Pioneer Petrotech Services Inc.

Smart Gauges and Simple Software

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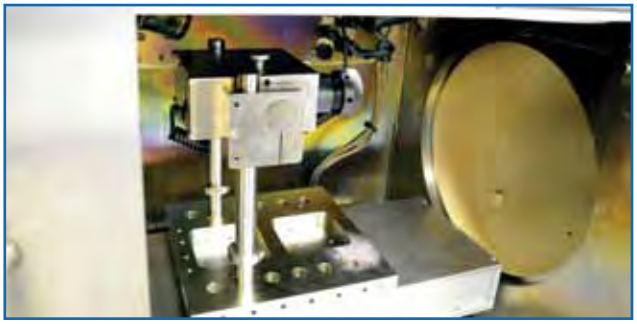
Company Profile

Pioneer Petrotech Services Inc. is headquartered in the beautiful city of Calgary, Alberta Canada. PPS also has regional offices in Algeria, China, Columbia, Indonesia, and Venezuela, as well as multiple international representatives. The company was first incorporated in 1999 as a manufacturer of downhole pressure and temperature measurement gauges. From this point forward PPS has become recognized as a global leader in research, development, and manufacturing of high quality downhole pressure and temperature gauges, surface data loggers, permanent downhole gauges, and geothermal logging tools.

Investing in Technology

PPS's lab and calibration facilities have always been world class, and as part of PPS's commitment to innovation and quality, an Electron Beam Welding Machine has been acquired. EB Welding is one of the best controlled, most robust welding processes which produces the highest quality welds. The better welds translates to more reliable and robust downhole tools.



EB Welding Machine

Quality Control

Recognizing the need for a comprehensive Quality System as part of all operations, PPS has established a program, which incorporates both a corporate Quality Manual and detailed quality control procedures. The quality system has been designed to comply with the requirements of the International Organization for Standardization ISO 9001, and PPS was certified in 2013.

"We strive to continually improve the effectiveness of our quality management system and our commitment to customer satisfaction by monitoring our performance against our established objectives and through leadership that promotes employee involvement."

Features of PPS Electronic Gauges

Robust under High Temperature and Extreme Well Conditions

Based on state-of-the-art technologies and production engineering, PPS products can work consistently for long periods of time under sour or corrosive conditions, high working temperatures of up to 350°C and high pressure environments. The innovative mechanical and electronic design also makes the gauges resistant to vibration and interference.

Easy to Operate with Simple-to-Use Software

PPS's proprietary software is very user friendly, whether your equipment needs SmartView, SmartLog or RemoteView. The user interfaces are very intuitive and makes interactions with the tool and data, from programming, downloading and reporting, seamless. The memory gauges contain large memory capacities so there is no need to reprogram the gauges after every run, unless you are using a different sample rate. All data files are in ASCII format.

Low Power Consumption and Long Battery Life

PPS gauges will work continuously over a long period of time utilizing low power consumption. One single C size Lithium battery pack will power some models for over one year at a 30 second sampling rate.

High Sensitivity and Accuracy

Piezo or quartz crystal transducers provide high sensitivity for accurate data acquisition.



PPS25 Silicon-Sapphire Memory Gauge

The **PPS25 Silicon-Sapphire Memory Gauge** measures bottomhole pressures and temperatures helping to evaluate productivity during many phases of well development including drilling, evaluation and production. One of the key advantages of the PPS25 is how easy it is to use from start to finish including programming, running a job and gauge maintenance. The SmartView software has a very user friendly interface, so operators with minimal experience can feel confident running the gauges and retrieving data. Also once the gauge is programmed with the desired sampling rates and durations, jobs can be run consecutively without needing to reprogram the gauge, saving time onsite.

Sensor Type	Silicon-Sapphire

Pressure

Range–psi	6K | 10K | 15K
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3

Temperature

Rating–°C	125 (257 °F) | 150 (302 °F) | 177 (350 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.01

Characteristics

Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.75 (19 mm) | 1.25 (32 mm)
Overall Length–inches	9.8 (248 mm) | 10.8 (274 mm)
Housing Material	Inconel 718 | Stainless Steel 17-4
Sampling Rate	1 sec to 18 hours per sample
Memory Capacity	2,000,000 data sets (4 million data sets optional)

Applications:

- **Pressure Build-up Tests**
- **Production Tests**
- **Pressure Gradients**
- **Pre/During/Post Stimulation Evaluation**
- **Interference Tests**
- **Fracturing Monitoring**
- **Injection Pressure Monitoring**
- **Coil Tubing Well Stimulation**

PPS25XM Critical Memory Gauge

The **PPS25XM Critical Memory Gauge** features an advanced Piezo pressure transducer, high temperature electronics technology and welded housing in order to maximize the gauge's performance in hostile well conditions from high concentration CO_2 or H_2S, to high pressure and high temperature. Additionally there are reinforced metal to metal seals securing the parts which prevents leaks, creating long term stability and reliability even in corrosive environments.

Applications:

- **Pressure Build-up Tests**
- **Pressure Gradients**
- **Pre/During/Post Stimulation Evaluation**
- **Interference Tests**
- **Fracturing Monitoring**
- **Drill Stem Tests**

Sensor Type	Piezo
Pressure	
Range–psi	10K | 15K | 20K | 25K | 30K
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Rating–°C	177 (350 °F) | 200 (392 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.01
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	1.27 (32 mm) | 1.375 (35 mm)
Overall Length–inches	17.8 (452 mm) | 20 (508 mm)
Housing Material	Inconel 718 | MP35N
Sampling Rate	1 sec to 18 hours per sample
Memory Capacity	2,000,000 data sets (4 million data sets optional)

PPS28 Quartz Memory Gauge

The **PPS28 Quartz Memory Gauge** has an integrated quartz pressure transducer and high temperature electronics making it highly accurate and stable, perfect for critical well testing. It is designed for applications where high quality data is required from a high temperature environment. The SmartView software which accompanies the gauge has a very user friendly interface, so operators with minimal experience with memory gauges can feel confident programming the gauges and retrieving data.

Sensor Type	Quartz

Pressure

Range–psi	10K | 16K | 20K | 25K
Accuracy–psi full scale	± 0.015% (Typically), ± 0.02%
Resolution–psi	<0.01
Drift–psi/year	<0.02% FS

Temperature

Rating–°C	150 (302 °F) | 177 (350 °F)
Accuracy–°C	± 0.2
Resolution–°C	<0.005

Characteristics

Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.75 (19 mm) | 1.27 (32 mm) | 1.375 (35 mm)
Overall Length–inches	24.8 (629 mm) | 25.2 (640 mm)
Housing Material	Inconel 718 | Stainless Steel 17-4 | MP35N
Sampling Rate	1s – 18hrs/per sample (0.1s – 1.8hrs/per sample optional)
Memory Capacity	2,000,000 data sets (4 million datasets optional)

Applications:

- **Pressure Build-up Tests**
- **Pressure Gradients**
- **Interference Tests**
- **Injection Pressure Monitoring**
- **Drill Stem Tests**
- **Production Tests**
- **Pre/During/Post Stimulation Evaluation**
- **Fracturing Monitoring**

PPS28-200°C Quartz Memory Gauge

The **PPS28-200°C Quartz Memory Gauge** integrates a hybrid quartz pressure transducer with PPS's proprietary leading-edge hybrid high temperature electronics module and metal-to-metal and elastomer sealing technology for reliability in extreme conditions. Thanks to the latest innovations in hybrid electronic technology gauge life is greatly extended at extreme temperature, an advantage that allows the PPS28 gauge to dependably perform at a maximum temperature of 200 °C (392 °F).

