ForeSite® Sense Thermal

Provides comprehensive multiparameter downhole sensing for well production, injection, and monitoring

The ForeSite Sense thermal optical pressure and temperature solution operates reliably at elevated temperatures and pressures.

Applications

- Thermal recovery wells, high-rate wells, intelligent wells, multizone wells, geothermal wells
- In-well flow pressure measurement
- Reservoir pressure measurement during shut-ins
- Management and control of well ramp-up
- Thermal recovery monitoring: steam-assisted gravity-drainage, carbon capture and storage, and steam flood wells
- Producer, injector, observation well monitoring
- Single and dual pressure and temperature gauge configurations
- Pump monitoring (electric submersible pump, rod lift, or progressing cavity pump)

Features and Benefits

- Accurate, reliable pressure readings optimize production efficiencies at elevated temperatures.
- Option to integrate with high-density thermal array provides a one-fiber/one-cable solution.
- Slimline 1/4 in. capillary line aids in deployment and well operations.
- Real-time data processing delivers visualization and remote monitoring of well inflow at the reservoir.
- Corrosion-resistant Inconel® materials withstand challenging environments.

Tool Description

The Weatherford ForeSite Sense thermal optical pressure and temperature solution is rated for maximum operating temperatures of 572°F (300°C) and operating pressures of up to 2,000 psi (138 bar). The high-pressure version is rated to 5,000 psi (345 bar). Its 1/4-inch outer diameter allows for normal handling under tight conditions, including spooling operations and deployments inside coiled tubing or in feed-through and swellable packers.

The thermal gauge is well suited for ultrahigh temperature thermal applications because it is unaffected by optical losses caused by hydrogen darkening, providing high accuracy and resolution.

ForeSite Sense thermal measurements are based on wavelength shifts of the Bragg grating sensor. The PT gauge can be deployed standalone for wellbore or pump monitoring, or it can be integrated with array temperature sensors for a more complete monitoring solution. The integrated solution provides multiple distributed, discrete temperature sensing points and a single P/T measurement on a single optical fiber.

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Options

- Pump-down capillary insertion inside coiled tubing
- Alloy 718 material designs for most well types
- Coiled tubing (1 to 1-1/4 in.) long/short string
- Clamp-on ESP/production tubing
- Integration with all ForeSite Sense gauges

Specifications

Operational Performance

Maximum temperature	572°F (300°C)
Calibrated temperature	77 to 572°F (25 to 300°C)
Calibrated pressure range	Atm to 2,000 psi (Atm to 138 bar)
Calibrated pressure range (High-pressure version)	Atm to 5,000 psi (Atm to 345 bar)
Maximum non-operating pressure	>6,000 psi (>413 bar)
Minimum storage temperature	-40°F (-40°C)
Update rate	≥1 second

Pressure Metrology

Accuracy	±3 psi (±0.2 bar)
Resolution*	≤0.1 psi (≤0.007 bar)
Long-term stability/yr**	<1 psi/yr (<0.07 bar/yr)

*Based on the RMS-wh and RMS-mr nForm™ data acquisition systems
**Preliminary specification

Temperature Metrology

Accuracy	±0.9°F (±0.5°C)
Resolution	≤0.018°F (≤0.01°C)
Long-term stability/yr**	<0.32°F (<0.18°C)

Mechanical

Material	Inconel 718
Outside diameter	0.25 in. (6.35 mm)
Length	9.35 in. (237.5 mm)

Shock and Vibration Data

Vibration	15 G_{rms} [20 to 2,000 Hz (NavMat)]
Shock	100g, 9 ms half sine
Drop	500g, 1 ms half sine

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Specifications (continued)

Nomenclature for Pressure and Temperature Settings

Designation	Pressure	Temperature
Low	<2 Kpsi (<138 bar, <13.8 MPa)	<185°F (<85°C)
Moderate	2 to 10 Kpsi (138 to 689 bar, 13.8 to 69 MPa)	185 to 302°F (85 to 150°C)
High	10 to 15 Kpsi (689 to 1,034 bar, 69 to 103 MPa)	302 to 356°F (150 to 180°C)
Extreme	15 to 20 Kpsi (1,034 to 1,379 bar, 103 to 138 MPa)	356 to 392°F (180 to 200°C)
Ultra	>20 Kpsi (>1,379 bar, >138 MPa)	392 to 482°F (200 to 250°C)
Thermal I	–	482 to 572°F (250 to 300°C)
Thermal II	–	>572°F (>300°C)

