

Proteus

Electrohydraulic flow control and monitoring system



Rated to 7,500 psi
[52 MPa]



Rated up to 325 degF
[163 degC]



Compatible with Agiliti*
modular digital completions

APPLICATIONS

- Multizone intelligent completions, including those with limited wellhead or packer penetrations

BENEFITS

- Enables optimization of well performance by reducing unwanted water and gas production
- Enhances dynamic reservoir characterization through periodic zonal tests without need for interventions
- Eliminates costs and risks of well interventions by using surface-controlled chokes
- Improves production or injection sweep
- Simplifies installation by minimizing the number of control lines
- Additionally enables operation of surface-controlled ball valve without additional hydraulic lines

FEATURES

- Modular system design
- Multiple choke positions, including fully open and fully closed
- Contingency mechanical shift mechanism
- Real-time zonal pressure and temperature (PT) measurements
- High unloading pressure differential for high-rate wells
- System preassembly and testing at the manufacturing plant
- Real-time data analysis and interpretation using WellWatcher Advisor* real-time intelligent completion software

Proteus* electrohydraulic flow control and monitoring system is an integrated modular unit that enables operators to simplify well design, reduce installation complexity, increase downhole control, and efficiently optimize production.

Integrated system

The system combines a Universal Electrohydraulic Module, field-proven flow control valve, single or dual PT gauges, and an optional absolute position sensor in a single compact assembly. The unit is controlled from surface using a powerful, user-friendly operating system.

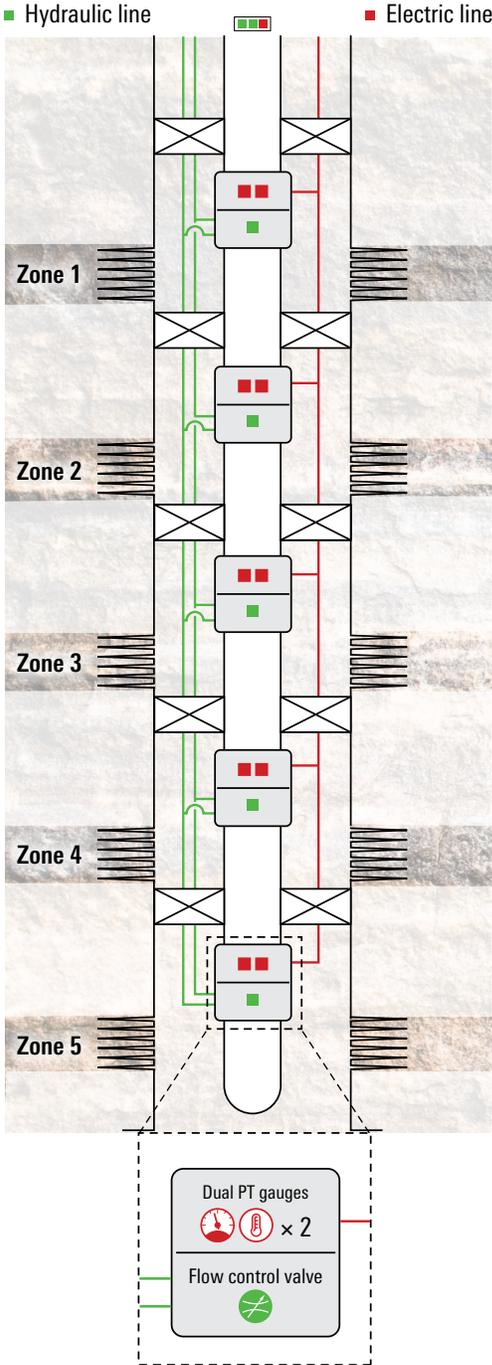
Flow control valve

Various options are available for the multiposition flow control valve. TRFC-DP direct-position valves, which can shift directly from any position to any other position, can be used together with a built-in absolute position sensor that detects the choke position. Alternatively, indexed-position TRFC-HD dual-line multiposition flow control valves or ball-type SFIV-II* surface-controlled bidirectional isolation valves (lubricator valves) can be used. Other features include

- fast choke positioning for multiple zones in one set sequence from the surface control room when multiple Proteus systems are installed together
- a protective sleeve that prevents exposure of choke seals to erosive fluid flow at high differential pressures during actuation and operation.