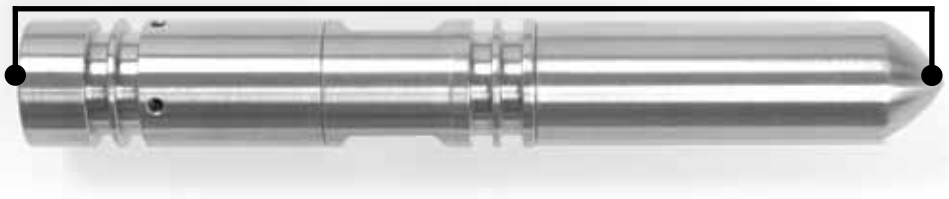
Applications:

- **Pressure Build-up Tests**
- **Pressure Gradients**
- **Interference Tests**
- **Injection Pressure Monitoring**
- **Drill Stem Tests**
- **Production Tests**
- **Pre/During/Post Stimulation Evaluation**
- **Fracturing Monitoring**

Sensor Type	Quartz
Pressure	
Range–psi	16K | 20K | 25K | 30K
Accuracy–psi full scale	± 0.015% (Typically), ± 0.02%
Resolution–psi	<0.01
Drift–psi/year	<0.02% FS
Temperature	
Rating–°C	200 (392 °F)
Accuracy–°C	± 0.2
Resolution–°C	<0.005
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.75 (19 mm) | 1.27 (32 mm) | 1.375 (34 mm)
Overall Length–inches	24.8 (630 mm) | 25.2 (640 mm)
Housing Material	Inconel 718 | MP35N
Sampling Rate	1s – 18hrs/per sample (0.1s – 1.8hrs/per sample optional)
Memory Capacity	2,000,000 data sets (4 million datasets optional)

PPS51 Short Memory Gauge

The **PPS51 Short Memory Gauge** is designed for applications with length limitations. The most common usage is for building this gauge into other downhole tools, such as water injection and plunger lift equipment. It is also used for general pressure surveys for gradient or build up tests. The gauge length is only 4.8 inches, including one half AA lithium battery pack. The same user-friendly SmartView software is used for programming, downloading and processing data.



Actual length 4.8”

Sensor Type	Silicon Sapphire
Pressure	
Range–psi	Up to 15 kpsi
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Rating–°C	150 (302 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.01
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.75 (19 mm)
Overall Length–inches	4.8 (122 mm)
Housing Material	Inconel 718 | Stainless Steel 17-4
Sampling Rate	1 sec. to 18 hours per sample
Memory Capacity	1,000,000 data sets

Applications:

- **Stimulation Monitoring**
- **Pipeline Monitoring**
- **Fracture Monitoring**
- **Injection Pressure Monitoring**
- **Perforation Monitoring**
- **Workover Monitoring**

PPS52 Skinny 1/2” OD Memory Gauge

The **PPS52 1/2” Outside Diameter Memory Gauge** is designed for applications with outside diameter challenges. The half inch outside diameter of this memory gauge allows users to run this tool in tight space conditions. The most common usage is for pressure and temperature measurement with small inner diameter coiled tubing.

Applications:

- **Coiled Tubing Operations**
- **Drill Stem Tests**
- **Gradient Survey**
- **Pressure Build Up**
- **Workover Monitoring**
- **Stimulation Monitoring**

Sensor Type	Silicon Sapphire
Pressure	
Range–psi	Up to 10 kpsi
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Rating–°C	150 (302 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.01
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.50 (12 mm)
Overall Length–inches	8.75 (222 mm)
Housing Material	Inconel 718 | Stainless Steel 17-4
Sampling Rate	1 sec. to 18 hours per sample
Memory Capacity	1,000,000 data sets

PPS55 Fast Sampling Gauge

The **PPS55 Fast Sampling Gauge** offers a great opportunity to catch sharp pressure changes, such as the pressure breaking point for reservoir fracturing or perforating operations. The gauge can record up to 500 data points per second. The large memory capacity of four million data points, allows operators to have sufficient downhole running time during job operations.

Sensor Type	Silicon Sapphire
Pressure	
Range–psi	Up to 15 kpsi
Accuracy–psi full scale	± 0.1%
Resolution–psi	0.005% FS
Drift–psi/year	<3
Temperature	
Rating–°C	150 (302 °F) | 177 (351 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.05
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	0.75 (19 mm) | 1.25 (31 mm)
Overall Length–inches	9 (228 mm) | 12 (304 mm)
Housing Material	Inconel 718 | Stainless Steel 17-4
Sampling Rate	Up to 500 data sets per second
Memory Capacity	4,000,000 data sets

Applications:

- **Stimulation Monitoring**
- **Injection Pressure Monitoring**
- **Perforation Monitoring**
- **Workover Monitoring**

PPS62 Pressure & External RTD Gauge

The **PPS62 Pressure & External RTD Gauge** combines a piezo sensor with a highly accurate RTD probe to allow users to obtain fast pressure and temperature responses. This product is primarily designed for detecting tubing and casing leakage problems. CCL can be added to the gauge for immediate measurement of temperature, pressure while locating casing collars. The gauge can be run in tandem with a depth measurement system, such as the PPS36 DepthWatcher which will enable the user to record line tension, speed and depth inconjunction with downhole data from the gauge.

Applications:

- **Stimulation Monitoring**
- **Pressure Build-up Tests & Gradients**
- **Production Tests**
- **Tubing and Casing Leakage Checking**
- **Interference Tests**
- **Injection Pressure Monitoring**
- **Coil Tubing Operation**
- **Monitor Artificial Lift Valve Efficiency**

Sensor Type	Peizo/RTD
Pressure	
Range–psi	10K | 15K
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Rating–°C	150 (302°F) | 177 (350°F)
Accuracy–°C	± 0.2
Resolution–°C	<0.01
Characteristics	
Service	H_2S Services
Power Source	Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature
Max OD–inches	1.27 (32 mm)
Overall Length–inches	22.3 (566 mm)
Housing Material	Inconel 718
Sampling Rate	1s – 18 hrs/per sample (0.1s – 1.8 hrs/per sample optional)
Memory Capacity	2,000,000 data sets

PPS63 RTD-CCL Memory Gauge

The **PPS63 RTD-CCL Memory Gauge** with its highly accurate RTD probe measures immediate temperature gradients while also measuring pressure and locating casing collars by CCL (casing collar locator). The gauge can be run in tandem with a depth measurement system, such as the PPS36 DepthWatcher which will enable the user to record line tension, speed and depth inconjunction with downhole data from the gauge.

Sensor Type	Peizo/RTD
Pressure	
Range–psi	10K | 15K
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Rating–°C	150 (302°F) | 177 (350°F)
Accuracy–°C	± 0.2
Resolution–°C	<0.01
Characteristics	
Service	H_2S Services
Power Source	2.7 - 3.9 VDC, Lithium Battery Pack
Communication	USB / RS232
Data Set	Time / Pressure / Temperature / RTD / CCL
Max OD–inches	1.5 (38 mm)
Overall Length–inches	33.5 (85 mm)
Housing Material	Inconel X-750 | Inconel 718
Sampling Rate	0.1 second to 1.8 hours per sample
Memory Capacity	1,000,000 data sets standard Larger memory optional

Applications:

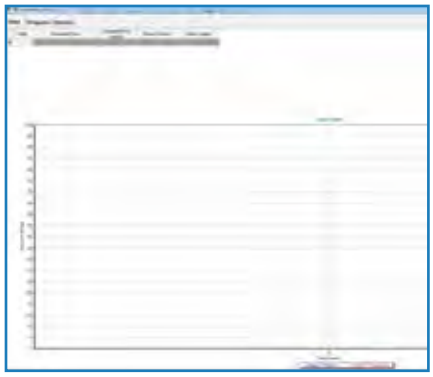
- **Locate tubing damage such as corrosion holes or leaks**
- **Locate small casing leaks**
- **Monitor the efficiency of artificial lift valve systems**
- **Record accurate static and flowing temperature readings**
- **Determine crossflow over multiple comingled intervals**

Memory Gauge Accessories

High Temperature Batteries

USB Gauge Interface Cable

Battery Tester



SmartView Software

Gauge Carrier

O-ring Grease

Carrying Case

O-rings

Crossovers

PPS26 Surface Read-Out Gauge

The **PPS26 Surface Readout (SRO) Gauge** is designed for real time sampling of pressure and temperature data for applications focused on production optimization, well stimulation or reservoir development. Due to the gauge's stability and strong transmission distance, the PPS26 can send data from downhole to surface through one single conductor wireline cable at well depths up to 7,000 meters.

Sensor Type	Silicon-Sapphire	Quartz
Pressure		
Range–psi	Up to 15 kpsi	Up to 20 kpsi
Accuracy–psi full scale	± 0.03%	± 0.02%
Resolution–psi	0.0003%	<0.01
Drift–psi/year	<5	± 0.02% FS
Temperature		
Rating–°C	150 (302 °F) | 177 (350 °F)	177 (350 °F) | 200 (392 ºF)
Accuracy–°C	± 0.5	± 0.2
Resolution–°C	0.01	<0.005
Characteristics		
Service	H_2S Services	H_2S Services
Power Source	+12 VDC/100 mA	+12 VDC/100 mA
Communication	USB / RS232	USB / RS232
Data Set	Time / Pressure / Temperature	Time / Pressure / Temperature
Max OD–inches	1.44 (36 mm)	1.44 (36 mm)
Overall Length–inches	8.26 (209 mm)	17.64 (448 mm)
Housing Material	Inconel 718 | SS17-4	Inconel 718 | SS17-4
Sampling Rate	1 sec per sample	1.5 sec per sample

Applications:

- **Pressure Build-up Tests**
- **Pressure Gradients**
- **Interference Tests**
- **Injection Pressure Monitoring**
- **Drill Stem Tests**

PPS58 Memory-SRO Combo Gauge

The **PPS58 Combo SRO-Memory Gauge** offers flexibility in gauge operations for customers who want to use the gauge in either memory working mode or surface read out mode. An SRO adapter is installed on the gauge to connect to a wireline cable head to be able to change the gauge from a memory tool to a surface read out tool. SmartView software is used for memory gauge applications and a PPS26 surface unit with PPS SRO software is used for SRO operations.

