4322-SYS-NAVAIR

Automated Pressure Calibrator

Service Manual

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About the Product Manual Set

Product manual set consists of a Model Number 4322 Operators Manual and a Model Number 4322 Service Manual available as Print On Demand documents hosted on the Technical Manual Application System (TMAPS – NATEC's Technical manual master database).

System Calibration

For Navy calibration actions calibrate IAW NA 17–35MTL–3.

FLUKE®
Calibration

4322

Automated Pressure Calibrator

Service Manual

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Chapter 1
Introduction and Specifications

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Introduction

This chapter supplies information about the Product, the manual set, safety information, contact information, and specifications.

Product Overview

The Fluke 4322 Automated Pressure Calibrator (the Product or Calibrator) is a transportable system including an automated controller for calibration and testing of pressure measurement instruments (see Figure 1-1). The Calibrator can calibrate and test analog gauges, digital gauges, pressure transducers, pressure switches, and other pressure devices.

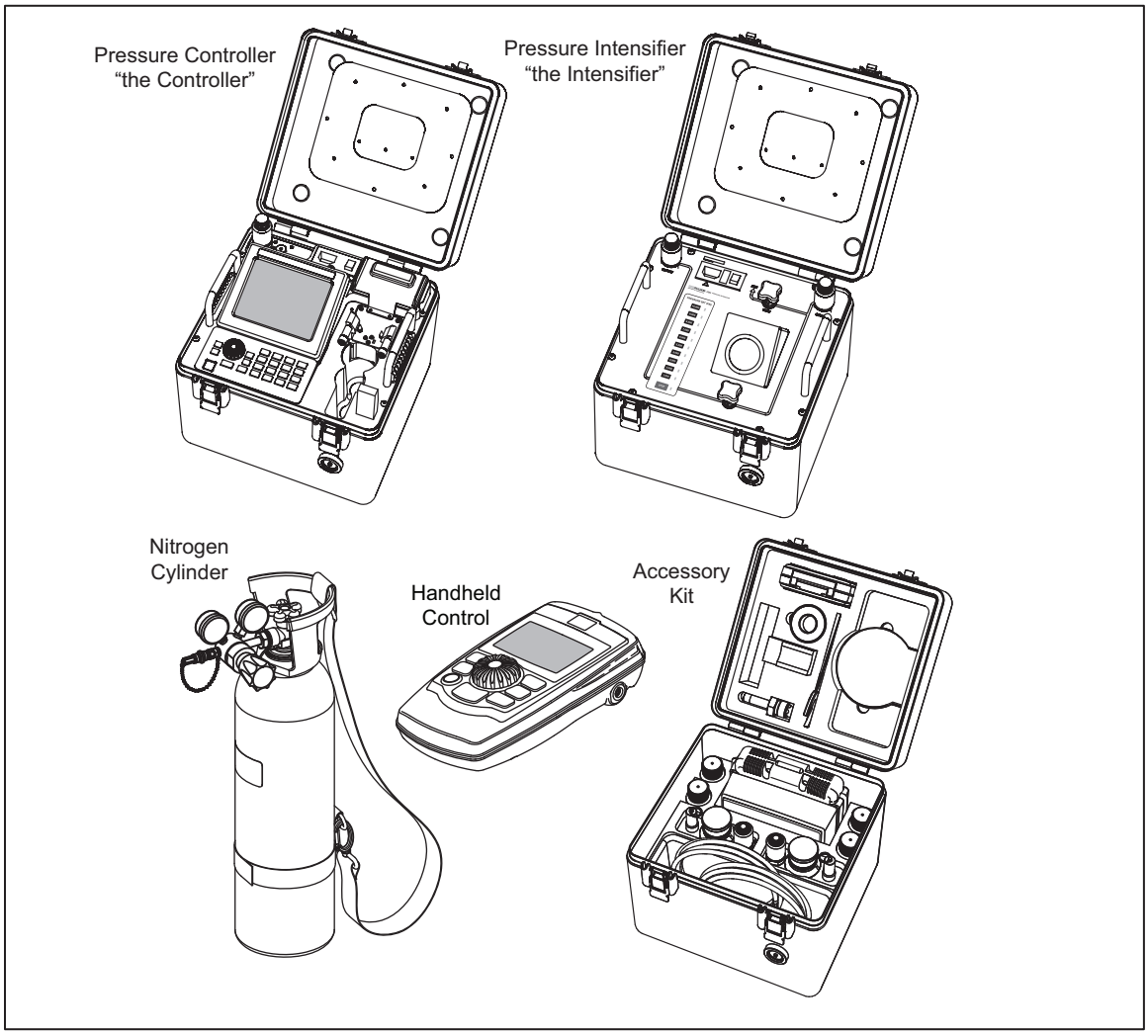


Figure 1-1. Main Components of 4322-SYS-NAVAIR Configuration of 4322 Automated Pressure Calibrator

For maximum versatility and portability, the Calibrator consists of a Pressure Controller (the Controller), a Pressure Intensifier (the Intensifier), a Nitrogen Cylinder, and an Accessory Kit that can be used in three different configurations. Determination of which configuration to use depends on how much pressure is necessary to complete the calibration.

Safety Information

A **Warning** identifies condition and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

See Table 1-1 for a list of symbols used in this manual and on the Calibrator.

Table 1-1. Symbols

Symbol	Description	Symbol	Description
	Risk of Danger. Important information. See manual.		Conforms to relevant North American Safety Standards.
CE	Conforms to European Union directives		Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.
	Earth ground		Hazardous voltage
	Conforms to relevant Australian EMC requirements		

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury:

- **High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.**
- **Read all safety Information before you use the Product.**
- **Carefully read all instructions.**
- **Use the Product only as specified, or the protection supplied by the Product can be compromised.**
- **Examine the case before you use the Product. Look for cracks or missing plastic. Carefully look at the insulation around the terminals.**
- **Do not use the Product if it operates incorrectly.**
- **Do not use and disable the Product if it is damaged.**
- **Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.**
- **Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.**
- **Make sure the ground conductor in the mains power cord is connected to a protective earth ground. Disruption of the protective earth could put voltage on the chassis that could cause death.**

- **Before using this equipment to generate or apply pressure, ensure integrity of all components to be pressurized and that they are rated to adequate working pressure.**
- **Do not put the Product where access to the mains power cord is blocked.**
- **Do not use test leads if they are damaged. Examine the test leads for damaged insulation and measure a known voltage.**
- **Do not exceed the Measurement Category (CAT) rating of the lowest rated individual component of a Product, probe, or accessory.**
- **Keep fingers behind the finger guards on the probes.**
- **Do not apply more than the rated voltage, between the terminals or between each terminal and earth ground.**
- **Do not touch voltages > 30 V ac rms, 42 V ac peak, or 60 V dc.**
- **Do not use the Product around explosive gas.**

The Product Manual Set

The Calibrator includes an Operators Manual and a Service Manual. Both manuals are online at www.flukecal.com and on a CD in the Accessory Kit.

Note

Not all available components are included in every configuration of a 4322 system. Both manuals assume model 4322-SYS-NAVAIR, which includes all major components available, except for the 4322-REM Handheld Control, which is ordered separately.

- The *4322 Operators Manual* contains basic system and feature information, operation instructions, and basic user maintenance and troubleshooting information.
- This *4322 Service Manual* contains service, calibration, and repair information and instructions.

General Specifications

Power Requirements ..... 100 V ac to 240 V ac (-15 %, +10 %), 50 Hz to 60 Hz

Maximum Power Consumption

- Controller ..... 110 VA
- Intensifier ..... 250 VA

Operating Temperature Range ..... 0 °C to 50 °C

Storage Temperature Range ..... -30 °C to 71 °C

Humidity ..... 5 % to 95 %

Vibration ..... Meets MIL-T-28800D

Altitude (operation) ..... 2,000 m

Weight

- Controller ..... ~12 kg (27 lb)
- Intensifier ..... ~14 kg (31 lb)
- Accessory Kit with Handheld Control ..... ~12 kg (27 lb)
- Nitrogen Cylinder ..... ~12 kg (26 lb)

Dimensions

- Controller, Intensifier, and Accessory Kit ..... 33 cm Height x 31 cm Width x 31 cm Depth (13 in Height x 12 in Width x 12 in Depth)
- Nitrogen Cylinder ..... 69 cm Height x 18 cm Diameter (27 in Height x 7 in Diameter)

Remote Communication Interfaces ..... RS-232, USB type B, IEEE-488.2, USB type A (PRINTER port only)

Pressure Range ..... 3.5 kPa (0.5 psi) absolute to 70 MPa (10,000 psi)

Operating Medium ..... Dry nitrogen supply, or ambient air compressed by on-board pump.

Warm-up Time ..... 15 minutes from power on, after at least 60 minutes ambient temperature acclimation time within the working temperature range.

Safety ..... IEC 61010-1: Overvoltage Category II, Pollution Degree2,

Electromagnetic Compatibility (EMC)

- International ..... IEC 61326-1: Controlled Electromagnetic Environment

  CISPR 11: Group 1, Class A

  Group 1: Equipment has intentionally generated and/or uses conductively-coupled radio frequency energy that is necessary for the internal function of the equipment itself.

  Class A: Equipment is suitable for use in all establishments other than domestic and those directly connected to a low-voltage power supply network that supplies buildings used for domestic purposes. There may be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted and radiated disturbances.

  Emissions that exceed the levels required by CISPR 11 can occur when the equipment is connected to a test object.
- Korea (KCC) ..... Class A Equipment (Industrial Broadcasting & Communication Equipment)

  Class A: Equipment meets requirements for industrial electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and not to be used in homes.
- USA (FCC) ..... 47 CFR 15 subpart B. This product is considered an exempt device per clause 15.103.

Pressure Limits

Recommended Supply Pressure

Controller ..... Greater of 700 kPa (100 psi) or 10 % above max target pressure, not to exceed 73 MPa (10,500 psi).

Intensifier ..... 3.5 MPa to 14 MPa (500 psi to 2,000 psi)

Max System Working Pressure ..... 70 MPa (10,000 psi)

Max Supply Pressure

Controller ..... 73 MPa (10,500 psi)

Intensifier ..... 20 MPa (3,000 psi)

Max Nitrogen Cylinder Pressure ..... 14 MPa (2,000 psi)

Max Regulator Pressure

Inlet ..... 28 MPa (4,000 psi)

Outlet ..... 17 MPa (2,500 psi)

Connections, Accessories, and Adapters ..... Refer to the subsequent tables.

Controller, Intensifier, and Nitrogen Cylinder Connections

Unit	Name	Type of Fittings [1]	Maximum Working Pressure Limit
Controller	TEST Port	IQC70 female, coupler located on CPS	70 MPa (10,000 psi)
	SUPPLY Port	IQC70 female coupler	
	Hose Purge	IQC70 male stem, located on CPS	
Intensifier	SUPPLY Port	IQC70 female coupler	70 MPa (10,000 psi)
	OUTLET Port	IQC70 female coupler	
N2 Cylinder Assembly	Cylinder Valve	CGA580 female coupler	20 MPa (3,000 psi)
	Regulator Inlet	CGA580 nipple	20 MPa (3,000 psi)
	Regulator Outlet	Miniature QC female coupler	20 MPa (3,000 psi)

Note:
1. IQC70 is a Fluke Calibration interlocking quick connection nominally rated to 70 MPa (10,000 psi).

Adaptor Kit Fittings

Name	Type of Fittings [1]	Maximum Working Pressure Limit [2]
Fitting, 1/2 Male Pipe Thread (NPT)	IQC70 male stem	70 MPa (10,000 psi)
Fitting, 1/4 Male Pipe Thread (NPT)		
Fitting, 1/8 Male Pipe Thread (NPT)		
Fitting, 1/2 Female Pipe Thread (NPT)		
Fitting, 1/4 Female Pipe Thread (NPT)		
Fitting, 1/8 Female Pipe Thread (NPT)		
Fitting, DH200 female (HF4 Equivalent)		
Fitting, AN6 Female		
Fitting, AN4 Female		
Fitting, HM4 Equivalent		
Fitting, AN6 Male		
Fitting, AN4 Male		
Fitting, 1/4 ID Hose Barb	IQC70 male stem	700 kPa (100 psi)
Fitting, 1/8 ID Hose Barb	IQC70 male stem	700 kPa (100 psi)

Notes:
1. IQC70 is a Fluke Calibration interlocking quick connection nominally rated to 70 MPa (10,000 psi).
2. Working pressures indicated are for adaptors only. Actual pressure capability may be limited by the integrity or maximum working pressure of the fitting to which the adaptor is connected.

High-Pressure Hoses

Name	Type of Fittings [1]	Maximum Working Pressure Limit
Test hoses, 3 m (10 ft)	IQC70 male stem at one end, and IQC070 female coupling at the other.	70 MPa (10,000 psi)
Interconnect hose, 1.8 m (6 ft)	IQC70 male stem at both ends.	70 MPa (10,000 psi)
Supply hose, 1.8 m (6 ft)	IQC70 male stem at one end, and miniature QC male stem at the other.	20 MPa (3,000 psi) [2]

Notes:
1. IQC70 is a Fluke Calibration interlocking quick connection nominally rated to 70 MPa (10,000 psi).
2. Hose limited to 3,000 psi due to miniature QC used to connect to the fitting on the regulator.

Measurement Specifications

Barometer Module Range ..... 70 kPa to 110 kPa absolute (10 psi to 16 psi) absolute

Pressure Transducer Module Ranges

Note: Pressure modules are switched automatically and transparently to the operator.

A150k..... 3.5 kPa to 150 kPa absolute (0.5 psi to 22 psi)
G700k ..... 50 kPa to 700 kPa gauge (7 psi to 100 psi)
G10M ..... 700 kPa to 10 MPa gauge (100 psi to 1,500 psi)
G70M ..... 10 MPa to 70 MPa gauge (1,500 psi to 10,000 psi)

Resolution ..... Greater of 0.001% of reading or 0.00004 psi (0.28 Pa)

Measurement Uncertainty

Measurement Mode	Range	Uncertainty [1]
Gauge [2]	-98 kPa to +28 kPa (-14.2 psi to +4 psi) gauge	±25 Pa (0.0036 psi, 0.1 in H_2O at 20 °C)
	28 kPa to 70 MPa (4 psi to 10,000 psi) gauge	±0.1 % of reading
Absolute	3.5 kPa to 130 kPa (0.5 psi to 19 psi) absolute	±25 Pa (0.0036 psi, 0.1 in H_2O at 20 °C)
	130 kPa to 70 MPa (19 to 10,000 psi) absolute	±0.1 % of reading
Vacuum [2]	0 kPa to 98 kPa (0 to 14.2 psi, 0 to 29 inHg)	±25 Pa (0.0074 inHg)

Notes:
1. Measurement uncertainty is defined as the maximum deviation from the indicated value of measured pressure for 1 year after alignment including hysteresis, linearity, repeatability, stability, temperature, humidity effects, and calibration reference standard measurement uncertainty. Expression of uncertainty uses a coverage factor of 2 and conforms with the recommendations of the ISO Guide to the Expression of Uncertainty in Measurement.
2. Negative gauge and vacuum pressure values assume the ambient atmospheric pressure is approximately 101 kPa (14.7 psi) absolute.

Pressure Control Specifications

Control Precision ..... Greater of ± 0.025 % of reading or ± 25 Pa (0.0036 psi).

Control Ranges

Pressure Source	Measure Mode	Range
On-board Pump	Gauge [1]	-98 kPa to 2 MPa (-14.2 to 300 psi)
	Absolute	3.5 kPa to 2 MPa (0.5 to 300 psi)
	Vacuum (negative gauge) [1]	0 to 98 kPa (0 to 14.2 psi, 0 to 29 inHg)
External Gas Supply	Gauge	28 kPa to 70 MPa (4 to 10,000 psi)
	Absolute	130 kPa to 70 MPa (19 to 10,000 psi)

Note:
1. Negative gauge and vacuum pressure values assume the ambient atmospheric pressure is approximately 101 kPa (14.7 psi) absolute.

Typical Control Set Times

Measure Mode	Range	Time (seconds) [5]
Gauge [7]	<28 kPa (4 psi)	90 [1] [6]
	28 kPa to 700 kPa (4 to 100 psi)	30 [2]
	700 kPa to 7 MPa (100 to 1,000 psi)	30 [3]
	7 to 70 MPa (1,000 to 10,000 psi)	60 [4]
Absolute	<14 kPa (2 psi)	180 [1] [6]
	14 to 130 kPa (2 to 19 psi)	90 [1] [6]
	130 to 700 kPa (19 to 100 psi)	30 [2]
	700 kPa to 7 MPa (100 to1,000 psi)	30 [3]
	7 to 70 MPa (1,000 to 10,000 psi)	60 [4]
Vacuum [7]	>88 kPa (12.7 psi, 26 inHg)	180 [1] [6]
	0 to 88 kPa (12.7 psi, 26 inHg)	90 [1] [6]

Notes:

1. Assumes 100 cc test volume and pressure steps no greater than 17 kPa (2.5 psi), uses on-board pump control.
2. Assumes 100 cc test volume and pressure steps no greater than 70 kPa (10 psi), using with external gas supply.
3. Assumes 50 cc test volume and pressure steps no greater than 700 kPa (100 psi), using with external gas supply.
4. Assumes 25 cc test volume and pressure steps no greater than 7 MPa (1,000 psi), uses with external gas supply.
5. Set times are typical and reflect time to ready indication using default control limits in dynamic control mode.
6. Times for sub-atmospheric set points assume that the temperature is below the boiling point for the target pressure of any liquid in the UUT and CPS.
7. Negative gauge and vacuum pressure values assume the ambient atmospheric pressure is approximately 101 kPa (14.7 psi) absolute.

Pressure Switch Testing Specifications (Handheld)

Maximum Input Voltage..... 10 V (protected up to 1,000 V dc)

Resistance Thresholds ..... Set to 1 KΩ opened / 90 Ω closed (±5 %)

Dead-band Limits..... -98 kPa (-14.2 psi) gauge to 70 MPa (10,000 psi) gauge

Chapter 2
Theory of Operation

Title **Page**

Introduction

This chapter contains theory of operation principles and information for the Controller and the Intensifier.

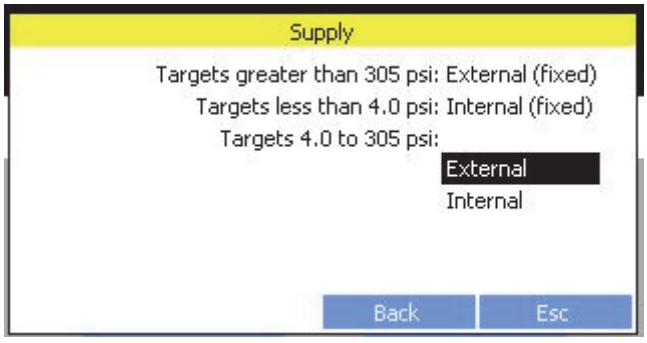
Controller

The main function of the Controller is to have a user set a target pressure then accurately control and measure applied pressure to a unit under test (UUT). When a user sets a target pressure, the Controller uses the user supply selection to determine whether to use the internal pump, an external source, or both as follows:

- When the target pressure is <4 psig, the Controller must use the internal pump. See "Internal Pressure Source (Internal Pump)" on page 2-7.
- For target pressures between 4 psig and 305 psig, the user can choose whether to use the internal pump or external supply. This is set on the Main menu as shown below. See "External Pressure Source (Intensifier or Nitrogen Cylinder)" on page 2-4.

Note

If the source is shut off or runs out and the External supply is selected, the Controller will not automatically switch to the internal pump.



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- When the target pressure is >305 psig, the Controller must use the external supply. See "Internal Pressure Source (Internal Pump)" on page 2-7.

Pressure Control

The Controller offers three different control modes to set pressure: Static Mode sets the target pressure and stops controlling, adjusting only when the measured pressure has exceeded specific limits. Dynamic Mode sets the target pressure and constantly adjusts to maintain the target. Dynamic Control with Jog Approach uses the same control as Dynamic Mode, but pressure is set to a point short of the test point. The user then uses the jog function to adjust pressure to the desired UUT reading.

The control modes are set in the settings and also as part of a test. If a target pressure is set on the Main menu, the Controller uses the control parameters in the settings. If a test is run, the Controller uses the control parameters saved in the test. The two modes have similar control parameters but control pressure differently. See the *4322 Operators Manual* for more information on the control modes.

Note

When a test is run, the Controller temporarily switches to the test settings for the duration of the test. After the test is complete, the Controller automatically reverts back to the system settings.

In addition to the control modes, the Controller has two pressure limits that the user can set in the Settings menu or in the Test menu:

- The **upper and lower pressure limits** are user configurable protective pressure limits that protect the UUT from accidental overpressure. The limits are used when the target pressure is manually set from the Main menu. If the target pressure entered is more than the upper limit or less than the lower limit, the Controller will not accept the target pressure value and displays an out of range error message.
- The **control hold limit** is a symmetrical positive and negative range of pressure above (upper hold limit) and below (lower hold limit) the target. The Controller does not let the applied pressure go outside the hold-limit range. The hold limit is used to determine the "Ready" condition in dynamic control mode. Static control mode uses a combination of the hold limit and stability limit to determine the "Ready" condition. The hold-limit ranges are different for each mode.

Note

When a Test Sequence is run, the Controller automatically vents excess pressure to protect the UUT whenever pressure greater than 110 % of the UUT full scale range is sensed. No manual setting of upper limit or other settings is necessary to engage this protection.

See the *4322 Operators Manual* for more information on the pressure limits. Read the subsequent sections to learn how the Controller uses the different valves to internally control pressure. Each valve has a reference designator that is used throughout this chapter. Figure 2-1 is an illustration that shows where each of the valves are physically located. Figure 2-2 shows a schematic of the isolation valves, solenoids, piezo-electric valves in the Controller. Table 2-1 shows the configurations of the isolation valves, solenoids, and piezo-electric valves at different phases or pressures.

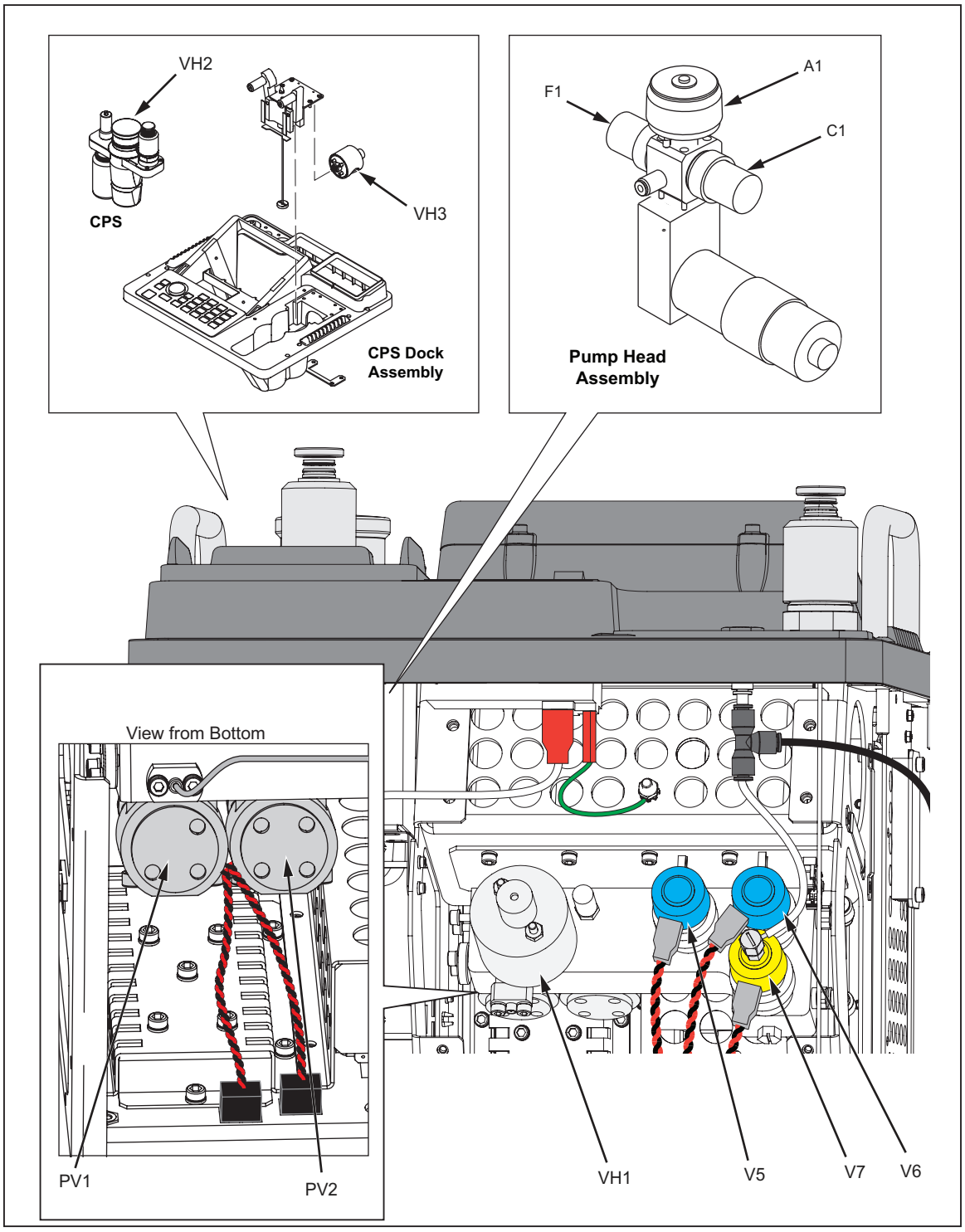

Figure 2-1. Location of the Pressure Valves

External Supply Pressure Control

The Controller can set pressure from 28 kPa to 70 MPa gauge (4 psig to 10,000 psig) using external supply gas, such as from the nitrogen cylinder or Intensifier. The sequence below describes pressure control and measurement processes when using an external pressure source. Refer to Figure 2-2 and Table 2-1 as required.

1. The operator connects a nitrogen supply to the supply port and turns on the supply.

Note

When the Controller is turned on, it is completely vented and all valves are set to the positions indicated in the "pressure vented" row of Table 2-1.

2. Pressure enters the system manifold and is blocked from entering the system by the electrically controlled PV1 valve. When the voltage to the valve is changed, the piezo material inside the valve contracts or expands opening and closing the valve.
3. Next, the operator sets a target pressure value. For ascending excursions, the microprocessor configures the valves VH1, V5, and V6 in the system as shown in Figure 2-2 and Table 2-1. The pressure transducer for the pressure range selected is activated and starts measuring pressure. For descending excursions, the controller decreases pressure while reading the current pressure transducer until pressure is within the range of the pressure transducer needed for the target pressure. Then the microprocessor configures valves VH1, V5, and V6 and starts reading the appropriate transducer.
4. After the valves are configured, the microprocessor then applies a voltage to PV1 to increase the pressure or applies a voltage to PV2 to decrease the pressure of the test port and UUT (if connected).
5. Pressure is measured by one of four pressure transducer modules. Each pressure transducer module has a specific range of pressure it measures and is isolated by control valves V5, V6 and VH1 to prevent overpressure damage.
6. As pressure increases, the microprocessor reads the pressure readings from the transducer pressure modules. As the pressure reaches the target pressure, the microprocessor changes the voltage to the PV1 to slow the rate of pressure increase. If the Controller is in dynamic control mode, the microprocessor then continues to keep the pressure at the target pressure with small voltage adjustments to PV1 and PV2 as required. If the Controller is in static control mode, the microprocessor removes voltage from PV1 and PV2 once pressure is within a ready band and will re-adjust the pressure if the pressure falls outside this band.
7. To decrease pressure to a downward target pressure, the microprocessor temporarily opens VH2. When VH2 is opened, all pressure in the UUT and in the Controller is sent to the CPS where waste and contaminates are trapped (see "Contamination Prevention System" on page 2-9). When near the target pressure, the microprocessor closes and adjusts the voltage to PV2 and PV1 to precisely control pressure to the target pressure. This is repeated for every downward target pressure.
8. If the VENT key is pushed, or the test is complete, the microprocessor pulses VH2 in a controlled manner until pressure approaches atmosphere. The system and all valves are then set to the positions indicated in the "pressure vented" phase of Table 2-1. The system stays vented until a target pressure is set again.
9. If the ABORT key is pushed, the microprocessor opens VH2 to very quickly vent the system to atmosphere. The system and all valves are then set to the positions indicated in the "pressure vented" phase of Table 2-1. The system stays vented until a target pressure is set again.

Figure 2-2 shows the isolation valves, solenoids, and piezo-electric valves in the

Controller. Table 2-1 shows the configurations of the isolation valves, solenoids, and piezo-electric valves at different phases or pressures.

Internal Pump Pressure Generation and Control

The internal pump is used to control pressures below 4 psig. Between 4 psig and 300 psig, either the pump or external supply can be selected. When the internal pump is used, the microprocessor closes PV1 and PV2 to isolate the external supply.

Note

For best results, the external supply should be removed.

The microprocessor uses the atmosphere valve (A1) and the coarse valve (C1) to change pressure quickly and uses the atmosphere valve (A1) and the fine valve (F1) for precise pressure control. Refer to Figure 2-2 and Table 2-1 as required.

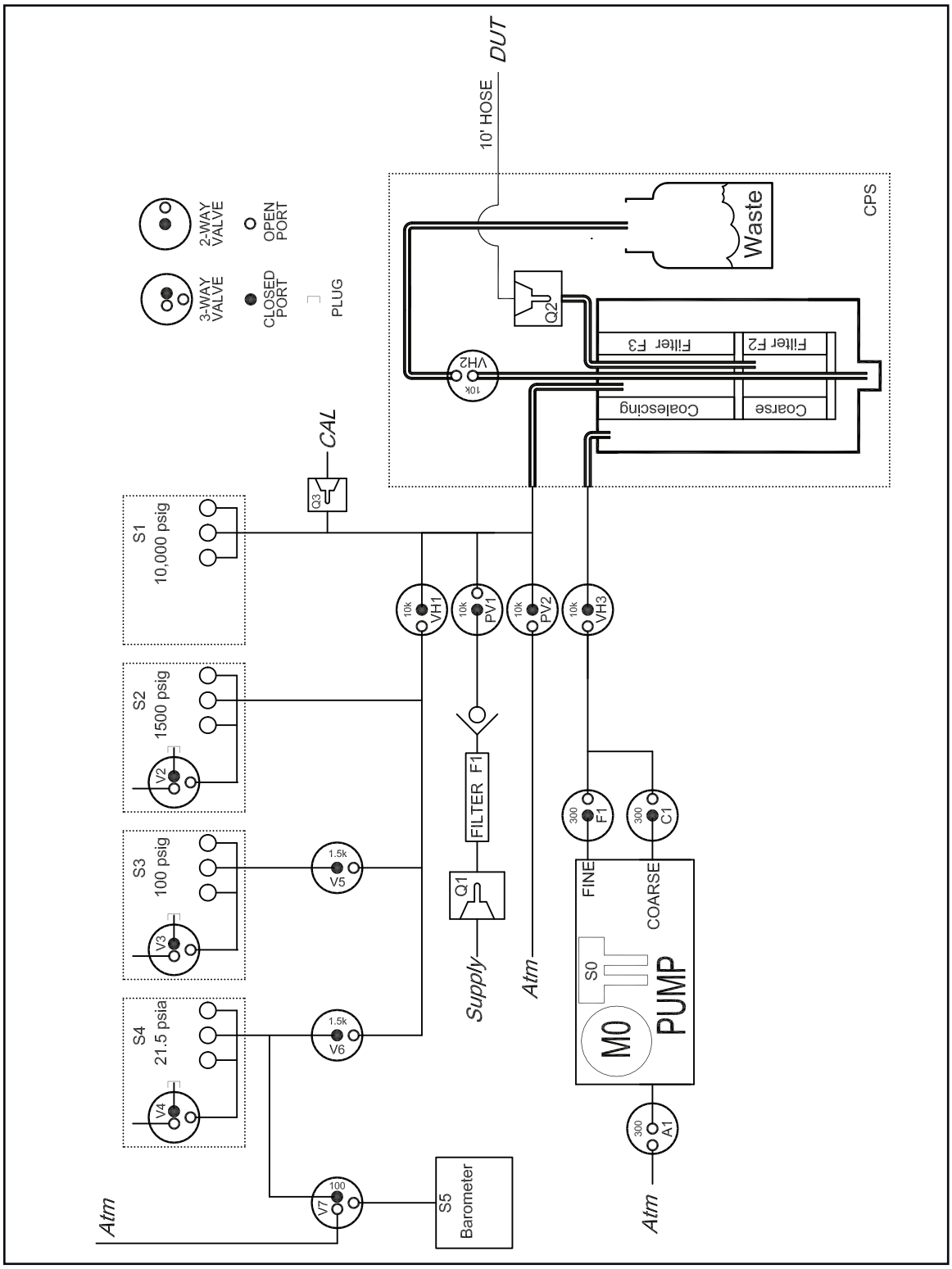

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Figure 2-2. Pressure Valve Schematic

Table 2-1. Valve and Solenoid Positions

Phase or Pressure	PV1 In Ctrl	PV2 Out Ctrl	VH1 S2 ISO	VH2 CPS VLV	VH3 PMP ISO	V2 S2 VENT	V3 S3 VENT	V4 S4 VENT	V5 S3 ISO	V6 S4 ISO	V7 BARO 3-WAY	A1 PMP ATM	C1 PMP CRS	F1 PMP FNE
Pressure Vented	CLSD	CLSD	OPN	OPN	OPN	OPN	OPN	OPN	OPN	OPN	S4	OPN	OPN	CLSD
Pressure between 4 psig to 7.6 psig (External Source)	CTRL	CTRL	OPN	CLSD	CLSD [1]	CLSD	CLSD	CLSD	OPN	OPN	ATM	OPN	OPN	CLSD
Pressure between 4 psig to 110 psig (External Source)	CTRL	CTRL	OPN	CLSD	CLSD [1]	CLSD	CLSD	OPN	OPN	CLSD	ATM	OPN	OPN	CLSD
Pressure between 110 psig to 1,650 psig (External Source)	CTRL	CTRL	OPN	CLSD	CLSD [1]	CLSD	OPN	OPN	CLSD	CLSD	ATM	OPN	OPN	CLSD
Pressure between 1,650 psig to 10,000 psig (External Source)	CTRL	CTRL	CLSD	CLSD	OPN [1]	OPN	OPN	OPN	CLSD	CLSD	ATM	OPN	OPN	CLSD
Pressure between 0 psia to 23.6 psia (Internal Pump)	CLSD	CLSD	OPN	OPN	CLSD	CLSD	CLSD	CLSD	OPN	OPN	ATM	CTRL	CTRL	CTRL
Pressure between 23.6 psia to 110 psig (Internal Pump)	CLSD	CLSD	OPN	OPN	CLSD [1]	CLSD	CLSD	OPN	OPN	CLSD	ATM	CTRL	CTRL	CTRL
Pressure between 110 psig to 300 psig (Internal Pump)	CLSD	CLSD	OPN	OPN	CLSD [1]	CLSD	OPN	OPN	CLSD	CLSD	ATM	CTRL	CTRL	CTRL

Note:

[1] – ISO 3 opens and controls during most of each downward excursion, venting into the waste bottle. Once near the downward target pressure, ISO 3 closes and either the pump or PV2 and PV1 precisely control pressure to the final target pressure

Removable Components

Read the subsequent sections to learn more about the removable components in the Controller.

Pressure Transducer Modules

To measure pressure, the Controller uses four Pressure Transducer Modules (pressure module). A pressure module (shown in Figure 2-3), is a serviceable and replaceable pressure measurement component that is installed behind the display which allows for easy access to calibrate or replace a failed pressure module. Each pressure module has an assigned slot with a specific pressure range.

⚠Caution

To prevent damage to the pressure modules, turn off power prior to removal and installation.

Each pressure module has three internal sensor elements that make three separate measurements. The three measurements are constantly monitored and compared against each other to ensure that all three sensor elements are reading the same pressure. If one of the sensor elements measure a value that is unlike the other two sensor elements measurements, the Controller shows “CalChk” on the top of the Main menu. See “CalCheck” on page 2-15.

Each pressure module is calibrated individually against an external reference. See the calibration procedure in Chapter 3 for calibration instructions.

Barometer

The barometer module (shown in Figure 2-3), supplies the Controller with an atmospheric pressure value for absolute measurements. The barometer gets an atmospheric pressure reading through the ATM port on the front panel on the Controller. The barometer is a serviceable and replaceable module that must be regularly calibrated.

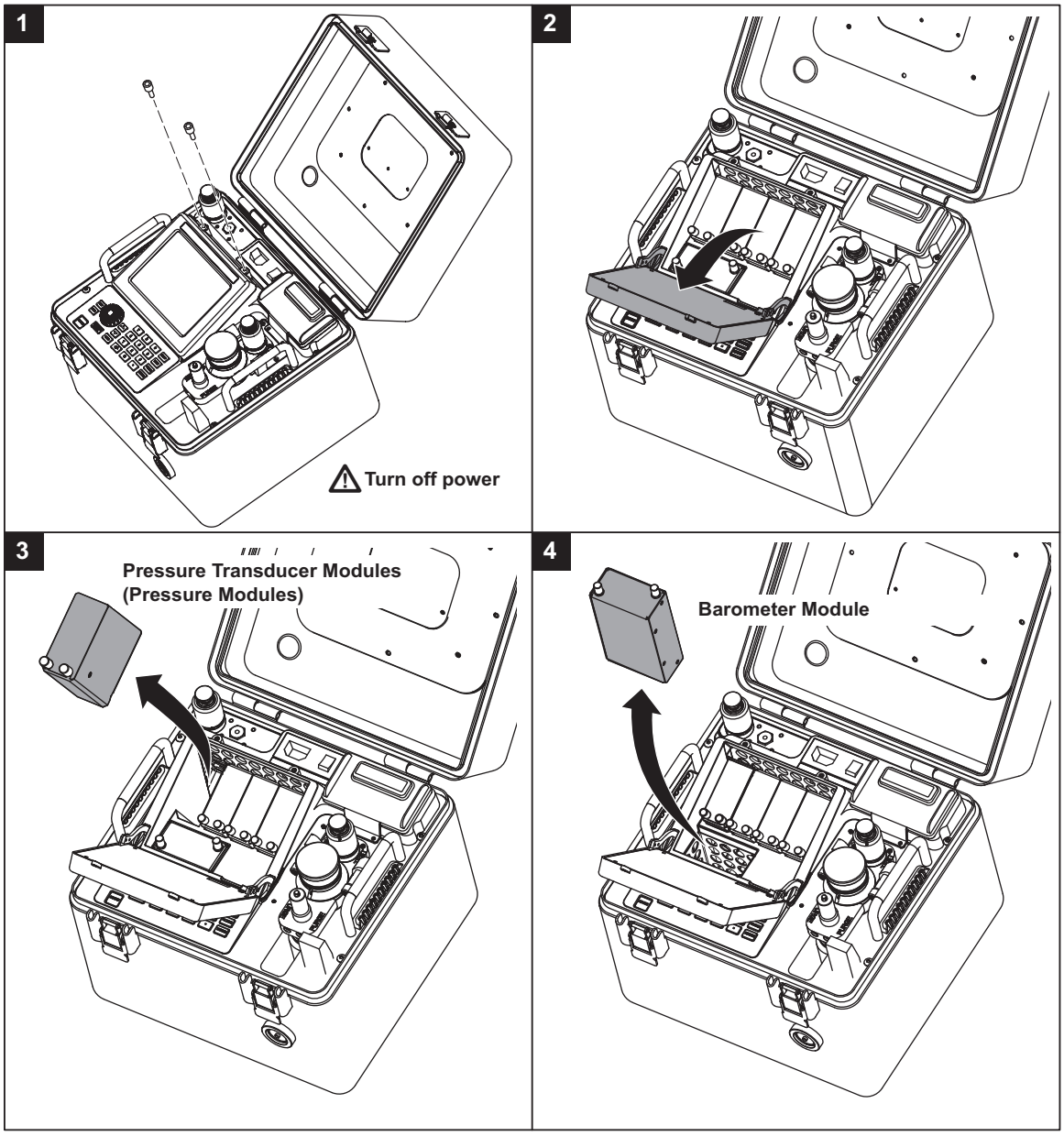

Figure 2-3. Pressure Transducer Modules and Barometer Removal

Contamination Prevention System

To prevent damage to the Controller from contaminates that can be in the UUT and hoses such as water, dirt, oil and grease, the Controller is equipped with an integrated Contamination Prevention System (CPS). The CPS consists of an electronically controlled vent, a male and female QC fitting, a filter, and a purge port with a 60 ml plastic waste container (see Figure 2-4). The UUT connects directly to the CPS and does not require a separate inline connection.

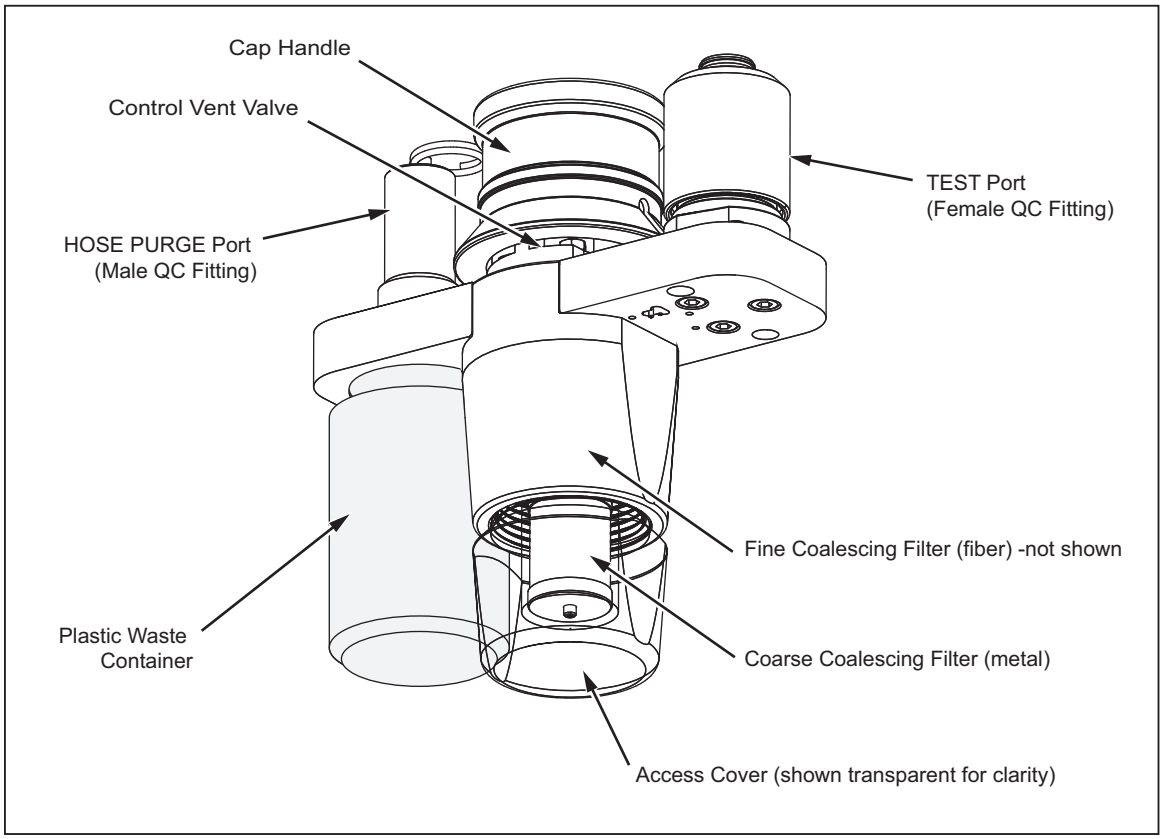

Figure 2-4. Contamination Prevention System (CPS)

During ascending pressure excursions, the controller increases pressure to near the set point by introducing gas with the compressor (internal supply) or through PV1 fine control up valve (external supply). Fine pressure is then accomplished using compressor control or PV1 and PV2 fine control valves. The coarse filter (F2) and coalescing filter (F3) prevent contamination from the UUT from entering the 4322 control valves and measurement circuit.

During descending pressure excursions, the Controller decreases pressure to near the set point by pulsing the control vent valve on the CPS (VH2). In the process of reducing pressure, contaminants are drawn out of the UUT through the coarse filter (F2). Liquid contaminates that are not trapped in the filter are purged under pressure through the control vent valve and into the 60 mL waste container. Fine pressure is then accomplished using compressor control or PV1 and PV2 fine control valves (see Figure 2-5).

Note

The test medium exhausted through the CPS is sent through an additional coalescing filter. The filter can be identified as an externally visible white filter which is inserted into the waste bottle when the CPS is mounted into the Controller. The purpose of this filter is to prevent vaporized test medium being expelled from the Controller.

⚠Caution

To prevent damage to the Controller, drain as much liquid as possible out of the UUT before it is connected to the Controller. Empty the waste container after each test (refer to the Operators Manual for instructions).

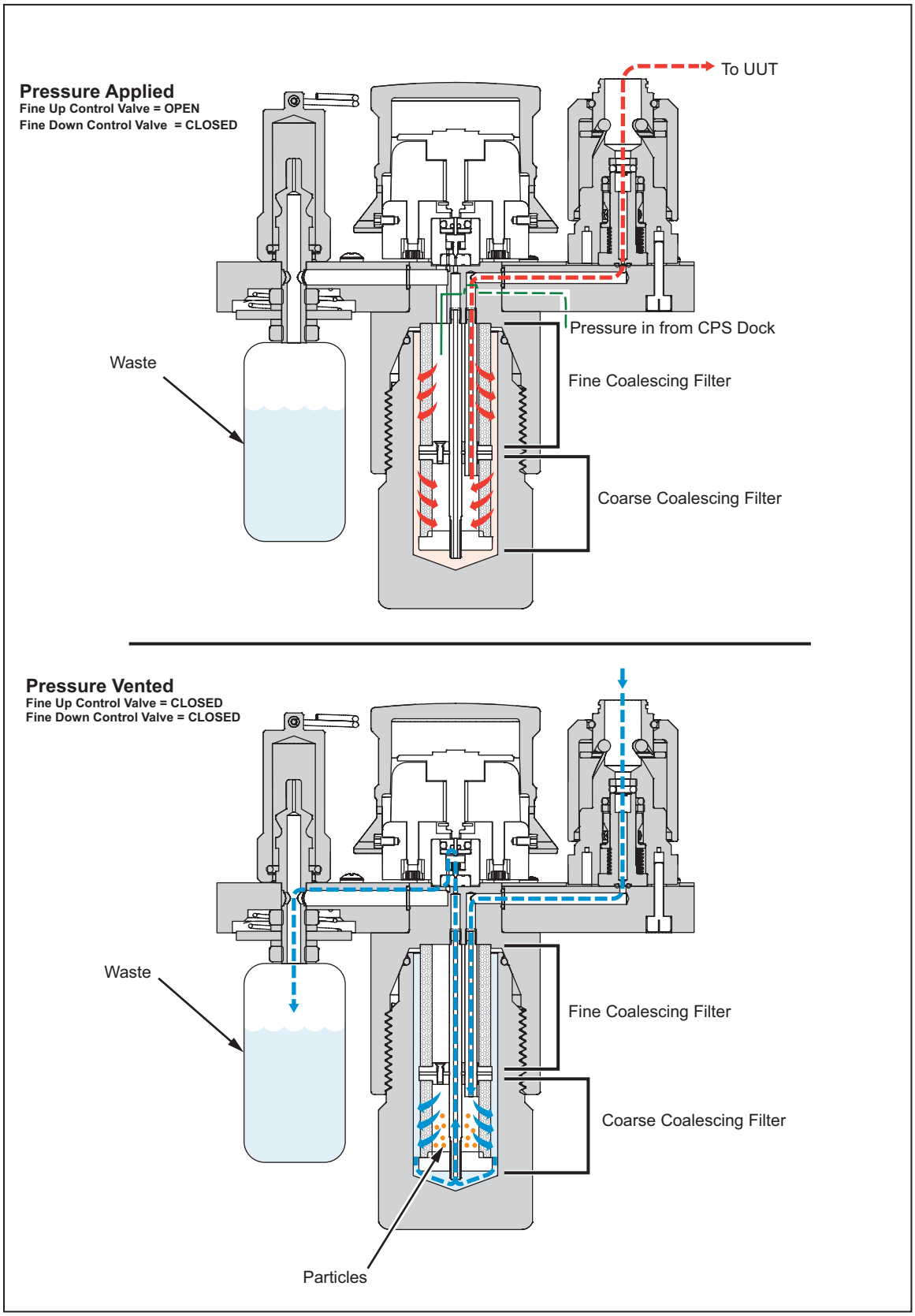

Figure 2-5. CPS Pressure Routing (Cross-Section View)

CalCheck

Each pressure module features three redundant pressure sensing elements. Measurement uncertainty is reduced during normal operation by averaging the output of the three elements to determine the final pressure measurement used by the Controller. The Controller also monitors the individual pressure measurement of the elements and compares them to each other. If one of the elements does not agree with the other two within expected limits, the Controller will display an on-screen CalCheck alert. In addition to the alert, a "CalChk" notification indicating the range of the suspect pressure module will appear in the upper left portion of the Main menu over the Ready Indicator until the issue is resolved (the indicator flashes on and off every 2 seconds). The CalChk indicator can be selected to view the original on-screen error message (see Figure 2-6). The CalCheck feature is performed constantly and transparently to the operator. Action is only required if the CalChk indicator is displayed.

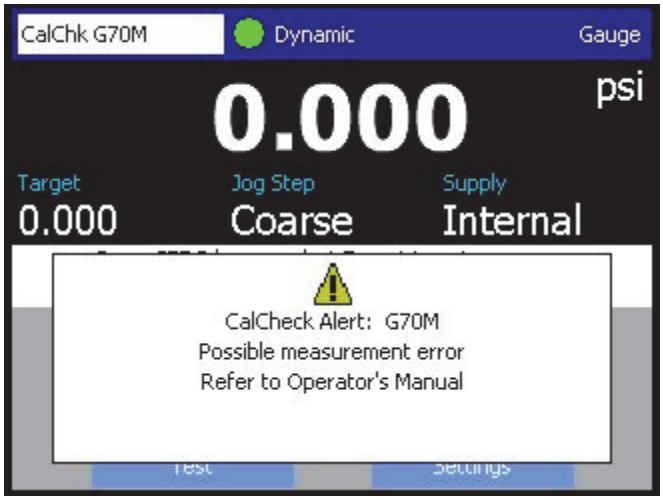

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Figure 2-6. CalCheck Indicator

AutoZero and BaroCheck

During normal use, the barometer module reads atmospheric pressure through the ATM port on the front panel of the Controller, and is not exposed to the pressure excursions seen by the pressure modules. This limited use and the intrinsic measurement characteristics of the barometer module offer a very stable reference pressure for measurement assurance features. A direct reading of atmospheric pressure also allows the Controller to determine gauge pressure with the intrinsically absolute pressure module and to measure absolute pressure with the gauge pressure modules.