* Inconel is a registered trademark of Special Metals Corporation

ForeSite® Sense Thermal

Optical Downhole Cable

The ForeSite Sense optical downhole cable provides a high-performance signal pathway for downhole pressure, temperature, and seismic measurements. This cable accommodates up to four single- or multi-mode fibers in any combination. Its fibers support distributed temperature sensing (DTS) and distributed acoustic sensing (DAS), as well as Bragg grating pressure and temperature gauges, multi-point temperature arrays, flowmeters, and seismic accelerometers. The Bragg grating sensors can be multiplexed on a single fiber, and a downhole cable splitter enables further multi-zone sensing architectures for enhanced production-monitoring capabilities.

The cable is engineered for reliable performance throughout the life of the well. The proprietary design incorporates an ultra-premium fiber-protection system that guards against cable stresses and degradation to eliminate the need for periodic replacement.

This protection system also helps maintain the factory-calibrated temperature-profiling measurement throughout the life of the well. The cable can be supplied with hydrogen-resistant fibers that prevent long-term degradation of the optical system caused by hydrogen intrusion.

The standard 1/4-in. outside diameter (OD) cable is compatible with all Weatherford optical completion components, including connectors, splitter assemblies, sensors, and wellhead-pressure barriers. Weatherford accommodates a range of cross-coupling clamping variations and provides a choice of final encapsulation materials and configurations, such as 0.43 × 0.43 in. (11 × 11 mm) square or 0.43 in. (11 mm) round, or flatpack packaging.

Features and Benefits

- Multi-fiber design enables multi-parameter measurements in the wellbore, which reduces the number of wellhead penetrations and monitoring system complexity.
- Cable compatibility with all Weatherford optical sensing products facilitates monitoring system design flexibility and reduces overall system cost.
- Cable packaging is identical to other in-well hydraulic and instrument lines, which enables use of standard handling and installation techniques.
- Flexible cable can pass through wellheads, packers, and other in-well completion equipment to reduce installation time and costs.

ForeSite® Sense Thermal

Optical Downhole Cable

Specifications

Construction

Model	Extreme		Thermal
Cable size	1/4 in. (6.35 mm)		
Wall thickness	0.028 in. (7.112 mm)	0.035 in. (0.889 mm)	0.035 in. (0.889 mm)
Optical fibers	Up to 4 fibers[a], single-mode or multi-mode		
Inner metal tube	304 Stainless steel		
Buffer	AA1070 Aluminum		None
Outer armor tube: INCOLOY® 825* OD × wall	0.25-in. OD × 0.028 in. wall (6.35 mm OD × 7.112 mm wall)	0.25-in. OD x 0.035 in. wall (6.35 mm OD × 0.889 mm wall)	

Mechanical Properties

Weight in air	0.1 lb-ft (0.1488 kg-m)	0.11 lb-ft (0.1637 kg-m)	
Working pressure	20,000 psi (1,379 bar)	25,000 psi (1,724 bar)	
Collapse pressure	>30,000 psi (2,068 bar)	>35,000 psi (2,413 bar)	>30,000 psi (2,068 bar)
Burst pressure	20,000 psi (1,379 bar)	25,000 psi (1,724 bar)	15,000 psi (1,034 bar)
Maximum tensile load	1,500 lb (680 kg)	2,000 lb (907 kg)	
Maximum splice-free length	27,000 ft (8,229 m)	10,000 ft (3,048 m)	

Environmental Specifications

Maximum operating temperature[b]	392°F (200°C)		572°F (300°C)
Minimum storage temperature	-40°F (-40°C)		
Pressure range	Atm to 20,000 psi (1,379 bar)	Atm to 25,000 psi (1,724 bar)	Atm to 20,000 psi (1,379 bar)

[a] nLink-Thermal may have more fibers on a case-by-case basis. Custom optical fiber configurations can include any combination of single-mode or multi-mode optical fibers.
[b] DTS temperature range will depend on optical fiber selection.

* Incoloy is a registered trademark of Special Metals Corporation.

ForeSite® Sense Thermal

Outdoor Optical Data Acquisition System

The ForeSite Sense outdoor optical data acquisition system provides an economical means for obtaining pressure and temperature (PT) data from downhole optical PT gauges. This outdoor optical data acquisition system can be used in gas lift optimization, sand-face monitoring, and frac-string monitoring applications.

