

### Self-Powered Intelligent Data Retrieval (SPIDR®) System

# The SPIDR® System delivers accurate downhole pressures without the cost, risk, and hassle of downhole gauges!

Unique SPIDR technology measures and converts wellhead pressures to bottom-hole pressures for determining skin, permeability,  $P^*$ , and more.

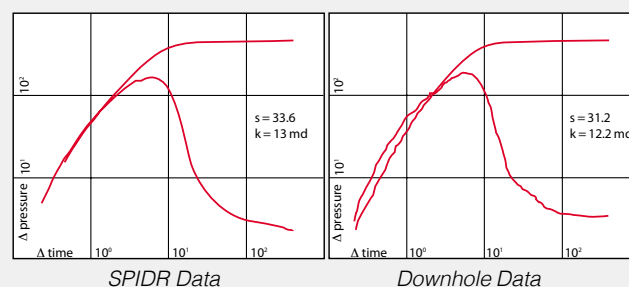
## ACCURATE DOWNHOLE PRESSURES WITHOUT THE COST AND RISK OF RUNNING DOWNHOLE GAUGES



The SPIDR® system is used for pressure-transient testing without the cost and risk of running gauges downhole. The SPIDR acquires high resolution pressure data at the wellhead during flowing and shut-in, which is then converted to bottomhole conditions using proprietary models. The conversion is accurate for wells that have no standing liquid column. The validity of the SPIDR system has been proven on thousands of wells all over the world for more than 25 years.

Because the SPIDR system is nonintrusive, it can be used to test wells where downhole gauges are impractical: highly deviated wells, horizontal wells, wells with tubing restrictions, sour-gas wells, high-pressure wells, and wells with high bottomhole temperatures.

### SPIDR Data is Equivalent to Downhole Data



These pressure-derivative plots are from an 18,000-ft (5,500-m), hot, high-productivity well in the Eugene Island area of the Gulf of Mexico. Both a SPIDR system and downhole gauges were used to test the well.

### Basic Formation Properties to Full Reservoir Analysis

After wellhead pressures are converted to bottomhole pressures, the pressure/flow data can be used for any type of reservoir study. For medium- to high-permeability formations, a 3-day test is typically sufficient to calculate basic near-bore and reservoir properties, including skin, permeability, and  $P^*$ . Longer tests that track pressure changes to reservoir boundaries can be used to calculate reservoir size, as well. SPIDR data is compatible with commercial production software packages that demand high-frequency/high-resolution pressure and rate data.

Proprietary SPIDR software generates all of the plots needed for reservoir analysis, including Horner plots, pressure-derivative plots, Miller-Dyes-Hutchinson plots, and AOF curves.

### Take Advantage of Shut-Ins to Check Well Performance

Scheduled well or platform shut-ins (due to weather or maintenance issues) are a great opportunity to capture pressure data for reserves estimation and for estimating skin across the completion. Because the SPIDR system is portable and easily transported offshore via helicopter, it can be mobilized immediately with a phone call to Halliburton. SPIDRs can be used to acquire buildup data for calculating skin, permeability, and  $P^*$ . Unscheduled



The 9-lb (4.1-kg) SPIDR test kit includes everything you need to test: the SPIDR, a tee fitting to install below the tree cap-pressure gauge, and oil-filled capillary tubing to connect the SPIDR to the tee. Also included are instructions and a prepaid Federal Express return shipping label.



Because the SPIDR is connected to the wellhead, it acts as its own surface readout (SRO) system, allowing anyone with a laptop to communicate with it. A key benefit is that tests can be terminated early if data indicates that the test objectives have been achieved. This allows the well to be returned to production ahead of plan, often generating sufficient revenue to pay for the cost of the test.

shut-ins also present opportunities because the SPIDR system can be used to conduct a drawdown test when the well is returned to production, providing essentially the same information as a buildup test.

### How a SPIDR System Rental Works

SPIDR test kits are available for both short and long term well testing and surveillance. The kit includes a SPIDR, a coil of oil-filled stainless-steel capillary tubing, a tee fitting for installation below the tree cap-pressure gauge, instructions, and a prepaid return shipping label. The SPIDR test kit can be ready to ship within an hour of receiving a request.

