ForeSite® Sense Hybrid

Combines optical and electrical technologies for comprehensive multiparameter downhole sensing for well production, injection, and monitoring

Applications

- Wide-ranging subsurface monitoring capacities throughout the expected well or field life
- Zonal isolation monitoring and pressure-transient analysis
- Pressure and temperature (P/T) applications and reservoir pressure monitoring
- P/T data monitoring for automation and analysis of artificial lift
- Intelligent completions and artificial lift optimization
- Subsea monitoring

Features and Benefits

- Fully hybridized gauge is rated to 348°F (177°C) for exceptional accuracy and resolution in demanding environments.
- Fully welded gauge assemblies include 100% pressure testable sealing interfaces, with no elastomer seals.
- V0-rated cablehead with redundant metal-to-metal sealing is fully pressure-testable for enhanced versatility and reliability.
- P/T gauge eliminates wireline intervention and production downtime for pressure surveys in vertical or horizontal wells.
- Shear quartz resonator transducer provides stability and repeatability.
- Full digital signal transmission eliminates data corruption when installed with other wellbore electrical signal sources, such as electronic submersible pumps (ESPs).

Tool Description

The ForeSite Sense hybrid solution is a value-adding production-optimization solution for superior real-time reservoir monitoring.

This electronic pressure and temperature gauge gauge is used in zonal-isolation, intelligent-completion, and artificial-lift applications to acquire P/T data for production optimization and reservoir management decisions.

Weatherford incorporates hybrid electronic technology into the gauge design to provide a rigorous operating envelope that covers extreme environmental, handling, and wellbore conditions. The implemented design specifications enable exceptional performance.

Single-sensing gauges, dual gauges with splitter, and dual-sensing gauges with or without cable bypass configurations are all standard offerings.

The ForeSite Sense hybrid solution provide permanent monitoring of pressures and temperatures.

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Specifications

Operational Performance

Maximum operating temperature	348°F (177°C)	
Calibrated temperature range	77 to 392°F (25 to 200°C)	
Available operational ranges	Pressure	Temperature
	10,000 psi (689.5 bar) (68.95 MPa)	77 to 302°F (25 to 150°C)
	16,000 psi (1,103.2 bar) (110.32 MPa)	77 to 302°F (25 to 150°C) 77 to 348°F (25 to 177°C)
	20,000 psi (1,379 bar) (137.90 MPa)	77 to 348°F (25 to 177°C)
	25,000 psi (1,723.7 bar) (172.37 MPa)*	77 to 348°F (25 to 177°C)
Maximum non-operating pressure at maximum temperature	10% over calibrated pressure	
Minimum storage temperature	–49°F (–45°C)	
Operating current	3.8 mA	

Pressure Metrology

Accuracy at maximum temperature	0.015%
Resolution at maximum temperature	0.00008%
Long-term stability/year at maximum temperature	<0.5 psi/yr (<0.034 bar/yr) (<0.0034 MPa/yr)

Temperature Metrology

Accuracy	+/–0.18°F (+/–0.10°C)
Resolution	<0.01°F (<0.005°C)
Long-term stability/year	<0.18°F/yr (<0.1°C/yr) @ 348°F (177°C)

Mechanical

Weight	1.6 lb (0.73kg)
Outside diameter	0.875 in. (22.2 mm)
Length	16.0 in. (406 mm)

Shock and Vibration Data

Vibration	40 G_{mms} NavMat, 0-5 kHz
Shock	500 g, 1 ms
Drop	1,000 g, 1 ms

* Special Request
A TR-2385 qualified gauge is also available: xQuartzPT-QS

ForeSite® Sense Hybrid

Dry Mate Cablehead for Quartz PT Gauge

The ForeSite Sense dry mate cablehead provides a highly reliable electromechanical connector for the quartz PT electronic gauge. Redundant metal-to-metal seals and complete field pressure testability maximizes reliability of the downhole sensing system throughout the life of the well. The dry mate cablehead combined with the quartz hybrid electronic-quartz permanent monitoring system is a value-added production optimization solution for superior permanent, real-time reservoir pressure and temperature monitoring.

The dry mate cablehead is tested to the same combined environmental stress standards as the quartz gauge. The combined environmental stresses in a well can subject the cablehead termination to extreme temperatures, pressures, vibration and shock.