This outdoor optical monitoring system can help operators to maximize recovery. Operators input this real-time data into Weatherford nodal modeling software to design a precise gas-injection program that delivers a higher, more stable production rate.

Additional in-well optical fibers can easily be integrated into the system for increased functionality.

Features and Benefits

- Real-time downhole single-point pressure and temperature monitoring captures flowing bottom-hole pressures and pressure-transient data
- Data-transmission capability enables transfer over existing customer SCADA infrastructure

Specifications

PT Gauge Monitoring

Number of optical channels	1 to 4
Units of measure (selectable)	Metric, Imperial, Oilfield

Output Options

MODBUS®, serial 232, 422, 485, TCP/IP	ASCII, RTU
External Communications	RJ-45 Ethernet
Internal Storage	30 days at 1 Hz

Electrical Power

Input voltage	24 V DC nominal
Power Consumption	<50 W (30 W typical)

Mechanical

Packaging	IP66/Nema 4X
Classification	IECEx Zone2

Environmental

Operating temperature range (shaded)	-5 to 131°F (-15 to 55°C)
Shipping and storage temperature range	-40 to 176°F (-40 to 80°C)
Relative humidity, non-condensing	95%
Transportation vibration	6.0 Grms

ForeSite® Sense Thermal

Wellhead Optical-Sensing Data Acquisition Unit

The ForeSite Sense wellhead optical-sensing data acquisition unit provides standalone data acquisition, storage, and transmission of downhole optical sensor data. This unit functions efficiently on satellite platforms or in desert, arctic, and swamp locations where environmental protection, central power, and communications are limited or unavailable. Locations without controlled air will not affect the local storage capacity of the system or its capability to deliver web-enabled, on-demand access to readings.

This unit monitors downhole optical sensors as part of the Weatherford optical monitoring family of products and solutions. The optical-sensing data acquisition unit has the storage capacity to hold an extensive amount of high-frequency data from downhole optical gauges, and can support optical PT gauges from multiple wells.

The configuration and application software is identical to that used in other Weatherford data acquisition units, which supports communication protocols that conform to industry standards for flexible data handling.

Features and Benefits

- External status display facilitates system operation checks.
- High-rate recording capability ensures that data is recorded at the highest density—even if only a slow update rate is sent to the control room in the production facility.
- Data recording enables detailed analysis of any production anomalies and allows for data retrieval if the data link is lost.
- Passive downhole equipment facilitates upgrading of the surface unit hardware and software as enhancements become available to improve overall sensing system performance.

Options

- Zone 2 certification
- Solar panel system

Specifications

PT Gauge Monitoring

Monitoring capability	52 wells, maximum
Units of measure (selectable)	Metric, imperial, and oilfield

Physical

Zone 2 dimensions (W × H × D)	24 × 30 × 8 in. (610 × 762 × 203 mm)
Zone 2 weight	125 lb (57 kg)

ForeSite® Sense Thermal

Wellhead Optical-Sensing Data Acquisition Unit

Specifications (continued)

Output Options

MODBUS® protocol*, serial 232, 422, 485, TCP/IP	ASCII, RTU, master or slave
Simple serial 232, 422, 485	ASCII
OPC 2.0 data access standard	Client and server
Data files by LAN or WAN	Flat file or web browser
Web-enabled data visualization and transfer	LAN and web browser
Direct SQL database access	ODBC driver

* MODBUS is a registered trademark of Schneider Automation Inc.

Electrical Power

24 VDC nominal	18 to 32 VDC
AC nominal	120/230 VAC
Maximum current	1.6 amp @ 24 VDC
Power consumption	38 W (typical, at room temperature)

Environmental

Operating temperature range (shaded)	-40° to 145°F (-40° to 63°C)
Shipping and storage temperature range	-40° to 185°F (-40° to 85°C)
Relative humidity, non-condensing	95%
Transportation vibration	3.0 Grms, random and sine

ForeSite® Sense Thermal

BGI Data Acquisition Unit

The ForeSite Sense BGI data acquisition unit interrogates fiber optic Bragg-grating sensors to provide continuous, reliable and actionable information. This data-acquisition unit represents the latest generation of high-performance surface instrumentation for monitoring Weatherford electronic and optical downhole sensors.

