

LUNA



Custom Sensor
Construction and Keying

ODiSI 6100

Class 1 Laser Product
Appareil Laser Classe 1
Laser Produkt Klasse 1
IEC60825-1, 2014

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Optical Distributed Sensor Interrogator Model ODiSI 6100:
User's Guide *ODiSI 6100* Software
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1 Introduction

Luna's standard HD strain and temperature sensors are designed, manufactured, and calibrated for optimal performance and accuracy. However, there are cases where ODiSI users choose to construct their own sensors to better suit unique test environments. When constructing custom sensors for use with ODiSI systems, there are several elements that should be carefully considered to ensure that the new sensor provides reliable measurements.

2 Sensor Construction

2.1 Sensor Fiber Selection

Luna's ODiSI systems make strain and temperature measurements by monitoring changes to the Rayleigh backscatter pattern present in all optical fiber. With this in mind, it is beneficial to use fiber types that have higher Rayleigh scattering as this provides the ODiSI with a stronger signal with which to make measurements. Generally, fiber types advertised as low bend loss or bend insensitive have a higher numerical aperture and hence, a higher Rayleigh scatter level.

Another important aspect of the fiber is its coating. Sensors that will be bonded directly to a test article should have a thin, rugged coating that can transfer the strain from the test article to the fiber. Luna's standard HD sensors utilize a polyimide coating on the fiber, which is optimal for strain transfer and readily available.

2.2 Sensor Connector

In order to make accurate measurements of the Rayleigh scatter, it is important for the sensor to have a high-quality connector. To ensure proper function with the ODiSI, connectors should have a return loss between -87.5 dB and -60 dB and an insertion loss better than -0.5 dB. Meeting these loss requirements necessitates the use of angled physical contact (APC) connectors. The connection to the ODiSI remote module utilizes an LC/APC connector. This is a standard connector design and available from several vendors.

The end faces of these connectors are susceptible to contamination by dust or oil and can be easily scratched so it is important to use dust caps when storing the sensor and cleaning the connector before each connection.

2.3 Sensor Strain Relief Region

The section of the sensor immediately following the connector is of particular importance. The first 10 cm of the fiber sensor is used by the ODiSI to identify which sensor is connected. This region of the fiber sensor should be protected with a form of tubing which helps to prevent damage to the fiber and minimizes the amount of strain that can be induced in the fiber. Luna manufactured HD strain sensors are constructed with 10 cm of fiberglass sleeving acting as a strain relief although a 900 μm furcation tubing is a suitable low temperature alternative.

2.4 Splices in Sensor

While it is possible to use fusion splices to assemble or repair fiber sensors, the ODiSI will make the best measurements when there are no splices within the sensor. If splices do need to be used, they must have a return loss better than -87.5 dB in order to distinguish them from optical connectors. Since splicing requires stripping off a portion of the fiber coating, it is important that this region is immediately reinforced using a splice protection sleeve. These sleeves help to prevent damage to the splice during sensor handling or installation.

2.5 Sensor Termination

The method used to terminate the end of the fiber sensor is also important to the function of the sensor. Luna recommends constructing terminations by splicing at least 10 cm of coreless termination fiber to the end of the sensor. This coreless fiber allows for the termination of the sensor without large back reflection. A large back reflection will reduce the measurement quality of the ODiSI system by inducing noise and possibly making sections of the sensor unreadable. As with the connector, the termination must have a return loss better than -60 dB.

Crushed fiber, index matching gel, and looped fiber terminations are not recommended for use with ODiSI systems. These types of terminations are easily damaged and can be inconsistent or change during a test. They also do not often meet the -60 dB return loss requirement.

