Pioneer Petrotech Services Inc.

Proudly Canadian

PPS71 GEOTHERMAL MEMORYTOOL

User Manual (MAN-0011 Rev. 04)

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REVISION HISTORY

Revision	Date	Comments
01	2015-08-12	Combined Geothermal Memory Gauge with GRD user manual Rev. 06 and Geothermal Memory Gauge user manual Rev. 09. Replaced draft system user manual (MANU-0011) Rev 01 & 02. Updated specifications, formatting, module information and imagery. The following history from previous manuals have been transferred: 2010-08-20 R01 Initial release 2010-12-15 R02 Information about maintenance of spinner 2011-01-13 R03 More Information about operation time and maintenance 2011-02-07 R04 More Information about flask test 2011-07-27 R05 Update for maintenance tool kit 2011-09-19 R06 Update for specification 2012-01-31 R07 Update for description about accessories 2013-06-12 R08 Updated specification. Updated information about setting the type of spinner by SmartLog; Updated parts list for gauge, accessories, options and maintenance kit 2013-11-07 R09 Information about how to install spinner and disassemble flask Housing
02	2017-08-02	- Reference to EC17-0005 - Added PPS71 Pt & PTS Tools and renamed tool names in Appendix A, E. - Added PPS71 Quartz & Inconel to Appendix F - Updated Part name to item 1 in Appendix G -Added PT, PTS and Quartz to Appendix J - Updated section 1.3
03	2019-10-25	- More information about using centralizer with 1.69” spinner
04	2022-04-26	Reference to EC22-0003. Updated tool with new 3-reed TPS sub (01-AC-2676-A) and 7/16-28UNEF pressure filter (01-AC-2181-A).

1. Introduction

1.1. Objective

This manual explains the general operation of the PPS71 Geothermal Memory Tool. It can provide those working with the tool the necessary knowledge and skills for programming, deployment, retrieval, and data extraction (downloading of data files from the tool). All personnel involved in the process of operating thePPS71 geothermal tools, should familiarize themselves with the detailed procedures outlined in this manual.

This manual includes important information about the operation of PPS71 geothermal tools. Please read it carefully before operating the tools.

PPS SmartLog software is used with the PPS71 geothermal tools. This manual will cover some of the basic steps using the software to prepare the tool for operations; however will not cover all of the software's capabilities in detail. Please refer to the software manual for further instructions on advanced features.

1.2. Overview

The PPS71 geothermal tool is designed for extreme, high temperature downhole conditions. The tool can measure pressure, temperature, casing collar locations, gamma ray (optional) and Flow Profile (optional). The robust electronics combined with vacuum flask technology allow the tool to perform at 350 °C (662 °F)* continuously, for four hours. The main component of the PPS71 geothermal tool is the Memory module. The module is protected by a flask (Heat Shield Inner Tube) housing for operations up to 350 °C*, or a regular housing for operations up to 177 °C.

The tool can be run in the traditional mode (pressure and temperature) or run in conjunction with a depth recorder (such as the PPS36 DepthWatcher which records depth, speed, time and tension) to incorporate depth with downhole data, thereby becoming a mini-logging tool.

1.3. Configurations

- **PPS71 PT**

  The **PPS71 PT Geothermal Tools** are designed for extreme, high temperature downhole conditions. The robust electronics combined with vacuum flask technology allow these products to perform at 350 °C (662 °F) continuously, for four hours. The tool measures pressure and temperature, and can be configured as either a memory tool or surface read out (SRO) tool. The measurements are done with a highly sensitive silicon-sapphire (Piezo) transducer and a resistance temperature detector (RTD). The RTD is exposed to the well fluids for faster response and higher accuracy

- **PPS71 PTS**

The **PPS71 PTS Geothermal Tools** are designed for extreme subsurface conditions. The robust electronics combined with vacuum flask technology allow these products to perform at 350 °C (662 °F) continuously, for four hours. The PTS tool measures pressure, temperature, and flow profile and can be configured as either a memory tool or surface read out (SRO) tool. The measurements are done with a highly sensitive silicon-sapphire (Piezo) transducer, a fast response resistance temperature detector (RTD) and the customer's choice of either a continuous or full-bore spinner flowmeter. Both continuous and full-bore spinners are intended for quantitative use in flow streams with the spinners' greatest quantitative application being injection profiling.

- **PPS71 PTS-C**

The **PPS71 PTS-C Geothermal Tools** are designed for extreme subsurface conditions. The robust electronics combined with vacuum flask technology allow these products to perform at 350 °C (662 °F) continuously, for four hours. The tool measures pressure, temperature, casing collar location, and flow profile and can be configured as either a memory tool or surface read out tool (SRO) tool. The measurements are done with a highly accurate silicon-sapphire (Piezo) transducer, a fast response resistance temperature detector (RTD), and the customer's choice of either a continuous or full-bore spinner flowmeter and a highly sensitive CCL. The CCL has a magnet and central coil arrangement which amplifies current providing a readable voltage spike or "collar kick" as data, giving end users an important control for depth correlation.

- **PPS71 ELITE**

The **PPS71 Elite Geothermal Tools** are designed for extreme, high temperature downhole conditions. The robust electronics combined with vacuum flask technology allow these products to perform at 350 °C (662 °F) continuously, for four hours. The tool measures pressure, temperature, casing collar location, flow profile and gamma rays, and can be configured as either a memory tool or surface read out tool (SRO) tool. The measurements are done with a highly accurate silicon-sapphire (Piezo) transducer, a fast response resistance temperature detector (RTD), a continuous or full-bore spinner flowmeter, magnetic CCL and sensitive gamma ray crystal which detects incoming gamma rays from the formation.

- **PPS71 QUARTZ**

The **PPS71 Quartz Geothermal Tools** are designed for extreme, high temperature downhole conditions. The robust electronics combined with vacuum flask technology allow these products to perform at 350 °C (662 °F) continuously, for four hours. The tool measures pressure, temperature, casing collar location, flow profile and gamma ray, and can be configured as either a memory tool or surface read out tool surface read out tool (SRO) tool. The measurements are done with a superior quartz transducer, a fast response resistance temperature detector (RTD), a continuous or full-bore spinner flowmeter, magnetic CCL and sensitive gamma ray crystal. By combining the downhole measurements with PPS's DepthWatcher (PPS36), a depth versus time recorder, customers have the capability to create synchronized profile logs which have many applications for the end user such as monitoring radioactive tracers in injected fluids, interpreting lithology, estimating shale volume and correlating cores with logged depth.

*** Note: 350°C for 1.75" OD flask**

FRAGILE! If the tool includes a flask housing - PLEASE HANDLE WITH CARE!

1.4. APPLICATIONS

- Steam Injection Profile Logging
- Geothermal Well Test
- Real-time Pressure Build-Up Tests
- Real-time Pressure and Temperature Gradients
- Tubing and Casing Leak Detection
- Fluid Production/Injection Profiles

1.5. PRIMARY FEATURES

- Memory logging capabilities
- Fast data transfer @10samples/sec
- Robust electronics and vacuum flask technology for outstanding performance at 350°C (662°F)*
- Creates complete profile logs when used in conjunction with PPS36 DepthWatcher
- Performs as an exceptional pressure and temperature tool when ordered without gamma and spinner
- Can be used as a temperature tool with a regular housing (up to 177°C)
- The tool automatically recognizes bidirectional flow
- Advanced customer support with online maintenance and software tutorials available

1.6. RESPONSIBLE PERSONNEL

All personnel, such as Field Supervisors, Field Engineers and Field Service Managers involved in the process of running PPS71 Geothermal Tools, and acquiring job data from the tools should familiarize themselves with the operational instructions included in this manual. Failure to do so may result in non-optimum job data or tool damage.

*** Note: 300°C for 1.56" OD flask**

2. Getting Started

This is a quick overview of the steps necessary to get started with a PPS71 Geothermal Memory Tool. For more details on any particular step please refer to that expanded section of the manual.

(1) Test the flask housing for heat protective capabilities
(2) Install SmartLog software
(3) Attach and configure the spinner if recording Flow Profile, or a bullnose if not
(4) Run diagnostics on the tool using SmartLog software
(5) Program the tool
(6) Add a battery
(7) Install the housing (either flask or standard)
(8) Fill the spinner with (high temperature) hydraulic oil
(9) Run the job(s)
(10) Disassemble tool
(11) Attach a computer using the USB cable and download job data

It is essential to test and inspect the flask housing prior to any operation. If the flask is damaged or fails the temperature test please contact PPS immediately and DO NOT run the tool, as this could result in permanent irreparable damage.

2.1. Testing the Flask Housing

To ensure optimum performance of the flask (Heat Shield Inner Tube) and proper protection for the module, regular inspection of the flask is necessary and PPS recommends testing the flask before **EVERY** operation. To properly test the flask you'll need an RTD thermometer (0 – 100°C, Error < ±0.5°C, Resolution 0.1°C) as the test measurement instrument and the ambient temperature should be between 20 to 30°C.

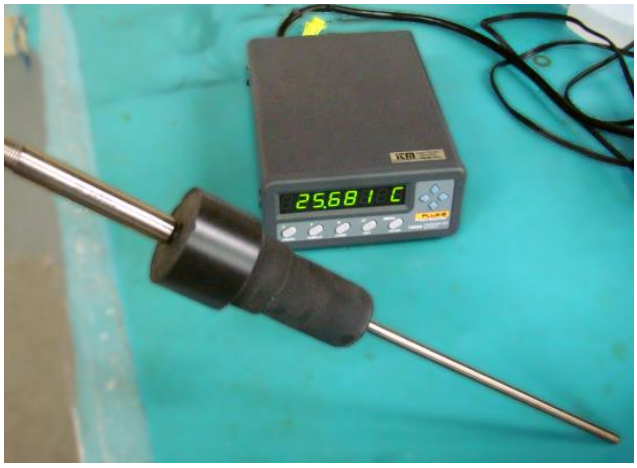


Figure 1 - RTD thermometer and heat insulator for testing

(1) Begin by boiling five litres (5L) of water to the boiling point (100°C)

(2) Fill the flask with the boiled water to 10-cm below the top of the flask

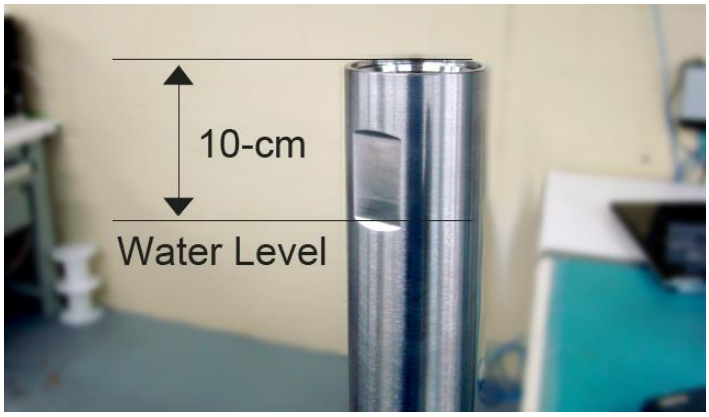


Figure 2 - Water level for flask testing

(3) Sink the RTD probe into the top of the flask, sealing it with the heat isolator

Figure 3 - Insert RTD probe into the flask and seal with heat insulator

(4) Start recording the RTD temperature readings every three (3) minutes for the next fifteen (15) minutes

(5) After fifteen (15) minutes subtract the temperature at 15 minutes from the start temperature in order to calculate the temperature difference, as illustrated in the chart below.

The temperature difference should be no greater than 16°C / 30°F after the first 15 minutes of the test.

Test Sample

Elapsed Time (min.)	Temp. °C	Temp. °F
0	81.40	178.52
3	80.88	177.58
6	80.24	176.43
9	79.79	175.62
12	79.55	175.19
15	79.33	174.79
Temp. Difference @ 15 min	**2.07**	**3.73**

Figure 4 – Calculating temperature difference when testing the flask

(6) Remove the RTD probe and the heat isolator

(7) Empty the water out of the flask

(8) Let the flask air dry

2.2. INSTALLING SMARTLOG

Before installing the SmartLog software, you should have your computer system ready with any one of the following operating systems: Windows 2000/XP/Vista/7/8/10.

The SmartLog software CD or USB drive in the shipping package contains all the files you need to install the program. Alternatively, registered customers can download the latest version from our web site at www.pioneerps.com.

- **To install PPS SmartLog software from the CD/USB:**

(1). Connect the USB drive or Insert the CD into your CD drive.
(2). To view the contents, click the **My Computer** icon on your computer desktop or in the Start Menu and then choose the **Compact Disc, DVD, or USB** icon.
(3). Double click the **Setup.exe** icon to launch the SmartLog installation.
(4). Follow the instructions leading you to finish the installation process.

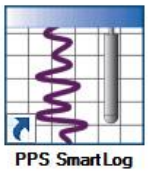


Figure 5 - PPS SmartLog software shortcut

2.3. ATTACHING SPINNER

The next step in preparing for field operations is attaching the spinner or spinner/centralizer combo in order to measure Flow Profile.

If you are not measuring Flow Profile, you can skip to the instructions for attaching a bullnose or centralizer.

