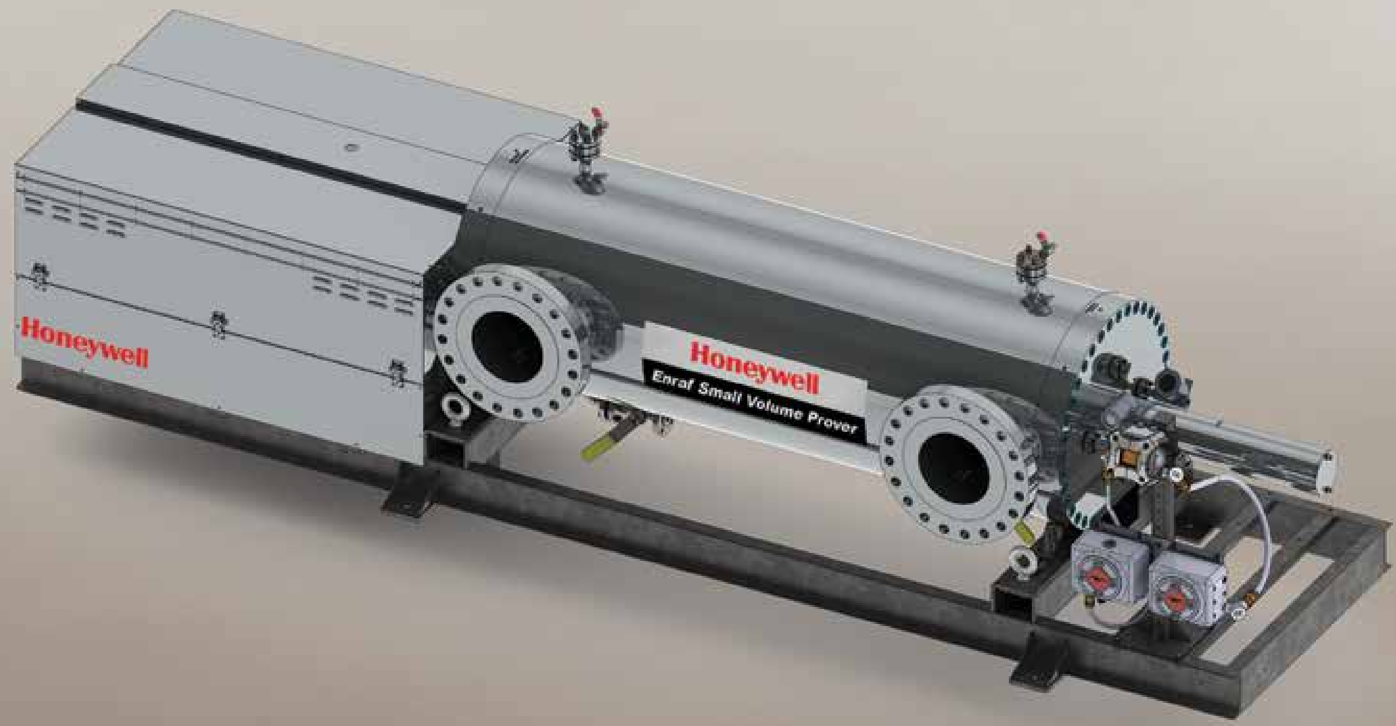
Honeywell



FOR ALL PROVERS EQUIPPED WITH
SVP CONTROLLER

Honeywell Enraf
SVP Controller Operation Manual

HONEYWELL ENRAF

SVP CONTROLLER OPERATION MANUAL

FOR ALL PROVERS EQUIPPED WITH
SVP CONTROLLER

3rd Edition
Released March 2016

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THE HONEYWELL ENRAF PROVER SERIES

Safety instructions for installation, commissioning, operation and maintenance

Preface

The Honeywell Enraf (HE) SVP (Small Volume Prover) is a high precision instrument for verification of calibration of flow metering equipment. The SVP Controller and the Fusion4 Local Access Device (LAD) form the control aspects of the SVP. The LAD is a hand held controller used to interface to the SVP Controller allowing tasks such as the adjustment of parameters, resetting of alarms and calibration. The LAD facilitates two way data communications between the SVP Controller and the LAD, allowing the rapid transfer of transaction data, configuration files and calibration records and even upgrading of firmware in the field. The following warnings apply to all components of the SVP.

Warning

Only use the instrument for its intended purpose.

EC declaration of conformity

Refer to the EC declaration of conformity and ATEX certificate(s), shipped with the instrument.

Installation

The mechanical and electrical installation shall only be carried out by trained personnel with knowledge of the requirements for installation of explosion proof equipment in (potentially) explosive atmospheres.

The entire installation procedure shall be carried out in accordance with national, local and company regulations. The entire electrical installation shall be carried out in accordance with the International Standard EN 60079-14 for electrical equipment to be installed in (potentially) explosive atmospheres.

No specific installation requirements apply to the LAD; the device is factory ready for connection to Fusion4 parent devices (for example the SVP Controller).

Warning – Risk of Explosion

Do not open any of the electronics enclosures when an explosive atmosphere may be present.

Warning – Risk of Explosion

Explosion proof (Ex d) compound cable glands or conduit sealed directly at all cable entries must be used.

Which type depends on local & national requirements and legislation. For the SVP Controller these glands and seals are installed at the factory.

Warning – Risk of Explosion

Unused cable entries must be sealed with an approved metric or NPT threaded stopping (“Stopper”) plugs. Take care to select whichever is appropriate and contact Honeywell Enraf in case of doubt. Improper installation of cable glands, conduit or stopping plugs will invalidate the Ex approval.

Warning – Risk of Explosion

Intrinsically safe connections to the SVP are factory wired. No unauthorized changes are allowed as these would invalidate the approval.

The LAD and the SVP Controller are intrinsically safe devices and as such may only be connected to devices with compatible intrinsically safe parameters. Intrinsically safe cabling may only be connected to the outside 5 pin socket of the SVP Controller. Connection of non-intrinsically safe signals will invalidate the approval. The electrical data of the intrinsically safe circuits is to be taken from the ATEX/IECEx certificates (numbers see below) which are shipped with the instruments.

Warning – Risk of Explosion

In order to withstand the explosion pressure the bolts of the SVP Controller lid must be fastened hand-tight (approximately 13.5 to 17.6 Nm [10 to 13 Lbf-Ft]) but don’t overtighten so as not to damage the threads.

Warning – Risk of Explosion

For ensuring intrinsic safety, ground connection of one of the internal boards to the enclosure and the box to the local grounding system is crucial. The former is done at the factory but the local grounding is required to ensure compliant installation.

Warning

For information on the dimensions of the flameproof joints, contact Honeywell Enraf.

Warning – Risk of injury

Honeywell Enraf recommends mains power to be shut off, including lockout-tagout at that mains switch to ensure safety during maintenance and related work being performed on the inside of the drive end cover.

Warning – Risk of injury

Ensure that the motor drive end and downstream shaft covers are always in place before operating the device, to guard against human injury.

Warning – Risk of injury

Pressurize system slowly to avoid a hydraulic shock which could result in damage to prover, personnel, and/or piping systems.

Warning – Risk of injury

Ensure that the unit is fully depressurized and drained prior to disassembly or service.

Commissioning

The commissioning of the instrument shall be conducted by qualified engineers, trained by Honeywell Enraf and with knowledge of the (local and national) requirements for electrical equipment in (potentially) explosive atmospheres.

Operation

After commissioning the Honeywell Enraf SVP and its associated SVP Controller can be used for its intended purpose. After connecting to the SVP Controller the LAD can be used for its intended purpose. The memory card can be removed and inserted also in hazardous areas but be aware that the device is then no longer suitably protected against ingress of water.

Maintenance and troubleshooting

In the unlikely event of malfunction, only a qualified service engineer, trained by Honeywell Enraf and with knowledge of safety regulations for working in (potentially) explosive atmospheres is allowed to repair the instrument.

Additional information

If you require additional information, contact Honeywell Enraf or its representative.

Approvals :
Refer to the EC declaration of conformity and ATEX certificate(s), shipped with the instrument (as it may vary per configuration)

CE Directives and approvals:

CE Directive	Certificate number
94/9/EC ATEX electrical	LCIE 05 ATEX 6068X
94/9/EC ATEX mechanical	Honeywell Enraf declared
2006/42/EC Machinery Directive	Honeywell Enraf declared
97/23/EC Pressure Equipment Directive	60330-2009-CE-HOU-DNV

Environmental conditions:

Ambient pressure : atmospheric

Relative humidity : 5 – 95 %

Ingress Protection (IP rating) : IP56

Ambient temperature : ATEX Approval

Standard Temperature: -20°C to +40°C (-4°F to +104°F)

Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F) or -20°C to +60°C (-4°F to +140°F)

CSA Approval

Standard Temperature: -20°C to +40°C (-4°F to +104°F)

Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F)

IECEx Approval

Standard Temperature: -20°C to +40°C (-4°F to +104°F)

Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F) or -20°C to +60°C (-4°F to +140°F)

Special Approvals : up to 60°C (140°F)

Additional information specific to the SVP Controller

Approvals :
ATEX: II 2 G Ex d [ia] IIB T6 Gb
IECEx: Ex d [ia] IIB T6 Gb

Certificates:

Approval	Certificate number
ATEX	12ATEX0101 X
IECEx	DEK 12.0021X
CSA	11.2370409

Additional information specific to the Fusion4 LAD

Approvals :
II 2 G Ex ia IIB T4 Gb
Ex ia IIB T4 Gb

Certificates:

Approval	Certificate number
ATEX	KEMA 10ATEX0152
IECEx	IECEx KEM 10.0070
CSA	11.2395571

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CHAPTER 1 INSTALLATION

1.1 Electrical Connection

The Honeywell Enraf small volume prover is certified by one of the following agencies:

CSA/US certified for Class 1 Group D T2C

CSA/US certified for Class 1 Group C T3B

ATEX certified for II 2 (1) G Ex d [ia Ga] IIB T4 Gb

IECEx compliant for Ex db [ia Ga] IIB T4 (See Individual Certificates)

Be certain to conform to all applicable national and local electrical codes when making electrical connections to the Honeywell Enraf small volume prover to maintain electrical safety ratings.

Refer to Section 6 of this manual for connection to several brands of flow computers. The proving computer used for the operation of the provers **must** be equipped with the double chronometry function. For brands not detailed, consult Honeywell Enraf and the flow computer manufacturer.

If equipped with CONDAT® or Prove-It prover control systems, refer to the operators' manual for instructions for installation and operation.

The Honeywell Enraf small volume prover must be correctly earth grounded prior to electrical service connection.

1.1.1 Field wiring

The installation of this device must be carried out in accordance with all appropriate international, national and local standards and site regulations for intrinsically safe apparatus

1.1.2 Breaker

A readily accessible disconnecting/breaker device shall be incorporated external to the equipment.

1.1.3 Enclosures

The picture below shows the three electrical enclosures mounted on the Small Volume Prover. The connections to the SVP Controller Box are made at the factory and must not be modified. All of your connections are to be made in the Power Box and the Customer Connection Box.

Figure 1-1: Electrical Enclosures

1.1.3.1 Customer Connection Box

The picture below shows the Customer Connection Box where you can connect your flow computer and other signals to the SVP.

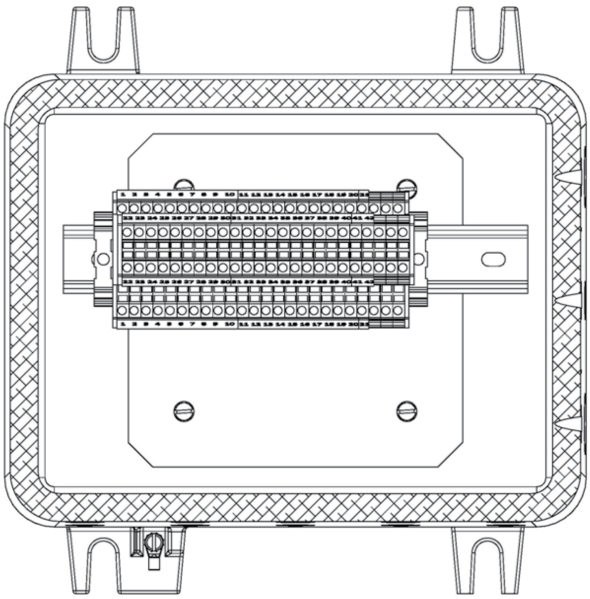

Figure 1-2: Customer Connection Box

1.1.3.2 Power Box

The picture below shows the Power Box with two separate power connections: one for the motor which generates electrical noise during operation and one for clean or instrument power.

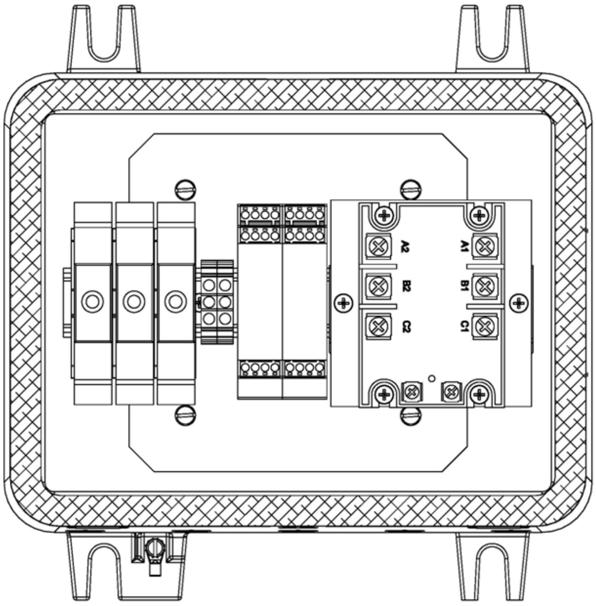

Figure 1-3: Power Box

1.1.3.3 SVP Controller Box

Connection of the LAD is as shown below.

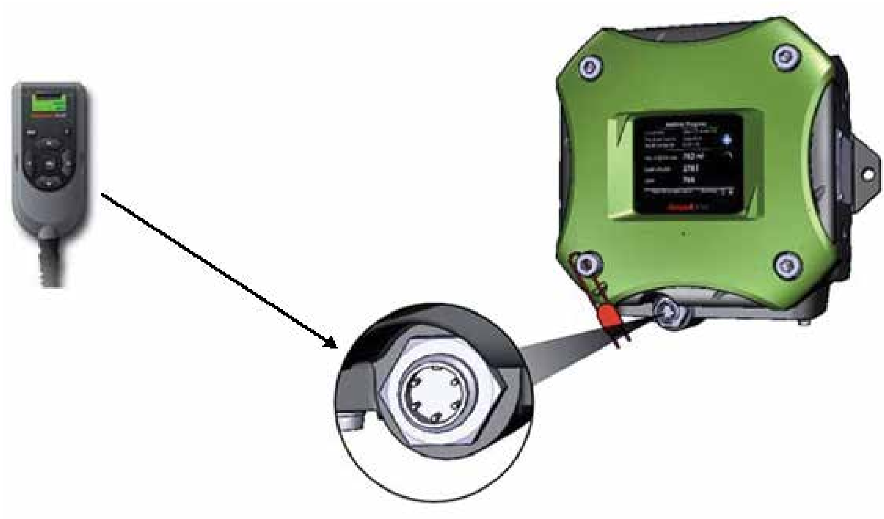

Figure 1-4: SVP Controller Box with LAD

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CHAPTER 2 CONTROLLER INFORMATION

2.1 Initial Power up

Upon initial power up of the SVP Controller the Prover Status screen will be displayed showing the operating mode of the prover (Meter Calibration, Prover Calibration, or Prover Test) and the following information:

- Piston status or position
- Motor status
- Error status
- Number of cycles
- Stop time
- Sweep time

An example of a Prover Status screen is shown below.

Prover Status · Meter Calibration	
Piston	Parked Position
Motor	Idle
Error Status	No Error
Cycle	776
Stop Time	10-31-12 11:29:32 AM
Sweep Time	00:00:01:102

Press OK to enter menu	Stop	

2.2 Navigating the SVP Controller Menus Using the LAD

Pressing the OK button on the Local Access Device (LAD) will result in the Main Menu screen being displayed on the SVP Controller.

2.2.1 Text Conventions

In the following sections of this document the entity and entity related text are shown in a distinctive format as shown below.

All [Entity] and <entity-related> text is recognizably formatted.

2.2.2 General

The SVP Controller can be configured through the wired Ex i interface with a Local Access Device (LAD).

The LAD (Local Access Device) is a hand held controller used to interface with the Fusion4 product family, allowing tasks such as parameter adjustment, alarm resetting, and calibration. The device facilitates two-way data communications between the SVP Controller and the LAD, allowing the rapid transfer of transaction data, configuration files and calibration records, and even firmware upgrading while in the field.