At the well site, simply unpack the SPIDR and connect it to the well. It takes only a few minutes with an adjustable wrench to install and commence testing. The SPIDR operates unattended, measuring and recording wellhead pressures with the option to automatically adjust the data storage rate to that of pressure change. The SPIDR can also accommodate two external transducers, allowing simultaneous monitoring of other test variables, such as flow rate, temperature, and pressure. External transducers are powered by the SPIDR, but may be located several hundred feet away.

When the test is finished, remove the SPIDR and fittings and pack it all in the original shipping carton, affix the prepaid shipping label, and return the kit to us. You also can download or view the test data at any time without interrupting recording or erasing any data. This data can be sent to Halliburton engineers for immediate analysis.

Once we have received the data from the test, we convert the wellhead pressures to downhole conditions and provide a text file of wellhead pressures, flow rates, bottomhole pressures, elapsed time, delta time and delta pressure, diagnostic plots, and analysis. We can provide both traditional pressure transient analysis and G-Function analysis of pre-fracture injection tests.

### Unsurpassed Measurement Accuracy and Precision

The SPIDR measures pressure with accuracy, precision, and repeatability. Its internal pressure transducer is a shear-mode, quartz-crystal resonator whose frequency changes with pressure. A second quartz crystal provides temperature compensation, which, with the physical isolation of the SPIDR from the well bore, ensures that the pressure data is unaffected by temperature changes in the well and its surroundings.

In addition to accuracy, the SPIDR has a 1-second sample rate and a resolution of 0.01 psi (68.95 Pa), which allow it to track fast pressure transients and detect small pressure changes. This precision is necessary to test high permeability wells and to perform pre-frac tests on low permeability wells.

## WELL PERFORMANCE TESTS

### Buildup Test

*To determine important reservoir properties, such as wellbore damage (skin), reservoir permeability, reservoir boundaries, and reservoir geometry.*

A buildup test requires the well to be shut-in after producing for an extended time at a stable rate. It is one of the most common pressure-transient test because it is simple to conduct. A buildup test of insufficient duration can lead to incorrect interpretation of reservoir properties.

The SPIDR is used for buildup tests when there is no liquid column in the wellbore. If an external pressure transducer is connected to the annulus prior to shut-in, packer integrity can be evaluated as described in the Packer Leakage Test (below). If there is uncertainty as to the presence of a liquid column, a two-rate test should be used.

### Two-Rate Test

*To obtain most of the same information as a Buildup Test, but without a shut-in (often performed when there might be a liquid column in the wellbore).*

The Two-Rate Test requires the flow rate of the well to be changed after an extended stable flow period, allowing pressure to decay naturally. Flow rate must remain at a rate sufficient to continuously unload produced fluids. Flow rates and wellhead pressures before and after the change must be monitored closely. The SPIDR can simultaneously measure flow rates and wellhead pressures when installed as shown at right.