- **Attaching a Spinner**

Figure 6 - Insert the spinner into the memory module

Figure 7 - Hand screw the spinner onto the pressure sub

The spinner is attached to the pressure sub as seen in the previous figures. Start by screwing the spinner on by hand. Finish tightening the spinner using two wrenches as per the next figures. Place one wrench at position A and the other at position B. Use the open-end wrench at position A to stabilize the module and the open-end wrench at position B to tighten the spinner. See below for wrench sizes:

Tool OD	Position	Wrench Size
1.75”	A	1 – 5/8”
	B	1 – 1/2"
1.56”	A	1 – 3/8”
	B	1 – 1/4"

Figure 8 – Wrench sizes for connecting spinner to pressure sub

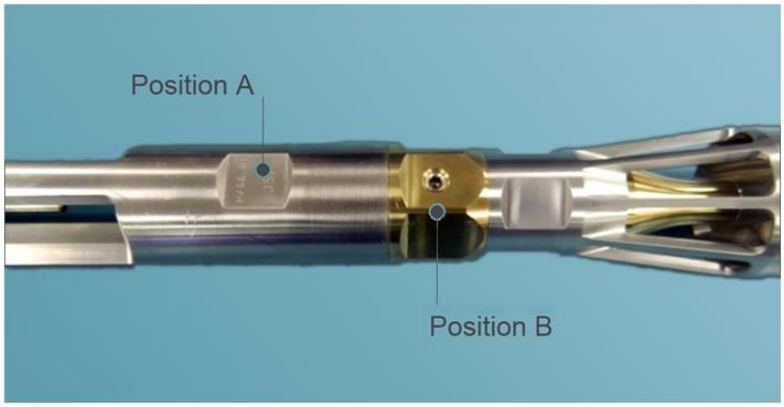


Figure 9 - Positions for the wrenches to tighten the spinner

- **Attaching a Centralizer & Spinner Combo**

Figure 10 - Insert the centralizer into the memory module

Note: The centralizer shown in Figure 10 is combined with a spinner.

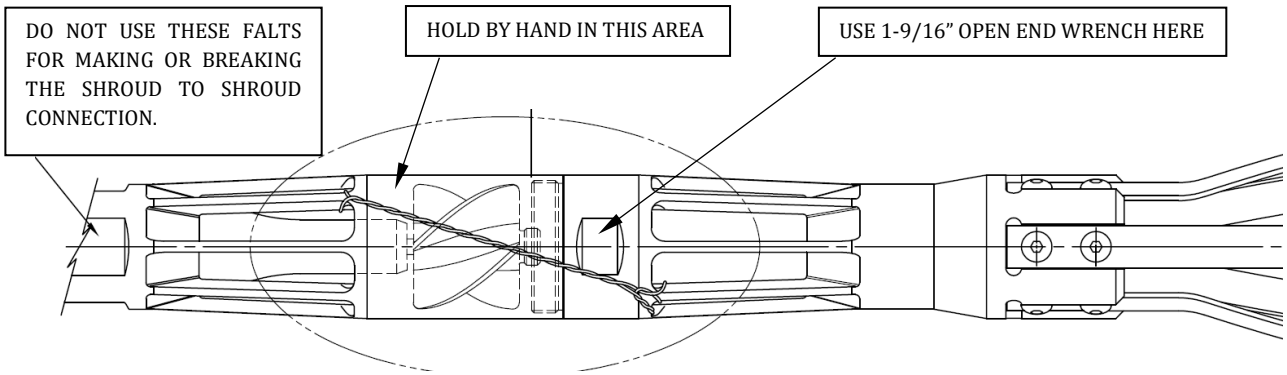
Figure 11 - Hand tighten the centralizer in place

The centralizer is attached to the pressure sub. Start screwing on the centralizer by hand. Then tighten the centralizer using two open-end wrenches. Place one wrench (1-5/8") at position A as seen in the figure above, then place the second open-end wrench (1-1/2") on the wrench flat on the centralizer.

- **Attaching a Centralizer on 1.69" Spinner**

(1) Remove the bullnose of spinner
(2) Apply anti-sieve to the threads of the centralizer
(3) Hold the spinner by hand as shown below, make up or break apart the connection by tapping the end wrench gently with a hammer.
(4) Apply safety wiring through ribs, twisting and terminating approximately as shown below.

Use Inconel 600, 0.032" DIA wire, the direction that the wiring lays – CRITICAL.



- **Attaching a Bullnose - No Flow Profile**

Figure 12 - PPS71 bullnose

Figure 13 - Attaching the bullnose to the memory module

The bullnose is attached to the pressure sub as seen in the previous figures. Start screwing on the bullnose by hand. Finish tightening the bullnose using two wrenches as per the next figures. Place one wrench at position A and the other at position B (on bullnose). Use the wrench at position A to stabilize the module and the other wrench at position B to tighten the bullnose. See below for wrench sizes:

Tool OD	Position	Wrench Size
1.75”	A	1 – 5/8”
	B	1 – 1/2"
1.56”	A	1 – 3/8”
	B	1 – 3/8"

Figure 14 – Wrench sizes for connecting bullnose to pressure sub

Figure 15 - PPS71 bullnose

2.4. SETTING THE SPINNER TYPE IN THE TOOL STRING

Using a USB cable, connect the Memory module to a computer.

Figure 16 - PPS71 Geothermal memory module without gamma

Figure 17 - Six pin USB Cable

Use a six pin 3.6VDC USB cable for Memory Module without Gamma Ray Detector.

Use a four pin 7.2VDC USB cable for Memory Module with Gamma Ray detector.

Figure 18- PPS71 Geothermal memory module with gamma ray detector

Figure 19 - Four pin USB Cable

Once the module is connected, open the SmartLog software on the computer. The Tool String settings found under the Options page in SmartLog, display the position and length measurements of the different components of the Memory Tool. SmartLog can determine the

tool string for known tool configurations; however it may be necessary to modify these items manually. Any item in the grid can be modified at any time.

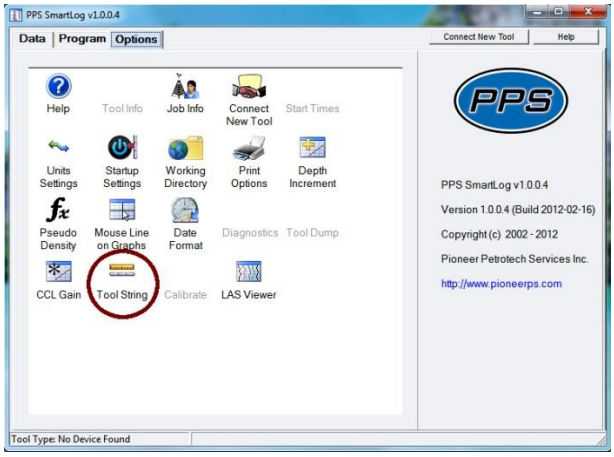


Figure 20 - SmartLog Options Page; Tool String

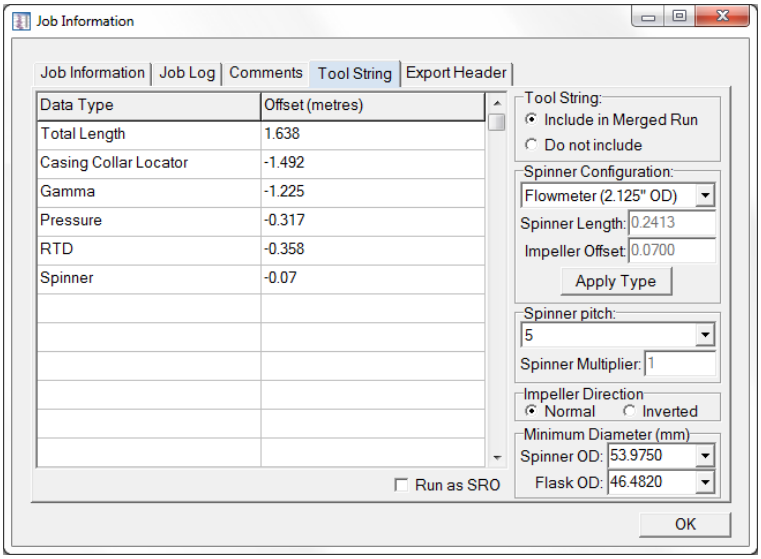


Figure 21 - Tool string settings

Please Check the SmartLog manual for detailed instructions on adjusting Data Type, Offset, and what it means to include the Tool String in a Merged Run. For now you'll be adjusting the Spinner configuration, pitch, impeller direction and minimum diameter.

- ## Spinner Configuration

Spinner configuration is the type of spinner attached to the tool, with spinner types being interchangeable. The Tool String offsets are measured from the bottom of the tool, and the spinner is located at the bottom. This means a change in spinner type will affect the offsets of the other components. Therefore the spinner type options must be set to correspond with the physical spinner type connected to the tool.

Select the appropriate spinner type from the drop-down list and click the Apply Type button. This will adjust the tool string offset values in SmartLog to account for the different spinner.

If the spinner type does not appear in the list, select Custom and enter the Spinner Length and Impeller Offset manually. The Spinner Length is the distance from the bottom of the spinner to the pressure port. The Impeller Offset is the distance from the bottom of the spinner to the impeller.

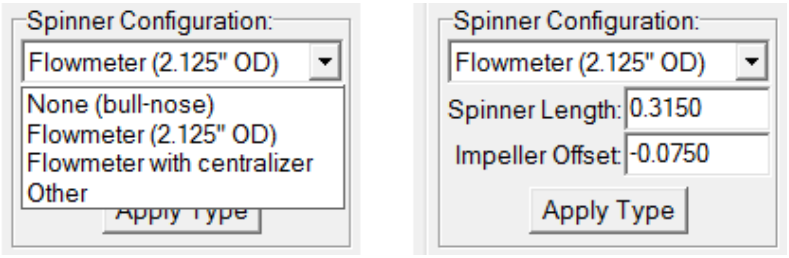


Figure 22 - Spinner configuration window

- ## Impeller Pitch

Also, important when replacing the spinner is the impeller pitch. This value indicates the inches/per revolution in relation to the physical spins of the impeller. This is often a one to one ratio where one spin equals one rotation, but in certain circumstances you may need a spinner that spins slower or faster before registering a rotation. This is where the pitch can be useful.

The pitch value depends on the impeller. To determine the pitch, refer to the impeller specifications or contact the vendor. Select the pitch value from the drop-down list:

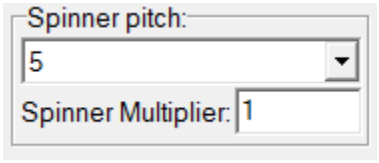


Figure 23 - Spinner pitch drop down menu

If the impeller's pitch value is not listed, select Custom, and enter the Spinner Multiplier manually. In this case, the spinner multiplier is the value that must be multiplied with the impeller's pitch in order to get standardized rotations/second. This value is normally: (pitch/5).

- ## Flow Direction

  The spinner values represent the rate of spins as well as the rotation direction. During Normal operation the values will be positive when the impeller rotates in one direction and negative for the other direction. Select Inverted to have the values read opposite for the corresponding direction.

- ## Spinner Outside Diameter

  The Spinner OD (outside diameter) is automatically updated based on the spinner selected, but if using another spinner type, ensure the Spinner OD is updated according to the spinner dimensions.

  After the spinner information is updated, click OK to close the Job Information. If the spinner information has been changed then you will see the following request:

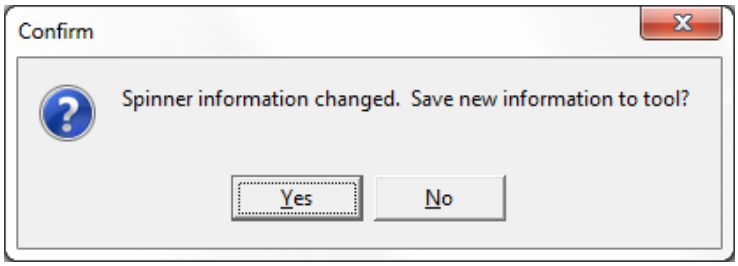


Figure 24 - Saving spinner type

Click **Yes** to save the information to the tool. This will allow the tool to remember the information for the spinner that is connected to it, so you will not have to re-enter it again in the software later.

2.5. RUNNING DIAGNOSTICS

The PPS SmartLog software diagnostics confirm that the module measures pressure, temperature, CCL, gamma (optional) and Flow Profile (optional). This manual will cover the basics on diagnostics and programming.

For more information about the software, please refer to the SmartLog Software Manual, Section 7.14 for Diagnostics and Section 6.2 for Programming.

Select "Diagnostics" under the Options Tab.

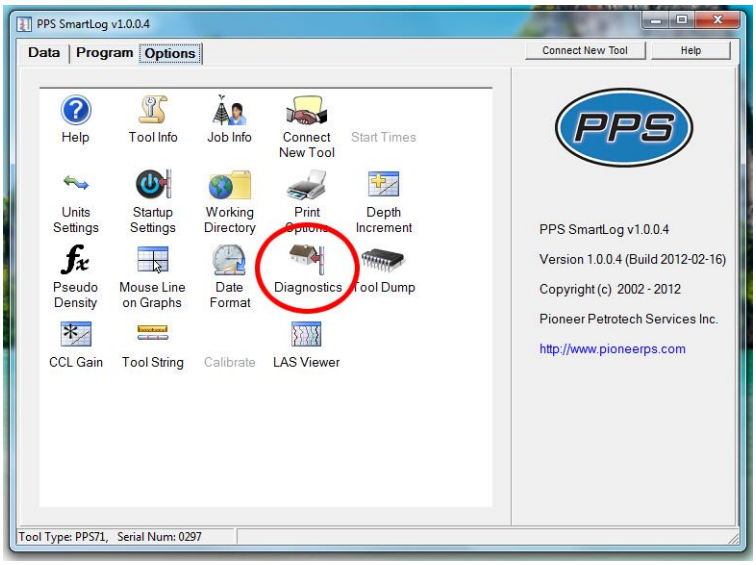


Figure 25 - Screenshot of SmartLog Diagnostics

- **Bench Test Pressure & Temperature**

  From the drop down menu select the sampling rate. Then run a bench test on the Pressure and RTD temperature by clicking the "Start" button. Samples should be generating at the rate selected.

