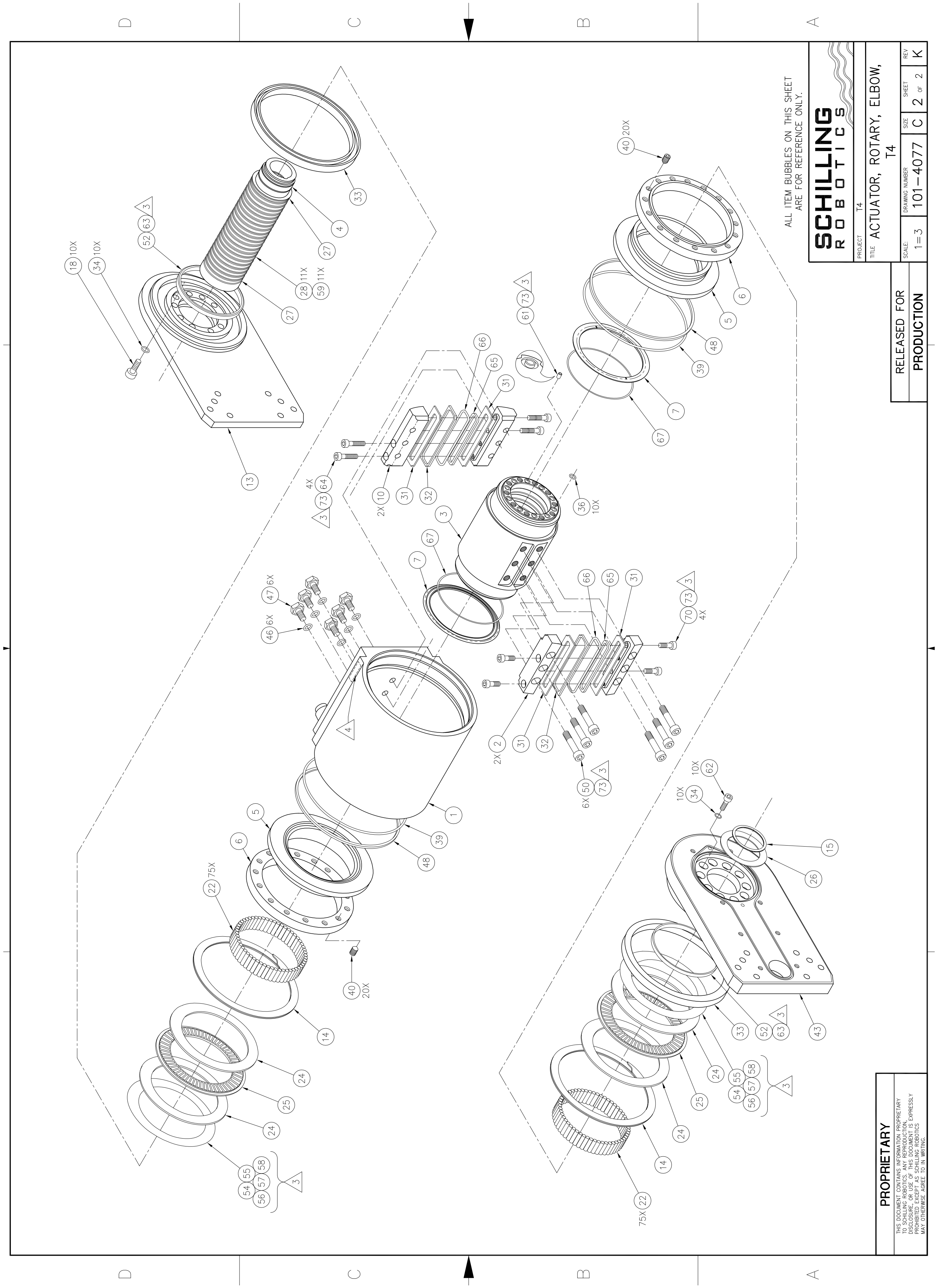
	SIGNATURE	DATE
DRAWN	P. NEVIN	7/16/98
DESIGNED	S. WRIGHT	6/26/98
CHECKED		
LEAD	L.C.	

SCHILLING ROBOTICS

PROJECT T4

TITLE ACTUATOR, ROTARY, ELBOW, T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101–4077	C	1 OF 2	K


ALL ITEM BUBBLES ON THIS SHEET ARE FOR REFERENCE ONLY.
SCHILLING ROBOTICS
PROJECT T4
TITLE ACTUATOR, ROTARY, ELBOW, T4
SCALE: 1=3
DRAWING NUMBER 101-4077
SIZE C
SHEET 2 OF 2
REV K
RELEASED FOR PRODUCTION
PROPRIETARY
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO SCHILLING ROBOTICS. ANY REPRODUCTION, DISCLOSURE, OR USE OF THIS DOCUMENT IS EXPRESSLY PROHIBITED EXCEPT AS SCHILLING ROBOTICS MAY OTHERWISE AGREE TO IN WRITING.

NOTE: *Refer to part list and drawing 101-4470 for top level assembly.*

Compensator, 2 Liter, 8-10 psi, 101-4163

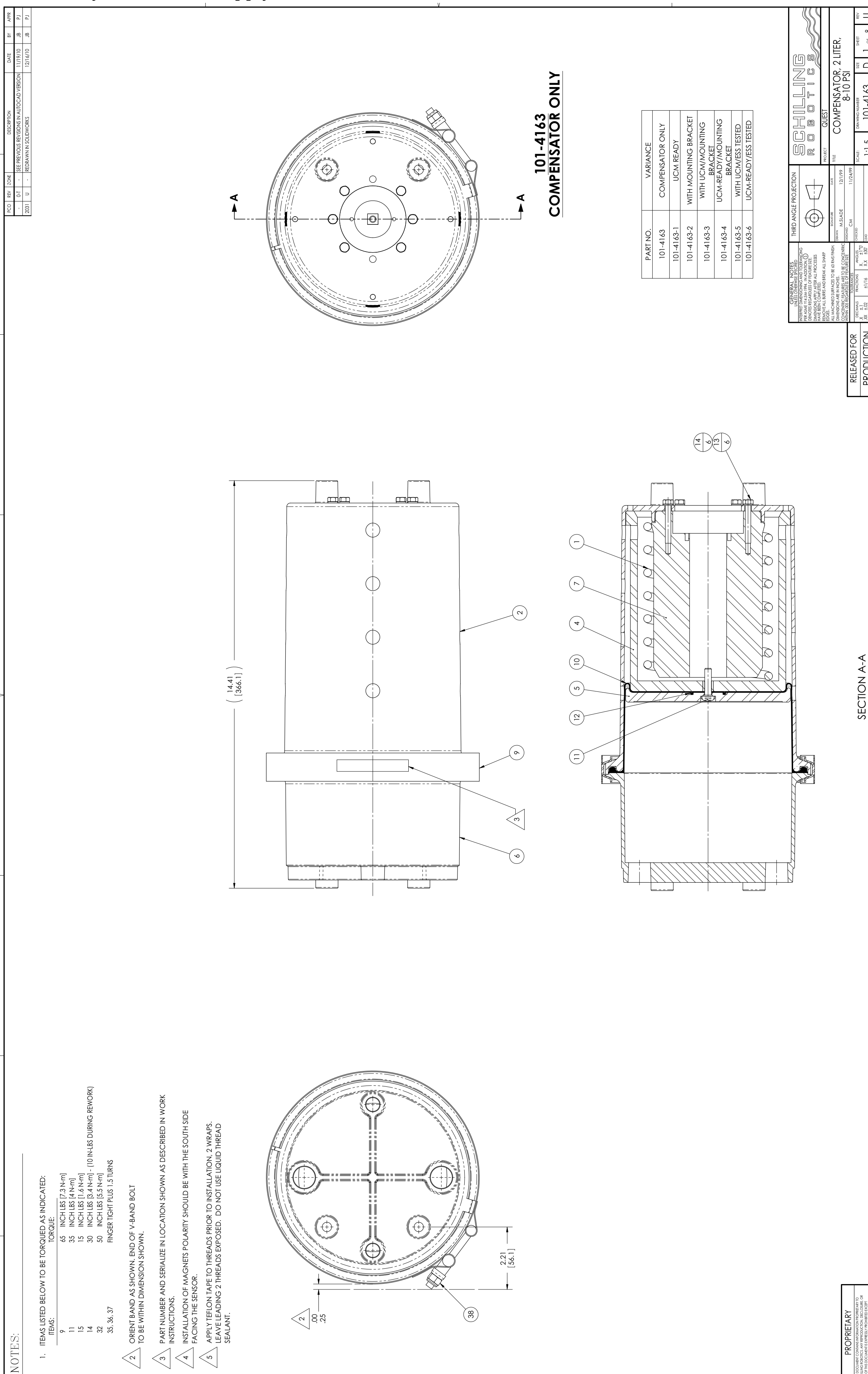
Rev. B

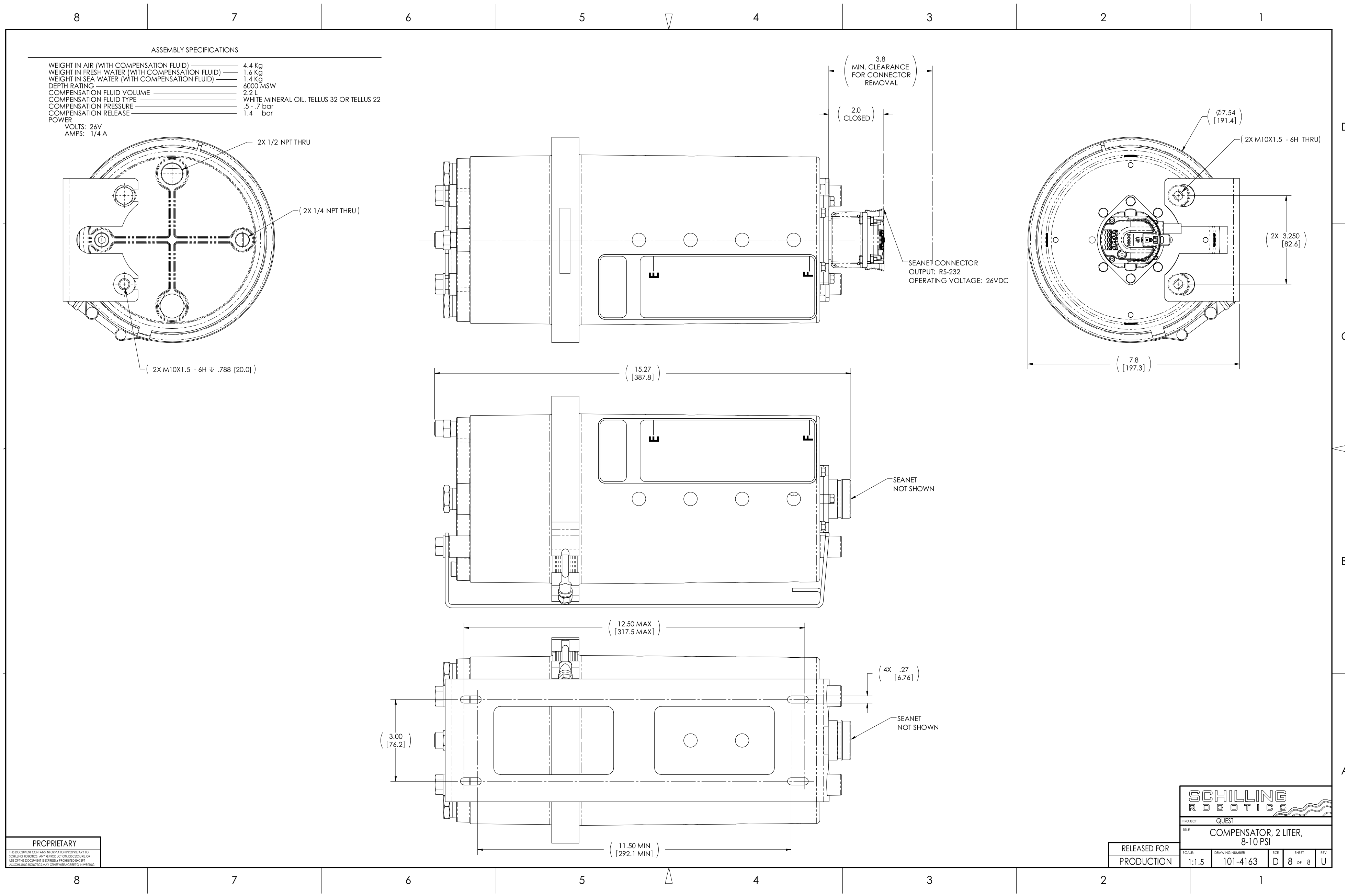
Item	P/N	Description	Qty
1	002-2219	SPRING,COMP,2 LITER	1
2	001-5629	HOUSING,SW SIDE,2.2 LITER COMP	1
4	001-5630	PISTON,2.2 LITER,COMPENSATOR	1
5	001-5631	GDE,DIAPHRAGM,TOP,COMP	1
6	906-0027	MOLDED,HOUSING,COMP,OIL SIDE	1
7	001-5978	GUIDE,SPRING,COMP,2.2 LITER	1
9	002-2245	CLAMP,V-STAMP,7.375,ID,SS	1
10	004-0895	DIAPHRAGM,COMP,2 LITER	1
11	002-2272	SCREW,SEALING,M6X25,316SS	1
12	004-0015	O-RING,2-121 BUNA 70	1
13	002-9005	WSHR,FLAT,M5,SMALL OD,316SS	6
14	002-8004-35	HHCS,M5X35,FULL THD,316SS	6
38	002-0183	NUT,1/4-20,SS,NYLINSR	1
50	101-4163-WI	WORK INSTRUCTIONS	0

WARNING

Do not loosen or remove the compensator housing clamp unless the spring and piston have been restrained as directed by a service instruction. Uncontrolled release of the spring can cause serious personal injury and damage to surrounding equipment.

NOTE: *Only Sheet 1 and 8 apply.*




ASSEMBLY SPECIFICATIONS
WEIGHT IN AIR (WITH COMPENSATION FLUID) 4.4 Kg
WEIGHT IN FRESH WATER (WITH COMPENSATION FLUID) 1.6 Kg
WEIGHT IN SEA WATER (WITH COMPENSATION FLUID) 1.4 Kg
DEPTH RATING 6000 MSW
COMPENSATION FLUID VOLUME 2.2 L
COMPENSATION FLUID TYPE WHITE MINERAL OIL, TELLUS 32 OR TELLUS 22
COMPENSATION PRESSURE .5 - .7 bar
COMPENSATION RELEASE 1.4 bar
POWER
VOLTS: 26V
AMPS: 1/4 A
2X 1/2 NPT THRU
2X 1/4 NPT THRU
2X M10X1.5 - 6H ⊽ .788 [20.0]
3.8 MIN. CLEARANCE FOR CONNECTOR REMOVAL
2.0 CLOSED
SEANET CONNECTOR
OUTPUT: RS-232
OPERATING VOLTAGE: 26VDC
Ø7.54 [191.4]
2X M10X1.5 - 6H THRU
2X 3.250 [82.6]
7.8 [197.3]
15.27 [387.8]
SEANET NOT SHOWN
12.50 MAX [317.5 MAX]
4X .27 [6.76]
3.00 [76.2]
11.50 MIN [292.1 MIN]
PROPRIETARY
RELEASED FOR PRODUCTION
SCHILLING ROBOTICS
PROJECT QUEST
TITLE COMPENSATOR, 2 LITER, 8-10 PSI
SCALE 1:1.5
DRAWING NUMBER 101-4163
SIZE D
SHEET 8 OF 8
REV U

Pitch / Yaw, 101-4182

Rev. C

Item	P/N	Description	Qty
1	001-1897	BLK,MANF,PITCH/YAW,T2	1
2	001-1898	SLIPRING,MANF,PITCH/YAW,T2	2
7	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	4
11	002-0052P	NAS 6404PU3,NLK	8
14	004-0585	O-RING,.189X.039,N70(APPLE)	20
15	004-0586	O-RING,1.417X.039,N70(APPLE)	2
16	004-0583	SEAL,SLIPRING,PITCH (PER SDI P	24
17	003-0081	BEARING, SLYD RING	4
18	004-0222	O-RING,2-010 BUNA 90	20
19	004-0303	O-RING,2-022 V75	2
20	101-4821	ACTR,RTRY,PITCH,W/FLATS,T3	2
23	007-0108	MANF,RTR,PITCH/YAW,T2	2
25	002-0700	RING,RETING,SMALLEY #WSM150	2
26	003-0068	RACE,THR,TORRINGTON,TRA2435	2
27	002-0045P	NAS 6404PU7,NLK	12
29	004-0036	O-RING,2-027 BUNA 70	24
50	101-4182-WI	WORK INSTRUCTIONS	0

NOTES:

1. DELETED

2. CLOCK ITEM 2 SO THAT THE TICK MARK ON IT IS ALIGNED TO THE TICK MARK ON ITEM 23.

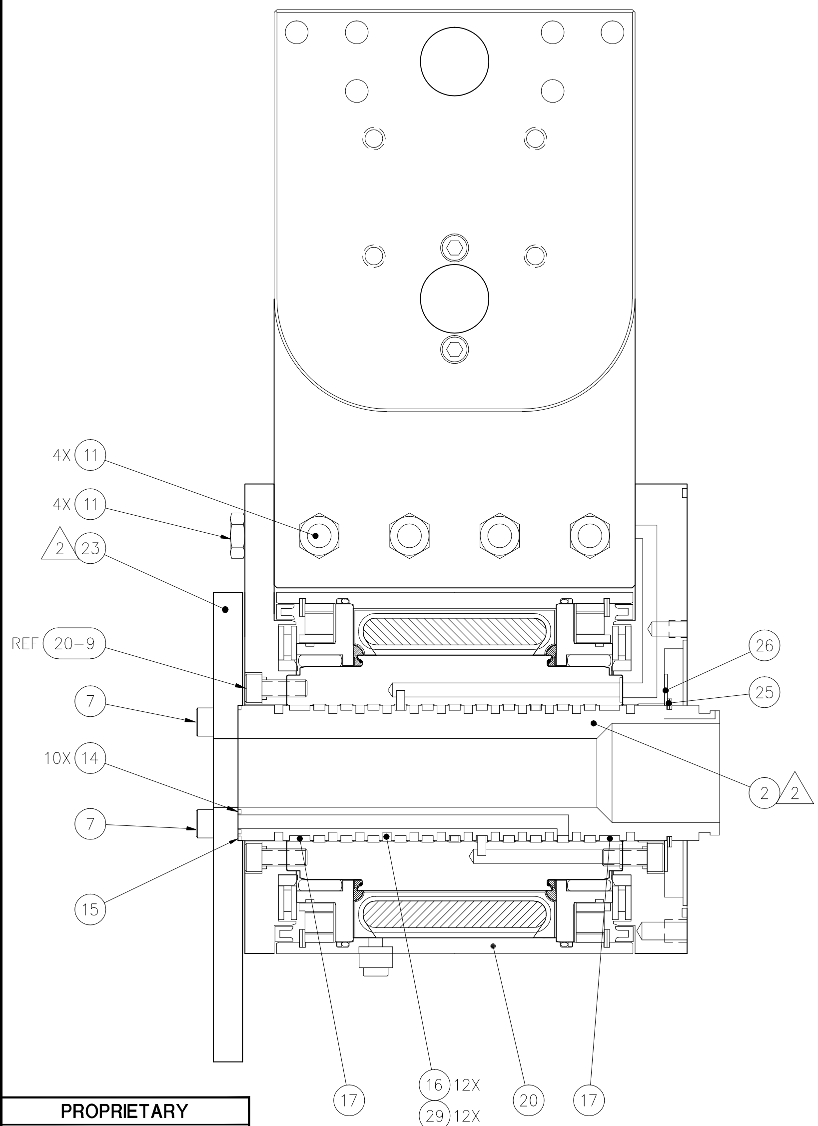
3. SERIALIZE IN LOCATION SHOWN AS DESCRIBED IN THE WORK INSTRUCTIONS.

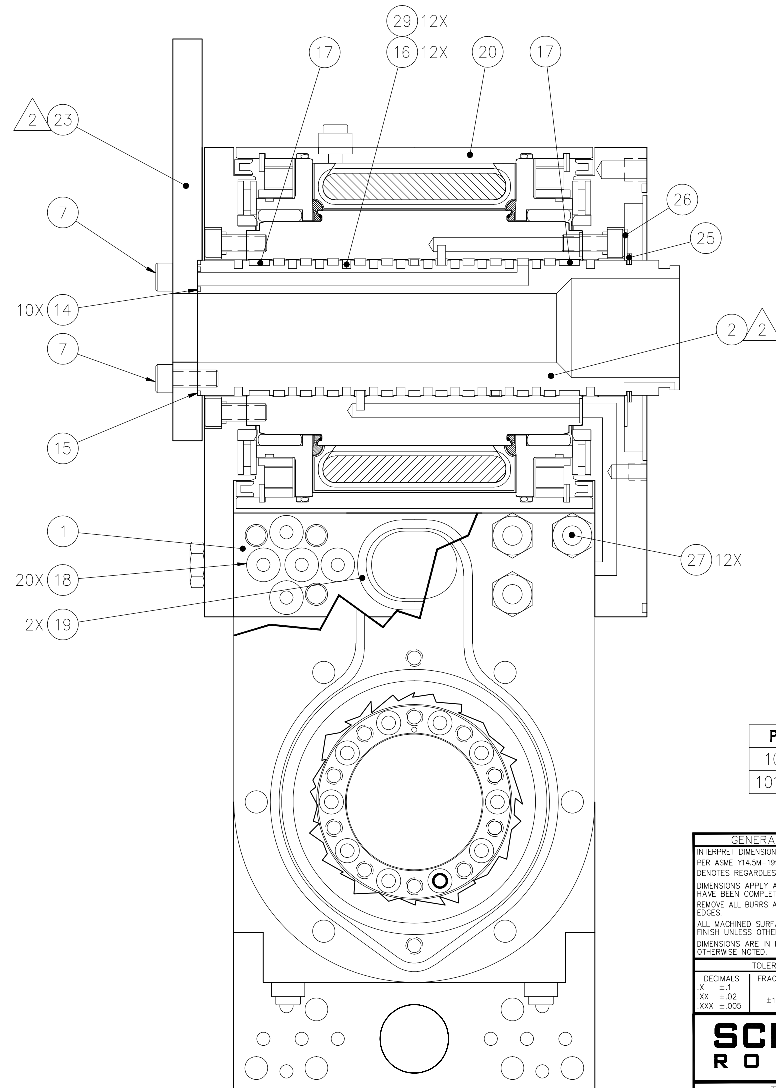
4. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:	
7, (20–9)	76 INCH LBS.	[8.6 Nm]
11, 27	21 FOOT LBS.	[28.5 Nm]
11, 27 5	18.5 FOOT LBS.	[25.1 Nm]

5. FOR 101–4182–1 ASSEMBLY ONLY.

PCO	REV	ZONE	SHT	DESCRIPTION	DATE	BY	APPR
	Ø	–	–	PRELIMINARY	4/30/99	MS	CO
	A	–	–	RELEASED FOR PRODUCTION	5/7/99	LD	CO
	B	A1	ALL	UPDATED TITLE BLOCK	10/23/99	MS	CO
	C	B4 D3	1	ADDED 20–9 REF ADDED NOTE 4	10/12/01	ZG	SLW
	D	D3	1	CHANGED TORQUE FOR ITEM 7 & 20–9	6/9/03	SLW	GLC
0692	E	–	–	ADDED VAR. TABLE & DELTA NOTE 5	12/3/09	RDJ	JK





PART NO.	VARIANCE
101–4182	STANDARD
101–4182–1	GAMMA

GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.

DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.

REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.

ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	MS	4/27/99
DESIGNED	SLW	3/29/99
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

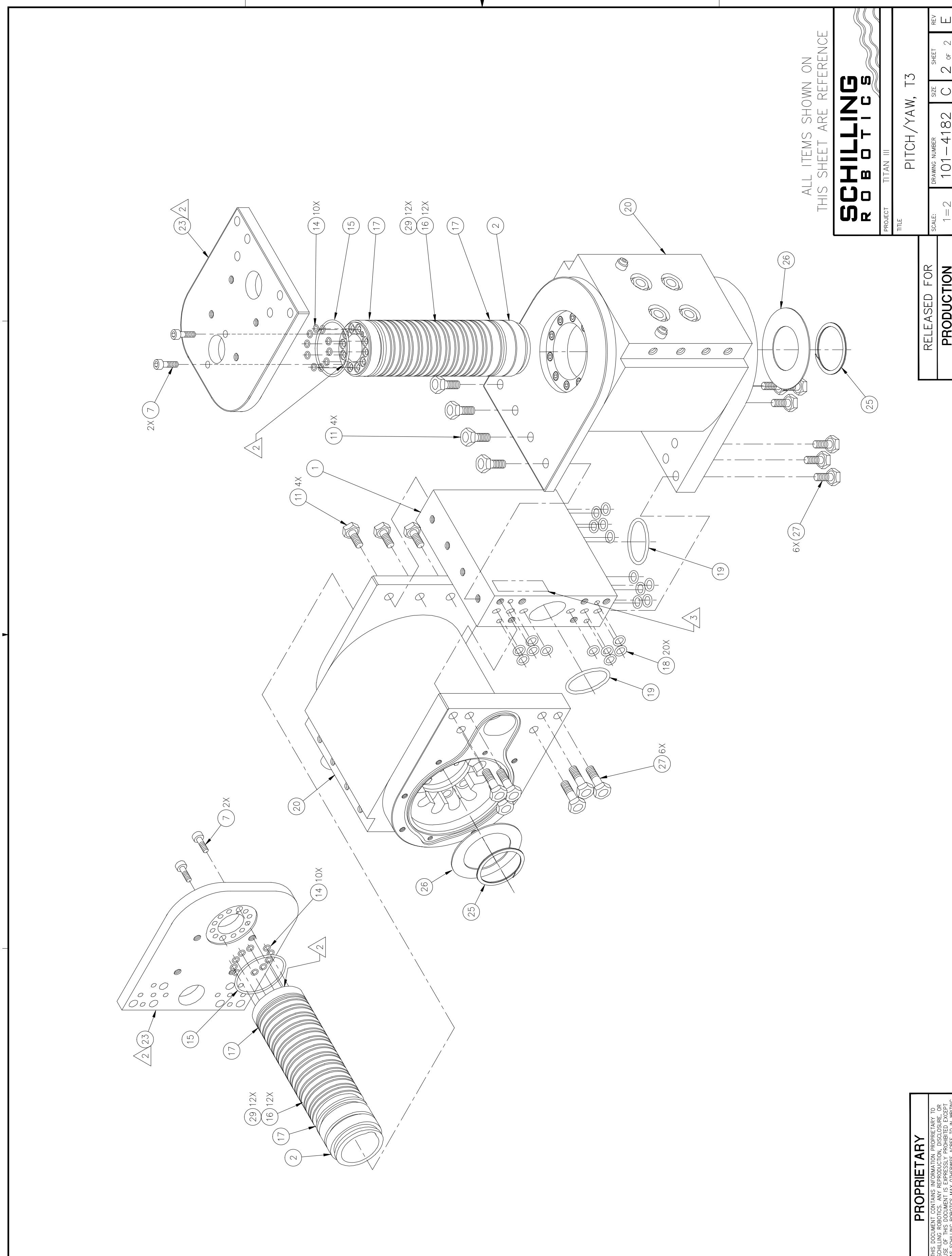
PROJECT TITAN III

TITLE PITCH/YAW, T3

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1	101–4182	C	1 OF 2	E

RELEASED FOR PRODUCTION

PROPRIETARY


ALL ITEMS SHOWN ON THIS SHEET ARE REFERENCE
SCHILLING ROBOTICS
PROJECT TITAN III
TITLE PITCH/YAW, T3
SCALE: 1=2
DRAWING NUMBER 101-4182
SIZE C
SHEET 2 OF 2
REV E
RELEASED FOR PRODUCTION
PROPRIETARY
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Compensator, 2 Liter, 8-10 psi, Manip, 101-4470

Rev. G

Item	P/N	Description	Qty
1	101-4163	COMPENSATOR,2 LITER,8-10 PSI	1
2	006-1651	VALVE,RLF,CIRCLE SEAL,559T1-2M	1
4	006-1680	FITTING,HYD,-4 JIC,1/2 NPT,SS	1
5	006-0027	FIT,HYD,-4,JIC,CAP-S(4FNTX-S)	1
6	006-1625	FIT,HYD,1/2,PIPE,PLUG,HEX,HD	1
7	006-0225	FIT,HYD,1/4,PIPE,PLUG,HOLLOW H	1
8	001-6315	BRKT,COMP SINGLE,QIK RELEASE	1
9	002-8007-20P	HHCS,M10X20,FULL THD,316SS,NLK	2
10	002-9029	WSHR,FLAT,M10,REGULAR OD,316SS	2
11	002-2448	LABEL,COMPENSATOR	1
21	002-0798	TAPE,1/2~PIPE,PTFE,TEFLON	0
22	002-0805	LUBE,AQUA SHIELD, 8 OZ	0
23	002-3051	GREASE,EP,1 LB CAN	0
50	101-4470-WI	WORK INSTRUCTIONS	0

WARNING

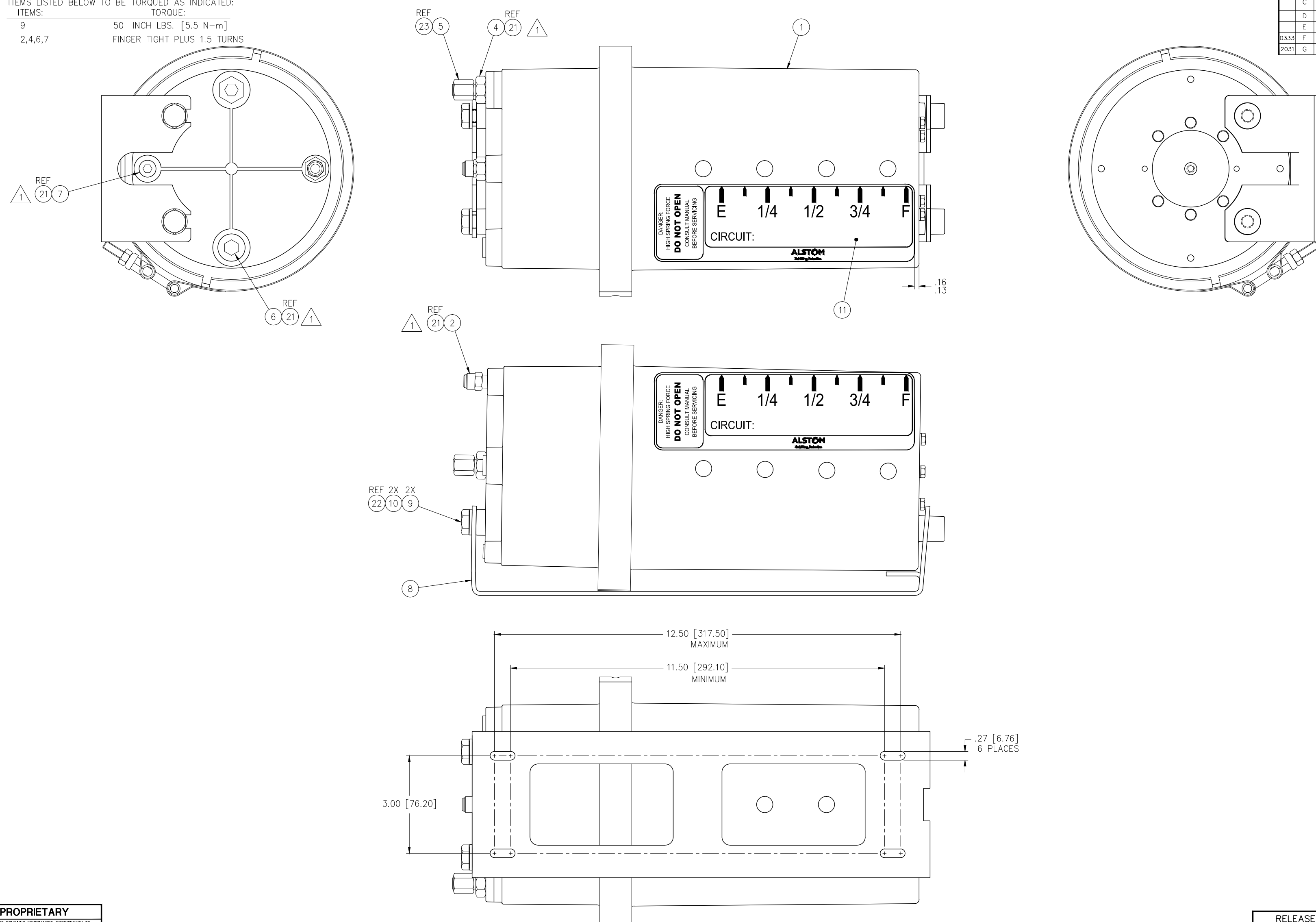
Do not loosen or remove the compensator housing clamp unless the spring and piston have been restrained as directed by a service instruction. Uncontrolled release of the spring can cause serious personal injury and damage to surrounding equipment.

NOTES:

1. APPLY TEFLON TAPE TO THREADS PRIOR TO INSTALLATION, 2 WRAPS LEAVING LEADING 2 THREADS EXPOSED. DO NOT USE LIQUID THREAD SEALANT.
2. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
9	50 INCH LBS. [5.5 N-m]
2,4,6,7	FINGER TIGHT PLUS 1.5 TURNS

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	PRELIMINARY	1/19/01	AL	AL
	A	–	RELEASED FOR PRODUCTION	1/30/01	LD	AL
	B	C6 C4	DELETED ITEM 3 ADDED DIM .16/.13	4/24/01	ZG	CM
	C	B6 B6	UPDATED ITEM 8 DELETED ITEMS 9 & 10 (2X EACH)	3/25/02	DM	WK
	D	–	DELETED ITEM 20 AND 30	4/22/03	RJ	WK
	E	–	ITEM 8 WAS BUBBLED AS ITEM 9	2/19/08	DI	RJ
0333	F	–	ADDED REFERENCE BUBBLES	6/23/09	CRL	JK
2031	G	–	UPDATED NOTE 1 AND 2.	12/15/10	JB	PJ



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RELEASED FOR **PRODUCTION**

GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.

DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.

REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.

ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	AL	01/18/01
DESIGNED	CM	11/24/99
CHECKED		
LEAD	CM	

SCHILLING ROBOTICS

PROJECT T3

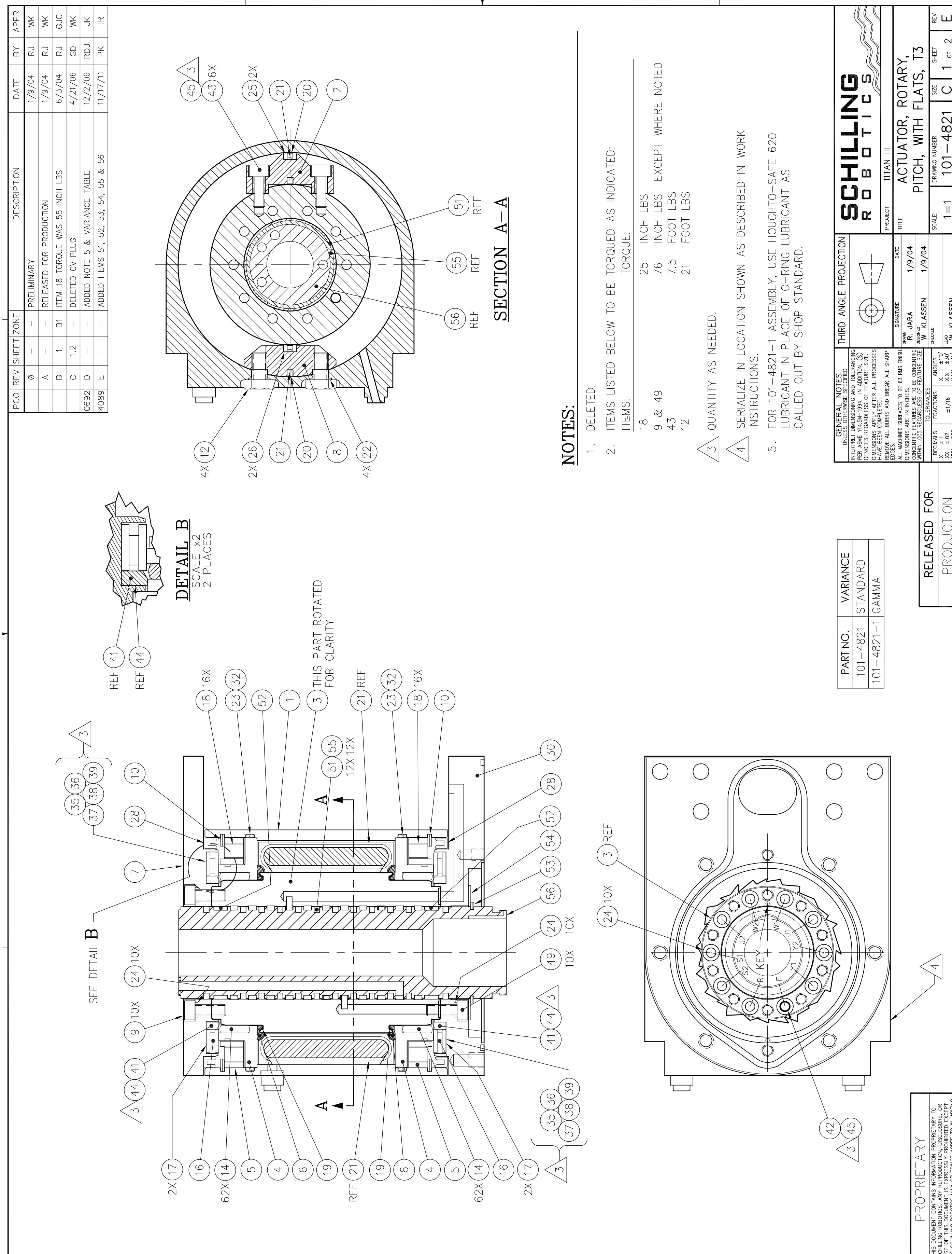
TITLE COMPENSATOR, 2 LITER, 8-10 PSI, MANIPULATOR

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101-4470	D	1 OF 1	G

Actuator, Rotary, Pitch, w/Flats, T3, 101-4821

Rev. D

Item	P/N	Description	Qty
1	001-5129	HOUSING,PITCH,T3	1
2	001-6951	VANE,ROTOR,W/FLATS,T3	1
3	001-6950	ROTOR,PITCH,W/ FLATS,T3	1
4	001-1886	PL,END,PITCH,T2	2
5	001-1887	RING,TRQ,PITCH,T2	2
6	001-5358	SEAL,END,PITCH,T3 1/2	2
7	001-1889	FLG,OUT,PITCH,T2	1
8	001-5354	VANE, STATOR, PITCH, T3 1/2	1
9	002-0934P	SHCS,10-32X1/2,A286,SLVR,NLK	10
10	002-0878	RING,RETING,INTL,W/LOCKING TAB	2
12	002-0038P	NAS 6404PU1,NLK	4
14	003-0012	TORRINGTON,Q11406	124
16	003-0075	BRG,THR,NTA4052,TORRINGTON	2
17	003-0076	WSHR,THR,TRB4052,TORRINGTON	4
18	002-0703P	SCR, SET, 1/4-28X.312,FLAT,NLK	32
19	004-0887	O-RING, 2.400 X .040, BUNA 70	2
20	001-5355	SEAL,VANE,PITCH,T3 1/2	2
21	004-0968	O-RING,2-028,DISOGRIN 70 DURO	2
22	004-0137	O-RING,.244x.039 BUNA 90 APPLE	4
23	004-0582	O-RING,2-044 N90	2
24	004-0627	O-RING,.189X.039,BUNA 90	30
25	001-5356	BACK-UP,VANE SEAL,PITCH RTR VA	2
26	001-5357	BACKUP,VANE SEAL,PITCH STATOR	2
28	004-0609	SEAL,FLUROCARBON #AR10400-340-	2
30	007-0109	MANF,STATOR,PITCH,T2	1
32	001-2175	RING,BACK-UP,PITCH	2
35	001-2192	SHIM,PITCH,.001THK	0
36	001-2193	SHIM,PITCH,.003THK,T2	0
37	001-2194	SHIM,PITCH,.005THK,T2	0
38	001-2195	SHIM,PITCH,.007THK,T2	0
39	001-2196	SHIM,PITCH,.008THK,T2	0
41	001-2214	RING,P/Y,BRG	2
42	001-2729	SLEEVE	1
43	002-0679	SHCS,10-32X1/2,ALLOY STL(UNBRA	6
44	002-1032	ADH,LOCTITE 609,RETING CMPD	0
45	002-0795	ADH,#271 RED LOCTITE 50ML	0
47	010-0474	TOOL,INSTL,CV PLUG 156	0
48	010-1115	PITCH ASSEMBLY TOOL	0
49	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	10
51	004-0583	SEAL,SLIPRING,PITCH (PER SDI P	12
52	003-0081	BEARING, SLYD RING	2
53	002-0700	RING,RETING,SMALLEY #WSM150	1
54	003-0068	RACE,THR,TORRINGTON,TRA2435	1


PCO | REV | SHEET | ZONE | DESCRIPTION | DATE | BY | APPR
Ø | - | - | PRELIMINARY | 1/9/04 | RJ | WK
A | - | - | RELEASED FOR PRODUCTION | 1/9/04 | RJ | WK
B | 1 | B1 | ITEM 18 TORQUE WAS 55 INCH LBS | 6/3/04 | RJ | GJC
C | 1,2 | - | DELETED CV PLUG | 4/21/06 | GD | WK
0692 | D | - | - | ADDED NOTE 5 & VARIANCE TABLE | 12/2/09 | RDJ | JK
4089 | E | - | - | ADDED ITEMS 51, 52, 53, 54, 55 & 56 | 11/17/11 | PK | TR
SECTION A-A
DETAIL B
SCALE x2
2 PLACES
SEE DETAIL B
THIS PART ROTATED FOR CLARITY
KEY
NOTES:
1. DELETED
2. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:
ITEMS: TORQUE:
18 25 INCH LBS
9 & 49 76 INCH LBS EXCEPT WHERE NOTED
43 7.5 FOOT LBS
12 21 FOOT LBS
3 QUANTITY AS NEEDED.
4 SERIALIZE IN LOCATION SHOWN AS DESCRIBED IN WORK INSTRUCTIONS.
5. FOR 101-4821-1 ASSEMBLY, USE HOUGHTO-SAFE 620 LUBRICANT IN PLACE OF O-RING LUBRICANT AS CALLED OUT BY SHOP STANDARD.
PART NO. | VARIANCE
101-4821 | STANDARD
101-4821-1 | GAMMA
RELEASED FOR PRODUCTION
GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
THIRD ANGLE PROJECTION
DRAWN R. JARA 1/9/04
DESIGNED W. KLASSEN 1/9/04
LEAD W. KLASSEN
SCHILLING ROBOTICS
PROJECT TITAN III
TITLE ACTUATOR, ROTARY, PITCH, WITH FLATS, T3
SCALE: 1=1
DRAWING NUMBER 101-4821
SIZE C
SHEET 1 OF 2
REV E
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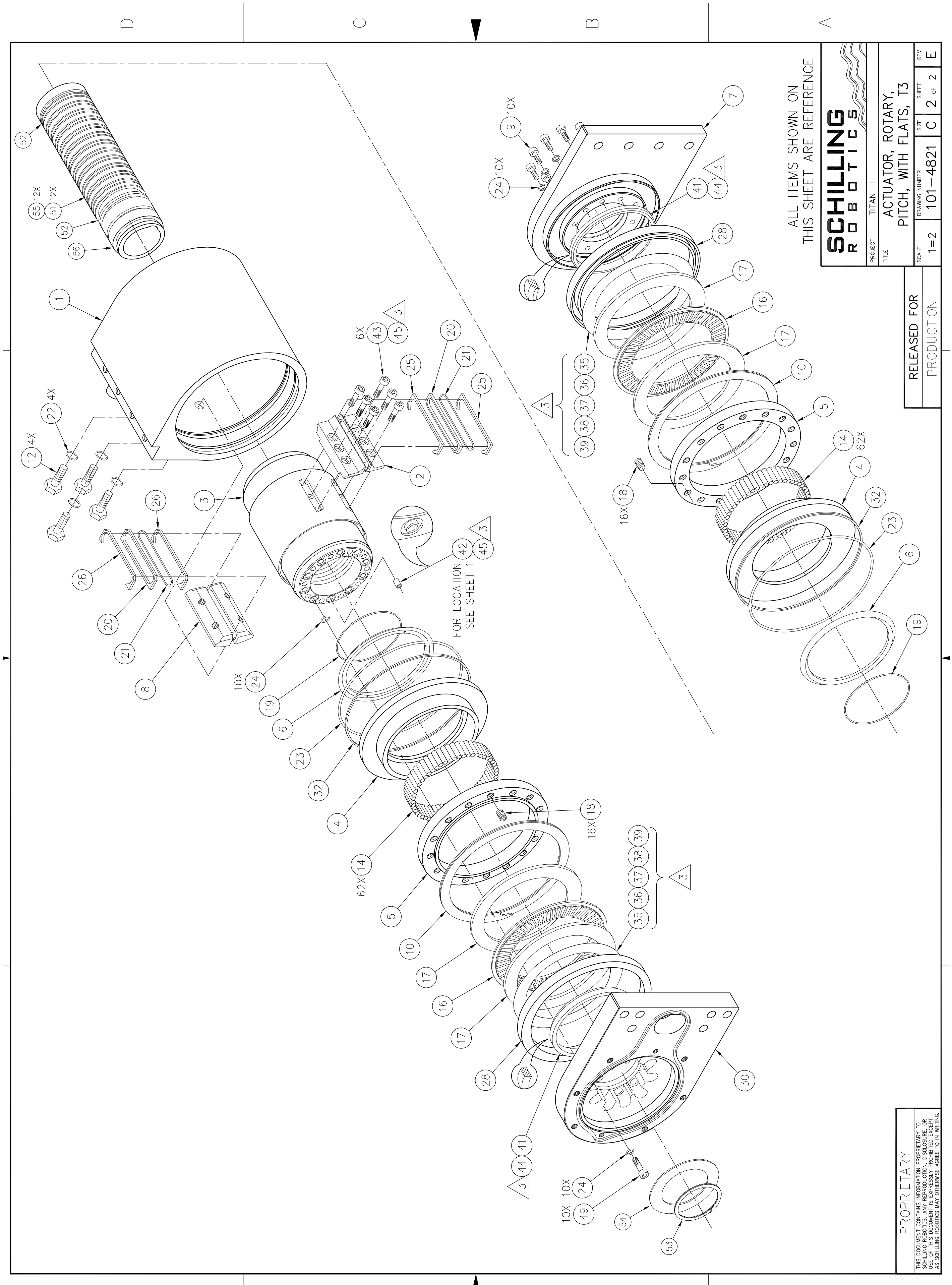
ALL ITEMS SHOWN ON
THIS SHEET ARE REFERENCE
FOR LOCATION
SEE SHEET 1
SCHILLING
ROBOTICS
PROJECT TITAN III
TITLE ACTUATOR, ROTARY,
PITCH, WITH FLATS, T3
SCALE: 1=2
DRAWING NUMBER 101-4821
SIZE C
SHEET 2 OF 2
REV E
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Cable Ass'y, Slave Arm, T4 SCE, 101-4839

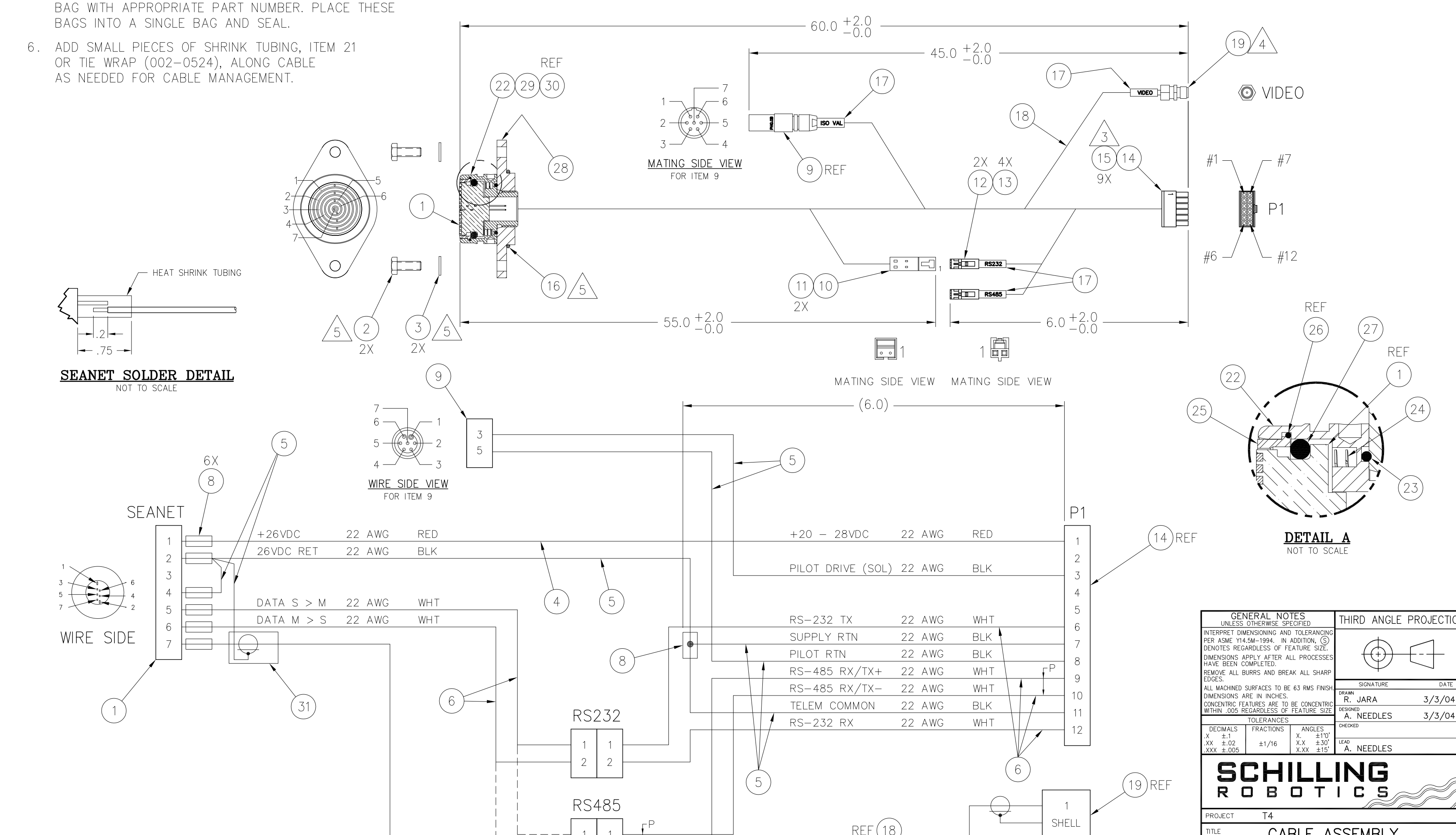
Rev. D

Item	P/N	Description	Qty
1	101-4307	PENETRATOR,SEANET,7 CONTACTS	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	12.75
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
20	005-1706	TBG,SHRINK,3/8 WHT	.13
21	005-1523	TBG,SHRINK,3/16 WHT,ALPHA #FIT	.5
22	001-7099	SHELL,FLOWTHRU,THREAD	1
23	004-0912	O-RING,2-021, BUNA 90	1
24	002-2280	SPR, SMALLEY C112-L1	1
25	001-7100	RING,RTNG,PENETRATOR	1
26	004-0976	O-RING,.040 X 1.25 ID,BUNA 70	1
27	004-0926	O-RING, 2-212, BUNA 70	1
28	001-8900	PLT,ADPTR,FLOW THRU/THD SHELL	1
29	002-2578	CAP,VINYL,SEANET PENETRATOR	1
30	010-0835	WRENCH, SEANET, SPANNER	0
31	005-1216	TBG,SHRINK,3/32(BRIM # SH135-3	.5
1000	101-4839-WI	WORK INSTRUCTIONS	0

NOTES:

1. DELETED.
2. DELETED.
3. (△3) CRIMP AND SOLDER USING MOLEX CRIMPING TOOL, P/N 1825432.
4. (△4) SEE SPEC SHEET FOR 005-4468 FOR STRIP, SOLDER ASSEMBLY AND CRIMP DETAILS.
5. (△5) BAG ITEMS 2, 3 AND 16 IN INDIVIDUAL BAGS. ALSO, BAG A 1.5" PIECE OF SHRINK TUBING (ITEM 20). LABEL EACH BAG WITH APPROPRIATE PART NUMBER. PLACE THESE BAGS INTO A SINGLE BAG AND SEAL.
6. ADD SMALL PIECES OF SHRINK TUBING, ITEM 21 OR TIE WRAP (002-0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
7. VINYL CAP, ITEM 29, AND SPANNER WRENCH, ITEM 30, NOT SHOWN.
8. USE TOOLING FIXTURE 010-1262, 0-30 PSI PRESSURE GAUGE AND NITROGEN BOTTLE TO TEST PENETRATOR ASSEMBLY FOR LEAKS. CONNECT FIXTURE 010-1262 TO GAUGE AND BOTTLE. INSTALL CABLE ASSEMBLY USING SUPPLIED FASTENERS TORQUED TO 30 INCH LBS. APPLY 15 PSI PRESSURE TO FIXTURE FOR APPROXIMATELY 1 MIN. LISTEN AND FEEL FOR ANY LEAKS AT THE PENETRATOR AND OBSERVE GAUGE FOR ANY PRESSURE LOSS. IF LEAK IS DETECTED AT THE PENETRATOR, REPAIR AND REPEAT TEST.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	PRELIMINARY	3/3/04	RJ	AN
	Ø	–	RELEASED FOR PROTOTYPE	3/10/04	RJ	AN
	1–B	–	SEE PREVIOUS REV FOR ECO HISTORY	4/30/08	NLH	SLW
	C	–	NOTE 8: 15 PSI WAS 20 PSI, ADDED "FOR APPROXIMATELY I MIN." AND "OBSERVE GAGE FOR ANY PRESSURE LOSS"	9/28/06	NLH	WK
	D	–	ADD BALLOON CALL-OUT FOR SHRINK TUBING (ITEM 31) USED AROUND VIDEO WIRE	2/24/09	MHB	AN
3145	E	C3	ADDED LOCATION OF ITEM 16, DELETED NOTE 1	7/7/11	CRL	TL



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RELEASED FOR PRODUCTION

GENERAL NOTES
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INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1	±1/16	X. ±1°0'
.XX ±.02		X.X ±30'
.XXX ±.005		X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	R. JARA	3/3/04
DESIGNED	A. NEEDLES	3/3/04
CHECKED		
LEAD	A. NEEDLES	

SCHILLING ROBOTICS

PROJECT: T4
TITLE: CABLE ASSEMBLY, SLAVE ARM, T4 SCE

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101–4839	C	1 OF 1	E

NOTE: *Part list only.*

Control Ass'y, Slave Arm, 4Km, 101-4859

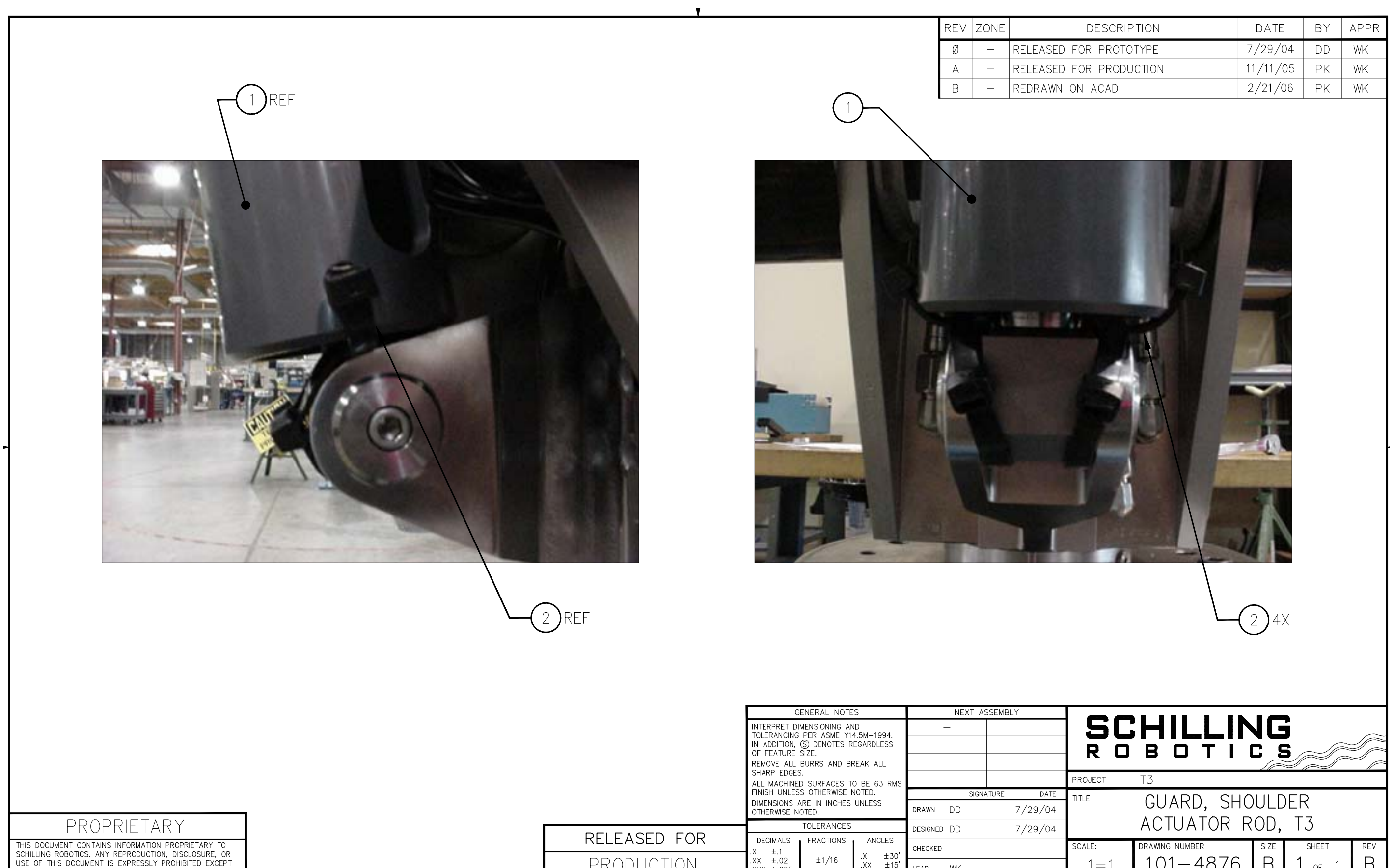
Rev. B

Item	P/N	Description	Qty
1	101-5752	PCB ASSY,T4 IN ARM CONTROLLER	1
2	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
3	001-6985	HOUSING,PCB,SLAVE CONTRL ELECT	1
4	002-0006	BHCS,4-40X1/4,SS	9
5	002-0475-1	STANDOFF,MOD,9mm LONG,M-F,4-40	1
6	002-0692	SHCS,4-40X.375,SS	2
7	001-7010	SPACER, .5 OD X .31 LONG	2
8	002-0799	GREASE,SILICON DC-5	0
20	002-2531	ADH, #425 BLUE LOCTITE, 70 OZ	0

Guard, Shoulder Actuator Rod, Titan, 101-4876

Rev. B

Item	P/N	Description	Qty
1	001-6942	GUARD,SHLDR ACTR ROD,T3	1
2	002-2530	CABLE TIE, 18" X .30, UV BLACK	4



SeaNet to CPC Deck Test Cable, 101-4882

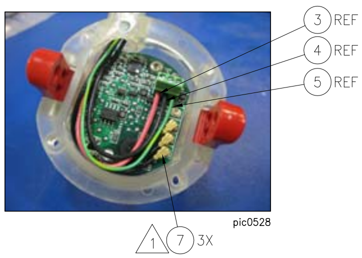
Rev. K

Item	P/N	Description	Qty
1	101-7980	CONNECTOR,SEANET,STANDARD	1
2	006-2534	HOSE,1/4IDX3/8OD,.022NY/85POLY	12.5
3	005-2453	WIRE,18 AWG,RED,TEFZEL	13.34
4	005-4885	WIRE,18 AWG,BLK,TEFZEL	13.34
5	005-4886	WIRE,22 AWG,GRN/YEL,TEFZEL	13.34
6	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	1.25
7	005-5390-3.7	CABLE,COAX,IPX-IPX,3.7M	3
8	002-3095	LABEL,WIRE,1 X 2.5	0
9	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	.25
10	005-2790	WIRE,22 AWG,STRANDED,GRN	1.25
11	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
12	005-1794	PIN,CONN,CPC,AMP #66587-2	7
13	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
14	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.25
15	002-3066	URETHANE,70,SHORE A	0
16	005-2791	WIRE,22 AWG,STRANDED,BLUE	1.25
18	002-1509	ADHESIVE,EPOXY,DP100 PLUS,50ML	0
20	010-1103	TOOL,INSTL,FERRULE TBG,SEANET	0
1000	101-4882-WI	WORK INSTRUCTIONS	0

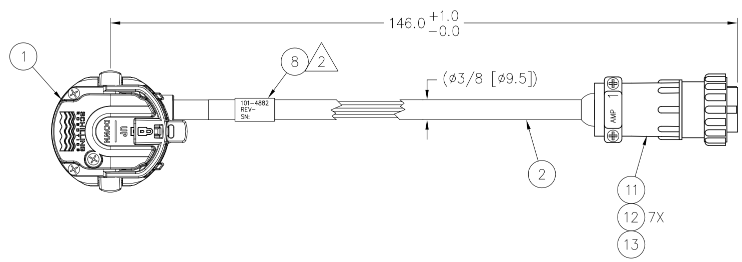
NOTES:

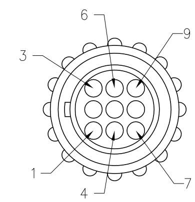
1. OUTSIDE OF COAX CABLES, ITEM 7, IS THE SHIELD, SO IT IS ACCEPTABLE FOR THEM TO TOUCH.
2. SERIALIZE IN LOCATION SHOWN, PER SHOP STANDARD.
3. WIRING, CABLES, AND PINS TO BE SOLDERED PER 1PC-A-620, CLASS 2 SPECIFICATION, UNLESS OTHERWISE INDICATED.
4. CUT AND SPLICE COAX CABLE, ITEM 7, PER VIDEO COAX SPLICE OR COAX SPLICE DETAIL.
5. SHIELDS ARE GROUNDED TOGETHER ON PC BOARD.
6. CLEAN WIRES WITH ALCOHOL. WATER BLOCK WIRES USING EPOXY, ITEM 18, AS SHOWN.
7. CLEAN END OF HOSE, ITEM 2, WITH ACETONE UNTIL TUBE IS NO LONGER CLEAR. SEAL WIRES WITH URETHANE, ITEM 15, USING TOOL #010-0985.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	A	–	RELEASED FOR PRODUCTION	9/7/04	CA	WK
	B	–	UPDATED NOTES, SEE ECO	11/1/04	CA	WK
	C	–	ADDED SOLID WIRE AND MOLDING OP	1/13/05	CA	WK
	D	–	ADD DELTA NOTE 10	4/13/05	KJ	RJ
	E	–	MODIFY AND ADD NOTES	7/5/05	KJ	WK
	F	–	ITEM 21 21X WAS 1X	1/11/06	PK	WK
	G	C3	ADDED VIDEO LINE CONNECTION BETWEEN CPC AND SEANET CONNECTORS	5/31/07	CRL	SLW
	H	–	UPDATED NOTES, REVISED SEANET CONN	7/19/07	PK	WK
	J	C1	ADDED BALLOON NUMBER FOR ITEM 26	7/31/07	CRL	SLW
	K	B2	REVISED WIRING DIAGRAM: VIDEO LINE TO CPC PIN 9 WAS TO PIN 1	8/17/07	CRL	SLW
	L	–	UPDATE DRAWING TO SHOW SHIELDS GROUNDED TOGETHER	11/16/07	VDM	PJ
	M	–	REVISED ITEM 9 VIEWS	2/7/08	RDJ	SLW
0347	N	–	DELETED DETAIL D, UPDATED NOTES 1, 4, 5, 9, AND 10, UPDATED DETAIL C AND WIREING DIAGRAM	6/29/09	NLH	JWS
3366	P	–	UPDATED ASSEMBLY AND DRAWING	9/14/11	NLH	TL



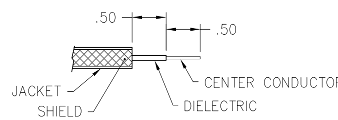
SEANET (1) WITHOUT LID (PHOTO)



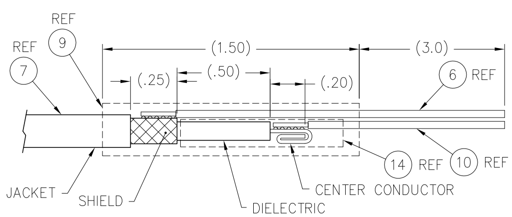


MATING SIDE VIEW

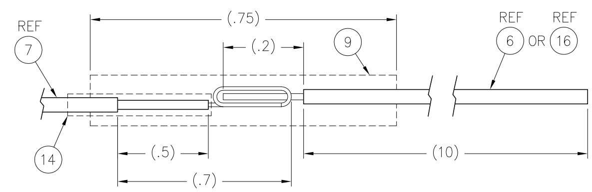
SCALE 2:1



COAX STRIP DETAIL



VIDEO COAX SPLICE DETAIL

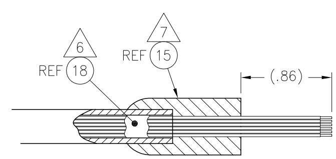


COAX SPLICE DETAIL

LOCATED INSIDE ITEM 2 BOOT

COAX TO WIRE SPLICE

NTS



WIRE CUT DETAIL

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.
TOLERANCES

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	C. ADE	9/7/04
DESIGNED	C. ADE	9/7/04