### Drawdown Test

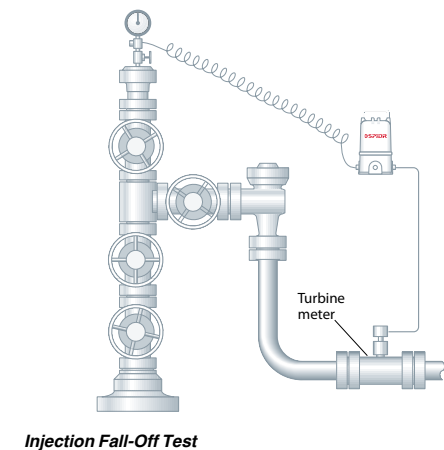
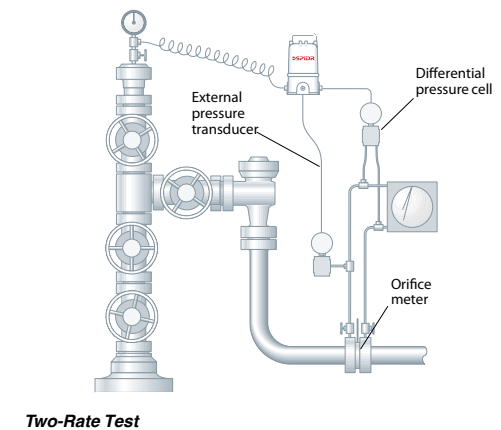
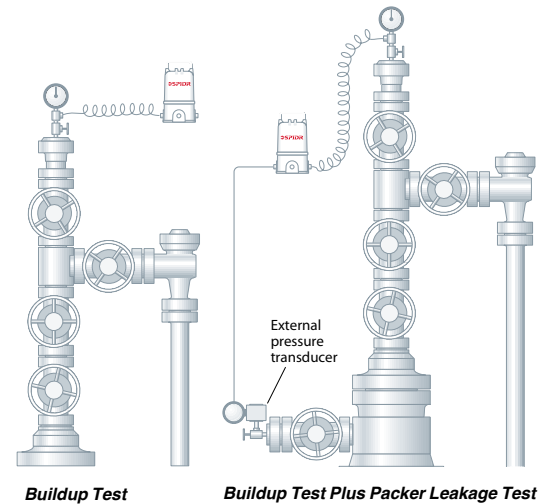
*Same purpose as Buildup Test, plus reservoir limits.*

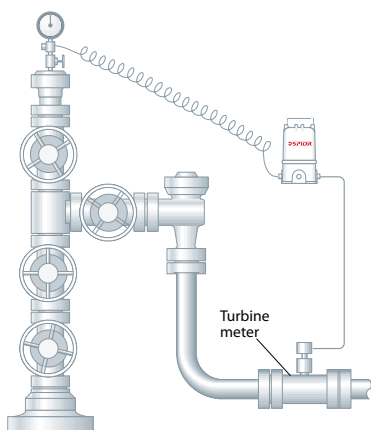
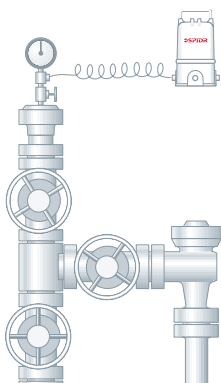
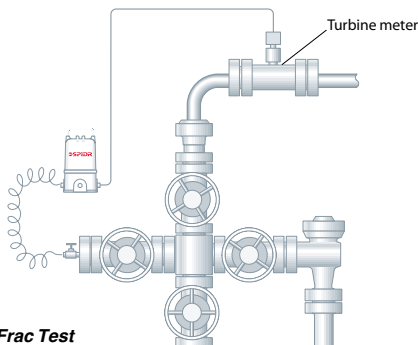
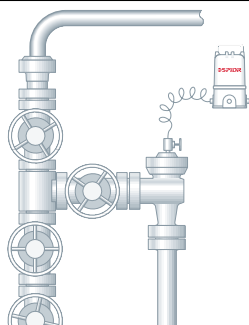
The test is run by producing the well through a constant choke setting after an extended shut-in period, or by doubling the rate if the well is already producing. An extended Drawdown Test can be used to identify reservoir boundaries and geometry. Extended Drawdown Tests allow a reservoir model to be created, tested, and modified until it matches the actual performance of the reservoir.

### Injection Fall-Off Test

*To determine the magnitude of “skin” and reservoir permeability around the wellbore.*

Skin may result from the accumulation of foreign matter screened or filtered by the sand face from the injected fluid. This test is similar to the Buildup Test in that the change in wellhead pressure is monitored after flow is interrupted.



**Step-Rate Test****Well Communication Test****Pre-Frac Test****Frac Monitoring**

## Step-Rate Test

*For injection wells, to determine the maximum injection rate possible without fracturing the reservoir.*

The test is conducted by recording injection pressure and injection rate at several increasing injection rates. When an increase in injection rate does not result in a proportionate increase in injection pressure, fracture pressure has been reached. Injection rates are monitored with a turbine flowmeter connected to the SPIDR. SPIDR software is used to plot injection rates, cumulative injected volume, and pressure as a function of time. Packer and tubing integrity may also be evaluated during the test by monitoring the casing pressure with an external pressure transducer.

