Technical Documentation

Differential Optical Sensor Unit

Model OSU-1001-H2U

User Manual

This page is intentionally left blank.

Differential Optical Sensor Unit

Model OSU-1001-H2U

From Serial No. 103600

Rev 2.2 - December 2019

SERVICE WARNING

The DirectShear-Optical™ Sensor Unit contains no user-serviceable parts. It should be opened and serviced by qualified personnel only.

Table of Contents

1. Getting Started 2
   Principle of Operation 2
   Features and Benefits 3
   Additional Required Equipment 3
   Initial Setup 3
2. Description 4
   Front Panel at a Glance 5
   Rear Panel at a Glance 6
3. Device Operation 7
   Powering the System 7
   Battery Charging 8
   System Warmup 9
   Grounding 9
   System Connection 9
   Output Voltage Selection 9
   Data Acquisition Settings 10
   DC Offset Measurement 10
4. Specifications 11
5. Service and Repair 12
6. WARRANTY 12
7. Corporate Contact 13

Table of Figures

Figure 1-1: Photograph of the Optical Sensor Unit 2
Figure 2-1: OSU-1001-H2U 4
Figure 2-2: The OSU front panel. 5
Figure 2-3: The OSU rear panel. 6
Figure 3-1: Battery voltage indicator states and corresponding voltages. 8
Figure 3-2: Channel selector indicator states. 9
Figure 4-1: Specifications Table. 11
Figure 4-2: Mechanical Specifications Table. 11

1. Getting Started

Principle of Operation

The OSU-1001-H2U Differential Optical Sensor Unit (OSU) is a fully integrated fiber optic and analog optoelectronics system that provides the ability to measure mean and fluctuating quantities of interest, e.g., wall shear stress or pressure, using a differential optical sensor. The OSU provides a stable light source and fiber optics to transmit light to and from the sensor head as well as optoelectronics to convert the light reflected from the sensor head to a single analog voltage signal for output to a data acquisition system. The type OSU-1001-H2U control unit makes use of transimpedance amplifiers and an instrumentation amplifier to enable measurement of both mean and dynamic components.

Figure 1-1: Photograph of the Optical Sensor Unit.

Features and Benefits

- Ability to measure mean and fluctuating quantities using a variety of optical devices
- Integrated rechargeable lithium-ion battery system minimizes power line noise
- Duplex LC fiber connection to differential optical sensor
- System status and battery voltage LED indicators
- Channel selector to choose between single-channel or differential operation

Additional Required Equipment

The following additional components and specifications are recommended for AC and DC testing/calibration with the optical differential Optical Sensor Unit:

- OSU-compatible differential optical sensor head
- RG58 coaxial cable with BNC connectors
- Data acquisition system (DAQ) – AC/DC measurement
    - Sensing Range: 1 V
    - Resolution: 100 nV
    - Sampling frequency: sensor dependent
- Digital multimeter – DC measurement only
    - 6.5 digits with power line cycle (PLC) integration
    - DAQ or PC connection (e.g., GPIB)

Initial Setup

Preparing the Optical Sensor Unit (OSU)

The OSU should be powered for a minimum of thirty minutes prior to testing to avoid undesirable start-up transients during measurement. A ground switch is located on the front of the system to connect the internal ground to the wall outlet when desired. Please refer to the Device Operation section for additional details regarding proper system operation.

Charging the Optical Sensor Unit

Prior to using the system for the first time, the lithium ion batteries should be fully charged. Please refer to the Battery Charging section for details on the proper charging procedure. Initial charging of the system takes between 10-14 hours to achieve a full charge. Once fully charged, the system will operate for approximately 20 hours before requiring additional charging.

2. Description

The OSU-1001-H2U Differential Optical Sensor Unit is an integrated fiber optic and electronic system that provides the ability to measure mean and fluctuating quantities of interest using a differential optical sensor, e.g., wall shear stress or pressure. The OSU provides a stable light source and fiber optics to transmit light to and from the sensor head as well as optoelectronics to convert the light reflected from the sensor head to a single analog voltage signal for output to a data acquisition system. Integrated rechargeable lithium ion batteries minimize noise due to EMI and provide up to 20 hours of continuous operation.