The AutoZero feature compares the active pressure module output to the internal atmospheric pressure reference, tares the difference and in some modes dynamically compensates for changes in atmospheric pressure. The function happens automatically and seamlessly during every vent operation after the Controller has determined that pressure measurement is fully vented and stable.

- Gauge pressure measurement with intrinsically gauge pressure modules (G700K, G10M, G70M): AutoZero tares the reading to zero gauge pressure at vent.
- Absolute pressure measurement with intrinsically gauge pressure modules (G700K, G10M, G70M): AutoZero tares the reading to zero gauge pressure measurement at vent. For all subsequent measurements, the output is dynamically compensated to indicate absolute pressure by adding the outputs of the active gauge pressure module and the barometer module.

- Gauge and vacuum pressure measurement with the intrinsically absolute pressure module (A150K): AutoZero tares the reading to zero gauge pressure at vent. At all other pressures, the output is dynamically compensated for small changes in atmospheric pressure measured by the barometer module.
- Absolute pressure measurement with the intrinsically absolute pressure module (A150K): AutoZero tares the absolute pressure reading to align with the barometer module at vent. This tare is used for all subsequent measurements until the next vent routine.

The BaroCheck feature also utilizes the stability of the barometer module to ensure measurement performance at low pressure. The BaroCheck function compares the outputs of the A150K pressure module and the barometer module at several points in the atmospheric pressure range. If the pressure modules agree within the expected tolerance, the BaroCheck function will compensate the output of the A150K pressure module by the difference. If the pressure modules do not agree within the expected tolerance, one of the components may be failing or exceeding measurement tolerance, so compensation will not be applied and the Controller will alert the user to a potential measurement issue.

The BaroCheck function is recommended to be run at least once every 30 days. The Controller keeps track of when BaroCheck has been run, and will indicate if 30 days has been exceeded with a “BaroChk” indication in the top left of the Main menu.

The BaroCheck function can be performed by selecting “BaroCheck” under the Calibration tab in the Settings Menu while in Advanced Mode. If the user selects to run a test procedure or perform a calibration while the Controller is displaying the BaroCheck indication, the operator will be prompted to first perform the BaroCheck routine. If more than 35 days has passed since the last successful BaroCheck routine, the Controller will force BaroCheck to be performed before proceeding with a test procedure or calibration.

Once initiated, the BaroCheck runs automatically. As the BaroCheck function runs, the Controller prompts the user to cap the test port and asks to proceed. The Controller shows that BaroCheck is in progress for approximately 15 to 45 minutes as it automatically sets several test points and verifies measurement. The variation in time needed to complete BaroCheck is influenced by the Controller temperature stability which is affected by how the system has been warmed up and used prior to running BaroCheck. In some cases, the process can take up to an hour. The Controller beeps three times at the conclusion of the test to alert that the function is complete. When BaroCheck detects damage or an out of tolerance condition, the Controller notifies the user to run the BaroCheck function again or to check calibration of the A150K and barometer modules.

Emergency Pressure Relief

For emergency pressure relief, the red ABORT key immediately vents all pressure and cancels the test. When the red ABORT key is pushed, the Controller closes any open menus and returns to the Main menu.

The Controller has an automatic pressure relief function that releases pressure if it exceeds the upper or lower pressure limits. If an over pressure occurs, the Controller sounds an alarm for 8 seconds, aborts the test, and logs an event in the Event Log. In addition, if the display is rotated to access the Pressure Transducer Modules and pressure control is active, the Controller performs an automatic emergency pressure relief to protect the user.

To recover from an over pressure, correct the over pressure condition and then cycle Controller power.

Intensifier

The Pressure Intensifier (the Intensifier) is an electric pressure booster system that can boost a gas pressure (nitrogen) supply of (500 to 2,000) psig up to 10,000 psig.

Note

The Intensifier requires at least 500 psi from the Nitrogen Cylinder to boost pressure. If the Intensifier detects that not enough supply pressure is available, the Intensifier stops pressure generation and flashes the **STOP** *LED until supply pressure is increased.*

As shown in Figure 2-7, the front panel shows a schematic of the internal pressure line routing. This helps visually identify how pressure can be vented and isolated with the VENT and ISOLATION valves. This is helpful to quickly connect and disconnect the OUTPUT QC fittings and to troubleshoot the system if a leak is suspected (see "Pressure Generation and Leak Test" in Chapter 5). Refer to the *4322 Operators Manual* for a description of each item on the front panel along with venting and isolation instructions.

Set Pressure and Generation

When a set pressure is selected, an electronically controlled servo motor drives a four piston, mechanical boost pump. The rate of pressure accumulation is dependent on the supply pressure, and the motor speed and test volume. The higher the supply pressure, the faster the pressure generates. Pressure generated by the boost pump is contained in a 15 cc internal accumulator and in the system pressure lines.

An electrical pressure sensor monitors and measures the pressure in the accumulator and transmits pressure measurement values to the electronic motor controller. The internal pressure is shown on a gauge on the front panel.

As the measured pressure in the accumulator approaches the selected pressure value, the Intensifier decreases the rate of pressure generation and changes the speed of the motor as necessary to hold the selected pressure in the system (referred to as "Pressure on Demand").

Notes

Once stable, the Intensifier boost pressure is typically 5% to 8 % higher than the set pressure requested. This feature allows the set pressure to be equal to the maximum pressure required for calibration.

The Intensifier is not made to store pressure when not in operation. After **STOP** *is pushed, pressure slowly bleeds from the accumulator.*

Pressure On-Demand

The Intensifier continuously supplies the pressure selected until **STOP** is pushed. This makes sure that the Controller has sufficient pressure available to complete the UUT calibration. The Intensifier can boost supply pressures as low as 500 psi, but the rate of generation is slower with lower supply pressures. This is most noticeable when test volumes (UUT + tubing) are larger. If the Intensifier detects that not enough supply pressure is available, the Intensifier stops pressure generation and flashes the **STOP** LED until supply pressure is increased.

Boost pressure selection is dependent on the pressure necessary to complete the UUT calibration. For a typical UUT calibration, select a set pressure equal to or greater than the maximum pressure necessary in the calibration sequence. For multiple UUT calibrations in the same location, set the boost pressure to the lowest available selection that is equal to or higher than the highest pressure necessary to complete the UUT calibrations. For example, if the highest pressure in the calibration sequence is 2,500 psi, select 3,000 psi for the intensifier set pressure. If the highest pressure in the calibration is 6,000 psi, select 7,000 psi for the set pressure.

Note

The higher the set pressure, the faster the Nitrogen Supply depletes.

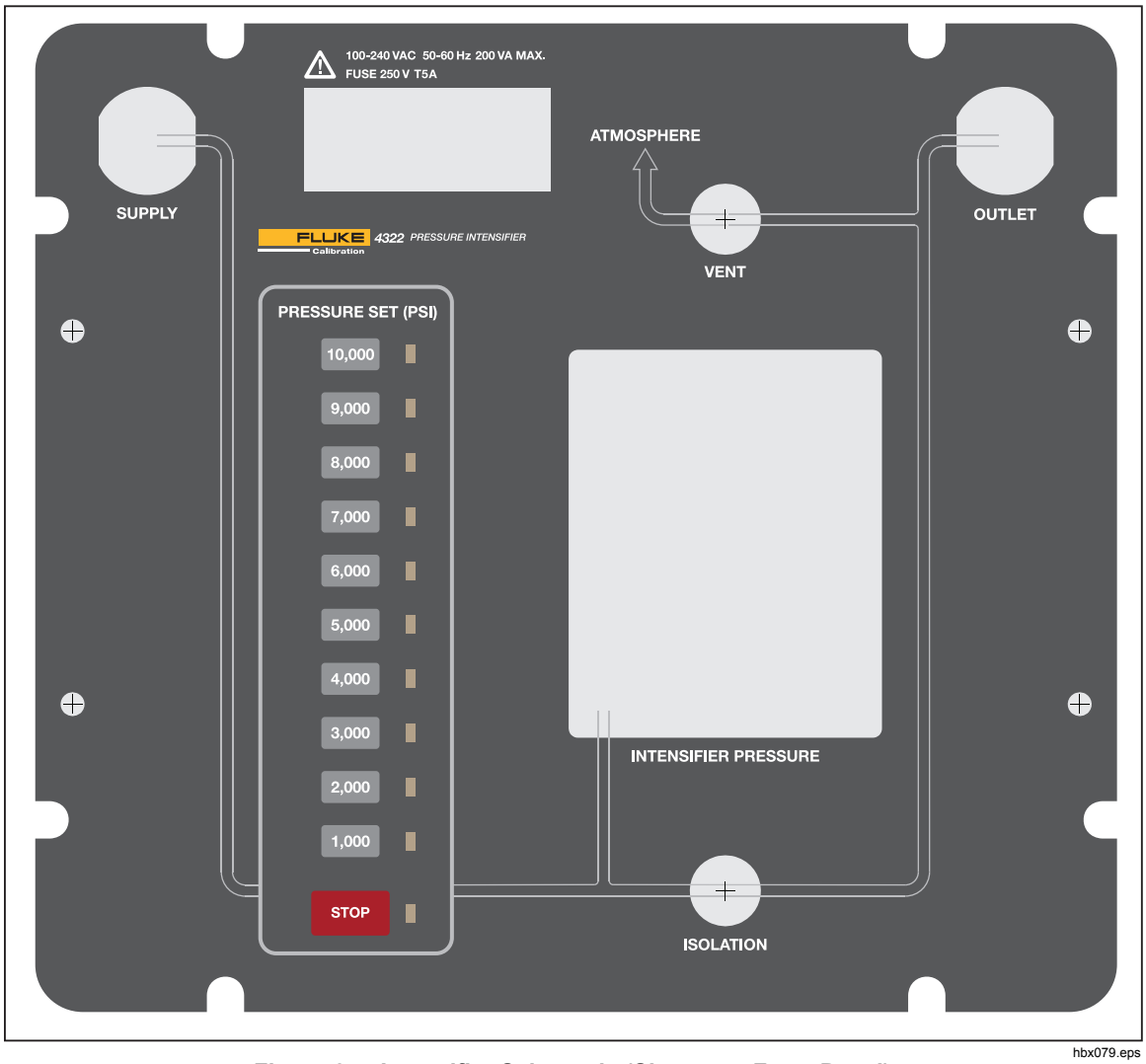

Figure 2-7. Intensifier Schematic (Shown on Front Panel)

Overpressure Relief

The Intensifier is fitted with an automatic pressure relief valve that automatically and instantaneously vents excess pressure if the pressure goes above 11,500 psi. This pressure relief valve is a safety feature and it resets automatically once pressure has decreased to the working range of the Intensifier. This valve is not adjustable and replacement is necessary if it is venting pressure prematurely.

Electronic Pressure Sensor and Gauge

An electronic pressure sensor (transducer) is installed on the pressure manifold. This transducer provides pressure measurement data to the internal circuitry that controls the internal motor. The electronic pressure sensor must be field aligned if the pressure generation amount is off by more than 10 % or if the Intensifier stabilizes at a pressure less than what the Controller requires when set to an equivalent pressure. This can be determined if the boost pressure selected does not match what the front-panel gauge indicates after pressure has stabilized. If a new electronic pressure sensor is installed, the new sensor must have a field alignment performed followed by a factory alignment to store the new coefficients. See “Electronic Pressure Sensor Alignment” in Chapter 5 for instructions.

The gauge is an independent pressure gauge that provides a front-panel indication of the internal pressure in the system. The gauge is not connected nor does it communicate with the pressure sensor. There is no adjustment procedure for the gauge.

Chapter 3
Calibration and Alignment

Introduction

This chapter supplies information and instructions on how to calibrate and align the G70M, G10M, G700K, A150K, and barometer modules in the Controller.

Note

This chapter does not contain information on the Intensifier because the Intensifier does not require a calibration procedure. If the pressure transducer in the Intensifier needs adjusted, use the adjustment procedure in the 4322 Service Manual.

Fundamentals

Pressure transducer modules (the modules) are removable and interchangeable without effect on their measurement performance or calibration. Calibration data required for the reliable operation of the modules is stored onboard a memory chip inside of each module. This data is retained even if the module is inserted in a different Controller. Though it is not recommended, the coefficients can be manually adjusted in View/Edit Calibration menu.

Calibration is performed with the automated self-calibration function that is a feature of the Controller. When the calibration is finished, the Controller compares the measurements made by the modules to the external reference pressure standard. The Controller then displays the pass or fail information for the modules tested. If the modules fail the calibration, then the modules must be adjusted.

⚠Caution

To prevent damage to the product, only personnel that are qualified should calibrate the product.

The calibration process has two test types: Calibration and Alignment. Calibration is a performance verification procedure that tests to see if the module is within tolerance. Alignment is a performance verification procedure as well, but lets the operator automatically apply calculated calibration coefficients to bring the module into tolerance. This is done by “activating” the changes after the Alignment procedure is complete.

Required Equipment

The equipment in Table 3-1 is required to complete the calibration procedure.

Table 3-1. Calibration Equipment

Primary Reference		
Classifications	**Minimum Use Specifications**	**Suggested Equipment**
Automated Pressure Calibrator (APC)	See Required Components	Supplied with Fluke 4322
Pressure Controller	Range: 0.5 psia to 10,000 psia (-14.2 to 10,000 psig) Fluke 4322 required	Supplied with Fluke 4322
CPS module (Contamination Prevention System)	Clean and dry.	Supplied with Fluke 4322
Cylinder hose	10,000 psi, Fluke 4322 QC stem	Supplied with Fluke 4322
Intensifier outlet hose	10,000 psi, Fluke 4322 QC stem	Supplied with Fluke 4322
Test hose	10,000 psi, Fluke 4322 QC stem, King Nutronics QC stem	Supplied with Fluke 4322
Reference pressure standard	Gauge pressure: 0 to 4 psig: ±0.001 psi 4 to 10,000 psig: ±0.025 % of reading Vacuum Pressure: 0 to 30 inHg: ±0.025 % of reading or ±0.002 in-Hg, whichever is greater Absolute Pressure: 0.5 to 35 inHga: ±0.002 inHg 17.2 to 10,000 psia: ±0.025 % of reading	King Nutronics 3689 or equivalent
Nitrogen Supply	Clean, dry, minimum 500 psig	Nitrogen Cylinder
IEEE cable	Standard: IEEE-488.2 Minimum length: 2 ft	Supplied with Fluke 4322

Environmental Conditions

Laboratory environmental conditions required to complete this procedure:

- Ambient temperature range: 60 °F to 85 °F. Must not change more than ± 4 °F throughout the calibration.
- Ambient relative humidity: 5 % to 95 %. Must not change more than ±20 % RH throughout the calibration.
- Low wind and draft area.

Equipment Setup

The operator can choose to calibrate all installed modules or only selected ranges. A pressure supply sufficient to reach the selected modules' maximum pressure must be connected. For example, to calibrate the G10M (1500 psig) module, a gas cylinder with approximately 2000 psi could be used, or a gas supply with a minimum pressure of 500 psig and the 4322 Intensifier could be used. To calibrate the G70M (10,000 psi) module, the 4322 intensifier must be used.

Note

The supply must be disconnected in order to calibrate the barometer module and the A150K module.

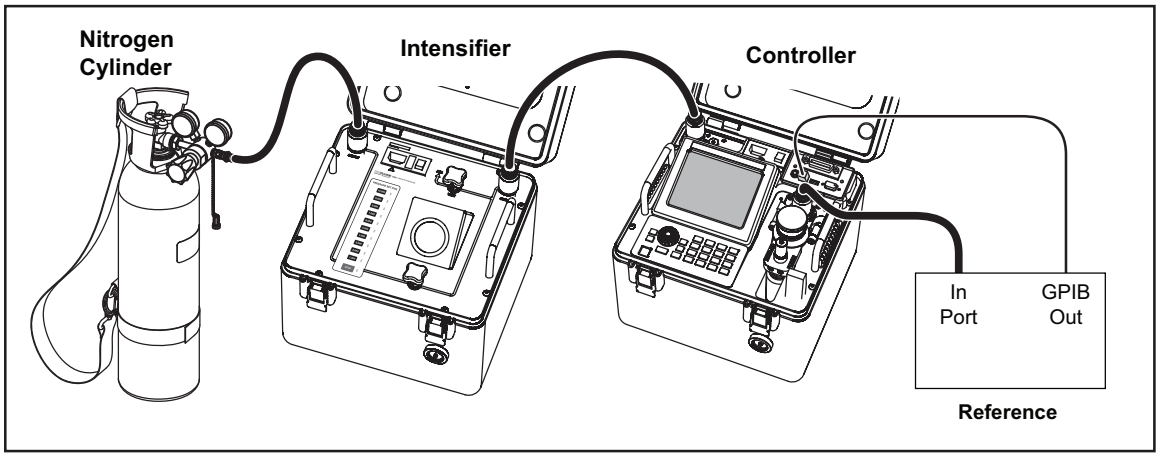

Figure 3-1. Equipment Setup

Preliminary Operations

Prepare for the calibration procedure as follows:

1. Turn on the 4322 Pressure Controller (the Controller) and let it warm up for at least 1 hour.
2. Turn on the reference pressure standard and let it warm up for at least 1 hour.
3. Connect the Nitrogen Cylinder supply to the Controller as follows (see Figure 3-1):

Note

Do not connect the supply to the Controller when calibrating the barometer module and the A150K module. For all other modules, make sure the supply is connected.

a. Make sure the Nitrogen Cylinder pressure is more than 500 psig and no more than 2000 psig.

⚠Warning

To prevent injury or possible death, do not over pressurize the Nitrogen Cylinder. Maximum pressure of the Cylinder is 2000 psig.

b. Connect the male end of the regulator hose to the Nitrogen Cylinder regulator port.

c. Connect the female end of the regulator hose to the male SUPPLY QC port on the Intensifier.

d. Fully open the Nitrogen Cylinder regulator to supply pressure.

Note

Close the Nitrogen Cylinder regulator when the Intensifier is not in use.

4. Connect the Intensifier to the Controller as follows (see Figure 3-1):
   a. Connect the two male ends of the system interconnect hose to the OUTPUT port on the Intensifier and the SUPPLY port on the Controller.
   b. On the Intensifier, make sure the VENT valve is closed and the ISOLATION valve is full open.
   c. Fully open the Nitrogen Cylinder regulator to supply pressure to the Intensifier.
5. Put a clean, dry CPS into the Controller.
6. Connect the Controller to the reference pressure standard as follows:
   a. Connect the male end of the test hose to the TEST port on the CPS in the Controller.
   b. Connect the female end of the test hose to the TEST port on the reference pressure standard.

Note

For connection to the reference pressure standard, the female QC adaptor must be removed from the test hose and an adaptor from the AN4 female hose termination to the reference pressure standard quick connect stem must be installed.

   c. Connect the Controller IEEE interface to the reference pressure standard IEEE interface with an IEEE 488.2 cable.
7. Turn on the Intensifier.
8. On the Intensifier, set the required boost pressure.
9. Set up communication between the Controller and the KN 3689 as follows:
   a. On the KN 3689, select option **2** to select **COMPUTER CONTROL**.
   b. After selection, the display reads: **ENTER IEEE ADDRESS**. Type in **10** and push **ENTER**.
   c. Push down the VENT knob on the KN 3689 to zero the reading. The display reads: **SYSTEM VENTING** while the zeroing is in progress.
   d. When venting is complete, the display reads: **PULL UP VENT KNOB**. After this message is shown, pull up the VENT knob on the KN 3689 and confirm the reading shows: **.000 PSIG**.

Module Calibration Procedure

This procedure supplies instructions on how to perform the Calibration procedure on the G70M, G10M, G700K, A150K, and barometer modules. As mentioned in the Fundamentals section, Calibration is a performance verification procedure that tests to see if the module is within tolerance. No changes to the coefficients can be made with the Calibration procedure. After the Calibration procedure is complete, an Alignment should be completed if any of the modules did not pass the calibration.

1. Select the **Advanced Operating** mode on the startup screen.
2. Select **Settings**.
3. Select **Calibration** to edit the Calibration menu.
4. Select **Run Calibration**.
5. Select the desired module as shown in Figure 3-4.

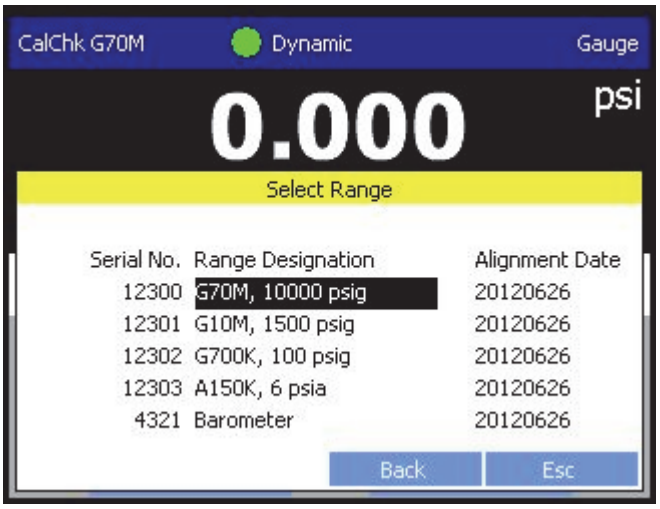

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Figure 3-2. Module Selection

6. Fill in the Run Calibration menu as follows (see Figure 3-5):

Note

Text enclosed in [brackets] denotes a custom user entry.

   a. Test type: **Gauge Calibration or Abs Calibration**
   b. Adjustment Tol %**:** *[user entry]*

Note

Adjustment Tol % will be disabled if Use Tol is set to No.

   c. Use Tol: **Yes** to use the Adjustment tol % from the last step or **No**
   d. Head Relative to 4322: **0** if on the same surface. If not, measure the head-height difference and enter it into the field. Use a positive (+) value if the UUT is above the Controller and a negative (-) value if the UUT is below.
   e. Reference SN: [*serial number of the KN 3689*]
   f. Addr: **10**
   g. Time/Date: [*automatically populated*]
   h. Operator: [*enter initials*]

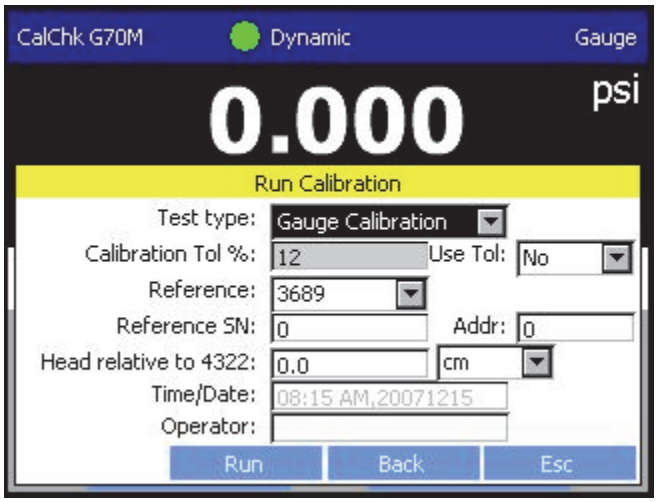

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Figure 3-3. Calibration Menu Configuration

7. Select **Run**. This starts the calibration procedure.

   The Calibration procedure is an automated process. The Controller automatically sets pressure, dwells, and takes measurements. As the test runs, the Controller reads the measurements from the modules and receives measurements data from the KN 3689 over the GPIB connection. The measurements are compared by the Controller. When the calibration procedure is running, the data and pass/fail information is displayed on the screen. After the pass/fail information is shown on the screen, a new screen appears that shows the deviation calculations.

Module Alignment Procedure

This procedure supplies instructions on how to perform the alignment procedure on the G70M, G10M, G700K, A150K, and barometer modules. As mentioned in the Fundamentals section, Alignment is a performance verification procedure that tests to see if the module is within tolerance. If it is out of tolerance, the deviation is automatically calculated and shown on the screen at the end of the test. At this time, the operator can "activate" the corrections to bring the module back into tolerance.

1. Select the **Advanced Operating** mode on the startup screen.
2. Select **Settings**.
3. Select **Calibration** to edit the Calibration menu.
4. Select **Run Calibration**.
5. Select the desired module as shown in Figure 3-4.

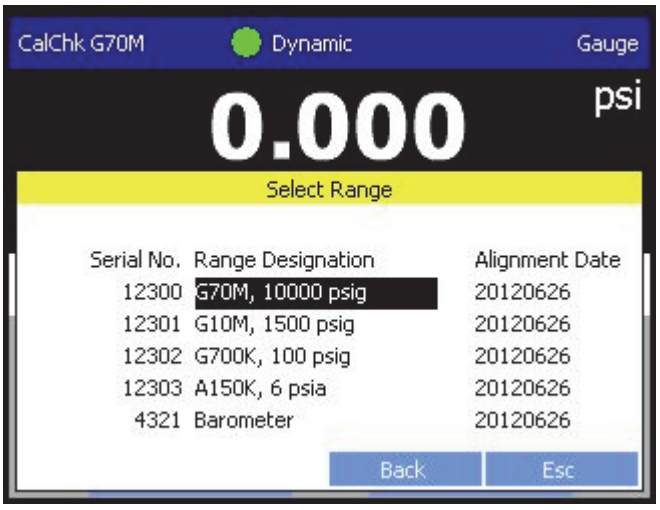

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Figure 3-4. Module Selection

6. Fill in the Run Calibration menu as follows (see Figure 3-5):

Note

Text enclosed in [brackets] denotes a custom user entry.

a. Test type: **Alignment**

b. Adjustment Tol %**:** *[user entry]*

c. Use Tol: **Yes** to use the Adjustment tol % from the last step or **No**

d. Head Relative to 4322: **0** if on the same surface. If not, measure the head-height difference and enter it into the field. Use a positive (+) value if the UUT is above the Controller and a negative (-) value if the UUT is below.

e. Reference SN: [*serial number of the KN 3689*]

f. Addr: **10**

g. Time/Date: [*automatically populated*]

h. Operator: [*enter initials*]

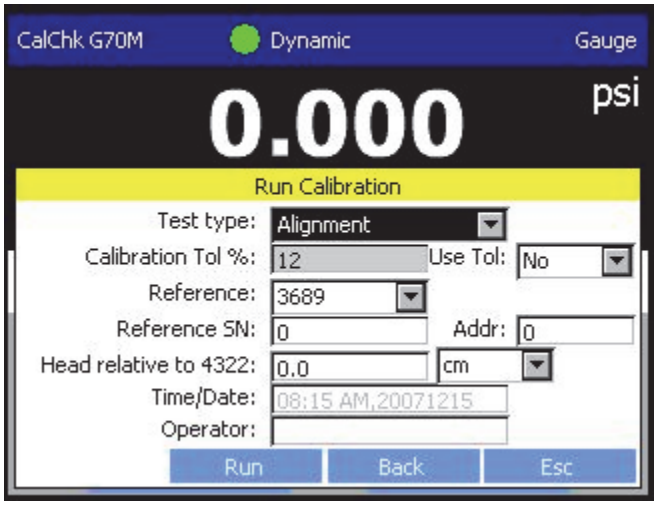

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Figure 3-5. Alignment Menu Configuration

7. Select **Run**. This starts the Alignment procedure.

   The Alignment procedure is an automated process. The Controller automatically sets pressure, dwells, and takes measurements. As the test runs, the Controller reads the measurements from the modules and receives measurements data from the KN 3689 over the GPIB connection. The measurements are compared by the Controller. When the Alignment procedure is complete, a new screen will appear that shows the test results with deviation calculations. To finalize the Alignment, select “Activate” on the bottom of the menu to save the new coefficents to the module. The Alignment procedure is now complete. Calibration should be performed to verify that the aligned range meets measurement tolerances.

Chapter 4
Controller Maintenance

Title **Page**

Introduction

This chapter supplies maintenance procedures and part replacement procedures for the Controller.

⚠Warning

To prevent injury to personnel or damage to the Product, Controller maintenance is to only to be completed by maintenance personnel who have been formally trained on how to complete the maintenance procedures.

Note

The replacement procedures in this chapter only contain specific instructions on how to replace a part and do not list part numbers. For a full list of part numbers, see Chapter 7 "List of Replaceable Parts".

Table 4-1. Controller Maintenance Time Schedule

Maintenance Item	Time Interval	Instructions
Replace pump seal and lubricate pump	2 years or 1,000 hours, whichever occurs first	See page 4-33
Replace CPS fiber filter	Annually or as required	See page 4-28
Clean CPS metal filter	Annually or as required	See page 4-28

Safety

To ensure safety, read the warnings below prior to performing maintenance on the Controller.

⚠⚠Warning

To prevent possible electrical shock, fire, or personal injury:

- **Disconnect the mains power cord before you remove the Product covers.**
- **Use only specified replacement parts.**
- **Have an approved technician repair the Product.**

Standard Torque Look-Up Table

Torque value for standard hardware is listed in Table 4-2. If a nonstandard torque value is required, the torque value is listed in the procedure next to the hardware. For example: "Install the low profile screw (①) that secure the planet gear (⑦) to the lower cam mount plate (②). Torque to 7.8 Nm (69.0 in-lb)."

Table 4-2. Standard Hardware Torque Values

Button or Socket Head Cap Screws	
Nominal Size	**Torque Nm (in-lb)**
M2	0.69 (0.61)
M3	0.9 (8.0)
M4	2.3 (20.4)
M5	4.6 (40.7)
M6	7.8 (69.0)
M8	19.1 (169.0)

Maintenance Procedures

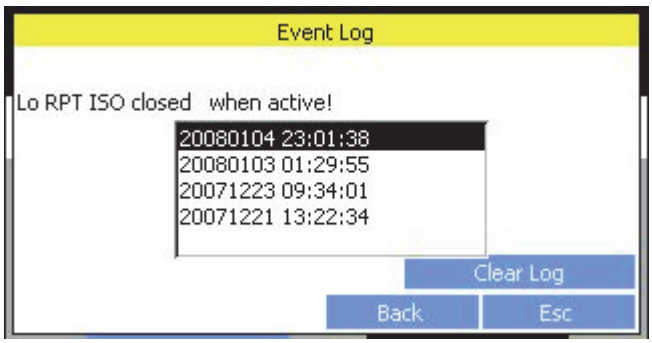
This section supplies maintenance information and procedures for the Controller.

The Controller is easy to maintain and troubleshoot. The onboard software monitors the system status and provides error messages to the user if any of the internal components fail. Chapter 8 lists the error codes along with a description of the problem and an action to take to resolve the issue.

The Controller also has additional features to help maintenance personnel perform maintenance on the Controller. Read the subsequent sections to learn more about the Event Log, CalCheck, and Self-Calibration.

Event Log

The Event Log is an automated event recorder used by maintenance personnel to see if the Controller has experienced any failures, overpressures, or exceedences. Each recorded event has specific information on the event and contains a date and time stamp to indicate when the event occurred.



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View the events in the Event Log as follows:

1. Select **Settings** on the Main menu.
2. Select the **Internal** tab.
3. Select **Event Log** to open the ID menu.

Clear the events in the Event Log as follows:

1. Select **Settings** on the Main menu.
2. Select the **Internal** tab.
3. Select **Event Log** to open the ID menu.
4. Select **Clear Log**.

Front-Panel and Case Cleaning

To clean the Calibrator, wipe it with a cloth that is lightly dampened with water or mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol based fluids.

Pressure Leakage Test

Leak Test is a function of the Controller that checks the Controller and UUT connection for pressure leaks. To detect leaks, the Controller generates pressure and monitors the rate of pressure change over a specified time period. The total change in pressure (dP) and average rate of change is shown on the Leak Test menu and stays on the menu until the test is reaccomplished. See Table 4-3 for a list of leak test parameters.

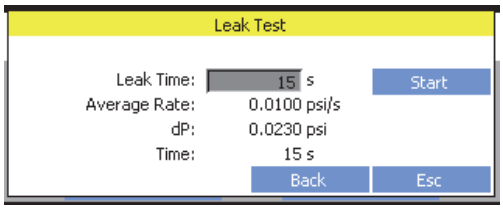
To test for a leak:

1. Connect the male end of the test hose to the female **TEST** port on the Controller.
2. Connect female end of the test hose to the male **QC adapter** on the UUT.

Note

A leak test can be done without a UUT connected to troubleshoot the Controller.

3. Navigate to and select **Leak Test** on the bottom of the Main menu. The Leak Test menu opens.



4. Enter the leak test time in seconds into the **Leak Time** field.

Note

The leak test menu contains an Average Rate, dP (pressure change), and Time values. These values are leak test result values and are not adjustable settings. When the menu opens, the values shown are from the last test completed and will update after the leak test is complete.

5. Navigate to and select **Start** to start the leak test.
6. If the leak rates are excessive, search for a leak path around the adapter fittings first. To search for leaks, use a spray bottle with a mixture of water and diluted soap to spray on the fittings. If a there is a leak, bubbles from the soap visually show where the leak is. See Figure 4-1.

Table 4-3. Leak Test Parameters

Parameter	Description
Leak Time	Amount of time to run the leak test.
Average Rate	Shows the average rate of change of pressure for the test completed. Measured in units for each second.
dP	Shows the total change in pressure for the test completed.
Time	Shows the length of time the test ran.

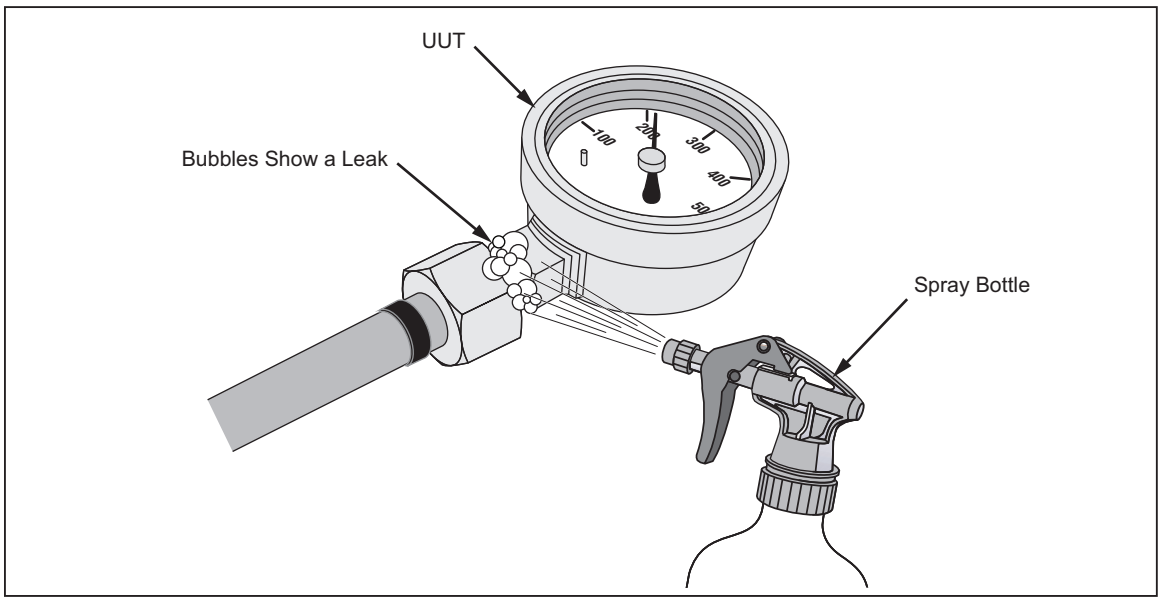


Figure 4-1. Spray Test

Pressure Generation Test (On-Board Motor)

Use the following instructions to test the internal piston pump. The internal piston pump generates pressure and also can create a vacuum. To fully test, both functions should be checked.

Check pressure generation as follows:

1. Turn on the Controller. Disconnect all pressure hoses.
2. Put the Controller in **Gauge** mode and set the supply to **Internal Supply**. See the *4322 Operators Manual* for instructions.
3. Set a 300 psi target pressure. After the Ready indicator shows, let the Controller stabilize for 5 minutes.
4. Push ESC to stop pressure control then wait 30 seconds.
5. Run the **Leak Test** tool or if remotely operated, send the “rate” command. See the *4322 Operators Manual* for remote operation instructions.
6. Allowable leak rate across all ranges is 0.01 % of reading. At 300 psi, 0.03 psi/sec is allowable.

Check the vacuum as follows:

1. Put the Controller in **Absolute** mode and set the supply to **Internal Supply**. See the *4322 Operators Manual* for instructions.
2. Set a 0.5 psi target pressure. After the Ready indicator shows, let the Controller stabilize for 5 minutes.
3. Push ESC to stop pressure control then wait 30 seconds.
4. Run the **Leak Test** tool or if remotely operated, send the “rate” command. See the *4322 Operators Manual* for remote operation instructions.
5. The allowable leak rate is 0.0015 psi/s at 0.5 psi (0.01 % of the reading if in negative gauge measurement mode).

Fuse Replacement

The Controller has a replaceable fuse located inside the power module on the front panel that protects against drawing excessive current from the mains supply. See Table 4-4.

⚠⚠Warning

To prevent possible electrical shock, fire, or personal injury, use only specified replacement parts.

Table 4-4. Replacement Fuse (Controller)

Fuse	Fluke Part Number
⚠ FUSE,FUSE,5X20MM,1A,250V,SLOW	808055

To replace the fuse (see Figure 4-2):

1. Disconnect the mains-power cord from the power-entry module.
2. Open the power-entry module and remove the fuse holder.
3. Replace the fuses with exact replacements as listed in Table 4-4.

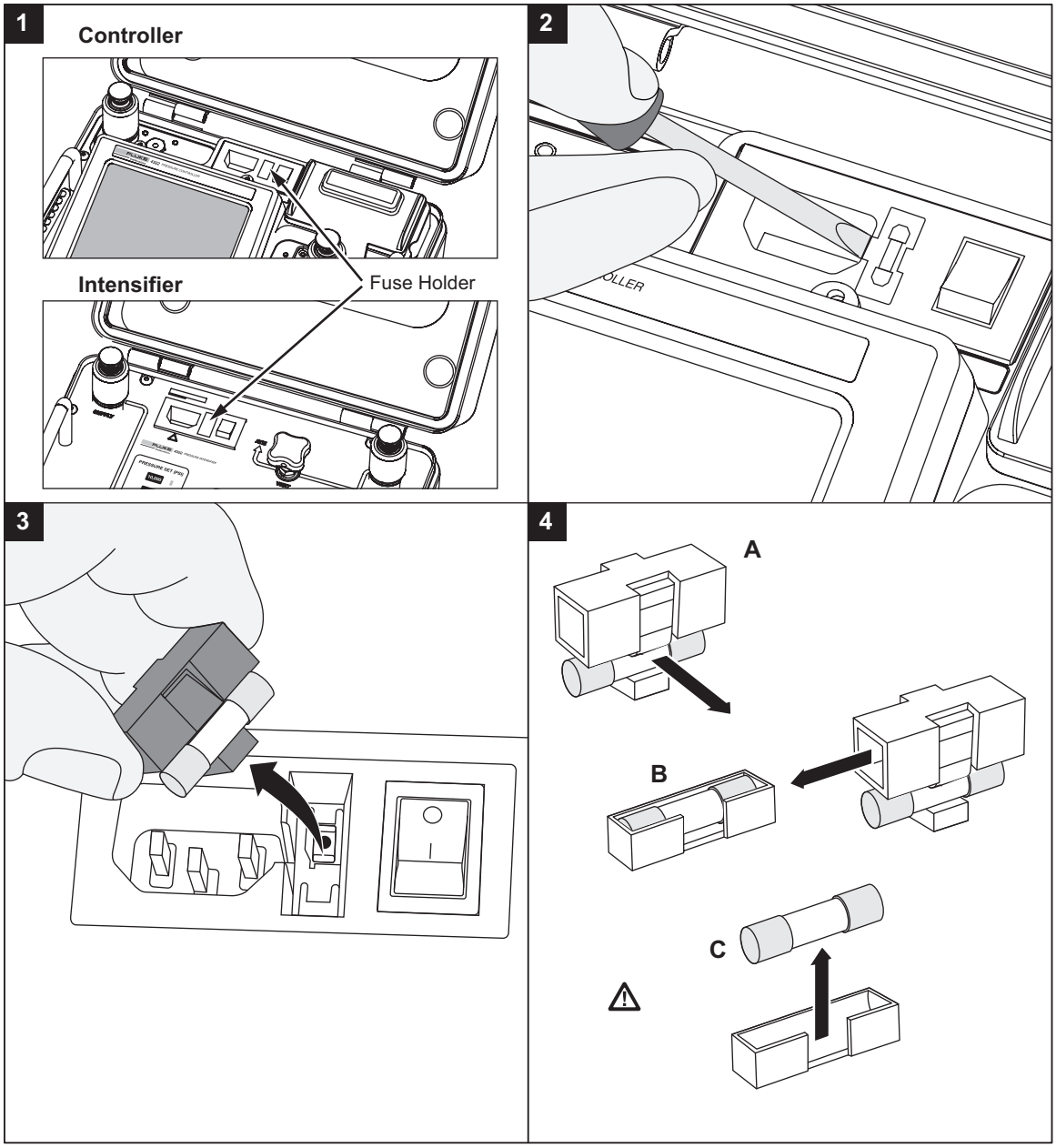


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Figure 4-2. Controller Fuse Replacement

Controller Part Replacement

This section supplies instructions on how to replace specific parts within the Controller.

Note

The replacement procedures in this chapter only contain specific instructions on how to replace a part and do not list part numbers. For a full list of part numbers, see Chapter 7 "List of Replaceable Parts".

Chassis

This procedure supplies instructions on how to remove the chassis to gain access to the parts and subassemblies inside the case. Use the following instructions and reference Figure 4-3 to remove chassis (③) from the case (②).

⚠⚠Warning

To prevent injury and electric shock, disconnect the power cord prior to the removal procedure.

Remove the chassis and control panel as follows (see Figure 4-3):

1. Remove the power cord and disconnect the supply pressure and UUT.
2. Remove the CPS.
3. Remove the four control panel assembly screws (①).
4. Use the handles and lift the chassis (③) out of the case (②). Put the chassis on a padded work surface. Continue to "Control Panel Separation" if it is necessary to remove the control panel.

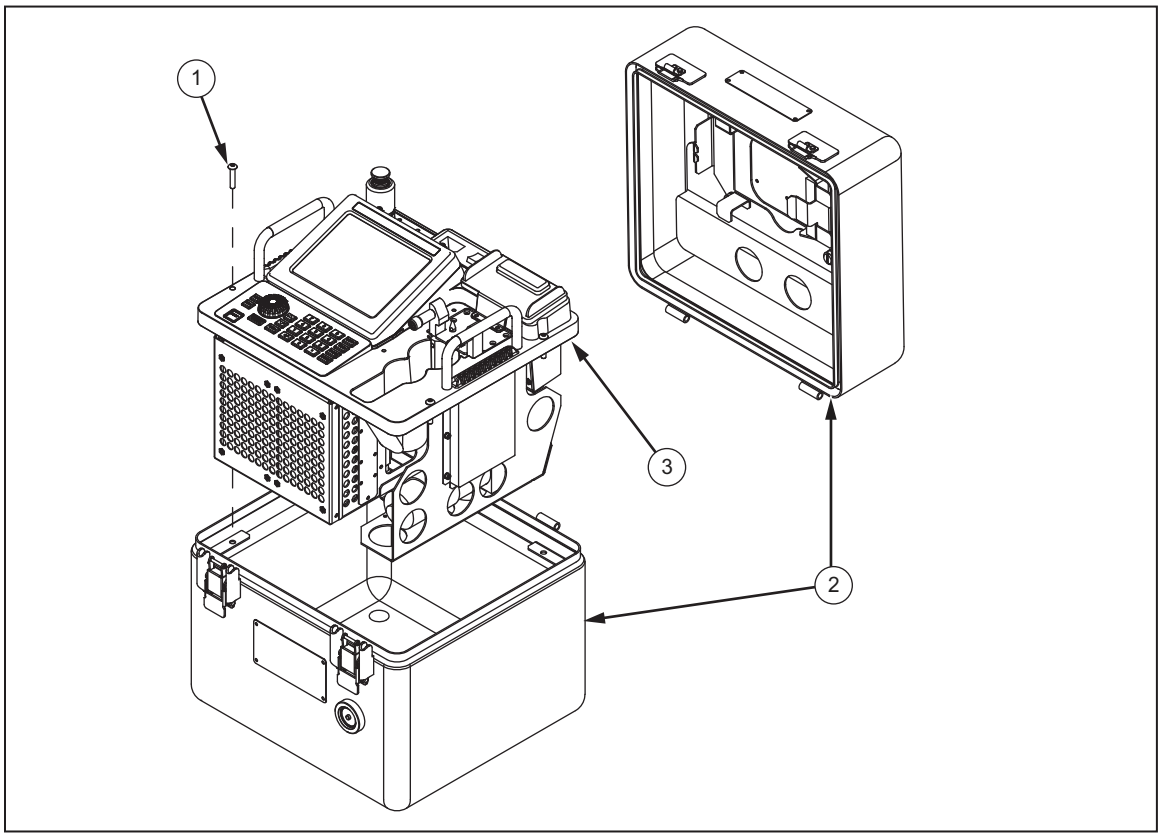

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Figure 4-3. Controller Case and Chassis

Reinstall the chassis and control panel as follows (see Figure 4-3). Skip step 1 if the control panel was not removed.

1. Reinstall the control panel on the chassis as follows (see Figure 4-4):
   a. Connect the keypad ribbon cable (④) and feed the display ribbon cable (⑤) and the backlight power cable (⑥) through the control panel (②).
   b. Carefully put the control panel (②) on top of the chassis (③).
   c. With the display propped open, connect the display ribbon cable (⑤) and the backlight power cable (⑥) on the rear of the display.
   d. Connect the atmosphere vent tube (⑪) on the control panel (②).
   e. Install the four screws that secure the supply tube-weld (③) and the output tube-weld (⑨) to the manifold.
   f. Install the four screws and washers (④) that secure the handles to the control panel (③).
   g. Install the six screws (①) that secure the control panel (②) to the chassis (③).
2. Install the chassis into the case as follows (see Figure 4-3):
   a. Use the handles to put the chassis (③) into the case (②).
   b. Install the eight control panel assembly screws (①).

Control Panel Separation

If required for individual part replacement, separate the control panel from the chassis as follows (see Figure 4-4):

1. Use the instructions in "Pressure Transducers and Barometer" on page 4-26 to remove the pressure transducers and barometer.
2. Remove the two screws (⑨) that secure the control panel (①) to the chassis.
3. Remove the four screws and washers (⑦) that secure the handles to the control panel (①).
4. Remove the six screws and washers (④) that secure the electronics cover/power supplies (③) then remove. To fully remove the cover, disconnect the cable from (J14) of main PCA and remove (P4) and (P5) on power supply to allow removal of the electronics cover/power supplies (see Figure 4-5).
5. Disconnect the following cables from main PCA (see Figure 4-5):
   a. Gently pry or flip up the elongated locking bar at the bottom of the connector to disconnect the display ribbon cable from (J9) on the main PCA. Slide the ribbon cable out and away.
   b. Disconnect the display power cable from (J7) on the main PCA.
   c. Remove anti-vibration cover then disconnect the keyboard cable from (J16) on the main PCA.
   d. Remove anti-vibration cover then disconnect the communication box cable from (J11) on the main PCA.
   e. Disconnect the CPS dock VH2 cable from (J6) on the main PCA.
   f. Disconnect the CPS isolation valve VH3 cable from (J8) on the main PCA.
6. Remove the pump bracket assembly (⑤). See "Pump Bracket" on page 4-16.
7. Remove the communications box (not shown) to allow access to the CPS isolation valve. See "Communications Box" on page 4-24.
8. Remove the CPS NC isolation valve on the CPS dock. See "CPS Dock and NC Isolation Valve" on page 4-29.
9. Disconnect the N, L, G wires (①) on the power entry module shown in Figure 4-6.

10. Remove the t-fitting (②) shown in Figure 4-6 by pressing in on the plastic ring around the tube and pulling the TEE away from the bulkhead fitting.
11. Remove tubeweld (③) shown in Figure 4-6. To do this, remove the two screws (⑩) and washers (⑨) that secure the tubeweld (⑧) to the manifold.

Note

It is critical to have the fitting facing up when removed to ensure that the spring (④) and ball (⑤) are not lost. The seat check valve (⑦) should stay in the tubeweld."Facing up" is defined as the chassis is oriented upside down with the control panel pointed down towards, or resting, on the work bench.

Once the tubeweld has been removed, use a piece of tape to cover the fitting on the manifold to keep the spring and ball inside.

12. Remove the display. See “Display” on page on page 4-22.
13. Separate the control panel from the chassis. Make sure the tubeweld is not damaged or bent during the separation.

Reinstall the control panel as follows (see Figure 4-4):

1. Install the display. See “display” on page on page 4-22.
2. Install the tubeweld (③) shown in Figure 4-6. To do this, first insert the spring (④) down into the mating seat, then insert the ball (⑤). Then install the two screws (⑩) and washers (⑨) that secure the tubeweld (⑧) to the manifold.

Note

It is critical to have the fitting facing (front panel display facing down on the work bench) up when removed to ensure that the spring (④) and ball (⑤) are not lost. The seat check valve (⑦) and o-ring (⑥) should stay in the tubeweld.

3. Connect N, L, G wires (①) on the power entry module shown in Figure 4-6.
4. Install the t-fitting (②) shown in Figure 4-6.
5. Connect the tubeweld HM2 fitting (⑭) to the CPS dock (see Figure 4-4).

Note

The o-ring (⑩) and anti-extrusion ring (⑪) should remain in CPS dock. The sleeve actuator (⑫) and wave spring (⑬), should stay on the tubeweld HM2 fitting. The sleeve actuator orientation is important. The thin flange portion should face away from the CPS dock and towards the wave spring.

6. Install the CPS NC isolation valve on the CPS dock. See “CPS Dock and NC Isolation Valve” on page 4-29.
7. Install the communications box (not shown) to allow access to the CPS isolation valve. See “Communications Box” on page 4-24.
8. Install the pump bracket assembly (⑤). See “Pump Bracket” on page 4-14.
9. Disconnect the following cables from main PCA (see Figure 4-5):
   a. Connect the display ribbon cable to (J9) on the main PCA.
   b. Connect the display power cable to (J7) on the main PCA.
   c. Connect the keyboard cable to (J16) on the main PCA. Reinstall the anti-vibration device.
   d. Connect the communication box cable to (J11) on the main PCA. Reinstall the anti-vibration device.
   e. Connect the CPS dock VH2 cable to (J6) on the main PCA.

f. Connect the CPS isolation valve VH3 cable to (J8) on the main PCA.

