

# SkoFlo Actuator and Optional Positive Displacement Flow Meter

SF3 Actuator



User Guide for Modbus  
Application Firmware  
Version 1.6

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## ABOUT SKOFLO

Our experience and track record speak for themselves. SkoFlo has delivered over 20,000 valves since 1988. 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.

## 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.

### 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

AFM Autonomous Flow Measurement  
CSR Continuous Setpoint Regulation

LCD Liquid Crystal Display  
LVDT Linear Variable Differential Transformer  
PCB Printed Circuit Board  
PDFM Positive Displacement Flow Meter  
psi Pounds per square inch  
ZFS Zero-Flow Shutdown

## 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 SF3 Application Firmware User Manual.

### 1. User Interface

The SkoFlo Surface Actuator can display information and be controlled/programmed both locally and remotely. The local interface consists of three input buttons and a liquid crystal display (LCD). The valve can also be adjusted manually via the override handle – push to engage and turn to adjust. See Figure 1 for more details.

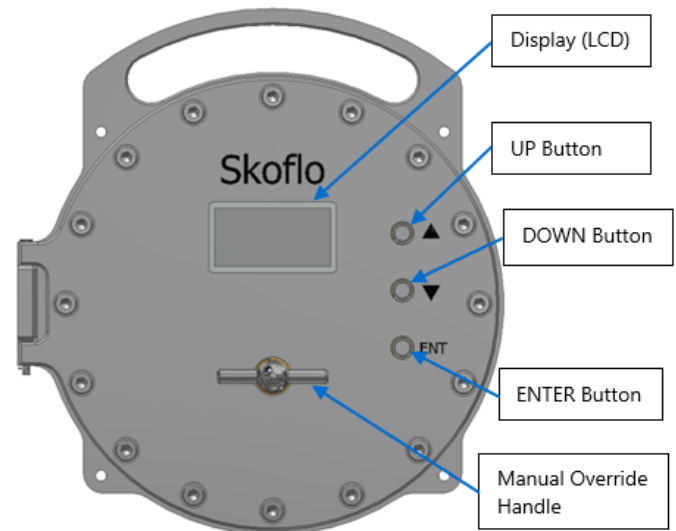


Figure 1 – Local Interface Details

### 2. Startup Procedure

#### ! WARNING



ENSURE THAT ALL ELECTRICAL COVERS, CABLE GLANDS, THREADED ADAPTORS OR CONDUIT ENTRIES ARE CORRECTLY INSTALLED BEFORE APPLYING POWER



- 2.1 Apply power to the SF3.
- 2.2 The Bootloader firmware is active for a few seconds, during which time an information screen is displayed.

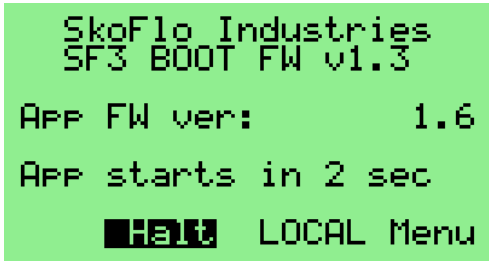


Figure 2 – Information Screen

- 2.3 Once the boot-up process completes, the "Startup" screen appears.

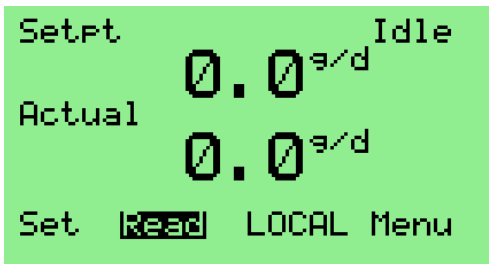


Figure 3 – Startup Screen

**! NOTICE**

IF, INSTEAD OF "LOCAL", THE TEXT "REMOTE" APPEARS IN THE BOTTOM LINE OF THE SCREEN (AND THE "READ" FIELD IS MISSING), THE SF3 WAS LAST CONTROLLED FROM A REMOTE COMPUTER. WITH THE SF3 IN THIS STATE, THE LOCAL INTERFACE CAN ONLY BE USED TO READ (BUT NOT CHANGE) CONFIGURATION AND CALIBRATION PARAMETERS, AND OPERATIONS SUCH AS TAKING FLOW MEASUREMENTS CANNOT BE INITIATED. TO ESTABLISH LOCAL ACCESS, USE THE UP AND DOWN BUTTONS TO HIGHLIGHT THE "REMOTE" FIELD, PRESS THE 'ENTER' BUTTON TO ENABLE EDITING, PRESS THE UP OR DOWN BUTTON UNTIL THE OPTION "LOCAL" IS DISPLAYED, AND PRESS THE 'ENTER' BUTTON AGAIN TO COMPLETE THE OPERATION.



- 2.4 Open any isolation valves slowly (1 second or longer) and pass flow through the unit.
- 2.5 A PDFM measurement or flow-setting operation can now be initiated (as described in Sections 5.7 and 7, respectively).

## USER INTERFACE BASICS

### 3. Menu Navigation

- 3.1 The menu pages of the SF3 are shown below.

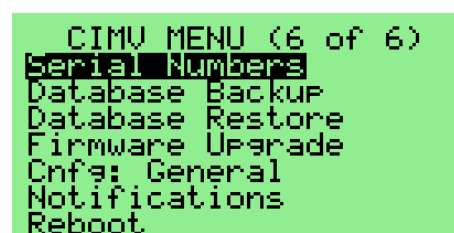
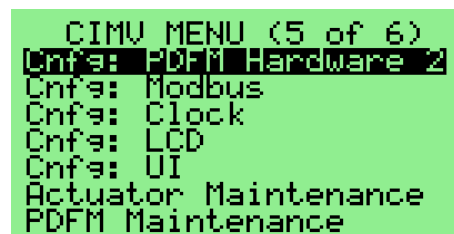
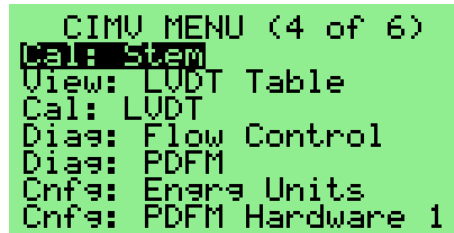
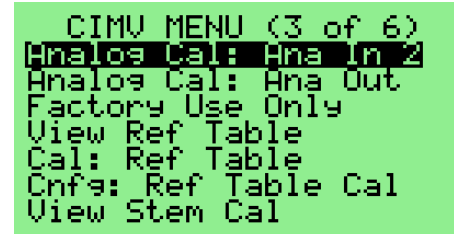
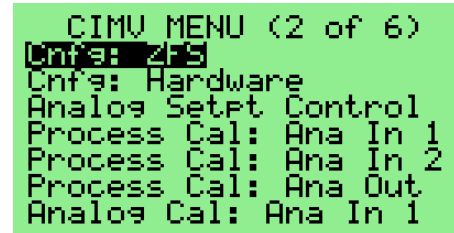
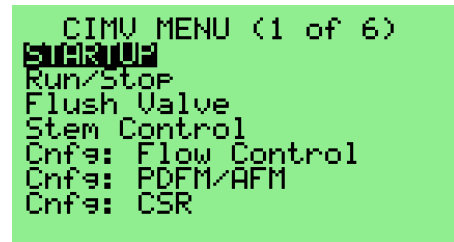


Figure 4 – Menu Pages

- 3.2 Navigation through the menu pages is accomplished using the UP and DOWN buttons.
- 3.3 To select a screen from a menu page, use the UP or DOWN buttons to move through the screen selections until the desired selection is highlighted, then press the ENTER button. The selected screen will then appear.

#### 4. Parameter Editing

- 4.1 To select a screen's parameter for editing, press the UP or DOWN button until the desired parameter field is highlighted, then press ENTER.
- 4.2 Two methods are used in the local user interface to edit a screens configuration and calibration parameters: *Option Selection* and *Numeric Entry*.
- 4.3 Option Selection

- 4.3.1 In the *Option Selection* method, a parameter value is selected from a list of valid options. The UP and DOWN buttons are used to scroll through the available options; when the desired option is displayed, the ENTER button is used to select that option.
- 4.3.2 As an example, consider the selection of the pressure unit in the "Cnfg: Engrg Units" screen. Press the UP or DOWN button until the "Pressure:" field is highlighted.

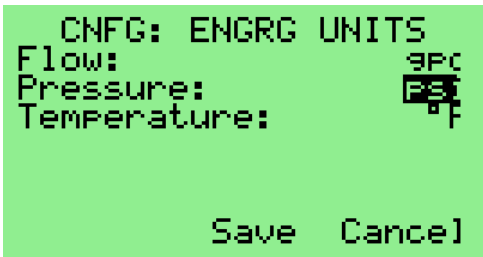


Figure 5 – Option Selection 1

- 4.3.3 Press the ENTER button. An asterisk appears to the left of the field to indicate that the SF3 is now in editing mode.

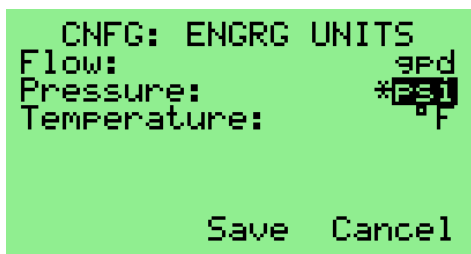


Figure 6 – Option Selection 2

- 4.3.4 Press the UP or DOWN button until the desired pressure unit is displayed ("bar" in this example).

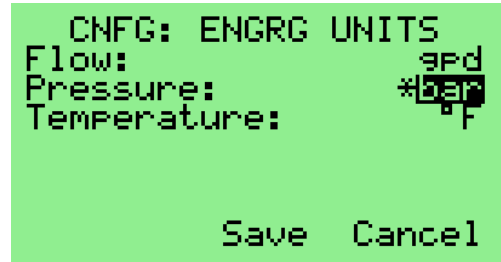


Figure 7 – Option Selection 3

- 4.3.5 Press the ENTER button to select the value. The asterisk disappears, indicating that editing mode has been exited.

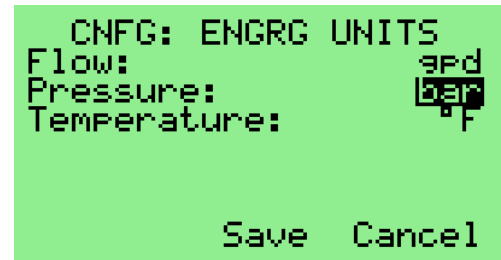


Figure 8 – Option Selection 4

#### 4.4 Numeric Entry

- 4.4.1 In the *Numeric Entry* method, a parameter value is entered by using the UP, DOWN, and ENTER buttons to specify the digits in the value.
- 4.4.2 As an example, consider the specification of the flow setpoint in the "Startup" screen. Press the UP or DOWN button until the "Setpt" field is highlighted. In this example, a setpoint value of '9.3' will be entered.

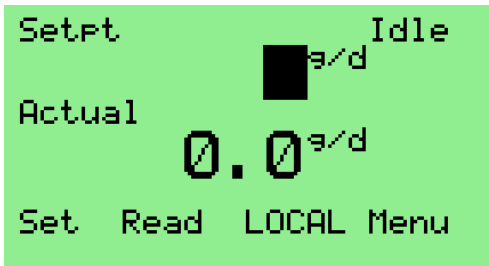


Figure 9 – Numeric Entry 1

- 4.4.3 Note that the width of the highlighted field reflects the maximum number of characters (including decimal point) that can be used to specify the parameter value (7, in this example).

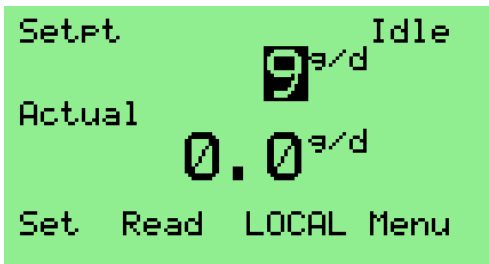


- 4.4.4 Press the ENTER button. An empty single-character field is highlighted to indicate that editing mode has been entered.



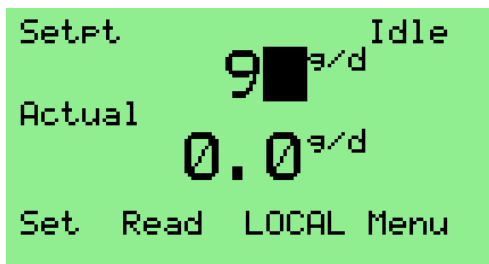
**Figure 10 – Numeric Entry 2**

- 4.4.5 Press the UP button until the character '9' is displayed in the field.



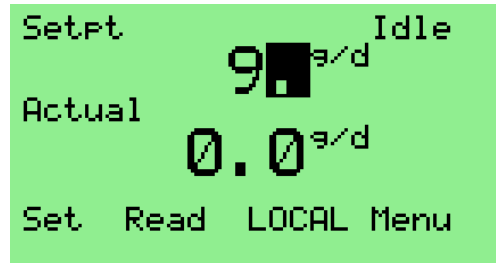
**Figure 11 – Numeric Entry 3**

- 4.4.6 Press the ENTER button to accept this value. The entered value shifts to the left and is no longer highlighted, and a new blank field appears to its right.