Features and Benefits

- Field-proven design combines the highest industry standards with seal redundancy and pressure testability.
- Corrosion-resistant cablehead alloys comply with the NACE MR0175 standard, and can be installed in corrosive and sour-gas environments.
- The cablehead is rated to 392°F (200 °C) and 20,000psi (1379 bar) to provide exceptional longevity and reliability under demanding environmental conditions.
- Cable armor stress relief against tensile loading prevents external stresses on the pressure seals.
- Redundant pressure testable, bi-directional metal-to-metal seals permit a secure and reliable pressure barrier from the cable to gauge termination.

Specifications

Operational performance

Service temperature	-13 to 392°F (-25 to 200°C)
Service pressure	20ksi (1,379 bar)
Minimum storage temperature	-49°F (-45°C)
Electrical rating	1,000 volts

Material

Wetted	Nickel base alloys (Inconel® 120Ksi)

Seals*

TEC (cable)	Dual compression set, metal-metal, pressure testable
Gauge	Metal C-ring compression, tapered metal-metal seal face, pressure testable

Mechanical

Weight	0.9 lb (0.408 kg)
Outside diameter	0.875 in. (22.2 mm)
Make-up length	8.376 in. (212.75 mm)

*The xQuartzPT GT Cablehead version is V0 rated and meets ISO 14998 V0 standards.

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Electronic Gauge Mandrel

The ForeSite Sense electronic gauge mandrel provides a means for mounting a pressure/temperature (P/T) gauge on the completion string. Each mandrel is machined from a single billet, with no welds, to provide mechanical protection along the full length of the gauge. A metal-to-metal interface between gauge and mandrel enhances sealing reliability.

Configurations of the gauge mandrel are available to support above-packer and interzonal monitoring requirements as well as single- or multi-gauge configurations for redundancy or tubing- and annulus-pressure measurement.

The gauge mandrel meets all completion sizes while maintaining full bore ID. It supports control-line bypass for applications requiring chemical-injection or intelligent-well configurations where control lines are required for flow-control valves.

Features and Benefits

- Mandrel alloys are compatible metals used in completion design.
- Premium threads and connections comply with completion design.
- Design accommodates single or multiple gauges with splitter block assembly.

Specifications

- Designed to API 5CT specifications
- Burst and collapse pressure calculated per API 5C3

ForeSite® Sense Hybrid

Splitter Block and Cable Splice Assemblies

The ForeSite Sense splitter block assemblies accommodate the connection of dual pressure/temperature (PT) gauges, a single PT gauge and cable bypass, or dual cable bypasses from a single conductor tubing-encapsulated cable (TEC) . Complete cable and dual gauge terminations to the splitter block are accomplished with three connections.The simplified splitter design requires no field assembly, which increases overall system integrity. All connections are pressure testable.

Cable splice assemblies allow field splicing in the event that the cable becomes damaged during system conveyance. Splice assemblies use field-proven dual metal-to-metal seals that are fully pressure testable.

Features and Benefits

- Splitter block assembly mandrel mount simplifies interconnectivity and reduces the number of mechanical and electrical connections.
- Simplified cable splitter is a one-in/two-out interconnection splice system.
- Internal connections within the splitter assembly are wire free.
- Design incorporates 100% metal-to-metal seals, with no elastomeric seals used for in-well seals.
- Internal bus bar connectorized system electrically interconnects dry mateable connectors for the cable and gauges to eliminate component failure resulting from vibration induced by production or well operations.
- Field testable splitter blocks and cable splice assembly seals facilitate confirmation of mechanical, electrical, and pressure-bearing integrity.

Specifications

Parameter	Splitter block	Cable splice
Seals	Welded and dual metal to metal	Dual metal to metal
Pressure testable	Fully pressure testable to system design specifications, testing performed onsite after final makeup	
Material	INCOLOY® 718	316L SS Alternate: INCOLOY 718 (high-yield alloys)
Interconnections	Single-pin dry connect	Metal-wire crimp
Pressure rating	INCOLOY: 20,000 psi (137.9 MPa)	INCOLOY: 20,000 psi (137.9 MPa) Stainless: 10,000 psi (68.9 MPa)
Collapse pressure**	INCOLOY: 22,000 psi (151.7 MPa)	INCOLOY: 22,000 psi (151.7 MPa) Stainless: 11,000 psi (75.8 MPa)

* INCOLOY is a registered trademark of the Special Metals Company
** Collapse pressure calculated in accordance with API 5C3.

ForeSite® Sense Hybrid

Hybrid Optical/Electrical Downhole Cable

The ForeSite Sense hybrid optical/electrical downhole cable provides a reliable pathway for the transmission of data for in-well pressure- and temperature-sensing systems. It also provides power to downhole gauges. This hybrid optical/electrical downhole cable can be used in conjunction with a range of permanently installed optical and electronic downhole pressure and temperature gauges while enabling distributed temperature sensing (DTS) measurements. It is compatible with all Weatherford optical and electrical sensing products.