10. Connect the cable from (J14) of main PCA and connect (P4) and (P5) on power supply to allow for installation of the electronics cover/power supplies (see Figure 4-5).
11. Install the six screws and washers (④) that secure the electronics cover/power supplies (③).
12. Install the four screws and washers (⑦) that secure the handles to the control panel (①).
13. Install the two screws (⑨) that secure the control panel (①) to the chassis.
14. Use the instructions in “Pressure Transducers and Barometer” on page 4-26 to remove the pressure transducers and barometer.

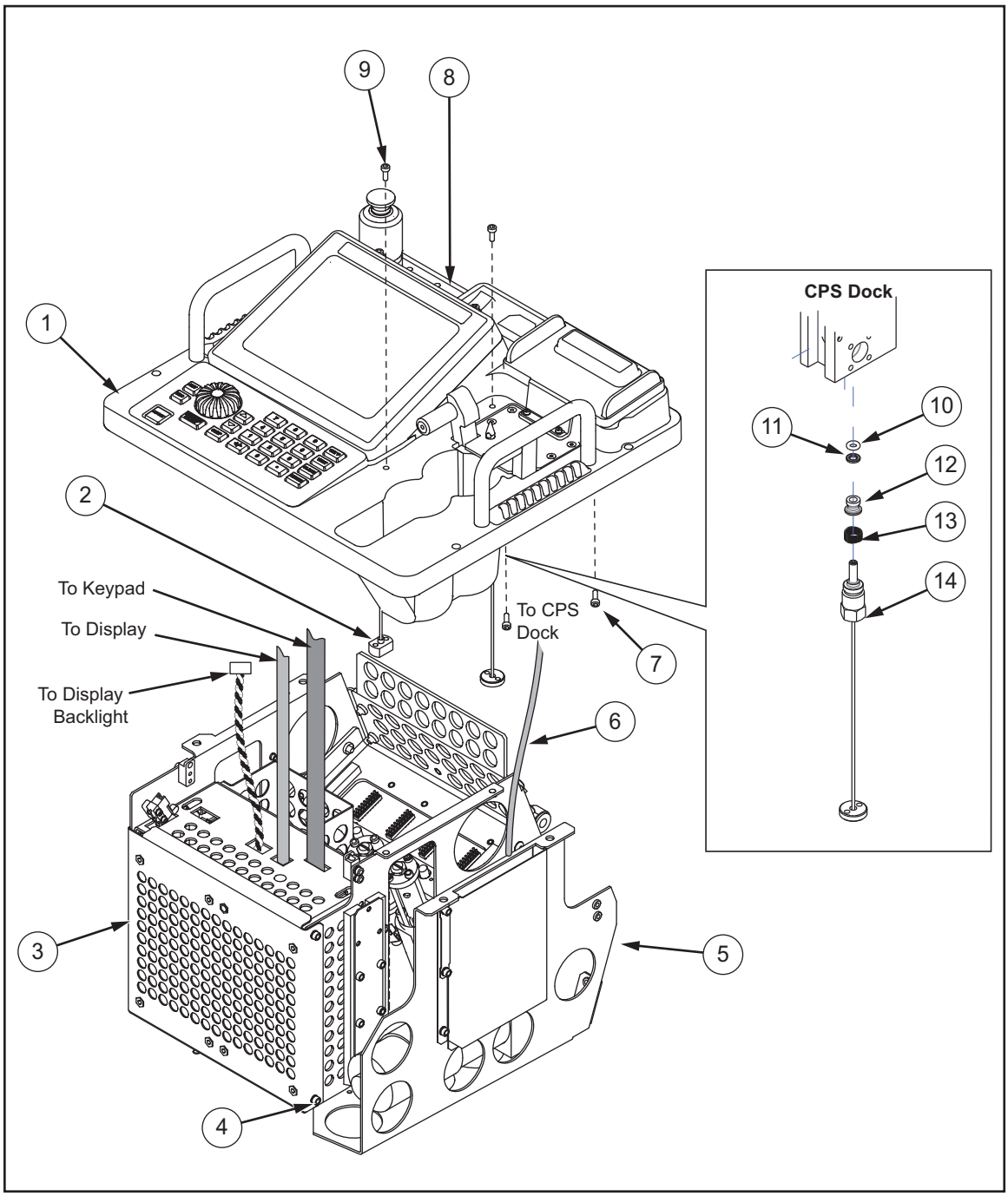

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Figure 4-4. Control Panel Removal

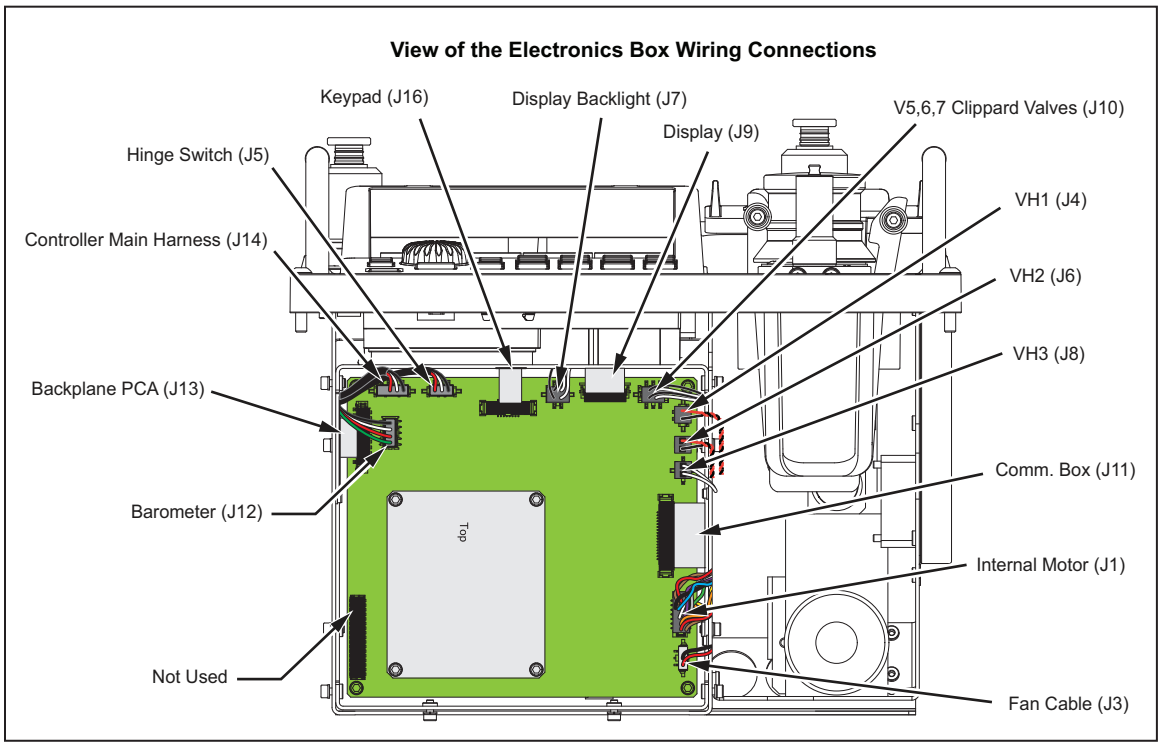

Figure 4-5. Electronics Box Cables

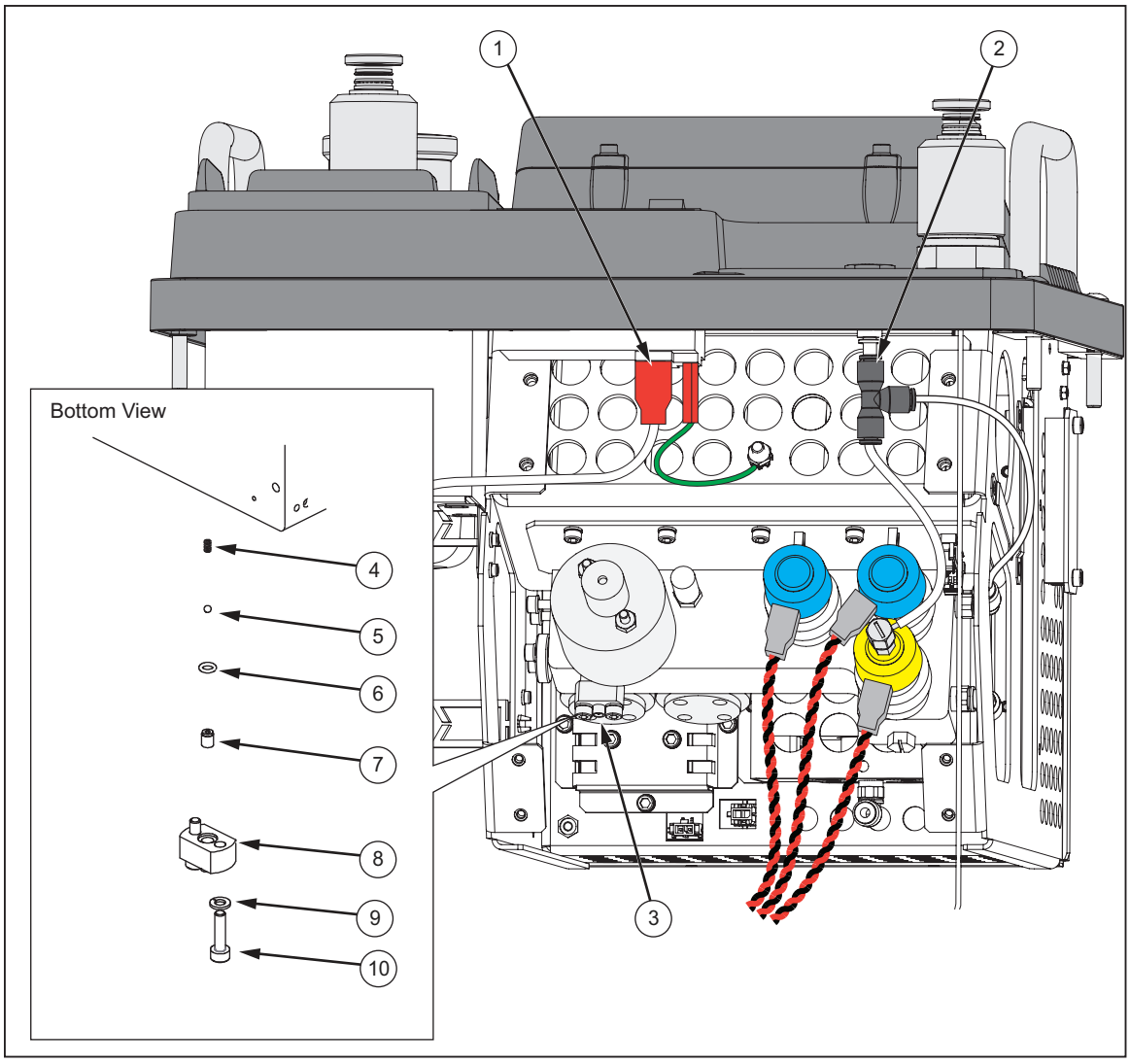

Figure 4-6. Power Module and Tubeweld

Pump Bracket

Use the following instructions and reference Figure 4-7 to remove the pump bracket assembly (⑤).

1. Use the instructions in "Chassis" on page 4-9 to remove the chassis.

   Note

   The control panel does not need to be separated from the chassis to complete this procedure.

2. If not removed as part of prior steps, remove the handle (①) from the pump bracket assembly by removing the two screws and lock washers (items ⑥ and ⑦).
3. There are three pairs of screws with lock washers that hold the pump bracket assembly (⑤) to the chassis (①). One pair attaches to the communications box, another pair attaches to the bottom inside to the chassis, and the third pair attaches to the cross member bracket. Remove the six screws (④) and ⑩) and washers (items ③ and ⑨) that secure the pump bracket assembly (⑤) to the chassis (②). The cross member bracket does not need to be removed from the chassis to remove the pump bracket assembly.
4. Pull the pump bracket assembly (⑤) from the chassis and disconnect the wiring (⑧) and the vent line (⑪) to the piston and pump head assembly. Use a 3/8 inch wrench to loosen the vent line compression fitting.

Use the following instructions and reference Figure 4-7 to reinstall the pump bracket assembly (⑤).

1. Connect the wiring (⑧) and the vent line (⑪) to the piston and pump head assembly and put the pump bracket assembly (⑤) on the chassis.
2. Install the six screws (items ④ and ⑩) and washers (items ③ and ⑨) that secure the pump bracket assembly (⑤) to the chassis (②).
3. Install the two screws and lock washers (items ⑥ and ⑦) that secure the pump bracket assembly (⑤) to the handle (①).
4. Use the instructions in "Chassis and Control Panel" on page 4-9 to put the chassis into the case.

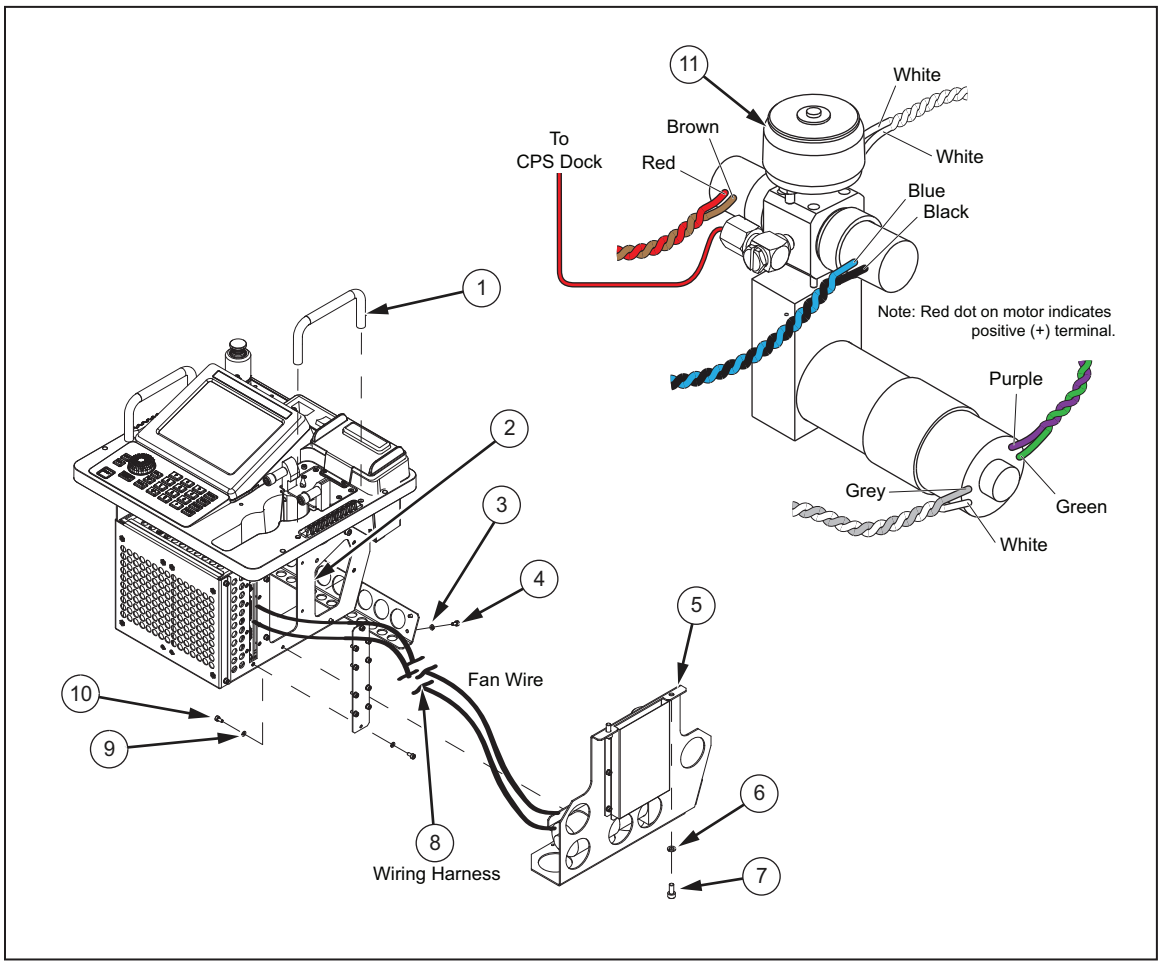

Figure 4-7. Piston and Pump Head Assembly Removal

Manifold

Use the following instructions and reference Figures 4-8 and 4-9 to extract the manifold assembly from the chassis.

1. Use the instructions in “Chassis and Control Panel” on page 4-9 to remove the chassis and take off the control panel.
2. Disconnect the pressure lines and electrical connections in order to remove the manifold assembly as follows (see Figure 4-8):
   a. Remove the two screws and washers (① and ②) that secure the fan bracket (not shown) to the manifold assembly. This bracket covers the NC isolation valve (⑫) on the manifold assembly.
   b. Disconnect the vent lines (⑦ and ⑧) that connects to the control panel atmosphere vent fitting. Disconnect the Barometer tube line (⑯) from the side of the manifold.
   c. Put the Controller face down and remove PV1 (⑬) and PV2 (⑭) electrical connectors.
   d. Disconnect the electrical connectors to valves V7, V6, and V5 (⑨, ⑩, and ⑪. Also disconnect the NC valve cable (⑫) from the main PCA (not shown) labeled as "VH1" on the board. Pry off the anti-vibration cover from the J1 connector and remove the ribbon cable connector from the backplane PCA.
3. Prepare the manifold assembly for extraction as follows (see Figure 4-9):
   a. Remove the two screws that secure the output tube-weld (③) on the manifold that that connects to the CPS dock.
   b. Remove the two screws and washers (④) that secure the right side of the manifold to the chassis (one screw is button head to accommodate clearance for the communication box).
   c. Remove the four screws and washers (① and ②) that secure the left side of the manifold to the chassis.
4. Extract the manifold from the chassis. To do this, slowly remove the manifold assembly from the chassis and make sure all wires and tubes are disconnected.
5. Use the instructions in “Precision, Isolation, and Control Valves and Backplane PCA” on page 4-33 to replace the necessary part. Once the parts are replaced, use the instructions in “Manifold Assembly Reinstallation” to put the manifold assembly into the chassis.

Use the following instructions and reference Figures 4-8 and 4-9 to put the manifold assembly into chassis.

1. Put the manifold assembly into the chassis.
2. Install the two screws and washers (④) that secure the right side of the manifold to the chassis (one screw is button head to accommodate clearance for the communication box). See Figure 4-9.
3. Install the four screws and washers (① and ②) that secure the left side of the manifold to the chassis.
4. Install the two screws that secure the output tube-weld (③) on the manifold that that connects to the CPS dock (see Figure 4-9).
5. Connect the pressure lines and electrical connections in order to remove the manifold assembly as follows (see Figure 4-8):
   a. Install the two screws and washers (① and ②) that secure the fan bracket (not shown) to the manifold assembly. This bracket covers the NC isolation valve (⑫) on the manifold assembly. The M4 x 12 is used for the ferrite clamp.
   b. Connect the ground wire (⑤) from the manifold assembly.

c. Install the vent line (items ⑦ and ⑧) that connects to the control panel atmosphere vent fitting and ensure the line from the manifold to the barometer manifold is reconnected.
d. Put the Controller face down and connect the PV1 (⑬) and PV2 (⑭) electrical connectors.

Note

PV1 and PV2 have different electrical connectors which are not interchangeable. This helps to ensure the correct connection.

e. Connect the ribbon cable from the THM backplane PCA.
f. Connect the N, L, and G wires (③) to the power entry module (④).

⚠⚠ Warning

To prevent the risk of electric shock, the protective earth ground (⑤) must be installed as shown in Figure 4-8.

g. Connect the electrical connectors (⑨, ⑩, ⑪, and ⑫).

Note

The polarity does not matter for a solenoid. The red/black wires can be connected to either spade lug on the valve.

6. Use the instructions in "Chassis and Control Panel" on page 4-9 to put the chassis into the case.

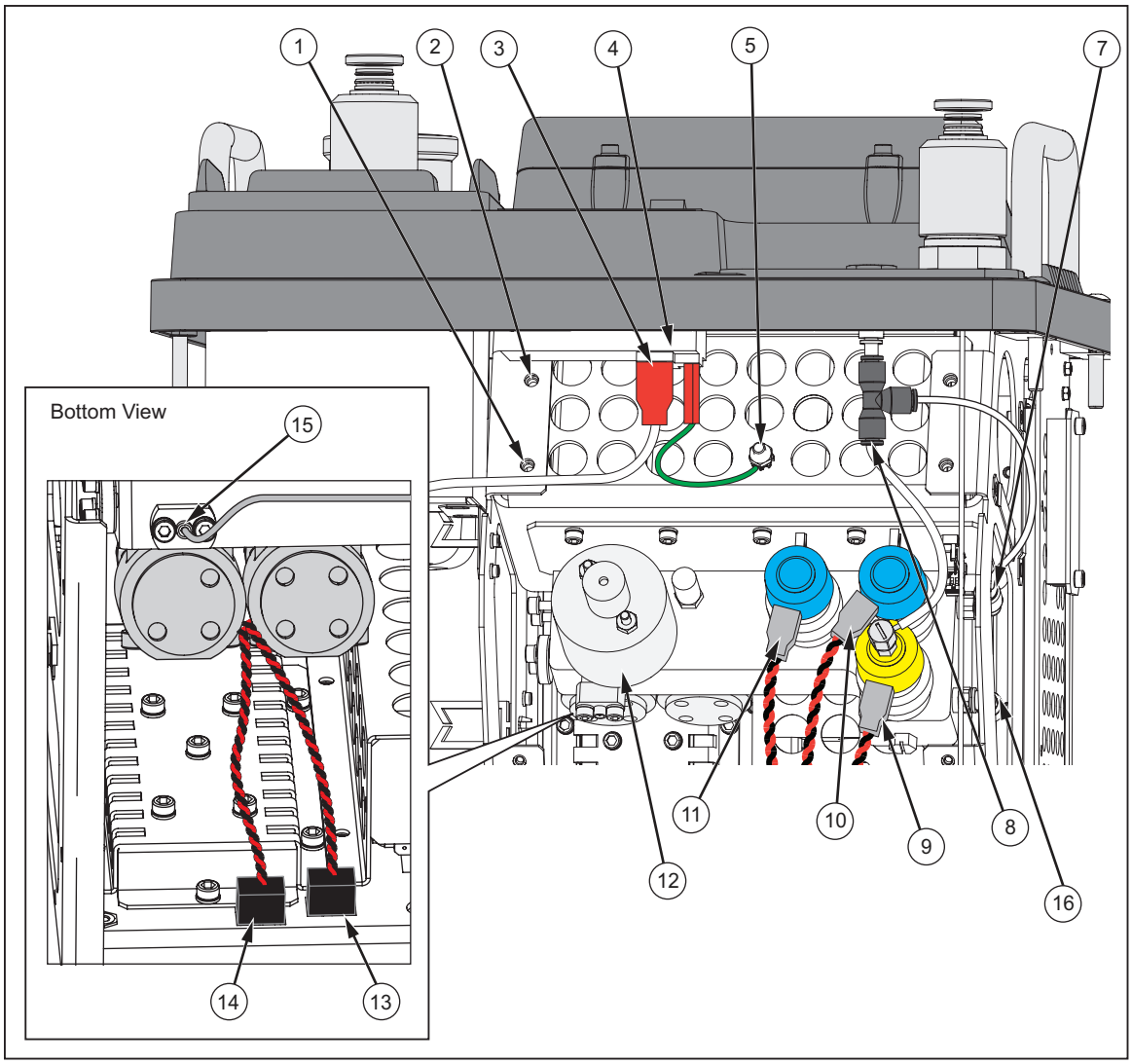

Figure 4-8. Pressure Line and Power Lines

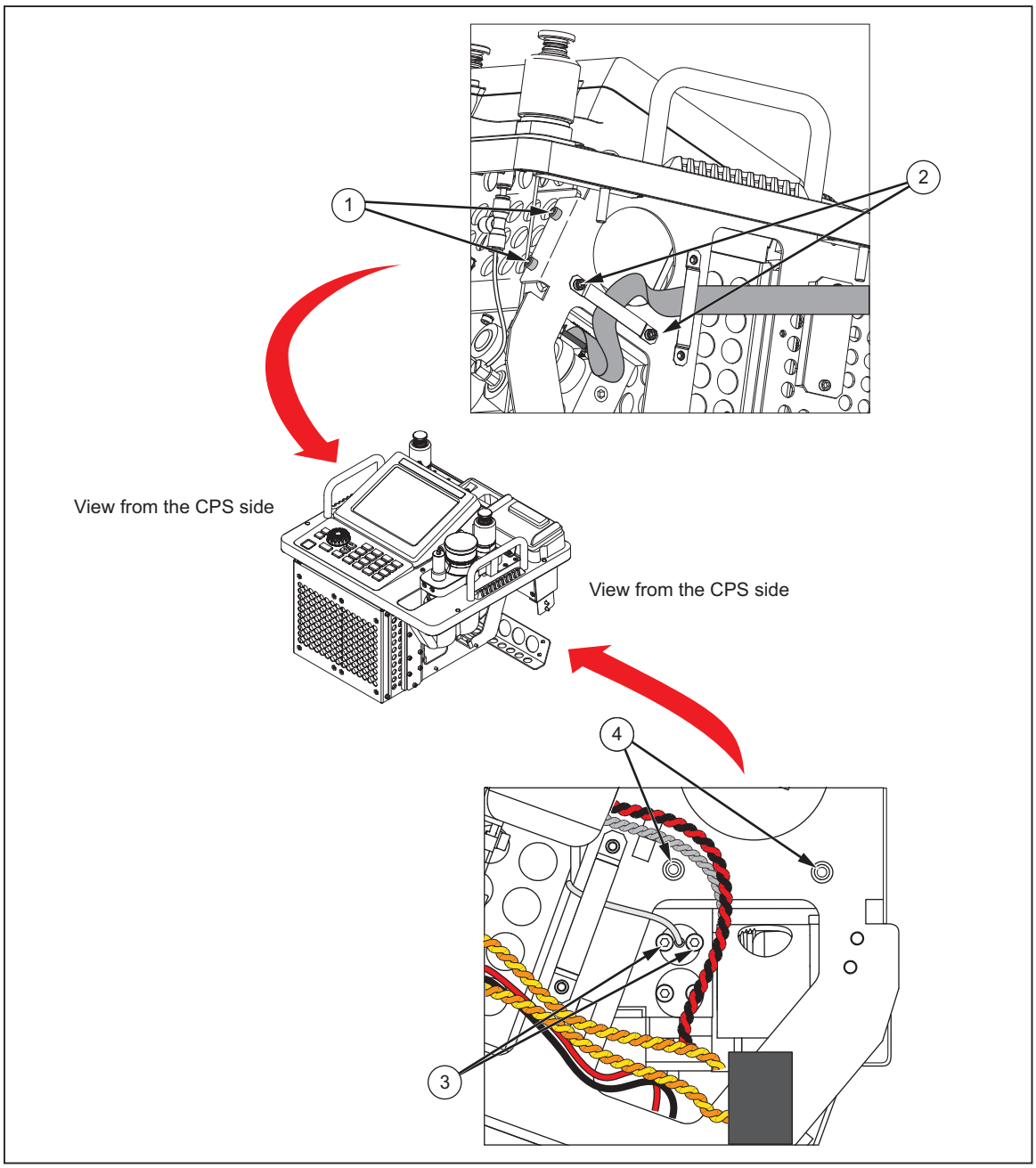

Figure 4-9. Manifold Removal

Display

Use the following instructions and reference Figure 4-10 to replace the display.

1. Use the instructions in “Chassis and Control Panel” on page 4-9 to remove the chassis.

   Note

   The control panel does not need to be separated from the chassis to complete this procedure.

2. Gain access to the main PCA to unplug display cables by performing the first few steps of the procedure “Access the Electronics Box”. Once the main PCA is accessed, disconnect the ribbon cable (J9) and the backlight power connector (J7) shown in Figure 4-20.
3. Remove the two screws (②) that secure the display (①) to the control panel (④).
4. Tilt the display (①) forward to gain access to the four hinge screws (③).
5. Remove the four hinge screws (③).
6. Remove the display. Carefully pull the ribbon cable (⑥) and the backlight power connector (⑤) through the control panel.
7. Install the new display. Insert the new ribbon cable (⑥) and the backlight power connector (⑤) into the control panel.
8. Add Loctite and install the four hinge screws (③).
9. Tilt the display (①) into the control panel.
10. Install the two screws (②) that secure the display (①) to the control panel (④).
11. Turn on the Controller and check the display.

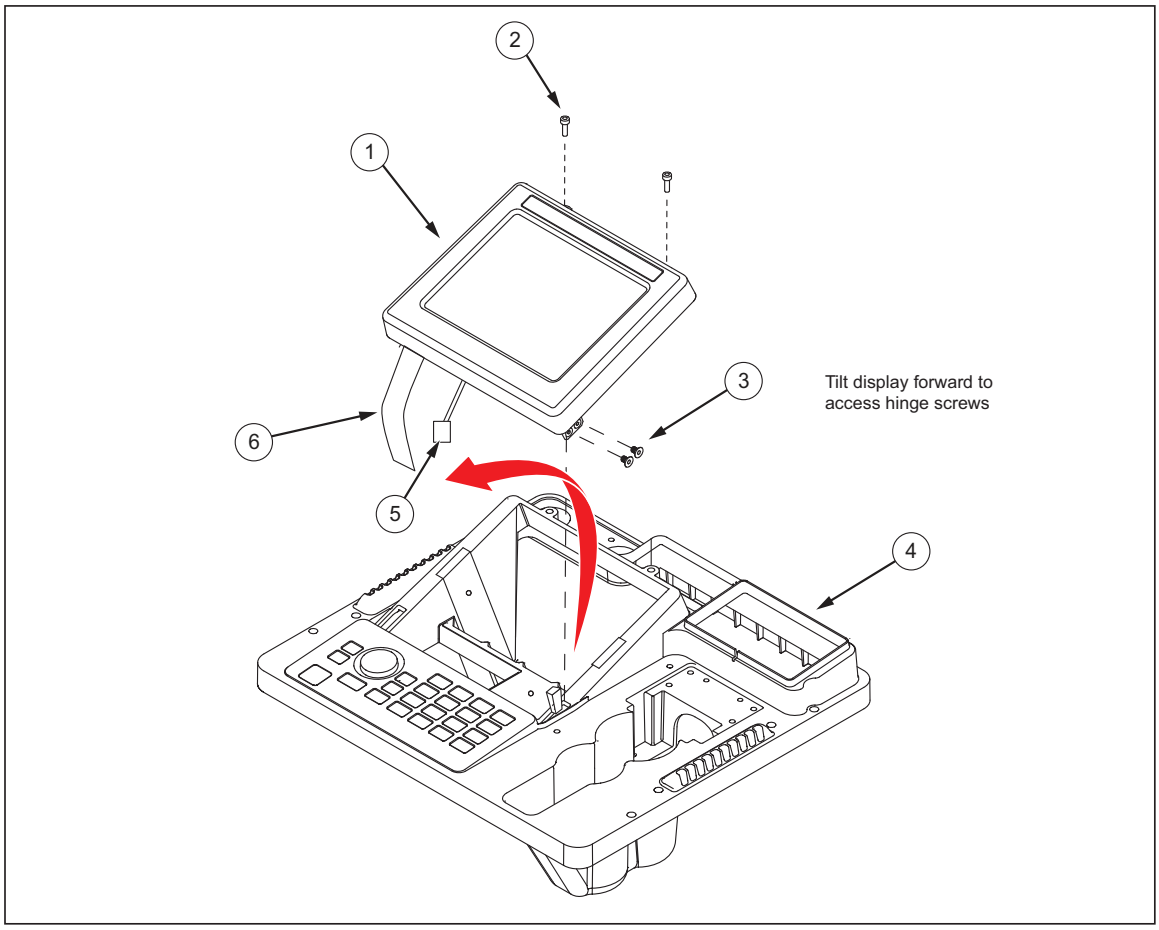

Figure 4-10. Display Assembly

Keypad, Encoder, or Encoder Wheel

Use the following instructions and reference Figure 4-11 to replace the keypad (⑤), encoder (④), or encoder wheel (①):

To replace the keypad (⑤):

1. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis and take off the control panel.
2. Lift off the encoder wheel (①) from the encoder (④) by prying upward with screwdriver.
3. Remove the nut and washer from the encoder (④) using a nut driver.
4. Remove the eight screws (③) that secure the keypad (⑤) to the control panel (②).
5. Remove the keypad and put the new keypad in the control panel.
6. Install the eight screws (③) that secure the keypad (⑤) to the control panel (②).
7. Install the nut and washer on the encoder (④) using a nut driver.
8. Push on the encoder wheel (①) onto the encoder (④).
9. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the control panel and put the chassis back into the case.

To replace the encoder (④) or encoder wheel (①):

1. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis and take off the control panel.
2. Disconnect the wire (not shown) from the encoder (④).

3. Lift off the wheel (①) from the encoder (④).
4. Remove the washer and nut (not shown) that secures the encoder to the keypad (⑤).
5. Remove the encoder (④) and put the new encoder on.
6. Install the washer and nut (not shown) that secures the encoder to the keypad (⑤).
7. Put the encoder wheel (①) on the encoder (④).
8. Connect the wire (not shown) to the encoder (④).
9. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the control panel and put the chassis back into the case.

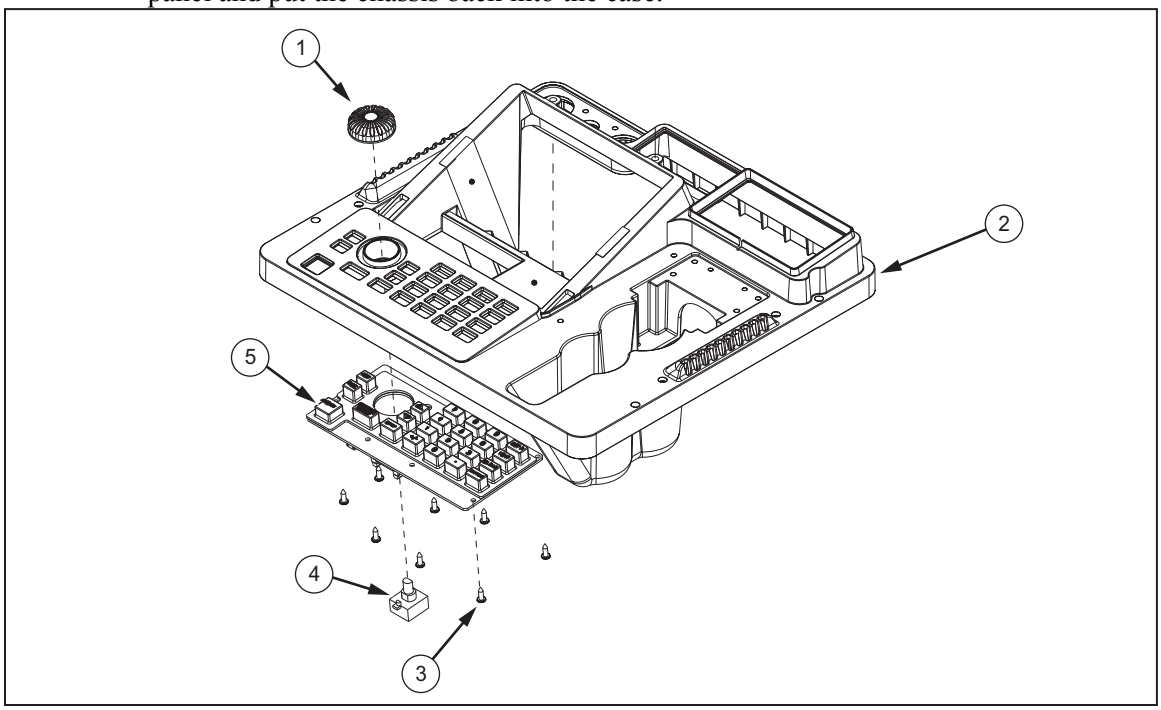

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Figure 4-11. Keypad Replacement

Communications Box

Use the following instructions and reference Figure 4-12 to replace the communications box (①):

1. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis.

Note

The control panel does not need to be separated from the chassis to complete this procedure.

2. Remove the two flanges (⑤) that secure the lower communications box (④) to the chassis. To do this, remove the four screws and washers (⑥ and ⑦) on each flange (⑤).
3. Slide the upper communications box (①) out of the top of the control panel (③) while pushing up from the bottom.
4. Remove the anti-vibration device from the ribbon cable connector. Use a small flathead screwdriver to slowly pry the device off. After the device is removed, disconnect the ribbon cable.
5. Connect the ribbon cable to the new communication box.

6. Install the anti-vibration device.
7. Slide the upper communications box (①) into the top of the control panel (③).
8. Install the two flanges (⑤) that secure the lower communications box (④) to the chassis. To do this, install the four screws and washers (⑥ and ⑦) on each flange (⑤).
9. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the control panel and put the chassis back into the case.

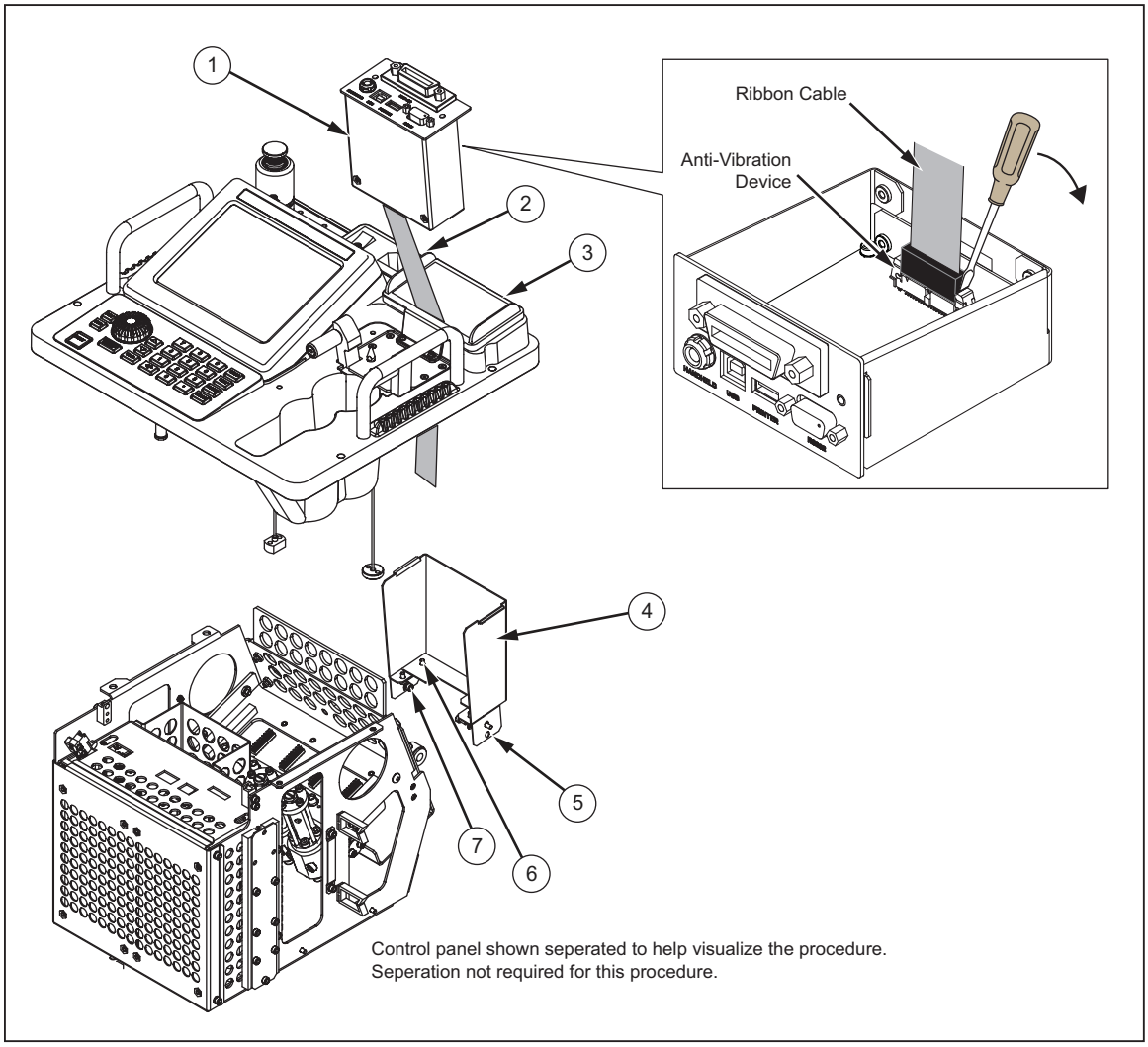

Figure 4-12. Communications Box Replacement

Pressure Transducers and Barometer

Use the following instructions and reference Figure 4-13 to replace a pressure transducer module and/or the barometer.

⚠⚠Warning

To prevent possible personal injury, shut off the supply pressure and vent the system before removing a transducer module.

1. Remove the two screws that secure the display to front panel.
2. Tilt the display forward to expose the transducer and barometer modules.
3. Loosen the two knobs on the top of the pressure transducer module.
4. Lift up to remove.
5. To put the module into the slot, align the pressure transducer module in the appropriate slot. See step 3 in Figure 4-13.

Note

Make sure that the barometer is oriented correctly with the Fluke Calibration logo in the top left corner. The barometer will not function if inserted upside-down.

6. Tighten the two knobs on the top of the pressure transducer module.
7. Close the display.
8. Install the two screws that secure the display to front panel.

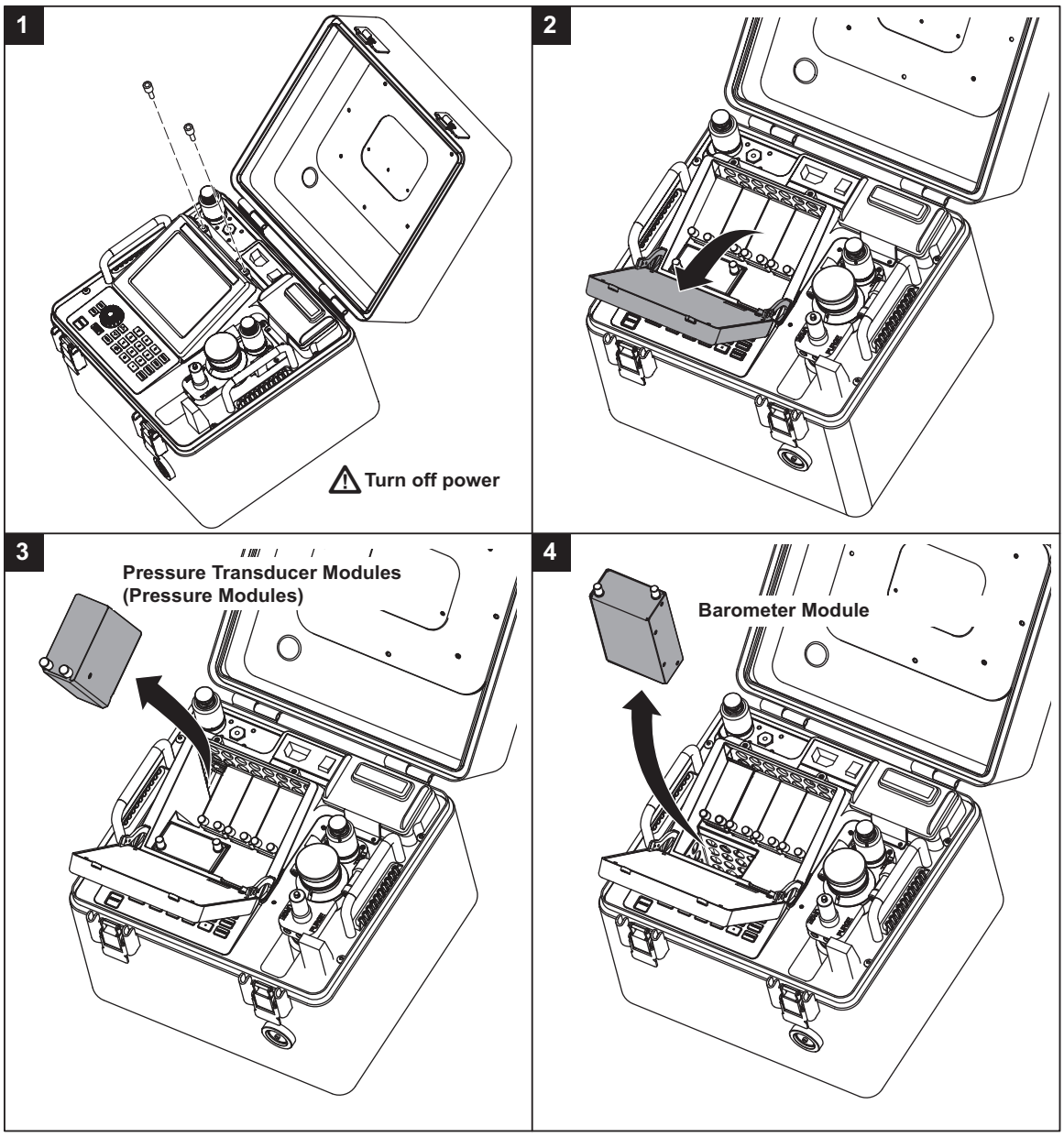

Figure 4-13. Pressure Transducer and Barometer Removal

Contamination Prevention System (CPS)

Use the instructions in the subsequent sections to replace the CPS filters, dock, and NC isolation valve.

Fine and Coarse CPS Filters (Internal)

Use the following instructions and reference Figure 4-14 to replace the fine and coarse filters in the CPS.

Filter removal:

1. Remove the CPS from the Controller.
2. Remove the filter housing (⑫).
3. Remove the first filter retainer (⑩).
4. Remove the second filter retainer (⑨).
5. Remove the coarse filter (⑧) from the assembly.
6. Grab and pull out the upper filter retainer (items ③, ④, ⑤, and ⑥) to gain access to the fine filter (①).
7. Remove the fine filter (①).

Filter installation:

1. Install the fine filter (①).
2. Carefully align the upper filter retainer (④, ⑤, and ⑥) on the pressure port (⑦) and push it into place. The screw heads (③) should be positioned towards the fine filter.
3. Position the coarse filter (⑧) into place then install the second filter retainer (⑨).
4. Install the second filter retainer (⑩).
5. Install the filter housing (⑫).

CPS Vent Filter (External)

Use the following instructions and reference Figure 4-14 to replace the external vent filter located on the outside of the CPS that is inserted into the waste container.

Filter removal:

1. Remove the CPS from the Controller.
2. Remove the filter retainer (⑬).
3. Remove the filter (⑭).

Filter installation:

1. Install the filter (⑭).
2. Install the filter retainer (⑬).

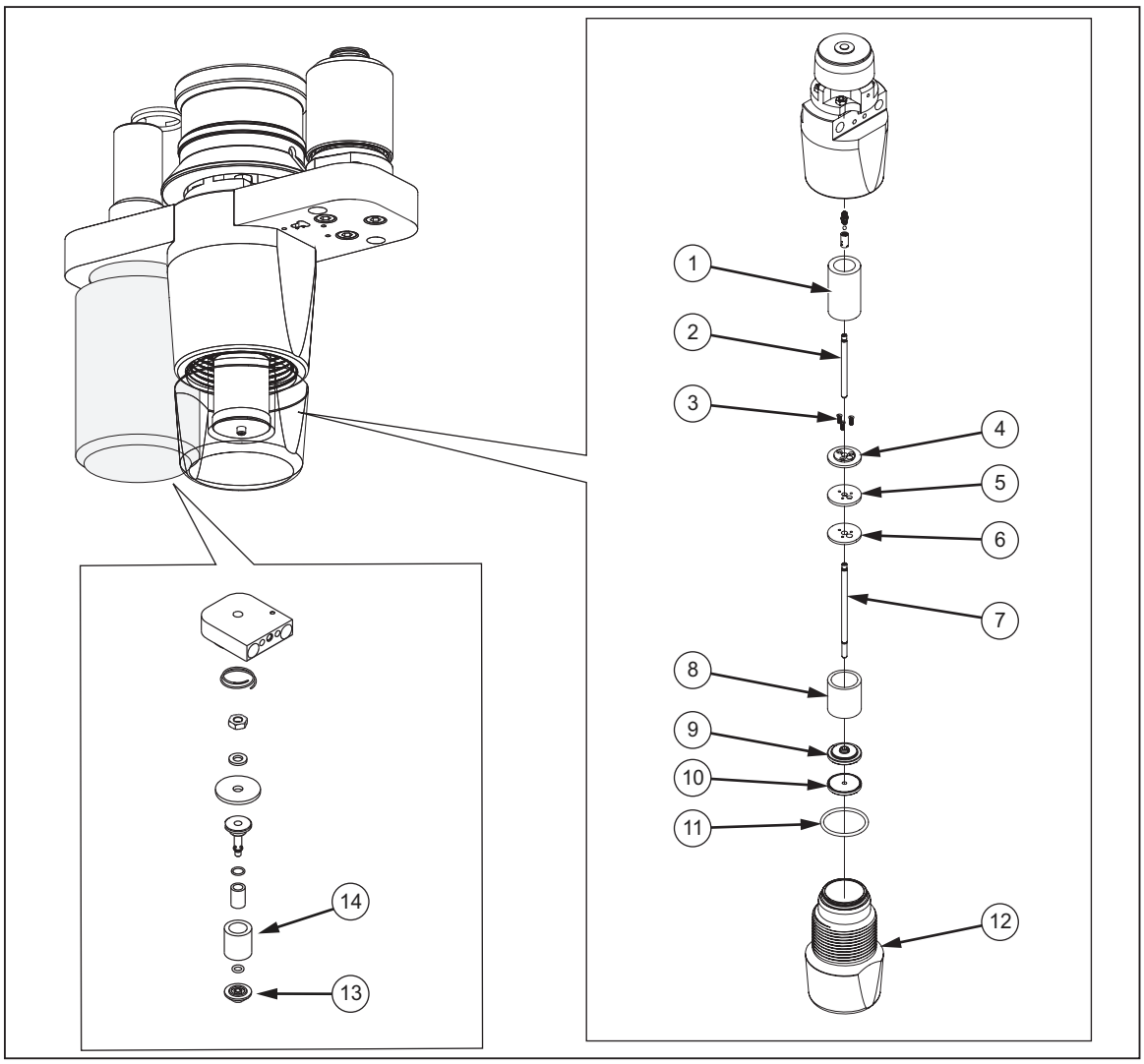

Figure 4-14. Coarse and Fine Filters

CPS Dock and NC Isolation Valve

Use the following instructions and reference Figure 4-15 and 4-16 to replace the CPS dock assembly and/or the NC isolation valve.

