# ODiSI 6000

## Optical Distributed Sensor Interrogators

**The ODiSI 6000 Series is an innovative measurement system specifically designed to address the test challenges of 21st century advanced materials and systems.**

The ODiSI provides thousands of strain or temperature measurements per meter of a single high-definition fiber sensor. The high-definition data can fully map the contour of strain for a structure under test or the continuous thermal profile of a process in real time.

The sensor is flexible, low profile, requires no electrical source and can be bonded to sharply curved surfaces, embedded within structures or mounted directly to electrical surfaces.
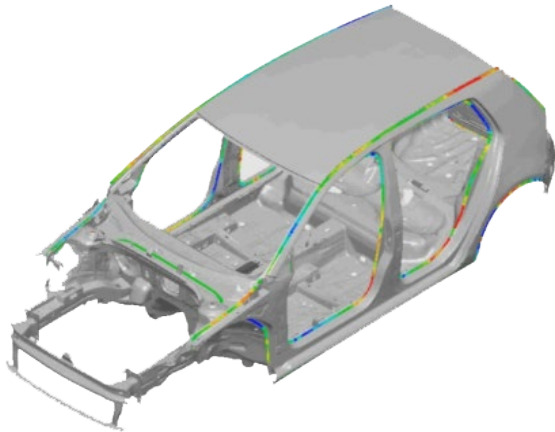
An automotive frame is instrumented with fiber and then tested under load. Test data is then superimposed on the CAD model.

**Acquire thousands of strain or temperature measurements per meter of optical fiber.**

## KEY FEATURES

- **Multichannel measurements** of strain and temperature— multiplex over 150,000 distinct measurement locations
- **Flexible, lightweight** and easy-to-install sensors reduce time to first measurement
- Passive, corrosion resistant, dielectric **sensors go where other sensors can't** — in bends, corners, embedded inside materials
- **Long sensor life** — no drift or recalibration required, cycle counts $>10^7$
- **Large strain range and high resolution** allow for mapping of complex strain fields and large strain gradients

## APPLICATIONS

- Characterize strain on/in new materials and complex structures
- Profile temperature in-situ to maximize the efficiency of critical processes
- Measure two- and three-dimensional strain fields to validate FE models
- Evaluate multi-material joining
- Embed sensors within materials to create "smart parts"

## HIGH-DEFINITION DISTRIBUTED FIBER OPTIC SENSING

The ODiSI is a highly sophisticated measurement system that is able to measure and acquire strain and temperature data using standard optical fiber with unmatched spatial resolution and precision. High-definition fiber optic sensing (HD-FOS) is a distributed sensing technology that is based on the measurement of the naturally occurring Rayleigh backscatter in optical fiber and delivers maximum spatial resolution for static and quasi-static applications.

HD-FOS uses small, lightweight optical fibers that operate as versatile, distributed sensors which can be easily installed in challenging locations and environments.

This unique measurement system delivers several valuable benefits for measurement and control applications:

- Map strain or temperature fields with ultra-high spatial resolution
- Capture strain and temperature details not available with "point" sensors
- Deploy lightweight, flexible fiber sensors in demanding environments and difficult-to-instrument locations

## ODiSI SENSOR AND MEASUREMENT CONFIGURATIONS

The ODiSI system comes configured with 1, 2, 4 or 8 channels able to measure standard Rayleigh HD-FOS sensors. In standard mode, each channel supports an HD-FOS sensor up to 10 m in length. With the Extended Range option, up to four channels can support sensors up to 50 m in length each.

The ODiSI system can be configured to measure strain or temperature with a gage pitch (spacing of adjacent gage centerpoints) of 0.65 mm, 1.3 mm or 2.6 mm. When configured for a gage pitch of 0.65 mm, for example, the ODiSI system acquires 1,538 strain or temperature measurement points along every meter of the HD-FOS sensor.

| Model | Channels |
|-----------|----------|
| ODiSI 6001 | 1 |
| ODiSI 6102 | 2 |
| ODiSI 6104 | 4 |
| ODiSI 6108 | 8 |

The ODiSI system is able to measure HD-FOS data at rates up to 250 Hz. The per-channel measurement rate will depend on several factors, including number of channels, gage pitch and sensor length. See Specifications for more information on real-time measurement rates.