The cable is available with 0.035-in. (0.899-mm) armor wall thickness. The electrical conductor is #18 AWG copper. The tubing material is available in 316L stainless steel or INCOLOY® 825 alloy. The cable accommodates up to 4 optical fibers with any combination of singlemode and multimode to meet the application requirements. Between the conductor and armor tube ID, filler and insulator materials are used to both centralize and offer mechanical integrity to the cable system and insulate the electrical conductor from the armor. The insulator and filler materials are selected based upon the maximum service temperature.

in addition to the standard 'eddy-current testing' process, all cables are pressure tested to confirm cable armor integrity prior to leaving the manufacturing plant.

Features and Benefits

- Encapsulation in a variety of polymeric materials is offered to suit a range of well conditions
- Multi-fiber design enables multi-parameter measurements in the wellbore
- Cable design withstands harsh-environment downhole installations
- Installation technique isolates and protects the cable from stress, thus enhancing reliability throughout the life of the well

Specifications

Construction

Conductor	Solid copper - 18 AWG Copper
Optical fibers	Up to 4 fibers, single-mode or multimode
Insulator	Natural FEP
Filler layer	Solid FEP Material
Tubing material	316L stainless steel or Incoloy 825 alloy
Tubing OD, in. (mm)	0.25 (6.35)
Tube wall thickness	0.035 in. (0.89 mm)

Physical Properties

Continuous maximum operating pressure	INCOLOY 825: 20,000 psi (1,379.03 bar)
Collapse pressure	INCOLOY 825: 40,000 psi (2,758.06 bar)
Weight, bare	INCOLOY 825: 162 lb/1,000 ft (241 kg/1,000 m)
Ultimate tensile load	2,600 lb (1,180 kg)

INCOLOY is a registered trademark of Special Metals Corporation

ForeSite® Sense Hybrid

Hybrid Optical/Electrical Downhole Cable

Specifications (continued)

Electrical Properties

Armor DC resistance at 68°F (20°C)	INCOLOY 825: 22.5 Ohms per 1,000 ft INCOLOY 825: 73.8 Ohms per 1,000 m
Capacitance, conductor to tube	27 pf/ft (88 pf/m)
Conductor DC resistance, at 68°F (20°C)	7 Ohms per 1,000 ft (23 Ohms per 1000 m)
Voltage rating	1,000 Vdc
Insulation resistance (minimum)	3600 Mohm per 1000 ft (11,800 Mohm/Km)

Typical Encapsulation Options

Material	Material Temperature Rating
Polypropylene	302°F (150°C)
Santoprene	302°F (150°C)
Nylon 11 (Rilsan)	275°F (135°C)
PVDF	302°F (150°C)
ETFE (Tefzel)	302°F (150°C)
ECTFE 350LC	302°F (150°C)
ECTFE 902 (Halar)	347°F (175°C)
FEP	392°F (200°C)
MFA/PFA	392°F (200°C)

ForeSite® Sense Hybrid

Hybrid Splice Kit

The ForeSite Sense hybrid splice kit provides a compact, low-profile connection for in-well hybrid cables used for optical sensing, electrical communication and power. It is pressure testable, for verification of sealing components and functionality.

Features and Benefits

- Compact hybrid splice facilitates connections for optical/electrical cable designs.

Specifications

Working pressure	17,500 psi (120.6 MPa)
Maximum test pressure	15,000 psi (103.0 MPa)
Operating temperature	1.4 to 347°F (-17 to 175°C)
Number of optical fibers (any combination sm or mm)	Up to 4
Conductor	#18 A.W.G. Copper
Approximate length	36.6 in. (930 mm)
Approximate diameter at union	0.75 in. (19 mm)

ForeSite® Sense Hybrid

Cable Protector

The ForeSite Sense cable protector supports single or multiple cables and control lines outside the tubing to prevent damage or stretch where the cable or control line crosses pipe joints, safety valves, crossovers, and other associated downhole hardware.

Weatherford provides a wide range of cable protectors to suit different types of well-monitoring applications. The type of cable protector required depends upon completion configuration, wellbore geometry, and well type. The cable protector is customized for specific tubing sizes, thread types, materials, coupling dimensions, number of cable or control lines, encapsulation size of cable or control lines, and overall dimension requirements inside the casing.