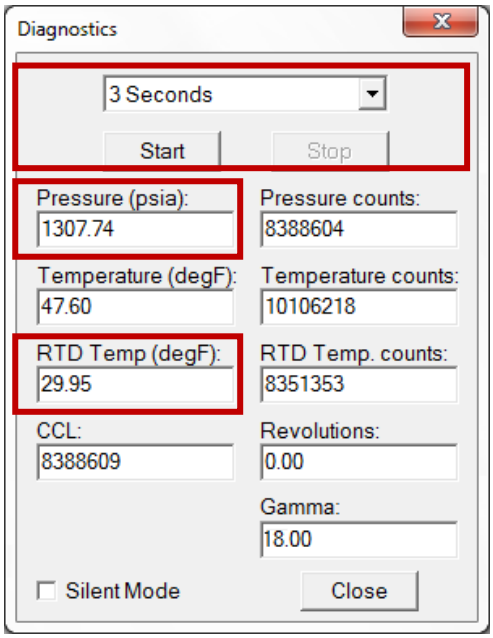


Figure 26 - Diagnostics sampling rate drop down menu and start button

- **Bench Test CCL**

  Next do a CCL test. Using a metal screwdriver, touch the CCL section of the module. The reading in the Diagnostics panel will show that the CCL is functioning.

Figure 27 - Testing CCL to check the reading in Diagnostics panel

- **Bench Test Gamma Ray Detection**

If you are not measuring gamma, you can skip this step.

With the memory module connected to the computer check the gamma reading in the diagnostics panel. Then place the gamma tester beside the gamma section of the module and check that there is an increase in the gamma reading.

Figure 28 - Checking gamma

Figure 29 - Place the gamma ray tester beside the module

Figure 30 - Checking gamma with gamma ray tester beside the module

- **Bench Test Flow Profile**

If you are not measuring Flow Profile, you can skip this step.

Lastly is doing a spinner test by blowing on the impeller in order to get it turning. The revolutions measurement in the Diagnostics panel should be showing greater than zero as the impeller turns.

Figure 31 - Checking the revolutions measurement in Diagnostics panel

2.6. PROGRAMMING A TOOL

To start programming the tool, in the SmartLog software select the Program Tab then Downhole Tool Tab.

Tool sampling programs are created by typing values into the program grid cells. The sampling program defines how often the tool will be taking pressure and temperature sample rate, as well as how long it will run at that rate -duration. To completely define a step in the new program, you must enter values for both rate and duration. The program over-run rate is automatically set to the last entered rate value.

*The **Rate** value tells the tool the amount of time to wait before taking the next sample. The **Duration** value is the total performing time at that rate.*

Programming Procedure:

1) Create a new program by typing the rate and duration values into the program grid cells, or load a saved program file into the cells (refer to the SmartLog user manual for instructions on loading a saved program file).

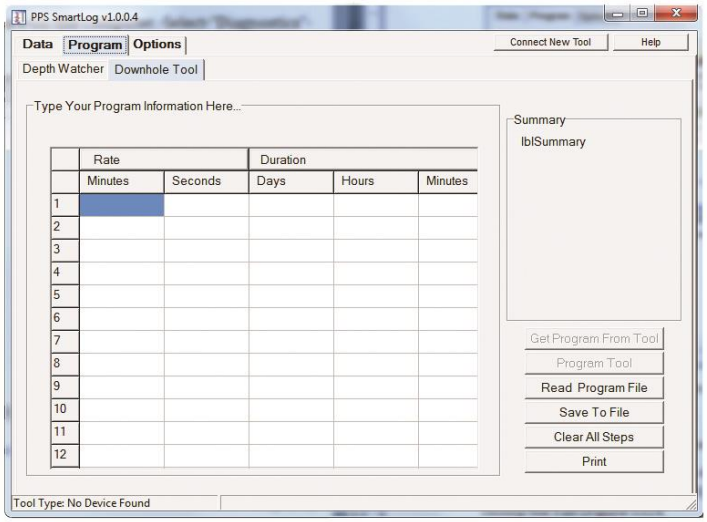


Figure 32 - Program page of SmartLog software

We recommend using 1s sampling rate for the first 30minutes, BUT if CCL and/or Gamma Ray data information are necessary, 0.1s sampling rate must be used.

2) When the tool finishes its last program step, it will continue working. It continues to take samples at the rate of the last program step until the memory capacity is full, the battery charge is fully consumed, or the battery is disconnected. To define a specific overrun rate, add a final program step.

3) When you have the program steps ready, click the Program Tool button to save the information. Before saving, it will display the Erase confirmation dialog box below.

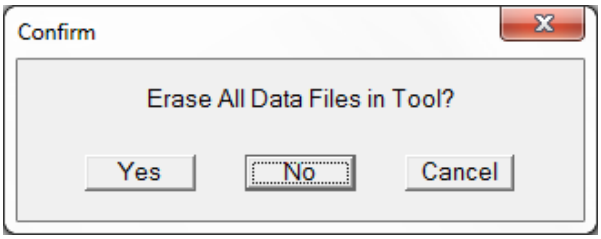


Figure 33 - Erase confirmation dialog box

4) To permanently erase all data on the tool click **Yes** (THIS CANNOT BE UNDONE). To program the tool without erasing the existing data, click **No**. To abort the operation and not erase the tool or program it, click Cancel.

For more information about programming steps and saving or loading programming files, please refer to the SmartLog User Manual.

2.7. ADDING A BATTERY

PPS recommends using a **new battery** for every operation. It is very important to check the battery voltage before connecting it to the module.

- **Activate and test battery**

  Plug the battery into a PPS Battery Tester activating the battery. The red LED on the battery will turn on.

Figure 34 - Plugging the battery into the PPS battery tester

Pressing the black button on the battery tester will be applying load to the battery. As you are applying load check the voltage reading on the tester.

For the Memory Module with gamma the battery voltage must be higher than 6.5 volts and for the Memory Module without gamma the battery voltage must be higher than 3.2 volts.

- **Test battery with module**

  If the battery voltage is measuring high enough on the tester try plugging it into the module. After a few moments the battery's LED should start to flash, for a total of 16 times. The tool has now started to run the program.

Figure 35 - Attaching the battery to the module

It may take a few seconds for the LED on the battery pack to start flashing but be sure to make note of the time the battery light begins blinking as this will be required later for the job start time.

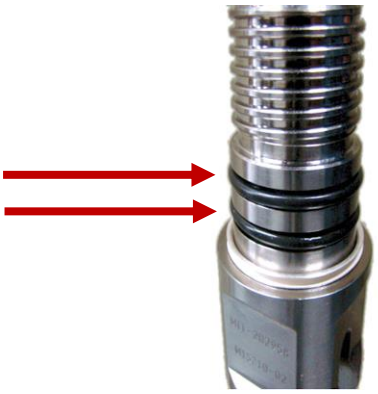
2.8. ADDING A HOUSING (1.75" OD TOOL)

The instructions for adding different housings are similar. However, if you are using a 1.56" OD tool the flask will be torqued with the aid of a Parmelee Wrench (01-AC-6599-A), skip to Section 2.9 in this case.

Install the battery pack on the end of the module.

On the opposite end of the module above the RTD install one metal C-ring.

Install two O-rings in the O-ring grooves above the metal C-ring.

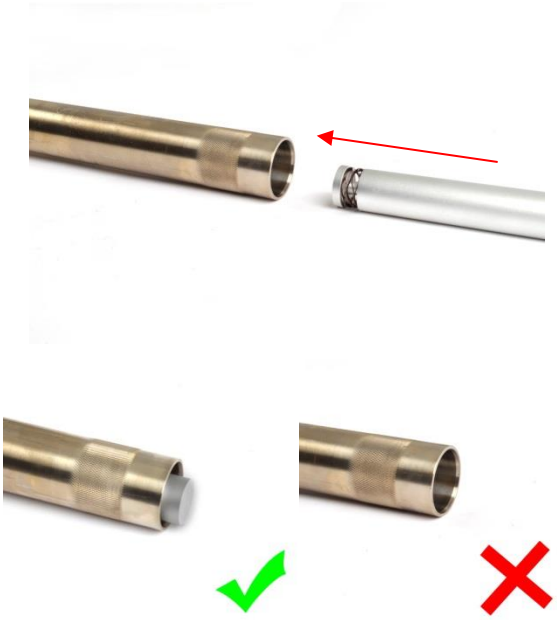


Apply O-ring grease to the O-rings.

Then apply anti-sieve to the threads of the module.

Place the housing on a large, clean, horizontal surface and carefully insert the spacer into the housing (spring side in first). The module will later push the spacer in place.

Do not drop down the spacer bar into the housing. Doing so may damage the housing.

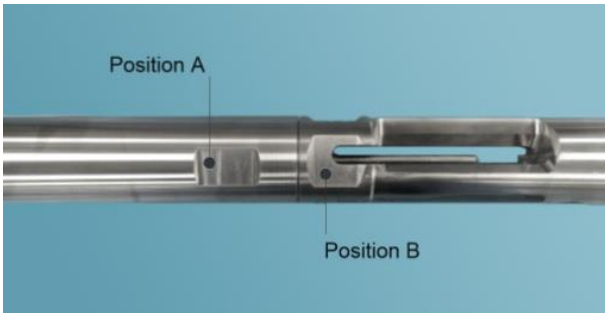


Insert the module (battery side first) into the housing while pushing onto the spacer.

Slowly push the module into the housing. Do not force the module.

Gently hand-tighten the housing in place.

Place a stabilizing wrench in position A and place a torque wrench on the RTD at position B.



When torquing the sub assembly only use the wrench flats as shown above. Otherwise, the sub can be damaged.

Check the torque direction mark on the handle of the torque wrench.

Torque to **90 ft-lbs** in order to properly engage the C-ring seal.

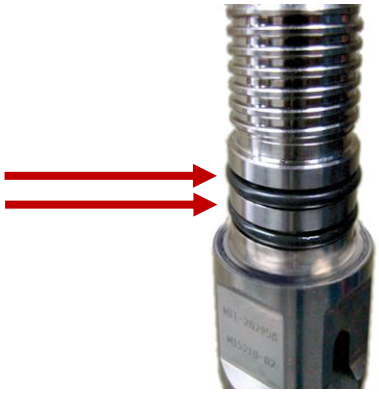
Figure 36 - Steps for installing the housing on the memory module (1.75" OD)

2.9. ADDING A HOUSING (1.56" OD TOOL)

If you are using a 1.56" OD tool the housing will be torqued with the aid of a Parmelee Wrench (01-AC-6599-A). Do not use a regular pipe wrench as it will damage the housing.

Install the battery pack on the end of the module.

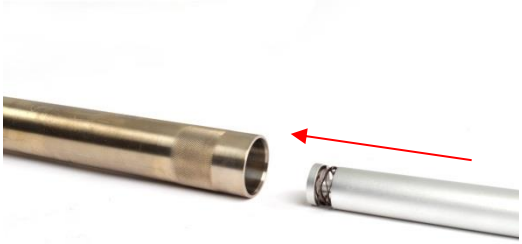
Install two O-rings in the O-ring grooves (as pictured).



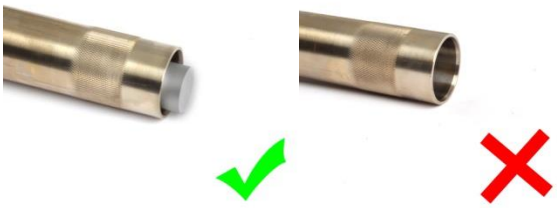
Apply O-ring grease to the O-rings.

Then apply anti-sieve to the threads of the module.

Place the housing on a large, clean, horizontal surface and carefully insert the spacer into the housing (spring side in first). The module will later push the spacer in place.



Do not drop down the spacer bar into the housing. Doing so may damage the housing.

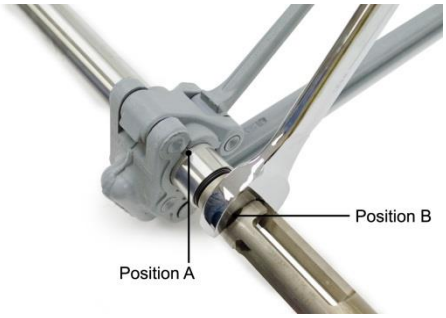


Insert the module (battery side first) into the housing while pushing onto the spacer.

Slowly push the module into the housing. Do not force the module.

Gently hand-tighten the housing in place.

Place the Parmelee Wrench in position A to stabilize the housing and place the 1-1/4" wrench on the RTD at position B.



When torquing the sub assembly only use the wrench flats as shown above. Otherwise, the sub can be damaged.

Tighten in the direction as shown here.

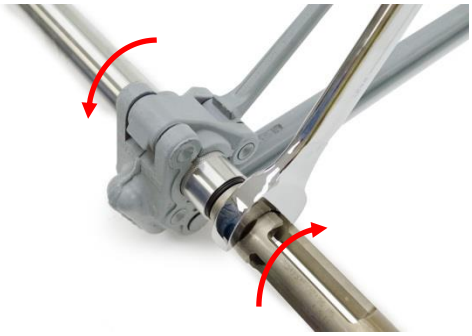


Figure 37 - Steps for installing the housing on the memory module (1.56" OD)

2.10. FILLING THE SPINNER WITH OIL

If using a spinner, it is necessary to fill it with hydraulic oil to properly lubricate the spinner prior to running the tool. It is best to position the tool in an upright position when filling it with oil. Fill an oil can with high temperature oil, such as the Tri-Flow Superior Lubricant supplied in the PPS71 maintenance kit.

1) Remove one of the plugs using a size 5/32" Allen key.

Figure 38 - Removing the oil plugs from the spinner

2) Insert the tube end of the oil can into the open plug. Then pump oil into the open plug until fluid comes out the impeller. The fluid first travels into the top of the spinner before coming down past the impeller. Repeat this procedure using the plug on the other side. Once full, re-install the oil plug.

Figure 39 - Filling the spinner with oil

The PPS71 Geothermal Tool is now ready for operations. Remember the following maximum downhole times for the 1.75" and 1.56" OD tools:

Max. downhole operation times for 1.75" OD Tool:
4 hours at 350°C (662°F) or
6 hours at 300°C (572°F) or
8 hours at 250°C (482°F) or
10 hours at 200°C (392°F) or
12 hours at 180°C (356°F)

Max. downhole operation times for 1.56" OD Tool:
4 hours at 300°C (572°F) or
5.5 hours at 250°C (482°F) or
7.5 hours at 200°C (392°F) or
10 hours at 180°C (356°F)

2.11. REMOVING THE HOUSING (1.75" OD TOOL)

Once operations are complete you MUST wait at least 30 minutes until the tool is cool enough before opening the flask housing. This will prevent damage to the threads.