Sensor bonded on outer diameter of spring
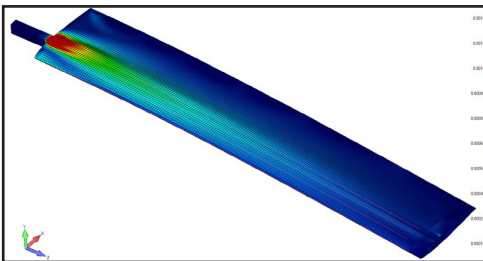
### Transform Structural Testing

ODiSI is ideal for strain measurements on and in composite materials, including materials characterization, FE model verification and full scale test.
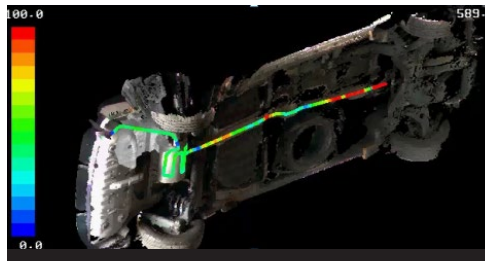
### Accelerate Design

With continuous, high resolution mapping of strain and temperature, "hot spots" and large strain gradients are easily identified, located and accurately characterized.
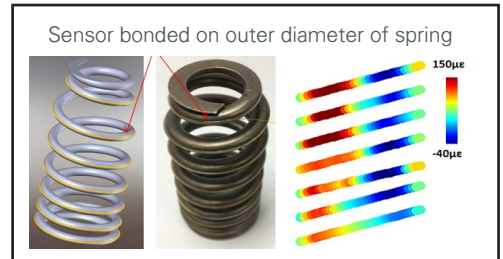
### Ensure Quality

With no "line of sight" issues and the ability to bond to curved and otherwise difficult-to-gage locations, ODiSI sensors go where no other sensors can. The result is more comprehensive data and the full picture of performance.

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## ODiSI 6000 BASE CONFIGURATION

- ODiSI 6000 Series mainframe with 1, 2, 4 or 8 channels

- ODiSI controller laptop running Linux OS and the ODiSI application software

- For each channel, one rugged standoff cable and one remote module which connects the fiber optic sensors to the mainframe

## ADDITIONAL BASE CONFIGURATION FEATURES

**Easy-to-Use Software**
- Quickly identify and configure HD fiber sensors
- View real-time data plots versus length or time
- Save data to disk and replay test data

**Real-Time Streaming Data**
- View and stream measurements in real time to a file or via TCP-IP to another computer

**Ease of Integration**
- IEEE 1588 Precision Time Protocol network synchronization
- JSON-based digital streaming data format
- Sync output TTL pulse

**Reliability and Traceability**
- Continuous optical alignment and calibration with every scan, requiring no user intervention
- Strain sensors and associated coefficients calibrated with NIST-traceable fixtures
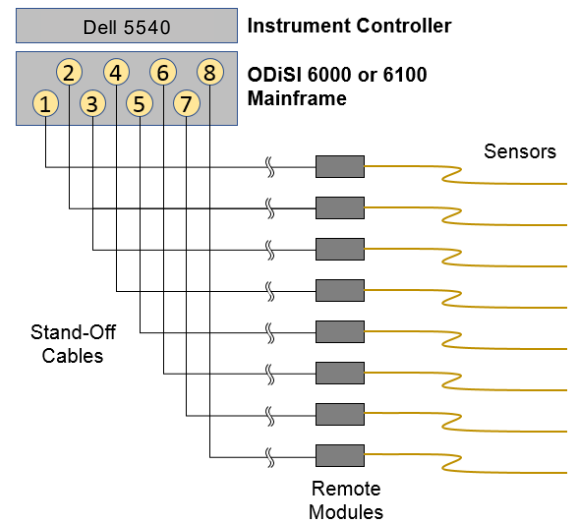
Components of ODiSI 6000 system (8 channels shown)

## ODiSI APPLICATION SOFTWARE

The ODiSI system includes easy-to-use software to configure the system and to acquire, visualize and log measurement data.

- Automatic plug-and-play sensor identification
- Real-time display of multichannel data
- Interactive touch-to-locate tool for identifying key gage locations and segments
- Save, replay and export measurement data
- Real-time streaming of data over Ethernet

The ODiSI Remote Software, available to download at lunainc.com/odisi-software, allows the remote control and viewing of real-time data from a remote, networked ODiSI system.