The one-piece assembly has no loose parts, with the bolting inbuilt to the protector. Using a pre-engaged swing bolt enables easy fitting and torqueing during installation, which saves rig time and reduces the risk of cable damage. If needed, cable protector refurbishment is offered where practical.

The protectors, which are ductile yet hard-wearing and reliable, are highly resistant to steady-state shock and shock loads. The standard protectors withstand high axial loads up to 30 tons (67,200 lbf) and high lateral loads up to 20 tons (44,800 lbf).

Protector material is all-cast carbon steel or stainless steel, which conforms to NACEMR0175 for sour wells. For optical or electronic cables, Weatherford provides predominantly cast-cross-coupling protectors as a safe means of deploying cable in the well. Other alloys suited for harsh environments are also available. Advanced polymers are offered for low friction and superior impact resistance.

Features and Benefits

- Bolting system locks the protector in place with a close fit over the coupling.
- Bolting or tightening torque resists axial and rotational lateral movement.
- Contoured profile mitigates the potential for impact while running or pulling the completion string by deflecting the cable away from damaged casing and production string hang-ups.
- Angled or chambered profile protects the bolting mechanism against running hang-ups.

ForeSite® Sense Hybrid

Cable Protector (continued)

Specifications

General	Wiper Blade	I-Wire	Cast/Strapped X-Coupling	Stamped X-Coupling	Polymer X-Coupling
Well geometry	Vertical, no deviation, no dogleg	Vertical, no deviation, no dogleg	Any well deviation through horizontal	Any well deviation through horizontal	Any well deviation through horizontal
Applications	Single, 1/4-in., bare line only	Up to 2 1/4-in. lines	For any cable and line combination and encapsulation	Up to five bare lines or three encapsulated cables	For any cable and line combination and encapsulation
Outer diameter*	2-7/8 to 3-1/2 in. (50.8 to 76.2 mm)	All tubing sizes	All tubing sizes	All tubing sizes	All tubing sizes
Length	15 in. (381 mm)	18 in. (457.2 mm)	Varies upon design criteria	Varies upon design criteria	Varies upon design criteria
Make-up	Pneumatic or manual with 3/4-in. banding	Pneumatic or manual with 3/4-in. banding	30-ft/lb (40.7-N•m) captive bolts	Pneumatic or manual with hinged tapered pin	30-ft/lb (40.7-N•m) captive bolts
Casing size	5 to 6-5/8 in. (127 to 168.3 mm)	4-1/2 to 6-5/8 in. (114.3 to 168.3 mm)	5-1/2 to 9-5/8 in. (139.7 to 244.5 mm)	5-1/2 to 9-5/8 in. (139.7 to 244.5 mm)	5-1/2 to 9-5/8 in. (139.7 to 244.5 mm)
Casing weight	20.3 to 50.4 lb (9.2 to 22.9 kg)	18.8 to 20 lb (8.5 to 9.1 kg)	User specified	User specified	User specified
Special protector**	N/A	N/A	Available	Available	Available

* Protector clearance with tubing and casing combinations are verified for each completion

** SSSV, SSAV, GLM, injection valve, ICD/ICV, and X-overs

Note: Selection criteria and final cable protector programmed are project specific. Torque and drag, and tubing-stress-analysis tools, will support the final choice.

ForeSite® Sense Hybrid

Tubing Hanger Termination Kit: Bend Restrictor for Tubing Encapsulating Cable (TEC)

The ForeSite Sense bend restrictor for 1/4-in. downhole instrument cables prevents cable damage at high stress points at the top of the tubing hanger. The tubing bend restrictor is placed at the fitting on top of the hanger to prevent the cable from breaking at the fitting and to prevent the minimum bending radius of the cable from being exceeded.

The 1/4-in. TEC is typically fed through the tubing hanger on dry trees. The TEC is normally sealed off with one or two metal-to-metal seal fittings, with one on top and one on the bottom of the tubing hanger. Further, the cables are normally wrapped once or twice around the neck of the tubing hanger before landing the hanger. During the landing process, pinching or breaking of the Instrument TEC cable can occur. The bend restrictor reduces the probability of cable damage.

Features and Benefits

- Sizes available for 1/8-, 1/4-, 3/8-, and 1/2-in. tubing fittings; adapters for other sizes or configurations are available upon request.

Tubing Hanger Termination Kit: Tubing Hanger Feed-Through Fitting

The ForeSite Sense tubing hanger feed-through fitting provides a pressure barrier at the point of entry between the tubing hanger and the cable. TEC downhole Instrument cables are typically fed through the tubing hanger on dry trees and are sealed off with one or two metal-to-metal seal fittings.