1. Use the instructions in “Chassis and Control Panel” on page 4-9 to remove the chassis from the case. The control panel does not need to be removed for this procedure.
2. Remove the pump bracket assembly from the chassis. See “Pump Bracket” on page 4-14.
3. Remove the NC isolation valve as follows (see Figure 4-16):
   a. Remove the Communications Box. See “Communications Box” on page 4-24.
   b. Remove the wire cover (with the EMI gasket) by removing the seven screws and lock washers. This will free the solenoid valve wires.
   c. With a soft grip pair of channel locks, turn the NC isolation valve (④) counterclockwise to remove.
   d. Remove the four screws (③) that attach base of the NC isolation valve to the CPS dock.
   e. Remove the valve body (①) from the CPS dock.

4. Remove the CPS dock as follows (see Figure 4-15):
   a. Remove the brass tube fitting adaptor from the bottom of the CPS dock.
   b. Disconnect the tubeweld HM2 fitting (⑭) to the CPS dock (see Figure 4-4).
   c. Remove the four screws (②) that secure the CPS dock (①) to the control panel (⑥). When removing the CPS dock, be careful not to lose the wave spring which sits loosely up inside of the tubeweld pressure port.
   d. Put the new CPS dock (①) into the control panel (⑥).
   e. Reconnect the tubeweld HM2 fitting (⑭) to the CPS dock.
   f. Attach the brass tube fitting adaptor to the bottom of the CPS dock.

Note

The o-ring (⑩) and anti-extrusion ring (⑪) should remain in CPS dock. Items (⑫) and (⑬), should stay on the tubeweld HM2 fitting.

   g. Install the four screws (②) that secure the CPS dock to the control panel (②).
5. Install the NC isolation valve as follows (see Figure 4-15):
   a. Put the valve body (①) into the CPS dock.
   b. Install the four screws (③) that attach base of the NC isolation valve to the CPS dock.
   c. With a soft grip pair of channel locks, turn the NC isolation valve (④) clockwise to install.
   a. Connect the tubeweld HM2 fitting (⑭) to the CPS dock (see Figure 4-5).
6. Reinstall the pump bracket assembly. See “Pump Bracket” on page 4-14.
7. Use the instructions in “Chassis and Control Panel” on page 4-9 to install the control panel and put the chassis back into the case.

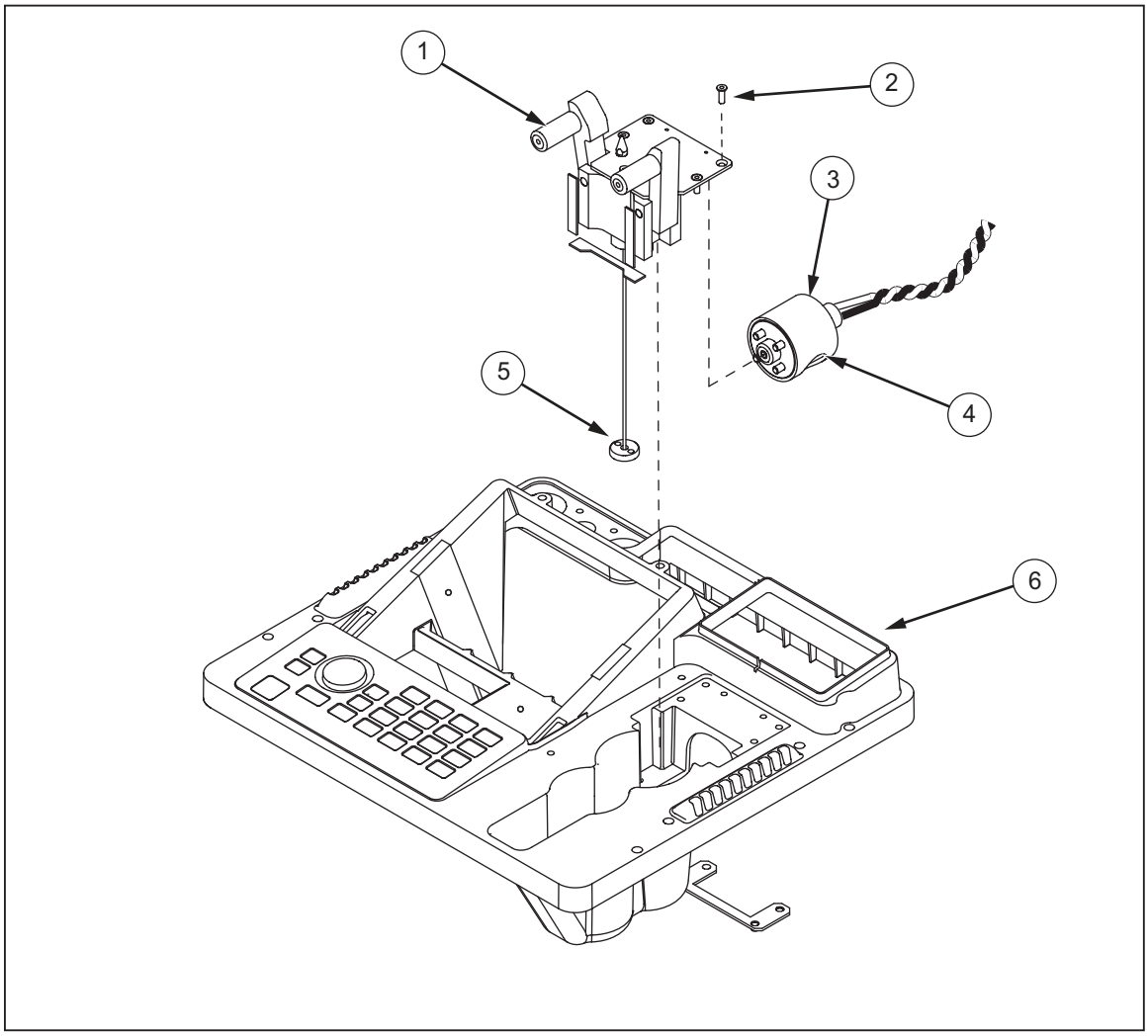

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Figure 4-15. CPS Dock Replacement

Piston Pump Head Clippard Valves

Use the following instructions and reference Figure 4-16 to replace the fine or coarse Clippard valves.

1. Remove the pump bracket assembly from the chassis. See “Pump Bracket” on page 4-16
2. Position the complete pump head assembly so that the solenoid (⑨) is upright. This is to prevent the internal items from falling out.
3. Use a pair of soft jaw channellock pliers to loosen (counterclockwise) the knurled retaining ring (⑧). Once loose, turn it by hand to back it off from the threads. Remove the solenoid body (⑨) from the pump head (⑪).

Note

Since the solenoid is upright, when the Clippard valve is removed, the shim, seat, and o-ring should stay in the pump head. Make sure these items are remain in the pump head.

4. Put the new solenoid assembly on the pump head (⑪).
5. Use a pair of soft jaw channellock pliers to tighten (clockwise) the solenoid retaining ring (⑧).
6. Reinstall the pump bracket assembly. See “Pump Bracket” on page 4-16.

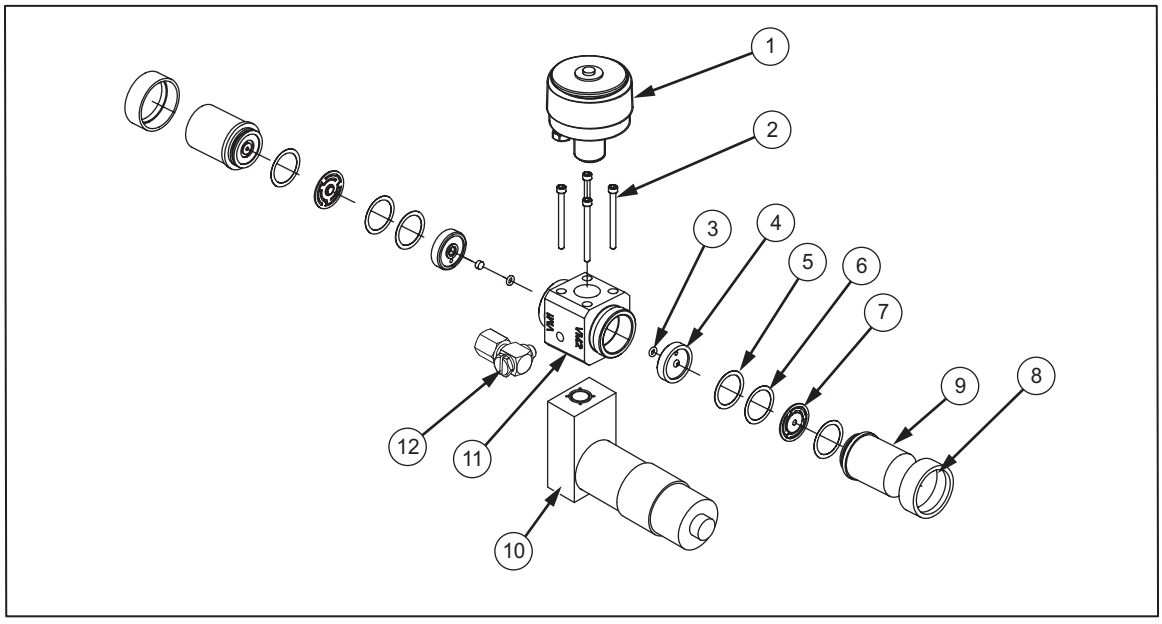

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Figure 4-16. Pump Head and Piston Removal

Piston Seal Replacement

Use the following instructions to replace piston seal in the piston pump (see Figure 4-17).

1. Remove the pump bracket assembly from the chassis. See “Pump Bracket” on page 4-16.
2. Remove the piston pump head along with the Clippard valves. See Figure 4-16. The Clippard valves can stay attached to the pump head.
   a. Use a pair of soft jaw channel lock pliers to loosen (counterclockwise) the atmospheric solenoid valve (①). Once loose, turn by hand to remove. Be careful not to lose the poppet and spring from inside the valve seat.
   b. Remove the four screws (②) and gently pull off the pump head.
3. Remove the four screws (②) that secure the crank cover (①) on the rear portion of the pump cylinder (⑤) to gain access to the piston crank (⑧).
4. Rotate the piston crank (⑧) so that the piston is at the top of piston shaft. With a marker, mark the alignment position on the piston crank (⑦) and also which hole on the crank it was installed in. This will aid with reinstallation.
5. Mark the outer face of the connecting rod (⑥) with an orientation marking. Make sure this mark is showing when reinstalled.
6. Remove the crank screw (⑦). Use a pair of rubber gripped pliers to hold the piston crank (⑥) in place while turning the screw.
7. Push the piston out of the top of the cylinder.
8. Remove the o-ring from the piston.
9. Clean the piston with alcohol.
10. Lubricate a new o-ring with super-lube (Synco item number 21030). Use of this grease is important.
11. Install the new o-ring.
12. Lubricate the piston wrist pin where the crank screw (⑦) goes through with film of super-lube. Do not use too much grease.
13. Push the piston (③) into cylinder (⑤) as follows:
    a. Place the round chamfered piston installation guide (④), part of kit 4237107, on top of the cylinder (⑤).
    b. Insert the piston (③) into the piston installation guide (④) then use a soft tip tool to push the piston into the cylinder (⑤). The chamfered walls of the piston installation guide will aid with the installation and prevent the seal from becoming damaged when installed.

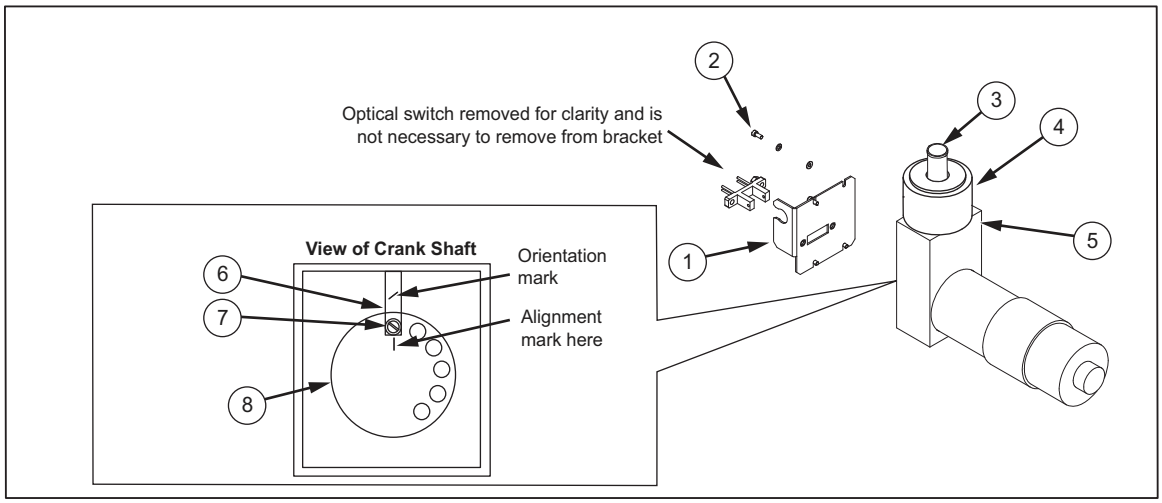

Figure 4-17. Piston Seal Installation

14. Reconnect the connecting rod (⑥) to the crank (⑦) in the same screw hole used

previously with the marking visible.

15. Install the piston pump head along with the clippard valves. See “Piston Pump Head Clippard Valves” on page 4-32.
16. Install the pump bracket assembly on the chassis. See “Pump Bracket” on page 4-16.

Precision, Isolation, and Control Valves and Backplane PCA

Use the following instructions to replace the precision, isolation, and control valves and backplane PCA.

Precision Control Valve

Use the following instructions and reference Figure 4-18 to replace the precision control valve (⑧).

1. Remove the two screws (⑦) that secure the precision control valve (⑧) to the manifold (⑤). Make sure not to lose the o-ring (⑥) when removed.
2. Put the o-ring (⑥) in the new precision control valve (⑧) and secure it to the manifold (⑤) with two screws (⑦).

Control Valves

Use the following instructions and reference Figure 4-18 to replace a control valve (items ⑩, ⑪, or ⑫).

1. To replace a control valve (items ⑩, ⑪, or ⑫), insert a small pointed screwdriver into the side of the valve. Pry counterclockwise to remove the valve. Once loose, remove by hand.
2. Screw in the new isolation valve by hand and hand tighten. Insert a small pointed screwdriver into the side of the valve. Pry clockwise to tighten the valve.

Backplane PCA

Use the following instructions and reference Figure 4-18 to replace the backplane pca (③).

1. Remove the manifold assembly from the chassis. See “Manifold” on page 4-18.
2. Remove the four screws (①) that secure the system manifold bracket (②) to the manifold (⑤).
3. Remove the four screws and washers (④) that secure the backplane pca (③) to the system manifold bracket (②).
4. Install the four screws and washers (④) to secure the new backplane pca (③) to the system manifold bracket (②).
5. Install the four screws (①) that secure the system manifold bracket (②) to the manifold (⑤).
6. Reinstall the manifold assembly into the chassis. See “Manifold” on page 4-18.

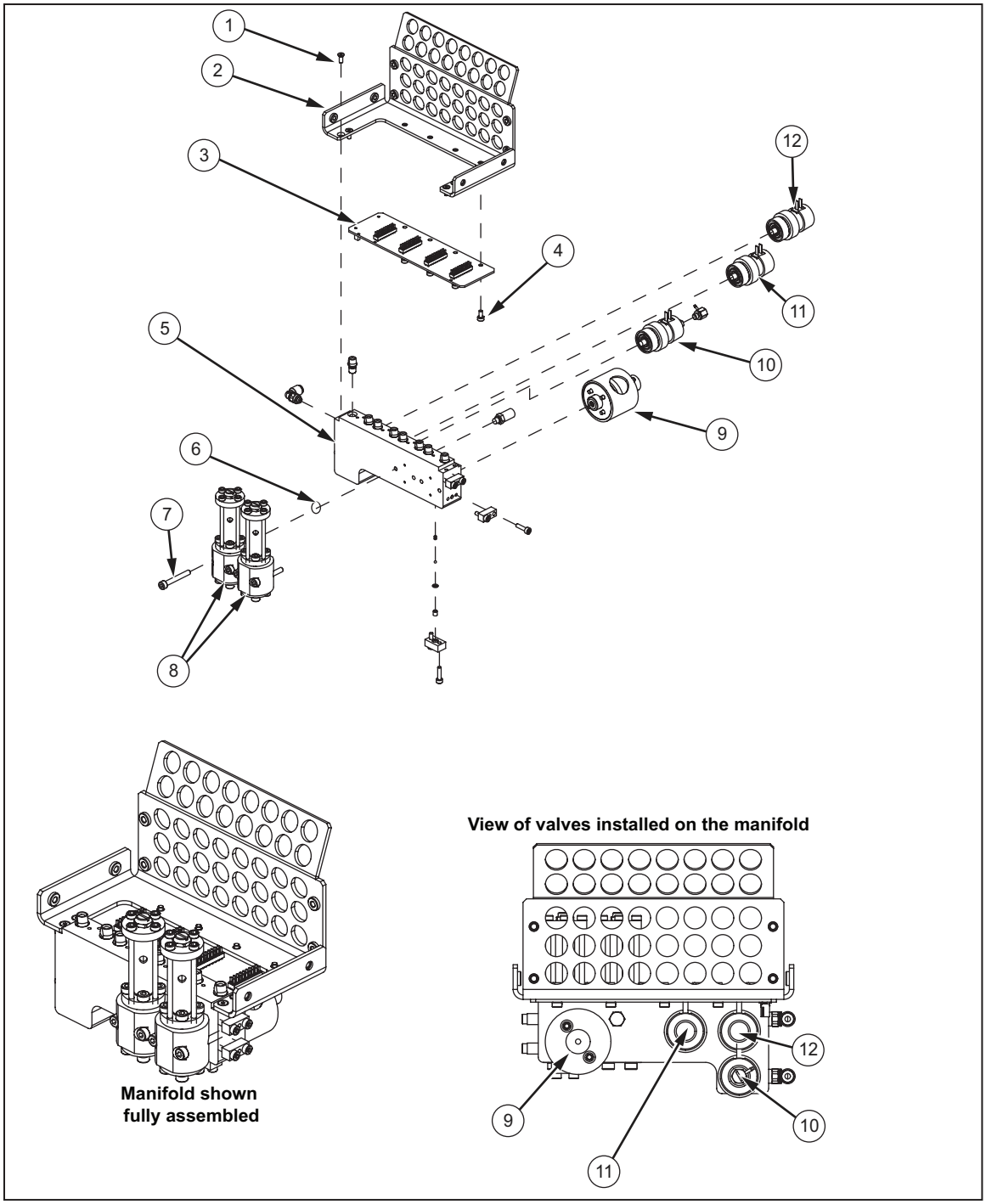

Figure 4-18. System Manifold Exploded View

NC Isolation Valve

Use the following instructions and reference Figure 4-19 to replace the NC isolation valve (④).

1. With a soft grip pair of channel locks, turn the NC isolation valve (④) counterclockwise to remove.
2. Remove the four screws (③) that attach base of the NC isolation valve to the manifold assembly.
3. Remove the valve body (①) from the manifold assembly.
4. Put the new valve body (①) into the manifold assembly.
5. Install the four screws (③) that attach base of the NC isolation valve to the manifold assembly.
6. With a soft grip pair of channel locks, turn the NC isolation valve (④) clockwise to install.

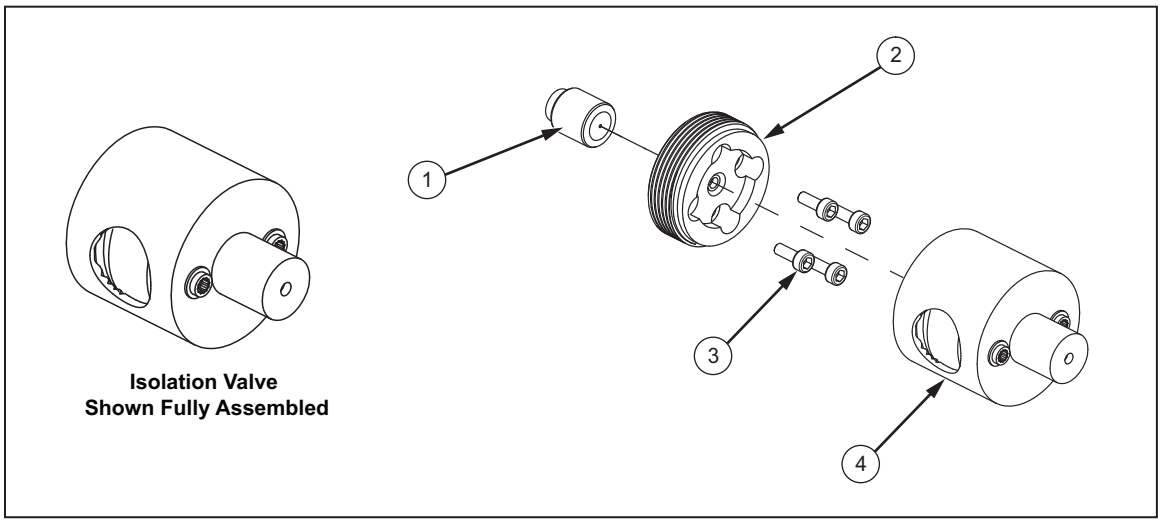

Figure 4-19. NC Isolation Valve

PCAs

Use the following instructions to gain access to the electronics box to replace the processor pca, the main pca, or the power supply pca. These pca assemblies listed can be accessed from the front of the electronics box without any additional tear down. If the amplifier pca assemblies on the back of the main pca need to be replaced, the electronic box needs to be removed to remove the screws that attach it to the metal pca cover.

Access the Electronics Box

Use the following instructions and reference Figure 4-20 to gain access to the electronics box.

1. Remove the mains power cord from the power entry module.
2. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis.
3. Remove the six screws and washers (⑧) that secure the electronic box cover (⑦) to the chassis. The two power supply pca assemblies (items ⑥ and ⑨) are attached to the electronic box cover (⑦). Disconnect the wiring.
4. When finished with the part replacement procedure, reconnect the wiring and install the six screws and washers (⑧) that secure the electronic box cover (⑦) to the chassis.
5. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the chassis back into the case.

Power Supply PCA

Use the following instructions and reference Figure 4-20 to replace the power supply pca (items ⑥ and ⑨).

1. Use the instructions in "Access the Electronics Box" to open the electronics box.
2. After the cover is removed with the power supply pca assemblies attached, remove the eight screws and washers (⑤) that secure the two power supply pca assemblies (items ⑥ and ⑨) to the electronic box cover (⑦).
3. Put the two new power supply pca assemblies (items ⑥ and ⑨) in the electronic box cover (⑦).
4. Install the eight screws and washers (⑤) that secure the two power supply pca assemblies (items ⑥ and ⑨) to the electronic box cover (⑦).
5. Use the instructions in "Access the Electronics Box" to close the electronics box.

Processor PCA

Use the following instructions and reference Figure 4-20 to replace the processor pca (⑩).

1. Use the instructions in "Access the Electronics Box" to open the electronics box.
2. Remove the four screws and washers (④) that secure the processor pca (⑩) to the main pca standoffs (③).
3. Install the new processor pca (⑩) on the main pca standoffs (③). Secure it with four screws and washers (④).

Main PCA and P-VLV PCA

Use the following instructions and reference Figure 4-20 to replace the main pca (⑪) or the p-vlv pca (⑫).

1. Use the instructions in "Access the Electronics Box" to open the electronics box.
2. Disconnect all wire connectors from the main pca (⑪) and disconnect the two precision control valve connectors to the bottom of the p-vlv pca (⑫). See Figure 4-20 for an illustration of all the connectors.
3. Remove the four screws and washers (②) that secure the main pca (⑫) to the p-vlv pca standoffs (①).
4. Remove the main pca (⑪) from the electronics box (⑭).
5. Remove the standoffs (①) that secure the p-vlv pca (⑫) to the electronics box (⑭)
6. Lift the p-vlv pca (⑫) out of the electronics box (⑭). The amplifier pca assemblies (⑬) will stay in the electronics box (⑭).
7. Carefully align the new p-vlv pca (⑫) on top of the amplifier pca assemblies (⑬).
8. Once aligned, slowly push down on the new p-vlv pca (⑫) to connect the two amplifier pca assemblies (⑬).
9. Install the standoffs (①) that secure the p-vlv pca (⑫) to the electronics box (⑭)
10. Install the four screws and washers (②) that secure the main pca (⑪) to the p-vlv pca standoffs (①).
11. Install the main PCA (⑪).
12. Connect all wire connectors from the main pca (⑪) and connect the two precision control valve connectors to the bottom of the p-vlv pca (⑫). See Figure 4-20 for an illustration of all the connectors.
13. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the control panel and put the chassis back into the case.

Amplifier PCA

Use the following instructions and reference Figure 4-20 to replace the amplifier pca assemblies (⑬).

Note

The amplifier pca assemblies (⑬) are located behind the p-vlv pca (⑫). If just the amplifier pca assemblies (⑬) need replaced, the electronics box does not need to be opened and replacement can be accomplished from the rear of the electronics box as described by the instructions in this procedure. To gain access to the rear of the electronics box, one of two methods can be used: (1) removal of the control panel and tilting the electronics box – or – (2) Removal of the manifold assembly.

1. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis and take off the control panel. Remove all the screws and washers that secure the electronics box (⑭) to the chassis. Rotate the electronics box 45 degrees to gain access to the 12 screws and washers (⑯) that secure the amplifier pca assemblies (⑬) to the heat shield cover (⑮).
2. Remove the 12 screws and washers (⑯) that secure the amplifier pca assemblies (⑬) to the heat shield cover (⑮).
3. Remove the heat shield cover (⑮).
4. Slowly pull out the amplifier pca assemblies (⑬).
5. Align the new amplifier pca assemblies (⑬) and slowly push them into place.
6. Install the heat shield cover (⑮).
7. Install the 12 screws and washers (⑯) that secure the amplifier pca assemblies (⑬) to the heat shield cover (⑮).
8. Use the instructions in "Chassis and Control Panel" on page 4-9 to reinstall the control panel – or – the instructions in "Manifold" on page 4-18 to reinstall the manifold assembly.

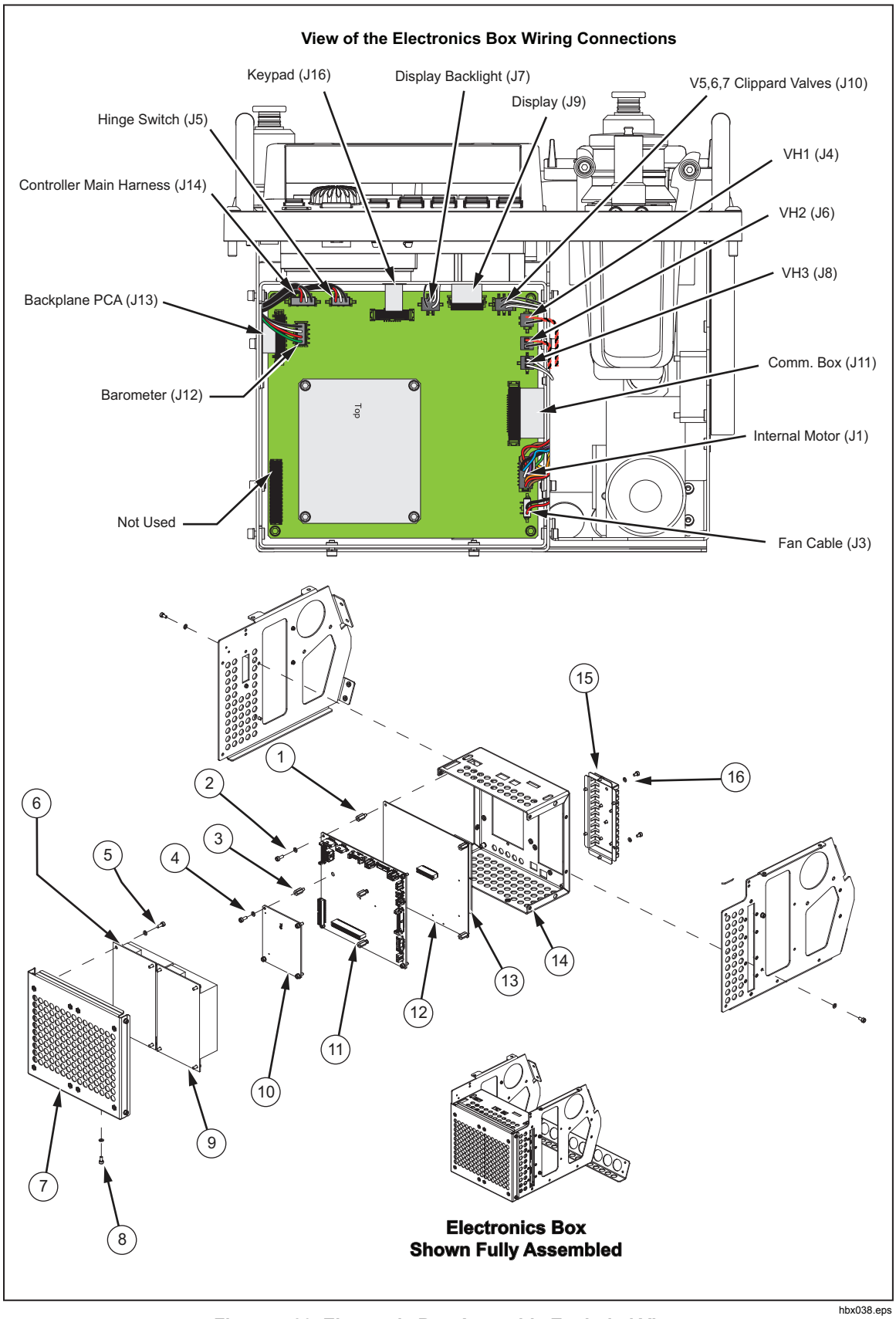

Figure 4-20. Electronic Box Assembly Exploded View

Quick Connect Fittings (QC) and Filter

Use the instructions below and Figure 4-21 to replace the QC fitting (⑪).

1. Use the instructions in "Chassis and Control Panel" on page 4-9 to remove the chassis.
2. Put the control panel (⑫) on a flat work surface upside down.
3. Remove the three screws (②) that secure the HM2 collar (⑤) to the quick connect (⑪).
4. Remove the three screws (⑥) that secure the QC adapter (⑦) to the quick connect (⑪).
5. Remove the quick connect (⑪) from the control panel (⑫).
6. Remove the filter (⑩) and o-ring (⑨) from the quick connect (⑪).
7. Put the filter (⑩) and o-ring (⑨) in the new quick connect (⑪).
8. Position the quick connect fitting on the control panel and install the o-ring.
9. Position the QC adapter (⑦) in the control panel (⑫) and secure it to the quick connect (⑪) with three screws (⑥). Tighten the screws in a star shaped pattern. After tightened, torque the screws to 2.3 Nm (20.4 in-lb).
10. Slide the tube (①) through the QC adapter (⑦) into the quick connect (⑪) until it stops.
11. Position the HM2 collar (⑤) on top of the QC adapter (⑦) and secure it with three screws (②) and lock washers (③).
12. Use the instructions in "Chassis and Control Panel" on page 4-9 to install the control panel and put the chassis back into the case.

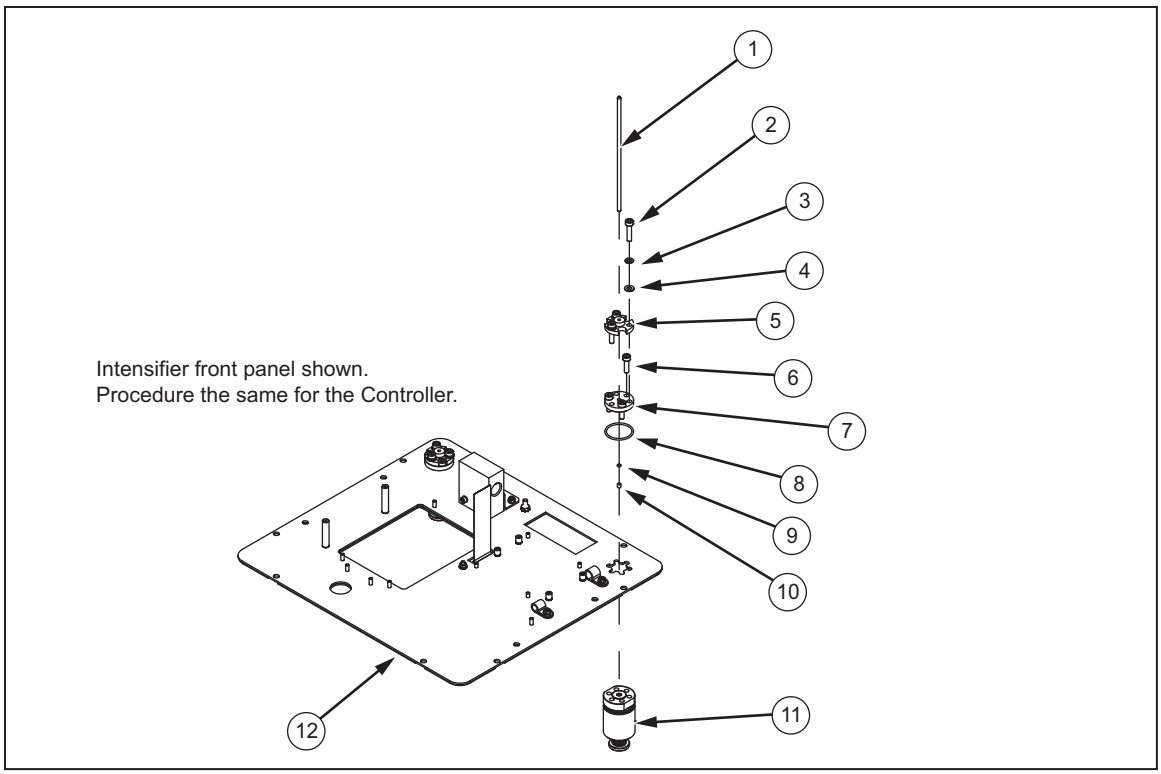

Figure 4-21. Quick-Connect Fitting

Chapter 5
Intensifier Maintenance

Title **Page**

Introduction

This chapter supplies maintenance procedures and part replacement procedures for the Intensifier. Table 5-1 lists the maintenance tasks for the Intensifier and the recommended time interval between maintenance.

⚠Warning

To prevent injury to personnel or damage to the Product, Intensifier maintenance is to only to be completed by maintenance personnel who have been properly trained on how to complete the maintenance procedures.

Note

The replacement procedures in this chapter only contain specific instructions on how to replace a part and do not list part numbers. For a full list of part numbers, see Chapter 7 "List of Replaceable Parts".

Table 5-1. Intensifier Maintenance Time Schedule

Maintenance Item	Time Interval	Instructions
Pressure Generation and Leak Test	1 year or 750 hours, whichever occurs first. Complete after maintenance is performed on the Intensifier.	See page 5-7
Electronic Pressure Sensor Alignment	2 years or 1,500 hours, whichever occurs first	See page 5-8
Pressure Port, Shaft Seals, Piston Seals, and Backup Rings Replacement	2 years, 1,000 hours or as required	See page 5-9

Safety

To ensure safety, read the warnings below prior to performing maintenance on the Controller.

⚠⚠Warning

To prevent possible electrical shock, fire, or personal injury:

- **Disconnect the mains power cord before you remove the Product covers.**
- **Use only specified replacement parts.**
- **Have an approved technician repair the Product.**
- **FINGER AMPUTATION HAZARD - To prevent personal injury, do not operate or service the Intensifier outside its case with power applied. The rotating parts in the booster pump assembly move with extremely high torque and can start unexpectedly.**

Standard Torque Look-Up Table

Torque value for standard hardware is listed in Table 5-2. If a nonstandard torque value is required, the torque value is listed in the procedure next to the hardware. For example: "Install the low profile screw (①) that secures the planet gear (⑦) to the lower cam mount plate (②). Torque to 7.8 Nm (69.0 in-lb)."

Table 5-2. Standard Hardware Torque Values

Button or Socket Head Cap Screws	
Nominal Size	**Torque Nm (in-lb)**
M2	0.69 (0.61)
M3	0.9 (8.0)
M4	2.3 (20.4)
M5	4.6 (40.7)
M6	7.8 (69.0)
M8	19.1 (169.0)

Intensifier Hour Meter

The Intensifier has two built-in electronic hour meters that assist with maintenance:

- The **maintenance** hour meter displays how many hours the motor was used since the last reset. Service personnel can choose when to reset the maintenance hour meter to support their organizations maintenance practices and procedures. It is recommended that the maintenance hour meter be reset after the internals seals are replaced or an electronic pressure sensor alignment.
- The **total** hour meter is the total amount of hours the Intensifier has been used since it was manufactured. The total hour meter starts at the factory and cannot be reset.

How to read the maintenance and total hour meters:

1. Turn on the Intensifier. If the Intensifier is on, cycle power.
2. Push and hold STOP then also press and hold 3,000 to read the maintenance hour meter.

   -- or --

   Push and hold STOP then also press and hold 5,000 to read the total hour meter.
3. Read the maintenance or total hours. To read the hours, compare the LED or LEDs that are flashing to Table 5-3.

To clear maintenance hour meter:

1. Press and hold STOP and then also press and hold 8,000 for 5 seconds.
2. The 1,000 LED will then flash slowly (same as usage display for zero hours).
3. Press STOP again to clear display and return to normal operation.

Table 5-3. Hour Meter Conversion Table

Flashing LED	Maintenance Hours	Total Hours
1,000	0 - 199	0 - 1,999
2,000	200 - 299	2,000 - 2,999
3,000	300 - 399	3,000 - 3,999
4,000	400 - 499	4,000 - 4,999
5,000	500 - 599	5,000 - 5,999
6,000	600 - 699	6,000 - 6,999
7,000	700 - 799	7,000 - 7,999
8,000	800 - 899	8,000 - 8,999
9,000	900 - 999	9,000 - 9,999
10,000	1,000 - 1,099	10,000 - 10,999
10,000 and 1,000	1,100 - 1,199	11,000 - 11,999
10,000 and 2,000	1,200 - 1,299	12,000 - 12,999
10,000 and 3,000	1,300 - 1,399	13,000 - 13,999
10,000 and 4,000	1,400 - 1,499	14,000 - 14,999
10,000 and 5,000	1,500 - 1,599	15,000 - 15,999
10,000 and 6,000	1,600 - 1,699	16,000 - 16,999
10,000 and 7,000	1,700 - 1,799	17,000 - 17,999
10,000 and 8,000	1,800 - 1,899	18,000 - 18,999
10,000 and 9,000	1,900 - 1,999	19,000 - 19,999
10,000 and 9,000 and 8,000	More than 2,000	More than 20,000

Maintenance Procedures

This section supplies maintenance information for the Intensifier.

Front-Panel and Case Cleaning

To clean the Calibrator, wipe it with a cloth that is lightly dampened with water or mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol based fluids.

Pressure Generation and Leak Test

A pressure generation and leak test is a procedure to see how quickly the Intensifier can generate and keep pressure at the target pressure. If the pressure does not build to the target pressure within 2.5 minutes with the isolation valve closed and at least 500 psi supply pressure, the piston seals need to be replaced.

Note

It is recommended that all four piston and two shaft seals be replaced together.

Complete the pressure generation and leak test as follows:

1. Close the **ISOLATION** valve to isolate the pressure and close the **VENT** valve if it is open.
2. Connect the Intensifier to the Nitrogen Cylinder with a supply pressure of 500 psi.
3. Turn on the Intensifier.
4. Use the target boost pressure selection keys to select [10,000]. After selected, the green LED to the right of the key illuminates and stays illuminated until STOP is pushed.
5. Watch the pressure gauge and keep track of how long it takes for the pressure gauge to reach 10,000 psi. The pressure should generate to more than 10,000 psi. Closely observe and record only the amount of time it takes to reach or pass 10,000 psi.

Note

The normal time it takes to generate to 10,000 psi with the Isolation valve closed is approximately 2 minutes with new seals. If it takes longer than 4 minutes, or if the pressure never reaches 10,000 psi, the piston seals or ICM assemblies need to be replaced. For replacement instructions, see "Pressure Port Shaft Seal, ICM, and Piston Seals" on page 5-24.

6. After pressure reaches 10,000 psi, let pressure stabilize at 10,000 psi for 2 minutes.
7. Push STOP to stop pressure generation and write down the pressure. Wait 60 seconds and write down the pressure. If pressure decreases by more than 1,000 psi in 60 seconds, then there is a leak in the interconnection tubing or the check valves. If pressure decreases by more than 2,000 psi in 60 seconds, then the Intensifier has a leak and needs repaired or ICM replacement is necessary.

⚠Caution

To prevent damage to the internal components in the Intensifier, do not use until the leak is repaired.

8. Turn off the supply pressure.
9. Open the isolation valve and vent valve to vent the pressure from the Intensifier.

Electronic Pressure Sensor Alignment

The electronic pressure sensor must be field aligned if the pressure generation amount is off by more than 10 %. If a new electronic pressure sensor is installed, the new sensor must have a field alignment performed followed by a factory alignment to store the new coefficients.

To complete a field alignment:

Notes

At any time, push **STOP** *or cycle power to abort the process with no change.*

If only a field alignment is required, a supply of at least 1,000 psi is necessary to complete the procedure. If a field and factory alignment is required, another Intensifier is required to generate 10,000 psi.

1. Connect the Controller **TEST** port to Intensifier **OUTLET** port.
2. Connect the Controller **SUPPLY** port to a supply with more than 1,000 psi available such as a charged Nitrogen Cylinder.

   Note

   If a factory alignment is necessary after this procedure, connect an Intensifier to the Controller that can generate 10,000 psi.
3. Turn off and disconnect the pressure supply to the Intensifier.
4. Push **VENT** on the Controller to vent pressure.
5. Open the Intensifier **VENT** valve and the **ISOLATION** valve to vent the Intensifier.
6. On the Intensifier, push and hold down **STOP** then push and hold down [2,000] for 3 seconds. After the [1,000] LED starts to slowly flash, continue to the next step.
7. Close the **VENT** valve on the Intensifier.
8. On the Controller, set a target pressure of 1,000 psi. After 1,000 psi is set, wait for Controller ready signal (green light).
9. On the Intensifier, push [1,000].

   If the is procedure is successful, the [1,000] LED flashes slowly that indicates that the process is successful. The Intensifier saves the new factory alignment values to memory.

   If the procedure failed, the [2,000] LED continually flashes and the new values are not saved. A failure could be because of values not within typical limits, a damaged sensor, or due to error in sequence. Cycle power and try again.

To complete a factory alignment on a new pressure sensor (continued from a successful field alignment):

10. Connect the Controller **SUPPLY** port to a supply with more than 10,000 psi available such as another Intensifier.
11. On the Controller, set a target pressure of 10,000 psi. After 10,000 psi is set, wait for controller ready signal (green light).
12. On the Intensifier, push and hold down **STOP** then push and hold down [10,000] for 5 seconds.

    If the procedure is successful, the [10,000] LED flashes slowly that indicates that the process is successful. The Intensifier saves the new factory alignment values to memory.

    If the procedure failed, the [2,000] LED continually flashes and the new values are not saved. A failure could be because of values not within typical limits, a damaged sensor, or due to error in sequence. Cycle power and try again.
13. Vent pressure in the Controller and Intensifier and disconnect if complete.

Seal Replacements

It is recommended that the pressure port, shaft seals, piston seals, and backup rings be replaced within the time interval listed in Table 5-1 to ensure performance to the specifications. Seals may need to be replaced sooner if a leak occurs that requires maintenance action.

Note

It is recommended that the four piston seals be replaced together.

To replace the seals, perform the procedure in "Pressure Port Shaft and Seal Replacement" on page 5-24 and the piston seals portion of the procedure in "Clevis Bearing, Roller, and Piston Seals Replacement" on page 5-25. These seals come in kits that are orderable and defined in Chapter 7 in "Rebuild Kits".

Fuse Replacement

The Intensifier has a fuse that protects from overcurrent. See Table 5-4.

⚠⚠Warning

To prevent possible electrical shock, fire, or personal injury, use only specified replacement parts.

Table 5-4. Replacement Fuse (Intensifier)

Fuse	Fluke Part Number
⚠ FUSE 5X20 5A S/B 250V	2077364

To replace the fuse (see Figure 5-1):

1. Disconnect the mains-power cord from the power-entry module.
2. Open the power entry module and remove the fuse holder.
3. Replace the fuses with exact replacements as listed in Table 5-4.

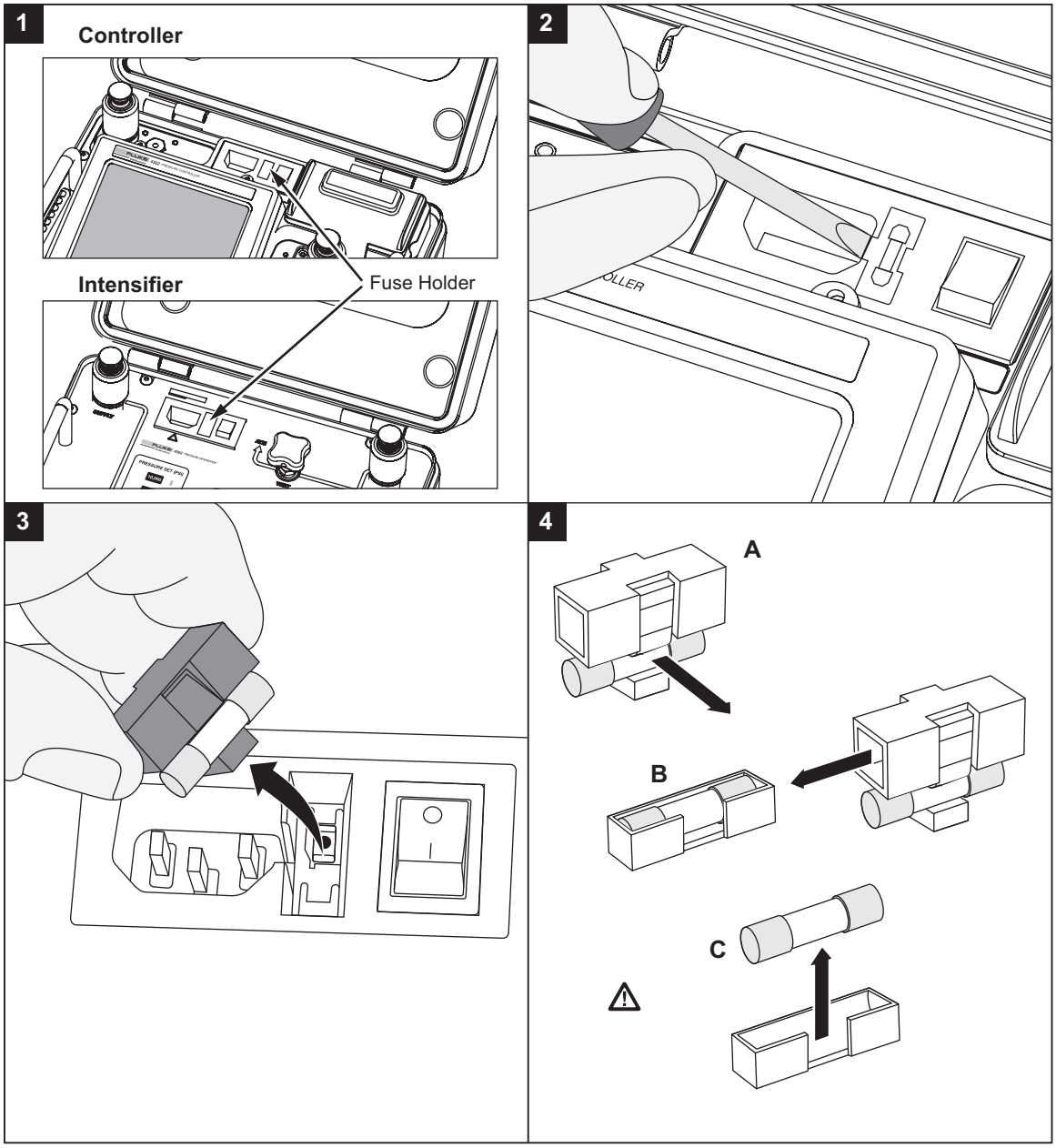

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Figure 5-1. Fuse Replacement

Intensifier Part Replacement

This section supplies instructions on how to replace specific parts within the Intensifier.

Note

The replacement procedures in this chapter only contain specific instructions on how to replace a part and do not list part numbers. For a full list of part numbers, see Chapter 7 "List of Replaceable Parts".

Chassis

This procedure supplies instructions on how to remove the chassis from the Intensifier case to gain access to the parts and subassemblies inside the case. The Intensifier chassis consists of the control panel assembly and the booster pump assembly. After the chassis is removed, the booster pump assembly must be separated to gain access to the internal components.

Use the following instructions and Figure 5-2 to remove chassis (①) from the case (②).

1. Turn off the supply source and vent pressure from the Intensifier by opening the isolation and vent valves.
2. Disconnect the supply and outlet ports.
3. Remove the power cord.

⚠ Warning – Finger Amputation Hazard

To prevent personal injury, do not connect power or operate the Intensifier while servicing Intensifier outside its case. The rotating parts in the booster pump assembly move with extremely high torque and can start unexpectedly if power is connected.

4. Loosen the eight control panel assembly screws (③).
5. Use the handles and lift the chassis (①) from the case (②). Put the chassis upside down on a padded work surface.