Figure 2-1: OSU-1001-H2U

Low-Noise Power Circuit

The OSU power circuitry includes an AC/DC converter, two 10Ah lithium ion batteries, and a custom charging and power conditioning circuit. The OSU provides low noise +/-12V power to the optoelectronics via either AC line power or batteries that enable operation for up to 20 hours on a single charge.

Optoelectronics

A single fiber-coupled light-emitting diode (LED) provides illumination for both sensor channels. Changes in the amount of light reflected off the sensing element provide a differential measurement for both mean and dynamic components. The light reflected from the sensor is then coupled to photodiodes with transimpedance amplifier circuits, followed by an instrumentation amplifier which outputs a single analog voltage for sampling by a data acquisition system.

Single-Channel or Differential Operation

A selector button on the front panel allows the user to measure the output voltage for each channel or the differential voltage. This enables the OSU to be used for single- or dual-fiber sensors and provides a method to check that the fibers are properly seated.

Calibration

Each OSU is calibrated and paired via serial number with a differential optical sensor and the pair should be used together for measurement. The results of each system calibration are presented in individual sensor calibration sheets.

Front Panel at a Glance

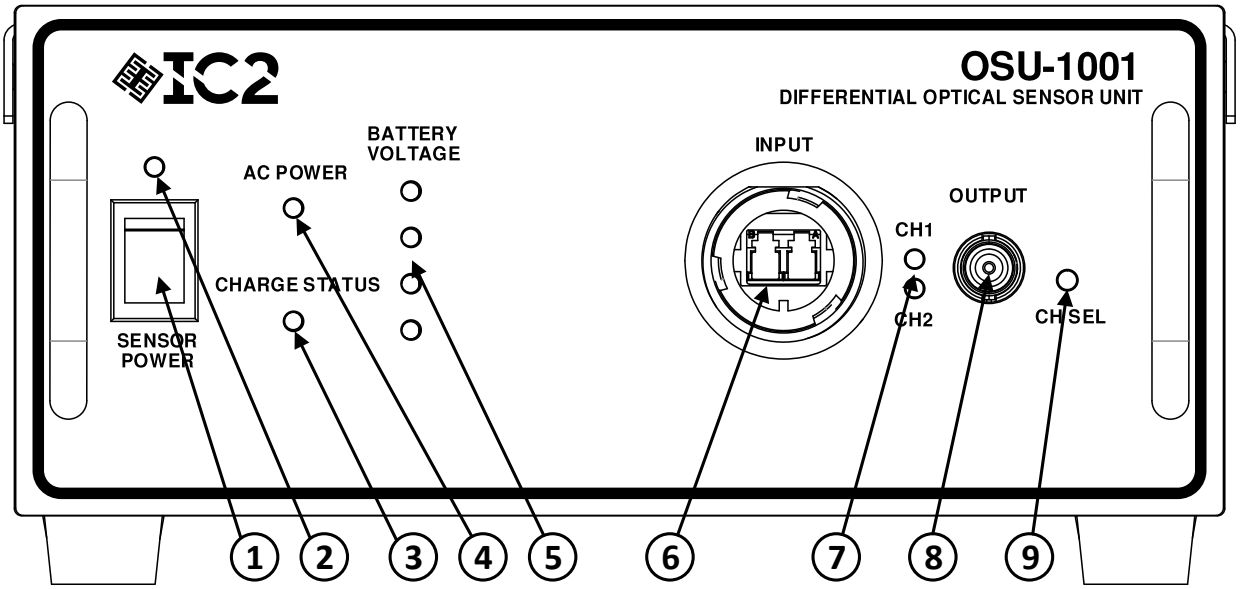

Figure 2-2: The OSU front panel.

