Linear Pro Series
Fiber Optic Temperature Monitoring System

• Production and Injection Well Optimization
• Steam Flood Management
• Completion Integrity
• Artificial Lift Monitoring / Optimization
• Horizontal Well Profiles
Are you looking for a trusted partner?

AP Sensing has more than 20 years of OTDR (Optical Time Domain Reflectometry) expertise. Our Distributed Temperature Sensing (DTS) systems are based on this and other key technologies from Agilent Technologies (formerly Hewlett Packard Co.), the global leader in optical measurements and an innovator in optical design and assembly techniques.

At the core of every AP Sensing DTS system are key and exclusive opto-electronic components from Agilent Technologies in Boeblingen, Germany. These components contribute to AP Sensing equipment reliability, operating range, and lifespan.

At AP Sensing and Agilent Technologies, product quality is the foundation of our business.

Imagine thousands of temperature detection points and you only install one, simple cable!

With AP Sensing’s Linear Pro Series, a continuous sequence of temperature profiles are provided for the entire well. The profiles can be acquired at time intervals of your choice during production, injection and shut-in periods, yielding a complete understanding of the dynamics of the well.

Distributed Temperature Sensing systems use a passive, fiber optic cable as the sensing element. Based on the quantum mechanical Raman Effect and a patented code-correlation measurement technique, a single AP Sensing Linear Pro Series instrument offers accurate temperature profiling at distances up to 12 thousand meter and on 12 independent channels. The Pro Series performs measurements down to a spatial resolution of less than 1 meters with less than 0.1 °C temperature resolution.
Flow Profiling Capability

DTS (distributed temperature sensing) technology gives oil and gas operators a reliable and cost-effective way to better manage reservoirs, wellbores, and completions by monitoring temperature profiles along the entire well at user-selected intervals. These profiles can be used to increase production and improve overall oil and gas recovery.

Flow profiling is the quantitative estimation of the zonal flow contribution of commingled producing wells or the injection distribution injector wells; over the life of the well.

DTS technology performs flow profiling in oil, gas, and water wells at production, injection or shut-in conditions, especially gas producing and water injection wells. DTS is an essential tool to assess the reservoir performance and exercise effective reservoir management. It is very effective for determining differential reservoir depletion, cross-flow between reservoir layers and other near-wellbore effects.

The AP Sensing Advantage

DTS systems are expensive and because most cannot be installed outdoors, require climate-controlled enclosures or buildings; this constraint drastically limits their potential use.

The AP Sensing Linear Pro Series solves this problem, allowing operators to install systems outdoors and on a large scale to help optimize their fields.

AP Sensing Linear Pro Series Features

- Cost-effective deployment, requires NO climate-controlled enclosures or buildings. Durable outdoor housing (IP66 / NEMA 4) with an operating temperature range of -40°C to 60°C; (-40°F – 140°F)
- Can use solar panels, DC or AC power; extremely low power consumption
- Permits multiple well monitoring; integrated switch (up to 12 channels)
- Easy to integrate with network and SCADA solutions; uses standard interfaces
- Industry leading quality, reliability and lifespan expectations
- Provides capability to transmit data directly to the office (cell phone or radio), allowing for remote configuration and troubleshooting; reduces service and support expenses
## DTS Application / Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| **Steam Flood Management**| - Monitor steam movement toward producing wells, thereby improving recovery and optimizing steam utilization  
- Identify steam breakthrough zones using distributed temperature profiles |
| **Completion Integrity**  | - Provide early detection of flow behind casing, completion leaks, underground blowouts and other completion integrity problems |
| **Artificial Lift Monitoring** | - Optimize well performance by monitoring producing fluid levels, pump, and/or motor heat generation for ESP (electric submersible pump) or PCP (progressing cavity pump) installations; as well as annular fluid column height and gas injection entry points for gas lift; and integration them into control systems |
| **Horizontal Well Profiles** | - Identify steam breakthrough or gas entry locations, either with permanently installed DTS systems or retrievable surveys using coiled tubing |
Reliability

Are you looking for a reliable, worry free solution?

