sense the difference

Distributed-sensing based hydraulic fracture monitoring and seismic acquisition

www.silixa.com

Fracture monitoring with Silixa's ArrayFrac™ service

Installation type: permanent

Completion and fracture operations in unconventional wells can comprise 50% or more of the total well cost. Silixa's ArrayFrac™ fracture monitoring services maximise well productivity, placement and cost.

The application of distributed fiber optic measurements is allowing operators to have a better understanding of different completion designs and how they can optimize those designs for specific formations and basins. Silixa is focused on delivering high quality, high resolution acoustic (iDAS™) and temperature (ULTIMA™ DTS, XT-DTS™) measurements that are setting the standard in the industry.
Silixa's iDAS provides a true acoustic measurement in amplitude, phase, and frequency with an industry leading spatial resolution as fine as 6.5 feet (2m). This allows us to provide higher resolution, higher quality real-time data for completion allocations that allow operators to make real-time completion decisions on wells being fracked and future decisions on the optimum frac design. Typically, the optical fiber cable will be placed on the outside of the production casing on a plug and perf completion. The optical fibers provide an in-situ sensor array that makes it possible to acquire temperature and true acoustic information at every point along the cable path.

Acoustic and temperature data is acquired continuously giving the user a complete picture of where fluid and proppant are going in the well. Individual perforation clusters show up as active or inactive and more detailed analysis of the data indicates the relative amount of slurry and sand that is taken by each cluster in a stage giving unique insight into the effectiveness of the fracturing process.
Silixa's fracture monitoring package includes a mixture of real-time visualization, near-real-time processing and display and post survey analysis designed to give the stimulation engineer the tools to make confident on-the-fly decisions about pumping, rapid decisions about the adjustment of subsequent stages, and properly informed decisions about future well placement and completion strategy based on fundamental acoustic and temperature responses to fluid movement.

Silixa can integrate third party data, such as depth based petrophysical logs and time based pump pressures, into the larger data set so that composite data presentations give the end user a comprehensive view of the downhole environment and stimulation conditions.