SCHILLING ROBOTICS

PROJECT T4

TITLE CABLE ASSEMBLY, SEANET TO CPC

RELEASED FOR

PROPRIETARY

J-Box, Deck Test, Titan 4, 101-4898

Rev. H

Item	P/N	Description	Qty
1	005-0554	CONN,RECP,DB25(SKTS)205207-11,	1
2	005-5567	ENCLOSURE,14PIN,9PIN,DB-25,GND	1
3	003-0007	FEET,RUB,STICK ON MA CONT HSG	4
4	005-2513	RING,TERM,16-22 AWG,1/4IN. STU	1
5	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
6	005-0263	SW,PWR MDL WTH SW & FUSE,06A2D	1
7	005-1627	TBG,SHRINK,3/16~,SURF IRRADIAT	.15
8	002-0159	BHCS,6-32X3/8,SS	8
9	005-0555	CONN,PIN FEM,D-SUB(66682-4 AMP	4
10	005-0239	CONN,SKT,CPC,66594-2,AMP	18
12	005-3134	CONN,CPC 17-9,RVS SEX,SQ FLG,R	1
13	005-0587	FUSE,6.3A,250V,SLO-BLO,5x20mm	2
15	005-1760	WIRE,18 AWG,BLK,600V,TEFLON	4
16	005-0603	CONN,SCRLOCK FOR DB CONNS	2
17	005-0264	CA,PWR CORDSET(86537030 PANEL	1
18	005-0219	WIRE,22 AWG.,7/32 TEFLON,BLK,.	4
19	001-1463	LABEL,I.D. W/ OPNDATA	1
20	002-0524	CABLE, TIE, 3 IN X .09 WIDE	4
21	002-1787	FHMS,4-40X.25LG,82DEG,18-8,NYL	4
22	002-0226	NUT,4-40,SS	4
23	005-0448	TBG,SHRINK,1/4,SURF IRRADIATED	.15
25	002-1507	STDF,3/16 HEX X .25LG,M-F 4-40	4
29	005-4650	CONN,3 PIN,HSG,.156 SPACE,RAMP	1
30	005-4647	CONN,4 PIN,HSG,.156 SPACE,RAMP	1
31	005-1871	PIN,CRIMP,18-24 AWG,GOLD	4
33	005-5568	PWR SPLY MDL,AC-DC,24V,60W	1
34	005-2858	CONN,BNC CHASSIS,ISOLATED	1
35	005-2857	CONN,CAP/CHAIN,MALE BNC	1
36	002-0426	BHCS,4-40X3/8,SS	1
100	101-4898-WI	WORK INSTRUCTIONS	0

J-Box, Deck Test, Titan 4, CAM, Innova, 101-4898-2

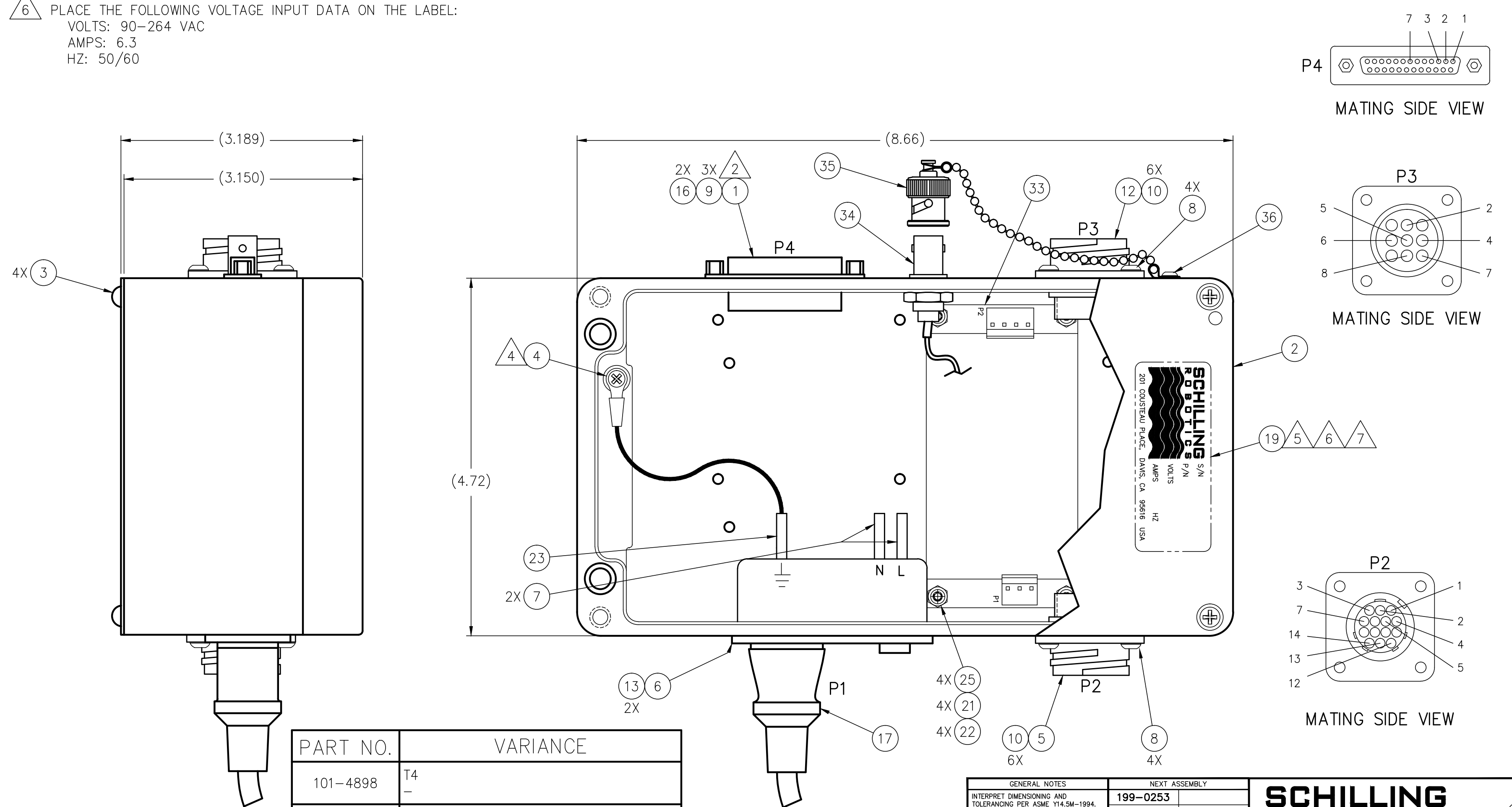
Rev. C

Item	P/N	Description	Qty
1	005-0554	CONN,RECP,DB25(SKTS)205207-11,	1
2	005-5567	ENCLOSURE,14PIN,9PIN,DB-25,GND	1
3	003-0007	FEET,RUB,STICK ON MA CONT HSG	4
4	005-2513	RING,TERM,16-22 AWG,1/4IN. STU	1
5	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
6	005-0263	SW,PWR MDL WTH SW & FUSE,06A2D	1
7	005-1627	TBG,SHRINK,3/16~,SURF IRRADIAT	.15
8	002-0159	BHCS,6-32X3/8,SS	8
9	005-0555	CONN,PIN FEM,D-SUB(66682-4 AMP	4
10	005-0239	CONN,SKT,CPC,66594-2,AMP	18
12	005-3134	CONN,CPC 17-9,RVS SEX,SQ FLG,R	1
13	005-0587	FUSE,6.3A,250V,SLO-BLO,5x20mm	2
15	005-1760	WIRE,18 AWG,BLK,600V,TEFLON	4
16	005-0603	CONN,SCRLOCK FOR DB CONNS	2
17	005-0264	CA,PWR CORDSET(86537030 PANEL	1
18	005-0219	WIRE,22 AWG.,7/32 TEFLON,BLK,.	4
19	001-1463	LABEL,I.D. W/ OPNDATA	1
20	002-0524	CABLE, TIE, 3 IN X .09 WIDE	4
21	002-1787	FHMS,4-40X.25LG,82DEG,18-8,NYL	4
22	002-0226	NUT,4-40,SS	4
23	005-0448	TBG,SHRINK,1/4,SURF IRRADIATED	.15
25	002-1507	STDF,3/16 HEX X .25LG,M-F 4-40	4
29	005-4650	CONN,3 PIN,HSG,.156 SPACE,RAMP	1
30	005-4647	CONN,4 PIN,HSG,.156 SPACE,RAMP	1
31	005-1871	PIN,CRIMP,18-24 AWG,GOLD	4
33	005-5568	PWR SPLY MDL,AC-DC,24V,60W	1
34	005-2858	CONN,BNC CHASSIS,ISOLATED	1
35	005-2857	CONN,CAP/CHAIN,MALE BNC	1
36	002-0426	BHCS,4-40X3/8,SS	1
1000	101-4898-2-WI	WORK INSTRUCTIONS	0

NOTES:

1. BALLOONED NUMBERS CORRESPOND TO THE SEQUENCE NUMBERS IN THE BILL OF MATERIAL.
2. DISCARD NUT AND WASHER (BOX HAS THREADED HOLES).
3. USE CABLE TIES, ITEM 20, AS REQUIRED FOR WIRE MANAGEMENT.
4. ANCHOR GROUND LUG TO CASE GROUND WITH MASKED HOLE.
5. PLACE SERIAL NUMBER HERE. SERIALIZE THE ASSEMBLY USING THE LAST 5 DIGITS OF THE WORK ORDER NUMBER. ADD THE DESIGNATION −1, −2, −3, ETC. FOR JOBS CONTAINING MORE THAN 1 ASSEMBLY.
6. PLACE THE FOLLOWING VOLTAGE INPUT DATA ON THE LABEL:
   VOLTS: 90–264 VAC
   AMPS: 6.3
   HZ: 50/60
7. PLACE PART NUMBER ON THE LABEL FOLLOWED BY THE BOM REVISION

REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
A	–	–	RELEASED FOR PRODUCTION	10/7/04	CA	WK
B	–	–	CHANGED WIRING P2 PINS 4 & 5	11/1/04	RJ	GC
C	1	B3,D4	MOVED GND LUG, ADDED NOTE 5	1/13/05	DD	SLW
D	ALL	–	REMOVE PAGE 2 AND MODIFY BOX & NOTES	7/8/05	KJ	WK
E	ALL	–	ADD SHEET 3 & A −1 VARIANCE	10/13/05	KJ	WK
F	–	–	ADDED WIRING TABLE, UPDATED ITEM 18 IN SHT 2 AND 3.	10/13/05	KJ	WK
G	–	–	ADDED NOTES 5, 6 AND 7	11/16/06	JG	WK
H	ALL	–	ADDED BNC VIDEO CONNECTOR, DELETED SHT 2 OF 3	5/31/07	CRL	SLW
J	–	–	REFER TO ECO	5/31/07	CRL	SLW
K	–	–	ADDED −2 CONFIURATION AND SHEET 3	8/17/07	NLH	SLW
L	SHT2,3	–	ADDED RS-485 DATA + AND − ON DIAGRAMS	8/1/08	NLH	AH



PART NO.	VARIANCE
101–4898	T4 –
101–4898–1	VARIANCE OBSOLETE –
101–4898–2	CAMERA FOR INNOVA –

PROPRIETARY

RELEASED FOR PRODUCTION

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REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±0.1 .XX ±0.02 .XXX ±0.005	±1/16	.X ±30' .XX ±15'

NEXT ASSEMBLY: 199–0253, 199–0263, 199–0264, 199–0265

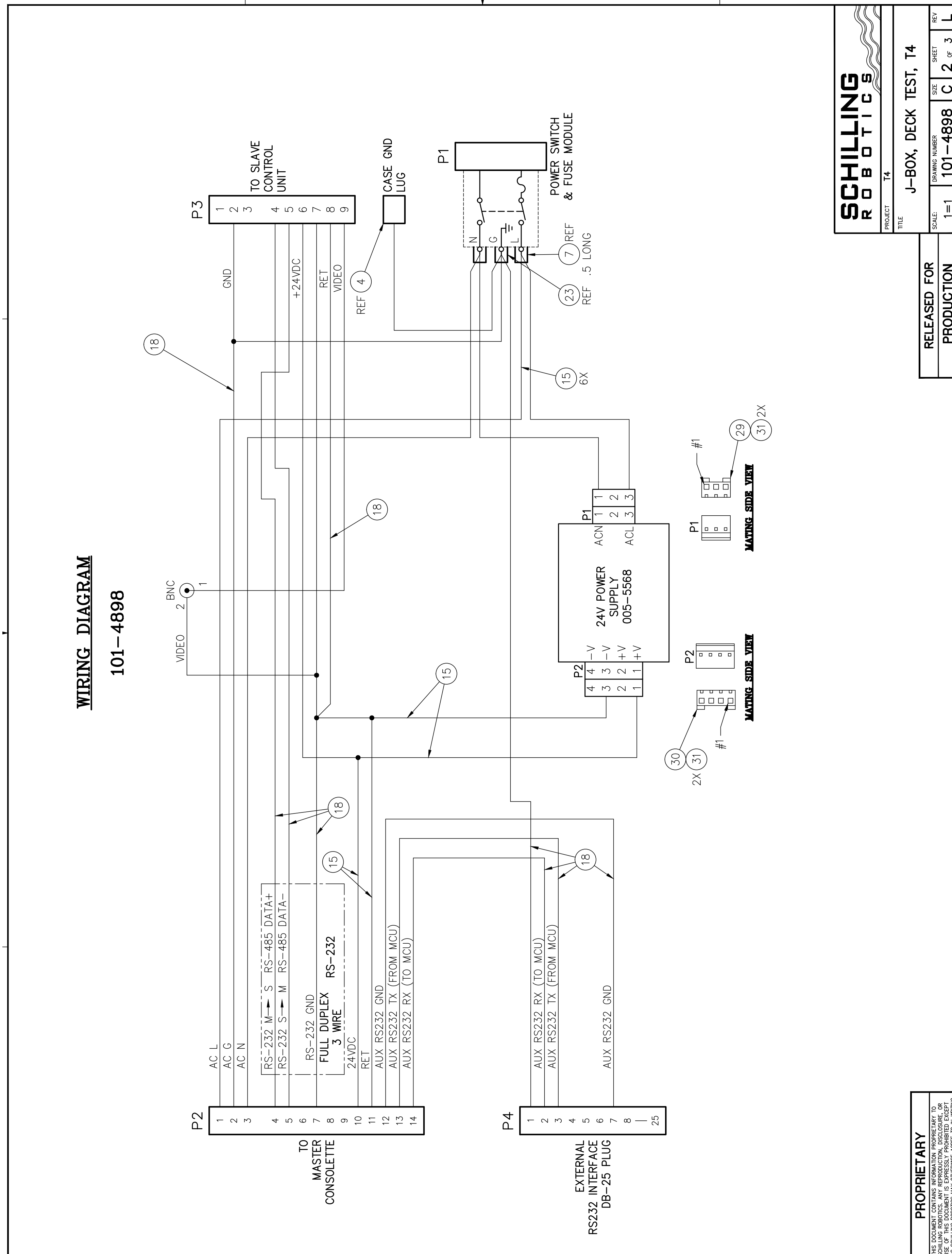
	SIGNATURE	DATE
DRAWN	CA	10/6/04
DESIGNED	CA	10/6/04
CHECKED		
LEAD	WK	

SCHILLING ROBOTICS

PROJECT: T4

TITLE: J–BOX, DECK TEST, T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1	101–4898	C	1 OF 3	L



WIRING DIAGRAM
101-4898
P3
TO SLAVE CONTROL UNIT
GND
+24VDC
RET
VIDEO
CASE GND LUG
REF 4
P1
POWER SWITCH & FUSE MODULE
N G L
7 REF .5 LONG
23 REF
15 6X
18
BNC
VIDEO
24V POWER SUPPLY 005-5568
ACN
ACL
-V -V +V +V
P1
P2
MATING SIDE VIEW
#1
29 31 2X
30 31 2X
15
18
P2
TO MASTER CONSOLETTE
AC L
AC G
AC N
RS-232 M→ S RS-485 DATA+
RS-232 S→ M RS-485 DATA-
RS-232 GND
FULL DUPLEX 3 WIRE RS-232
24VDC
RET
AUX RS232 GND
AUX RS232 TX (FROM MCU)
AUX RS232 RX (TO MCU)
P4
EXTERNAL RS232 INTERFACE DB-25 PLUG
AUX RS232 RX (TO MCU)
AUX RS232 TX (FROM MCU)
AUX RS232 GND
SCHILLING ROBOTICS
PROJECT T4
TITLE J-BOX, DECK TEST, T4
SCALE: 1=1
DRAWING NUMBER 101-4898
SIZE C
SHEET 2 OF 3
REV L
RELEASED FOR PRODUCTION
PROPRIETARY
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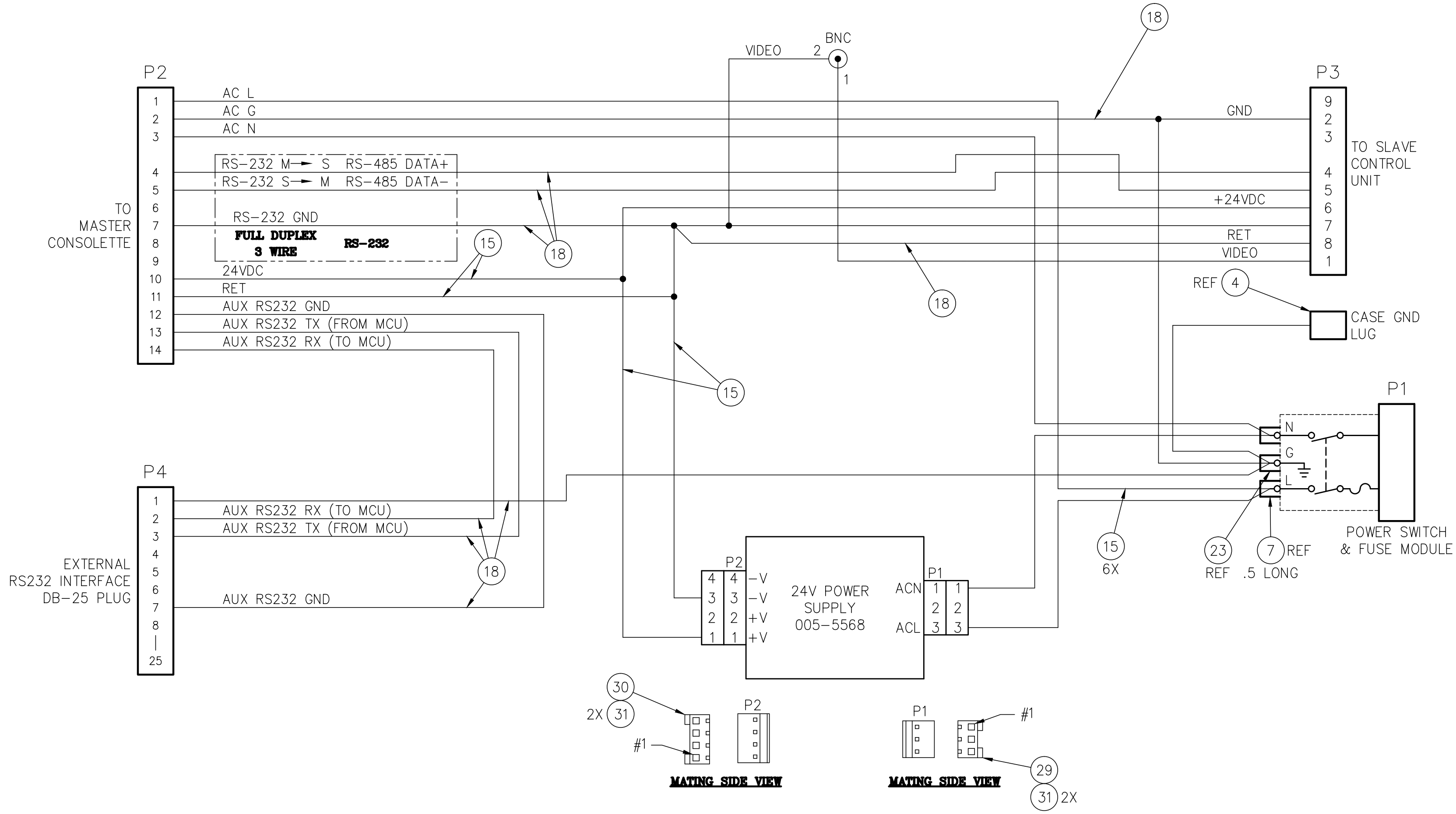
WIRING DIAGRAM

101–4898–2



PROPRIETARY

RELEASED FOR PRODUCTION

SCHILLING ROBOTICS

PROJECT	T4			
TITLE	J–BOX, DECK TEST, T4			
SCALE: 1=1	DRAWING NUMBER 101–4898	SIZE C	SHEET 3 OF 3	REV L

7.8 Inch Intermeshing Jaw Kit, 101-4928

Rev. A

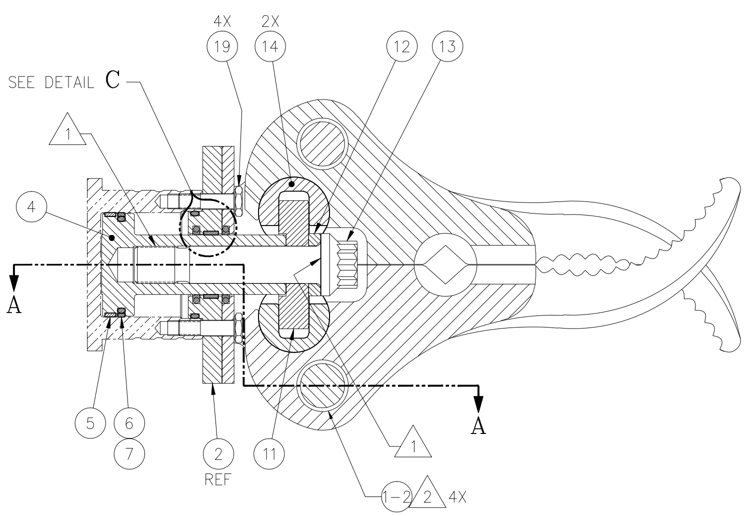
Item	P/N	Description	Qty
1	101-3576	JAW ASSY,7.8IN INTERMESHING	2
2	001-7215	GLAND,NOSE,WRIST,T3/4	1
3	007-0578	NOSE BLOCK,CONAN JAW TO T3/4	1
4	001-7214	PISTON,CONAN JAW TO T3/4 WRIST	1
5	001-7218	BEARING,1.75OD,.064WALX.185THK	1
6	004-0046	O-RING,2-127 BUNA 70	1
7	004-0646	SEAL,JAW PSTN,GAMMA	1
8	004-0588	O-RING,2-129 BUNA 90	1
9	004-0650	SEAL,ROD,LIN ACTR,GAMMA	2
10	001-5398	BRG,ROD,1.0DIA,ORKOT	1
11	001-5396	PLATE,T-BAR,LOCKING	1
12	001-7216	SPACER,1.045ODX.641IDX.200THK	1
13	001-7520	BOLT,6 PT,5/8-18,STD	1
14	001-2908	BRG,ACTR,BRZ	2
15	003-0006	BRG,THR,0.75X1.50X0.078	4
16	001-7217	PIN,.75 OD X 2.00 LONG	2
17	002-3105	BOLT,SHLDR,.5 DIA X .5,3/8-16	4
18	002-0050P	NAS 6404PU2,NLK	4
19	002-0332P	NAS 6404U9,NYLON PATCH	4
20	002-1925	ANTI-SIEZE,1 OZ TUBE	1

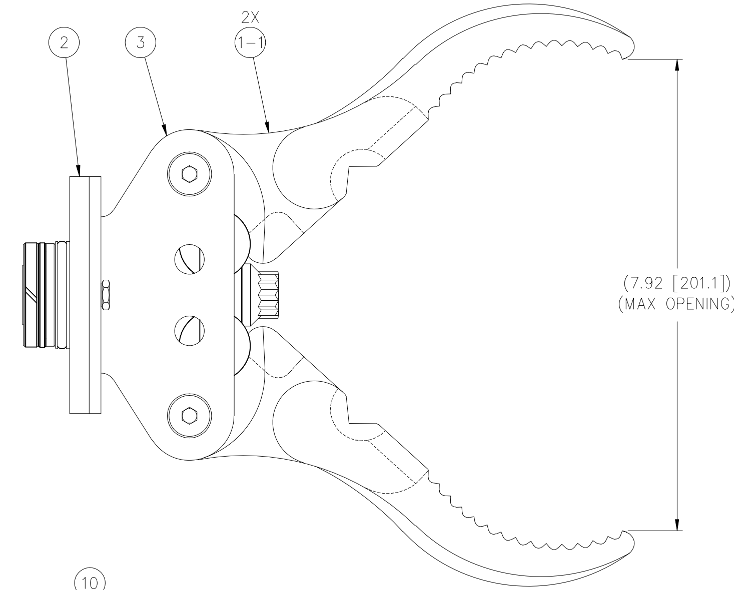
PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	PRELIMINARY	12/15/04	DD	CA
	Ø	–	RELEASED FOR PROTOTYPE	2/24/05	DD	DD
	1	–	ADDED ITEM 17 TO TORQUE TABLE	8/8/08	NLH	AH
	2	–	ADD NOTE 2: APPLY ADHESIVE TO BEARINGS. CLARIFY ITEM BUBBLES	4/3/09	MHB	SW
0369	A	–	RELEASE FOR PRODUCTION	7/2/09	MHB	SW

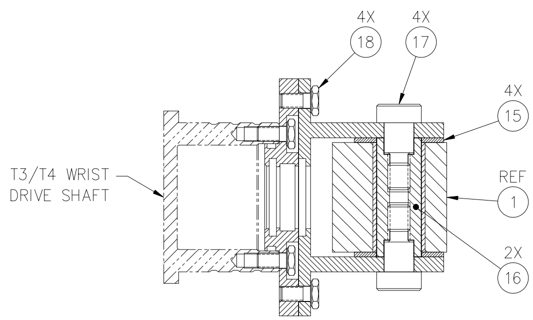
NOTES:

1. ENSURE ITEM (20) IS APPLIED TO BOLT HEAD AND THREADS.
2. ADD PRIMER AND LOCTITE 271 TO OUTER SURFACE OF BEARING BEFORE INSTALLATION.
3. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

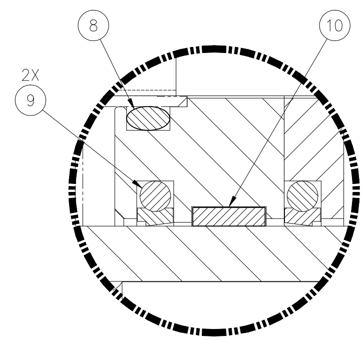
ITEMS:	TORQUE:
13	160 FOOT LBS. [216.9 Nm]
17, 18, 19	21 FOOT LBS. [28.5 Nm]







SECTION A–A
ITEMS REMOVED FOR CLARITY



DETAIL C

PROPRIETARY
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RELEASED FOR
PRODUCTION

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ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	DD	12/15/04
DESIGNED	CA	6/19/03
CHECKED		
LEAD	CA	

SCHILLING ROBOTICS

PROJECT T3/T4

TITLE KIT, JAW, 7.8 INCH INTERMESHING, T3/T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101–4928	C	1 OF 1	A

NOTE: *Part list only.*

Control Ass'y, Slave Arm, 7Km, 101-5033-1

Rev. A

Item	P/N	Description	Qty
1	101-5752-4	PCB ASSY,T4,7K ARM CON J16	1
2	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
3	001-7448	HOUSING,PCB,7000M,T4	1
4	002-0006	BHCS,4-40X1/4,SS	9
5	002-0475-1	STANDOFF,MOD,9mm LONG,M-F,4-40	1
6	002-0692	SHCS,4-40X.375,SS	2
7	001-7928	SPACER,0.50D X 0.21	2
8	001-7449	BLOCK,PCB,BONDING,7000M,T4	1
20	002-2531	ADH, #425 BLUE LOCTITE, 70 OZ	0
22	002-4811	EPOXY,WEST SYSTEM,105B,RESIN	0
23	002-4812	EPOXY,WEST SYS,205B HARDENER	0
24	002-0799	GREASE,SILICON DC-5	0
25	010-1543	PLATE FIXTURE	0
1000	101-5033-1-WI	WORK INSTRUCTIONS	0

Cable Ass'y, Slave Arm, T4 SCE, 101-5082

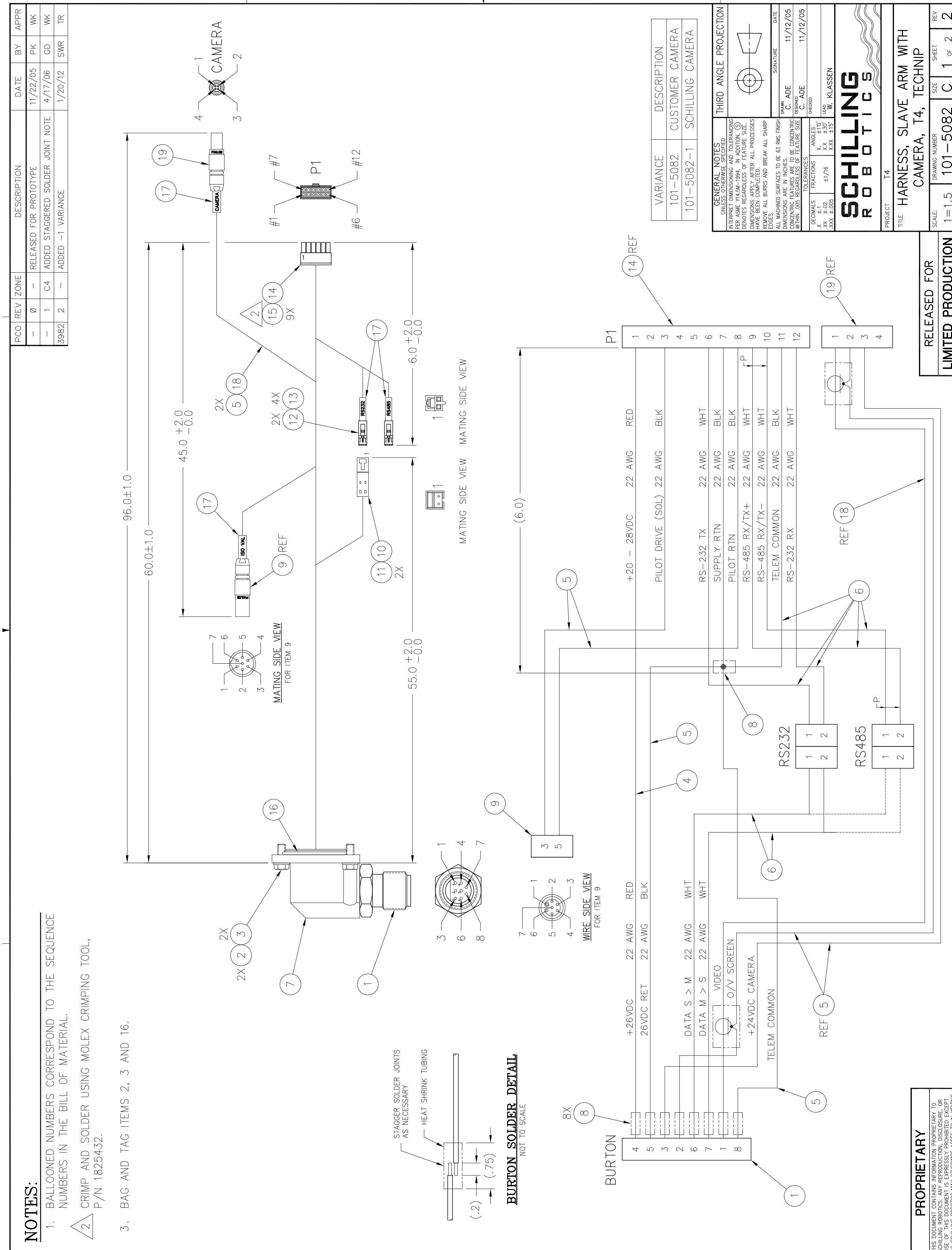
Rev. 2

Item	P/N	Description	Qty
1	005-3244	CONN,8 PIN,15 SHELL,BURTON,BHD	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	28.5
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
7	001-7521	HSG,CONN,BURTON 15 SHELL,UA,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-1335	CONN,4 PIN,MALE FD	1

Harness, Slave Arm, T4/Camera, 101-5082-1

Rev. 2

Item	P/N	Description	Qty
1	005-3244	CONN,8 PIN,15 SHELL,BURTON,BHD	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	28.5
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
7	001-7521	HSG,CONN,BURTON 15 SHELL,UA,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-1335	CONN,4 PIN,MALE FD	1


NOTES:
1. BALLOONED NUMBERS CORRESPOND TO THE SEQUENCE NUMBERS IN THE BILL OF MATERIAL.
2 CRIMP AND SOLDER USING MOLEX CRIMPING TOOL, P/N 1825432.
3. BAG AND TAG ITEMS 2, 3 AND 16.
PCO REV ZONE DESCRIPTION DATE BY APPR
- Ø - RELEASED FOR PROTOTYPE 11/22/05 PK WK
- 1 C4 ADDED STAGGERED SOLDER JOINT NOTE 4/17/06 GD WK
3982 2 - ADDED -1 VARIANCE 1/20/12 SWR TR
VARIANCE DESCRIPTION
101-5082 CUSTOMER CAMERA
101-5082-1 SCHILLING CAMERA
CAMERA
P1
#1 #6 #7 #12
96.0±1.0
60.0±1.0
45.0 +2.0 -0.0
55.0 +2.0 -0.0
6.0 +2.0 -0.0
(6.0)
MATING SIDE VIEW
MATING SIDE VIEW FOR ITEM 9
WIRE SIDE VIEW FOR ITEM 9
BURTON SOLDER DETAIL NOT TO SCALE
STAGGER SOLDER JOINTS AS NECESSARY
HEAT SHRINK TUBING
(.2) (.75)
BURTON
+26VDC 22 AWG RED
26VDC RET 22 AWG BLK
DATA S > M 22 AWG WHT
DATA M > S 22 AWG WHT
VIDEO
O/V SCREEN
+24VDC CAMERA
TELEM COMMON
+20 - 28VDC 22 AWG RED
PILOT DRIVE (SOL) 22 AWG BLK
RS-232 TX 22 AWG WHT
SUPPLY RTN 22 AWG BLK
PILOT RTN 22 AWG BLK
RS-485 RX/TX+ 22 AWG WHT
RS-485 RX/TX- 22 AWG WHT
TELEM COMMON 22 AWG BLK
RS-232 RX 22 AWG WHT
RS232
RS485
REF
THIRD ANGLE PROJECTION
GENERAL NOTES UNLESS OTHERWISE SPECIFIED
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REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE
TOLERANCES
DECIMALS X ±.1 .XX ±.02 .XXX ±.005
FRACTIONS ±1/16
ANGLES X ±1°0' X.X ±0°30' X.XX ±0°15'
DRAWN C. ADE 11/12/05
DESIGNED C. ADE 11/12/05
CHECKED
LEAD W. KLASSEN
SCHILLING ROBOTICS
PROJECT T4
TITLE HARNESS, SLAVE ARM WITH CAMERA, T4, TECHNIP
SCALE: 1=1.5 DRAWING NUMBER 101-5082 SIZE C SHEET 1 OF 2 REV 2
RELEASED FOR LIMITED PRODUCTION
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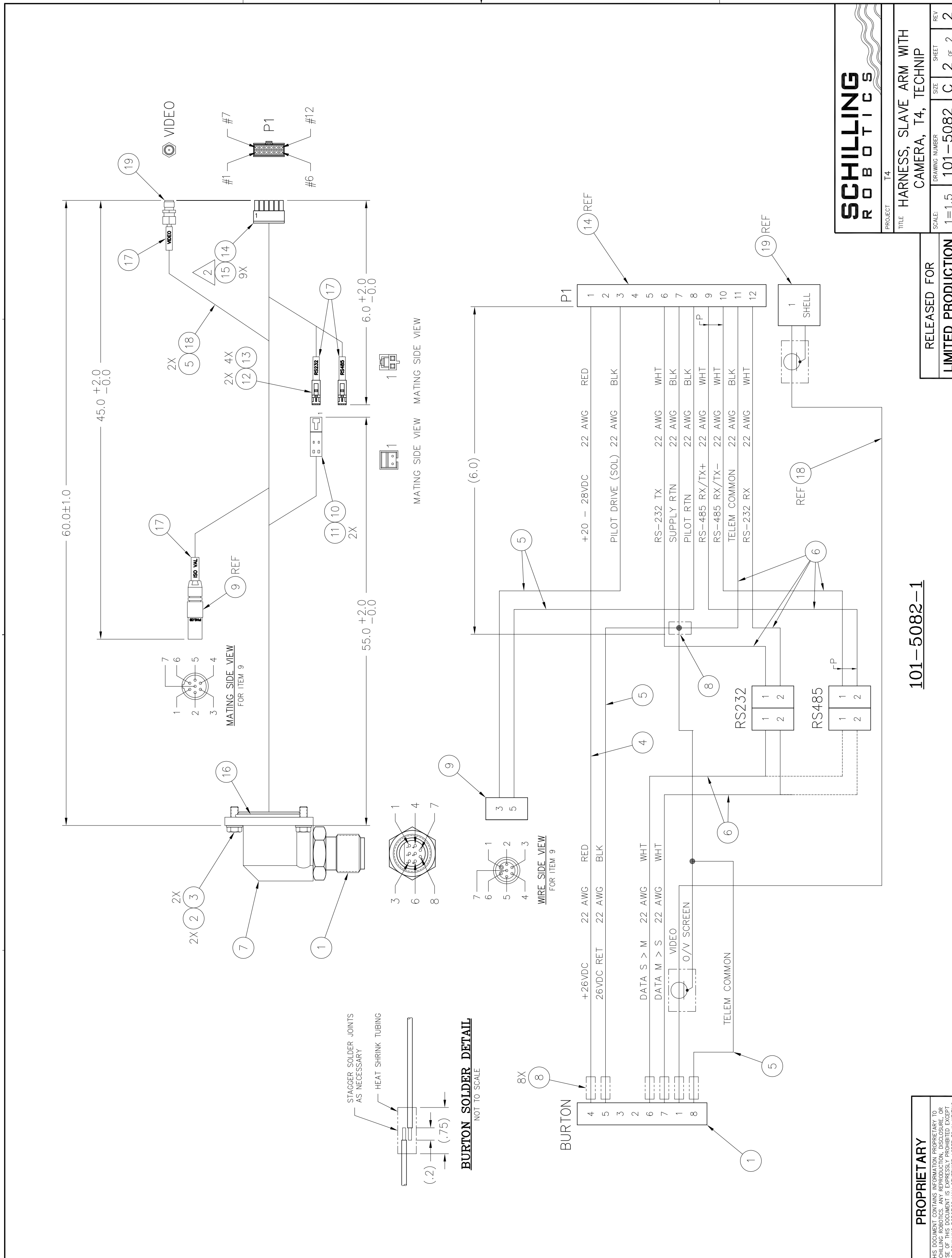
SCHILLING
ROBOTICS
PROJECT T4
TITLE HARNESS, SLAVE ARM WITH CAMERA, T4, TECHNIP
SCALE: 1=1.5
DRAWING NUMBER 101-5082
SIZE C
SHEET 2 OF 2
REV 2
RELEASED FOR
LIMITED PRODUCTION
PROPRIETARY
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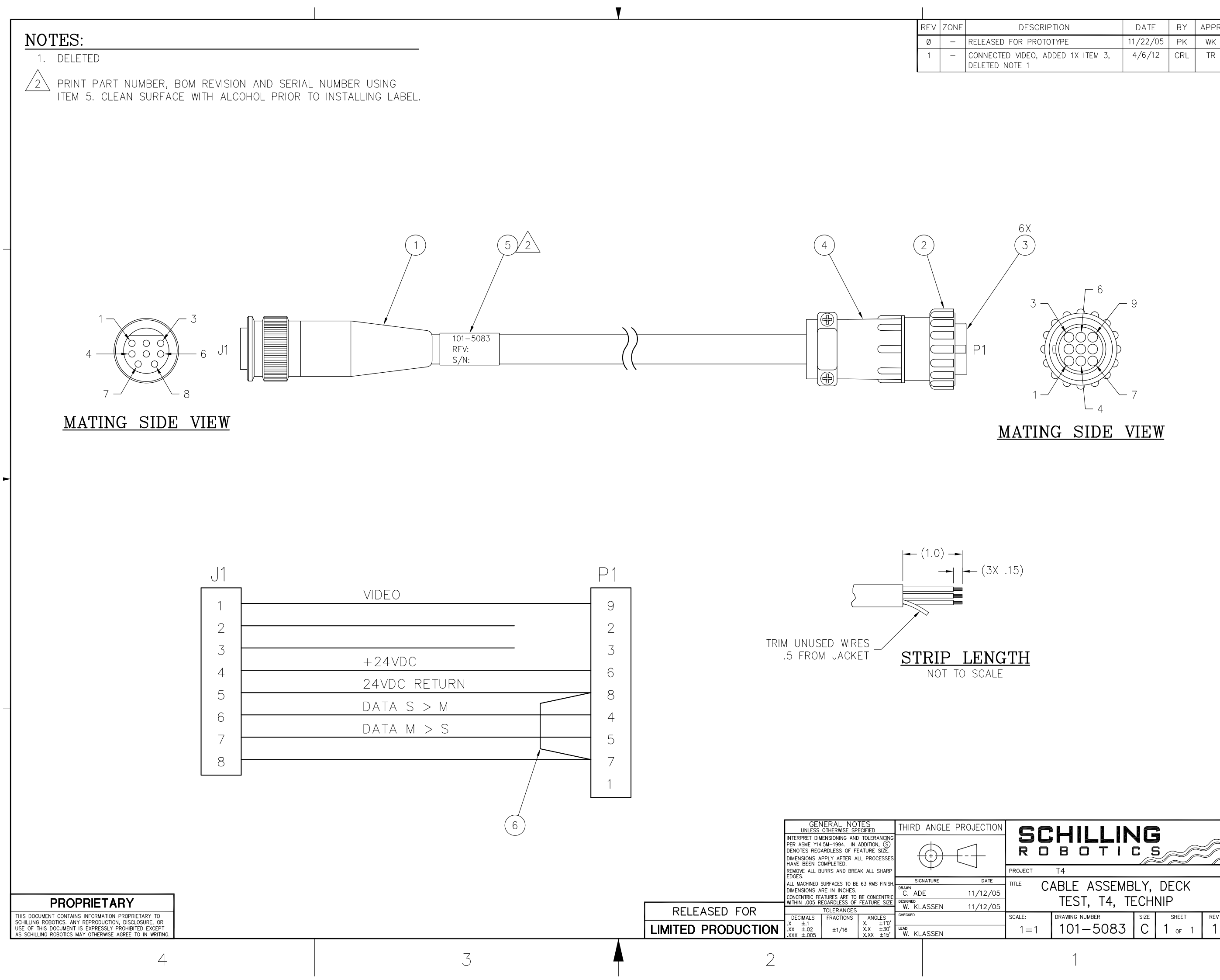
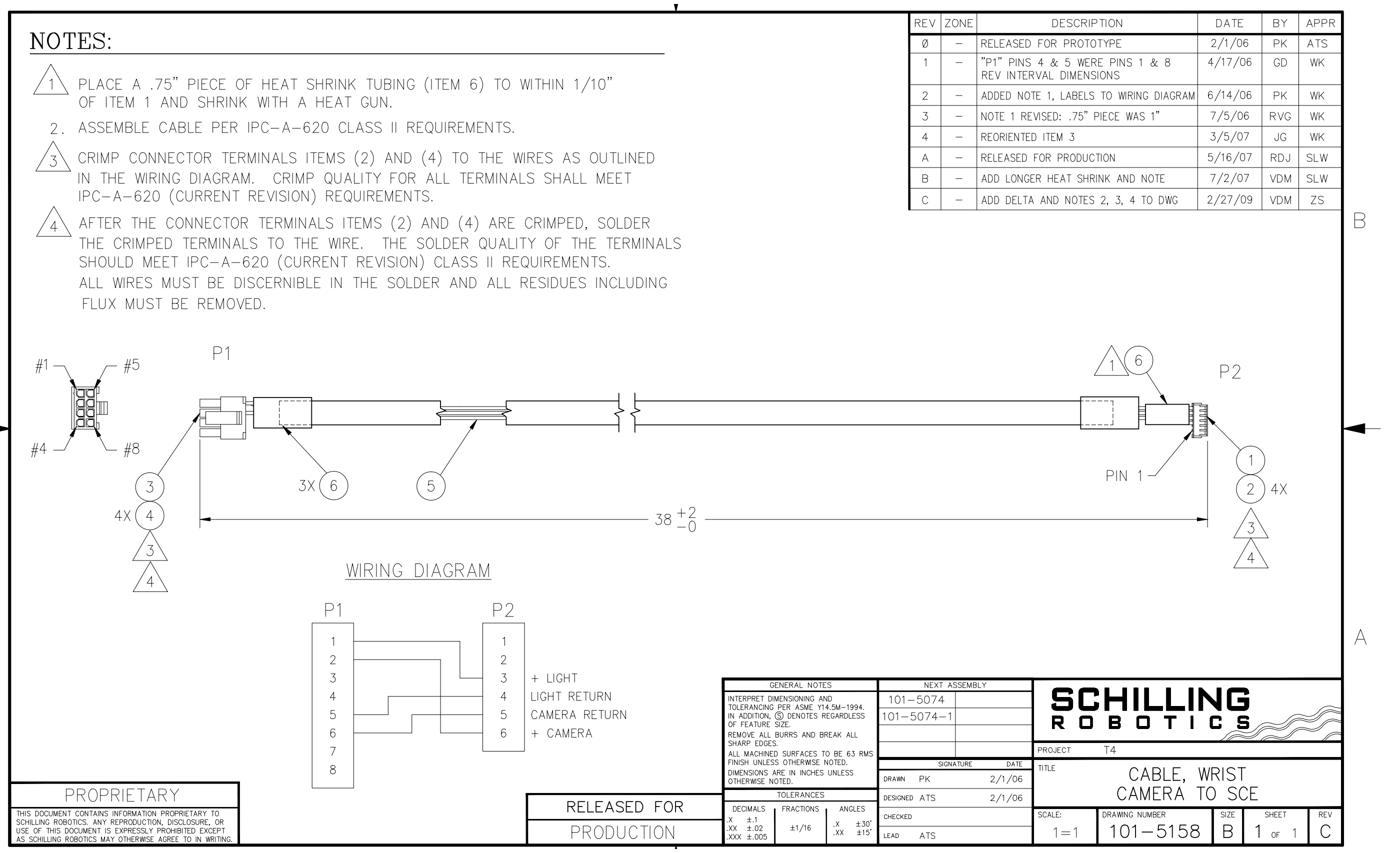
101-5082-1
VIDEO
P1
#1
#6
#7
#12
60.0±1.0
45.0 +2.0 -0.0
55.0 +2.0 -0.0
6.0 +2.0 -0.0
(6.0)
MATING SIDE VIEW
MATING SIDE VIEW FOR ITEM 9
WIRE SIDE VIEW FOR ITEM 9
BURTON SOLDER DETAIL
NOT TO SCALE
STAGGER SOLDER JOINTS AS NECESSARY
HEAT SHRINK TUBING
(.75)
(.2)
+20 - 28VDC 22 AWG RED
PILOT DRIVE (SOL) 22 AWG BLK
RS-232 TX 22 AWG WHT
SUPPLY RTN 22 AWG BLK
PILOT RTN 22 AWG BLK
RS-485 RX/TX+ 22 AWG WHT
RS-485 RX/TX- 22 AWG WHT
TELEM COMMON 22 AWG BLK
RS-232 RX 22 AWG WHT
+26VDC 22 AWG RED
26VDC RET 22 AWG BLK
DATA S > M 22 AWG WHT
DATA M > S 22 AWG WHT
VIDEO
O/V SCREEN
TELEM COMMON
BURTON
RS232
RS485
SHELL
REF

Cable Ass'y, Deck Test, 101-5083

Rev. 2

Item	P/N	Description	Qty
1	005-3243	CONN,8 PIN,15 SHELL, BURTON	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	6
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0
6	005-0219	WIRE,22 AWG.,7/32 TEFLON,BLK,.	.17





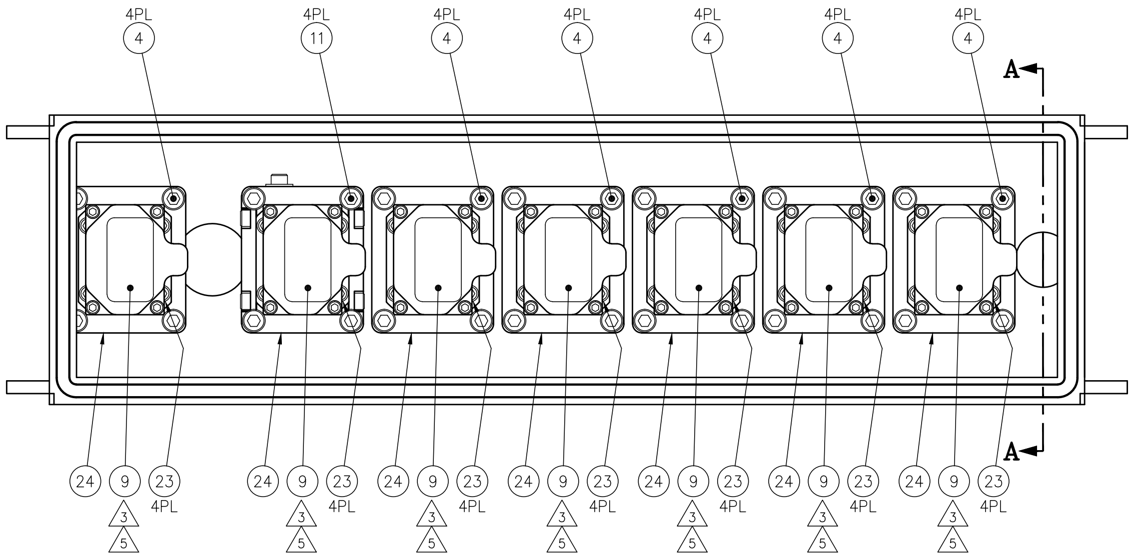
NOTE: *Drawing only.*

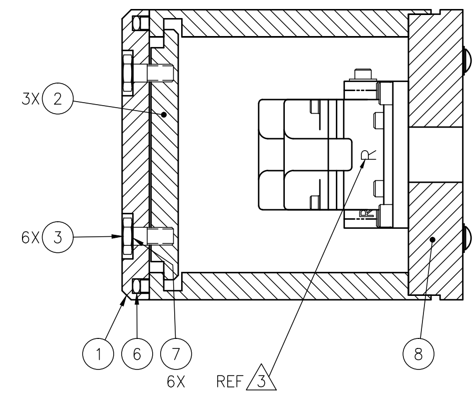
Forearm, 101-5723

Rev. A

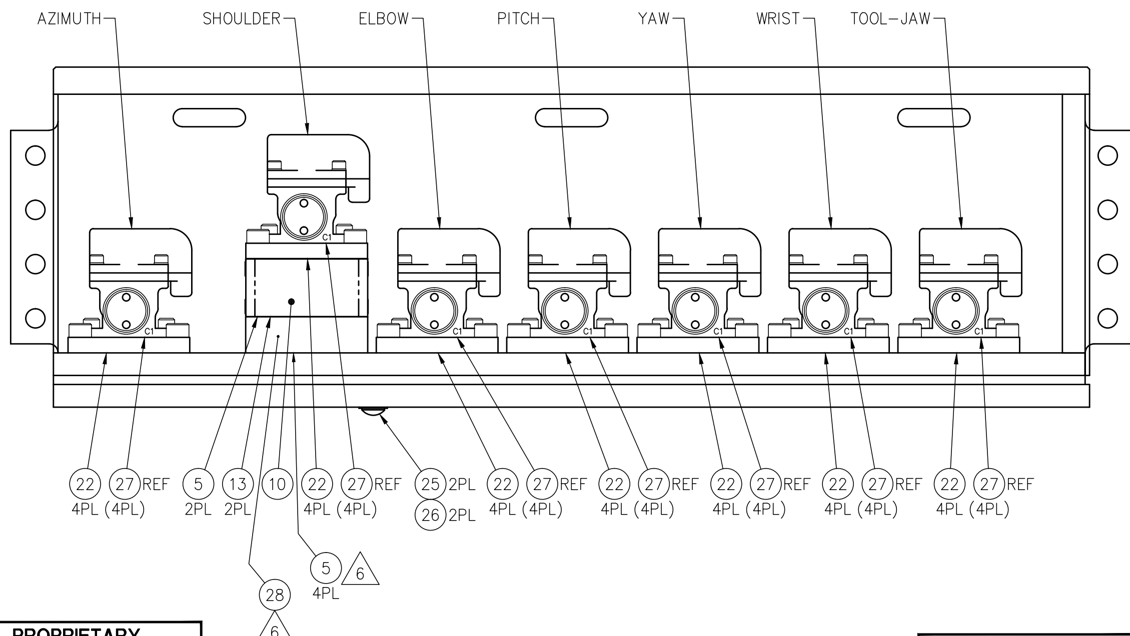
Item	P/N	Description	Qty
1	001-3167	LID,FA,T3	1
2	001-1785	CLP,FA COV	3
3	002-0052P	NAS 6404PU3,NLK	6
4	002-0095P	SHCS,10-32X3/8,316SS,NLK	24
5	004-0222	O-RING,2-010 BUNA 90	6
6	004-0601	O-RING,2-275,N70	1
7	004-0137	O-RING,.244x.039 BUNA 90 APPLE	6
8	007-0193	FOREARM,T3	1
9	006-2330	VALVE,SERVO,MOOG 30-389B,WLEMO	7
10	101-6190	LOCK VALVE ASSY,3000 PSI,T4	1
11	002-4871P	SHCS,10-32X1-3/4,SS,NLK	4
13	004-0114	O-RING,2-013 BUNA 90	2
22	004-0665	O-RING,.326X.039,BUNA 90	28
23	002-0933	SHCS,6-32,5/16LONG,ALLOY STL	28
24	001-2637	PL,ADPTR SERVO	7
25	004-0627	O-RING,.189X.039,BUNA 90	2
26	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	2
27	004-0561	O-RING,.228X.040,BUNA 70	0
28	101-3965	RLF V,UNIV	1
50	101-5723-WI	WORK INSTRUCTIONS	0

REV	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	RELEASED FOR PROTOTYPE	1/27/07	JG	SLW
	1	–	ITEM 28 WAS 14, 5 WAS 15	2/14/07	JG	SLW
	2	–	UPDATED ITEMS 10 AND 11	8/14/07	CRL	SLW
	3	–	ADDED VARIANCE TABLE	9/25/07	NLH	SLW
	4	A–4	UPDATED ITEM 28 TO ACTUAL THICKNESS	1/14/08	RDJ	SLW
	A	–	RELEASED FOR PRODUCTION	3/10/08	JG	SLW
0492	B	–	UPDATED NOTE 1, ADDED DELTA NOTE 6	10/16/09	NLH	GV
0692	C	–	ADDED ITEM 3 & 23 TO TORQUE TABLE	12/3/09	RDJ	JK





SECTION A–A



NOTES:

1. DELETED
2. ITEMS 1, 2, 3, 6, 7, AND 15 ARE REMOVED FROM TOP VIEW FOR CLARITY.

3 WITH FOREARM ORIENTED IN THE POSITION SHOWN, INSTALL THE VALVES, ITEM 9, PER THE WORK INSTRUCTIONS, WITH THE PRESSURE SIDE (MARKED "P" ON THE VALVE AND LOCKVALVE) TO THE LEFT, AND THE RETURN (MARKED "R") TO THE RIGHT.

4. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
23	15 INCH LBS. [1.7 Nm]
4	45 INCH LBS. [5.1 Nm]
3	21 FOOT LBS. [28.5 Nm]

5 SERVO VALVE 101–6947 IS USED FOR ITEM 9 ON THE RAD HARD VARIANCE

6 FOR NON–DASH VARIANT ONLY. DO NOT INSTALL ON 101–5723–1.

PART NO.	VARIANCE
101–5723	DEFAULT
101–5723–1	RAD HARD

PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES		
DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

THIRD ANGLE PROJECTION

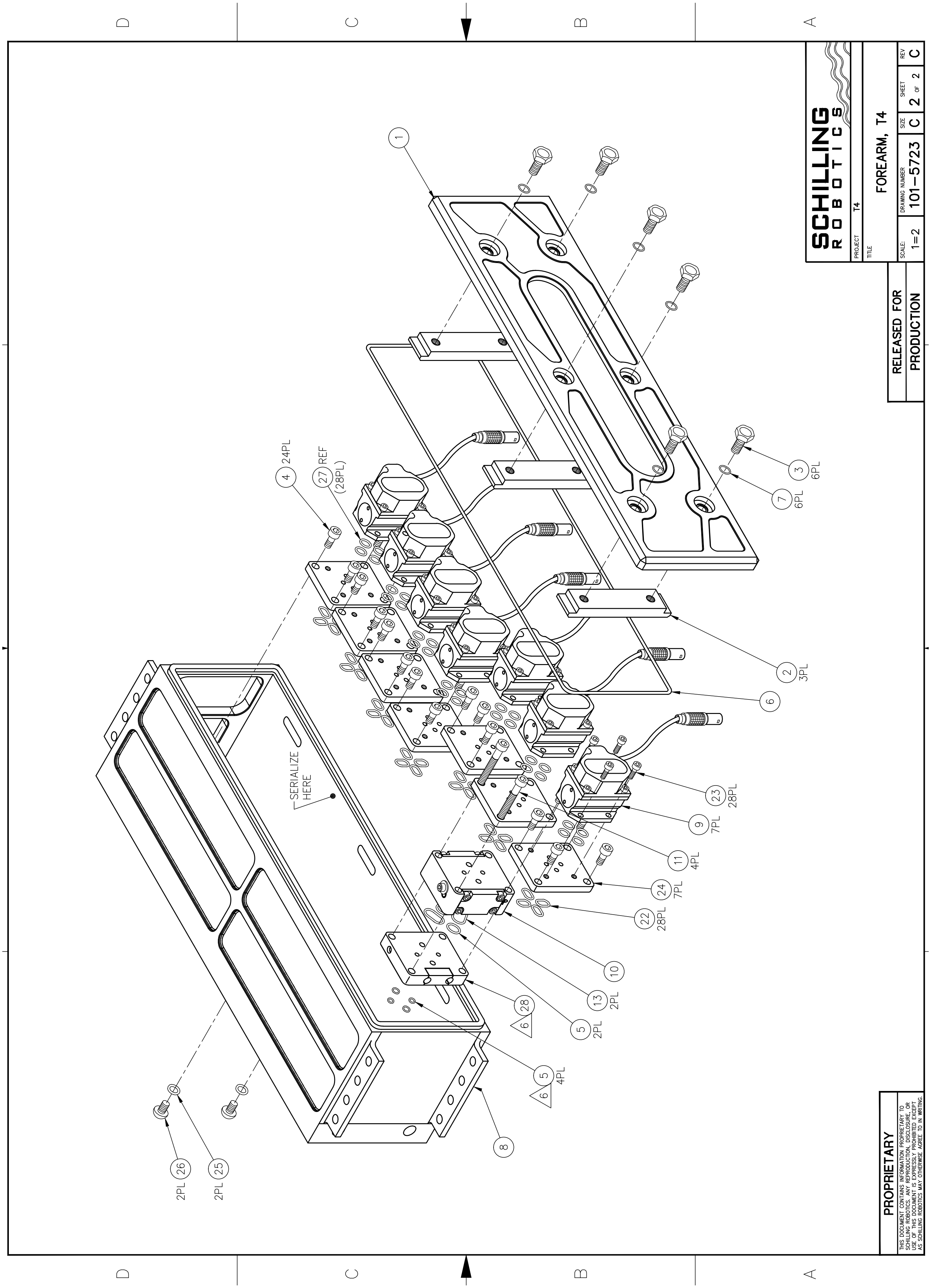
	SIGNATURE	DATE
DRAWN	JG	1/27/07
DESIGNED	SLW	1/25/07
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

PROJECT: T4

TITLE: FOREARM, T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.25	101–5723	C	1 OF 2	C


SCHILLING
ROBOTICS
PROJECT T4
TITLE FOREARM, T4
SCALE: 1=2
DRAWING NUMBER 101-5723
SIZE C
SHEET 2 OF 2
REV C
RELEASED FOR PRODUCTION
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SERIALIZE HERE
1
2 3PL
3 6PL
4 24PL
5 2PL
5 4PL
6
6
6
7 6PL
8
9 7PL
10
11 4PL
13 2PL
22 28PL
23 28PL
24 7PL
25 2PL
26 2PL
27 REF (28PL)
28
A
B
C
D

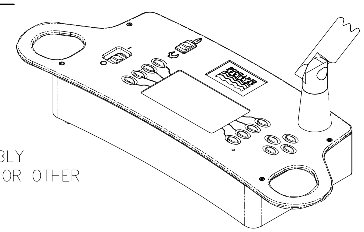
Master Controller, Univ. Input, Gen2, 101-5781

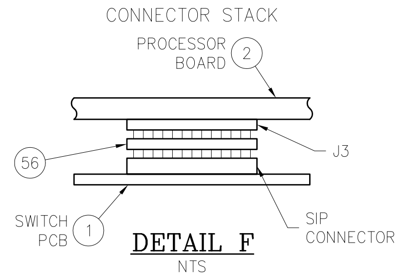
Rev. A

Item	P/N	Description	Qty
1	101-5782	FACEPLATE,ASSY,MA,CONT,GEN II	1
2	005-5195	PCB,MASTER PROCESSOR,MCU	1
3	101-1645	MA CONT ARM	1
5	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
7	101-5992	CABLE ASSY,POWER/CONTROL,MCU	1
8	002-0137	SHCS,6-32X3/8,SS	4
9	002-0011	BHCS,6-32X1/4,18-8,SS	1
10	002-0161	CLP,CA,1/8	1
11	002-0082	SHCS,10-24X5/8,SS	3
16	001-8895	HOUSING,UNIV CONTROLLER	1
17	003-0007	FEET,RUB,STICK ON MA CONT HSG	4
19	001-3893	NAMEPLATE,SCHILLING ROBOTICS	1
23	002-0862	WSHR,#8 LOCKINTL TOOTH,SS	1
24	002-0403	SHCS,8-32X1/4,SS	1
25	035-0731	WRG DIG,MCU,85-264VAC IN,W/MP	0
32	002-0020	SHCS,10-24X3/4,SS	1
33	001-1463	LABEL,I.D. W/ OPNDATA	1
37	002-3648	STANDOFF,4-40 X 11/32,SS	1
38	002-3647	BHCS,6-32,3/16,SS,SELF LOCKING	2
39	002-0119	NUT,6-32,SS,NYLOCK	4
40	002-0006	BHCS,4-40X1/4,SS	2
50	002-0279	CASE,SHIPPING,MA CONT	1
51	002-2660	LABEL,ELEC SHOCK,2.3"TRIANGLE	1
53	005-3853	TERM,RING,26-22AWG,#8 STUD,UNI	2
54	005-4886	WIRE,22 AWG,GRN/YEL,TEFZEL	.8
56	005-5571	SOCKET STRIP,13 PIN,MCU	1
1000	101-5781-WI	WORK INSTRUCTIONS	0

NOTES:

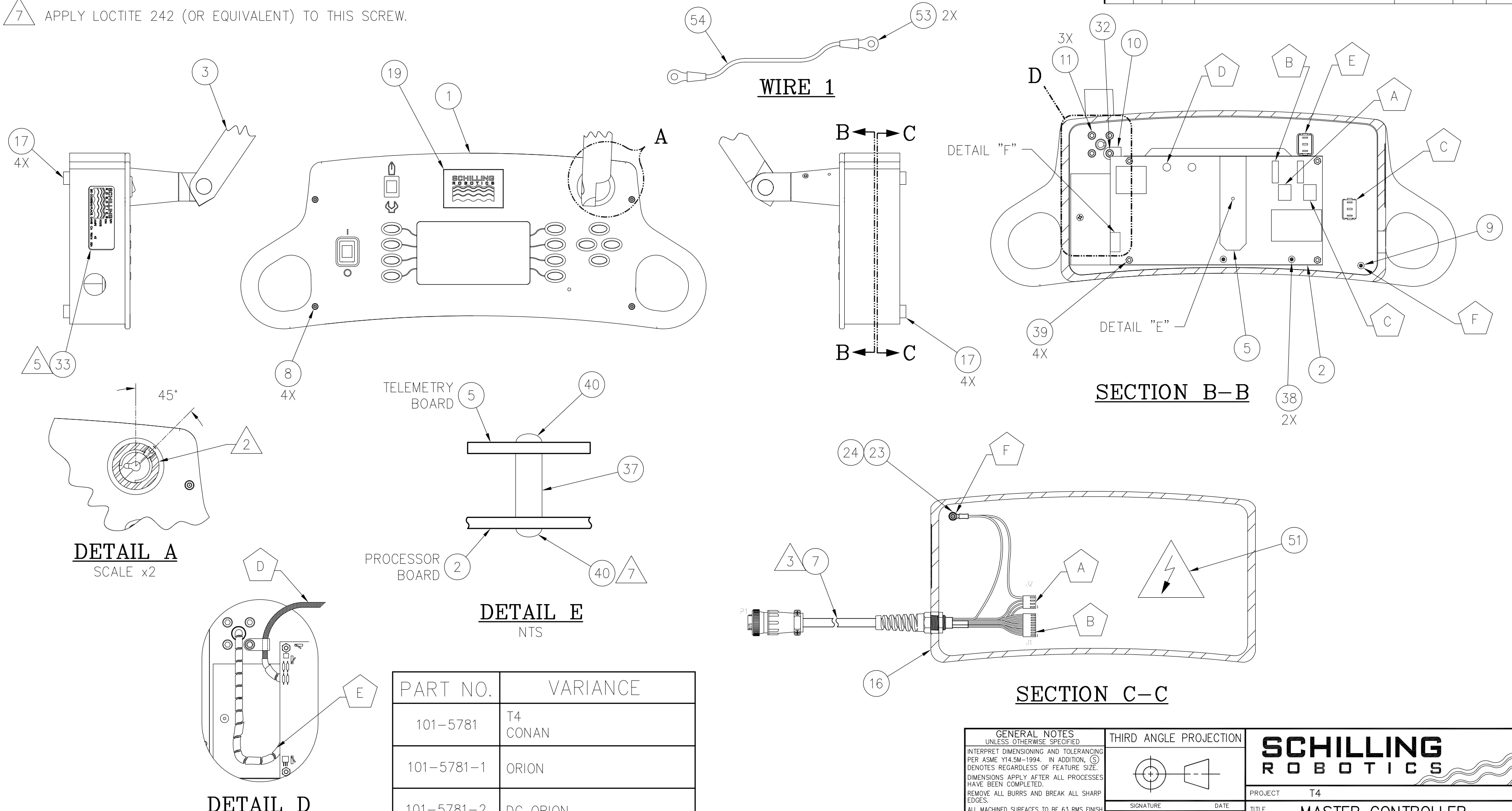
1. DELETED
2. (△2) SET SCREW OF MCA BASE CLOCK AS INDICATED.
3. (△3) REFER TO 035-0731 FOR WIRING DIAGRAM AND HEX SWITCH SETTINGS.
4. MATCHING PENTAGON NOTES REPRESENT CABLE ASSEMBLY CONNECTIONS TO EITHER THE PCB ASSEMBLY (ITEM 2) OR OTHER CABLE ASSEMBLIES.
5. (△5) SERIALIZE IN LOCATION SHOWN AS DESCRIBES IN WORK INSTRUCTIONS.
6. ITEM 50 NOT SHOWN FOR CLARITY.
7. (△7) APPLY LOCTITE 242 (OR EQUIVALENT) TO THIS SCREW.