Features and Benefits

- Metal fitting alloys are available in either Inconel or stainless steel.
- Fitting configuration uses common rear and front ferrule metal seals.

ForeSite® Sense Hybrid

HWHO-A Hybrid Wellhead Outlet Kit

The ForeSite Sense HWHO-A hybrid wellhead outlet kit accommodates the feed-through and exit of hybrid optical/electrical downhole cable from a platform or onshore wellhead. This outlet kit provides a reliable feed-through for transmitting in-well pressure and temperature data and also transmits power to the downhole gauges. The HWHO-A is manufactured to suit client requirements in terms of compatibility with flange size and material specification. Construction designs accommodate maximum service temperatures up to 302°F (150°C). CO_2 and acid service are provided as per customer requirements.

Features and Benefits

- Hybrid wellhead outlet provides safe, reliable connections for downhole hybrid optical/electrical cable designs.
- Outlet testing meets API 6A specifications with optional API 6FB certification.
- Multi-fiber pass-through design facilitates multi-parameter measurements in the wellbore.
- Outlet pressure-testing capability enables confirmation of fully engaged seals upon installation.
- Outlet sour service rating obtained in compliance with NACE MR 00175/ISO 15156.

Specifications

Version	Version HT	Version HT-6FB	Version MT
Working pressure	15,000 psi (103.0 MPa)		
API 6A rating*	-20°C ≤ T ≤ 150°C FF-NL PSL 3	-20°C ≤ T ≤ 150°C FF-NL PSL 3	-20°C ≤ T ≤ 100°C FF-NL PSL 3
ATEC/IECEx rating	Ex e IIC T3 Gb		
Fire tested API 6FB	No	Yes	No
Number of optical fibers (any combination SM or MM)	Up to 4	1 or 2	Up to 4
Ambient temperature	4 to 302°F (-20 to 150°C)	4 to 302°F (-20 to 150°C)	4 to 212°F (-20 to 100°C)
Primary barrier	Metal-to-metal seal		
Secondary barrier	Glass to metal for Electrical / Metal to epoxy for Fiber		
Maximum current	3A Single/dual conductor 3A triple conductor	3A Single/dual conductor 3A triple conductor	5A Single only
Maximum peak voltage	275 V (up to 440V**)	275 V (up to 440V**)	450V
Ingress protection	IP54 min	IP54 min	IP68
Approximate dimensions	735 mm (29 in.) length 367 mm (14.5 in.) diameter	735 mm (29 in.) length 367 mm (14.5 in.) diameter	68 6mm (27 in.) length 392 mm (15.5 in.) diameter

* Other options available – PR2 and PSL 3G
** Dependent on ATEX temperature range requirements

ForeSite® Sense Hybrid

Electrical Surface Instrument Cable

The ForeSite Sense electrical surface instrumentation cable provides electrical power connection and signal communication from the wellhead outlet to the surface instrument system. This Gardex® FieldBus cable is a 600 volt, 18 AWG shielded twisted pair instrumentation cable with XLPE insulation. It is approved for Class I, Zone 1 locations.

Gardex FieldBus cable is flexible, with impervious armor that prevents the entrance of water, gas and corrosive elements into the electrical core. It may be installed in tray, duct, conduit, self-supported or direct burial applications.

Features and Benefits

- Completely self-contained fieldbus communication cable is suitable for use in harsh environments.

Specifications

General

Wire size (AWG)	18 AWG
Number of pairs	1 (multi-pair available)
Inner jacket thickness	0.04 in. (1.02 mm)
Armor thickness	0.025 in. (0.64 mm)
Armor diameter	0.54 in.(13.7 mm)
Outer jacket thickness	0.05 in. (1.27 mm)
Nominal overall diameter	0.65 in. (16.51 mm)
Approximate net weight	182 lb per 1000 ft (597 kg per 1000 m)
Temperature rating	-94 to 194°F (-70 to 90°C)
Insulation	Passes ASTM D 746-04 brittleness temperature impact test at -103°F (-75°C) Passes MIL-C-13777 cold bend test at -85°F (-65°C)
UL listed	NEC Type MC, UL 1569 NEC Type MC-HL, UL 2225
UL approved and marked	FT-4 designation (flame test) -40°F (-40°C) meeting cold impact requirement of CSAC22.2 No. 0.3