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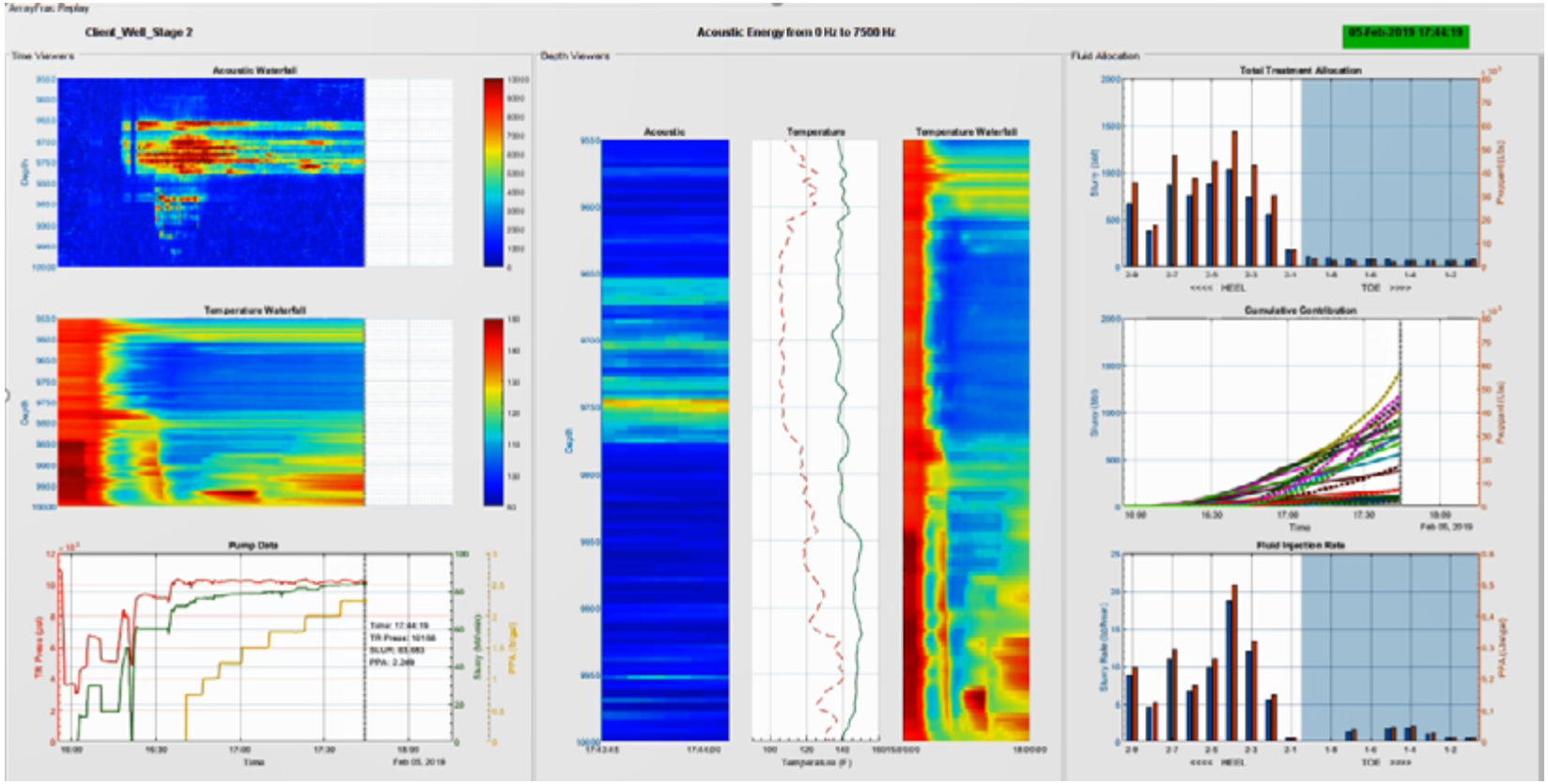
Installation type: permanent

Click to activate



Top left: DAS and DTS waterfall plots during frac treatment displaying activity at each perforation cluster and any acoustic or thermal activity below mechanical plug depth

Bottom Left: Frac treatment data over the pressure pumping interval for individual stage (sync in time with the DAS and DTS waterfall plots)

Center Panel: DTS curves showing pre injection temperature baseline and real-time temperature curve

Top Right: Bar chart of the real-time treatment allocations of slurry and proppant of both the current treatment stage and the previous treatment stage (in blue highlight)

Center Right: Line chart of the real time treatment allocations of slurry and proppant for the active stage, a change in slope indicates a change in fluid volume

Bottom Right: Bar chart of the cumulative treatment allocations by perf cluster for current treatment stage and the previous treatment stage (in blue highlight)

Fracture monitoring with Silixa's ArrayFrac™ service

Installation type: permanent

Key benefits

- Actionable information from the treated well
- Instantaneous answers about fluid and proppant placement
- Confirm completion integrity
- Decide when to use diversion and then monitor effectiveness
- Make informed adjustments to subsequent stages to better exploit the shale
- Optimize future well placement and spacing based on real well information

Data & answer products

- Real-time allocations for slurry and proppant
- Enhanced diversion determination
- Animated integrated fracture allocation deliverables
- Multi-stage allocation analysis
- Active and passive stage allocation

Silixa technology strength

- Phase coherent acoustic measurements
- Higher resolution data
- Accurate & consistent allocation of slurry/proppant
- Leading distributed acoustic spatial resolution better than 10 feet (3m)
- Rapid DTS measurement capability, as fast as 1s, with spatial sampling from 4.9 inches (12.5cm)

Crosswell monitoring - ArrayXwell™

Installation type: permanent

Silixa's ArrayXwell™ service accurately locates microseismic and strain events in real-time, allowing operators to improve stimulation and completion designs to maximize recovery.