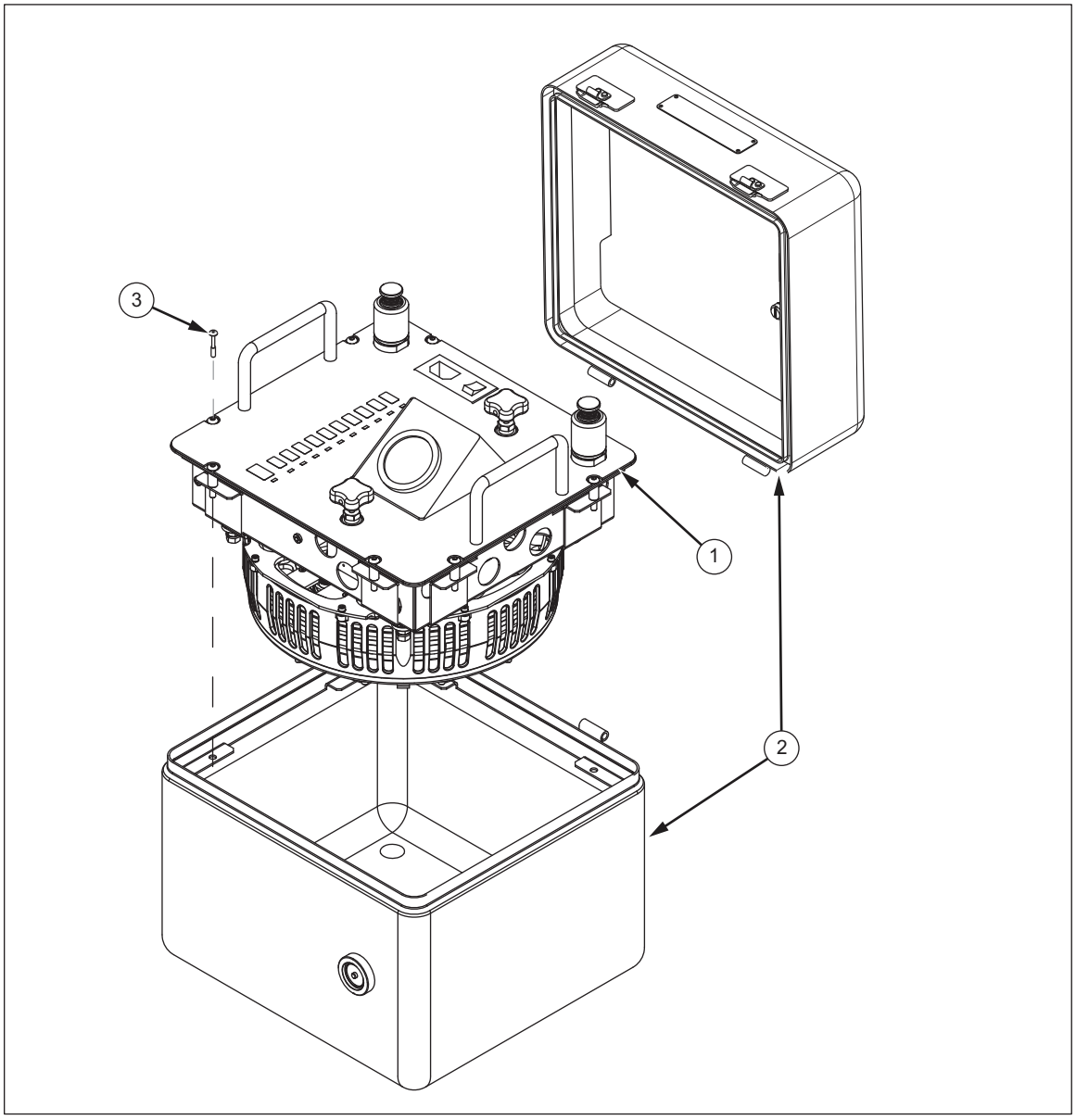

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Figure 5-2. Intensifier Case Removal

Use the following instructions and Figure 5-3 to separate the control panel assembly from the booster pump assembly. The following steps are best performed with the intensifier placed upside down on the work bench resting on the control panel assembly (①) handles:

1. Remove the four screws (⑤) and the four lock washers (④) that secures the upper pressure line (③) to the control panel assembly (①).
2. Disconnect the fitting (⑦) from the pressure port shaft so that it may be moved to separate the pump booster assembly (⑥) from the control panel assembly (①).
3. Remove the eight hex nuts (items ⑫ and ⑭) and lock washers (items ⑬ and ⑪) secures the booster pump assembly (⑥) to the control panel assembly (①).
4. Separate the control panel assembly (①) from the booster pump assembly (⑥) as follows:
   a. Separate the control panel assembly (①) from the booster pump assembly (⑥).
   b. Remove the motor cable retaining clamp (not shown) from the bottom of the control panel assembly (①).
   c. Unplug the motor wires from the motor controller inside the control panel assembly (①).
5. Disconnect the upper coupling (②) and lower coupling (⑦) that connects the pressure supply lines to the booster pump assembly (④).
6. Put the booster pump assembly (⑥) on a flat work surface.

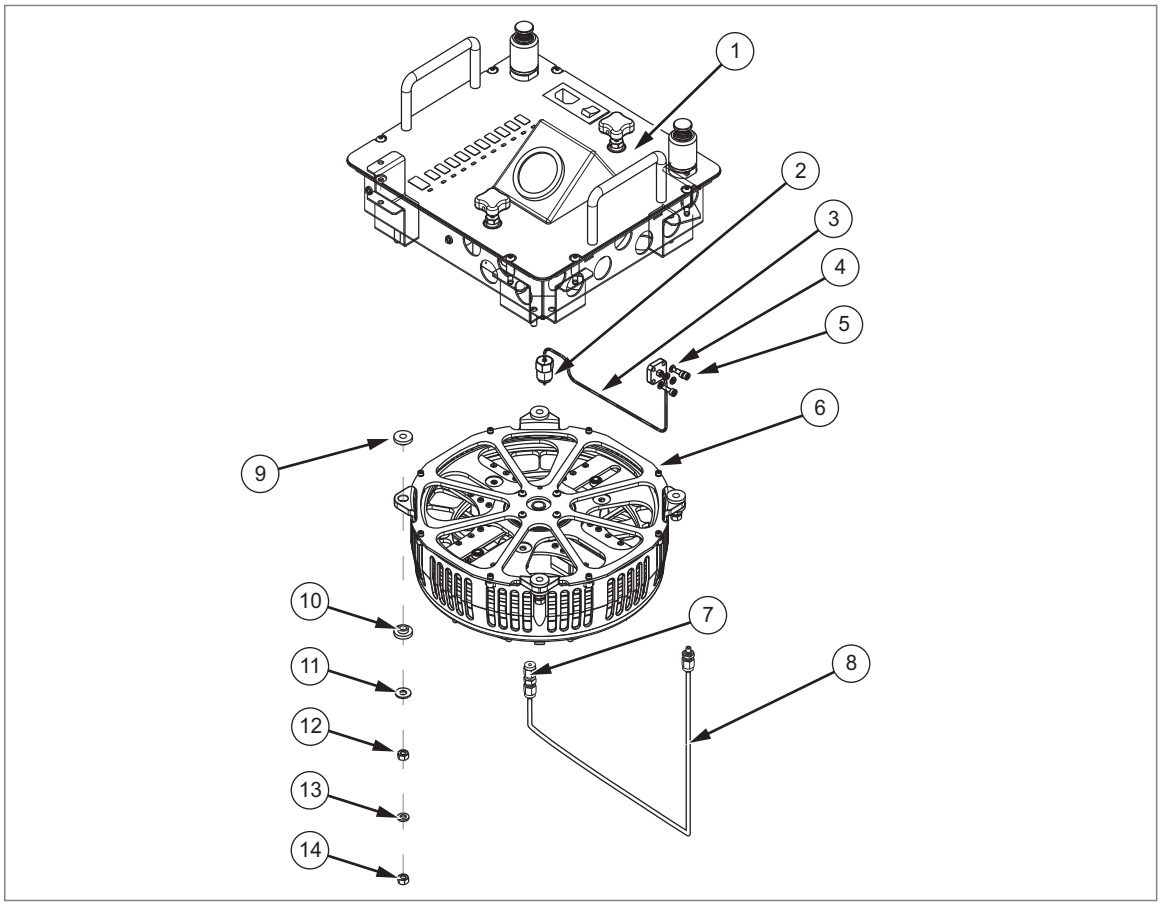

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Figure 5-3. Housing Assembly Removal

Use the following instructions and Figure 5-3 to reconnect the control panel assembly to the booster pump assembly:

1. Put the booster pump assembly (⑥) on a flat work surface.
2. Connect the control panel assembly (①) to the booster pump assembly (⑥) as follows:
   a. Install the motor cable retaining clamp (not shown) on the bottom of the booster pump assembly (⑥).
   b. Connect the motor wires from the motor controller inside the control panel assembly (①).
3. Reconnect the upper pressure coupling (②) and lower pressure coupling (⑦) that connects the pressure supply lines to the booster pump assembly (④).
4. Reconnect the control panel assembly (①) to the booster pump assembly (⑥).
5. Install the eight 7/16 inch nuts (items ⑫ and ⑭) and lock washers (items ⑬ and ⑪) secures the booster pump assembly (⑥) to the control panel assembly (①).
6. Install the four screws (⑤) and the four lock washers (④) that secures the upper pressure line (③) to the control panel assembly (①).

Use the following instructions and Figure 5-2 to put the chassis into the case:

1. Use the handles and carefully lower the chassis (①) into the case.
2. Tighten the eight control panel assembly screws (③).

Pump Cam

Separating the cam assembly from the pump rotor housing is a critical process. Familiarize yourself with the following steps before beginning the disassembly. This process will require plastic spacing shims to center the rotor in the stator. The spacers should be 0.03 inch thick. Without these, the rotor will be pulled to the stator once it is removed from the motor shaft. The rare-earth magnets used in the motor are extremely strong and will make it difficult to re-center for reassembly.

1. Remove the chassis and separate the chassis. See "Chassis" on page 5-11.
2. Remove the eight outer screws (⑨) and lock washers (⑧) which secure the upper-shaft mount plate (③) to the booster pump assembly housing (⑤), and remove the four inner screws (①) and lock washers (②) which secure the plate to the cam assembly (④) as shown in Figure 5-5.
3. Remove the lock washers which are located between the upper-shaft mount plate (③) and the booster pump assembly housing (⑤).
4. Place the booster pump assembly on a support block with the bottom side facing up. The support block should only support the cam assembly and not the pump housing.
5. Remove the 1/8 inch compression tube fitting and the retaining "C-clip".
6. Insert the plastic spacers in the small gap between the black stator and the polished rotor as shown in Figure 5-4.

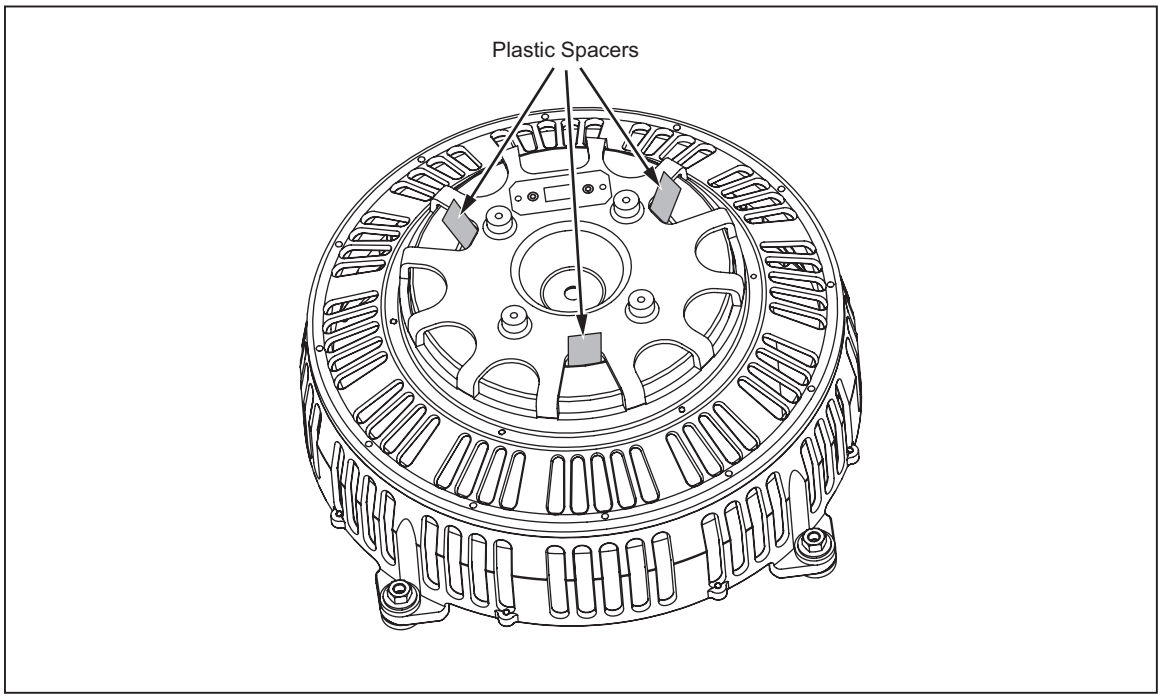

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Figure 5-4. Pump Motor with Plastic Spacers

7. Lift the pump housing off from the cam assembly.
8. Remove the shaft wave spring and shaft bearing.

Note

The bearing might be retained in the sun gear hub. Be careful not to lose it as it has a loose fit and may fall out.

Use the following instructions and Figure 5-5 to reinstall the pump cam assembly (④) into the booster pump assembly (⑤):

1. Put the pump cam assembly (④) on a 5-inch support block on a flat-work surface with the pressure shaft and planetary gears positioned upwards.
2. Install wave spring over the pressure shaft, then install the shaft bearing.
3. Slowly lower the booster pump assembly (⑤) onto the pump cam assembly (④). Align the planetary gears with the sun gear (⑥) and the outer gear ring (⑦).

Note

To align the gears, rotate the gears with a rubber tipped pry tool as the pump cam assembly is lowered. The pump cam assembly fully seats in the booster pump assembly housing when all five gears are properly aligned.

4. Remove any temporary plastic spacers if necessary and install the pressure shaft retaining clip and supply fitting. Turn the assembly over and place on rubber feet on work surface.
5. Put the upper-shaft mount plate (③) on the top of the booster pump assembly housing (⑤), being sure to first place lock washers between the plate and the booster pump housing. The milled lip faces down towards the cam assembly.
6. Install the four inner 3 mm screws (①) and lock washers (②) to secure the upper shaft mount plate (③) to the upper shaft bearing hub.

7. Place the sheet metal cover plate over the top and install the eight outer screws (⑨) and lock washers (⑧) securing both the sheet metal cover and the upper shaft mount plate to the pump assembly housing.

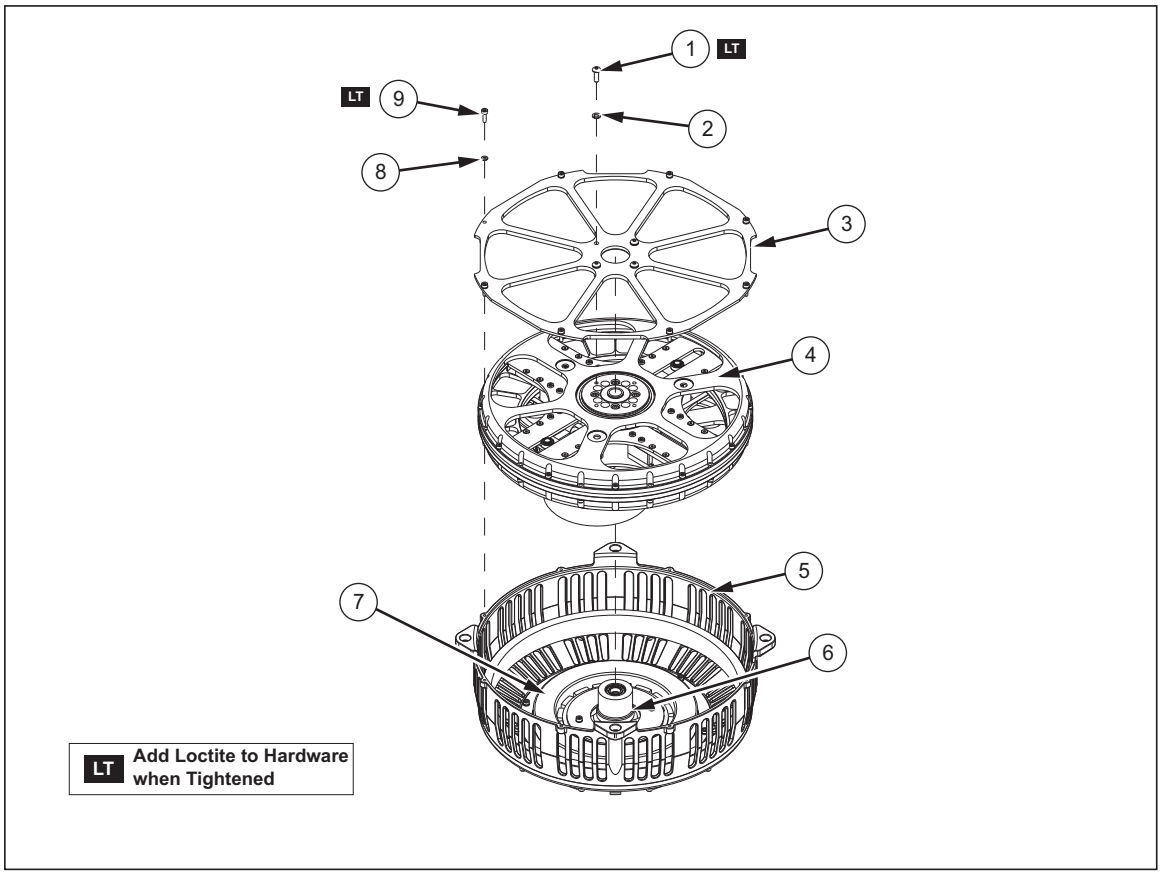

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Figure 5-5. Pump Cam Assembly Removal

Pump Cam Disassembly

Use the following instructions and Figure 5-6 to disassemble the pump cam assembly:

Note

This procedure supplies instructions on how to completely disassemble the entire pump cam assembly. Many procedures only requires the pump cam assembly to be partially disassembled. Only perform the amount of steps required to remove the part or subassembly from the pump cam assembly to prevent extra work.

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Remove pump cam assembly from the booster pump assembly housing. See “Pump Cam” on page 5-14.
3. Position the cam assembly so that the planetary gears are facing down.
4. Remove the 12 screws and lock washers (items ① and ②) that secures the upper cam mount plate (③) to the lower cam mount plate (㉕).
5. Remove the four screws (④) that secures the upper shaft bearing hub (⑤) to the upper piston guide plate (⑪).
6. Carefully lift the and remove the upper cam mount plate (③).
7. Remove the upper wave spring (⑦).
8. Remove the 16 screws (⑧) that secure the upper piston guide plate (⑪) to the piston guide rail spacers (⑮).

Note

These are the two sets closest to the inside of the hub (socket head screws).

9. Lift and remove the upper piston guide plate (⑪).
10. To remove the cam - flip the cam assembly upside down and remove the 12 screws and lock washers (items ㉗ and ㉖) from the bottom side of the lower cam mount plate (㉕).
11. Lift and remove the cam (⑬).
12. Lift and remove the ICM and shaft assembly (⑭).The assembly is free to lift out from the cam housing, but it may require a gentle nudge. While grabbing the opposite sides of the cam plate, gently tap the whole assembly down against the work surface. This will help push the shaft / guide plate assembly out from the cam housing.

Pump Cam Reassembly

Use the following instructions and Figure 5-6 to reassemble the pump cam assembly:

1. Position the piston guide rail spacers (⑮) on the lower piston guide plate (⑰) and secure them from the underside with 16 (two per spacer) socket head screws (19) and lock washers (⑱).
2. Place the ICM and shaft assembly (⑭) on the lower piston guide plate (⑰) with the pressure port shaft pointing down and away as shown in Figure 5-6. Be sure that it sits flat on the lower guide plate.
3. Flip the lower guide plate over and install the lower wave spring (㉑). The three "valleys" of the wave spring (the fourth valley is the break in the spring) should be resting on the piston guide plate and aligned halfway between each ICM. A thin film of Krytox grease should be applied to both sides of the spring.
4. Place the lower shaft bearing hub (㉓) on top of the wave spring and secure it with four 3 mm HEX screws (㉔). Torque to 20 in-lb (2.3 Nm) in a cross pattern to compress the spring evenly.
5. Flip the lower guide plate assembly back over and push the hub down into the lower cam mount plate and planetary gear assembly (㉕) until the hub is flush with the back surface of the cam mounting plate.
6. Place the cam (⑬) on top of the lower cam mount plate (㉕) while positioning each piston so they fit inside the cam. The top side of the cam is identified with a small milled oval slot on the far outside edge. The slot faces up and away from the lower cam mount plate and the planetary gears.
7. Secure the cam from the underside using twelve of the 2.5 mm HEX screws (㉖) and lock washers (㉕) using every-other slot.
8. Place the upper piston guide (⑪) over the top of the ICM and shaft assembly (⑭) and secure it to the piston guide rail spacers using sixteen 2.5 mm HEX screws (⑧) and lock washers (⑨).

Note

The piston guide rails (⑫) should already be attached and they face down towards the ICMs.

9. Place the upper wave spring (⑦) on the upper piston guide plate (⑪). The three "valleys" of the wave spring should be resting on the piston guide plate and aligned halfway between each ICM. A thin film of Krytox grease should be applied to both sides of the spring.
10. Position the upper cam mount plate (③) over the wave spring. The upper shaft bearing (⑥) and hub (⑤) should still be part of the cam mounting plate. Secure the hub to the ICM and shaft assembly using four 3 mm HEX screws and lock washers. Torque to 20 in-lb (2.3 Nm) in a cross pattern to compress the spring evenly.
11. Secure the upper cam mount plate to the cam using the remaining twelve 2.5 mm HEX screws (①) and lock washers (②).

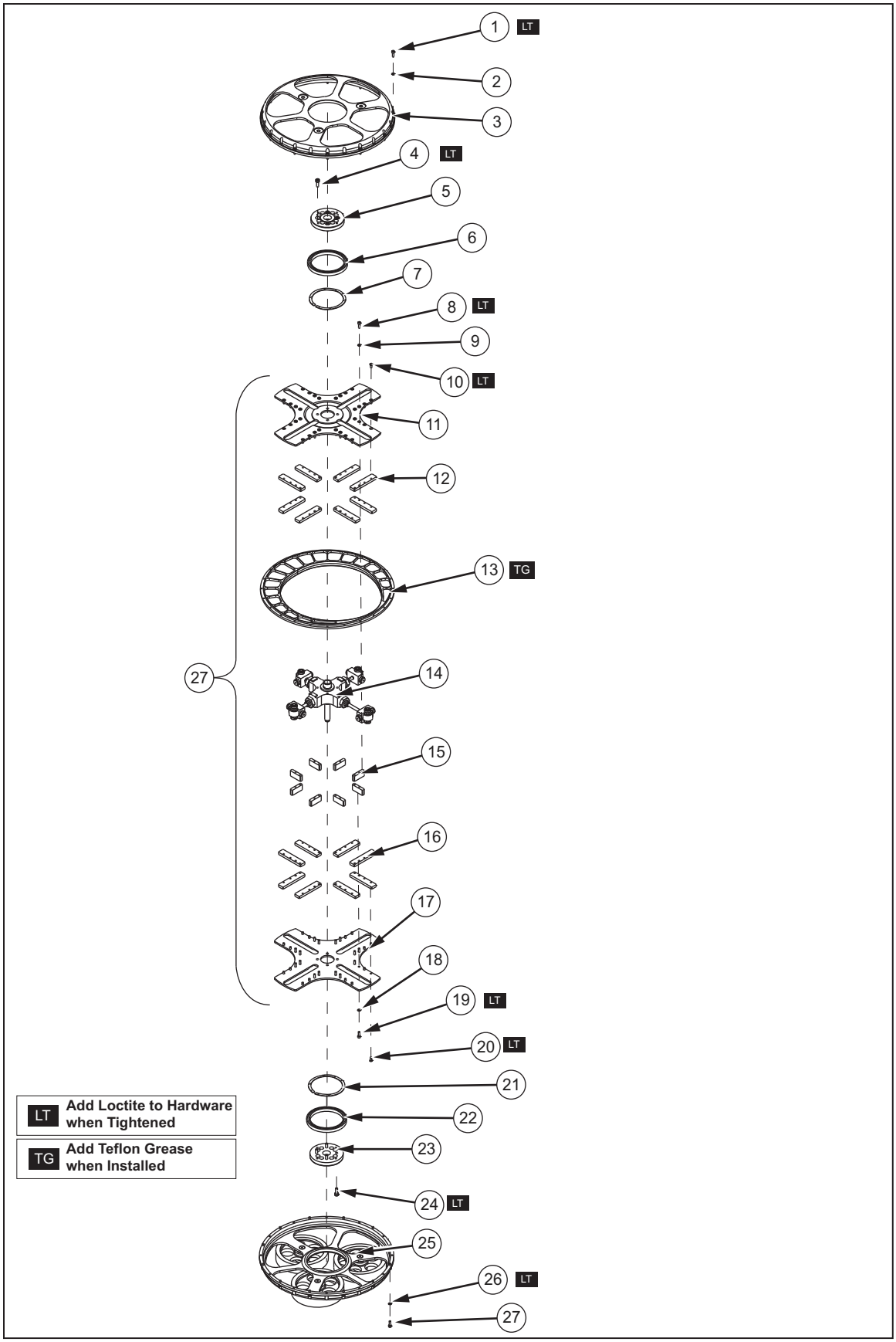

Figure 5-6. Cam Assembly Replacement

Motor Controller

Use the following instructions and Figure 5-7 to replace the motor controller (⑦).

1. Remove the chassis and separate the chassis. See "Chassis" on page 5-11.

Note

Depending on the previous level of disassembly the control panel assembly screws may not be fully removed as the spacers help captivate the screws. The screws must be fully removed to remove the support bracket (⑧). Hold the spacer tube to prevent it from spinning while removing the screws.

2. Put the control panel on a flat work surface upside down, supported with mounting blocks on the outside edges.
3. Remove the four screws (⑥) that secures the support bracket (⑧) to the control panel assembly (②) and handles (①), and remove the grommets from between the panel and the handles.
4. Remove the support bracket (⑥): begin by partially lifting and sliding the bracket to clear the motor controller mounting flange away from under the stainless steel tubing. Then proceed to step 5.

Note

The motor controller (⑦) is attached to the support bracket (⑥).

5. Disconnect the wires to the motor controller (⑦).
6. Remove the two screws (③) and lock washers (④) that secures the motor controller (⑦) to the support bracket (⑥).
7. Position the new motor controller in the support bracket (⑥) and secure it with two screws (③) and two lock washers (④).
8. Connect the wires to the motor controller (⑦).
9. Install the support bracket (⑥) on the control panel assembly (②) with four screws (⑥) and two lock washers (⑤).
10. Put the chassis together and put into the case. See "Chassis" on page 5-11.

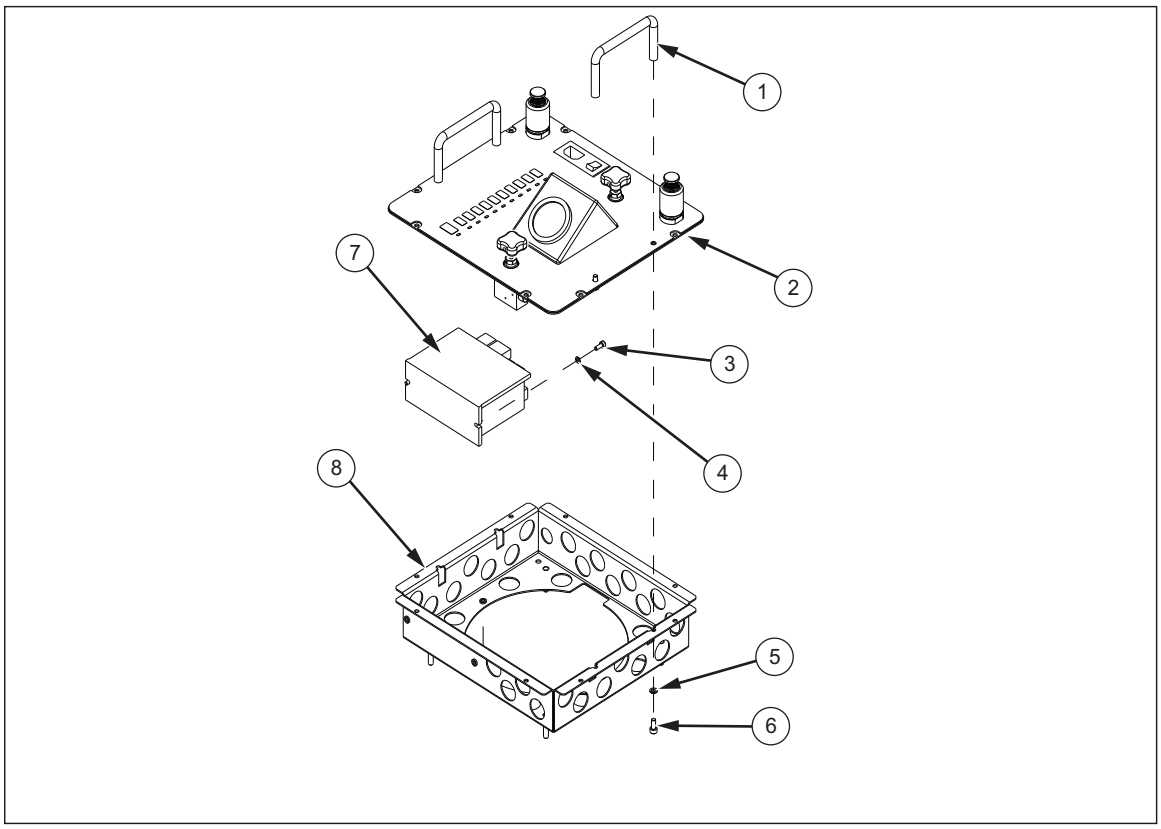

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Figure 5-7. Motor Controller Replacement

Planetary Gears and Gear Bearings

Use the following instructions and Figure 5-8 to replace a planetary gear (⑦) or bearing (items ⑤ and ⑨).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Remove pump cam assembly from the booster pump assembly housing. See “Pump Cam” on page 5-14.
3. Remove the c-clip (⑩) that is connected to the bottom of the bearing pin (③).
4. Remove the planetary gear (⑦) from the bearing pin (③). Leave the wave spring (④) on the bearing pin (③).
5. Remove the bearings (items ⑤ and ⑨) from the planetary gear (⑦).

Note

Skip to step 8 if the gear does not need replaced. If the gear needs replaced, continue to the next step.

6. Remove the internal retaining rings (⑥ and ⑧) from the planet gear (⑦).
7. Install the internal retaining rings (⑥ and ⑧) in the new planet gear (⑦).
8. Install the bearings (⑤ and ⑨) into the planet gear (⑦). Use a bench-top press as required to push the bearings into the planet gear.

Note

Make sure the bearings are pressed into the planet gear to the depth illustrated in Figure 5-8. If the bearings do not meet the depth requirements shown, the c-clip will not lock onto the bearing pin.

9. Put the planetary gear (⑦) on the bearing pin (③) Make sure the wave spring (④) is installed between the planetary gear (⑦) and bearing pin (③).
10. Install the c-clip (⑩) on the bearing pin (③) to hold the assembly together.
11. Put the pump cam assembly into the booster pump assembly housing. See “Pump Cam” on page 5-14.
12. Put the chassis together and put into the case. See “Chassis” on page 5-11.

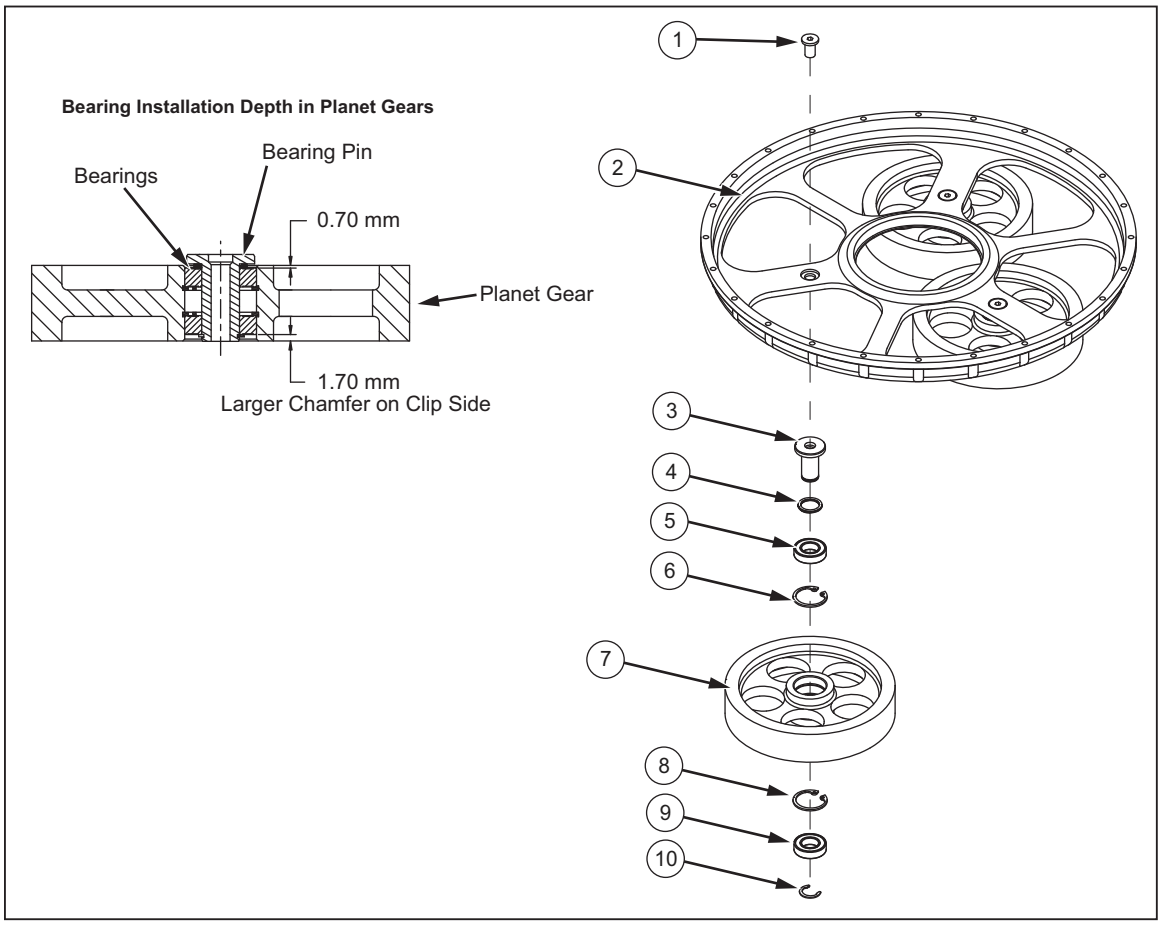

Figure 5-8. Planetary Gear Replacement

Pressure Port Shaft and Seals

Use the following instructions and Figure 5-9 to replace the pressure port shaft (②) and seals (① and ③).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Remove pump cam assembly from the booster pump assembly housing. See “Pump Cam” on page 5-14.
3. Disassemble the pump cam to gain access to the ICM shaft assembly. The pressure port shaft can only be removed after all four of the ICM assemblies (④) have been removed from the cylinder housing (⑦). See "ICM" on page 5-25.
4. After the ICM assemblies are all removed from the pump cam assembly, remove the pressure port shaft (②) from the cylinder housing (⑦) by pushing it out.
5. Remove the two o-rings (① and ③) and replace with new o-rings.

⚠Caution

To prevent damage to the o-rings, lubricate the o-rings with a small amount of Krytox RFE PFPE synthetic lubricant before they are put on the pressure port shaft.

6. Position the pressure port shaft (②) with the four cylinder housing (⑦) ports. After properly aligned, push the pressure port shaft (②) into the cylinder housing (⑦).
7. Reassemble the pump cam. See “Pump Cam Reassembly” on page 5-18.
8. Put the pump cam assembly into the booster pump assembly housing. See “Pump Cam” on page 5-14.
9. Put the chassis together and put into the case. See “Chassis” on page 5-11.

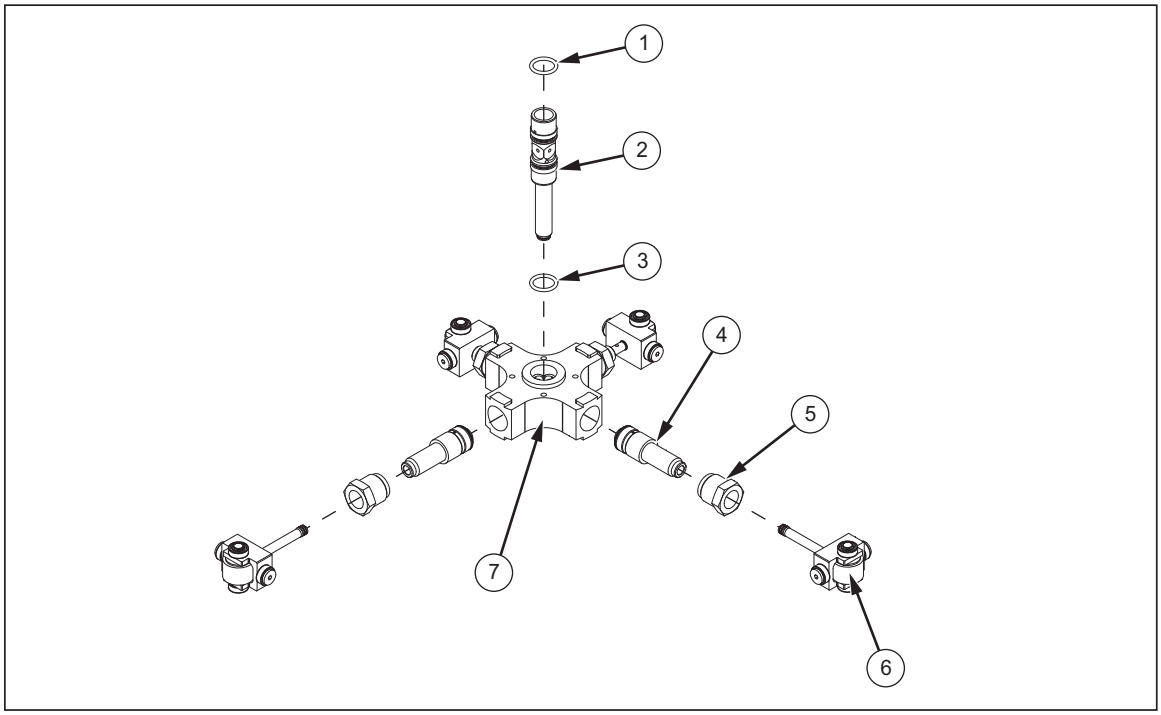

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Figure 5-9. ICM Shaft Assembly

ICM

Use the following instructions and Figures 5-6 and 5-9 to replace an ICM assembly (④).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Remove pump cam assembly from the booster pump assembly housing. See “Pump Cam” on page 5-14.
3. Disassemble the pump cam to gain access to the ICM shaft assembly. The ICM shaft assembly must be removed from the lower piston guide plate (⑰) to give clearance for the removal of the piston and clevis assemblies.
4. Remove the lower piston guide plate (⑰) from the lower cam mount plate (㉕) by pulling it up and out. The lower shaft bearing hub (㉓) forms a tight fit with the bearing and might need to be pushed out if it can't be simply lifted. If so, grab the lower cam mount plate on the outside edges and gently tap down on the work bench against the pressure port shaft.
5. Remove the lower shaft bearing hub (㉓) and lower wave spring (㉑) by removing the four 3 mm socket head screws (㉔).
6. Separate the ICM shaft assembly from the lower piston guide plate.
7. Remove the piston and clevis assembly (⑥) from the ICM assembly (④) by pulling it straight out from the ICM.
8. Remove the cylinder retaining nut (⑤) that holds the ICM assembly (④) in position.
9. Remove the ICM assembly (④) from the cylinder housing (⑦).

Note

The ICM assembly is held together with small pins. Handle the ICM very carefully.

10. Slide the new ICM assembly (④) into the cylinder housing (⑦). Check to make sure the o-ring is present on the end of the ICM. Sometimes the o-ring remains stuck to the pressure port shaft when the ICM is removed from the housing.
11. Install and the torque the cylinder retaining nut (⑤) on the cylinder housing (⑦) to 250 in-lb. If replacing all four ICM assemblies, then use a two-step process where half of the torque is applied to all four nuts before the final 250 inch-pounds are applied. Apply the torque to the opposite nut, then repeat for the other pair.
12. Reassemble the pump cam. See “Pump Cam Reassembly” on page 5-18.
13. Put the pump cam assembly into the booster pump assembly housing. See “Pump Cam” on page 5-14.
14. Put the chassis together and put into the case. See “Chassis” on page 5-11.

Piston Clevis Bearing, Roller, and Piston Seals

Use the following instructions and Figure 5-12 to replace a piston clevis bearings (②, ⑩ and ⑰), roller (⑤), and piston seals (⑫, ⑬, and ⑭).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Remove pump cam assembly from the booster pump assembly housing. See “Pump Cam” on page 5-14.
3. Disassemble the pump cam assembly to gain access to the piston clevis. Only perform the amount of steps required to remove the clevis from the pump cam. Each

clevis can be removed when the low stroke of the cam is positioned in front of a clevis. See “Pump Cam Disassembly” on page 5-17.

4. To replace the piston seals (⑫, ⑬, and ⑭):
   a. Remove the entire piston clevis assembly from the ICM assembly.
   b. Remove the piston (⑪) from the piston clevis assembly (⑥).To loosen, use the hex tool as illustrated in steps 4 and 5 in Figure 5-11.
   c. Remove the seal retainer (⑮) from the end of the piston (⑪) with a small flathead screwdriver as shown in Figure 5-10.
   d. Remove the old o-ring (⑭), seal (⑬), and centering ring (⑫). Discard the seals to make sure they are not used again.
   e. Place the new o-ring (⑭), seal (⑬), and centering ring (⑫) on the piston (⑪) as shown in Figure 5-10. Add a small amount of Loctite 222 to the threads of the seal retainer (⑮). Fully tighten the seal retainer (⑮).

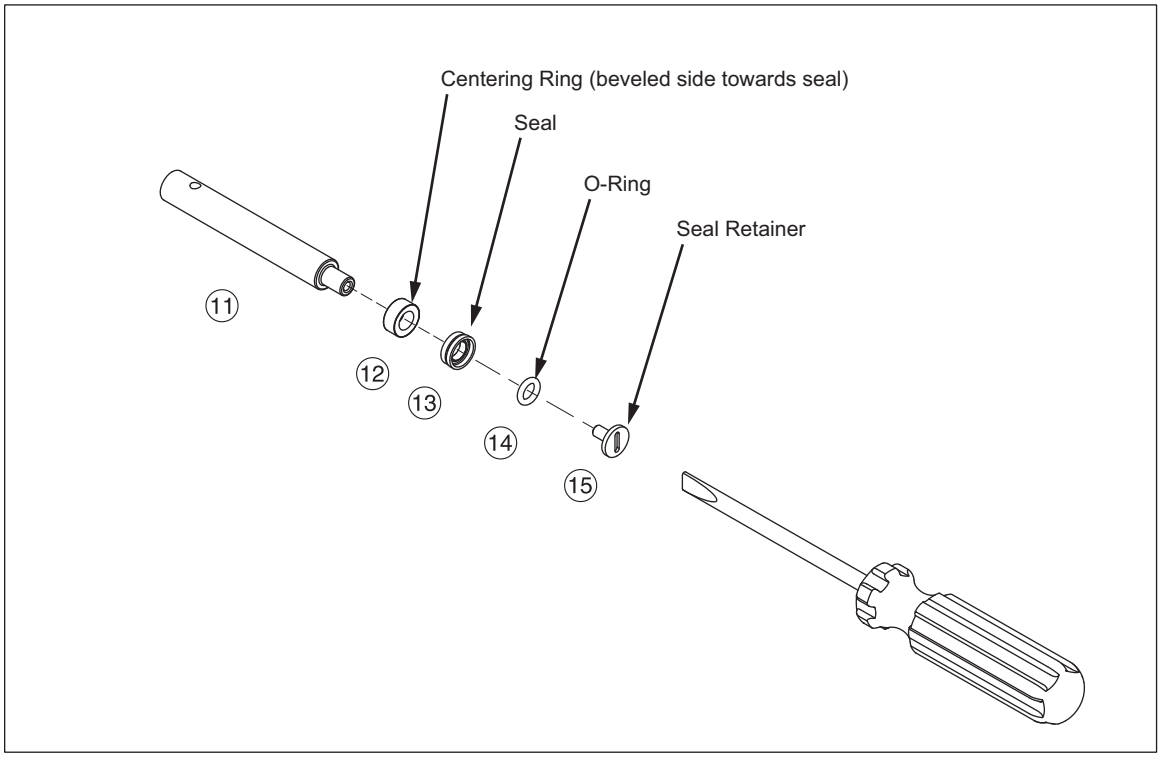

Figure 5-10. Seal Installation Tool

5. Insert the piston into the ICM cylinder as follows:

Note

The piston must be inserted into the ICM cylinder with the aid of the piston seal installation tool in order to compact the seals to achieve a good seal. The insertion side of the piston seal installation tool cylinder is wide and gradually tapers to the same diameter of the ICM cylinder. Use the following instructions to reinstall the piston with the piston seal installation tool:

a. Position the piston insertion tool on the end of the ICM as shown in step 1 in Figure 5-11. Note that the clevis assembly needs to be removed for this procedure.

b. Apply a small film of Krytox silicon lubricant to the o-ring (⑭), seal (⑬), and centering ring (⑫) As in Figure 5-10. Ensure that excessive Krytox silicon lubricant is not at the tip of the piston seals. Do not let Krytox work its way to the ICM inlet valve.

c. Carefully and slowly insert piston seal into insertion tool and then into ICM cylinder as shown in step 2. Move the piston back and forth in the ICM cylinder several times to allow the seals to form to the cylinder wall.

d. Remove the piston insertion tool and keep the piston in the ICM cylinder.

e. Apply a small amount of Loctite 222 to piston threads. Install the clevis assembly on the end of the piston. To tighten, use the hex tool as illustrated in steps 4 and 5 in Figure 5-11.

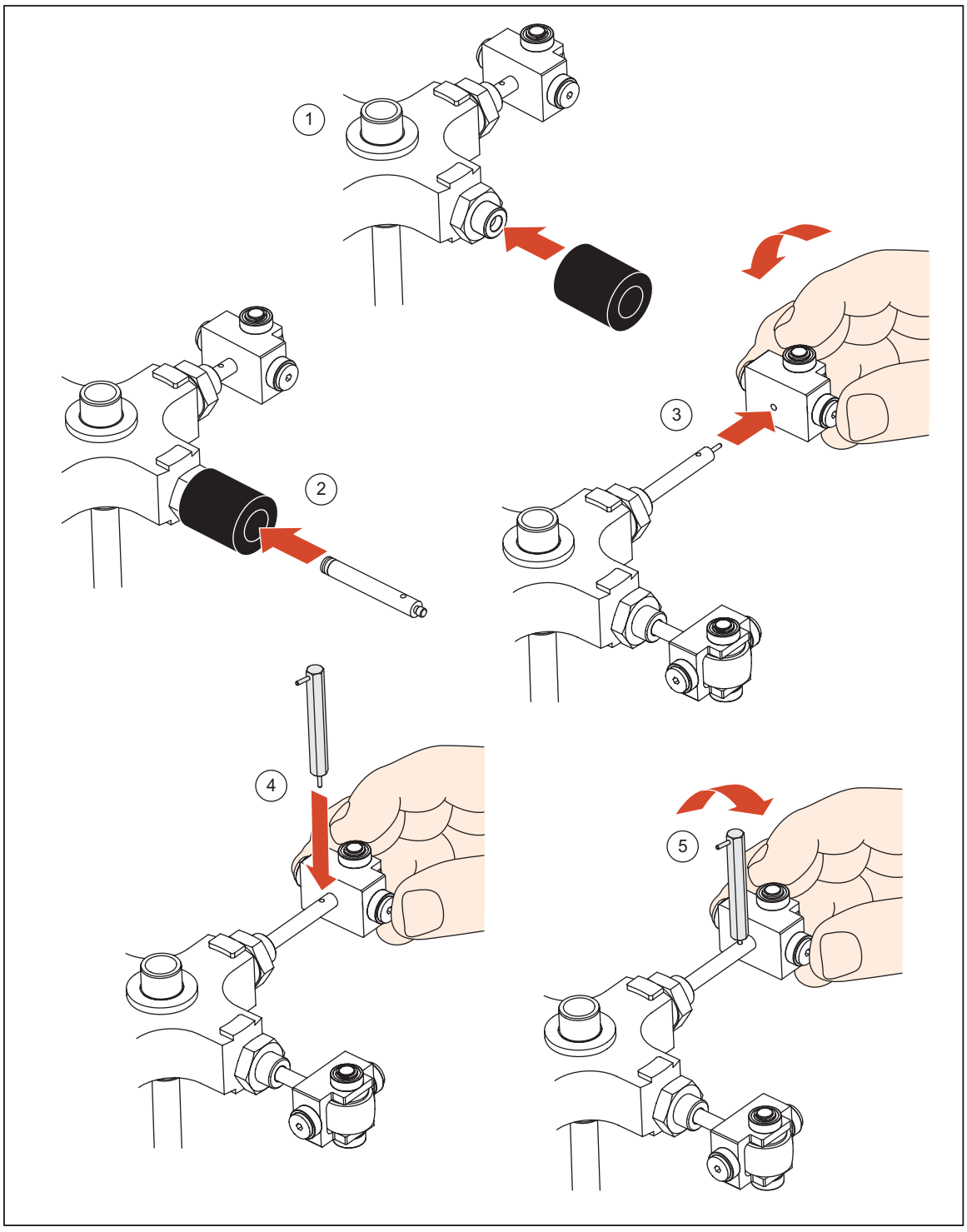

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Figure 5-11. Piston Insertion

6. To replace the roller (⑤), refer to Figure 5-12:
   a. Remove the c-clip (①) that retains the bearing (②).
   b. Push the roller shaft (③) through the roller block (⑥). Use of a bench-top press is recommended.
   c. Remove the roller (⑤) and put the new roller in the roller block (⑥).

d. Push the roller shaft (③) into the roller block (⑥). Use of a bench-top press is recommended.

e. Install the c-clip (①) that retains the bearing (②).
Reassemble the pump cam assembly. Use the pump cam reassembly procedure on page 5-18.

7. To replace the piston clevis bearings (②, ⑩ and ⑰):

   a. Remove the c-clips (① and ⑯) that retains the bearings (② and ⑰).

   b. Replace the bearings then install the c-clips (① and ⑯) that retains the bearings (② and ⑰).

   c. Remove the end screws (⑧) that secures the bearings (⑩) to the roller block (⑥).

   d. Replace the bearings then install the end screws (⑧) that retains the bearings (⑩). Add Loctite to the screws.