Multichannel sensor plot (strain/temperature versus length) in the ODiSI application software
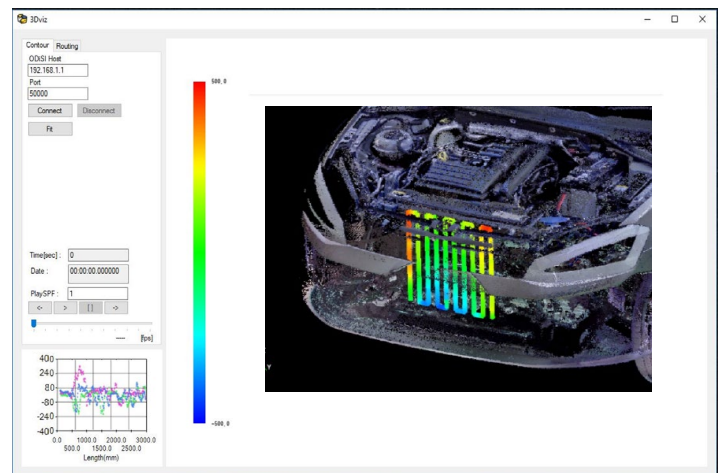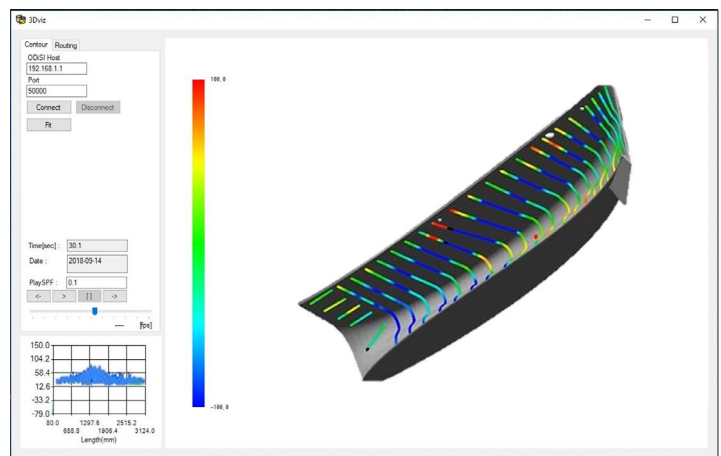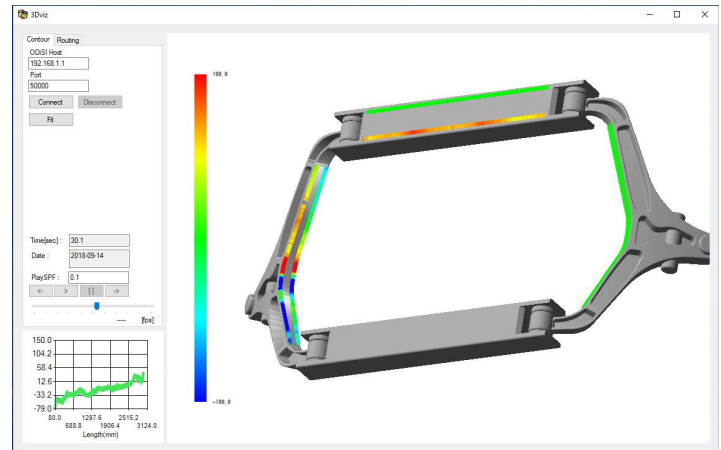
# 2D AND 3D VISUALIZATION SOFTWARE

The ODiSI 2D and 3D Visualization Software allows strain or temperature data to be visualized in three dimensions directly on a CAD model or in two dimensions on a standard photo or 2D image. Simply load an .stl or graphics file of the test article, map the sensor routing onto the model or image, and then view color-coded temperature or strain data directly on the image or 3D model.

Data can be loaded from a previously acquired ODiSI data file or streamed in real-time from an ODiSI system that is connected to the network. The visualization software can create videos of the evolution of strain and temperature over time to provide greater insight into designs.