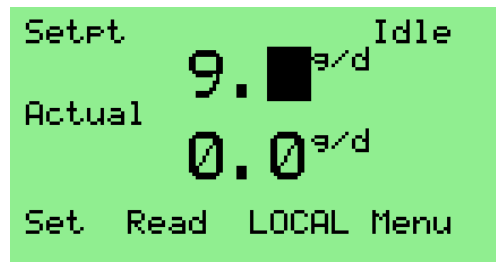
**Figure 12 – Numeric Entry 4**

- 4.4.7 Press the DOWN button until the decimal point character is displayed in the field.



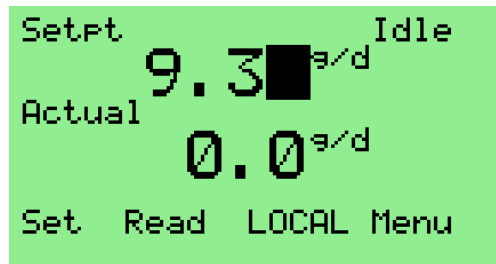
**Figure 13 – Numeric Entry 5**

- 4.4.8 Press the ENTER button to accept this character.



**Figure 14 – Numeric Entry 6**

- 4.4.9 Press the UP button until the character '3' is displayed in the field, then press the ENTER button to accept it.



**Figure 15 – Numeric Entry 7**

- 4.4.10 Once all the characters have been entered, press the ENTER button again to accept the value. The entire field is again highlighted, indicating that editing mode has been exited.

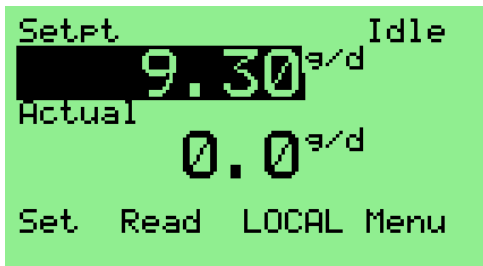


Figure 16 – Numeric Entry 8

## STARTUP SCREEN

### 5. Introduction

- 5.1 Descriptions of the various fields of the “Startup” screen are provided in the following figure.

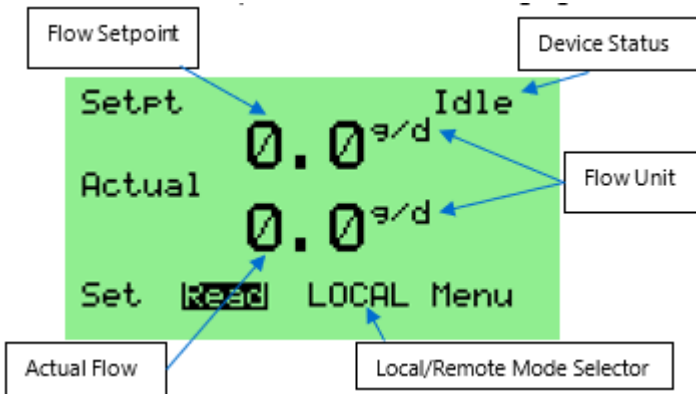


Figure 17 – Startup Screen Details

- 5.2 If the ENTER button is pressed when the “Set” field is highlighted, the SF3 will adjust the stem to produce the setpoint flow.
- 5.3 If the ENTER button is pressed when the “Read” field is highlighted, a PDFM flow measurement will be initiated.
- 5.4 When the Local/Remote Mode Selector field is highlighted, it can be used to configure the SF3 control mode, either as “LOCAL” (control via the buttons and LCD) or “REMOTE” (control via a remote computer using, for example, the Modbus protocol). It is changed using the Option Selection method.
- 5.5 If the ENTER button is pressed when the “Menu” field is highlighted, the “Startup” screen is exited, and the first menu page is displayed.
- 5.6 If one of the Analog Input ports is configured to monitor inlet pressure, a line will appear in the LCD showing the current measured inlet pressure value, as shown below.

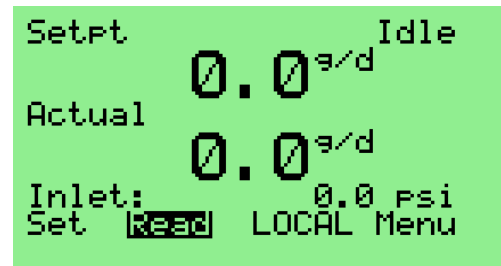


Figure 18 – Startup Screen with Inlet Pressure

- 5.7 If one of the Analog Input ports is configured to monitor outlet pressure, a line will appear in the LCD showing the current measured outlet pressure value, as shown below.

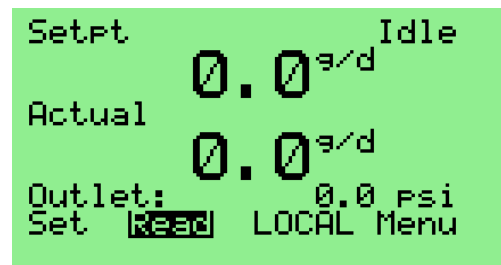


Figure 19 – Startup Screen with Outlet Pressure

- 5.8 If one Analog Input port is configured to monitor inlet pressure and the other Analog Input port is configured to monitor outlet pressure, the LCD will alternately display the inlet pressure and the outlet pressure on the same line.

### 6. Measuring Flow

- 6.1 Press the UP or DOWN button until the “Read” field is highlighted.

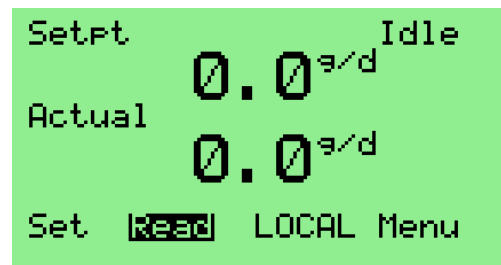


Figure 20 – Selecting Flow Measurement

- 6.2 Press the ENTER button to start a PDFM measurement. The Device Status field changes from “Idle” to “Reading FM...” to indicate that a measurement is in progress. If necessary, the measurement process can be aborted by pressing the ENTER button with the “Abort” field highlighted. Note that, when measuring very low flows, it may take as long as 70 seconds for a measurement to complete.

```

Setpt  Reading FM...
      0.0 g/d
Actual 0.0 g/d
Abort  LOCAL Menu
  
```

Figure 21 – Reading Flow Meter

- 6.3 Once the measurement is complete, the “Actual” field of the screen updates to display the measured flow.

## 7. Setting Flow

- 7.1 Press the UP or DOWN button until the “Setpt” field is highlighted.

```

Setpt  Idle
      0.0 g/d
Actual 0.0 g/d
Set  Read  LOCAL Menu
  
```

Figure 22 – Entering Set Point

- 7.2 Enter the desired flow using the *Numeric Entry* editing method (as described in section 0), then use the DOWN button to highlight the “Set” field. (In this example, the setpoint is changed to ‘9.3 g/d’.)

```

Setpt  Idle
      9.30 g/d
Actual 0.0 g/d
Set  Read  LOCAL Menu
  
```

Figure 23 – Setting Flow Rate

- 7.3 Press the ENTER button to command the SF3 to change its output flow to match the specified setpoint value.
- 7.4 The SF3 starts by measuring the current flow rate. Based on the value obtained, it adjusts the stem to a new position, waits until the configured post-move delay period has expired, and re-measures the flow. During the process, the status of flow measurement and stem adjustment operations is

displayed in the Device Status field. The process is repeated until either the specified setpoint flow is achieved or the configured maximum number of adjustments is reached.

- 7.5 To configure the post-move delay and maximum number of adjustments parameters, see section 11.

## 8. Device Status Messages

- 8.1 Table 1 summarizes the status and error messages that may be displayed in the Device Status field of the “Startup” and other screens.

Table 1 – Device Status Messages

Message	Description
Idle	No operation is in progress.
Opening (pp.p%)	The stem is opening (pp.p is the current stem position).
Closing (pp.p%)	The stem is closing (pp.p is the current stem position).
Waiting (mm:ss)	The post-move delay is active (mm:ss displays the number of minutes and seconds remaining).
Reading FM...	A flow meter measurement is in progress.
Duty cycle ltd	The maximum on-time for the motor that controls stem position has been exceeded. To clear this condition, wait 10 minutes or longer, then retry the operation that generated this message.
INVALID SETPT	The specified setpoint flow value is outside of the calibrated flow range of the SF3. To clear this fault, specify a flow rate supported by the SF3 in its Reference Table and retry setting the flow rate.
0-FLOW SHUTDN	A zero-flow shutdown (ZFS) condition is in effect. See section 14 for more information on ZFS and how to clear this condition.
NO REF TABLE	The SF3 has no valid Reference Table. To clear this fault, create a Reference Table as described in section 35, then retry setting the flow rate.
NO FLOWMETER	No flow meter (internal PDFM or external flow meter) is configured for the SF3. To clear this fault, configure a flow meter as described in section 15.
MOTOR STALL	A stall condition was detected for the motor that controls stem position. To clear this fault, retry setting a flow or a stem position; if the fault persists, contact SkoFlo for assistance.
NO VALVE PROF	No valid valve profile exists for this SF3. Contact SkoFlo for assistance.
NO LVDT TABLE	No valid PDFM calibration table exists for this SF3. Contact SkoFlo for assistance.

Message	Description
ERR 26	The piston in the PDFM has not returned to its proper starting position. Contact SkoFlo for assistance.
ERR 30	An over-current condition was detected in the solenoid that controls the PDFM. Contact SkoFlo for assistance.
ERR 35	A fault has been detected in the encoder that is used to determine stem position. Contact SkoFlo for assistance.

## CONFIGURATION SCREENS

### 9. Run/Stop

- 9.1 In the "Stopped" state, the display is backlit in blue, and the following operations are disabled: taking a PDFM measurement, setting a flow rate, setting a stem position.
- 9.2 In the "Run" state, the display is backlit in green, and all operations are available.
- 9.3 As shipped from the factory, the SF3 is configured to power up in the "Stopped" state.
- 9.4 To configure the Run/Stop parameters, navigate to the "Run/Stop" screen, shown below.

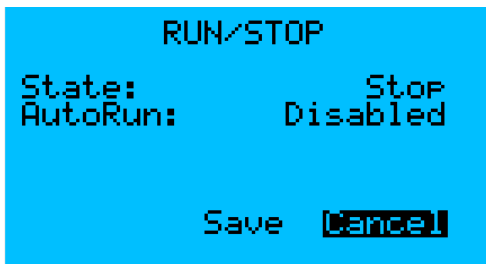


Figure 24 – Run/Stop Screen

- 9.5 The "State" parameter specifies whether the SF3 is in the "Run" or "Stopped" state. Its value is changed using the Option Selection method.
- 9.6 If the "AutoRun" parameter is configured as "Enabled", the SF3 is automatically put in the "Run" state after a power-cycle or software reboot. Its value is changed using the Option Selection method.
- 9.7 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.
- 9.8 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 10. Stem Control

- 10.1 To view the current stem status or set the stem to a new position, navigate to the "Stem Control" screen, shown below.

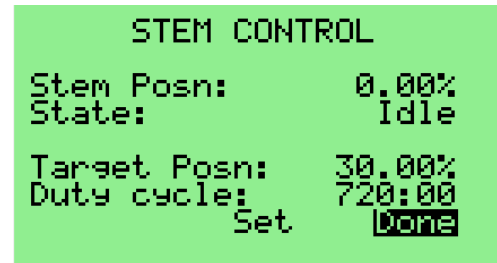


Figure 25 – Stem Control Screen

- 10.2 The "Stem Posn" field is a read-only display of the current stem position as a percentage of fully open.
- 10.3 The "State" field is a read-only display of the current device status. See Table 1 for a list of possible device status values.
- 10.4 The "Duty cycle" field is a read-only display of the number of hours and minutes remaining before a stem move will be blocked due to duty cycle limitations on the motor that controls the stem. Its value decreases when the stem is moving and increases (up to a firmware-controlled limit) when the stem is idle.
- 10.5 To set a new stem position, perform the following operations:
  - 10.5.1 Press the UP or DOWN button until the "Target Posn" field is highlighted.
  - 10.5.2 Specify the new stem position using the Numeric Entry method.
  - 10.5.3 Press the UP or DOWN button until the "Set" field is highlighted.
  - 10.5.4 Press the ENTER button to initiate the move to the new stem position. The "State" and "Stem Posn" fields update to reflect their current dynamic values, and the "Set" field becomes an "Abort" field, as shown below. Pressing the ENTER button when the "Abort" field is highlighted will terminate the move.

```

STEM CONTROL
Stem Posn:      31.56%
State:         Closing...

Target Posn:    30.00%
Duty cycle:    719:58
Abort Done
  
```

Figure 26 – Setting Stem Position 1

10.5.5 When the move completes, the screen is updated as shown below.

```

STEM CONTROL
Stem Posn:      30.00%
State:         Idle

Target Posn:    30.00%
Duty cycle:    720:00
Set Done
  
```

Figure 27 – Setting Stem Position 2

10.5.6 To exit the screen, press the UP or DOWN button until the "Done" field is highlighted, then press the ENTER button.

