

# SkoFlo Actuator and Optional Positive Displacement Flow Meter

SF3 Actuator



Operations and  
Maintenance Manual

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**Note:** This document shall remain in accordance with the current revision of Certification-Controlling document DOC-03913. Confirm alignment during document revision.

## ABOUT SKOFLO

Our experience and track record speak for themselves. SkoFlo has delivered over 20,000 valves since 1988. We are the only company that proves our products by testing in surface applications before deploying them subsea. The result is that SkoFlo products have amassed over 25 million continuous operating hours. This level of experience is unparalleled and provides the basis for being the solution provider to our served market.

## REFERENCE DOCUMENTS

Detailed information on how to configure, calibrate, and operate the SkoFlo Actuator and Optional PDFM using the front panel display and buttons can be found in the SkoFlo document *SkoFlo Actuator User Guide for Modbus Application Firmware Version x.x* (where *x.x* is the version of the Surface PDFM Application firmware). Please contact SkoFlo to request the appropriate user guide for the version of Application firmware running on your SkoFlo Actuator.

The Firmware version can be found on the information screen that appears for a few seconds when the SF3 is powered on.

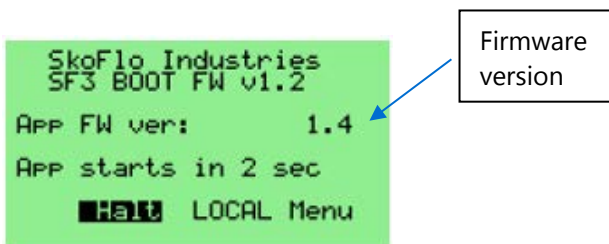


Figure 1 – Information Screen

## GENERAL INFORMATION

### Product Overview

The SkoFlo Surface Actuator can be paired with various SkoFlo valves to provide autonomous adjustment. The unit can be controlled remotely or locally via the controls on the front of the device. When paired with a suitable measurement device (SkoFlo PDFM, 3rd party flowmeter, or pressure transducer) the actuator can automatically readjust the valve to maintain the desired set point.

### Guidelines for Using this Manual


The following instructions are provided to ensure safe and proper installation and operation.

- Read all instructions prior to installation and operation of this product.
- Follow all warning and caution notes.
- Install this product as specified in the instructions provided by SkoFlo.
- Prior to use, educate personnel in the proper installation, operation, and maintenance of this product.
- Only use replacement parts specified by SkoFlo.

### Warning, Caution, Notice


Throughout this manual there are steps and procedures which, if not followed, may result in a hazard. The following flags are used to identify the level of potential hazard.

**! WARNING**




WARNING IS USED TO INDICATE THE PRESENCE OF A HAZARD WHICH CAN CAUSE SEVERE INJURY, DEATH, OR SUBSTANTIAL PROPERTY DAMAGE IF THE WARNING IS IGNORED.

**! CAUTION**



CAUTION IS USED TO INDICATE THE PRESENCE OF A HAZARD WHICH CAN CAUSE INJURY OR PROPERTY DAMAGE IF THE WARNING IS IGNORED.

**! NOTICE**



NOTICE IS USED TO NOTIFY PEOPLE OF INSTALLATION, OPERATION, OR MAINTENANCE INFORMATION, WHICH IS IMPORTANT BUT NOT HAZARD RELATED.

### Abbreviations and Acronyms

PDFM	Positive Displacement Flow Meter
LVDT	Linear Variable Differential Transformer
NEC	National Electrical Code
CEC	Canadian Electrical Code
ATEX	ATmosphères EXplosibles
IECEX	International Electrotechnical Commission Explosive
SS	Stainless Steel
BOM	Bill Of Materials
psi	Pounds per square inch

- GPD Gallon (US) per Day
- LPH Liters per Hour
- mm Millimeters
- SHCS Socket Head Cap Screw
- AFM Autonomous Flow Measurement
- CSR Continuous Setpoint Regulation
- ZFS Zero-Flow Shutdown
- PCB Assembly Power and Communication PCB Assembly

## PRODUCT APPROVALS

**! WARNING**

FLAMEPROOF JOINTS ARE NOT INTENDED TO BE REPAIRED  
*LES JOINTS INFLAMMABLES NE SONT PAS DESTINÉS À ÊTRE RÉPARÉS*

**! WARNING**

THE USER IS REQUIRED TO SELECT AND INSTALL APPROPRIATE CABLE GLANDS, THREAD ADAPTORS OR CONDUIT CONNECTIONS THAT MEET ALL LOCAL CODES AND HAZARDOUS LOCATION REQUIREMENTS  
*L'UTILISATEUR DOIT CHOISIR ET INSTALLER DES GLANDES DE CÂBLES APPROPRIÉES, DES ADAPTATEURS DE FILETAGE OU DES CONNEXIONS DE CONDUITS QUI RÉPONDENT À TOUS LES CODES LOCAUX ET AUX EXIGENCES DE LOCALISATION DANGEREUSE*

**! WARNING**

DISCONNECT THE EQUIPMENT FROM THE SUPPLY CIRCUIT BEFORE OPENING. KEEP ASSEMBLY TIGHTLY CLOSED WHEN IN OPERATION.  
*DÉBRANCHEZ L'ÉQUIPEMENT DU CIRCUIT D'ALIMENTATION AVANT D'OUVRIER. GARDER L'ASSEMBLAGE FERMÉ EN FONCTIONNEMENT.*

**! WARNING**

THE USER IS REQUIRED TO ENSURE THE ELECTRICAL CONNECTION MEETS ALL RELEVANT NEC AND CEC REQUIREMENTS AND ANY OTHER LOCAL CODES  
*L'UTILISATEUR DOIT S'ASSURER QUE LA CONNEXION ÉLECTRIQUE CONFORME À TOUTES LES EXIGENCES NEC ET CEC PERTINENTES ET À TOUT AUTRE CODES LOCAUX.*

**! WARNING**

TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, CONDUIT RUNS MUST HAVE A SEALING FITTING CONNECTED WITHIN 18 INCHES (NEC) OR 50mm (CEC) OF THE ENCLOSURE  
*POUR RÉDUIRE LE RISQUE D'IGNITION D'ATMOSPHÈRES DANGEREUSES, LES RUNS DE CONDUIT DOIVENT ÊTRE MUNIS D'UN RACCORD DE RACCORDEMENT RACCORDÉ À 18 POUÇES (NEC) OU À 50mm (CEC) DE L'ENVELOPPE*

## 1. Model Number Guide

Table 1 – Actuator Model Number Guide

VOLTAGE CODE	VOLTAGE	CONDUIT CODE	CONDUIT SIZE	PDFM CODE	PDFM TYPE
AC	120-240 VAC	M	M20	P10	10,000 psi
DC	24 VDC	N	1/2" NPT	P5	5,000 psi
				00	NONE

31256	-	XX	-	X	-	X	-	XX	-	XX	-	XX	
				M	MODBUS			S5	5:1			S5	STAINLESS STEEL
				H	HART			D9	9:1			S2	SUPER DUPLEX
				PROTOCOL CODE	COM. PROTOCOL			D15	15:1			MATERIAL CODE	FASTENER MATERIAL
								GEAR CODE	GEAR MODULE				

## 2. Enclosure Ratings

ATEX & IECEx: II 2 G Ex db IIB T6 Gb, -40°C < Ta < +59°C

ATEX Certificate Number: ITS-I21ATEX28968X

IECEx Certificate Number: IECEx ETL 20.0046X

NEC & CEC: CLASS I, DIVISION 1, GROUP C, T6, -40°C < Ta < +59°C

Conforms to: UL STD 1203 & 61010-1

Certified to: CSA STD C22.2 #30 & 61010-1

Ingress Protection: IP66 / NEMA 4X



## HYDRAULIC INFORMATION

**! WARNING**

REFER TO THE PRODUCT DATASHEET FOR DESIGN PRESSURE DETAILS.

PDFM Flow Range: 0.2 to 1,200 GPD (0.03 to 189 LPH)

Max Fluid Temperature: 59°C (138°F)

PDFM Process Connections:

- 5,000 psi: 1/4" NPT
- 10,000 psi: 3/8" MP Autoclave

## ELECTRICAL INFORMATION

### ! WARNING



REFER TO THE ELECTRICAL SECTION OF THE PRODUCT DATASHEET FOR ELECTRICAL DETAILS.