Construction

Conductor	18 AWG, 7 strand annealed tin copper, Class B strand per ASTM B-8 and B-33
Insulation	Cross-linked polyethylene (XLPE)
Shielded pair	Twisted with tin copper drain wire and aluminum foil shield
Shielded pair jacket	Flame-retardant black ARCTIC Grade PVC
PVC armor	Continuously welded and corrugated aluminum

Electrical

Impedance	100 ohms
Mutual capacitance,	17 pf per ft (55.8 pf per m)
Inductance	0.17 µH/ft (.56 µH/m)
Conductor resistance at 68°F (20°C)	7.34 ohms per 1000 ft (24.1 ohms per 1000 m)

Gardex is a registered trademark of Rockbestos-Suprenant Cable Corporation.

ForeSite® Sense Hybrid

Surface Fiber Optic Cable

ForeSite Sense surface fiber optic cable consists of a zero-halogen-polyolefin outer jacket containing four polyester elastomer buffered fibers surrounded by an aramid yarn strength member.

Specifications

Optical Fibers

Optical fiber numbers	50 H (1 and 2)	010X (3 and 4)
Applicable specifications	CCITT G.651 & IEC 60793-2-10 Type A1a	CCITT G.652B & IEC 60793-2-50 Type B1.1
Fiber type	Graded Index, multi-mode	Single-mode
Core diameter	50 µm ± 2.5 µm	8.3 µm nominal
Cladding diameter	125 µm ± 2 µm	125 um ± 1 um
Coating diameter	245 µm ± 10 µm	
Attenuation	< 3.50dB/Km @ 850nm < 1.50dB/Km @ 1300nm	< 0.70 dB/Km @ 1310nm < 0.70 dB/Km @ 1550nm
Proof test	100 Kpsi	

Mechanical Properties

Outer jacket OD	0.230 in. (5.84 mm)
Maximum Installation tension (IEC 60794-1-E1)	225 lb (1000 N)
Maximum operating tension (IEC 60794-1-E1	91 lb (400 N)
Crush (IEC 60794-1-E3)	700 N/cm
Impact (IEC 60794-1-E4)	1.0 N-m
Cable bend (IEC 60794-1-E11)	20 N, 10 Cycles
Minimum bend radius installation	4.4 in. (11.2 cm)
Minimum bend radius operating	2.2 in. (5.6 cm)
Cable weight	22 lb/1000 ft (33 kg/km)

Environmental Properties

Storage temperature	-40 to 176°F (-40 to 80°C)
Operating temperature	-4 to 176°F (-20 to 80°C)

ForeSite® Sense Hybrid

Surface Data Acquisition Unit

The ForeSite Sense surface data acquisition system collects data collection from the quartz pressure and temperature gauge. This stand-alone system monitors up to 64 quartz PT gauges in up to 16 wells. This surface system is capable of high-speed data transfer, connectivity, and data storage. It provides continuous service in harsh environments including desert, swamp, platform, and low temperature environments. Power requirements are suitable for use with solar arrays or thermoelectric generators.

The system is fully compatible with Weatherford reservoir monitoring system software including Admin Client, SCADA, Launcher, Data Viewer, Web Data Viewer, Database Reporting Tool, DCE Triggering Tool, and PanQL™ software (auto-transient quick look). A Windows®-based operating system requires no custom programming.The unit provides remote access to real-time and historical data through a web-browser.

The surface data acquisition unit has been assessed and certified to the requirements of the European Union ATEX Directive 94/9/EC as Ex nA IIB T4 Gc IP66 (-20°C ≤ Ta ≤65°C) for installation and operation in flammable gas atmospheres it is marked as Group II Category 3 G (Class I, Zone 2).

Features and Benefits

- Modular design enables phased implementation for multi-well and multi-gauge projects to ease the integration of future installations.
- Easy setup and field termination offer fast and trouble-free installations with all output options and configurations performed at the wellsite.
- Fast data rates enable data recording at the highest density irrespective of transfer rate to the client SCADA or server, enabling detailed analysis of any production anomalies.