## 11. Flow Control Configuration

11.1 To configure the various parameters used by the SF3 when setting a flow rate, navigate to the "Cnfg: Flow Control" screen, shown below.

```

CNFG: FLOW CONTROL
Post-move:      0 secs
Max adjusts:    10

Save Cancel
  
```

Figure 28 – Flow Control Configuration Screen

11.2 The "Post-move" parameter specifies the number of seconds the SF3 will wait after moving to a new stem position before taking a new flow measurement. Its value is changed using the Option Selection method.

11.3 The "Max adjusts" parameter specifies the maximum number of times the SF3 will try moving the stem and measuring flow before terminating the operation. Its value is changed using the Option Selection method.

11.4 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.

11.5 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

## 12. PDFM and AFM Configuration

12.1 Autonomous Flow Measurement (AFM) is a feature in which the PDFM is configured to take flow measurements automatically at a configurable rate.

12.2 To configure the various PDFM and AFM parameters, navigate to the "Cnfg: PDFM/AFM" screen, shown below.

```

CNFG: PDFM/AFM
Bulk mod:      0.0 psi
Spec gravity:  1.0000
AFM state:     Disabled
AFM period:    15 min
AFM auto-restart: No

Save Cancel
  
```

Figure 29 – PDFM/AFM Configuration Screen

12.3 The "Bulk mod" parameter specifies (in the currently configured pressure unit) the value of bulk modulus used by the SF3. This value is used to compensate the PDFM flow value for the effects of inlet pressure. If the value '0.0' is specified, no compensation will be made. Its value is changed using the Numeric Entry method.

12.4 The "Spec gravity" parameter specifies the value of specific gravity used by the SF3 to calculate mass flow rate when the flow unit is set to "kg/m". Its value is changed using the Numeric Entry method.

12.5 The "AFM state" parameter specifies whether AFM is enabled or disabled. Its value is changed using the Option Selection method.

12.6 The "AFM period" parameter specifies how often, in minutes, the SF3 takes a flow measurement with the PDFM. Its minimum value is '5', and its maximum value is '65534' (18.2 hours). Its value is changed using the Numeric Entry method.

12.7 The "AFM auto-restart" parameter specifies whether AFM is enabled automatically after a power-cycle or software reboot. Its value is changed using the Option Selection method.

- 12.8 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.
- 12.9 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 13. Continuous Setpoint Regulation (CSR) Configuration

- 13.1 Continuous Setpoint Regulation is a feature in which the stem adjusts autonomously to keep the actual flow rate (as measured by the flow meter) at the current setpoint value.
- 13.2 A deadband parameter is used to determine how much error between the setpoint and the measured flow rate is allowed before a CSR adjustment is triggered.
- 13.3 To configure the various CSR parameters, navigate to the "Cnfg: CSR" screen, shown below.

```

CNFG: CSR
State:      Disabled
Period:     15 min
Deadband:   0.0 g/d
Deadband Pct: 3.0%
Use deadband Pct: Yes
Auto-enable: No
Save  [Cancel]

```

**Figure 30 – CSR Configuration Screen**

- 13.4 The "State" parameter specifies whether CSR is enabled or disabled. Its value is changed using the Option Selection method.
- 13.5 The "Period" parameter specifies how often, in minutes, the SF3 checks whether the actual flow is outside the deadband. Its minimum value is '5', and its maximum value is '65534' (45.5 days). Its value is changed using the Numeric Entry method.
- 13.6 The "Deadband" parameter specifies the deadband as a flow, in the currently configured flow unit; its value is only used if the "Use deadband pct" parameter is set to "No". Its value is changed using the Numeric Entry method.
- 13.7 The "Deadband pct" parameter specifies the deadband as a percent of the current flow setpoint; its value is only used if the "Use deadband pct" parameter is set to "Yes". Its value is changed using the Numeric Entry method.

- 13.8 The "Use deadband pct" parameter specifies whether the deadband is a flow or a percent of the flow setpoint. Its value is changed using the Option Selection method.
- 13.9 The "Auto-enable" parameter specifies whether CSR is automatically enabled after a power-cycle or software reboot. Its value is changed using the Option Selection method.
- 13.10 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.
- 13.11 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 14. Zero-Flow Shutdown (ZFS) Configuration

- 14.1 Zero-Flow Shutdown is a feature in which the stem is commanded to close fully if zero-flow readings are obtained from a configurable number of consecutive flow measurements.
- 14.2 A ZFS condition is cleared by commanding the SF3 to set a flow rate or to move to a new stem position.
- 14.3 To configure the various ZFS parameters, navigate to the "Cnfg: ZFS" screen, shown below.

```

CNFG: ZFS
State:      Disabled
Max 0-flow reads: 4
Save  [Cancel]

```

**Figure 31 – ZFS Configuration Screen**

- 14.4 The "State" parameter specifies whether the ZFS feature is enabled or disabled. Its value is changed using the Option Selection method.
- 14.5 The "Max 0-flow reads" parameter specifies the number of consecutive zero-flow readings required to trigger a shutdown. Its minimum value is '1', and its maximum value is '9'. Its value is changed using the Option Selection method.
- 14.6 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.



14.7 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 15. Hardware Configuration

15.1 To configure the various hardware features of the SF3, navigate to the “Cnfg: Hardware” screen, shown below.

```

CNFG: HARDWARE
FlowMeter:      Internal
AnaIn 1:       Unused
AnaIn 2:       Unused
AnaOut Src:    Unused
AnaOut Mode:   Disabled

Save  [Cancel]
    
```

Figure 32 – Hardware Configuration Screen

- 15.2 All hardware configuration parameters are changed using the Option Selection method.
- 15.3 The “FlowMeter” parameter specifies the type of flow meter (if any) to be used to provide flow measurements.
- 15.4 Table 2 summarizes the options available for the Flow Meter parameter.

Table 2 – Flow Meter Options

Option	Description
None	Flow measurements are not supported.
Internal	The internal flow meter is used for flow measurements.

- 15.5 The “Analn 1” and “Analn 2” parameters specify how the SF3 interprets electrical signals it receives through the Analog Input 1 port and the Analog Input 2 port, respectively.
- 15.6 Table 3 summarizes the options available for the Analog Input 1 and Analog Input 2 parameters.

Table 3 – Analog Input 1 and 2 Options

Option	Description
Unused	Information received through the port is ignored.
Inlet press	The value represents the pressure measured at the inlet of the SF3.
Outlet press	The value represents the pressure measured at the outlet of the SF3.
Flow setpt	The value represents the flow rate setpoint to be maintained by the SF3.

- 15.7 The “AnaOut Src” parameter specifies the property whose process value is represented by the current or voltage signal produced by the Analog Output port.
- 15.8 Table 4 summarizes the options available for the Analog Output Source parameter.

Table 4 – Analog Output Source Options

Option	Description
Unused	No process value is represented. The port provides a constant 0-mA or 0-Volt output, depending on the Analog Output Mode configuration.
PDFM flow	The output represents the current PDFM flow measurement, adjusted per the value of the Bulk Modulus parameter.
PDFM raw	The output represents the current unadjusted PDFM flow measurement
Analn1 PV	The output represents the process value currently configured for Analog Input 1.
Analn2 PV	The output represents the process value currently configured for Analog Input 2.

- 15.9 The “AnaOut Mode” parameter specifies whether the Analog Output port outputs a current or a voltage signal, as well as the minimum and maximum values for that signal.
- 15.10 Table 5 summarizes the options available for the Analog Output Mode parameter.

Table 5 – Analog Output Mode Options

Option	Description
Disabled	No signal is output at the port.
4-20 mA	Output is a current with range 4 mA to 20 mA.
0-20 mA	Output is a current with range 0 mA to 20 mA.
0-24 mA	Output is a current with range 0 mA to 24 mA.



<b>0-5 V</b>	Output is a voltage with range 0 V to 5 V.
<b>0-10 V</b>	Output is a voltage with range 0 V to 10 V.
<b>+/-5 V</b>	Output is a voltage with range -5 V to +5 V.
<b>+/-10 V</b>	Output is a voltage with range -10 V to +10 V.

15.11 The “AnaIn 1” and “AnaIn 2” parameters may not be configured to the same option (except for “Unused”). If such configuration is attempted, an error message will appear and the “Save” field will disappear, as shown below. Changing one of analog input options will remove the error condition.

```

CNFG: HARDWARE
FlowMeter: Internal
AnaIn 1: Inlet press
AnaIn 2: Inlet press
AnaOut Src: Unused
AnaOut Mode: Disabled
ERR: AnaIn1=AnaIn2
Cancel
    
```

**Figure 33 – Hardware Configuration Error Screen**

15.12 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button.

15.13 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 16. Engineering Units Configuration

16.1 To configure the engineering units used to specify flow, pressure, and temperature, navigate to the “Cnfg: Engrg Units” screen, shown below.

```

CNFG: ENGRG UNITS
Flow: g/d
Pressure: Psi
Temperature: °F

Save Cancel
    
```

**Figure 34 – Engineering Units Configuration Screen**

16.2 Flow, pressure, and temperature units are changed using the Option Selection method.

16.3 Table 6 summarizes the abbreviations used in the Flow, Pressure, and Temperature fields.

**Table 6 – Unit Abbreviations**

Abbreviation	Property	Unit
<b>g/d</b>	flow	U.S. gallons per day
<b>g/h</b>	flow	U.S. gallons per hour
<b>g/m</b>	flow	U.S. gallons per minute
<b>l/d</b>	flow	liters per day
<b>l/h</b>	flow	liters per hour
<b>l/m</b>	flow	liters per minute
<b>m<sup>3</sup>/d</b>	flow	cubic meters per day
<b>m<sup>3</sup>/h</b>	flow	cubic meters per hour
<b>m<sup>3</sup>/m</b>	flow	cubic meters per minute
<b>mL/d</b>	flow	milliliters per day
<b>mL/h</b>	flow	milliliters per hour
<b>mL/m</b>	flow	milliliters per minute
<b>kg/m</b>	flow (mass flow)	kilograms per minute
<b>psi</b>	pressure	pounds per square inch
<b>bar</b>	pressure	bar
<b>kPa</b>	pressure	kilopascal
<b>°F</b>	temperature	degrees Fahrenheit
<b>°C</b>	temperature	degrees Centigrade

16.4 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button.

16.5 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 17. PDFM Hardware Configuration 1

17.1 To view the first set of parameters used to control the operation of the PDFM, navigate to the “Cnfg: PDFM Hardware 1” screen, shown below.

```

CNFG: PDFM HARDWARE 1
HiV on-time: 50 ms
Piston const: 0.2276
LUDT Pri ampl: 750

Cancel
    
```

**Figure 35 – PDFM Hardware Configuration 1 Screen**

17.2 The fields display control parameter values that are configured at the factory.

17.3 To exit the screen, press the ENTER button.

## 18. PDFM Hardware Configuration 2

- 18.1 To view the second set of parameters used to control the operation of the PDFM, navigate to the “**Cnfg: PDFM Hardware 2**” screen, shown below.

```

CNFG: PDFM HARDWARE 2
LVDT Phase cal:      7
State:               Idle
                    [EXIT]
  
```

**Figure 36 – PDFM Hardware Configuration 2 Screen**

- 18.2 The fields display control parameter values that are configured at the factory.
- 18.3 To exit the screen, press the ENTER button.

## 19. Analog Setpoint Control

- 19.1 To configure the parameters associated with controlling setpoints based on the current flowing into one of the analog input ports, navigate to the “**Analog Setpt Control**” screen, shown below. (The Analog Setpoint Control feature is active when the “Flow Setpt” option is configured for either Analog Input 1 or Analog Input 2. See Section 15 for details.)

```

ANALOG SETPT CONTROL
OnAnaInUnderrange:
  Setpt To Cal Limit
OnAnaInOverrange:
  Move Stem To Max
                    Save [Cancel]
  
```

**Figure 37 – Analog Setpoint Control**

- 19.2 All analog setpoint control configuration parameters are changed using the Option Selection method.
- 19.3 The “OnAnaInUnderrange” parameter specifies how the SF3 behaves if Analog Setpoint Control is active and the configured analog input current falls below 4 mA.
- 19.4 The “OnAnaInOverrange” parameter specifies how the SF3 behaves if Analog Setpoint Control is active and the configured analog input current rises above 20 mA.

- 19.5 Table 7 summarizes the options available for the “OnAnaInUnderrange” parameter.

**Table 7 – OnAnaInUnderrange Options**

Option	Description
<b>No Setpt Change</b>	The SF3 flow setpoint remains at the value it had before the input current fell below 4 mA.
<b>Setpt To Cal Limit</b>	The SF3 flow setpoint is set to the flow value configured for an input current of 4 mA.
<b>Move Stem to Min</b>	The stem moves to the minimum stem percent position (0%).
<b>Move Stem to Max</b>	The stem moves to the maximum stem percent position.

- 19.6 Table 8 summarizes the options available for the “OnAnaInOverrange” parameter.