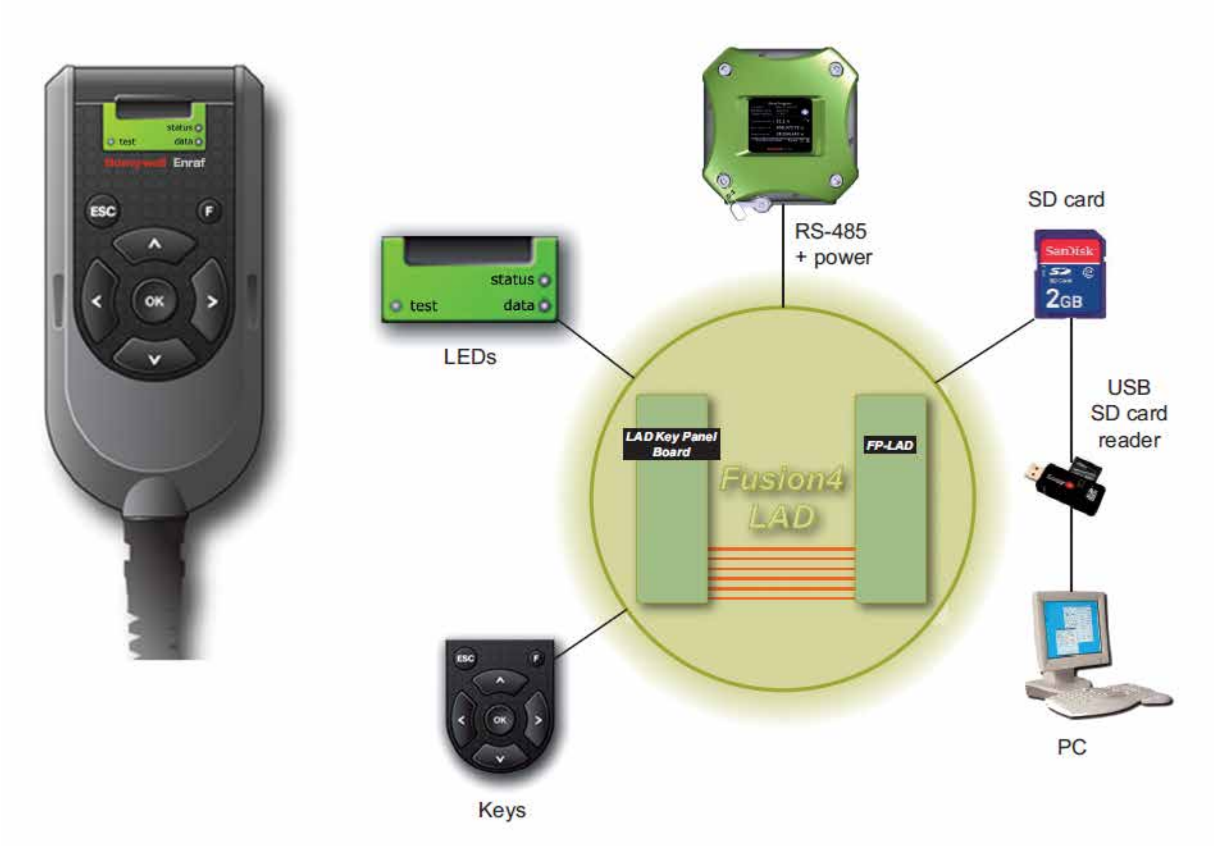

Figure 2-1: The Local Access Device (LAD) and its system overview

2.2.3 Commissioning

The LAD is used to commission the SVP Controller by configuring entities (or parameters) to the desired specific values. This is done by using the LAD to navigate through the Menu functions of the SVP Controller (See 2.3.4).

2.3 Menus and Navigation

2.3.1 General

An intuitive and informative Human Machine Interface (HMI) is available to the user to operate, configure, and service the SVP Controller. This menu-based user interface is as clear and accessible as possible, using easily understandable colored icons for the Main Menu and logically structured sub-menus.

2.3.1.1 Key benefits

- Clean, intuitive, and informative user interface
- No need to memorize parameter codes, enumeration value
- Diagnostic screens
- Record-based approach to transactions and calibrations make re-use possible
- Interoperable with the Local Access Device (LAD)
- Provides a graphical user interface to the LAD

2.3.2 Main Menu

Figure 2-2: Main Menu

2.3.3 Screen Input Fields

2.3.3.1 Text Input Screen

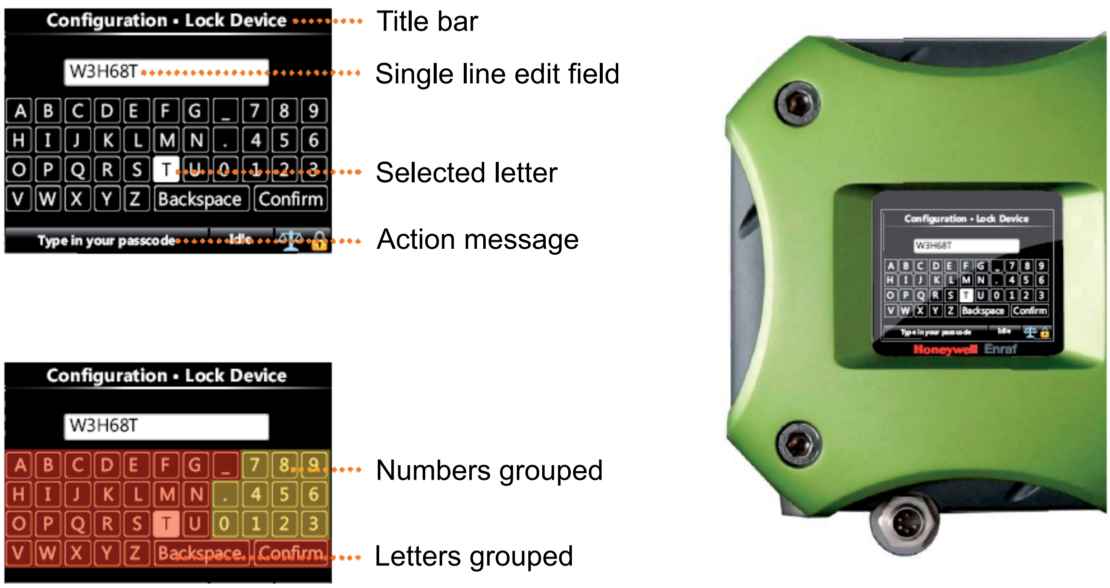

Figure 2-3: Text Input Screen

2.3.3.2 Numeric Input Screen

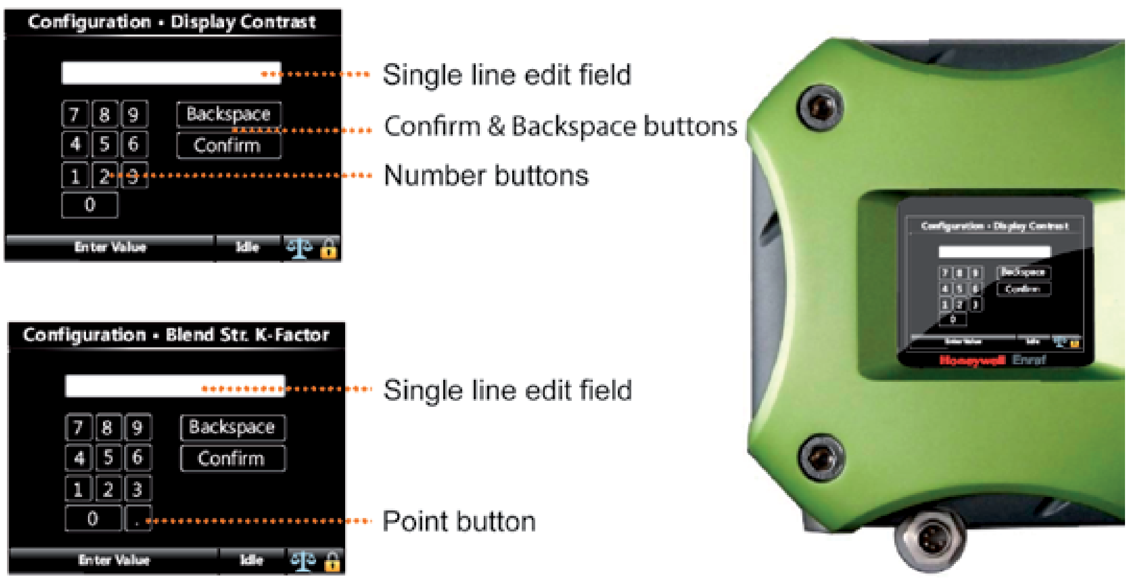

Figure 2-4: Numeric Input Screen

2.3.3.3 Enumeration Input Screen

Figure 2-5: Enumeration Input Screen

2.3.3.4 Status Bar

Figure 2-6: Status Bar

- Always visible on all screens
- Contains the following information:
  - Context-specific information/directions to user
  - Status of the transactions (e.g., Idle, Running, Error)
  - Device Locking Icon

2.3.4 Menu Structure

For a high level overview of the entities and parameters, see the following diagram (Figure 2-7).

For a detailed view of all menu items, see the individual section.

Continued on next page

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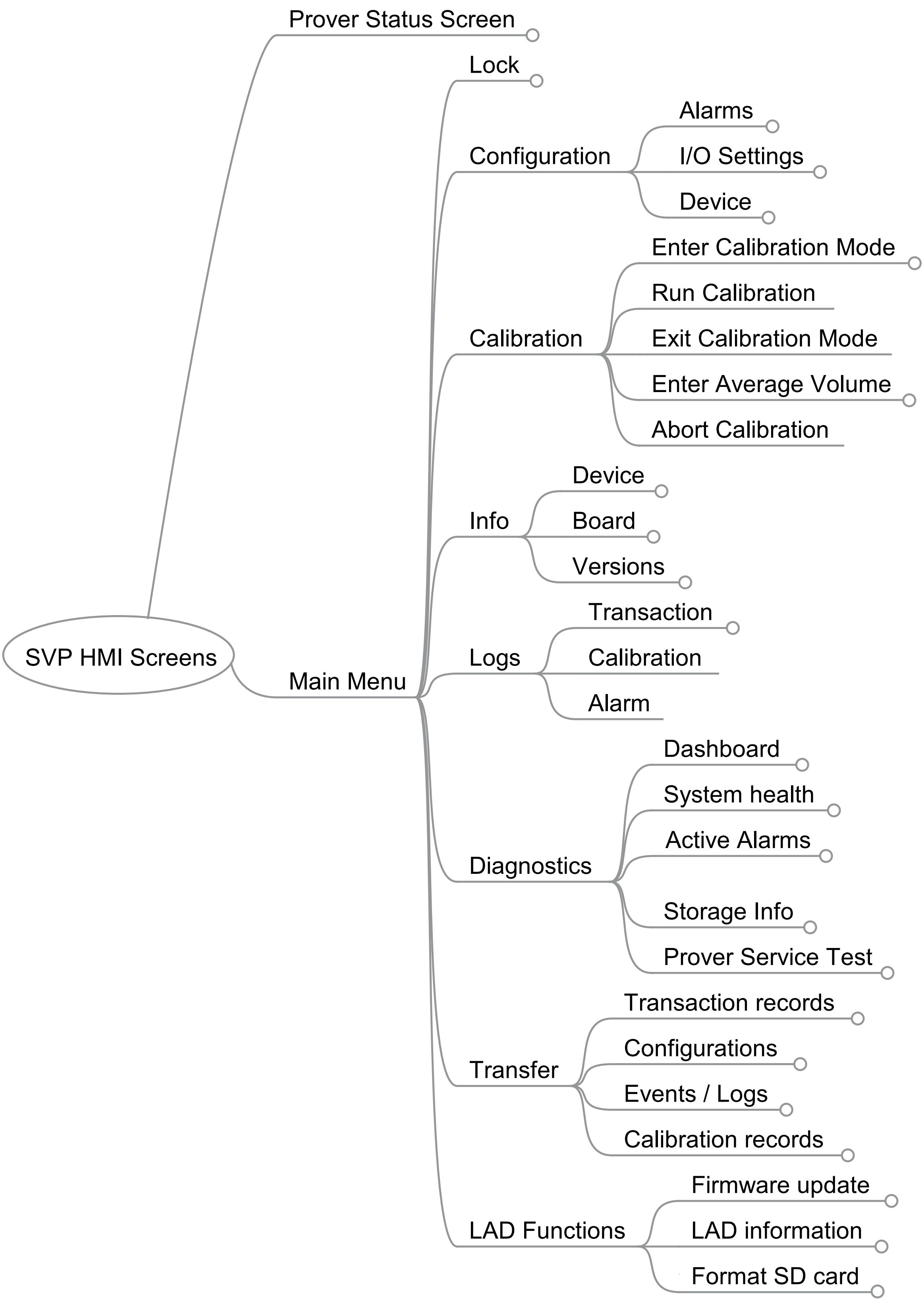

Figure 2-7: Menu Structure

2.3.5 Device Locking Menu 

Within this screen, the user can lock and unlock the SVP Controller.

- A single password is used to lock the controller from further configuration via HMI.
- Password is alphanumeric
  - Only capital letters
  - A-Z, 0-9, _, and '.'
  - No spaces
  - Maximum of 6 characters
- Device remains unlocked until explicitly locked again

The "lock status" is shown at the status bar in the bottom right corner (padlock) as seen in the following screen.

Figure 2-8: Device Locking Menu

To lock the device, the user must enter a password.

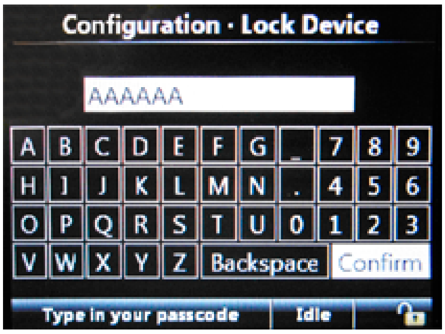

Figure 2-9: Password Input Screen

To unlock the controller, the user must enter the password as entered during the locking of the controller. The password will be stored in non-volatile memory.

Note that the locking feature is not infallible as the password is visible to any user with a LAD connected to the controller. It is intended to keep the uninformed user from accidentally changing configuration settings. Changing the configuration parameters will not affect the performance of the prover although caution must be used if changing the Motor parameters or the Sensor Pair. Changing of the Sensor Pair is only applicable if you have the optional third optical switch installed.

Changing of the Motor parameters should only be done after consultation with Honeywell Enraf experts as damage to the drive end could occur; the Motor parameters are set at the factory for the specific model of your prover.

When the device is locked, the following configuration parameters cannot be changed via the LAD menu until the user unlocks the controller again.

>>Device

1. Identification
   - Site Name
   - Device Name
2. Units
   - Units of volume
3. Display
   - Display brightness
   - Display Contrast
   - Session time out value
4. Time
   - Date display format
   - Time display format
   - Date
   - Time
5. Motor
   - Motor switch timeout
   - Motor off delay
6. Sensor Pair
7. Volume
   - Total volume
   - Upstream volume
   - Downstream volume

>> I/O Setting

1. Output
   - Alarm Relay output

>> Alarm

1. Service due reminder
   - Alarm action
2. Machine Fault
   - Alarm action
3. Cycle count Threshold
   - Cycle count

>> Cannot apply configuration (path is Transfer/Configuration/ Apply Configuration).

>> Cannot see and acknowledge or reset alarms (path is Diagnostics/ Active Alarm or Diagnostics/Prover Service Test/Clear Task).

>> Cannot upgrade any firmware (path is LAD Functions/ Firmware update).

The following tasks can be performed even if the controller is locked:

1. Navigate to Calibration and Enter, Run, Exit, Enter Average Volume, and Abort Calibration
2. Navigate and see System Info
3. Navigate to Logs and see and retrieve Transaction, Calibration and Alarm logs
4. Retrieve configuration (path is Transfer/Configuration/ Retrieve Configuration)
5. Navigate and view Diagnostics/Dashboard menu and activate or deactivate alarm output
6. Navigate and view storage info (path is Diagnostics/Storage Info)
7. Navigate to Diagnostics/Prover Service Test/Run Prover Service Test to activate the prover test
8. Navigate to LAD Function and view LAD information
9. Navigate to LAD Function and Format SD card

2.3.6 Configuration 

2.3.6.1 Using the Configuration Menu

Figure 2-10: Configuration Menu

- Via the Configuration menu, you can access the device configuration parameters
- The diagram below (Figure 2-11) allows you to locate all of the configuration parameters
- Always the current device configuration values are shown
- All configuration values are edited one at a time in type-specific data entry window

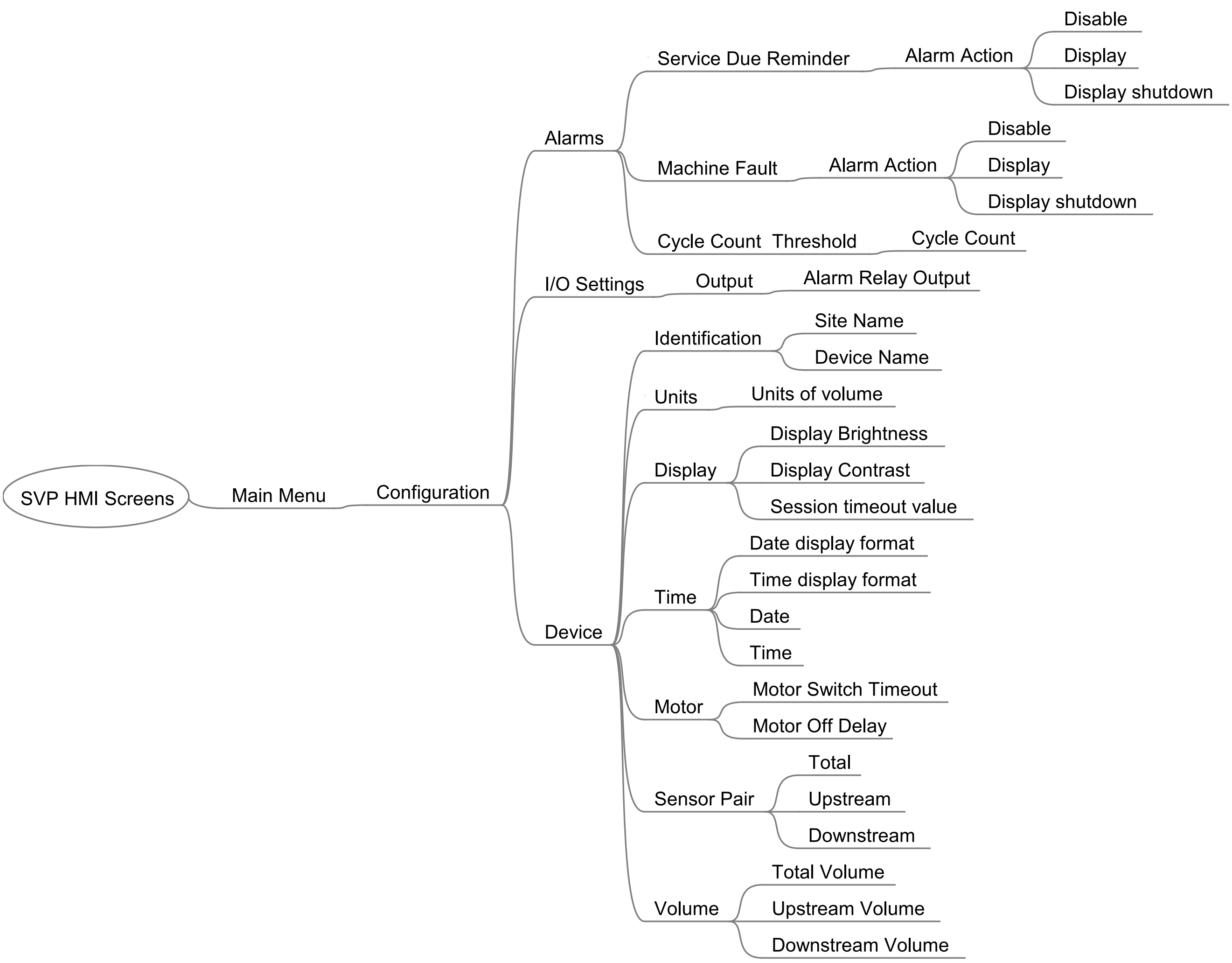

Figure 2-11: Configuration Menu Tree

2.3.6.2 Device

2.3.6.2.1 Identification

Entity	Description	Value range
[Site name]	The name of the site at which the SVP is located	Can be a text string of maximum 20 characters
[Device name]	The name of the SVP itself. In order to have a unique identification of the device by a text string Will be shown in the running screens.	Can be a text string of maximum 20 characters

2.3.6.2.2 Units

Entity	Description	Name	Unit
[Units of volume]	With this entity the user can select the engineering units for volume	Liter Cubic meter Cubic centimeter Cubic decimeter US Gallons UK Gallons Barrel	L m3 cm3 dm3 US gal UK gal bbls

2.3.6.2.3 Display

Entity	Description	Value range
[Display brightness]	With this entity the user can select the brightness of the display. The brightness is controlled by the backlight of the display	0% (low) - 100% (high)
[Display contrast]	With this entity the user can select the contrast of the display	0% (low) - 100% (high)
[Session timeout value]	This value selects the time in seconds between last key press on LAD and the moment the display will switch back to one of the running screens	
[User display language]	This entity selects the display language for the running screens	• English US • List may expand as additional languages are supported

2.3.6.2.4 Time

Entity	Description	Value range
[Date display format]	This entity selects the format of the date	• DD-MM-YY • MM-DD-YY • YY-MM-DD • DD-MM-YYYY • MM-DD-YYYY **Note:** *Only the first 3 selections will be completely visible on the SVP screen*
[Time display format]	This entity selects the format of the time	• 24 hours • 12 hours **Note:** *When setting the clock, first set the controller to 24-hour mode, then set the time. This will allow the proper AM or PM to be displayed when 12-hour mode is selected.*
[Date]	This entity selects the actual date and will be used for time stamping of transactions, calibrations, and alarms	
[Time]	This entity selects the actual time and will be used for time stamping of transactions, calibrations, and alarms	

2.3.6.2.5 Motor

These parameters are set at the factory and must not be changed without consulting Honeywell Enraf experts or damage to the prover may occur.