DETAIL F
NTS

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	PRELIMINARY	1/8/07	JG	SLW
	Ø	–	RELEASED FOR PROTOTYPE	1/12/07	JG	SLW
	1	–	CORRECTED VARIANCE PART NUMBER	4/11/07	DI	GV
	2	–	CALLOUTS 37 & 40 WAS 34–36, 39/4X WAS 26/4X, 38/3X WAS 9/5X; ADDED ITEM CALLOUTS F, 9, 51, 53/2X & 54	6/11/07	RDJ	SLW
	3	–	ADDED DETAILS "E" & "F"; REVISED NOTE 3 AND ADDED DELTA NOTE 7; ZONE B-1, 2X WAS 3X; ZONE C-4, ADDED ITEM 17 CALLOUT; ZONE B-4, 5 WAS 6	7/19/07	RDJ	SLW
	4	–	ADDED DETAIL "G"	7/23/07	RDJ	MM
	5	–	ADDED -2 AND -3 VARIANCE	11/1/07	NLH	SLW
	A	–	RELEASED FOR PRODUCTION	11/1/07	NLH	SLW
0692	B	–	REVISED DETAIL "G" INTO WIRING DIAG. & ADDED -2 & -3 ALL TO NEW SHT 2; MOVED OLD SHT 2 TO NEW SHT 3	11/3/09	RDJ	JK
4088	C	SHT2	COMBINED 101-5781-2 & 101-5781-3 WIRING DIAGRAMS	2/24/12	CRL	SS



DETAIL D

PART NO.	VARIANCE
101-5781	T4 CONAN
101-5781-1	ORION
101-5781-2	DC ORION
101-5781-3	DC TITAN/CONAN

PROPRIETARY

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RELEASED FOR
PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

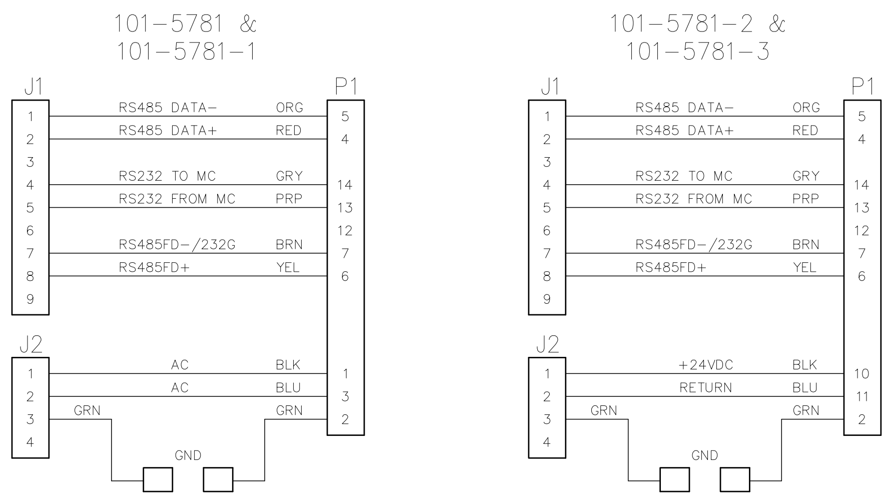
THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	J. GARDNER	1/8/07
DESIGNED	M. MEADOWS	1/8/07
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

PROJECT: T4
TITLE: MASTER CONTROLLER, UNIVERSAL INPUT, GEN II

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=3	101-5781	C	1 OF 3	C



WIRING DIAGRAM
N.T.S.

RELEASED FOR
PRODUCTION
PROPRIETARY

SCHILLING ROBOTICS

PROJECT: T4				
TITLE: MASTER CONTROLLER, UNIVERSAL INPUT, GEN II				
SCALE: 1=3	DRAWING NUMBER: 101-5781	SIZE: C	SHEET: 2 OF 3	REV: C

Face Plate, Master Controller, 101-5782

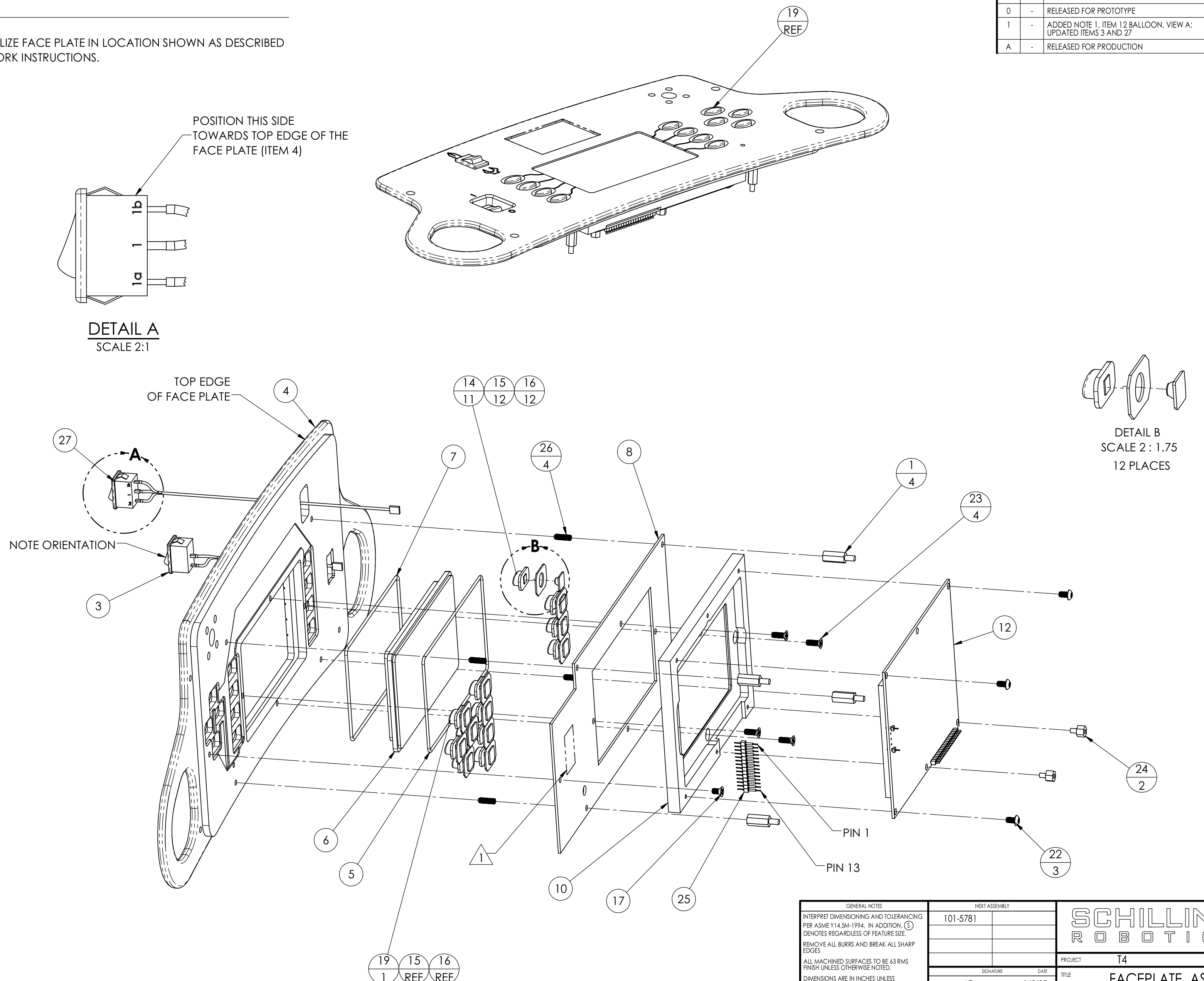
Rev. A

Item	P/N	Description	Qty
1	002-3646	STANDOFF,6-32,9/16 LONG,SS	4
3	101-1819	POWER SWITCH ASSY,MA	1
4	001-8896	FACEPLATE,UNIV MASTER CONT	1
5	004-0113	O-RING,2-047 BUNA 70	1
6	001-8894	LENS,FACEPLATE,MCU	1
7	004-1054	O-RING,4.378 X .071 BUNA 70	1
8	005-0033	PCB,SW,TIT,MA	1
10	001-8911	ADAPTER,SCD,MCU,GEN II	1
12	101-5901-1	LCD DISPLAY ASSEMBLY	1
14	001-8873	BUTTON,FACEPLATE,MCU,BLACK	11
15	001-0365	PL,MCA BACKUP	12
16	005-0185	KEYPAD,SINGLE BTN,SPST,CNDCT R	12
17	002-0124	FHMS,6-32X1/4,SS,HEXDRIVE	1
19	001-8873-1	BUTTON,FACEPLATE,MCU,RED	1
22	002-0011	BHCS,6-32X1/4,18-8,SS	3
23	002-0429	FHMS,PH,6-32X3/8,100DEG,C'SINK	4
24	002-3479	STANDOFF,6-32x3/16,1/4 HEX,MCU	2
25	005-5570	INTERCONNECT STRIP,13 PIN,MCU	1
26	002-3649	SCREW,SET,6-32 X .75, SS	4
27	101-5943	ASSY,JAWSWITCH,MCU,GEN II	1
1000	101-5782-WI	WORK INSTRUCTIONS	0

NOTES:

1. SERIALIZE FACE PLATE IN LOCATION SHOWN AS DESCRIBED IN WORK INSTRUCTIONS.

REV	ZONE	DESCRIPTION	DATE	BY	APPR
0	-	PRELIMINARY	1/5/07	JG	SLW
0	-	RELEASED FOR PROTOTYPE	1/12/07	JG	SLW
1	-	ADDED NOTE 1, ITEM 12 BALLOON, VIEW A; UPDATED ITEMS 3 AND 27	7/19/07	JG	SLW
A	-	RELEASED FOR PRODUCTION	11/1/07	NLH	SLW



GENERAL NOTES

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.

REMOVE ALL BURRS AND BREAK ALL SHARP EDGES

ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

NEXT ASSEMBLY: 101-5781

	SIGNATURE	DATE
DRAWN	JG	1/5/07
DESIGNED	MM	1/5/07
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

PROJECT: T4

TITLE: FACEPLATE, ASSEMBLY, MA, CONTROLLER, GEN II

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1.75	101-5782	C	1 OF 1	A

RELEASED FOR PRODUCTION

Harness, 6-Pin, 20 Shell, 101-5887

Rev. 3

Item	P/N	Description	Qty
1	005-5259	CONN,BULKHEAD,20 SHELL,6 COND	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	15
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12.5
7	001-8853	HSG,CONN,BURTON,20SHELL,BCR,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
21	005-1523	TBG,SHRINK,3/16 WHT,ALPHA #FIT	.5
26	005-1706	TBG,SHRINK,3/8 WHT	.1
1000	101-5887-WI	WORK INSTRUCTIONS	0

NOTES:

1. DELETED

2. (△2) REFER TO COAX STRIP DETAIL FOR ITEM 19 INSTALLATION. SLIDE FERRULE (A) OVER CABLE. STRIP CABLE AS SHOWN. TIN CENTER CONDUCTOR. FLAIR BRAID AND INSERT EXTENSION (B) UNDER BRAID WITH CENTER CONDUCTOR PROTRUDING THROUGH HOLE IN EXTENSION. SOLDER CONTACT (C) TO CENTER CONDUCTOR. SLIDE FERRULE (A) OVER BRAID AND CRIMP. INSTALL CABLE ASSEMBLY INTO BODY AND TIGHTEN. CRIMP SIZE REQUIRED: CONTACT: SOLDER, FERRULE: .100" HEX CRIMP TOOL.

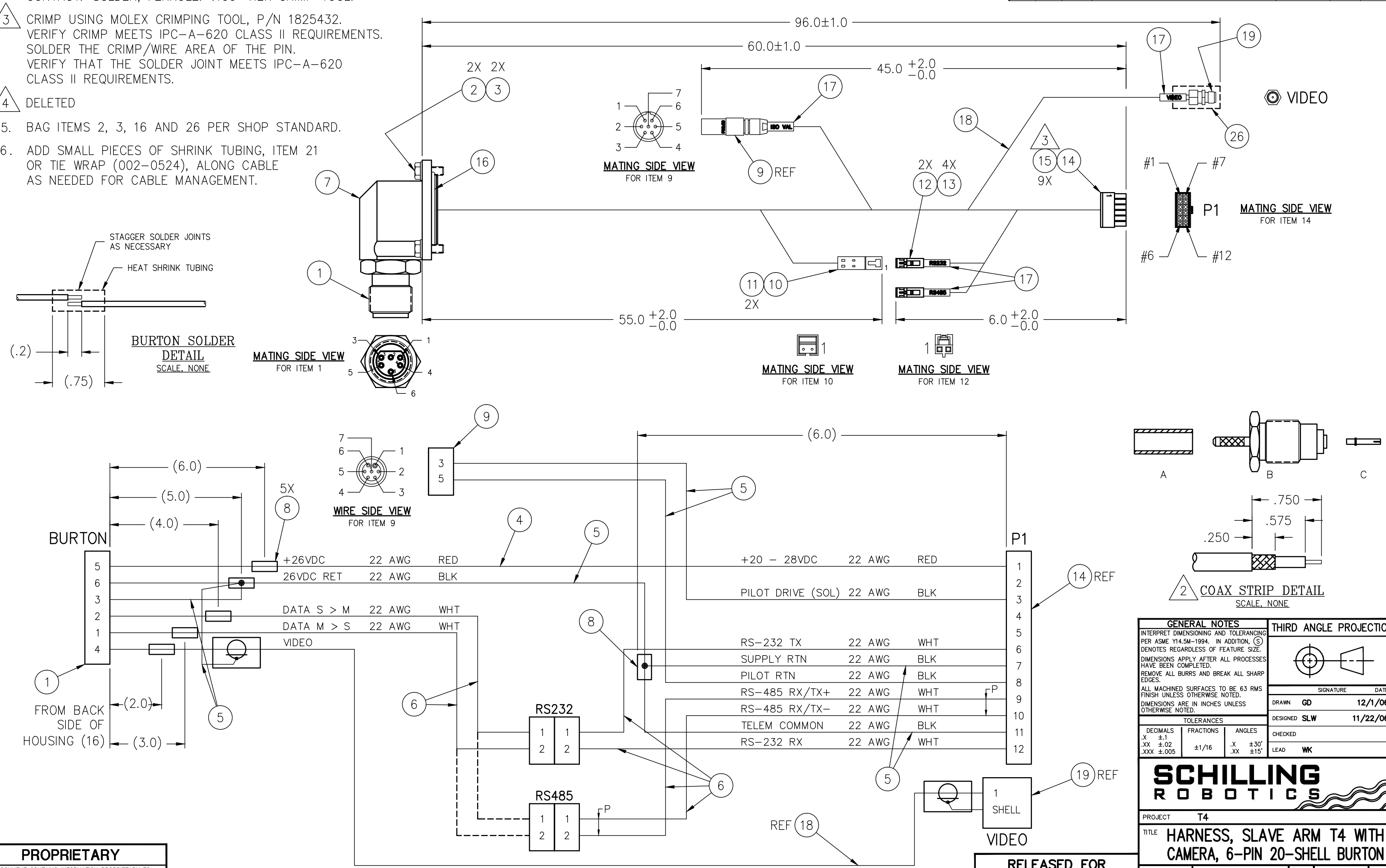
3. (△3) CRIMP USING MOLEX CRIMPING TOOL, P/N 1825432. VERIFY CRIMP MEETS IPC-A-620 CLASS II REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC-A-620 CLASS II REQUIREMENTS.

4. (△4) DELETED

5. BAG ITEMS 2, 3, 16 AND 26 PER SHOP STANDARD.

6. ADD SMALL PIECES OF SHRINK TUBING, ITEM 21 OR TIE WRAP (002-0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	RELEASED FOR PROTOTYPE	12/1/06	GD	WK
	1	–	REVISED NOTES AND VIDEO SHIELD CONNECTION	4/11/07	CRL	SLW
	2	–	REVISED BUBBLES	11/21/07	DI	GV
	3	–	CHANGED TO 8 PIN BURTON VIEW SHOWING MATING SIDE	2/1/08	VDM	SLW
	4	–	6 PIN BURTON WAS 8 PIN BURTON.	4/11/08	NLH	SLW
	5	C-2	REMOVED ITEM 5 2X CALLOUT	7/7/08	PK	SLW
	6	B-4	CHANGE WIRING OF BURTON FOR CUSTOMER	4/6/09	MHB	SLW
0843	7	–	REVISED NOTES, ADDED COAX STRIP DETAIL	12/30/09	CRL	GV



THIRD ANGLE PROJECTION

GENERAL NOTES
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES		
DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

	SIGNATURE	DATE
DRAWN	GD	12/1/06
DESIGNED	SLW	11/22/06
CHECKED		
LEAD	WK	

SCHILLING ROBOTICS

PROJECT: T4

TITLE: HARNESS, SLAVE ARM T4 WITH CAMERA, 6-PIN 20-SHELL BURTON

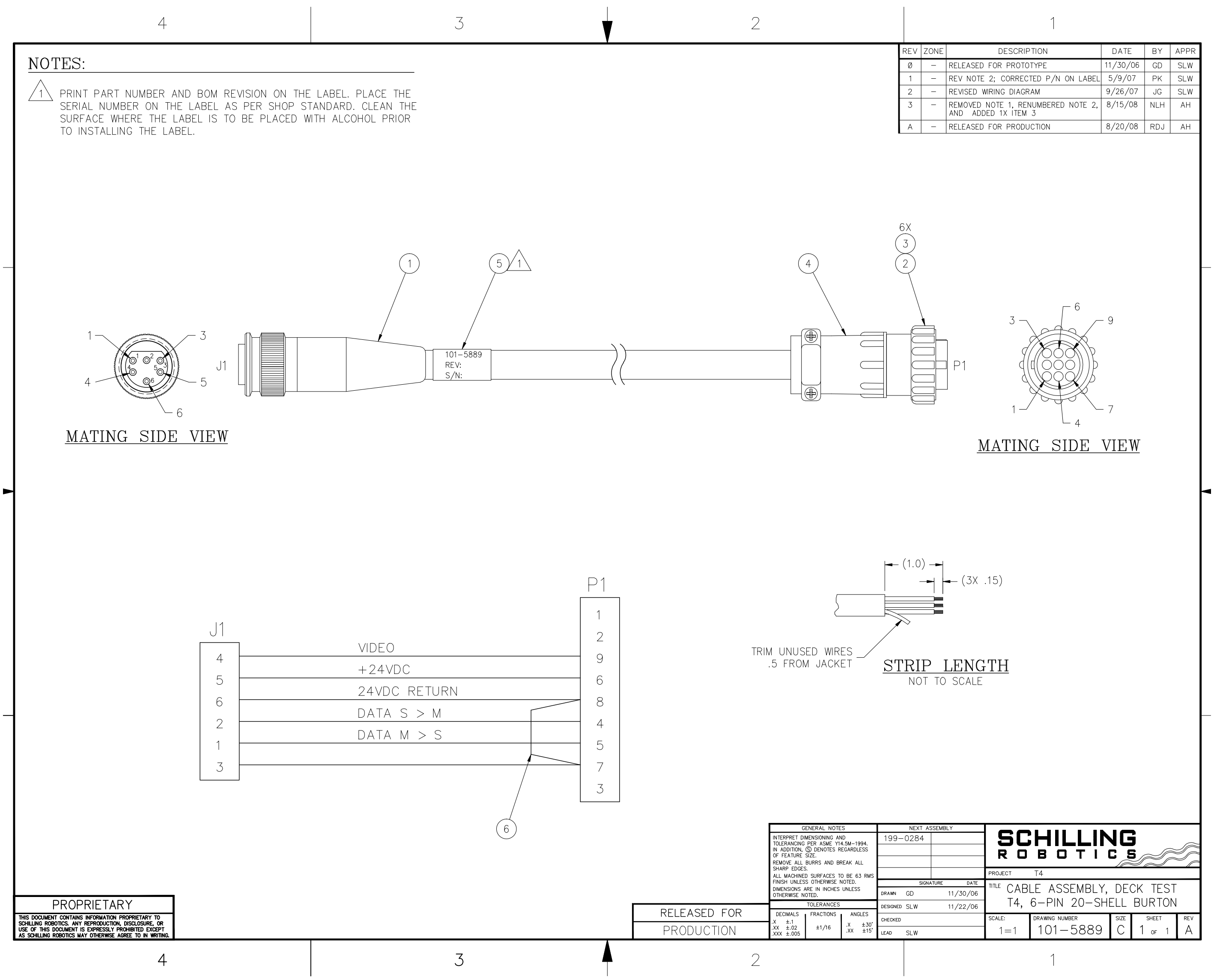
SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101-5887	C	1 OF 1	7

RELEASED FOR PROTOTYPE

Cable Ass'y, Deck Test, 101-5889

Rev. B

Item	P/N	Description	Qty
1	005-5286-15	CABLE,55,6- PIN,20-SHELL,15FT	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	6
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0
6	005-0219	WIRE,22 AWG.,7/32 TEFLON,BLK,.	.17
1000	101-5889-WI	WORK INSTRUCTIONS	0



Upper Arm, HAWE, 101-5977

Rev. B

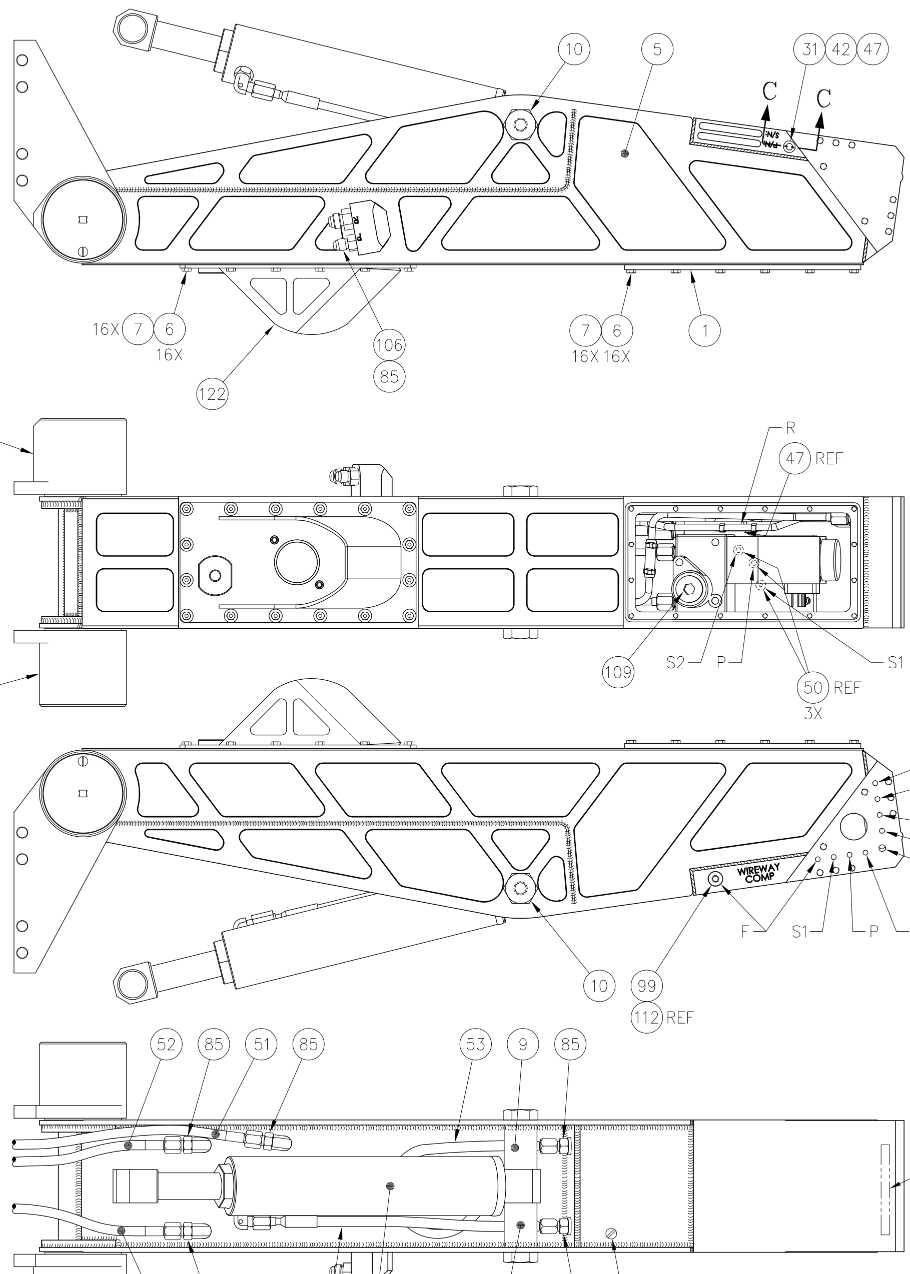
Item	P/N	Description	Qty
1	001-7098	COVER,UPPERARM,FRONT,T4	1
3	001-3318	HSG,LEFT,T3	1
4	001-2457	HSG,RIGHT	1
5	007-0574	UPPERARM,T4	1
6	002-1112P	NAS 6403PU1,NLK	32
7	004-0627	O-RING,.189X.039,BUNA 90	32
8	001-3334	PIN,STEPPED,T3/SP	1
9	001-3491	SPCR	1
10	001-3490P	HHCS,3/4X16X.90,316,MOD,NLK	2
11	001-2455	ADPTR,SHLDR	1
12	003-0119	BRG,RLR,TAPERED 1.5X2.72	4
15	101-2354	LIN ACTR,T3	1
17	001-9084	TUBE,AZ,CASE,T4 UPPERARM	1
18	001-9082	TUBE,AZ,A1,T4 UPPERARM	1
19	001-9083	TUBE,AZ,A2,T4 UPPERARM	1
20	001-9086	TUBE,SHLDR EXT,T4 UPPERARM	1
21	001-9087	TUBE,SHLDR RETRACT,T4 UPPERARM	1
25	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	12
31	006-0940	VALVE,RLF,T4,RLF,T3,J-BOX	1
32	001-5425	LID,SHOULDER,T3	2
34	002-0111	SHCS,1/4-28X1,SS	2
35	001-8934	PLATE,SERVO VALVE,T4	1
36	101-5979	VALVE,SOLENOID,HAWE	1
38	004-0861	O-RING,3-902,B90	0
39	001-8935	BLOCK,SERVO VALVE,UPPER ARM,T4	1
40	002-3507	SHCS,1/4-28 X 3 1/2,ALLOY	3
42	002-1114	RING,RETING,INTL,7/16 BORE,SS	1
43	006-1304	FIT,PLUG,2HP5ONSS,-2 HOL,HEX/S	3
47	004-0087	O-RING,2-011 BUNA 90	2
50	004-0222	O-RING,2-010 BUNA 90	5
51	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
52	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	2
53	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	2
57	001-5426	ROD,LID,SHOULDER,T3	1
60	001-2461	FLG,SHLDR	2
61	001-2462	RETAINER,SHOULDER,TITAN	1
62	001-9085	TUBE,PRESS,FLTR T4 UPPERARM	1
63	004-0048	O-RING,2-041 BUNA 70	2
64	004-0662	SEAL,FURON #AR 10400-333UC	2
65	004-0210	O-RING,2-128 BUNA 70	2
66	001-9088	TUBE,RETURN,3/8,T4 UPPERARM	1
70	001-2475	SHIM,SMALL,.001	0
71	001-2476	SHIM,SMALL,.003	0

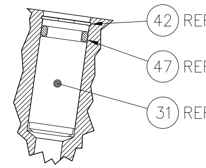
Upper Arm, HAWE, 101-5977 (cont.)

Rev. B

Item	P/N	Description	Qty
72	001-2477	SHIM,SMALL,.010	0
73	001-2478	SHIM,LARGE,.001	0
74	001-2479	SHIM,LARGE,.003	0
75	001-2480	SHIM,LARGE,.010	0
85	006-0015	FTG,HYD,-4 JIC,-4 ST,4F50X-SS	18
87	002-0792	SCR,SELF SEALING W/O-RING,B90	3
96	004-0792	O-RING,8.10 IDX.070,BUNA 70	2
99	006-0029	FTG,HYD,-4ST PLUG,4HP50N-SS	1
106	006-0777	FIT,HYD,-6 JIC,-6 ST,CONN,MALE	3
107	004-0133	O-RING,2-014 BUNA 90	1
108	004-0806	O-RING,2-019,B90	1
109	006-2169	FTG,HYD,-10 ST PLUG 10HP5ON-SS	1
110	002-0790	WSHR,1/4IDX.5OD,SS .032THK	5
111	002-0795	ADH,#271 RED LOCTITE 50ML	0
112	004-0082	O-RING,3-904 BUNA 90	0
113	004-0123	O-RING,3-906 BUNA 90	0
117	006-1517	FLTR ELEM,NORMAN,U-90341	1
118	004-0319	O-RING,3-910 BUNA 90	0
121	004-0130	O-RING,2-022 BUNA 70	1
122	007-0559	COVER,UPPERARM,W/SEANET,T3	1
123	006-1592-1	VALVE, RLF,25PSI CRACK MOD	1
124	001-5495	BOSS,1/2 1/2-20,RLF V	1
126	005-0448	TBG,SHRINK,1/4,SURF IRRADIATED	1
210	101-5977-WI	WORK INSTRUCTIONS	0

	Ø	–	–	RELEASED FOR PROTOTYPE	1/29/07	JG	SLW
	1	1 2	– –	ADDED ITEM 40 TO TORQUE TABLE ADDED ITEMS 34,40,47,50,107,108 AND 111	4/20/07	JG	SLW
	2	–	–	ADDED CALL OUT FOR ITEMS 109 AND 117	9/19/07	NLH	WK
	A	–	–	RELEASED FOR PRODUCTION	3/10/08	JG	SLW
0978	B	–	–	DEL NOTE 1 & 2; ADD ITEM 36 TO NOTE 3; ADD NOTE 8, ITEM CALLOUTS 35, 36, 39, 43, 110 & 126; REVISED NOTE 5	3/15/10	PK	WK
4443	C	–	–	CORRECTED TORQUE TABLE, CORRECTED ITEM NUMBER CALLOUTS	5/31/12	CRL	SS





SECTION C–C
SCALE x4

NOTES:

1. DELETED
2. DELETED
3. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:	
6	8 FOOT LBS.	[10.8 N–m]
25	65 IN LBS.	[7.3 N–m]
34, 40	11 FOOT LBS.	[14.9 N–m]
85	15 FOOT LBS.	[20.3 N–m]
10	240 FOOT LBS.	[325.4 N–m]
117	50 IN LBS.	[5.7 N–m]
106, 109	35 FOOT LBS.	[47.4 N–m]
36 (SOLENOID SCREWS)	45 IN LBS.	[5.1 N–m]
43, 87	31 IN LBS.	[3.5 N–m]
99	10 FOOT LBS.	[13.6 N–m]

4. QUANTITY AS REQUIRED.
5. SERIALIZE IN LOCATION SHOWN PER SHOP STANDARD.
6. IF LEE VALVE (ITEM 38) IS REMOVED, THE LEE MULTI-SEAL (P/N 004-0791) NEEDS TO BE REPLACED. (IT IS NOT REUSABLE). SEE 101-2663 DRAWING. BE CAREFUL NOT TO SCRATCH BORE.
7. ALL OVERALL DRAWING DIMENSIONS ARE FOR REFERENCE ONLY. METRIC EQUIVALENTS SHOWN IN BRACKETS [ ].
8. CUT SHRINK TUBING TO LEAVE 1/2" OF THREADED ROD EXPOSED ON EACH SIDE.

PROPRIETARY

RELEASED FOR

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES
DECIMALS .X ±.1 | FRACTIONS | ANGLES X. ±1°0'

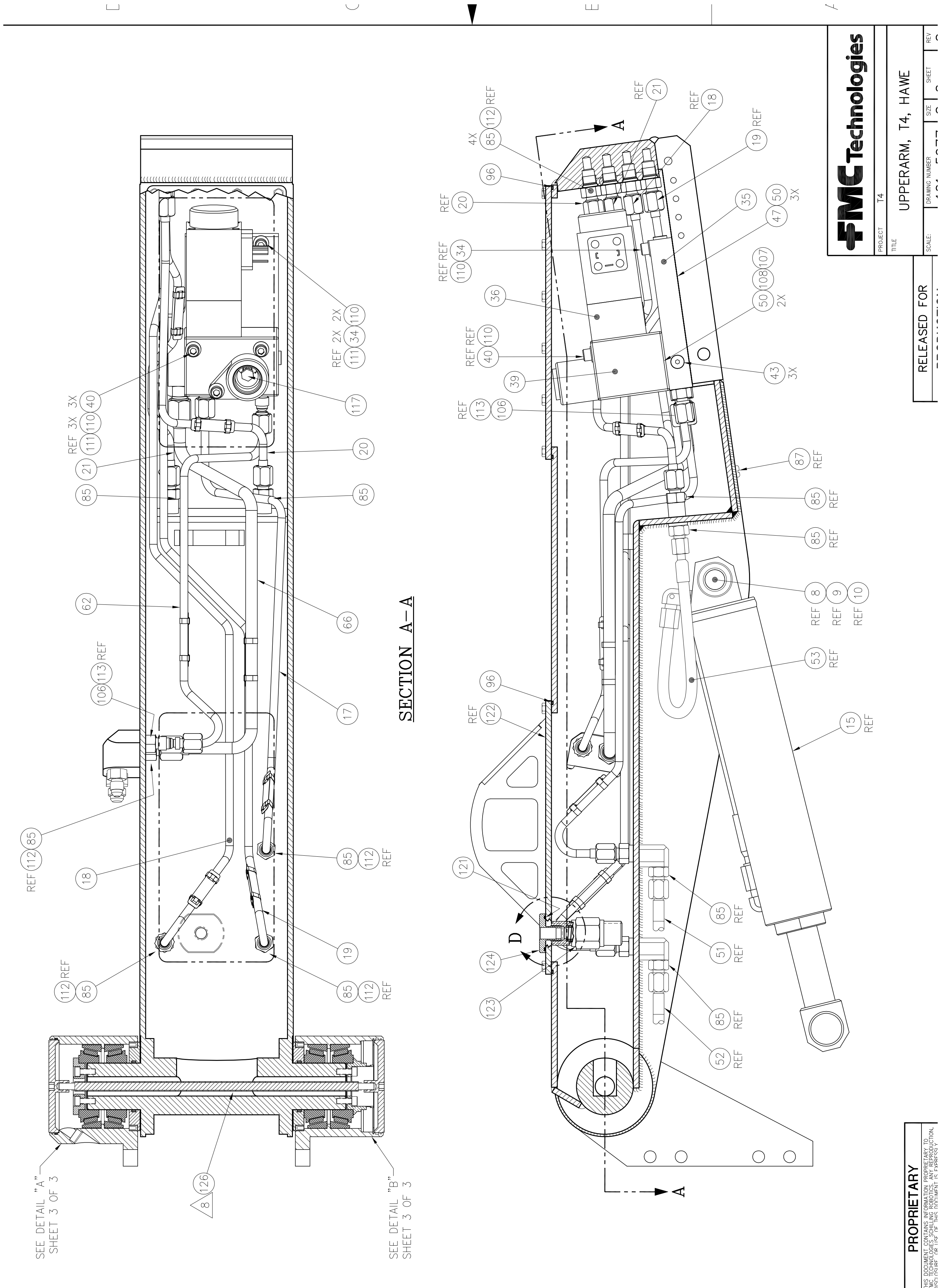
THIRD ANGLE PROJECTION

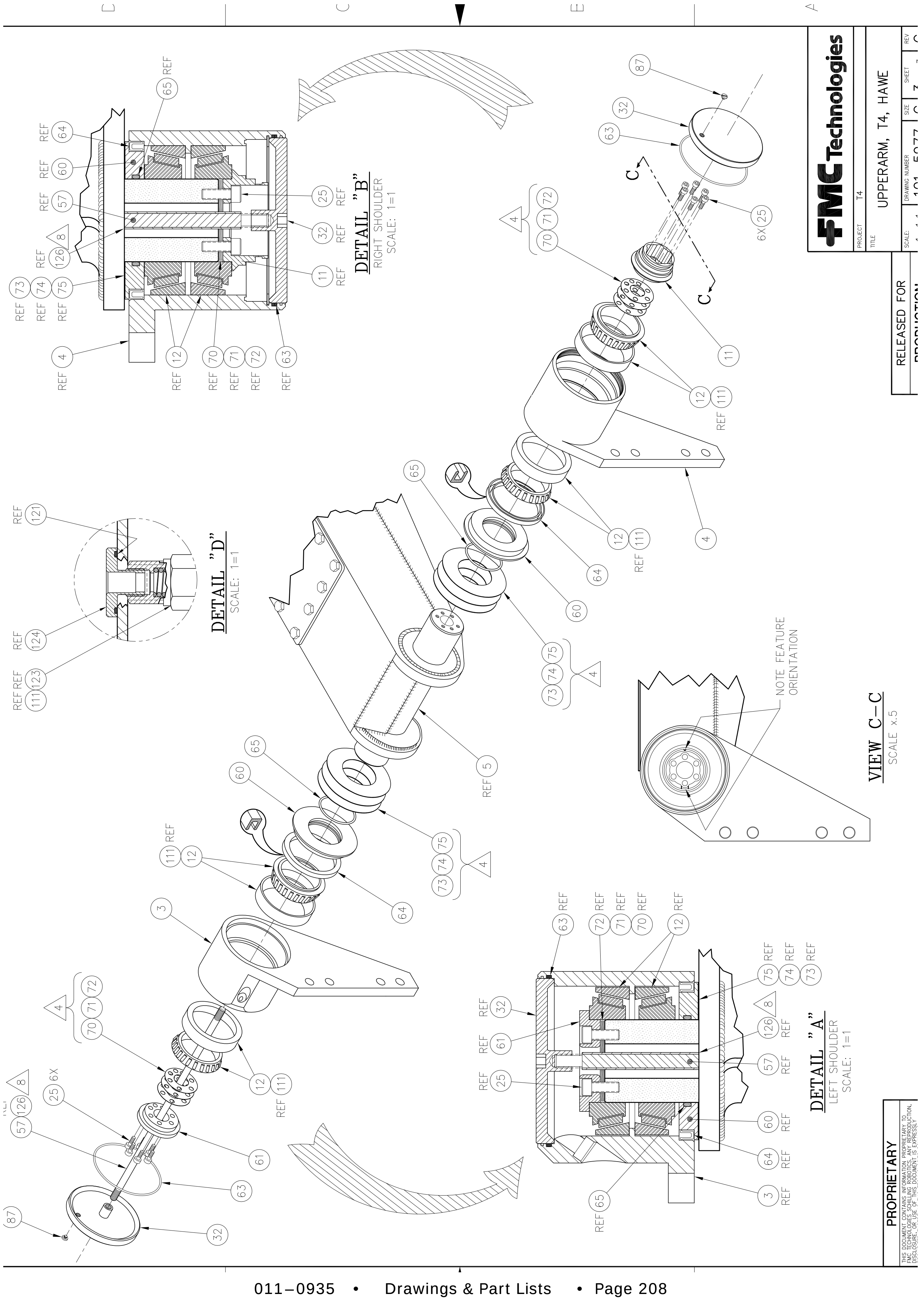
	SIGNATURE	DATE
DRAWN	J. GARDNER	1/29/07
DESIGNED	S. WRIGHT	1/25/07
CHECKED		

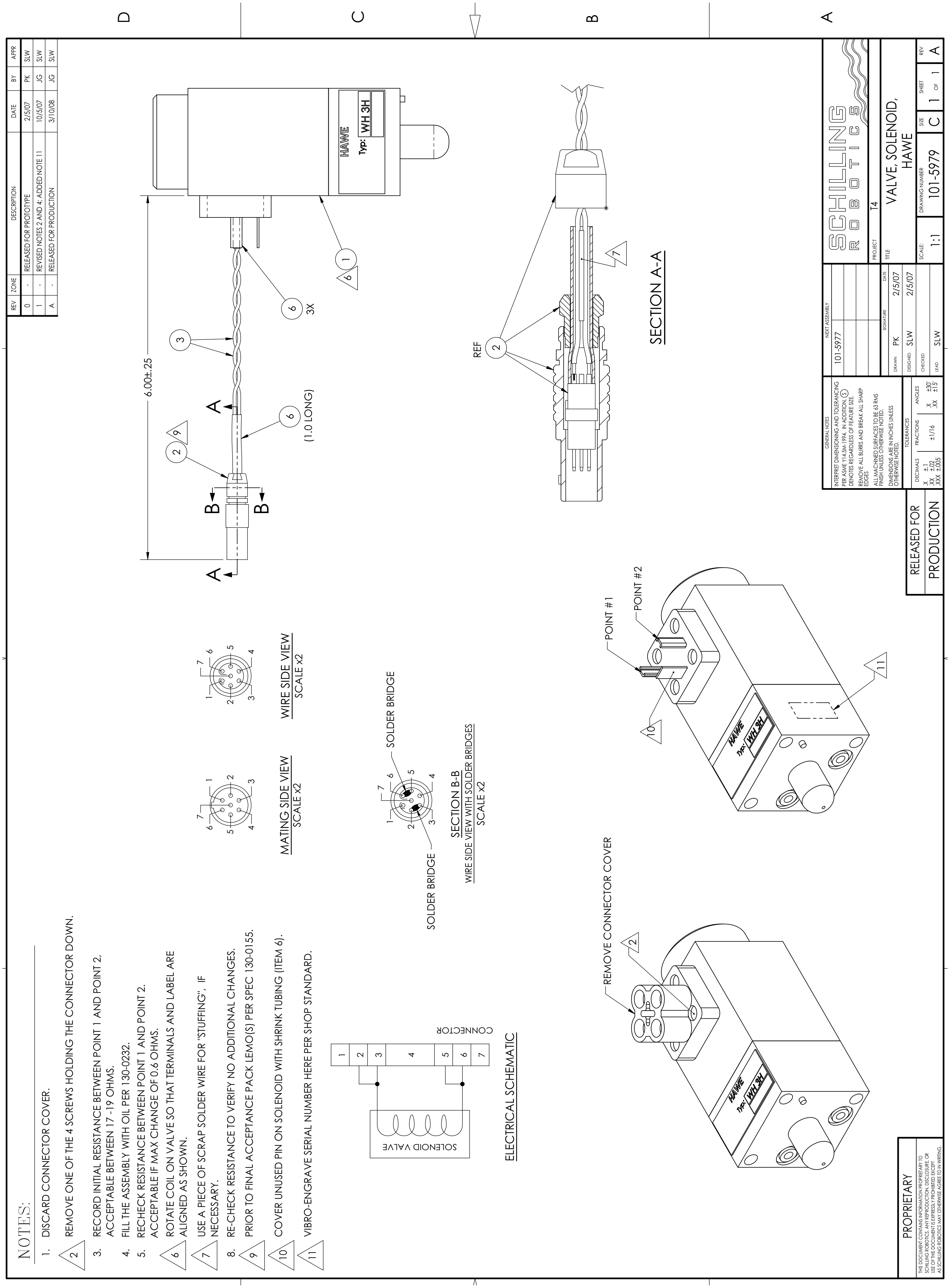
FMC Technologies

PROJECT T4
TITLE UPPERARM, T4, HAWE

SCALE: | DRAWING NUMBER | SIZE | SHEET | REV


FMC Technologies
PROJECT T4
TITLE UPPERARM, T4, HAWE
RELEASED FOR
SECTION A-A
SEE DETAIL "A" SHEET 3 OF 3
SEE DETAIL "B" SHEET 3 OF 3
PROPRIETARY
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO FMC TECHNOLOGIES SCHILLING ROBOTICS. ANY REPRODUCTION,


DETAIL "B"
RIGHT SHOULDER
SCALE: 1=1
DETAIL "D"
SCALE: 1=1
DETAIL "A"
LEFT SHOULDER
SCALE: 1=1
VIEW C–C
SCALE x.5
NOTE FEATURE ORIENTATION
UPPERARM, T4, HAWE
RELEASED FOR
PROPRIETARY

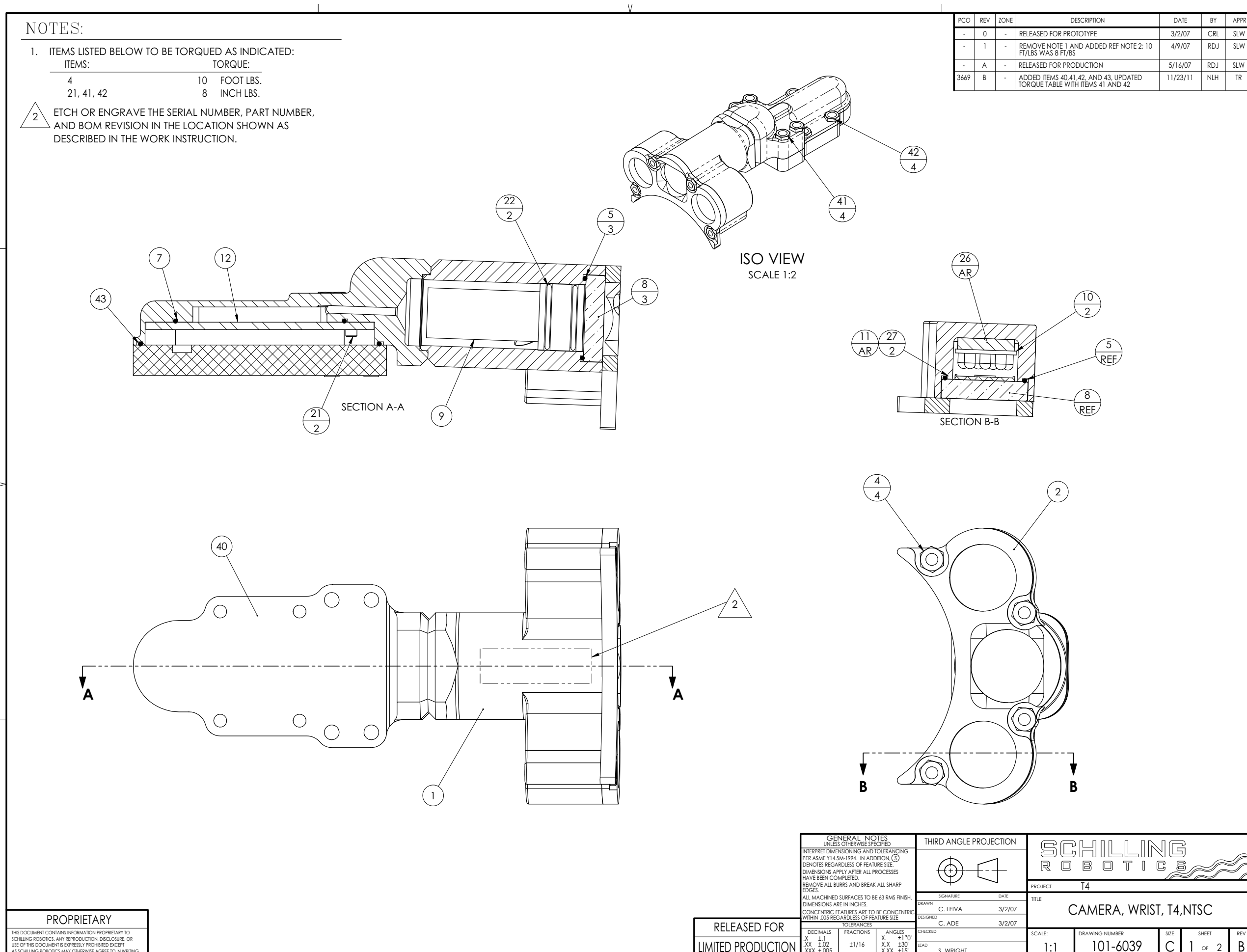


NOTE: *Drawing only.*

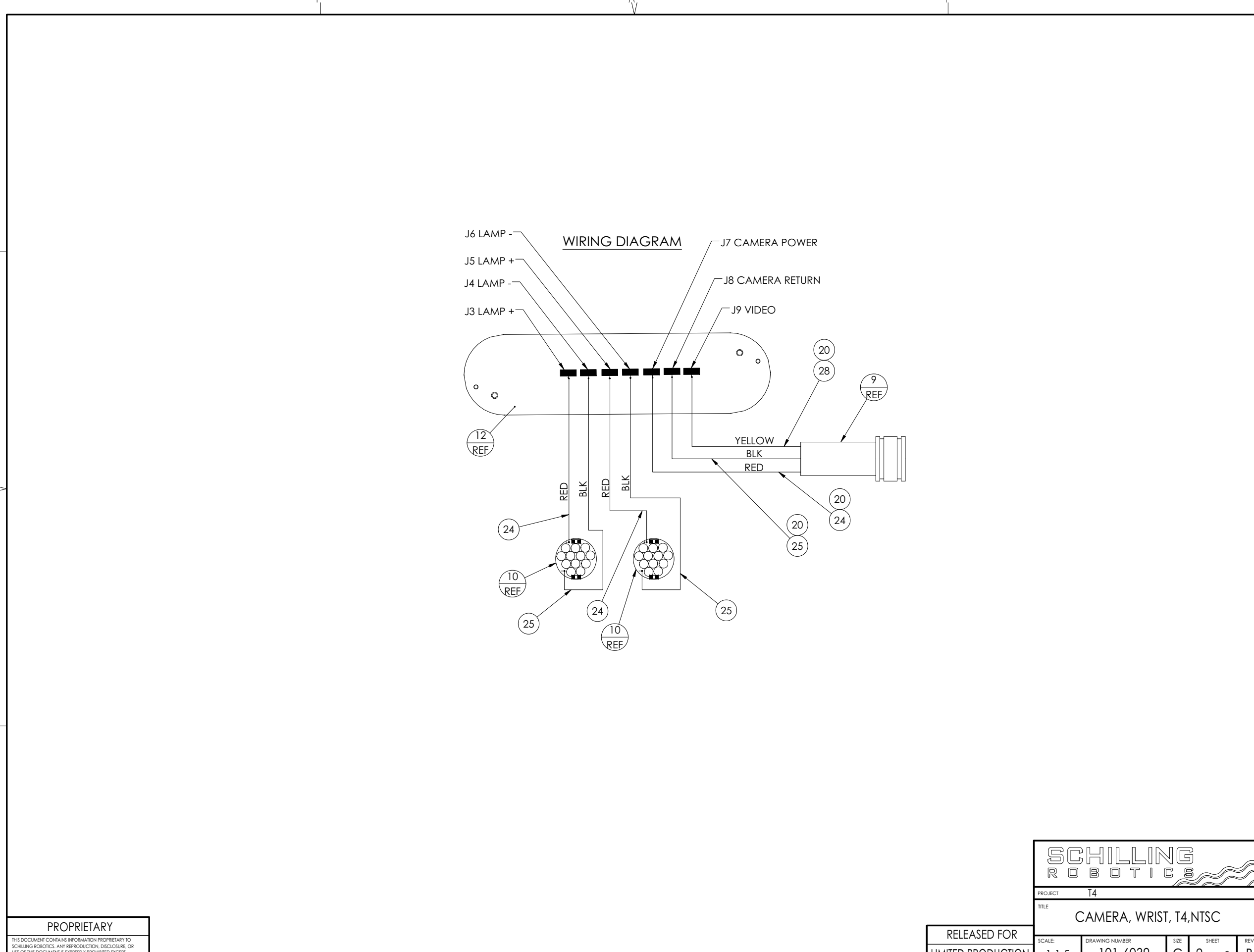
Titan Wrist Camera, NTSC, 101-6039

Rev. E

Item	P/N	Description	Qty
1	007-0675	HOUSING,CAMERA,WIRST,T4	1
2	001-7684	BEZEL,WRIST CAMERA,T4	1
4	002-1112P	NAS 6403PU1,NLK	4
5	004-0832	O-RING,2-026,BUNA 70	3
7	004-0043	O-RING,2-033 BUNA 70	1
8	001-9110	WINDOW,36mmX8mm,SAPHIRE	3
9	005-5375	CAMERA,COLOR BULLET NTSC	1
10	101-6006	ASSY,PCB WRIST CAM LED BOARD	2
11	005-5411	EPOXY,OPT CLEAR HIGH IMPACT	0
12	101-6005	ASSY,PCB CAMERA BOARD	1
20	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.13
21	002-3256	SHCS,4-48 X 1/4, ALLOY	2
22	004-0695	O-RING,2-021,BUNA 70	2
24	005-3087	WIRE,26AWG,STRD,TEFZEL,600,RED	2.3
25	005-2154	WIRE,26AWG,19/38 TEFZEL 600V	2.3
26	002-3292	FOAM STRIP,3/8 THICK	.3
27	001-7886	DIFFUSER,CAMERA LIGHT	2
28	005-3092	WIRE,26AWG,STRD,TEFZEL,600,YEL	.8
30	005-5980	DESICCANT,MOIST ABSORB BOARD	0
40	010-1958	SHIPPING PLATE, WRIST CAMERA	1
41	002-0333P	NAS 6404PU14,NLK	4
42	002-0038P	NAS 6404PU1,NLK	4
43	004-0139	O-RING,2-040 BUNA 70	1
1000	101-6039-WI	WORK INSTRUCTIONS	0



PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
-	0	-	RELEASED FOR PROTOTYPE	3/2/07	CRL	SLW
-	1	-	REMOVE NOTE 1 AND ADDED REF NOTE 2; 10 FT/LBS WAS 8 FT/BS	4/9/07	RDJ	SLW
-	A	-	RELEASED FOR PRODUCTION	5/16/07	RDJ	SLW
3669	B	-	ADDED ITEMS 40,41,42, AND 43, UPDATED TORQUE TABLE WITH ITEMS 41 AND 42	11/23/11	NLH	TR



Titan Wrist Camera, PAL, 101-6040

Rev. D

Item	P/N	Description	Qty
1	007-0675	HOUSING,CAMERA,WIRST,T4	1
2	001-7684	BEZEL,WRIST CAMERA,T4	1
4	002-1112P	NAS 6403PU1,NLK	4
5	004-0832	O-RING,2-026,BUNA 70	3
7	004-0043	O-RING,2-033 BUNA 70	1
8	001-9110	WINDOW,36mmX8mm,SAPHIRE	3
9	005-5376	CAMERA,COLOR BULLET PAL	1
10	101-6006	ASSY,PCB WRIST CAM LED BOARD	2
11	005-5411	EPOXY,OPT CLEAR HIGH IMPACT	0
12	101-6005	ASSY,PCB CAMERA BOARD	1
20	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.13
21	002-3256	SHCS,4-48 X 1/4, ALLOY	2
22	004-0695	O-RING,2-021,BUNA 70	2
24	005-3087	WIRE,26AWG,STRD,TEFZEL,600,RED	2.3
25	005-2154	WIRE,26AWG,19/38 TEFZEL 600V	1.5
26	002-3292	FOAM STRIP,3/8 THICK	.3
27	001-7886	DIFFUSER,CAMERA LIGHT	2
28	005-3088	WIRE,26AWG,STRD,TEFZEL,600,BLU	.8
29	005-3089	WIRE,26AWG,STRD,TEFZEL,600,GRN	.8
30	005-5980	DESICCANT,MOIST ABSORB BOARD	0
40	010-1958	SHIPPING PLATE, WRIST CAMERA	1
41	002-0333P	NAS 6404PU14,NLK	4
42	002-0038P	NAS 6404PU1,NLK	4
43	004-0139	O-RING,2-040 BUNA 70	1
1000	101-6040-WI	WORK INSTRUCTIONS	0

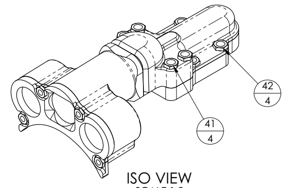
NOTES:

1. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

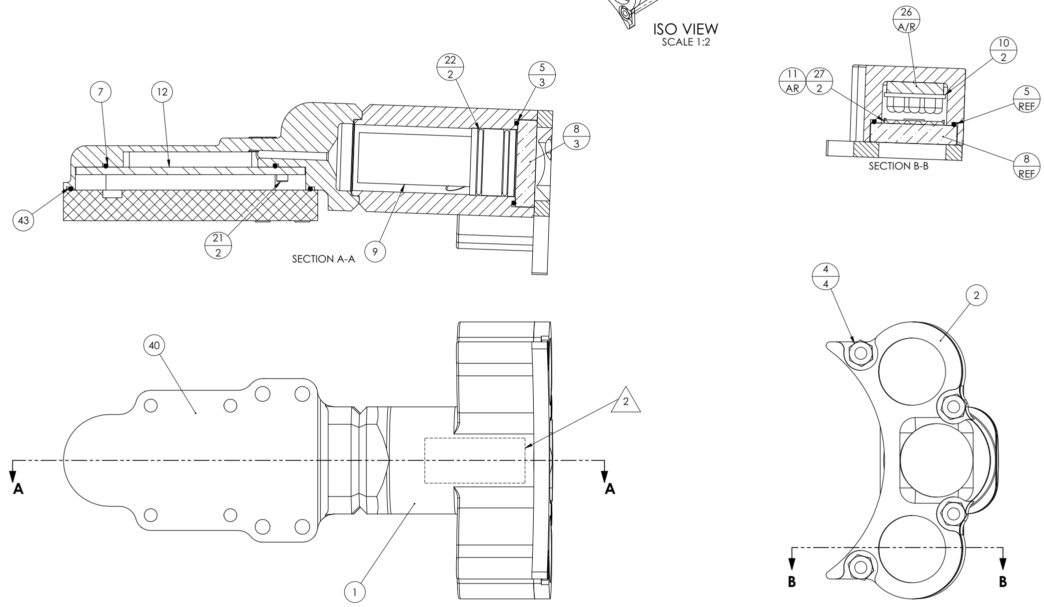
ITEMS:	TORQUE:
4	10 FOOT LBS.
21, 41, 42	8 INCH LBS.

2. ETCH OR ENGRAVE SERIAL NUMBER, PART NUMBER AND BOM REVISION IN LOCATION SHOWN AS DESCRIBED IN WORK INSTRUCTIONS.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
-	0	-	RELEASED FOR PROTOTYPE	3/2/07	CRL	SLW
-	1	-	REVISED NOTES AND BUBBLES	4/9/07	DI	SLW
-	A	-	RELEASED FOR PRODUCTION	5/16/07	RDJ	SLW
3669	B	-	ADDED ITEMS; 40,41,42, AND 43, UPDATE TORQUE TABLE WITH ITEMS 41 AND 42	11/23/11	NLH	TR



ISO VIEW
SCALE 1:2



GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	C. LEIVA	3/2/07
DESIGNED	C. ADE	3/2/07
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

PROJECT: T4

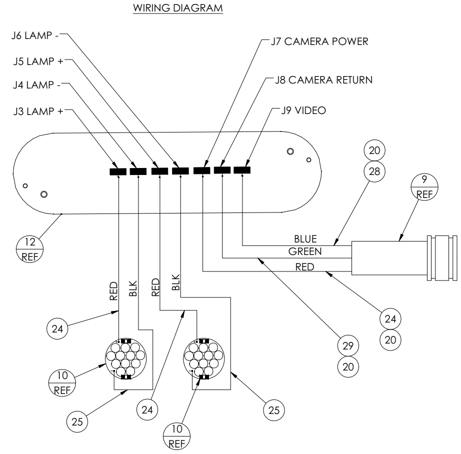
TITLE: CAMERA, WRIST, T4, PAL

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1	101-6040	C	1 OF 2	B

RELEASED FOR LIMITED PRODUCTION

PROPRIETARY

WIRING DIAGRAM



SCHILLING ROBOTICS

PROJECT: T4

TITLE: CAMERA, WRIST, T4, PAL

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1.5	101-6040	C	2 OF 2	B

RELEASED FOR LIMITED PRODUCTION

PROPRIETARY

Harness, 8-Pin, 20 Shell, 101-6147

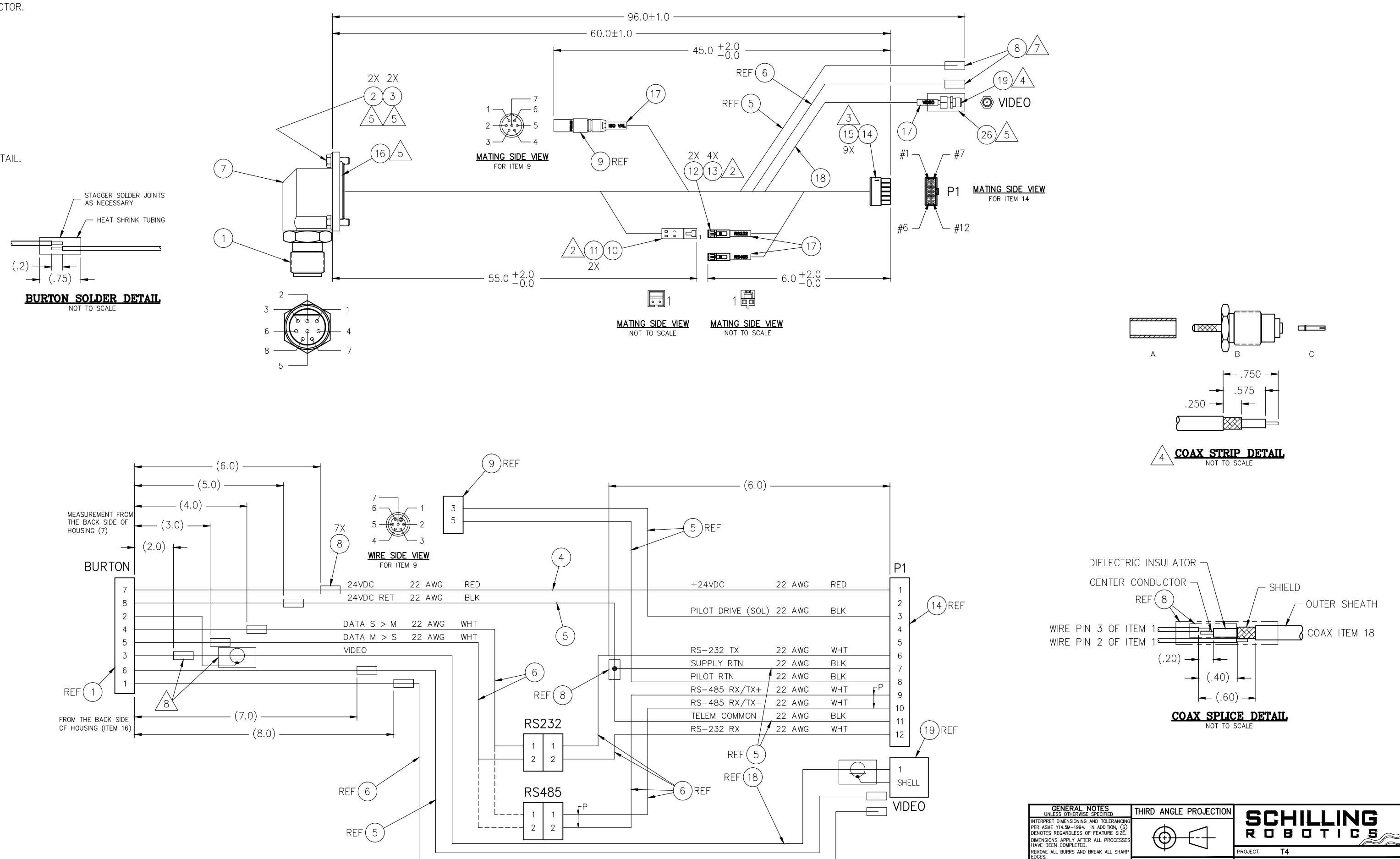
Rev. 3

Item	P/N	Description	Qty
1	005-2060	CONN,8 PIN,BHD RECPT.,2 FT.	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	22
6	005-2788	WIRE,22 AWG,STRANDED,WHT	20.5
7	001-8853	HSG,CONN,BURTON,20SHELL,BCR,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	.75
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
21	005-1523	TBG,SHRINK,3/16 WHT,ALPHA #FIT	0
26	005-1706	TBG,SHRINK,3/8 WHT	.1
27	010-1527	TOOL,CRIMP,MOLEX 63811-8700	0
28	010-1739	TOOL,CRIMP,MOLEX 63819-0000	0
1000	101-6147-WI	WORK INSTRUCTIONS	0

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	RELEASED FOR PROTOTYPE	4/2/07	CRL	SLW
	1	–	CHANGED PIN OUT & DELETED NOTE 7	4/13/07	CRL	SLW
	2	–	CHANGED 8 PIN BURTON VIEW SHOWING MATING SIDE	1/31/08	VDM	SLW
	3	–	UPDATE ITEM 5 AND 6 CALLOUTS	7/9/08	NLH	SLW
2036	4	–	REVISED NOTES, ADDED COAX STRIP DETAIL AND COAX SPLICE DETAIL	12/7/10	CRL	GV

NOTES:

1. DELETED
2. CRIMP USING MOLEX CRIMP TOOL, ITEM 27. VERIFY CRIMP MEETS THE IPC–A–620, CLASS II REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620, CLASS II REQUIREMENTS.
3. CRIMP USING MOLEX CRIMPING TOOL, ITEM 28 VERIFY CRIMP MEETS IPC–A–620 CLASS II REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620 CLASS II REQUIREMENTS.
4. REFER TO COAX STRIP DETAIL FOR ITEM 19 INSTALLATION. SLIDE FERRULE (A) OVER CABLE. STRIP CABLE AS SHOWN. TIN CENTER CONDUCTOR. FLAIR BRAID AND INSERT EXTENSION (B) UNDER BRAID WITH CENTER CONDUCTOR PROTRUDING THROUGH HOLE IN EXTENSION. SOLDER CONTACT (C) TO CENTER CONDUCTOR. SLIDE FERRULE (A) OVER BRAID AND CRIMP. INSTALL CABLE ASSEMBLY INTO BODY AND TIGHTEN. CRIMP SIZE REQUIRED: CONTACT: SOLDER, FERRULE: .100" HEX CRIMP TOOL.
5. BAG ITEMS 2, 3, 16 AND 26 PER SHOP STANDARD.
6. ADD SMALL PIECES OF SHRINK TUBING, ITEM 21 OR TIE WRAP (002–0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
7. CAP WIRE ENDS WITH SHRINK TUBING, ITEM 8.
8. SOLDER SPLICE COAX TO WIRES, ITEM 1, PER COAX SPLICE DETAIL. SOLDER JOINTS TO MEET IPC–A–620, CLASS II REQUIREMENTS.