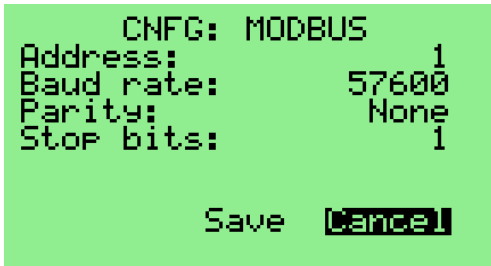
**Table 8 – OnAnaInOverrange Options**

Option	Description
<b>No Setpt Change</b>	The SF3 flow setpoint remains at the value it had before the input current rose above 20 mA.
<b>Setpt To Cal Limit</b>	The SF3 flow setpoint is set to the flow value configured for an input current of 20 mA.
<b>Move Stem to Min</b>	The stem moves to the minimum stem percent position (0%).
<b>Move Stem to Max</b>	The stem moves to the maximum stem percent position.

- 19.7 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button.
- 19.8 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 20. Modbus Configuration

- 20.1 To configure the Modbus communication parameters for communication between a remote computer and this SF3, navigate to the “**Cnfg: Modbus**” screen, shown below.



**Figure 38 – Modbus Configuration Screen**

- 20.2 The “Address” parameter specifies the Modbus address used to access this SF3 from a remote computer. Its minimum value is ‘1’, and its maximum value is ‘247’. Its value is changed using the Numeric Entry method. The SF3 is shipped from the factory with the Address parameter set to ‘1’.
- 20.3 The “Baud rate” parameter specifies the bit rate at which a remote computer communicates with this SF3. Its value is changed using the Option Selection method.
- 20.4 Table 9 summarizes the options available for the Baud Rate parameter. The SF3 is shipped from the factory with the Baud Rate parameter set to ‘57600’.

**Table 9 – Modbus Baud Rate Options**

Option
1200
2400
4800
9600
19200
38400
57600

- 20.5 The “Parity” parameter specifies type of parity used in communications between a remote computer and this SF3. Its value is changed using the Option Selection method.
- 20.6 Table 10 summarizes the options available for the Parity parameter. The SF3 is shipped from the factory with this parameter set to ‘None’.

**Table 10 – Modbus Parity Options**

Option
None
Odd
Even

- 20.7 The “Stop bits” parameter specifies the number of stop bits used in communications between a remote computer and this SF3. Its value is changed using the Option Selection method.
- 20.8 Table 11 summarizes the options available for the Stop Bits parameter. The SF3 is shipped from the factory with this parameter set to ‘1’.

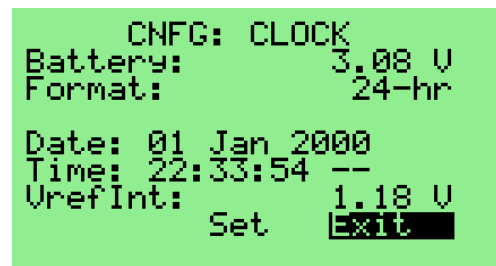
**Table 11 – Modbus Stop Bits Options**

Option
1
2
1.5

- 20.9 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button. **Note:** The new configuration will not take effect until the SF3 is power-cycled or software rebooted.
- 20.10 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 21. Clock Configuration

- 21.1 To configure the real-time clock and its associated parameters, navigate to the “Cnfg: Clock” screen, shown below.



**Figure 39 – Clock Configuration Screen 1**

- 21.2 To change any of the clock settings, press the UP or DOWN button until the “Set” field is highlighted, then press the ENTER button.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 01 Jan 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 40 – Clock Configuration Screen 2

21.3 The “Format” parameter specifies whether the time is displayed in 12-hour or 24-hour format. Its value is changed using the Option Selection method.

21.4 To set the date, do the following:

21.4.1 Press the UP or DOWN button until the field to the right of the “Date:” label is highlighted.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 01 Jan 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 41 – Setting the Date 1

21.4.2 Enter the day of the month using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jan 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 42 – Setting the Date 2

21.4.3 Press the DOWN button to highlight the Month field.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 43 – Setting the Date 3

21.4.4 Enter the month using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 44 – Setting the Date 4

21.4.5 Press the DOWN button to highlight the Year field.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 45 – Setting the Date 5

21.4.6 Enter the year using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2000
Time: 22:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 46 – Setting the Date 6

21.5 To set the time, do the following:

21.5.1 Press the UP or DOWN button until the field to the right of the “Time:” label is highlighted.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 47 – Setting the Time 1

21.5.2 Enter the hour using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 48 – Setting the Time 2

21.5.3 Press the DOWN button to highlight the Minute field.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:37:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 49 – Setting the Time 3

21.5.4 Enter the minute using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:52:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 50 – Setting the Time 4

21.5.5 Press the DOWN button to highlight the Second field.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:52:55 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 51 – Setting the Time 5

21.5.6 Enter the seconds using the Option Selection method.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:52:00 --
UrefInt:     1.18 V
          Save  Cancel

```

Figure 52 – Setting the Time 6

21.5.7 If the format is set to “12-hr”, use the DOWN button to highlight the “AM/PM” field, and enter the desired value using the Option Selection method.

21.6 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

21.7 To apply the changes that have been specified, navigate to the “Save” field and press the ENTER button.

```

CNFG: CLOCK
Battery:      3.08 V
Format:      24-hr

Date: 18 Jun 2020
Time: 13:52:58 --
UrefInt:     1.18 V
          Set   Exit

```

Figure 53 – Setting the Time 7

21.8 Press the DOWN button to highlight the “Exit” field, then press the ENTER button to exit the screen.

## 22. LCD Configuration

- 22.1 To view the parameters that control the appearance of the LCD and control the heater that regulates its temperature, navigate to the “**Cnfg: LCD**” screen, shown below.

```

CNFG: LCD
LCD temp:      3.98°F
Heater state:  On
Heater mode:   Control
Setpoint:     50.00°F
Hysteresis:    2.00°F
Contrast:      25
               Cancel

```

Figure 54 – LCD Configuration Screen

- 22.2 The “LCD temp” field displays the current temperature of the LCD assembly, as measured by a sensor in the assembly.
- 22.3 The remaining fields display the values of control parameters that are set at the factory.
- 22.4 To exit the screen, press the ENTER button.

## 23. User Interface (UI) Configuration

- 23.1 To configure the various features of the user interface, navigate to the “**Cnfg: UI**” screen, shown below.

```

CNFG: UI
Timeout:      30 sec
              Save Cancel

```

Figure 55 – UI Configuration Screen

- 23.2 The “Timeout” parameter specifies (for screens that do not display real-time data) how long, in seconds, the SF3 keeps the screen active before automatically returning to the “**Startup**” screen if no buttons are pressed. The minimum value is ‘30’, and the maximum value is ‘65534’ (about 18 hours). Its value is changed using the Numeric Entry method.
- 23.3 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button.

- 23.4 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

## 24. Hardware Monitors

- 24.1 To view usage statistics for the PDFM and actuator installed in the SF3, navigate to the “**Hardware Monitors**” screen, shown below.

```

HARDWARE MONITORS
PDFM Ops:      0
Actr Revs:     84.7
               Exit

```

Figure 56 – Hardware Monitors Screen

- 24.2 The “PDFM Ops” field displays the number of times the PDFM has been activated to perform a flow measurement.
- 24.3 The “Actr Revs” field displays the number of revolutions the stem has made in its execution of stem position-setting requests.
- 24.4 To exit the screen, press the ENTER button.

## 25. General Configuration

- 25.1 To view information about the PCB and firmware installed in the SF3, navigate to the “**Cnfg: General**” screen, shown below.

```

CNFG: GENERAL
PCB P/n:      90064 Rev A
PCB s/n:      90064002
Boot FW ver:  1.3
App FW ver:   1.5
Unique ID:    000E801C
              -53345704-20313031
              Exit

```

Figure 57 – General Configuration Screen

- 25.2 To exit the screen, press the ENTER button.

## 26. Serial Numbers

- 26.1 To view the serial numbers assigned to the PCB, the actuator, and the valve installed in the SF3, navigate to the “**Serial Numbers**” screen, shown below.

```

SERIAL NUMBERS
PCB:          1007
Actuator:     A12345
Valve:        U54321
               Done
  
```

Figure 58 – Serial Numbers Screen

26.2 To exit the screen, press the ENTER button.

## 27. Reboot

27.1 To reboot the processor in the SF3, navigate to the “Reboot” screen, shown below.

```

REBOOT
Reboot  Cancel
  
```

Figure 59 – Reboot Screen

27.2 To exit the screen without rebooting the processor, navigate to the “Cancel” field and press the ENTER button.

27.3 To reboot the processor, navigate to the “Reboot” field and press the ENTER button. The SF3 will go through its power-up initialization sequence, after which the “Startup” screen will appear.

## 28. Factory Use Only

28.1 This screen should only be used if directed to do so by a qualified SkoFlo Industries representative.

## CALIBRATION SCREENS

### 29. Analog Input 1 Process Calibration

29.1 The process calibration for Analog Input 1 is used to specify the relationship between the current (in mA) flowing from an external transducer into Analog Input 1 and the process value that is represented by that current.

29.2 Before starting this calibration, make sure that Analog Input 1 is configured for the desired transducer property. Section 15 describes how to do this configuration. In this example, Analog Input 1 is configured for Inlet Pressure.

29.3 Navigate to the “Process Cal: Ana In 1” screen, shown below.

```

PROCESS CAL: ANA IN 1
Confia:      Flow setpt
CtrlDeadband: 100 uA
Curr(mA)    Flow( a/d)
  4.00      0.0
 20.00     0.0
Save  Cancel
  
```

Figure 60 – Analog Input 1 Process Calibration 1

29.4 Press the UP or DOWN button until the field to the right of the lesser input current value (‘4.00 mA’, in this example) is highlighted.

```

PROCESS CAL: ANA IN 1
Confia:      Flow setpt
CtrlDeadband: 100 uA
Curr(mA)    Flow( a/d)
  4.00      0.0
 20.00     0.0
Save  Cancel
  
```

Figure 61 – Analog Input 1 Process Calibration 2

29.5 Using the Numeric Entry method, enter the transducer process value (‘10.0 psi’, in this example) that corresponds to the lesser input current value.

```

PROCESS CAL: ANA IN 1
Confia:      Flow setpt
CtrlDeadband: 100 uA
Curr(mA)    Flow( a/d)
  4.00      10.0
 20.00     0.0
Save  Cancel
  
```

Figure 62 – Analog Input 1 Process Calibration 3

29.6 Press the UP or DOWN button until the field to the right of the greater input current value (‘20.00 mA’, in this example) is highlighted.



```

PROCESS CAL: ANA IN 1
Config:      Flow setpt
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      10.0
 20.00      0.0
Save Cancel

```

Figure 63 – Analog Input 1 Process Calibration 4

- 29.7 Using the Numeric Entry method, enter the transducer process value ('5000.0 psi', in this example) that corresponds to the greater input current value.

```

PROCESS CAL: ANA IN 1
Config:      Flow setpt
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      10.0
 20.00      5000.0
Save Cancel

```

Figure 64 – Analog Input 1 Process Calibration 5

- 29.8 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.
- 29.9 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 30. Analog Input 2 Process Calibration

- 30.1 The process calibration for Analog Input 2 is used to specify the relationship between the current (in mA) flowing from an external transducer into Analog Input 2 and the process value that is represented by that current.
- 30.2 Before starting this calibration, make sure that Analog Input 2 is configured for the desired transducer property. Section 15 describes how to do this configuration. In this example, Analog Input 2 is configured for Outlet Pressure.
- 30.3 Navigate to the "**Process Cal: Ana In 2**" screen, shown below.

```

PROCESS CAL: ANA IN 2
Config:      Unused
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      0.0
 20.00      0.0
Save Cancel

```

Figure 65 – Analog Input 2 Process Calibration 1

- 30.4 Press the UP or DOWN button until the field to the right of the lesser input current value ('4.00 mA', in this example) is highlighted.

```

PROCESS CAL: ANA IN 2
Config:      Unused
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      0.0
 20.00      0.0
Save Cancel

```

Figure 66 – Analog Input 2 Process Calibration 2

- 30.5 Using the Numeric Entry method, enter the transducer process value ('20.0 psi', in this example) that corresponds to the lesser input current value.

```

PROCESS CAL: ANA IN 2
Config:      Unused
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      20.0
 20.00      0.0
Save Cancel

```

Figure 67 – Analog Input 2 Process Calibration 3

- 30.6 Press the UP or DOWN button until the field to the right of the greater input current value ('20.00 mA', in this example) is highlighted.