AP Sensing’s DTS systems use a “low power” semiconductor laser, proven IC’s and unrivaled manufacturing processes developed over the past 30 years. These design attributes and processes lead to the lowest failure rate, the lowest cost of ownership, and the highest quality DTS system on the market. The optoelectronic components, in the heart of the instrument, are hermetically sealed in inert gas and temperature stabilized by design. The design ensures that sensitive components, and the system at large, are protected from condensation, dust, vibration, shock, corrosion, and harsh environmental temperatures.

Instrument:
- Proven field reliability with industry’s lowest maintenance and warranty cost
- Industry leading robustness against vibration and shock
- Incorporates a hermetically sealed optical block for long life operation
- Highest measurement repeatability throughout the entire operating temperature range
- Remote logging
- Extreme operating temperature range
- Lowest laser output power – inherently safe in operation
- Low power consumption – 15 W typically

Lifespan and quality relies on Agilent's 20 years of OTDR experience, proven ICs and solid manufacturing processes with industries lowest failure rates in photonic test & measurement.

Smart Calibration

Fibers will have different refraction indices; splicing is necessary; there will be the need for junction points and connectors; there may be different stresses inadvertently applied to the fiber; however, AP Sensing designed a flexible and powerful sensor calibration that corrects for these sources of measurement error.

The system automatically corrects for chromatic dispersion and provides an easy to read loss trace just like an OTDR.

Accurate Data

With dual ended operation (two channels connected to one sensor cable), the system automatically corrects for changes in the Stokes / Anti-stokes ratio which results from certain environmental or mechanical effects (e.g. stress, fiber bends, splices, hydrogen darkening). This ensures accurate temperature measurements over the life of the installed fiber.

Communication options:
- Wireless modem
- Radio link
- Satellite
- GSM Modem
- USB - direct link to PC or Laptop
- TCP/IP/Ethernet
- Relays
- SD Card for on board data storage

Protocol options:
- Open, fully documented protocol SCPI
- ModBus RS232; RS485; TCP/IP
- OPC
- National Instruments LabView
- POSC XML (Oil & Gas standard)
- ASCII File easy export / import
Robustness

You operate in extreme environmental conditions!

When it comes to instrument robustness, AP Sensing is the established benchmark; AP Sensing offers the only DTS on the market with ISO 13628-6 certification. This certification, emerging from the offshore oil and gas industry, is one of the toughest tests to pass for shock, vibration, and temperature variations.

ISO 13628-6 Test Coverage & more

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Vibration</td>
<td>6 gms / 10min (5' before &amp; 5' after temperature cycling)</td>
</tr>
<tr>
<td>Chapter 11.3.5</td>
<td></td>
</tr>
<tr>
<td>Sine Vibration</td>
<td>5 to 25Hz / ±2mm.</td>
</tr>
<tr>
<td>Chapter 11.2.5.2.2</td>
<td>25 to 150Hz / 5 g</td>
</tr>
<tr>
<td>Shock Test</td>
<td>10 g / 11ms half sine,</td>
</tr>
<tr>
<td>Chapter 11.2.5.2.1</td>
<td>6 directions &amp; 240 g</td>
</tr>
<tr>
<td>Temperature Cycling</td>
<td>Operating temperature range -10°C to +60°C, 10 cycles</td>
</tr>
<tr>
<td>Chapter 11.3.5</td>
<td>and -15°C to +65°C</td>
</tr>
<tr>
<td>Burn-In / Freeze-In</td>
<td>Burn-in (+65°C) and freeze-in (-15°C), 48hrs each</td>
</tr>
<tr>
<td>Chapter 11.2.5.3 and 11.3.5.2</td>
<td></td>
</tr>
</tbody>
</table>

AP Sensing DTS systems run on the proven, real-time VX Works operating system, which is also used in aerospace systems like the Mars Pathfinder. Unlike traditional Windows based platforms, VX works is extremely stable, not susceptible to viruses or cyber attacks. The instrument operates independently from its communication infrastructure and will continue even with network outages. The equipment is designed for harsh environments and expects power interruptions; it will automatically continue operation within 30 seconds of power being restored. The onboard memory is non volatile.

Our extreme operating temperature range is enabled through the use of a highly integrated optoelectronic block and a unique reference fiber design. The laser, detector, filters and other key electronics are temperature stabilized ensuring accurate measurements over the widest operating temperature range on the market.