Specifications

General

CPU	Arbor Ares-530WT with Intel® Atom™ E3845, 1.91 GHz processor
Memory	DDR3L RAM 4 GB, 1333 MHz
Operating system	Windows
Software	Web-viewer reservoir monitoring software controlling data collection, storage, display, and I/O output
Display	4-line by 20-characters, vacuum florescent
Power (approximate - application specific)	18 to 36 VDC or 85 to 264 VAC input, 55W maximum power consumption
Bandwidth capability	Up to 64 gauges
Update rate selectable range	1 second to no limit
Data storage	Up to 2 years
Units	Configurable (metric, imperial, oilfield)

Communications

Serial port	One RS232, one RS422 or RS485 selectable
Ethernet	Two ports, 10/100/1000 BaseT
Protocol	Modbus ASCII, Modbus RTU, Modbus TCP/IP, OPC version 1.0 and 2.0, CSV ASCII, formatted ASCII

ForeSite® Sense Hybrid

Surface Data Acquisition Unit

Specifications (continued)

Physical

Overall dimensions	32.5 H x 26 W x 10.35 D in. (826 H x 661 W x 263 D mm)
Mounting dimensions	Four 3/8 in. (10 mm) bolts
Horizontal mounting spacing	18 in. (457 mm) centers
Vertical mounting spacing	31.25 in. (794 mm) square pattern
Weight	95 lb (43.1 kg)
Enclosure material	316 stainless steel

Environment

Operating temperature	-40° to 140°F (-40° to 65°C)
Relative humidity	95% non-condensing
Certification markings	ATEX, CE
Transportation vibration	NAVMAT P9294 section 3

ATEX Certifications

Standard	Group II, category 3 G (Class 1, Zone 2)
Optional	ATEX directive category II GP 11B for use in Zone 1 hazardous locations

ForeSite® Sense Hybrid

Interrogation Unit

The ForeSite Sense interrogation unit querries quartz PT permanent downhole gauges to provide pressure and temperature monitoring. The primary function of this rack-mounted unit is to send raw PT gauge data to the surface acquisition unit so that Weatherford software can convert the data to processed pressure and temperature information based upon calibration values for each specific sensor.

The secondary function is to monitor and control the downhole quartz PT gauges through commands sent to the downhole interface (DHI) card to enable or disable power. It also receives diagnostic and state-of-health information from the downhole quartz PT gauges.

All the sensor connections and the data interface connections are accessed through the interrogagtion unit front panel. The front panel is accessible by pulling the handles on the front cover and allowing the cover to rotate in a downward direction. Only AC main power is connected to the back.The interrogation unit is 3U high (5.25 in. of rack height) and has a perforated cover on the top and bottom for cooling. 1U of space is required above and below the unit and other rack items to allow cool, dry air to move through the chassis. The 1U cable management tray included on the bottom of the unit will satisfy cooling-space requirements for the bottom of the unit. A total of 5U (8.75 in. of rack space) is required for ideal installation. The unit dissipates less than 100 W (128 quartz PT gauges connected), when operating.

The interrogation unit accommodates up to eight third-generation DHI cards that can each communicate to a downhole telemetry line (downhole tubing encapsulated cable—TEC). Each single conductor TEC cable can have up to 16 individual addressable quartz PT gauges. Thus, a single rack mount interrogation instrument can receive data from up to 128 quartz pressure-temperature gauges.

Features and Benefits

- Multiple port Ethernet switch facilitates interconnection with all DHI cards; a serial port bus accommodates legacy connections.
- Moderate operating range withstands temperatures from 41 to 104°F (5 to 40°C).

Specifications

General

Design life	25 years
Maximum number of Quartz PT gauges interfaced per rack	128

Outputs

Communications	Ethernet RS422/RS485
DHI to wellhead	Type: One twisted-pair plus shield ground Connector: Spring release terminal Output signal: Up to 50 VDC at 200 mA

ForeSite® Sense Hybrid

Interrogation Unit

Specifications (continued)

Input Power

Frequency	50 to 60 Hz nominal AC single phase, operating range 47 to 63 Hz
Operating voltage	Universal 85 to 265 VAC
Current	2.5 Amps maximum

Physical

Dimensions (W x D x H)	Standard 19-in EIA rack-mount 3U high 19 in. x 14.5 in. x 5.25 in. (483 mm x 369 mm x 133.4 mm)
Weight	Approximately 18 lb (8.2 kg), depending upon exact DHI count configuration

Environmental

Operating temperature:	+5 to +40°C (41 to 104°F)
Storage temperature:	-40 to +85°C (-40 to 185°F)
Humidity:	0 to 85% non-condensing
Maximum operating elevation:	3,050 meters (10,000 feet)
Shock and vibration:	Transportation vibration Navmat P9294 profile random vibration 10 minutes per axis six Grms, non-operating. Operational vibration 0.1 g sweep 0.1 octave/minute 5 to 100 Hz, 90 minutes per axis (TelecordiaGR-63-CORE for network equipment operation) Shock 10 g, peak 2-ms half sine in each of three axes
Enclosure:	IP Rating: IP 20 – Closed to ingress of objects larger than 12.5 mm and not water protected. For indoor use only. Suitable for use in Pollution Degree 2: (where) normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected.
EC directive(s)	Directive 2006/95/EC, Low Voltage Directive
Applicable standards	EN 61010-1:2010, Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1 General requirements