```

PROCESS CAL: ANA IN 2
Config:      Unused
CtrlDeadband: 100 uA
Curr(mA)    Flow( g/d)
  4.00      20.0
 20.00      0.0
Save Cancel

```

Figure 68 – Analog Input 2 Process Calibration 4

- 30.7 Using the Numeric Entry method, enter the transducer process value ('8000.0 psi', in this example) that corresponds to the greater input current value.

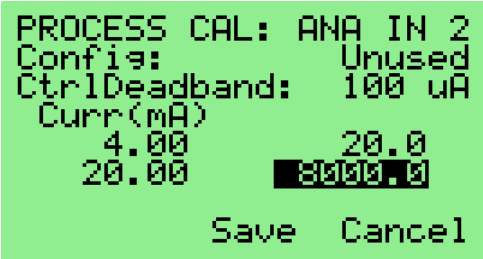


Figure 69 – Analog Input 2 Process Calibration 5

- 30.8 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.
- 30.9 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 31. Analog Output Process Calibration

- 31.1 The process calibration for the Analog Output is used to specify the relationship between the current (in mA) or voltage (in Volts) emitted by the Analog Output and the process value that is represented by that current or voltage.
- 31.2 Before starting this calibration, make sure that the Analog Output is configured for the desired output source and output mode. Section 15 describes how to do this configuration. In this example, the output source is configured for PDFM Flow and the output mode is configured as a 4-20 mA current source.
- 31.3 Navigate to the "Process Cal: Ana Out" screen, shown below.

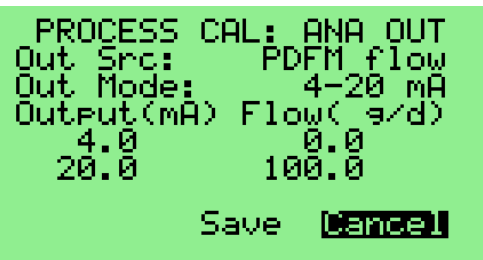


Figure 70 – Analog Output Process Calibration 1

- 31.4 Press the UP or DOWN button until the field to the right of the lesser output current value ('4.0 mA', in this example) is highlighted.

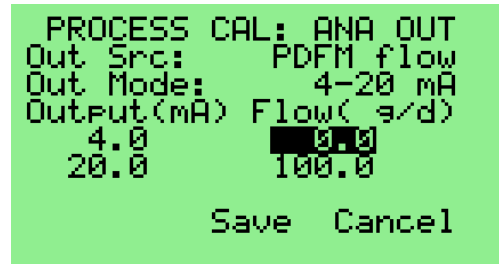


Figure 71 – Analog Output Process Calibration 2

- 31.5 Using the Numeric Entry method, enter the output process value ('1.0 g/d', in this example) that corresponds to the lesser output current value.

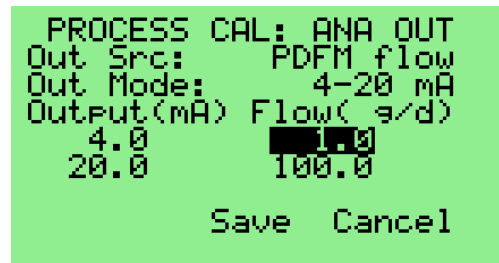


Figure 72 – Analog Output Process Calibration 3

- 31.6 Press the UP or DOWN button until the field to the right of the greater output current value ('20.0 mA', in this example) is highlighted.

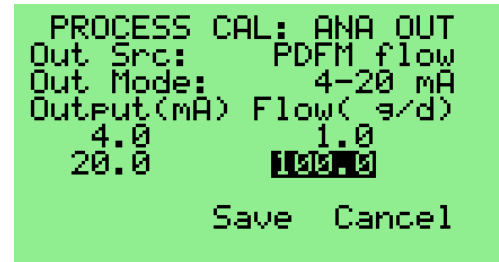


Figure 73 – Analog Output Process Calibration 4

- 31.7 Using the Numeric Entry method, enter the sensor process value ('700.0 g/d', in this example) that corresponds to the greater output current value.

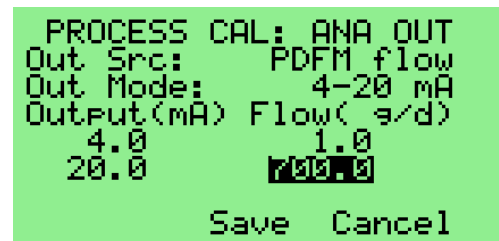


Figure 74 – Analog Output Process Calibration 5

- 31.8 To apply the changes that have been specified and exit the screen, navigate to the "Save" field and press the ENTER button.

- 31.9 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

### 32. Analog Input 1 Analog Calibration

- 32.1 The analog calibration for Analog Input 1 is used to determine the relationship between the current (in mA) flowing into the Analog Input 1 port and the digital value that represents it in the SF3 firmware.
- 32.2 A calibrated current source with an output range of at least 4 mA to 20 mA is required to perform this calibration. The output of the current source must be applied to the Analog Input 1 port.
- 32.3 Navigate to the "Analog Cal: Ana In 1" screen, shown below.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 0.41    FU: 0

PV1: 4.0   FU1: 9072
PV2: 20.0  FU2: 49499

Set_FV1 Set_FV2 Done

```

Figure 75 – Analog Input 1 Analog Calibration 1

- 32.4 Press the UP or DOWN button until the "Set\_FV1" field is highlighted.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 0.41    FU: 0

PV1: 4.0   FU1: 9072
PV2: 20.0  FU2: 49499

Set_FV1 Set_FV2 Done

```

Figure 76 – Analog Input 1 Analog Calibration 2

- 32.5 Configure the current source to supply 4 mA of current to the Analog Input 1 port. Wait 1 minute or longer for the value displayed in the "FU:" field to stabilize.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 3.90    FU: 8811

PV1: 4.0   FU1: 9073
PV2: 20.0  FU2: 49230

Set_FV1 Set_FV2 Done

```

Figure 77 – Analog Input 1 Analog Calibration 3

- 32.6 Press the ENTER button to capture the first calibration value. The value displayed in the "PV:" field updates to match the value in the "PV1:" field, and the value displayed in the "FU:" field updates to match the value in the "FU:" field.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 4.00    FU: 8811

PV1: 4.0   FU1: 8811
PV2: 20.0  FU2: 49230

Set_FV1 Set_FV2 Done

```

Figure 78 – Analog Input 1 Analog Calibration 4

- 32.7 Press the DOWN button to highlight the "Set\_FV2" field.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 4.00    FU: 8811

PV1: 4.0   FU1: 8811
PV2: 20.0  FU2: 49230

Set_FV1 Set_FV2 Done

```

Figure 79 – Analog Input 1 Analog Calibration 5

- 32.8 Configure the current source to supply 20 mA of current to the Analog Input 1 port. Wait 1 minute or longer for the value displayed in the "FU:" field to stabilize.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 20.11   FU: 49500

PV1: 4.0   FU1: 8811
PV2: 20.0  FU2: 49230

Set_FV1 Set_FV2 Done

```

Figure 80 – Analog Input 1 Analog Calibration 6

- 32.9 Press the ENTER button to capture the second calibration value. The value displayed in the "PV:" field updates to match the value in the "PV2:" field, and the value displayed in the "FU:" field updates to match the value in the "FU:" field.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 20.00    FU: 49500

PV1: 4.0    FU1: 8811
PV2: 20.0   FU2: 49500

Set_FV1 Set_FV2 Done

```

Figure 81 – Analog Input 1 Analog Calibration 7

- 32.10 Press the DOWN button to highlight the “Done” field.

```

ANALOG CAL: ANA IN 1
Unit: mA
PV: 20.00    FU: 49500

PV1: 4.0    FU1: 8811
PV2: 20.0   FU2: 49500

Set_FV1 Set_FV2 Done

```

Figure 82 – Analog Input 1 Analog Calibration 8

- 32.11 Press the ENTER button to exit the screen.

### 33. Analog Input 2 Analog Calibration

- 33.1 The analog calibration for Analog Input 2 is used to determine the relationship between the current (in mA) flowing into the Analog Input 2 port and the digital value that represents it in the SF3 firmware.
- 33.2 A calibrated current source with an output range of at least 4 mA to 20 mA is required to perform this calibration. The output of the current source must be applied to the Analog Input 2 port.
- 33.3 Navigate to the “Analog Cal: Ana In 2” screen, shown below.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 0.07     FU: 0

PV1: 4.0    FU1: 9694
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 83 – Analog Input 2 Analog Calibration 1

- 33.4 Press the UP or DOWN button until the “Set\_FV1” field is highlighted.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 0.07     FU: 0

PV1: 4.0    FU1: 9694
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 84 – Analog Input 2 Analog Calibration 2

- 33.5 Configure the current source to supply 4 mA of current to the Analog Input 2 port. Wait 1 minute or longer for the value displayed in the “FV:” field to stabilize.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 3.89     FU: 9434

PV1: 4.0    FU1: 9694
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 85 – Analog Input 2 Analog Calibration 3

- 33.6 Press the ENTER button to capture the first calibration value. The value displayed in the “PV:” field updates to match the value in the “PV1:” field, and the value displayed in the “FV1:” field updates to match the value in the “FV:” field.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 4.00     FU: 9432

PV1: 4.0    FU1: 9432
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 86 – Analog Input 2 Analog Calibration 4

- 33.7 Press the DOWN button to highlight the “Set\_FV2” field.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 4.00     FU: 9432

PV1: 4.0    FU1: 9432
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 87 – Analog Input 2 Analog Calibration 5

- 33.8 Configure the current source to supply 20 mA of current to the Analog Input 2 port. Wait 1 minute or longer for the value displayed in the “FV:” field to stabilize.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 19.90    FU: 48878

PV1: 4.0    FU1: 9432
PV2: 20.0   FU2: 49135

Set_FV1 Set_FV2 Done

```

Figure 88 – Analog Input 2 Analog Calibration 6

- 33.9 Press the ENTER button to capture the second calibration value. The value displayed in the "PV:" field updates to match the value in the "PV2:" field, and the value displayed in the "FV2:" field updates to match the value in the "FV:" field.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 20.00    FU: 48882

PV1: 4.0    FU1: 9432
PV2: 20.0   FU2: 48882

Set_FV1 Set_FV2 Done

```

Figure 89 – Analog Input 2 Analog Calibration 7

- 33.10 Press the DOWN button to highlight the "Done" field.

```

ANALOG CAL: ANA IN 2
Unit: mA
PV: 20.00    FU: 48880

PV1: 4.0    FU1: 9432
PV2: 20.0   FU2: 48882

Set_FV1 Set_FV2 Done

```

Figure 90 – Analog Input 2 Analog Calibration 8

- 33.11 Press the ENTER button to exit the screen.

### 34. Analog Output Analog Calibration

- 34.1 The analog calibration for the Analog Output is used to determine the relationship between the digital value applied to the port by the SF3 firmware and the current (in mA) or voltage (in Volts) supplied by the Analog Output port.
- 34.2 A calibrated multimeter is required to perform this calibration. It must be connected to the Analog Output port.
- 34.3 Before starting this calibration, make sure that the Analog Output is configured for the desired output mode. Section 15 describes how to do this configuration. In this example, the output mode is configured as a  $\pm 5V$  voltage source, and the

multimeter must be configured to measure the voltage produced at the Analog Output port.

- 34.4 Navigate to the "Analog Cal: Ana Out" screen, shown below.

```

ANALOG CAL: ANA OUT
Mode: +/-5 V

Set_Min_FV
  PV1: -5.010 V
Set_Max_FV
  PV2: +4.970 V
Save Cancel

```

Figure 91 – Analog Output Analog Calibration 1

- 34.5 Press the UP or DOWN button until the "Set\_Min\_FV" field is highlighted.

```

ANALOG CAL: ANA OUT
Mode: +/-5 V

Set_Min_FV
  PV1: -5.010 V
Set_Max_FV
  PV2: +4.970 V
Save Cancel

```

Figure 92 – Analog Output Analog Calibration 2

- 34.6 Press the ENTER button to command the SF3 to set the Analog Output to its minimum value, then use the DOWN button to highlight the "PV1:" field.

```

ANALOG CAL: ANA OUT
Mode: +/-5 V

Set_Min_FV
  PV1: -5.010 V
Set_Max_FV
  PV2: +4.970 V
Save Cancel

```

Figure 93 – Analog Output Analog Calibration 3

- 34.7 Wait until the voltage reported by the multimeter stabilizes.
- 34.8 Using the Numeric Entry method, enter in the "PV1:" field the voltage value reported by the multimeter ('-4.995 V', in this example).

```

ANALOG CAL: ANA OUT
Mode:      +/-5 V

Set_Min_FV
  PU1:    -4.995 V
Set_Max_FV
  PU2:    +4.970 V
  Save  Cancel
  
```

Figure 94 – Analog Output Analog Calibration 4

- 34.9 Press the DOWN button to highlight the "Set\_Max\_FV" field.

```

ANALOG CAL: ANA OUT
Mode:      +/-5 V

Set_Min_FV
  PU1:    -4.995 V
Set_Max_FV
  PU2:    +4.970 V
  Save  Cancel
  
```

Figure 95 – Analog Output Analog Calibration 5

- 34.10 Press the ENTER button to command the SF3 to set the Analog Output to its maximum value, then use the DOWN button to highlight the "PV2:" field.

```

ANALOG CAL: ANA OUT
Mode:      +/-5 V

Set_Min_FV
  PU1:    -4.995 V
Set_Max_FV
  PU2:    +4.970 V
  Save  Cancel
  
```

Figure 96 – Analog Output Analog Calibration 6

- 34.11 Wait until the voltage reported by the multimeter stabilizes.
- 34.12 Using the Numeric Entry method, enter in the "PV2:" field the voltage value reported by the multimeter ('4.994 V', in this example).

```

ANALOG CAL: ANA OUT
Mode:      +/-5 V

Set_Min_FV
  PU1:    -4.995 V
Set_Max_FV
  PU2:    +4.994 V
  Save  Cancel
  
```

Figure 97 – Analog Output Analog Calibration 7

- 34.13 To apply the changes that have been entered and exit the screen, navigate to the "Save" field and press the ENTER button.

- 34.14 To exit the screen without saving any changes, navigate to the "Cancel" field and press the ENTER button.