Distributed acoustic sensing based microseismic monitoring delivers greater insight into the subsurface hydraulic fracturing dynamics than conventional methods, offering detailed information on reservoir stability and fluid flow paths.

Large aperture & higher data quality

Conventional microseismic surveys, acquired using geophones in observation wells, typically will have 12-40 receivers. Either the receiver spacing, array length or both will be less than optimal. Distributed acoustic sensing (iDAS™) captures acoustic energy every meter along a sensing cable installed either in an observation well or the stimulation well itself. The fiber may be permanently in the cement or temporarily inside the casing.

Silixa's advanced sensing architecture provides noise reduction superior to other DAS systems, which is critical for microseismic event detection thresholds and hypocenter location accuracy. The result for the client is vital information on the hydraulic fracture zone, enabling improvements to stimulation operations, wellbore spacing and wellbore azimuth.

Data acquisition even in the treatment well

A serious deterrent to using geophones is the possible long-term damage to the monitor well during shut in. This limitation is removed for DAS, since no shut in is required. In addition, the unavailability of a nearby monitor well is not a factor if the treatment well is also the monitor well. Geophone tools in the treatment well would be destroyed by the proppant; however the DAS fiber is outside the casing, providing significant immunity to damage.

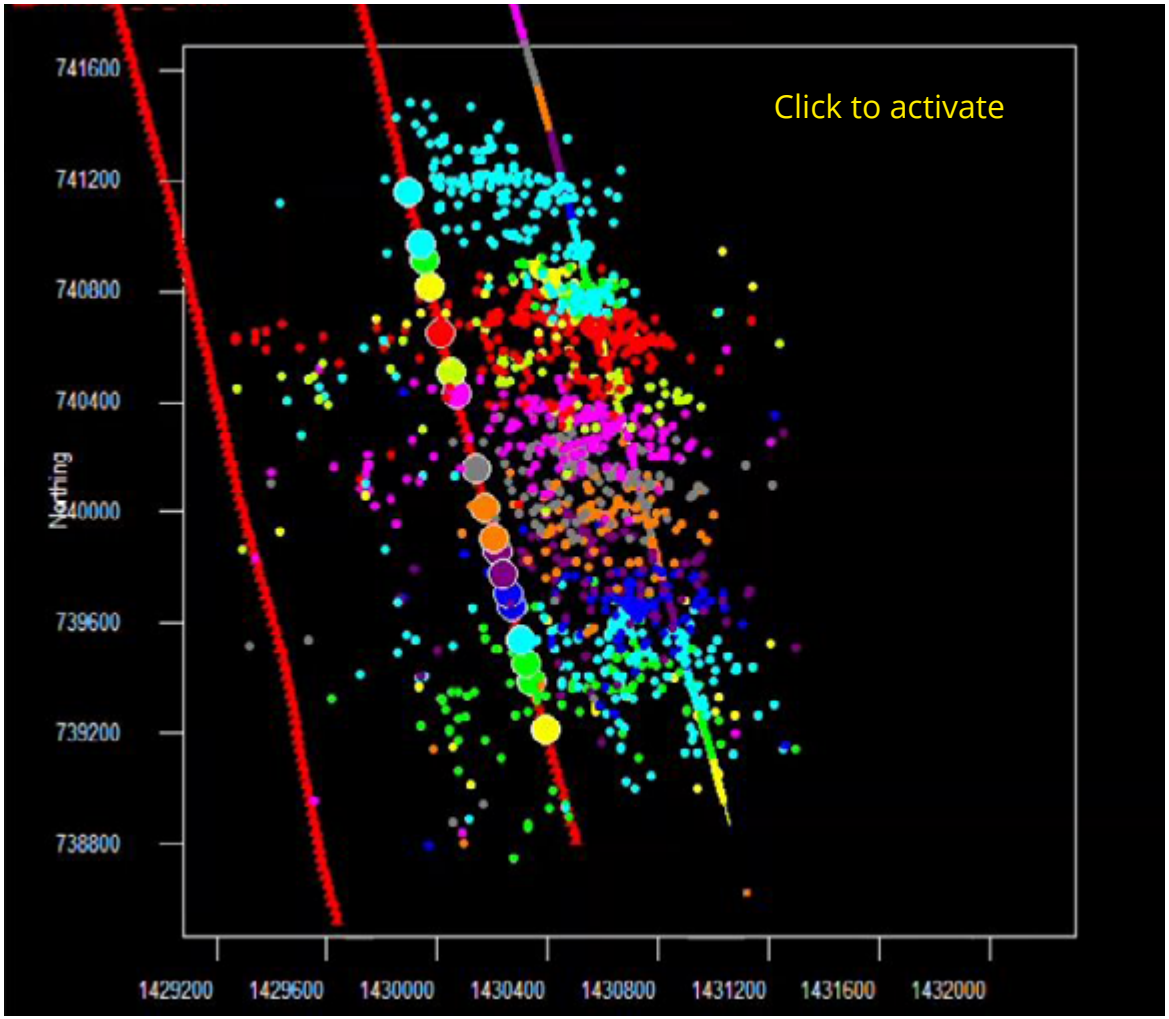
Cost-effective solution

Vertical Seismic Profiles (VSP), strain and perf allocation surveys can be done with either ArraySeis or/and Carina® Seismic, the same array, so no additional installation costs are required. Once the array is installed, all five of our downhole surveys are possible:

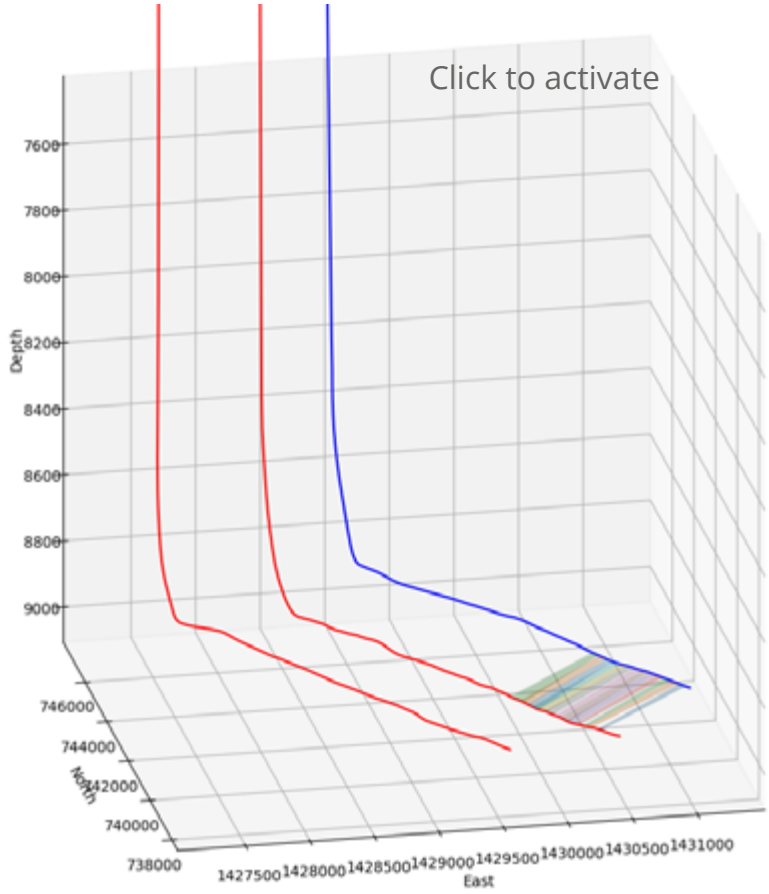
- Hydraulic fracture microseismic monitoring
- Hydraulic fracture strain monitoring
- Production strain monitoring
- Flow allocation monitoring
- VSPs