GENERAL NOTES	THIRD ANGLE PROJECTION	SCHILLING ROBOTICS
DRAWN: C. LEIVA 4/2/07	PROJECT: T4	TITLE: HARNESS, SLAVE T4 8–PIN 20–SHELL
DESIGNED: S. WRIGHT 4/2/07	SCALE: 1=1.5	DRAWING NUMBER: 101–6147
LEAD: S. WRIGHT	SIZE: D	SHEET 1 of 1, REV 4

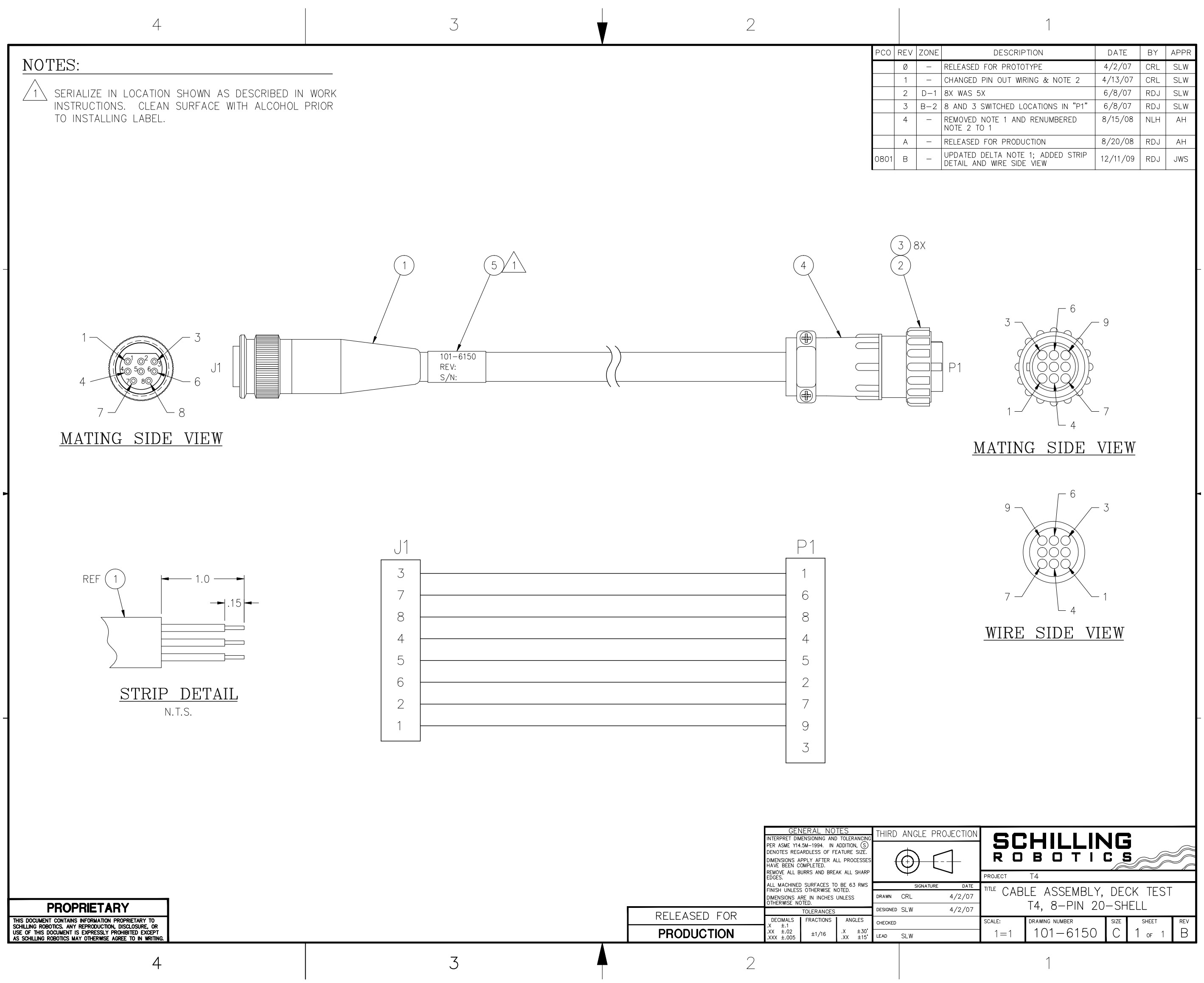
RELEASED FOR PROTOTYPE

PROPRIETARY

Cable Ass’y, Deck Test, 101-6150

Rev. B

Item	P/N	Description	Qty
1	005-2059	CONN,8 PIN,BURTON SUBSEA,10 FT	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	8
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0



Cable Ass'y, SeaNet CS-MSAJ9, 101-6778

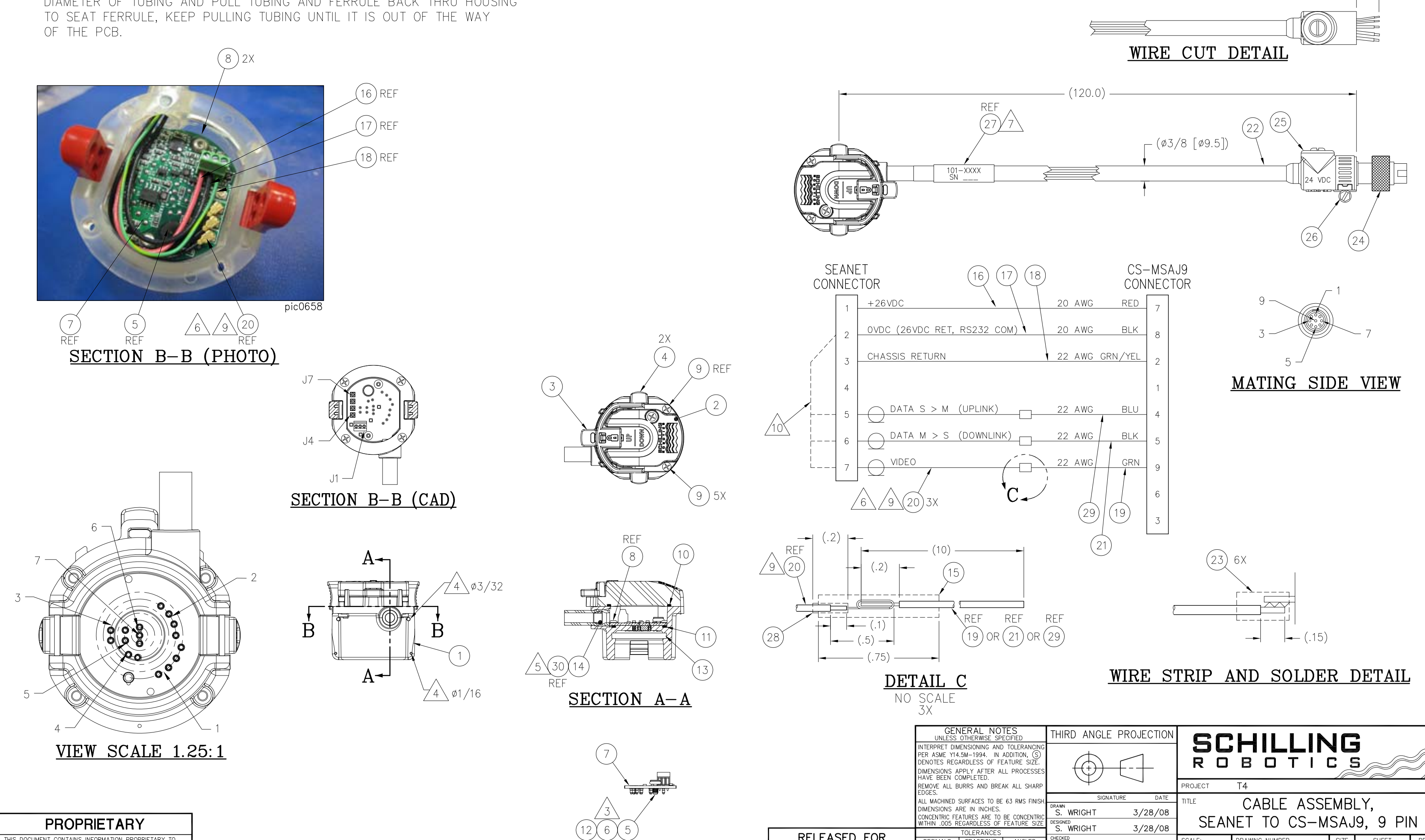
Rev. F

Item	P/N	Description	Qty
1	001-9191	HSG,MACHINED,SEANET,LATCHING	1
2	001-10184	MOLDED CAP,SEANET,W/ CSK HOLE	1
3	906-0053	MOLDED,BAIL,SEANET,LATCHING	1
4	906-0054	MOLDED,LATCH,SEANET,LATCHING	2
5	001-9192	POPPET,OIL VALVE,PCB,SEANET	1
6	002-3566	SPRING,COMP,LEE,LC-014A-1-SS	1
7	005-5391	PCB,ASSY,SEANET GENERATION 2	1
8	002-3665	BHCS,4-40 X .18,SS	2
9	002-4889	SCREW,FILLISTER,6-32x3/8,18-8	5
10	004-0098	O-RING,2-030 BUNA 70	1
11	004-0020	O-RING,2-028 BUNA 70	1
12	004-0170	O-RING,2-007 BUNA 70	1
13	004-0046	O-RING,2-127 BUNA 70	1
14	001-9193	FERRULE,TUBG,1/4,SEANET,LATCH	1
15	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	.2
16	005-6176	WIRE,20AWG 19/32 TEFZEL RED	12.5
17	005-6177	WIRE,20AWG 19/32 TEFZEK BLACK	12.5
18	005-4886	WIRE,22 AWG,GRN/YEL,TEFZEL	12.5
19	005-2790	WIRE,22 AWG,STRANDED,GRN	.8
20	005-5390-3.7	CABLE,COAX,IPX-IPX,3.7M	3
21	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	.8
22	001-9009	BOOT,SEANET/IMPULSE,STRAIGHT	1
23	005-1216	TBG,SHRINK,3/32(BRIM # SH135-3	.4
24	005-5916	CONN,9 PIN,CS-MSAJ9 #20-CCP	1
25	002-0792	SCR,SELF SEALING W/O-RING,B90	1
26	002-3180	CLP,HOSE,1/2-29/32,NARROW,SS	1
27	002-3095	LABEL,WIRE,1 X 2.5	0
28	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.4
29	005-2791	WIRE,22 AWG,STRANDED,BLUE	.8
30	010-1103	TOOL,INSTL,FERRULE TBG,SEANET	0
31	010-1104	TOOL,CUTTER,.100 WIRE	0
33	010-1131	TOOL,CRIMP,PIN,END,SEANET,MOD	0
1000	101-6778-WI	WORK INSTRUCTIONS	0

NOTES:

1. DELETED
2. DELETED.
3. (3) PRESS SPRING, ITEM 6, OVER END OF POPPET, ITEM 5, AFTER INSTALLED THRU PCB, ITEM 7.
4. (4) USING CUTTERS 010-1104 CUT 316SS WELD ROD (ø3/32 & ø1/16) TO .75" LONG. THEN CRIMP ONE END OF PIN WITH CRIMPERS 010-1131.
5. (5) INSTALL TUBING THRU HOUSING ITEM 1, THEN INSTALL FERRULE, ITEM 14 INTO END OF TUBING USING TOOL, ITEM 30. APPLY O-RING LUBE TO OUTSIDE DIAMETER OF TUBING AND PULL TUBING AND FERRULE BACK THRU HOUSING TO SEAT FERRULE, KEEP PULLING TUBING UNTIL IT IS OUT OF THE WAY OF THE PCB.
6. (6) OUTSIDE OF COAX CABLES, ITEM 20, IS THE SHIELD, SO IT IS ACCEPTABLE FOR THEM TO TOUCH.
7. (7) SERIALIZE ITEM 27 PER SHOP STANDARD. CLEAN SURFACE WITH ALCOHOL PRIOR TO INSTALLING LABEL.
8. WIRING AND CABLES TO BE SOLDERED PER IPC-A-620, CLASS 2 SPECIFICATION, UNLESS OTHERWISE INDICATED.
9. (9) CUT AND SPLICE COAX CABLE, ITEM 20, PER DETAIL 'C'.
10. (10) SHIELDS ARE GROUNDED TOGETHER ON PC BOARD.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	RELEASED FOR PROTOTYPE	4/1/08	CRL	SLW
	A	–	RELEASED FOR PRODUCTION	4/25/08	VDM	SLW
	B	–	REPLACED 22 WITH STRAIGHT MOLDED TUBING	11/14/08	RDJ	RMB
	C	–	ITEMS 16 AND 17 WERE 18 AWG	2/4/09	RDJ	WK
0417	D	–	UPDATED DETAIL C, DELTA NOTE 7, ITEM CALLOUTS, PICTURE AND ITEM 25 GEOMETRY. DELETED NOTE 1,	7/28/09	NLH	JS
1271	E	–	REVERSED PINS 3 & 7 ON MATING VIEW	5/20/10	CRL	GV
3594	F	–	DELETED NOTE 2 TO ANNEAL BAIL	10/17/11	SWR	KM



PROPRIETARY

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO SCHILLING ROBOTICS. ANY REPRODUCTION, DISCLOSURE, OR USE OF THIS DOCUMENT IS EXPRESSLY PROHIBITED EXCEPT AS SCHILLING ROBOTICS MAY OTHERWISE AGREE TO IN WRITING.

RELEASED FOR PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	S. WRIGHT	3/28/08
DESIGNED	S. WRIGHT	3/28/08
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

PROJECT: T4

TITLE: CABLE ASSEMBLY, SEANET TO CS-MSAJ9, 9 PIN

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.75	101-6778	C	1 OF 1	F

Wrist Actuator, 101-6789

Rev. G

Item	P/N	Description	Qty
1	001-3341	BASE,WR,T3,UNIL	1
2	001-1828	COV,WR BASE,T2	1
4	001-2058	MANIFOLD,WRIST,T2,UNIL	1
5	001-2069	BOLT,OIL SPLY T2 WR	5
6	001-1832	VALVE,PL,WR MOTOR	1
7	001-2059	SHAFT, DRIVE, WRIST, T2	1
8	001-2070	HSG,SLIPRING T2 WR	1
9	001-2060	PL,WEAR,WR MOTOR	1
10	101-7282	KIT,NOSE BLOCK PISTON,HS	1
20	001-2063	PLGR	1
21	001-1847	CORE SPRT,LVDT,WR,T2	1
23	001-2064	SL,LVDT WR	1
24	001-1850	LINER,LVDT,WR	1
26	001-1852	BRG,RACE,WR	1
27	002-0745P	SHCS,1/4-28X.75,ALLOY,NLK	5
28	002-0358	SHCS,4-40X.18,SS	2
29	002-0709	CLP,SERVO,SM23,BERG	2
30	002-0710	RING,RETING,EXTERNAL,SMALLEY #	1
31	002-0711	SPR,LC-026E-14-MW,LEE	1
32	002-0712	RING,RETING,INTL,VH56,SMALLEY	1
33	001-3683	SHCS,5/16-24X2.365(UNBRAKO ONL	3
36	003-0011	TORRINGTON,B148	1
37	003-0013	TORRINGTON,NTA 2840	1
38	003-0074	WSHR,THR,TRA2840,TORRINGTON	1
39	003-0075	BRG,THR,NTA4052,TORRINGTON	1
40	003-0076	WSHR,THR,TRB4052,TORRINGTON	2
41	003-0077	RLR,NEEDLE,2X6.3 MM(.078X.25)	119
43	004-0570	O-RING,2-038 N70	1
45	004-0139	O-RING,2-040 BUNA 70	2
47	004-0413	O-RING,2-026 V75	1
48	004-0017	O-RING,2-031 BUNA 70	1
49	004-0081	O-RING,2-035 BUNA 70	1
50	004-0698	O-RING,2-011,DISOGRIN 90 DURO	8
51	004-0666	O-RING,2-046,BUNA 90	2
52	004-0445	O-RING,2-006 V90	5
60	004-0648	SEAL,SLIPRING,WRIST,T2 GAMMA	4
61	004-0574	SEAL,AR10103-212-UH,FLUROCARBO	1
62	004-0575	SEAL,AR10103-214-UH,FLUROCARBO	1
63	004-0576	WSHR,CRUSH,5/16	8
64	006-1282	PLUG, CV, CVES1568180A, 316 SS	2
65	101-1883	GERTR ASSY	1
68	101-1409	RSLR/LVDT WR,T2/T3	1
69	001-1914	CORE,LVDT	1

Wrist Actuator, 101-6789 (cont.)

Rev. G

Item	P/N	Description	Qty
71	004-0114	O-RING,2-013 BUNA 90	1
73	001-1984	BSHG,WR OIL SPLY TUBE	8
79	004-0222	O-RING,2-010 BUNA 90	7
80	001-2202	SHIM,WR,.002 THK	0
81	001-2203	SHIM,WR,.003THK,T2	0
82	001-2204	SHIM,WR,.005THK,T2	0
83	002-1127	PIN,SPIROL,.033X.125,SS	2
85	002-1925	ANTI-SIEZE,1 OZ TUBE	0
170	010-0474	TOOL,INSTL,CV PLUG 156	0
171	010-0523	TOOL,INSTL,CV PLUG 156 SHORT	0
173	010-0236	TOOL,BRG PUSHER,T2/3	0
174	010-0220	TOOL,RESIZE,WR,T2/3	0
175	010-0194	INSTL TOOL, .25	0
176	010-0237	TOOL,RESIZING	0
177	010-0184	TOOL,INSTL,M,1.75	0
178	010-0185	TOOL,SIZING,F,1.75	0
179	010-0577	FXTR,TEST,WR DYNO	0
202	101-6789-WI	WORK INSTRUCTIONS	0

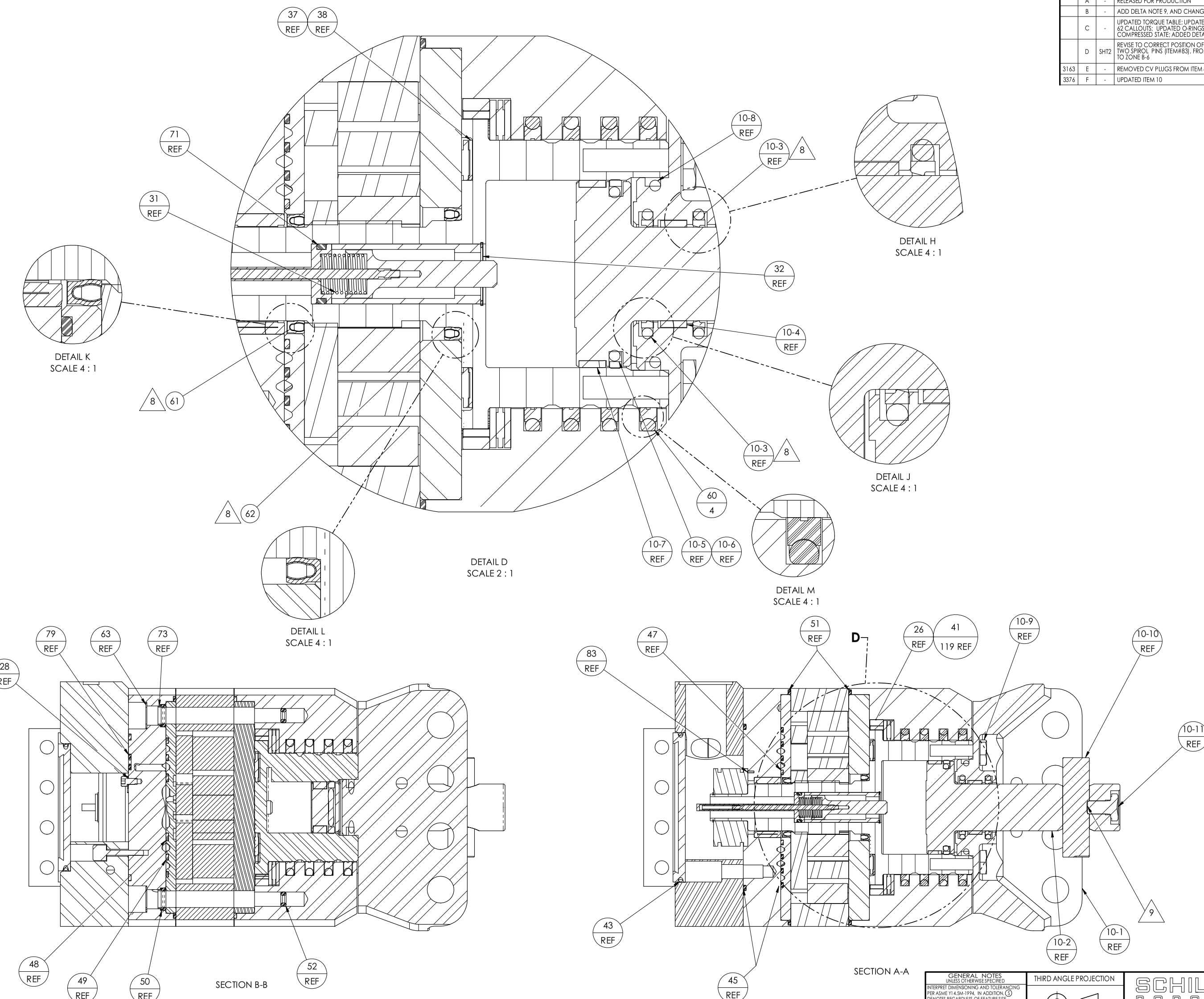
NOTES:

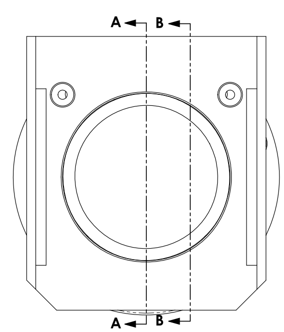
1. PARTS (27) 5X, REMOVED FOR CLARITY IN THIS VIEW.
2. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
28	9.5 INCH LBS. [1.07 N-M]
27	15 FOOT LBS. [20.3 N-M]
10-9 AND 10-11	21 FOOT LBS.[28.5 N-M]
5 AND 33	25 FOOT LBS.[33.9 N-M]

3. QUANTITY AS REQUIRED.
4. SEE SHEET 3 FOR SUB-ASSEMBLY DETAIL.
5. SERIALIZE IN LOCATION SHOWN AS DESCRIBED IN WORK INSTRUCTIONS.
6. ALL OVERALL DRAWING DIMENSIONS ARE FOR REFERENCE ONLY. METRIC EQUIVALENTS SHOWN IN BRACKETS [ ].
7. INSTALL OUTER RING WITH NARROW GROOVE UP AND LARGE GROOVE DOWN.
8. INSTALL SEALS ITEMS 59, 61, AND 62 WITH ORIENTATION SHOWN.
9. GROOVE IN T-BAR PIN (ITEM 10-10) MUST ENGAGE WITH TIP OF RETAINING BOLT (ITEM 10-11) WHEN INSTALLED ONTO PISTON (ITEM 10-2).

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
	A	-	RELEASED FOR PRODUCTION	4/28/08	VDM	SLW
	B	-	ADD DELTA NOTE 9, AND CHANGE BUBBLES	7/22/08	VDM	SLW
	C	-	UPDATED TORQUE TABLE; UPDATED ITEMS 61 & 62 CALLOUTS; UPDATED O-RINGS TO SHOW COMPRESSED STATE; ADDED DETAIL M	9/8/08	PK	WK
	D	SHT2	REVISE TO CORRECT POSITION OF ONE OF TWO SPIROL PINS (ITEM#83), FROM ZONE C-6 TO ZONE B-6	4/3/09	MHB	SLW
3163	E	-	REMOVED CV PLUGS FROM ITEM 8	10/19/11	SWR	MJ
3376	F	-	UPDATED ITEM 10	1/9/12	PK	TR





RELEASED FOR PRODUCTION

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TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

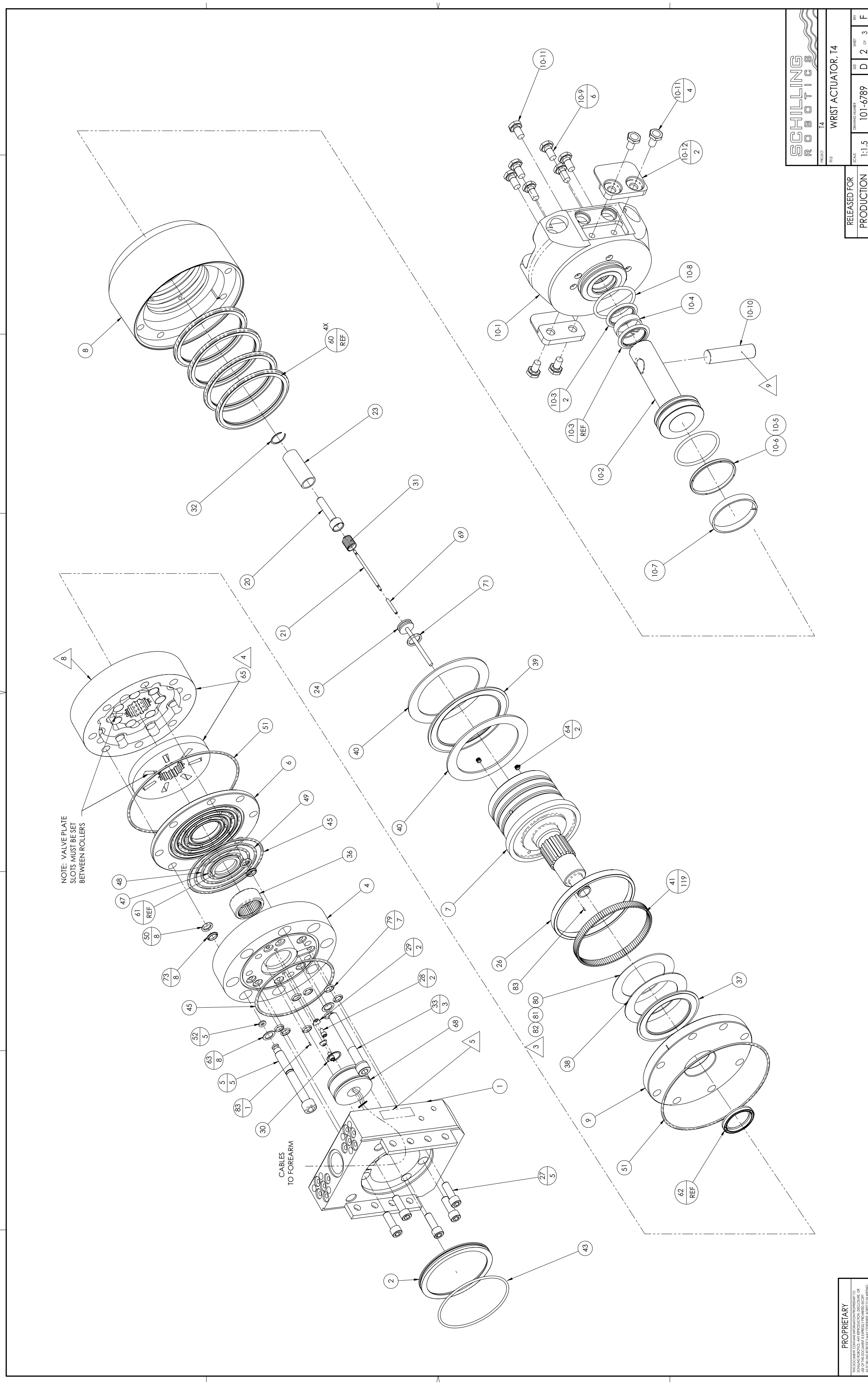
	SIGNATURE	DATE
DRAWN	V. MEADOWS	4/28/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

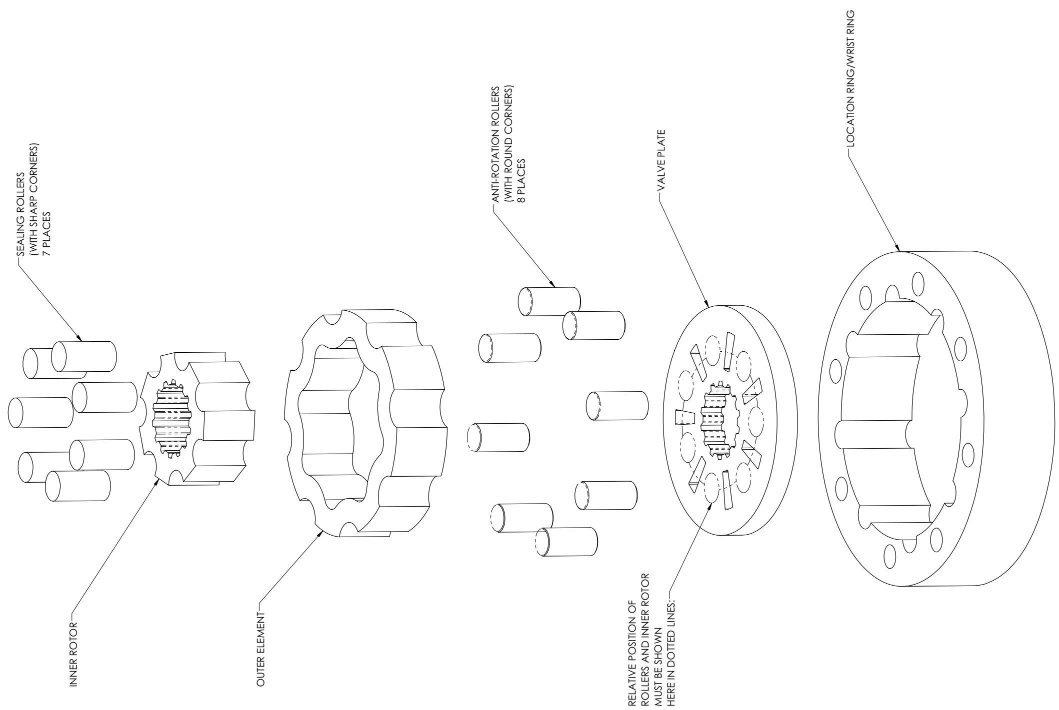
SCHILLING ROBOTICS

PROJECT T4

TITLE WRIST ACTUATOR, T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1	101-6789	D	1 OF 3	F


SCHILLING ROBOTICS
T4
WRIST ACTUATOR, T4
1:1.5
101-6789
D
2 OF 3
F
RELEASED FOR PRODUCTION
PROPRIETARY
NOTE: VALVE PLATE SLOTS MUST BE SET BETWEEN ROLLERS
CABLES TO FOREARM



SCHILLING ROBOTICS
PROJECT T4
TITLE WRIST ACTUATOR, T4
SCALE: 1.25:1 | DRAWING NUMBER 101-6789 | SIZE D | SHEET 3 OF 3 | REV F

RELEASED FOR PRODUCTION

PROPRIETARY

Slave Arm, T4, 101-6790

Rev. F

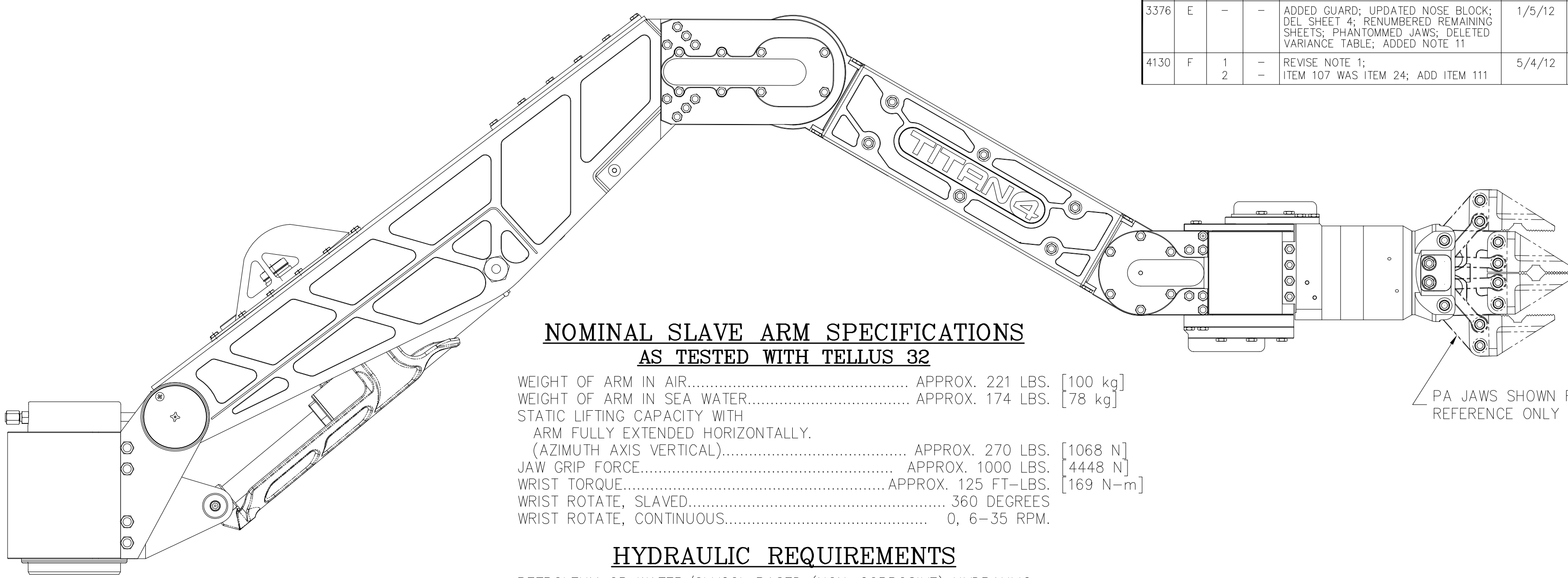
Item	P/N	Description	Qty
1	101-4042	ACTR,AZ,ONE PIECE SPDL, T3	1
2	101-5977	UPPERARM,T4,HAWE	1
3	101-4077	ACTR,RTRY,ELB,T3	1
4	101-5723	FOREARM,T4	1
5	101-4821	ACTR,RTRY,PITCH,W/FLATS,T3	2
6	101-6789	WRIST,ACTR,T4	1
9	101-2628	RSLR,AZ,T3	1
10	101-1405	RSLR,ELB,T2/T3	1
11	101-1407	RSLR,PITCH,T2/T3	1
12	101-1408	RSLR,YAW,T2/T3,GAMMA	1
13	101-1573	RSLR,SHLDR,T2/T3,SP,GAMMA	1
15	004-0642	O-RING,2-010,DISOGRIN 90 DURO	6
16	002-0046P	NAS 6404PU8,NLK	8
17	004-0222	O-RING,2-010 BUNA 90	56
18	004-0190	O-RING,2-012 BUNA 90	3
19	002-0038P	NAS 6404PU1,NLK	28
20	002-0050	NAS 6404U2	8
21	001-2897	BLK,ELB,PORTED,T2	1
22	004-0003	O-RING,2-024 BUNA 70	3
23	002-0317P	NAS 6404PU10,NLK PATCH	8
25	002-0061P	NAS 6406PU6,NLK	8
26	004-0080	O-RING,2-020 BUNA 70	2
27	002-0052P	NAS 6404PU3,NLK	28
30	004-0627	O-RING,.189X.039,BUNA 90	4
31	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	4
34	001-3317	TUBE,SHLDR	1
35	004-0086	O-RING,2-011 BUNA 70	2
37	002-0705	RING,RETING,INTL,SMALLEY WH562	1
38	025-0102	HYD SCHEM AND MAP,T4,HAWE	0
41	004-0087	O-RING,2-011 BUNA 90	8
43	004-0137	O-RING,.244x.039 BUNA 90 APPLE	8
45	001-1800	WIRE GUIDE,SLAVE ARM	5
46	001-1799	CLP,RSLR,T2	5
47	002-0095P	SHCS,10-32X3/8,316SS,NLK	8
48	002-0701	RING,RETING,SMALLEY #WSW137	5
49	002-0704	RING,RETING,INTL,SMALLEY VH400	1
50	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	1
51	001-2460	RING,RSLR,SHLDR	1
52	001-3319	LID,AZ,T3	1
53	001-1822	COVER,AZIMUTH	1
54	006-0015	FTG,HYD,-4 JIC,-4 ST,4F50X-SS	1
55	004-0226	O-RING,2-155 BUNA 70	1
56	004-0563	O-RING,2-160 BUNA 70	1

Slave Arm, T4, 101-6790 (cont.)

Rev. F

Item	P/N	Description	Qty
57	004-0611	SEAL,FLUROCARBON #AR10400-329-	1
58	002-1920	PIN,SPR,1/8X1/2,SS 302	1
60	001-1915	SPR,RSLR,T2	3
61	004-0113	O-RING,2-047 BUNA 70	1
62	004-0641	O-RING,5.822X.070,BUNA 70 (THR	1
64	002-0346P	NAS 6404PU6,NLK	20
65	001-2673	COV,WIRE,ELB,T2,TALL	1
66	001-2674	COV,RSLR,ELB,T2,TALL	1
67	001-2676	COV,WIRE,PITCH/YAW,T2,TALL	2
68	001-2675	COV,RSLR,PITCH/YAW,T2,TALL	2
70	004-0139	O-RING,2-040 BUNA 70	2
71	004-0049	O-RING,2-045 BUNA 70	2
73	006-0027	FIT,HYD,-4,JIC,CAP-S(4FNTX-S)	2
74	006-0028	FIT,HYD,-6,JIC,CAP-S(6FNTX-S)	1
79	001-5294	SHAFT, SHEAR PIN	1
80	001-5295	END,SHEAR PIN	2
81	002-1888	SHCS,5/16-24X3/4L,120K-150K	2
82	002-0286	ADH,LOCTITE 271(RED 10CC BTL)	0
87	001-5494	WIRE GDE, RSLVR, T3	3
89	001-7151	LOGO PLATE,TITAN 4,316 SS	2
90	001-5511	BUMPER,SHLDR,PVT,RIGHT	1
91	001-5512	BUMPER,SHLDR,PVT,LEFT	1
92	002-0801	SEALANT,730 RTV SOLVENT RESIST	0
93	906-0067	GUARD, LINACT,8IN	1
94	002-3428	TAPE,ADHESIVE,VHB	1.2
95	101-5158	CABLE,WRIST CAMERA TO SCE	1
96	005-4948	CABLE,SMA-M TO SMA-M,36"	1
97	005-1706	TBG,SHRINK,3/8 WHT	.25
98	001-1897	BLK,MANF,PITCH/YAW,T2	1
99	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	4
100	004-0303	O-RING,2-022 V75	2
102	007-0108	MANF,RTR,PITCH/YAW,T2	2
103	002-0045P	NAS 6404PU7,NLK	12
104	004-0585	O-RING,.189X.039,N70(APPLE)	20
105	004-0586	O-RING,1.417X.039,N70(APPLE)	2
106	004-1201	O-RING,.228X.040 DISOGRIN9251	10
107	002-5460	WSHR,NORD-LOCK,NL1/4"SS-254	10
108	007-0133	MANF,RTR,ELB,T2	1
109	001-12476	BOLT,12 PT,1/4-28X 9/16",MP35N	2
110	004-1202	O-RING, 2-030, DISOGRIN 9251	1
111	002-0813	WRAP,SPIRAL,1/4IN	.75
200	101-6790-WI	WORK INSTRUCTIONS	0

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
	A	–	–	RELEASED FOR PRODUCTION	5/18/08	VDM	SLW
	B	–	–	UPDATED VARIANCE TABLE	8/21/08	NLH	AH
0937	C	1 2, 3	A2 B1 –	ADDED GENERAL NOTE 10; OBSOLETED –2 VARIATION ADDED TORQUE VALUE NOTATION	8/19/10	RDJ	WK
1892	D	2	C2	REMOVED ITEM 59	10/14/10	SWR	JAK
3376	E	–	–	ADDED GUARD; UPDATED NOSE BLOCK; DEL SHEET 4; RENUMBERED REMAINING SHEETS; PHANTOMMED JAWS; DELETED VARIANCE TABLE; ADDED NOTE 11	1/5/12	PK	TR
4130	F	1 2	– –	REVISE NOTE 1; ITEM 107 WAS ITEM 24; ADD ITEM 111	5/4/12	PK	JAK



NOMINAL SLAVE ARM SPECIFICATIONS
AS TESTED WITH TELLUS 32

WEIGHT OF ARM IN AIR.......... APPROX. 221 LBS. [100 kg]
WEIGHT OF ARM IN SEA WATER.......... APPROX. 174 LBS. [78 kg]
STATIC LIFTING CAPACITY WITH
ARM FULLY EXTENDED HORIZONTALLY.
(AZIMUTH AXIS VERTICAL).......... APPROX. 270 LBS. [1068 N]
JAW GRIP FORCE.......... APPROX. 1000 LBS. [4448 N]
WRIST TORQUE.......... APPROX. 125 FT–LBS. [169 N–m]
WRIST ROTATE, SLAVED.......... 360 DEGREES
WRIST ROTATE, CONTINUOUS.......... 0, 6–35 RPM.

HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON–CORROSIVE) HYDRAULIC FLUID AT 3000 PSID NOM. AT A FLOW OF 1.5–5 GPM. [6 lpm–18 lpm]

NOTES:

1. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
2–10	240 FOOT LBS. [325.4 N–m]
16,19,20,23,27,64,7–77,103	21 FOOT LBS. [28.5 N–m]
25	73 FOOT LBS. [99.0 N–m]
81,109	30 FOOT LBS. [40.7 N–m]
47	5 FOOT LBS. [6.8 N–m]
99	76 INCH LBS. [8.6 N–m]
31	30 INCH LBS. [3.4 N–m]

2. DELETED.
3. SERIALIZE IN INDICATED AREA PER WORK INSTRUCTIONS.
4. REFER TO THE USER MANUAL FOR INSTALLATION AND OPERATIONAL SECTIONS.
5. HOSES MAY NOT BE PROVIDED BY SCHILLING ROBOTICS.
6. ALL OVERALL DRAWING DIMENSIONS ARE FOR REFERENCE ONLY. METRIC EQUIVALENTS SHOWN IN BRACKETS [ ].
7. INDICATED JOINT RANGE OF MOTION REPRESENTS THE MECHANICAL LIMITS OF THE ARM. OPERATIONAL LIMITS WILL BE LESS.
8. REFER TO "FORWARD KINEMATICS AND JACOBIAN OF TITAN 2 MANIPULATORS" FOR EXPLANATION OF PARAMETERS a_X, b_X, AND c_X.
   - ⊙ OUT OF THE PAGE
   - ⊗ INTO THE PAGE
9. SEE LOWER LEVEL ASSEMBLY DRAWINGS AND ASSOCIATED WORK INSTRUCTIONS FOR MORE DETAILED ASSEMBLY AND DISASSEMBLY INFORMATION.
10. DELETED
11. CLOCK ITEM 101–56 SO THAT THE TICK MARK ON IT IS ALIGNED TO THE TICK MARK ON ITEM 102.

RELEASED FOR PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

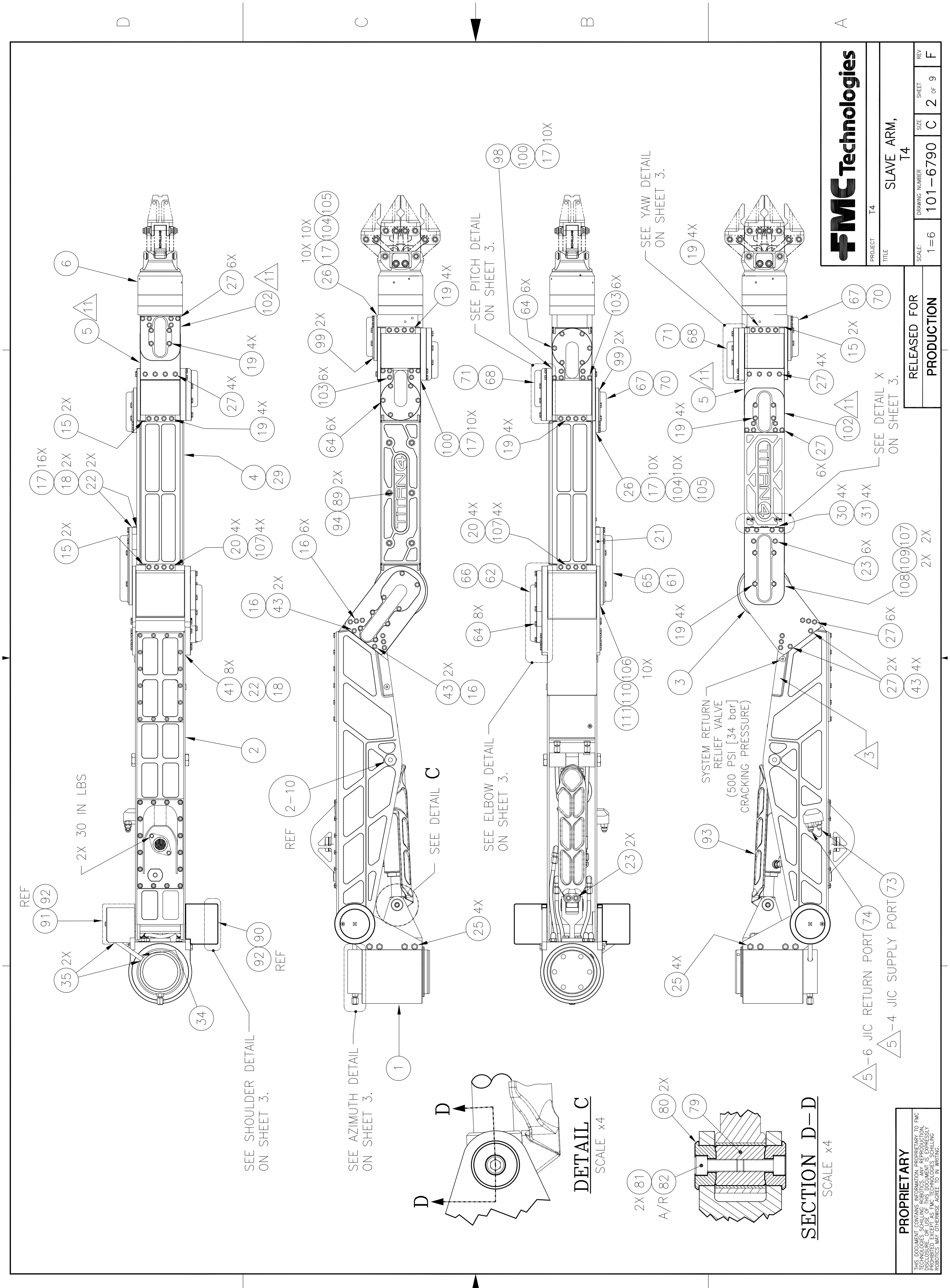
	SIGNATURE	DATE
DRAWN	V. MEADOWS	5/15/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

FMC Technologies

PROJECT: T4

TITLE: SLAVE ARM, T4

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=4	101–6790	C	1 of 9	F


FMC Technologies
PROJECT T4
TITLE SLAVE ARM, T4
SCALE: 1=6
DRAWING NUMBER 101-6790
SIZE C
SHEET 2 of 9
REV F
RELEASED FOR PRODUCTION
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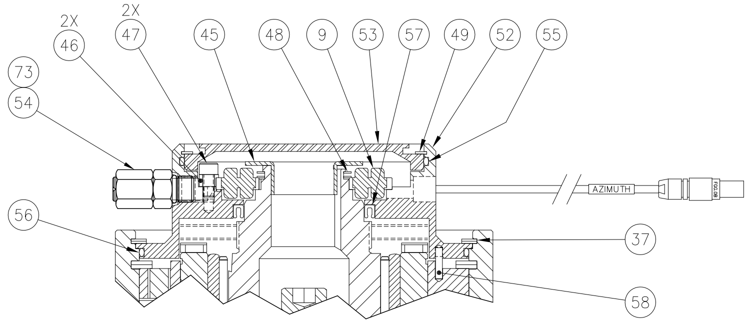
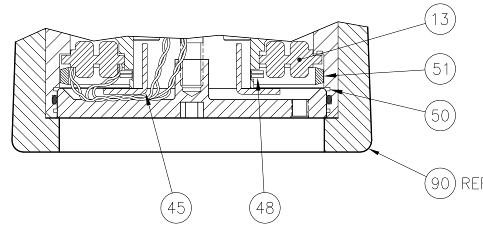
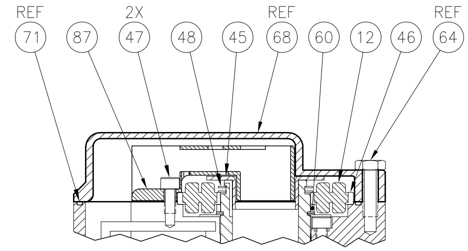
SEE SHOULDER DETAIL ON SHEET 3.
SEE AZIMUTH DETAIL ON SHEET 3.
SEE ELBOW DETAIL ON SHEET 3.
SEE PITCH DETAIL ON SHEET 3.
SEE YAW DETAIL ON SHEET 3.
SEE DETAIL X ON SHEET 3.
SEE DETAIL C
2X 30 IN LBS
SYSTEM RETURN RELIEF VALVE (500 PSI [34 bar] CRACKING PRESSURE)
-6 JIC RETURN PORT
-4 JIC SUPPLY PORT
DETAIL C
SCALE x4
SECTION D-D
SCALE x4



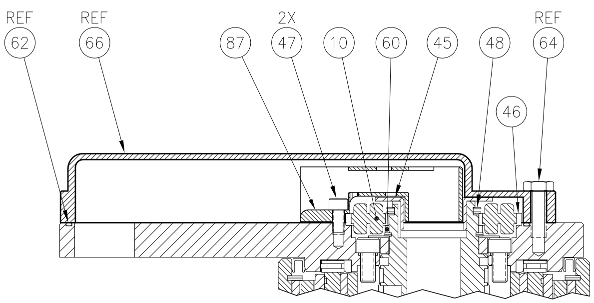
AZIMUTH DETAIL



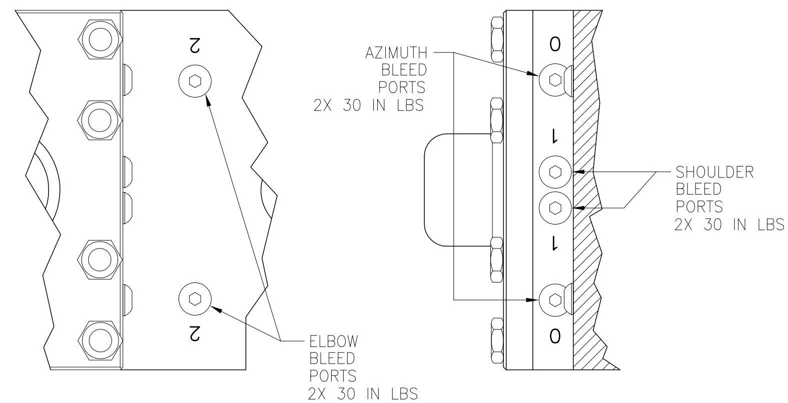
RIGHT SHOULDER DETAIL
SCALE x1.5



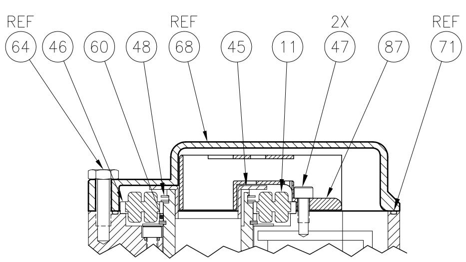
YAW DETAIL



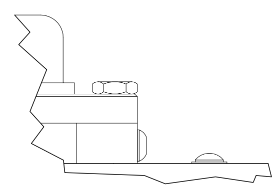
ELBOW DETAIL



DETAIL X
SCALE x1.5



PITCH DETAIL



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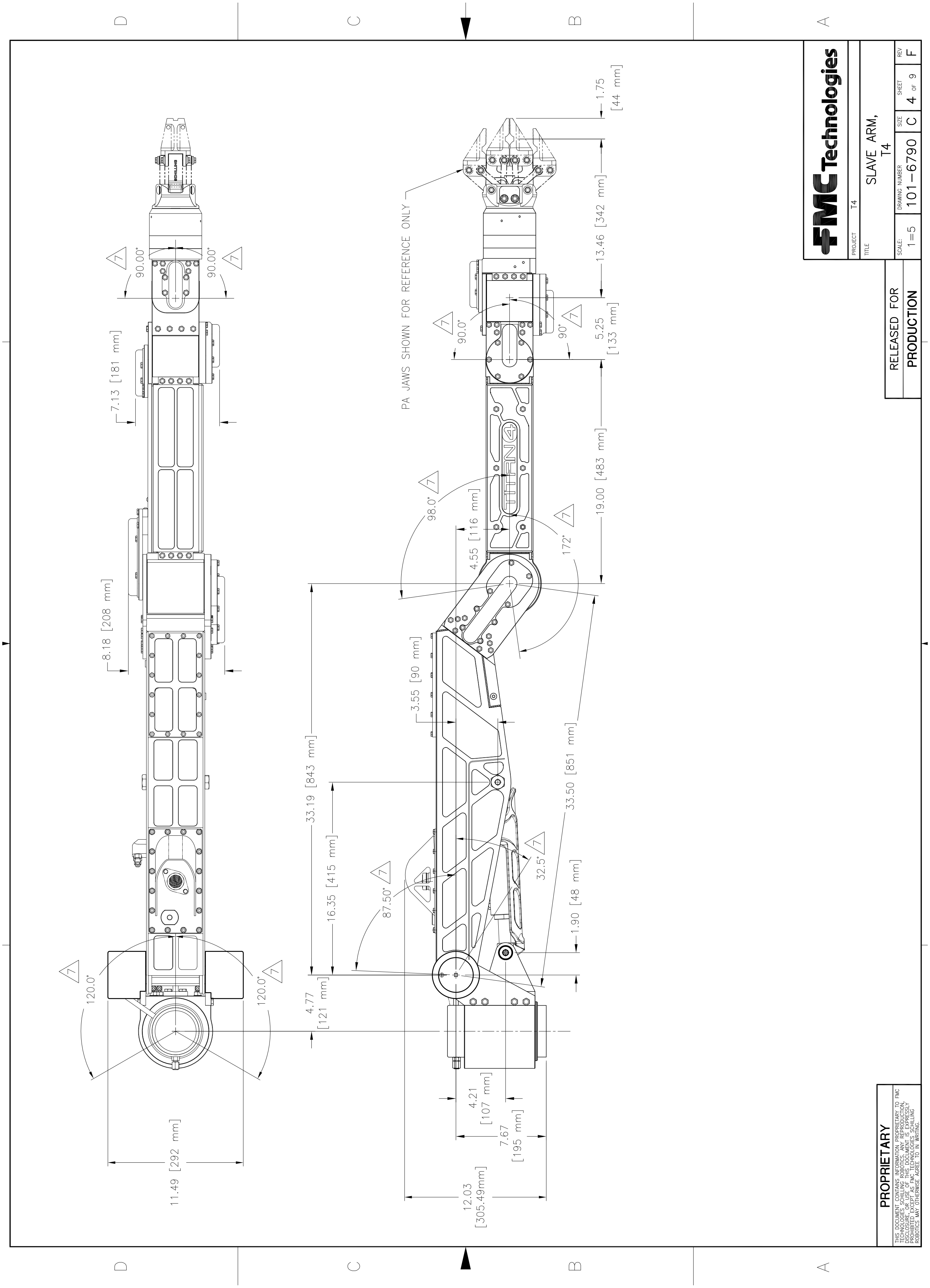
RELEASED FOR PRODUCTION

FMC Technologies

PROJECT	T4				
TITLE	SLAVE ARM, T4				
SCALE: 1=1.5	DRAWING NUMBER 101–6790	SIZE C	SHEET 3 of 9	REV F	


PA JAWS SHOWN FOR REFERENCE ONLY
1.75 [44 mm]
13.46 [342 mm]
5.25 [133 mm]
19.00 [483 mm]
4.55 [116 mm]
3.55 [90 mm]
33.50 [851 mm]
33.19 [843 mm]
16.35 [415 mm]
1.90 [48 mm]
4.77 [121 mm]
4.21 [107 mm]
7.67 [195 mm]
12.03 [305.49mm]
7.13 [181 mm]
8.18 [208 mm]
11.49 [292 mm]
90.00°
90.0°
90°
98.0°
172°
32.5°
87.50°
120.0°
7
RELEASED FOR PRODUCTION
FMC Technologies
PROJECT T4
TITLE SLAVE ARM, T4
SCALE: 1=5
DRAWING NUMBER 101-6790
SIZE C
SHEET 4 OF 9
REV F
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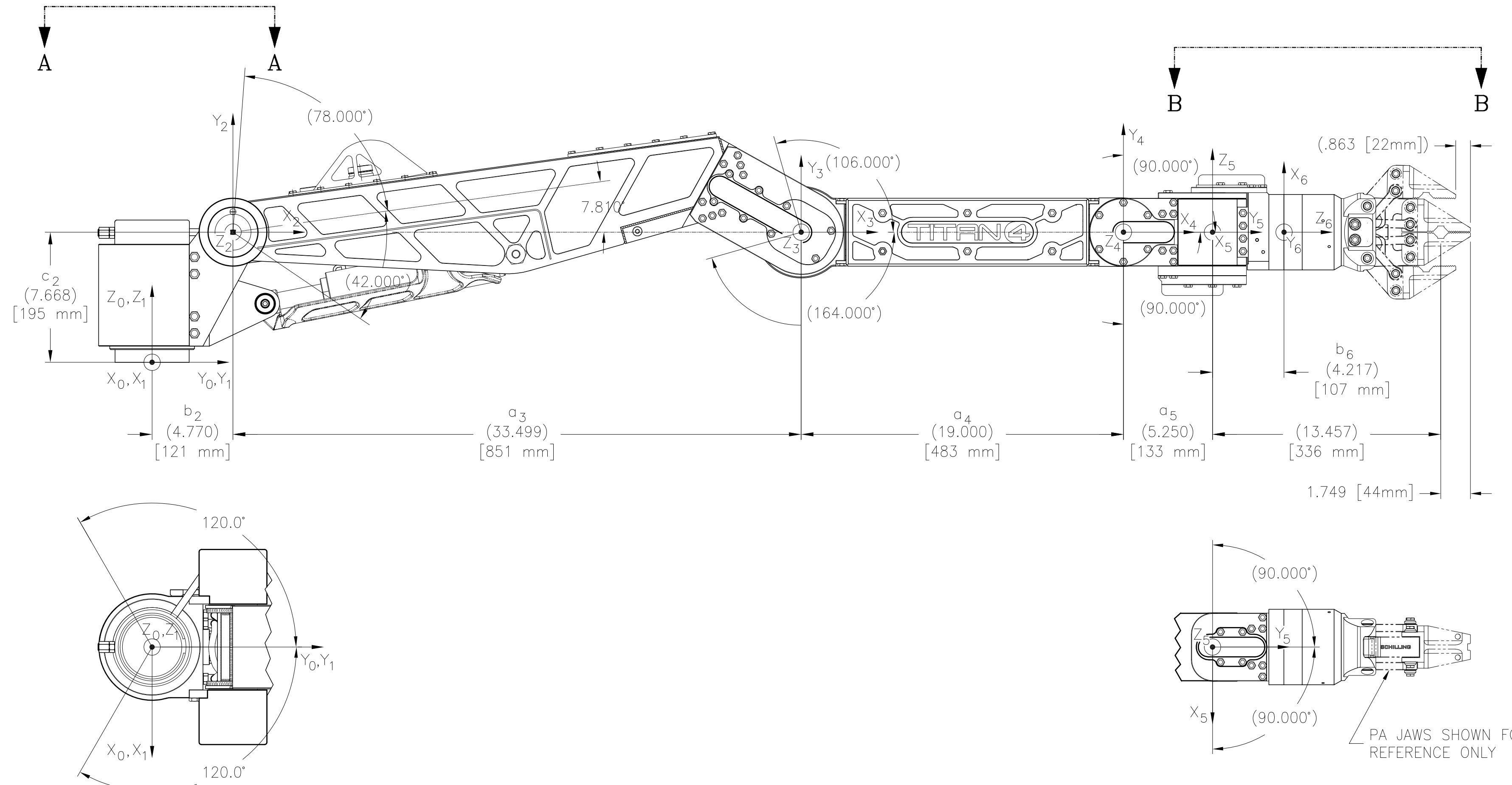
KINEMATIC DIMENSIONS – ARM CONFIGURATION WITH JOINT ANGLES EQUAL TO ZERO DEGREES

8



VIEW A–A

VIEW B–B

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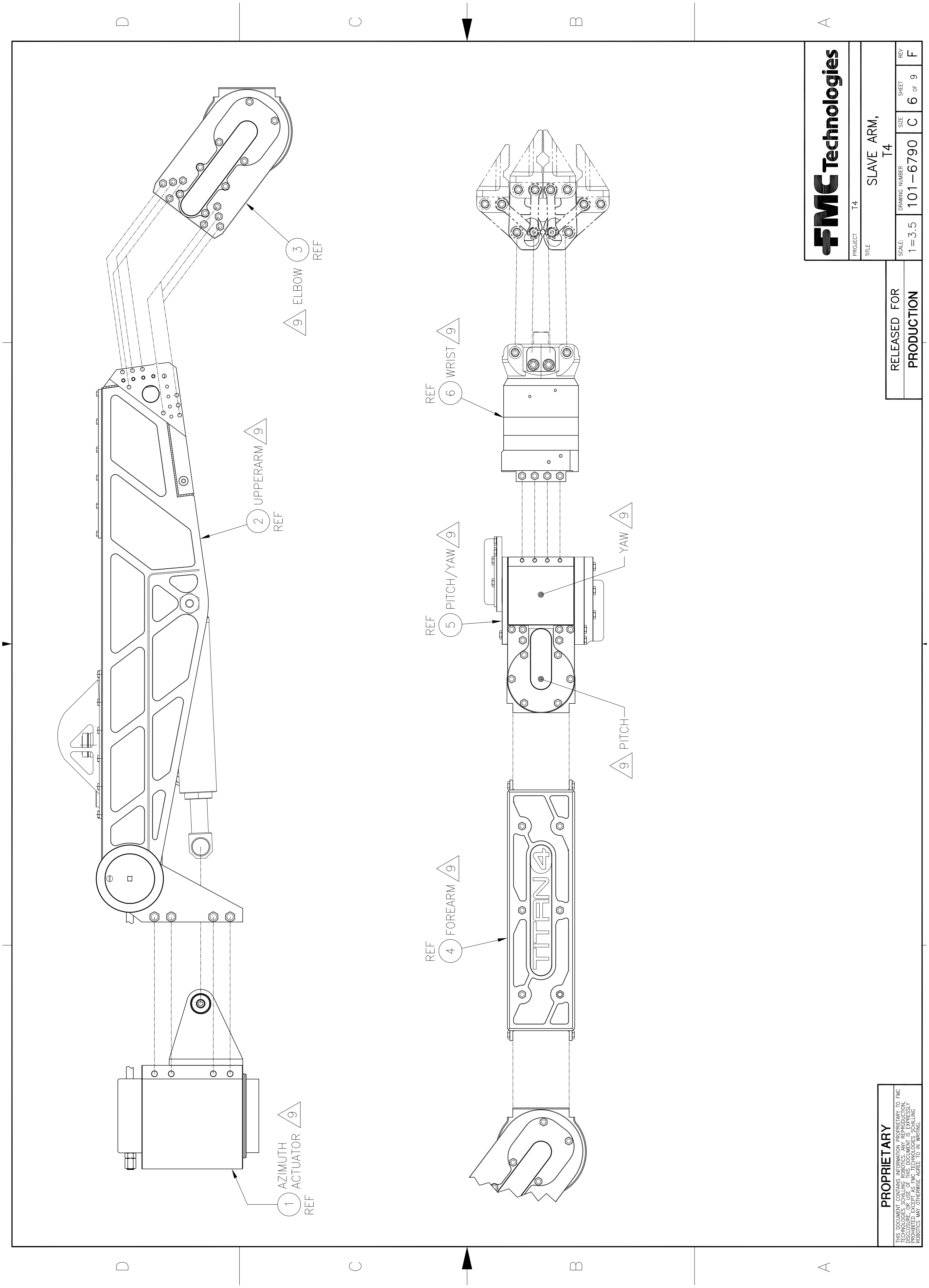
RELEASED FOR
PRODUCTION