## 35. Reference Table Calibration

- 35.1 The Reference Table is a table that specifies the flow values that were measured in this SF3 at each of a series of stem positions. Data in this table are used by the SF3 to calculate the first stem position to move to when a command to set a flow rate is processed.
- 35.2 Before generating a new table, ensure that flow is passing through the SF3.
- 35.3 To generate a Reference Table, first navigate to the "Cal: Ref Table" screen, shown below.

```

CAL: REF TABLE
MaxFlow:   TBD   9pd

Stem:     57.81%
Flow:     ?   9pd

Inc Dec Read Set Exit
  
```

Figure 98 – Reference Table Generation Screen

- 35.4 The first step is to determine the maximum flow to be recorded in the Reference Table. This is done by moving the stem and taking flow measurements until the desired maximum flow is obtained.
- 35.5 Press the UP or DOWN button until the "Inc" field is highlighted, then press and hold the ENTER button until the stem is opened to 100%.
- 35.6 To close the stem (*i.e.*, decrease the stem percentage), press the UP or DOWN button until the "Dec" field is highlighted, then press and hold the ENTER button until the desired stem position is reached. This position must be no greater than 90%.
- 35.7 To take a flow reading at the current stem position, press the UP or DOWN button until the "Read" field is highlighted, then press the ENTER button to start a PDFM measurement.
- 35.8 Repeat steps 35.6 and 35.7 as necessary until the desired maximum flow rate is found.

```

CAL: REF TABLE
MaxFlow:  TBD  aPd

Stem:  79.88%
Flow:  690.1 aPd

Inc Dec Read Set Exit

```

Figure 99 – Setting Max Flow

- 35.9 Press the UP or DOWN button until the “Set” field is highlighted, then press the ENTER button to record the maximum flow. The display changes to the **“Confirm Max Flow”** screen, as shown below.

```

CONFIRM MAX FLOW

MaxFlow:  690.1 aPd

MaxFlow is valid.

Back Start Exit

```

Figure 100 – Confirming Max Flow

- 35.10 If the specified flow is acceptable, press the ENTER button with “Start” highlighted to start the table generation process. (If not, or if the max flow is reported as invalid, press the UP button to highlight the “Back” field, press the ENTER button to return to the previous screen, and repeat steps 35.5 through 35.9.)
- 35.11 The **“Build Ref Table”** screen appears. The stem position and flow values are updated as the table generation process progresses.

```

BUILD REF TABLE
Stem Flow[a/d ]

1  90.79%  754.6
State:  Reading FM...
Inlet:  ? Psi
-- Pause --

```

Figure 101 – Generating the Reference Table

- 35.12 If desired, the table generation process may be paused by pressing the ENTER button with the “Pause” field highlighted. The screen updates, as shown below, when any active stem move, or flow meter read operation completes.

```

BUILD REF TABLE
Stem Flow[a/d ]

1  90.79%  888.3
2  88.04%  888.3
State:      Idle
Inlet:      ? Psi
Back Resume Abort

```

Figure 102 – Operation Paused

- 35.13 When the process is paused, the following options are available:

- Calibration can be restarted by pressing the ENTER button with the “Back” field highlighted.
- Calibration can be terminated by pressing the ENTER button with the “Abort” field highlighted.
- Calibration can be continued by pressing the ENTER button with the “Resume” field highlighted.

- 35.14 The data collection operation is complete when the “State” field reports “Idle” and “Back” and “Next” fields are displayed. The screen will appear similar to that shown below.

```

BUILD REF TABLE
Stem Flow[a/d ]

26 15.87%  0.713
27 12.98%  0.476
28 10.06%  0.0
State:      Idle
Inlet:      ? Psi
Back -- Next

```

Figure 103 –Reference Table Complete

- 35.15 Press the UP or DOWN button until the “Next” field is highlighted, then press the ENTER button to advance to the **“Save Ref Table”** screen, as shown below.

```

SAVE REF TABLE

Table data is valid.

Back View Save Exit

```

Figure 104 – Saving the Reference Table

- 35.16 Scenario (1a): No errors are detected in the calibration data.



35.16.1 Press the ENTER button to save the table.

35.16.2 The screen updates as shown below.

```

REF TABLE STATUS
Status:
  Table stored.
Select OK to finish.
Stem will move to 50%
Back      View  OK
  
```

**Figure 105 – Reference Table Status**

35.16.3 Press the ENTER button to exit the Reference Table Generator. The stem will start moving to the indicated position, and the display will return to the “Startup” screen.

35.17 Scenario (1b): The reference table data are not valid.

35.17.1 Press the DOWN button to highlight the “Exit” field, then press the ENTER button to exit the Reference Table Generator. Re-enter the “**Cnfg: Ref Table Cal**” screen and retry the calibration.

### 36. Reference Table Calibration Configuration

36.1 To configure the various parameters used during the reference table calibration process, navigate to the “**Cnfg: Ref Table Cal**” screen, shown below.

```

CNFG: REF TABLE CAL
Post-move:      0 secs
FM reads to avg: 1
Stem step size: 3.0 %
Save  Cancel
  
```

**Figure 106 – Reference Table Calibration Configuration Screen**

36.2 The “Post-move” parameter specifies how many seconds the calibration process waits after reaching a stem position before taking a flow measurement. The minimum value is ‘0’, and the maximum value is ‘15’.

36.3 The “FM reads to avg” parameter specifies the number of flow measurements that are taken and averaged at each calibration point. This value is not configurable.

36.4 The “Stem step size” parameter specifies the spacing between the stem positions at which calibration data is acquired. The minimum value is ‘2.0’, and the maximum value is ‘20.0’. Its value is changed using the Numeric Entry method.

36.5 To apply the changes that have been specified and exit the screen, navigate to the “Save” field and press the ENTER button.

36.6 To exit the screen without saving any changes, navigate to the “Cancel” field and press the ENTER button.

### 37. View Reference Table

37.1 To examine the data of the active reference table, navigate to the “**View Ref Table**” screen, shown below.

```

VIEW REF TABLE
Stem Flow [g/d ]
1  90.02%  888.2
2  88.39%  868.2
3  86.71%  837.7
4  85.05%  806.9
5  83.38%  785.5
PgUp PgDn Done
  
```

**Figure 107 – View Reference Table Screen**

37.2 The reference table viewer consists of a number of linked screens, each displaying a portion of the reference table data. Use the UP or DOWN button to highlight the “PgDn” field and press the ENTER button to display the next screen of data. Use the UP or DOWN button to highlight the “PgUp” field and press the ENTER button to display the previous screen of data.

37.3 To exit the screen, navigate to the “Done” field and press the ENTER button.

### 38. Stem Calibration

38.1 The stem, along with the encoders that support the determination of the stem’s position, are calibrated at the factory. The stem must be recalibrated if any of the following occurs:

- The valve has been removed from the SF3 and any valve is re-installed.
- The drive assembly has been replaced.

38.2 Before starting the calibration process, ensure that both the drive assembly and a valve are installed in the SF3.

- 38.3 To calibrate the stem, navigate to the “Cal: Stem” screen, shown below. Information about the hardware configuration of the SF3 is displayed on the screen. (If any fault condition is present that would prevent calibration of the stem from being performed, an error message will be displayed on this screen and the “Start” button will not appear.)

```

CAL: STEM

Valve model:
SF5000HTVA_700D

Start [EXIT]

```

**Figure 108 – Stem Calibration Initial Screen**

- 38.4 Use the UP or DOWN button to highlight the “Start” field, then press the ENTER button to start the calibration. The motor starts moving the stem, and the display updates as shown below.

```

STEM CAL: HW CHECK

MotorDirection:    ?
GearboxRatio:     ?
  MtrCts   Rotary
  45548   300.13°
Open to test Posn 1
Back [PAUSE] Abort

```

**Figure 109 – Stem Calibration HW Check Screen 1**

- 38.5 The stem moves to various positions in order to determine that (1) motor movement and stem position reporting are in sync, and (2) the gearbox ratio of the SF3 matches the value for which the firmware is configured. Once this is done, the display updates as shown below.

```

STEM CAL: HW CHECK

MotorDirection:    ok
GearboxRatio:     5:1
  MtrCts   Rotary
  34489   222.29°
Move to lwr hard stop
Back [PAUSE] Abort

```

**Figure 110 – Stem Calibration HW Check Screen 2**

- 38.6 Next, the stem closes until it reaches the lower hard stop, at which time a clicking sound may be heard. Once the lower hard stop is located, the stem reverses direction and opens to establish the lower soft-stop position (which corresponds to 0%

stem position). After this, the screen updates as shown below as the firmware proceeds to calibrate the hardware offset in the SF3’s rotary encoder.

```

STEM CAL: ROTARY OS

PeakSensorNbr:    7
RotaryCalSts:    Done
  MtrCts   Rotary
  2254   73.03°
Set Cal Config Params
Back [PAUSE] Abort

```

**Figure 111 – Stem Calibration Rotary Offset Screen**

- 38.7 Once the rotary offset calibration completes, the firmware initiates stem movements which allow it to calculate the deadband in the SF3 gearbox assembly. While this progresses, the screen updates as shown below.

```

STEM CAL: DEADBAND

  MtrCts   Rotary
  2962   89.79°
Start deadband calc
Back [PAUSE] Abort

```

**Figure 112 – Stem Calibration Deadband Screen**

- 38.8 After the deadband has been determined, the screen updates as shown below as the firmware proceeds to calibrate the hardware offset in the SF3’s linear encoder. While this progresses, the screen updates as shown below.

```

STEM CAL: LINEAR OS

PeakSensorNbr:    38
LinearCalSts:    Idle
  MtrCts   Rotary   Linear
  7088  179.99°  7.447
Opening stem 360 deg
Back [PAUSE] Abort

```

**Figure 113 – Stem Calibration Linear Offset Screen**

- 38.9 Once the linear offset calibration completes, the stem returns to the lower soft stop position. The stem then opens, collecting motor count, linear encoder, and rotary encoder angle information at specific increments of motor rotation. Once the upper hard stop position is reached, the stem closes, again collecting calibration information at specific intervals. While this opening and closing

process progresses, information similar to that shown below is displayed on the screen.

```

STEM CAL: STEM SPAN
MtrCts: Row 1 LinPv
15024 0°: 7.258
Angle: 90°: --
25.52° 180°: --
270°: --
Open to next cal Pt
Back Pause Abort
  
```

**Figure 114 – Stem Calibration Stem Span Screen**

38.10 Scenario (1a): A fault is detected during the calibration process

38.10.1 The process is halted, and the nature of the fault is displayed in the second-to-last line of the screen, as shown below (for the case of an unexpected stall). To restart the calibration, use the UP or DOWN button to highlight the “Back” field, then press the ENTER button. To exit the calibration process, highlight the “Abort” field and press the ENTER button.

```

STEM CAL: STEM SPAN
MtrCts: Row 5 LinPv
76426 0°: 5.878
Angle: 90°: 5.798
305.71° 180°: 0.0
270°: 0.0
UNEXPECTED STALL
Back - Abort
  
```

**Figure 115 – Stem Calibration Stem Span Error Screen**

38.10.2 Table 12 lists faults that might be detected.

**Table 12 – Stem Calibration Process Faults**

Error Text	Description
<b>UNEXPECTED STALL</b>	The motor stalled during calibration after the lower hard stop was detected.
<b>DEV NOT IN RUN MODE</b>	The SF3 is in “Stopped” mode.
<b>DEVICE IS BUSY</b>	A calibration operation could not be executed because another operation was in progress.
<b>HARD STOP NOT FOUND</b>	The lower hard stop was never detected.
<b>CAL PT ANGLE FAULT</b>	The SF3 was unable to move the stem to a target rotary angle within the required accuracy.
<b>ENCODER COMM FAULT</b>	The SF3 was not able to communicate with the encoder circuit board.

Error Text	Description
<b>ENCODER OFFLINE</b>	A motor move could not be initiated because communication with the encoder has been lost.
<b>VALVE PROFILE FAULT</b>	No valid Valve Profile is stored in the SF3.
<b>MOTOR START FAULT</b>	An attempt to initiate a stem movement failed.
<b>CLEAR MTR CTS FAULT</b>	The SF3 was unable to set the motor counts to ‘0’ at the lower soft stop.
<b>SET MTR TORQUE FAULT</b>	The SF3 was unable to adjust the motor torque to the appropriate value for the current calibration operation.
<b>UNEXPECTED DEV STS</b>	An unexpected Device Status was generated.
<b>ENCDR DIR FAULT</b>	The stem position reported by the encoder is not consistent with the direction in which the motor is rotating (possibly due to incorrect wiring of the motor).
<b>StemCal error 1814</b>	Rotary offset calibration failed to start.
<b>StemCal error 1815</b>	Rotary offset calibration had to be aborted.
<b>StemCal error 1816</b>	Rotary offset calibration failed with error code 6660.
<b>StemCal error 1817</b>	Rotary offset calibration failed with error code 6661.
<b>StemCal error 1818</b>	Rotary offset calibration failed with unknown error code.
<b>StemCal error 1819</b>	Deadband calibration failed.
<b>StemCal error 1820</b>	Linear offset calibration failed to start.
<b>StemCal error 1821</b>	Linear offset calibration reached upper hard stop with detecting a peak sensor transition.
<b>StemCal error 1822</b>	An unexpected peak sensor transition was detected during linear offset calibration.
<b>StemCal error 1823</b>	Linear offset calibration had to be aborted.
<b>StemCal error 1824</b>	Linear offset calibration failed with error code 6660.
<b>StemCal error 1825</b>	Linear offset calibration failed with error code 6661.
<b>StemCal error 1826</b>	Linear offset calibration failed with unknown error code.
<b>StemCal error 1827</b>	During stem span calibration, a stall was detected before reaching the upper hard stop.
<b>StemCal error 1828</b>	During stem span calibration, the stem did not reach the target rotary angle within the required tolerance.
<b>StemCal error 1829</b>	A command to erase stem span calibration data failed.
<b>StemCal error 1830</b>	A command to erase encoder calibration data failed.
<b>StemCal error 1831</b>	A command to erase encoder board configuration data failed.
<b>StemCal error 1832</b>	A command to store stem span calibration data failed.