Supply Voltage Options:

- 120 – 240 VAC / 50 – 60Hz
- 24 ±4 VDC

Max Power Consumption: 80W

Max Grounding Capacity: 10 Gauge (5.3mm)

Operating Temperature: -20°C to +59°C (-4°F to +138°F)

HART Analog Output:

- 4 – 20 mA
- 4 mA multidrop current

Analog Output:

- 4 – 20 mA
- 0 – 20 mA
- 0 – 24 mA
- 0 – 5 V
- 0 – 10 V
- ± 5 V
- ± 10 V

Pressure Sensor Input:

- 4 – 20 mA
- 24 VDC Supply

Conduit Entry Details: 4X ½"-14 NPT or M20 x 1.5

## FASTENER INFORMATION

The actuator enclosure fasteners shall be torqued to the following values:

- Cover Fasteners: 125 in.lbf [14.1 Nm]
- PDFM/Blanking Plate Fasteners: 65 in.lbf [7.3 Nm]
- Window Fasteners: 25 in.lbf [2.8 Nm]
- Gearbox Fasteners: 65 in.lbf [7.3 Nm]

Table 2 – Fastener Details

Description	Thread	Length	Material	Min Material Yield Strength
Cover Fasteners	M8x1.25 – 6g	20 mm OR 21 mm	A2 SS OR A4 SS OR Super Duplex	206 MPa
PDFM/Blanking Plate Fasteners	M6x1 – 6g	20 mm	316 SS	206 MPa
Window Fasteners	M4-0.7 – 6g	8 mm	316 SS	206 MPa
Single Gearbox Fasteners	M8x1.25 – 6g	45 mm	18-8 SS OR	206 MPa
Dual Gearbox Fasteners	M8x1.25 – 6g	60 mm	18-8 SS	206 MPa

## STORAGE AND HANDLING

### ! NOTICE



IT IS RECOMMENDED TO STORE THE ASSEMBLY IN THE SHIPPING CRATE, IF POSSIBLE.

The SF3 actuator should be lifted via the top handle or the two eye bolts located on the back of the enclosure.

### ! NOTICE



DO NOT LIFT THE UNIT VIA THE PIPED CONNECTION BETWEEN THE PDFM AND VALVE. THIS MAY DAMAGE THE UNIT AND CAUSE THE CONNECTION TO LEAK.

The SF3 actuator should be stored in a shelter and be protected from moisture and particulates. Storage temperatures shall be between -20°C and 70°C (-4°F and 158°F).

Any open hydraulic and electrical connections will be furnished with plastic blanking plugs.

It is important not to store production chemicals in the unit. These chemicals can settle, possibly resulting in damage to the unit. SkoFlo recommends that the unit be stored with a mixture of glycol and water as the preservation fluid.

## INSTALLATION

### ! WARNING



CHEMICAL COMPATIBILITY SHALL BE DONE AND CHECKED BEFORE USE, EXCEPT FOR MEG WATER MIXTURE.

Required tools:

- 6mm Allen wrench
- 5mm Allen wrench
- 4mm Allen wrench
- Flat head terminal screwdriver
- Torx T15 screwdriver

### 3. Mounting

The SF3 actuator is designed to be panel mounted, via the four M6 clearance holes located in the electronics enclosure. Figure 2 details the panel mounting hole positions and cutout.

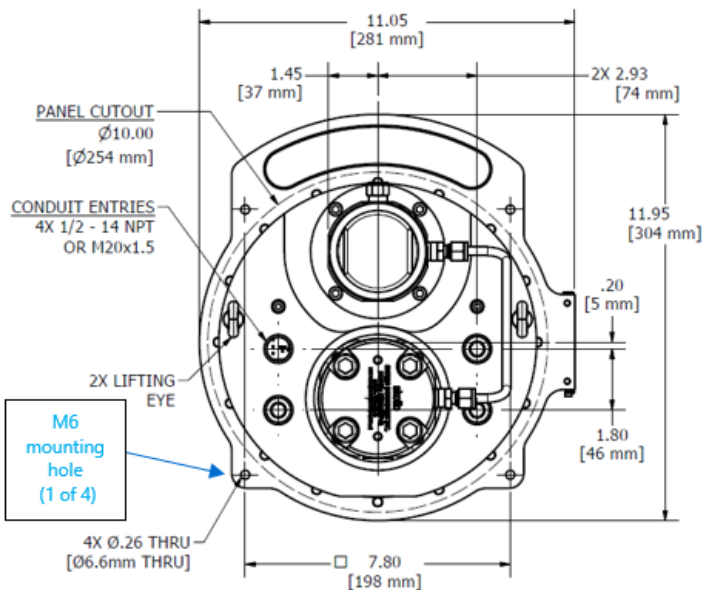


Figure 2 - Panel Mounting Hole Positions and Cutout

### 4. Hydraulic Installation

Refer to the relevant valve O&M Manual for more information on commissioning.

Install the unit so that the flow is in the proper direction. The "IN" connection and "OUT" connections are marked respectively.

The orientation of the valve can be adjusted in 90-degree increments. See Section 10 for more details on removing and replacing the valve.

The PDFM (where applicable) has two "OUT" connections. One will be connected to the valve, the other can be used to supply pressure to an optional pressure sensor.

An inline filter should be installed upstream of the unit. Clean chemicals and proper filtering are very important. For filter recommendations, refer to the operations and maintenance manual for your SkoFlo valve.

A check valve shall be installed immediately downstream of the unit to prevent reverse flow and well fluids entering the device.

### ! NOTICE



BEFORE WIRING, CHECK THAT THE SUPPLY VOLTAGE MATCHES WHAT IS ENGRAVED ON THE NAMEPLATE. ALL WIRING SHOULD BE DONE IN ACCORDANCE WITH PREVAILING CODES BY QUALIFIED PERSONNEL.

### 5. Electrical Installation

To open the electronics enclosure, unscrew the sixteen M8 captive fasteners in the cover. The cover is hinged to the enclosure base.

### ! NOTICE



THERE IS A WIRED CONNECTION BETWEEN THE ELECTRONICS ENCLOSURE COVER AND BASE. DETACH THE ELECTRICAL RIBBON CONNECTOR FROM THE PCB BEFORE REMOVING THE COVER.

There are multiple conduit entries located in the electronics enclosure base. They are for power, communication, and input from optional pressure sensors and/or flow meters. Select the most appropriate entry for each application.

### ! NOTICE



THE USER IS RESPONSIBLE FOR PREVENTING INGRESS VIA ANY CABLE GLANDS, THREADED ADAPTORS OR CONDUIT CONNECTIONS THEY MAY INSTALL.

The PCB Assembly can be removed to aid assembly, if preferred:

- 5.1 Disconnect the ribbon connection to the display board – spread the connector tabs



to release the ribbon.

- 5.2 Disconnect the wired connections to the Drive and Motor Encoders – both are connected via plugs on the front of the PCB Assembly. Press the tabs and pull to release.
- 5.3 First noting the locations, disconnect the PDFM wires – *Flat head terminal screwdriver*.
- 5.4 First noting the locations, disconnect the motor wires – *Flat head terminal screwdriver*.
- 5.5 Unscrew the 5 captive fasteners – *Torx T15 terminal screwdriver*.
- 5.6 Remove the PCB Assembly to expose the conduit entries.
- 5.7 To replace the PCB Assembly, work backwards through the previous steps. Each of the motor and PDFM wires should have a tag that corresponds to a PCB label.

The unit is purchased either in an AC configuration or a DC configuration. On the printed circuit board below the power connection, the white check box next the word AC or DC will be checked specifying the configuration. Use the table printed on the printed circuit board to determine how to connect the wires to the PWR connections.

### 6. Communications Interface

The Modbus interface uses a TIA/EIA-485 2 wire interface. If an external termination resistor is not used, the SF3 has a 120-ohm termination resistor built in that is configurable via a DIP switch on board, as shown in Figure 3. Move SW1 Pos 1 to ON to enable the resistor. This should be done on the last device in the chain.



Figure 3 - PCB Assembly Modbus Termination

The HART interface uses the Analog Output 'IOUT' and 'GND\_ISO' connections for the HART Terminals. The unit can be configured to control the current in the HART loop, or it

can be configured for a multi-drop network with a 4 mA loop current.

Figure 4 details the user connections for the PCB Assembly. Larger versions of all the electronics images can be found in Appendix A – Wiring Diagrams, as well as a diagram detailing how to connect multiple units.