FMC Technologies

PROJECT T4				
TITLE SLAVE ARM, T4				
SCALE: 1=4.5	DRAWING NUMBER 101–6790	SIZE C	SHEET 5 OF 9	REV F


FMC Technologies
PROJECT T4
TITLE SLAVE ARM, T4
SCALE: 1=3.5
DRAWING NUMBER 101-6790
SIZE C
SHEET 6 OF 9
REV F
RELEASED FOR PRODUCTION
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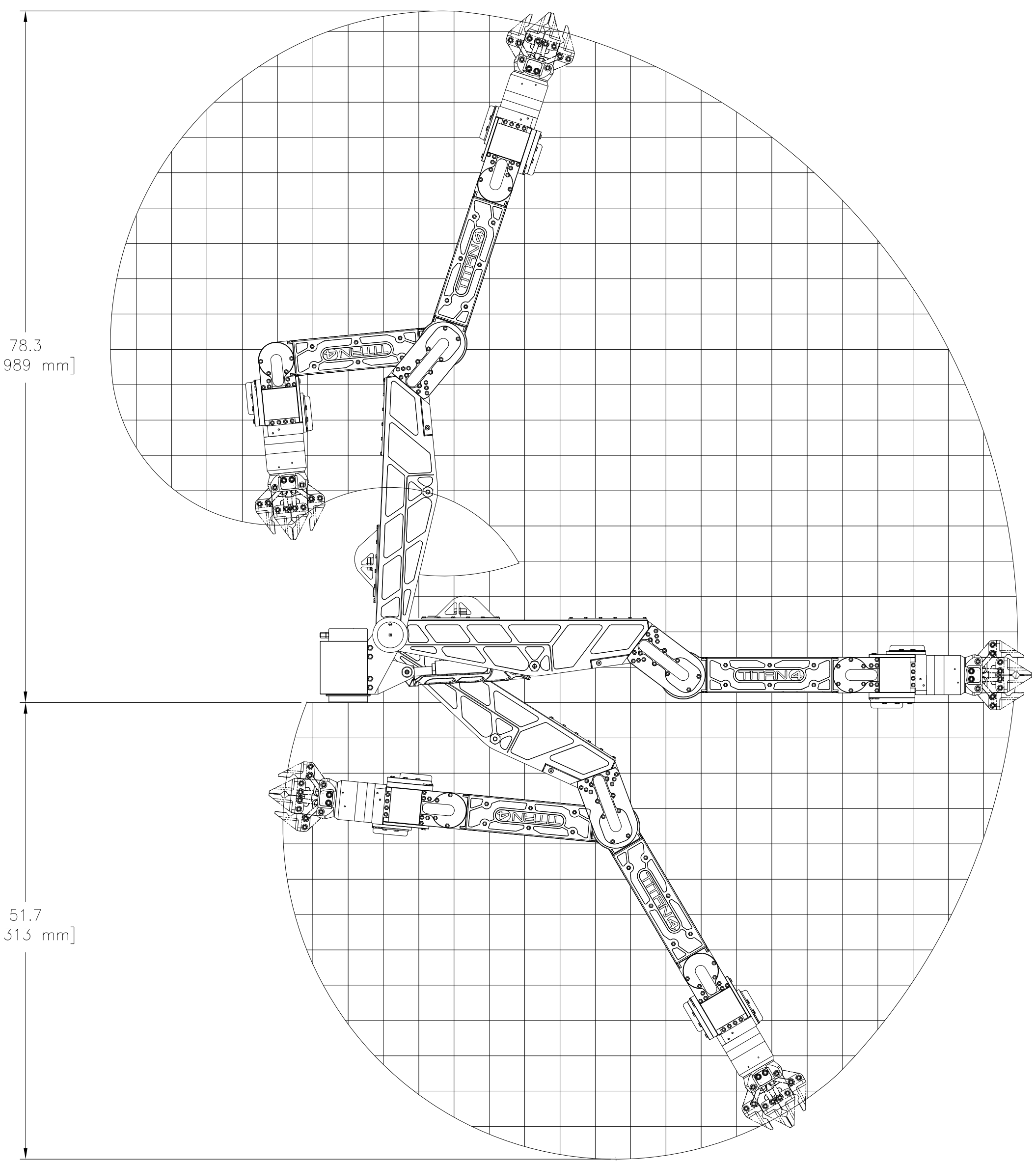
1 AZIMUTH ACTUATOR REF 9
2 UPPERARM REF 9
3 ELBOW REF 9
4 FOREARM REF 9
5 PITCH/YAW REF 9
6 WRIST REF 9
YAW 9
PITCH 9
TITAN 4
D
C
B
A



1 SQUARE = 4 INCHES
= [101.6 mm]

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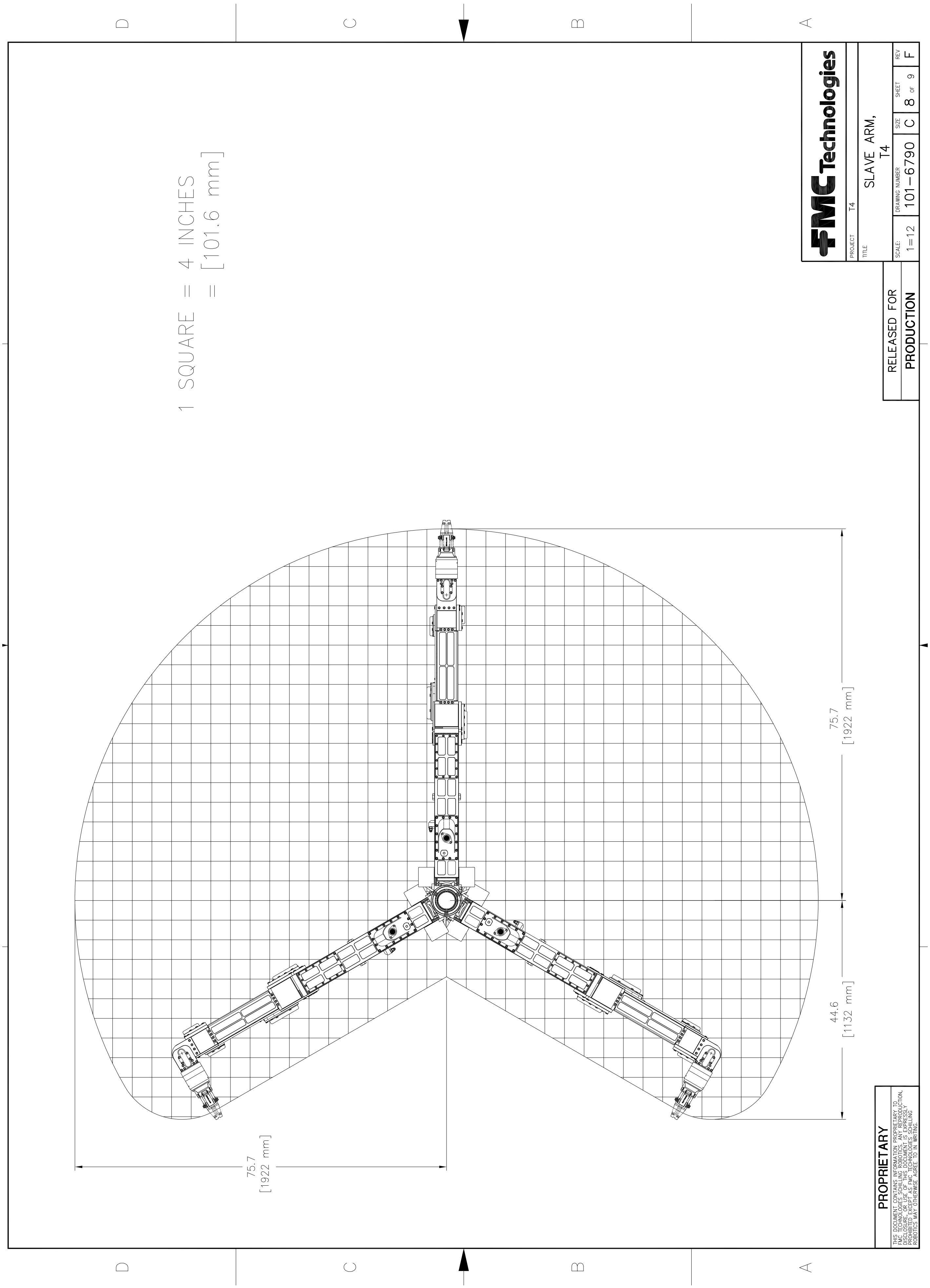
RELEASED FOR
PRODUCTION

FMC Technologies

PROJECT T4				
TITLE SLAVE ARM, T4				
SCALE: 1=10	DRAWING NUMBER 101–6790	SIZE C	SHEET 7 OF 9	REV F


D
C
B
A
1 SQUARE = 4 INCHES
= [101.6 mm]
75.7
[1922 mm]
44.6
[1132 mm]
75.7
[1922 mm]
RELEASED FOR
PRODUCTION
FMC Technologies
PROJECT T4
TITLE SLAVE ARM, T4
SCALE: 1=12
DRAWING NUMBER 101-6790
SIZE C
SHEET 8 OF 9
REV F
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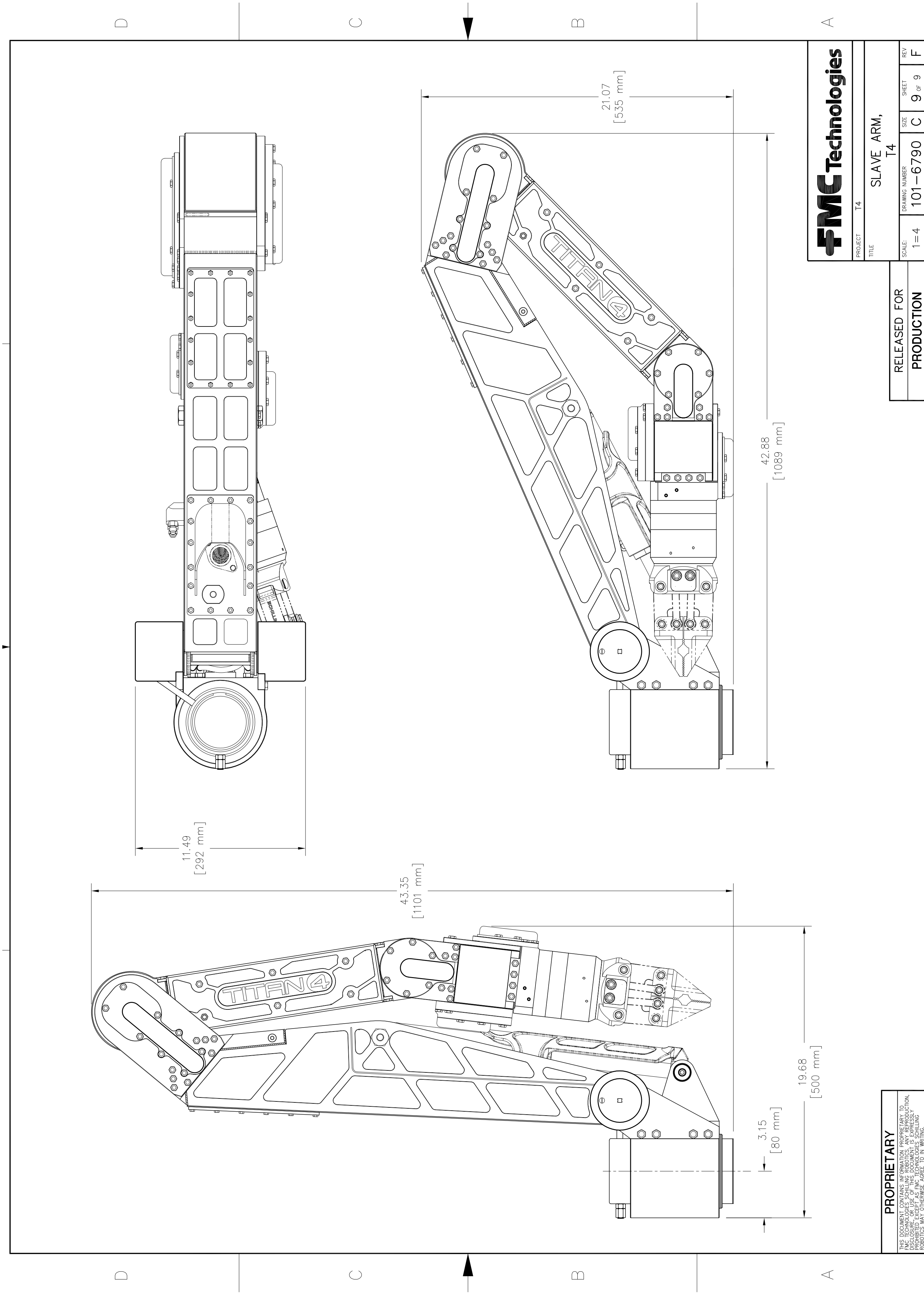
FMC Technologies
PROJECT T4
TITLE SLAVE ARM, T4
SCALE: 1=4
DRAWING NUMBER 101–6790
SIZE C
SHEET 9 OF 9
REV F
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21.07 [535 mm]
42.88 [1089 mm]
11.49 [292 mm]
43.35 [1101 mm]
19.68 [500 mm]
3.15 [80 mm]

Harness, SA, T4, Camera, 101-6852

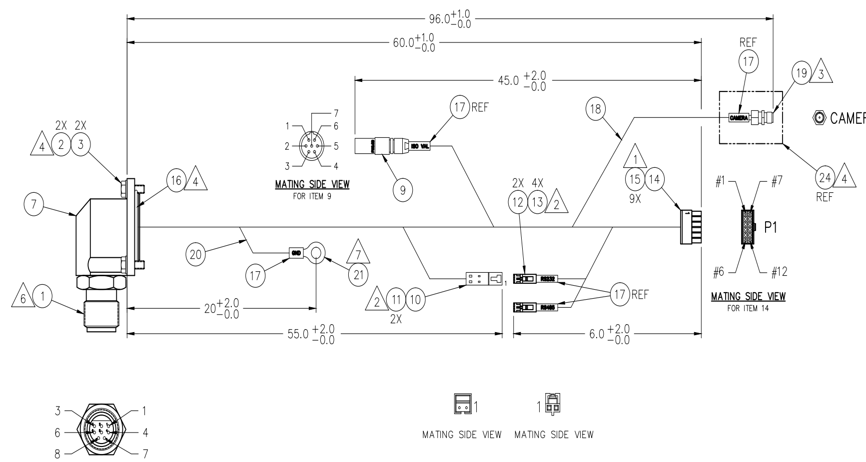
Rev. B

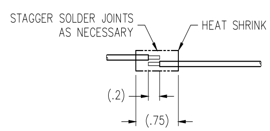
Item	P/N	Description	Qty
1	005-3244	CONN,8 PIN,15 SHELL,BURTON,BHD	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	12.75
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
7	001-7521	HSG,CONN,BURTON 15 SHELL,UA,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
20	005-3485	WIRE,18 AWG, TEFZEL, GRN/YEL	2
21	005-6040	LUG,RING,22-18AWG,1/4,NO-UNSUL	1
22	010-1527	TOOL,CRIMP,MOLEX 63811-8700	0
23	010-1739	TOOL,CRIMP,MOLEX 63819-0000	0
24	005-1706	TBG,SHRINK,3/8 WHT	.1
100	101-6852-WI	WORK INSTRUCTIONS	0

NOTES:

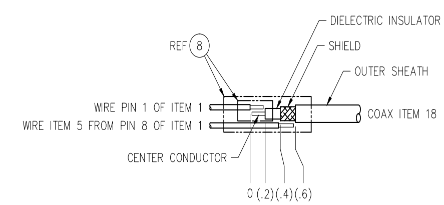
1. (△1) CRIMP PINS USING CRIMP TOOL ITEM 23. INSPECT THE CRIMP TO VERIFY THAT IT MEETS IPC–A–620 CLASS 3 REQUIREMENTS. SOLDER THE CRIMPED WIRE TO THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620 CLASS 3 REQUIREMENTS.
2. (△2) CRIMP USING MOLEX CRIMP TOOL ITEM 22. VERIFY CRIMP MEETS THE IPC–A–620 CLASS 3 REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620 CLASS 3 REQUIREMENTS.
3. (△3) REFER TO COAX STRIP DETAIL FOR ITEM 19 INSTALLATION. SLIDE FERRULE (A) OVER CABLE. STRIP CABLE AS SHOWN. TIN CENTER CONDUCTOR. FLAIR BRAID AND INSERT EXTENSION (B) UNDER BRAID WITH CENTER CONDUCTOR PROTRUDING THROUGH HOLE IN EXTENSION. SOLDER CONTACT (C) TO CENTER CONDUCTOR. SLIDE FERRULE (A) OVER BRAID AND CRIMP. INSTALL CABLE ASSEMBLY INTO BODY AND TIGHTEN. CRIMP SIZE REQUIRED: CONTACT: SOLDER, FERRULE: .100" HEX CRIMP TOOL.
4. (△4) BAG AND TAG ITEMS 2, 3, 16, AND A 1.5" PIECE OF ITEM 24 PER SHOP STANDARD.
5. ADD SMALL PIECES OF SHRINK TUBING, ITEM 8 OR TIE WRAP (002–0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
6. (△6) VERIFY O–RING ON BURTON CONNECTOR, ITEM 1, IS INSTALLED BEFORE MATING WITH HOUSING, ITEM 7.
7. (△7) CRIMP LUG ITEM 21 TO WIRE ITEM 20 PER IPC–A–620 CASS 3 REQUIREMENTS. VERIFY THAT THE CRIMP MEETS THE IPC REQUIREMENT PRIOR TO SOLDERING THE LUG AND WIRE TOGETHER. SOLDER LUG ITEM 21 TO THE CONDUCTOR OF WIRE ITEM 20. VERIFY THE SOLDER JOINT MEETS IPC–A–620 CLASS 3 REQUIREMENTS.
8. (△8) SOLDER STRIPPED COAX WIRES TO WIRES OF ITEM 1 PER COAX SPLICE DETAIL. SOLDER JOINTS TO MEET IPC–A–620 CLASS 3 REQUIREMENTS.
9. (△9) SPLICE WIRES PER THE BURTON SOLDER DETAIL.
10. (△10) CAP ALL UNUSED WIRES FROM ITEM 1 WITH SHRINK TUBING ITEM 8. SECURE THE WIRES NEATLY INTO THE CABLE BUNDLE.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	A	–	RELEASED FOR PRODUCTION	6/03/08	JG	SLW
1961	B	–	UPDATED NOTES, UPDATED SPLICE DETAIL ON BURTON END CONN, ADDED DIM 20 +2.0/–0.0, UPDATED ITEM C/O, ADDED COAX STRIP DETAIL, ADDED COAX SPLICE DETAIL	11/10/10	SWR	CC

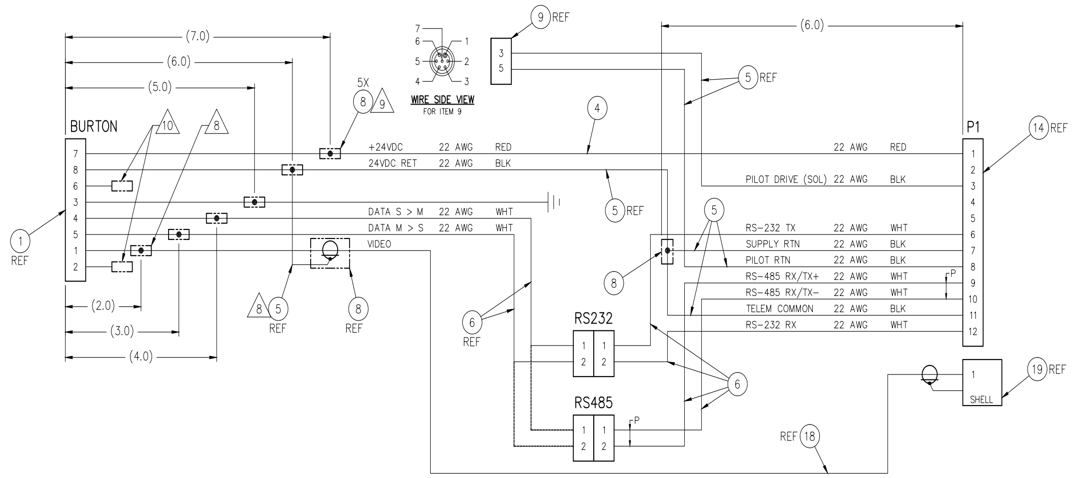


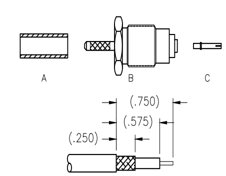


BURTON SOLDER DETAIL
NTS



COAX STRIP DETAIL
NTS





△3 **COAX STRIP DETAIL**
NTS

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RELEASED FOR PRODUCTION

GENERAL NOTES — UNLESS OTHERWISE SPECIFIED: INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE. DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES. ALL MACHINED SURFACES TO BE 63 RMS FINISH. DIMENSIONS ARE IN INCHES. CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES: DECIMALS .X ±.1, .XX ±.02, .XXX ±.005; FRACTIONS ±1/16; ANGLES .X ±1/0°, .X.X ±30', X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	J GARDNER	6/03/08
DESIGNED	T. LOMBARDO	5/22/08
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

PROJECT: T4

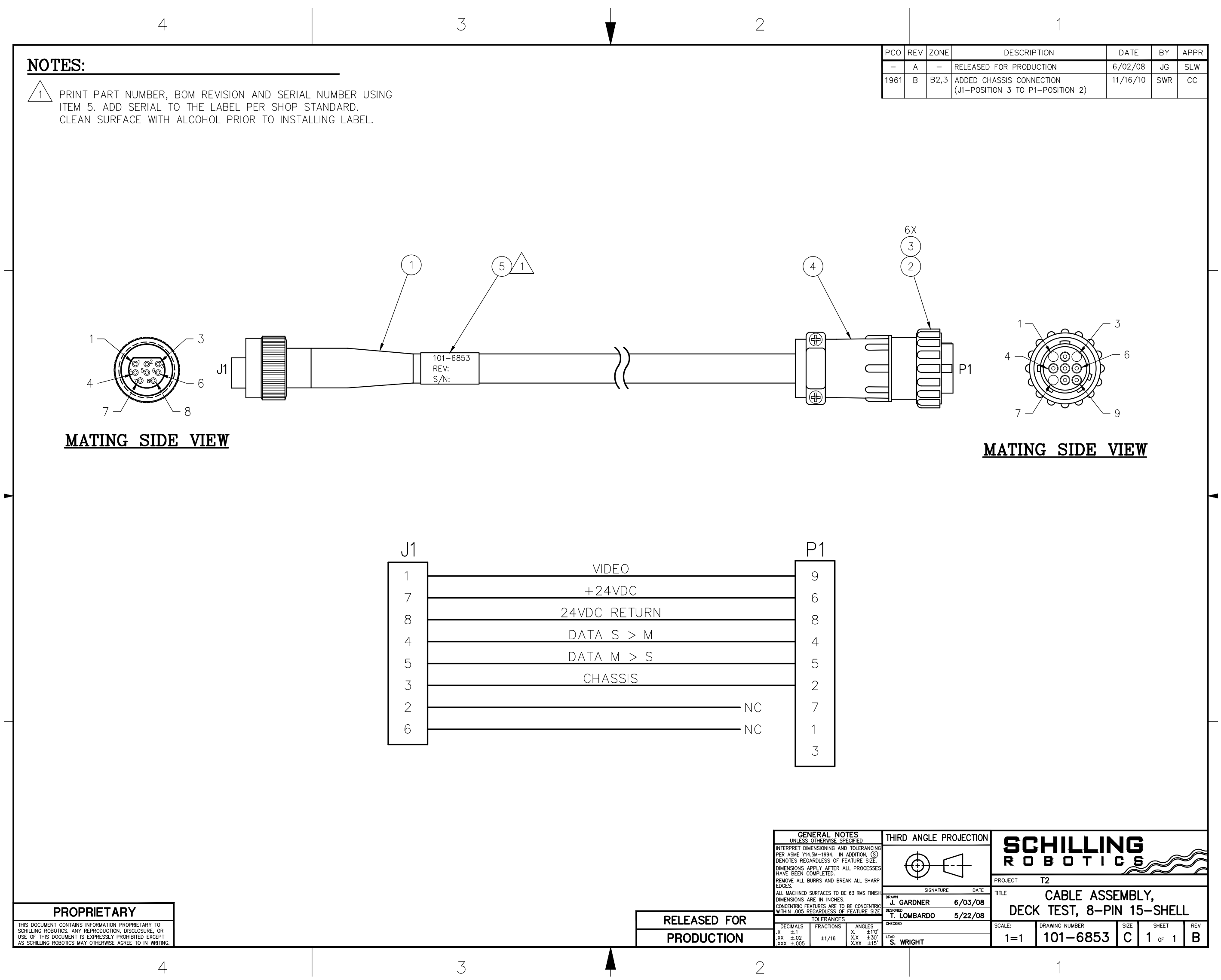
TITLE: HARNESS, SLAVE ARM, T4 WITH CAMERA, TMT

SCALE	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101–6852	D	1 OF 1	B

Cable Ass'y, 8-Pin, 15 Shell, 101-6853

Rev. C

Item	P/N	Description	Qty
1	005-3243-12	CONN,8 PIN,15 SHELL,BURTON 12	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	6
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0
100	101-6853-WI	WORK INSTRUCTIONS	0



NOTE: *Use drawing 101-6926 for reference.*

Cable Ass'y, Deck Test, 101-6926-1

Rev. B

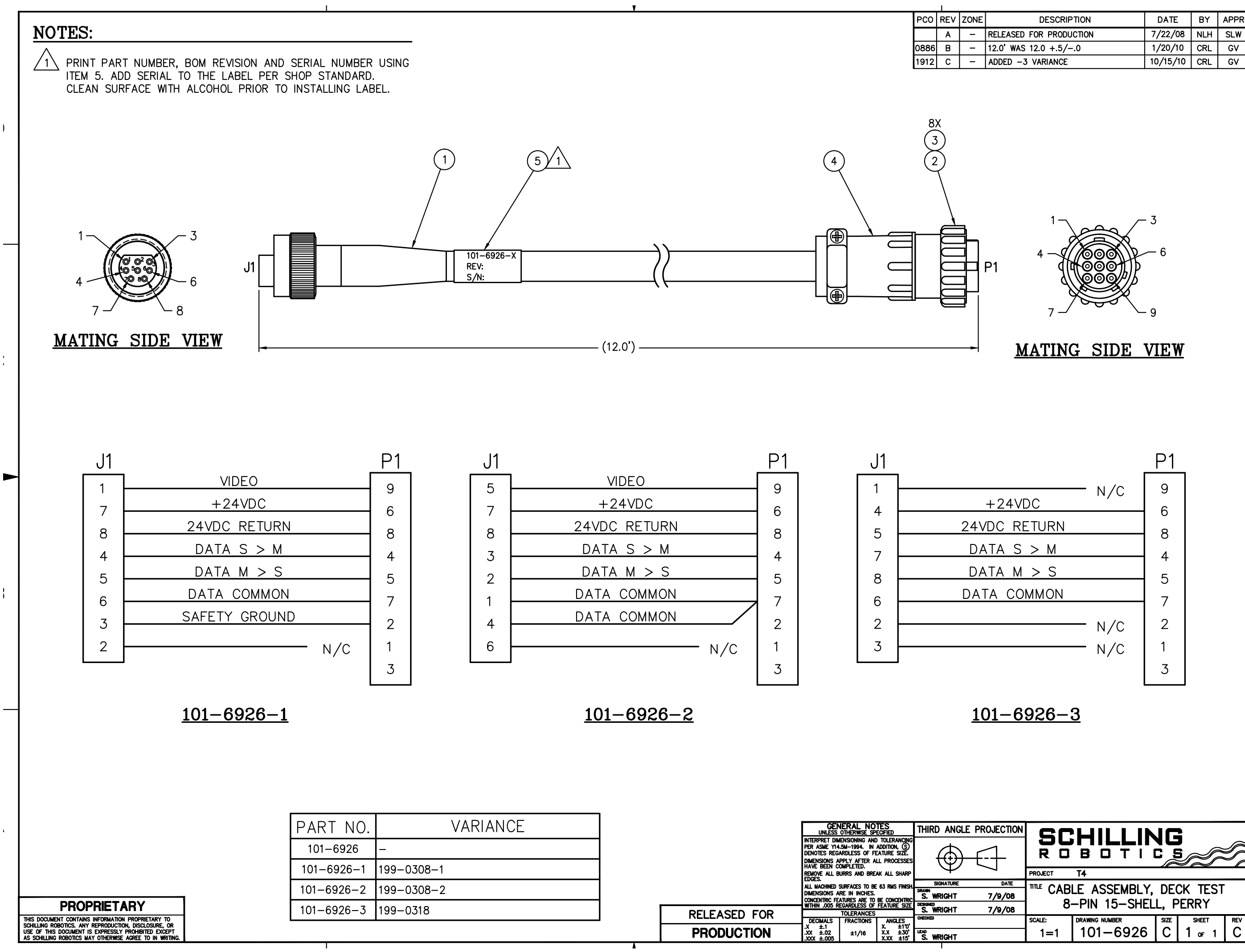
Item	P/N	Description	Qty
1	005-3243-12	CONN,8 PIN,15 SHELL,BURTON 12	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	8
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0
1000	101-6926-1-WI	WORK INSTRUCTIONS	0

NOTE: *Use drawing 101-6926 for reference.*

Cable Ass'y, Deck Test, 101-6926-2

Rev. B

Item	P/N	Description	Qty
1	005-3243-12	CONN,8 PIN,15 SHELL,BURTON 12	1
2	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
3	005-1794	PIN,CONN,CPC,AMP #66587-2	8
4	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
5	005-4096	LABEL,3/8 IN,PANDUIT	0
1000	101-6926-2-WI	WORK INSTRUCTIONS	0



Harness, 8-Pin, Burton w/Safety,101-6927

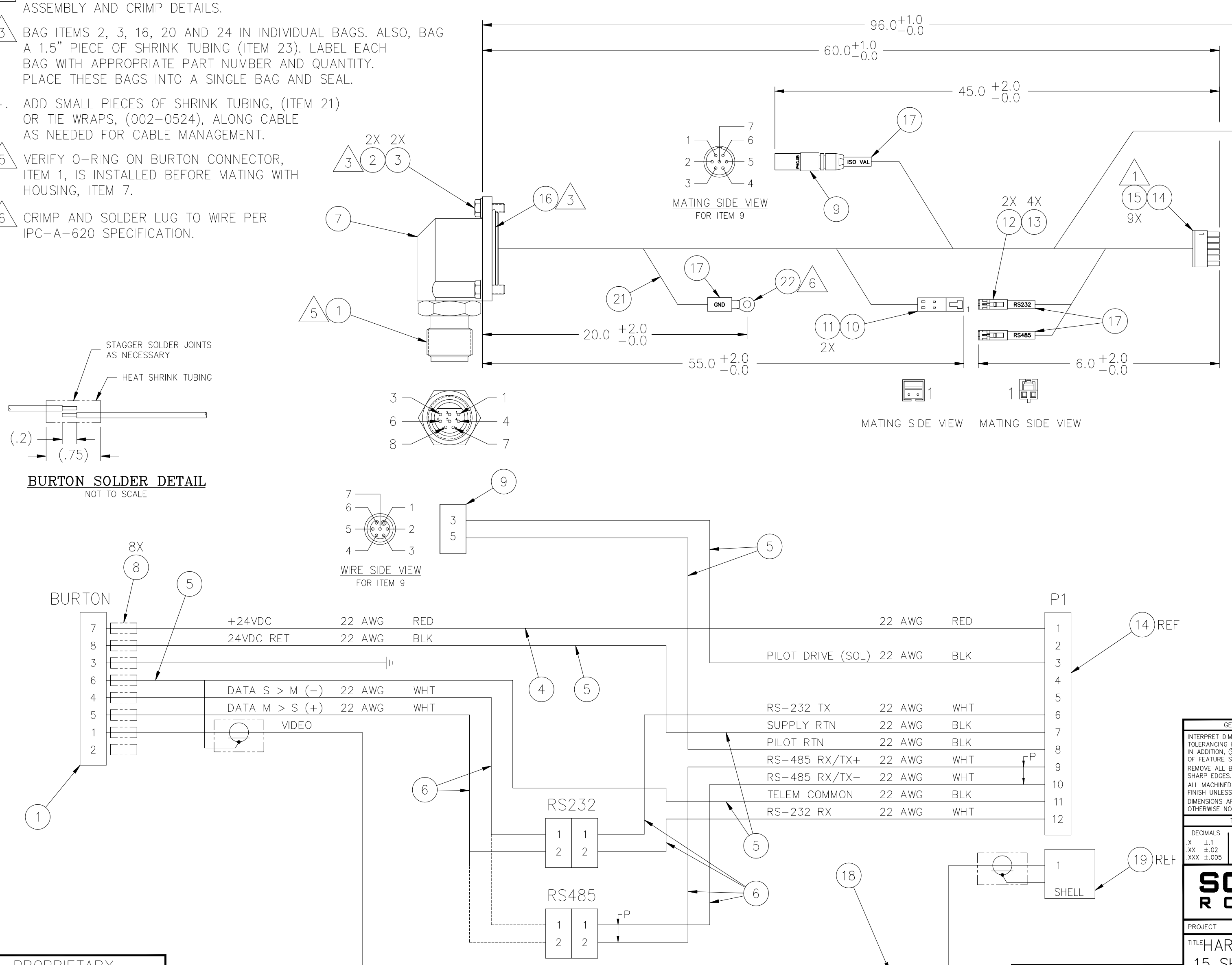
Rev. D

Item	P/N	Description	Qty
1	005-3244	CONN,8 PIN,15 SHELL,BURTON,BHD	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	18
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
7	001-7521	HSG,CONN,BURTON 15 SHELL,UA,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
20	002-0921	SHCS,1/4-28X3/8,SS	1
21	005-3485	WIRE,18 AWG, TEFZEL, GRN/YEL	2
22	005-6040	LUG,RING,22-18AWG,1/4,NO-UNSUL	1
23	005-1706	TBG,SHRINK,3/8 WHT	.13
24	002-1584	WSHR,LOCK,1/4,SS	1
100	101-6927-WI	WORK INSTRUCTIONS	0

REV	ZONE	DESCRIPTION	DATE	BY	APPR
A	–	RELEASED FOR PRODUCTION	7/22/08	NLH	SLW
B	–	ADDED TELEM COMM TO PIN 6	7/24/08	RDJ	SLW
C	–	"(ITEM 23)" IN NOTE 3 WAS "(ITEM 20)"	7/31/08	RDJ	AH
D	–	ADD ITEM 24, AND 2.0IN IN LENGTH TO GROUND WIRE	10/23/08	VDM	WK

NOTES:

1. CRIMP AND SOLDER USING MOLEX CRIMPING TOOL, P/N 1825432.
2. SEE SPEC SHEET FOR 005-4468 FOR STRIP, SOLDER ASSEMBLY AND CRIMP DETAILS.
3. BAG ITEMS 2, 3, 16, 20 AND 24 IN INDIVIDUAL BAGS. ALSO, BAG A 1.5" PIECE OF SHRINK TUBING (ITEM 23). LABEL EACH BAG WITH APPROPRIATE PART NUMBER AND QUANTITY. PLACE THESE BAGS INTO A SINGLE BAG AND SEAL.
4. ADD SMALL PIECES OF SHRINK TUBING, (ITEM 21) OR TIE WRAPS, (002-0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
5. VERIFY O-RING ON BURTON CONNECTOR, ITEM 1, IS INSTALLED BEFORE MATING WITH HOUSING, ITEM 7.
6. CRIMP AND SOLDER LUG TO WIRE PER IPC-A-620 SPECIFICATION.



PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED.
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

NEXT ASSEMBLY: 199-0308-1

	SIGNATURE	DATE
DRAWN	SLW	7/10/08
DESIGNED	SLW	7/10/08
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

PROJECT T4

TITLE HARNESS, SLAVE ARM, 8-PIN, 15 SHELL, WITH SAFETY GROUND

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101-6927	C	1 OF 1	D

Harness, 8-Pin, Burton,101-6928

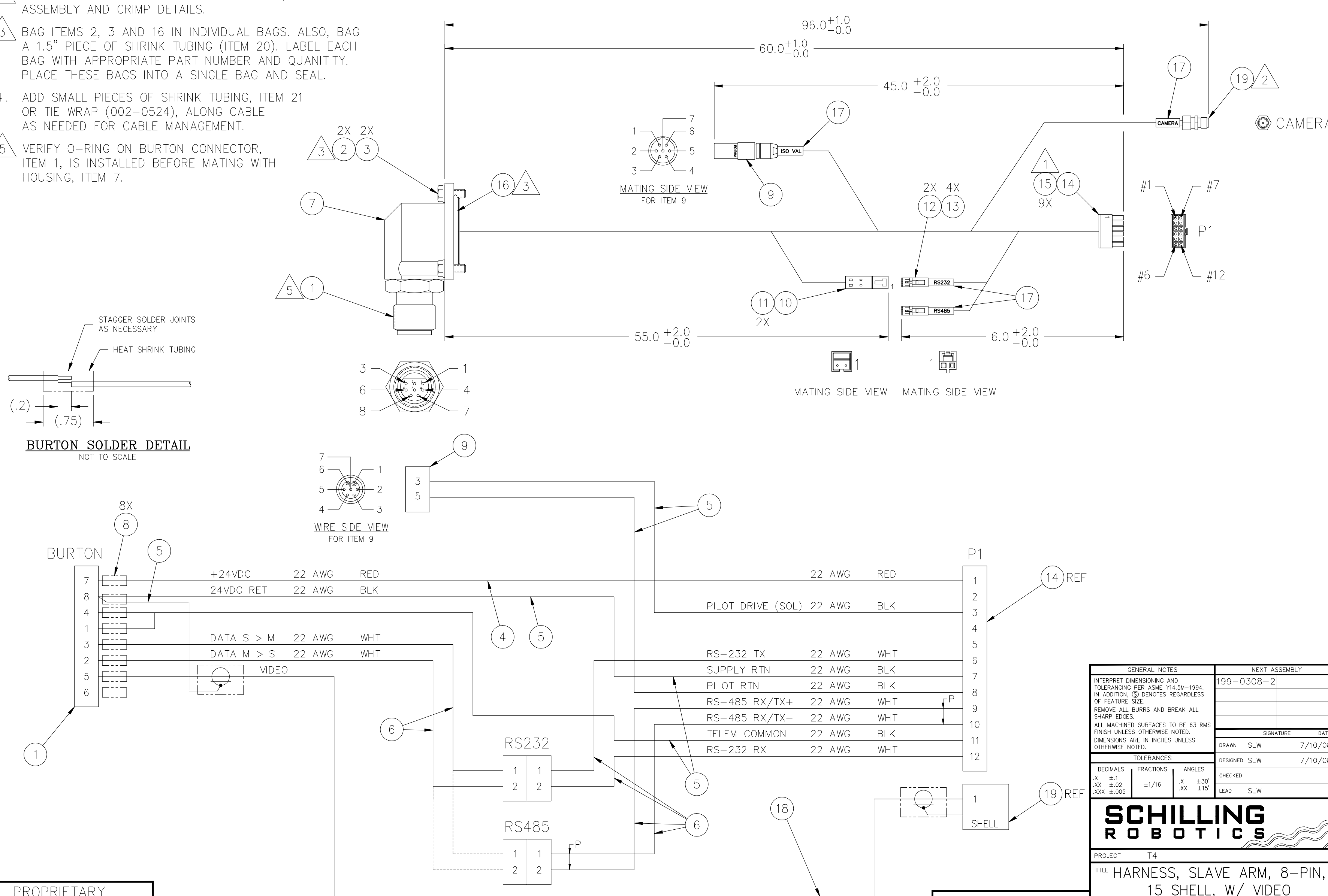
Rev. C

Item	P/N	Description	Qty
1	005-3244	CONN,8 PIN,15 SHELL,BURTON,BHD	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	18
6	005-2788	WIRE,22 AWG,STRANDED,WHT	12
7	001-7521	HSG,CONN,BURTON 15 SHELL,UA,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	3
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
20	005-1706	TBG,SHRINK,3/8 WHT	.13
100	101-6928-WI	WORK INSTRUCTIONS	0

NOTES:

1. (△1) CRIMP AND SOLDER USING MOLEX CRIMPING TOOL, P/N 1825432.
2. (△2) SEE SPEC SHEET FOR 005-4468 FOR STRIP, SOLDER ASSEMBLY AND CRIMP DETAILS.
3. (△3) BAG ITEMS 2, 3 AND 16 IN INDIVIDUAL BAGS. ALSO, BAG A 1.5" PIECE OF SHRINK TUBING (ITEM 20). LABEL EACH BAG WITH APPROPRIATE PART NUMBER AND QUANITITY. PLACE THESE BAGS INTO A SINGLE BAG AND SEAL.
4. ADD SMALL PIECES OF SHRINK TUBING, ITEM 21 OR TIE WRAP (002-0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
5. (△5) VERIFY O-RING ON BURTON CONNECTOR, ITEM 1, IS INSTALLED BEFORE MATING WITH HOUSING, ITEM 7.

REV	ZONE	DESCRIPTION	DATE	BY	APPR
A	–	RELEASED FOR PRODUCTION	7/22/08	NLH	SLW
B	–	ADDED TELEM COMM TO PINS 1 & 4	7/24/08	RDJ	SLW



GENERAL NOTES	NEXT ASSEMBLY
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES. ALL MACHINED SURFACES TO BE 63 RMS FINISH UNLESS OTHERWISE NOTED. DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.	199-0308-2

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±30' .XX ±15'

	SIGNATURE	DATE
DRAWN	SLW	7/10/08
DESIGNED	SLW	7/10/08
CHECKED		
LEAD	SLW	

SCHILLING ROBOTICS

PROJECT T4

TITLE HARNESS, SLAVE ARM, 8-PIN, 15 SHELL, W/ VIDEO

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101-6928	C	1 OF 1	B

RELEASED FOR PRODUCTION

Cable, SeaNet, Gen 3, 101-7230 (Generic)

NOTE: *Cable supplied in various lengths (see drawing variance table).*

Rev. B

Item	P/N	Description	Qty
1	001-11937	HSG, MACHINED SEANET,GEN3	2
2	001-10834	MOLDED CAP,SEANET,W/2 CSK HOLE	2
3	906-0053	MOLDED,BAIL,SEANET,LATCHING	2
4	906-0054	MOLDED,LATCH,SEANET,LATCHING	4
5	001-10836	POPPET,SEANET,0.228 VALVE	2
6	002-5084	SPRING,COMP,LEE,LC-020CD-01S	2
7	101-7702	PCA,ASSY,SEANET GEN 3	2
8	002-0358	SHCS,4-40X.18,SS	4
9	002-4889	SCREW,FILLISTER,6-32x3/8,18-8	12
10	004-0098	O-RING,2-030 BUNA 70	2
11	004-0020	O-RING,2-028 BUNA 70	2
12	004-0102	O-RING,2-009 BUNA 70	2
13	004-0046	O-RING,2-127 BUNA 70	2
14	001-9193	FERRULE,TUBG,1/4,SEANET,LATCH	2
15	006-2534	HOSE,1/4IDX3/8OD,.022NY/85POLY	6.8
16	005-2453	WIRE,18 AWG,RED,TEFZEL	7.2
17	005-4885	WIRE,18 AWG,BLK,TEFZEL	7.2
18	005-4886	WIRE,22 AWG,GRN/YEL,TEFZEL	7.2
19	005-5390-2.2	CABLE,COAX,IPX,2.2M	4
20	002-3538	LABEL,SHRINK,0.500" KROY	0
21	002-5134	PIN,GROOVED,3/32X.75,L/4,316SS	4
22	002-5135	PIN,GROOVED,1/16X.75,L/5,316SS	4
30	010-1103	TOOL,INSTL,FERRULE TBG,SEANET	0
35	010-1536	FIXTURE,POPPET,PCB,SEANET	0
1000	101-7230-WI	WORK INSTRUCTIONS	0

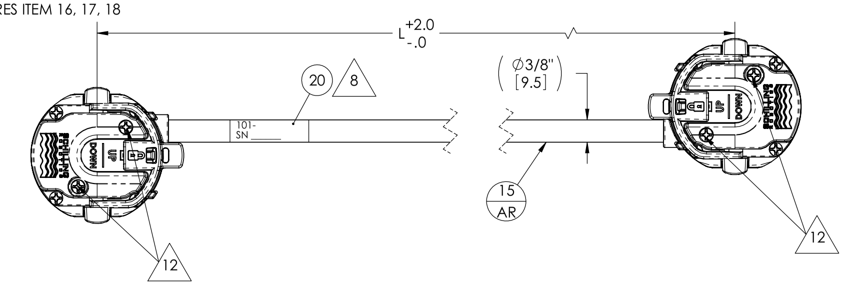
NOTES:

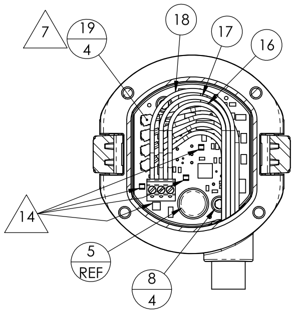
1. NOTE DELETED
2. NOTE DELETED
3. NOTE DELETED
4. INSTALL TUBING THRU HOUSING, ITEM 1; APPLY 0-RING LUBE AS NEEDED FOR EASE OF INSTALL; INSTALL FERRULE, ITEM 14, INTO END OF TUBE USING TOOL, ITEM 30; CLEAN OUTSIDE DIAMETER OF TUBE AND MATING SURFACE OF HOUSING WITH ALCOHOL; PULL TUBING AND FERRULE BACK THRU HOUSING TO SEAT FERRULE; KEEP PULLING TUBING UNTIL IT IS OUT OF THE WAY OF THE PCB; HOUSING AND HOSE SHOULD NOT SPIN INDEPENDENTLY.
5. PRESS SPRING, ITEM 6, OVER END OF POPPET, ITEM 5, AFTER INSTALLED THRU PCA, ITEM 7.
6. SHIELDS ARE GROUNDED TOGETHER ON PC BOARD.
7. OUTSIDE OF COAX CABLES, ITEM 19, IS THE SHIELD, SO IT IS ACCEPTABLE FOR THEM TO TOUCH.
8. PRINT PART NUMBER, BOM REVISION AND SERIAL NUMBER USING ITEM 20; CLEAN SURFACE WITH ALCOHOL PRIOR TO INSTALLING LABEL.
9. ANY CHANGES TO THIS DRAWING MUST BE REVIEWED FOR THEIR IMPACT ON COTS DEVICES USING SEANET PENETRATORS, AND REFLECTED IN THE SEANET INTERFACE REQUIREMENT COT DRAWING 130-0170.
10. ROUTING OF COAX CABLE, ITEM 19, MUST NOT BE DIRECTLY OVER POPPET VALVE, ITEM 5. SEE VIEWS FOR COAX ROUTING.
11. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
8	15 INCH OZ.
9	4 INCH LBS.

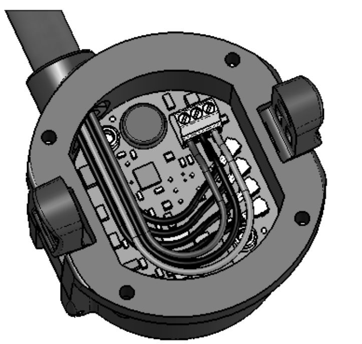
12. TORQUE BLEED SCREWS TO 7 INCH LBS IN INITIAL ASSEMBLY THEN BACK OFF AND RE-TORQUE TO 4 INCH LBS.
13. DO NOT TIN ENDS OF WIRES ITEM 16, 17, AND 18.
14. ROUTING OF COAX CABLE, ITEM 19, AND WIRES ITEM 16, 17, 18 MUST NOT COVER LEDS ON PCA.

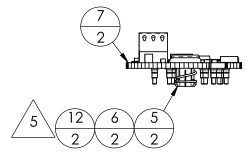
PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
0630	0	-	RELEASED FOR PROTOTYPE	11/16/09	PK	DFM
0876	1	-	REVISED ITEM 8 TORQUE, ADDED -2.0, -6.0, AND -7.5 VARIANCES	2/1/10	CRL	DFM
1617	2	-	WAS ACAD DRAWING; UPDATED DELTA NOTE 8	9/1/10	RDJ	DFM
1932	A	-	RELEASED FOR PRODUCTION; ADDED NOTE 13 AND NOTE 14 TO DRAWING.	12/14/10	JB	DFM
3474	B	-	ADDED -4.5 VARIANCE TO TABLE	9/30/11	PK	AAP
3594	C	-	DELETED NOTE 2 TO ANNEAL BAIL	10/17/11	SWR	KM



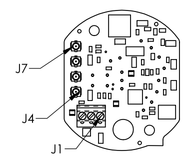


SECTION B-B
SCALE 1 : 1

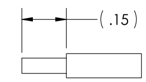




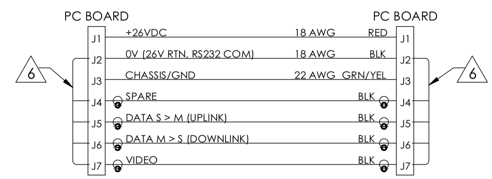
POPPET INSTALL DETAIL
SCALE 1:1

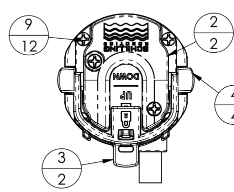


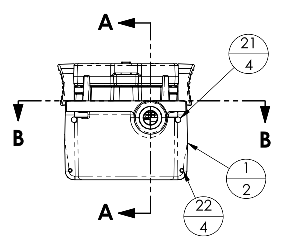
PCA DETAIL
SCALE 1:1

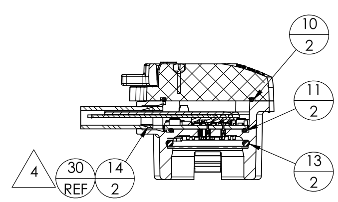


WIRE STRIP DETAIL
FOR ITEM 16, 17, 18
NOT TO SCALE

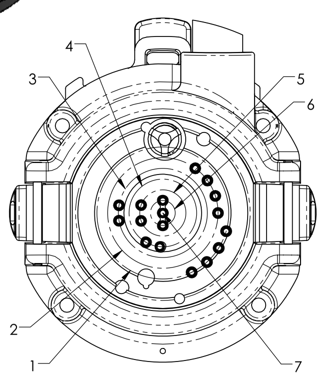




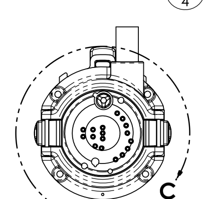




SECTION A-A



DETAIL C
SCALE 1.5 : 1



PART NUMBER	HOSE / H"	LENGTH / L"
101-7230-10.0	393 (10m)	394
101-7230-7.5	296.5 (7.5m)	297.5
101-7230-6.0	237.5 (6.0m)	238.5
101-7230-4.5	177.5 (4.5m)	178.5
101-7230-3.5	140.5 (3.5m)	141.5
101-7230-2.0	81.5 (2.0m)	82.5
101-7230-1.0	39.5 (1.0m)	40.5
101-7230	--	--

PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	P. KUHL	10/12/09
DESIGNED	D. MAYNE	10/12/09
CHECKED		
LEAD	D. MAYNE	

SCHILLING ROBOTICS

PROJECT: UHD2

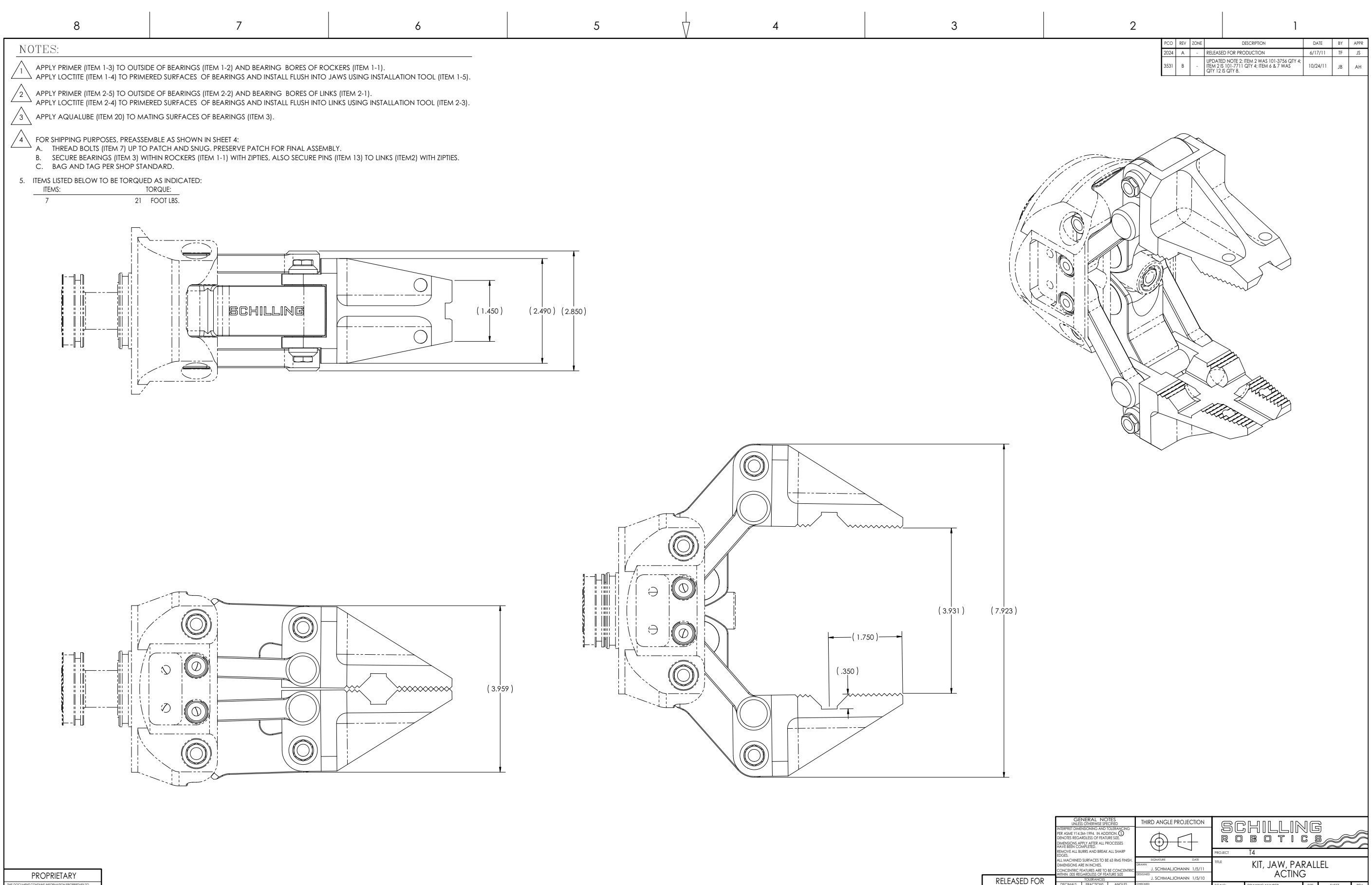
TITLE: CABLE ASSEMBLY, SEANET, GEN3

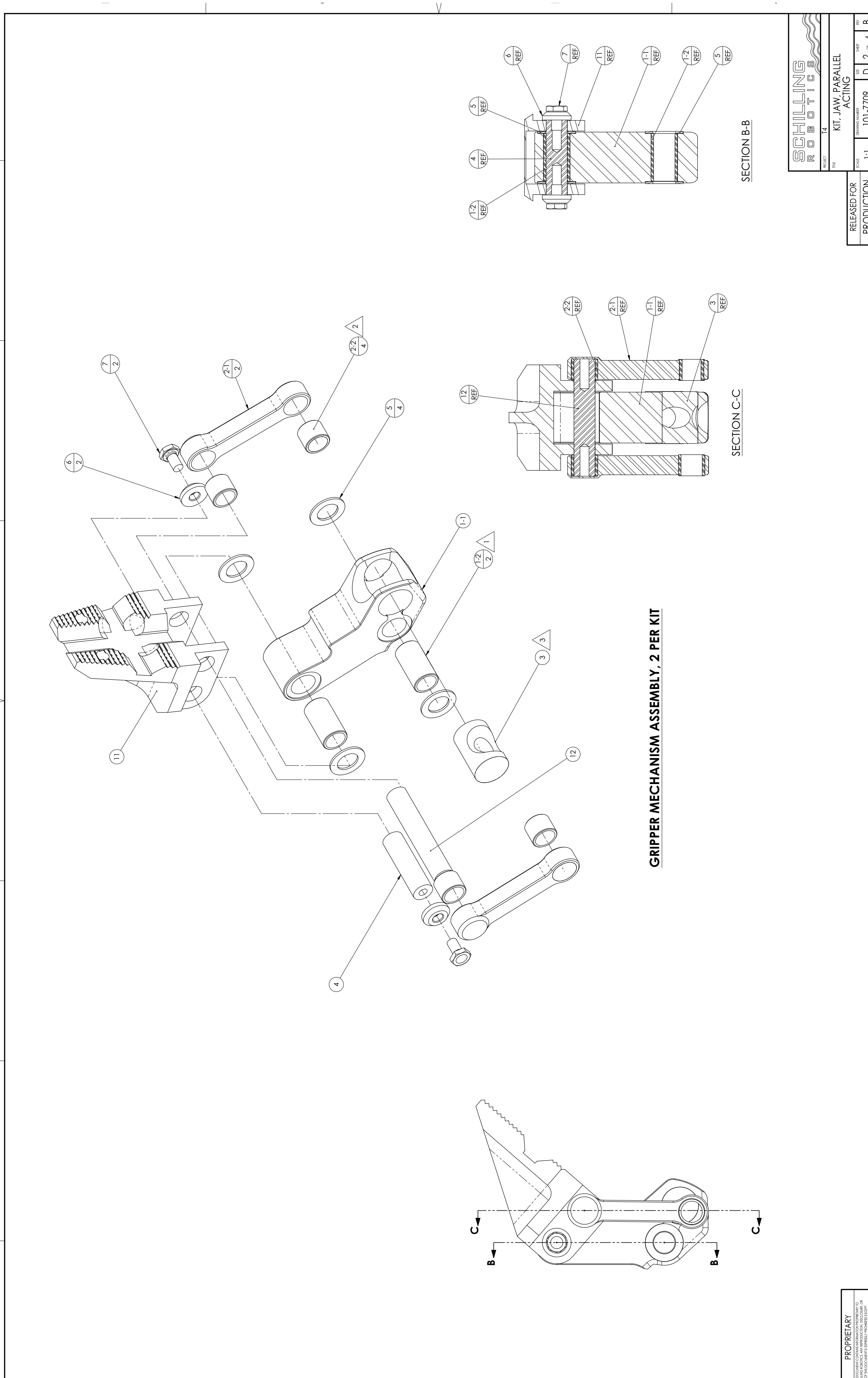
SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1.5	101-7230	C	1 OF 1	C

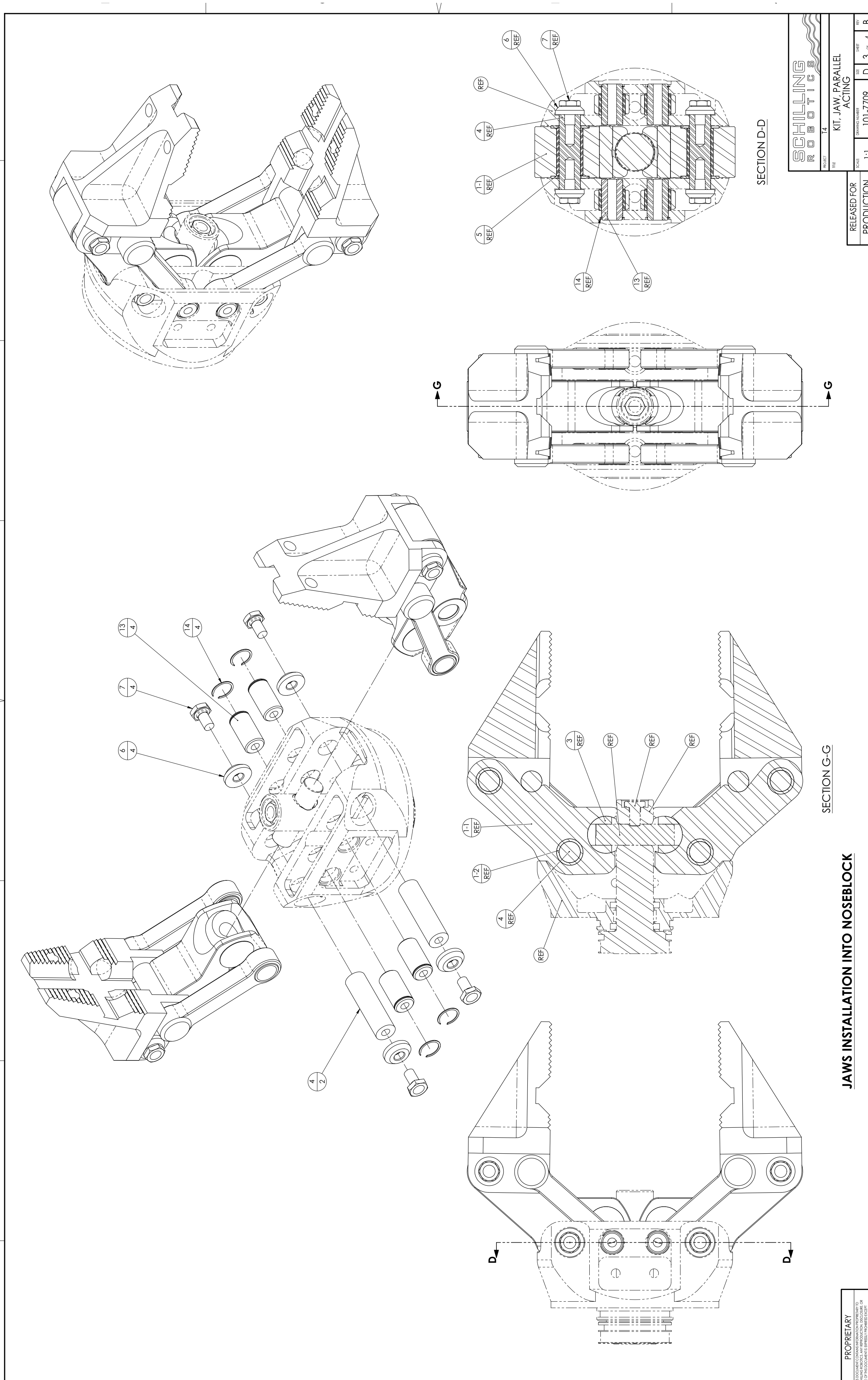
Jaw Kit, Parallel Acting, 101-7709

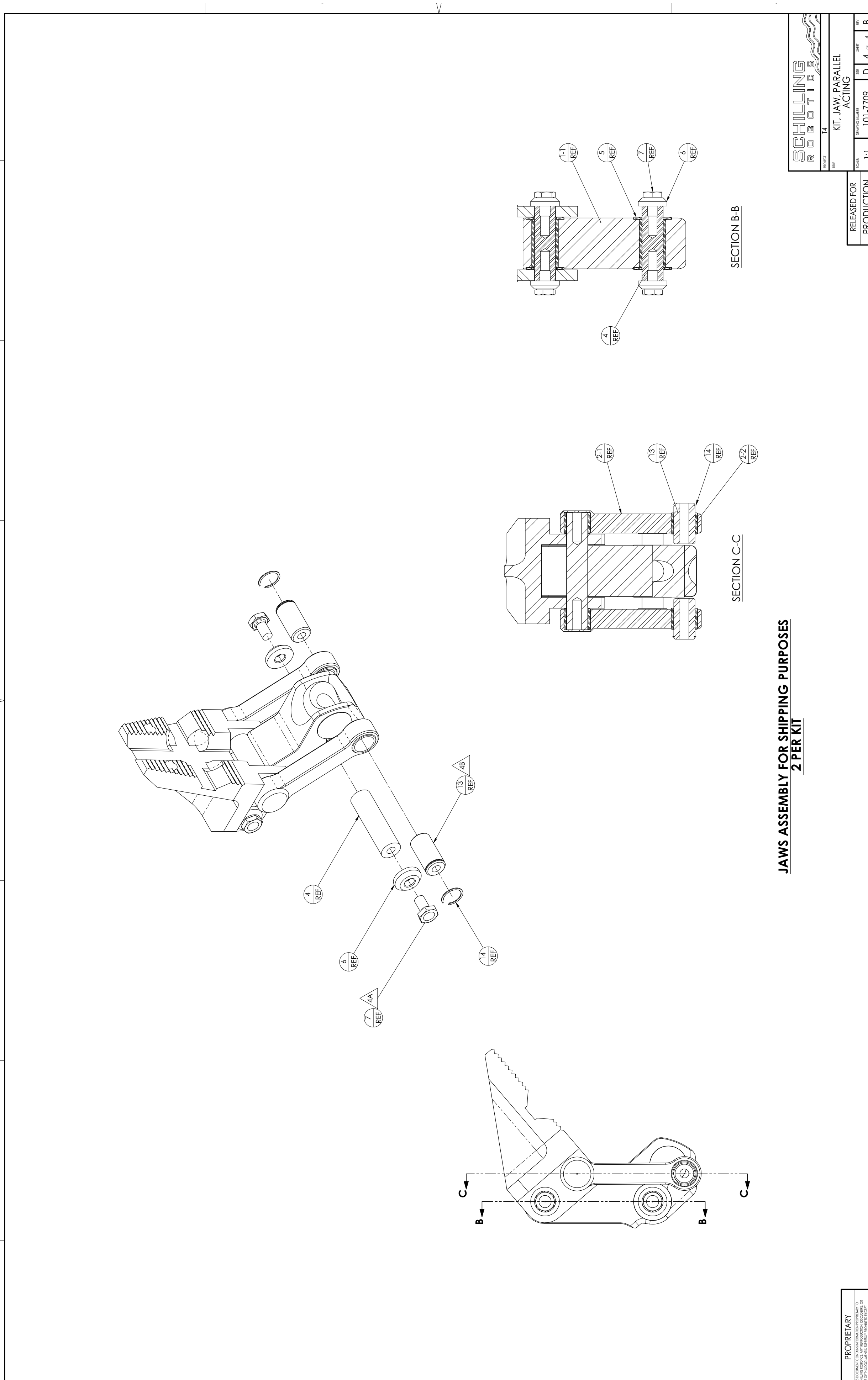
Rev. B

Item	P/N	Description	Qty
1	101-7710	ROCKER W/ BEARINGS,PA JAW	2
2	101-7711	LINK ASSY,PA,3.9IN/10CM	4
3	001-9835	BEARING,JAW ACTUATOR,T4	2
4	001-1840	PIN,.5X2.0,JAW,T2	4
5	001-10899	WASHER,JAWS,ORKOT,T4	8
6	001-2071	WSHR,T2 JAW	8
7	002-0038P	NAS 6404PU1,NLK	8
11	001-7196	JAW,PA,.75-1.00 CROSSBAR,T4	2
12	001-1841	PIN,.5X3.0,JAW,T2	2
13	001-2062	PIN,.5X1.0,JAW,T2	4
14	002-0710	RING,RETING,EXTERNAL,SMALLEY #	4
20	002-0805	LUBE,AQUA SHIELD, 8 OZ	0




GRIPPER MECHANISM ASSEMBLY, 2 PER KIT
SECTION B-B
SECTION C-C
SCHILLING ROBOTICS
KIT, JAW, PARALLEL ACTING
101-7709
1:1
D
2 of 4
B
RELEASED FOR PRODUCTION
PROPRIETARY


SCHILLING ROBOTICS
T4
KIT, JAW, PARALLEL ACTING
101-7709
D
3 of 4
B
1:1
RELEASED FOR PRODUCTION
SECTION D-D
SECTION G-G
JAWS INSTALLATION INTO NOSEBLOCK
PROPRIETARY


SCHILLING ROBOTICS
T4
KIT, JAW, PARALLEL ACTING
101-7709
1:1
D
4 of 4
B
RELEASED FOR PRODUCTION
SECTION B-B
SECTION C-C
JAWS ASSEMBLY FOR SHIPPING PURPOSES
2 PER KIT
PROPRIETARY

Camera, T4 Wrist, PAL, 5Km, 101-8188-1

Rev. C

Item	P/N	Description	Qty
1	007-0675	HOUSING,CAMERA,WIRST,T4	1
2	001-7684	BEZEL,WRIST CAMERA,T4	1
4	002-1112P	NAS 6403PU1,NLK	4
5	004-0832	O-RING,2-026,BUNA 70	3
7	004-0043	O-RING,2-033 BUNA 70	1
8	001-9110	WINDOW,36mmX8mm,SAPHIRE	3
9	005-5376	CAMERA,COLOR BULLET PAL	1
10	101-6006	ASSY,PCB WRIST CAM LED BOARD	2
11	005-5411	EPOXY,OPT CLEAR HIGH IMPACT	0
12	101-6005	ASSY,PCB CAMERA BOARD	1
20	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.13
21	002-3256	SHCS,4-48 X 1/4, ALLOY	2
22	004-0695	O-RING,2-021,BUNA 70	2
24	005-3087	WIRE,26AWG,STRD,TEFZEL,600,RED	2.3
25	005-2154	WIRE,26AWG,19/38 TEFZEL 600V	2.3
26	002-3292	FOAM STRIP,3/8 THICK	.3
27	001-7886	DIFFUSER,CAMERA LIGHT	2
28	005-3092	WIRE,26AWG,STRD,TEFZEL,600,YEL	.8
30	005-5980	DESICCANT,MOIST ABSORB BOARD	0
40	010-1958	SHIPPING PLATE, WRIST CAMERA	1
41	002-0333P	NAS 6404PU14,NLK	4
42	002-0038P	NAS 6404PU1,NLK	4
43	004-0139	O-RING,2-040 BUNA 70	1

Camera, T4 Wrist, NTSC, 5Km, 101-8188-2

Rev. B

Item	P/N	Description	Qty
1	007-0675	HOUSING,CAMERA,WIRST,T4	1
2	001-7684	BEZEL,WRIST CAMERA,T4	1
4	002-1112P	NAS 6403PU1,NLK	4
5	004-0832	O-RING,2-026,BUNA 70	3
7	004-0043	O-RING,2-033 BUNA 70	1
8	001-9110	WINDOW,36mmX8mm,SAPHIRE	3
9	005-5375	CAMERA,COLOR BULLET NTSC	1
10	101-6006	ASSY,PCB WRIST CAM LED BOARD	2
11	005-5411	EPOXY,OPT CLEAR HIGH IMPACT	1
12	101-6005	ASSY,PCB CAMERA BOARD	1
20	005-0654	TBG,SHRINK,3/64,BLK,BRIM # SH1	.13
21	002-3256	SHCS,4-48 X 1/4, ALLOY	2
22	004-0695	O-RING,2-021,BUNA 70	2
24	005-3087	WIRE,26AWG,STRD,TEFZEL,600,RED	2.3
25	005-2154	WIRE,26AWG,19/38 TEFZEL 600V	2.3
26	002-3292	FOAM STRIP,3/8 THICK	.3
27	001-7886	DIFFUSER,CAMERA LIGHT	2
28	005-3092	WIRE,26AWG,STRD,TEFZEL,600,YEL	.8
30	005-5980	DESICCANT,MOIST ABSORB BOARD	0
40	010-1958	SHIPPING PLATE, WRIST CAMERA	1
41	002-0333P	NAS 6404PU14,NLK	4
42	002-0038P	NAS 6404PU1,NLK	4
43	004-0139	O-RING,2-040 BUNA 70	1

NOTES:

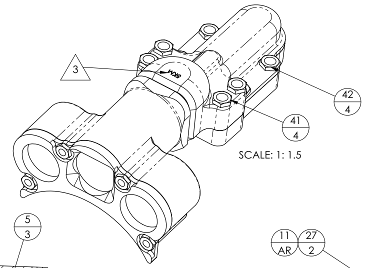
1. ITEMS LISTED BELOW TO BE TORQUED AS INDICATED:

ITEMS:	TORQUE:
4	10 FOOT LBS.
21, 41, 42	8 INCH LBS.