Error Text	Description
StemCal error 1833	A command to store encoder calibration data failed.
StemCal error 1834	A command to store encoder board configuration data failed.

38.11 Scenario (1b): No faults are detected during the calibration process

38.11.1 Stem motion continues until the stem has returned to the initial calibration point, at which time the "State" is reported as "Idle" and the "Pause" button becomes "Next". At this point, the screen appearance will be similar to the figure below.

```

STEM CAL PROGRESS
MtrCts:  Row 0   LinPv
 2186      0°:  9.743
Angle:    90°:  9.583
359.30°  180°:  9.457
          270°:  9.307
State: Idle
Back    Next Abort
    
```

Figure 116 – Stem Calibration Progress Screen 3

38.11.2 With the "Next" field highlighted, press the ENTER button to continue.

38.12 Scenario (2a): No errors are detected in the calibration data.

38.12.1 The screen updates as shown below.

```

STEM CAL COMPLETE
Table data is valid.

Back View Save Abort
    
```

Figure 117 – Stem Calibration Complete Screen

38.12.2 To examine the calibration data prior to saving it, press the UP button to highlight the "View" field, then press the ENTER button. The "View Stem Cal" screen appears, which can be scrolled through to examine the data. When finished, press the UP or DOWN button until the "Done" field is highlighted, then press the ENTER button.

38.12.3 To save the calibration data, press the ENTER button with the "Save" field highlighted. The "Stem Table Store Sts" screen appears as shown below.

```

STEM TABLE STORE STS
Status: Table stored.

Stem will be moved
to 50% position.  OK
    
```

Figure 118 – Stem Table Store Status Screen

38.12.4 Press the ENTER button to exit the Stem Calibration process. The stem will start moving to the indicated position, and the display will return to the "Startup" screen.

38.13 Scenario (2b): One or more errors are detected in the calibration data.

38.13.1 The screen updates as shown below.

```

STEM CAL COMPLETE
There are error(s)
in the table data.
Select 'Errs' for
details.

Back View Errs Abort
    
```

Figure 119 – Stem Calibration Failure Screen

38.13.2 Press the ENTER button with "Errs" highlighted to see a display of the error(s) detected.

```

STEM CAL ERRORS
LinPvTblNumRows:  ok
LinPvValues:      ok
LinPvSlope:       ERR
DeadbandCts:      ok
MtrCalFv1Value:   ok
MtrCalFv2Value:   ok
Pause Padm       Done
    
```

Figure 120 – Stem Calibration Errors Screen 1

38.13.3 Press the ENTER button to see additional displays of detected errors.

```

STEM CAL ERRORS
MtrCalPv1Value:    ok
MtrCalPv2Value:    ok
MtrCalSlope:       ok
StemCalInPv1Val:   ok
StemCalInPv2Val:   ok
StemCalOutPv1Val:  ok
PgUp PgDn Done
  
```

Figure 121 – Stem Calibration Errors Screen 2

```

STEM CAL ERRORS
StemCalOutPv2Val:  ok
StemCalSlope:     ok
PgUp PgDn Done
  
```

Figure 122 – Stem Calibration Errors Screen 3

38.13.4 Press the DOWN button to highlight the “Done” field, then press the ENTER button to return to the “**Stem Cal Complete**” screen. (See Figure 119.)

38.13.5 Use the UP or DOWN button to highlight one of the following options, then press the ENTER button.

- “View”, to review the collected calibration data.
- “Back”, to repeat the calibration process.
- “Abort”, to exit the stem calibration process.

### 39. View Stem Calibration

39.1 To examine the data of the stem calibration, navigate to the “**View Stem Cal**” screen, shown below.

```

VIEW STEM CAL
Version:          3
EncdrPcb: 90063 Rev A
EncdrAppFw:      1.7
EncdrId: 003F0030
-424E5303-20383635
PgUp PgDn Done
  
```

Figure 123 – View Stem Calibration Screen

39.2 The stem calibration viewer consists of a number of linked screens, each displaying a portion of the calibration data. Use the UP or DOWN button to highlight the “PgDn” field and press the ENTER

button to display the next screen of data. Use the UP or DOWN button to highlight the “PgUp” field and press the ENTER button to display the previous screen of data.

39.3 To exit the screen, navigate to the “Done” field and press the ENTER button.

### 40. LVDT Calibration

- 40.1 The LVDT in the PDFM is calibrated at the factory. The LVDT must be recalibrated if the PDFM is rebuilt.
- 40.2 Before starting the calibration process, ensure that the PDFM is installed in the SF3.
- 40.3 To calibrate the LVDT, navigate to the “**Cal: LVDT**” screen, shown below.

```

CAL: LVDT
A low and stable flow
rate is required for
optimal calibration.
Set the flow rate to
about 10 g/d
before starting.
Ready Cancel
  
```

Figure 124 – LVDT Calibration Initial Screen

- 40.4 **NOTE:** In order to get an accurate LVDT calibration, the user must provide a flow into the PDFM of about 10 gallons per day, and this flow must remain constant during the calibration process.
- 40.5 Once the required flow has been established, press the UP or DOWN button to highlight the “Ready” field, then press the ENTER button to advance to the “**LVDT Cal: Ready**” screen, shown below.

```

LVDT CAL: READY
Start Cancel
  
```

Figure 125 – LVDT Calibration Ready Screen

- 40.6 Press the ENTER button with the “Start” field highlighted to start the calibration sequence and advance to the “**LVDT Cal: Progress**” screen, shown below.

```

LVDT CAL: PROGRESS
  Calibrating...
Calibrating LVDT
Phase...
....
                Abort
  
```

**Figure 126 – LVDT Calibration Progress Screen 1**

- 40.7 **NOTE:** The LVDT calibration may take many minutes to complete. After the “Calibrating LVDT phase” portion of the process completes, an estimate of calibration time remaining will appear on the screen. Please note that this is only an estimate; the actual time may vary considerably.
- 40.8 The calibration process may be aborted by pressing the ENTER button any time the “Abort” field is displayed. If this is done, the “**Confirm Abort**” screen appears, shown below. Press the UP or DOWN button to highlight the “Yes” field, then press ENTER to complete the abort request.

```

CONFIRM ABORT

Are you sure you
want to abort this
calibration?

Yes  No
  
```

**Figure 127 – LVDT Calibration Confirm Abort Screen**

- 40.9 Once all the calibration data has been collected, a PDFM measurement (using the newly generated LVDT data) is automatically initiated. During this measurement, the screen appears as shown below, with the “Piston posn” field being periodically updated.

```

LVDT CAL: PROGRESS
  Calibrating...

Verifying ratio
table...
Piston Posn: 344 thou
                Abort
  
```

**Figure 128 – LVDT Calibration Progress Screen 2**

- 40.10 Once the measurement completes, the “**LVDT Cal: Finished**” screen appears, as shown below. A “Confidence” value may also appear, which

represents an assessment of the quality of the data that was generated during the calibration process.

```

LVDT CAL: FINISHED
  Verification:

Measured flow:
                10.6 g/d

ViewTable  Save  Exit
  
```

**Figure 129 – LVDT Calibration Finished Screen**

- 40.11 To view the LVDT table that has been generated, press the UP button to highlight the “ViewTable” field, then press the ENTER button to display the “**View: LVDT Table**” screen. (See section 41 for help with this screen.)
- 40.12 To save the new LVDT table data, press the UP or DOWN button until the “Save” field is highlighted, then press the ENTER button.
- 40.13 To exit the screen, press the UP or DOWN button until the “Exit” field is highlighted, then press the ENTER button.

## 41. View LVDT Table

- 41.1 To examine the data in the LVDT table, navigate to the “**View: LVDT Table**” screen, shown below.

```

VIEW: LVDT TABLE
StepSize:      50 thou
StartPosn:    0 thou
EndPosn:      700 thou
PhaseIdxOffset: 7
CalType:      Local

PgUp  PgDn  Done
  
```

**Figure 130 – View LVDT Table Screen**

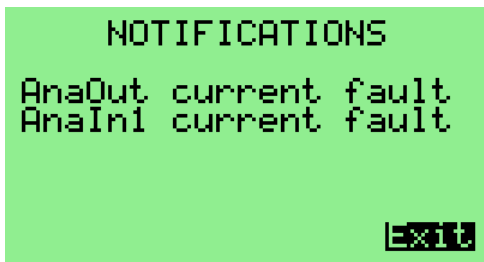
- 41.2 The LVDT table viewer comprises of a number of linked screens, each displaying a portion of the calibration data. Use the UP or DOWN button to highlight the “PgDn” field and press the ENTER button to display the next screen of data. Use the UP or DOWN button to highlight the “PgUp” field and press the ENTER button to display the previous screen of data.
- 41.3 To exit the screen, navigate to the “Done” field and press the ENTER button.



## DIAGNOSTIC SCREENS

### 42. Notifications

- 42.1 Notifications provide information about faults that currently exist in the SF3. For example, if the Analog Input port is configured to provide inlet pressure information via its 4-to-20 mA interface and no current is detected flowing into the port, an "Analog Input Current Fault" notification will be generated by the device firmware.
- 42.2 The Notifications screen provides a summary of all notifications that are currently active in the SF3.
- 42.3 Navigate to the "**Notifications**" screen, an example of which is shown below.



**Figure 131 – Notifications Screen**

- 42.4 The following notifications may be displayed on this screen:
- 42.4.1 A "PDFM service" notification is generated when the "PDFM Usage Monitor" value exceeds the "PDFM Service Life" value; it indicates that the PDFM should be replaced or serviced, as appropriate. This notification is cleared when the required maintenance has been performed and the "PDFM Usage Monitor" has been reset to '0'.
- 42.4.2 An "AnaOut current fault" notification is generated when all of the following conditions are met: (1) the Analog Output Source is configured to a value other than 'Unused'; (2) the Analog Output Mode is configured to '4-to-20 mA', '0-to-20 mA', or '0-to-24 mA'; and (3) no current is being output from the Analog Output "ISO I-OUT" pin (most likely because no load is connected between the "ISO I-OUT" and "ISO\_GND" pins). This notification is cleared when one or more of these conditions are changed.
- 42.4.3 An "Analn1 current fault" notification is generated when both of the following

conditions are met: (1) the Analog Input 1 Configuration is set to a value other than 'Unused'; and (2) the current entering the Analog Input 1 port is less than 4 mA or greater than 20 mA. This notification is cleared when one or both of these conditions are changed.

- 42.4.4 An "Analn2 current fault" notification is generated when both of the following conditions are met: (1) the Analog Input 2 Configuration is set to a value other than 'Unused'; and (2) the current entering the Analog Input 2 port is less than 4 mA or greater than 20 mA. This notification is cleared when one or both of these conditions are changed.
- 42.4.5 A "Stem discontinuity" notification is generated when the SF3 firmware has detected instabilities in the reporting of stem position. It indicates that stem positions may not be reported correctly during future stem moves due to changes in the hardware that determines stem position. If this notification appears, the stem must be recalibrated (as described in section 38). This notification is cleared when the stem is successfully recalibrated.
- 42.4.6 An "Analn1 proc cal fault" notification is generated when both of the following conditions are met: (1) the Analog Input 1 Configuration is set to a value other than 'Unused'; and (2) the process calibration data associated with Analog Input 1 is not valid. This notification is cleared when one or both of these conditions are changed.
- 42.4.7 An "Analn2 proc cal fault" notification is generated when both of the following conditions are met: (1) the Analog Input 2 Configuration is set to a value other than 'Unused'; and (2) the process calibration data associated with Analog Input 2 is not valid. This notification is cleared when one or both of these conditions are changed.

### 43. Flow Control Diagnostics

- 43.1 The Flow Control Diagnostics screen allows the user to see additional diagnostic information when a Drive-to-Flow-Setpoint operation is in progress.