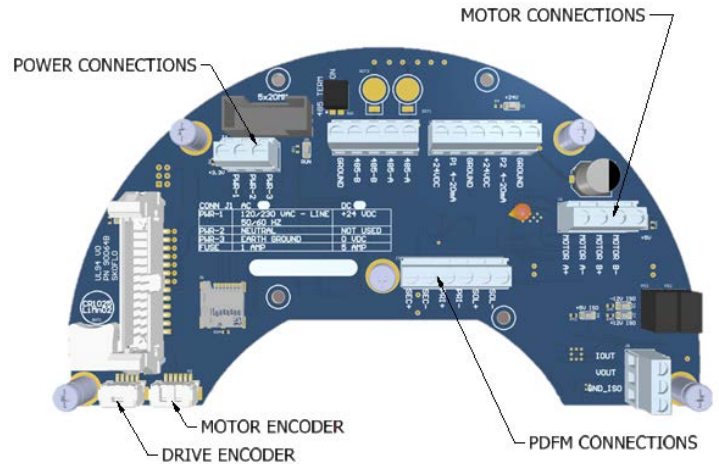


Figure 4 - PCB Assembly Connections

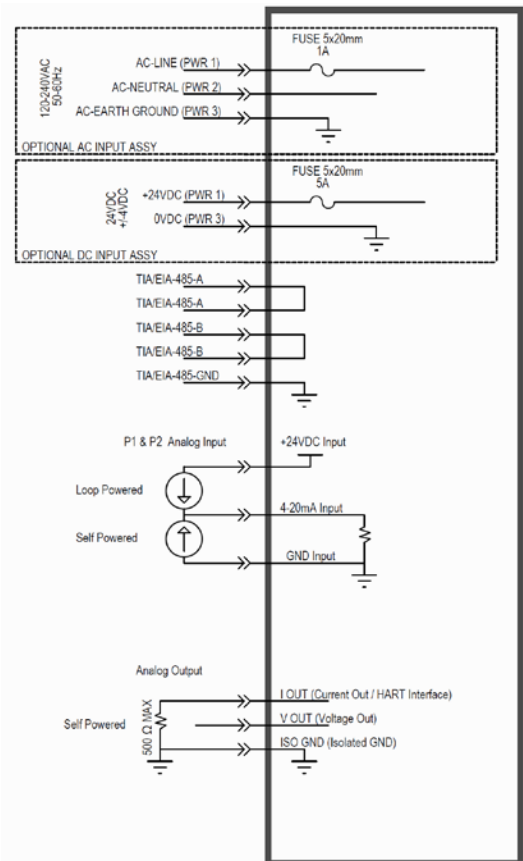
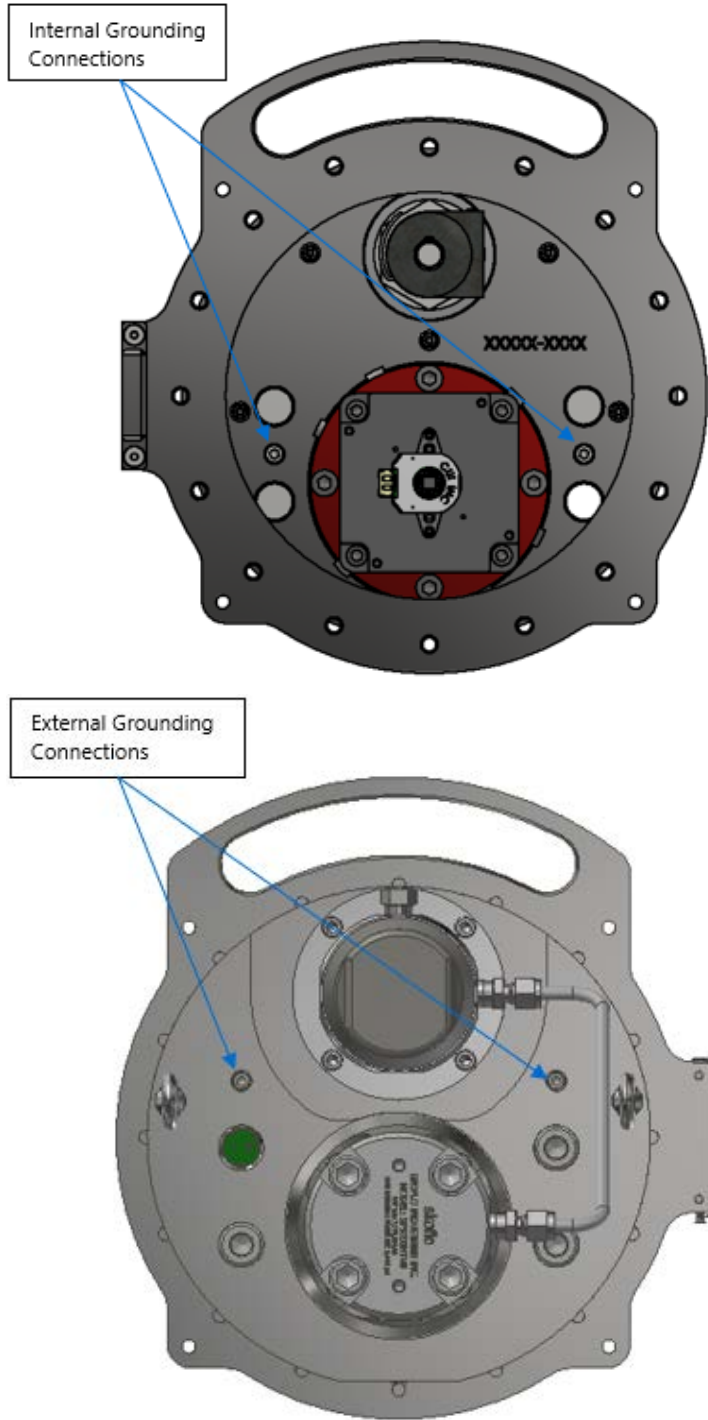


Figure 5 – SF3 Wiring Diagram

The unit has two internal grounding connections inside the enclosure base and two supplementary connections on the exterior of the base. Figure 6 details the locations of the various grounding connections.



**Figure 6 – Locations of Grounding Connections**

Once all the necessary electrical connections are made, close the cover and torque the sixteen cover fasteners to 125 in.lbf [14.1 Nm] – 6mm Allen wrench.

## OPERATION

The information outlined in this manual assumes the device is being controlled locally. For details on how to control or program the device remotely please refer to the appropriate SkoFlo Actuator User Guide.

### 7. User Interface

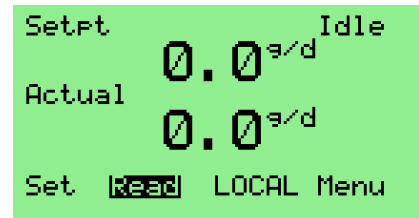
The SkoFlo Surface Actuator can display information and be controlled/programmed both locally and remotely. The local interface is three input buttons and an LCD display. The valve can also be adjusted manually via the override handle – push to engage and turn to adjust. See Figure 7 for more details.



**Figure 7 – Local Interface Details**

### 8. Actuator Operation

- 8.1 Apply power to the SF3.
- 8.2 Once the boot-up process completes, the "Startup" screen will appear.



**Figure 8 - Startup Screen**

- 8.3 Open any isolation valves slowly (1 second or longer) and pass flow through the valve.



- 8.4 A PDFM measurement or flow-setting operation can now be initiated. See the Measuring Flow or Setting Flow section of the appropriate Use Guide for detailed information.

**9. Specific Conditions of Use / Schedule of Limitations**

- 9.1 Flamepaths are not intended to be modified or repaired.
- 9.1 Entries provided are to be properly sealed by the end user with a suitable device for the location.

**ACTUATOR MAINTENANCE**

**Table 3 - Actuator Maintenance Tool Requirements**

Tools and Parts	Qty
5mm Allen Wrench	1
6mm Allen Wrench	1
Flat Head Terminal Screwdriver	1
Dynatex Anti-seize & Lubricating Compound (or similar)	1

**Table 4 –Spares Kit Part Numbers**

Item	Part Number
Seal Kit (PDFM Only)	31291
Seal Kit (Actuator Only)	31292
PDFM Hydraulic Spares	30844
PDFM Assembly	30732-XXX
Drive Assembly	31241-XX

**10. Removing and Replacing the Valve**

- 10.1 Remove power from the actuator.
- 10.2 Close any upstream isolation valves, then remove any hydraulic connections with the SkoFlo valve, including the one from the PDFM – where applicable.
- 10.3 Unscrew the four M6 fasteners connecting the valve bracket to the electrical enclosure – *5mm Allen Wrench*.
- 10.4 Separate the valve from the actuator.

- 10.5 Unscrew the fasteners connecting the bracket to the valve and separate the two parts.
- 10.6 See the relevant O&M Manual for more information on valve maintenance.

**! WARNING**

ANY SERVICE REPAIR SHALL BE PERFORMED BY TRAINED PERSONNEL.

**! NOTICE**

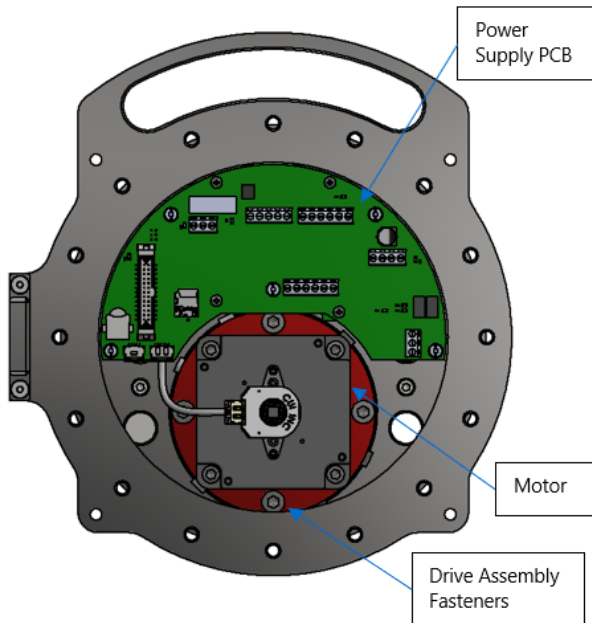
IF ANY ABNORMALITIES ARE FOUND THROUGHOUT THE MAINTENANCE, PLEASE REPORT TO THE RESPECTIVE ENGINEERS.