When the housing has cooled place a stabilizing open-end wrench onto the housing at position A and placing an open-end wrench on the RTD section at position B begin loosening the housing. Continue unscrewing the housing with your hands.

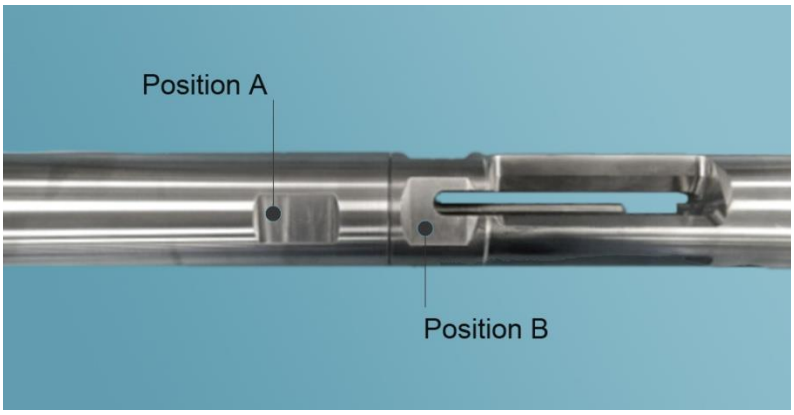


Figure 40 - Position of the wrenches to unscrew the flask

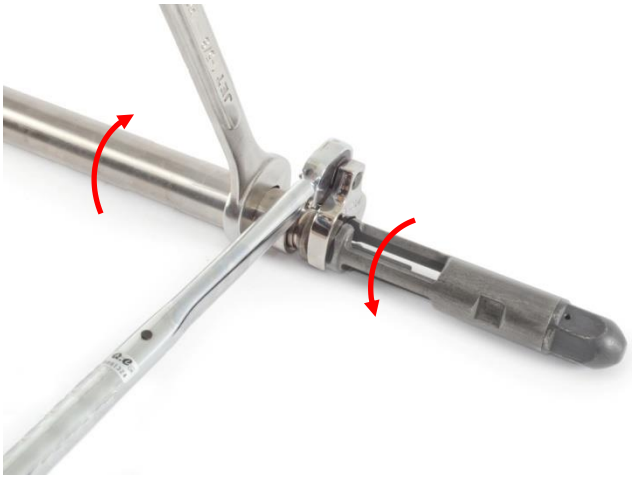


Figure 41 - Correct wrench positions to remove the housing

For the PPS71 tool with gamma ray module, it is necessary to let the internal components cool down slowly. Move the housing down just enough to expose the top portion of the memory module. Leave the tool in this position for at least an hour.

Figure 42 - Expose the memory module and leave the tool to cool down

Gamma Tools should not be heated or cooled at a rate greater than 5 °F per minute.

2.12. REMOVING THE HOUSING (1.56" OD TOOL)

Once operations are complete you MUST wait at least 30 minutes until the tool is cool enough before opening the flask housing. This will prevent damage to the threads.

When the housing has cooled, place the Parmelee Wrench onto the housing at position A and place the 1-1/4" open-end wrench on the RTD section at position B. Begin loosening the housing. Continue unscrewing the housing with your hands.

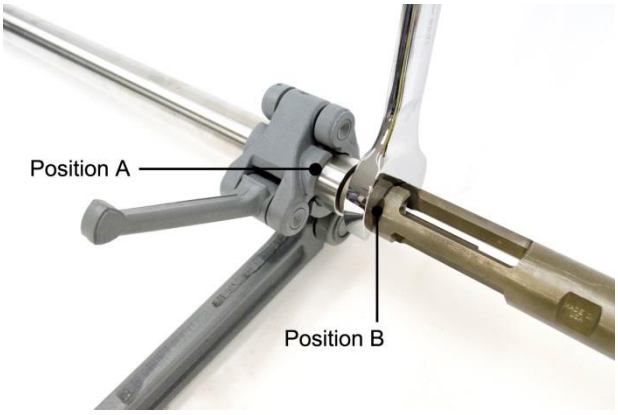


Figure 43 - Position of the wrenches to unscrew the flask

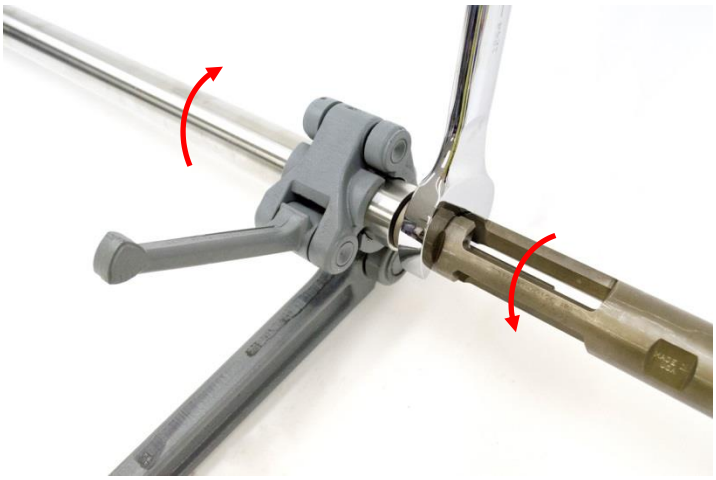


Figure 44 - Correct wrench positions to remove the housing

For the PPS71 tool with gamma ray module, it is necessary to let the internal components cool down slowly. Move the housing down just enough to expose the top portion of the memory module. Leave the tool in this position for at least an hour.

Figure 45 - Expose the memory module and leave the tool to cool down

Gamma Tools should not be heated or cooled at a rate greater than 5 °F per minute.

2.13. DOWNLOADING DATA

Sample data collected is held in the tool's memory in distinct packages called "jobs". By using the SmartLog software these jobs can be downloaded, one at a time, to create data files on the computer. These data files can then be read and viewed at any time using SmartLog without the need to connect to the device again.

When you download a job, you are transferring a set of data from the tool's memory to a file on your computer's hard drive. The data file is given a default filename in your working directory, but you can change the filename or directory prior to saving. Once downloaded, the data points are automatically displayed in the applicable data chart.

Downloading Procedure:

1) Connect the tool to your computer using the correct USB cable. (Use a six pin 3.6VDC USB cable for Memory Module without Gamma Ray Detection or a four pin 7.2VDC USB cable for Memory Module with Gamma Ray).

2) Start SmartLog to automatically connect to the tool or click the Connect New Tool button at the top of the main window to establish communication.

3) Click the Download button to display a list of all jobs in the memory of the connected tool.

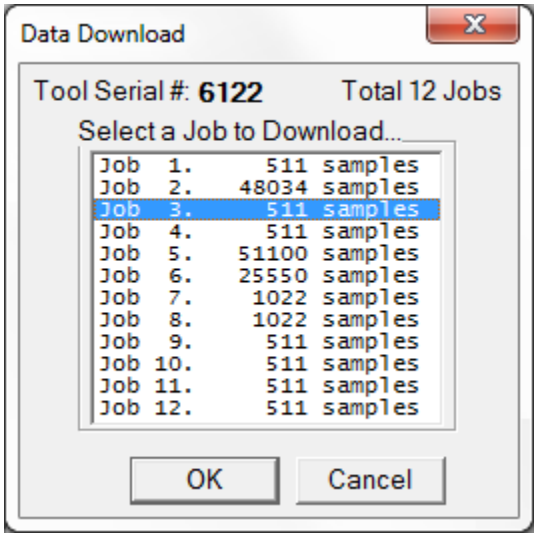


Figure 46 - Memory Tool data download dialog box

4) The Data Download window displays a list of the current jobs on the tool and the estimated number of samples of each job.

5) Double-click the job you want to download or select the job and click the OK button.

6) A Save As dialog box will appear allowing you to select a directory and file name to save the job data to.

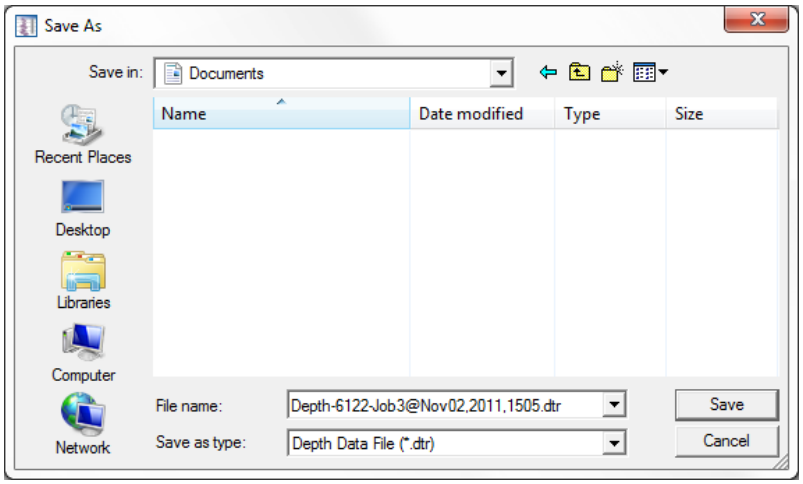


Figure 47 - Save as window for downloaded data file

7) Click the Save button.

8) **You must select a start time**. Enter the correct start time. Once the start date and start time are correct, click OK.

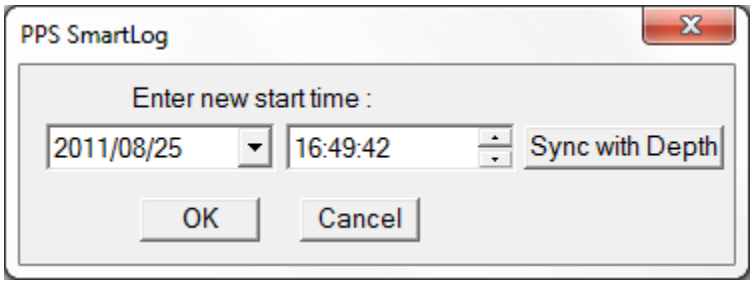


Figure 48 - Setting job start time when downloading data

10) A progress window will appear, followed by a message indicating that the data is being processed.

11) Once the download is complete, a confirmation message appears which displays the name and location of the downloaded data file.

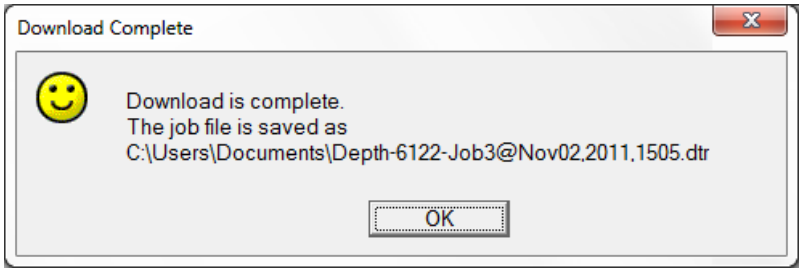


Figure 49 - Download complete message

12) Click OK. The data will be displayed on the applicable charts in SmartLog. The data will appear on the Pressure, Temperature, CCL, Spinner, and Gamma pages, depending on which data sets exist on the tool.

3. Maintenance

PPS recommends basic field maintenance in conjunction with manufacturer's maintenance in order to ensure successful operations and optimal performance of the PPS71 Geothermal Tools.

Basic field maintenance includes the following procedures to be done prior to each operation:

- Running diagnostics on the memory module, checking the pressure, temperature, CCL, gamma ray and Flow Profile measurements are functional;
- Performing an RTD temperature test to ensure the flask still provides a good heat shield;
- Checking the battery voltage is strong enough for operations;
- Checking the housing C-Ring is in good condition and clean;
- Replacing the housing O-Rings as needed;
- Cleaning or changing the pressure filter;

And includes the following procedures to be done after each operation:

- Removing the standard or flask housing;
- Changing the pressure filter; and
- Cleaning the spinner.

3.1. CHANGE PRESSURE FILTER

1) Using a 1/2" socket wrench, remove the pressure filter.

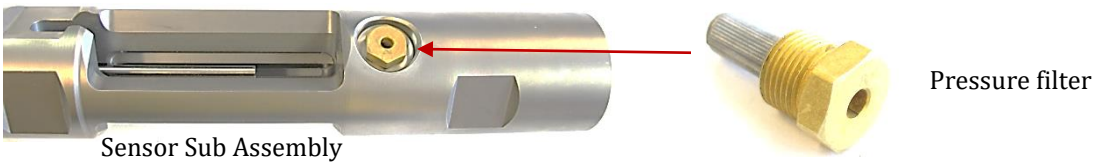


Figure 50 - Pressure filter

2) Using a non-conductive, anti-corrosive cleaner and a clean dry cloth to clean the pressure filter or if needed, change the pressure filter; Re-install the pressure filter with the 1/2" socket wrench.
3) Ensure the correct pressure filter is matched to the appropriated sensor sub assembly as they have different thread size.

