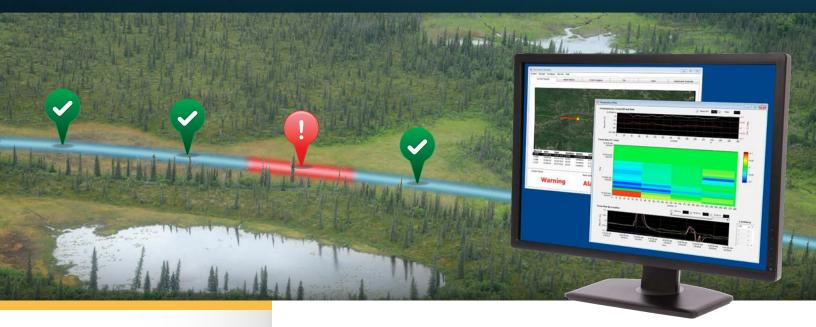# FiberPatrol® FP7000
Fiber Optic Pipeline Integrity Monitoring System

SENSTAR

FEATURES AND BENEFITS

- Detect and locate pipeline leaks and third-party interference (TPI) over a distance of up to 40 km (24.9 mi) per processor
- Pinpoint leak and TPI events with an accuracy of ±10 m (±33 ft)
- Combined Distributed Differential Temperature Sensing (DDTS) and Distributed Acoustic Sensing (DAS) for optimized leak detection:
  - Detect small leaks in both liquid and gas pipelines (below 1% of capacity)
  - Detect leaks during all phases of pipeline operation (filling, steady-state operation, and draining)
- Buried fiber optic cable is EMI and lightning immune
- Can also be used for fence-mounted intrusion detection
- Continues to operate up to the point of a cable cut – 100% cut immunity when in redundant configuration
- Software-configurable detection zones
- System can use available fibers in existing communications/SCADA cable
- No electronics, power, or communication infrastructure required along pipeline
- Alarms reported by zone number, meter mark, and GPS coordinates
- Flexible integrations with security management and SCADA systems

📄 DATASHEET

The FiberPatrol FP7000 enhances integrity management programs for both gas and liquid-carrying pipelines by providing early detection of leaks and third-party interference (TPI).

Combining Distributed Differential Temperature Sensing (DDTS) and Distributed Acoustic Sensing (DAS) technologies, the FP7000 detects and locates small leaks faster and more accurately than traditional flow and pressure-monitoring solutions, while TPI detection helps to avoid leaks in the first place by detecting digging or tampering before damage can occur.

Faster detection with fewer nuisance alarms

The FP7000 uses standard single-mode fiber optic cable as its sensor. The system accurately measures the change in temperature of the sensor cable relative to any reference point in time with an update rate of approximately 1 Hz. The system also continuously monitors the level of acoustic noise along the cable in real time.

To minimize nuisance alarms, the leak detection algorithm uses an optimal weighting of these measurements to determine when a leak alarm should be declared.

Optimize for right-of-way

Detection settings can be set on a per-zone basis to adjust to varying conditions along the pipeline right-of-way, such as road crossings, water crossings, or above-ground sections.

Avoid accidents in the first place

TPI detection is performed by analyzing the DAS signal through a TPI-optimized detection algorithm, which includes threshold, spatial and timing parameters to optimize detection while rejecting nuisance alarms.

The FP7000 can also be deployed alongside Senstar perimeter intrusion detection systems for above-ground infrastructure for complete and integrated end-to-end pipeline security.

HOW IT WORKS

FiberPatrol works by transmitting pulses of laser light into an optical fiber and accurately measuring the minute light reflections that occur along its length. Using a patented technique based on Coherent Optical Time Domain Reflectometry (C-OTDR) principles, the FP7000's DDTS function can detect temperature rates of change as low as 0.001°C per minute. This extreme sensitivity enables the FP7000 to detect smaller leaks than what is possible with any other leak detection system.

Leak Detection

The FiberPatrol FP7000 detects leaks using two different sensing techniques: Distributed Differential Temperature Sensing (DDTS) and Distributed Acoustic Sensing (DAS).

DDTS senses minute temperature changes at the sensor cable location caused by liquid or gas leaks. Transported liquids such as crude oil will typically be at a different temperature than the surrounding soil. Leaking gaseous materials, on the other hand, will be cooled by the Joule-Thomson effect. The plume of cooled gas can be detected by direct impingement on the sensor cable itself or by conduction through the intervening soil.

The FP7000 implements a background subtraction algorithm that compensates for weather-induced temperature changes that affect long portions of the sensor cable, enabling the FP7000 to respond only to localized temperature changes characteristic of a leak.

The DAS capability of the FP7000 detects the orifice noise caused by a liquid or gas pipeline leak. The DAS bandwidth is up to 2,000 Hz. Filters can be set in the frequency domain to reject acoustic noise stemming from pipeline vibrations or nearby rotating equipment.