- 10.7 Coat the valve’s square drive with anti-seize compound.
- 10.8 Place the bracket on the valve and tighten the fasteners.
- 10.9 Remove the grommet from the bracket.
- 10.10 Insert the valve’s square drive into the actuator driveshaft. Use the grommet hole to help with installation.
- 10.11 Rotate the valve to the desired orientation and tighten the four M6 fasteners connecting the bracket to the actuator enclosure – *5mm Allen wrench*
- 10.12 Replace grommet in bracket.
- 10.13 Reconnect any hydraulic connections and apply power to the actuator. Open slowly (1 second or longer) any upstream isolation valves.
- 10.14 Recalibrate the stem. See the Stem Calibration section of the appropriate User Guide for more details.

**11. Removing and Replacing the Drive Assembly**

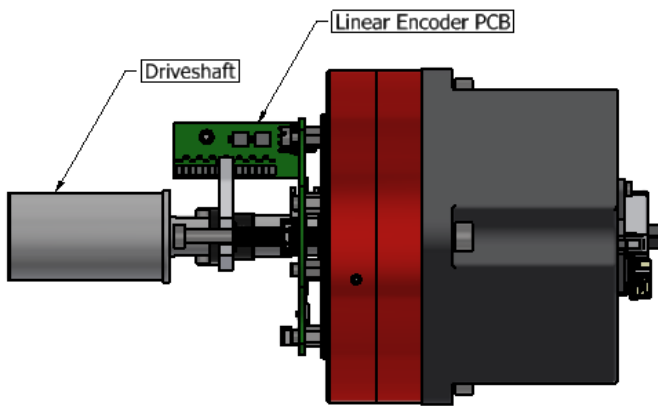
- 11.1 First remove power from the SF3.
- 11.2 Remove the valve – see Section 10 for more details.
- 11.3 Open the electronics enclosure by unscrewing the sixteen M8 captive fasteners in the cover – *6mm Allen Wrench*.
- 11.4 Remove the PCB Assembly – see Section 5 for more details.
- 11.5 Unscrew the four M8 fasteners connecting

the drive assembly to the enclosure base. See Figure 9 for more details – *6mm Allen wrench*.



**Figure 9 – Actuator with Cover Removed**

- 11.6 Withdraw the entire drive assembly from the electronics enclosure noting the orientation of the linear encoder PCB. See Figure 10 for more details.
- 11.7 The driveshaft bearing may still be attached to the driveshaft. If so, remove and replace in the enclosure base.
- 11.8 Transfer the grey encoder cable from the old drive assembly to the replacement one. Press the tab and pull to release.



**Figure 10 - Drive Assembly**

- 11.9 Ensuring the encoder cable exits in line with the 10 O'clock cutout, insert the drive assembly into the electronics enclosure.
- 11.10 Taking care not to trap any wires or knock the Encoder PCB, slide the driveshaft through the bearing housed in the enclosure base, until the gearbox housing bottoms out on the base.
- 11.11 Replace the four M8 fasteners and torque to 65 in.lbf [7.3 Nm] – *6mm Allen Wrench*.
- 11.12 Reinstall the PCB Assembly– see Section 5 for more details
- 11.13 Close the cover and torque the sixteen cover fasteners to 125 in.lbf [14.1 Nm] – *6mm Allen Wrench*.

## 12. Replacing the PCB Assembly Battery



### **! NOTICE**

Battery Details: 3V coin cell, Li-MnO<sub>2</sub> (CR1025)

- 12.1 Open the electronic enclosure cover and remove the PCB Assembly (see Section 5 for more details) – *6mm Allen wrench, terminal screwdriver*.
- 12.2 Remove the old battery from its holder.
- 12.3 Insert the new battery.
- 12.4 Battery details: 3V coin cell, Li-MnO<sub>2</sub> (CR1025)
- 12.5 Replace the PCB Assembly and reconnect the various electrical connections – *terminal screwdriver*.
- 12.6 Close the cover and torque the sixteen cover fasteners to 125 in.lbf [14.1 Nm] – *6mm Allen Wrench*.

## PDFM MAINTENANCE

### 13. General

Spares kits available for typical maintenance items are listed in Table 4. SkoFlo recommends the user purchase one seal kit for every 10 PDFMs in service and 1 hydraulic spares kit for every 20 PDFMs in service. A complete PDFM assembly is also offered.

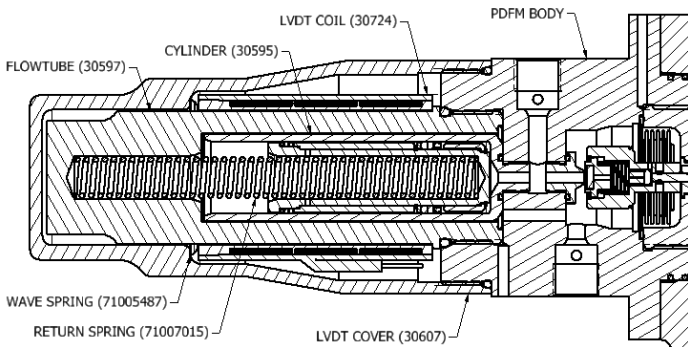
The PDFM cup seal (71006710) and pad (27099) have a maintenance interval of 1,000,000 measurements. The PDFM

software will alert the user when it is time to replace the seals.

**Table 5 – PDFM Maintenance Tool Requirements**

Tools and Parts	Qty
Vise	1
600 ft.lb [813 Nm] Torque wrench	1
4' Breaker bar	1
1-13/16" Deep Socket (6 point recommended)	1
1-3/8" Socket	1
2" Wrench	1
1" Wrench	1
PDFM Manual Calibration Kit (XXXXX)	1
5/8" Socket and wrench with extension bar	1
5mm Allen wrench	1
3mm Allen wrench	1
7/64" Allen wrench	1
Pick or small flat head electrical screwdriver	1
Terminal screwdriver	1
External Circlip Pliers	1
Brass rod (< Ø.12")	1
Parker Super Lube (or equivalent)	1
Dynatex Anti-Seize & Lubricating Compound (or equivalent)	1

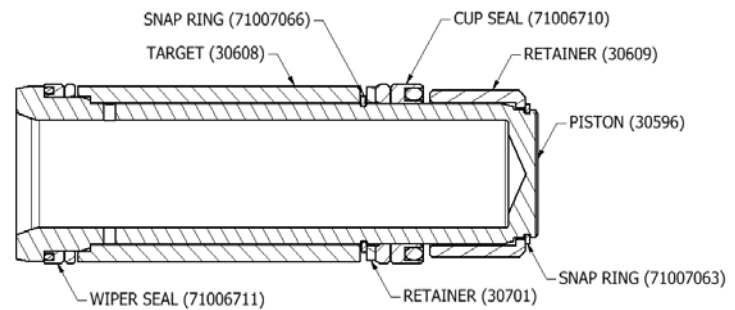
**14. Replacing the Piston Seals**



**Figure 11 - PDFM Hydraulic Portion Cross Section**

- 14.1 Remove power from the SF3, close any upstream isolation valves, and remove any hydraulic connections with the PDFM.
- 14.2 Open the electronic enclosure cover (see Section 5 for more details) – *6mm Allen wrench*.
- 14.3 Noting the position of the wires, disconnect the PDFM from the PCB Assembly.

- 14.4 Unscrew the four M6 SHCSs (71007080) connecting the hydraulic portion of the electronics enclosure base – *5mm Allen wrench*.
- 14.5 Separate the PDFM subassembly from the electronics enclosure base and secure the PDFM body in a vise.
- 14.6 Unscrew the LVDT cover (30607) – *2" wrench*.
- 14.7 Carefully remove the wave spring (71005487) and LDVT coil (30724) from the flowtube (30597).
- 14.8 Unscrew the flowtube from the PDFM body – *1-3/8" Socket and breaker bar*.
- 14.9 Remove the return spring (71007015) and unscrew the cylinder (30595) – *1" Wrench*.
- 14.10 Using a brass rod, push the piston assembly out of the cylinder (from the threaded end) – *Brass rod*.
- 14.11 Disassemble the piston assembly by removing the two spiral wound snap rings – *Pick or small flathead screwdriver*
- 14.12 Apply a thin coat of Parker Super Lube to the new cup seal (71006710) and wiper seal (71006711).



**Figure 12 – Piston Assembly Cross Section**

- 14.13 Reassemble the piston assembly with the new cup and wiper seals. Ensure the seals are installed in the correct orientation (see Figure 12 for details) – *Pick or small flathead screwdriver*.
- 14.14 Screw the cylinder into the PDFM body and torque wrench tight – *1" Wrench*.
- 14.15 Insert the piston assembly into the cylinder taking care not to damage the cup seal.

14.16 Apply a thin coat of anti-seize compound to the flowtube thread.

14.17 First insert the return spring into the flowtube and then guide the other end inside the piston.

14.18 Screw the flowtube into the PDFM body and torque to:

- 200 ft.lbf [271 Nm] for 5,000 psi unit
- 300 ft.lbf [406 Nm] for 10,000 psi unit
- Use 1-3/8" Socket and torque wrench

14.19 Slide the LVDT coil over the flowtube.

14.20 The orientation of the coil is important; the wires should exit the coil in the direction of the body.

14.21 Apply a thin coat of anti-seize compound to the PDFM body thread, then screw on the LVDT cover and torque wrench tight – 2" wrench.