## Well Communication Test

*For planning enhanced recovery schemes or determining which wells are producing from the same reservoir.*

The flow from one of the two wells is interrupted while the pressure in the other wells is monitored for a detectable pressure response. The time required to observe a pressure response is a function of the magnitude of the pressure pulse generated, the distance between the wells, the permeability of the reservoir, and the resolution of the pressure gauge. A communication test that requires 100 hours using a gauge with 1-psi (6.89 kPa) resolution requires only 6 hours using a SPIDR with its 0.01-psi (68.95-Pa) resolution. No external transducers are required for this test.

## STIMULATION PLANNING AND EXECUTION

### Pre-frac Injection Fall-Off Test (DFIT)

*To economically determine pore pressure, permeability, and other critical characteristics of multiple low-permeability zones in order to optimize frac design. Also called Minifrac, Fluid Efficiency Test (FET), Mini Fall-Off Test (MFO), and Diagnostic Fracture-Injection Test (DFIT).*

The SPIDR's high-resolution pressure recording (0.01 psi / 68.95 Pa) is ideal for this application. A small amount of KCl is pumped at fracture rates until breakdown occurs. The volume of fluid pumped is closely monitored. At this point, the pumps are stopped; the pressure is allowed to "fall-off" naturally and is recorded at high frequency. This test can be used to calculate pore pressure, permeability, in-situ stress, formation/fluid efficiency, fracture toughness, leakoff coefficients, and near wellbore effects can be determined. The acquisition of permeability and pressure play a crucial role in optimizing fracture design and predicting rates. The SPIDR can also be used to record injection rate and volume during these tests.

### Frac Monitoring

*To determine the pressure at which fracturing occurs and monitor offset wells for frac interference*

The SPIDR can monitor the fracturing process at wellhead pressures up to 30,000 psi (207 MPa). The SPIDR is unaffected by pulsations of high-pressure, multistage pumps, and is isolated from proppants added to the frac fluid. The



SPIDR can remain on the well for long periods after the frac job is completed to monitor pressure.

The SPIDR is ideally suited to monitor pressure on offset wells during a frac. The SPIDR can be left unattended on offset wells for months at a time to watch for interference effects. Multiple SPIDRs can be installed to provide real-time monitoring of interference effects during your frac.

## REGULATORY COMPLIANCE

### Initial/Annual “Bottomhole” Survey

For single-phase gas wells or for gas/condensate wells that are above the dew point at the surface, many regulatory agencies (state and federal) allow the use of SPIDR data in lieu of running downhole gauges. This is especially the case if the well is deviated, high-pressure, high-temperature, sour, or has acid gas. To find out if your well would be a candidate for surface testing, contact your regulatory agency.

### Packer Leakage Test

*To verify isolation of the annulus from the tubing in a single completion well or in a dual-completion well to verify that each zone is isolated from the other and that both zones are isolated from the annulus.*

This test is frequently required by regulatory agencies. To perform a packer leakage test, attach the SPIDR to the annulus, and monitor casing pressure for changes while you flow the well at several different rates.

### Deliverability Test

*Commonly used by gas producers, gas purchasers, and regulatory agencies for estimating a well's sustainable production rate. Also called Multi-Point, Four-Point, and Absolute Open-Flow Potential (AOF) testing. Each state has its own specific requirements for performing deliverability tests.*

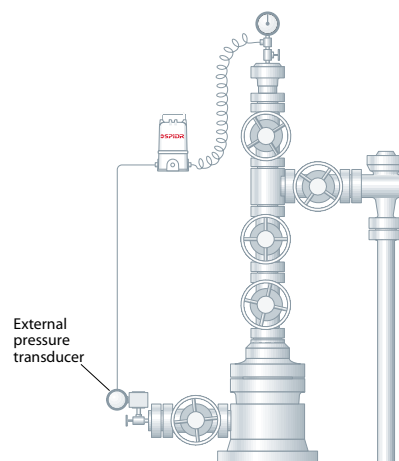
This test determines the flowing-wellhead pressure as a function of flow rate. It requires the measurement of wellhead pressure at a minimum of two stable flow rates. The SPIDR and two external transducers are connected to the wellhead and meter-run as shown at bottom right.