Applications:

- **Pressure Build-up Tests**
- **Pressure Gradients**
- **Production Tests**
- **Interference Tests**
- **Injection Pressure Monitoring**
- **Drill Stem Tests**
- **Pre/During/Post Stimulation Evaluation**
- **Fracturing Monitoring**
- **Coil Tubing Well Stimulation**

Sensor Type	Piezo	Quartz
Pressure		
Range–psi	Up to 20 kpsi	Up to 20 kpsi
Accuracy–psi full scale	± 0.03%	± 0.02%
Resolution–psi	0.0003%	<0.01
Drift–psi/year	< 3	< 0.02%FS
Temperature		
Rating–°C	150 (302 °F) | 177 (350 °F)	150 | 177 | 200 (392 °F)
Accuracy–°C	± 0.5	± 0.2
Resolution–°C	0.01	<0.005
Characteristics		
Service	H_2S Services	H_2S Services
Power Source	12 VDC | Lithium Battery	25VDC/30mA | Lithium Battery
Communication	USB / RS232	USB / RS232
Data Set	Time / Pressure / Temperature	Time / Pressure / Temperature
Working Mode	Memory or SRO	Memory or SRO
Max OD–inches	1.44 (36 mm)	1.44 (36 mm)
Overall Length–inches	11.4 (290 mm)	30.4 (772 mm)
Housing Material	Inconel 718 | SS 17-4	Inconel 718
Sampling Rate	1 sec to 18 hours per sample	1 sec to 18 hours per sample
Memory Capacity	2,000,000 data sets	2,000,000 data sets

PPS27 Permanent Downhole Monitoring Systems

Overview

PPS27 permanent downhole monitoring systems have multiple levels of gauges and surface data acquisition units (SDAU) to choose from. This equipment can be used for diverse applications from low pressure CBM wells to extremely corrosive wells with high concentration carbon dioxide [CO_2] and/or hydrogen sulphide [H_2S].

PPS can also provide all the accessories necessary for intelligent well completions. This includes gauge carriers, downhole cable, cable protectors, cable head and wellhead outlets.

Premium, Elite & LPLT Series

Customers can choose from single to multi-drop permanent gauge completions with an option of gauge reading tubing pressure or annulus pressure. All of PPS's state-of-the-art downhole tools incorporate industry leading sensors, innovative electronic components, and an electron beam welded housing design.

The Premium Series offers peizo silicon-sapphire downhole electrical gauges that record point measurements of pressure, temperature and/or vibration. They are rated up to 10,000 psi [68,947 kPa] and 125˚C [257˚F], however higher ratings are available by request.

The Elite Series offers highly accurate quartz downhole electrical gauges that record point measurements of pressure and temperature. They are rated up to 25,000 psi [172,369 kPa] and 200˚C [392˚F], and additional pressure and temperature ranges are available upon request.

The low pressure low temperature LPLT Series offers quarz downhole electrical gauges with the high accuracy and resolution associated with quartz gauges at a mid-range cost. They are rated up to 10,000 psi [68,947 kPa] and 130˚C [266˚F].

There are different SDAU configurations to choose from, including SmartWatcher Touch which provides instant data trending and charting or SmartWatcher II which makes it possible to connect up to four wells—with a maximum of four gauges per well—and therefore a total of 16 gauges communicating to the surface unit.

Analog Series

The **PPS27 Analog Series** is specifically designed for low cost permanent low pressure, low temperature monitoring and remediation monitoring. Using 4-20mA output and integrated cable head, this option can provide high quality data, with easy installation and no need for additional surface monitoring

Benefits:

- **Analyze draw-down and build-up pressure transients to enhance production**
- **Increase asset management by enabling a deeper understanding of reservoir performance and optimization**
- **Acquire pressure and temperature information without requiring well intervention**

PPS27 Permanent Downhole Monitoring

equipment. Overall the design is based on the Premium Series of peizo silicon-sapphire gauges, but modified to provide a reliable and effective alternative for applications below 3,000 psi and 110˚C.

27XM Thermocouple Series

PPS27XM Thermocouple Series is for extreme high temperature applications such as those experienced in thermal oil recovery, like Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation (CSS) as well as other geothermal applications.

The main components of the PPS27XM are a pressure sensor, thermocouple sensor(s), pressure chamber and surface unit. With no electronics downhole, thermocouple monitoring is robust, versatile and doesn't experience electromagnetic interference, providing high accuracy data acquisition.

System Applications

- Production optimization
- Injection monitoring
- CO_2 injection monitoring
- Observation well monitoring
- Pump system monitoring
- Well testing without additional equipment
- Intelligent completions
- Pressure build-up surveys without additional equipment

Elite Series
Quartz Gauges

Sensor	Quartz
Pressure Ranges*–psi	10K | 16K | 25K
Temperature Range*–°C	150 | 177 | 200
Service	H_2S / CO_2 Services

* Additional pressure and temperature ranges available upon request

Premium Series
Piezo Gauges

Sensor	Piezo
Pressure Ranges*–psi	6K | 10K
Temperature Range*–°C	20 to 125
Vibration Sensor	MEMS Accelerometer
Service	H_2S / CO_2 Services upon request

* Additional pressure and temperature ranges available upon request

LPLT Series
Quartz Gauges

Sensor	Quartz
Pressure Ranges–psi	5K | 10K
Temperature Range–°C	20 to 130
Service	H_2S / CO_2 Services upon request

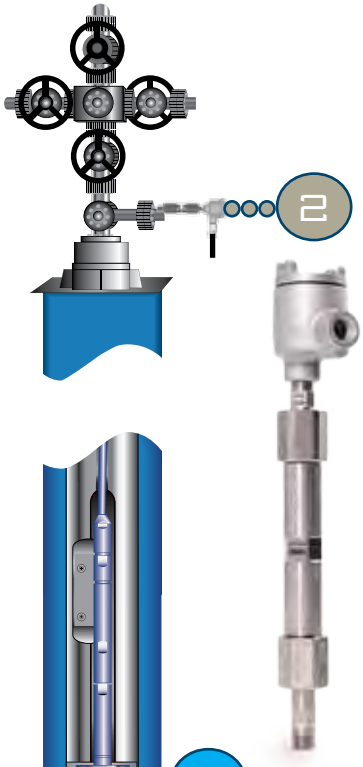
Analog Series
Silicon Sapphire Gauges

Sensor Type	Silicon-Sapphire
Pressure Range–psi	0 to 3K psi
Temperature Range–°C	20 to 110

XM Series
Thermocouple(s)

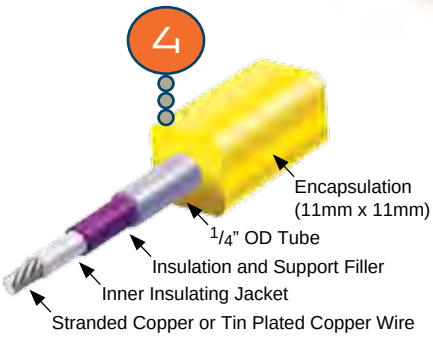
Pressure Sensor Type	Capillary sensor
Temperature Sensor Type	Thermocouple(s)
Temperature Range	0 to 300 °C (or higher)
Pressure Range	0 to 3 kpsi (up to 10kpsi if required)

PPS27 PDMS Diagram



System Components:

1. Surface Data Acquisition Unit
2. Wellhead Outlet
3. Cable Protectors
4. Electric Downhole Cable
5. Gauge Carrier
6. Downhole Gauges



PPS27 PDMS Surface Units

SmartWatcher

PPS SmartWatcher is a data acquisition unit available in multiple configurations for downhole data interfacing, processing and logging. This system has a modular structure that connects to multiple gauges with a single cable (maximum four downhole gauges) and supports Modbus/RTU communication. The modular structure allows for maximum flexibility with unit expansion for different applications, enhanced reliability in harsh environments, independent mobility for unit improvement, upgrades and certification, and convenience for production and unit maintenance.