Entity	Description	Value range
[Motor switch timeout]	Configurable time interval by which piston puller must have reached motor stop switch before detection of a motor timeout error. Covers retraction of piston from parked position to motor stop switch. Units are in seconds	Configurable range is from 5 seconds to 120 seconds; factory recommended settings per model are shown below. S05 16 | S35 38 | S120 62 S15 14 | S50 26 S25 22 | S85 58
[Motor off delay]	Configurable delay which controls when motor turns off after piston puller has retracted to motor stop switch. Can be adjusted to affect optimal positioning of puller in preparation for next retraction sequence. Units are in seconds	Configurable range is from 0 to 60 seconds; factory recommended settings per model are shown below. S05 0 | S35 2 | S120 2 S15 0 | S50 2 S25 1 | S85 2

2.3.6.2.6 Sensor Pair

Standard provers have an Upstream optical sensor and a Downstream optical sensor. An option is available for a third optical switch. The configuration entities are as shown below.

Entity	Description	Sensor used as “high sensor”	Sensor used as “low sensor”
[Total]	Selects the Upstream Sensor to be used as the “high” volume gate and the Downstream Sensor to be used as the “low” volume gate. This is the default configuration	Upstream Sensor	Downstream Sensor
[Upstream]	Selects the Upstream Sensor to be used as the “high” volume gate and the Midstream Sensor to be used as the “low” volume gate	Upstream Sensor	Midstream Sensor
[Downstream]	Selects the Midstream Sensor to be used as the “high” volume gate and the Downstream Sensor to be used as the “low” volume gate	Midstream Sensor	Downstream Sensor

2.3.6.3 I/O Settings

2.3.6.3.1 Alarm Relay Output

The Alarm Relay Output can be configured to be Energized (normally closed) or De-energized (normally open).

2.3.6.4 Alarms

The following alarm entity applies to Service Due Reminder and Machine Fault.

Entity	Description	Value range
[Alarm action]	With this entity the user can configure the alarm behavior in case this particular alarm will occur	• <Disabled>: The alarm is ignored • <Display>: - Alarm shown on the display - Alarm-indication output set to ON - Next prover cycle will be allowed • <Shutdown>: - Alarm shown on the display - Alarm-indication output set to ON - Operation of further machine run cycles are disabled until the alarm is cleared - Still able to perform diagnostics via RunProver Test or via Dashboard screen from LAD

The Service Due Reminder alarm is activated when the cycle count reaches the threshold value programmed by the user at the Cycle Count Threshold menu. The default setting for the Cycle Count Threshold is 1000.

2.3.7 Prover Calibration 

The menu screens for Prover Calibration are shown in the diagram below (Figure 2-12). See Chapter 4 for detailed calibration procedures.

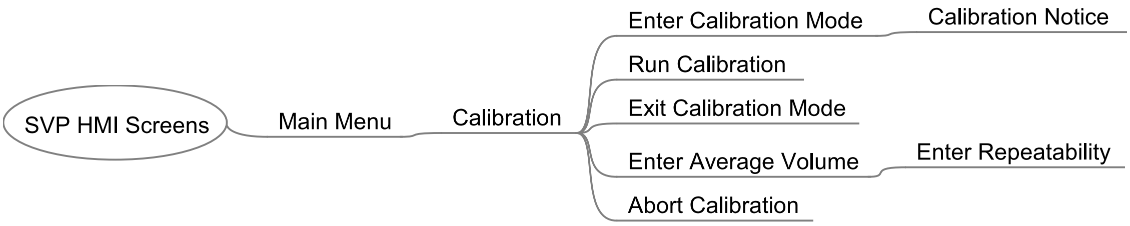

Figure 2-12: Prover Calibration

2.3.8 System Information 

The SVP Controller "About" box is showing important information about:

- The Device (SVP Controller)
- The individual boards (HMI, SVP and Option)
- The firmware versions

Figure 2-13: System Information

Within this screen identification information is shown of the following device components:

- Device serial number
- Production date
- Serial number of each FlexConn board
- Hardware version of each FlexConn board
- Application firmware version of each FlexConn board
- Build information of the firmware of each FlexConn board
- Boot firmware information of the firmware of each FlexConn board

- FlexConn stack firmware version of each FlexConn board
- Build information of the FlexConn stack firmware of each FlexConn board

The menu tree below shows how the information menus are accessed.

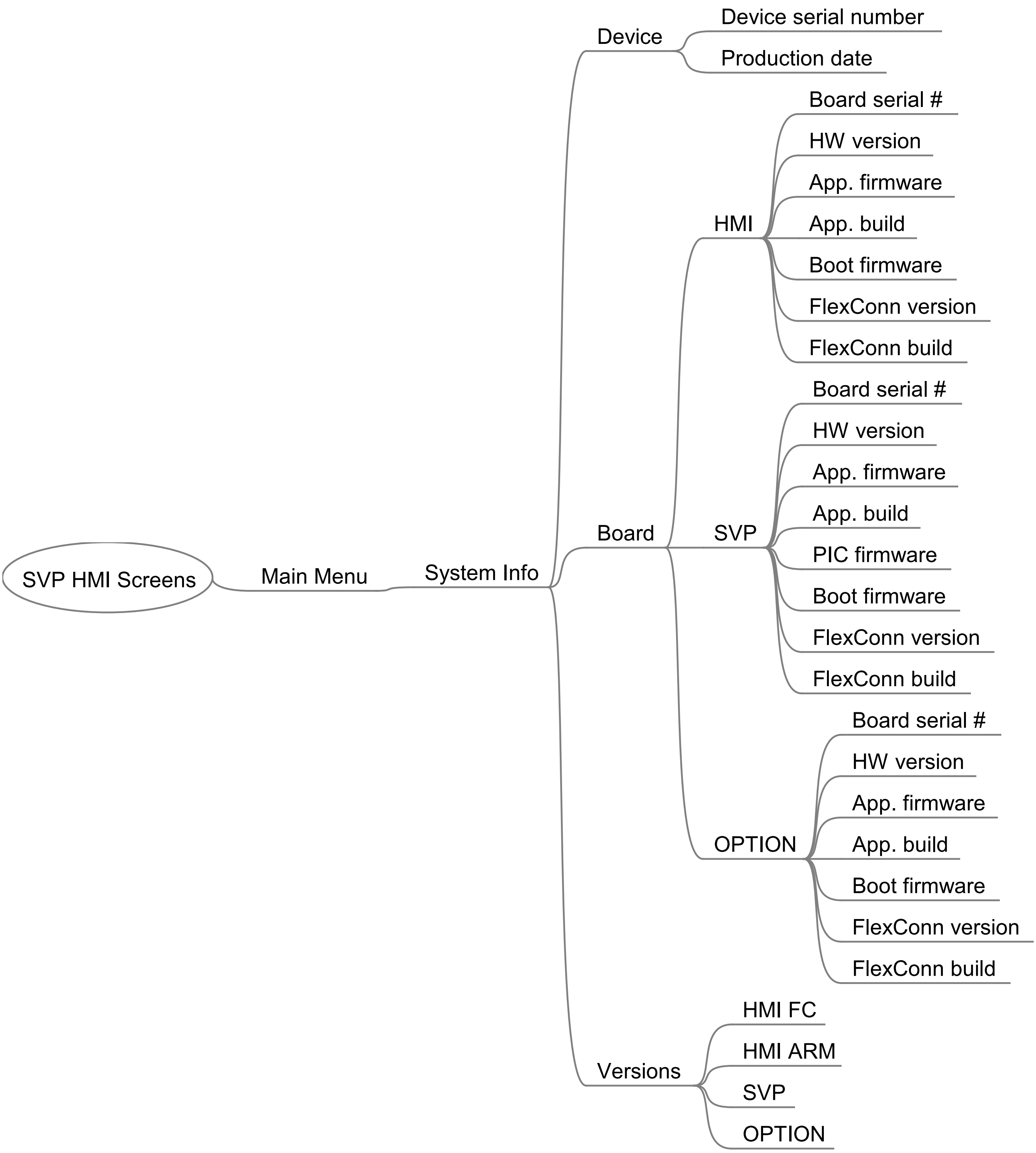

Figure 2-14: System Information Menu Tree

2.3.9 Logs 

This is the user interface to various logs maintained in non-volatile memory including:

- Transaction logs: complete information for each transaction
- Calibration log: shows the sequence of SVP calibrations over time
- Alarm Log: a chronological list on when alarms occurred and what type of alarms they were

Figure 2-15: Logs

The log memory will be a rolling memory file with the oldest data being overwritten first when the memory is full. Note that the log will be simply overwritten without issuing a warning message.

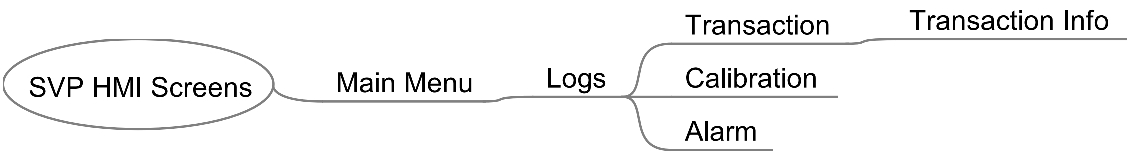

Figure 2-16: Logs Menu Tree

2.3.9.1 Transaction Logs

The transaction log will contain the following data for each Prover run:

- Date and time
- Sweep time in seconds
- Number of prover cycles

2.3.9.1.1 Transaction information

The details of any transaction can be viewed by going to that transaction and pressing OK. After every prover run cycle in calibration of meter mode the following parameters will be logged after completing the prover run

- Transaction ID
- Stop Transaction date and time
- Cycle count
- Sweep time
- Alarm information
- Sensor Pair
- Device Serial Number
- Transaction record version

2.3.9.2 Calibration Logs

The details of any transaction can be viewed by going to that transaction and pressing OK. After every prover run cycle in prover calibration mode the following parameters will be logged after completing the prover run. The calibration log contains the following information:

- Date and time
- Sweep time in seconds
- Average volume
- Repeatability

There are no units displayed for the average volume as they will be known by the user and to avoid complications if the units specified in the Configuration/Device/Units menu are changed.

2.3.9.3 Alarm Logs

The Alarm log forms a permanent record of the same information that can be viewed while an alarm is active from the Diagnostics/Active Alarms screen. This information consists of the date and time stamp and descriptive text.

2.3.10 Diagnostics 

This menu provides the following features:

- High-level view of all device I/O functions showing their state as "High"/"Low"
- Each output function can be tested by selecting and activating it
- Internal memory usage overview
- System health overview
- Active alarms overview
- Clear alarms
- Activate the Run Prover Test mode

Figure 2-17: Diagnostics

Within this screen, the user can view the diagnostics about the following subjects:

- Overview of all I/O (Dashboard)
- Overview of system health
- Overview of all active alarms
- Overview of device tasks such as clearing tasks, clearing alarms, and running prover test task
- Overview of available memory storage space for data logs and total number of available logs

The diagram below shows all of the information available to you. Note that the parameters marked with an * are not relevant for the first release of the SVP Controller. They are reserved for future use or for internal testing.

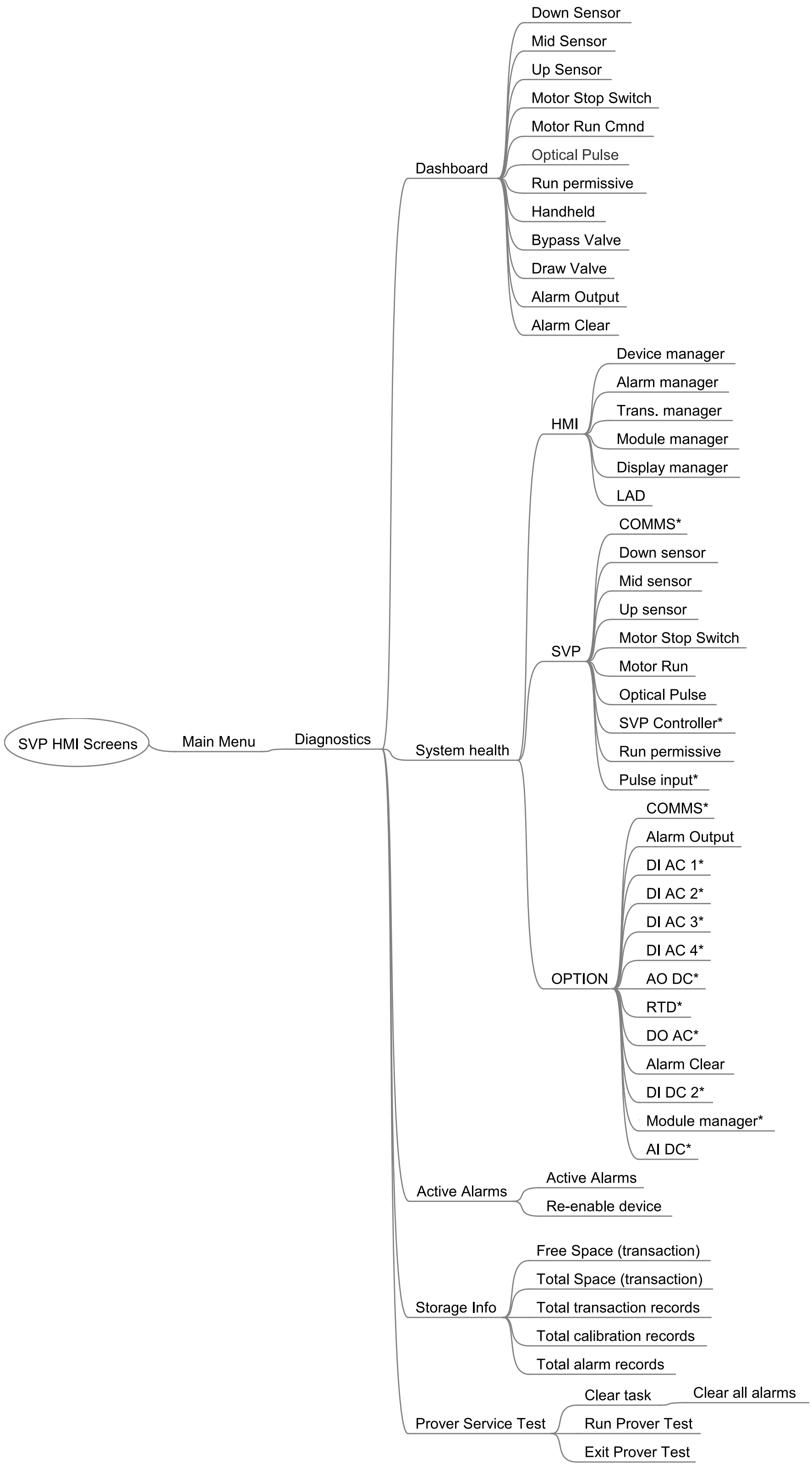

Figure 2-18: Diagnostics Menu Tree

2.3.11 Transfer 

Note: Only when the LAD is connected!

Via this user's interface, the following type of records can be transferred between the SVP Controller and the LAD:

- Transaction records
- Configurations
- Events/logs (alarms)
- Calibration records

Figure 2-19: Transfer

The diagram below shows all of the information available to you.