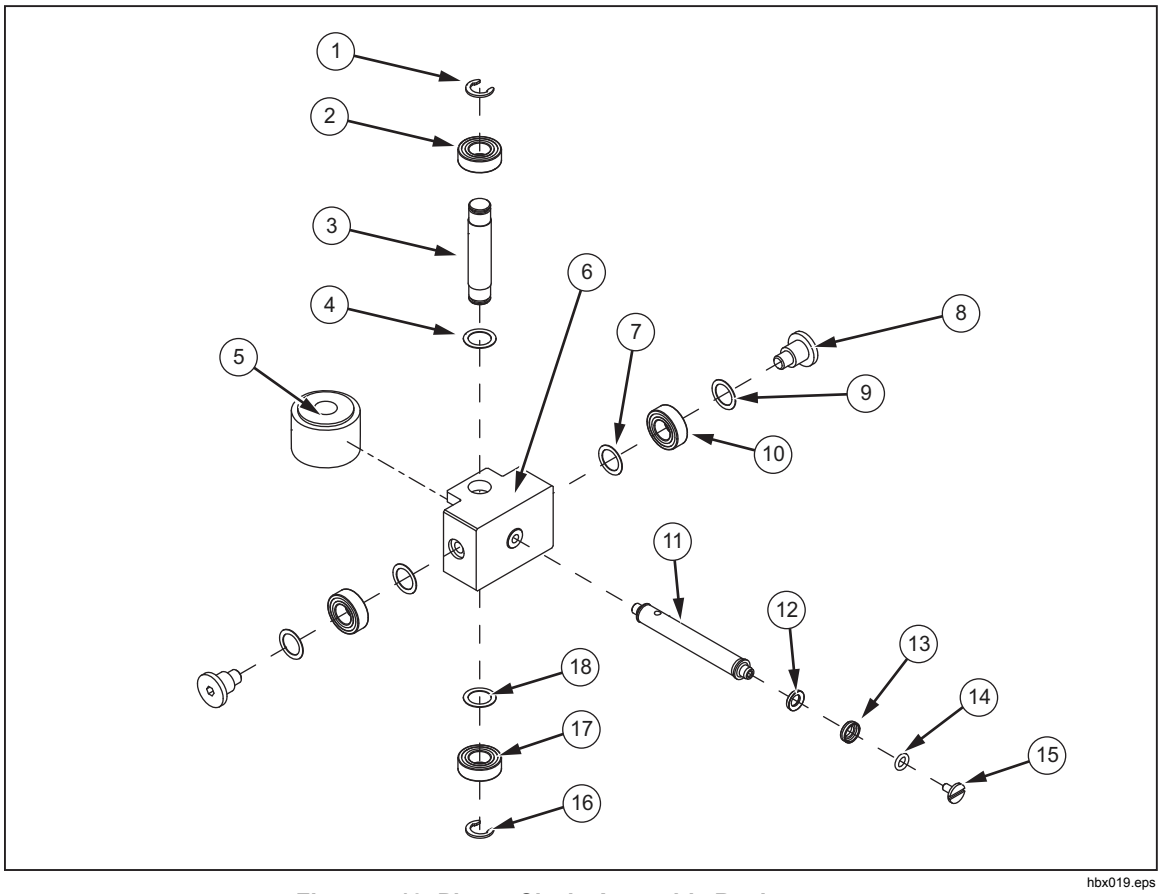

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Figure 5-12. Piston Clevis Assembly Replacement

Pressure Gauge

Use the following instructions and Figures 5-7 and 5-13 to replace the pressure gauge (②).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.

Note

Depending on the previous level of disassembly the control panel assembly screws may not be fully removed as the spacers help captivate the screws. The screws must be fully removed to remove the support bracket (⑧). Hold the spacer tube to prevent it from spinning while removing the screws.

2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface
3. As shown in Figure 5-7, remove the four screws (⑥) that secures the support bracket (⑧) to the control panel assembly (②) and handles (①).
4. As shown in Figure 5-7, remove the support bracket (⑧).
5. Disconnect the pressure supply connection (④) to the HF2-1/4 NPT adapter (③).
6. Remove the HF2-1/4 NPT adapter (③) from the pressure gauge (②).
7. Remove the pressure gauge (②) from the control panel (①).
8. Put the new pressure gauge (②) in the control panel (①).
9. Apply PTFE tape to the NPT threads on the pressure gauge (②).
10. Install the HF2-1/4 NPT adapter (③) on the pressure gauge (②).
11. Connect the pressure supply connection (④) to the HF2-1/4 NPT adapter (③).
12. As shown in Figure 5-7, install the support bracket (⑥) on the control panel assembly (②) with four screws (⑥) and two lock washers (⑤).
13. Put the chassis together and put into the case. See “Chassis” on page 5-11.

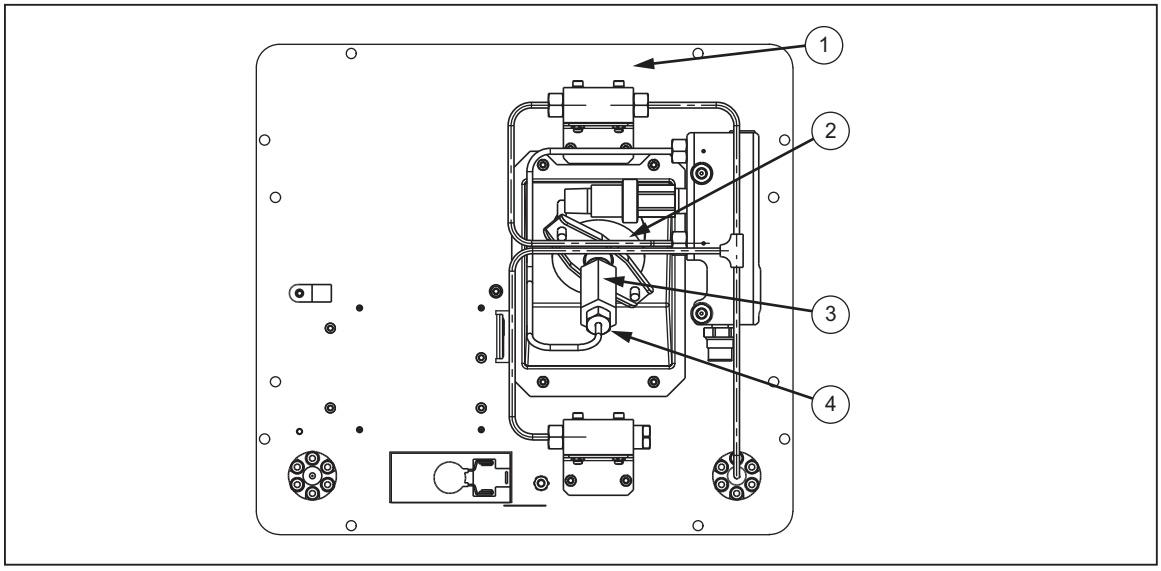

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Figure 5-13. Pressure Gauge Replacement

Vent or Isolation Valve

Use the following instructions and Figure 5-14 to replace the vent (②) or isolation valve (④).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface.
3. Disconnect the HF-2 gland (⑥) to the valve (② or ④).
4. Remove the two hex nuts (⑪) that secures the valve bracket (⑩) to the control panel (①).
5. Remove the two screws (⑨) that secures the valve (④) to the valve bracket (⑩).
6. Install the new valve with two screws (⑨) and lock washers (⑧).
7. Put the chassis together and put into the case. See “Chassis” on page 5-11.

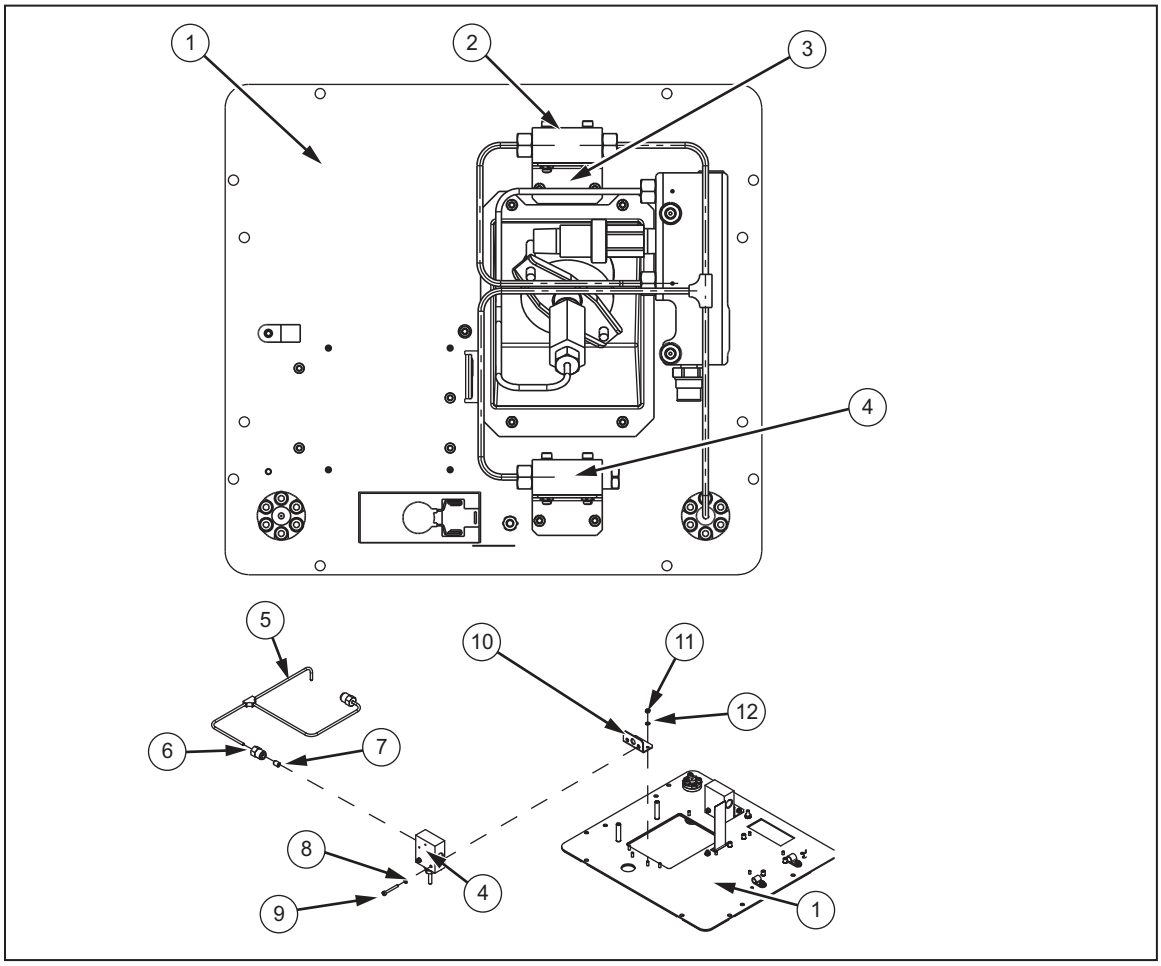

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Figure 5-14. Isolation and Vent Valve Replacement

Electronic Pressure Sensor

Use the following instructions and Figure 5-15 to replace the electronic pressure sensor (④).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface.
3. Disconnect the pressure sensor (④) wire ribbon connecter from the pca.
4. Remove the pressure sensor (④) from the manifold (③).
5. Install the new pressure sensor (④) in the manifold (③), wrapping the NPT threads with PTFE tape.
6. Connect the wires to the pressure sensor (④) at the pca.
7. Put the chassis together and put into the case. See “Chassis” on page 5-11.
8. Align the pressure sensor, perform both the field and factory alignment procedures. Use the instructions in “Electronic Pressure Sensor Alignment” on page 5-8.

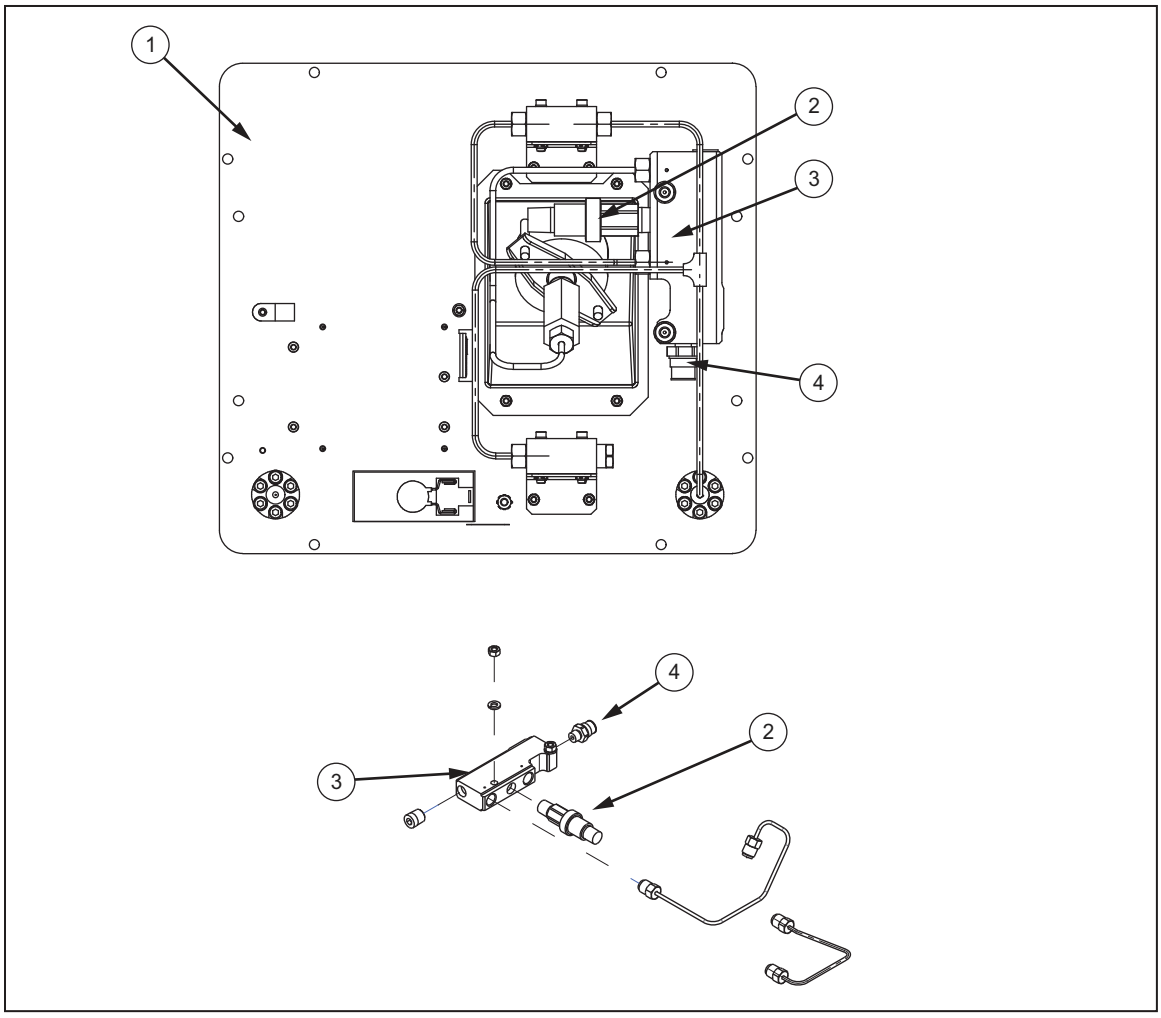

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Figure 5-15. Pressure Transducer Replacement

Overpressure Relief Valve

Use the following instructions and Figure 5-15 to replace the overpressure relief valve (②).

1. Remove the chassis and separate the chassis. See "Chassis" on page 5-11.
2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface.
3. Remove the pressure relief valve (②) from the manifold (③).

Note

Ensure manifold threads are clean and free of debris.

4. Put the new pressure relief valve (②) on the manifold (③). Use PTFE tape on the NPT threads. The arrow indicates the direction of relief. The arrow should point away from the manifold.
5. Put the chassis together and put into the case. See "Chassis" on page 5-11.

Power Entry Module

Use the following instructions and Figure 5-16 to replace the power entry module (⑬).

1. Remove the chassis and separate the chassis. See "Chassis" on page 5-11.
2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface.
3. Disconnect the wires to the power entry module (⑬).
4. Depress the metal tabs at the bottom of the power entry module and push it out through the front panel.
5. Put the new power entry module (⑬) in the control panel (①).
6. Connect the wires to the power entry module (⑬).

⚠⚠Warning

To prevent personal injury and shock hazard, if the ground terminal was removed from the front panel, make sure the stack-up of wires are separated with a nut and tooth lock washer as they were before removal.

7. Put the chassis together and put into the case. See "Chassis" on page 5-11.

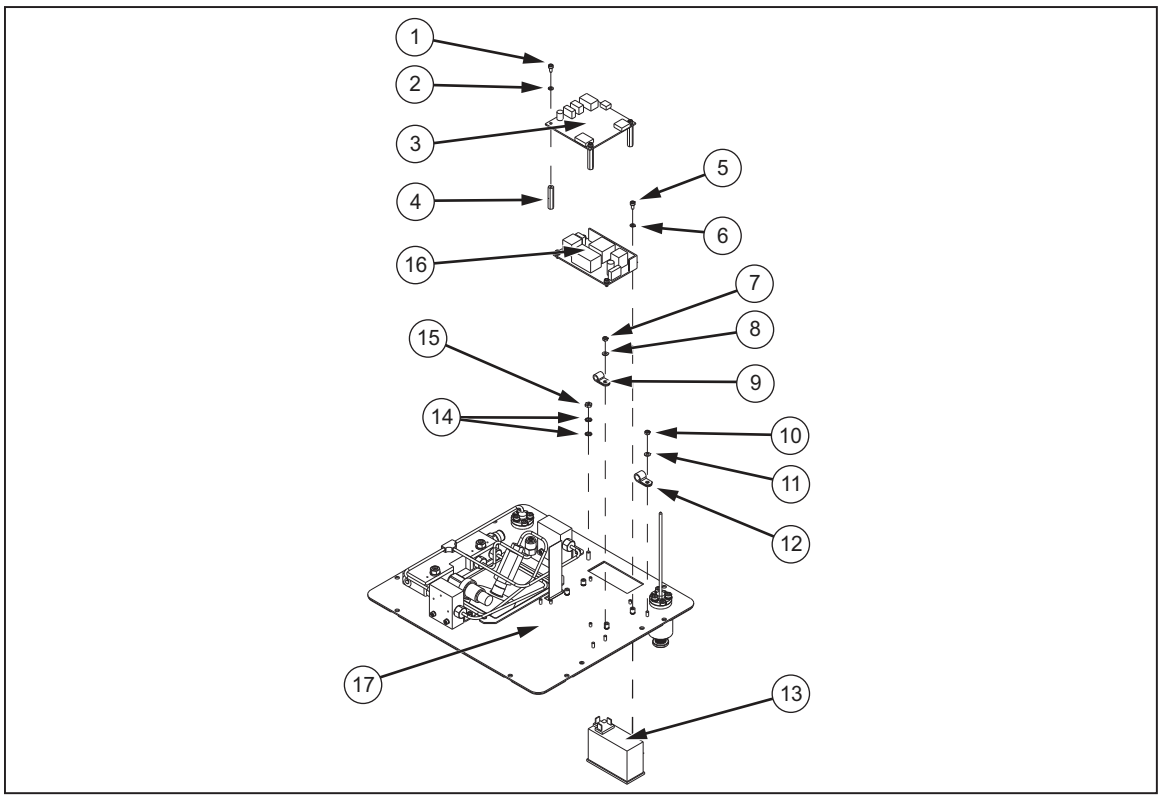

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Figure 5-16. Power Entry Module and Power Supply PCA Replacement

Power Supply PCA and Intensifier PCA

Use the following instructions and Figure 5-16 to replace the power supply pca (⑯).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Put the control panel (①) on a flat work surface upside down, using support blocks to keep it raised above the surface.
3. Disconnect the wires to the power supply pca (⑯) and the Intensifier pca (③). The membrane keypad connector is marked at "J1" on the pca. The ribbon cable connector releases by lifting up on the left and right side edges.
4. Remove the four screws (①) that secures the intensifier pca (③) to the standoffs (④).
5. For power supply pca (⑯) replacement, remove the four screws (①) and lock washers (②) and standoffs (④) from the power supply pca (⑯).
6. Remove the four screws (⑤) that secures the power supply pca (⑯) to the control panel (⑰). There are four small spacers under the power supply which will need to be reused.
7. Remove the power supply pca (⑯).
8. Position the new power supply pca (⑯) on the control panel (⑰) and on the small spacers, and then secure it with four screws (⑤) and lock washers (⑥).
9. Position the intensifier pca (③) on the standoffs (④) and secure it with four screws (①) and lock washers (②).
10. Connect the wires to the power supply pca and intensifier pca.

11. Put the chassis together and put into the case. See “Chassis” on page 5-11.

Quick Connect Fittings (QC) and Filter

Use the following instructions and Figure 5-17 to replace both of the QC fittings (⑪).

1. Remove the chassis and separate the chassis. See “Chassis” on page 5-11.
2. Put the control panel (①) on a flat work surface upside down.

Note

Depending on the previous level of disassembly the control panel assembly screws may not be fully removed as the spacers help captivate the screws. The screws must be fully removed to remove the support bracket (⑧). Hold the spacer tube to prevent it from spinning while removing the screws.

3. Remove the three screws (②) that secures the HM2 collar (⑤) to the quick connect (⑪). These are the three which are elevated above the other three.
4. Remove the three screws (⑥) that secures the QC adapter (⑦) to the quick connect (⑪). Be careful not to lose the small filter element from the underside of the QC adaptor as it is free to fall out when the adaptor is removed from the quick connect body.
5. Remove the quick connect (⑪) from the control panel (⑫).
6. Remove the filter (⑩) from the QC adapter (⑪).
7. Put the filter (⑩) in the new quick connect adapter (⑦).
8. Position the quick connect fitting on the control panel and the o-ring (⑧) on the opposite side of the panel.
9. Position the QC adapter (⑦) and secure it to the quick connect (⑪) with three screws (⑥). Before tightening the screws, pull down on the QC sleeve as if to release the QC two or three times to help center the QC. Tighten the screws in a star shaped pattern. After tightened, torque the screws to 2.3 Nm (20.4 in-lb).
10. Position the HM2 collar (⑤) on top of the QC adapter (⑦) and secure it with three screws (②) and lock washers (③), and flat washer (④). Ensure that there is a small gap 0.25 mm to 0.5 mm (0.010 in to 0.020 in), between the QC adapter and the HM2 collar. If necessary adjust the position on the HM2 collar to ensure this small gap.
11. Put the chassis together and put into the case. See “Chassis” on page 5-11.

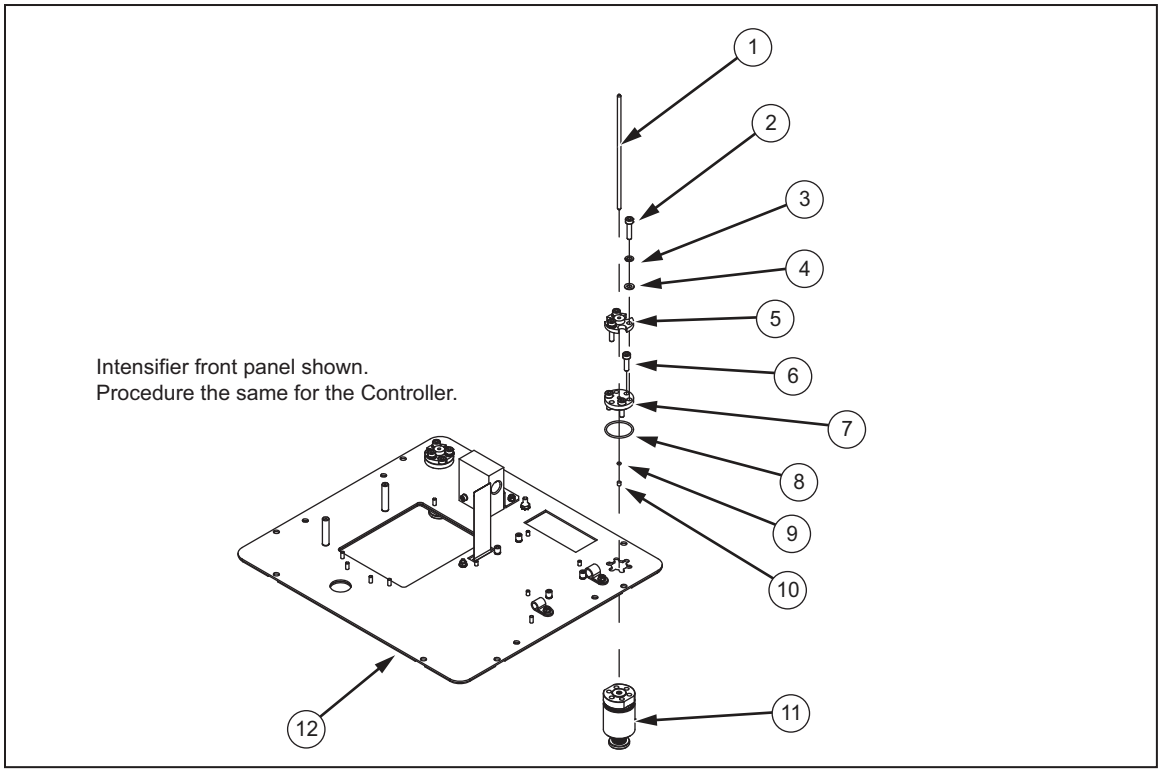

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Figure 5-17. Quick Connect Fitting Removal

Chapter 6
Nitrogen Cylinder Maintenance

Title **Page**

Introduction

This chapter supplies maintenance instructions and procedures for the Nitrogen Cylinder.

⚠Warning

Cylinder maintenance is to only to be completed by maintenance personnel who have been formally trained on how to complete the maintenance procedures.

The Nitrogen Cylinder (the Cylinder) is used to supply very high pressure gas and should be handled with care, especially when it is filled. The Cylinder must be regularly inspected and hydrostatically tested every 5 years.

Safety

Do not use, handle, or service the Cylinder until the safety information below is read and understood.

⚠Warnings

For safe operation and maintenance of the product and to prevent injury:

- **Do not ship the Cylinder while pressurized or with the regulator assembly attached.**
- **Do not alter or obscure the Cylinder markings.**
- **Do not allow your Cylinder to roll around while traveling.**
- **Do not drop, strike or heat the Cylinder.**
- **Do not expose your Cylinder to excessive heat.**
- **Do not attempt to modify the threads or force a valve into the Cylinder.**
- **Do not attempt to remove metal from the Cylinder by any means as it will render the cylinder unsuitable for the rated pressure containment.**
- **Do not modify the Cylinder by adding extra openings for gauges or filling ports.**
- **Do not re-paint the Cylinder with paints that require baking at elevated temperatures.**
- **Only use air-drying paints. Do not use caustic paint strippers or corrosive cleaners as they will damage the Cylinder.**
- **Do not use the Cylinder for anything other than its intended purpose.**

Visual Inspection

The visual inspection makes sure the Cylinder is in good operating condition before it is used. Never use the Cylinder if it shows signs of corrosion, gouges, indents, bulges, heat damage or if it has been dropped or otherwise damaged.

Visually inspect the Cylinder before use as follows:

1. Check to make sure the Cylinder has been hydrostatically tested in the last 5 years.
2. Check the internal pressure to make sure it is within proper range (500 psig to 2,000 psig).
3. Check for leaks. In the unlikely event that a leak is detected, under no circumstances should the cylinder be re-filled until repaired.

External Cylinder Cleaning Procedure

Clean the outside of the Nitrogen Cylinder with soap and water, a solvent wipe, or a nonmetallic scrub pad.

⚠Warning

To prevent damage to the project or personal injury, make certain that the cleaning product used is specifically marked with "suitable for aluminum".

Internal Cylinder Cleaning Procedure

Clean the inside of the Nitrogen Cylinder as follows:

⚠Warning

To prevent personal injury, keep the threads and inside of the cylinder dry and free from oil, dirt or other contaminants.

For oil, grease, and lubricants:

Note

Complete the process without a break. Never leave cylinder freestanding with water.

1. Mix together 1 tablespoon of liquid dish wash detergent to 1 gallon of tap water to make a soapy solution.
2. Pour the soapy solution into the cylinder and shake to agitate the water.
3. Rinse several times with tap water then rinse twice with demineralized or soft water.
4. Steam clean and dry the cylinder with clean compressed air.

⚠Caution

To prevent damage to the product, make sure the cylinder is completely dry before installing the regulator.

For corrosion:

1. Mix together two to three cups of aluminum oxide tumbling chips to two quarts of soft water and one teaspoon of liquid washing detergent.
2. Pour the oxide chip mixture into the cylinder.
3. Use a tumbling machine to tumble the cylinder at 25 to 35 rpm for 10 minutes with a wet detergent aluminum oxide chip combination.

4. Rinse cylinder completely with warm tap water (or soft water if the tap water is hard).
5. Steam clean and dry the cylinder with clean compressed air.

⚠Caution

To prevent damage to the product, make sure the cylinder is completely dry before installing the regulator.

Nitrogen Recharge Procedure

Use the procedure in this section to recharge the Cylinder and or follow all local fill procedures.

⚠Warning

To prevent injury to personnel or damage to equipment:

- **Do not over pressurize the Nitrogen Cylinder. Maximum pressure of the Cylinder is 2,000 psig.**
- **Never fill a Cylinder that has the safety relief device altered in any manner.**
- **Never fill a Cylinder that is outside its periodic inspection and retest period.**
- **Never modify the Cylinder in any way or add attachments that are not authorized. Unauthorized modifications are illegal and could render the cylinder dangerous.**
- **Before the Cylinder is recharged, visually inspect the Cylinder as instructed in "Visual Inspection" section. Verify that the Cylinder has a working pressure (PW) stamped on the crown that will not be exceeded by the filling apparatus.**

Recharge the Cylinder with nitrogen as follows (see Figure 6-1):

1. Connect a filling regulator with a built-in safety relief valve set to 2,000 psi to the fill adapter located in the Accessory Kit. Connect the nitrogen source to the filling regulator.
2. Connect the fill adapter to the Cylinder. Remove the Nitrogen Cylinder regulator if it is installed. See Figure 6-1.

⚠Warning

To prevent injury to personnel or damage to equipment, do not over pressurize the Nitrogen Cylinder. Maximum pressure of the Cylinder is 2,000 psig.

3. Close the bleed valve.
4. Open the Cylinder main shutoff.
5. Open the pressure valve on the nitrogen source and slowly fill the Cylinder to 2,000 psig or less.
6. Once the Cylinder reads 2,000 psig or is at the desired pressure <2,000 psig, close the pressure valve on the nitrogen source and close the Cylinder Main Shutoff.

7. Open the bleed valve to vent the nitrogen from the fill regulator.
8. Disconnect the filling regulator and the fill adapter.
9. Reconnect the Nitrogen Cylinder Regulator.

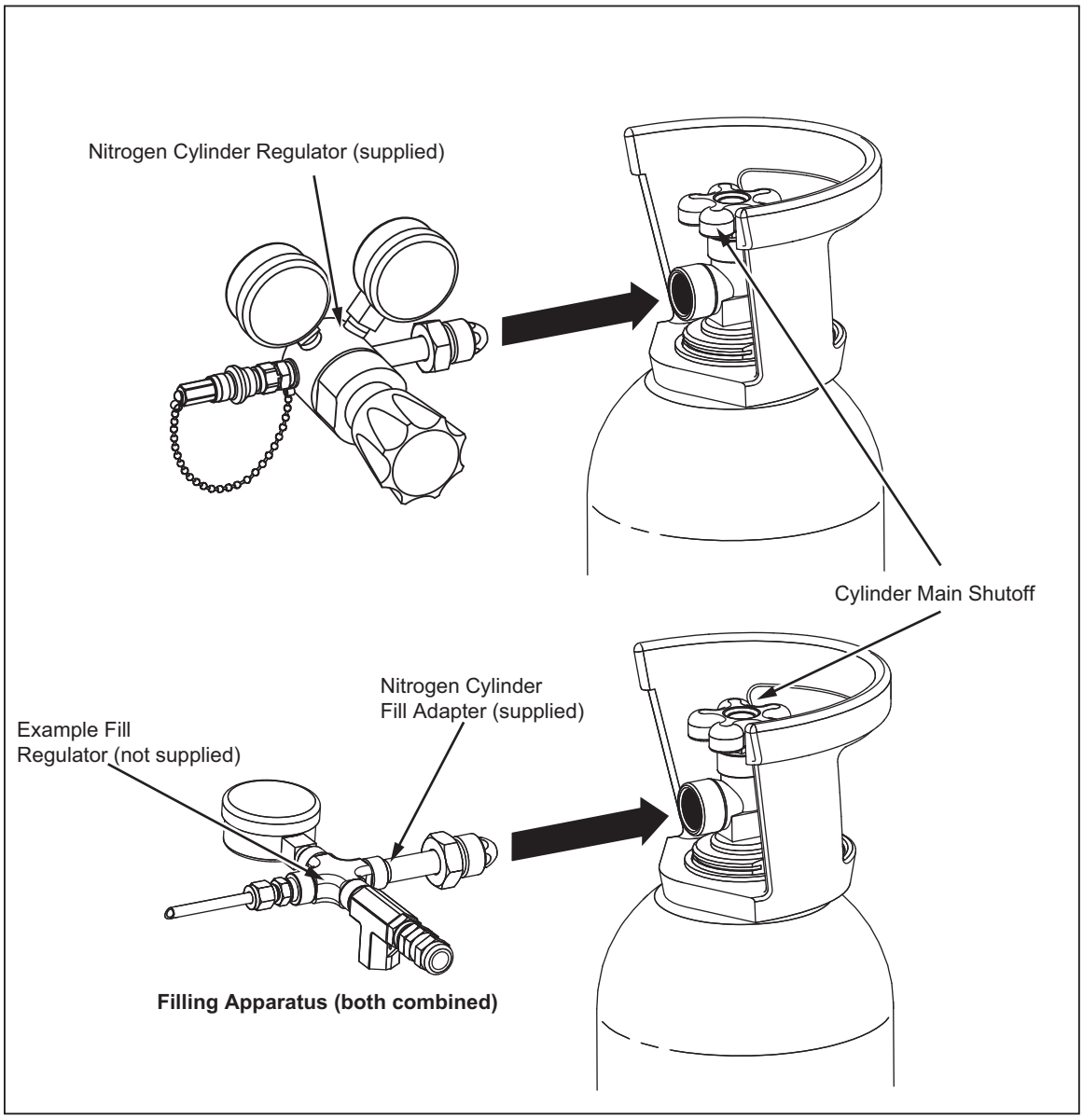

Figure 6-1. Nitrogen Fill Adapter

Chapter 7
List of Replaceable Parts

Title **Page**

Introduction

This chapter contains an illustrated list of replaceable parts for the 4322 Controller, Intensifier, and the Accessory Kit. Parts are shown by assembly, alphabetized by reference designator. Each assembly is accompanied by an illustration that shows the location of each part and its reference designator.

The parts lists contain:

- Reference designator (for example, “H11”)
- Description
- Fluke part number
- Quantity
- Notes

⚠Caution

An * symbol shows a device that may be damaged by static discharge.

How to Order Replacement Parts

Electronic components can be ordered directly from the Fluke Corporation and its authorized representatives with the Fluke part number. Parts price information is available from the Fluke Corporation or its representatives.

To contact Fluke Calibration, call one of the following telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

In the event the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To make sure you get prompt delivery of the correct part, include in your order:

- Instrument model and serial number
- Part number and revision level of the pca (printed circuit assembly) that contains the
- part.
- Reference designator
- Fluke part number
- Description (as given under the Description heading)
- Quantity

Calibrator Final Assembly

Table 7-1. Calibrator Final Assembly

Ref	Description	Part Number
A1	4322 CONTROLLER	4237630
A2	4322 INTENSIFIER	4237653
A3	4322 NITROGEN CYLINDER	4221336
A4	HANDHELD CONTROL	4113229
A5	4322 ACCESSORY KIT	4208134
Not Shown	4322,ACCESSORY DOCUMENATION KIT	4362344

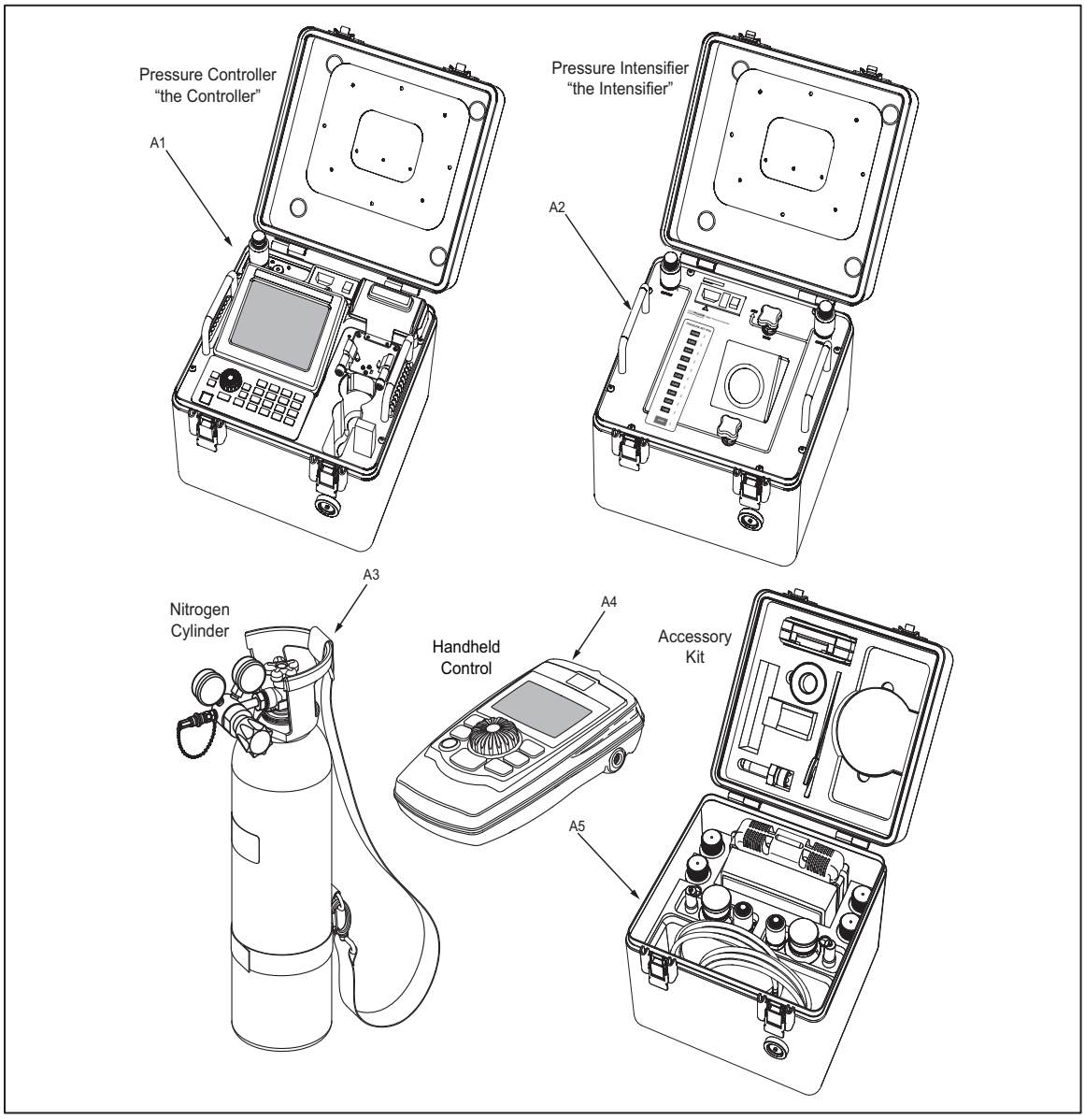

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Figure 7-1. Final Assembly

Table 7-2. Accessory Kit Assembly

Ref	Description	Part Number	Quantity	Notes
A1	HANDHELD CONTROL	4113229	1	[1]
A2	FOAM	4179356	1	
A4	CD	4133223	1	
A5	REGULATOR	4345640	1	
A6	WRENCH	4176844	1	
A7	TAPE	3322925	1	
A8	SPARES KIT	4221360	1	
A9	FILL ADAPTER	4176871	1	
A10	ACCESSORY CASE	4227197	1	
A11	FOAM INSERT	4179356	1	
A13	ADAPTERS KIT	4221351	1	
A14	WASTE BOTTLES	3139463	4	
A15	CPS ASSEMBLY, BLUE	4591465	1	
A16	CPS ASSEMBLY, ORANGE	4591476	1	
A17	HOSE BUCKET	4221918	1	
	GPIB CABLE	3866449	1	
	PORTABLE SUPPLY HOSE	4218163	1	
	HOSE INTERCONNECT	4218094	1	
	TEST HOSE 10 FT – BLUE	4591526	1	
	TEST HOSE 10 FT – ORANGE	4591532	1	
NOT SHOWN	MANUAL, SERVICE, MANUAL, PORTABLE AUTOMATED PRESSURE CALIBRATOR FOR 4322-SYS-NAVAIR	4133214	1	
NOT SHOWN	MANUAL, OPERATORS, MANUAL, PORTABLE AUTOMATED PRESSURE CALIBRATOR FOR 4322-SYS-NAVAIR	4133206	1	
NOT SHOWN	DVD, TRAINING VIDEO FOR 4322-SYS-NAVAIR	4362733	1	

Note:
[1] – Handheld Control and test leads sold separately.

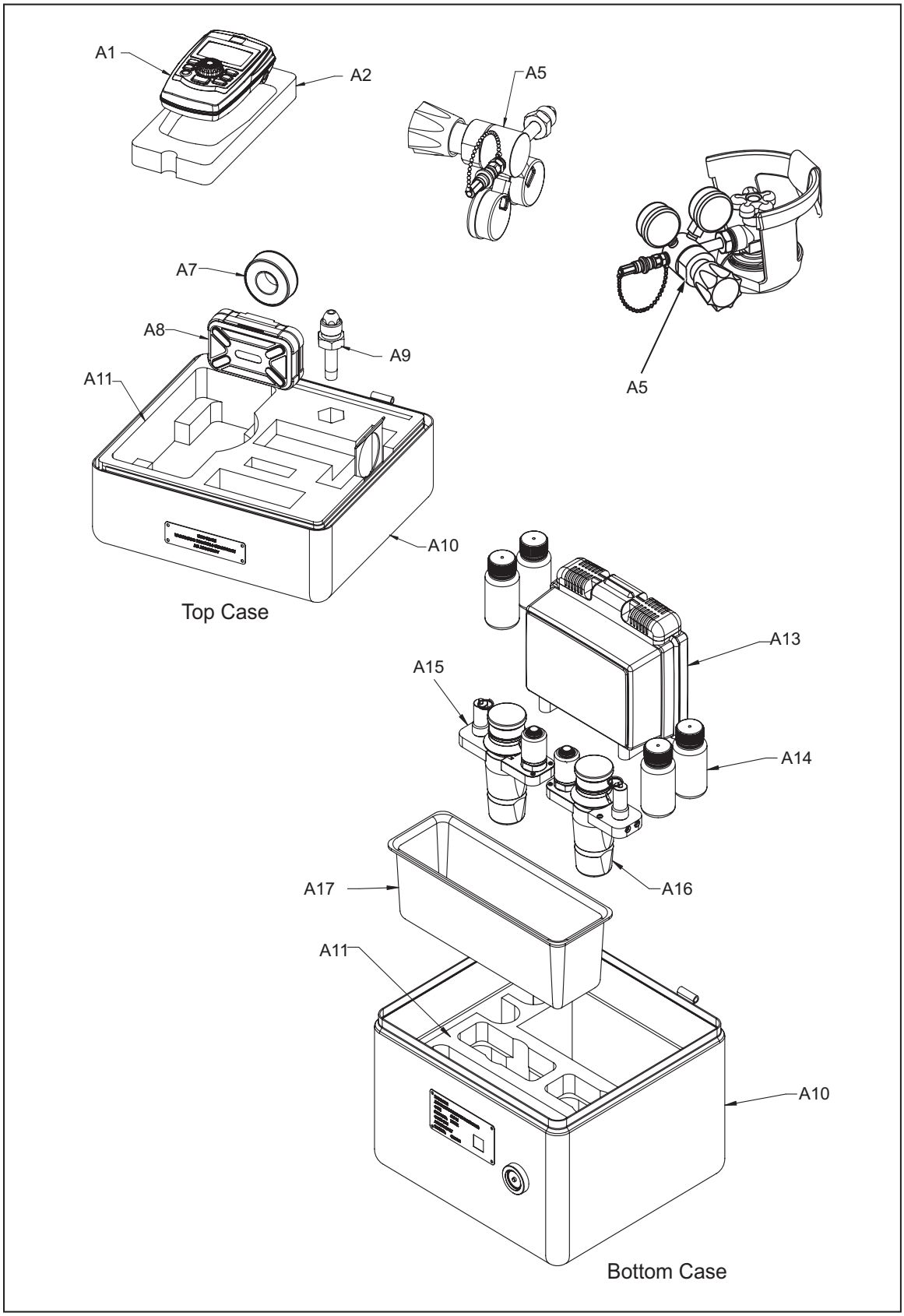

Figure 7-2. Accessory Kit Assembly

Table 7-3. Adapter Kit Assembly

Item	Description	Part Number	Quantity	Notes
H1	FITTING, HM4 EQUIVALENT	4150810	1	
H2	FITTING, HF4 EQUIVALENT	4150822	1	
H3	FITTING, 1/8 MALE PIPE THREAD (NPT)	4150831	1	
H4	FITTING, 1/4 MALE PIPE THREAD (NPT)	4150846	1	
H5	FITTING, 1/2 MALE PIPE THREAD (NPT)	4150854	1	
H6	FITTING, 1/8 FEMALE PIPE THREAD (NPT)	4150868	1	
H7	FITTING, 1/4 FEMALE PIPE THREAD (NPT)	4150879	1	
H8	FITTING, 1/2 FEMALE PIPE THREAD(NPT)	4150887	1	
H9	FITTING, AN4 MALE	4150893	1	
H10	FITTING, AN6 MALE	4150902	1	
H11	FITTING, AN4 FEMALE	4150916	1	
H12	FITTING, AN6 FEMALE	4150925	1	
H13	FITTING, 1/8 ID HOSE BARB	4150933	1	
H14	FITTING, 1/4 ID HOSE BARB	4150940	1	

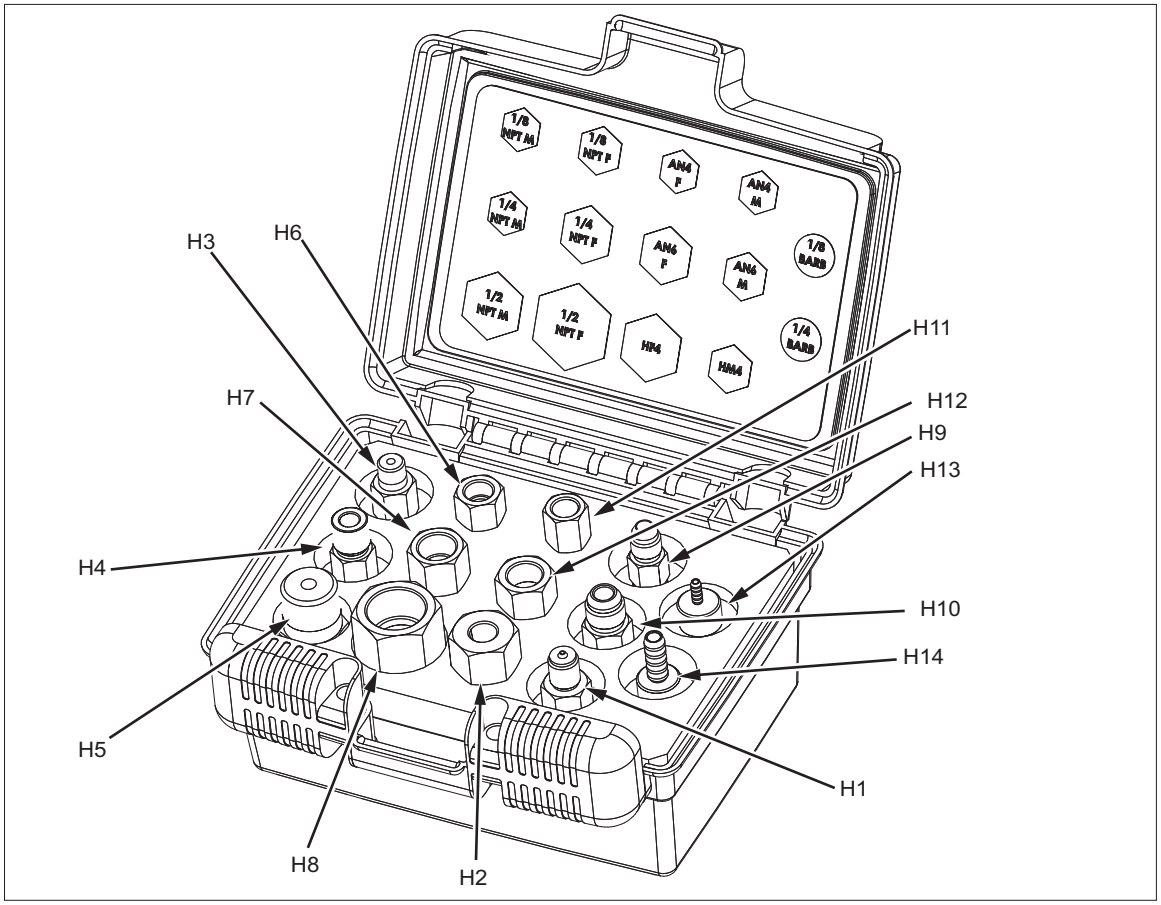

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Figure 7-3. Adapters Kit Assembly

Table 7-4. Spares Kit Assembly (not shown)

Description	Part Number	Quantity	Notes
O-RING, URETHANE, 14 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398685	1	
O-RING, URETHANE, 12 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398697	1	
O-RING, URETHANE, 8 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398703	1	
O-RING, FLUOROCARBON, SHORE A 75, BLK, AS 568A-014, 0.489 ID, 0.070 W, ROHS COMPL.	2527053	2	
48547, BUSHING NON-RIBBED	2213849	2	
O-RING, CAST URETHANE, 90 DURO, 003 (0.060 W X 0.056 ID)	4261927	9	
SEAL ASSEMBLY, HIGH PRESSURE, T61 SEAL /P02 BACKUP RING /FKM O-RING	4338494	4	
O-RING, URETHANE, 3.5 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398715	2	
DECAL, SPARE PARTS CASE	4179300	1	
CASE, ABS, 3.875 IN X 2.375 IN X 1.375 IN, WITH HANDLE, BLACK	4184213	1	
FUSE 5X20 5A S/B 250V	2077364	1	
4322-5933, CUT DETAIL, COALESCING FILTERS	4358838	2	
FUSE, FUSE, 5X20 MM,1 A, 250 V, SLOW	808055	1	
WRENCH, INTENSIFIER PISTON	4225996	1	
TOOL, PISTON INSERTION, 4322	4367097	1	
FILTER, METAL	4155812	1	
O-RING, POLYURETHANE, 90 DURO, 1 MM W X 2 MM ID, TRANSLUCENT	4326327	6	
O-RING, SILICON, 3 MM W X 13 MM ID, 70 DURO, RED-ORANG	4404489	1	

Controller Final Assembly

Table 7-5 lists and Figure 7-4 shows the orderable assemblies inside the Controller. Some of the assemblies have internal parts that can be separately ordered and are listed in the subsequent sections. Use the "A" reference designator to find replacement parts for these assemblies.