As a part of the Weatherford production and reservoir monitoring solution, the BGI unit supports hundreds of downhole optical pressure and temperature sensors in multiple wells. This state-of-the-art Bragg-grating interrogator (BGI) delivers readings on demand and is Web-enabled for remote access and control. Its local storage capacity enables the system to hold an extensive amount of high-frequency data over broad time intervals.

The BGI surface instrument is completely scalable up to 52 optical ports to permit expansion of the number of Bragg-grating pressure and temperature gauges to meet application requirements.

The system is compatible with all Weatherford Bragg-grating based technology. The interrogation system utilizes a rugged, stable optical source that provides an increased optical power budget, enabling interrogation of sensors even in the presence of high attenuation caused by poor optical connections or hydrogen darkening.

The BGI data acquisition unit enables downhole pressure and temperature gauges and temperature arrays to be integrated with other optical or electronic sensing types, such as distributed-temperature-sensing (DTS), multi-phase flowmeter, seismic sensors and quartz gauges.

Features and Benefits

- Simple scalability to 52 ports provides configuration flexibility and maximum coverage across multiple well installations.
- Modular system hardware and software components enable easy upgrading as enhancements become available to improve sensing system performance.
- On-demand web browser facilitates viewing of real-time and historical data to provide actionable information for production optimization.
- System compatibility with other Weatherford instrumentation supports a range of optical-sensor types by simply adding a suitable interrogation module and optical multiplexer.
- High-frequency interrogation and storage of well data provide for detailed analysis of production anomalies.
- High-rate recording capability ensures that data is recorded at the highest density—even if only a slow update rate is sent to the control room in the production facility.
- On-site and remote configuration, setup, and output options enable simplified operations.

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BGI Data Acquisition Unit

Specifications

General Specifications

Number of optical ports	4, 8, 16, 32, or 52
Number of PT sensors per port	3 or 4, depending on maximum pressure
Update rate selectable range	1 sec to no limit
Communications port	Ethernet

Mechanical Specifications

Packaging	3U 19-in. rack
Weight (4 port version)	17 lb, 9 oz
Enclosure	IP20
Electronic PCB	3U Eurocard standard

Electrical Power Specifications

Input voltage	100 to 120 / 200 to 240 V~ 50/60 Hz 2.5A
CE low-voltage directive 73/23/EEC compliant	IEC 60204-1

Environmental Specifications

Operating temperature range	-4° to 145°F (-20° to 63°C)
Storage temperature range	-40° to 185°F (-40° to 85°C)
Thermal shock	<18°F/hr (<10°C/hr)
Relative humidity, non-condensing, operating range	10 to 80%
Relative humidity, non-condensing, storage range	0 to 95%
CE electromagnetic compatibility, 89/336/EEC compliant	IEC 61000-4-2 through 4-6, IEC 61326-1
Operational vibration	10 to 2,000 Hz, 0.1 g (Navmat), 10 mins
Transportation vibration	10 to 2,000 Hz, 6 g (Navmat), 10 mins

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ForeSite® Sense Thermal

Distributed Temperature Sensing

ForeSite Sense thermal distributed temperature sensing (DTS) systems deliver wellbore thermal profiles along the entire length of optical fiber. This DTS functionality enables operators of oil and gas fields to monitor the temperature at all points in one or more wells and hence calculate parameters such as inflow/outflow rates and gas/fluid contributions, in addition to observing the performance of control valves, gas lift, and monitoring well integrity and flow assurance.

The DTS monitoring solution is available as a permanent monitoring system as well as an ad hoc logging service when characterization or a health check is required.

Features and Benefits

- Compatible with industry standard optical fibers for ease of system integration.
- Rugged design features Weatherford downhole optical cable, the industry's most durable and longest-lasting in-well optical cable.
- Double-ended DTS configurations improve long-term accuracy and stability.
- Downhole optical cable compatibility facilitates use of other optical sensors and gauges from the Weatherford monitoring solutions portfolio.

Options

- Rackmount or outdoor systems
- ATEX Certification
- Optical Switch 2, 4, or 16 channels

Specifications

Specifications for rackmount unit (DTS-y3k) and outdoor unit (wh-DTS-y3k) are the same.