Sensor sub assembly	Pressure filter
Sensor Sub Assembly,3-Reed TPS, 1.750 OD	01-AC-2181-A Pressure Filter,7/16-28 UNEF Thread,50 Microns
Sensor Sub Assembly,2-Reed,1.75OD	01-AC-1030-A Pressure Filter,1/8-27 NPT Thread,50 Microns

Figure 51 - Installing the pressure filter with a socket wrench

3.2. ASSEMBLY, DISASSEMBLY AND CLEANING THE 2.125" OD SPINNER

- **Disassembly and Cleaning of the 2.125"/1.69" OD Spinner (for 1.75" OD Flask)**

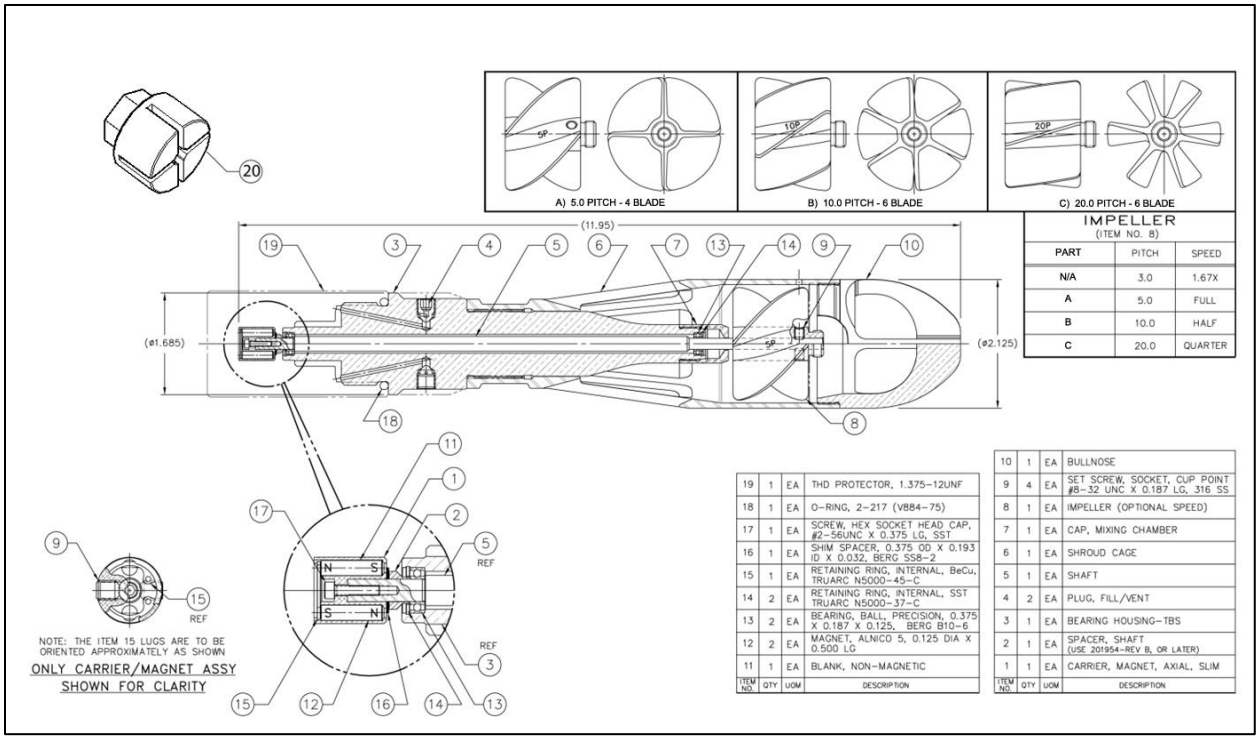


Figure 52 - Detailed illustration of the 2.125" and 1.69" OD spinner

1) Remove the bullnose (#10) using the bullnose remover (#20) and two wrenches. Slip the bullnose remover on, then position the 1-5/16" wrench on the shroud cage (#6). Place the 1-1/2" wrench on the top of the bullnose remover. Stabilize with the 1-5/6" wrench and then twist the 1-1/2" wrench to loosen the bullnose.

2) Remove the magnet carrier (#1), shim (#16), and spacer shaft (#2). Using an Allen key (size 5/64") loosen the two set screws located on opposite sides of the carrier. Remove the screw on the top of the carrier as well.

3) Remove the two set screws (#9) on the impeller. First align the set screw with the small hole on the shroud cage (#6). Using an Allen key (size 5/64") go through the hole to reach the screw and loosen it. Turn the impeller to line up the other screw and remove the screw on this side.

4) For removing the impeller, use the impeller puller tool. The puller helps to prevent excessive loads from being applied to the bearings. To use the puller tool, unscrew the mandrel end so that the threads are fully exposed on the opposite end. Screw the puller onto the impeller moving counter-clockwise (left hand thread). Then hold the housing and puller body, while rotating the mandrel to the right to extract the impeller.

5) Next remove the shroud cage (#6) from the housing (#3). Attach the 1-1/2" wrench on the bearing housing (#3), then place the 1-5/16" wrench on the top of the shroud cage. Use the 1-1/2" wrench as a stabilizer and twist the 1-5/16" wrench to loosen the cage. Once loosened, you can then unscrew the cage by hand until it comes off completely.

6) Remove the mixing chamber cap (#7) from the housing (#3), positioning a 9/16" wrench on the cap itself, and stabilize with a larger wrench on the housing. Twist the cap to loosen it. Continue unscrewing the cap by hand.

7) Remove the retainer rings from the top and bottom of the housing (#14) using retainer ring pliers. If you need to change the magnets, you must remove the retainer ring (#15) from the carrier.

8) Use the shaft (#5) to push the bottom bearings (#13) out. Then use the shaft again to push the top bearing out.

9) Clean all the parts thoroughly and check for damage. Make sure to clean the parts with an industrial solvent. If the housing body is extremely dirty, you can blow it out with compressed air, after rinsing with solvent.

- ## Assembly of the 2.125" and 1.69" OD Spinner (for 1.75" OD Flask)

Once everything has been cleaned it's time to put the spinner back together. It is important to check each piece as you re-assemble the spinner to ensure that nothing has been damaged. This is especially important with the bearings. PPS recommends changing the bearings after every use of the tool. To check that the bearings are functional and there is no damage to the housing, use your finger to rotate the bearing; this will indicate that the movement is smooth and not impeded by any damage. Please refer to Figure 52 (Detailed illustration of the 2.125" OD spinner).

1) To begin re-assembling the spinner, insert the top bearing (#13) first.

2) Install the top retainer ring (#14) using the pliers. Make sure the ring is installed properly by checking that it sits in the groove above the bearing. You can use the pliers to ensure it lies flat in the groove.

3) Insert the shaft (#5). The shaft has two indented sections. The short section matches the top of the housing, while the long section matches the bottom of the housing. This ensures that the shaft is inserted correctly into the housing.

4) With the shaft in place, install the bottom bearing (#13) and retainer ring (#14). Once again check that the retainer ring is installed properly and sits flat in the groove above the bearing.

5) Tighten the mixing chamber cap (#7) onto the housing body by hand. Then use two wrenches to tighten the cap in place.

6) Install the shroud cage (#6) by screwing the cage on by hand. Then attach a 1-1/2"wrench on the bearing housing (#3), and a 1-5/16" wrench on the top of the shroud cage. Use the 1-1/2" wrench as a stabilizer and twist the 1-5/16" wrench to tighten the cage.

7) Pre-install the set screws (#9) into the impeller (#8) using Loctite. Place a set screw on an Allen Key, apply a small amount of Loctite, and insert it into the impeller. Repeat on the other side.

8) Find the flat spots on the sides of the shaft and the corresponding notches. Once the impeller is installed in the shroud cage it will cover the flat spots on the shaft, so in order to orientate the set screws correctly you will have to use the notches as your guide.

9) Insert the impeller onto the shaft. Insert the Alan key through the hole in the shroud cage and into the set screw. Use the Alan key to position the impeller so that the top lies flush with the top of the shaft.

10) Slowly tighten the set screw. You want the screws tight but not too tight, because you want the impeller to be able to slide still. The screws need about a ¼ of a turn to get the right tension. Tighten the other side as well.

11) On the top of the spinner, install the shaft spacer (#2). The larger side is closest to the top of the shaft.

12) Then put the shim spacer (#16) on top of the spacer.

13) Insert the magnet (#12) and the blank (#11) back into the carrier. Change the magnet if needed.

14) Install a retainer ring in the top of the carrier. You want the retainer ring pin holes to line-up horizontally to the blank and magnet; as shown in Figure x.

15) Pre-install the set screws into the magnet carrier. First place a set screw on the Alan key, then apply a small amount of Loctite. Now set the screw in place. Repeat this procedure for the other screw.

16) Install the carrier onto the shaft. The two side set screws line up with the flat spots on the barrel of the shaft. Move the impeller at the bottom of the shaft to help line up the screws. Once aligned, tighten with the Allen key.

17) Insert the screw (#17) in the top of the magnet carrier. Hold the impeller from the bottom to tighten the screw completely.

18) Screw the bullnose (#10) to the shroud cage (#6) by hand. Attach the bullnose remover (#20) to the bullnose. Use wrenches; 1-5/16" and 1-1/2" to tighten further.

19) It is important to lubricate the spinner. Remove the plugs located on either side of the housing body.

20) Insert the tube end of the oil can into the open plug. Then pump oil into the open plug until fluid comes out the impeller. The fluid first travels into the top of the spinner before coming down past the impeller. Repeat this procedure using the plug on the other side. Now the tool is completely lubricated prior to running downhole.

21) Replace the plugs and attach the spinner to PPS71 Geothermal MEM module.

Please contact your PPS representative if you have any questions.

3.3. ASSEMBLY, DISASSEMBLY AND CLEANING THE 1.44" OD SPINNER

- **Disassembly and Cleaning of the 1.44" OD Spinner (for 1.56" OD Flask)**

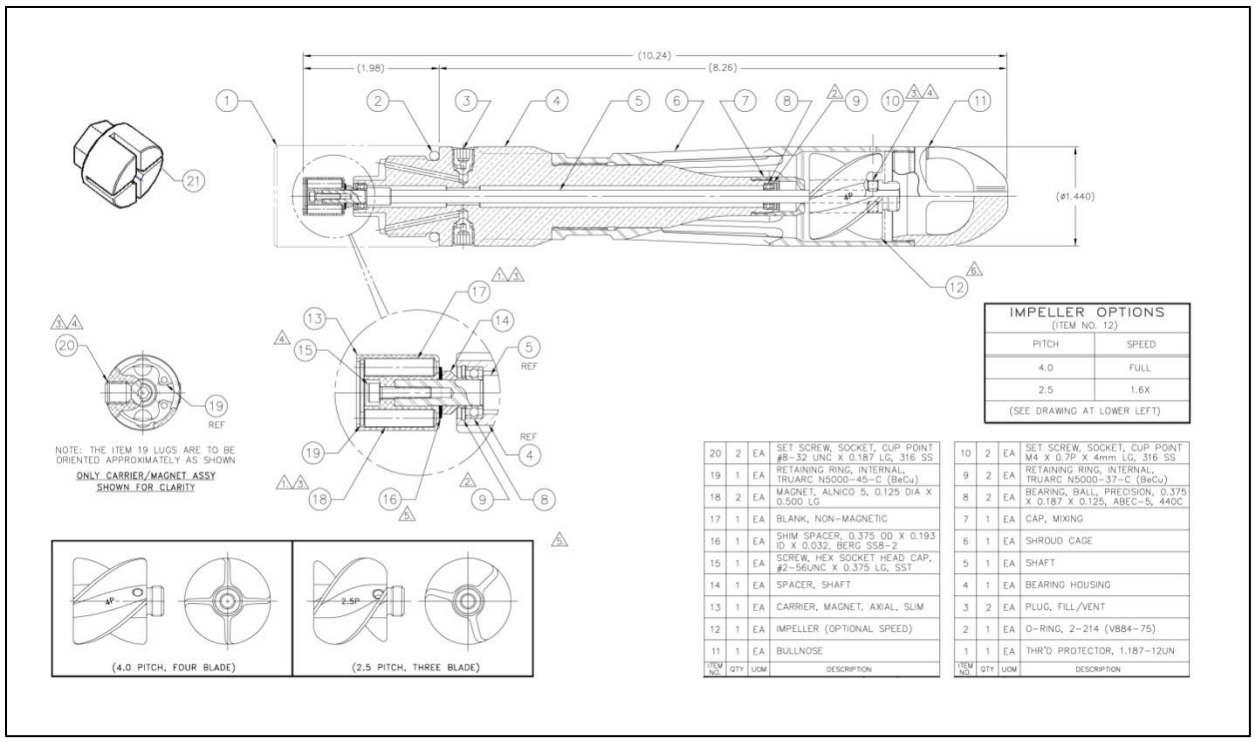


Figure 53 - Detailed illustration of the 1.44" OD spinner

1) Remove the bullnose (#11) using the bullnose remover (#21) and two wrenches. Slip the bullnose remover on, then position the 1-1/8" wrench in the middle of the housing and place the 1-1/2" wrench on the top of the bullnose remover. Stabilize with the wrench on the body and then twist the other wrench to loosen the bullnose.

2) Remove the magnet carrier (#13), shim (#16), and spacer shaft (#14). Using an Allen key (size 5/64") loosen the two set screws located on opposite sides of the carrier. Remove the screw on the top of the carrier as well.

3) Remove the two set screws (#10) on the impeller. First align the set screw with the small hole on the shroud cage (#6). Using an Allen key (size 5/64") go through the hole to reach the screw and loosen it. Turn the impeller to line up the other screw and remove the screw on this side.

4) For removing the impeller, use the impeller puller tool. The puller helps to prevent excessive loads from being applied to the bearings. To use the puller tool, unscrew the mandrel end so that the threads are fully exposed on the opposite end. Screw the puller onto the impeller moving

counter-clockwise (left hand thread). Then hold the housing and puller body, while rotating the mandrel to the right to extract the impeller.

5) Next remove the shroud cage (#6) from the housing (#3). Attach the 1-1/4" wrench on the bearing housing (#4), then place the 1-1/8" wrench on the top of the shroud cage. Use the 1-1/4" wrench as the stabilizer and twist the 1-1/8" wrench to loosen the cage. Once loosened, you can then unscrew the cage by hand until it comes off completely.

6) Remove the mixing chamber cap (#7) from the housing (#3), positioning a 9/16" wrench on the cap itself, and stabilize with a larger wrench on the housing. Twist the cap to loosen it. Continue unscrewing the cap by hand.

7) Remove the retainer rings from the top and bottom of the housing (#9) using retainer ring pliers. If you need to change the magnets, you must remove the retainer ring (#19) from the carrier.

8) Use the shaft (#5) to push the bottom bearings (#8) out. Then use the shaft again to push the top bearing out.