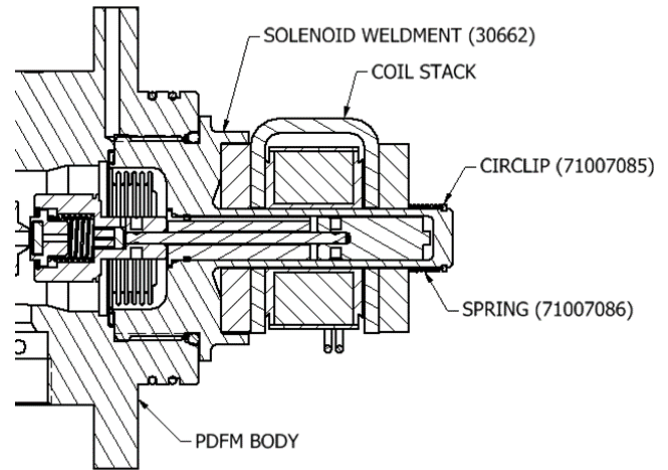
14.22 Reconnect the hydraulic portion of the PDFM to the base of the electronics enclosure and torque the four M6 fasteners to 65 in.lbf [7.3 Nm] – 5mm Allen wrench.

14.23 Reconnect the PDFM wires to the PCB Assembly.

14.24 Close the cover and torque the sixteen cover fasteners to 125 in.lbf [14.1 Nm] – 6mm Allen Wrench.

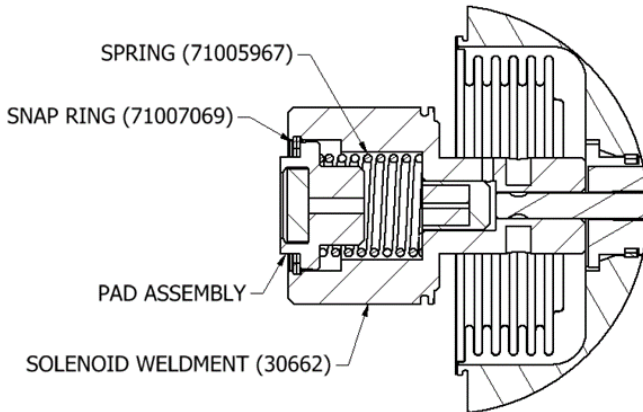
14.25 Recalibrate the PDFM LVDT. See the LVDT Calibration section of the appropriate User Guide for more details.

## 15. Replacing the PDFM Pad



**Figure 13 – Solenoid Cross Section**

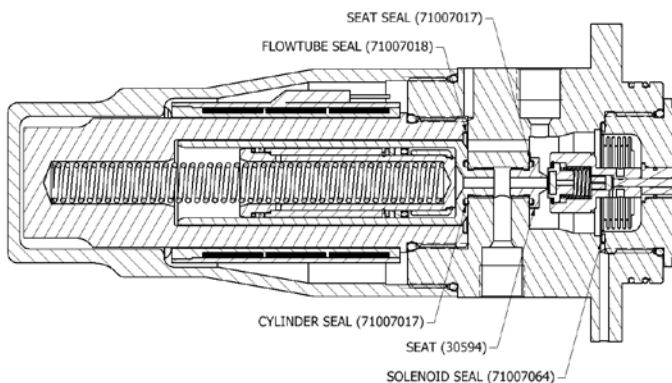
- 15.1 Remove any hydraulic connections from the PDFM.
- 15.2 Open the electronic enclosure cover (see Section 5 for more details) – 6mm Allen wrench.
- 15.3 Noting the position of the wires, disconnect the PDFM from the PCB Assembly.
- 15.4 Unscrew the four M6 SHCSs (71007080) connecting the hydraulic portion of the electronics enclosure base – 5mm Allen wrench.
- 15.5 Separate the hydraulic portion of the PDFM from the electronics enclosure base and secure the PDFM body in a vise.
- 15.6 Remove the circlip (71007085), spring (71007086) and coil stack from the solenoid weldment – Circlip pliers.
- 15.7 Unscrew the solenoid weldment (30662) from the PDFM body – 1-13/16" Socket and breaker bar.
- 15.8 Remove the snap ring (71007069), pad assembly and spring (71005967) from the solenoid weldment (see Figure 14 for more details) – Pick or small flathead screwdriver.



**Figure 14 - Solenoid Pad Assembly**

- 15.9 Place the spring over the replacement pad assembly and insert into the solenoid weldment.
- 15.10 Retain the pad assembly with the replacement snap ring (71007069) – *Pick or small flathead screwdriver.*
- 15.11 Apply a thin coat of anti-seize compound to the solenoid thread, then screw into the PDFM body and torque to:
  - 300 ft.lbf [406 Nm] for 5,000 psi unit
  - 475 ft.lbf [609 Nm] for 10,000 psi unit
  - Use 1-13/16" Socket and torque wrench
- 15.12 Reinstall the coil stack, spring, and circlip – *Circlip pliers.*
- 15.13 Follow steps 14.22 to 14.25 to reassemble the rest of the unit.

## 16. Replacing the Metal C-rings



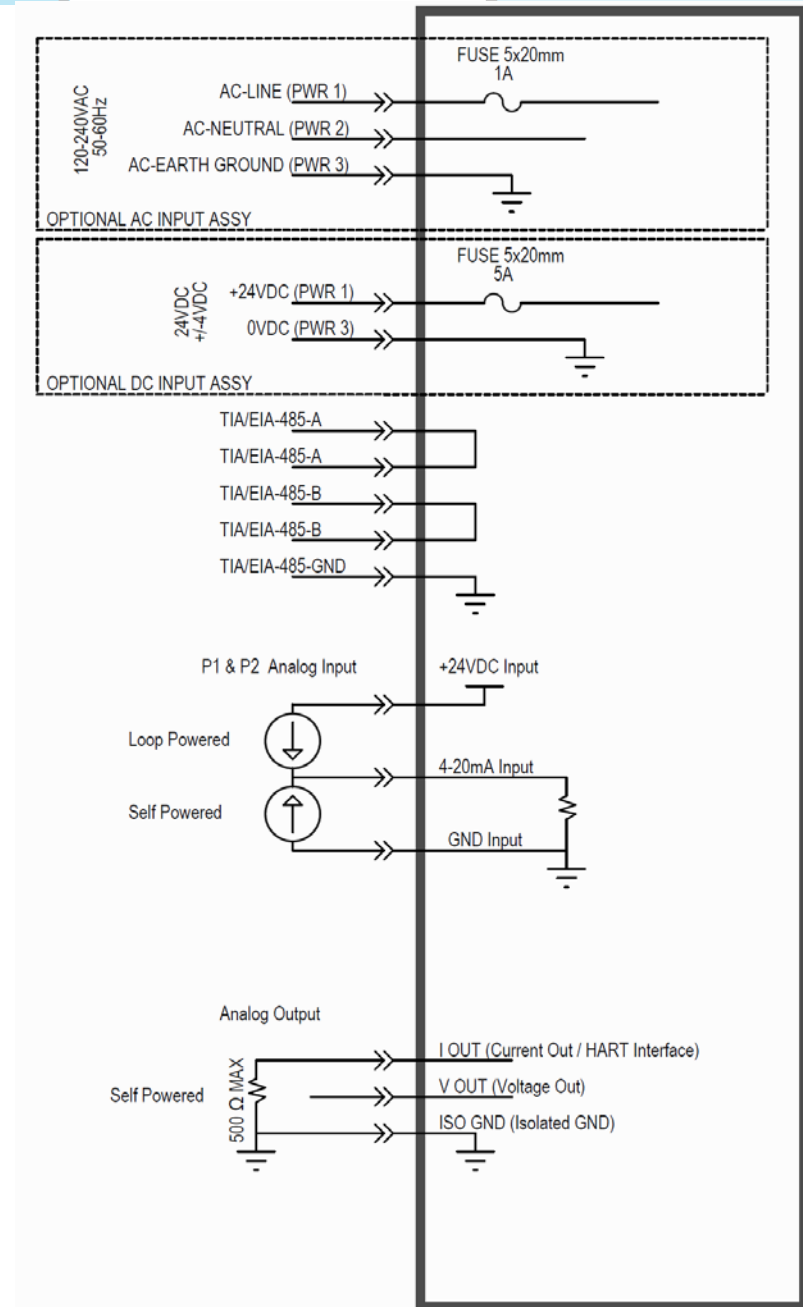
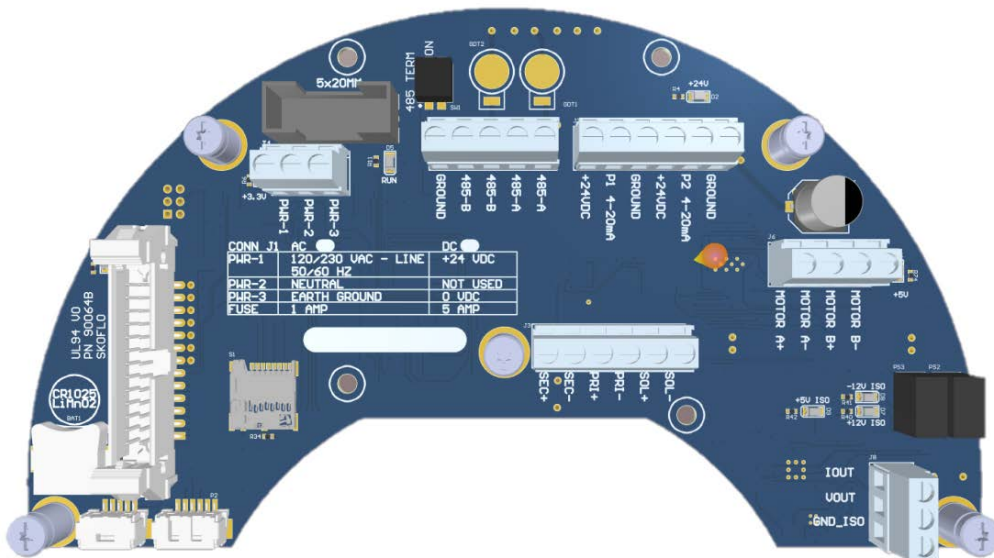
**Figure 15 - Metal C-Ring Locations**