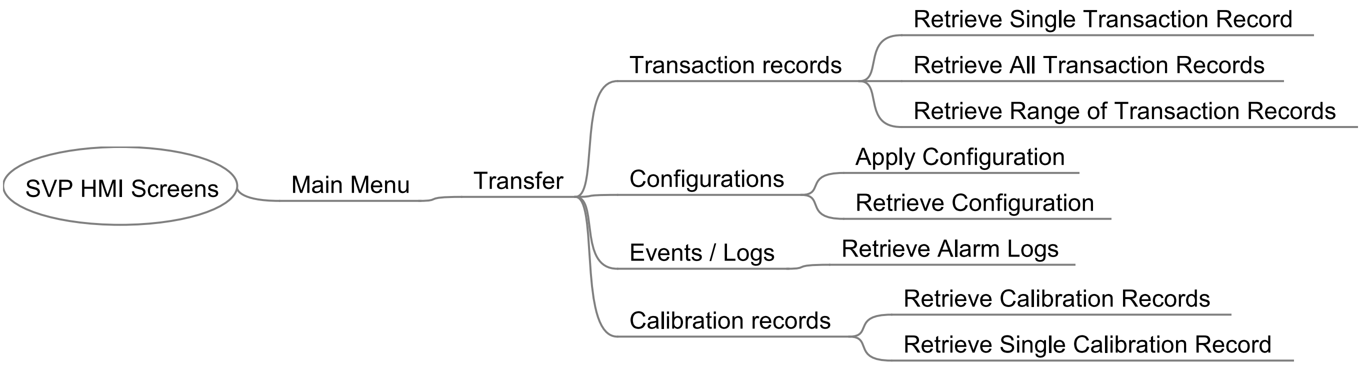

Figure 2-20: Transfer Menu Tree

2.3.12 LAD Settings 

Note: Only when the LAD is connected!

This is the user interface to the LAD specific functionality:

- Firmware download to the SVP Controller and the LAD
- Management of the LAD's stored records
- Format SD card

Figure 2-21: LAD Settings

The diagram below shows all of the information available to you.

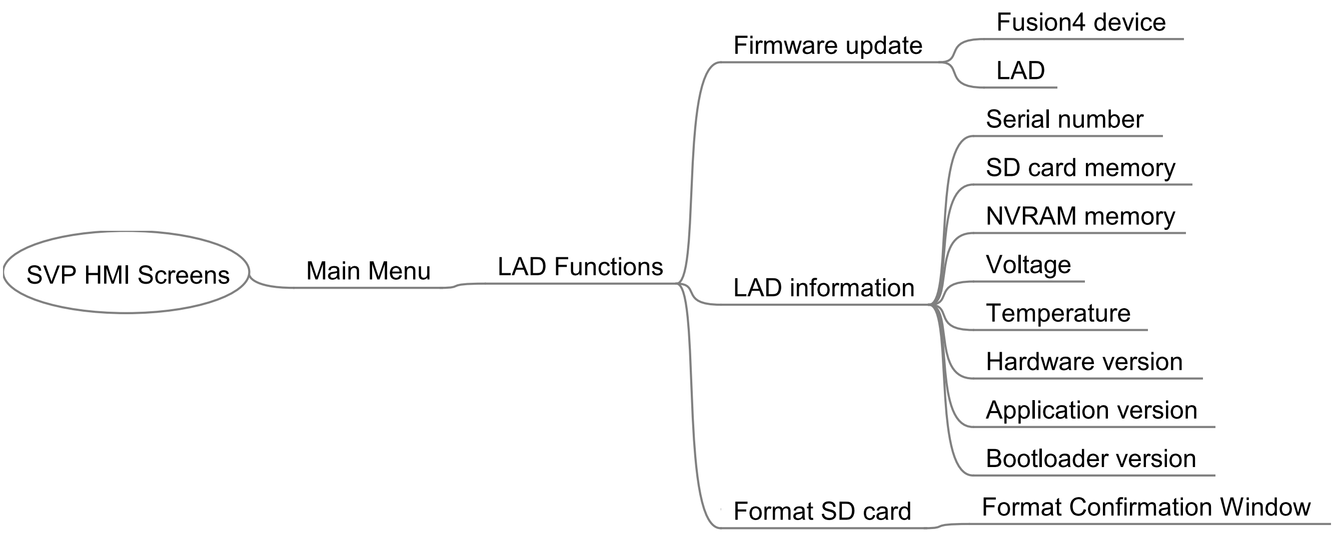

Figure 2-22: LAD Settings Menu Tree

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CHAPTER 3 OPERATIONS

3.1 Operating Instructions

1. *Firstly, carry out the removal and replacement of transit seals with the operation seals (as supplied) prior to introducing liquid into the Honeywell Enraf small volume prover.*
2. Open fluid inlet valve slowly. After the inlet valve is completely open, open fluid outlet valve, connecting the prover to the process line.
3. Vent trapped air from the prover by opening the vent valves located at the top of the prover flow tube.
4. Close process diverter valve, slowly to divert the flow through the prover.
5. The Honeywell Enraf small volume prover is now ready for meter proving. Refer to the appropriate proving computer manual for procedures for performing meter proving runs.
6. After meter proving runs have been completed, open process diverter valve, and slowly close the prover connection valves.

If you have the optional third optical switch installed on your prover refer to Chapter 2 section 2.3.6.2.6 for Sensor Pair configuration prior to operating your prover in any of the following three modes of operation.

3.2 Meter Calibration

Upon initial power up of the SVP Controller the Prover Status screen will indicate that the operating mode of the controller is Meter Calibration. This is the default operating mode of the controller. The other two operating modes, Prover Test and Prover Calibration, require entering into those modes via the LAD. In order to do proving runs on a meter make sure that you are operating in the Meter Calibration mode as indicated by the "Prover Status – Meter Calibration" screen as shown below.

Prover Status · Meter Calibration	
Piston	Unknown Position
Motor	Idle
Error Status	No Error
Cycle	779
Stop Time	10-31-12 11:32:32 AM
Sweep Time	00:00:01:102

Press OK to enter menu	Stop	

On the first power up and after any machine fault alarm, the piston position will be unknown and one proving run needs to be successfully completed in order to initialize the piston position status. Upon sending the signal from the PROVEit software or the other flow computers, the prover motor will retract the piston assembly and the proving run will start. At the end of the proving run the flow rate will be displayed on the screen and the next proving run can be initiated.

During the return and proving mode different piston positions and the motor status will be displayed on the SVP controller screen. At the end of the proving run the sweep time, cycle count and the stop time will be updated. If any errors occur during the proving run the error will be reported on the screen and will need to be cleared via the LAD (Main menu/Diagnostics/Dashboard/Alarm Clear – see Chapter 5 - Troubleshooting).

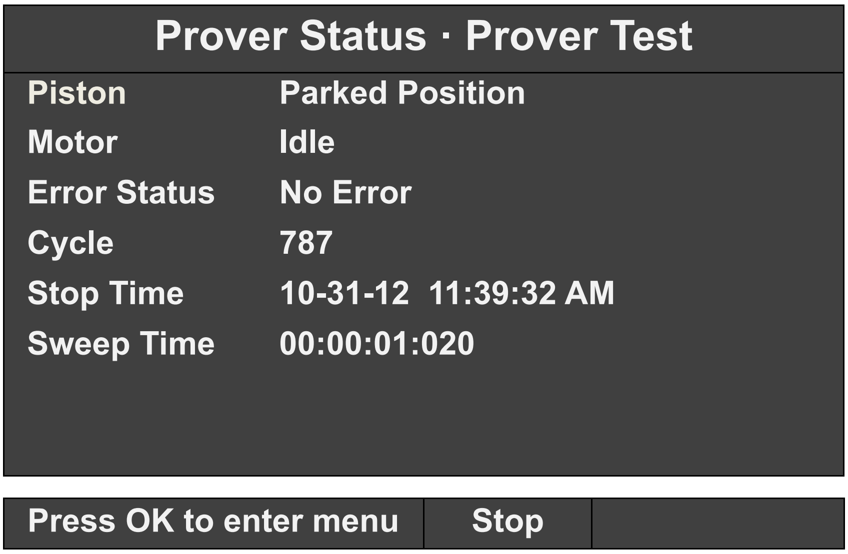
3.3 Prover Test

The Prover Test mode can be useful to become familiar with your prover and to verify proper operation. This mode is accessed by navigating with the LAD through the following menus: Main Menu/Diagnostics/Prover Service Test/Run Prover Test.

Pressing OK on the LAD at Run Prover Test causes a prover run cycle to be executed, and the SVP Controller display will appear as shown below. With the piston at the extreme downstream position, the Parked Position, the motor will pull the piston upstream and the piston position will be shown on the Prover Status screen as the associated optical sensor flag passes through the Downstream sensor and the Upstream sensor until the motor stop switch is activated. Run Prover Test can be executed repeatedly while the liquid flows through the prover pushing the piston towards the downstream side. This test will only run in the absence of a Flow Computer run permissive signal; it will not be executed if the run permissive has been asserted by a Flow Computer.

See Chapter 5 - Troubleshooting if an error status is indicated.

To exit this operating mode use the LAD to navigate to Main Menu/ Diagnostics/Prover Service Test/Exit Prover Test



3.4 Prover Calibration

The third operating mode of the controller is Prover Calibration and will be described in more detail in the next chapter.

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CHAPTER 4 CALIBRATION

4.1 General

It is recommended that prior to doing any volumetric calibration that the personnel involved read the API Manual of Petroleum Measurement Standards (MPMS) Chapter 3 – Proving Systems sec 3.8, and the MPMS Chapters 3.3.7.1, and 12.2.4 – pertaining to the calculation for the volume of provers.

Although the prover may be calibrated with procedures traceable to the National Institute of Standards and Technology (NIST) by a number of techniques, only two techniques for volume determination will be described here, a volumetric calibration and a gravimetric (mass) calibration.

The gravimetric calibration method requires collecting the volume of water displaced by the prover during a prove pass and determining its mass by weighing it with a precision scale or balance. Corrections are made for the density of the water and the buoyancy of the air displaced by the volume of water per API 14.6, and applying various other correction factors such as the temperature and pressure effects on the flow tube and the volume switch position. De-ionized or distilled water should be utilized for the gravimetric method. API 4.9.4 is the API standard used for the density determination of water.

The displaced volume has been calibrated as described in the MPMS API chapters,: 4.2, 4.9 and 12.2.4.

The Honeywell Enraf small volume prover base volume has been determined at the factory. Recalibration is recommended either at 1 year intervals, or as determined by the authorities and parties responsible for the measurement. Recalibration is also required after any maintenance which may affect the base volume, i.e.: complete switch bar replacement. Honeywell Enraf small volume prover optical switches are field replaceable and adjusted to an extremely high degree of precision. Individual switch replacement does not necessitate re-calibration. See Section 6.7 for more information on optical switches.

4.2 Static Leak Detection

The Honeywell Enraf static leak detection procedure should be used prior to water draw or at any time that meter proof repeatability is difficult to attain. It is not necessary to remove the prover from the process line to perform a leak test. It is only necessary to block off the inlet and outlet of the prover with it full of fluid. Block off the drain valves and verify there is no leak path from the prover. If necessary, insert blind flanges into the inlet and outlet ports to isolate the prover from the system. It is also necessary to have a differential pressure gauge with a sufficient pressure rating to withstand line pressure if the prover is not removed from the process line. Temperatures, both ambient and fluid, should be stable during the procedure.

4.2.1 Equipment

1. Static leak differential pressure creator assembly, included with prover.
2. Differential pressure gauge 0-69 kPa (10 psi) or greater with sufficient static pressure specifications to be equal or greater than the current prover pressure.
3. Plumbing and valve arrangement similar to that shown in Figure 4-1.

4.2.2 Static Leak Detection Procedure

1. Block all inlet and outlet ports on the prover (including drains).
2. Refer to Figure 4-1, 4-2 & 4-4 below and install the differential pressure gauge (1) between the inlet and outlet ends of the prover.
3. Fill the prover with liquid and vent off all air from the system.
4. Determine there are not leaks from the prover ports.
5. If necessary, blind the inlet, outlet ***and drain lines*** with blind flanges.
6. Power up the proving computer and the Honeywell Enraf prover.
7. From the proving computer, initiate a proving run to pull the piston upstream.
8. Remove the plug from the drive cover end panel.
9. Install the differential pressure creator (2) in the threaded hole provided in the drive system end plate and hand tighten, refer to Figure 4-3.
10. Rotate the adjustment screw (3) Figure 4-4 clockwise to push the plunger out to apply force to the piston shaft and create a differential pressure between the inlet and the outlet of the prover. Rotate the adjustment screw until a differential pressure of 6 psid has been created. Pressurize the unit slowly and watch the pressure gauge. In some cases it might happen that applied pressure of 6 psid will be significantly lost in the first couple of minutes. The reason is that the poppet valve will need short period of time to fully close and stabilize.

    Therefore, it is our recommendation to allow at least 5 minutes between the applied pressure and actual data recording.

11. Look the prover over for any obvious external leaks.
12. Start observing the differential pressure gauge for a period of 20 minutes. If the pressure has not dropped by more than 25% of the starting differential pressure, it may be assumed that there are no piston seal leaks. If the pressure has dropped to lower levels, it should

be assumed that there is a seal leak, and the prover piston seals should be replaced. Refer to Figure 4-5.

Figure 4-1: Static Leak Detection Set-up

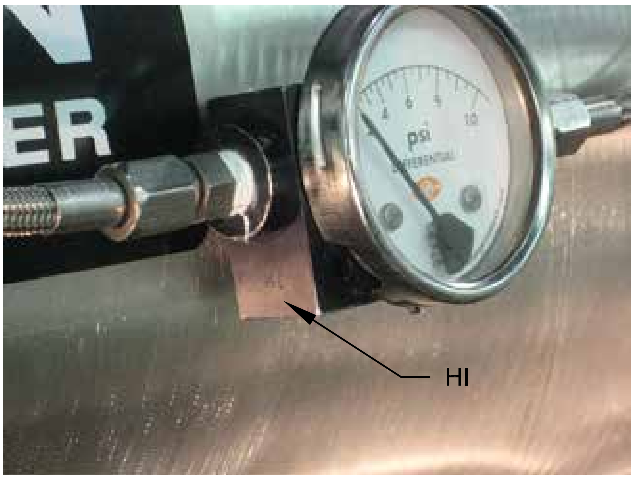


Figure 4-2: Gauge with HI & LOW markings

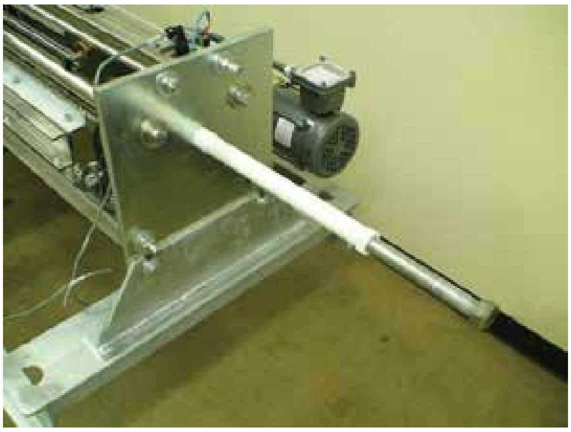


Figure 4-3: Differential pressure creator inserted in drive end plate.