9) Clean all the parts thoroughly and check for damage. Make sure to clean the parts with an industrial solvent. If the housing body is extremely dirty, you can blow it out with compressed air, after rinsing with solvent.

- ## Assembly of the 1.44" OD Spinner (for 1.56" OD Flask)

Once everything has been cleaned it's time to put the spinner back together. It is important to check each piece as you re-assemble the spinner to ensure that nothing has been damaged. This is especially important with the bearings. PPS recommends changing the bearings after every use of the tool. To check that the bearings are functional and there is no damage to the housing, use your finger to rotate the bearing; this will indicate that the movement is smooth and not impeded by any damage. Please refer to Figure 53 (Detailed illustration of the 1.44" OD spinner).

1) To begin re-assembling the spinner, insert the top bearing (#8) first.

2) Install the top retainer ring (#9) using the pliers. Make sure the ring is installed properly by checking that it sits in the groove above the bearing. You can use the pliers to ensure it lies flat in the groove.

3) Insert the shaft (#5). The shaft has two indented sections. The short section matches the top of the housing, while the long section matches the bottom of the housing. This ensures that the shaft is inserted correctly into the housing.

4) With the shaft in place, install the bottom bearing (#8) and retainer ring (#9). Once again check that the retainer ring is installed properly and sits flat in the groove above the bearing.

5) Tighten the mixing chamber cap (#7) onto the housing body by hand. Then use two wrenches to tighten the cap in place.

6) Install the shroud cage (#6) by screwing the cage on by hand. Then attach a 1-1/4"wrench on the bearing housing (#4), and a 1-1/8" wrench on the top of the shroud cage. Use the 1-1/4" wrench as a stabilizer and twist the 1-1/8" wrench to tighten the cage.

7) Pre-install the set screws (#10) into the impeller (#12) using Loctite. Place a set screw on an Allen Key, apply a small amount of Loctite, and insert it into the impeller. Repeat on the other side.

8) Find the flat spots on the sides of the shaft and the corresponding notches. Once the impeller is installed in the shroud cage it will cover the flat spots on the shaft, so in order to orientate the set screws correctly you will have to use the notches as your guide.

9) Insert the impeller onto the shaft. Insert the Alan key through the hole in the shroud cage and into the set screw. Use the Alan key to position the impeller so that the top lies flush with the top of the shaft.

10) Slowly tighten the set screw. You want the screws tight but not too tight, because you want the impeller to be able to slide still. The screws need about a ¼ of a turn to get the right tension. Tighten the other side as well.

11) On the top of the spinner, install the shaft spacer (#14). The larger side is closest to the top of the shaft.

12) Then put the shim spacer (#16) on top of the spacer.

13) Insert the magnet (#18) and the blank (#17) back into the carrier. Change the magnet if needed.

14) Install a retainer ring in the top of the carrier. You want the retainer ring pin holes to line-up horizontally to the blank and magnet; as shown in Figure x.

15) Pre-install the set screws into the magnet carrier. First place a set screw on the Alan key, then apply a small amount of Loctite. Now set the screw in place. Repeat this procedure for the other screw.

16) Install the carrier onto the shaft. The two side set screws line up with the flat spots on the barrel of the shaft. Move the impeller at the bottom of the shaft to help line up the screws. Once aligned, tighten with the Allen key.

17) Insert the screw (#15) in the top of the magnet carrier. Hold the impeller from the bottom to tighten the screw completely.

18) Screw the bullnose (#11) to the shroud cage (#6) by hand. Attach the bullnose remover (#21) to the bullnose. Use wrenches; 1-1/8" and 1-1/2" to tighten further.

19) It is important to lubricate the spinner. Remove the plugs located on either side of the housing body.

20) Insert the tube end of the oil can into the open plug. Then pump oil into the open plug until fluid comes out the impeller. The fluid first travels into the top of the spinner before coming down past the impeller. Repeat this procedure using the plug on the other side. Now the tool is completely lubricated prior to running downhole.

21) Replace the plugs and attach the spinner to PPS71 Geothermal MEM module.

Please contact your PPS representative if you have any questions.

3.4. VIEWING SPINNER MAINTENANCE VIDEOS

The spinner needs to be cleaned after each operation to ensure successful performance. You can follow the detailed instructions below or view the complete spinner maintenance in a video from the PPS website.

Go to the Download section of the PPS website.

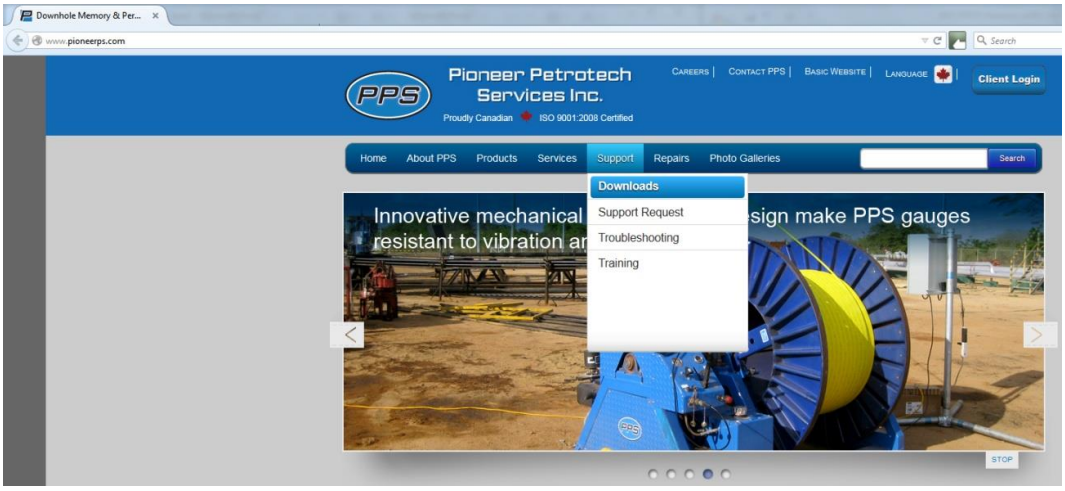


Figure 54 - Where to find the Downloads section on PPS website

Enter a user name and password or request a user name and password. PPS will need a valid device serial number in order to process the request.

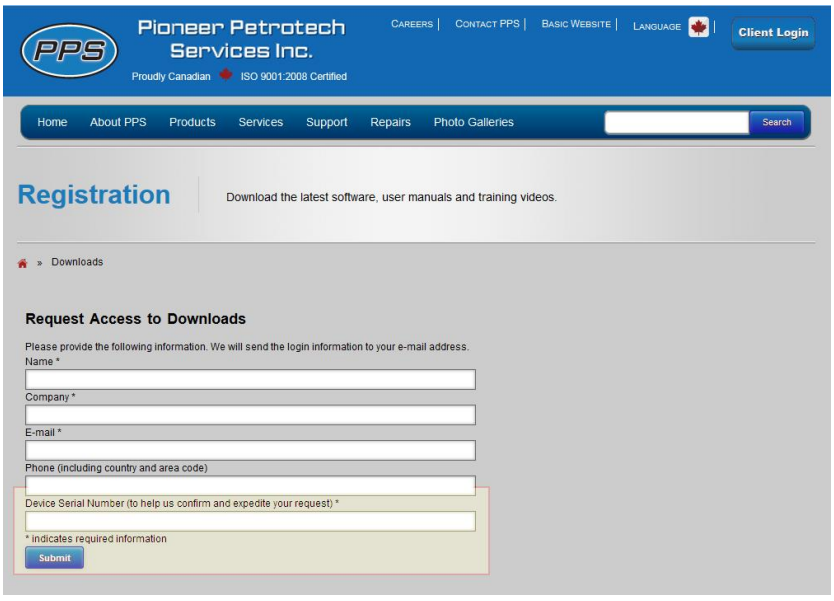


Figure 55 - Requesting a user name requires a device serial number

From the download section there are PPS71 maintenance videos that can be viewed online or downloaded for viewing at another time.

3.5. MANUFACTURER'S MAINTENANCE

The manufacturer's maintenance is implemented at the PPS manufacturing facility or an authorized representative location. The following maintenance services are performed:

- Full function check and test
- Failed components and parts replacement
- Calibration and verification
- Failure analysis and report

It is recommended that all PPS71 Geothermal Tools be recalibrated at least once a year to maintain normal operating condition and performance.

4. Troubleshooting

Symptoms	*Possible problems*	*Solutions*
LED does not flash after the battery is installed	Battery was not installed correctly.	Unplug the battery and plug it back in again.
	Battery has not been activated.	Activate the battery
	Battery has not enough power.	Change the battery.
	Memory is Full.	Erase the memory.
	Gauge is defective.	Return the gauge for check and repair.
SmartLog software doesn't detect the gauge, or the gauge was detected, but it stopped communicating	Gauge is not properly connected to the computer.	Make sure the gauge is connected according to the instructions. Refer to Software Manual for more information.
	COM port is locked.	Reboot computer and restart the software.
	Software or drivers are corrupt or damaged	Upgrade to latest software version or reinstall (ensure USB devices disconnected).
	Interface box is defective.	Use another interface box.
	Gauge is defective. (Try connecting to another gauge to confirm)	Return the gauge for check and repair.
Data recorded to memory is noisy	Low voltage of the battery	Check the battery voltage or change the battery.
Data is out of the gauge specification	The gauge may need to be recalibrated	Use the Diagnostics function to check if the gauge is sending the correct data, verify with the calibration records.
Could not download job files	Record files are corrupt	Use the "DUMP" function to dump memory of the gauge and then send to PPS for data retrieving.
Gamma ray reading is zero	Sample rate is not 0.1 second/sample	Set sample rate to 0.1 second/sample

For more information, please contact PPS for support. Thank You!

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Total Free in Canada & USA: 1-888-PP-GAUGE (774-2843)
E-mail: sales@pioneerps.com
Website: www.pioneerps.com

APPENDIX A: PPS71 Memory Tool Part Numbers

Item	P/N	Tool Name	Description / Type	Appendix
1	09-71-0010-A1	PPS71 PTS-C Tool (1.75" Inconel)	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile & CCL	E
2	09-71-0011-A1	PPS71 PTS-C Tool (1.75" BeCu)	10Kpsi/175°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure, temperature, flow profile & CCL	
3	09-71-0012-A1	PPS71 ELITE Tool (1.75" Inconel with Gamma)	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	F
4	09-71-0013-A1	PPS71 ELITE Tool (1.75" BeCu with Gamma)	10Kpsi/175°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	
5	09-71-0016-A1	PPS71 ELITE Tool (1.56" Inconel with Gamma)	5Kpsi/300°C, 1.56" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile, gamma& CCL	G
6	09-71-0017-A1	PPS71 ELITE Tool (1.56" BeCu with Gamma)	5Kpsi/175°C, 1.56" OD, BeCu Standard Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	
7	09-71-0018-A1	PPS71 PT Tool (1.75" Inconel)	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure & temperature	E
8	09-71-0019-A1	PPS71 PT Tool (1.75" BeCu)	10Kpsi/350°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure & temperature	
9	09-71-0020-A1	PPS71 PTS Tool (1.75" Inconel)	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature & flow profile	
10	09-71-0021-A1	PPS71 PTS Tool (1.75" BeCu)	10Kpsi/350°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure, temperature & flow profile	

APPENDIX B: Maintenance Kit (For 1.75” OD)

Item	P/N	Part Name	Description	QTY
One Standard Kit (P/N: 14-71-0133)				
1	01-AC-1061-A	Alan key set	Alan key set, imperial (5/32” and 5/64”)	1
2	33-71-1116-C	Bullnose remover	PPS Part	1
3	01-AC-1031-A	Impeller puller	PPS Part	1
4	01-AC-1055-A	Crow foot wrench	1-1/2" crow foot open end	1
5	01-AC-1062-A	Loctite	10mL	1
6	01-AC-1064-A	Lubricant	475°F, 18oz	1
7	01-AC-1063-A	Metal oil can	16oz	1
8	01-AC-1056-A	Open end wrench	1-5/16”	1
9	01-AC-1057-A	Open end wrench	1-5/8”	1
10	01-AC-1059-A	Open end wrench	9/16”	1
11	01-AC-1033-A	Retainer ring plier	For 1/8" to 3 1/2" Retaining Rings	1
12	01-AC-1058-A	Socket wrench	1/2" square drive, 1/2" size	1
13	01-AC-1054-A	Torque wrench	1/2" drive	1

APPENDIX C: Maintenance Kit (For 1.56” OD)

Item	P/N	Part Name	Description	QTY
One Standard Kit (P/N: 14-71-0134)				
1	01-AC-1061-A	Alan key set	Alan key set, imperial (5/32” and 5/64”)	1
2	33-71-1116-C	Bullnose remover	PPS Part	1
3	01-AC-2182-A	Open end wrench	Wrench, open end 1-3/8"	1
4	01-AC-1031-A	Impeller puller	PPS Part	1
5	01-AC-1062-A	Loctite	10mL	1
6	01-AC-1064-A	Lubricant	475°F, 18oz	1
7	01-AC-1063-A	Metal oil can	16oz	1
8	01-AC-6609-A	Open end wrench	1-1/8”	1
9	01-AC-1060-A	Open end wrench	1-1/4”	1
10	01-AC-1059-A	Open end wrench	9/16”	1
11	01-AC-1033-A	Retainer ring plier	For 1/8" to 3 1/2" Retaining Rings	1
12	01-AC-1058-A	Socket wrench	1/2" square drive, 1/2" size	1
13	01-AC-1054-A	Torque wrench	1/2" drive	1

APPENDIX D: Thermometer Part Numbers

Item	P/N	Part Name	Description	QTY
1	01-AC-1066-A	RTD probe	Pt100, -50°C to 500°C	1
2	01-AC-1065-A	RTD Thermometer	4 digital RTD thermometer	1
3	33-71-0107-C	Rubber plug	Heat isolator	1