Carina® XwellXpress - Microseismic monitoring

Installation type:
permanent or intervention



Fiber optic array – red
Treatment well – color by stage
Microseismic events – color by frac stage co-located in real-time
Frac hits – large dots color by frac stage



Frac Hit Corridor mapping
Overlaps and gaps observed

Fracture flowback monitoring with Silixa's ArrayProfile™ service

Installation type:
permanent or intervention

Our ArrayProfile™ fracture flowback monitoring services offer a better way to understand reservoir response to fracturing operations by providing valuable intelligence for multi-well pad operations.

Phase-coherent distributed acoustic data (iDAS™) together with the highest resolution temperature data (ULTIMA™ DTS, XT-DTS™) captured during the initial production provides operators with rapid feedback concerning the highest producing stages.

Advanced and intuitive sensing technology

Flowback following stimulation is accompanied by a broad range of thermodynamic and acoustic effects, many of which can be measured easily using Silixa's advanced distributed sensing technology. Warmback dynamics impart low frequency strain onto the fiber, leading to signals which can be made visible owing to Silixa's uniquely stable optoelectronics architecture. High producing perforations generate noise which can be measured and evaluated to reveal information relating to the magnitude and physical nature of the flowback fluid.

One solution for the well lifetime

As stimulated wells evolve, the change in produced flow from highly liquid to nearly 100% gas can present challenges for conventional sensors. Silixa's distributed sensing suite, comprising iDAS, ULTIMA DTS and XT-DTS, provides tools for understanding early flowback conditions. Our ultra-sensitive temperature sensing system, which can be deployed on singlemode and multi-mode fibres alike, provides operators with an approach for monitoring Joule-Thomson cooling, even in late stage, low producing conditions.

Cost-effective

iDAS life of well monitoring technology is cost-effective, as the cost of fiber deployment alleviates the need for costly wireline operations and can be spread across the pad lifetime. In addition to flowback monitoring, a permanently installed fiber optic cable can be used for:

- Hydraulic fracture monitoring
- VSPs
- Microseismic
- Production profiling over time
- Artificial lift optimization

Carina® Seismic - complete clarity

Installation type: permanent or intervention

Carina Seismic service delivers high-accuracy, repeat seismic on demand without interrupting production or risking infrastructure. By utilizing Silixa's new family of engineered Constellation™ cables the Carina® Sensing System offers numerous benefits beyond conventional geophones for seismic data acquisition and permanent reservoir monitoring.

Performance beyond geophones

With the combination of up to 20dB improvement in SNR, fine spatial sampling and full wellbore coverage for every shot, Carina Seismic data offers unprecedented detail in every shot record.