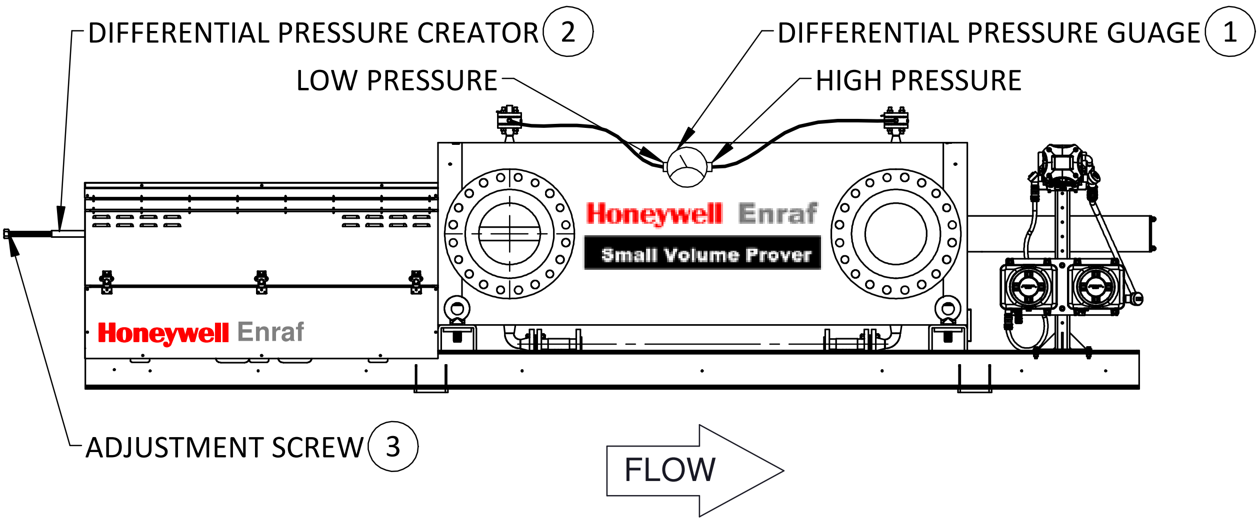


Figure 4-4: Static Leak Detection set-up overview

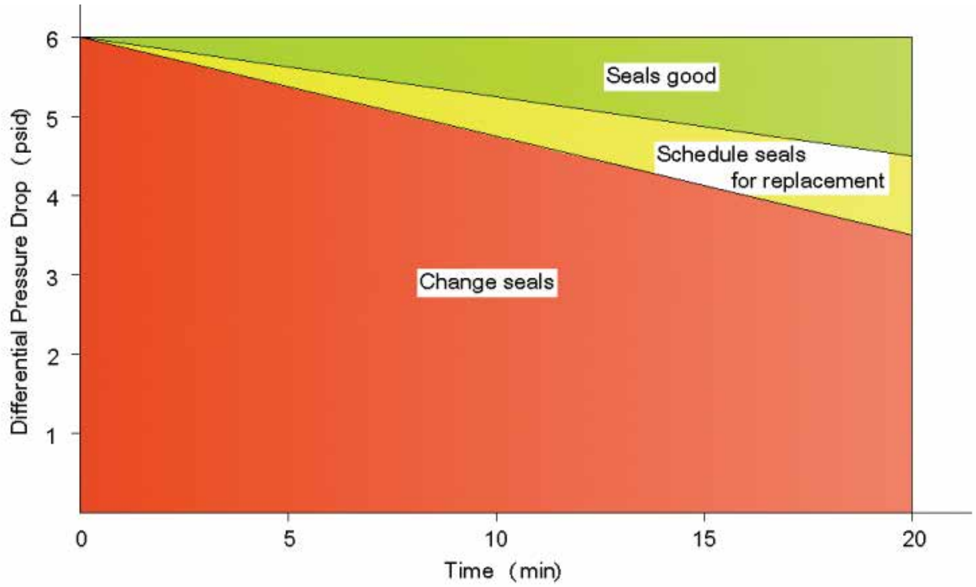


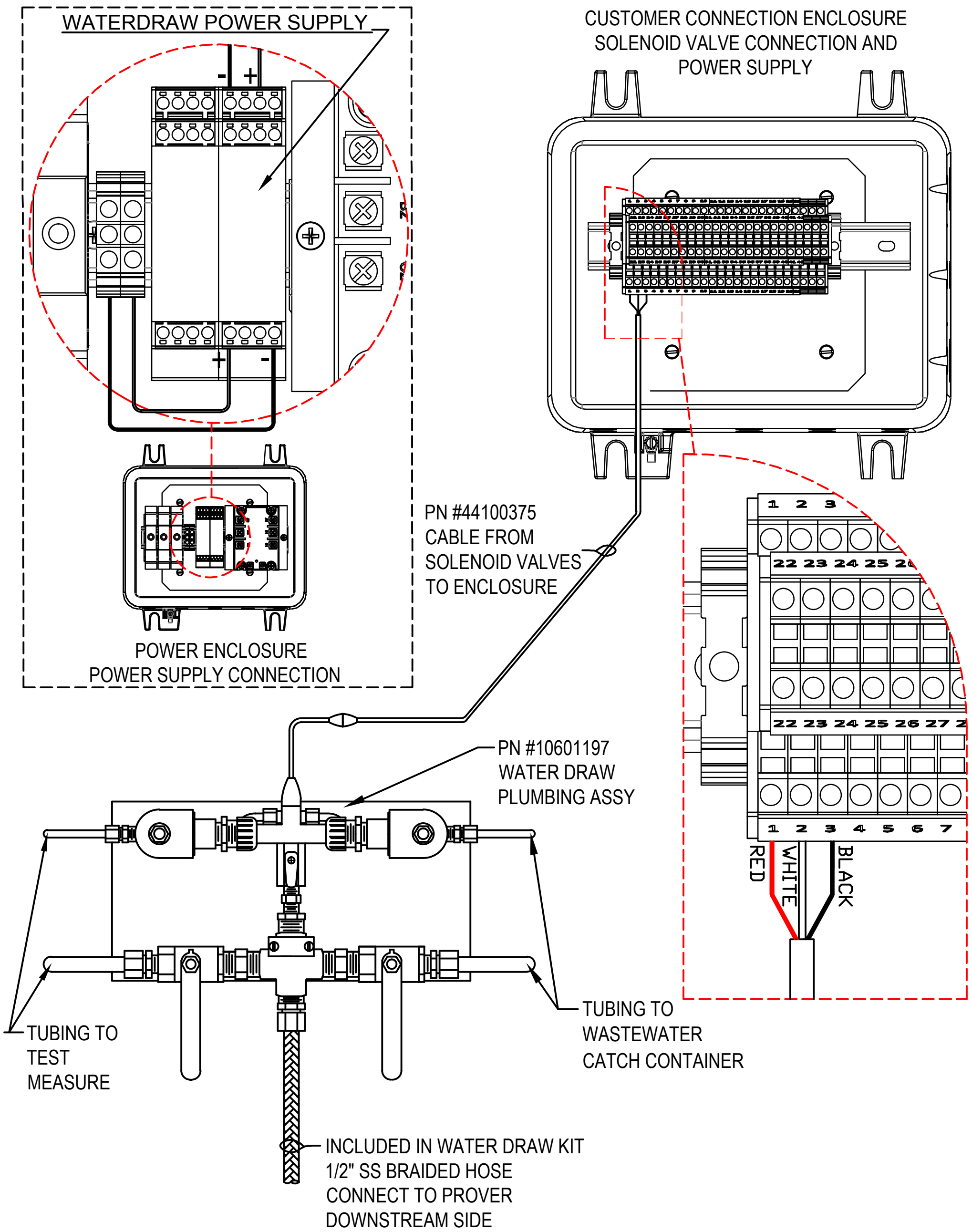
Figure 4-5: Recommendation for seal change

4.3 Volume Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, (see Figure 4-6).
2. Source of clean potable water. Pump or water supply must have steady flow of approximately 38 Lpm (10 GPM) at 172-690 kPa (25-100 psi) Water supply must maintain non-pulsating pressure.
3. Certified volume test measures (conforming to API chapter 4 section 7) traceable to the U.S. NIST (or other National standards). The test measure should be of the same volume as the displaced volume of the prover. If, however, the test measure is smaller than the prover volume, there must be at least two test measures, as the flow during water draws should be continuous for the greatest precision. *Example:* For a 20-gallon prover uses a single 76 L (20 gal) test measure.
4. Certified high resolution pressure gauge: 0-690 kPag (0-100 psig) psig
5. Three traceable thermometers with 0.1°C (0.2°F) degree graduations (for thermometer reference positions see Figure 4-7).
6. Water overboard container, volume to be at least as large as test measure, and approximately the same height.

Note: Honeywell Enraf Water Draw P&T kit or equivalent assembly eases installation of water draw prover instrumentation. The Honeywell Enraf Water Draw P&T kit consists of four traceable temperature thermometers (one spare thermometer included) and one pressure gauge. All thermometers come with the calibration certifications if ordered from Honeywell Enraf.



Customer Connection Enclosure		
Description	**Terminal Number**	**Wire Color**
Water Draw SV1	1	Red - Water Draw Cable
Water Draw SV2	2	White - Water Draw Cable
Water Draw Common	3	Black - Water Draw Cable

Figure 4-6: Water Draw Kit

Procedure

Water draw notes:

Perform steps 12-17 at least twice prior to taking data to purge the system of air, assure the temperature is stable, and to get familiar with the procedure.

Repeat the water draw procedure until at least 3 consecutive draws repeat within 0.02% or other repeatability criteria that the certifying parties agree upon. The flow rate on at least one run must vary by 25% to assure integrity of prover seals and absence of leakage.

Failure to achieve the necessary repeatability may be caused by leaking valves, air in the system, varying pressure, leaking seals, or faulty calibration technique.

1. Be certain that all maintenance that needs to be done to the prover has been accomplished before starting the volumetric calibration. It is advisable to perform a static leak test prior to performing a water draw, see Section 4.2. Replace the seals on the prover if there is any doubt as to their integrity.
2. Block prover inlet and outlet by using a blind flanges or double block and bleed valves.
3. Refer to Honeywell Enraf water draw configuration, Figure 4-7, and install Honeywell Enraf available water draw kit, see Figure 4-6. Install certified thermometers and certified pressure gauge, even if the prover is equipped with P&T transmitters.

   If using Honeywell Enraf Water Draw P&T kit, remove the plug in the wafer spacer and connect the pressure gauge P1 to the opening (see Figure 4-7 for reference).

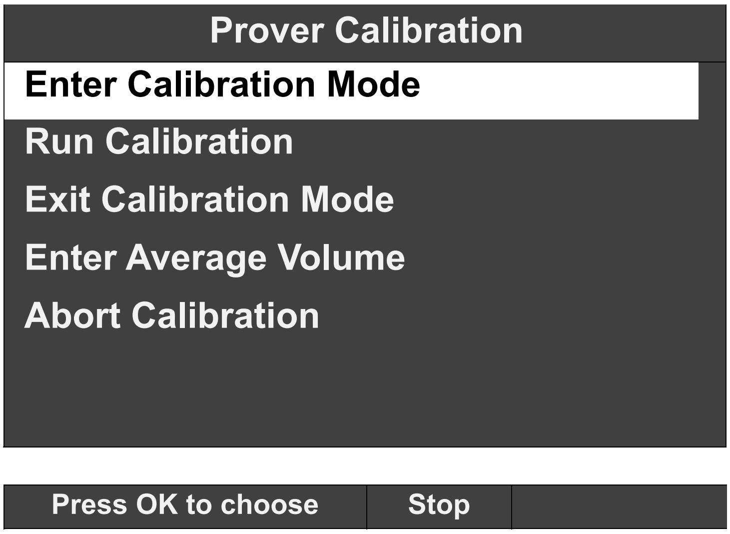
   The thermometer used to monitor prover fluid temperature T1 is supposed to be installed into the spare thermowell located on the downstream side of the flow tube (see Figure 4-7 for reference).

   The thermometer used to monitor switch bar temperature T2 is supposed to be installed on top of the switch bar close to the center line between two optical switches (see Figure 4-7 for reference).

   The thermometer used to monitor test measure temperature T3 is supposed to be installed on the test measure (see Figure 4-7 for reference).

   Have available Table 1 to record data from prover calibration using volumetric water draw technique.
4. Connect water supply to prover, (refer to Figure 4-7).
5. Make sure that the water draw kit is wired to the customer connection enclosure as specified in the Figure 4-6.
6. Turn water supply on, and open valves V1, V2, and V3. After all air is bled off, close V2 and V3. Open V5 valve and allow water to circulate until the temperature has stabilized and is not changing.

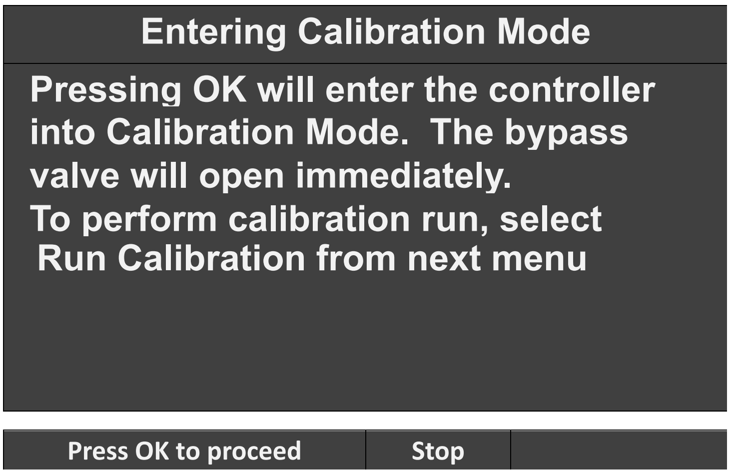
7. Valve V2 may be opened slightly to allow just a very small stream of water to flow; this will bleed off air, which may be in the water supply. At the end of the temperature stabilization close the V5 valve.
8. Place properly wetted and drained test measure under the water draw valves.
9. Ensure power is applied to the prover. Navigate to Calibration screen from the Main Menu as shown below.



10. Enter the prover calibration mode using “Enter Calibration Mode” submenu.

Notification to user after selecting Enter Calibration Mode will show up on the SVP Controller screen (see below).

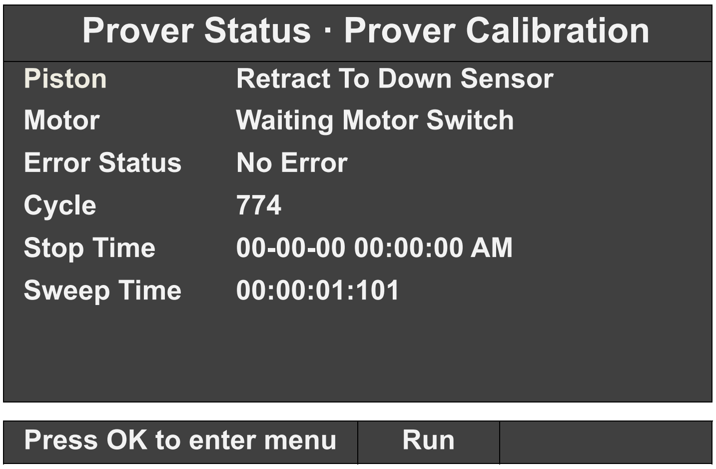
Please note that permissive signal from the flow computer will be ignored while in prover calibration mode.



11. Bypass valve (SV2) will be turned ON immediately after entering the prover calibration mode and the water from the prover will be drained into the wastewater catch container.

12. Select “Run Calibration” which will cause the prover piston to be returned to the upstream position and start the draw sequence. See resulting Prover Status screen as shown below.

After selecting Run Calibration following screen appears.



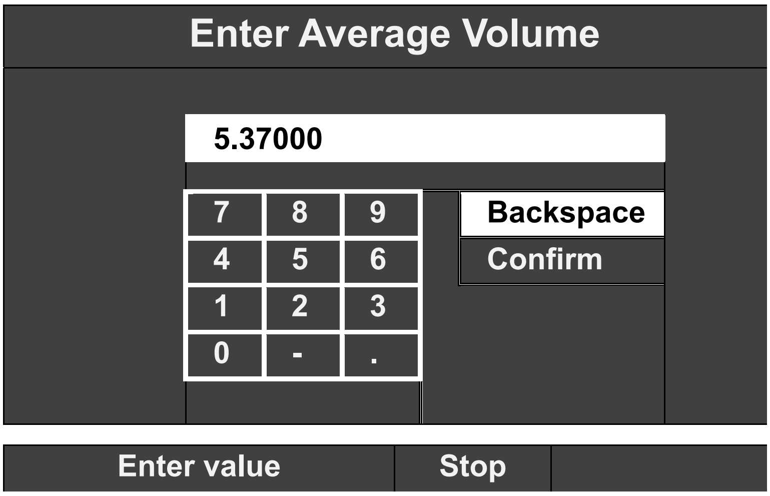
13. Water should now be draining into the wastewater container until the flag reaches the first optical (volume) switch. When the first optical switch is reached, the signal will be sent to the SVP controller to switch the valves (turn the SV2 valve OFF and turn the SV1 valve ON). At that time the water will start flowing into the Test Measure.
14. Record the prover pressure (Pp) at P1 while only the water draw valve is open (SV1). Valves V5 and V6 must be closed while recording this pressure, which is the pressure at the start and the end of volume switching.
15. Record temperature (Td) at T2, which is the detector temperature, by opening the drive cover and placing the thermometer midway between volume switches, which is the location of the switch bar temperature transmitter thermowell.
16. Record fluid temperature (Tp) at T1.
17. When the flag reaches the second optical (volume) switch, the draw valve (SV1) is turned OFF and the bypass valve (SV2) is turned ON. Carefully record scale reading (SR) and test measure temperature (Ttm) at T3.
18. After all data is collected, drain the test measure.
19. Repeat steps 12 through 18 as necessary to obtain the required number of well repeating runs (including one run at 25% flow rate variance).

Please note that a log will be saved with start time and sweep time after each calibration run.

20. Once you have completed the calibration, select the “Exit Calibration” menu which will turn the bypass valve (SV2) OFF.

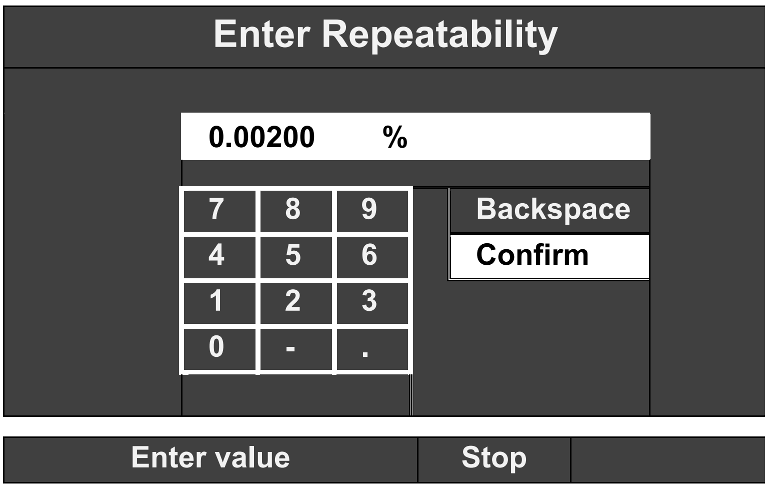
21. Calculate prover volume per Section 4.5.
22. Enter the average calibration volume calculated in the previous step by selecting the “Enter Average Volume” menu. This screen can be accessed while still in the Calibration mode or at a later time by entering the Calibration menu and then accessing this screen directly.

After selecting Enter Average Volume following screen appears



23. After the Average Volume has been entered and confirmed the following screen is displayed to enter the Repeatability in percent (%). The entered average volume and the repeatability values will be stored in the log with a timestamp of the entry.

After selecting Enter Average Volume following screen appears



Selecting “Abort Calibration” will stop the calibration process. This action will stop the motor if in running state, bypass value (SV2) will be turned ON and draw valve (SV1) will be turned OFF. If the Prover is in sweep mode with the piston moving downstream no action will be taken for upstream and downstream sensor inputs. Calibration log entry will not be made.

In calibration mode alarms will be generated as per the configuration, and the run permissive signal from the flow computer or the run prover test signal will be ignored. The operating mode of the prover will be saved in NVM so that the mode will be restored if power is turned off while in Prover Calibration mode.

To exit calibration mode navigate to the Exit Calibration Mode menu and press OK.

A copy of Table 1 can be used to enter water draw data.