SmartWatcher II

This is the most advanced SDAU that PPS offers, because it is able to have up to four wells communicating to it. Each well can have a maximum of four gauges connected for a total of 16 gauges communicating with the SmartWatcher II unit. Other features include internal memory, an SD card, Modbus/Push data port via RS485 or RS232, AC & DC power entries, and solar station availability. The electronics are enclosed in a NEMA-4 box with a large viewing window so that data reading and system status can be monitored without opening the door. The unit is compatible with PPS's online remote monitoring.

SmartWatcher Touch

SmartWatcher Touch surface data acquisition unit provides a convenient touch screen for viewing real time numeric data or graphical representations of the data. Two channels of pressure, one channel of temperature and three axes of vibration can all be displayed at the same time. The samples that are displayed are simultaneously saved to text files which can later be extracted to a standard USB memory drive.

PPS27 PDMS Accessories

Gauge Carrier

PPS gauge carriers are designed for long term reliability with pressure testable metal to metal seals and can be configured for single, dual and Y-splice gauges. Materials are available to meet any type of downhole environment, such as 4140, 4150, 13CrL80, SN95, 1925 or Super 13 Chrome. The carrier is machined from one solid block of material and complies with API 5CT guidelines.

Permanent Downhole Cable

The standard cable that PPS uses is suitable for high pressure, high temperature environments. The cable has ¼-inch outside diameter steel outer cable and can be either SS316 or Alloy825. Other features of this cable include:

- Maximum pressure up to 20,000 PSI
- Temperature rating up to 150˚C or 200˚C based on material and environment
- Tensile rating >1 tonne typical
- Conductor 18AWG stranded wire

Cable Head & Cable Splice

The cable head and cable splice have multiple metal to metal seals and are pressure testable in the field. The cable head has rotation and vibration protection built in. The specifications are:

- ¼” tube cable with max OD 0.875”
- SS316 / Inconel718
- Pressure Rating 25,000 PSI
- Temperature Rating 0 to 200 °C

PPS27 PDMS Accessories

Cable Protectors

Cable protectors are used across the tubing joints to protect the cable from mechanical damage. Customers can choose from iron cast or cannon style protectors. Iron cast protectors are recommended due to their exceptional longitudinal and rotational slippage resistance (Longitudinal > 5 tonnes, Rotational > 3 tonnes), and crush resistance (~ 4 tonnes).

Wellhead Outlet

The wellhead outlet is a device that is used to connect downhole cable to the surface data acquisition system. Its primary purpose is to provide wellhead pressure control upon cable termination. It has metal to metal seals, accepts one conductor and can accommodate most flanged connections.

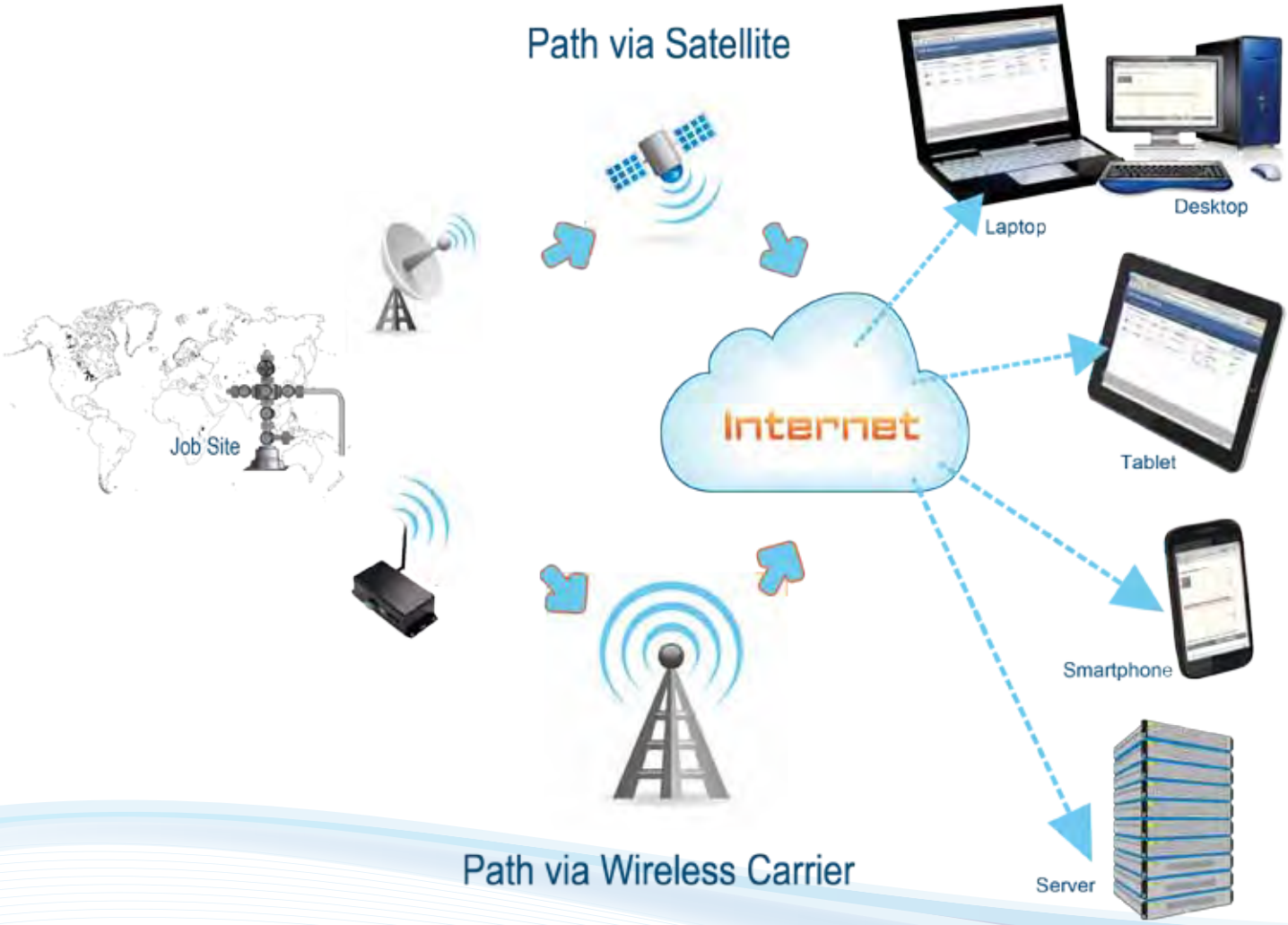
PPS Software

SmartWatcher software allows for system configuration and diagnostics. It has full Modbus support and displays data in real time as needed. Data can also be downloaded from an SD card and flash memory.

SmartGate Remote Data Monitoring System

In applications where it is critical to have access to real time data, SmartGate provides a convenient solution. At the job site a surface unit is setup to communicate via a wireless internet gateway. Then customers can use SmartGate's web-based platform, to access and download real time data as needed. Data from the tools is also stored in the SDAU's or logger's memory and on secured servers at the PPS headquarters in Calgary, designated solely for PPS clients.

The SmartGate system is capable of sending alert emails and text messages to registered users, if the data received from the tools moves outside of the acceptable parameters created on setup. Users can also change the alarm settings and sampling rates of the connected device, if changes need to be made to ensure optimum operations. This gives client's peace of mind knowing their job site is being monitored day and night.



PPS31 Wellhead Pressure Logger

The **PPS31 Wellhead Pressure Logger** is a programmable gauge that samples pressure and temperature providing real time monitoring. The logger has a highly viewable LCD display where data can be read and also has built in memory. The intrinsically safe design means this logger can be used in hazardous areas.

Applications:

- **Gas Wellhead Build-up Tests**
- **Stimulation Monitoring**
- **Pipeline Monitoring**
- **Fracture Monitoring**
- **Wellhead Monitoring**
- **Injection Pressure Monitoring**
- **Perforation Monitoring**
- **Workover Monitoring**

Sensor Type	Silicon-Sapphire
Pressure	
Range–psi	Up to 15 kpsi
Accuracy–psi full scale	± 0.03%
Resolution–psi	0.0003%
Drift–psi/year	<3
Temperature	
Sensor Rating–°C	-20 (-4 °F) to 70 (158 °F)
Accuracy–°C	± 0.5
Resolution–°C	0.01
Environmental Temperature–°C	-40* (-40 °F) ~ 70 (158 °F)
Characteristics	
Service	H_2S/CO_2 Services (available upon request)
Power Source	Lithium Battery Pack
Data Set	Time / Pressure / Temperature
Data Receiving Mode	Wireless (915 MHz, ISM)
Wireless Transmission Distance	328’ (100 m)
Transmission Power	+10 dbm
Overall Length–inches	10 (254 mm)
Work Mode	MRO / SRO
Sample Rate	1 sec to 18 hours per sample
Memory Capacity	2,000,000 data sets
Connection	1/2” NPT/Autoclave
Safety Rating	Class I, Division 1, Exia IIC T4, CE Marking (-40 °C~55 °C)

* LCD Display environmental temperature is -20 °C~ 70 °C

PPS33 RemoteWatcher

PPS33 RemoteWatcher is a low-power multi-sensor monitoring system designed for applications that require simultaneous multipoint pressure, differential pressure, temperature and/or flow monitoring. The system is highly adaptive and cost effective. Customers can choose from multiple sensor and surface unit configurations based on the number of sensors needed and the transmission distance required.