Table 7-5. Controller Top-Level Assembly

Ref.	Description	Part Number	Notes
A1	CONTROL PANEL ASSEMBLY	-	
A2	PRESSURE TRANSDUCER MODULE, 150 KPA ABS (21.5 PSIA)-TESTED	4237225	
A3	PRESSURE TRANSDUCER MODULE, 700 KPA (100 PSIG)-TESTED	4237233	
A4	PRESSURE TRANSDUCER MODULE, 10 MPA (1500 PSIG)-TESTED	4237240	
A5	PRESSURE TRANSDUCER MODULE, 70 MPA (10000 PSIG)-TESTED	4237257	
A6	BARO-4322, 4322 BAROMETER MODULE-TESTED	4237269	
A7	ASSEMBLY, BLUE, NEWPORT, TESTED	4591465	
	ASSEMBLY, ORANGE, NEWPORT,TESTED	4591476	
A8	SYSTEM MANIFOLD	-	
A9	PUMP BRACKET ASSEMBLY, 4322 CONTROLLER ,TESTED	4483369	See Figure 7-6
A10	PCAs, ELECTRONICS BOX, AND CHASSIS WALLS	-	See Figure 7-8
A11	CASE	4227172	
A12	COMM BOX ASSEMBLY	4227321	

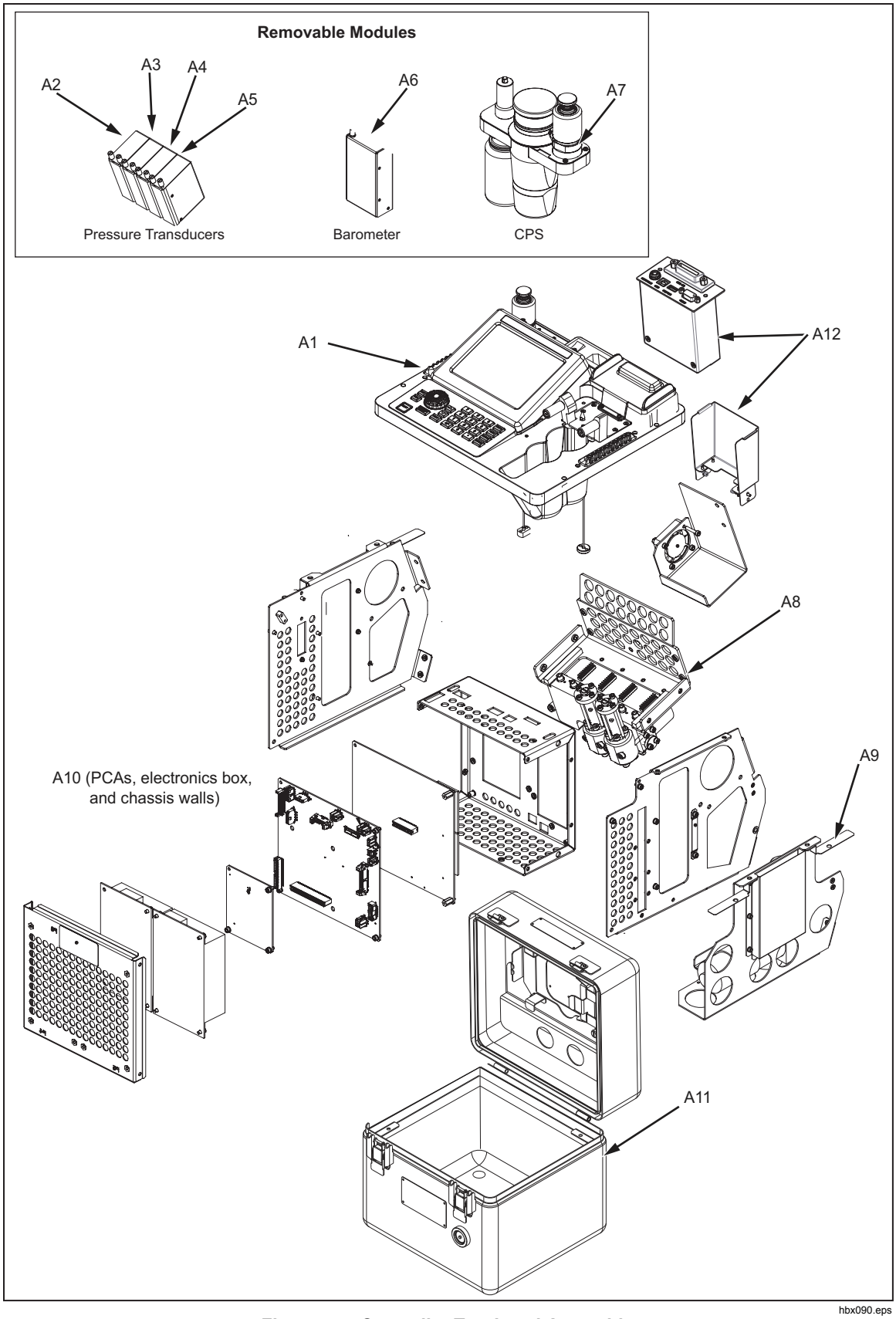

Figure 7-4. Controller Top-Level Assembly

Table 7-6. A1 Control Panel Assembly

Ref.	Description	Part Number	Quantity	Notes
A1	DISPLAY ASSEMBLY	4227342	2	
A2	MANIFOLD MOUNT QC W/DUST CAP AND CHAIN	4408161	1	
A3	DOCK ASSEMBLY, 4322 CONTROLLER, TESTED	4483357	1	
A4	NC ISOLATION VALVE (VH3)	4244728	1	
A5	POWER ENTRY MODULE	3136592	1	
A6	KEYPAD ASSEMBLY	4159904	1	
A7	ENCODER WHEEL	4244689	1	
A8	SUPPLY TUBEWELD	4217377	1	
H1	SCREW	3153164	2	
H2	O-RING 1 MM X 2 MM ID	4326327	3	
H3	FITTING 10-32 X 10-32 BHD	3137725	1	
H4	2T X 10/32 OSEAL ADAPTER	3141516	1	
H5	TEE	3143366	1	
H6	20 MM URETHANE TUBING	3232660	2	
H7	QC ID NAMEPLATE	4172586	4	
H8	M3 LWASH	3153752	10	
H9	M3 NUT	2678004	4	
H10	SHCS M2 X 10	3153642	2	
H11	M2 LWASH	3154329	2	
H12	DUST SEAL RETENTION PLATE	4233848	1	
H13	FHSHC M3 X 10	3153199	4	
H14	DIE-CUT FOAM TAPE	4357511	1	
H15	O-RING	4318510	1	
H16	8 MM ANTI EXTRUSION RING	4155801	1	
H17	QC SLEEVE ACTUATOR	4155593	1	
H18	WAVE SPRING	4234535	1	
H19	TUBEWELD ASSEMBLY	4213731	1	
H20	FITTING, COMPRESSION, ELBOW, 1/8 IN. OD TUBE, 10-32 THREAD, BRASS	4420504	1	
H21	O-RING	4326327	1	
H22	DUST COVER	4210254	1	
H23	KNOB	4282155	1	
H24	M9 PANEL NUT	4358814	1	
H25	WASHER, LOCKING	3469900	1	
H26	SCREW	3153328	8	
H27	NUT PLATE	4329240	1	
H28	FILTER	4212383	1	
H29	SPACER	4397183	1	[1]
H30	M4 LWASH	3153914	6	
H31	M4 X 14 SHCS A4	4370339	6	
H32	SHCS M3 X 6	3154248	4	
H33	⚠ FUSE, 5X20 MM, 1 A, 250 V, SLOW	808055	1	
H34	SCREW, 4-24 X 0.250, PHILLIPS, PAN HEAD, SHEET METAL SCREW, TYPE A PT, STAINLESS STEEL	3153328	8	
H35	CABLE ASSEMBLY, FLAT, 2 ROW, 0.05 IN CTR, SOCKETS, POLARIZING NOTCH, 16POS, 4.6 IN LONG	4244645	1	
H36	CONNECTOR ACCESSORIES, EJECTOR HEADER CAP, 0.05 IN CTR, 8POS	4345684	2	
H37	TAPE, NI-CU METALIZED POLYESTER FABRIC, 80C, 0.13 MM THICK, 25.4 MM WIDE	4330002	-	

Notes
[1] Only applicable for certain early model tube-welds.

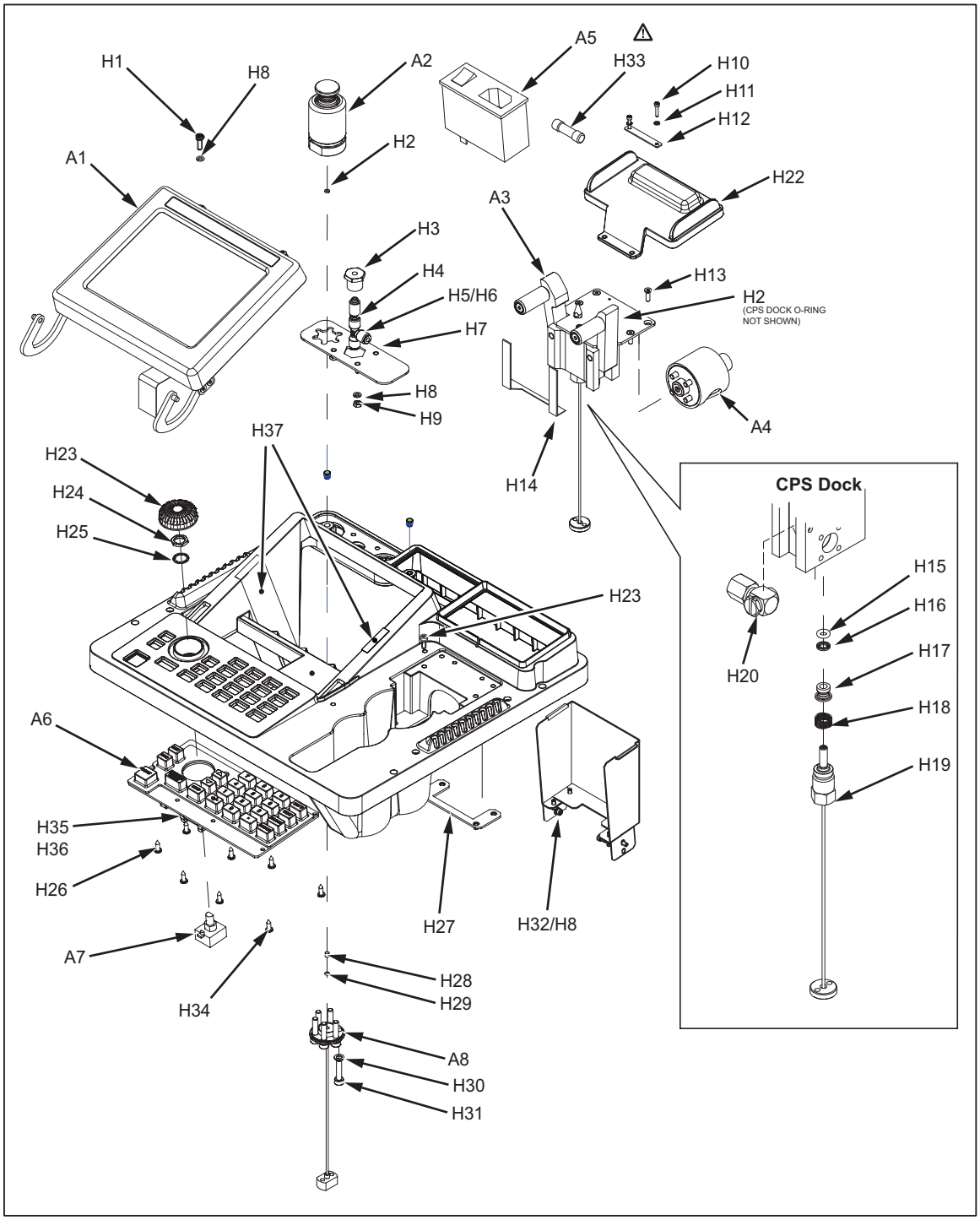

Figure 7-5. A1 Control Panel Assembly

Table 7-7. A8 System Manifold Assembly

Ref.	Description	Part Number	Quantity	Notes
A1	VH1 NC ISOLATION VALVE	4244762	1	
A2	V5 2-WAY VALVE (HI-P)	3466665	1	
A3	V6 2-WAY VALVE (HI-P)		1	
A4	V7 3-WAY VALVE	3139019	1	
A5	PV1 PRECISION CONTROL VALVE TESTED	4483384	1	
A6	PV2 PRECISION CONTROL VALVE TESTED	4483378	1	
A7	PCV BACKPLANE PCA	4109268	1	
H1	FOAM GASKET 50 MM	4330126	2	
H2	SYSTEM MANIFOLD BRACKET	4150350	1	
H3	M3 LWASH	3153752	10	
H4	SHCS M3 X 5	3152908	4	
H5	THM ALIGN PIN	4219249	8	
H6	10-32X 2T ELBOW	3141147	2	
H7	PLUG, 1/16 IN. ANPT, 5/32 IN HOLLOW HEX, SS, 3000 PSI	4408221	1	
H8	10-32 OSEAL PLUG	3136178	1	
H9	O-RING 1 MM W X 2 MM ID 90 DURO	4326327	4	
H10	SHCS M4 X 30	4235051	4	
H11	FILTER	4212383	2	
H12	SHCS M3 X 12	3153236	4	
H13	TUBEWELD	4217377	1	
H14	SEAT CHECK VALVE	4178007	1	
H15	O-RING 1 MM X 3 ID	4318449	1	
H16	BALL	3474441	1	
H17	SPRING	4408200	1	
H18	PLUG	4281004	1	
H19	SYSTEM MANIFOLD	4148167	1	
H20	MUFFLER 10-32	3138887	1	
H21	ELBOW 10-32 X BARB	1811839	1	
H22	FSHC M3 X 8	4212956	4	
H23	M4 x 10 SCHS	3153224	4	
H24	GASKET, I/O, FABRIC OVER FOAM, 6.4 MM H X 6.4 MM W, D-SHAPED, 18 IN. L, 0.328	4330126	?	
H25	102813-Z, TBG, URETHANE, 1/8OD CL, 110 MM	3232660 Dup of below	?	
H26	102813-Z, TBG, URETHANE, 1/8OD CL, 150 MM	3232660 Dup of above	?	

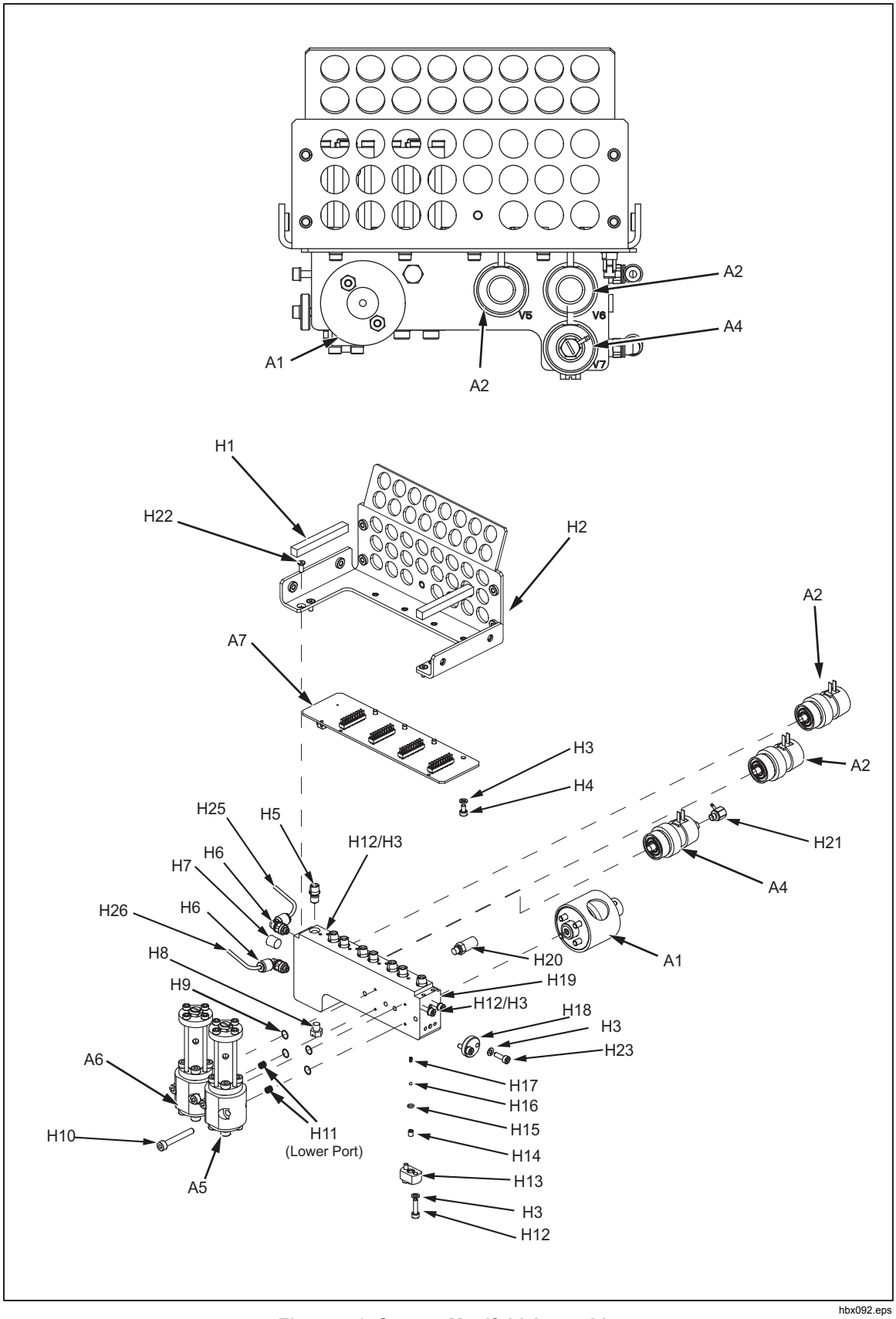

Figure 7-6. System Manifold Assembly

Table 7-8. A9 Pump Bracket Assembly

Ref.	Description	Part Number	Quantity	Notes
A2	VALVE KIT, CS-4193, SOLENOID ASSY, COIL AND SPIDER, 6 V	4399748	1	
A3	VALVE KIT, CS-4193-10, SOLENOID ASSY, COIL AND SPIDER,12 V	4399753	1	
A4	4322-PUMP,REBUILD KIT FOR 4322 PISTON PUMP	4237107	1	
A5	FAN CABLE WITH FAN	4244801	1	
H1	SHCS 2-56 X1	4235596	4	
H2	SHIM, 200 MICRONS, CLIPPARD	4399544	2	
H3	FINE SEAT	4241933	1	
H4	FILTER	4375674	1	
H5	O-RING 1 MM X 2 MM ID	4326327	2	
H6	TUBE FITTING	4420504	1	
H7	PUMP HEAD	4148743	1	
H8	COARSE SEAT	4241925	1	
H9	M2 FLAT WASHER	3154460	4	
H10	M2 LOCK WASHER	3154329	4	
H11	SHCS M2 X 4 LG	3154858	4	
H12	M3 HEX NUT	2678004	6	
H13	M3 LWASH	3153752	14	
H14	CABLE ASSEMBLY	4244770	1	
H15	VAC PUMP SENSOR BRACKET	4156152	1	
H16	FAN COWL	4154837	1	
H17	SHCS M3 X 6	3154248	8	
H18	PUMP BRACKET	4154828	1	
H19	M4 LWASHER	3153914	4	
H20	SHCS M4 X 8	3153319	4	
H21	SHIM, 50 MICRONS, CLIPPARD	4399559	4	
H22	PFA TUBING FOR H6 FITTING, 240 MM	3232357	?	

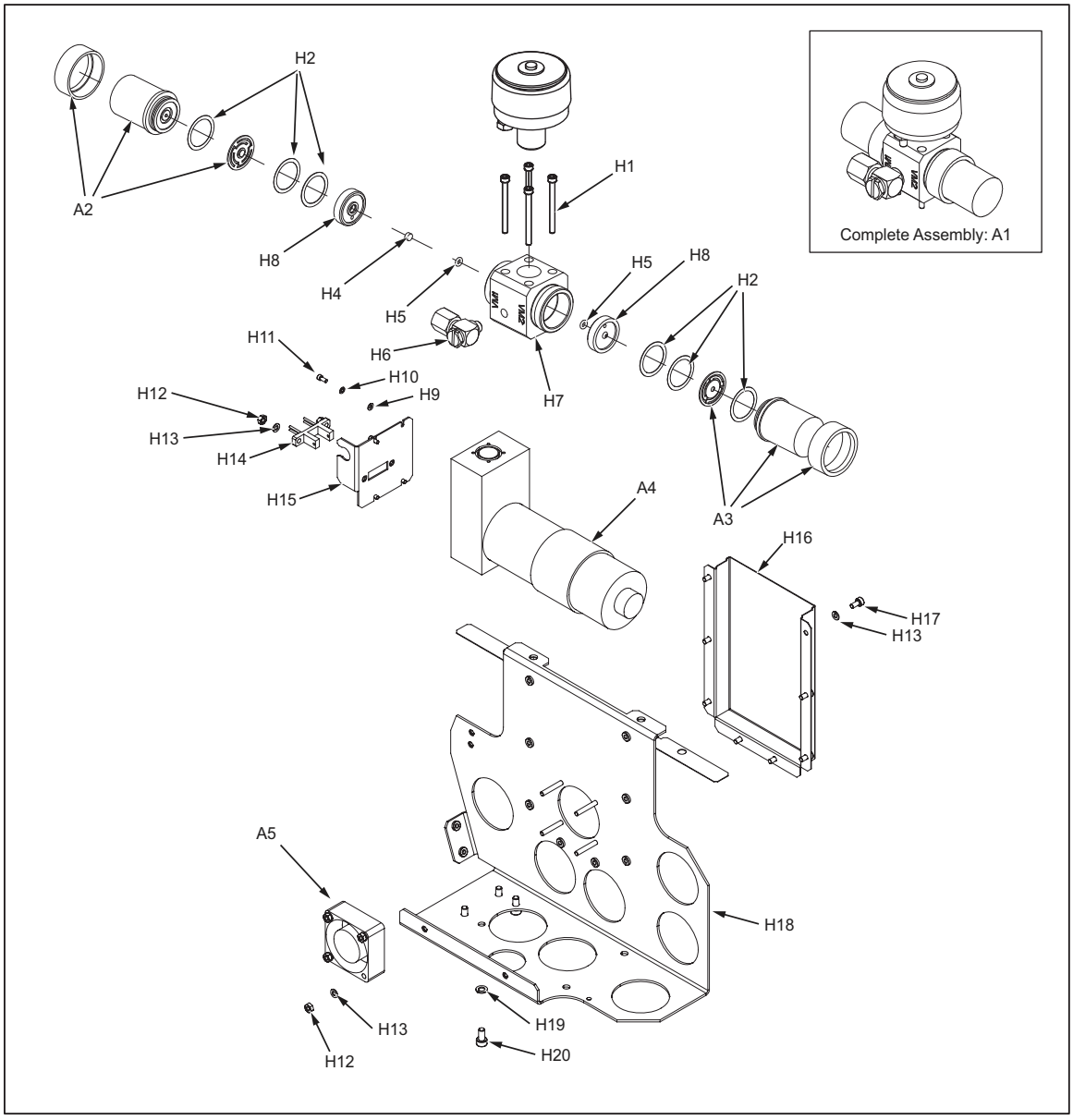

Figure 7-7. A9 Pump Bracket Assembly

Table 7-9. A10 Electronics Box Assembly

Ref.	Description	Part Number	Quantity	Notes
A1	P-VLV PCA	4213295	1	
A2	MAIN BOARD PCA, TESTED	4561120	1	
A3	BRAIN BOARD PCA, TESTED	4561112	1	
A4	POWER SUPPLY, 12 V	4369964	1	
A5	POWER SUPPLY, 5 V	4369958	1	
H1	M4 X 10 SHCS	3153272	6	
H2	M4 X 12 SHCS	3153285	1	
H3	M4 LWASH	3153914	7	
H4	FERRITE CLAMP	4335708	1	
H5	FAN COWL	4333637	1	
H6	M3 X 16 LGSHCS	3153688	4	
H7	M3 LWASH	3153752	60	
H8	M3 X .5 NUT	2678004	4	
H9	M4 HEX NUT	3153147	1	
H10	M4 EXT LWASH	3168103	2	
H11	M3 X 6 SHCS	3154248	41	
H12	COWL	4143056	1	
H13	M3 x 6 PHP	3153173	2	
H14	BARO PCA	4244692	1	
H15	PIN ALIGN THM	4219249	2	
H16	BARO MANIFOLD	4143111	1	
H17	ELBOW	3141147	1	
H18	LEFT CHASSIS WALL	4154791	1	
H19	RIBBON RETAINER	4228632	3	
H20	PLATE	4293932	1	
H21	FOAM 50 MM	4330126	2	
H22	M3 X 10 SHC	3153224	9	
H23	NUT HEX M2	2677986	2	
H24	M2 LWASH	3154329	2	
H25	SPACER	4233811	1	
H26	HINGE BLOCK	4157054	2	
H27	HINGE SWITCH	4244781	1	
H28	M2 X 16 SHCS	3154835	2	
H29	M2 FLAT WASHER	3154460	2	
H30	STANDOFF1	4221714	4	
H31	ELECTRONICS COVER	4154819	1	
H32	ELECTRONICS HOUSING	4157046	1	
H33	FOAM DI-CUT WIRE COVER	4313676	2	
H34	WIRE COVER	4183069	1	
H35	M4 X 10 BHSHC	3154820	1	
H36	WIRE CLIP	3154510	2	
H37	RIGHT CHASSIS WALL	4154804	1	
H38	PCA COVER	4157022	1	
H39	M3 X 5 SHCS	3152908	12	
H40	CROSSMEMBER	4157010	1	
H41	32.8 102515-Z, GROMMET, FLEX, PE, 0.062	3232548	2	
H42	2 PIEZO DRIVER AMPLIFIER MODULE, 1 CHANNEL, GAIN OF 10, -30 TO 130 V	4219164	1	

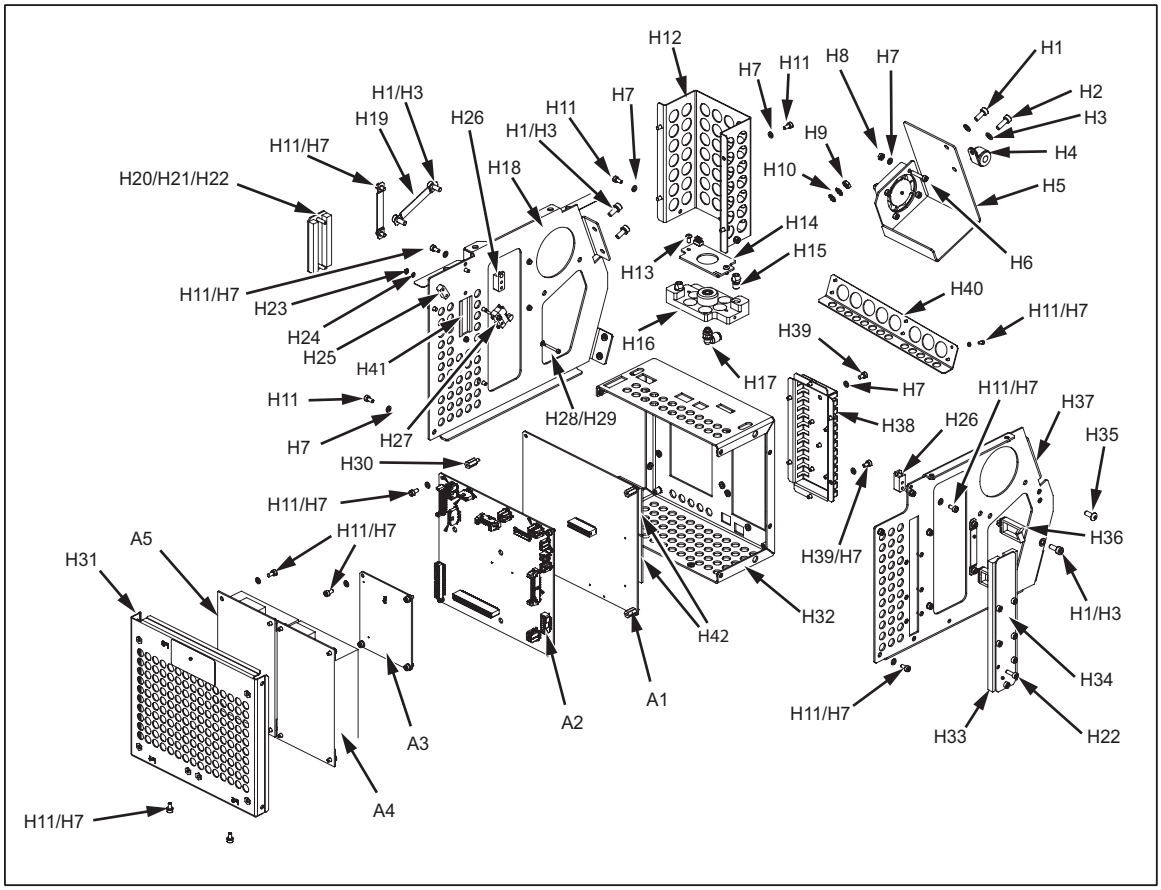

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Figure 7-8. A10 Electronics Box Assembly

Table 7-10. A15 CPS Assembly

Ref.	Description	Part Number	Quantity	Notes
H1	SURGE NIPPLE	4255160	1	
H2	BALL	3474441	1	
H3	SURGE VALVE CUP	4255149	1	
H4	FINE FILTER COALESCING FILTER PACK - 30 MM AND 20 MM LONG FILTERS	4358838	1	
H5	DUT TUBE	4155835	1	
H6	M1.6 X 5 SHCS	4219120	3	
H7	UPPER FILTER DISK	4155755	1	
H8	FILTER DISK GASKET	4155770	1	
H9	LOWER FILTER DISK	4155762	1	
H10	PURGE TUBE	4155820	1	
H11	COARSE FILTER METAL FILTER	4155812	1	
H12	LOWER FILTER RETAINER	4155587	2	
H13	O-RING	4320809	1	
H14	FILTER HOUSING	4155579	1	
H15	FILTER RETAINER	4255124	1	
H16	O-RING	4261793	1	
H17	METAL FILTER	4271434	1	
H18	O-RING	4261779	1	
H19	MOUNT	4255092	1	
H20	WASTE CONTAINER SEAL	4155796	1	
H21	M6 FLAT WASHER	3134319	1	
H22	1/4 – 28 HEX NUT	4218576	1	
H23	TAPERED SPRING	4218565	1	

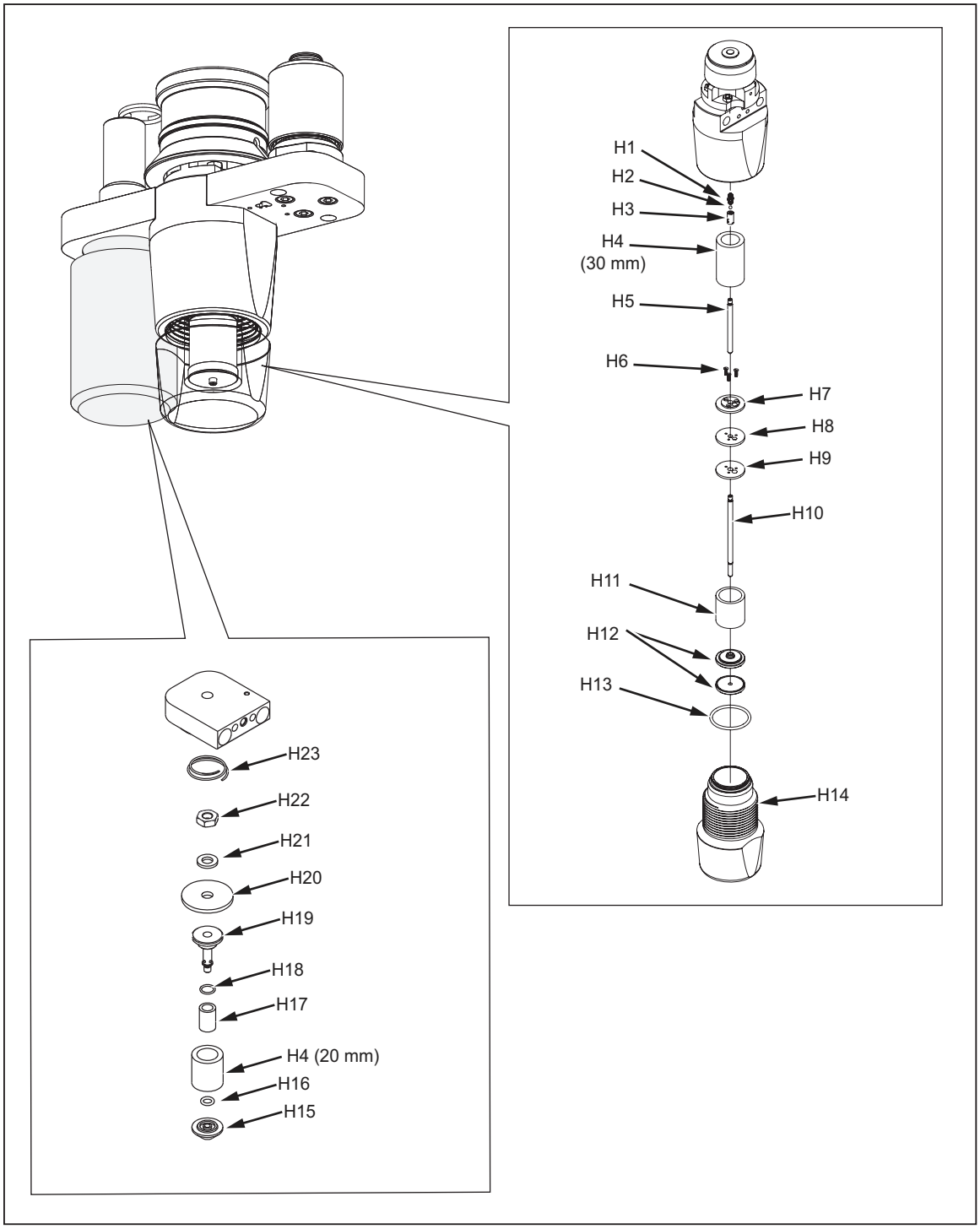

Figure 7-9. A15 CPS Assembly

Intensifier Final Assembly

Table 7-11. A1 Intensifier Assembly

Item	Description	Part Number	Quantity	Notes
A1	CONTROL PANEL ASSEMBLY	-	1	[2]
A2	BOOSTER PUMP ASSEMBLY	-	1	[2]
A3	CASE, INTENSIFIER	4227172	1	[1]
A4	TUBEWELD ASSEMBLY	4280424	1	
H1	UNION	4087953	1	
H2	10-32 FITTING	3148322	1	
H3	BOOSTER SUPPLY TUBE	4243427	1	
H4	M6 HEX NUT	2536890	8	
H5	M6 LOCK WASHER	3153533	4	
H6	1/4 FLAT WASHER	4424884	4	
H7	GROMMET	2213849	8	
H8	C-CLIP	3330240	4	
H9	CORNER GUSSET	4139472	4	
H10	SPACER	4160672	8	
H11	10-32 CAPTIVE SCREW	4297057	8	
H12	M3 X 10 LGSHC	3153224	4	
H13	M3 X LWASHER	3153752	4	
H14	O-RING	4261927	1	
H15	O-RING, VITON, BRN, 5-193	3136506	1	
H16	ACCY,ACCESSORY KIT, INTENSIFIER	4237216	1	
H17	SPOOL, HI P, COVER	4238575	1	

Notes
[1] – The case top and bottom cannot be ordered as separate parts.
[2] – Not orderable as a complete assembly.

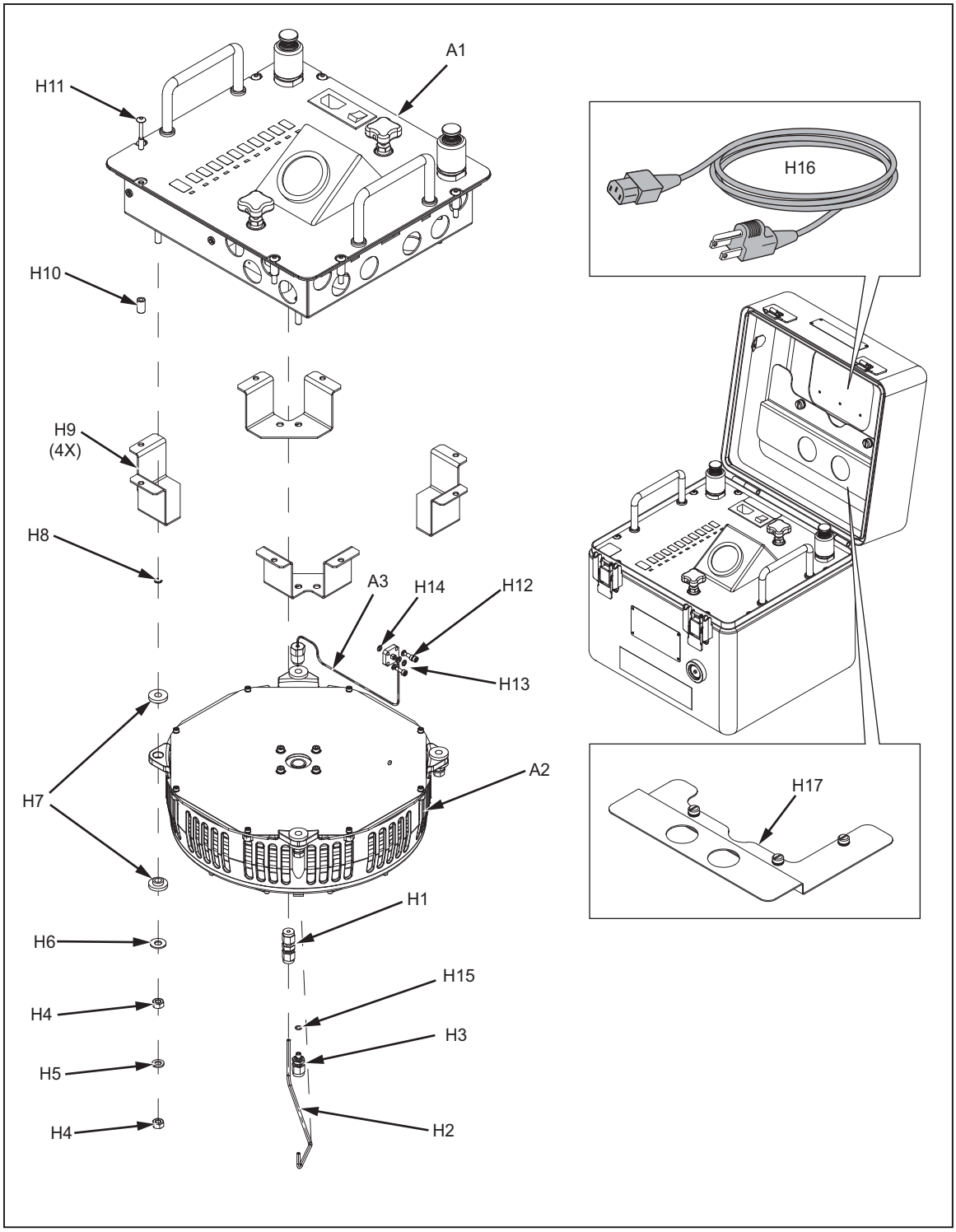

Figure 7-10. Intensifier Final Assembly

Table 7-12. A1 Control Panel Assembly (Page 1)

Item	Description	Part Number	Quantity	Notes
A1	ASSY, 10K PSI SENSOR	4235320	1	
A2	VALVE,PRESSURE RELIEF,MINIATURE,SS,1/4 NPTM INLET, TESTED	4483325	1	
A3	GAUGE W/CLAMP	4243475	1	
A4	MANIFOLD QUICK CONNECT ASSEMBLY	4345866	2	
A5	HF2 VALVE	3328687	2	
A6	TUBE - GAUGE TO MANIFOLD 4322-5675	4216993	1	
A7	TUBE - ISO VALVE TO MANIFOLD 4322-5676	4217000	1	
A8	BENT TUBEWELD 4322-5800	4217017	1	
H1	M6 HEX NUT	2536890	2	
H2	M6 LOCK WASHER	3153533	2	
H3	MANIFOLD	4139413	1	
H4	1/4NPT HEX PLUG SS-4-HP	4212390	1	
H5	M3 HEX NUT	2678004	11	
H6	M3 LOCK WASHER	3153752	20	
H7	GAUGE COWL	4139460	1	
H8	30-21 HF2 NFB HF2-1/4 NPT ADAPTER	4212352	1	
H9	SUPPLY TUBE - CONTROL PANEL 4322-5802	4243430	1	
H10	M4 X 20 SHCS	4370317	6	
H11	M4 LOCK WASHER	3153914	8	
H12	HM2 COLLAR 4322-5622	4139436	2	
H13	M4 X 14 SHCS	4370339	6	
H14	QC ADAPTER 4322-5798	4198741	2	
H15	O-RING, VITON, 1.5 MM W X 23 MM ID, 90 DURO, BLACK	4225265	2	
H16	SPACER, FILTER, QC MANIFOLD	4397183	2	
H17	1/8 X 1/8 FILTER D2-2	4212383	2	
H18	VALVE BRACKET U04912	3329110	2	
H19	VENT GLAND	4357293	1	
H20	FILTER DISK	3140024	1	
H21	O-RING	4219173	1	
H22	M3 X 15 SHCS	3335550	4	
H23	HF2 GLAND	3143178	8	
H24	HF2 COLLAR	3143184	8	
H25	O-RING	4326327	2	
H26	CONTRACT MFG ITEM, FUSE 5X20 5A S/B 250V	2077364	2	

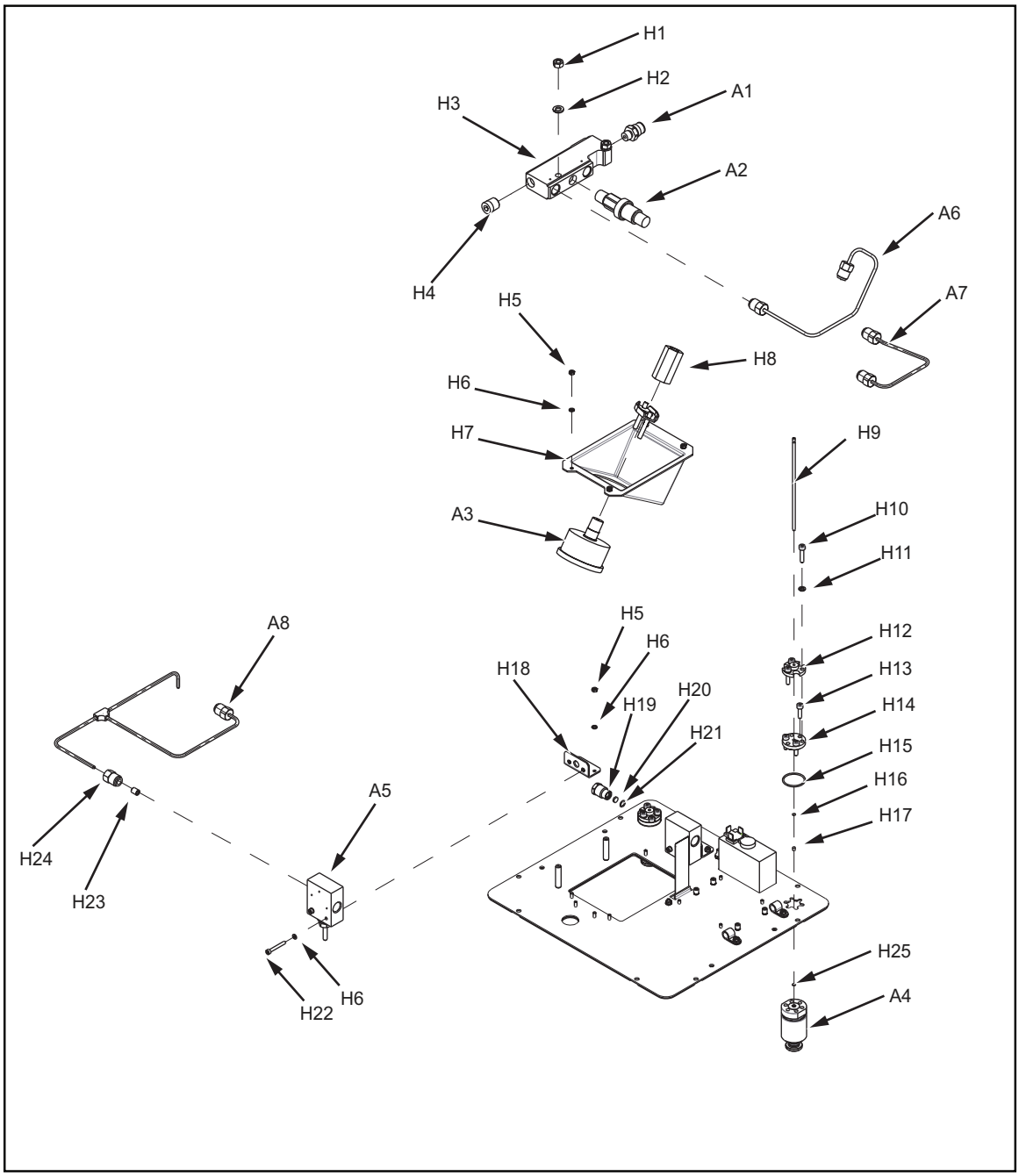

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Figure 7-11. Control Panel Assembly (Page 1)

Table 7-13. A1 Control Panel Assembly (Page 2)

Item	Description	Part Number	Quantity	Notes
A1	INTENSIFIER PCA	4142630	1	
A2	POWER SUPPLY PCA	4369947	1	
A3	MOTOR CONTROLLER	4212180	1	
A4	POWER ENTRY MODULE	4341311	1	
H1	M3 X 6 SHCS	3154248	8	
H2	M3 LWASH	3153752	8	
H3	M3 X 30 STANDOFF	3140491	4	
H4	KNOB	3337089	2	
H5	HANDLE	4340703	2	
H6	WASHERS	4334721	4	
H7	M4 X 10 SHCS	3153272	2	
H8	M4 LWASH	3153914	2	
H9	BRACKET	4139451	1	
H10	M5 LWASH	3154144	4	
H11	M5 X 12 SHCS	4058169	4	
H12	3/8 CABLE CLAMP	3988269	2	
H13	M4 FLAT WASHER	3153079	1	
H14	M4 X 10 SHCS	3153272	1	
H15	M4 HEX NUT	3153147	2	
H16	M4 EXT LWASH	3168103	2	
H17	M3 HEX NUT	2678004	4	
H18	M3 FLAT WASHER	3152972	4	
H19	M3 EXT LWASH	3153135	1	
H20	¼ IN CABLE CLAMP	3138271	1	
H21	CONTRACT MFG ITEM, FUSE 5X20 5 A S/B 250 V	2077364	2	

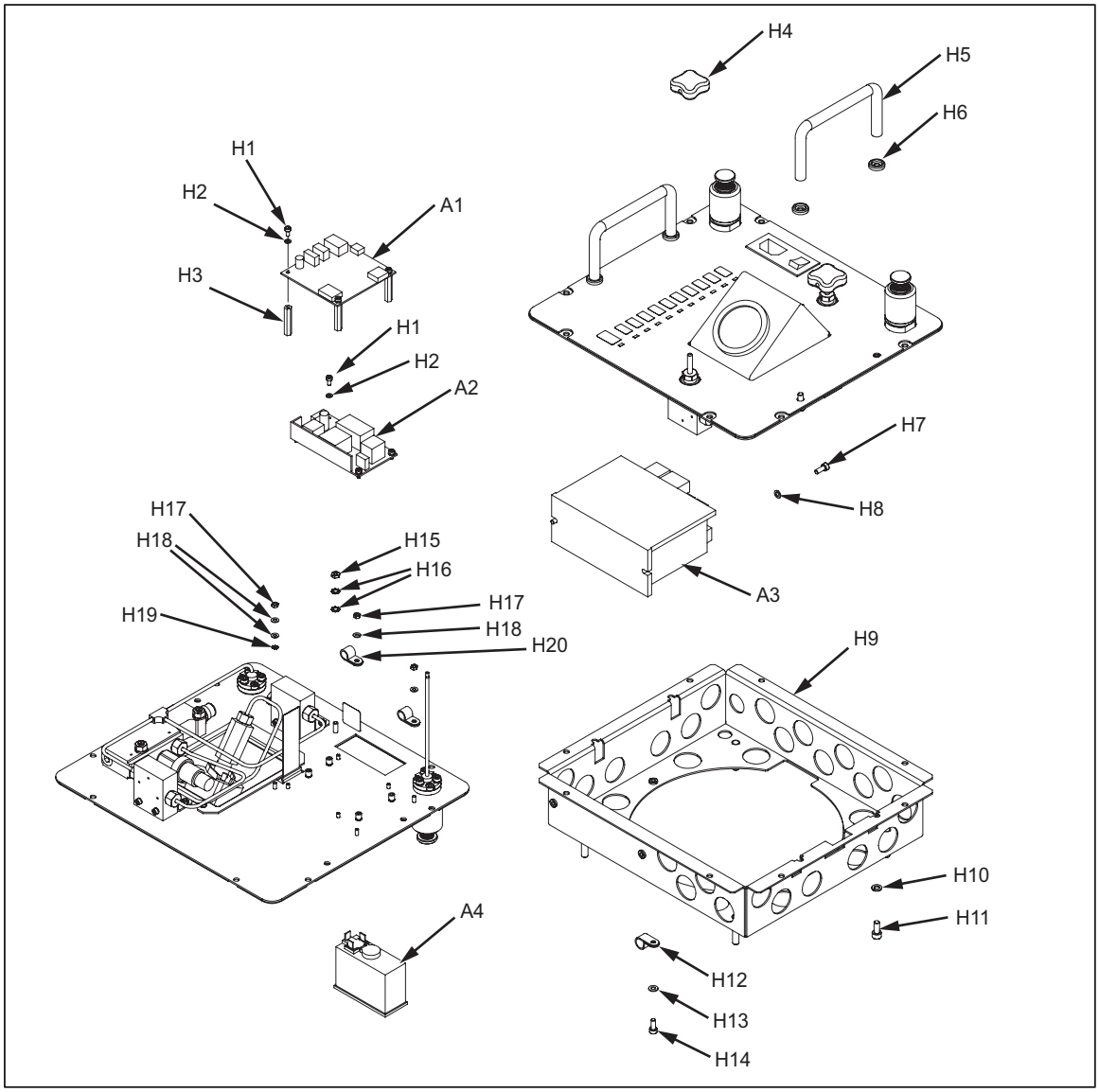

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Figure 7-12. Control Panel Assembly (Page 2)

Table 7-14. A2 Booster Pump Assembly

Item	Description	Part Number	Quantity	Notes
A1	ENCODER PCA	4213347	1	[1]
A2	PUMP CAM ASSEMBLY	-	1	[2]
A3	CAM PLATE & PLANET GEARS ASSEMBLY	-	-	[2]
H1	M4 X 12 SHCS	3153285	4	
H2	M4 LOCK WASHER	3153914	4	
H3	UPPER SHAFT MOUNT PLATE	4139956	1	
H4	C-CLIP	4218936	1	
H5	M3 X 8 SHCS	3153249	2	
H6	M3 LOCK WASHER	3153752	12	
H7	ENCODER MOUNT PLATE	4140079	1	
H8	M3 X 6 BHSHC	3154677	2	
H9	M3 X 10 SHCS	3153224	8	
H10	PLATE, COVER, INTENSIFIER	4388491	1	

Notes:
[1] – Part can be damaged by static discharge. Use proper electrostatic discharge (ESD) procedures.
[2] – Not orderable as a complete assembly.