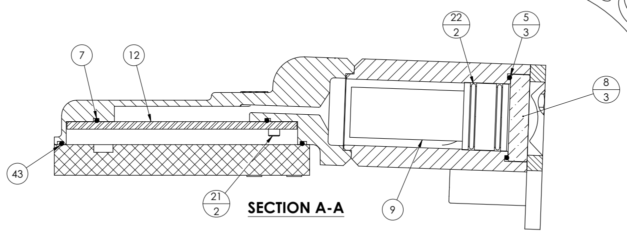
2. ETCH OR ENGRAVE THE SERIAL NUMBER, PART NUMBER, AND BOM REVISION IN THE LOCATION SHOWN AS DESCRIBED IN THE WORK INSTRUCTION.

3. LASER ETCH "5KM" IN LOCATION SHOWN AS DESCRIBED IN THE WORK INSTRUCTION.

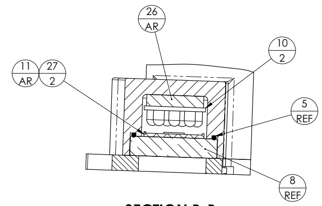
PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
3660	A	-	RELEASED FOR PRODUCTION	10/28/11	JB	TR
3669	B	-	ADDED ITEMS; 40,41,42, AND 43, UPDATED TORQUE TABLE WITH ITEMS 41 AND 42	11/23/11	NLH	TR



SCALE: 1: 1.5

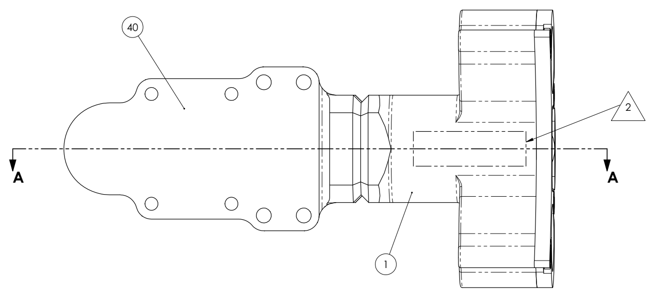


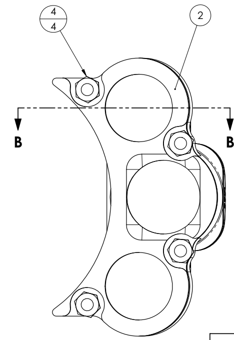
SECTION A-A



SECTION B-B

2 PLACES





PART NO.	VARIANCE
101-8188-1	PAL
101-8188-2	NTSC

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, S DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

SIGNATURE		DATE
DRAWN	J. BENTANCOURT	10/28/11
DESIGNED	T. RANSTROM	10/27/11
CHECKED		
LEAD	T. RANSTROM	

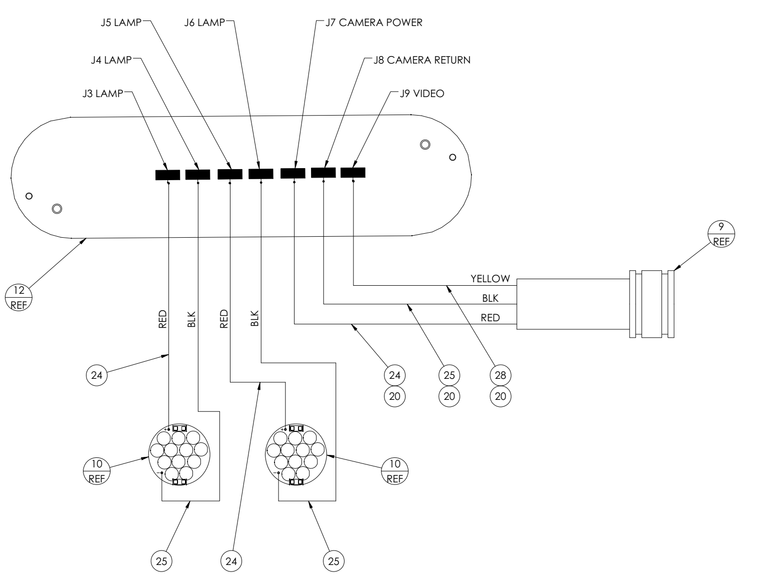
SCHILLING ROBOTICS

PROJECT T4

TITLE CAMERA, T4 WRIST, 5KM

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1	101-8188	C	1 OF 2	B

RELEASED FOR LIMITED PRODUCTION



WIRING DIAGRAM

SCHILLING ROBOTICS

PROJECT T4

TITLE CAMERA, T4 WRIST, 5KM

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1:1	101-8188	C	2 OF 2	B

RELEASED FOR LIMITED PRODUCTION

Harness, T4, BTN 2008, 07P Comp, 101-8357-1

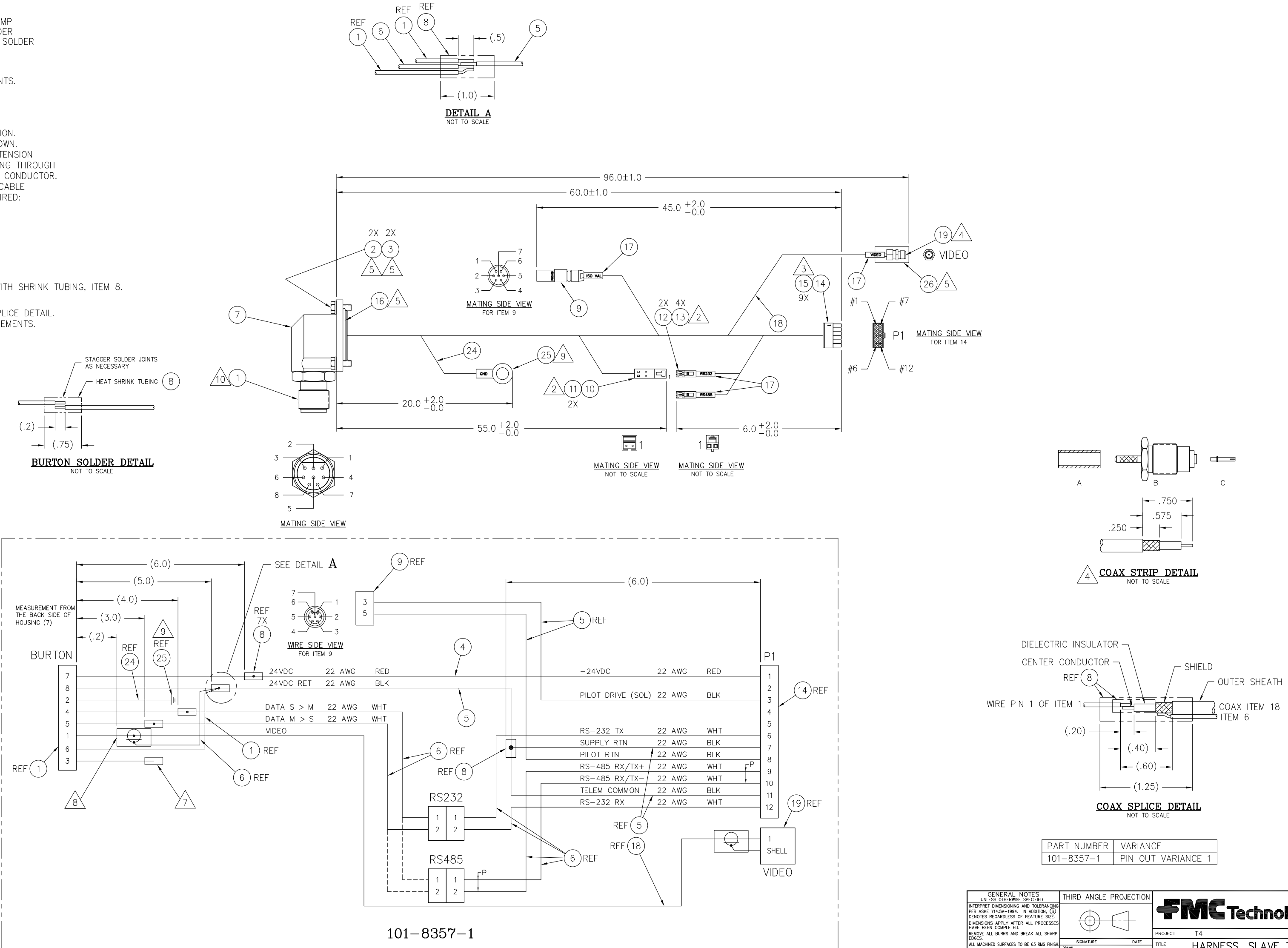
Rev. B

Item	P/N	Description	Qty
1	005-2060	CONN,8 PIN,BHD RECPT.,2 FT.	1
2	002-1048P	HHCS,10-32 X 1/2,18-8 SS,NLK	2
3	002-9026	WSHR,FLAT,M5,REG OD,316 SS	2
4	005-2789	WIRE,22 AWG,STRANDED,RED	5
5	005-2521	WIRE,22 AWG,BLK,STRD,TEFZEL	19
6	005-2788	WIRE,22 AWG,STRANDED,WHT	17.5
7	001-8853	HSG,CONN,BURTON,20SHELL,BCR,T4	1
8	005-0474	TBG,SHRINK,1/8,SURF IRRADIATED	.75
9	005-1336	CONN,7 PIN,FEM PC	1
10	005-4648	CONN,2 PIN,HSG,.1 GRID,CABLE	1
11	005-3476	TERM,MALE,SL, CRIMP,22-24 AWG	2
12	005-3749	HOUSING,RCPT,.100,2 CKT FEM	2
13	005-3474	TERM,FEM,SL,CRIMP,22-24 AWG	4
14	005-4649	CONN,12 PIN,RCPT,3MM,LATCH	1
15	005-4627	TERM,CRIMP,FEMALE,20-24AWG,3mm	9
16	004-0096	O-RING,2-029 BUNA 70	1
17	005-3155	SHRINK TBG,1/8~,WHT,PRINTABLE,	0
18	005-3486	COAX, RG178	8.5
19	005-4468	CONN.,SMA FEMALE TO RG178	1
21	005-1523	TBG,SHRINK,3/16 WHT,ALPHA #FIT	0
22	010-1527	TOOL,CRIMP,MOLEX 63811-8700	0
23	010-1739	TOOL,CRIMP,MOLEX 63819-0000	0
24	005-3485	WIRE,18 AWG, TEFZEL, GRN/YEL	2
25	005-6040	LUG,RING,22-18AWG,1/4,NO-UNSUL	1
26	005-1706	TBG,SHRINK,3/8 WHT	.1
27	101-8357-1-WI	WORK INSTRUCTION	0

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
4459	A	–	RELEASED FOR PRODUCTION	6/5/12	PK	AH

NOTES:

1. DELETED
2. (△2) CRIMP USING MOLEX CRIMP TOOL, ITEM 22. VERIFY CRIMP MEETS THE IPC–A–620, CLASS II REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620, CLASS II REQUIREMENTS.
3. (△3) CRIMP USING MOLEX CRIMPING TOOL, ITEM 23 VERIFY CRIMP MEETS IPC–A–620 CLASS II REQUIREMENTS. SOLDER THE CRIMP/WIRE AREA OF THE PIN. VERIFY THAT THE SOLDER JOINT MEETS IPC–A–620 CLASS II REQUIREMENTS.
4. (△4) REFER TO COAX STRIP DETAIL FOR ITEM 19 INSTALLATION. SLIDE FERRULE (A) OVER CABLE. STRIP CABLE AS SHOWN. TIN CENTER CONDUCTOR. FLAIR BRAID AND INSERT EXTENSION (B) UNDER BRAID WITH CENTER CONDUCTOR PROTRUDING THROUGH HOLE IN EXTENSION. SOLDER CONTACT (C) TO CENTER CONDUCTOR. SLIDE FERRULE (A) OVER BRAID AND CRIMP. INSTALL CABLE ASSEMBLY INTO BODY AND TIGHTEN. CRIMP SIZE REQUIRED: CONTACT: SOLDER, FERRULE: .100" HEX CRIMP TOOL.
5. (△5) BAG ITEMS 2, 3, 16 AND 26 PER SHOP STANDARD.
6. ADD SMALL PIECES OF SHRINK TUBING, ITEM 21 OR TIE WRAP (002–0524), ALONG CABLE AS NEEDED FOR CABLE MANAGEMENT.
7. (△7) CUT WIRE LENGTH TO 2 INCHES AND CAP WIRE END WITH SHRINK TUBING, ITEM 8.
8. (△8) SOLDER SPLICE COAX TO WIRES, ITEM 1, PER COAX SPLICE DETAIL. SOLDER JOINTS TO MEET IPC–A–620, CLASS II REQUIREMENTS.
9. (△9) CRIMP ITEM 25 TO ITEM 24 TO SHOP STANDARD.
10. (△10) TORQUE BURTON HEX TO 13.75 FT/LBS (165 IN/LBS).



PART NUMBER	VARIANCE
101–8357–1	PIN OUT VARIANCE 1

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1	±1/16	X. ±1/0°
.XX ±.02		X.X ±30'
.XXX ±.005		X.XX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	P. KUHL	6/5/12
DESIGNED	T. LOMBARDO	6/5/12
CHECKED		
LEAD	A. HOUK	

FMC Technologies

PROJECT: T4

TITLE: HARNESS, SLAVE T4 8–PIN 20–SHELL

SCALE	DRAWING NUMBER	SIZE	SHEET	REV
1=1.5	101–8357	D	1 OF 1	A

RELEASED FOR PRODUCTION

Titan 4 Manipulator System, 199-0295

Rev. 5

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-4839	CABLE ASSY,SLAVE ARM,T4 SCE	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-4882	CABLE,SEANET / CPC	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
17	101-6778	CABLE,SEANET CS-MSAJ9	1
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0383	SPR KIT,T4,STD,W/T-BAR,OCEAN	0
48	008-0384	SP KIT,T4 ENHANCED	0
51	011-8239	MAN, T4, STD	2
60	101-4928	KIT,JAW,7.8IN INTMSHG,T3/T4	1
61	101-5074	CAMERA ASSEMBLY,WRIST,NTSC,T4	1

Titan 4 Manipulator System, 199-0295PAL

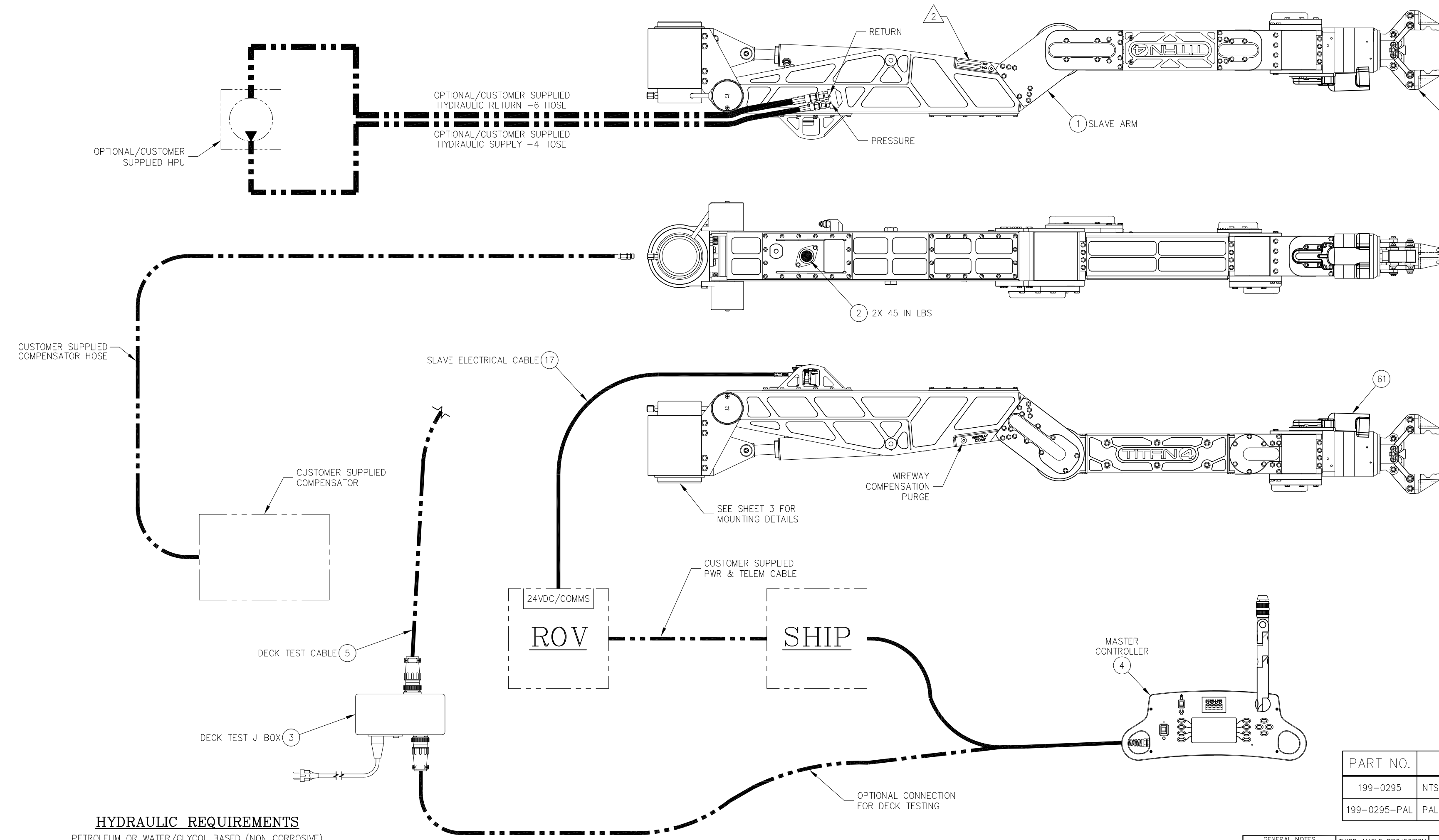
Rev. 5

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-4839	CABLE ASSY,SLAVE ARM,T4 SCE	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-4882	CABLE,SEANET / CPC	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
17	101-6778	CABLE,SEANET CS-MSAJ9	1
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0383	SPR KIT,T4,STD,W/T-BAR,OCEAN	0
48	008-0384	SP KIT,T4 ENHANCED	0
51	011-8239	MAN, T4, STD	2
60	101-4928	KIT,JAW,7.8IN INTMSHG,T3/T4	1
61	101-5074-1	CAMERA ASSEMBLY,WRIST,PAL,T4	1

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
	Ø	–	–	RELEASED FOR PROTOTYPE	4/1/08	CRL	SLW
	1	1	–	CUSTOMER SUPPLIED COMPENSATOR HOSE WAS ITEM 8, UPDATED ITEM 1	5/27/08	CRL	SLW
0819	2	1	C4	ADDED TORQUE NOTATION TO ITEM 2	2/04/11	SWR	SS
3397	3	1	D1	ADDED ITEM 6 CALLOUT	8/26/11	SWR	TR

NOTES:

1. DELETED
2. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
3. ITEMS 3, 5, 12, 19, 20, 22, 23, 24, 40, 42, 51 NOT SHOWN.



PART NO.	VARIANCE
199-0295	NTSC CAMERA
199-0295-PAL	PAL CAMERA

HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE)
HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM.
PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

RELEASED FOR PROTOTYPE

GENERAL NOTES UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
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REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1/0° X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

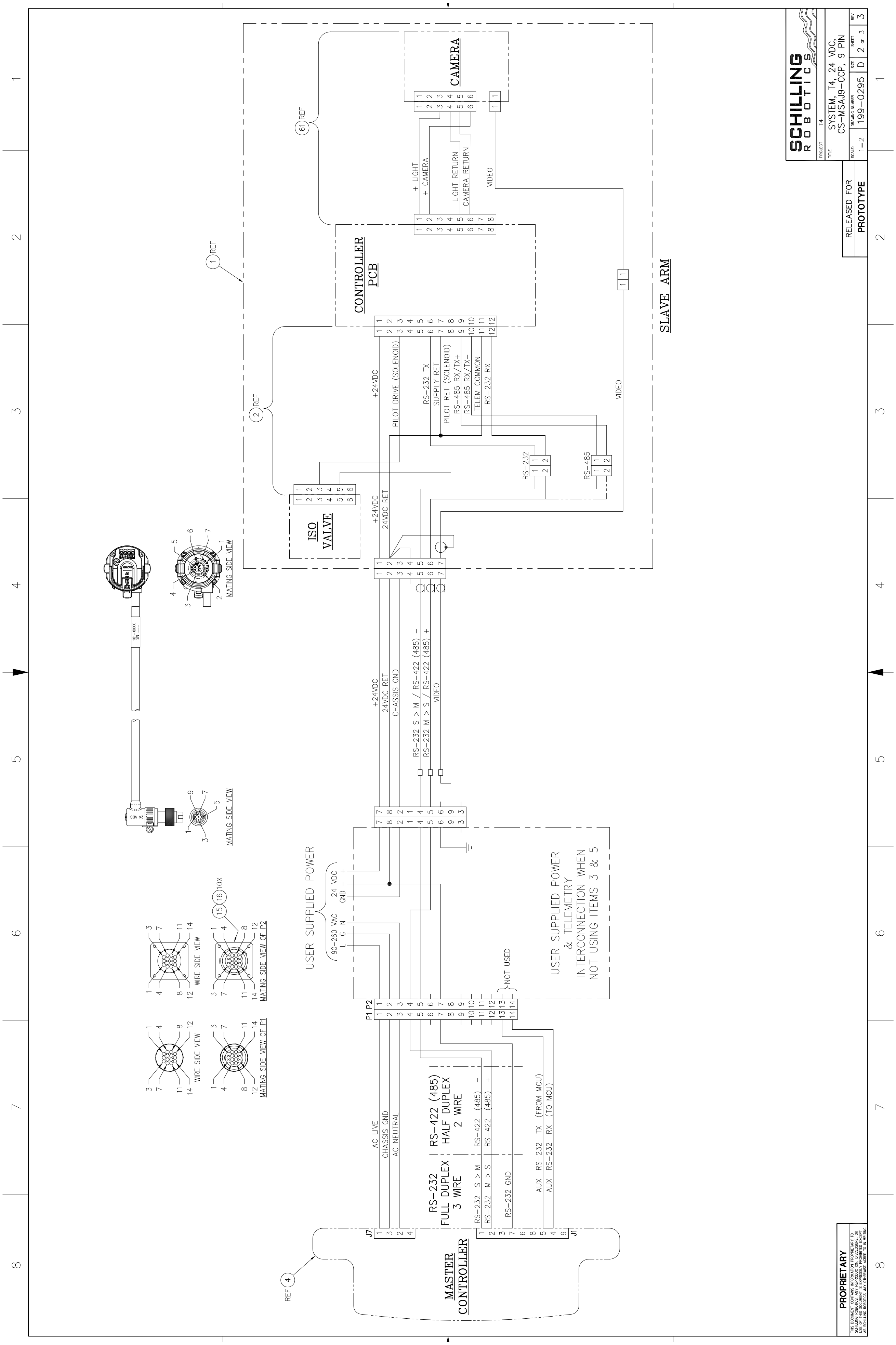
	SIGNATURE	DATE
DRAWN	S. WRIGHT	3/28/08
DESIGNED	S. WRIGHT	3/28/08
CHECKED		
LEAD	S. WRIGHT	

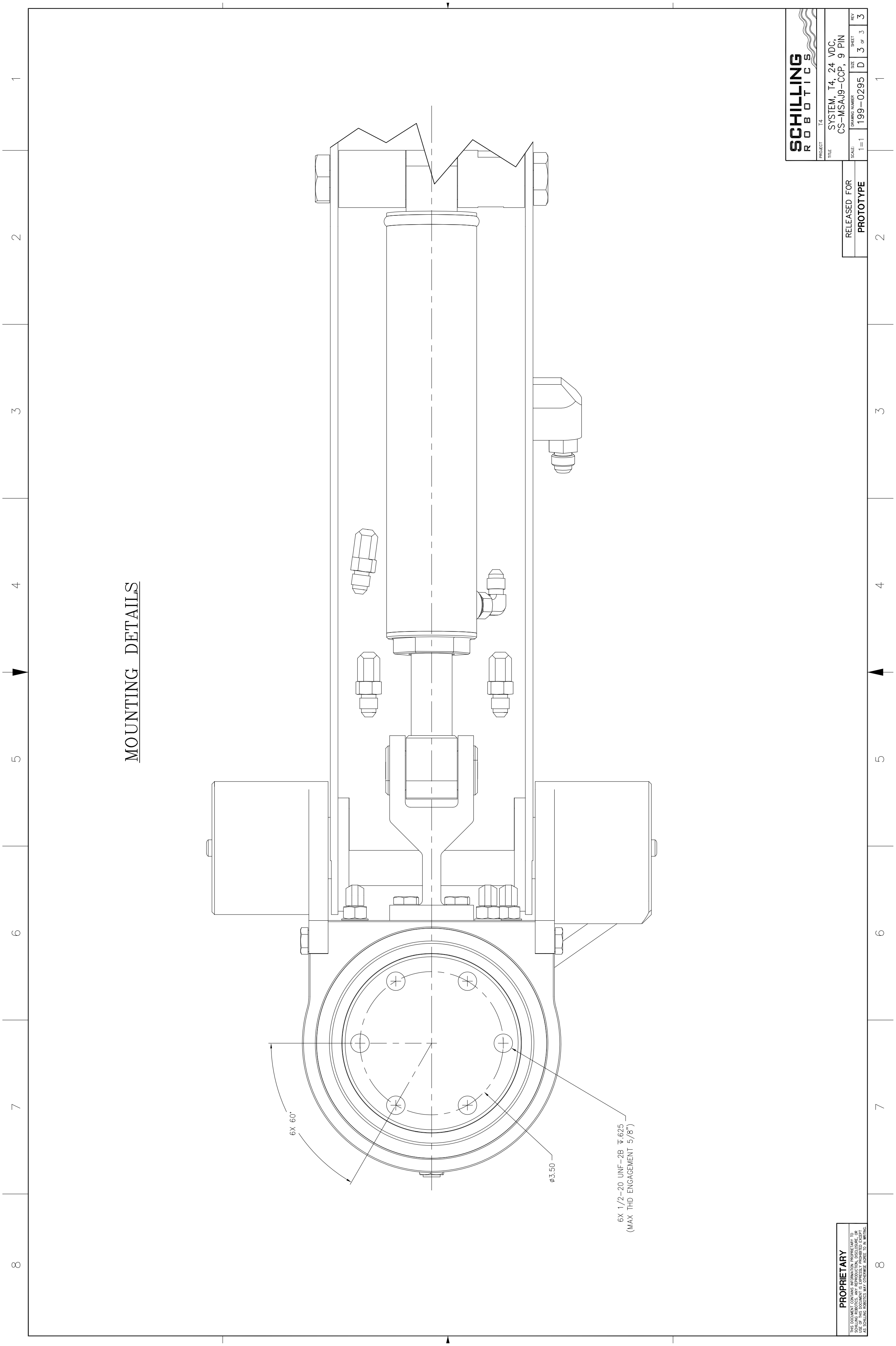
SCHILLING ROBOTICS

PROJECT: T4

TITLE: SYSTEM, T4, 24 VDC, CS-MSAJ9-CCP, 9 PIN

SCALE	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199-0295	D	1 OF 3	3


SCHILLING ROBOTICS
SYSTEM, T4, 24 VDC, CS-MSAJ9-CCP, 9 PIN
199-0295
RELEASED FOR PROTOTYPE
PROPRIETARY
CAMERA
CONTROLLER PCB
SLAVE ARM
ISO VALVE
USER SUPPLIED POWER
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
MASTER CONTROLLER
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
MATING SIDE VIEW
WIRE SIDE VIEW
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2


MOUNTING DETAILS
6X 60°
ø3.50
6X 1/2-20 UNF-2B ▽.625
(MAX THD ENGAGEMENT 5/8")
SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24 VDC,
CS-MSAJ9-CCP, 9 PIN
SCALE 1=1
DRAWING NUMBER 199-0295
SIZE D
SHEET 3 of 3
REV 3
RELEASED FOR
PROTOTYPE
PROPRIETARY
1 2 3 4 5 6 7 8

Titan 4 Manipulator System, 199-0296

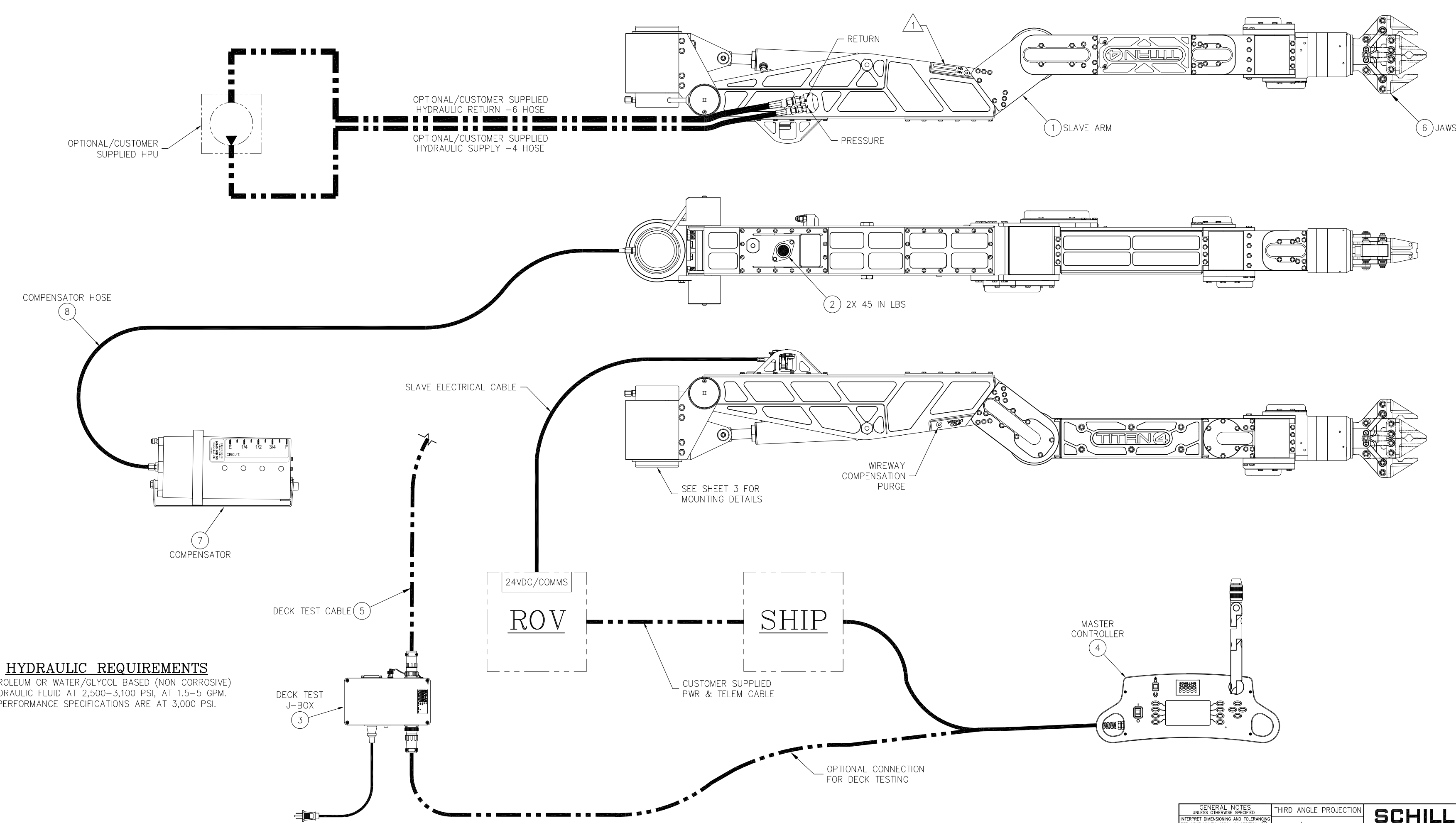
Rev. 4

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-4839	CABLE ASSY,SLAVE ARM,T4 SCE	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-4882	CABLE,SEANET / CPC	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0324	SP KIT,T4,ENHANCED	0
51	011-8239	MAN, T4, STD	2

NOTES:

1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12, 19, 20, 22, 23, 24, 40, 42, AND 51 NOT SHOWN.

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	–	RELEASED FOR PROTOTYPE	6/11/08	CRL	SLW
0819	1	1	C4	ADDED TORQUE NOTATION TO ITEM 2	2/04/11	SWR	SS
3397	2	1	D1	ADDED ITEM 6 CALLOUT	8/26/11	SWR	TR



HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM. PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

PROPRIETARY

RELEASED FOR **PROTOTYPE**

GENERAL NOTES UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
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ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES		
DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1/2° .XX ±30' .XXX ±15'

THIRD ANGLE PROJECTION

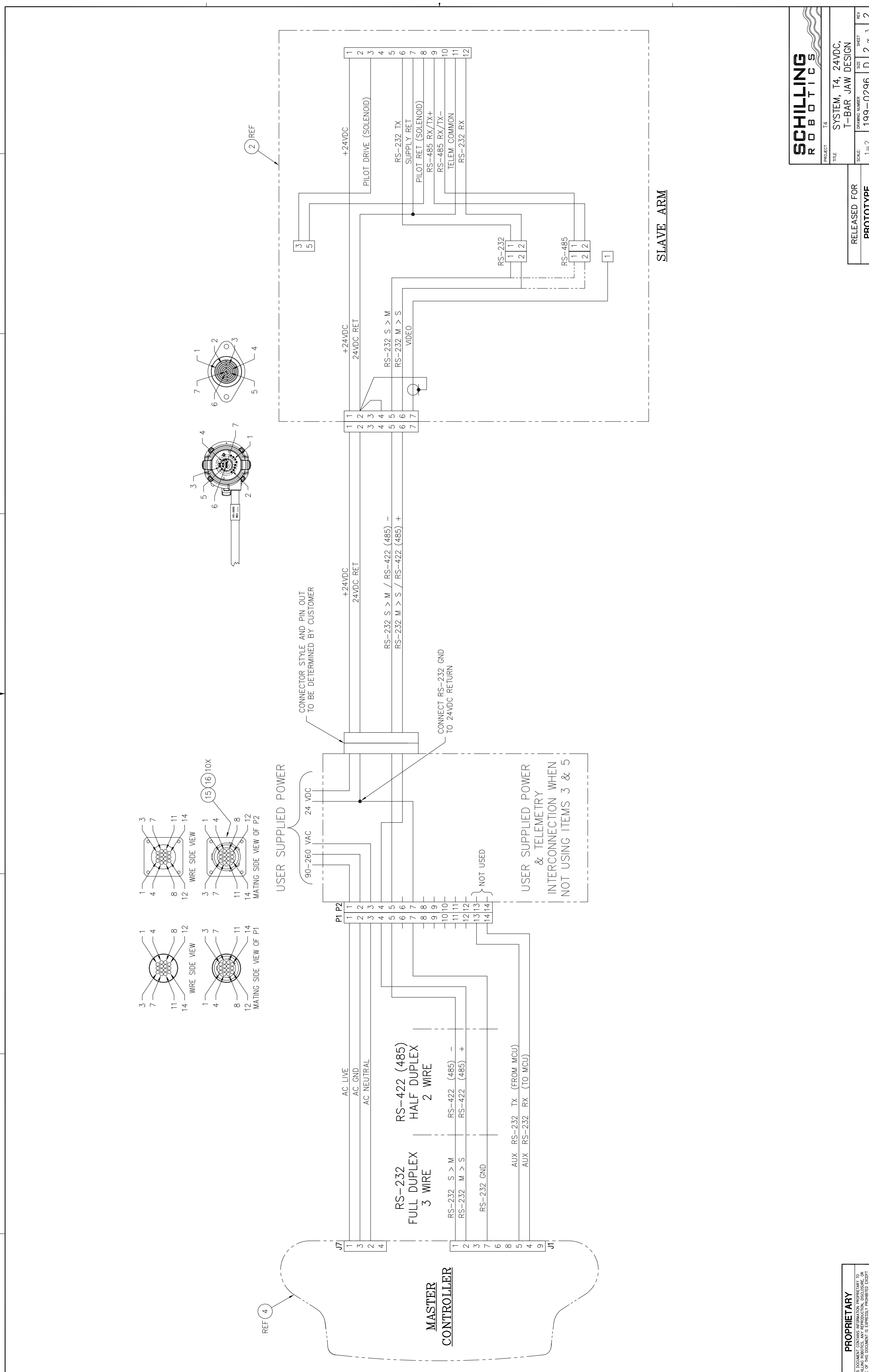
	SIGNATURE	DATE
DRAWN	C. LEIVA	6/11/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

PROJECT: T4

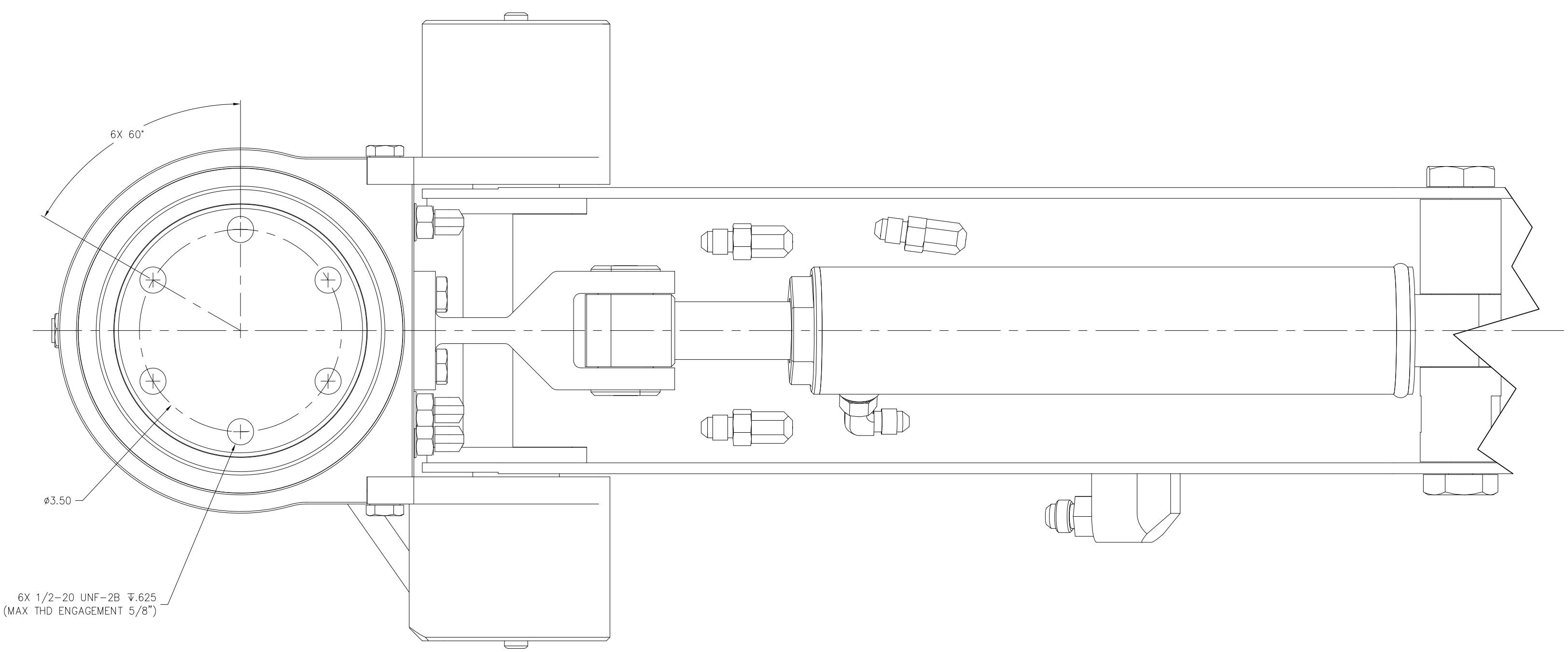
TITLE: SYSTEM, T4, 24VDC, T-BAR JAW DESIGN

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199-0296	D	1 of 3	2



SCHILLING ROBOTICS
SYSTEM, T4, 24VDC, T-BAR JAW DESIGN
199-0296
RELEASED FOR PROTOTYPE
SLAVE ARM
MASTER CONTROLLER
USER SUPPLIED POWER
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
CONNECTOR STYLE AND PIN OUT TO BE DETERMINED BY CUSTOMER
CONNECT RS-232 GND TO 24VDC RETURN
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
PROPRIETARY

MOUNTING DETAILS



RELEASED FOR PROTOTYPE

SCHILLING ROBOTICS	
PROJECT	T4
TITLE	SYSTEM, T4, 24VDC, T-BAR JAW DESIGN
SCALE	1=1
DRAWING NUMBER	199-0296
SIZE	D
SHEET	3 of 3
REV	2

Titan 4 Manipulator System, 199-0299

Rev. 5

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-5082	HARNESS,SA,T4/CAMERA,TECHNIP	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-5083	CA ASSY,DECKTEST,T4,TECHNIP	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0324	SP KIT,T4,ENHANCED	0
51	011-8212	MNL,T4,STD	2

Titan 4 manipulator System, 199-0299-1

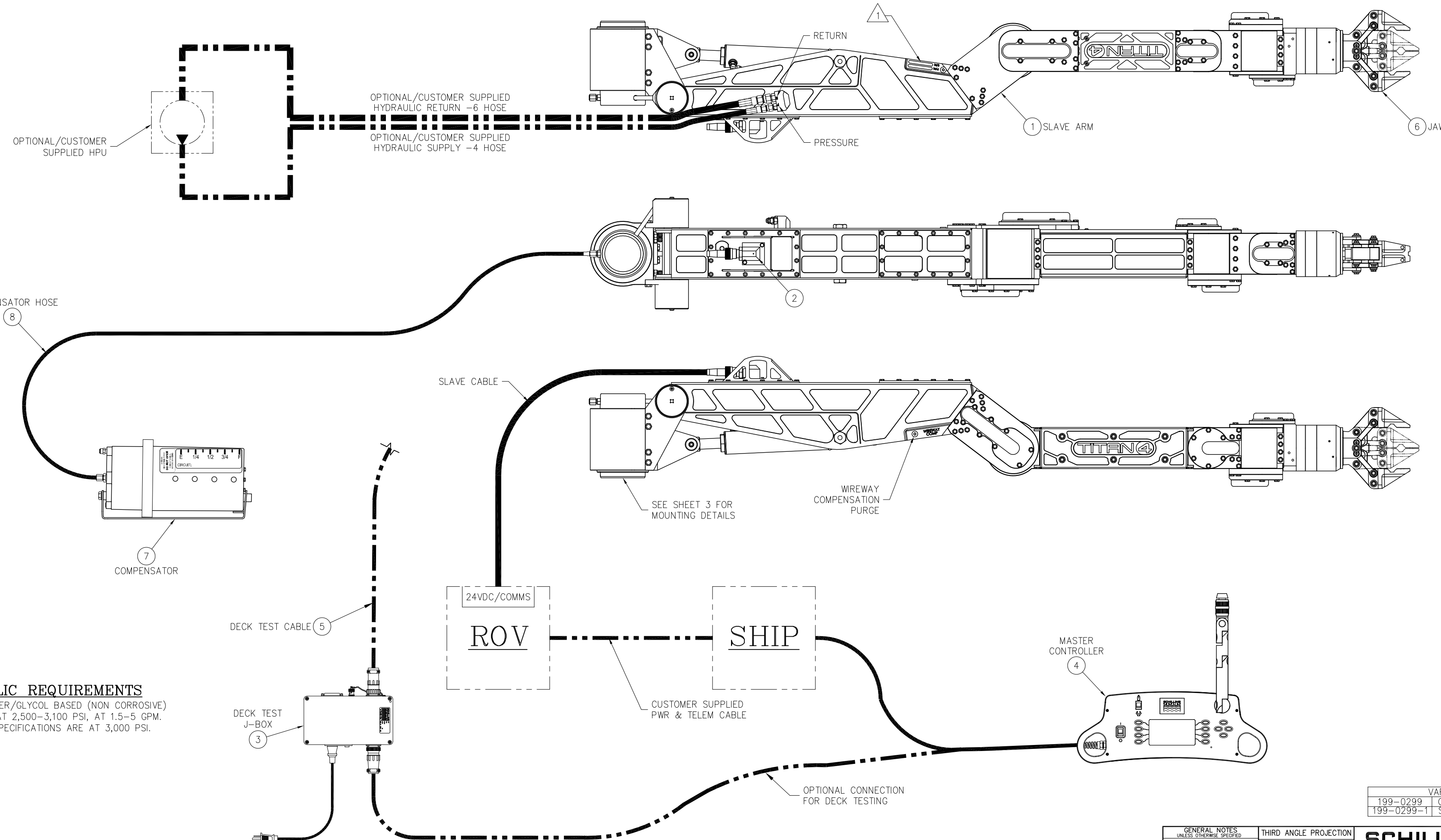
Rev. 1

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-5082-1	HARNESS,SA,T4/CAMERA,TECHNIP	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-5083	CA ASSY,DECKTEST,T4,TECHNIP	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0324	SP KIT,T4,ENHANCED	0
51	011-8239	MAN, T4, STD	2

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	RELEASED FOR PROTOTYPE	6/11/08	CRL	SLW
3397	1	C1	ADDED ITEM 6 CALLOUT	8/26/11	SWR	TR
3982	2	–	ADDED –1 VARIANCE	1/19/12	NLH	TR

NOTES:

1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12, 19, 20, 22, 23, 24, 40, 42, AND 51 NOT SHOWN.



HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM.
PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

VARIANCE	
199–0299	CUSTOMER CAMERA
199–0299–1	SCHILLING CAMERA

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES

DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	.X ±1/2° .XX ±30' .XXX ±15'

THIRD ANGLE PROJECTION

	SIGNATURE	DATE
DRAWN	C. LEIVA	6/11/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

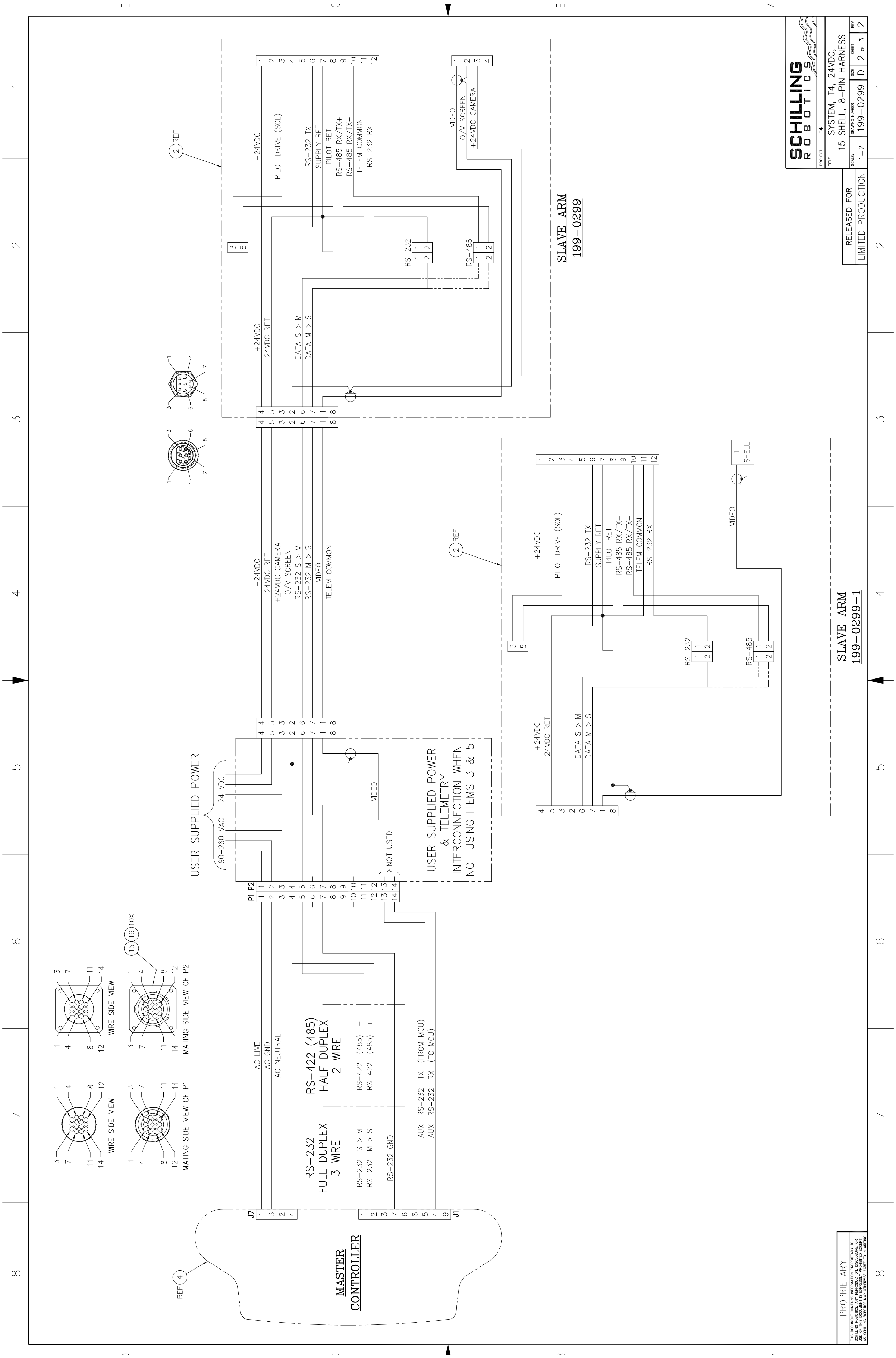
RELEASED FOR LIMITED PRODUCTION

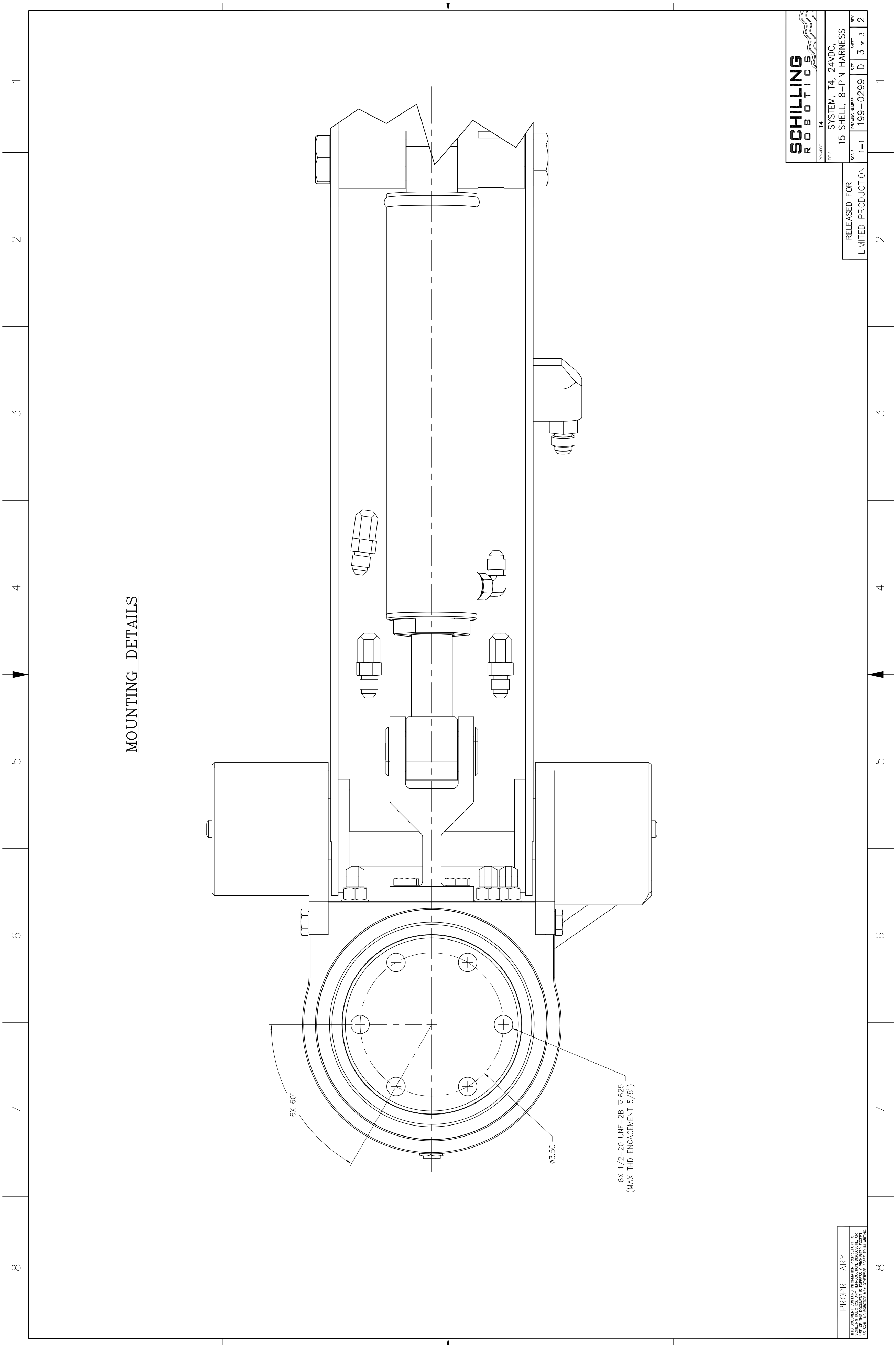
SCHILLING ROBOTICS

PROJECT: T4

TITLE: SYSTEM, T4, 24VDC, 15 SHELL, 8–PIN HARNESS

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199–0299	D	1 OF 3	2


SCHILLING ROBOTICS
SYSTEM, T4, 24VDC, 15 SHELL, 8-PIN HARNESS
199-0299
RELEASED FOR LIMITED PRODUCTION
SLAVE ARM 199-0299
SLAVE ARM 199-0299-1
MASTER CONTROLLER
USER SUPPLIED POWER
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
WIRE SIDE VIEW
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2
PROPRIETARY



MOUNTING DETAILS
6X 60°
ø3.50
6X 1/2-20 UNF-2B ⊽ .625
(MAX THD ENGAGEMENT 5/8")
SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24VDC,
15 SHELL, 8-PIN HARNESS
SCALE: 1=1
DRAWING NUMBER 199-0299
SIZE D
SHEET 3 OF 3
REV 2
RELEASED FOR
LIMITED PRODUCTION
PROPRIETARY
THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO SCHILLING ROBOTICS. ANY REPRODUCTION, DISCLOSURE, OR USE OF THIS DOCUMENT IS EXPRESSLY PROHIBITED EXCEPT AS SCHILLING ROBOTICS MAY OTHERWISE AGREE TO IN WRITING.

Titan 4 Manipulator System, 199-0300

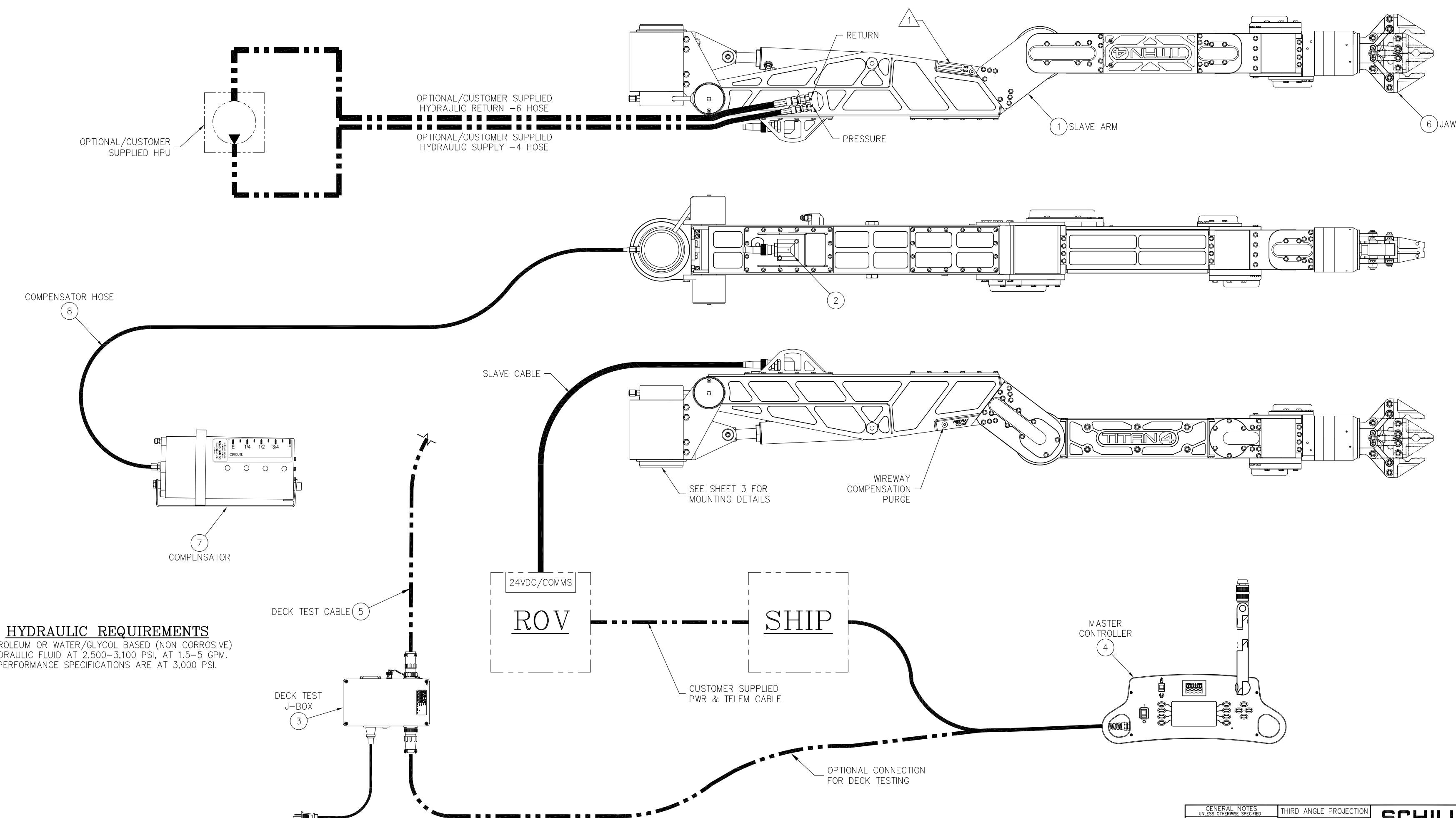
Rev. 4

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-5887	HARNESS,SA,T4/CMRA,6-PIN20SHEL	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-5889	CA ASSY,DECK TEST,6PIN,20SHELL	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0324	SP KIT,T4,ENHANCED	0
51	011-8239	MAN, T4, STD	2

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	RELEASED FOR PROTOTYPE	6/11/08	CRL	SLW
3397	1	C1	ADDED ITEM 6 CALLOUT	8/26/11	SWR	TR

NOTES:

1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12, 19, 20, 22, 23, 24, 40, 42, AND 51 NOT SHOWN.



HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE)
HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM.
PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

RELEASED FOR **PROTOTYPE**

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, (S) DENOTES REGARDLESS OF FEATURE SIZE.
DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED.
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
ALL MACHINED SURFACES TO BE 63 RMS FINISH.
DIMENSIONS ARE IN INCHES.
CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE

TOLERANCES		
DECIMALS	FRACTIONS	ANGLES
.X ±.1 .XX ±.02 .XXX ±.005	±1/16	X. ±1°0' X.X ±30' X.XX ±15'

THIRD ANGLE PROJECTION

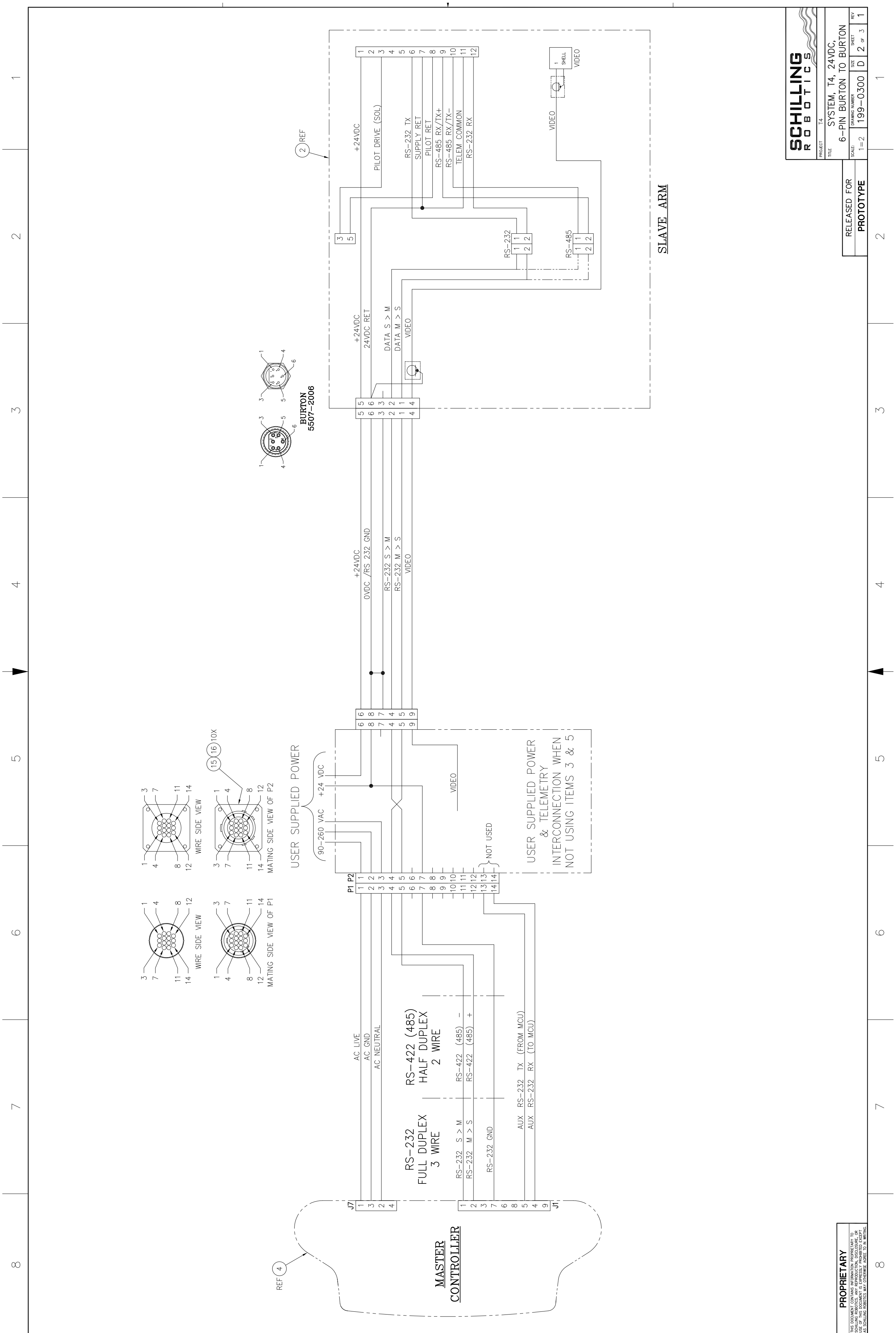
	SIGNATURE	DATE
DRAWN	C. LEIVA	6/11/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

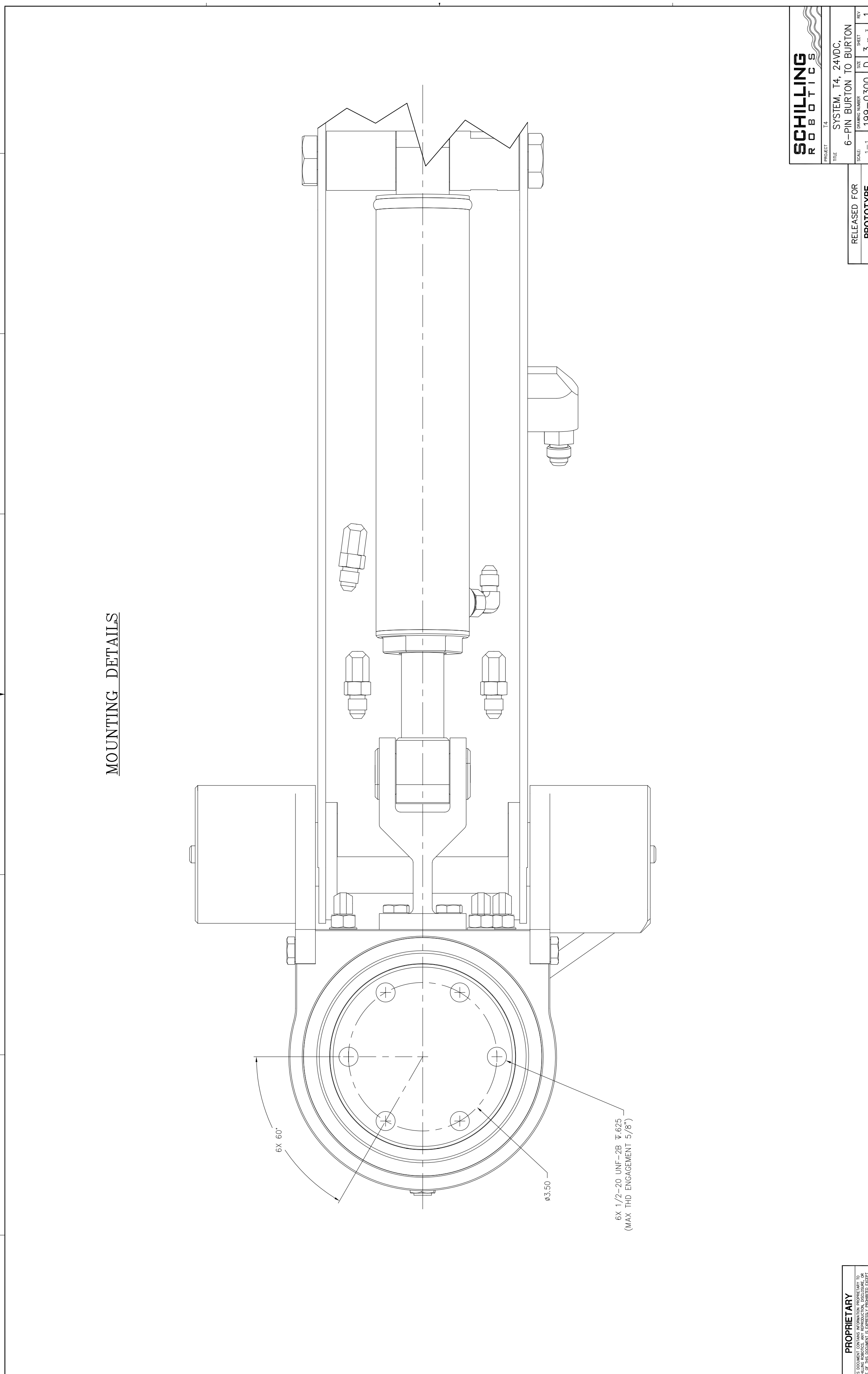
SCHILLING ROBOTICS

PROJECT T4

TITLE SYSTEM, T4, 24VDC, 6–PIN BURTON TO BURTON

SCALE:	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199–0300	D	1 OF 3	1


SCHILLING ROBOTICS
SYSTEM, T4, 24VDC, 6-PIN BURTON TO BURTON
199-0300
RELEASED FOR PROTOTYPE
SLAVE ARM
MASTER CONTROLLER
BURTON 5507-2006
+24VDC
PILOT DRIVE (SOL)
RS-232 TX
SUPPLY RET
PILOT RET
RS-485 RX/TX+
RS-485 RX/TX-
TELEM COMMON
RS-232 RX
VIDEO
RS-232
RS-485
24VDC RET
DATA S > M
DATA M > S
0VDC /RS 232 GND
RS-232 S > M
RS-232 M > S
USER SUPPLIED POWER
90-260 VAC
+24 VDC
NOT USED
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
WIRE SIDE VIEW
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2
AC LIVE
AC GND
AC NEUTRAL
RS-422 (485) HALF DUPLEX 2 WIRE
RS-232 FULL DUPLEX 3 WIRE
RS-232 GND
AUX RS-232 TX (FROM MCU)
AUX RS-232 RX (TO MCU)
PROPRIETARY


MOUNTING DETAILS
6X 60°
ø3.50
6X 1/2-20 UNF-2B ↧.625
(MAX THD ENGAGEMENT 5/8")
SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24VDC,
6-PIN BURTON TO BURTON
SCALE 1=1
DRAWING NUMBER 199-0300
SIZE D
SHEET 3 of 3
REV 1
RELEASED FOR
PROTOTYPE
PROPRIETARY

Titan 4 Manipulator System, 199-0301

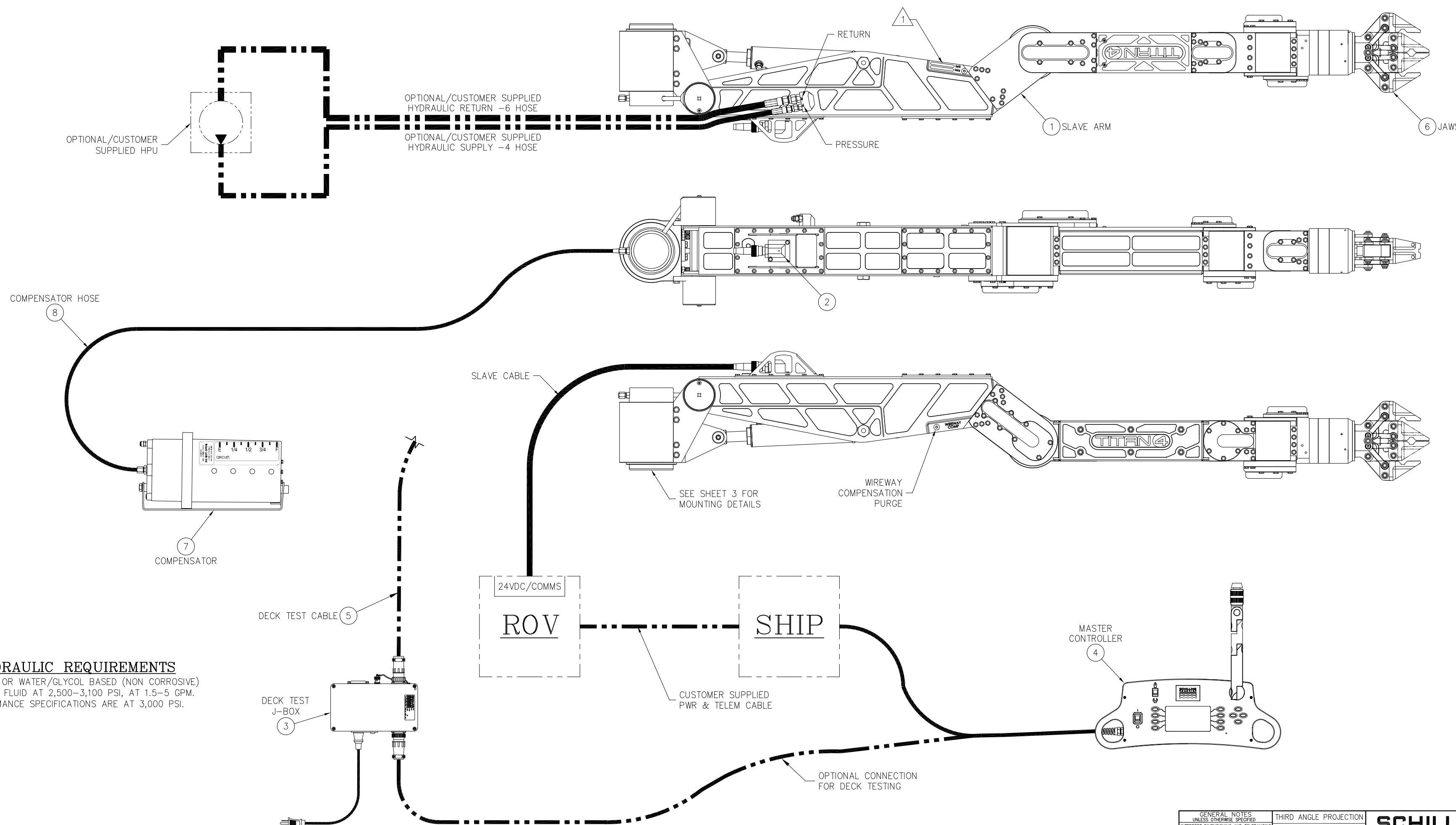
Rev. 4

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6147	HARNESS,SA,T4,8PIN,20SHELL	1
3	101-4898-2	J-BOX,DECK TEST,T4,CAM,INNOVA	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6150	CA ASSY,DECK TST,8PIN,20SHELL	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0324	SP KIT,T4,ENHANCED	0
51	011-8239	MAN, T4, STD	2

NOTES:

1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12, 19, 20, 22, 23, 24, 40, 42, AND 51 NOT SHOWN.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	Ø	–	RELEASED FOR PROTOTYPE	6/11/08	CRL	SLW
3397	1	C1	ADDED ITEM 6 CALLOUT	8/26/11	SWR	TR



HYDRAULIC REQUIREMENTS

PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM. PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

PROPRIETARY

RELEASED FOR **PROTOTYPE**

GENERAL NOTES UNLESS OTHERWISE SPECIFIED: INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE. DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES. ALL MACHINED SURFACES TO BE 63 RMS FINISH. DIMENSIONS ARE IN INCHES. CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES: DECIMALS .X ±.1, .XX ±.02, .XXX ±.005; FRACTIONS ±1/16; ANGLES X. ±1°0', X.X ±.30', X.XX ±.15'

THIRD ANGLE PROJECTION

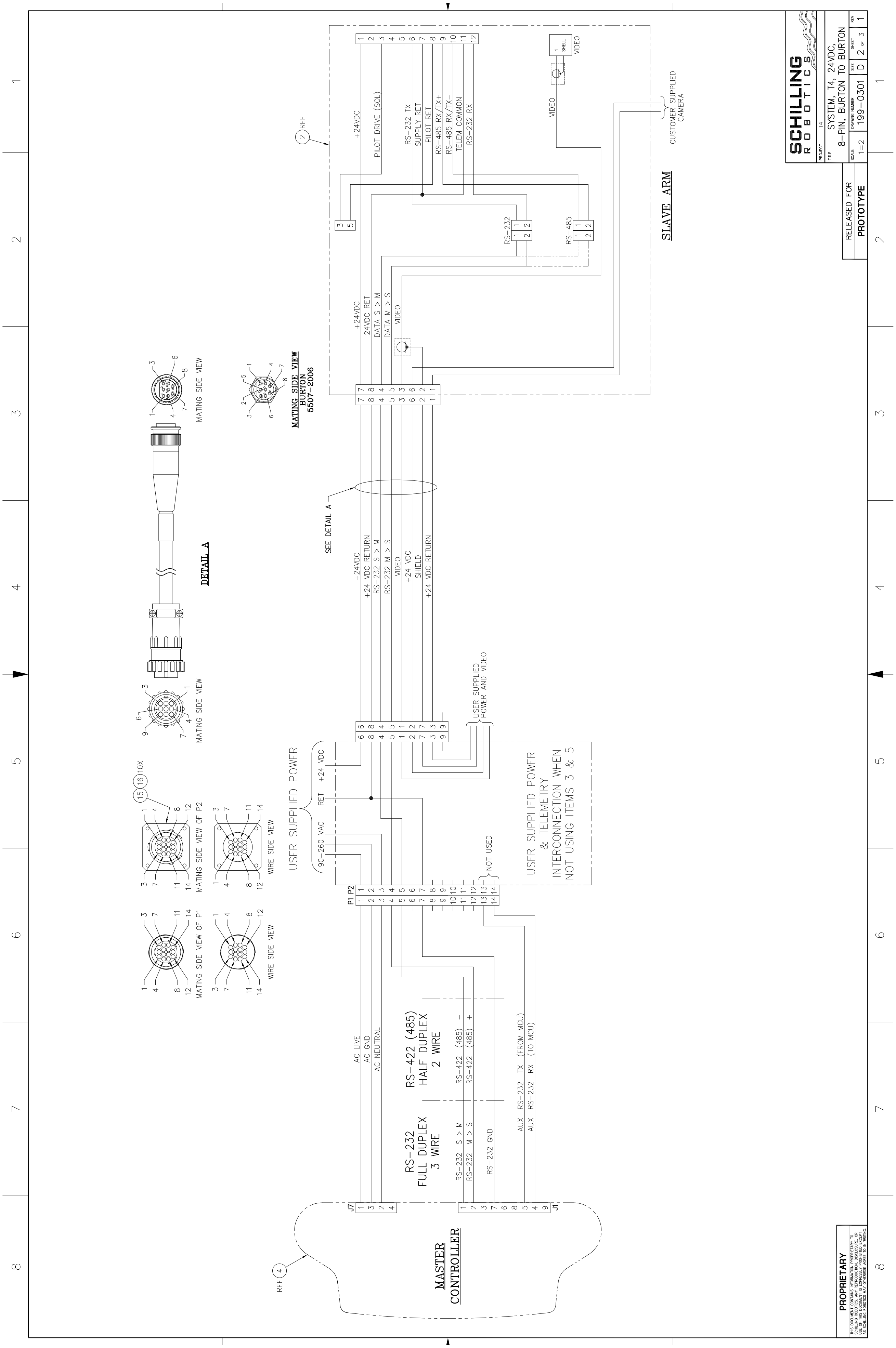
	SIGNATURE	DATE
DRAWN	C. LEIVA	6/11/08
DESIGNED	S. WRIGHT	4/8/08
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

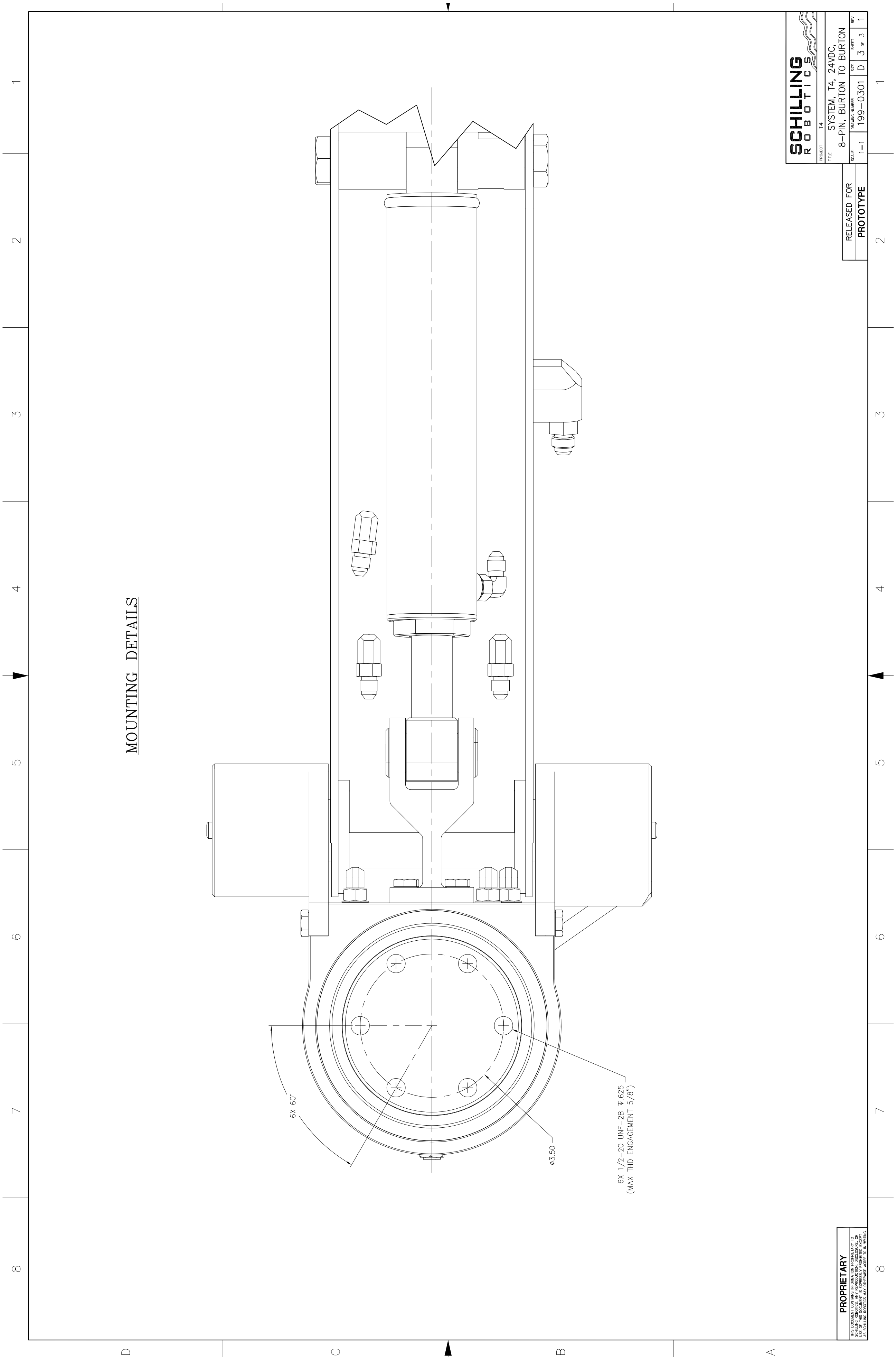
PROJECT: T4

TITLE: SYSTEM, T4, 24VDC, 8-PIN, BURTON TO BURTON

SCALE	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199-0301	D	1 of 3	1



SCHILLING ROBOTICS
SYSTEM, T4, 24VDC, 8-PIN, BURTON TO BURTON
199-0301
RELEASED FOR PROTOTYPE
SLAVE ARM
MASTER CONTROLLER
DETAIL A
SEE DETAIL A
MATING SIDE VIEW BURTON 5507-2006
USER SUPPLIED POWER
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
CUSTOMER SUPPLIED CAMERA
PROPRIETARY


MOUNTING DETAILS
6X 60°
⌀3.50
6X 1/2-20 UNF-2B ↧.625
(MAX THD ENGAGEMENT 5/8")
SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24VDC,
8-PIN, BURTON TO BURTON
SCALE 1=1
DRAWING NUMBER 199-0301
SIZE D
SHEET 3 of 3
REV 1
RELEASED FOR
PROTOTYPE
PROPRIETARY

Titan 4 Manipulator System, 199-0307

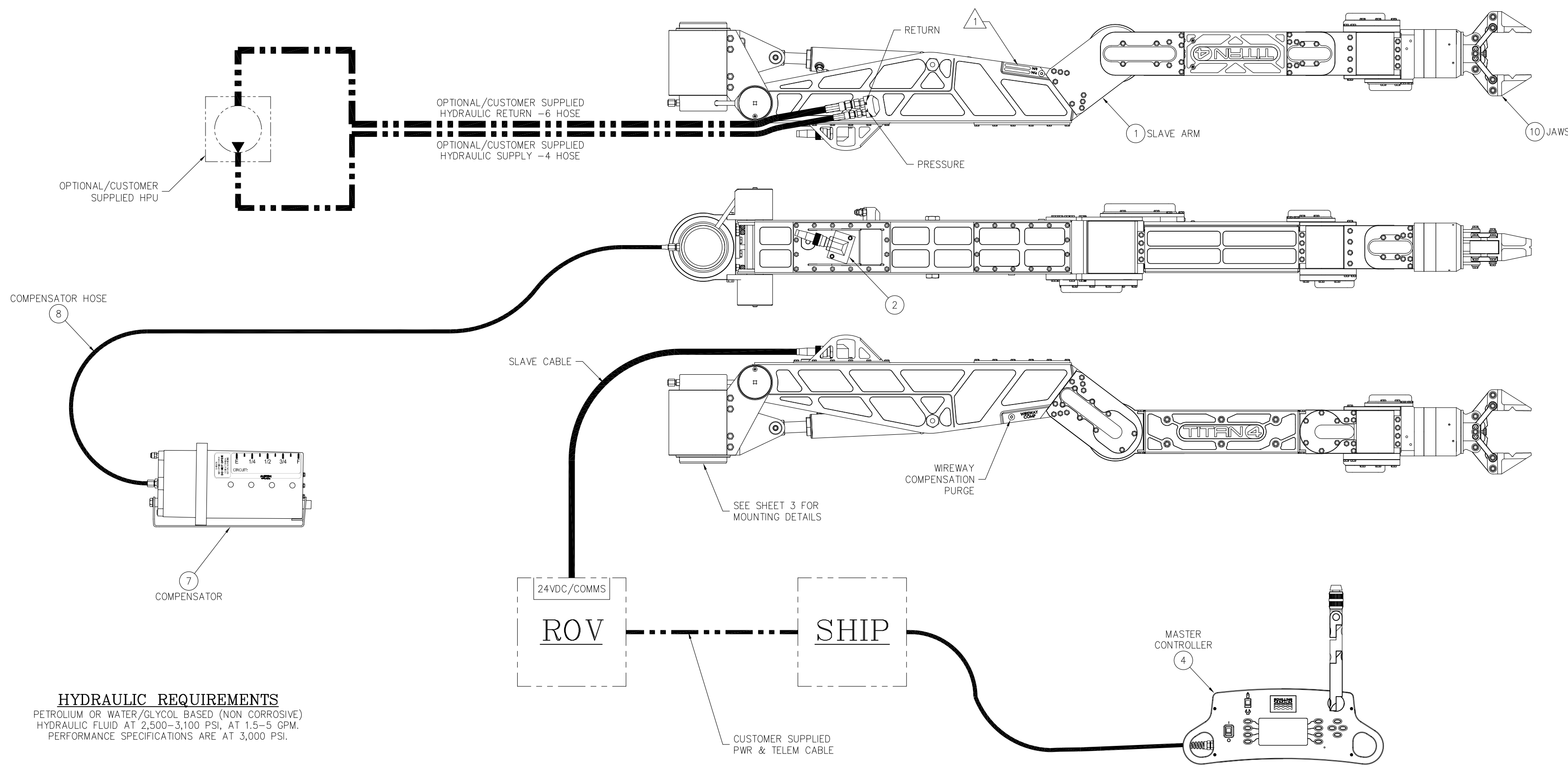
Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6852	HARNESS,SA,T4/CAMERA,TMT	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6853	CABLE ASSY,TST,8PIN 15 SH	1
6	005-5526-144	CABLE,1508 BURTON STYLE,144"	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
10	101-7709	KIT,JAW,PARALLEL ACTING	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0464	SP KIT,T4,HAWE,EN 0307	0
49	008-0293	SP KIT,T4,STANDARD,199-0276	0
50	008-0463	SP KIT,T4,ENHANCED,199-0307	0
51	011-8239	MAN, T4, STD	2

NOTES:

1. (△) HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 3, 5, 12, 19, 20, 22, 23, 24, 40, 42, 51 NOT SHOWN.

PCO	REV	SHEET	ZONE	DESCRIPTION	DATE	BY	APPR
–	A	–	–	RELEASED FOR PRODUCTION	6/03/08	JG	SLW
1961	B	2	B3	ADDED CHASSIS GND	11/04/10	SWR	CC
3397	C	1	C1	ADDED ITEM 10 CALLOUT	8/29/11	SWR	TR



HYDRAULIC REQUIREMENTS

PETROLIUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM. PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

PROPRIETARY

RELEASED FOR PRODUCTION

GENERAL NOTES UNLESS OTHERWISE SPECIFIED: INTERPRET DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994. IN ADDITION, Ⓢ DENOTES REGARDLESS OF FEATURE SIZE. DIMENSIONS APPLY AFTER ALL PROCESSES HAVE BEEN COMPLETED. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES. ALL MACHINED SURFACES TO BE 63 RMS FINISH. DIMENSIONS ARE IN INCHES. CONCENTRIC FEATURES ARE TO BE CONCENTRIC WITHIN .005 REGARDLESS OF FEATURE SIZE.

TOLERANCES: DECIMALS .X ±.1, .XX ±.02, .XXX ±.005; FRACTIONS ±1/16; ANGLES X ±1/2°, X.X ±30', X.XX ±15'

THIRD ANGLE PROJECTION

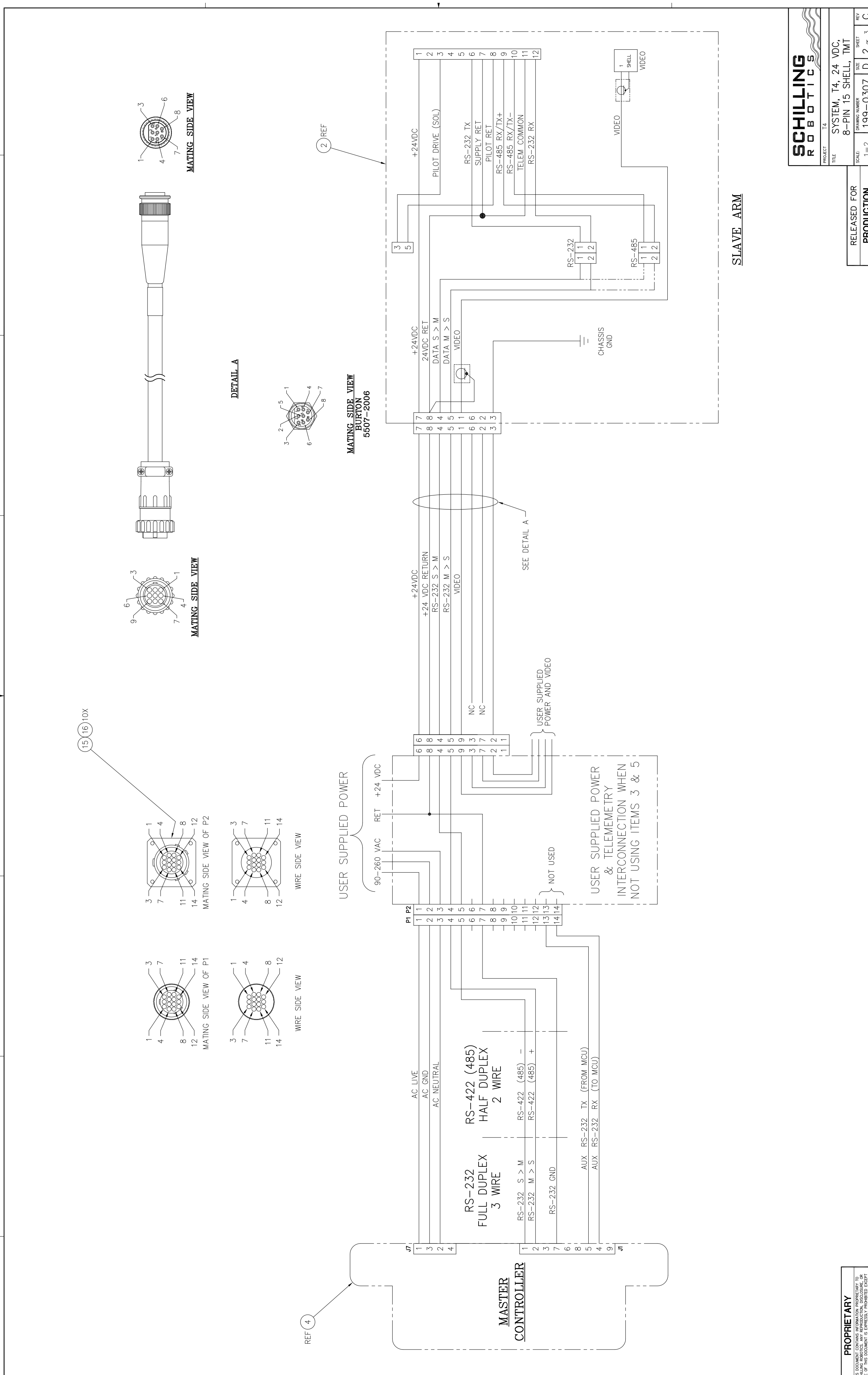
	SIGNATURE	DATE
DRAWN	J. GARDNER	6/03/08
DESIGNED	T. LOMBARDO	5/22/08
CHECKED		
LEAD	S. WRIGHT	

SCHILLING ROBOTICS

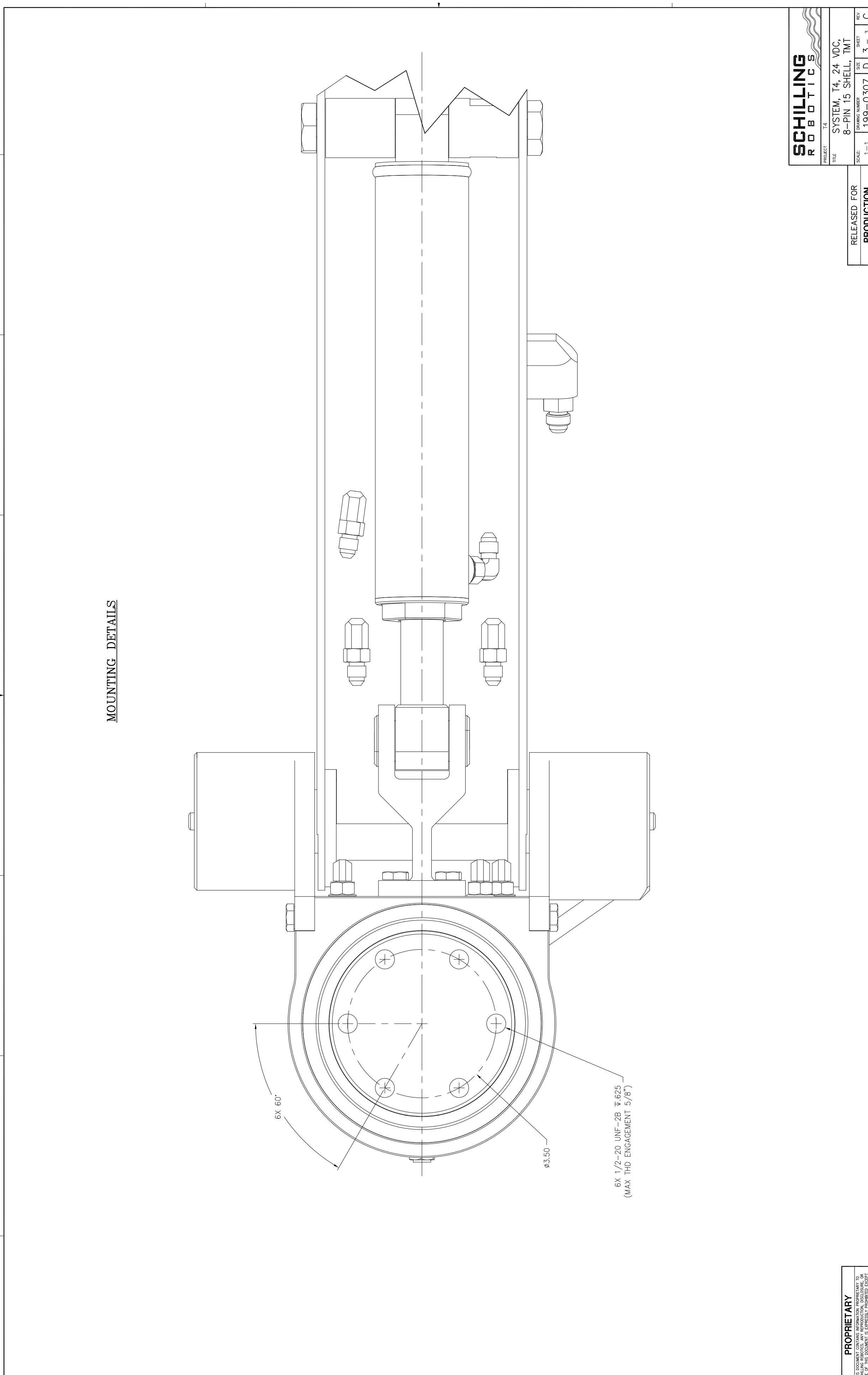
PROJECT: T4

TITLE: SYSTEM, T4, 24 VDC, 8–PIN 15 SHELL, TMT

SCALE	DRAWING NUMBER	SIZE	SHEET	REV
1=5	199–0307	D	1 of 3	C



SCHILLING ROBOTICS
SYSTEM, T4, 24 VDC, 8-PIN 15 SHELL, TMT
199-0307
RELEASED FOR PRODUCTION
PROPRIETARY
SLAVE ARM
MASTER CONTROLLER
MATING SIDE VIEW
MATING SIDE VIEW BURTON 5507-2006
DETAIL A
SEE DETAIL A
+24VDC
PILOT DRIVE (SOL)
RS-232 TX
SUPPLY RET
PILOT RET
RS-485 RX/TX+
RS-485 RX/TX-
TELEM COMMON
RS-232 RX
VIDEO
RS-232
RS-485
CHASSIS GND
+24VDC
24VDC RET
DATA S > M
DATA M > S
+24 VDC RETURN
RS-232 S > M
RS-232 M > S
NC
USER SUPPLIED POWER AND VIDEO
USER SUPPLIED POWER
90-260 VAC
RET
+24 VDC
NOT USED
USER SUPPLIED POWER & TELEMEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2
WIRE SIDE VIEW
AC LIVE
AC GND
AC NEUTRAL
RS-422 (485) HALF DUPLEX 2 WIRE
RS-422 (485) -
RS-422 (485) +
RS-232 FULL DUPLEX 3 WIRE
RS-232 GND
AUX RS-232 TX (FROM MCU)
AUX RS-232 RX (TO MCU)


SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24 VDC, 8-PIN 15 SHELL, TMT
SCALE 1=1
DRAWING NUMBER 199-0307
SIZE D
SHEET 3 of 3
REV C
RELEASED FOR PRODUCTION
MOUNTING DETAILS
6X 60°
ø3.50
6X 1/2-20 UNF-2B ⊽.625
(MAX THD ENGAGEMENT 5/8")
PROPRIETARY

NOTE: *Use drawing 199-0308 for reference.*

Titan 4 Manipulator System, 199-0308-1

Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6927	HRNS,SA,T4,8-PIN,BURT,W/SFTY	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-1	CABLE ASSY,DECK TEST,0308-1	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0482	SP KIT,T4,HAWE,EN 0308-1	0
51	011-8239	MAN, T4, STD	2

NOTE: *Use drawing 199-0308 for reference.*

Titan 4 Manipulator System, 199-0308-2

Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6928	HARNESS,SA,8-PN,BURTON	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-2	CA ASSY,DECK TEST,199-0308-2	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0483	SP KIT,T4,HAWE,EN 0308-2	0
51	011-8239	MAN, T4, STD	2

NOTE: *Use drawing 199-0308 for reference.*

Titan 4 Manipulator System, 199-0308-3

Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6927	HRNS,SA,T4,8-PIN,BURT,W/SFTY	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-1	CABLE ASSY,DECK TEST,0308-1	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0482	SP KIT,T4,HAWE,EN 0308-1	0
51	011-8239	MAN, T4, STD	2
61	101-5074	CAMERA ASSEMBLY,WRIST,NTSC,T4	1

NOTE: *Use drawing 199-0308 for reference.*

Titan 4 Manipulator System, 199-0308-4

Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6928	HARNESS,SA,8-PN,BURTON	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-2	CA ASSY,DECK TEST,199-0308-2	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0483	SP KIT,T4,HAWE,EN 0308-2	0
51	011-8239	MAN, T4, STD	2
61	101-5074-1	CAMERA ASSEMBLY,WRIST,PAL,T4	1

NOTE: *Use drawing 199-0308 for reference (sheet 3 for schematic).*

Titan 4 Manipulator System, 199-0308-7

Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6928	HARNESS,SA,8-PN,BURTON	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-2	CA ASSY,DECK TEST,199-0308-2	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0483	SP KIT,T4,HAWE,EN 0308-2	0
51	011-8239	MAN, T4, STD	2
61	101-5074	CAMERA ASSEMBLY,WRIST,NTSC,T4	1

NOTE: *Use drawing 199-0308 for reference (sheet 2 for schematic).*

Titan 4 Manipulator System, 199-0308-8

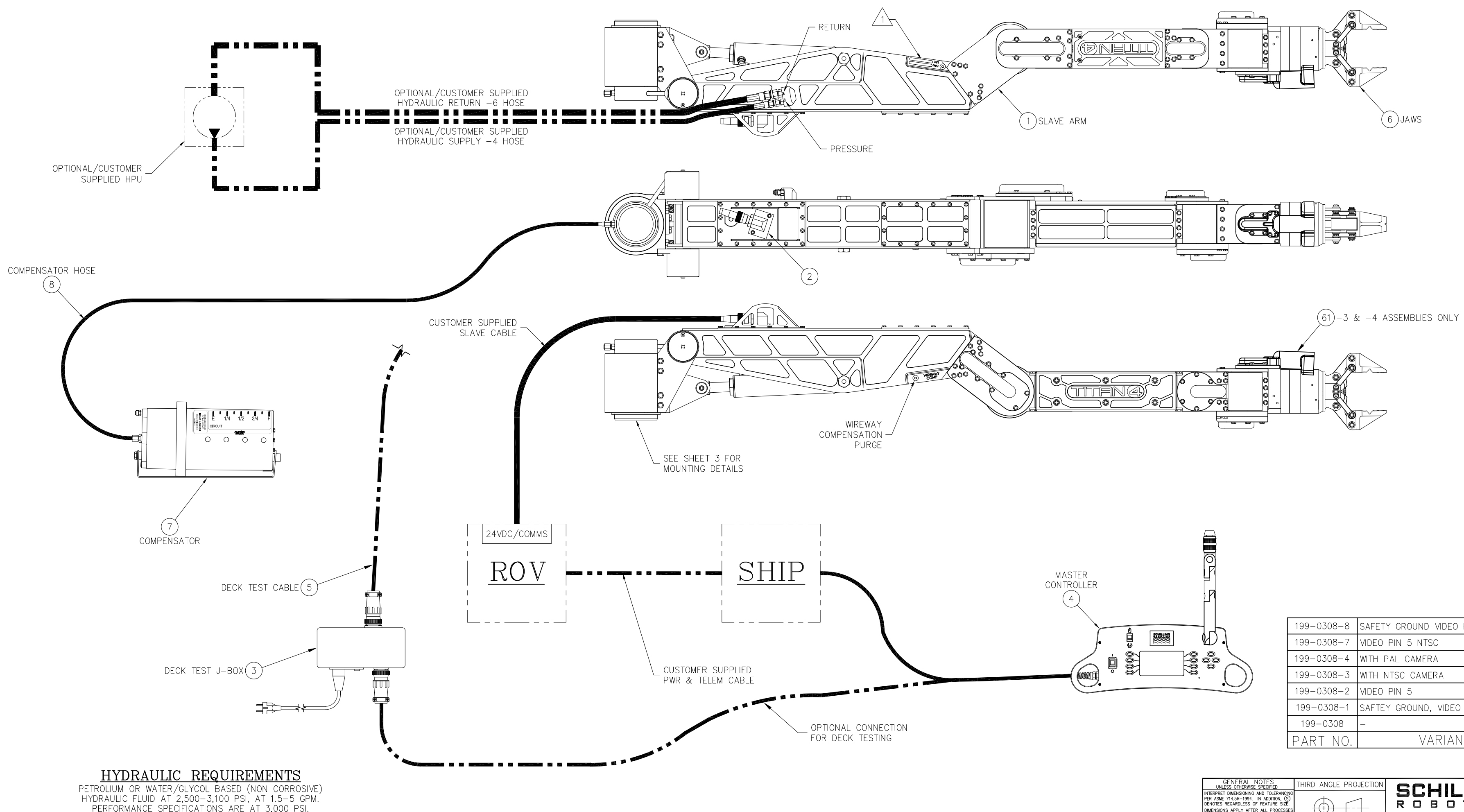
Rev. E

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-6927	HRNS,SA,T4,8-PIN,BURT,W/SFTY	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-6926-1	CABLE ASSY,DECK TEST,0308-1	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0482	SP KIT,T4,HAWE,EN 0308-1	0
51	011-8239	MAN, T4, STD	2
61	101-5074-1	CAMERA ASSEMBLY,WRIST,PAL,T4	1

NOTES:

1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12,15,16,19,20,22,23,24,42,51, NOT SHOWN.

PCO	REV	ZONE	DESCRIPTION	DATE	BY	APPR
–	A	–	RELEASED FOR PRODUCTION	7/22/08	NLH	SLW
–	B	–	ADDED -7 & -8 VARIATIONS	7/24/08	RDJ	SLW
2783	C	SHT 2 SHT 3	ADDED -8 TO SHEET LABEL ADDED -7 TO SHEET LABEL	4/29/11	TF	FS
3397	D	C1	ADDED ITEM 6 CALLOUT	8/29/11	SWR	TR



PART NO.	VARIANCE
199-0308-8	SAFETY GROUND VIDEO PIN1 PAL
199-0308-7	VIDEO PIN 5 NTSC
199-0308-4	WITH PAL CAMERA
199-0308-3	WITH NTSC CAMERA
199-0308-2	VIDEO PIN 5
199-0308-1	SAFTEY GROUND, VIDEO PIN 1
199-0308	–

HYDRAULIC REQUIREMENTS

PETROLIUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM. PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.

RELEASED FOR PRODUCTION

THIRD ANGLE PROJECTION

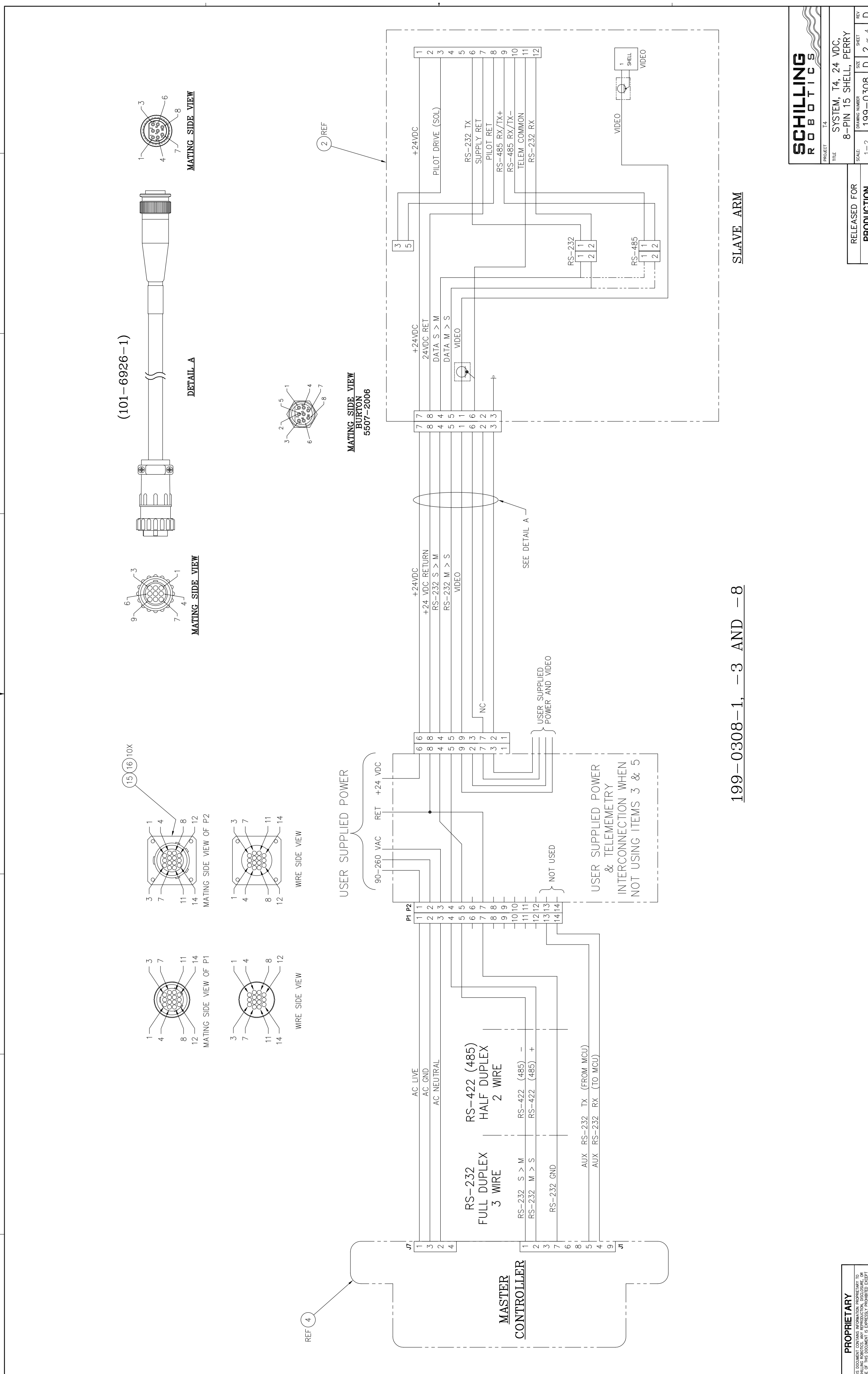
SCHILLING ROBOTICS

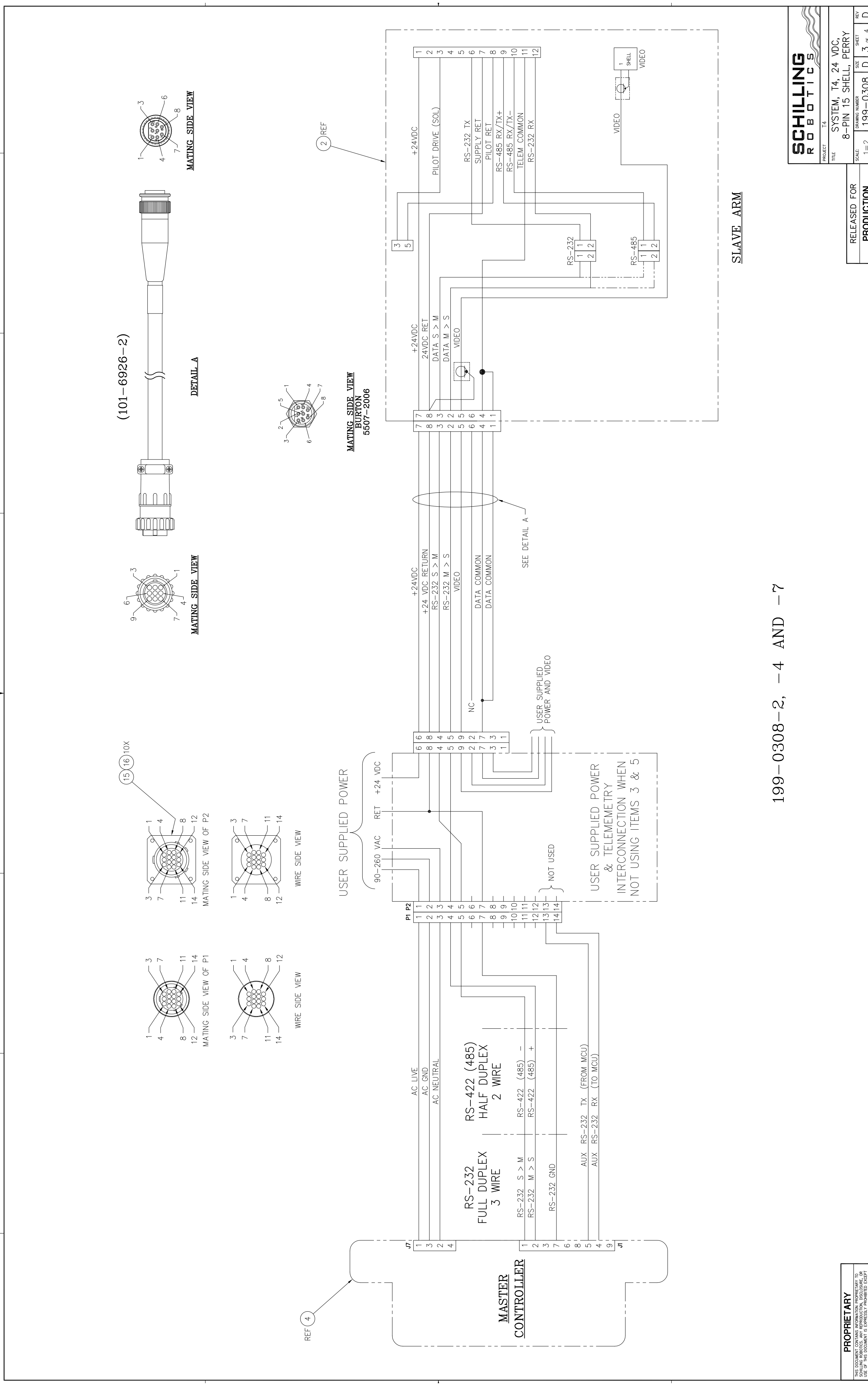
PROJECT: T4

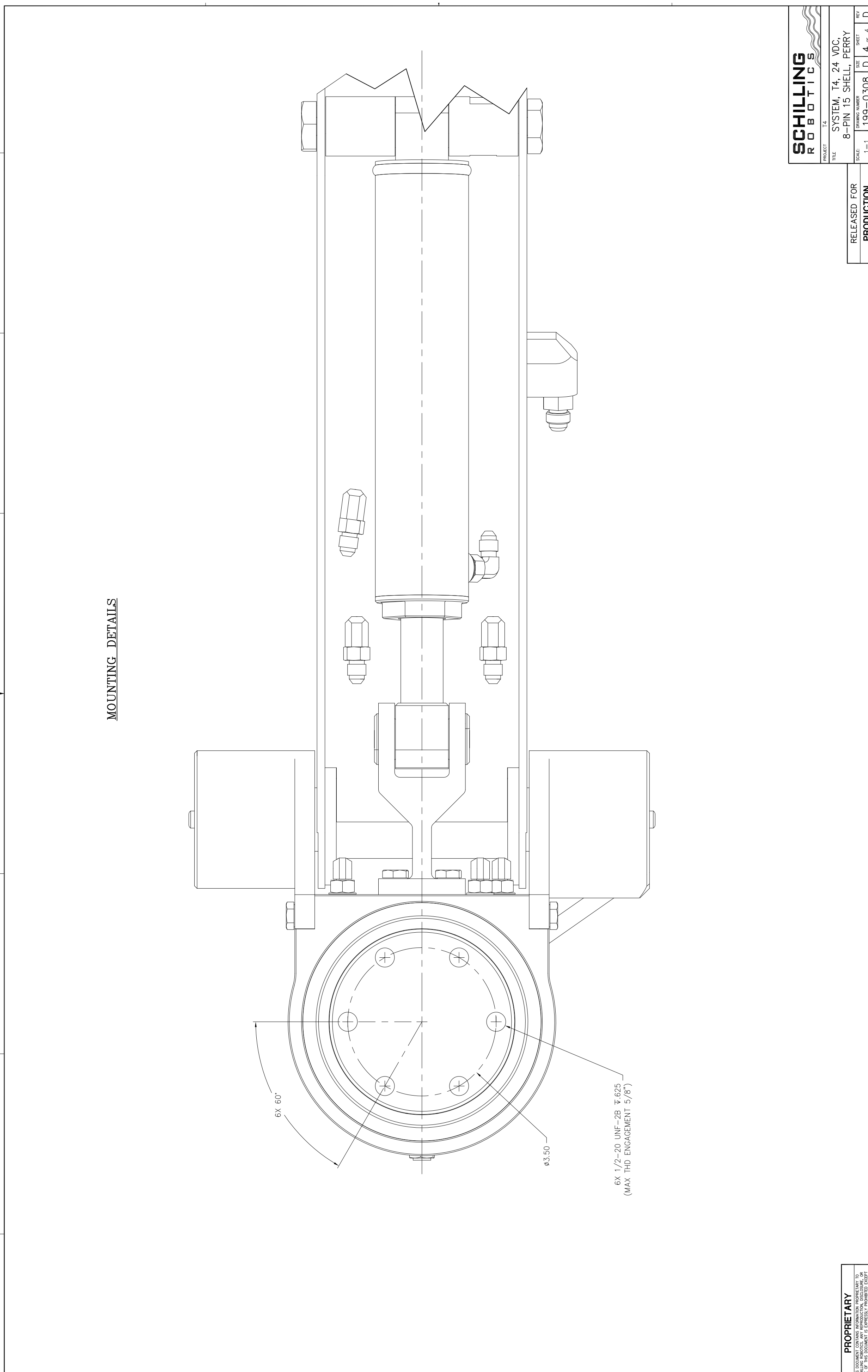
TITLE: SYSTEM, T4, 24 VDC, 8-PIN 15 SHELL, PERRY

DRAWN: S. WRIGHT 7/9/08 — DESIGNED: S. WRIGHT 7/9/08 — LEAD: S. WRIGHT

SCALE: 1=5 — DRAWING NUMBER: 199-0308 — SIZE: D — SHEET: 1 of 4 — REV: D


SCHILLING ROBOTICS
SYSTEM, T4, 24 VDC, 8-PIN 15 SHELL, PERRY
199-0308
RELEASED FOR PRODUCTION
PROPRIETARY
SLAVE ARM
MASTER CONTROLLER
199-0308-1, -3 AND -8
DETAIL A
(101-6926-1)
MATING SIDE VIEW
MATING SIDE VIEW BURTON 5507-2006
SEE DETAIL A
USER SUPPLIED POWER
USER SUPPLIED POWER AND VIDEO
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
NOT USED
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2
WIRE SIDE VIEW
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
AC LIVE
AC GND
AC NEUTRAL
+24VDC
PILOT DRIVE (SOL)
RS-232 TX
SUPPLY RET
PILOT RET
RS-485 RX/TX+
RS-485 RX/TX-
TELEM COMMON
RS-232 RX
VIDEO


SCHILLING ROBOTICS
SYSTEM, T4, 24 VDC, 8-PIN 15 SHELL, PERRY
199-0308
RELEASED FOR PRODUCTION
PROPRIETARY
199-0308-2, -4 AND -7
SLAVE ARM
MASTER CONTROLLER
DETAIL A
(101-6926-2)
MATING SIDE VIEW
MATING SIDE VIEW BURTON 5507-2006
MATING SIDE VIEW OF P1
MATING SIDE VIEW OF P2
WIRE SIDE VIEW
USER SUPPLIED POWER
90-260 VAC
RET
+24 VDC
USER SUPPLIED POWER AND VIDEO
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
NOT USED
SEE DETAIL A
+24VDC
+24 VDC RETURN
RS-232 S > M
RS-232 M > S
VIDEO
DATA COMMON
24VDC RET
DATA S > M
DATA M > S
PILOT DRIVE (SOL)
RS-232 TX
SUPPLY RET
PILOT RET
RS-485 RX/TX+
RS-485 RX/TX-
TELEM COMMON
RS-232 RX
RS-232
RS-485
RS-232 FULL DUPLEX 3 WIRE
RS-422 (485) HALF DUPLEX 2 WIRE
AC LIVE
AC GND
AC NEUTRAL
RS-232 GND
AUX RS-232 TX (FROM MCU)
AUX RS-232 RX (TO MCU)
REF

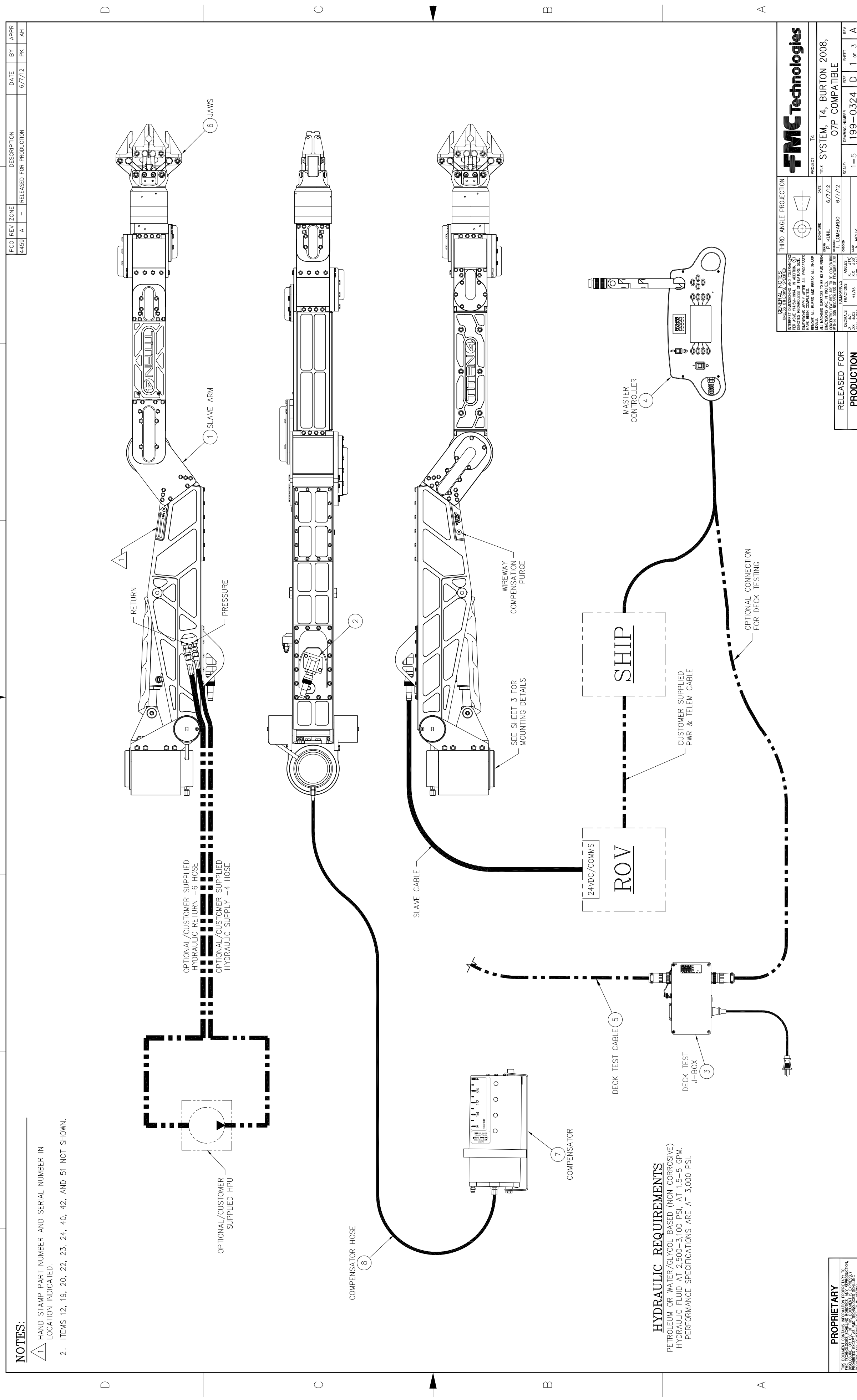


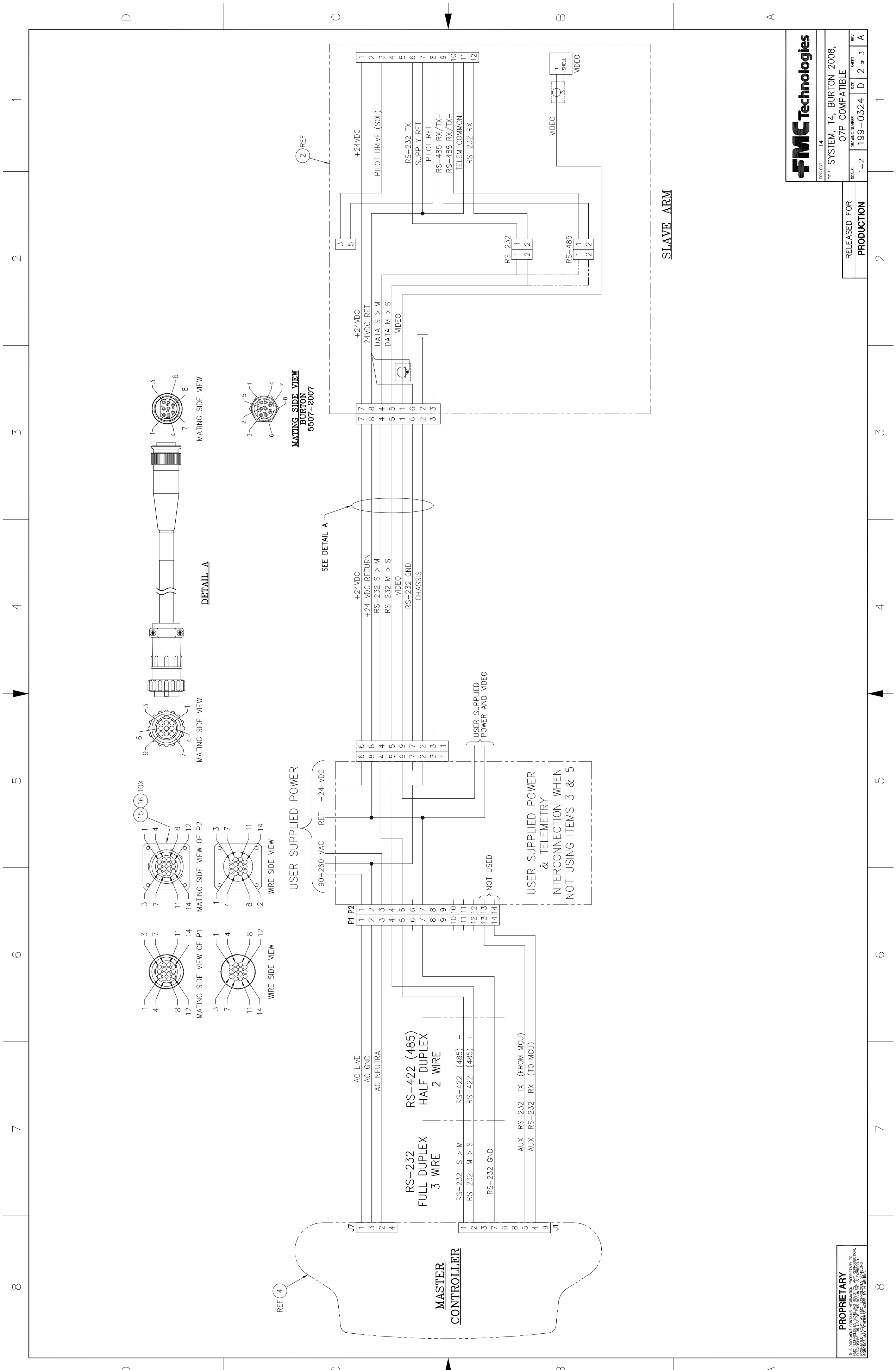
MOUNTING DETAILS
6X 60°
ø3.50
6X 1/2-20 UNF-2B ▽.625
(MAX THD ENGAGEMENT 5/8")
SCHILLING
ROBOTICS
PROJECT T4
TITLE SYSTEM, T4, 24 VDC,
8-PIN 15 SHELL, PERRY
SCALE: 1=1
DRAWING NUMBER 199-0308
SIZE D
SHEET 4 of 4
REV D
RELEASED FOR
PRODUCTION
PROPRIETARY

SYSTEM,T4,BTN 2008,07P COMP, 199-0324

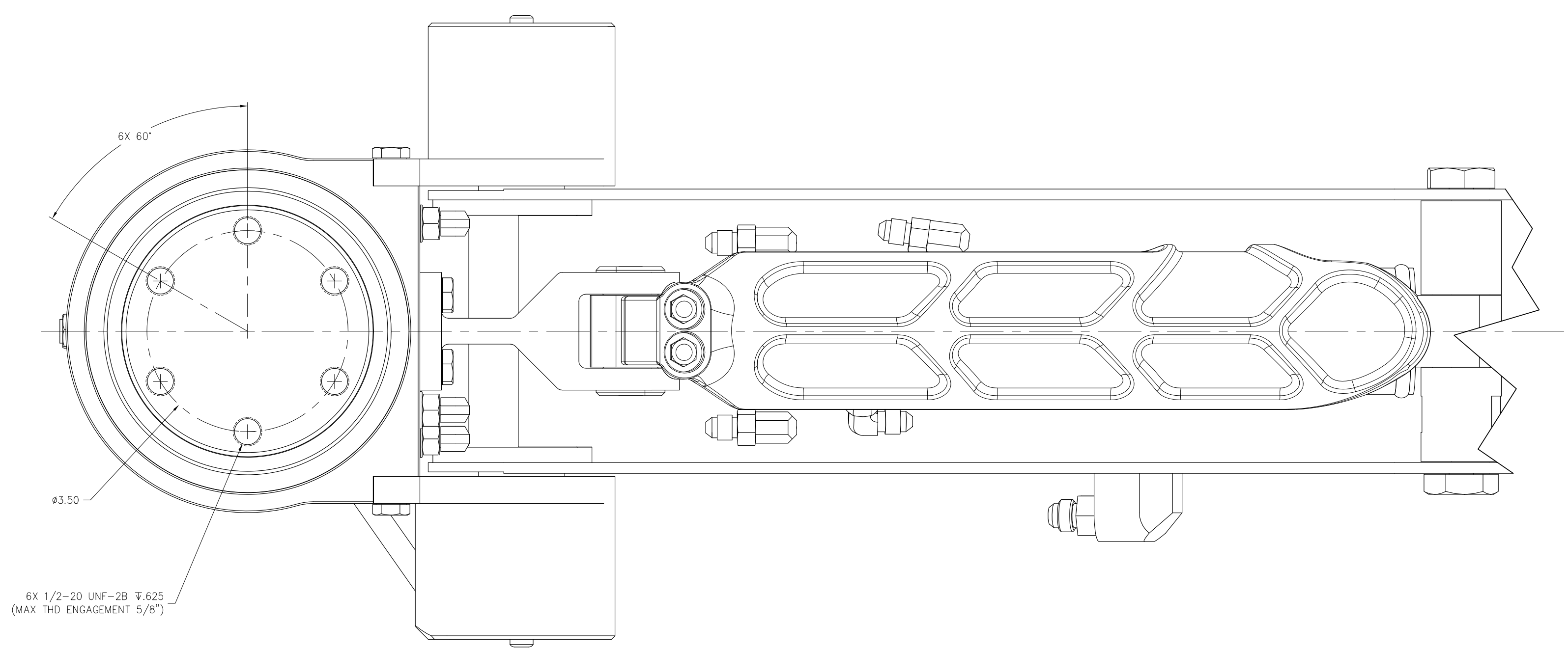
Rev. A

Item	P/N	Description	Qty
1	101-6790	SLAVE ARM,T4	1
2	101-8357-1	HARNESS,T4,BTN 2008,07P COMP	1
3	101-4898	J-BOX,DECK TEST,T4	1
4	101-5781	MASTER CONT,UNIV INPUT,GEN 2	1
5	101-4018-1	CA ASSY,CPC/BURTON,NULL MODEM	1
6	101-7709	KIT,JAW,PARALLEL ACTING	1
7	101-4470	COMP,2 LITER,8-10 PSI,MANIP	1
8	006-0311	HOSE ASY,HYD,-4JIC,-4JIC,144~,	1
9	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	002-2429	CASE,SHIPPING,53X29X15 ID	1
15	005-1839	CONN,CPC,17-14,RVS SEXRCPT	1
16	005-0239	CONN,SKT,CPC,66594-2,AMP	10
19	002-0071	WSHR,1/2,316SS	6
20	002-0715P	HHCS,1/2-20X1.5,316SS,NLK	6
22	005-3133	CONN,CPC 17-9,RVS SEXPLUG	1
23	005-1794	PIN,CONN,CPC,AMP #66587-2	6
24	005-1850	CONN,STRAIN RLF CPC 17 SHELL L	1
40	014-0695	SW,MASTER,T4,IN-ARM, CONTROL	0
42	101-4051	KIT,CLEVIS SHEAR PIN	1
47	008-0323	SP,KIT,T4,HAWE,STANDARD	0
48	008-0780	SP KIT,T4,ENHANCED, OR COMP	0
51	011-8239	MAN, T4, STD	2


NOTES:
1. HAND STAMP PART NUMBER AND SERIAL NUMBER IN LOCATION INDICATED.
2. ITEMS 12, 19, 20, 22, 23, 24, 40, 42, AND 51 NOT SHOWN.
JAWS
SLAVE ARM
RETURN
PRESSURE
WIREWAY COMPENSATION PURGE
SEE SHEET 3 FOR MOUNTING DETAILS
OPTIONAL/CUSTOMER SUPPLIED HYDRAULIC RETURN -6 HOSE
OPTIONAL/CUSTOMER SUPPLIED HYDRAULIC SUPPLY -4 HOSE
OPTIONAL/CUSTOMER SUPPLIED HPU
SLAVE CABLE
COMPENSATOR HOSE
COMPENSATOR
MASTER CONTROLLER
SHIP
ROV
24VDC/COMMS
CUSTOMER SUPPLIED PWR & TELEM CABLE
OPTIONAL CONNECTION FOR DECK TESTING
DECK TEST CABLE
DECK TEST J-BOX
HYDRAULIC REQUIREMENTS
PETROLEUM OR WATER/GLYCOL BASED (NON CORROSIVE) HYDRAULIC FLUID AT 2,500–3,100 PSI, AT 1.5–5 GPM.
PERFORMANCE SPECIFICATIONS ARE AT 3,000 PSI.
PCO 4459 REV A ZONE – DESCRIPTION RELEASED FOR PRODUCTION DATE 6/7/12 BY PK APPR AH
THIRD ANGLE PROJECTION
FMC Technologies
PROJECT T4
TITLE SYSTEM, T4, BURTON 2008, 07P COMPATIBLE
SCALE 1=5 DRAWING NUMBER 199-0324 SIZE D SHEET 1 of 3 REV A
RELEASED FOR PRODUCTION
PROPRIETARY


SLAVE ARM
+24VDC
PILOT DRIVE (SOL)
RS-232 TX
SUPPLY RET
PILOT RET
RS-485 RX/TX+
RS-485 RX/TX-
TELEM COMMON
RS-232 RX
VIDEO
RS-232
RS-485
REF
+24VDC
24VDC RET
DATA S > M
DATA M > S
VIDEO
SEE DETAIL A
+24VDC
+24 VDC RETURN
RS-232 S > M
RS-232 M > S
VIDEO
RS-232 GND
CHASSIS
DETAIL A
MATING SIDE VIEW
MATING SIDE VIEW
BURTON
5507-2007
USER SUPPLIED POWER AND VIDEO
USER SUPPLIED POWER
90-260 VAC
RET
+24 VDC
NOT USED
USER SUPPLIED POWER & TELEMETRY INTERCONNECTION WHEN NOT USING ITEMS 3 & 5
MATING SIDE VIEW OF P1
WIRE SIDE VIEW
MATING SIDE VIEW OF P2
WIRE SIDE VIEW
10X
P1 P2
AC LIVE
AC GND
AC NEUTRAL
RS-422 (485) HALF DUPLEX 2 WIRE
RS-422 (485) -
RS-422 (485) +
RS-232 FULL DUPLEX 3 WIRE
RS-232 S > M
RS-232 M > S
RS-232 GND
AUX RS-232 TX (FROM MCU)
AUX RS-232 RX (TO MCU)
J7
J1
MASTER CONTROLLER
REF
PROPRIETARY
FMC Technologies
PROJECT T4
TITLE SYSTEM, T4, BURTON 2008, 07P COMPATIBLE
SCALE 1=2
DRAWING NUMBER 199-0324
SIZE D
SHEET 2 of 3
REV A
RELEASED FOR PRODUCTION

MOUNTING DETAILS



FMC Technologies	
PROJECT	T4
TITLE	SYSTEM, T4, BURTON 2008, 07P COMPATIBLE
SCALE: 1=1	DRAWING NUMBER 199-0324
SIZE D	SHEET 3 OF 3
REV A	

RELEASED FOR
PRODUCTION

4 Spares Kits

- 4.1 Standard Spares Kits .... page 294
- 4.2 Enhanced Spares Kits .... page 303
- 4.3 Enhanced Spares Sub-Kits .... page 307

4.1 Standard Spares Kits

See following pages.