Application Solutions

The logger–sensor configuration allows customers to use one logger and up to six sensors as a network. The logger acts as a central stand-alone node, receiving data from the sensors. The logger is capable of displaying real-time data on an LCD screen, storing data into an SD card plus internal memory, and supporting MODBUS communication.

The router–sensor solution, on the other hand, allows customers to use a router and up to 60 sensors as a network. The router is capable of transferring data to a computer and other devices, through USB and RS232/485 communication.

The Gateway–sensor configuration allows customers to use the PPS Gateway and up to 16 sensors as a network. The Gateway is capable of transferring data to a computer and other devices, through USB and and RS232/485 communication. The Gateway also has a 2 GB (15,000,000 samples at 60 sec/sample) SD memory card as backup in the unlikely event of a power interruption.

The Gateway–sensor surface unit configuration allows customers to use the PPS Gateway and up to 16 sensors as a network, with the key difference being the LCD display with keypad and 16 real time status indicators. This allows customer to easily monitor sensor readings from the display panel, as well as check each sensor's signal strength and battery remaining. The status indicators clearly show which sensors are online or offline.

	System Configuration	Sensors Supported	Transmission Distance	Power Source	Sensor Safety Rating	SDAU Safety Rating	Interface	Sample Rate
PPS33	Sensors + Logger	6	100 m Zigbee® Standard or 1.1 km Zigbee® Pro*	Two lithium size D batteries	Class 1 Div 1 Ex ib IIB T4 Gb	Ex d IIB T5 Gb	USB/RS232 /RS485	1 to 120 sec/sample
PPS33	Sensors + Router	60	100 m Zigbee® Standard or 1.1 km Zigbee® Pro*	5V(USB) or DC 9-32 V	Class 1 Div 1 Ex ib IIB T4 Gb	N/A	USB/RS232 /RS485	1 to 120 sec/sample
PPS33LR	Sensors + Gateway	16	7 km*	5V(USB) or 9-28VDC	Designed for Class 1 Div1 (Ex ia IIB T4 Ga)	N/A	USB/RS232 /RS485	1 to 60 sec/sample
PPS33LR	Sensors + Gateway Surface Unit	16	7 km* or 15 km with high gain antenna * unobstructed line of sight	9-28VDC, 90-260VAC optional solar power station	Designed for Class 1 Div1 (Ex ia IIB T4 Ga)	N/A	MODBUS TCP/IP | PPS Remote Data Access | Wireless Repeater	1 to 60 sec/sample

PPS33 RemoteWatcher Sensors

PPS33 Wireless Sensors

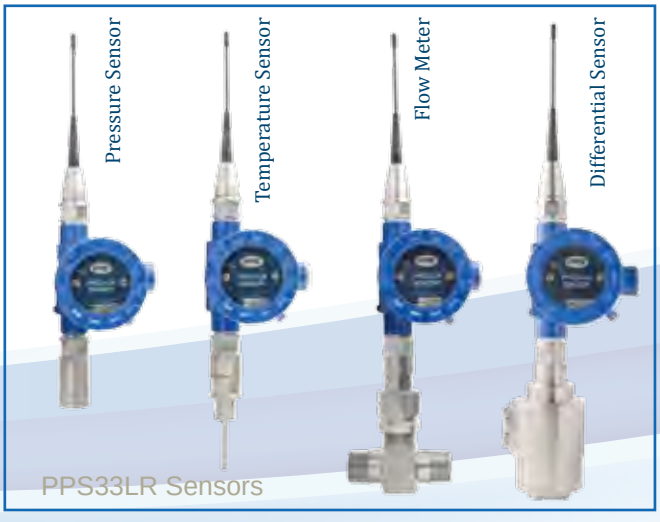
Sensor	Pressure (P+T) Sensor	Temperature Sensor	Turbine Flow Sensor	Differential Pressure Sensor
Sensor Type	Silicon-Sapphire	RTD	Turbine	Silicon-Sapphire
Range	1K | 3K | 5K | 10K psi*	-50°C to 200°C	15-1500 pulse/sec	Line: 2.9kpsi; Diff: 290 psi
Service	H_2S/CO_2 Services			
Environmental Temperature	-40 °C (-40 °F) to 70 °C (158 °F)			
Safety Rating	Class I Div 1 (Ex ib IIB T4 Gb)			
Battery Type	Lithium Size C 3.6V			
Connection	1/2" NPT | Autoclave			
Wireless Transmission Distance	100m Line of Sight (328ft) Standard | 1.1km (0.68 mile) Optional Pro Version			
Transmission Power	+1 dBm Standard / +10 dBm Optional Pro			

*Other pressure ranges available upon request

PPS33LR Wireless Sensors

Sensor	Pressure (P+T) Sensor	Temperature Sensor	Turbine Flow Sensor**	Differential Pressure Sensor
Sensor Type	Silicon-Sapphire	RTD	Turbine	Silicon-Sapphire
Range	5K | 10K | 15K psi*	-50°C to 200°C	15-1500 pulse/sec	Line: 2.9kpsi; Diff: 290 psi
Service	H_2S/CO_2 Services			
Environmental Temperature	-40 °C (-40 °F) to 70 °C (158 °F)			
Battery Type	Lithium Size D 3.6V			
Safety Rating	Designed for Class I Div1 (Ex ia IIB T4 Ga)			
Connection	1/2" NPT (others by request)		1" NPT	1/8" NPT Female
Wireless Transmission Distance	7 km Line of Sight | 15 km with high gain antenna			
Transmission Power	+24dBm (250mW) Software selectable			

* Other pressure ranges available upon request
** Transmitter limits only



PPS33 RemoteWatcher Surface Units

	Logger	Router	Gateway	Gateway Surface Unit
Environmental Temperature	-40°C to 70°C**	-40°C to 80°C	-40°C to 70°C	-40°C to 70°C
Power Source	Two size D Lithium batteries	DC 9-32 V	DC 9-32 V	DC 9-32 V
Battery Life–@ 60 sec sample rate	Up to 2 years	N/A	N/A	N/A
Sample Rate	1 sec to 120 sec/sample	1 sec to 120 sec/sample	1 sec to 120 sec/sample	1 sec to 120 sec/sample
Dimension–inch	5.7 X 4.625 (OD)	5.9 x 3.2 x 2	6.3 x 6.2 x 3.19	6.3 x 6.3 x 3.19
Safety Rating	Ex d IIB T5 Gb (-20°C to 55°C)	N/A	N/A	N/A
Data Set	Time/Pressure/ Temperature/Flow Rate	Time/Pressure/ Temperature/Flow Rate	Time/Pressure/ Temperature/Flow Rate	Time/Pressure/ Temperature/Flow Rate
Interface Types	USB/RS485	USB/RS232/RS485	USB/RS232/RS485	USB (RemoteView Software) RSRS232/RS485 (Modbus/Push)
Wireless Transmission Distance	100m Standard or 1.1km Pro	100m Standard or 1.1km Pro	7 km (unobstructed line of sight) or 15 km with high gain antenna	7 km (unobstructed line of sight) or 15 km with high gain antenna

* LR stands for PPS33 long range sensors
** LCD Display environmental temperature is -20 °C ~ 70 °C