APPENDIX E: PPS71 Tool & Accessories (PT, PTS, PTS-C; 1.75” OD)

Item	P/N	Part Name	Description	QTY
One Standard Full Set				
1	09-71-0010-A1	PPS71 PTS-C Memory Tool	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile &CCL	1
2	01-AC-0015-B1	Battery	PPS 180°C C size battery pack (6-PIN)	2
3	01-AC-1047-A	C-Ring	Metal C-ring	2
4	01-AC-0073-A1	O-Ring	Kalrez , 2-123	2
5	32-71-0008-A0	Space bar	Aluminum spacer bar with spring, overall length 12.18IN.	1
6	33-71-0106-A	Sucker rod crossover	PPS Part, 15/16”-10UNS-2A (1.75” housing)	1
7	33-71-0102-A	Tandem crossover	PPS Part (for 1.75” housing)	1
8	01-AC-1143-A	Bullnose	Bullnose(for 1.75” housing)	1
9	01-AC-2181-A	Pressure filter	7/16-28UNEF thread pressure for 1.75OD sub (use with 3-reed switch sensor sub)	2
10	01-AC-1049-A	O-Ring grease	450°C, 100g	1
11	01-AC-1051-A	Anti-seize compound	800°C, 225ml	1
12	14-DB-0001	Battery tester	PPS Digital Battery Tester (6-pin)	1
13	01-AC-1052-A	USB download box	PPS USB Download Box (3.6V)	1
14	01-AC-1053-A	Software CD	PPS SmartLog and PPS71 User Manual	1
15	01-AC-1482-A	Case (1170)	Black case for 2×PPS71 gauges and parts	1
16	14-71-0133	Maintenance Kit	Maintenance kit for spinner (1.75” OD)	1
Options / Substitutions				
1	09-71-0011-A1	PPS71 PTS-C MEMORY TOOL	PPS71 geothermal memory gauge 10kpsi/175°C, 1.75” BeCu housing	
2	09-71-018-A1	PPS71 PT MEMORY TOOL, Inconel	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure & temperature	
3	09-71-019-A1	PPS71 PT MEMORY TOOL, BeCu	10Kpsi/350°C, 1.75" OD, BeCu Flask Housing Dataset: Pressure & temperature	
4	09-71-020-A1	PPS71 PTS MEMORY TOOL, Inconel	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature & flow profile	
5	09-71-021-A1	PPS71 PTS MEMORY TOOL, BeCu	10Kpsi/350°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure, temperature& flow profile	
6	01-AC-0015-B1	Battery	PPS 180°C C size battery pack (6-PIN)	
7	01-AC-0014-B1	Battery	PPS 165°C C size battery pack (6-PIN)	
8	01-AC-1068-A	Impeller	3-pitch	
9	01-AC-1069-A	Impeller	5-pitch	
10	01-AC-1070-A	Impeller	10-pitch	
11	01-AC-1071-A	Impeller	20-pitch	
12	01-AC-1072-A	Bearing	Ball bearing (Part #13 in Fig. 37)	

13	01-AC-1050-A	Retainer ring	(Part #14 in Fig. 37)	
14	01-AC-1030-A	Pressure filter	1/8-27 NPT, 50 microns (use with 2-reed switch sensor sub)	
15	01-AC-1047-A	C-Ring	Metal C-ring	
16	01-AC-0073-A1	O-Ring	Kalrez , 2-123	
17	01-AC-1049-A	O-Ring grease	450°C, 100g	
18	01-AC-1051-A	Anti-seize compound	800°C, 225ml	
19	01-AC-1387-A	Centralizer	4.5” Bow spring centralizer	
20	01-AC-1067-A	Spinner	Spinner with a 5-pitch impeller	

APPENDIX F: PPS71 Tool & Accessories (Elite, Quarts, 1.75” OD)

Item	P/N	Part Name	Description	QTY
One Standard Full Set				
1	09-71-0012-A1	PPS71 Elite Memory Tool	10Kpsi/350°C, 1.75" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	1
2	01-AC-0014-B3	Battery	Battery C+C 4Pin 165C	2
3	01-AC-1047-A	C-Ring	Metal C-ring	2
4	01-AC-0073-A1	O-Ring	Kalrez , 2-123	2
5	01-AC-2152-A	Spacer bar	Aluminum Bar OD1.0 - 9.31IN Includes spring for 466mm G-Ray & 4 Magnets & C+C	1
6	33-71-0106-A	Sucker rod crossover	PPS Part, 15/16”-10UNS-2A (1.75” housing)	1
7	33-71-0102-A	Tandem crossover	PPS Part (for 1.75” housing)	1
8	01-AC-1143-A	Bullnose	Bullnose (for 1.75” housing)	1
9	01-AC-1067-A	Spinner	Spinner with a 5-pitch impeller	1
10	01-AC-2181-A	Pressure filter	7/16-28UNEF thread pressure for 1.75OD sub (use with 3-reed switch sensor sub)	1
11	01-AC-1049-A	O-Ring grease	450°C, 100g	1
12	01-AC-1051-A	Anti-seize compound	800°C, 225ml	1
13	14-DB-0001	Battery tester	PPS Digital Battery Tester (4-pin)	1
14	14-71-0106	USB download box	PPS71 7.2VDC USB Download Box	1
15	01-AC-1053-A	Software CD	PPS SmartLog and PPS71 User Manual	1
16	01-AC-1482-A	Case (1170)	Black case for 2×PPS71 gauges and parts	1
17	14-71-0133	Maintenance Kit	Maintenance kit for spinner (1.75” OD)	1
Options / Substitutions				
1	09-71-0013-A1	PPS71 Elite Memory Tool	10Kpsi/175°C, 1.75" OD, BeCu Standard Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	

2	09-71-0022-A1	PPS71 Quartz Memory Tool, Inconel	10Kpsi/175°C, 1.75" OD, Quartz, Inconel Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	
3	09-71-0023-A1	PPS71 Quartz Memory Tool, BeCu	10Kpsi/175°C, 1.75" OD, Quartz, BeCu Housing Dataset: Pressure, temperature, flow profile, gamma & CCL	
4	01-AC-0014-B3	Battery	Battery C+C 4Pin 165C	
5	01-AC-1068-A	Impeller	3-pitch	
6	01-AC-1069-A	Impeller	5-pitch	
7	01-AC-1070-A	Impeller	10-pitch	
8	01-AC-1071-A	Impeller	20-pitch	
9	01-AC-1072-A	Bearing	Ball bearing (Part #13 in Fig. 37)	
10	01-AC-1050-A	Retainer ring	(Part #14 in Fig. 37)	
11	01-AC-1030-A	Pressure filter	1/8-27 NPT, 50 microns (use with 2-reed switch sensor sub)	
12	01-AC-1047-A	C-Ring	Metal C-ring	
11	01-AC-0073-A1	O-Ring	Kalrez , 2-123	
12	01-AC-1049-A	O-Ring grease	450°C, 100g	
13	01-AC-1051-A	Anti-seize compound	800°C, 225ml	
14	01-AC-1387-A	Centralizer	4.5” Bow spring centralizer	
15	01-AC-2181-A	Pressure filter	7/16-28UNEF thread pressure for 1.75OD sub	

APPENDIX G: PPS71 Tool & Accessories (Elite 1.56” OD with GRD)

Item	P/N	Part Name	Description	QTY
One Standard Full Set				
1	09-71-0016-A1	PPS71 Elite Memory Tool	5Kpsi/300°C, 1.56" OD, Inconel Flask Housing Dataset: Pressure, temperature, flow profile & CCL	1
2	01-AC-0014-B3	Battery	Battery C+C 4Pin 165C	2
3	01-AC-0073-A1	O-Ring	Kalrez , 2-123	2
4	01-AC-2152-A	Spacer bar	Aluminum Bar OD1.0 - 9.31IN Includes spring for 466mm G-Ray & 4 Magnets & C+C	1
5	33-71-1150-A0	Sucker rod crossover	PPS Part (for 1.56” housing)	1
6	33-71-1152-A0	Tandem crossover	PPS Part (for 1.56” housing)	1
7	33-71-1151-A0	Bullnose	Bullnose (for 1.56” housing)	1
8	01-AC-2177-A	Spinner	Spinner with 1.44” OD	1
9		Pressure filter	9/16-18UNF thread pressure filter for 1.56OD sub assembly	2
10	01-AC-1049-A	O-Ring grease	450°C, 100g	1

11	01-AC-1051-A	Anti-seize compound	800°C, 225ml	1
12	01-AC-6599-A	Barrel Wrench	Gearench ZT2:1.560	1
13	01-AC-1054-A	Torque wrench	1/2" drive	1
14	01-AC-6605-A	Crow foot wrench	1-3/8" crow foot open end	1
15	01-AC-1060-A	Open end wrench	1-1/4”	1
16	01-AC-1058-A	Socket wrench	1/2" square drive, 1/2" size	1
17	14-DB-0001	Battery tester	PPS Digital Battery Tester (4-pin)	1
18	14-71-0106	USB download box	PPS71 7.2VDC USB Download Box	1
19	01-AC-1053-A	Software CD	PPS SmartLog and PPS71 User Manual	1
20	01-AC-1482-A	Case (1170)	Black case for 2×PPS71 gauges and parts	1
21	14-71-0134	Maintenance Kit	Maintenance kit for spinner (1.56” OD)	1
Options / Substitutions				
1	09-71-0017-A1	PPS71 Elite Memory Tool	5Kpsi/175°C, 1.56" OD, BeCu Standard Housing Dataset: Pressure, temperature, flow profile & CCL	*
2	01-AC-0014-B3	Battery	Battery C+C 4Pin 165C	*
3	01-AC-6606-A	Impeller	4-pitch	*
4	01-AC-6607-A	Impeller	2.5-pitch	*
5	01-AC-1072-A	Bearing	Ball bearing (Part #13 in Fig. 37)	*
6	01-AC-1050-A	Retainer ring	(Part #14 in Fig. 37)	*
7		Pressure filter	9/16-18UNF thread pressure filter for 1.56OD sub assembly	*
8	01-AC-0073-A1	O-Ring	Kalrez , 2-123	*
9	01-AC-1049-A	O-Ring grease	450°C, 100g	*
10	01-AC-1051-A	Anti-seize compound	800°C, 225ml	*

APPENDIX H: Spinner Accessories Part Numbers

Item	P/N	Part Name	Description	QTY
1	01-AC-1072-A	Bearing	Ball bearing	*
2	01-AC-1833-A	Bearing housing	Bearing housing, for 2.125"&1.69" Spinner	*
3	01-AC-2183-A	Bearing housing	Bearing housing,, for 1.44" Spinner	*
4	01-AC-1838-A	Blank	Blank	*
5	01-AC-1837-A	Bullnose	Bullnose,, for 2.125" Spinner	*
6	01-AC-2184-A	Bullnose	Bullnose, for 1.69" Spinner	*
7	01-AC-2185-A	Bullnose	Bullnose, for 1.44" Spinner	*
8	01-AC-1243-A	Hex cap screw	Hex cap screw 2-56x.375	*
9	01-AC-1068-A	Impeller	3-pitch, for 2.125" Spinner	*
10	01-AC-1069-A	Impeller	5-pitch, for 2.125" Spinner	*
11	01-AC-1070-A	Impeller	10-pitch, for 2.125" Spinner	*
12	01-AC-1071-A	Impeller	20-pitch, for 2.125" Spinner	*
13	01-AC-1877-A	Impeller	3-pitch, for 1.69" Spinner	*
14	01-AC-1386-A	Impeller	5-pitch, for 1.69" Spinner	*
15	01-AC-1780-A	Impeller	10-pitch, for 1.69" Spinner	*
16	01-AC-1911-A	Impeller	20-pitch, for 1.69" Spinner	*
17	01-AC-6607-A	Impeller	2.5-pitch, for 1.44" Spinner	*
18	01-AC-6606-A	Impeller	4-pitch, for 1.44" Spinner	*
19	01-AC-1839-A	Magnet	Magnet	*
20	01-AC-1831-A	Magnet carrier	Magnet carrier	*
21	01-AC-1836-A	Mixing chamber cap	Mixing chamber cap, for 2.125"&1.69" Spinner	*
22	01-AC-2186-A	Mixing chamber cap	Mixing chamber cap, for 1.44" Spinner	*
23	01-AC-1841-A	O-ring	O-ring 2-217, for 2.125"&1.69" Spinner	*
24	01-AC-2187-A	O-ring	O-ring 2-214, for 1.44" Spinner	*
25	01-AC-1239-A	Plug	Plug	*
26	01-AC-1050-A	Retaining ring	Retaining ring 37C	*
27	01-AC-1237-A	Retaining ring	Retaining ring 45C	*
28	01-AC-1241-A	Set screw	Set screw 8-32x.187	*
29	01-AC-1834-A	Shaft	Shaft, for 2.125"&1.69" Spinner	*
30	01-AC-2188-A	Shaft	Shaft, for 1.44" Spinner	*
31	01-AC-1240-A	Shim spacer	Shim spacer .375x.193	*
32	01-AC-1835-A	Shroud cage	Shroud cage for 2.125" Spinner	*
33	01-AC-1912-A	Shroud cage	Shroud cage for 1.69" Spinner	*
34	01-AC-2189-A	Shroud cage	Shroud cage for 1.44" Spinner	*
35	01-AC-1832-A	Spacer shaft	Spacer shaft	*

36	01-AC-1842-A	Thread protector	Thread protector, for 2.125"&1.69" Spinner	*
37	01-AC-2190-A	Thread protector	Thread protector, for 1.44" Spinner	*

APPENDIX I: Parts to Convert a Memory Tool to an SRO Tool

It is easy to change the memory tool to an SRO tool by adding a couple of key parts. The PPS71 Geothermal SRO Tool uses an SRO transmitter in place of a battery to power the tool. Next you'll need the application cable, surface unit and flask housing to complete the SRO tool*.