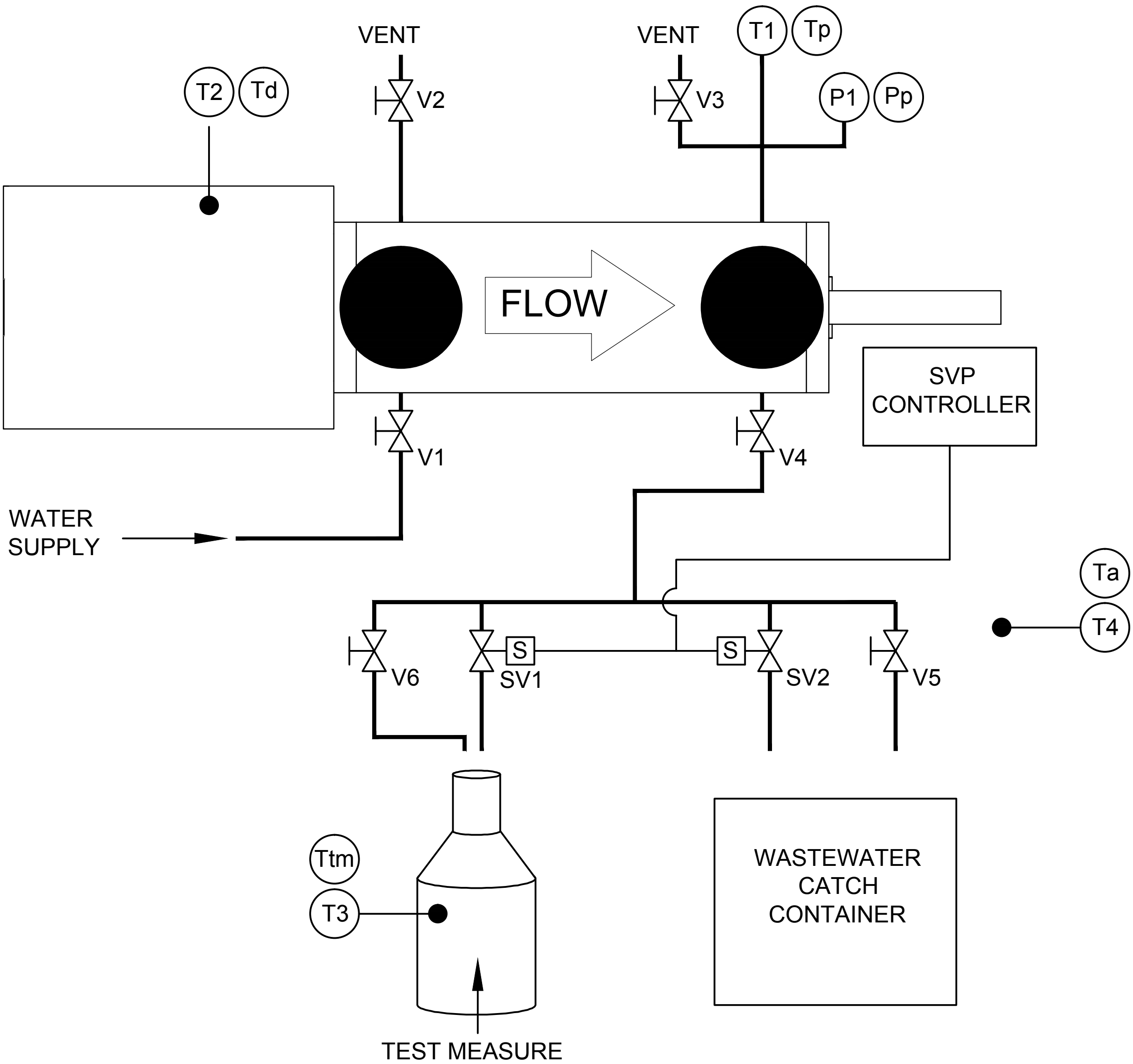


Figure 4-7: Water Draw Plumbing Diagram

Volumetric Water Draw Data Sheet

Date:					
Prover Serial Number:					
Prover Model Number:					
Report Number:					
Location:					
Base Temperature (Tb):					
Base Measure Volume-from calibration cert. (BMV):					
Volume Measure Thermal Coefficient (Gc):					
Compressibility Factor (water) (CPL):					
Flow Tube Area Thermal Expansion Coefficient (Ga):					
Detector Linear Thermal Expansion Coefficient (Gl):					
Modulus of Elasticity of flow tube (E):					
Flow Tube Inside Diameter (inches) (ID):					
Flow Tube Wall Thickness (inches) (WT):					
	Fill 1	Fill 2	Fill 3	Fill 4	Fill 5
Fill Time (minutes) =					
Flow Rate (Nominal Volume/Fill Time) =					
Temperature Prover (*Tp*) =					
Temperature Detector (*Td*) =					
Prover Pressure (*Pp*) =					
Scale Reading on Volume Measure (*SR*) =					
Volume of Water adjusted for SR (*BMVa*) =					
Test Measure Temperature (*Ttm*) =					
Correction for Temp. Differential (*Ctdw*) =					
Effect of Temp. on Test Measure (*CTStm*) =					
Effect of Temperature on Prover (*CTSp*) =					
Combined effect of CTSM & CTSP (*CCTs*) =					
Volume Waterdraw (*WD*) =					
Effect of Pressure on Flow Tube (*CPSp*) =					
Compressibility of water in prover (*CPLp*) =					
Corrected Water Drawn Volume (*WDzb*) =					

Table 1: Volumetric Water Draw Data Sheet

4.4 Gravimetric Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, Figure 4-6.
2. Precision electronic weigh scales of the correct size and resolution: for example for an S25 prover, balance must have a capacity of at least 100kg and +/-4 gram (200 lb. and +/- 0.01 lb.). resolution. (1 part out of 20,000 or better resolution). For proper scale verification prior to the gravimetric water draw refer to API 4.9.4.
3. Certified test weight set: ANSI/ASTM Class 3 equivalent or better.
4. Source of air-free or deaerated deionized or distilled water with approximately 38 Lpm at 172-690 kPag (10 GPM at 25-100 psig) steady, non-fluctuating, pressure.
5. A volume catch container ideally, large enough for the volume of fluid dispensed by the prover. Container must be designed to be placed on the precision balance or scales.
6. Certified high resolution pressure gauge: 0-690 kPag (0-100 psig).
7. Three traceable thermometers with 0.1°C (0.2°F) graduations (for thermometer reference positions see Figure 4-7).
8. Water draw data sheet, Table 2.
9. Water overboard container, volume to be at least as large as test measure.

Note: Honeywell Enraf Water Draw P&T kit or equivalent assembly eases installation of water draw prover instrumentation. The Honeywell Enraf Water Draw P&T kit consists of four traceable temperature thermometers (one spare thermometer included) and one pressure gauge. All thermometers come with the calibration certifications if ordered from Honeywell Enraf.

Procedure

Water draw notes:
Perform steps 14 – 21 at least twice prior to taking data to purge the system of air, assure the temperature is stable, and to get familiar with the procedure.

Repeat water draw procedure until at least 3 consecutive draws repeat within 0.02% or other repeatability criteria that the certifying parties agree upon. The flow rate on at least one run must vary by 25% to assure integrity of prover seals and absence of leakage.

Failure to achieve the necessary repeatability may be caused by leaking valves, air in the system, varying pressure, leaking seals, or faulty calibration technique.

1. Be certain that all maintenance that needs to be done to the prover has been accomplished before starting the gravimetric calibration. It is advisable to perform a static leak test prior to performing a water draw, see Section 4.2. Replace the seals on the prover if there is any doubt as to their integrity.
2. Block prover inlet and outlet by using a blind flanges or double block and bleed valves.
3. Refer to Honeywell Enraf water draw configuration, Figure 4-7, and install Honeywell Enraf available water draw kit, see Figure 4-6. Install certified thermometers and certified pressure gauge, even if the prover is equipped with P&T transmitters.

   If using Honeywell Enraf Water Draw P&T kit, remove the plug in the wafer spacer and connect the pressure gauge P1 to the opening (see Figure 4-7 for reference).

   The thermometer used to monitor prover fluid temperature T1 is supposed to be installed into the spare thermowell located on the downstream side of the flow tube (see Figure 4-7 for reference).

   The thermometer used to monitor switch bar temperature T2 is supposed to be installed on top of the switch bar close to the center line between two optical switches (see Figure 4-7 for reference).

   The thermometer T4 is supposed to be used to monitor ambient temperature (see Figure 4-7 for reference).

   Have available Table 2 to record data from prover calibration using gravimetric water draw technique.
4. Calibrate the scale as specified in API 4.9.4.
5. Connect water supply to prover, (refer to Figure 4-7)
6. Make sure that the water draw kit is wired to the customer connection enclosure as specified in the Figure 4-6.
7. Turn water supply on, and open valves V1, V2, V3. After all air is bled off, close V2 and V3. Open V5 valve and allow water to circulate until the temperature has stabilized and is not changing.
8. Valve V2 may be opened slightly to allow just a very small stream of water to flow; this will bleed off air, which may be in the water supply.
9. Calibrate scales with test weights totaling +/- 10% of draw weight per API 4.9.4.
10. With volume catch container on the scales and under water draw valve, tare scales.

11. Ensure power is applied to the prover. Navigate to Calibration screen from the Main Menu as shown below.

Prover Calibration

Enter Calibration Mode
Run Calibration
Exit Calibration Mode
Enter Average Volume
Abort Calibration

Press OK to choose	Stop	

12. Enter the prover calibration mode using "Enter Calibration Mode" submenu. Notification to user after selecting Enter Calibration Mode will show up on the SVP Controller screen (see below).

Please note that permissive signal from the flow computer will be ignored while in prover calibration mode.

Entering Calibration Mode

Pressing OK will enter the controller into Calibration Mode. The bypass valve will open immediately.
To perform calibration run, select Run Calibration from next menu

Press OK to proceed	Stop	

13. Bypass valve (SV2) will be turned ON immediately after entering the prover calibration mode and the water from the prover will be drained into the wastewater catch container.

14. Select "Run Calibration" which will cause the prover piston to be returned to the upstream position and start the draw sequence. See resulting Prover Status screen as shown below.

After selecting Run Calibration following screen appears.

Prover Status · Prover Calibration	
Piston	Retract To Down Sensor
Motor	Waiting Motor Switch
Error Status	No Error
Cycle	774
Stop Time	00-00-00 00:00:00 AM
Sweep Time	00:00:01:101

Press OK to enter menu	Run	

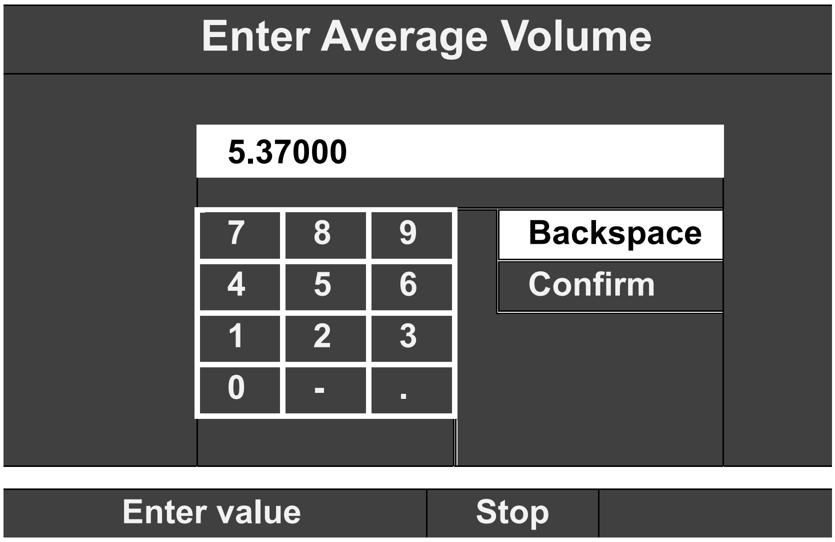
15. Water should now be draining into the wastewater container until the flag reaches the first optical (volume) switch. Note: To decrease the time necessary to reach the first volume switch, valve V5 may be opened until just before the first volume switch has been reached.
16. When the first optical switch is reached, the signal will be sent to the SVP controller to switch the valves (turn the bypass valve SV2 OFF and turn the draw valve SV1 ON). At that time the water will start flowing into the Test Measure.
17. Record the prover pressure (Pp) at P1 while only the water draw valve is open (SV1). Valves V5 and V6 must be closed while recording this pressure, which is the pressure at the start and the end of volume switching. Note: The draw can be sped up by opening valve V6 after the valves have switched to flowing into the Test Measure located on the scale and the prover pressure (Pp) is recorded. Again close V6 at least 13mm or 2L (1/2" or 1/2 gal) prior to solenoid draw valve switching.
18. Record ambient temperature (Ta) at T4.
19. Record temperature (Td) at T2, which is the detector temperature, by opening the drive cover and placing the thermometer midway between volume switches, which is the location of the switch bar temperature transmitter thermowell.
20. Record fluid temperature (Tp) at T1 (at prover).
21. Allow Test Measure located on the scale to fill until the second volume switch (downstream sensor) is reached resulting in the draw valve (SV1) turning OFF and bypass valve (SV2) turning ON. Carefully record scale reading (Ww).

22. After all data is collected, drain the catch container and tare scales.
23. Repeat steps 14 through 22 as necessary to obtain the required number of well repeating runs (including one run at 25% flow rate variance).

Please note that a log will be saved with start time and sweep time after each calibration run.

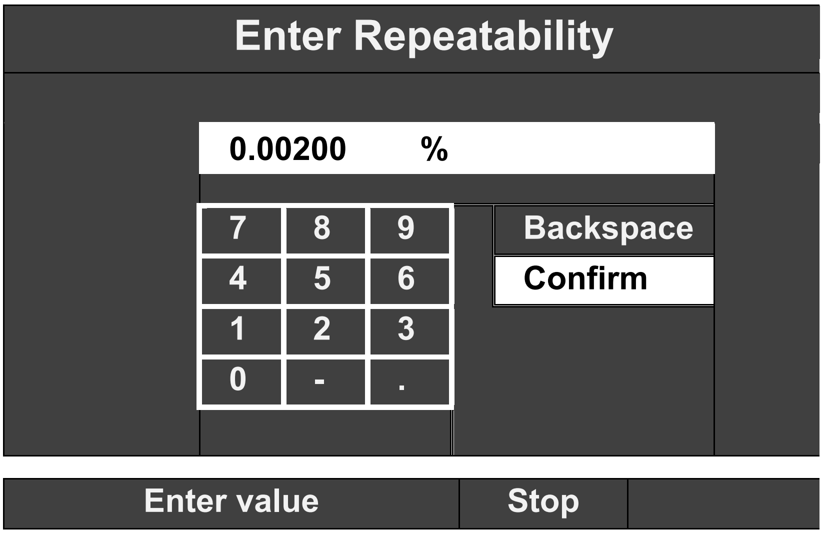
24. Once you have completed the calibration, select the “Exit Calibration” menu which will turn the bypass valve (SV2) OFF.
25. Calculate prover volume per Section 4.5.
26. **Please Note:** A copy of Table 2 for gravimetric calibration can be used to enter water draw data. An Excel readable file is available from Honeywell Enraf which will calculate the corrected prover volume using the gravimetric method.

After selecting Enter Average Volume following screen appears



27. Enter the average calibration volume calculated in the previous step by selecting the “Enter Average Volume” menu. This screen can be accessed while still in the Calibration mode or at a later time by entering the Calibration menu and then accessing this screen directly.
28. After the Average Volume has been entered and confirmed the following screen is displayed to enter the Repeatability in percent (%). The entered average volume and the repeatability values will be stored in the log with a timestamp of the entry.

After selecting Enter Average Volume following screen appears



Selecting “Abort Calibration” will stop the calibration process. This action will stop the motor if in running state, bypass value (SV2) will be turned ON and draw valve (SV1) will be turned OFF. If the Prover is in sweep mode with the piston moving downstream no action will be taken for upstream and downstream sensor inputs. Calibration log entry will not be made.

In calibration mode alarms will be generated as per the configuration, and the run permissive signal from the flow computer or the run prover test signal will be ignored.

The operating mode of the prover will be saved in NVM so that the mode will be restored if power is turned off while in Prover Calibration mode.

To exit calibration mode navigate to the Exit Calibration Mode menu and press OK.

A copy of Table 2 can be used to enter water draw data.

Gravimetric Water Draw Data Sheet

Date:					
Prover Serial Number:					
Prover Model Number:					
Report Number:					
Location:					
Standard Temperature (Tb):					
Standard Pressure (Pb)					
Elevation (h)					
Field Test Weight Density					
Reference Test Weight Density					
Compressibility Factor (water) (CPL):					
Flow Tube Area Thermal Expansion Coefficient (Ga):					
Detector Linear Thermal Expansion Coefficient (Gl):					
Modulus of Elasticity of flow tube (E):					
Flow Tube Inside Diameter (inches) (ID):					
Flow Tube Wall Thickness (inches) (WT):					
	Fill 1	Fill 2	Fill 3	Fill 4	Fill 5
Fill Time (minutes) =					
Temperature Air (*Ta*) =					
Temperature Prover (*Tp*) =					
Temperature Detector (*Td*) =					
Prover Pressure (*Pp*) =					
Water Electrical Conductivity =					
Total Mass of Water (*Ww*) =					
Density of Air (ρA) =					
Calculated Density of Water (ρw) =					
Correction of Air Buoyancy of Weighing (*CBW*) =					
Corrected Mass of Water (*Mw*) =					
Volume of Water (*Vw*) =					
Effect of Pressure on Water (*CPL*) =					
Temperature Correction on Prover (*CTS*) =					
Pressure Correction on Prover (*CPS*) =					
Corrected Water Volume (*WD*) =					

Table 2: Gravimetric Water Draw Data Sheet

4.5 Calculations

Volumetric Water Draw Calculations

Water draw volume corrections taken from API Manual of Petroleum Measurement Standards API chapters,: 4.2, 4.9 and 12.2.4. and Appendix B.4 F2.a, 11.2.3.5.