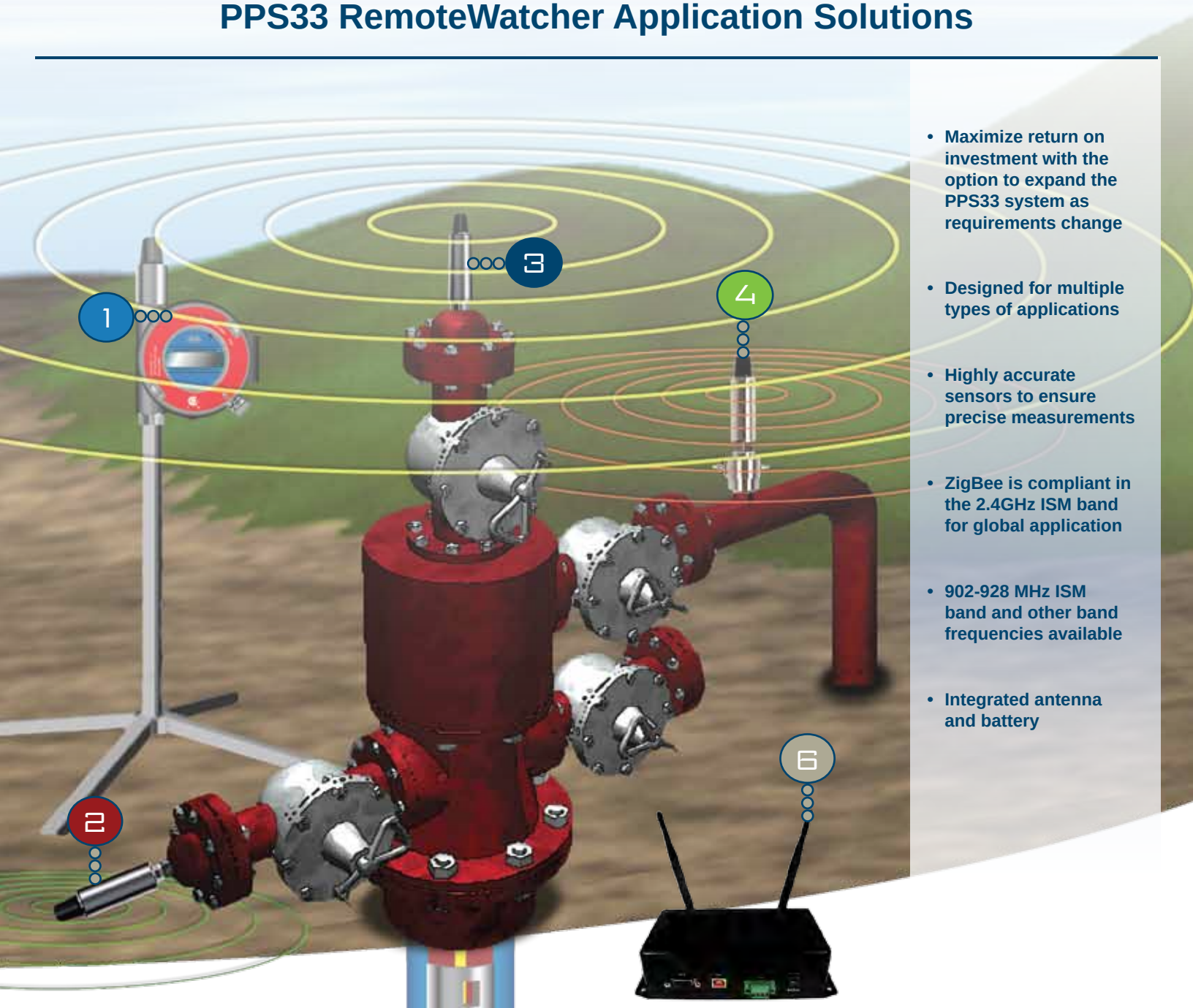
Logger

Gateway Surface Unit

Gateway

Router

PPS33 RemoteWatcher Application Solutions

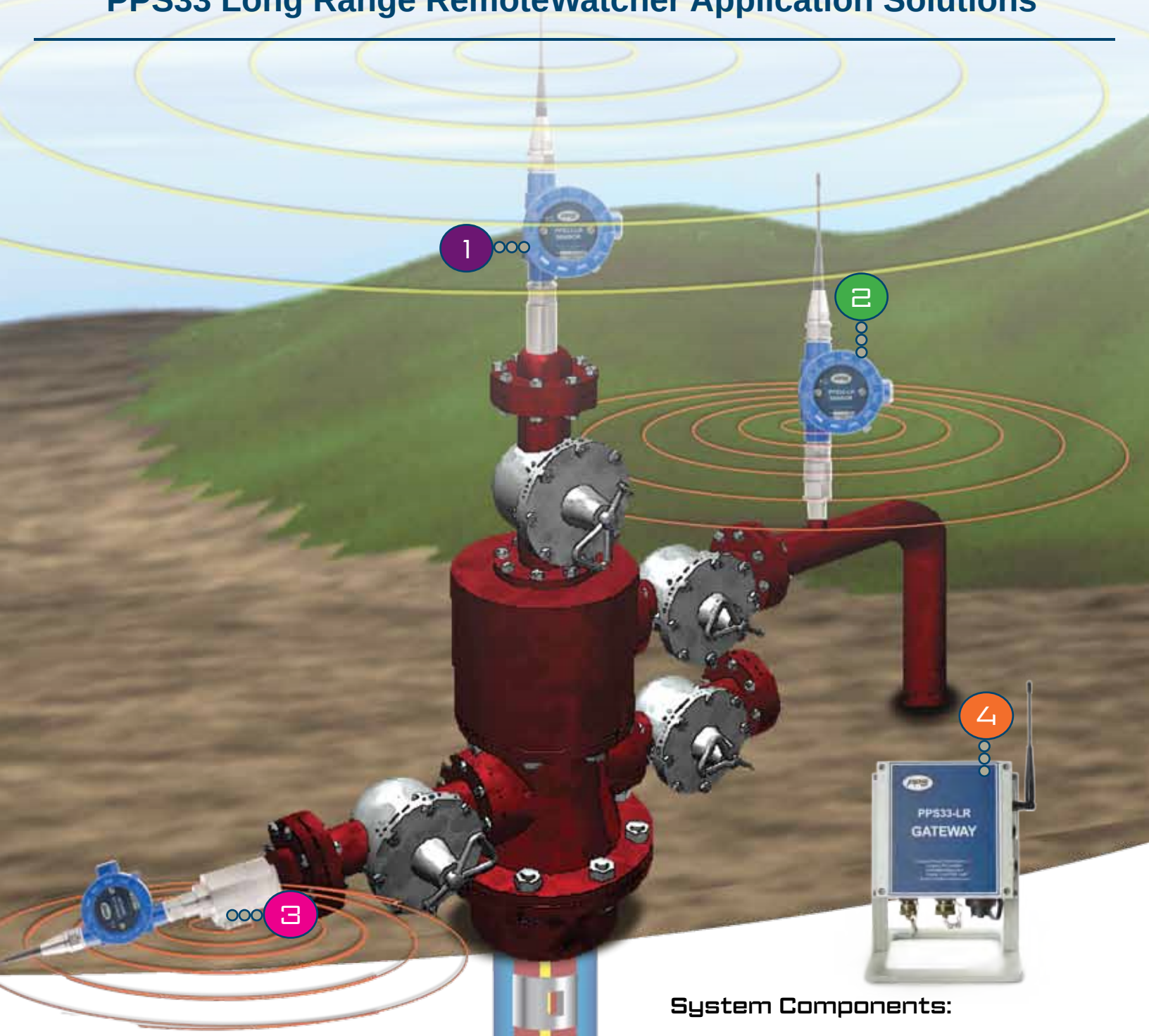


- Maximize return on investment with the option to expand the PPS33 system as requirements change
- Designed for multiple types of applications
- Highly accurate sensors to ensure precise measurements
- ZigBee is compliant in the 2.4GHz ISM band for global application
- 902-928 MHz ISM band and other band frequencies available
- Integrated antenna and battery

System Components:

1. Wireless Logger
2. Temperature Sensor
3. Pressure Sensor
4. Differential Sensor
5. Flow Sensor (Not Shown)
6. Router (Optional)

PPS33 Long Range RemoteWatcher Application Solutions



System Components:

1. LR Temperature Sensor
2. LR Pressure Sensor
3. LR Differential Sensor
4. PPS Gateway
5. LR Flow Sensor (Not Shown)
6. PPS Gateway System (Not Shown)

ESPLink Monitoring & Control System

The **ESPLink electric submersible pump monitoring system** can measure pressure, temperature, pump motor operating parameters, and vibration on the x, y and z axes. One of the key advantages of the PPS system is the high level of accuracy and resolution provided for all measurements.

A gauge is placed underneath the ESP motor in line with the completion string and can measure all or some of the following parameters depending on the gauge chosen; intake pressure and temperature, discharge pressure, motor y-point voltage, current leakage, motor winding/oil temperature and vibration (x, y, z). The discharge pressure is routed through a pressure tube.

Vibration analysis, properly done, allows the operator to evaluate the condition of pumps and avoid failures. By using three axes of vibration as a leading indicator of ESP health, operators can recognize issues and plan preventative maintenance before the pump is damaged beyond repair. This allows for accurate forecasting regarding preventative pump maintenance and helps increase ESP longevity.