- Easily interpret and communicate complex data
- Visualize large data sets using contour and 3D mapping
- Quickly focus on critical areas of interest
- Visualize and share ODiSI data mapped on imported .stl files (3D) or image files (2D)
- Visualize live data in real time from an ODiSI system
- Visualize previously logged ODiSI measurement data
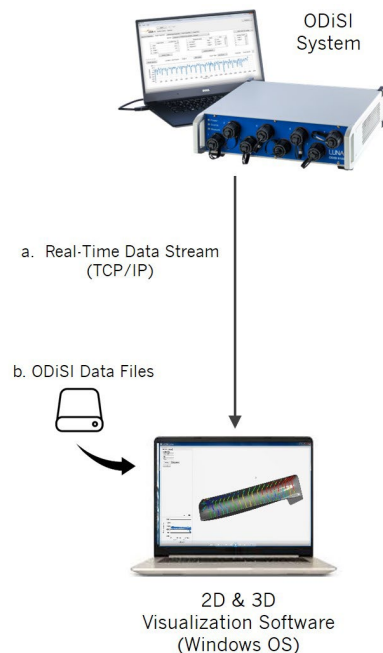


The ODiSI 2D and 3D Visualization Software can display real-time data from a networked ODiSI system (a) or data from previously logged data files (b).



The ODiSI 2D and 3D Visualization Software displays real-time data, as well as previously recorded data on 2D images or 3D models, which can be manipulated and moved to visualize different perspectives.

# PERFORMANCE

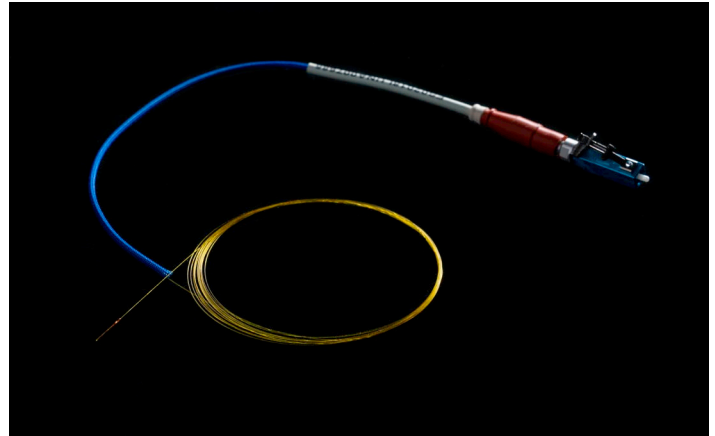| Parameter | | Specification | | | Units |
|---|---|---|---|---|---|
| **Gage Pitch[1]** | | 0.65 mm | 1.3 mm | 2.6 mm | |
| Number of channels | | 1, 2, 4 or 8 channels | | | |
| Maximum sensor length per channel | | 10 (Standard) or 50 (Extended range) | | | m |
| Gages (measurement locations) per meter of sensor | | 1,538 | 768 | 384 | gages/m |
| Measurement rates (Rates are aggregate; divide by number of active channels to determine the per-channel rate) | 2.5 m mode | 62.5 | 125 | 250 | Hz |
| | 5 m mode | 40 | 80 | 160 | Hz |
| | 10 m mode | 25 | 50 | 100 | Hz |
| | 20 m mode | 12.5 | 25 | 50 | Hz |
| | 50 m mode | - | 10 | 20 | Hz |
| Standoff cable length | | 10, 50 or 100 | | | m |
| Maximum patch cord length[2] (patch cords can be added between remote module and sensor) | Standard | 9 | | | m |
| | Extended range | 6 | | | m |
| **HD Strain Measurement** | | | | | |
| Strain measurement range | | ±12,000 | | | µε |
| Resolution | | 1 | | | µε |
| Instrument accuracy | | ±1 | | | µε |
| System (instrument and sensor) accuracy[3] | | ±25 | ±30 | ±30 | µε |
| Measurement uncertainty at zero strain[4] | Standard | ±10 | ±6 | ±4 | µε |
| | Extended range | ±14 | ±7 | ±4 | µε |
| Measurement uncertainty across full strain range[4] | | ±22 | ±16 | ±6 | µε |
| Dynamic loading rate | | 1 | 2.5 | 5 | Hz |
| **HD Temperature Measurement** | | | | | |
| Temperature measurement range (standard sensor) | | -40 to 200 | | | °C |
| Resolution | | 0.1 | | | °C |
| Measurement uncertainty | | ±2.2 | ±1.6 | ±0.6 | °C |
| **Environmental and Physical[5]** | | | | | |
| Class 1 laser | | <10 | | | mW |
| Operating temperature range | | 5 to 40 | | | °C |
| Storage temperature range | | 0 to 40 | | | °C |
| Operating and storage relative humidity (non-condensing) | | 10 to 90 | | | % RH |
| Operating altitude | | -15 to 3,000 | | | m |
| Dimensions — mainframe (W x D x H) | | 34 x 35 x 11 | | | cm |
| Dimensions — laptop controller (W x D x H) | | 36 x 24 x 17 | | | cm |
| Weight (mainframe and controller) | | 17 (7.8) | | | lb (kg) |
| Power (mainframe and controller) | | 160 | | | W |
| **Certifications** | | | | | |