Operating Performance

Unit type	DTS-y3k-10	Dwh-TS-y3k-16
Distance range	6.21 miles (10 km)	9.94 miles (16 km)
Spatial resolution	3.28 ft (1m)	
Sampling interval	1.64, 3.28, 6.56 ft (0.5, 1, 2 m) selectable	
Number of channels*	1, 2, 4, 16	
Temperature resolution**	32.054°F (0.03°C)	32.108 °F (0.06°C)

* optional switch required for 2, 4, and 16 channels
** 10 minute measurement, 1σ, without optical switch

Certifications

Unit type	DTS-y3k-10	DTS-y3k-16
ATEX Type "n"	II 3G Ex nA ic [op is] II C T4 Gc X	
Laser class	IEC 60825-1/2007, Class1M	

ForeSite® Sense Thermal

Distributed Temperature Sensing

Specifications (continued)

Environmental Parameters

Unit type	DTS-y3k-10	wh-DTS-y3k-16
Operating temperature	-40 to 149°F (-40 to +65°C)	
Storage temperature	-40 to 158°F (-40 to +70°C)	
Humidity (operating)	20% to 80% relative humidity (no condensation)	
Power requirements (AC) (W)	16	
Dimensions (W×H×D)***	7.79 × 5.20 × 6.39 in. (197.8 × 132.0 × 162.2 mm) (6 slots width)	
Dimensions for 316 SS Outdoor enclosure (W×H×D)	24 × 24 × 12 in. (609.6 x 609.6 x 304.8 mm)	
Unit type		

*** Dimensions exclude protective cap of optical connector

ForeSite® Sense Thermal

ULTRA Distributed Temperature Sensing

ForeSite Sense ULTRA distributed temperature sensing systems deliver wellbore thermal profiles and analysis for the entire length of optical fiber. ULTRA DTS functionality enables operators of oil and gas fields to monitor the temperature at all points in one or more wells and hence calculate parameters such as inflow/outflow rates and gas/fluid contributions, in addition to observing the performance of control valves, gas lift, and monitoring well integrity and flow assurance.

The ULTRA DTS monitoring solution is available as a permanent monitoring system as well as an ad hoc logging service when characterization or a health check is required. The system's downhole optical cable can be installed with or without other optical sensors and the surface equipment can be permanently installed or mobilized when a temperature profile is required.

The ULTRA DTS system is an integral part of its surface instrumentation and data system, providing a data source integrated with other installed sensing systems, including in-well reservoir pressure and temperature, flow, and multiphase-flow sensors.

Features and Benefits

- Compatible with industry standard optical fibers for ease of system integration.
- Rugged design features Weatherford downhole optical cable, the industry's most durable and longest-lasting in-well optical cable.
- Sensor system design uses no in-well electronics to withstand harsh environments and function in high-temperature operations.
- Integrated reference coils at the surface ensure consistent temperature accuracy.
- Double-ended DTS configurations improve long-term accuracy and stability.
- Downhole optical cable compatibility facilitates use of other optical sensors and gauges from the OmniWell® monitoring solutions portfolio.
- Compatibility with proprietary data visualization software provides seamless data analysis.

Options

- Rackmount or outdoor systems
- ATEX certification
- Single-ended, Double-ended and J-type configurations
- Integration with optical pressure and temperature sensors and optical flowmeters
- Monitoring ranges up to 9.9 miles (16 km) optical fiber length

ForeSite® Sense Thermal

ULTRA Distributed Temperature Sensing

Specifications

Operating Performance

Distance range	1.2, 2.5, 4.9, 7.5, 9.9 miles (2, 4, 8, 12, and 16 km)
Spatial resolution	2.3 ft (0.7 m)
Sampling interval	0.5 ft up to 2.5 miles (0.15 m up to 4 km) 0.8 ft up to 7.5 miles (0.25 m up to 12 km)
Number of channels	1, 2, 4, 6, 8, 12, or 24
Measurement interval	User selectable: from 30 sec to 24 hours
Measurement modes	Single-ended or dual-ended (including fiber break recovery

Environmental Parameters

Operating temperature*	(-10 to +60°C)
Storage temperature	(-40 to +80°C)
Humidity	0 to 95% relative humidity non-condensing
Power requirements	100 to 240 VAC, 50/60 Hz, 50 VA maximum
Laser class	IEC 60825-1:2007 1M (eye safe)
ATEX certification (optional)	EX II (1) GD; I M2

*Other temperature ranges available

ULTRA Dual-Ended Configuration Temperature Metrology – Measurement time: 30 seconds