Having the ability to control the pump is essential to maintaining optimum pump lifting efficiency. Using ESPLink operators can monitor intake and discharge pressure, as well as set parameters for the minimum and normal dynamic fluid level, and the critical and normal motor temperature. When these values are entered into the monitoring system, commands will be sent to the VFD to either stop or restart the pump when these specific levels are reached.

Accurate measurement of static and dynamic well parameters (intake pressure and temperature) on a multi-well reservoir can also enable reservoir engineers to update the reservoir model and perform transient analysis.

Touch System (ST)

LCD System (SL)

ESPLink Gauge

ESPLink Monitoring & Control System

Surface Touch System (ST)

Memory capacity	8 GB
MODBUS RS485	3 Wire Standard
Operating System	4.0 Android Operating System
Display	10.1” Colour Touchscreen
Power	110V to 240V AC
Operating Temperature	- 10 °C to 65 °C (14 °F to 149 °F)

Surface LCD System (SL)

Memory capacity	4 GB
MODBUS RS485	3 Wire Standard
Relay Output	2 x Form C, 250V AC, 10A, Configurable
Display	20 x 4 LCD character display
Power	110V to 240V AC
Operating Temperature	- 40 °C to 85 °C (- 40 °F to 185 °F)

ESPLink-4 Downhole Gauge

	Rating	Accuracy	Resolution
Pressure (Intake)	6,000 psi	0.05 % FS	0.02 psi
Current Leak	25 mA	0.05 % FS	1 uA
Temperature (Intake | Motor)	150 °C | 210 °C	0.67 % FS	0.01 °C

ESPLink-7 Downhole Gauge

	Rating	Accuracy	Resolution
Pressure (Intake)	6,000 psi	0.05 % FS	0.02 psi
Vibration (x, y, z)	12 g	0.5 % FS	2 mg
Current Leak	25 mA	0.05 % FS	1 uA
Temperature (Intake | Motor)	150 °C | 210 °C	0.67 % FS	0.01 °C

ESPLink-9 Downhole Gauge

	Rating	Accuracy	Resolution
Pressure (Intake | Discharge)	6K psi | 6K psi	0.05 % FS	0.02 psi
Vibration (x, y, z)	12 g	0.5 % FS	2 mg
Current Leak	25 mA	0.05 % FS	1 uA
Y-Point Voltage	1,000 V	10 V	5 V
Temperature (Intake | Motor)	150 °C | 210 °C	0.67 % FS	0.01 °C

ESPLink Gauge

PCPLink Monitoring & Control System

The **PCPLink (progressive cavity pump)** monitoring system provides real time downhole pressure measurements and the full vibration spectrum of three axes creating a snapshot of whether PCP is operating within optimum parameters. The SmartWatcher Touch surface unit was specifically designed to provide a convenient interface for viewing real time numeric data or graphical representations of the data.

By using vibration as a leading indicator of equipment health, operators can recognize issues and plan preventative maintenance thereby protecting and increasing pump longevity. As well pressure data can prompt operators to vary the pump speed, maximizing pump efficiency and production, all while maintaining bottom-hole pressure.

Having the ability to control the pump is essential to maintaining optimum pump lifting efficiency. Using PCPLink operators can monitor pressure, and temperature. Using these values, alarms can be setup for monitoring and control of the pump.

Pressure

Pressure Sensor	Dual Silicon-Sapphire
Pressure Range–psi	6K
Accuracy–full scale	± 0.03%
Resolution–psi @ 1sec	0.02

Temperature

Temperature Range–°C	20 to 125
Accuracy–°C	± 0.5
Resolution–°C @ 1sec	0.01

Vibration

Vibration Sensor	MEMS Accelerometer
Measurement Range	± 12g
Resolution	2.9 mg

Other Characteristics

Service	H_2S/CO_2 Services upon request
Maximum OD–inches	1.125
Data Set	Time / Pressure 1 & 2 / Temperature / Vibration
Housing Material	Inconel 718/SS316

System Applications

- Dual pressure monitoring provides information on PCP operating conditions
- Diagnose and plan PCP maintenance to prevent system failure and reduce pump down time.
- Increase pump lifting efficiency while controlling the pump operating time

PPS36 DepthWatcher

The **PPS36 DepthWatcher** is a portable depth recorder that runs on batteries or external power and has an LCD display that an operator can use to see the actual depth, speed, and tension during a slickline job. The recorder can be set up using a very simple menu or by connecting to a PC. It can be operated on a stand alone mode (Memory) or on a real time mode (SRO) with the use of a PC to display depth, speed, tension and two additional channels. It is also equipped with three additional 4-20mA channels for measuring other wellhead parameters.

Characteristics

Depth Accuracy	±0.3 ft. (0.1 m)
Display	LCD Graphic Display (320 x 240)
Memory	48 MBytes
Power Input Voltage	6 - 28 VDC, 200 mA at 12 VDC or Lithium Battery Pack
Sampling Rate	0.1 second to 1.8 hours
Encoder	+5 V Optical Encoder (512 pluses per rev. or better)
External Channels	3 × 4 - 20 mA
Depth Alarm	Up to 8 w/Close to Surface Alarm
Speed Alarm	One
Tension Alarm	One
Dimensions–inches	4.30 (H) × 7.90 (W) × 9.10 (L)
Weight	8 lbs
Operating Temperature	-20 °C (-4 °F) to 70 °C (158 °F)
Communication	USB 2.0 (Type–B Port)
Data Transfer Rates	Up to 1.8 MBits/second
Enclosure Type	NEMA 4

Applications:

- **Slickline Depth Recorder**
- **Coiled Tubing Depth Recorder with Customized Adapter**
- **Wireline Depth Recorder**

PPS71 Geothermal Tools

Components:

1. Casing Collar Locator
2. Gamma Ray Detector
3. Temperature Sensor
4. Pressure Sensor
5. Spinner
6. Bowspring Centralizer (Optional)
7. Flask Housing (Regular housing is also available)
8. SRO interface between the tool and the field laptop
9. SRO module
10. Depth Recorder (PPS36 for example - optional)

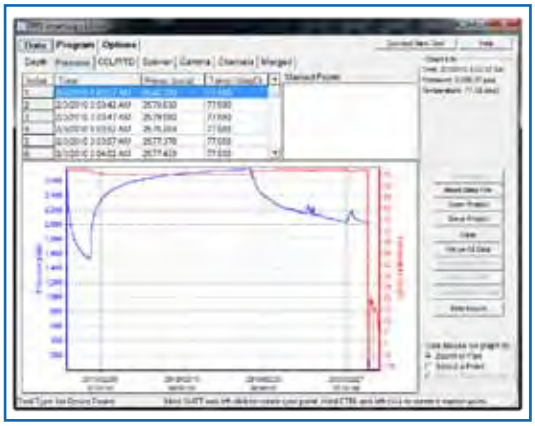
PPS36 DepthWatcher
(Depth, Speed, Time, Tension Recorder)

PPS71 Geothermal Tools are designed for extreme, high temperature downhole conditions. The robust electronics combined with vacuum flask technology allow this product to perform at 350 °C (662 °F) continuously, for four hours.

By combining the downhole measurements with a depth recorder, such as PPS's DepthWatcher (PPS36), customers have the capability to create synchronized profile logs.

SmartLog, PPS's proprietary software, creates temperature and pressure profiles based on depth that can be opened in any commercial logging software.

For more information on the PPS71 Tools, and to discover the best configuration of this tool for specific applications, please contact PPS.



PPS SmartLog Software

PPS71 Geothermal Tools

Specifications

Pressure Sensor	Piezo Silicon-Sapphire
Pressure Range	Up to 10,000 psi
Pressure Accuracy	± 0.03% FS
Pressure Resolution	0.0003% FS
Temperature Sensor	RTD (Pt1000; 4-wire)
Temperature Range	0 to 350 °C (662 °F)
Temperature Accuracy	± 0.5 °C
Temperature Resolution	0.01 °C
Flow Sensor	Reed switch/magnetic
Spinner Range	5 – 7,000 RPM
Spinner Accuracy	± 0.5 revolution - ± 0.25 revolution
Spinner Resolution	0.5 RPS - 0.1 RPS
Gamma Sensor	Crystal, NaI
Gamma Sensitivity	1 CPS/API

Other Characteristics

Data Sampling Rate	0.1 s – 1.8 hrs/per sample
Datasets	Time/Pressure/RTD/Flow Profile/CCL/Gamma Ray
Memory Capacity	1,000,000 datasets
SRO Module Sampling Rate	0.1 s – 1.8 hrs/per sample
SRO Module Communication Distance	7000 meters
SRO Interface Temperature Rating	-40 °C (-40 °F) to 85 °C (185 °F)
SRO Interface Power Source	100 – 240VAC
Interface	USB 2.0
Service	H2S
Operating Temperature Rating	177 °C (350 °F) Standard 350 °C (662 °F) Flask
Outside Diameter	1.56” (39 mm) / 1.75” (44 mm)
Overall Length	67.0” (1,702 mm) - 109.5” (2,781mm)
Material	Inconel 718/BeCu

PPS71 Geothermal Logging Tool

Features:

- **Fast data transfer @10samples/sec**
- **Features 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**
- **Advanced customer support with online maintenance and software tutorials are available**
- **Can be used as regular temperature tool with regular housing (up to 177°C)**
- **Data is always saved in downhole tool as backup when running in SRO mode**
- **The tool automatically recognizes bidirectional flow**

PPS PulseLink MWD Tool

The PPS **positive mud pulse MWD tool** was developed by Pioneer Petrotech in order to address the needs of customers engaged in horizontal and directional drilling. It provides the following survey/directional measurements: inclination, azimuth, dip angle, high-side/magnetic tool face, earth gravity and magnetic field.