## FLOW MEASUREMENT

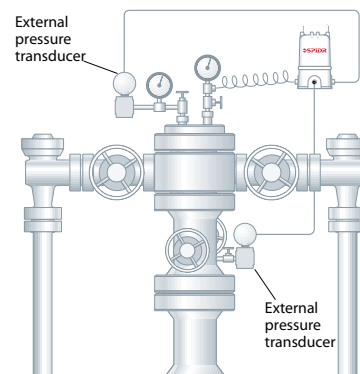
### Gas Meter Prover

*The SPIDR is used as a precision flowmeter or meter prover.*

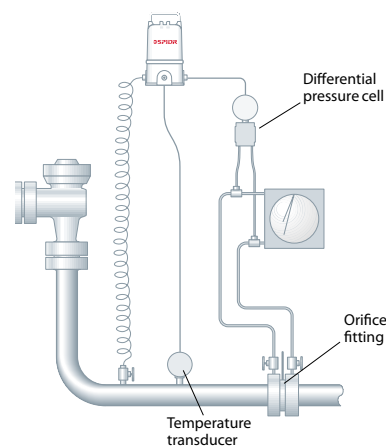
The SPIDR's ability to record line pressure, differential pressure, and gas temperature with high speed and high accuracy is unmatched. The SPIDR can collect pressure, temperature and rate at 1 sample per second for over 30 days. Each individual flow reading includes, in addition to date and time, the differential pressure, line pressure, and temperature. The SPIDR software can be used to generate a plot of rate versus time and a table of cumulative production for any time interval.



**Packer Leakage Test, Single Completion**



**Packer Leakage Test, Dual Completion**



**Test, Gas Meter Prover**

## SPIDR Specifications

<b>Full-Scale Pressure</b>	15,000 psi (103 MPa) or 30,000 psi (207 MPa)
<b>Resolution (Internal Transducer)</b>	0.01 psi (68.95 Pa)
<b>Repeatability</b>	≤0.01% of full scale
<b>Hysteresis</b>	≤0.01% of full scale
<b>Linearity</b>	≤0.01% of full scale
<b>Accuracy</b>	≤0.01% of full scale
<b>Thermal Compensation</b>	Indicated pressures unaffected by ambient temperature changes within the operating ambient temperature range of 15°F to 180°F (-26°C to 82°C)
<b>Maximum Memory Capacity</b>	9,000,000 data sets in single-channel mode 4,500,000 data sets in two-channel mode 3,000,000 data sets in three-channel mode
<b>External Transducers</b>	Excitation: 5V @ 5 mA DC Signal: 0.8 to 3.2V Available for pressure, differential pressure, temperature, and turbine flowmeters
<b>Resolution (External Transducers)</b>	1/2,000 Example: 6,000 psi (41.37 MPa) has a resolution of ~3 psi (0.02 MPa)
<b>Communications Interface</b>	USB, RS-232, INSITE®, Wireless Radio, Internet
<b>Power Supply</b>	3 alkaline “D” cells; life of 9 million samples or 2 years
<b>Pressure Fitting</b>	6,000 and 10,000 psi (41.3 and 68.95 MPa), 1/2-in. NPT, 30,000 psi (207 MPa) Autoclave
<b>Dimensions, L×W×H</b>	5-3/4 in. × 5-3/4 in. × 9 in. (146 mm × 146 mm × 229 mm)
<b>Weight</b>	8.5 lb (3.8 kg)
<b>Housing</b>	Modified cast-aluminum Class 1, Group D enclosure with chemical-resistant finish
<b>Programmable Sample Logic</b>	Data storage rate controlled by programmable sample interval and pressure window
<b>Fastest Sample Rate</b>	One per second
<b>CSA-Certified “Intrinsically Safe”</b>	
<b>ATEX-Certified</b>	
<b>Certified for Sour Service</b>	



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