Leak analysis software

The FP7000 includes leak analysis software that aids in optimizing detection parameters and in assessing leak events.
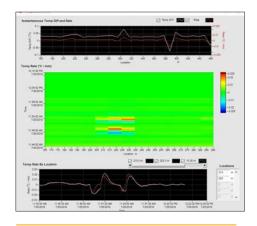
The leak analysis software runs on a Windows® workstation and enables the system operator to display the recorded sensor response in a number of ways for a specific time period and location range:

- Temperature rate of change versus time
- Waterfall display of the temperature rate of change versus time
- Amplitude of acoustic noise versus time
- Waterfall display of the amplitude of acoustic noise versus time
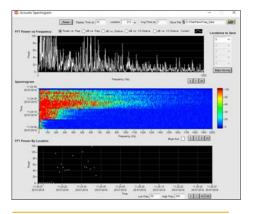- Frequency-domain display of the acoustic noise versus time

Being Windows®-based, the software can run from a centralized location and access the FP7000 from over the network.

Detection zones

Up to 1,440 distinct detection and reporting zones can be defined over the length of the sensor cable. Each zone can have its own individual detection settings and reports separately to the management system, using zones, cable distance and/or GPS coordinates.

Distributed Differential Temperature Sensing (DDTS) Analysis

Distributed Acoustic Sensing (DAS) Analysis

Typical leak detection performance

	GAS LEAK	LIQUID LEAK
Detection time	Less than 5 minutes	Less than 5 minutes
Leak characteristics	40 bar pipeline operating pressure	40 bar pipeline operating pressure
	Leak flow rate: approximately 500 Standard Liters per Minute (SLPM), representing 0.01% of the typical flow rate of a 24-inch gas transmission pipeline	Leak flow rate: approximately 50 Liters per Minute (LPM), 3°C temperature difference, representing 0.2% of the typical flow rate of a 20-inch oil transmission pipeline

Assumptions:

- *Direct-buried*
- *Sensor cable offset from pipeline: 0.5 m (1.5 ft)*
- *Soil type: Common soil with a porosity of 40%*

Third-Party Interference (TPI) Detection

TPI, including unauthorized excavation in a pipeline's right-of-way, is a leading cause of pipeline accidents and loss. The FP7000 includes an advanced TPI detection algorithm specifically designed to promote the physical security of buried pipelines.

Early warning of threats

The FP7000 detects activity within a few meters of the sensing cable. The actual distance will vary depending on the type of activity, and the soil conditions that occur between summer, winter, and in rainy seasons.

Continued detection after cable cut

If the sensor cable is cut, accidentally or in an attempt to defeat the sensor, the FP7000 immediately reports the incident, including its exact location.

Typical TPI detection ranges

Event	Typical detection range (perpendicular to sensor)
Manual digging	1 to 5 m (3 to 15 ft)[†]
Light vehicle	3 to 10 m (10 to 33 ft)
Heavy excavating machines	15 to 60 m (50 to 200 ft)

[†] *Cable installed above pipeline in a quiet environment*

Moreover, the sensor retains the ability to detect and localize intrusions right up to the point of the cut. In redundant configurations, complete cut-immunity is supported.

Reject nuisance alarms

The FP7000's advanced detection algorithms incorporate threshold, spatial and timing parameters that optimize the detection of interference events while rejecting nuisance alarms. The detection algorithms can also reject vibrations caused by traffic on roads and railways running parallel or perpendicular to the pipeline.
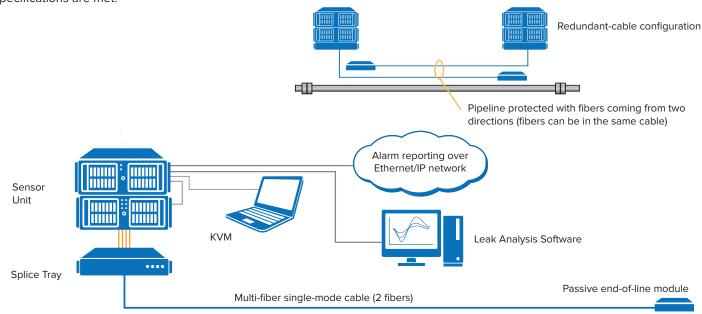
Fence detection

The TPI capability of the FP7000 can be applied to fence detection. When the sensor cable is mounted to a fence the FP7000 detects and locates any attempt to cut, climb, or otherwise break through the fence. The FP7000 works on most fence types including chain-link, standard weld-mesh, expanded metal mesh, and palisade fences. The sensor cable can be mounted on swinging gates to provide gate protection.

Between buried and fence sections, a 30 m (100 ft) buffer coil of sensor cable is recommended.