Fiber distance	547.9 ft (167 m)	1,637.9 ft (499.25 m)	2,720.6 ft (829.25 m)	17,472.1 ft (5,352.5 m)	18,643.4 ft (5,682.5 m)	19,727.7 ft (6,013 m)
Fiber temperature	32°F (0°C)	302°F (150°C)	167 °F (75°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)
Calibration error	3.19°C	2.19°C	2.19°C	1.08°C	1.91°C	2.40°C
Temperature repeatability	5.86°C	4.87°C	4.00°C	2.33°C	2.98°C	1.79°C
Spatial temperature resoultion	6.24°C	5.06°C	3.86°C	2.14°C	2.61°C	1.64°C
Spatial resolution	-	-	-	-	7.61 ft (2.32 m)	-

Temperature metrology specifications are dependent on the system configuration; please enquire with your local Weatherford representative.

ForeSite® Sense Thermal

ULTRA Distributed Temperature Sensing

Specifications

ULTRA Dual-Ended Configuration Temperature Metrology – Measurement time: 10 minutes

Fiber distance	547.9 ft (167 m)	1,637.9 ft (499.25 m)	2,720.6 ft (829.25 m)	17,472.1 ft (5,352.5 m)	18,643.4 ft (5,682.5 m)	19,727.7 ft (6,013 m)
Fiber temperature	32°F (0°C)	302°F (150°C)	167 °F (75°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)
Calibration error	0.79°C	2.22°C	0.99°C	1.49°C	1.86°C	1.17°C
Temperature repeatability	0.98°C	1.26°C	0.88°C	0.72°C	0.96°C	0.15°C
Spatial temperature resoultion	1.43°C	1.48°C	0.80°C	2.14°C	0.80°C	0.53°C
Spatial resolution	-	-	-	-	6.4 ft (1.95 m)	-
Worst-case environmental temperature effect	-	-	-	-	4.92°C	-
Low environmental temperature effect	-	-	-	-	2.23°C	-
High environmental temperature effect	-	-	-	-	1.22°C	-
Environmental temperature repeatability	-	-	-	-	1.09°C	-

ULTRA Dual-Ended Configuration Temperature Metrology – Measurement time: 1 hour

Fiber distance	547.9 ft (167 m)	1,637.9 ft (499.25 m)	2,720.6 ft (829.25 m)	17,472.1 ft (5,352.5 m)	18,643.4 ft (5,682.5 m)	19,727.7 ft (6,013 m)
Fiber temperature	32°F (0°C)	302°F (150°C)	167 °F (75°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)
Calibration error	0.53°C	0.48°C	1.13°C	0.49°C	0.47°C	0.33°C
Temperature repeatability	0.43°C	0.68°C	0.48°C	0.32°C	0.46°C	0.24°C
Spatial temperature resoultion	0.58°C	0.72°C	0.56°C	0.26°C	0.35°C	0.24°C
Spatial resolution	-	-	-	-	6.5 ft (1.98 m)	-

Temperature metrology specifications are dependent on the system configuration; please enquire with your local Weatherford representative.

ForeSite® Sense Thermal

DTS Distributed Temperature Sensing Unit

The ForeSite Sense DTS distributed temperature sensing unit delivers wellbore thermal profiles and analysis for the entire length of optical fiber. DTS capability enables operators to track the temperature at all points in one or more wells and monitor well integrity and flow assurance. DTS data can be used to calculate parameters such as inflow/outflow rates and gas/fluid contributions, in addition to observing the performance of control valves, SAGD, and gas lift.

The DTS monitoring solution is available as a permanent monitoring system as well as an ad hoc logging service when characterization or a health check is required. The system's downhole optical cable can be installed with or without other optical sensors and the surface equipment can be permanently installed or mobilized when a temperature profile is required.

The DTS system is an integral part of its surface instrumentation and data system, providing a data source integrated with other installed sensing systems, including in-well reservoir pressure and temperature, flow, and multiphase-flow sensors.

Features and Benefits

- Compatible with industry standard optical fibers for ease of system integration.
- Rugged design features ForeSite Sense downhole optical cable, the industry's most durable and longest-lasting in-well optical cable.
- Sensor system design uses no in-well electronics to withstand harsh environments and function in high-temperature operations.
- Integrated reference coils at the surface ensure consistent temperature accuracy.
- Double-ended DTS configurations improve long-term accuracy and stability.
- Downhole optical cable compatibility facilitates use of other optical sensors and gauges from the ForeSite Sense monitoring solutions portfolio.
- Compatibility with proprietary data visualization software provides seamless data analysis.