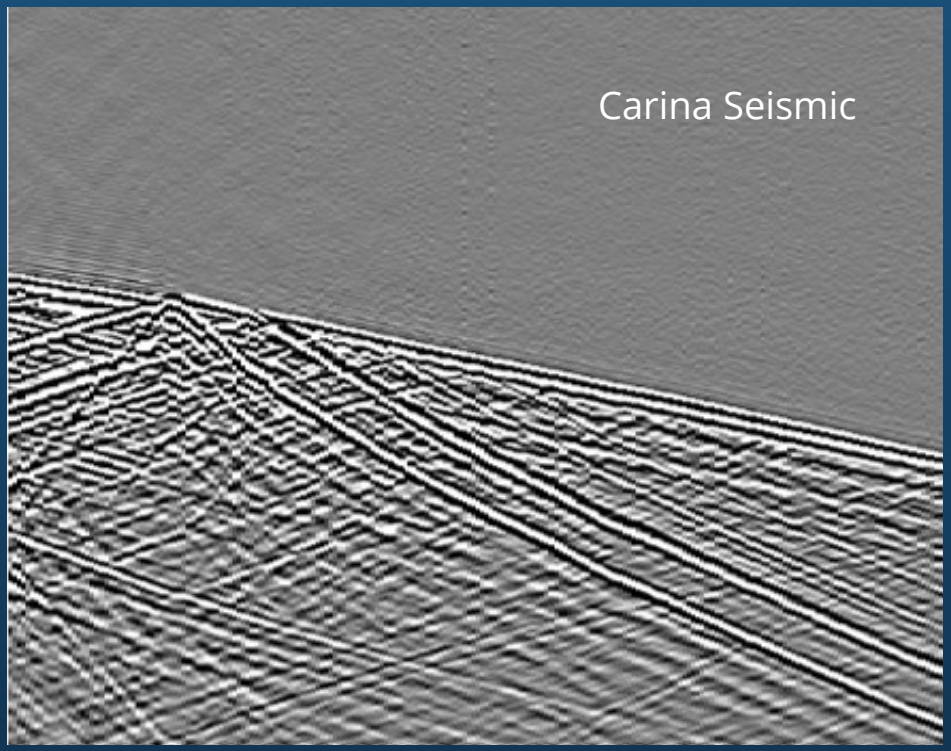
Recent field data shows a direct comparison between Carina Seismic and conventional wireline geophones. The test involved acquisition in a well with a Constellation enabled fiber-optic cable cemented behind the casing with wireline geophones deployed in the same well. The seismic source was a 26,000lb vibroseis situated approx. 700m from the wellhead.

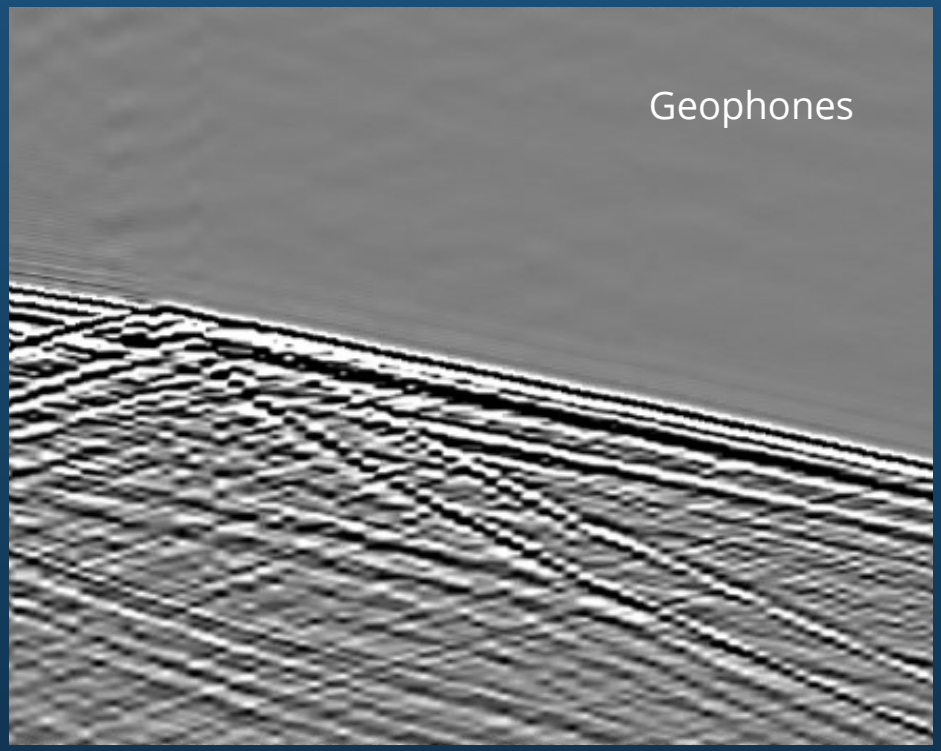
This data, collected at the CO2CRC Otway site, shows how Carina Seismic offers much greater detail in each shot record compared to geophones. Deep reflections are clearer, slower moving signals, such as converted shear reflections, are better resolved.