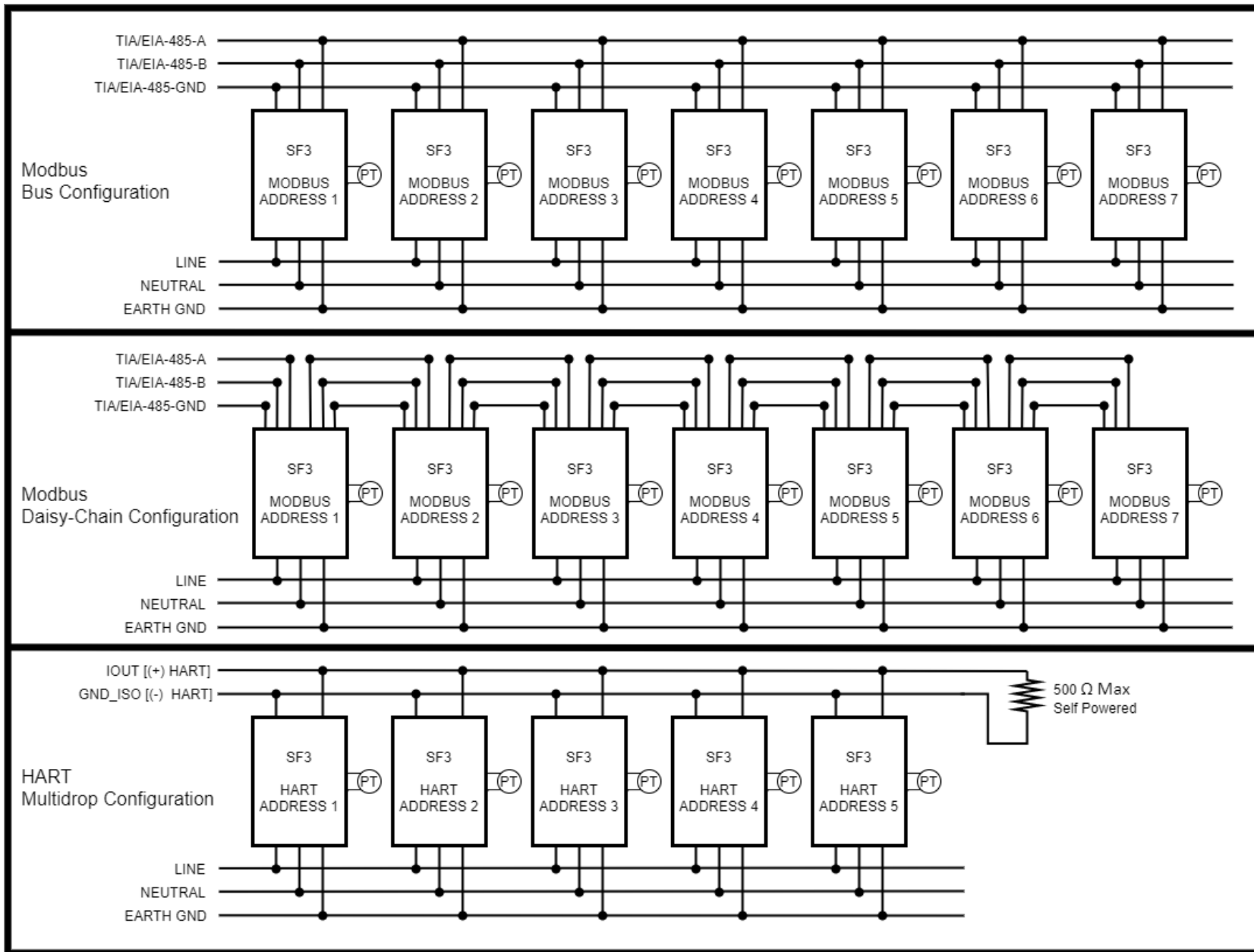
- 16.1 Follow steps 14.1 to 14.9 to access the flowtube (71007018) and cylinder (71007017) seals.
- 16.2 Remove the old seals – *Pick or small flathead screwdriver.*
- 16.3 Apply a drop of O-ring lubricant to the replacement seals (this will help keep the seals in place during assembly) and insert in their respective glands.
- 16.4 Follow steps 14.14 to 14.21 to reassemble the backside of the PDFM.
- 16.5 Follow steps 15.6 to 15.7 to remove the solenoid assembly.
- 16.6 Unscrew the seat (30594) from the solenoid body – *5/8" Socket and wrench with extension bar.*
- 16.7 Remove the old seals from the seat and PDFM body – *Pick or small flathead screwdriver.*
- 16.8 Apply a drop of O-ring lubricant to the replacement seals and insert in their respective glands.
- 16.9 Screw the seat into the PDFM body and torque wrench tight – *5/8" Socket and wrench with extension bar.*
- 16.10 Reinstall the coil stack, spring, and circlip – *Circlip pliers.*
- 16.11 Follow steps 14.22 to 14.25 to reassemble the rest of the unit.



### APPENDIX A – WIRING DIAGRAMS

Refer to table on PCB board to determine if power supply is AC or DC.