Symbols and Calculations from API 12.2.4:

Given:

RHOtm = Density of liquid (water) in test measure. (API 12.2.4)

RHOp = Density of liquid (water) in prover. (API 12.2.4)

CPL = Correction for the compressibility of liquid. (For water 3.2E-6)

T_b = Base calibration temperature. (60 deg. F. in US)

G_a = Area coefficient of expansion for flow tube. (API 12.2.1.11.2.1)

G_l = Linear coefficient of expansion for detector. (API 12.2.1.11.2.1)

G_c = Coefficient of expansion for the test measure
(from calibration certificate)

E = Modulus of elasticity for flow tube material (from API 12.2 Appendix A)

WT = Thickness of flow tube wall. (inches)

ID = Diameter of flow tube. (inches)

Calculate:

BMVa	=	Base Measured Volume adjusted for scale reading.
	=	BMV + SR
CTDW	=	Correction for prover/test measure liquid temperature difference.
	=	RHOtm ÷ RHOp
CTStm	=	Correction for effect of temperature on test measure.
	=	1 + (Ttm - 60) × (Gc)
CTSp	=	Correction for effect of temperature on prover.
	=	{(1+[(Tp-Tb)*Ga]) * (1+[(Td-Tb)*Gl])}
CCTs	=	Correction for prover/test measure steel temperature difference
	=	(CTStm)/(CTSp)
WD	=	Adjusted Base Volume of Draw
	=	BMVa*CTDW*CCTs
CPSp	=	Correction for the effect of pressure on prover
	=	1 + [(Pp*ID)/(E*WT)]

CPLp = Correction for effect of pressure on liquid (water)
= 1/[1-(0.0000032*Pp)]

WDz = Average of all WD's
= [@sum (WDz Fill 1..WDz Fill5)]/n

WDzb = Volume of Prover at 60 deg F and 1 atm
= WDz/(CPSp * CPLp)

Gravimetric Water Draw Calculations

Gravimetric Water Draw technique is completed in accordance with API 4.9.4. Volume correction factors are based on API Manual of Petroleum Measurement Standards API chapters,: 4.2, 4.9 and 12.2.4.

Corrections and representations:

Given:

Td = Temperature of detector bar. (deg F)

Tp = Temperature of prover. (deg F)

Ta = Temperature of ambient air. (deg F)

Pp = Pressure in prover. (psig)

Ww= Weight of water. (grams)

h = Elevation above sea level. (feet)

Dtw= Density of test weights. (gm/cc)

Ga = Area coefficient of expansion for flow tube. (API 12.2.4)

Gl = Linear coefficient of expansion for detector. (API 12.2.4)

E = Modulus of elasticity for flow tube material. (API 12.2 Appendix A)

WT = Thickness of flow tube wall. (inches)

ID = Diameter of flow tube. (inches)

Calculate:

Calculation of Air Density in USC Units:
ρA = 0.001223068*(1-(0.032 x h/1000))*(519.67/(Tf + 459.67))

Where: ρA is the density of air (gm/cc) (Per API 4.9.4)
h is the elevation above sea level (ft)
Tf is the test temperature (°F)

Calculation for the Correction for Air Buoyancy on Weighing (CBW)
CBW= {[1-(0.0012/ρTWr)]/[1- (0.0012/ρTWf)]} * {[1-(ρA/ρTWf)]/
[1- (ρA/ρFtp)]}

Where: CBW is the correction for air buoyancy on weighing,
ρTWr is the density of reference test weights (gm/cc),
ρTWf is the density of the field test weights (gm/cc) as per certificate of traceability,
ρFtp is the density of fluid at test temperature and test pressure (gm/cc),
ρA is the density of dry air (gm/cc)

Calculation for the Density of the Calibration Water

ρwtF = Density of water at temperature t °F (kg/cm) (From API 12.2.4 or calculate by algorithm taken from API 4.9.4)

Using the algorithm taken from API 4.9.4

ρwtF = ρ0*[1-((A* ρtF)+(B*(ρtF)^2)-(C*(ρtF)^3)+(D*(ρtF)^4)-(E*(ρtF)^5)))/1000]

Where: ρwtF is density at temperature t °F (kg/cm)
ρ0 is density at temperature t0, 999.97358 kg/m3
t is temperature (°F)
ΔtF is [(t – 32)/1.8]- t0
t0 is 3.9818E+00 (°C)
A is 7.0134E-08 (°C)-1
B is 7.926504E-06 (°C)-2
C is -7.575677E-08 (°C)-3
D is 7.314894E-10 (°C)-4
E is -3.596458E-12 (°C)-5

Note: Above provided equation provide density correlations for density of distilled water. If the water to be used in the Gravimetric Method does not meet the criteria of distilled or deionized water, water from an approved public water (potable) supply may be used in this procedure. However, the conductivity must not exceed 50µs. If the conductivity of the test water is between 50µs and 1,000µs, the density shall be determined as per API 4.9.4 section A.5.

Mw	=	Corrected Mass of Water (gm)
	=	Ww ÷ CBW
Vw	=	Volume of Water (cc)
	=	Mw ÷ ρwtF
CPLp	=	Correction for the effect of pressure on water
	=	1/[1 - (Pp * 0.0000032)]
CTSp	=	Correction for effect of temperature on prover
	=	{(1+[(Tp-Tb)*Ga])*(1+[(Td-Tb)*Gl])}
CPSp	=	Correction for effect of pressure
	=	1 + ((Pp - Pb) × ID)/(E × WT))
WD	=	Corrected Water Volume
	=	(Vw * CTS)/(CPL * CPS)

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CHAPTER 5 TROUBLESHOOTING

5.1 Run Prover Test

Running the prover in the Prover Test operating mode is a good way to verify proper operation. See Section 3.3 for more information.

5.2 Error Messages

If any device on the prover malfunctions the error will be shown on the controller screen. The following are possible errors and how to correct them.

5.2.1 Sensor out of sequence

This error message means that the proving sequence was not completed successfully. In order to clear the error check if:

- the optical switches are functioning (using the dashboard function – see 5.3.1),
- motor stop switch is functioning (using the dashboard function – see 5.3.1),
- the ramp (located on the guide block) is adjusted properly,
- the flag (located on the guide block) is correctly positioned.

5.2.2 Motor time out

This error message means that the signal from the motor stop has not been sent. To clear the error check if:

- motor stop switch is functioning (using the dashboard function – see 5.3.1),
- the ramp (located on the guide block) is adjusted properly,
- or any part of the drive mechanism is broken (such as main driving chain, etc.)

5.2.3 Sensor stuck

This error message means that one of the sensors is triggered and is sending the signal to controller at the beginning of the proving run. To clear the error check if:

- the optical switches are functioning (using the dashboard function – see 5.3.1),
- ensuring that the flag is not triggering one of the optical switches (if repositioning is required user can use dashboard function – “Motor run command” to relocate the piston assembly),
- motor stop switch is functioning (using the dashboard function – see 5.3.1),

5.2.4 Service due

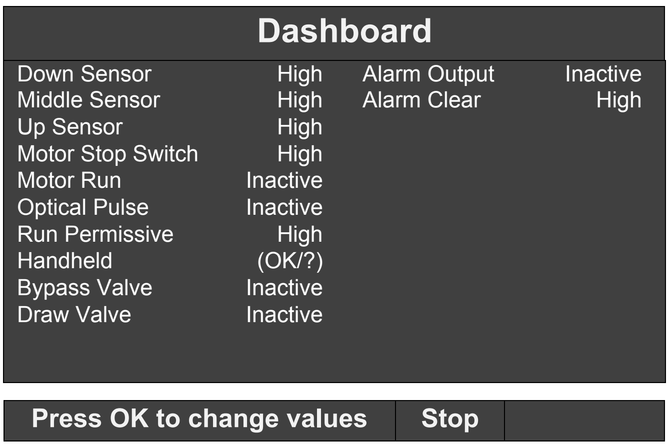
The prover is due for service as determined by the entry at Main Menu/ Configuration/Alarms/Service Due Reminder.

5.3 Diagnostics

There are several screens inside the Main Menu/Diagnostics menu to aid in troubleshooting.

5.3.1 Dashboard

The dashboard screen allows you to verify the status of the inputs and outputs of the SVP Controller. Each output function can be tested by selecting it and activating it.



A properly functioning optical switch will normally indicate “High” at the dashboard screen. Inserting an opaque flag into the optical switch will cause the state to change to “Low”.

To check if the motor stop switch is working properly you should select "Motor stop switch" and trigger the motor stop. The state should change from "High" to "Low".

To check if the motor is working you should scroll down to the "Motor run command" and press OK. The state of the motor will be changed from "Inactive" to "Active". You will need to press OK again in order to stop the motor.

5.3.2 System Health

The System Health screen allows you to check the status of the various assemblies that are contained in the SVP Controller. Contact Honeywell support if there are errors.

5.3.3 Active Alarms

The Active Alarms screen allows you to see if any alarms have been activated and to re-enable the device.

5.4 Troubleshooting Chart

Prover does not cycle when proving pass is initiated	
No power to Honeywell Enraf small volume prover	Check for continuity of power to prover, see Section 6
Interface cable between CIU or flow computer and Honeywell Enraf small volume prover is not properly connected	Check connections and integrity of cables, see Section 6 and flow computer manual
Above checks do not resolve problem	See Section 5 for troubleshooting controller, optical switches, and motor stop switch
Honeywell SVP Controller is not in Meter Calibration Mode	Exit Prover Test Mode (Section 3.3) or Prover Calibration Mode (Section 4.3 and 4.4)
Unsteady or absence of pulse from flow meter	
Defective flow meter signal cable or connection	Refer to applicable proving computer manual and check cables and connections
Defective pickup or pulser	Check for electrical or mechanical failure
Defective flow meter	Observe for pulse width variation and possible noise from meter (repair or replace flow meter)
Defective flow meter signal	Test input and output signals preamplifier with an oscilloscope
Defective CONDAT® interface unit or signal conditioners, if using CONDAT® prover control	Input a frequency signal with a signal generator and check for signal at computer or output of signal conditioner with an oscilloscope
If using flow computer of other manufacture	Check flow computer's operation manual for possible solution to problem

Table 3: Honeywell Enraf Troubleshooting Chart

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CHAPTER 6 ELECTRICAL SCHEMATICS & DRAWINGS

This section contains various electrical schematics and drawings for the Honeywell Enraf small volume prover. If there are electrical questions not addressed by these figures contact your nearest Honeywell Enraf representative or the factory directly.