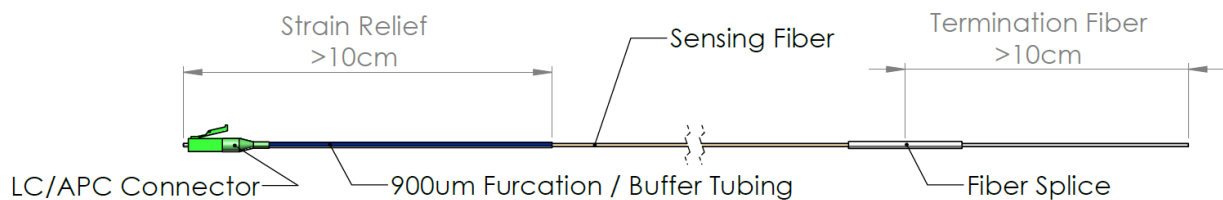


Figure 1: Sensor construction.

Table 1: Connector and termination Return Loss and Insertion Loss requirements.

	Return Loss (dB)	Insertion Loss (dB)
Connector	$-87.5 < RL < -60$	> -0.5
Termination	$RL < -60$	< -10

3 ODiSI 6100 Key Generation Software

For customers who have purchased the custom keying option, the software feature can be accessed through *Tools > Create Custom Key*.

3.1 Main Custom Keying Interface

The ODiSI Custom Key window will open, showing how many tokens remain and a description of what is attached to each channel.

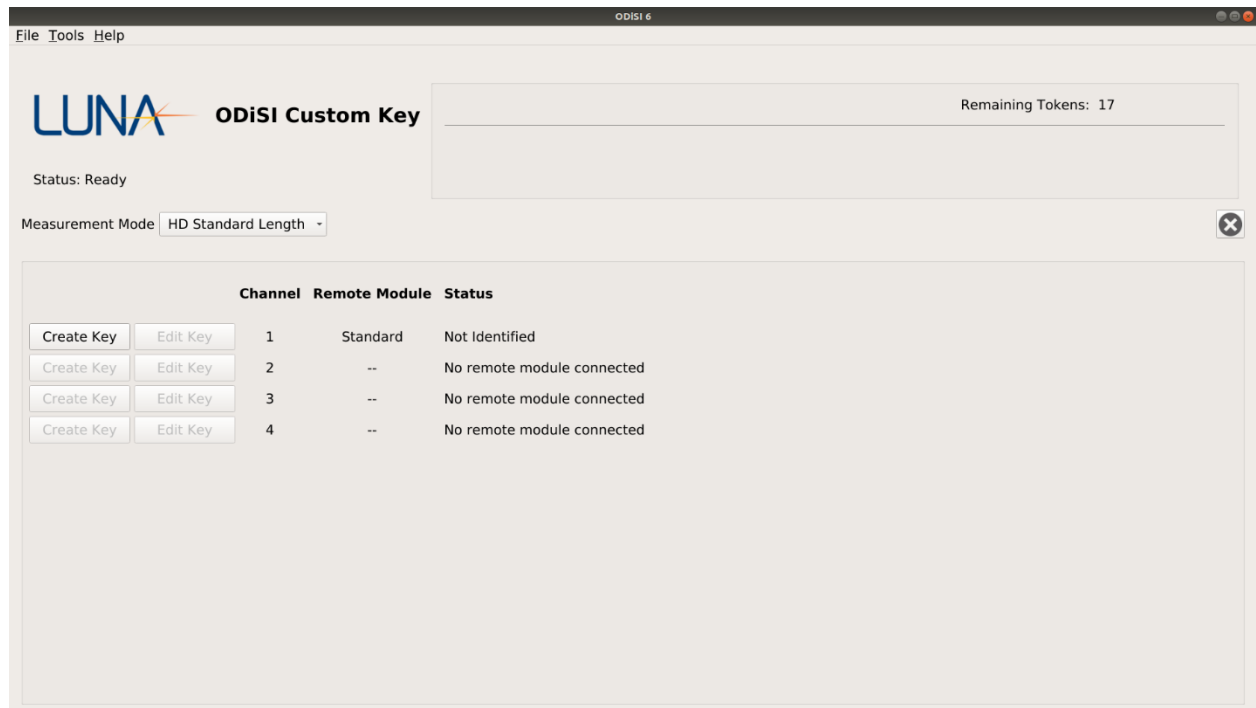


Figure 2: ODiSI Custom Keying window.