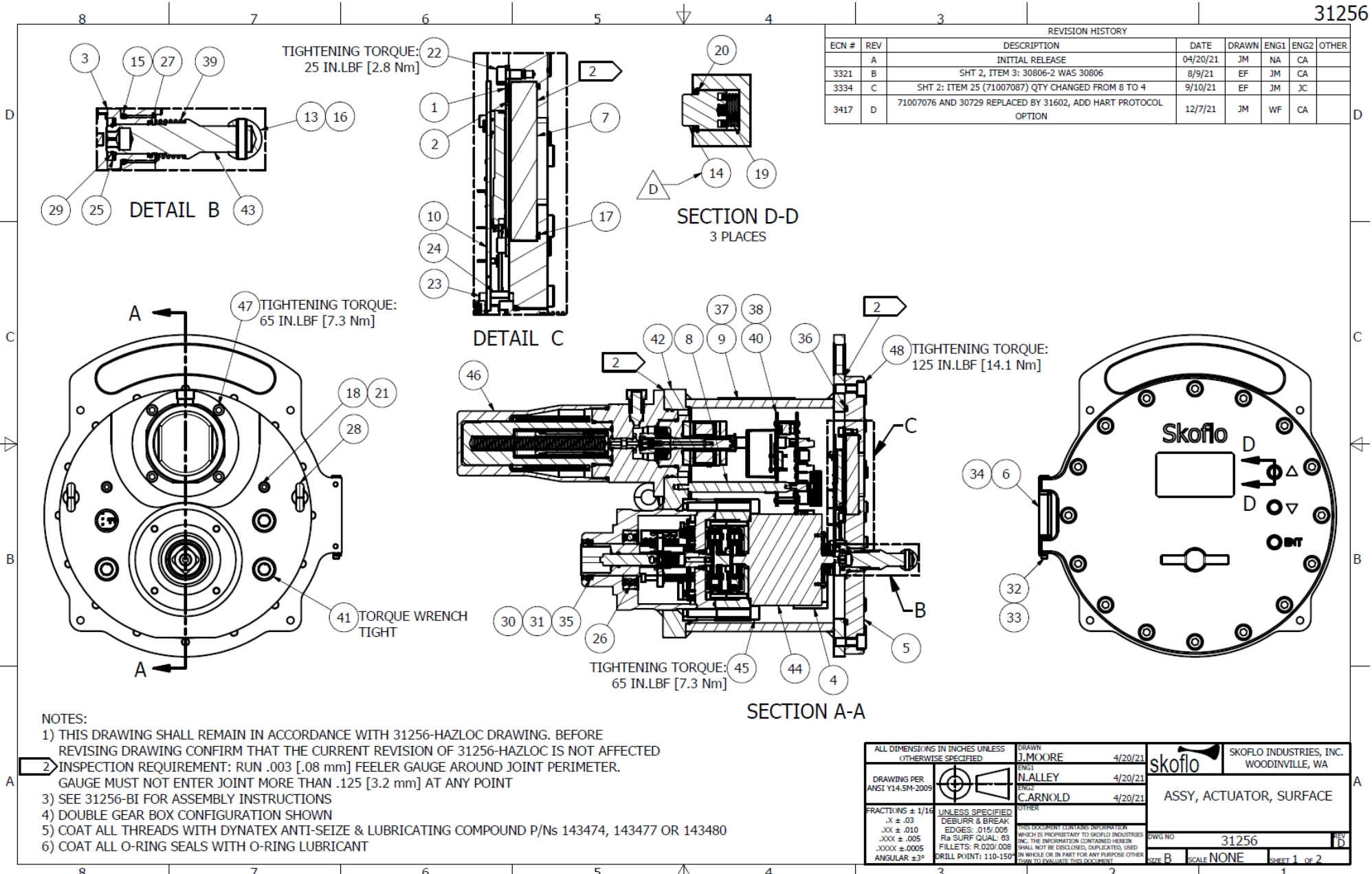




**SF3 Wiring Diagram - Multiple Units**

### APPENDIX B – SF3 ACTUATOR AND BOM DRAWING

31256



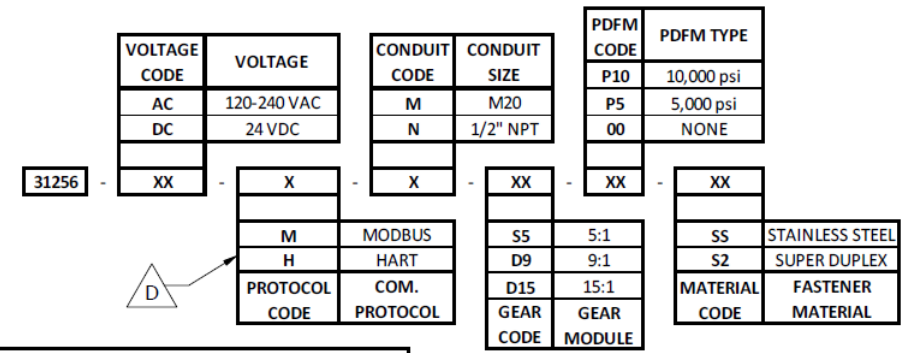
ECN #		REV	DESCRIPTION	DATE	DRAWN	ENGR1	ENGR2	OTHER
		A	INITIAL RELEASE	04/20/21	JM	NA	CA	
3321		B	SHT 2, ITEM 3: 30806-2 WAS 30806	8/9/21	EF	JM	CA	
3334		C	SHT 2: ITEM 25 (71007087) QTY CHANGED FROM 8 TO 4	9/10/21	EF	JM	JC	
3417		D	71007076 AND 30729 REPLACED BY 31602, ADD HART PROTOCOL OPTION	12/7/21	JM	WF	CA	

- NOTES:**
- THIS DRAWING SHALL REMAIN IN ACCORDANCE WITH 31256-HAZLOC DRAWING. BEFORE REVISING DRAWING CONFIRM THAT THE CURRENT REVISION OF 31256-HAZLOC IS NOT AFFECTED
  - INSPECTION REQUIREMENT: RUN .003 [.08 mm] FEELER GAUGE AROUND JOINT PERIMETER. GAUGE MUST NOT ENTER JOINT MORE THAN .125 [3.2 mm] AT ANY POINT
  - SEE 31256-BI FOR ASSEMBLY INSTRUCTIONS
  - DOUBLE GEAR BOX CONFIGURATION SHOWN
  - COAT ALL THREADS WITH DYNATEX ANTI-SEIZE & LUBRICATING COMPOUND P/Ns 143474, 143477 OR 143480
  - COAT ALL O-RING SEALS WITH O-RING LUBRICANT

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED	DRAWN J. MOORE 4/20/21	<b>SKOFL0 INDUSTRIES, INC.</b> WOODINVILLE, WA
	ENGR1 N. ALLEY 4/20/21	
DRAWING PER ANSI Y14.5M-2009	ENGR2 C. ARNOLD 4/20/21	ASSY, ACTUATOR, SURFACE
FRACTIONS ± 1/16 .X ± .03 .XX ± .010 .XXX ± .005 .XXXX ± .0005 ANGULAR ± 3°	UNLESS SPECIFIED DEBURR & BREAK EDGES: 0.15/0.06 R4 SURF QUAL: 63 FILLET: R.020/0.08 DRILL POINT: 110-150°	OTHER
THIS DOCUMENT CONTAINS INFORMATION WHICH IS PROPRIETARY TO SKOFL0 INDUSTRIES INC. THE INFORMATION CONTAINED HEREIN SHALL NOT BE DISCLOSED, DUPLICATED, USED IN WHOLE OR IN PART FOR ANY PURPOSE OTHER THAN TO EVALUATE THIS DOCUMENT		DWG NO 31256
		REV B
SIZE: B		SCALE: NONE
		SHEET 1 OF 2

PARTS LIST					
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL	HAZLOC LISTED
1	1	30722	RETAINER, WINDOW, PDFM/ACTUATOR, SURFACE	316 SS	YES
2	1	30806-2	GASKET, WINDOW, PDFM/ACTUATOR, SURFACE, .0625 THK	EPDM	YES
3	1	31023 ALT 31359	BUSHING, OVERRIDE SHAFT, ACTUATOR	954 BRONZE ALT AL-NI-BRZ	YES
4	1	31137	VCI, SF3, SURFACE	ASSEMBLY	NO
5	1	31253	COVER, ACTUATOR, SURFACE	316 SS	YES
6	1	31257	HINGE, COVER, ACTUATOR	316 SS	NO
7	1	31267	WINDOW, PDFM/ACTUATOR, SURFACE	LAMINATED GLASS	YES
8	5	31279	STANDOFF, THREADED, 10-32 TO 6-32, 4LG	304 SS	NO
9	1	31281	NAMEPLATE, ACTUATOR, SURFACE	316 SS	YES
10	1	31283	ASSY, PCB, DISPLAY AND BUTTON, ACTUATOR	ASSEMBLY	YES
11	1	31310	ASSY, CABLE, DRIVE ENCODER, ACTUATOR	ASSEMBLY	NO
12	1	31311	ASSY, CABLE, MOTOR ENCODER, ACTUATOR	ASSEMBLY	NO
13	1	31401	HANDLE, OVERRRIDE, ACTUATOR, SURFACE	316 SS	NO
14	3	31602	ASSY, BUTTON, ACTUATOR, SURFACE	SEE DWG 31602	NO
15	1	71001826	SL, O-RING, 3-910	EPDM	YES
16	1	71002082	RLPN, Ø.1875 X 0.75 LG	316 SS	NO
17	1	71007071	SL, O-RING, 2-045	EPDM	YES
18	4	71007072	SHCS, M5X0.8mm - 8	316 SS	YES
19	3	71007074	SPRING, BUTTON, PDFM/ACTUATOR	Stainless Steel	NO
20	3	71007075	SLRG, VH-50-516	316 SS	NO
21	4	71007079	FW, M5, DIN 125, TYPE A	316 SS	NO
22	7	71007081	SHCS, M4X0.7 - 8	A4-70	YES
23	4	71007082	SHCS, 6-32 UNC X .25	18-8 SS	NO
24	4	71007087	STANDOFF, M/F, #6-32, 1/4" HEX, 11/32" LG	18-8 SS	NO
25	1	71007149	SHIM, DISC, 0.5 ID, .045 THICK	316 SS	YES
26	1	71007150	BEARING, BALL, 30mm ID	Stainless Steel	YES
27	1	71007156	SL, O-RING, 2-015	EPDM	YES
28	2	71007239	EYEBOLT, LIFTING, M6, 12LG	Steel, Galvanized	NO
29	1	71007257	SLRG, WST-50-516	316 SS	YES
30	1	71007274	SL, SHAFT, ROTARY, 30MM ID, 37MM OD	NITRILE	YES
31	1	71007309	SLRG, DNH-37-502	302 SS	NO
32	1	71007445	PIN, CLEVIS, Ø3/16 X 3LG	18-8 SS	NO
33	1	71007446	PIN, COTTER, 1/8-3/16	316 SS	NO
34	2	71007449	SCREW, FLAT HEAD, M5 X 14LG	316 SS	NO
35	1	71007454	BEARING, BALL, 30MM X 4MM, SEALED	Stainless Steel	YES
36	1	71007457	SL, ORING, 2-265	EPDM	YES
37	4	71007465	SCREW, U-DRIVE, #2 X .188 LG	18-8 SS	NO
38	1	71007468	CONNECTOR, RIBBON, 10", ACTUATOR	ASSEMBLY	NO
39	1	71007548	SPRING, OVERRIDE RETURN, ACTUATOR, SURFACE	Stainless Steel	NO
40	1	SEE TABLE 1	ASSY, PCB, POWER & COMMUNICATION, ACTUATOR	ASSEMBLY	YES
41	3	SEE TABLE 2	PLUG, HAZARDOUS AREA	316 SS	YES
42	1	SEE TABLE 2	MACHINING, WELDMENT, ACTUATOR, SURFACE	316L SS	YES
43	1	SEE TABLE 3	SHAFT, OVERRIDE, ACTUATOR, SURFACE	316 SS	YES
44	1	SEE TABLE 3	ASSY, DRIVE, ACTUATOR, SURFACE	SEE DWG 31241	YES
45	4	SEE TABLE 3	SHCS, M8x1.25	18-8 SS	YES
46	1	SEE TABLE 4	SUBASSEMBLY, PDFM, SURFACE	SEE DWG 30732 OR 31289	YES
47	4	SEE TABLE 5	SHCS, M6X1 - 20	SEE TABLE 5	YES
48	16	SEE TABLE 5	SHCS, CAPTIVE, M8-1.25 X 21	SEE TABLE 5	YES