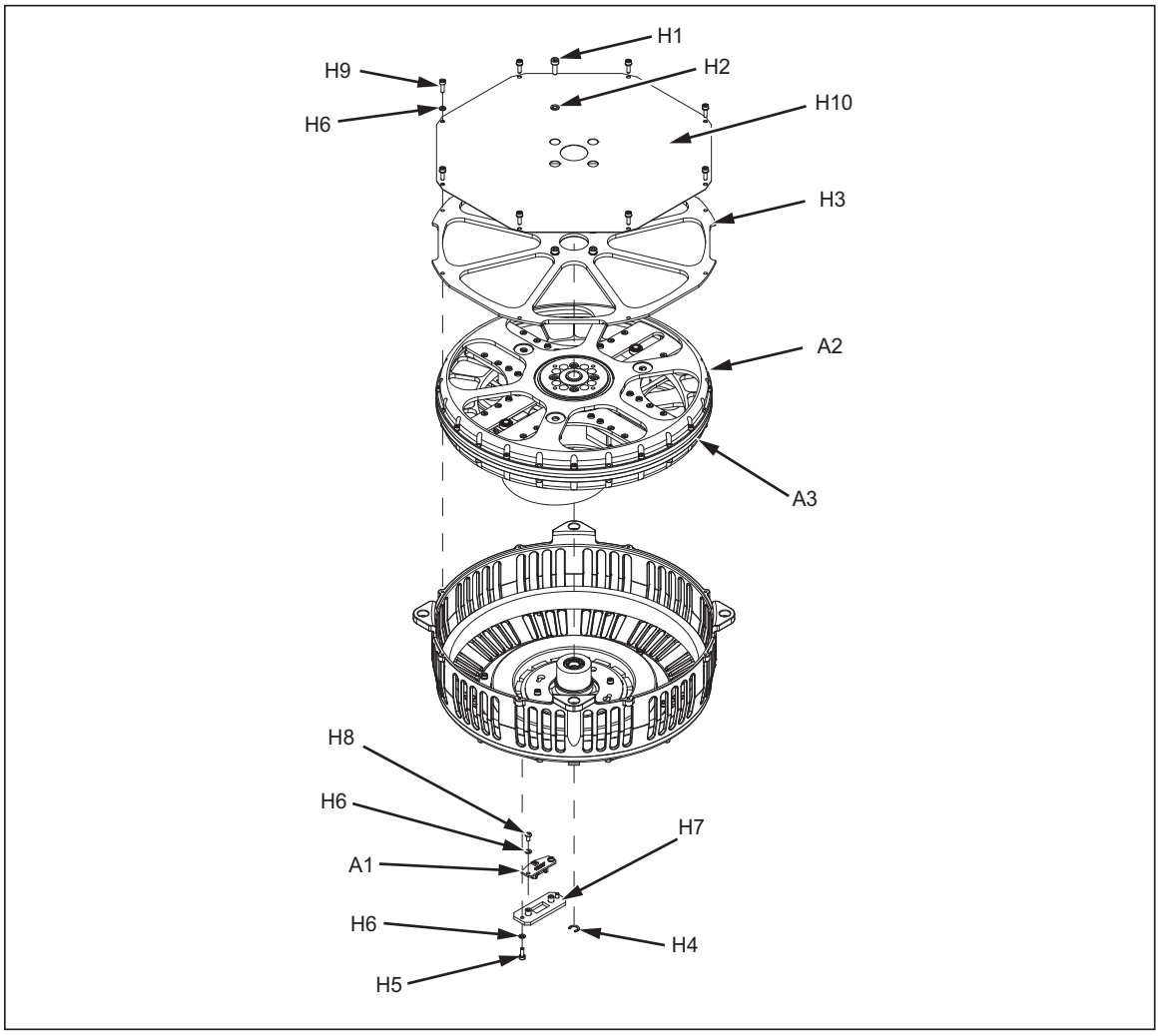

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Figure 7-13. A2 Booster Pump Assembly

Table 7-15. A2/A2 Pump Cam Assembly

Item	Description	Part Number	Quantity	Notes
A1	ICM & SHAFT ASSEMBLY	-	-	[1]
A2/A3	CAM PLATE & PLANET GEARS ASSEMBLY	-	-	[1]
H1	M3 X 10 SHCS	3153224	56	
H2	M3 LOCK WASHER	3153752	56	
H3	M4 X 12 SHCS	3153285	8	
H4	M3 X 8 FLAT HEAD	4212956	32	
H5	CAM MOUNT PLATE	4136182	1	
H6	SHAFT/BEARING HUB	4136271	2	
H7	BEARING	4212638	2	
H8	WAVE SPRING	4212645	2	
H9	PISTON GUIDE PLATE	4136259	2	
H10	PISTON GUIDE RAIL	4145987	16	
H11	CAM	4136153	1	
H12	PISTON GUIDE RAIL SPACER	4145993	8	
H13	102668-Z, WASHER, LOCK, SPLIT, STAINLESS, M4	3153914	8	

Note
[1] – Entire assembly is not orderable.

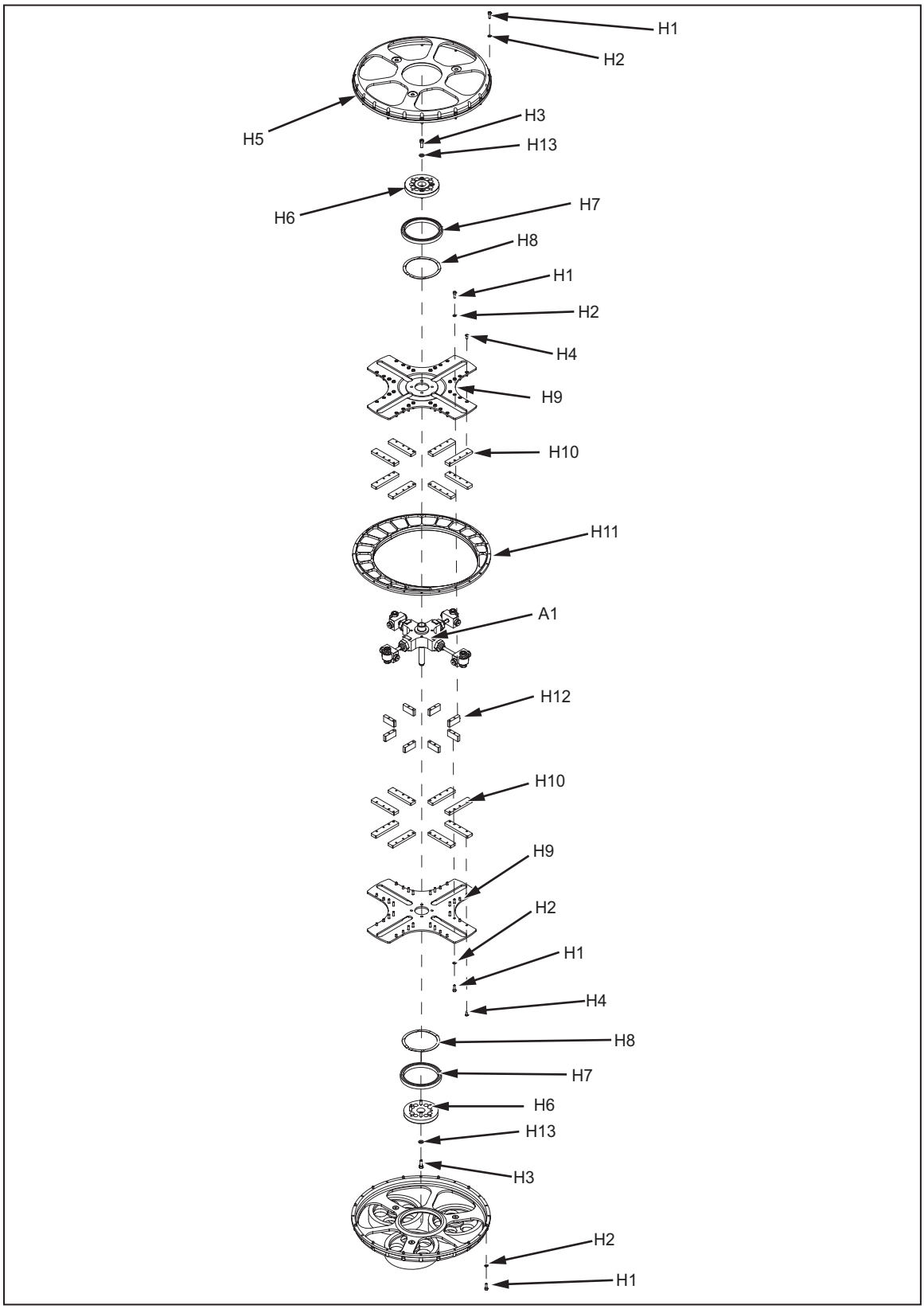

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Figure 7-14. A2/A2 Pump Cam Assembly

Table 7-16. A2/A3 Cam Plate and Planetary Gears Assembly

Item	Description	Part Number	Quantity	Notes
H1	LOW PROFILE SCREW	4212460	3	
H2	BEARING PIN	4140031	3	
H3	WAVE SPRING	4212650	3	
H4	BEARING	4212505	6	
H5	INTERNAL RETAINING RING	4216922	6	
H6	C-CLIP	4219005	3	
H7	CAM MOUNT PLATE	4136182	1	
H8	PLANET GEAR	4136846	3	

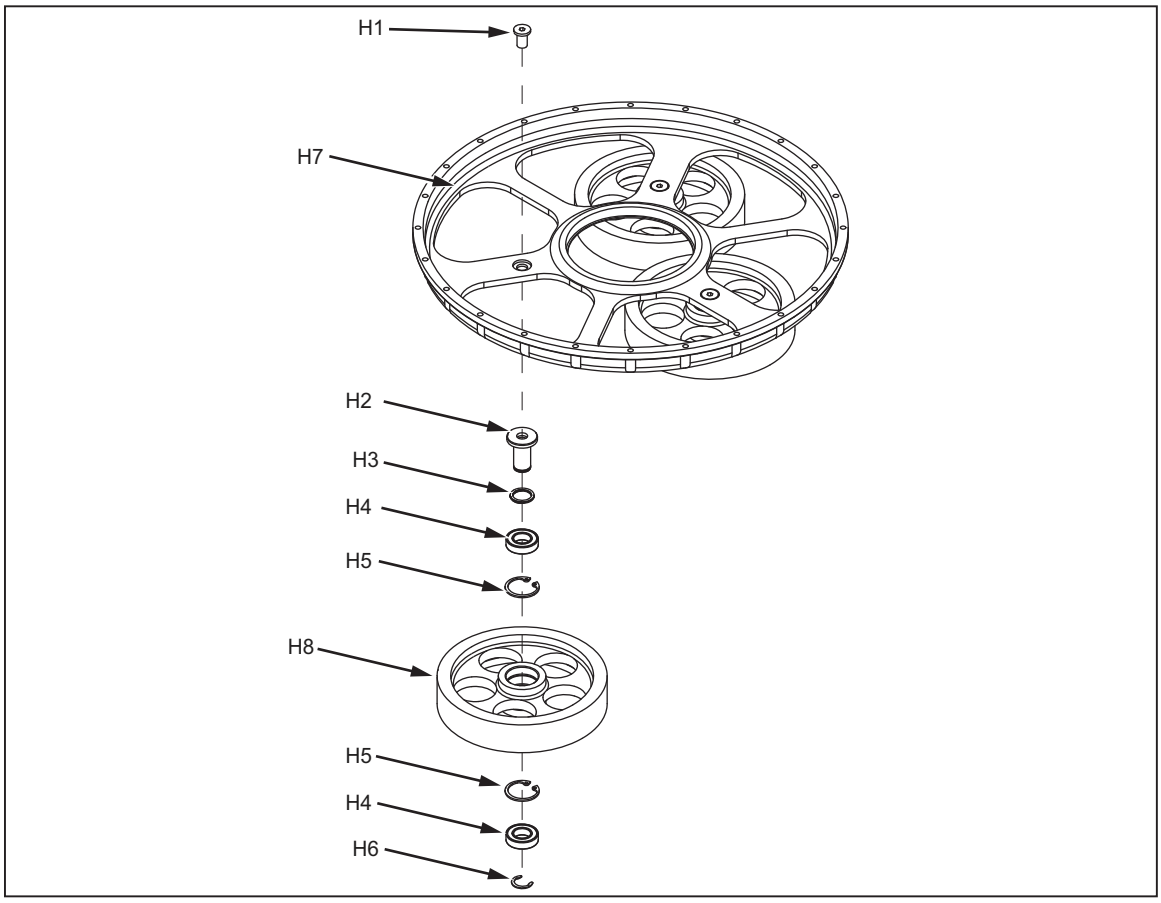

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Figure 7-15. A2/A3 Cam Plate and Planetary Gears Assembly

Table 7-17. ICM and Shaft Assembly

Item	Description	Part Number	Quantity	Note
A1	ICM ASSEMBLY	4217558	4	
A2	PISTON & CLEVIS ASSEMBLY	4217564	4	
H1	O-RING	2527053	2	
H2	PRESSURE PORT SHAFT	4136175	1	
H3	CYLINDER RETAINING NUT	4181212	4	
H4	CYLINDER HOUSING	4136244	1	
H5	O-RING,URETHANE, 3.5 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398715	4	
H6	O-RING,URETHANE, 14 MM ID X 1 MM C/S, PU90 DURO YELLOW, COMPOUND # U9001Y	4398685	4	

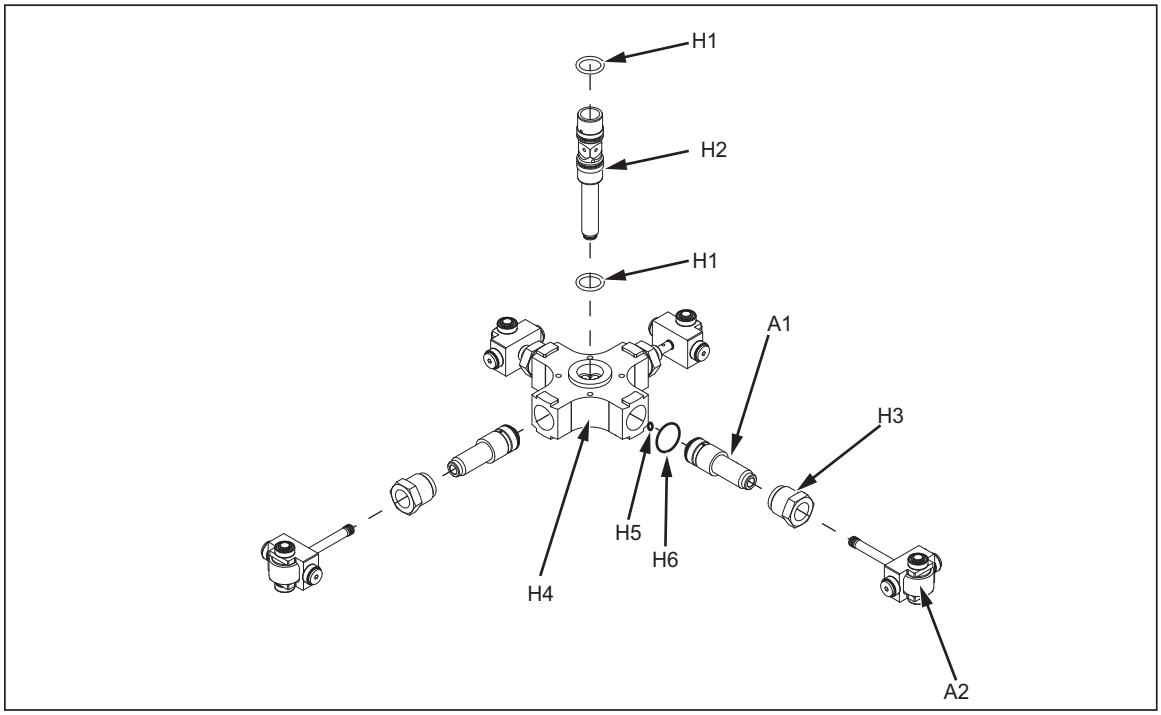

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Figure 7-16. ICM and Shaft Assembly

Table 7-18. Piston and Clevis Assembly

Item	Description	Part Number	Quantity	Note
H1	C-CLIP	3330240	2	
H2	BEARING	4212497	4	
H3	SHIM	4140101	4	
H4	PIN	4139995	1	
H5	CAM FOLLOWER	4342531	1	
H6	PISTON	4328000	1	
H7	SEAL ASSEMBLY, HIGH PRESSURE	4338494	1	
H8	SEAL RETAINER	4139988	1	
H9	SCREW, SHOULDER, EXTRA LOW HEAD, M4 X 5 MM L , 4 MM F, 303 SS	4216637	2	
H10	4322-5902, CLEVIS, GROOVED CAM, INTENSIFIER	4329463	1	

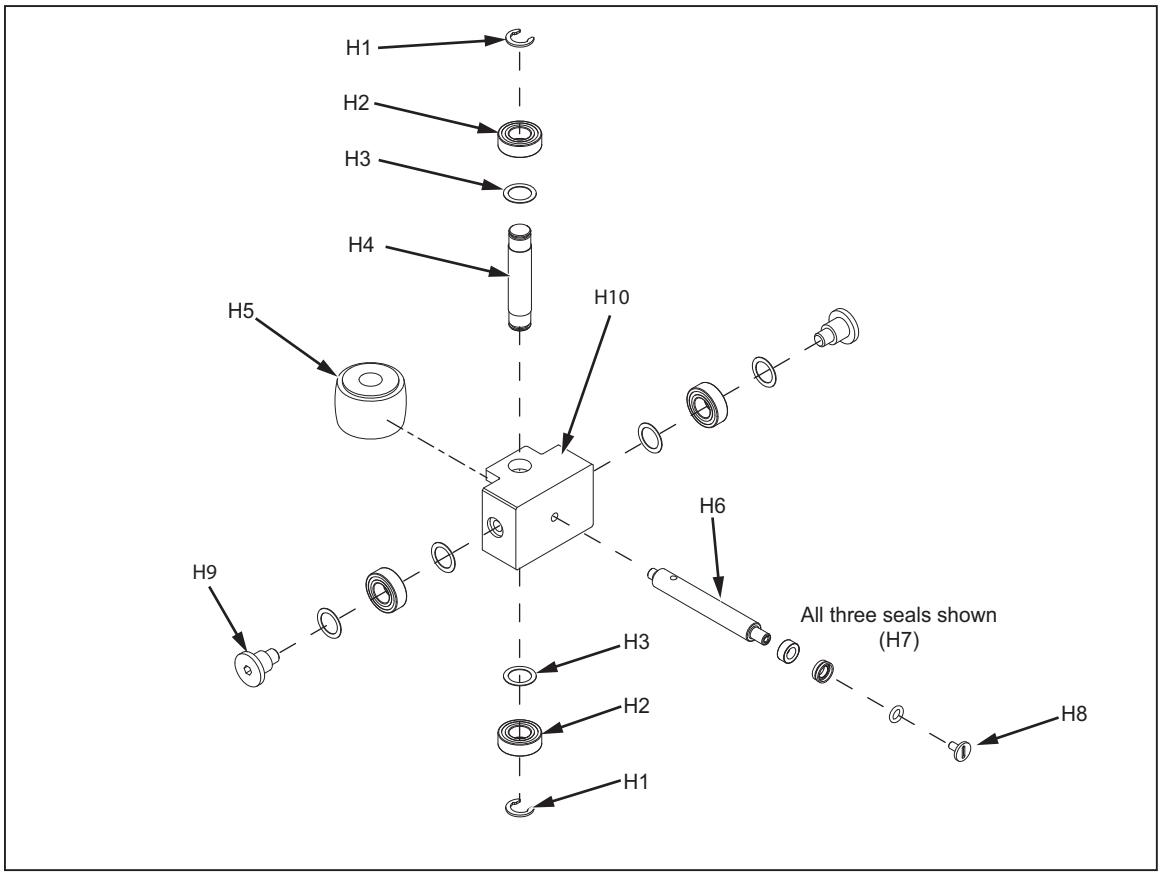

Figure 7-17. Piston and Clevis Assembly

Chapter 8
Troubleshooting

Title **Page**

Introduction

This chapter supplies troubleshooting and fault isolation information for the Controller and the Intensifier. Use the troubleshooting charts to isolate problems.

Controller Troubleshooting

Use the information in the subsequent sections to troubleshoot the Controller.

Controller Fault Codes

Code Number	Description	Action
01	IEEE port failure	1. Fault codes 01 and 02 indicates problems with the comm board pca. To clear the fault: 2. Check cable that connects to the comm pca to the main pca and try action again. 3. Turn off the Controller and disconnect and reconnect the cable connecting the comm pca to the main pca and cycle power. 4. Replace the wire that connects to the comm pca to the main pca. 5. Replace comm pca. See Chapter 4 for Controller part replacement procedures.
02	Printer interface failure	
21	Pressure transducer interface failure	Fault codes 21 through 23 indicate problems with the main pca. To clear the fault, reset from on-screen error message and try again. If the reset does not clear the fault, replace the main pca and try again. See Chapter 4 for Controller part replacement procedures.
22	Logic chip failure	
23	User data EEPROM corrupted	
31	User data memory failure	Fault codes 31 through 36 indicate problems with the microprocessor pca. If any of these faults show, there is a problem with the microprocessor pca and it must be replaced to clear the fault. See Chapter 4 for Controller part replacement procedures.
32	Time or date clock failure	
33	User data lost or corrupted	
34	System memory failure	
35	Host interface failure	
36	Internal device interface failure	

Code Number	Description	Action
41	[###] pressure transducer module not responding	Fault codes 41 through 53 indicates problems with the pressure transducer modules, the barometer modules, or the associated pca assemblies. To clear the fault: 1. Make sure the module is in the correct slot. 2. Turn off the Controller. Remove the module and put the module back into the Controller. Make sure the module is fully seated. 3. Cycle power. 4. If the fault code still shows, replace the associated pca. See Chapter 4 for Controller part replacement procedures.
42	[###]pressure transducer communication error	
43	[###] pressure transducer module calibration data corrupted	
44	[###] pressure transducer module communication CRC error	
45	[###] pressure transducer module loaded incorrectly	
46	CalCheck Error - [###] pressure transducer module	
47	[###] pressure transducer module address error	
48	[###] pressure transducer module not measuring	
49	[###] pressure transducer module element channel error	
50	[###] pressure transducer module measurement corruption	
51	[###] pressure transducer module measurement out of range	
52	Barometer module not responding	
53	Barometer module calibration data corrupted	
54	Barometer module communication data corruption	

Electrical Problems

Problem	Probable Cause	Action
The Controller does not turn on.	Not plugged in. Power not available. Fuse blown. Power module or power circuit board is bad.	Make sure the unit is plugged in and power is available. If the unit is plugged in, use the instructions in Chapter 4 to check and change the fuse. If the fuses are OK, replace the power module and power supply circuit assembly. See Chapter 4 for Controller part replacement procedures.
The Controller turns on but then restarts itself non-stop.	Power supply failing. Microprocessor PCB failure. Main PCB failure.	Replace power supply, microprocessor PCB, or main PCB.
Display does not turn on but emits the typical 3 beeps when powered up.	LCD backlight cable failure. LCD display flat cable failure. LCD module failure.	Reseat LCD backlight cable. Replace LCD backlight cable. Reseat LCD flat cable. Replace LCD flat cable. Replace LCD module.

Pressure Generation and Indication Problems

Problem	Probable Cause	Action
Controller cannot reach the target pressure.	No supply. Test port or UUT leaking/open. Supply tube plugged. Internal leak.	• Check the supply pressure to make sure supply pressure is available. • Check for leaks around the QC fittings and make sure the hose is not plugged. • If the internal pump is being used and pressure is not reaching the setpoint, the pump seals may be worn and need replacing. Use the instructions in the Service Manual to perform a pump check.
Controller does not hold pressure at the target pressure.	Test port or UUT leaking/open. Valves require service.	
Pressure does not build when internal motor is selected.	Test port or UUT leaking/open. Internal Leak. Pump requires service.	

CPS and Quick-Connect Problems

Problem	Probable Cause	Action
Cannot remove the CPS from the Controller.	System is pressurized. Dock interlock not working correctly.	Vent pressure. Once the CPS is removed, clean or repair the interlock.
Cannot connect the hose to the QC fitting.	Wrong fitting. The QC fitting is worn.	Vent pressure. Once the QC is removed, clean or repair the QC fitting.
QC has a leak.	Seal is damaged or is not fully tightened.	Replace seal. See the Service Manual for instructions.

Intensifier Troubleshooting

Use the information in the subsequent sections to troubleshoot the Intensifier.

⚠ Warning – Finger Amputation Hazard

To prevent personal injury, do not connect power or operate the Intensifier while servicing Intensifier outside its case. The rotating parts in the booster pump assembly move with extremely high torque and can start unexpectedly if power is connected.

Electrical Problems

Problem	Probable Cause	Action
The Intensifier does not turn on.	Not plugged in. Power not available. Fuse blown. Power module or power circuit board is bad.	Make sure the unit is plugged in and power is available. If the unit is plugged in, use the instructions in chapter 4 to check and change the fuse. If the fuses are OK, replace the power module and power supply circuit assembly. See Chapter 5 for Intensifier part replacement procedures.

Pressure Selection and LED Indications

Problem	Probable Cause	Action
STOP key LED flashing slow.	Supply pressure is below 500 psi.	Increase supply pressure to 500 psi or more. Push STOP to clear the error.
When pressure selection is made, green LED illuminates next to the pressure selection and immediately extinguishes. Then fast flashing red LED next to the STOP key.	Target pressure key pushed with the supply pressure below 500 psi.	Increase supply pressure to 500 psi or more. Push STOP to clear the error.
1,000 key LED flashing	Motor error. The max current was exceeded, possible phase error, other motor controller error.	Double check all motor cables and connections and/or clean the encoder disk surface with a lint free cloth.
2,000 key LED flashing	Invalid value in calibration sequence. The calibration was not updated.	Repeat the adjustment process.
No Intensifier reaction when front-panel key is pushed.	Button, keypad, or front panel ribbon cable is disconnected or damaged.	Make other selections. If other selection works, single key is bad. Replace the keypad. See Chapter 5 for Intensifier part replacement procedures.

Abnormal Noises

Problem	Probable Cause	Action
Grinding sound when the motor is turning.	Possible loose or detached bolt in the pump cam assembly.	Immediately push STOP and turn off the unit. Use the procedures in Chapter 5 to remove the chassis from the case and inspect for loose hardware.
Hissing sound when unit is off.	Vent valve may be open. Possible leak in the quick-connect fitting. Possible worn seal in the Main Pressure Shaft. Possible leak in an internal pressure supply line.	Close Vent valve. If sound persists, close Isolation valve. If sound stops then check tubing and outlet QC. If sound persists then replace pressure port and piston seals.
Loud, periodic pressure relief sound (“blow by”) when the motor is turning accompanied by slower pressure generation.	Possible worn or damaged piston seal.	Use the instructions in Chapter 5 to replace the piston seals on all four pistons.
Loud internal pressure relief sound before 10,000 psi accompanied by a rapid pressure decrease.	The internal pressure relief valve is discharging prematurely.	Use the instructions in Chapter 5 to replace the valve.

Pressure Generation and Indication Problems

Problem	Probable Cause	Action
Pressure generation is slow but **does** build to pressure selection.	Possible worn piston seals.	If generation takes more than 4 minutes to reach set pressure or if pressure generation is erratic (above and below set pressure) then replace seals.
Pressure generation is slow and **does not** build to pressure selection.	Worn piston seals.	Replace piston seals.
Pressure gauge shows spikes in pressure generation.	Possible worn springs in ICM or worn piston seal.	If spikes are excessive (above and below set pressure) then replace piston seals.
Pressure gauge does not match selection after motor stops and keeps pressure stable.	Gauge can be inaccurate. Pressure sensor needs to be calibrated.	When pressure is stable gauge should read pressure 5 % to 8% above set pressure. If this amount is more than 10 % off or if generated pressure is below set pressure, realign the pressure sensor.

Valves and Quick-Connect Problems

Problem	Probable Cause	Action
Cannot fully close or open the isolation or vent valve.	Valve is damaged.	Use the Vent or Isolation Valve replacement instructions in Chapter 5 to replace the part.
Cannot connect the hose to the Quick-Connect fitting.	Wrong fitting. The QC fitting is damaged.	Try another hose end to connect to the quick-connect fitting. If this also cannot be connected and if the plug is not in the quick connect, then the quick-connect fitting is damage and must be replaced. See Chapter 5.
QC has a leak.	Fitting is not inserted correctly. Seal is damaged.	A leak in the quick connect should be checked with a plug in the quick connect to rule out the hose connection. If the quick connect has a leak it must be rebuilt with new seals.
Cannot disconnect hose from QC.	There is pressure in the hose	Turn off Nitrogen Cylinder regulator and vent hose.

Chapter 9
Wiring Schematics

Title **Page**

Introduction

This chapter supplies wire and connector schematics for the Controller and Intensifier.

Controller Wiring Schematics

Figure 9-1 shows the part numbers of wiring harnesses in the Controller. Figures 9-2, 9-3, and 9-4 show each harness along with wire colors and connector pins.

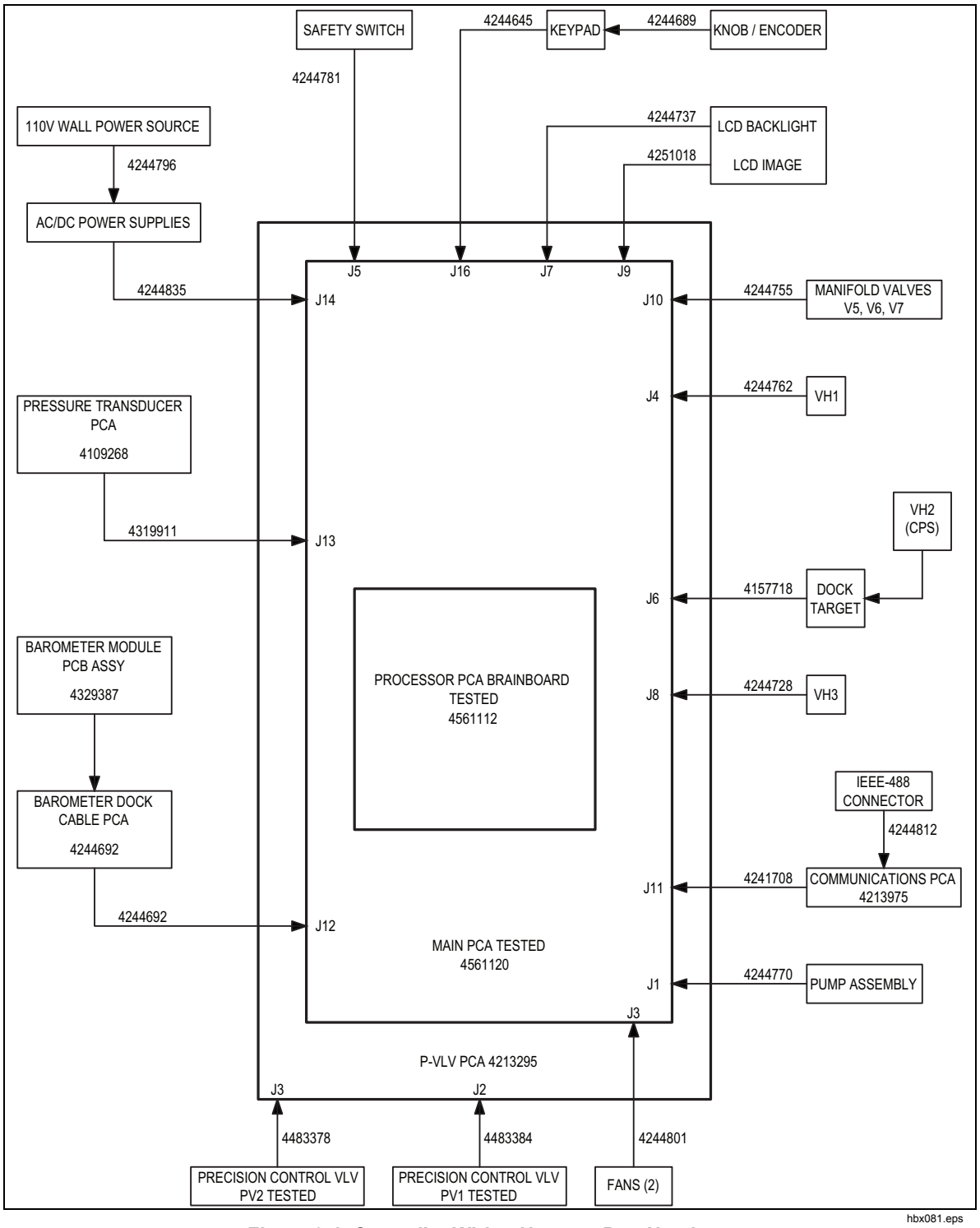

Figure 9-1. Controller Wiring Harness Part Numbers

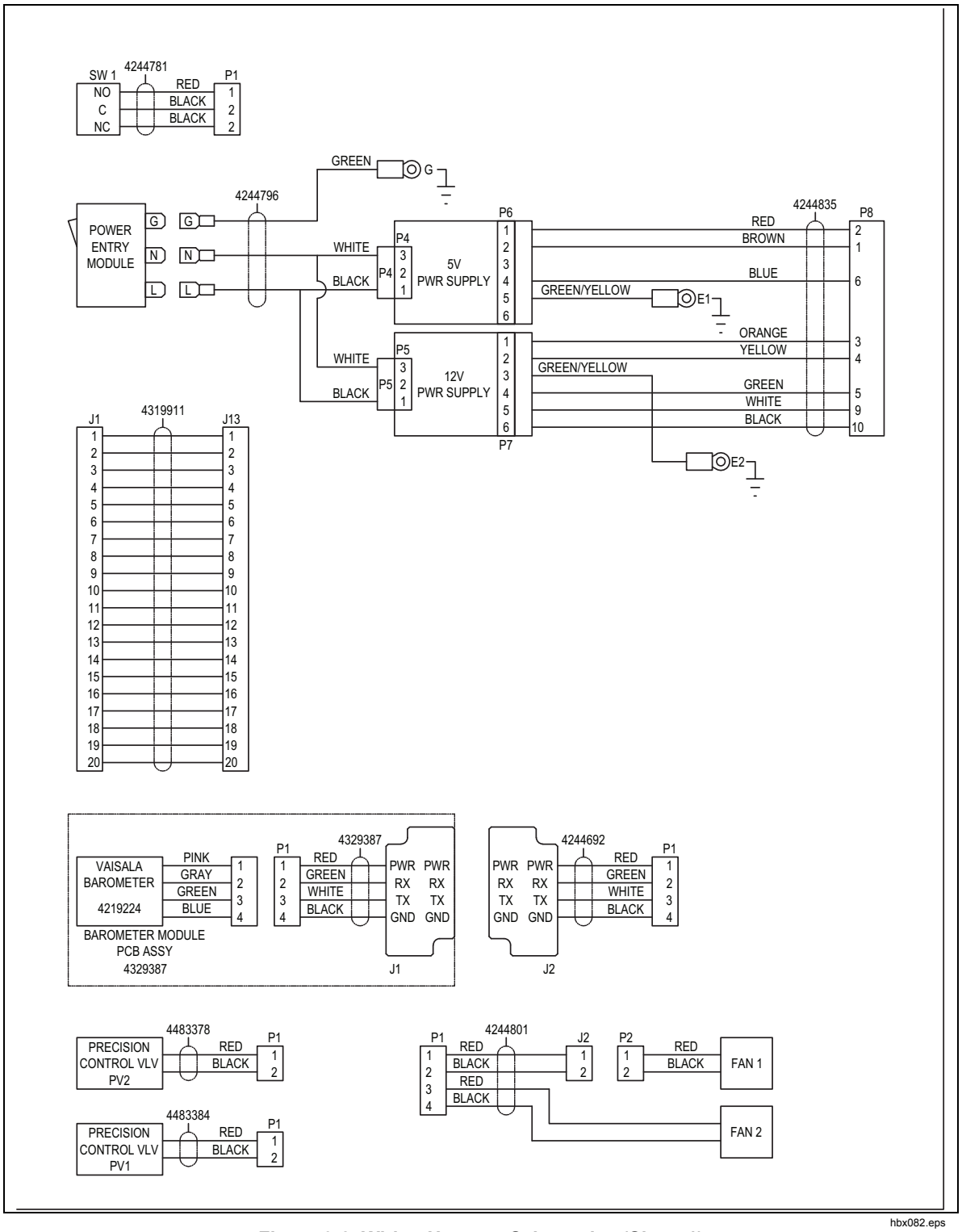

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Figure 9-2. Wiring Harness Schematics (Sheet 1)

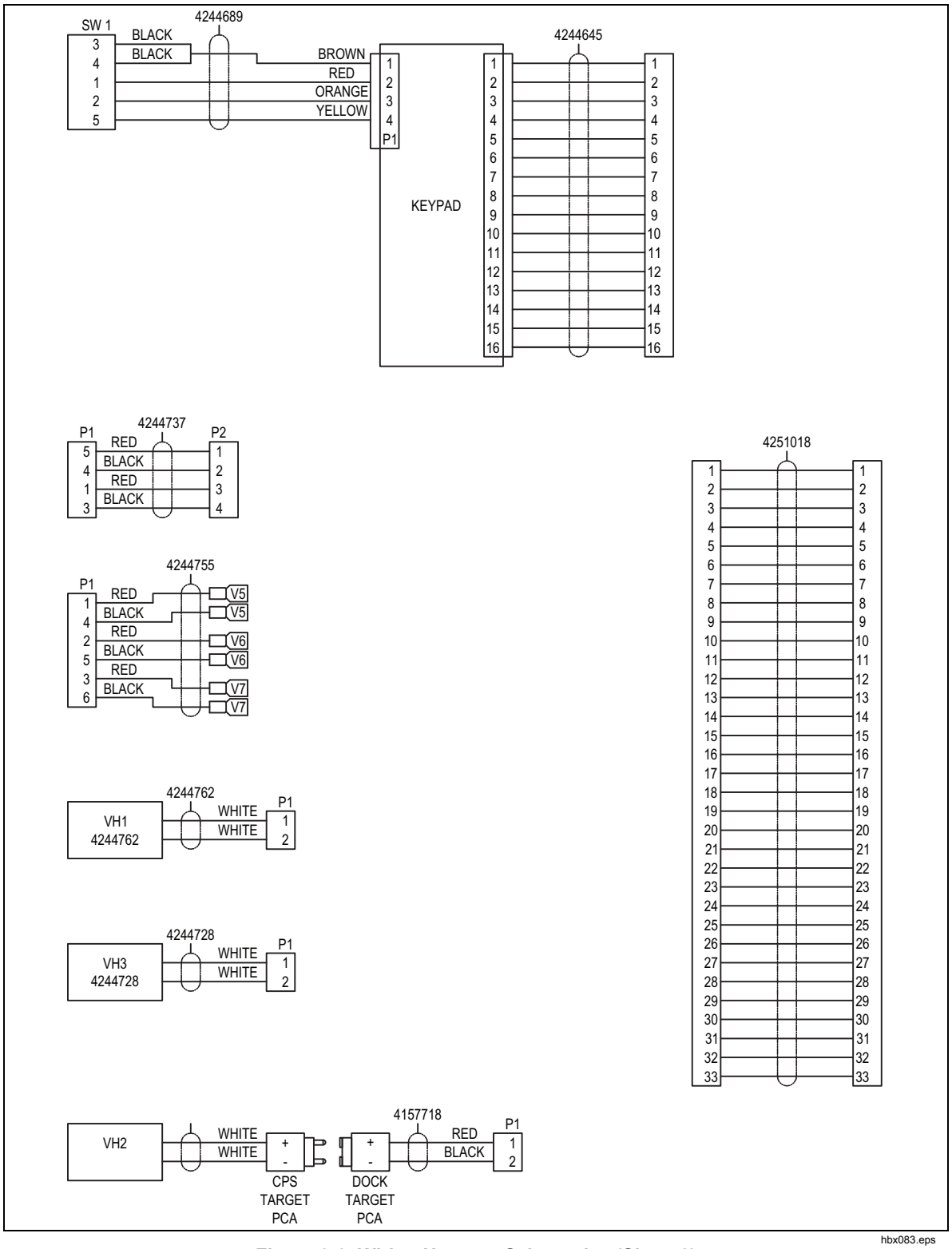

Figure 9-3. Wiring Harness Schematics (Sheet 2)

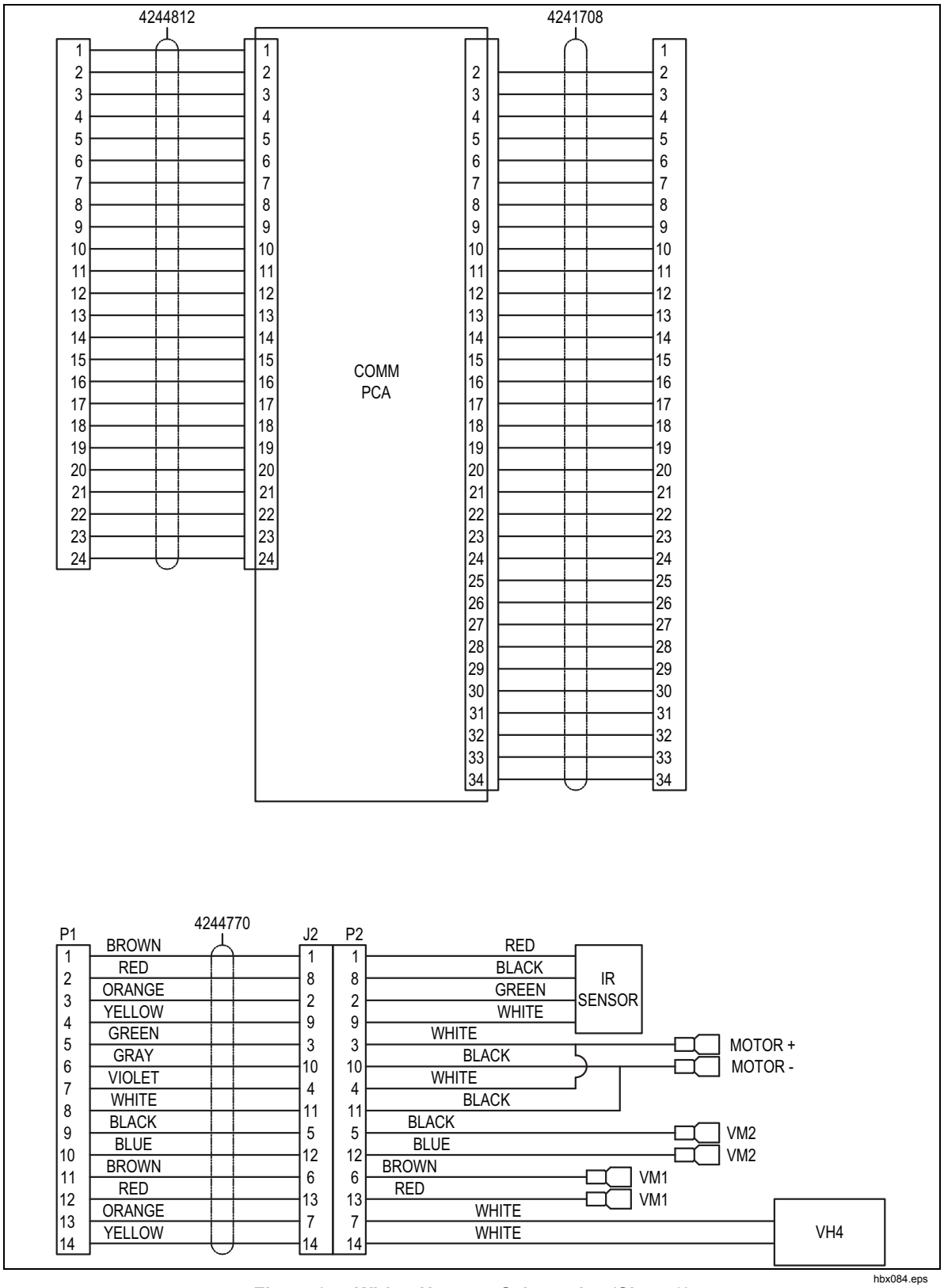

Figure 9-4. Wiring Harness Schematics (Sheet 3)

Intensifier Wiring Schematics

Figure 9-5 shows the internal wiring and connector pins for the Intensifier.

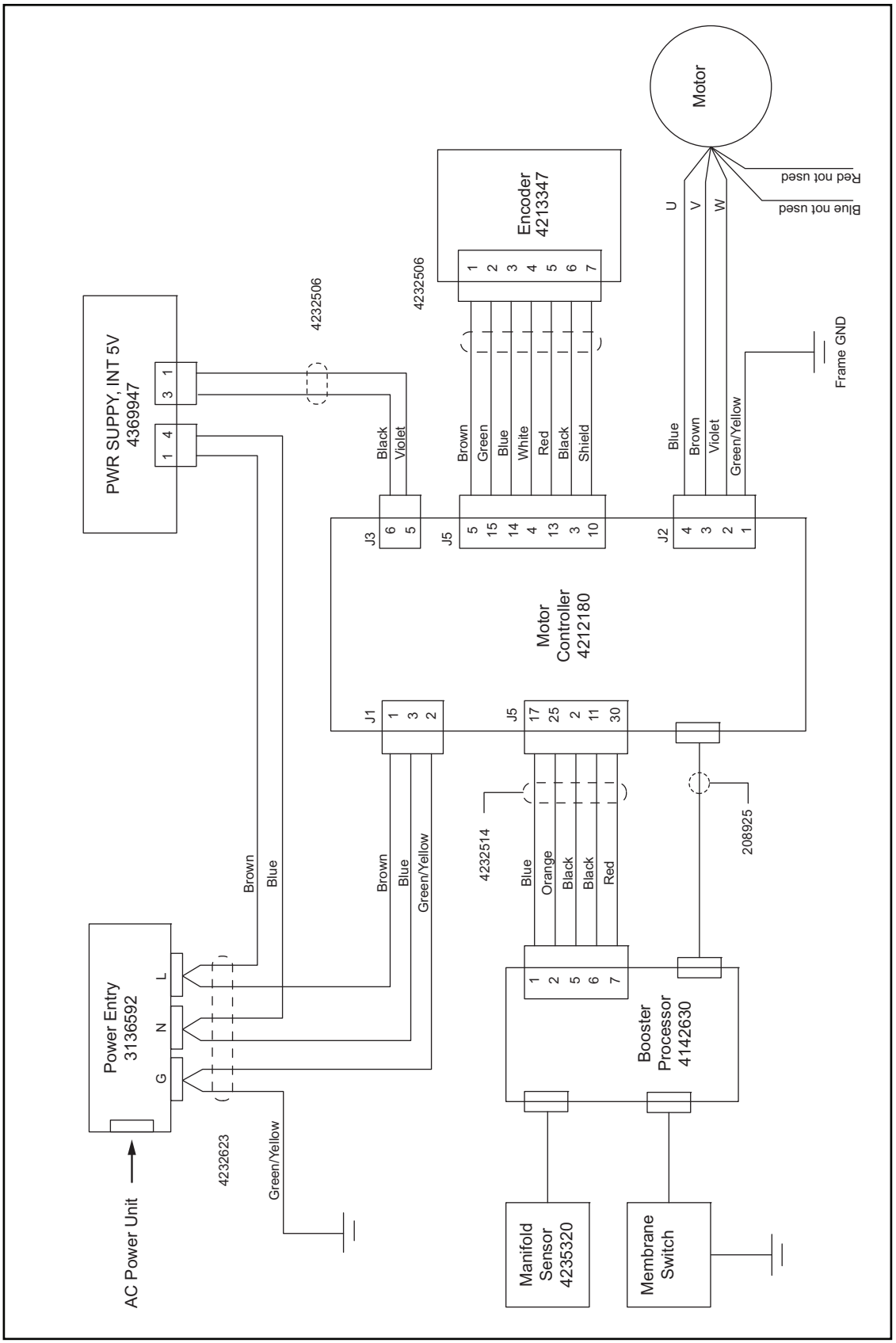

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Figure 9-5. Intensifier Wiring Diagram