Remaining Tokens: One token is used for each key that is successfully created. Additional tokens can be purchased by contacting a Luna sales representative.

Measurement Mode: The Measurement Mode selected from the drop-down menu has to match the total sensor length connected to the channel that the new sensor is plugged into.

Create Key: The “Create Key” button will be enabled for any channel that has a sensor connected, has the correct type of remote module, and where the total sensor length match the Measurement Mode and Remote Module selections. Click to make a Rayleigh backscatter measurement.

Edit Key: The “Edit Key” button will be enabled for any channels where the sensor identified is already using a custom key. This allows the user to change the designation of a sensor from strain to temperature or vice versa, in case of incorrect selection during the keying process.

Remote Module: Lists the type of remote module Identified on each channel.

Status: Lists the result of sensor Identification on each channel.

: Click to exit the Custom Keying interface.

3.2 Optical Backscatter

After clicking the “Create Key” button, the ODiSI will make a measurement for the chosen channel and will display a plot of the optical backscatter vs length for the selected channel. This process may take a few seconds, depending on the length of the sensor. By default, the plot will be scaled to show what the ODiSI software has determined to be the sensing region of the fiber (from the termination back to the nearest connector).

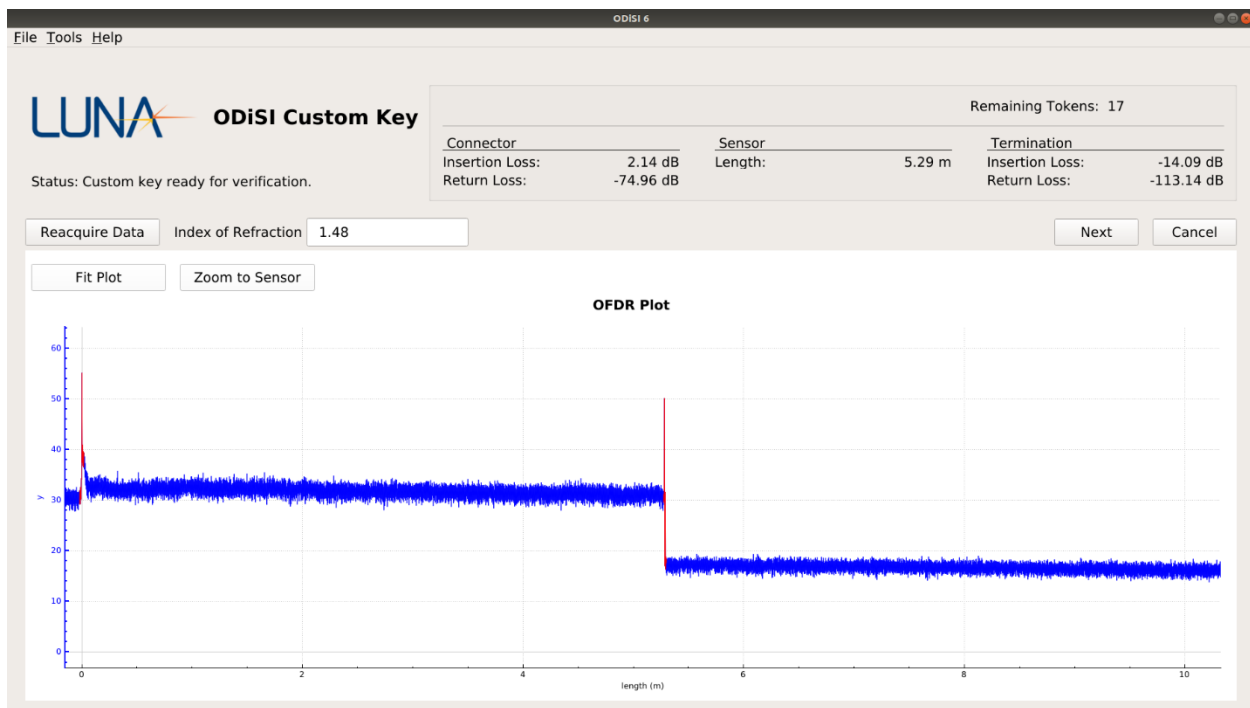


Figure 3: Rayleigh scatter pattern for a sensor including the connector and termination reflection peaks.