### CONFIGURATION NUMBER GUIDE



ITEM	24VDC - MODBUS/HART	120-240VAC - MODBUS/HART	DESCRIPTION
40	31282-D	31282-A	ASSY, PCB, POWER & COMMUNICATION, ACTUATOR

ITEM	1/2in NPT	M20	DESCRIPTION
41	71007089	71007256	PLUG, HAZARDOUS AREA
42	31249	31284	MACHINING, WELDMENT, ACTUATOR, SURFACE

ITEM	5:1	9:1	15:1	DESCRIPTION
43	31108	30864		SHAFT, OVERRIDE, ACTUATOR, SURFACE
44	31241-5	31241-9	31241-15	ASSY, DRIVE, ACTUATOR, SURFACE
45	71007260	71007263		SHCS, M8X1.25

ITEM	5,000 psi	10,000 psi	NONE		DESCRIPTION
			NPT	M20	
46	30732-001	30732-002	31289-1	31289-2	SUBASSEMBLY, PDFM, SURFACE

ITEM	STAINLESS STEEL	SUPER DUPLEX	DESCRIPTION
47	71007102	71007509	SHCS, M6x1 - 20
48	71007252 ALT 71007530	71007508	SHCS, CAPTIVE, M8-1.25 x 21

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED	DRAWN J. MOORE 4/20/21		SKOFLO INDUSTRIES, INC. WOODINVILLE, WA
DRAWING PER ANSI Y14.5M-2009	ENGR N. ALLEY 4/20/21		ASSY, ACTUATOR, SURFACE
FRACTIONS ± 1/16 .X ± .03 .XX ± .010 .XXX ± .005 .XXXX ± .0005 ANGULAR ± 3°	ENGR C. ARNOLD 4/20/21		
UNLESS SPECIFIED DEBURR & BREAK EDGES: .015/ .005 Ra SURF QUAL: 63 FILLET: R.020/ .008 DRILL POINT: 110-150°	OTHER	DWG NO 31256	BY D
THIS DOCUMENT CONTAINS INFORMATION WHICH IS PROPRIETARY TO SKOFLO INDUSTRIES INC. THE INFORMATION CONTAINED HEREIN SHALL NOT BE DISCLOSED, DUPLICATED, USED IN WHOLE OR IN PART FOR ANY PURPOSE OTHER THAN TO EVALUATE THIS DOCUMENT.		SCALE NONE	SHEET 2 OF 2



### APPENDIX C – PDFM MODULE BOM DRAWING

**SECTION VIEW**  
(30732-002 SHOWN)

**TIGHTENING TORQUE:**  
5 ksi = 300 ft.lbf [406 Nm]  
10 ksi = 475 ft.lbf [620 Nm]

**TIGHTENING TORQUE:**  
5 ksi = 200 ft.lbf [271 Nm]  
10 ksi = 300 ft.lbf [406 Nm]

**TABLE 1: WORKING PRESSURE SELECTION**

WORKING PRESSURE	5,000 PSI	10,000 PSI	DESCRIPTION
ITEM	30732-001	30732-002	
33	30615	30736	BODY, PDFM, SURFACE
34	71007315	71002083	PLUG
35	N/A	71003288	NUT

**30732**

REVISION HISTORY						
ECN #	REV	DESCRIPTION	DATE	DRAWN	ENGR	OTHER
	A	INITIAL RELEASE	9/17/18	JM	NA	SS
2762	B	ADD PLUG AND NUT TO BOM, ADD TABLE 1, RENUMBER PARTS, ADD TORQUES, ADD PRESSURE CONTAINING COLUMN, ADD 31049-HAZLOC REFERENCES	7/29/19	JM	NA	CA
3114	C	ADD DETAIL VIEW A	09/11/20	WF	JM	CA

PARTS LIST					
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL	PRESSURE CONTAINING
1	1	27099	PAD, SEAL, FLOWMETER, Ø.278	FFKM	NO
2	1	30594-X	SEAT, PDFM, SURFACE	NITRONIC 50 HS	NO
3	1	30595	CYLINDER, PDFM, SURFACE	NITRONIC 50 HS	NO
4	1	30596	PISTON, PDFM, SURFACE	NITRONIC 50 HS	NO
5	1	30597	FLOWTUBE, PDFM, SURFACE	NITRONIC 50 HS	YES
6	1	30607	COVER, LVDT, PDFM, SURFACE	CF8M SS	NO
7	1	30608	TARGET, PDFM, SURFACE	Alloy 49	NO
8	1	30609	RETAINER, PISTON SEAL, PDFM, SURFACE	316 SS	NO
9	1	30662	ASSY, SOLENOID, DUAL BELLOWS	SEE DWG 30662	YES (BODY)
10	2	30674	WASHER, YOKE, SOLENOID, SURFACE	Steel AISI 1018	NO
11	1	30675	YOKE, SOLENOID, SURFACE	Steel AISI 1018	NO
12	1	30701	WASHER, PISTON, PDFM, SURFACE	316 SS	NO
13	1	30713	HOLDER, PAD, SOLENOID, SURFACE	316 SS	NO
14	1	30724	COIL ASSEMBLY, LVDT, SURFACE	SEE DWG 30724	NO
15	1	30726	COIL, SOLENOID, PDFM, SURFACE	SEE DWG 30726	NO
16	1	71005445	SL, O-RING, 2-144	EPDM	NO
17	1	71005487	SPRING, WAVE, GAP TYPE, 1-610 SHAFT	316 SS	NO
18	1	71005967	SPRING, COIL, Ø.390 X 0.77, FLOWMETER, TAKEUP	ELGILOY	NO
19	1	71006710	SL, CUP, PISTON, FLOWMETER, Ø.875	SEE DWG 71006710	NO
20	1	71006711	SL, WIPER, PISTON, FLOWMETER, Ø.875	SEE DWG 71006711	NO
21	1	71007015	SPRING, COIL, Ø.480 X 7.23, PDFM RETURN, SURFACE	ELGILOY	NO
22	2	71007017	SL, METAL, ECI-000547-05-14-8-SPC	INCONEL 718, SILVER	NO
23	1	71007018	SL, METAL, ECI-001255-05-14-8-SPC	INCONEL 718, SILVER	YES
24	1	71007062	SL, O-RING, 2-920	EPDM	NO
25	1	71007063	SLRG, WS-62-516	316 SS	NO
26	1	71007064	SL, METAL, ECI-001497-05-14-8-SPC	INCONEL 718, SILVER	YES
27	1	71007065	SL, O-RING, 2-130	EPDM	NO
28	1	71007066	SLRG, WS-68-516	316 SS	NO
29	2	71007068	SL, O-RING, 2-036	EPDM	NO
30	1	71007069	SLRG, WH-50-516	316 SS	NO
31	1	71007085	SLRG, EXTERNAL, 0.5" OD	15-7 PH SS	NO
32	1	71007086	SPRING, SOLENOID COIL RETAINER	MUSIC WIRE	NO
33	1	SEE TABLE 1	BODY, PDFM, SURFACE	NITRONIC 50 HS	YES
34	1	SEE TABLE 1	PLUG	316 SS	YES
35	1	SEE TABLE 1	NUT, PLUG, 3/8 AUTOCLAVE	316 SS	YES

**NOTES**

- 1) COAT ALL THREADS WITH DYNATEX ANTI-SEIZE & LUBRICATING COMPOUND, PART No. 49558
- 2) LUBRICATE ALL O-RING SEALS WITH PARKER SLUBE 884-4 (OR SIMILAR)
- 3) THIS DRAWING SHALL REMAIN IN ACCORDANCE WITH PDFMA-HAZLOC AND 31049-HAZLOC DRAWINGS. BEFORE REVISING DRAWING CONFIRM THAT THE CURRENT REVISIONS OF PDFMA-HAZLOC AND 31049-HAZLOC IS NOT AFFECTED
- 4) ASSEMBLE PER WI-231

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED		DESIGN: J. MOORE 9/17/2018	SKOFLO INDUSTRIES, INC. WOODINVILLE, WA
DRAWING PER: ANSI Y14.5M-2009		ENGR: N. ALLEY 9/17/2018	
FRACTIONS: ± 1/64 X + .005 JOG: .010 JOG: .005 XXX: ± .005 ANGULAR: ± 3		ENGR: S. SPAHI 9/17/2018	SUBASSEMBLY, PDFM, SURFACE  <b>BOM DRAWING</b> DWG NO: 30732 SIZE: B SCALE: NONE SHEET 1 OF 1
UNLESS SPECIFIED DEBURR & BREAK EDGES: 0.15/005 RA SURF QUAL: 63 FILLETS: R.020/008 DRILL POINT: 110-150°		OTHER:	





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14241 NE 200<sup>th</sup> Street  
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