Shock proof up to 240G

Vibration tests: operating functional, random survival (5 to 500 Hz, up to 0.02g/Hz)

Temperature & humidity tests: -15 to 65°C operating, -40 to 80°C storage, up to 95% r.H. Humidity, 90% super soak tests 65°C/24h

Products are shock tested: up to 240G on all 6 sides, from up to 93cm

EMC Tests: Conducted, radiated, harmonic emission tests, etc.
Flexibility

Do you have special housing requirements for your DTS application?

AP Sensing DTS systems are designed for various applications. All have the same ruggedness and reliability; however, the different housing options allow you to deploy the equipment in the proper manner.

<table>
<thead>
<tr>
<th></th>
<th>Rack</th>
<th>Outdoor Standard</th>
<th>Outdoor Extreme</th>
<th>Outdoor ATEX Zone 1</th>
<th>Outdoor ATEX Zone 2</th>
<th>Portable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating</td>
<td>-10 to 60°C</td>
<td>-25 to 60°C</td>
<td>-10 to 60°C</td>
<td>-15 to 55 °C</td>
<td>-40 to 40°C /</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>14 to 140°F</td>
<td>-13 to 140°F</td>
<td>14 to 140°F</td>
<td>5 to 131°F</td>
<td>-40 to 104°F</td>
<td></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>15 W typ. 28 W max.</td>
<td>15 W typ. &lt; 40 W</td>
<td>15 W typ. 28 W</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>max.</td>
<td>max.</td>
<td>max.</td>
<td>max.</td>
<td></td>
</tr>
<tr>
<td>Protection Class</td>
<td>IP 66 NEMA 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of</td>
<td>1, 2, 4, 8, 12</td>
<td>1, 2, 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>88 x 448 x 364 mm</td>
<td>500 x 400 x 155 mm</td>
<td>670 x 470 x 250mm</td>
<td>500 x 400 x 155 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H x W x D)</td>
<td>3.46 x 17.64 x 14.33 inch</td>
<td>19.69 x 15.75 x 6.1 inch</td>
<td>26.38 x 18.5 x 9.84 inch</td>
<td>19.65 x 15.75 x 6.1 inch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>392 x 485 x 192 mm</td>
<td>392 x 485 x 192 mm</td>
<td>392 x 485 x 192 mm</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.43 x 19.09 x 7.56 inch</td>
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<td>15.43 x 19.09 x 7.56 inch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Simplicity

You want to have your first results quickly?

AP Sensing DTS systems come with an easy-to-use user interface called DTS Configurator (DTSC). DTSC is used to configure a DTS for stand-alone operation and view the measured results. It is a Windows based application which runs on XP, Vista, or Win 7 operating systems. Once the DTS is configured and running, the DTS Configurator, and its associated PC, can be removed from the system. Configurations can be developed using DTS Configurator without being attached to an actual DTS system.

Easy export of your measurement data

DTS Configurator uses standard data export functions and formats to share data with other Windows based applications.
Quality & Support

AP Sensing’s leadership in quality, reliability, and ruggedness is based on intelligent design, proven components and decades of experience.

Our instruments use the most reliable and proven laser on the market. It is low power and therefore inherently safe in any situation. AP’s patented code correlation technique allows this low power, safe laser to be used at record setting distances up to 12 km, the longest measurement range on the market. AP’s patented single receiver design ensures unprecedented measurement stability and reliability by eliminating complexity and drift effects well-known to dual receiver designs. The design eliminates the need for system re-calibration.

Furthermore, with the lowest system power requirements, our variety of housing options, quality, and ruggedness, you can deploy the AP Sensing DTS systems in almost any environment without the need for structures, special air conditioning, or ac power.

Solid instrument design, made with the best components, configured for your requirements.

- Calculated System MTBF of 33 years
- Calculated Laser MTBF of 60 years
- Optical Switches Tested to 100 Million Cycles (equivalent to 63 years)

Servic and Support

Our reputation is based on the industry’s lowest failure rate and best application fit. AP Sensing offers global service & support with a wide range of additional services and extended warranty. Every instrument and system we sell comes with a global warranty.

AP Sensing is your strategic business partner for success.

For more information on Distributed Temperature Sensing products, applications or services, please contact:

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