Measurement metrics table: Displays the measurement metrics associated with the identified sensor connector and termination, along with the calculated sensor length. Verify the return loss and insertion loss quality of the connector and the termination by examining the metrics table.

In order to be used with the ODiSI 6100, the connector and termination should fulfill the requirements shown in Table 1.

Red vertical cursors: The red cursors show the region of the data that will be used as a sensor key and are placed slightly within the connector reflection peak at the beginning and the termination reflection peak at the end.

Index of Refraction: This is used to calculate sensor length. An accurate Index of Refraction value for the fiber type being used should be input for the ODiSI to display length accurately.

Reacquire Data: Click the “Reacquire Data” on the top left to recapture the Rayleigh backscatter of this sensor with the accurate Index of Refraction.

Next: When satisfied with the backscatter trace, click the “Next” button to continue to validate the sensor function.

Cancel: Click to return to the main Custom Sensor Keying window.

3.3 Sensor Validation

The sensor validation screen will display a plot of strain or temperature vs length for the key that is being generated.

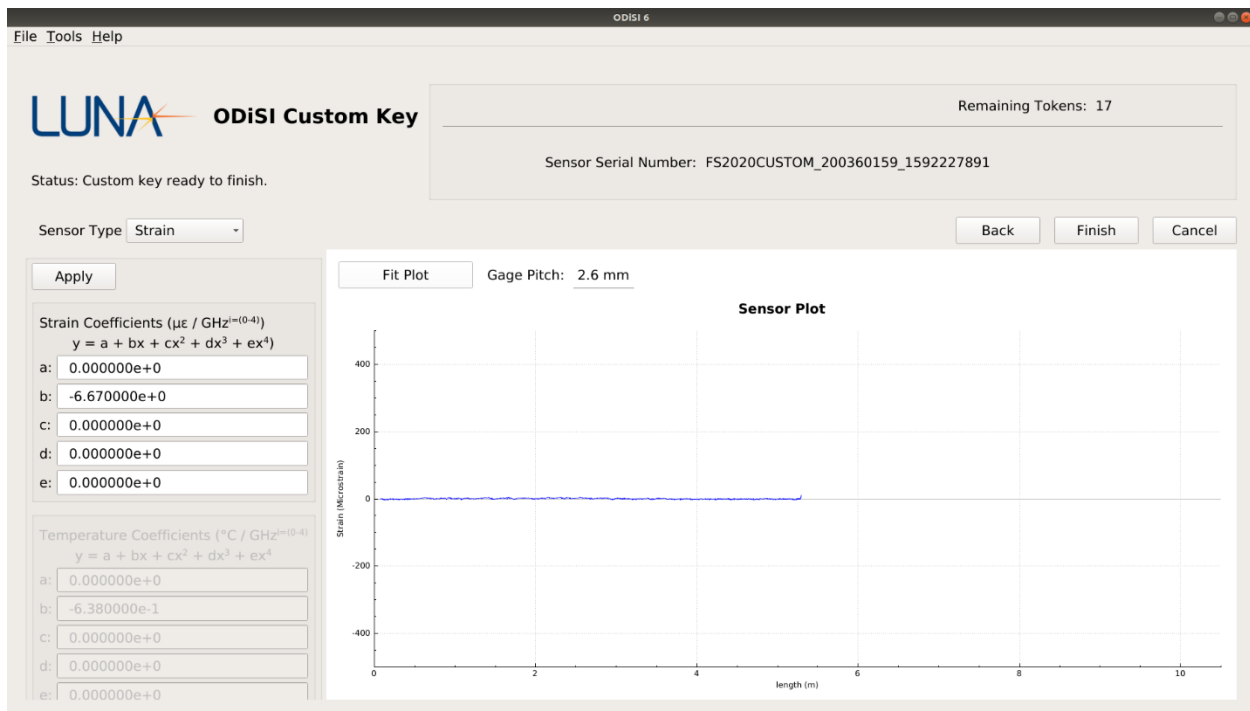


Figure 4: Sensor validation screen showing measurements and strain/temperature coefficients.