FP7000 Deployment

Buried with the pipeline, the fiber optic sensor cable is an armored, multi-fiber, single mode, telecommunications-type of cable suitable for direct burial. The FP7000 may use existing communications/SCADA cable, providing performance and attenuation specifications are met.

Redundant-cable configuration

Pipeline protected with fibers coming from two directions (fibers can be in the same cable)

Alarm reporting over Ethernet/IP network

Sensor Unit

KVM

Leak Analysis Software

Splice Tray

Passive end-of-line module

Multi-fiber single-mode cable (2 fibers)

Up to 40 km (24.9 mi)

Pipeline leak and TPI detection configuration

Technical specifications

MAIN FEATURES

- Provides leak and intrusion detection for pipelines from a central location
- Dual technology (DDTS and DAS) provides extreme leak detection sensitivity while reducing nuisance alarms
- Accurate locating of leak and interference events
- Software-assignable detection zones
- Event reporting by zone, cable distance, and/or GPS coordinates
- Central adjustment of all sensor parameters over long distances
- Flexible integration with security and pipeline integrity monitoring systems

SPECIFICATIONS

Detection performance
- Up to 40 km (24.9 mi) for fiber attenuation (installed) of 0.25 dB/km or less
- Detection accuracy: ±10 m (33 ft) typical
- Detection resolution: 30 m (100 ft) (minimum separation for two leaks or TPI disturbances to be reported separately)
- Leak temperature resolution: 0.0005°C
- Leak temperature rate resolution: 0.001 C/min
- Typical gas leak detection: 500 SLPM at 40 Bar, at 0.5 m cable offset, detection time 5 minutes
- Typical liquid leak detection: 50 LPM at 40 Bar, at 0.5 m cable offset, detection time 5 minutes
- Typical high-pressure gas leak detection (DAS): 500 PSI, 1/8" orifice, at 0.5 m cable offset, detection time 30 seconds
- Detection zones software-assignable

Cut cable detection
- Operation: as specified up to the cable cut
- Accuracy of cut location: 30 m (100 ft)

Optical
- Class 1, 1550 nm wavelength
- Connector type: FC/APC

Interfaces and software
- Networking: Dual Gigabit Ethernet
- Operating system: Windows® 10 Pro 64-bit
- HDD: minimum 2x1T RAID array

- Standard alarm interface – Standard API over TCP/IP from Network Manager

Environmental (sensor unit)
- Operating temperature: 10 to 35 °C (50 to 95 °F)
- Humidity: 20% to 80% non-condensing

Energy consumption
- Voltage, frequency: 100 – 240 VAC, 50/60 Hz
- Power: 250W maximum

Mechanical
- Standard 19-inch rack-mount, 51 cm (20 in) deep
- Height: processor 4U, controller 3U, splice enclosure 1U, KVM 1U
- Rack clearance required: 5 cm (2 in) front, 15 cm (6 in) back
- Weight: 48 kg (105 lbs) total with single processor, controller and 1U splice enclosure

FIBER OPTIC SENSOR CABLE

- Senstar provides fiber optic sensor cable tailored to meet the requirements of the specific application
- Existing optical cable may be used for sensor cable if requirements (positioning, attenuation and reflective discontinuities) are met
- Required fibers for sensing: 2

General characteristics
- Gel-filled loose tube construction with central strength member
- Single mode fiber
- 12 fibers per tube
- Single corrugated steel tape (CST) armor option
- Double polyethylene jacket

Environmental
- Temperature: –40 to 70 °C (–40 to 158 °F)
- Humidity: no restrictions

REGULATORY COMPLIANCE

- FCC Part 15 Class A
- CE: EC Low Voltage Directive 2006/95/EC

Orderable part numbers

Part Number	Description
FP7300xx	FiberPatrol sensor unit. Provides up to xx km of DDTS and DAS leak detection processing, where xx can be 20, 30 or 40 km (1 km = 3280 ft).
FP7302xx	FiberPatrol sensor unit. Provides up to xx km of DDTS and DAS-based leak detection processing and TPI processing, where xx can be 20, 30, or 40 (1 km = 3280 ft)
GB0296-15	15 in 1U rack-mount KVM (KB/LCD/Mouse)
FPKT0400	8 port KVM switch with 2 sets of cables
FPEM0400	1U rack-mount splice enclosure kit
FPMA0121	Dual Start module for FiberPatrol FP6100X/ FP7000 systems
FPMA0122	Dual End module for FiberPatrol FP7000
GM0749-24	Field splice enclosure (24 splice capacity, 3 cable ports)
FPKT0200	Splice consumables kit
FPSP0624	Fiber optic sensor/lead cable for leak and TPI detection applications. 24 fibers, corrugated steel tape armor, double polyethylene jacket
FPSW0400	FiberPatrol leak analysis software, license for use on one workstation

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