*** Note: PPS71 Geothermal SRO Tool is not available in 1.56" OD version.**

tem	P/N	Part Name	Description	QTY
1	01-AC-1782-A	Application cable	Customer hook up cable (30M)	1
2	14-71-1110	PPS71 SRO Sub	PPS71 SRO Sub Transmitter	1
3	14-71-1104	PPS71 SRO Surface Unit	PPS71 SRO Surface Unit Receiver Box	1
4	01-AC-1869-A	SRO Flask	PPS71 SRO Flask Housing	1
5	33-71-2053-A0	Sub barrier housing	PPS71 Flask sub barrier for SRO flask	1
6	01-AC-1172-A	USB Cable	Customer USB 2.0 cable (1.8M)	1
7	14-71-1116	0.7m Simulation test cable	0.75m simulation test cable (to receiver)	1
8	14-71-1117	2.2m Simulation test cable	2.2m simulation test cable (to tool)	1
9	14-71-1115	Cable simulator box	6km cable simulator box	1
10	33-71-2051-A	SRO Sleeve	SRO connection sleeve	1
11	01-AC-1989-A	SRO Sleeve Screws	Screw, FHP, SS, 6-32x5/16	7
12	MANU-0025	User Manual	PPS71 Geothermal SRO tool Manual	1

APPENDIX J: Specifications

PRESSURE MEASUREMENT	PPS71 ELITE		PPS71 PTS-C
Sensor Type	Piezo Silicon-Sapphire	Piezo Silicon-Sapphire	Piezo Silicon-Sapphire
Pressure Range	Up to 10,000 psi	Up to 5,000 psi (1.56" OD)	Up to 10,000 psi (1.75" OD)
Accuracy	± 0.03% FS	± 0.03% FS	± 0.03% FS
Resolution	0.0003% FS	0.0003% FS	0.0003% FS
TEMPERATURE MEASUREMENT			
Sensor Type	RTD (Pt1000; 4-wire)	RTD (Pt1000; 4-wire)	RTD (Pt1000; 4-wire)
Temperature Range	0 to 350 °C (662 °F)	0 to 300 °C (1.56" OD)	0 to 350 °C (1.75" OD)
Accuracy	± 0.5 °C	± 0.5 °C	± 0.5 °C
Resolution	0.01 °C	0.01 °C	0.01 °C
FLOW PROFILE			
Sensor Type	Reed switch/magnetic	Reed switch/magnetic	Reed switch/magnetic
Spinner Range	5 – 7,000 RPM	5 – 7,000 RPM	5 – 7,000 RPM
Accuracy (>=20 RPS)	± 0.5 revolution	± 0.5 revolution	± 0.5 revolution
Accuracy (<20 RPS)	± 0.25 revolution	± 0.25 revolution	± 0.25 revolution
Resolution (>=20 RPS)	0.5 RPS	0.5 RPS	0.5 RPS
Resolution (<20 RPS)	0.1 RPS	0.1 RPS	0.1 RPS

Flow Rate	Impeller	
	Pitch	Speed
LOW	3	x 1.67
	5	x 1
	10	x 0.5
HIGH	20	x 0.25
V (in/min) = N (RPM) x Impeller Pitch (in/rev)		

DATA STORAGE			
Sampling Rate	0.1 s – 1.8 hrs/per sample	0.1 s – 1.8 hrs/per sample	0.1 s – 1.8 hrs/per sample
Datasets	Time / Pressure / RTD / CCL / Gamma / Flow Profile (Optional)	Time / Pressure / RTD / CCL / Gamma / Flow Profile (Optional)	Time / Pressure / RTD / CCL / Flow Profile (Optional)
Memory Capacity	One million datasets	One million datasets	One million datasets
GAMMA RAY MEASUREMENT			
Sensor Type	Crystal, NaI(scintillation type)	Crystal, NaI(scintillation type)	N/A
Sensitivity	1.0 CPS/API	1.0 CPS/API	
Maximum Logging Speed	66 ft/min (20 m/min)	66 ft/min (20 m/min)	

ENVIRONMENTAL	PPS71 ELITE		PPS71 PTS-C
Module Temperature Rating	177 °C (351 °F) Standard housing 350 °C (662 °F) Flask (1.75" OD)	177 °C (351 °F) Standard housing, 300 °C (662 °F) Flask (1.56" OD)	177 °C (351 °F) Standard housing, 350 °C (662 °F) Flask (1.75" OD)
Electronics Rating	177 °C (351 °F)	177 °C (351 °F)	177 °C (351 °F)
Downhole Time	4 hours at 350 °C (662 °F)	4 hours at 300 °C (572 °F)	4 hours at 350 °C (662 °F)
	6 hours at 300 °C (572 °F)	5.5 hours at 250 °C (482 °F)	6 hours at 300 °C (572 °F)
	8 hours at 250 °C (482 °F)	7.5 hours at 200 °C (392 °F)	8 hours at 250 °C (482 °F)
	10 hours at 200 °C (392 °F)	10 hours at 180 °C (356 °F)	10 hours at 200 °C (392 °F)
	12 hours at 180 ºC (356 °F)	-	12 hours at 180 ºC (356 °F)
POWER SUPPLY			
Operation Voltage	5.5 – 7.2 VDC	5.5 – 7.2 VDC	2.7 – 3.9 VDC
Battery	165 °C (329 °F) Two C size Li-battery (5 A hr/7.2 V)	165 °C (329 °F) Two C size Li-battery (5 A hr/7.2 V)	180 °C (356 °F) C-size Li-battery (5 A hr/3.6 V)
Power Consumption	Operation current 40 mA Idle 35 mA	Operation current 40 mA Idle 35 mA	Operation current 5 mA, Idle 3 mA
Connector	Lemo 4 pin with locker	Lemo 4 pin with locker	Lemo 6 pin with locker
COMMUNICATION			
Interface	USB	USB	USB
Rate	115,200 bits/s	115,200 bits/s	115,200 bits/s
MECHANICAL & MATERIALS			
Service	H_2S	H_2S	H_2S
Outside Diameter	1.75" (44.5 mm)	1.56" (mm)	1.75" (44.5 mm)
Overall Length	82.5" (2,095 mm)	82.5" (2,095 mm)	67.0" (1,702 mm)
Housing Material	Inconel 718	Inconel 718	Inconel 718

PRESSURE MEASUREMENT	PPS71 PT	PPS71 PTS	PPS71 QUARTZ
Sensor Type	Piezo Silicon-Sapphire	Piezo Silicon-Sapphire	Quartz
Pressure Range	Up to 10,000 psi (1.75" OD)	Up to 10,000 psi (1.75" OD)	Up to 18,000 psi (1.75" OD)
Accuracy	± 0.03% FS	± 0.03% FS	± 0.02% FS
Resolution	0.0003% FS	0.0003% FS	< 0.01
TEMPERATURE MEASUREMENT			
Sensor Type	RTD (Pt1000; 4-wire)	RTD (Pt1000; 4-wire)	RTD (Pt1000; 4-wire)
Temperature Range	0 to 350 °C (1.75" OD)	0 to 350 °C (1.75" OD)	0 to 350 °C (1.75" OD)
Accuracy	± 0.5 °C	± 0.5 °C	± 0.5 °C
Resolution	0.01 °C	0.01 °C	0.01 °C
FLOW PROFILE			
Sensor Type	N/A	Reed switch/magnetic	Reed switch/magnetic
Spinner Range		5 – 7,000 RPM	5 – 7,000 RPM
Accuracy (>=20 RPS)		± 0.5 revolution	± 0.5 revolution
Accuracy (<20 RPS)		± 0.25 revolution	± 0.25 revolution
Resolution (>=20 RPS)		0.5 RPS	0.5 RPS
Resolution (<20 RPS)		0.1 RPS	0.1 RPS

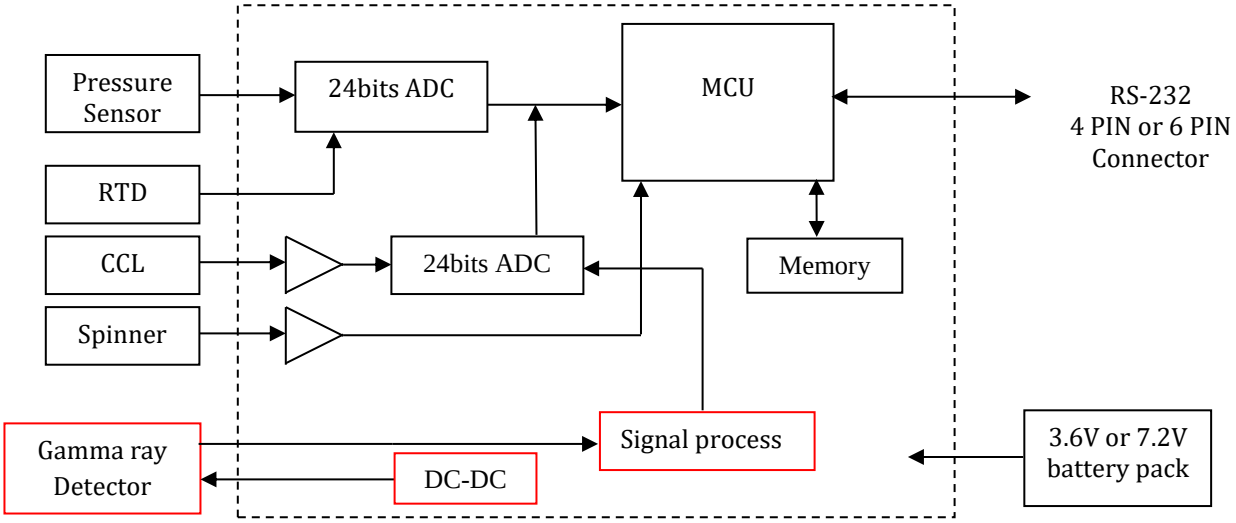
Flow Rate	Impeller	
	Pitch	Speed
LOW	3	x 1.67
	5	x 1
	10	x 0.5
HIGH	20	x 0.25
V (in/min) = N (RPM) x Impeller Pitch (in/rev)		

DATA STORAGE			
Sampling Rate	0.1 s – 1.8 hrs/per sample	0.1 s – 1.8 hrs/per sample	0.1 s – 1.8 hrs/per sample
Datasets	Time / Pressure / RTD	Time / Pressure / RTD / Flow Profile	Time / Pressure / RTD / CCL / Gamma / Flow Profile (Optional)
Memory Capacity	Six million datasets	Six million datasets	One million datasets
GAMMA RAY MEASUREMENT			
Sensor Type	N/A	N/A	Crystal, NaI(scintillation type)
Sensitivity			1.0 CPS/API
Maximum Logging Speed			66 ft/min (20 m/min)

ENVIRONMENTAL	PPS71 PT	PPS71 PTS	PPS71 QUARTZ
Module Temperature Rating	177 °C (351 °F) Standard housing 350 °C (662 °F) Flask (1.75" OD)	177 °C (351 °F) Standard housing 350 °C (662 °F) Flask (1.75" OD)	177 °C (351 °F) Standard housing, 350 °C (662 °F) Flask (1.75" OD)
Electronics Rating	177 °C (351 °F)	177 °C (351 °F)	177 °C (351 °F)
Downhole Time	4 hours at 350 °C (662 °F)	4 hours at 350 °C (662 °F)	4 hours at 350 °C (662 °F)
	6 hours at 300 °C (572 °F)	6 hours at 300 °C (572 °F)	6 hours at 300 °C (572 °F)
	8 hours at 250 °C (482 °F)	8 hours at 250 °C (482 °F)	8 hours at 250 °C (482 °F)
	10 hours at 200 °C (392 °F)	10 hours at 200 °C (392 °F)	10 hours at 200 °C (392 °F)
	12 hours at 180 ºC (356 °F)	12 hours at 180 ºC (356 °F)	12 hours at 180 ºC (356 °F)
POWER SUPPLY			
Operation Voltage	2.7 – 3.9 VDC	2.7 – 3.9 VDC	5.5 – 7.2 VDC
Battery	180 °C (356 °F) C-size Li-battery (5 A hr/3.6 V)	180 °C (356 °F) C-size Li-battery (5 A hr/3.6 V)	165 °C (329 °F) Two C size Li-battery (5 A hr/7.2 V)
Power Consumption	Operation current 5 mA, Idle 3 mA	Operation current 5 mA, Idle 3 mA	Operation current 50 mA Idle 35 mA
Connector	Lemo 6 pin with locker	Lemo 6 pin with locker	Lemo 4 pin with locker
COMMUNICATION			
Interface	USB	USB	USB
Rate	115,200 bits/s	115,200 bits/s	115,200 bits/s
MECHANICAL & MATERIALS			
Service	H_2S	H_2S	H_2S
Outside Diameter	1.75" (44.5 mm)	1.75" (44.5 mm)	1.75" (44.5 mm)
Overall Length	67.0" (1,702 mm)	67.0" (1,702 mm)	82.5" (2,095 mm)
Housing Material	Inconel 718	Inconel 718	Inconel 718

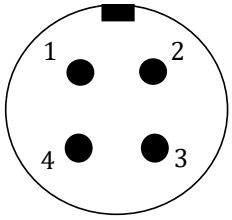
APPENDIX K: Diagram

PPS71 Circuit Block Diagram



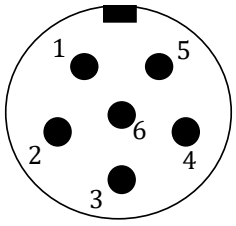
4-PIN Receptacle (PPS71 with Gamma)

PIN NUMBER	DESCRIPTION		
1	VCC	Power (Red)	7.2VDC
2	RX	Input (Blue)	TTL
3	TX	Output (Green)	TTL
4	GND	Ground (Black)	



6-PIN Receptacle (PPS71 without Gamma)

PIN NUMBER	DESCRIPTION		
1	VCC	Power (Red)	3.6VDC
2	GND	Ground (Black)	
3	TX	Output (Green)	TTL
4	VCC	Power (Red)	3.6VDC
5	GND	Ground (Black)	
6	RX	Input (Blue)	TTL



APPENDIX L: List of Images