Sensor Type: Select sensor type from this drop-down menu.

Coefficients: Lists the polynomial coefficients that the ODiSI uses to scale its optical measurement (spectral shift in GHz) to strain or temperature. The default coefficients match the strain and temperature response of Luna’s standard sensing fiber. Edit these values for custom fiber types.

Apply: Changes to the coefficients will take effect in the plot once the “Apply” button is pressed.

Finish: If the sensor performance is satisfactory, click the “Finish” button to save the new custom key and utilize one of the key tokens available on the system. The software returns to the main custom key window.

3.4 Patchcords

The software will create a sensor key when using patchcords as long as the patchcord enabled box is checked under the system settings. In this case the software identifies the beginning of the sensor and termination from the end of the last patchcord. All sensor tolerances remain in effect within the software. A damaged patchcord could result in the system not being able to generate a key with the patchcord in place.

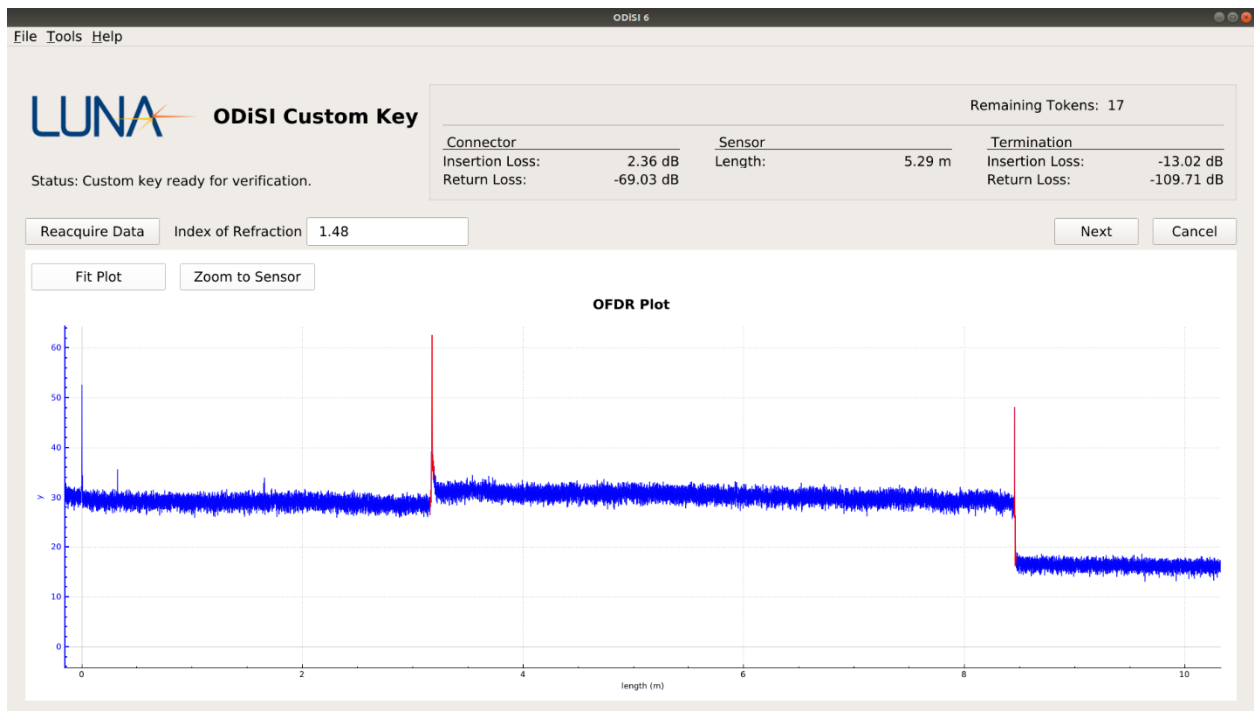


Figure 5: Rayleigh scatter pattern for a sensor connected through a 3 m patchcord.

4 Product Support Contact Information

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