Carina® Seismic - complete clarity

Installation type: permanent or intervention

Click to activate





Carina Seismic: stack of 5 sweeps, acquired with full wellbore coverage for every shot.
Total acquisition time: ~4mins.

Wireline geophones: stack of 5 sweeps, over 11 tool positions. Total acquisition time: ~4hrs.

*Data courtesy of CO2CRC Ltd

High quality seismic data at a fraction of the time and cost of conventional methods

Carina Seismic achieves full wellbore coverage for every shot, eliminating the need for repositioning a tool at different depths, enabling vertical seismic profiling within minutes instead of hours.

With permanently installed fibers, the receivers are available at all times with no further deployment costs. Repeat surveys can be acquired on-demand at a fraction of the cost, enabling more frequent surveys giving greater insight into changes in the reservoir.

Silixa's new suite of advanced software tools provides real-time field deliverables. Acquisition QC plots are generated at the wellsite to ensure high quality, accurate data is collected. SEGY files, fully populated with accurate source and receiver headers, are generated in real-time.

Silixa has worked closely with some of the world's largest operators to implement IT solutions that enable transfer of data to processing centers around the world. With fast-track processing flows, images can be available a few hours after acquisition for accelerated decision making.

Key benefits

- Higher signal-to-noise ratio offers unrivalled data quality and enables detailed fracture stimulation characterization
- Ability to acquire high resolution treatment, crosswell strain & microseismic, and production data with a single downhole fiber optic cable
- High-quality, high-frequency seismic for 4D mapping of fracture stimulations
- Better understanding of stimulation patterns to optimize well placement and spacing
- High-quality, high resolution crosswell strain & microseismic measurements to optimize frac design

Cable Orientation Beacon - cable mapping service

Installation type: permanent or intervention

Our cable mapping service is a cost-effective, low-risk solution for mapping the orientation of downhole optical sensing cables in order to avoid cable damage at perforation.

The Cable Orientation Beacon (COB) is an autonomous downhole sensor that is installed adjacent to the fiber optic cable (FOC) under a standard mid-joint clamp.

Fiber optic cables installed on the outside of completion casing are at risk of being damaged during perforation. To avoid damaging the FOC the perforation charges are oriented away from the FOC. In order to do this, the orientation of the FOC must be determined when the installation is complete.

Unlike traditional sensors that use wireline electromagnetic or ultrasonic tools inside the casing to detect the presence of the cable on the outside of casing, Silixa's COB measures its own orientation using an internal sensor, then transmits that data to the FOC via an acoustic signal to be detected by iDAS™.

The acoustic signal is read at surface and translated back to an orientation in the form of an angular position around the outside of the casing relative to the high side of the borehole.

Key benefits

- Significantly reduces overall costs by eliminating the need for tractored wireline services
- Can be installed under a variety of cable clamp types
- Eliminates the need for additional hardware on the casing, reducing the cost of fiber installation
- Reduced hardware makes running casing easier and improves chances of a successful cement job
- Provides downhole depth calibration points for the iDAS

Cable Orientation Beacon - cable mapping service

Installation type: permanent or intervention

Click to activate

Why choose Silixa?

We redefine the limits of the possible by delivering the world's highest quality data driven solutions from distributed fiber optic monitoring arrays.

» Originators of both DTS & iDAS technology
Provides integrated solutions and answers

» Supreme sensing array
Finest and adjustable sampling resolution gives maximum flexibility

» World's best resolution data
Highest precision data available

» Truly phase coherent acoustic data
Richer signal content gives more accurate answers

» Deep domain knowledge with fiber optic expertise
To support your decision making with confidence

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