PT gauges

Single or dual gauges transmit tubing or tubing and annulus PT readings from the zone of interest to surface. Up to 8 dual or 16 single gauges can be deployed with a single cable. Metris Extreme* HPHT permanent PT gauges or enhanced silicon-on-insulator (eSOI) gauges can be used.



Multiple (up to 12) Proteus systems can be multidropped on just one electric and two hydraulic lines.

Power and telemetry

Power and bidirectional high-rate telemetry are provided by a single, permanent electric cable. System health data are transmitted to surface for diagnostic and prognostic system health monitoring. The telemetry also makes the system immune to ESP noise.

Multidropping capability

The Electrohydraulic Modules enable multidropping up to 12 Proteus systems on one electric and two hydraulic lines, simplifying installation complexity and requiring only three wellhead penetrations.

Mechanical override option

A mechanical shifting option is also available; any valve can be opened using its integral shifting profile. The design of the electrohydraulic circuit eliminates any possibility of a hydraulic lock downhole, ensuring successful actuation of the valve using a shifting tool.

WellWatcher Advisor software

Through real-time workflows that integrate data from multiple zones or wells, WellWatcher Advisor real-time intelligent completion software provides solutions and the ability to

- determine the real-time liquid rate for each zone via mechanistic choke models
- improve the accuracy of rate calculations by using PVT data to correct fluid properties to downhole conditions
- compute the real-time pseudosteady-state productivity index and average reservoir pressure
- identify underperforming zones and wells
- improve the wellbore cleanup process
- optimize flow control valve positions to accelerate production and maximize recovery
- perform zonal back allocation of reserves using cumulatives.

Surface acquisition and control unit

The surface control system comprises a hydraulic power unit (HPU) and a logic-programmed control and operating system — the WellWatcher Instruct* multiwell acquisition unit — that automatically directs hydraulic pressure sequences to the appropriate control lines for reliable, remote operation of the flow control valves.

In addition, the WellWatcher Instruct unit acquires and stores downhole gauge and choke data as well as data from the surface HPU; it also detects alarms. Operators can easily interface with the surface system to view zone data in real time, quickly control the downhole valves and fine-tune well production, store historical data, and manage authorizations.

The surface system's remote communication capabilities facilitate well testing, diagnostics, and production optimization through either a local SCADA system or a remote connection with a subsea interface card.

Proteus System Specifications

Size	3½-in	4½-in
Max. OD, in [cm]	5.9 [14.98]	8.25 [20.96]
Min. ID, in [cm]	2.825 [7.176]	3.75 [9.53]
Tensile rating	As tubing	As tubing
Differential working pressure, psi [kPa]	7,500 [51,710]	7,500 [51,710]
Max. differential hydraulic pressure, psi [kPa]	10,000 [68,947]	5,000 [34,474]
Max. unloading pressure, psi [kPa]	3,000 [20,684]	1,500 [10,342]
Max. surround pressure, psi [kPa]	7,500 [51,710]	15,000 [103,421]
Max. flow rate, bbl/d [m ³ /d]	40,000 [6,360]	48,800 [7,759]
Max. choking differential, psi [kPa]	1,500 [10,342]	1,500 [10,342]
Min. operating temperature, degF [degC]	68 [20]	68 [20]
Max. operating temperature, degF [degC]	325 [163]	260 [127]
PT gauge configuration	Various configurations possible	

Note: Other sizes available on request

eSOI PT Gauge Specifications

Pressure accuracy, psi [kPa]	±3 [±20.7]
Pressure resolution, psi [kPa]	0.05 [0.34]
Temperature accuracy, degF [degC]	±0.27 [±0.15]
Temperature resolution, degF [degC]	0.007 [0.004]
Working pressure, psi [kPa]	10,000 [68,948]

Metris Extreme HPHT Permanent PT Gauge Specifications

Pressure accuracy, % full scale	±0.012
Pressure resolution, psi/s [kPa/s]	<0.006 [<0.041]
Temperature accuracy, degF [degC]	±0.27 [±0.15]
Temperature resolution, degF [degC]	0.009 [0.005] at 1-s gate time
Working pressure, psi [MPa]	10,000 to 25,000 [69 to 172]