- 43.2 Navigate to the “**Diag: Flow Control**” screen, shown below.

```

DIAG: FLOW CONTROL
Actual:      0.0  g/d
Stem Posn:  0.00%
State:      Idle
Adj#: 0     Time:
Setpt:      0.0  g/d
Adjs:10 Delay: 0 sec
           Set   Menu

```

**Figure 132 – Flow Control Diagnostics Screen 1**

- 43.3 Press the UP or DOWN button to highlight the “Setpt” field.

```

DIAG: FLOW CONTROL
Actual:      0.0  g/d
Stem Posn:  0.00%
State:      Idle
Adj#: 0     Time:
Setpt:      0.0  g/d
Adjs:10 Delay: 0 sec
           Set   Menu

```

**Figure 133 – Flow Control Diagnostics Screen 2**

- 43.4 Using the Numeric Entry method, enter the desired flow setpoint (“100 g/d”, in this example).

```

DIAG: FLOW CONTROL
Actual:      0.0  g/d
Stem Posn:  0.00%
State:      Idle
Adj#: 0     Time:
Setpt:      100.0 g/d
Adjs:10 Delay: 0 sec
           Set   Menu

```

**Figure 134 – Flow Control Diagnostics Screen 3**

- 43.5 Press the DOWN button to highlight the “Set” field.

```

DIAG: FLOW CONTROL
Actual:      0.0  g/d
Stem Posn:  0.00%
State:      Idle
Adj#: 0     Time:
Setpt:      100.0 g/d
Adjs:10 Delay: 0 sec
           Set   Menu

```

**Figure 135 – Flow Control Diagnostics Screen 4**

- 43.6 Press the ENTER button to start a Drive-to-Flow-Setpoint operation. The screen updates periodically to provide real-time diagnostic information during the process.

```

DIAG: FLOW CONTROL
Actual:      0.0  g/d
Stem Posn:  0.00%
State:      Reading FM...
Adj#: 0     Time:
Setpt:      100.0 g/d
Adjs:10 Delay: 0 sec
           Abort Menu

```

**Figure 136 – Flow Control Diagnostics Screen 5**

- 43.7 The Drive-to-Flow-Setpoint operation can be aborted by pressing the ENTER button with the “Abort” field highlighted.
- 43.8 To exit the screen, press the DOWN button to highlight the “Menu” field, then press the ENTER button.

#### 44. PDFM Diagnostics

- 44.1 The PDFM Diagnostics screen allows the user to see additional diagnostic information when a PDFM measurement is in progress.
- 44.2 Navigate to the “**Diag: PDFM**” screen, shown below.

```

DIAG: PDFM
Adj Flow:    0.0  g/d
Raw Flow:    0.0  g/d
State:      Idle
Piston posn: 0 mils
Solen curr:  67 mA
Next AFM:    Disabled
           Read  Menu

```

**Figure 137 – PDFM Diagnostics Screen 1**

- 44.3 Press the UP or DOWN button to highlight the “Read” field.

```

DIAG: PDFM
Adj Flow:    0.0  g/d
Raw Flow:    0.0  g/d
State:      Idle
Piston posn: 0 mils
Solen curr:  67 mA
Next AFM:    Disabled
           Read  Menu

```

**Figure 138 – PDFM Diagnostics Screen 2**

- 44.4 Press the ENTER button to start a PDFM measurement. The screen updates periodically to provide real-time diagnostic information during the PDFM measurement process.

```

DIAG: PDFM
Adj Flow: 0.0 g/d
Raw Flow: 0.0 g/d
State: Acquiring data
Piston posn: 0 mils
Solen curr: 659 mA
Next AFM: Disabled
Abort Menu
  
```

Figure 139 – PDFM Diagnostics Screen 3

- 44.5 The PDFM measurement operation can be aborted by pressing the ENTER button with the "Abort" field highlighted.
- 44.6 To exit the screen, press the DOWN button to highlight the "Menu" field, then press the ENTER button.

## MAINTENANCE SCREENS

### 45. PDFM Maintenance

- 45.1 Navigate to the "PDFM Maintenance" screen, shown below.

```

PDFM MAINTENANCE
Usage monitor: 20
Service life: 1000000
Last clr mon: 0
Total ops: 20
Clear Exit
  
```

Figure 140 – PDFM Maintenance Screen

- 45.2 The "Usage monitor" field reports the number of PDFM measurements that have been performed since the PDFM was last serviced.
- 45.3 The "Service life" field reports the number of measurement cycles for which the PDFM is designed.
- 45.4 The "Last clr mon" field reports the value of the PDFM Usage Monitor before the monitor was last cleared.
- 45.5 The "Total ops" field reports the number of PDFM measurements that have been performed since the PDFM was manufactured.

### 46. Database Backup

- 46.1 The SF3 firmware supports the ability to record in a file the contents of the database stored in its flash memory. This is referred to as a database backup.

- 46.2 Before starting this operation, make sure that an SD card is installed on the SF3 PCB.
- 46.3 Navigate to the "Database Backup" screen, shown below.

```

DATABASE BACKUP

Start Exit
  
```

Figure 141 – Database Backup Screen

- 46.4 Press the UP or DOWN button to highlight the "Start" field, then press the ENTER button.
- 46.5 If the database information is successfully written to a file on the SD card, the screen updates as shown below. The text shown in the "Timestamp:" field will be included in the filename of the file that is generated.

```

DATABASE BACKUP
Timestamp:
2020-06-18@150912
Backup successful.
Start Exit
  
```

Figure 142 – Database Backup Success Screen

- 46.6 If the backup operation fails, the screen is updated with information regarding the failure, such as shown in the sample screenshot below.

```

DATABASE BACKUP

Backup FAILED.
No SD card found:
(error code 1904)
Start Exit
  
```

Figure 143 – Database Backup Error Screen

- 46.7 To exit the screen, press the DOWN button to highlight the "Exit" field, then press the ENTER button.

## 47. Database Restore

- 47.1 The SF3 firmware supports the ability to write a database image to its flash memory from a file. This is referred to as a database restore operation.
- 47.2 Before starting this operation, make sure that an SD card containing the desired database image is installed on the SF3 PCB.
- 47.3 Navigate to the **"Database Restore"** screen, shown below.

```

DATABASE RESTORE
File timestamp:
[No selection]

Start Exit
  
```

**Figure 144 – Database Restore Screen 1**

- 47.4 Press the UP or DOWN button to highlight the "File timestamp" field.

```

DATABASE RESTORE
File timestamp:
[No selection]

Start Exit
  
```

**Figure 145 – Database Restore Screen 2**

- 47.5 Select the timestamp of the file from which the database is to be restored using the Option Selection method.

```

DATABASE RESTORE
File timestamp:
2020-06-18@150912
Ref APP ver: 1.3

Start Exit
  
```

**Figure 146 – Database Restore Screen 3**

- 47.6 When the screen updates, it also shows the version of the Application firmware that was installed in the SF3 at the time the database backup file was originally generated.
- 47.7 Press the DOWN button to highlight the "Start" field.

```

DATABASE RESTORE
File timestamp:
2020-06-18@150912
Ref APP ver: 1.3

Start Exit
  
```

**Figure 147 – Database Restore Screen 4**

- 47.8 Press the ENTER button to start the restore operation.
- 47.9 If the database is successfully restored, the screen updates as shown below.

```

DATABASE RESTORE
File timestamp:
2020-06-18@150912
Ref APP ver: 1.3
Restore successful.

Start Exit
  
```

**Figure 148 – Database Restore Screen 5**

- 47.10 If the restore operation fails, the screen is updated with information regarding the failure.
- 47.11 To exit the screen, press the DOWN button to highlight the "Exit" field, then press the ENTER button.

## 48. Firmware Upgrade

- 48.1 To initiate an upgrade of the Application firmware, start by installing an SD card on the SF3 PCB that contains the desired firmware image file in the root directory. (Firmware image files can be obtained by contacting SkoFlo or an authorized SkoFlo representative.)
- 48.2 The filename of the file must be of the form **"SF90055\_vXX\_YY.MBF"**, where **"XX\_YY"** is the Application firmware version (for example, **"01\_06"** for version 1.06).
- 48.3 Next, navigate to the **"Firmware Upgrade"** screen.

```

FIRMWARE UPGRADE

Press 'Start' to
begin firmware
upgrade...
      Start  Cancel

```

Figure 149 – Firmware Upgrade Screen

- 48.4 Press the UP or DOWN button to highlight the "Start" field, then press ENTER.
- 48.5 The firmware resets the SF3 and launches its bootloader, after which a screen similar to the one shown below appears.

```

SkoFlo Industries
SF3 BOOT FW v1.3

APP FW ver:      1.5
Ready to start APP FW

      Start  LOCAL Menu

```

Figure 150 – Bootloader Startup Screen

- 48.6 Press the ENTER button to go to the first menu screen, navigate to the "**Firmware Mgmt**" entry, then press ENTER. A screen similar to the one shown below appears.

```

FIRMWARE MGMT
Curr APP ver:    1.5
Selected file:
[No selection]

Ready to start APP FW

      Dnld      Exit

```

Figure 151 – Firmware Management Screen 1

- 48.7 Press the DOWN button to highlight the "Selected file" field.

```

FIRMWARE MGMT
Curr APP ver:    1.5
Selected file:
[No selection]

Ready to start APP FW

      Dnld      Exit

```

Figure 152 – Firmware Management Screen 2

- 48.8 Press the ENTER button to enable editing of the "Selected file" field, then press the DOWN button

to display the filename of the firmware image file ("**SF90055\_v01\_06.MBF**" in this example).

```

FIRMWARE MGMT
Curr APP ver:    1.5
Selected file:
*SF90055_v01_06.MBF

Ready to start APP FW

      Dnld      Exit

```

Figure 153 – Firmware Management Screen 3

- 48.9 Press the ENTER button to select this filename, then press the DOWN button to highlight the "Dnld" field.

```

FIRMWARE MGMT
Curr APP ver:    1.5
Selected file:
SF90055_v01_06.MBF

Ready to start APP FW

Dnld      Exit

```

Figure 154 – Firmware Management Screen 4

- 48.10 Press the ENTER button to start the process of downloading the new firmware into the SF3. As this download proceeds, the screen will display the progress of the operation.

```

FIRMWARE MGMT
Curr APP ver:    0.0
Selected file:
SF90055_v01_06.MBF

Downloading ( 18.9%)

Dnld      Exit

```

Figure 155 – Firmware Management Screen 5

- 48.11 Once the download completes, the SF3 will reset again and the Bootloader startup screen will be displayed for a few seconds, after which the new Application firmware will be launched and the "**Startup**" screen will appear.

## 49. Valve Flushing

- 49.1 It is possible that, in some situations, a chemical flowing through the valve contains debris that is large enough to lodge in the mechanism that regulates the flow and disrupt its operation. In some situations, especially with low flow setpoints, this can even prevent the valve from attaining the desired flow rate.
- 49.2 To address this potential problem, the SF3 supports a mechanism by which the stem is adjusted to its fully open position for a configurable amount of time to allow the debris to be flushed out of the valve. After this, the SF3 performs a Drive-to-Setpoint operation based on its most-recent flow setpoint value.

### ! NOTICE



THE FLUSHING FEATURE IS ONLY AVAILABLE FOR USE WITH VALVE MODELS WHOSE DESIGN INCLUDES AN OUT-OF-CONTROL PISTON. CONTACT FACTORY FOR FURTHER INFORMATION.

- 49.3 To invoke a flushing operation, first navigate to the “**Flush Valve**” screen.
- 49.4 If flushing is not supported for the valve model installed in the SF3, the screen will appear as shown below. Press the ENTER button to exit the screen.

```

FLUSH VALVE
State:      Idle
Flush time: 10 secs
(Flush not supported)
Start  Exit

```

**Figure 156 – Flush Valve Screen (Flush Not Supported)**

- 49.5 If flushing is supported, the screen will appear as shown below.

```

FLUSH VALVE
State:      Idle
Flush time: 10 secs
Start  Exit

```

**Figure 157 – Flush Valve Screen 1**

- 49.6 The “Flush time” parameter specifies how long the stem remains at its fully open position during the flushing sequence. Its value is configurable from 5 seconds to 60 seconds in 1-second increments using the Numeric Entry method.
- 49.7 When the Flush Time is configured as desired, press the UP or DOWN button until the “Start” field is highlighted.

```

FLUSH VALVE
State:      Idle
Flush time: 10 secs
Start  Exit

```

**Figure 158 – Flush Valve Screen 2**

- 49.8 Press the ENTER button to initiate the flushing sequence. The screen updates to show that the stem is moving to its fully open position.

```

FLUSH VALVE
State: Opening 1.3%
Flush time: 10 secs
Opening fully...
Abort Exit

```

**Figure 159 – Flush Valve Screen 3**

- 49.9 If necessary, the flushing operation can be terminated at any time by pressing the ENTER button with the “Abort” field highlighted. If terminated, the stem will return to its pre-flush position.
- 49.10 Once the stem reaches the fully open position, the SF3 waits for the configured Flush Time to pass, while the screen indicates that flushing is in progress.

```

FLUSH VALVE
State:      Flushing...
Flush time: 10 secs
Flushing...
Seconds remaining: 7
Abort Exit

```

**Figure 160 – Flush Valve Screen 4**

49.11 After the Flush Time expires, the stem returns to the position that corresponds to the current flow setpoint, as determined from the reference table.

```
FLUSH VALVE  
State: Closing 79.1%  
Flush time: 10 secs  
Restoring stem...  
Abort Exit
```

**Figure 161 – Flush Valve Screen 5**

49.12 Once that position is reached, a Drive-to-Setpoint operation is initiated.

49.13 The screen can then be exited by pressing the UP or DOWN button until the "Exit" field is highlighted, then pressing the ENTER button.



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