ForeSite® Sense Hybrid

Data Acquisition System

The ForeSite Sense data acquisition system collects and distributes real-time pressure and temperature data from Weatherford quartz gauges. This standalone system can monitor up to 32 pressure and temperature gauges in harsh environments, including desert, swamp, and arctic settings. It can withstand extreme weather conditions ranging from -22 to 149°F (-30 to +65°C).

The data acquisition system uses a 24 VDC input with a low current draw. This Class I Zone 2 ATEX-certified system is capable of high-speed data transfer and storing more than 6 years of data at a sample rate of once per second. The ability to initiate 'smart' trigger logging to record transients is standard in all systems. It can be configured to log at any user-defined rate and comes standard with digital and analog inputs and outputs to meet a wide range of field applications.

Features and Benefits

- Compact, powder-coated enclosure with an external visor facilitates on-site data viewing and configuration using the enhanced graphic display (EGD) and keypad or human machine interface (HMI) graphical touchscreen.
- HMI touchscreen display enables visualization of data charts, historical data or point-to-point data in real time with a single touch of the screen.
- Built-in web page interface enables on-site or remote configuration of output and setup options, for enhanced programming flexibility.
- Automatic control logic (ACL) offers flexibility and structured text programming for ease of system configuration.
- High-density data via secure digital (SD) card or universal serial bus (USB) download enables detailed analysis of production anomalies.

Specifications

Environmental

Temperature rating	EGD display models: -22° to 149°F (-30° to 65°C)
	HMI models – graphical touchscreen -22° to 140°C (-30° to 60°C)

Power Requirements

Electrical rating	85 to 230 VAC, 50/60 Hz (AC model)
	18 to 32 VDC (DC model)
Power	Single-gauge system: 23.2 W
	Fully loaded system: 33.5 W

Physical Properties

Physical size (W×D×H)	15.8 in. × 10.5 in. × 17.12 in. (401.3 × 266.7 × 434.85 mm)
Mounting type	Wall or pole (pole with standard mounting kit)
Weight	44 lb (19.95 kg) – standard powder coated enclosure
	55 lb (24.9 kg) – marine stainless steel enclosure

Weatherford®

ForeSite® Sense Hybrid

Data Acquisition System

Specifications (continued)

Communications

Optional Wi-Fi	Plug-on
Serial	RS232, RS485
Ethernet	10BaseT

Inputs/Outputs (Standard Configuration)

Digital inputs (DI)	Two each
Analog output (AO)	One, isolated, configurable for content selection
Analog inputs (AI)	Two, configurable 1 to 5 V, 4 to 20 mA

Gauge Properties for Gauge Interface Card (DHI)

Maximum number of DHI	2
Maximum number of gauges	32

Logging Capabilities

Maximum update range	1 second
Data storage (SD card)	> 6 years at maximum update rate (for 8GB SD Card and single gauge)

Firmware Upgrades

Available via preprogrammed SD card or via Weatherford Configuration Manager (WCM)

Standard Certifications

ATEX	II 3 G Ex nA IIB T4 Gc, -30ºC ≤ Ta ≤ +65ºC for EGD (enhanced graphic display models)
	II 3 G Ex nA IIB T4 Gc, -30ºC ≤ Ta ≤ +60ºC for HMI (human machine interface – color touchscreen)

ForeSite® Sense Hybrid

Distributed Temperature Sensing

The ForeSite Sense distributed temperature sensing (DTS) system delivers a wellbore thermal profile 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 with all ForeSite Sense monitoring solutions.

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	Wh-DTS-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 Hybrid

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)	

*** Dimensions exclude protective cap of optical connector

ForeSite® Sense Hybrid

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 with all ForeSite Sense reservoir monitoring solutions.
- 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 Hybrid

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 Hybrid

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 Hybrid

DTS Distributed Temperature Sensing Unit

ForeSite Sense DTS distributed temperature sensing units deliver wellbore thermal profiles and analysis for the entire length of optical fiber. The DTS capability 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. Weatherford 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 ForeSite Sense 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 with all ForeSite Sense reservoir monitoring solutions.
- 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

ForeSite® Sense Hybrid

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	

ForeSite® Sense Hybrid

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