Other measurements; gamma ray and PVT (pressure, vibration, temperature), come in compact modules that can be added or subtracted from the tool as needed.

PPS's unique down-hole coding and surface detection methods ensure the integrity of the real-time data from loss and disruption. A downhole vibration detection circuit provides real time data to the surface, visually displaying vibration levels for the operator, so they can change drilling parameters to protect the MWD tool. Also the overcurrent monitor will shut the pulser down if any overcurrent conditions are detected.

The retrievable and reseatable MWD tool can be operated over a wide flow rate range in collar sizes from 3-¾" (95.2 mm) outside diameter (OD) to 9-½" (241.3 mm) OD. If operations require, the tool can be retrieved and replaced by wireline due to its small diameter, allowing for cost-effective tool replacement.

The robust and ultra-compact design of the Driller Display Unit makes for easy placement on the drill floor. The transflective display screen and LED backlighting provide excellent viewability under all ambient light conditions.

The powerful and easy to use surface software provides MWD tool configuration, tests, diagnosis and data management. Digital signal processing in the software ensures that pulse detection is efficient over a wide range of drilling conditions.

PPS PulseLink MWD Tool

MWD Software

Technical Specifications

Collar OD–inches	3.75 (95.20-mm)	4.5 (114.30-mm)	6.5 (165.10-mm)	8 (203.20-mm)	9.5 (241.30-mm)
Tool Connections–inches	3.5 IF (88.90-mm)	4.0 IF (101.60-mm)	4.5 IF (114.30-mm)	6.625 Reg (158.80-mm)	7.625 Reg (197.17-mm)

Tool OD–inches	1.875
Shock	1,000 g, 0.5 mSec, half-sine
Vibration	20 g RMS, 15-500 Hz
Pressure Rating	20,000 psi @ 150 °C (137,900 kPa @ 300 °F)
Temperature Rating	150 °C (302 °F); 175 °C (347 °F) available upon request
Lost Circulation Material (LCM)	Up to 50 lbs/bbl (23 kg/bbl) evenly mixed medium nut plug
Maximum Sand Content	1.0%
Tool Length	At least 19.1 ft (5.82 m); dependent on configuration
Flow Rate Range	130 to 1060 Gallons/Minute
Power Source	Lithium Battery
Operating Time	200+ hours; dependent on configuration

Survey/Directional Measurement Parameters

Tool Face Update Rate	9 seconds
Short Survey Time	Minimum 95 seconds
Long Survey Time	Minimum 120 seconds
Measurement State	No sliding or rotation allowed when taking measurements
Survey While Drilling	Sliding - Yes / Rotating - Yes

Surface System Specifications

Driller Display Unit Operating Range	-30 °C to 75 °C (optional -40 °C to 50 °C)
Display Unit Screen	Viewable in direct sunlight and dim evening light
	8” (w) x 13” (h) x 2-1/2” (d)
Pressure Detector Range	0 ˜ 6,000 psi
Pressure Detector Data Transmission	CAN bus

Directional Specifications

	Range	Sensor Accuracy	Resolution
Inclination	0 ˜ 180 °	± 0.1 °	0.04 °
Azimuth	0 ˜ 360 °	± 0.5 °	0.09 °
Tool Face	0 ˜ 360 °	± 1 °	0.70 °
TMF	0 ˜ 76 µT	± 0.003 µT	0.074 µT
GT	0 ˜ 1.100 g	± 0.003 g	0.001 g
Dip	-90 ° ˜ +90 °	0.3 °	0.1°
Gamma Ray	0 ˜ 300 API	± 5%	1.53 API
Pressure	0 ˜ 20,000 psi	± 0.05%FS psi	0.61 psi
Temperature	0 ˜ 175 °C	± 1 °C	0.59 °C

PPS PulseLink LWD Resistivity Tool

Compensated Resistivity Measurements

Frequency	Measurement	Range	Accuracy
2 MHz	Phase Difference All Spacings	0.1–4,000 ohm-m	±2% [0.1–25 ohm-m] ±0.5 mmho/m [above 25 ohm-m]
	Attenuation Near Spacing	0.1–300 ohm-m	±2% [0.1–25 ohm-m] ±1.0 mmho/m [above 25 ohm-m]
	Attenuation Far Spacing	0.1–500 ohm-m	±2% [0.1–25 ohm-m] ±1.0 mmho/m [above 25 ohm-m]
400 kHz	Phase Difference All Spacings	0.1–4,000 ohm-m	±1% [0.1–25 ohm-m] ±1.0 mmho/m [above 25 ohm-m]
	Attenuation Near Spacing	0.1–300 ohm-m	±1% [0.1–25 ohm-m] ±2.0 mmho/m [above 25 ohm-m]
	Attenuation Far Spacing	0.1–500 ohm-m	±1% [0.1–25 ohm-m] ±2.0 mmho/m [above 25 ohm-m]

Transmitter / Receiver Spacings

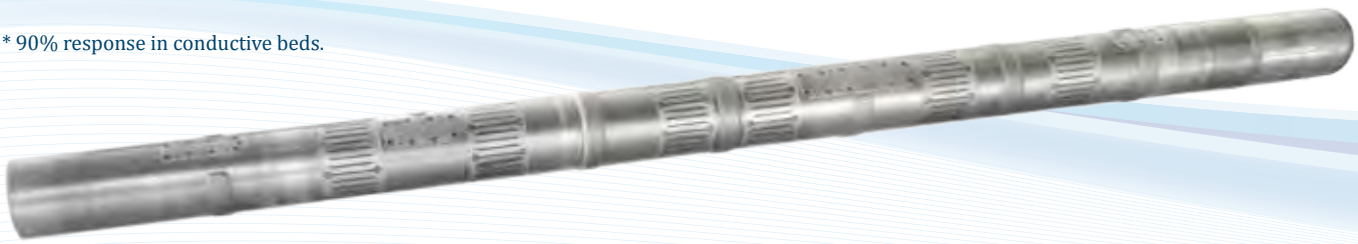
Measure Point

	UH					DH
	T_1	T_2	R_1	R_2	T_3	T_4
in.	-36.00	-22.50	-4.25	+4.25	+22.50	+36.00
mm	-914.4	-571.5	-107.9	+107.9	+571.50	914.4

Depth of Investigation, Vertical Resolution

R_f = 1 ohm-m R_{xo} = 0.5 ohm-m	Depth of Investigation		Vertical Resolution*
	Short Spacing Radius	Long Spacing Radius	
2 MHz Phase Difference	21 in. (533 mm)	28 in. (711 mm)	8 in. (203 mm)
400 kHz Phase Difference	30 in. (762 mm)	39 in. (991 mm)	12 in. (305 mm)
2 MHz Attenuation	34 in. (866 mm)	44 in. (1,118 mm)	8 in. (203 mm)
400 kHz Attenuation	52 in. (1,321 mm)	66 in. (1,676 mm)	12 in. (305 mm)
R_f = 10 ohm-m R_{xo} = 0.5 ohm-m	Depth of Investigation		Vertical Resolution**
	Short Spacing Radius	Long Spacing Radius	
2 MHz Phase Difference	26 in. (660 mm)	37 in. (940 mm)	8 in. (203 mm)
400 kHz Phase Difference	36 in. (914 mm)	49 in. (1,245 mm)	12 in. (305 mm)
2 MHz Attenuation	40 in. (1,016 mm)	53 in. (1,346 mm)	8 in. (203 mm)
400 kHz Attenuation	60 in. (1,524 mm)	76 in. (1,930 mm)	12 in. (305 mm)

* 90% response in conductive beds.



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Smart Gauges and Simple Software

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