## NOTES

1. Gage pitch is the distance between centerpoints of consecutive gages.
2. Total length of the patch cord plus the active sensor fiber must not exceed 10 m for Standard length configuration or 50 m for Extended Range configuration.
3. Accuracy reflects ODiSI measurements compared to NIST-traceable extensometer measurements. Data based on average of 150 measurements at each of seven increments of strain, from 0 to maximum strain. System accuracy includes errors from ODiSI instrument and Luna strain sensors.
4. Measurement uncertainty is equal to twice the standard deviation calculated from a set of 1000 measurements. Measurement uncertainty includes the effects of the instrument and Luna sensors.
5. Environmental and physical specifications listed are for an ODiSI system with a laptop controller.

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# HIGH-DEFINITION (HD) STRAIN AND TEMPERATURE SENSORS

Luna HD strain sensors are constructed using polyimide-coated low bend loss fiber with a diameter of 155 μm. HD strain sensors are NIST-traceable calibrated and are available in standard lengths ranging from 1 m to 50 m. HD strain sensors are available with a maximum temperature rating of 220 °C or 300 °C.

HD temperature sensors are encapsulated in a PTFE tube and are rated to a maximum temperature of 220 °C. HD temperature sensors are available in lengths up to 5 m.

HD sensors are supplied with calibrated scaling coefficients and a unique reference key that enables easy plug-and-play identification and operation with the ODiSI system. Measurement gage pitch (spacing) and location is software-configurable through the ODiSI application software.



High-definition strain sensor

## ODiSI ORDERING

| Catalog # | Description | Includes |
|---|---|---|
| **ODiSI 6001, ODiSI 6102, ODiSI 6104, ODiSI 6108** | ODiSI 6000 Series Distributed Sensing Instrument | Instrument controller laptop, mainframe with 1, 2, 4 or 8 channels enabled, HD standard length mode (up to 10 m sensor lengths) and ODiSI application software. Also includes one standoff cable and remote module for each channel and ruggedized shipping case. |
| **OPT06100-R** | Rack Mount Controller Option | Rack mount (1U) instrument controller (substituted for laptop). |
| **OPT06114/5** | Extended Range Option | Adds 20 m and 50 m HD sensing option on all active channels. Note: only 4 channels can be active in extended range mode simultaneously. Requires extended range remote modules (one is included). |
| **OPT06125** | 3D Visualization Software | Visualization software for mapping real-time or saved ODiSI data onto 3D models and 2D images. Compatible with Windows OS. |
| **OPT06123** | 2D Visualization Software | Visualization software for mapping real-time or saved ODiSI data onto 2D images. Compatible with Windows OS. |

## SENSOR ORDERING

| Catalog # | Description |
|---|---|
| **HD6SXXLC220P** | HD strain sensor, LC2+ connector, polyimide coating, 220 °C, length = XX m |
| **HD6SXXLC300P** | HD strain sensor, LC2+ connector, polyimide coating, 300 °C, length = XX m |
| **HD6TXXLC220P** | HD temperature sensors with PTFE sleeving, 200 °C, length = XX m |
| **FOSAPPKIT** | Fiber Optic Sensor Application Kit Materials (epoxy, tools, etc.) required to install 10 m of sensing fiber (does not include sensing fiber) |

*Specifications subject to change without notice.