6.1 Schematics for prover wiring

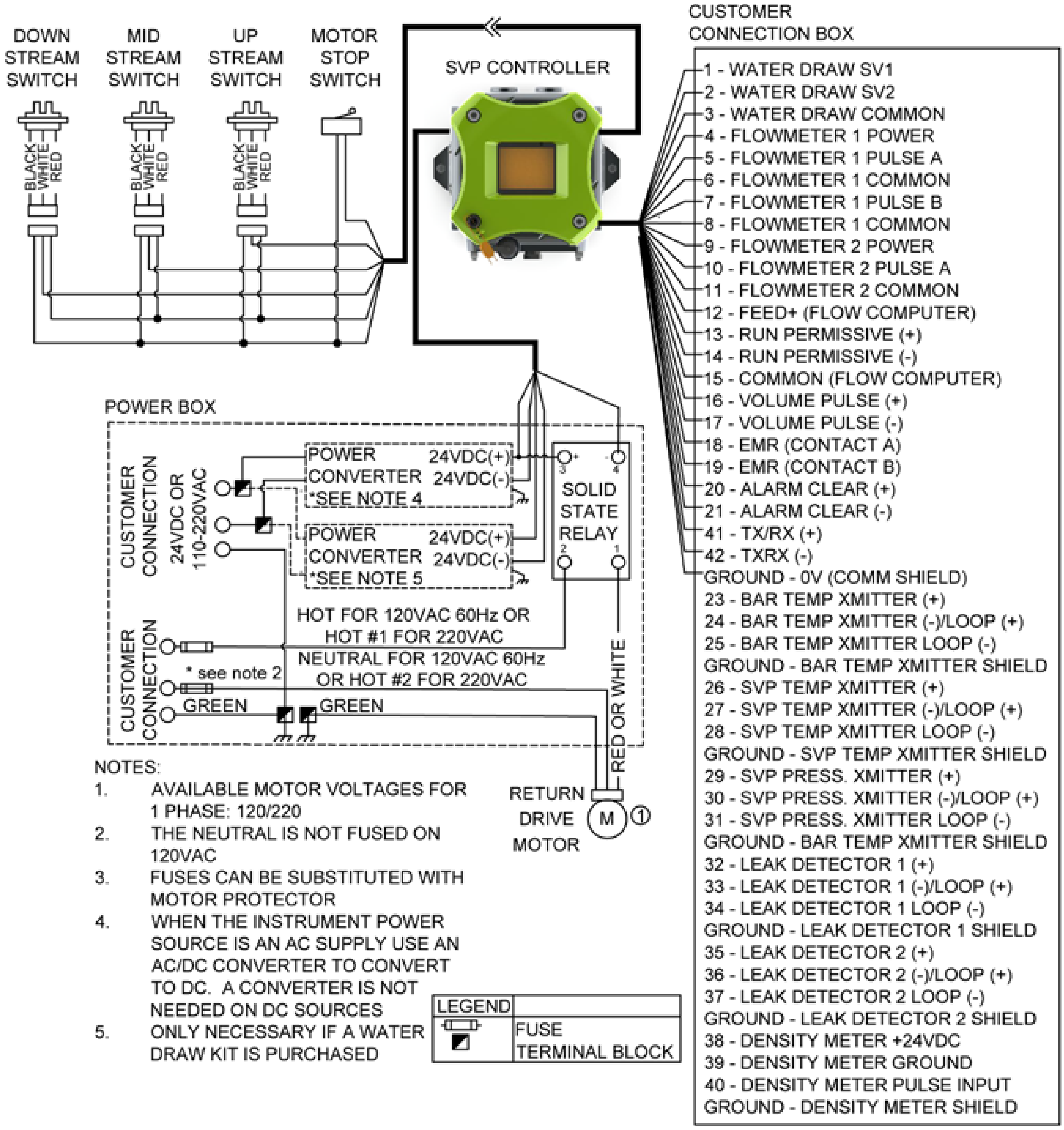


Figure 6-1: Wiring Diagram 1 Phase

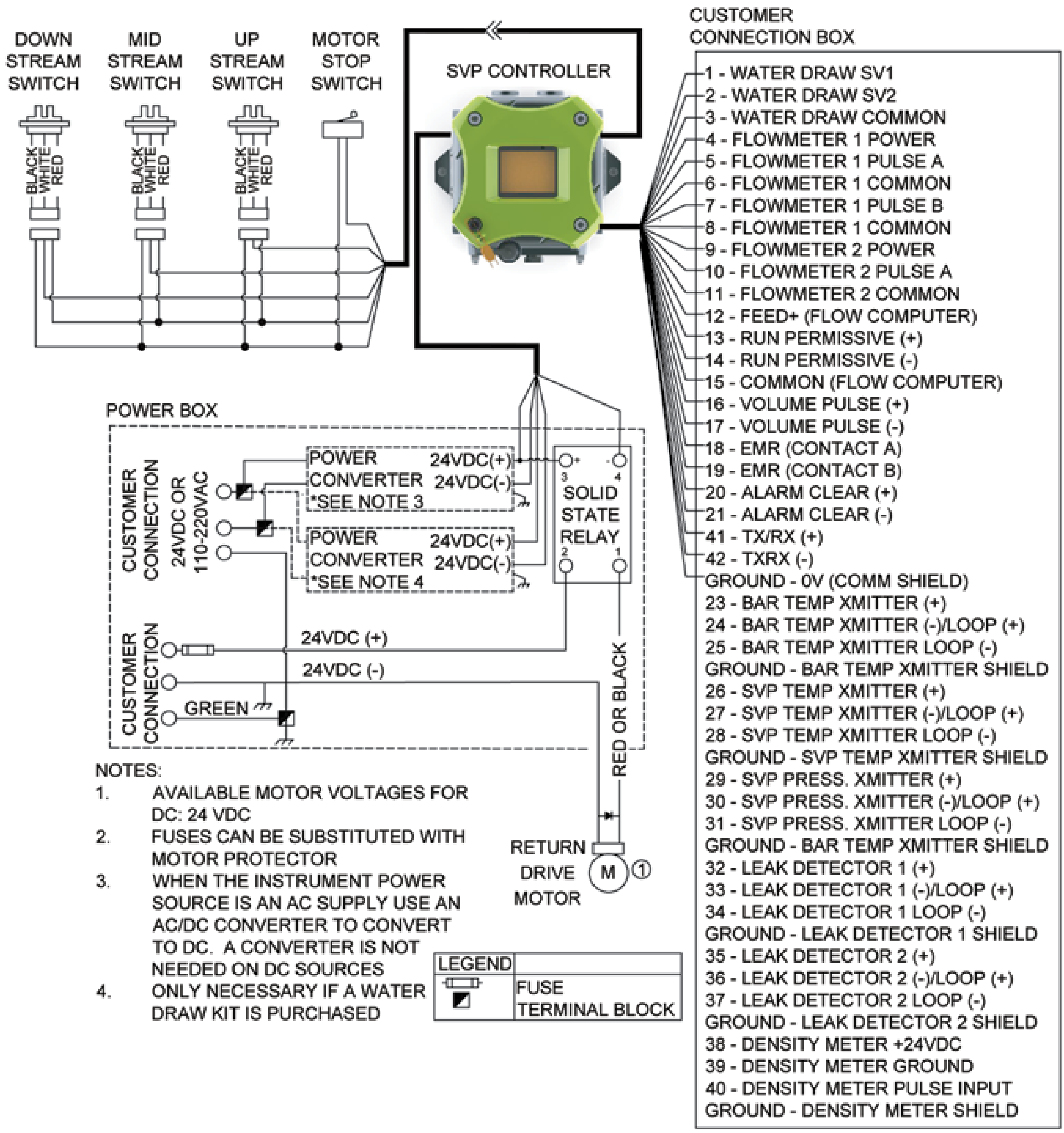


Figure 6-2: Wiring Diagram DC

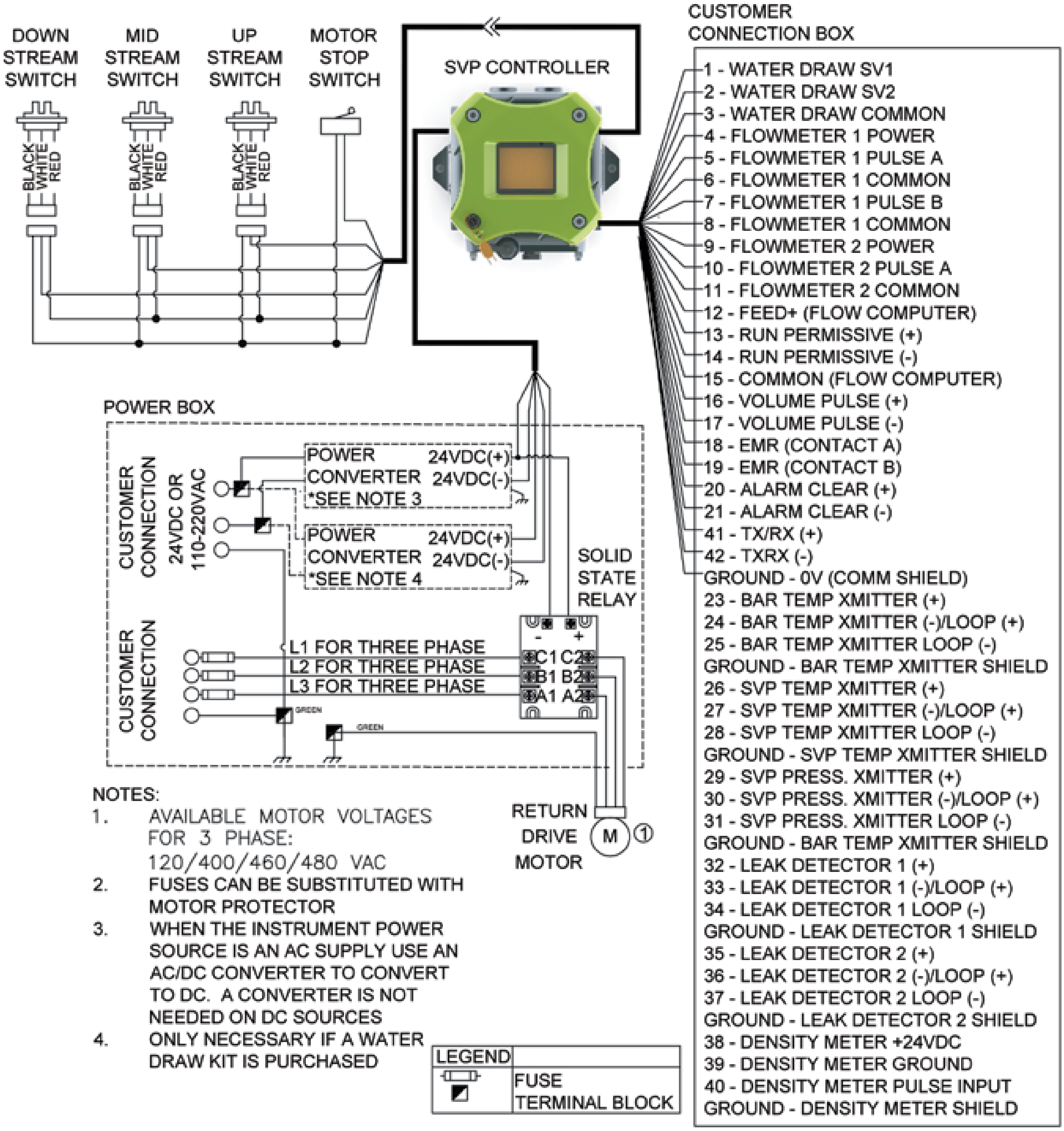


Figure 6-3: Wiring Diagram 3 Phase

6.2 Connections to Flow Computers

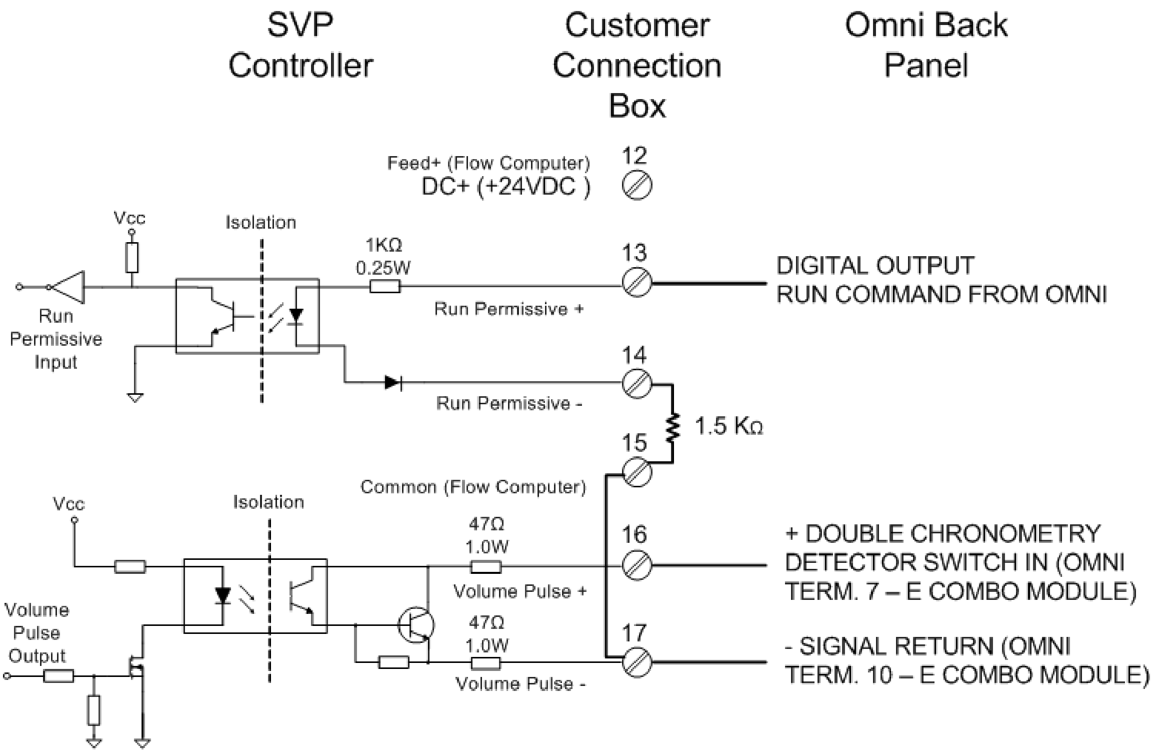
Shown below are diagrams showing how to connect the SVP Controller via the Customer Connection Box to various models of flow computers. Note that the first diagram shows a simplified representation of the Run Permissive Input and the Volume Pulse Output circuits in the SVP Controller. The 1500 ohm current limiting resistor shown in the diagrams is required with operating voltages from 12 to 24 volts DC. For operating voltages from 6 up to 12 volts, the 1500 ohm resistor must be replaced with a zero ohm jumper. The resistor and jumper must be connected to the terminals in the Customer Connection Box.

6.2.1 Omni

An Omni flow computer requires that the meter be connected to one of the two E Combo card pulse inputs. The E combo card will use the double chronometry proving method. Although there are other ways to make the connections, we will describe the connections according to the diagram below. The Volume Pulse + (terminal 16 of the Customer Connection Box) connects to the prover detector input of the E Combo Module. The prover detector input on the Omni is usually Pin #7. Connect Volume Pulse – (terminal 17 of the Customer Connection Box) to common on the rear of the Omni. This is usually Pin #10 which is tied to common on the power supply. The prover Run permissive + command (terminal 13 of the Customer Connection Box) connects to any Omni Digital I/O point. That point must be assigned a Boolean point that has been programmed with the value of/1927. Then the Digital I/O point must be assigned the Boolean point.

Example: Program the Boolean point 1025 with the statement/1927. Then program Digital I/O point #12 with the number 1025. Connect the run command wire to Digital Point # 12.

A 1500 ohm resistor must be installed between the Run permissive - (terminal 14 of the Customer Connection Box) and the common (terminal 15) for the run command to work properly. This setup will launch the prover when the I/O point goes high (voltage applied). When it is low (no voltage) the prover motor will be idle. A jumper must be connected between the Volume Pulse – (terminal 17 of the Customer Connection Box) and the Common (terminal 15 of the Customer Connection Box). Please read the Omni's Operator's manual prior to connection and or operation of the Honeywell Enraf small volume prover.



6.2.2 CONDAT CIU

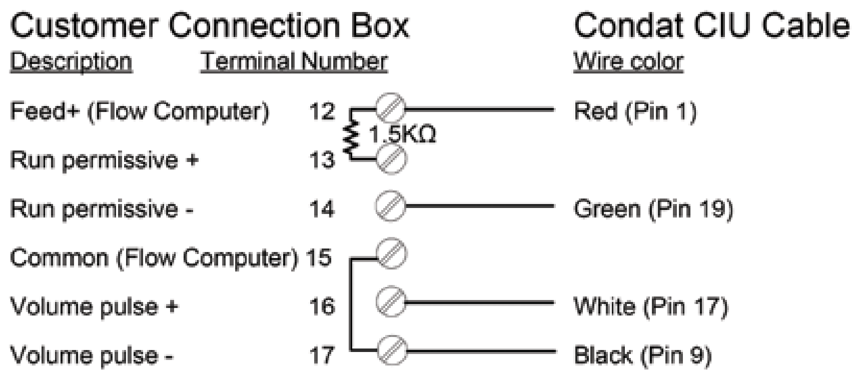
The Condat Interface Unit (CIU aka PIU) connects to the SVP controller using cable (Honeywell PN 44108889). The cable features a connector that attaches to the CIU at the connector labeled “Control”. The opposite end of the cable has colored leads for connection in the terminals in the Customer Connect Box. Please refer to the PROVEit Manuals for further connection instructions.

Note: The pin numbers listed adjacent to the colors signify the pin locations on the CIUs “Control” connector.

Within the Customer Connection Box, the terminals 12 and 15 are provided to securely land customer provided voltage or ground leads as needed. For the CIU the ground (earth) reference is Black (Customer Connection Box Terminal 17) and the nominal 15VDC supply is Red (Customer Connection Box Terminal 12).

While idle, Green (Customer Connection Box Terminal 14) will read nominal 15VDC and White (Customer Connection Box Terminal 16) will read nominally 5 VDC. When the run command is given, the CIU will drop Green to ground (earth) and the SVP controller starts the proving run.

When either optical switch is triggered on the downstream pass, the SVP controller will drop White to 0VDC for 25mS and the CIU will instruct the proving program to start or stop recording meter pulses. After the run is complete the CIU will return to idle conditions until the next run command is sent.

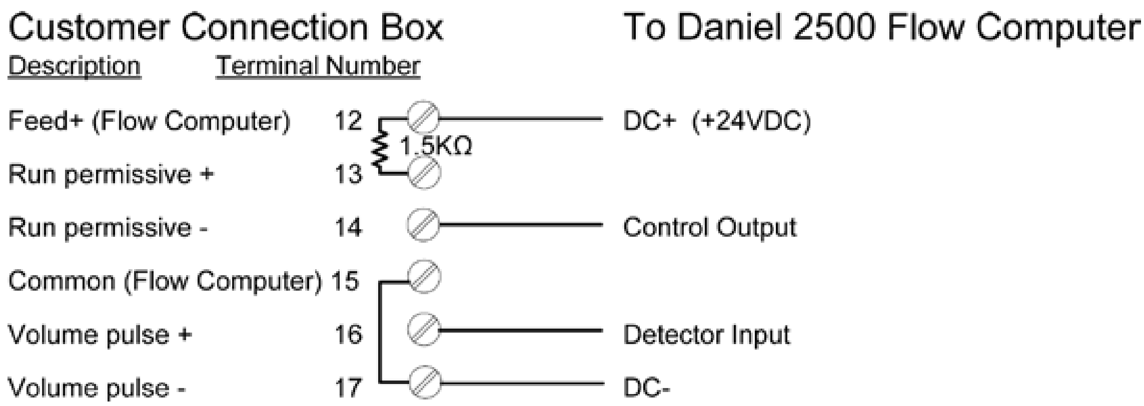


6.2.3 Daniels

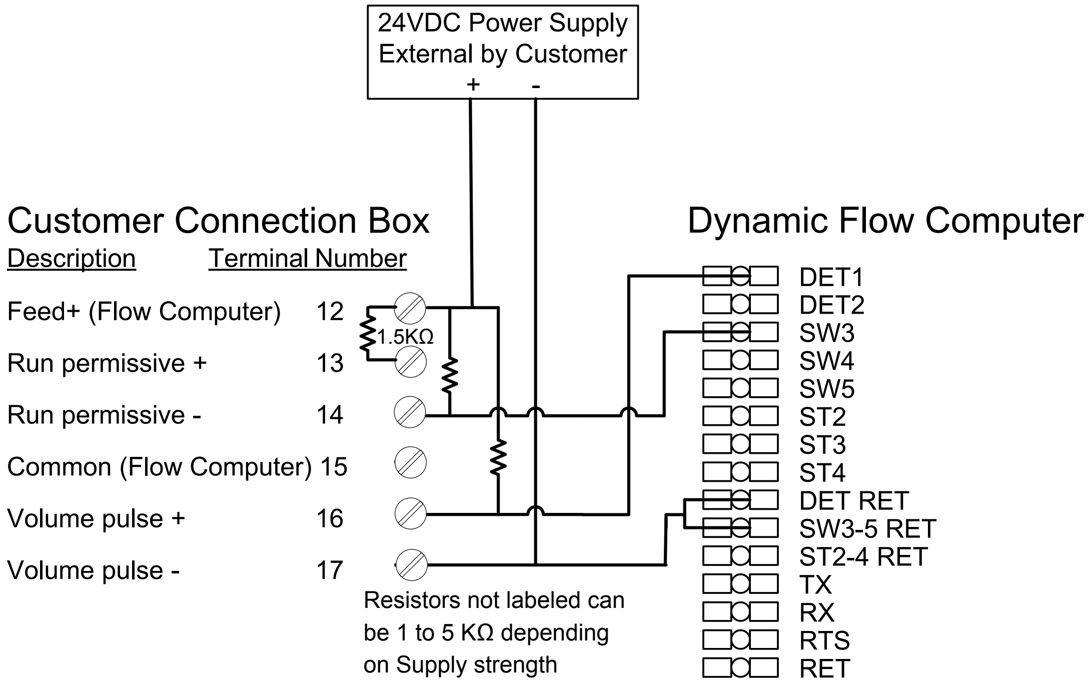
Actual terminal locations for the Daniel flow computer is dependent upon the application software being used in the Daniel flow computer. See the appropriate Daniel manual and software information for more information.

Warning

Due to scan speed, the 2500 has limitations in flow rate when used with small volume flow provers due to short time period between volume detectors.



6.2.4 Dynamic



6.3 After Sales Support

Honeywell GTS (Global Technical Services) support the Honeywell Enraf provers globally.

All after sales support enquiries should be channeled to GTS in the first instance.

Honeywell Enraf have strategically positioned global service partners in USA, Europe & Asia to support Honeywell Enraf provers worldwide.

In order to analyze the problem the following information is required:

- Serial number of prover
- Model number
- Point of contact
- Contact details
- Location of prover

- Process conditions when problems occurred (flow rate, viscosity, product, temperature, number of prover runs)
- Historic information about prover (date installed, repair history)
- Pictures of damage

Honeywell Enraf can offer;

- Commissioning & start-up (including replacement of the transit seals).
- A periodic maintenance service which normally consists of changing seals, checking alignment of drive end and changing optical switches and a differential pressure test to check for seal leakage. (Recommended annually)
- Water draw is (Recommended every 2 years)
- Small Volume Prover Inspection and Refurbishment
- Project consultation

Honeywell GTS:
Email - HFS-TAC-Support@Honeywell.com
Call: 1-800-423-9883

6.4 Frequently asked questions.

What type of prover is the Honeywell Enraf?	The Honeywell Enraf prover is classified as a **Small Volume Unidirectional Piston Displacement Prover.**
Why is the Honeywell Enraf prover considered to be small volume when it can hold up to 350 gallons of fluid?	The small volume classification is based on the volume displaced in relationship to the number of flow meter pulses collected. A large volume prover requires greater than 10,000 meter pulses be collected to generate a meter factor (typically a pipe prover). A small volume prover in conjunction with 'Double chronometry' can generate a meter factor in less than 10,000 meter pulses.
How can the Honeywell Enraf flow prover be used on Corriolis and UltraSonic meters?	By slowing the prover down to allow for longer run up time, the flow disturbance caused by the internal valve closure will have had enough time to stabilize and generate accurate repeatable readings.
What is 'Run up time'?	The run up time is the time it takes from the release of the piston to reach the start measurement switch. (1st Optical Switch)
Why is the upstream and downstream volume the same?	The Honeywell Enraf flow Prover has a piston shaft on both sides of piston body therefore the displaced volume is the same.
How does the flow prover measure volume pulses?	The Honeywell Enraf prover does not measure anything. It is a very accurate, but simple instrument that waits for a start signal from the flow computer and sends back the pulses as it passes the volume switches.
Can the fluid flow through the prover all the time?	Yes, many Honeywell Enraf provers are installed in "Standby Mode", but it is recommended to consider the more durable elastomer option when operating a prover in this way. This is the best practice for fluids that are at temperatures higher or lower than ambient continuous to allow for faster warm up time.
How much pressure drop does the Honeywell Enraf Flow Prover Have?	Under normal operating conditions the prover will generate 28 - 69 kPa (4 – 10 psi) pressure drop at maximum flow rate. This is based on water and is applicable to refined products such as diesel, jet, gasoline, etc. Products such as heavy crude oil can generate pressure drops of up to 20psi in some cases.
What motor sizes are used on Honeywell Enraf provers?	It depends on the prover model but in general an 05 uses 0.5hp/.35kW electric motor; 15, 25, 35, & 50 use a 1hp/.75kW electric motor; 85 uses a 2hp/1.5kW electric motor; 120 uses 5hp/3.7kW electric motor.
What are the installation considerations for a Honeywell Enraf prover?	Correct installation of the Honeywell Enraf prover is vital to a long and trouble-free operation. Critical elements include suitable foundations, pipe stress and load analysis on provers inlet and outlet ports, adequate upstream filtration and thermal pressure relief. If you have any questions, please consult the factory.
How is the installed base of Honeywell Enraf provers supported?	Honeywell Global Technical Support (GTS) is the focal point for all Honeywell Enraf related after-sales support questions and GTS is supported by a network of Honeywell service centers and strategically positioned service partners.
How can I receive information and support for the Honeywell Enraf prover?	Contact your local sales specialist. There is a Honeywell Enraf specialist located in each global region (Americas, Asia Pacific and Europe Middle-East & Africa - EMEA).

Table 4: Frequently Asked Questions.

Honeywell Enraf Americas, Inc.
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Roswell, GA 30076-4908
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Fax +770-475-1717
www.honeywellprocess.com

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Honeywell