Models 199-0293, 0307

Spares Kit, Standard, 008-0293 .... page 295

Models 199-0296, 0302, 0299, 0300, 0301, 0307, 0308-1, 0308-2, 0308-3, 0308-4, 0308-7, 0308-8

Spares Kit, HAWE, Standard, 008-0323 .... page 298

Models 199-0295, 0295PAL

Spares Kit, w/T-Bar, Standard, 008-0383 .... page 301

Spares Kit, Standard, 008-0293

Rev. B

Item	P/N	Description	Qty
1	001-1799	CLP,RSLR,T2	1
2	001-1915	SPR,RSLR,T2	1
3	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	2
4	002-0038P	NAS 6404PU1,NLK	6
5	002-0045P	NAS 6404PU7,NLK	4
6	002-0046P	NAS 6404PU8,NLK	4
7	002-0050	NAS 6404U2	4
8	002-0052P	NAS 6404PU3,NLK	6
9	002-0061P	NAS 6406PU6,NLK	2
10	002-0062P	NAS 6406PU12,NLK	2
11	002-0095P	SHCS,10-32X3/8,316SS,NLK	4
12	002-0317P	NAS 6404PU10,NLK PATCH	4
13	002-0346P	NAS 6404PU6,NLK	4
14	002-0403	SHCS,8-32X1/4,SS	2
15	002-0407	WSHR,FLAT,#6,SS	2
16	002-0424	SHCS,10-32X7/8,SS	2
17	002-0426	BHCS,4-40X3/8,SS	2
18	002-0428	FHMS,8-32X3/8,SS	2
19	002-0440	SHCS,3/8-24X1.0,SS	2
20	002-0513	SCR,SELF SEALING,W/O-RING,B90	2
21	002-0549	PIN,SPIROL,1/8X1/2,SS	2
22	002-0686	BHCS,10-24X.375LG,SS	2
23	002-0692	SHCS,4-40X.375,SS	2
24	002-0701	RING,RETING,SMALLEY #WSW137	5
25	002-0704	RING,RETING,INTL,SMALLEY VH400	2
26	002-0705	RING,RETING,INTL,SMALLEY WH562	2
27	002-0792	SCR,SELF SEALING W/O-RING,B90	2
28	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	2
29	002-0934P	SHCS,10-32X1/2,A286,SLVR,NLK	6
30	002-0964	SHCS,1/4-20X1.375,SS	2
31	002-0965	SHCS,1/4-20X1.625,SS	2
32	002-0966	SHCS,1/4-20X.75,SS	2
33	002-1112P	NAS 6403PU1,NLK	6
34	004-0003	O-RING,2-024 BUNA 70	5
35	004-0004	O-RING,2-012 BUNA 70	5
36	004-0017	O-RING,2-031 BUNA 70	5
37	004-0022	O-RING,2-010 BUNA 70	5
38	004-0036	O-RING,2-027 BUNA 70	5
39	004-0043	O-RING,2-033 BUNA 70	5
40	004-0048	O-RING,2-041 BUNA 70	5
41	004-0049	O-RING,2-045 BUNA 70	5
42	004-0080	O-RING,2-020 BUNA 70	5
43	004-0081	O-RING,2-035 BUNA 70	5

Spares Kit, Standard, 008-0293 (cont.)

Rev. B

Item	P/N	Description	Qty
44	004-0086	O-RING,2-011 BUNA 70	5
45	004-0087	O-RING,2-011 BUNA 90	10
46	004-1202	O-RING, 2-030, DISOGRIN 9251	1
47	004-0111	O-RING,2-032 BUNA 70	5
48	004-0113	O-RING,2-047 BUNA 70	5
49	004-0114	O-RING,2-013 BUNA 90	5
50	004-0123	O-RING,3-906 BUNA 90	5
51	004-0130	O-RING,2-022 BUNA 70	5
52	004-0133	O-RING,2-014 BUNA 90	5
53	004-0135	O-RING,2-015 BUNA 70	5
54	004-0137	O-RING,.244x.039 BUNA 90 APPLE	12
55	004-0139	O-RING,2-040 BUNA 70	5
56	004-0190	O-RING,2-012 BUNA 90	5
57	004-0210	O-RING,2-128 BUNA 70	5
58	004-0222	O-RING,2-010 BUNA 90	12
59	004-0226	O-RING,2-155 BUNA 70	5
60	004-0303	O-RING,2-022 V75	5
61	004-0413	O-RING,2-026 V75	5
62	004-0445	O-RING,2-006 V90	10
63	004-0518	RING,BACKUP,8-022 N90	5
64	004-0542	O-RING,2-034 BUNA 70	5
65	004-0561	O-RING,.228X.040,BUNA 70	10
66	004-0562	O-RING,2-158 BUNA 70	5
67	004-0563	O-RING,2-160 BUNA 70	5
68	004-0564	O-RING,2-161 BUNA 90	5
69	004-0570	O-RING,2-038 N70	5
70	004-0582	O-RING,2-044 N90	5
71	004-0585	O-RING,.189X.039,N70(APPLE)	12
72	004-0586	O-RING,1.417X.039,N70(APPLE)	10
73	004-0587	O-RING,2-003 BUNA 90	5
74	004-0588	O-RING,2-129 BUNA 90	5
75	004-0601	O-RING,2-275,N70	5
78	004-1201	O-RING,.228X.040 DISOGRIN9251	1
79	004-0627	O-RING,.189X.039,BUNA 90	12
80	004-0641	O-RING,5.822X.070,BUNA 70 (THR	5
81	004-0642	O-RING,2-010,DISOGRIN 90 DURO	10
83	004-0698	O-RING,2-011,DISOGRIN 90 DURO	5
84	004-0778	O-RING,6.30X.070,BUNA 70	5
85	004-0779	O-RING,7.16X.070,BUNA 70	5
89	006-1517	FLTR ELEM,NORMAN,U-90341	1
91	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
92	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	1
93	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	1

Spares Kit, Standard, 008-0293 (cont.)

Rev. B

Item	P/N	Description	Qty
94	101-1408	RSLR,YAW,T2/T3,GAMMA	1
95	101-1409	RSLR/LVDT WR,T2/T3	1
96	101-1774	PCB ASSY,OPTO ISO,RS422/232	1
97	101-2663	VALVE,SOLENOID,LEE	1
98	004-0576	WSHR,CRUSH,5/16	8
99	004-0791	SEAL,LEE MULTI-SEAL,SDBB213010	2
100	004-0225	O-RING,2-008 BUNA 90	32
101	004-0139	O-RING,2-040 BUNA 70	1
102	004-0036	O-RING,2-027 BUNA 70	1
104	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
110	002-0096P	SHCS,4-40X1/4,SS,NLK	1
116	101-4051	KIT,CLEVIS SHEAR PIN	1
117	004-0019	O-RING,2-118 BUNA 70	5
118	004-0889	O-RING,2-116,BUNA 70	5
119	004-0119	O-RING,2-143 BUNA 70	5
121	001-7519	BOLT,6 PT,1/2-20,STD	2
122	001-5381	PL,T-BAR,LOCKING	2
123	002-1925	ANTI-SIEZE,1 OZ TUBE	1

Spares Kit, HAWE, Standard, 008-0323

Rev. G

Item	P/N	Description	Qty
1	001-1799	CLP,RSLR,T2	1
2	001-1915	SPR,RSLR,T2	1
3	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	2
4	002-0038P	NAS 6404PU1,NLK	6
5	002-0045P	NAS 6404PU7,NLK	4
6	002-0046P	NAS 6404PU8,NLK	4
7	002-0050	NAS 6404U2	4
8	002-0052P	NAS 6404PU3,NLK	6
9	002-0061P	NAS 6406PU6,NLK	2
10	002-0062P	NAS 6406PU12,NLK	2
11	002-0095P	SHCS,10-32X3/8,316SS,NLK	4
12	002-0317P	NAS 6404PU10,NLK PATCH	4
13	002-0346P	NAS 6404PU6,NLK	4
14	002-0403	SHCS,8-32X1/4,SS	2
15	002-0407	WSHR,FLAT,#6,SS	2
16	002-0424	SHCS,10-32X7/8,SS	2
17	002-0426	BHCS,4-40X3/8,SS	2
18	002-0428	FHMS,8-32X3/8,SS	2
19	002-0440	SHCS,3/8-24X1.0,SS	2
20	002-0513	SCR,SELF SEALING,W/O-RING,B90	2
21	002-0549	PIN,SPIROL,1/8X1/2,SS	2
22	002-0686	BHCS,10-24X.375LG,SS	2
23	002-0692	SHCS,4-40X.375,SS	2
24	002-0701	RING,RETING,SMALLEY #WSW137	5
25	002-0704	RING,RETING,INTL,SMALLEY VH400	2
26	002-0705	RING,RETING,INTL,SMALLEY WH562	2
27	002-0792	SCR,SELF SEALING W/O-RING,B90	2
28	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	2
29	002-0934P	SHCS,10-32X1/2,A286,SLVR,NLK	6
30	002-0964	SHCS,1/4-20X1.375,SS	2
31	002-0965	SHCS,1/4-20X1.625,SS	2
32	002-0966	SHCS,1/4-20X.75,SS	2
33	002-1112P	NAS 6403PU1,NLK	6
34	004-0003	O-RING,2-024 BUNA 70	5
35	004-0004	O-RING,2-012 BUNA 70	5
36	004-0017	O-RING,2-031 BUNA 70	5
37	004-0022	O-RING,2-010 BUNA 70	5
38	004-0036	O-RING,2-027 BUNA 70	5
39	004-0043	O-RING,2-033 BUNA 70	5
40	004-0048	O-RING,2-041 BUNA 70	5
41	004-0049	O-RING,2-045 BUNA 70	5
42	004-0080	O-RING,2-020 BUNA 70	5
43	004-0081	O-RING,2-035 BUNA 70	5

Spares Kit, HAWE, Standard, 008-0323 (cont.)

Rev. G

Item	P/N	Description	Qty
44	004-0086	O-RING,2-011 BUNA 70	5
45	004-0087	O-RING,2-011 BUNA 90	10
46	004-1202	O-RING, 2-030, DISOGRIN 9251	1
47	004-0111	O-RING,2-032 BUNA 70	5
48	004-0113	O-RING,2-047 BUNA 70	5
49	004-0114	O-RING,2-013 BUNA 90	5
50	004-0123	O-RING,3-906 BUNA 90	5
51	004-0130	O-RING,2-022 BUNA 70	5
52	004-0133	O-RING,2-014 BUNA 90	5
53	004-0135	O-RING,2-015 BUNA 70	5
54	004-0137	O-RING,.244x.039 BUNA 90 APPLE	12
55	004-0139	O-RING,2-040 BUNA 70	5
56	004-0190	O-RING,2-012 BUNA 90	5
57	004-0210	O-RING,2-128 BUNA 70	5
58	004-0222	O-RING,2-010 BUNA 90	12
59	004-0226	O-RING,2-155 BUNA 70	5
60	004-0303	O-RING,2-022 V75	5
61	004-0413	O-RING,2-026 V75	5
62	004-0445	O-RING,2-006 V90	10
63	004-0518	RING,BACKUP,8-022 N90	5
64	004-0542	O-RING,2-034 BUNA 70	5
65	004-0561	O-RING,.228X.040,BUNA 70	10
66	004-0562	O-RING,2-158 BUNA 70	5
67	004-0563	O-RING,2-160 BUNA 70	5
68	004-0564	O-RING,2-161 BUNA 90	5
69	004-0570	O-RING,2-038 N70	5
70	004-0582	O-RING,2-044 N90	5
71	004-0585	O-RING,.189X.039,N70(APPLE)	12
72	004-0586	O-RING,1.417X.039,N70(APPLE)	10
73	004-0587	O-RING,2-003 BUNA 90	5
74	004-0588	O-RING,2-129 BUNA 90	5
75	004-0601	O-RING,2-275,N70	5
78	004-1201	O-RING,.228X.040 DISOGRIN9251	10
79	004-0627	O-RING,.189X.039,BUNA 90	12
80	004-0641	O-RING,5.822X.070,BUNA 70 (THR	5
81	004-0642	O-RING,2-010,DISOGRIN 90 DURO	10
83	004-0698	O-RING,2-011,DISOGRIN 90 DURO	5
91	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
92	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	1
93	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	1
94	101-1408	RSLR,YAW,T2/T3,GAMMA	1
95	101-1409	RSLR/LVDT WR,T2/T3	1
96	101-1774	PCB ASSY,OPTO ISO,RS422/232	1

Spares Kit, HAWE, Standard, 008-0323 (cont.)

Rev. G

Item	P/N	Description	Qty
97	101-5979	VALVE,SOLENOID,HAWE	1
98	004-0576	WSHR,CRUSH,5/16	8
100	004-0225	O-RING,2-008 BUNA 90	32
101	004-0139	O-RING,2-040 BUNA 70	1
102	004-0036	O-RING,2-027 BUNA 70	1
103	101-5978	VALVE,SERVO,MOOG W/ADPTR&MLEMO	2
104	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
105	001-9835	BEARING,JAW ACTUATOR,T4	2
106	001-9837	PIN,T-BAR,MP35N,T4	1
107	004-1080	SEAL,STEP,RSC100875-Z48NA,7/8"	2
108	001-9850	BEARING,ROD GLAND,T4,JAW	1
110	002-0096P	SHCS,4-40X1/4,SS,NLK	1
116	101-4051	KIT,CLEVIS SHEAR PIN	1
117	004-0019	O-RING,2-118 BUNA 70	5
118	004-0889	O-RING,2-116,BUNA 70	5
119	004-0119	O-RING,2-143 BUNA 70	5
121	001-7519	BOLT,6 PT,1/2-20,STD	2
122	001-5381	PL,T-BAR,LOCKING	2
123	002-1925	ANTI-SIEZE,1 OZ TUBE	1
124	006-1517	FLTR ELEM,NORMAN,U-90341	1

Spares Kit, w/T-Bar, Standard, 008-0383

Rev. 2

Item	P/N	Description	Qty
1	001-1799	CLP,RSLR,T2	1
2	001-1915	SPR,RSLR,T2	1
3	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	2
4	002-0038P	NAS 6404PU1,NLK	6
5	002-0045P	NAS 6404PU7,NLK	4
6	002-0046P	NAS 6404PU8,NLK	4
7	002-0050	NAS 6404U2	4
8	002-0052P	NAS 6404PU3,NLK	6
9	002-0061P	NAS 6406PU6,NLK	2
10	002-0062P	NAS 6406PU12,NLK	2
11	002-0095P	SHCS,10-32X3/8,316SS,NLK	4
12	002-0317P	NAS 6404PU10,NLK PATCH	4
13	002-0346P	NAS 6404PU6,NLK	4
14	002-0403	SHCS,8-32X1/4,SS	2
15	002-0407	WSHR,FLAT,#6,SS	2
16	002-0424	SHCS,10-32X7/8,SS	2
17	002-0426	BHCS,4-40X3/8,SS	2
18	002-0428	FHMS,8-32X3/8,SS	2
19	002-0440	SHCS,3/8-24X1.0,SS	2
20	002-0513	SCR,SELF SEALING,W/O-RING,B90	2
21	002-0549	PIN,SPIROL,1/8X1/2,SS	2
22	002-0686	BHCS,10-24X.375LG,SS	2
23	002-0692	SHCS,4-40X.375,SS	2
24	002-0701	RING,RETING,SMALLEY #WSW137	5
25	002-0704	RING,RETING,INTL,SMALLEY VH400	2
26	002-0705	RING,RETING,INTL,SMALLEY WH562	2
27	002-0792	SCR,SELF SEALING W/O-RING,B90	2
28	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	2
29	002-0934P	SHCS,10-32X1/2,A286,SLVR,NLK	6
30	002-0964	SHCS,1/4-20X1.375,SS	2
31	002-0965	SHCS,1/4-20X1.625,SS	2
32	002-0966	SHCS,1/4-20X.75,SS	2
33	002-1112P	NAS 6403PU1,NLK	6
34	004-0003	O-RING,2-024 BUNA 70	5
35	004-0004	O-RING,2-012 BUNA 70	5
36	004-0017	O-RING,2-031 BUNA 70	5
37	004-0022	O-RING,2-010 BUNA 70	5
38	004-0036	O-RING,2-027 BUNA 70	5
39	004-0043	O-RING,2-033 BUNA 70	5
40	004-0048	O-RING,2-041 BUNA 70	5
41	004-0049	O-RING,2-045 BUNA 70	5
42	004-0080	O-RING,2-020 BUNA 70	5
43	004-0081	O-RING,2-035 BUNA 70	5

Spares Kit, w/T-Bar, Standard, 008-0383 (cont.)

Rev. 2

Item	P/N	Description	Qty
44	004-0086	O-RING,2-011 BUNA 70	5
45	004-0087	O-RING,2-011 BUNA 90	10
46	004-1202	O-RING, 2-030, DISOGRIN 9251	1
47	004-0111	O-RING,2-032 BUNA 70	5
48	004-0113	O-RING,2-047 BUNA 70	5
49	004-0114	O-RING,2-013 BUNA 90	5
50	004-0123	O-RING,3-906 BUNA 90	5
51	004-0130	O-RING,2-022 BUNA 70	5
52	004-0133	O-RING,2-014 BUNA 90	5
53	004-0135	O-RING,2-015 BUNA 70	5
54	004-0137	O-RING,.244x.039 BUNA 90 APPLE	12
55	004-0139	O-RING,2-040 BUNA 70	5
56	004-0190	O-RING,2-012 BUNA 90	5
57	004-0210	O-RING,2-128 BUNA 70	5
58	004-0222	O-RING,2-010 BUNA 90	12
59	004-0226	O-RING,2-155 BUNA 70	5
60	004-0303	O-RING,2-022 V75	5
61	004-0413	O-RING,2-026 V75	5
62	004-0445	O-RING,2-006 V90	10
63	004-0518	RING,BACKUP,8-022 N90	5
64	004-0542	O-RING,2-034 BUNA 70	5
65	004-0561	O-RING,.228X.040,BUNA 70	10
66	004-0562	O-RING,2-158 BUNA 70	5
67	004-0563	O-RING,2-160 BUNA 70	5
68	004-0564	O-RING,2-161 BUNA 90	5
69	004-0570	O-RING,2-038 N70	5
70	004-0582	O-RING,2-044 N90	5
71	004-0585	O-RING,.189X.039,N70(APPLE)	12
72	004-0586	O-RING,1.417X.039,N70(APPLE)	10
73	004-0587	O-RING,2-003 BUNA 90	5
74	004-0588	O-RING,2-129 BUNA 90	5
75	004-0601	O-RING,2-275,N70	5
78	004-1201	O-RING,.228X.040 DISOGRIN9251	1
79	004-0627	O-RING,.189X.039,BUNA 90	12
80	004-0641	O-RING,5.822X.070,BUNA 70 (THR	5
81	004-0642	O-RING,2-010,DISOGRIN 90 DURO	10
83	004-0698	O-RING,2-011,DISOGRIN 90 DURO	5
88	101-6778	CABLE,SEANET CS-MSAJ9	1
91	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
92	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	1
93	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	1
94	101-1408	RSLR,YAW,T2/T3,GAMMA	1
95	101-1409	RSLR/LVDT WR,T2/T3	1

Spares Kit, w/T-Bar, Standard, 008-0383 (cont.)

Rev. 2

Item	P/N	Description	Qty
97	101-5979	VALVE,SOLENOID,HAWE	1
98	004-0576	WSHR,CRUSH,5/16	8
100	004-0225	O-RING,2-008 BUNA 90	32
101	004-0139	O-RING,2-040 BUNA 70	1
102	004-0036	O-RING,2-027 BUNA 70	1
103	101-5978	VALVE,SERVO,MOOG W/ADPTR&MLEMO	2
104	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1
105	001-9835	BEARING,JAW ACTUATOR,T4	2
106	001-9837	PIN,T-BAR,MP35N,T4	1
107	004-1080	SEAL,STEP,RSC100875-Z48NA,7/8"	2
108	001-9850	BEARING,ROD GLAND,T4,JAW	1
110	002-0096P	SHCS,4-40X1/4,SS,NLK	1
116	101-4051	KIT,CLEVIS SHEAR PIN	1
117	004-0019	O-RING,2-118 BUNA 70	5
118	004-0889	O-RING,2-116,BUNA 70	5
119	004-0119	O-RING,2-143 BUNA 70	5
121	001-7519	BOLT,6 PT,1/2-20,STD	2
122	001-5381	PL,T-BAR,LOCKING	2
123	002-1925	ANTI-SIEZE,1 OZ TUBE	1
124	006-1517	FLTR ELEM,NORMAN,U-90341	1

4.2 Enhanced Spares Kits

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Spares Kit, HAWE, Enhanced, 008-0324

Rev. G

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
10	101-4839	CABLE ASSY,SLAVE ARM,T4 SCE	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0257	SP KIT,T4 SENSORS	1
13	008-0327	SP,KIT,T4,HAWE,HYD,COMPONENT	1
14	008-0328	SP KIT,T4 HDW & SEALS	1
15	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
16	008-0385	SPARES KIT,JAW PIN DESIGN	1
17	002-5008	CASE,SHIPPING,PELICAN #1634	1

Spares Kit, w/T-Bar, Enhanced, 008-0384

Rev. D

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0257	SP KIT,T4 SENSORS	1
13	008-0327	SP,KIT,T4,HAWE,HYD,COMPONENT	1
14	008-0328	SP KIT,T4 HDW & SEALS	1
15	008-0385	SPARES KIT,JAW PIN DESIGN	1
16	101-6778	CABLE,SEANET CS-MSAJ9	1
17	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
18	002-5008	CASE,SHIPPING,PELICAN #1634	1

Spares Kit, Enhanced, 199-0307, 008-0463

Rev. D

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0462	SP KIT,T4,POSN CONT,5976	1
13	008-0150	SP KIT,T3,HYD CMPNT	1
14	008-0151	SP KIT,T3,HDW AND SEALS	1
15	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
16	002-5008	CASE,SHIPPING,PELICAN #1634	1

Spares Kit, HAWE, Enhanced, 008-0464

Rev. D

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0462	SP KIT,T4,POSN CONT,5976	1
13	008-0327	SP,KIT,T4,HAWE,HYD,COMPONENT	1
14	008-0328	SP KIT,T4 HDW & SEALS	1
15	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
16	008-0385	SPARES KIT,JAW PIN DESIGN	1
17	002-5008	CASE,SHIPPING,PELICAN #1634	1

Spares Kit, HAWE, Enhanced, 008-0482

Rev. D

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0481	SP KIT,T4,POS CONT,NO HRNS	1
13	008-0327	SP,KIT,T4,HAWE,HYD,COMPONENT	1
14	008-0328	SP KIT,T4 HDW & SEALS	1
15	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
16	008-0385	SPARES KIT,JAW PIN DESIGN	1
17	002-5008	CASE,SHIPPING,PELICAN #1634	1

Spares Kit, KAWE, Enhanced, 008-0483

Rev. D

Item	P/N	Description	Qty
1	008-0161	REFURB KIT,T3,AZ,3/00,INTL PAR	1
2	008-0113	REFURB KIT,T2/T3,LIN ACTR	1
3	008-0162	REFURB KIT,T3,ELB,INTL PARTS	1
4	008-0163	REFURB KIT,T3,P/Y(X2),INTL PAR	1
5	008-0478	KIT,SOFT GOODS,UA 5977	1
6	008-0120	REFURB KIT,T2/T3, FA	1
7	008-0121	REFURB KIT,T2/T3,P/Y,EXT PARTS	1
8	008-0122	REFURB KIT,T2/T3,ELB,EXT PARTS	1
9	008-0118	REFURB KIT,T2/T3,WR,UNI/BIL	1
11	101-4859	SL CONT ASSY,IN ARM SCE MDL,T4	1
12	008-0481	SP KIT,T4,POS CONT,NO HRNS	1
13	008-0327	SP,KIT,T4,HAWE,HYD,COMPONENT	1
14	008-0328	SP KIT,T4 HDW & SEALS	1
15	008-0363	SP KIT,MA,GEN II,UNIV INPUT	1
16	008-0385	SPARES KIT,JAW PIN DESIGN	1
17	002-5008	CASE,SHIPPING,PELICAN #1634	1

4.3 Enhanced Spares Sub-Kits

4.3.1 Index

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4.3.2 Part Lists

Refurb Kit, Linear Actuator, 008-0113

Rev. C

Item	P/N	Description	Qty
2	003-0086	BRG,27W01000-109-1/4 (SHAMBAN)	0
3	003-0087	BRG,GP0A01750-T24	0
4	003-0114	BRG,PVT,LIN ACTR,T2 GAMMA	2
5	003-0115	BRG,PSTN,LIN ACTR,T2 GAMMA	2
6	004-0082	O-RING,3-904 BUNA 90	2
9	004-0508	STEPSEAL,S48270-4203-109P	0
10	004-0509	SCRAPER,S48302-0108A-56	0
11	004-0513	SEAL,S48000-4186	0
12	004-0649	SEAL,PSTN,LIN ACTR,T2/3,GAMMA	1
13	004-0650	SEAL,ROD,LIN ACTR,GAMMA	2
14	004-0651	SCRAPER,ROD,LIN ACTR,T2 GAMMA	1
15	004-0669	O-RING,2-031,BUNA 90	2
16	001-0893	BRG,ROD	2

Refurb Kit, WR, UNI/BIL, 008-0118

Rev. C

Item	P/N	Description	Qty
1	003-0150	BRG,PSTN,LUYTEX	1
2	001-0903	BRG,ROD	1
3	001-2069	BOLT,OIL SPLY T2 WR	5
4	001-2202	SHIM,WR,.002 THK	4
5	001-2203	SHIM,WR,.003THK,T2	4
6	001-2204	SHIM,WR,.005THK,T2	4
7	001-3683	SHCS,5/16-24X2.365(UNBRAKO ONL	3
8	002-0075	SHCS,1/4-28X1,ALLOY	4
9	002-0733	SHCS,5/16-24X2.5 (UNBRAKO ONLY	0
10	002-0745P	SHCS,1/4-28X.75,ALLOY,NLK	5
11	004-0017	O-RING,2-031 BUNA 70	2
12	004-0039	SEAL,ROD STEP RSW100750-Z48NA,	2
13	004-0042	SEAL,STEP RSW100750-T46NA TIT	0
14	004-0045	GLYD,PSTN,SHAMBAN 32G01750A46	0
15	004-0046	O-RING,2-127 BUNA 70	2
16	004-0081	O-RING,2-035 BUNA 70	1
17	004-0087	O-RING,2-011 BUNA 90	8
18	004-0114	O-RING,2-013 BUNA 90	2
19	004-0133	O-RING,2-014 BUNA 90	2
20	004-0139	O-RING,2-040 BUNA 70	3
21	004-0222	O-RING,2-010 BUNA 90	7
22	004-0225	O-RING,2-008 BUNA 90	32
23	004-0413	O-RING,2-026 V75	2
24	004-0445	O-RING,2-006 V90	10
25	004-0570	O-RING,2-038 N70	2
26	004-0573	RING,ROTO GLYD,S48130205A42,SH	0
27	004-0574	SEAL,AR10103-212-UH,FLUROCARBO	1
28	004-0575	SEAL,AR10103-214-UH,FLUROCARBO	1
29	004-0576	WSHR,CRUSH,5/16	16
30	004-0588	O-RING,2-129 BUNA 90	2
31	004-0646	SEAL,JAW PSTN,GAMMA	1
32	004-0648	SEAL,SLIPRING,WRIST,T2 GAMMA	4
33	004-0666	O-RING,2-046,BUNA 90	2
34	004-0698	O-RING,2-011,DISOGRIN 90 DURO	8
35	001-1985	WSHR,THR JAW	4
36	003-0077	RLR,NEEDLE,2X6.3 MM(.078X.25)	10

Refurb Kit, Upper Arm, 008-0119

Rev. D

Item	P/N	Description	Qty
1	004-0003	O-RING,2-024 BUNA 70	3
2	004-0036	O-RING,2-027 BUNA 70	2
3	004-0049	O-RING,2-045 BUNA 70	2
4	004-0080	O-RING,2-020 BUNA 70	2
5	004-0082	O-RING,3-904 BUNA 90	3
6	004-0086	O-RING,2-011 BUNA 70	2
7	004-0087	O-RING,2-011 BUNA 90	10
8	004-0098	O-RING,2-030 BUNA 70	2
9	004-0112	O-RING,2-162 BUNA 70	2
10	004-0113	O-RING,2-047 BUNA 70	2
11	004-0123	O-RING,3-906 BUNA 90	4
12	004-0130	O-RING,2-022 BUNA 70	2
13	004-0137	O-RING,.244x.039 BUNA 90 APPLE	8
14	004-0139	O-RING,2-040 BUNA 70	2
15	004-0190	O-RING,2-012 BUNA 90	10
16	004-0222	O-RING,2-010 BUNA 90	36
17	004-0226	O-RING,2-155 BUNA 70	2
18	004-0518	RING,BACKUP,8-022 N90	2
19	004-0563	O-RING,2-160 BUNA 70	2
20	004-0571	O-RING,2-007 BUNA 90	4
21	004-0612	SEAL,FLUROCARBON #AR10400-223-	1
22	004-0627	O-RING,.189X.039,BUNA 90	40
23	004-0641	O-RING,5.822X.070,BUNA 70 (THR	2
24	004-0642	O-RING,2-010,DISOGRIN 90 DURO	6
25	004-0662	SEAL,FURON #AR 10400-333UC	2
26	001-2475	SHIM,SMALL,.001	2
27	001-2476	SHIM,SMALL,.003	2
28	001-2477	SHIM,SMALL,.010	2
29	001-2478	SHIM,LARGE,.001	2
30	001-2479	SHIM,LARGE,.003	2
31	001-2480	SHIM,LARGE,.010	2
32	002-0513	SCR,SELF SEALING,W/O-RING,B90	2
33	002-0792	SCR,SELF SEALING W/O-RING,B90	3
34	004-0792	O-RING,8.10 IDX.070,BUNA 70	2
35	004-0793	O-RING,3.66 IDX.070,BUNA 70	1
37	004-0048	O-RING,2-041 BUNA 70	2
38	004-0210	O-RING,2-128 BUNA 70	2
39	002-0288	SCR,SELF SEALING,W/O-RING,B90	2
41	004-0082	O-RING,3-904 BUNA 90	10
42	004-0083	O-RING,2-025 BUNA 70	3
43	004-0020	O-RING,2-028 BUNA 70	3

Refurb Kit, Forearm, 008-0120

Rev. C

Item	P/N	Description	Qty
1	002-0288	SCR,SELF SEALING,W/O-RING,B90	4
2	004-0022	O-RING,2-010 BUNA 70	34
3	004-0114	O-RING,2-013 BUNA 90	6
4	004-0137	O-RING,.244x.039 BUNA 90 APPLE	6
5	004-0561	O-RING,.228X.040,BUNA 70	28
6	004-0601	O-RING,2-275,N70	2
7	004-0627	O-RING,.189X.039,BUNA 90	2
8	004-0665	O-RING,.326X.039,BUNA 90	28
10	004-0222	O-RING,2-010 BUNA 90	6

Refurb Kit, Pitch / Yaw, External Parts, 008-0121

Rev. B

Item	P/N	Description	Qty
1	003-0081	BEARING, SLYD RING	4
2	004-0036	O-RING,2-027 BUNA 70	25
3	004-0049	O-RING,2-045 BUNA 70	2
4	004-0080	O-RING,2-020 BUNA 70	2
5	004-0139	O-RING,2-040 BUNA 70	2
6	004-0222	O-RING,2-010 BUNA 90	40
7	004-0303	O-RING,2-022 V75	2
8	004-0583	SEAL,SLIPRING,PITCH (PER SDI P	25
9	004-0585	O-RING,.189X.039,N70(APPLE)	25
10	004-0586	O-RING,1.417X.039,N70(APPLE)	2
11	004-0642	O-RING,2-010,DISOGRIN 90 DURO	8
12	004-0601	O-RING,2-275,N70	2

Spares Kit, Elbow, External Parts, 008-0122

Rev. D

Item	P/N	Description	Qty
1	004-0003	O-RING,2-024 BUNA 70	3
2	004-0004	O-RING,2-012 BUNA 70	2
3	004-0087	O-RING,2-011 BUNA 90	8
4	004-0113	O-RING,2-047 BUNA 70	2
5	004-0137	O-RING,.244x.039 BUNA 90 APPLE	14
6	004-0190	O-RING,2-012 BUNA 90	10
7	004-0222	O-RING,2-010 BUNA 90	16
8	004-0601	O-RING,2-275,N70	2
9	004-0627	O-RING,.189X.039,BUNA 90	40
10	004-0641	O-RING,5.822X.070,BUNA 70 (THR	2
11	004-0642	O-RING,2-010,DISOGRIN 90 DURO	4
12	004-0561	O-RING,.228X.040,BUNA 70	20
13	004-1201	O-RING,.228X.040 DISOGRIN9251	10
14	004-1202	O-RING, 2-030, DISOGRIN 9251	1
15	004-0113	O-RING,2-047 BUNA 70	2
16	002-1132	SHCS,1/4-28X3/4 UNBRAKO ONLY	6
17	002-0935P	SHCS,1/4-28x1/2,A286,SLVR,NLK	10

Spares Kit, MA, 008-0131

Rev. B

Item	P/N	Description	Qty
1	101-3824	PCB ASSY,MOTHER BD,85-264VAC	1
2	101-1774	PCB ASSY,OPTO ISO,RS422/232	1
3	101-1840	PCB ASSY, ANLG MA, GROUNDED	1
4	101-1839	PCB ASSY,8088 CPU,MA,GND	1

Spares Kit, Hydraulic Component, 008-0150

Rev. E

Item	P/N	Description	Qty
8	101-5978	VALVE,SERVO,MOOG W/ADPTR&MLEMO	2
216	006-1517	FLTR ELEM,NORMAN,U-90341	1
217	006-1458-1	HOSE ASSY,TELEFLEX,TEFZEL -4JI	1
218	006-1458-2	HOSE ASSY,TELEFLEX,TEFZEL,-4JI	1
219	006-1458-3	HOSE ASSY,TELEFLEX,TEFZEL,-4JI	1
220	006-1457-4	HOSE ASSY,TELEFLEX,TEFZEL,-4JI	1
221	006-1457-1	HOSE ASSY,TELEFLEX,TEFZEL,-4JI	1
231	006-0940	VALVE,RLF,T4,RLF,T3,J-BOX	1
236	101-2915	VALVE,HYD,3 WAY SPOOL,PILOT	1
238	101-2663	VALVE,SOLENOID,LEE	1
251	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
252	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	1
253	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	1
266	006-1158	HOSE ASSY,540N0606-6-6-6C-13	1

Spares Kit, Hardware and Seals, 008-0151

Rev. R

Item	P/N	Description	Qty
13	004-1201	O-RING,.228X.040 DISOGRIN9251	10
15	004-0642	O-RING,2-010,DISOGRIN 90 DURO	6
16	002-0046P	NAS 6404PU8,NLK	3
17	004-0222	O-RING,2-010 BUNA 90	7
18	004-0190	O-RING,2-012 BUNA 90	1
19	002-0038P	NAS 6404PU1,NLK	16
22	004-0020	O-RING,2-028 BUNA 70	2
23	002-0317P	NAS 6404PU10,NLK PATCH	2
25	002-0061P	NAS 6406PU6,NLK	1
26	004-0080	O-RING,2-020 BUNA 70	1
27	002-0052P	NAS 6404PU3,NLK	10
30	004-0627	O-RING,.189X.039,BUNA 90	1
31	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	1
35	004-0086	O-RING,2-011 BUNA 70	1
37	002-0705	RING,RETING,INTL,SMALLEY WH562	1
41	004-0087	O-RING,2-011 BUNA 90	2
43	004-0137	O-RING,.244x.039 BUNA 90 APPLE	2
45	001-1800	WIRE GUIDE,SLAVE ARM	1
46	001-1799	CLP,RSLR,T2	1
47	002-0095P	SHCS,10-32X3/8,316SS,NLK	6
48	002-0701	RING,RETING,SMALLEY #WSW137	1
49	002-0704	RING,RETING,INTL,SMALLEY VH400	1
50	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	1
51	001-2460	RING,RSLR,SHLDR	1
55	004-0226	O-RING,2-155 BUNA 70	5
56	004-0563	O-RING,2-160 BUNA 70	1
57	004-0611	SEAL,FLUROCARBON #AR10400-329-	1
58	002-1920	PIN,SPR,1/8X1/2,SS 302	1
60	001-1915	SPR,RSLR,T2	1
61	004-0113	O-RING,2-047 BUNA 70	5
62	004-0641	O-RING,5.822X.070,BUNA 70 (THR	5
64	002-0346P	NAS 6404PU6,NLK	6
70	004-0139	O-RING,2-040 BUNA 70	10
71	004-0049	O-RING,2-045 BUNA 70	10
77	002-1880P	SHCS,1/4-28X2.25,316SS,NLK	1
78	002-0062P	NAS 6406PU12,NLK	1
81	002-1888	SHCS,5/16-24X3/4L,120K-150K	1
93	004-0083	O-RING,2-025 BUNA 70	2
100	001-1984	BSHG,WR OIL SPLY TUBE	2
101	002-0011	BHCS,6-32X1/4,18-8,SS	1
102	002-0020	SHCS,10-24X3/4,SS	1
103	002-0045P	NAS 6404PU7,NLK	2
104	002-0050P	NAS 6404PU2,NLK	1

Spares Kit, Hardware and Seals, 008-0151 (cont.)

Rev. R

Item	P/N	Description	Qty
105	002-0082	SHCS,10-24X5/8,SS	1
106	002-0115	STANDOFF,RICHCO MSP-4N,	1
107	002-0137	SHCS,6-32X3/8,SS	1
108	002-0139P	SHCS,10-32X3/4,SS,NLK	1
109	002-0358	SHCS,4-40X.18,SS	1
110	002-0403	SHCS,8-32X1/4,SS	1
111	002-0440	SHCS,3/8-24X1.0,SS	1
112	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	6
113	002-0700	RING,RETING,SMALLEY #WSM150	1
114	002-0703	SCR,SET,1/4-28X.312,FLAT POINT	15
115	002-0705	RING,RETING,INTL,SMALLEY WH562	1
116	002-0707	SCR,SET,3/8-24 X.5,FLAT POINT	6
117	002-0708	RING,RETING,INTL,SMALLEY #VH20	1
118	002-0709	CLP,SERVO,SM23,BERG	1
119	002-0711	SPR,LC-026E-14-MW,LEE	1
120	002-0712	RING,RETING,INTL,VH56,SMALLEY	1
121	002-0726	PIN,1/16X3/16 SS	1
122	002-0727P	SHCS,1/4-28X1/2,ALLOY, NLK	2
123	002-0862	WSHR,#8 LOCKINTL TOOTH,SS	1
124	002-0933	SHCS,6-32,5/16LONG,ALLOY STL	6
125	002-1089P	SHCS,1/4-28X9/16 NLK	1
126	002-1106	SHCS,1/2-20X4,ALLOY STL	1
127	002-1127	PIN,SPIROL,.033X.125,SS	1
128	002-1133	SHCS 10-32 X 5/8,UNBRAKO	1
129	002-1140	NUT,1/2-20,NAS1291-8	1
130	002-0199	PIN,DWL,3/16X1/2,SS	1
131	002-1132	SHCS,1/4-28X3/4 UNBRAKO ONLY	6
132	003-0012	TORRINGTON,Q11406	55
133	003-0013	TORRINGTON,NTA 2840	1
134	003-0018	TORRINGTON,C436Q	20
135	003-0030	BRG,THR,TORRINGTON,NTA-4860	1
136	003-0067	BRG,THR,TORRINGTON TRB 4860	1
137	003-0068	RACE,THR,TORRINGTON,TRA2435	1
138	003-0071	BRG,THR,NEEDLE RLR,NTA 5266	1
139	003-0072	WSHR,THR,NEDDLE RLR,TRA 5266	1
140	003-0074	WSHR,THR,TRA2840,TORRINGTON	1
141	003-0075	BRG,THR,NTA4052,TORRINGTON	1
142	003-0076	WSHR,THR,TRB4052,TORRINGTON	1
143	004-1202	O-RING, 2-030, DISOGRIN 9251	1
144	004-0843	O-RING,.930 IDX.040,N70	1
202	002-1388P	NAS 6403PU34,NLK	2
206	002-1112P	NAS 6403PU1,NLK	7
225	002-0679	SHCS,10-32X1/2,ALLOY STL(UNBRA	3

Spares Kit, Hardware and Seals, 008-0151 (cont.)

Rev. R

Item	P/N	Description	Qty
234	002-1115P	SHCS,1/4-28X2.0,SS,NLK	1
240	002-1101	RING,RETING,INTL,SMALLEY,#WHM-	1
242	002-1114	RING,RETING,INTL,7/16 BORE,SS	1
263	004-0048	O-RING,2-041 BUNA 70	10
287	002-0792	SCR,SELF SEALING W/O-RING,B90	1
295	002-0096P	SHCS,4-40X1/4,SS,NLK	1
296	004-0792	O-RING,8.10 IDX.070,BUNA 70	10
730	002-0710	RING,RETING,EXTERNAL,SMALLEY #	1
774	001-1985	WSHR,THR JAW	2
778	001-2071	WSHR,T2 JAW	3
2107	002-1492	HHCS,1/4-20X1.25,SS	1
2108	002-0128P	SHCS,1/4-28X1.5,SS,NLK	1
2109	002-0068	WSHR,FL,1/4,316SS .625 OD,.050	1
2110	002-0790	WSHR,1/4IDX.5OD,SS .032THK	1
2111	001-7519	BOLT,6 PT,1/2-20,STD	2
2112	001-5381	PL,T-BAR,LOCKING	2
2113	002-1925	ANTI-SIEZE,1 OZ TUBE	1

Refurb Kit, AZ, Internal Parts, 008-0161

Rev. E

Item	P/N	Description	Qty
20	002-0703	SCR,SET,1/4-28X.312,FLAT POINT	3
21	002-0705	RING,RETING,INTL,SMALLEY WH562	1
22	002-0880	RING,RETING,INTL,W/LOCKING TAB	2
23	002-0707P	SCR, SET, 3/8-24X.5, FLAT, NLK	10
25	002-1541P	NAS 6406PU14,NLK	6
29	003-0018	TORRINGTON,C436Q	5
30	003-0071	BRG,THR,NEEDLE RLR,NTA 5266	2
31	003-0072	WSHR,THR,NEDDLE RLR,TRA 5266	2
34	004-0563	O-RING,2-160 BUNA 70	1
35	004-0564	O-RING,2-161 BUNA 90	2
38	004-0610	SEAL,FLUROCARBON #AR10400-348-	1
39	004-0190	O-RING,2-012 BUNA 90	6
51	002-5473	PIN,DWL,3/16X1/2,DELRIN	3
52	001-2173	RING,BACK-UP,AZ,T2	2
64	001-5324	CARR,VANE SEAL,AZ	2
66	001-5309	SEAL,VANE,AZ,T3	2
69	004-0542	O-RING,2-034 BUNA 70	2
70	002-0440	SHCS,3/8-24X1.0,SS	2
76	001-5308	SEAL,END,AZ,T3	2
79	001-5313	SEAL,BACK-UP,VANE,AZ,T3	4
80	002-1892	SHCS,7/16-20X1.25,ASTMA574	8
81	004-0697	O-RING,2-041,BUNA 90	2
83	004-0115	O-RING,.492x.039 BUNA 90 APPLE	6

- Drawings & Part Lists

Refurb Kit, Elbow, Internal Parts, 008-0162

Rev. E

Item	P/N	Description	Qty
7	001-5366	SEAL,END,ELB,T3 1/2	2
14	002-0879	RING,RETING,INTL,W/LOCKING TAB	2
15	002-0700	RING,RETING,SMALLEY #WSM150	1
18	002-0935P	SHCS,1/4-28x1/2,A286,SLVR,NLK	10
22	003-0012	TORRINGTON,Q11406	5
24	003-0067	BRG,THR,TORRINGTON TRB 4860	4
25	003-0030	BRG,THR,TORRINGTON,NTA-4860	2
26	003-0068	RACE,THR,TORRINGTON,TRA2435	1
27	003-0069	SLYDRING,BRG	2
28	004-0556	SEAL,SLIPRING,ELB,T2 (PER SDI	11
31	001-5365	BACK-UP,VANE SEAL ELB,T3 1/2	4
32	001-5364	SEAL,VANE,ELB,T3 1/2	2
33	004-0610	SEAL,FLUROCARBON #AR10400-348-	2
34	004-0561	O-RING,.228X.040,BUNA 70	20
35	004-1202	O-RING, 2-030, DISOGRIN 9251	1
36	004-0627	O-RING,.189X.039,BUNA 90	10
39	004-0562	O-RING,2-158 BUNA 70	2
40	002-0703P	SCR, SET, 1/4-28X.312,FLAT,NLK	10
46	004-0137	O-RING,.244x.039 BUNA 90 APPLE	6
47	002-0050P	NAS 6404PU2,NLK	6
48	001-2174	RING,BACK-UP,ELB	2
49	004-1201	O-RING,.228X.040 DISOGRIN9251	10
50	002-1132	SHCS,1/4-28X3/4 UNBRAKO ONLY	6
54	001-2197	SHIM,ELB,.001THK,T2	4
55	001-2198	SHIM,ELB,.003THK	4
56	001-2199	SHIM,ELB,.005THK,T2	4
57	001-2200	SHIM,ELB,.007THK	4
58	001-2201	SHIM,ELB,.008THK,T2	4
59	004-0210	O-RING,2-128 BUNA 70	11
62	002-0727P	SHCS,1/4-28X1/2,ALLOY, NLK	10
64	002-1816	SHCS,10-32X7/8,ALLOY STL	4
65	001-5367	CARR,VANE SEAL,ELB,T3 1/2	2
66	004-0111	O-RING,2-032 BUNA 70	2
67	004-0697	O-RING,2-041,BUNA 90	2
70	002-1133	SHCS 10-32 X 5/8,UNBRAKO	4
74	002-1089P	SHCS,1/4-28X9/16 NLK	2

Refurb Kit, Pitch / Yaw, Internal Parts, 008-0163

Rev. C

Item	P/N	Description	Qty
6	001-5358	SEAL,END,PITCH,T3 1/2	4
9	002-0934P	SHCS,10-32X1/2,A286,SLVR,NLK	20
10	002-0878	RING,RETING,INTL,W/LOCKING TAB	4
12	002-0038P	NAS 6404PU1,NLK	8
14	003-0012	TORRINGTON,Q11406	10
16	003-0075	BRG,THR,NTA4052,TORRINGTON	4
17	003-0076	WSHR,THR,TRB4052,TORRINGTON	8
18	002-0703P	SCR, SET, 1/4-28X.312,FLAT,NLK	20
19	004-0887	O-RING, 2.400 X .040, BUNA 70	4
20	001-5355	SEAL,VANE,PITCH,T3 1/2	4
21	004-0968	O-RING,2-028,DISOGRIN 70 DURO	4
22	004-0137	O-RING,.244x.039 BUNA 90 APPLE	8
23	004-0582	O-RING,2-044 N90	4
24	004-0627	O-RING,.189X.039,BUNA 90	60
25	001-5356	BACK-UP,VANE SEAL,PITCH RTR VA	4
26	001-5357	BACKUP,VANE SEAL,PITCH STATOR	4
28	004-0609	SEAL,FLUROCARBON #AR10400-340-	4
32	001-2175	RING,BACK-UP,PITCH	4
35	001-2192	SHIM,PITCH,.001THK	4
36	001-2193	SHIM,PITCH,.003THK,T2	4
37	001-2194	SHIM,PITCH,.005THK,T2	4
38	001-2195	SHIM,PITCH,.007THK,T2	4
39	001-2196	SHIM,PITCH,.008THK,T2	4
43	002-0679	SHCS,10-32X1/2,ALLOY STL(UNBRA	12
49	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	20

Spares Kit, Position Control, 008-0257

Rev. B

Item	P/N	Description	Qty
9	101-2628	RSLR,AZ,T3	1
10	101-1405	RSLR,ELB,T2/T3	1
11	101-1407	RSLR,PITCH,T2/T3	1
12	101-1408	RSLR,YAW,T2/T3,GAMMA	1
13	101-1573	RSLR,SHLDR,T2/T3,SP,GAMMA	1
668	101-1409	RSLR/LVDT WR,T2/T3	1

- Drawings & Part Lists

Spares Kit, HAWE, Hydraulic Component, 008-0327

Rev. B

Item	P/N	Description	Qty
8	101-5978	VALVE,SERVO,MOOG W/ADPTR&MLEMO	2
9	006-1517	FLTR ELEM,NORMAN,U-90341	1
17	001-9084	TUBE,AZ,CASE,T4 UPPERARM	1
18	001-9082	TUBE,AZ,A1,T4 UPPERARM	1
19	001-9083	TUBE,AZ,A2,T4 UPPERARM	1
20	001-9086	TUBE,SHLDR EXT,T4 UPPERARM	1
21	001-9087	TUBE,SHLDR RETRACT,T4 UPPERARM	1
36	101-5979	VALVE,SOLENOID,HAWE	1
62	001-9085	TUBE,PRESS,FLTR T4 UPPERARM	1
66	001-9088	TUBE,RETURN,3/8,T4 UPPERARM	1
231	006-0940	VALVE,RLF,T4,RLF,T3,J-BOX	1
251	101-2391	HOSE ASSY,AZ RTN,T3,UA	1
252	101-2392	HOSE ASSY,AZ C1,C2,UPRARM,T3	1
253	101-2393	HOSE ASSY,SHLDR,C1,C2,UPRARM,T	1

- Drawings & Part Lists

Spares Kit, HAWE, Hardware & Seals, 008-0328

Rev. D

Item	P/N	Description	Qty
15	004-0642	O-RING,2-010,DISOGRIN 90 DURO	6
16	002-0046P	NAS 6404PU8,NLK	3
17	004-0222	O-RING,2-010 BUNA 90	7
18	004-0190	O-RING,2-012 BUNA 90	1
19	002-0038P	NAS 6404PU1,NLK	16
22	004-0020	O-RING,2-028 BUNA 70	2
23	002-0317P	NAS 6404PU10,NLK PATCH	2
25	002-0061P	NAS 6406PU6,NLK	1
26	004-0080	O-RING,2-020 BUNA 70	1
27	002-0052P	NAS 6404PU3,NLK	10
30	004-0627	O-RING,.189X.039,BUNA 90	1
31	001-2950	BHCS,10-32X1/4,SS SMOOTH BOT	1
35	004-0086	O-RING,2-011 BUNA 70	1
37	002-0705	RING,RETING,INTL,SMALLEY WH562	1
41	004-0087	O-RING,2-011 BUNA 90	2
43	004-0137	O-RING,.244x.039 BUNA 90 APPLE	2
45	001-1800	WIRE GUIDE,SLAVE ARM	1
46	001-1799	CLP,RSLR,T2	1
47	002-0095P	SHCS,10-32X3/8,316SS,NLK	6
48	002-0701	RING,RETING,SMALLEY #WSW137	1
49	002-0704	RING,RETING,INTL,SMALLEY VH400	1
50	002-0861	RING,RETING,INTL,SMALLEY,#VH-3	1
51	001-2460	RING,RSLR,SHLDR	1
55	004-0226	O-RING,2-155 BUNA 70	5
56	004-0563	O-RING,2-160 BUNA 70	1
57	004-0611	SEAL,FLUROCARBON #AR10400-329-	1
58	002-1920	PIN,SPR,1/8X1/2,SS 302	1
60	001-1915	SPR,RSLR,T2	1
61	004-0113	O-RING,2-047 BUNA 70	5
62	004-0641	O-RING,5.822X.070,BUNA 70 (THR	5
64	002-0346P	NAS 6404PU6,NLK	6
70	004-0139	O-RING,2-040 BUNA 70	10
71	004-0049	O-RING,2-045 BUNA 70	10
77	002-1880P	SHCS,1/4-28X2.25,316SS,NLK	1
78	002-0062P	NAS 6406PU12,NLK	1
81	002-1888	SHCS,5/16-24X3/4L,120K-150K	1
93	004-0083	O-RING,2-025 BUNA 70	2
100	001-1984	BSHG,WR OIL SPLY TUBE	2
101	002-0011	BHCS,6-32X1/4,18-8,SS	1
102	002-0020	SHCS,10-24X3/4,SS	1
103	002-0045P	NAS 6404PU7,NLK	2
104	002-0050P	NAS 6404PU2,NLK	1
105	002-0082	SHCS,10-24X5/8,SS	1

Spares Kit, HAWE, Hardware & Seals, 008-0328 (cont.)

Rev. D

Item	P/N	Description	Qty
106	002-0115	STANDOFF,RICHCO MSP-4N,	1
107	002-0137	SHCS,6-32X3/8,SS	1
108	002-0330P	SHCS,10-32X1.25,316SST,NLK	1
109	002-0358	SHCS,4-40X.18,SS	1
110	002-0403	SHCS,8-32X1/4,SS	1
111	002-0440	SHCS,3/8-24X1.0,SS	1
112	002-0679P	SHCS,10-32X1/2,ALLOY,NLK	6
113	002-0700	RING,RETING,SMALLEY #WSM150	1
114	002-0703	SCR,SET,1/4-28X.312,FLAT POINT	15
115	002-0705	RING,RETING,INTL,SMALLEY WH562	1
116	002-0707	SCR,SET,3/8-24 X.5,FLAT POINT	6
117	002-0708	RING,RETING,INTL,SMALLEY #VH20	1
118	002-0709	CLP,SERVO,SM23,BERG	1
119	002-0711	SPR,LC-026E-14-MW,LEE	1
120	002-0712	RING,RETING,INTL,VH56,SMALLEY	1
121	002-0726	PIN,1/16X3/16 SS	1
122	002-0727P	SHCS,1/4-28X1/2,ALLOY, NLK	2
123	002-0862	WSHR,#8 LOCKINTL TOOTH,SS	1
124	002-0933	SHCS,6-32,5/16LONG,ALLOY STL	6
125	002-1089P	SHCS,1/4-28X9/16 NLK	1
126	002-1106	SHCS,1/2-20X4,ALLOY STL	1
127	002-1127	PIN,SPIROL,.033X.125,SS	1
128	002-1133	SHCS 10-32 X 5/8,UNBRAKO	1
129	002-1140	NUT,1/2-20,NAS1291-8	1
130	002-0199	PIN,DWL,3/16X1/2,SS	1
131	002-1132	SHCS,1/4-28X3/4 UNBRAKO ONLY	6
132	003-0012	TORRINGTON,Q11406	55
133	003-0013	TORRINGTON,NTA 2840	1
134	003-0018	TORRINGTON,C436Q	20
135	003-0030	BRG,THR,TORRINGTON,NTA-4860	1
136	003-0067	BRG,THR,TORRINGTON TRB 4860	1
137	003-0068	RACE,THR,TORRINGTON,TRA2435	1
138	003-0071	BRG,THR,NEEDLE RLR,NTA 5266	1
139	003-0072	WSHR,THR,NEDDLE RLR,TRA 5266	1
140	003-0074	WSHR,THR,TRA2840,TORRINGTON	1
141	003-0075	BRG,THR,NTA4052,TORRINGTON	1
142	003-0076	WSHR,THR,TRB4052,TORRINGTON	1
143	004-1202	O-RING, 2-030, DISOGRIN 9251	1
144	004-0843	O-RING,.930 IDX.040,N70	1
145	004-1201	O-RING,.228X.040 DISOGRIN9251	10
202	002-1388P	NAS 6403PU34,NLK	2
206	002-1112P	NAS 6403PU1,NLK	7
225	002-0679	SHCS,10-32X1/2,ALLOY STL(UNBRA	3

Spares Kit, HAWE, Hardware & Seals, 008-0328 (cont.)

Rev. D

Item	P/N	Description	Qty
242	002-1114	RING,RETING,INTL,7/16 BORE,SS	1
263	004-0048	O-RING,2-041 BUNA 70	10
287	002-0792	SCR,SELF SEALING W/O-RING,B90	1
295	002-0096P	SHCS,4-40X1/4,SS,NLK	1
296	004-0792	O-RING,8.10 IDX.070,BUNA 70	10
730	002-0710	RING,RETING,EXTERNAL,SMALLEY #	1
774	001-1985	WSHR,THR JAW	2
778	001-2071	WSHR,T2 JAW	3
2110	002-0790	WSHR,1/4IDX.5OD,SS .032THK	1
2113	002-1925	ANTI-SIEZE,1 OZ TUBE	1

Spares Kit, Master Controller, Universal Input, 008-0363

Rev. A

Item	P/N	Description	Qty
1	005-5195	PCB,MASTER PROCESSOR,MCU	1
2	005-4645	PCB ASSY,IN ARM TELEMETRY,T4	1

Spares Kit, Jaw Pin Design, 008-0385

Rev. A

Item	P/N	Description	Qty
1	001-9835	BEARING,JAW ACTUATOR,T4	2
2	001-9837	PIN,T-BAR,MP35N,T4	1
3	004-1080	SEAL,STEP,RSC100875-Z48NA,7/8"	2
4	001-9850	BEARING,ROD GLAND,T4,JAW	1

Spares Kit, Position Control, 008-0462

Rev. A

Item	P/N	Description	Qty
9	101-2628	RSLR,AZ,T3	1
10	101-1405	RSLR,ELB,T2/T3	1
11	101-1407	RSLR,PITCH,T2/T3	1
12	101-1408	RSLR,YAW,T2/T3,GAMMA	1
13	101-1573	RSLR,SHLDR,T2/T3,SP,GAMMA	1
14	101-6852	HARNESS,SA,T4/CAMERA,TMT	1
668	101-1409	RSLR/LVDT WR,T2/T3	1

Spares Kit, Position Controller, No HRNS, 008-0481

Rev. B

Item	P/N	Description	Qty
1	101-1409	RSLR/LVDT WR,T2/T3	1
9	101-2628	RSLR,AZ,T3	1
10	101-1405	RSLR,ELB,T2/T3	1
11	101-1407	RSLR,PITCH,T2/T3	1
12	101-1408	RSLR,YAW,T2/T3,GAMMA	1
13	101-1573	RSLR,SHLDR,T2/T3,SP,GAMMA	1

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