Options

- Single-ended, double-ended and J-type configurations
- Integration with optical pressure and temperature sensors and optical flowmeters
- Monitoring ranges up to 12.4 miles (20 km) optical fiber length

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DTS Distributed Temperature Sensing Unit

Specifications

Operating Performance

Distance range	3.1, 6.2, 9.3, 12.4 miles (5, 10, 15, and 20 km)
Spatial resolution	3.9 ft (1.2 m)
Sampling interval	0.82 ft up to 3.1 miles (0.25 m up to 5 km) 1.64 ft up to 6.2 miles (0.5 m up to 10 km) 3.28 ft up to 12.4 miles (1 m up to 20 km)
Number of channels	Up to 32
Measurement interval	Approximately 10 seconds to 14.8 hours (at 1-m sampling)
Measurement modes	Single-ended or dual-ended (including fiber break recovery

Environmental Parameters

Operating temperature*	32 to 104°F (0 to 40°C)
Storage temperature	-4 to 140°F (-20 to 60°C)
Humidity	85% maximum, non-condensing
Power requirements	100 to 240 VAC, 50/60 Hz, 50 VA maximum
Laser class	Class 1 (IEC 60852-1-2001)
Well operating temperature range	Up to 392°F (200°C)

*Other temperature ranges available

Single-Ended Configuration Temperature Metrology – Measurement time: 40 seconds

Fiber distance	328 ft (100 m)			32,021 ft (9,760 m)		
Fiber temperature	32°F (0°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)	167 °F (75°C)	302°F (150°C)
Calibration error	0.08°C	0.15°C	0.11°C	0.12°C	0.31°C	0.02°C
Temperature repeatability	0.83°C	0.86°C	1.02°C	2.31°C	2.34°C	2.65°C
Spatial temperature resoultion	0.85°C	0.89°C	1.06°C	2.33°C	2.34°C	2.69°C
Spatial resolution	-	-	-	<6.56 ft (<2 m)	<6.56 ft (<2 m)	<6.56 ft (<2 m)
Warm-up time at 68°F (20°C)	-	-	-	-	320 sec	-
Warm-up time at 32°F (0°C)	-	-	-	-	80 sec	-
Warm-up time at 104°F (40°C)	-	-	-	-	560 sec	

Temperature metrology specifications are dependent on the system configuration; please enquire with your local Weatherford representative.

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ForeSite® Sense Thermal

DTS Distributed Temperature Sensing Unit

Specifications (continued)

Single-Ended Configuration Temperature Metrology – Measurement time: 10 minutes

Fiber distance	328 ft (100 m)			32,021 ft (9,760 m)		
Fiber temperature	32°F (0°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)	167 °F (75°C)	302°F (150°C)
Calibration error	0.05°C	0.18°C	0.12°C	0.05°C	0.09°C	0.13°C
Temperature repeatability	0.21°C	0.24°C	34°C	0.62°C	0.64°C	0.72°C
Spatial temperature resoultion	0.25°C	0.32°C	0.40°C	0.63°C	0.64°C	0.75°C
Spatial resolution	-	-	-	<6.56 ft (<2 m)	<6.56 ft (<2 m)	<6.56 ft (<2 m)
Worst case env T effect	-	-	-	-	(1.52°C)	-
32°F (0°C) Env temp effect	-	-	-	-	(1.22°C)	-
104°F (40°C) Env temp effect	-	-	-	-	(0.82°C)	-
Env temp repeatability	-	-	-	-	(1.52°C)	-

Single-Ended Configuration Temperature Metrology – Measurement time: 1 hour

Fiber distance	328 ft (100 m)			32,021 ft (9,760 m)		
Fiber temperature	32°F (0°C)	167 °F (75°C)	302°F (150°C)	32°F (0°C)	167 °F (75°C)	302°F (150°C)
Calibration error	0.07°C	0.08°C	0.11°C	0.07°C	0.12°C	0.30°C
Temperature repeatability	0.17°C	0.18°C	0.16°C	0.37°C	0.35°C	0.36°C
Spatial temperature resoultion	0.16°C	0.26°C	0.30°C	0.32°C	0.32°C	0.41°C
Spatial resolution	-	-	-	<6.56 ft (<2 m)	<6.56 ft (<2 m)	<6.56 ft (<2 m)

Temperature metrology specifications are dependent on the system configuration; please enquire with your local Weatherford representative.