	Name	Description
1	Sensor Power Switch	Powers the signal conditioning electronics
2	Sensor Power LED	Indicates signal conditioning electronics status (on = powered)
3	Charge Status LED	Indicates battery charging status (on = charging)
4	AC Power LED	Indicates AC power status (on = AC line power)
5	Battery Voltage LEDs	Indicates battery voltage level
6	Sensor Input	Duplex LC fiber connection to sensor
7	Channel Selector LEDs	Indicates output voltage (red = CH1 or CH2, green = differential)
8	Sensor Output	BNC connection to DAQ
9	Channel Selector Button	Selects between single-channel and differential operation

Rear Panel at a Glance

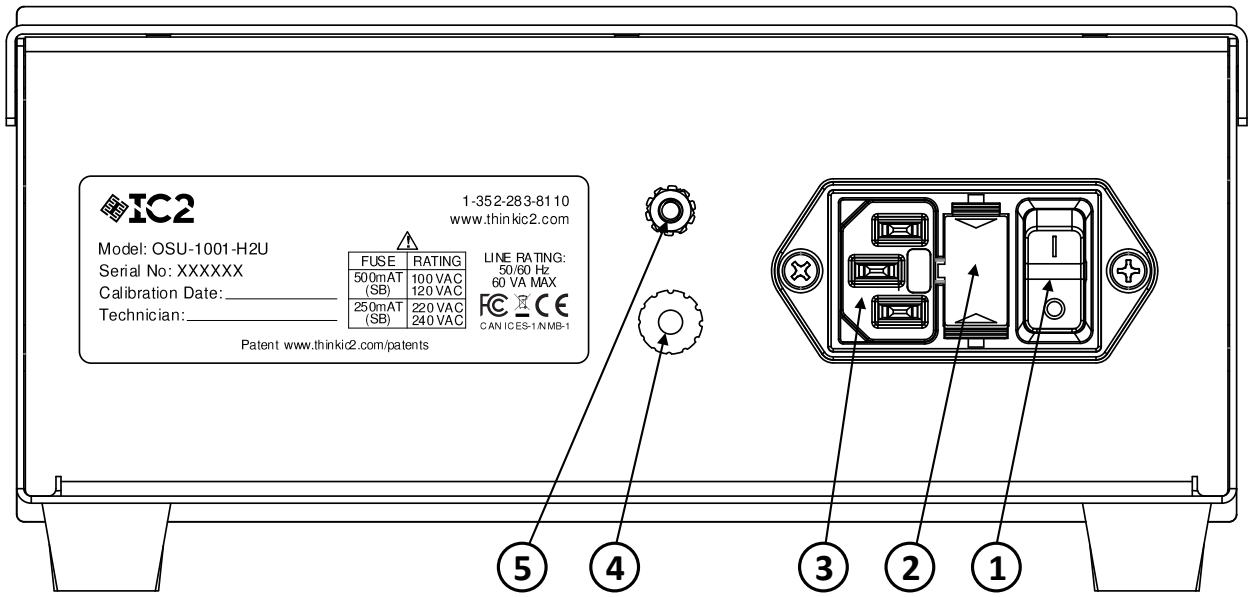

Figure 2-3: The OSU rear panel.

	Name	Description
1	AC Power Switch	Enables AC power operation and battery charging
2	Fuse Block	Contains fuses for line and neutral conductors
3	AC Line Receptacle	Accepts power cable with female IEC 320 C13 connector
4	Common Terminal	Used for grounding sensor and signal conditioning electronics
5	Earth Ground Stud	Connected to earth ground via AC line receptacle

3. Device Operation

Powering the System

The OSU is powered through either an internal AC/DC converter or a pair of lithium ion batteries. The batteries provide a low-noise power source that enables continuous operation for approximately 20 hours on a single charge.

Line Power Operation

The following procedure should be used to power the OSU for charging or operation on line power.

1. Check to see that the 120VAC line voltage is correct for the operating voltage in your area. The OSU comes with two 500mA slow-blow fuses installed for 120VAC operation. For operation at higher line voltages, refer to the Fuse Replacement section.

CAUTION **Operating the instrument on a line voltage with incorrect fuses installed may cause damage to the instrument, possibly voiding the warranty.**

2. Before connecting the power cord, make sure that the rear panel AC Power Switch and the front panel Sensor Power Switch are in the “off” position.
3. Connect the female end of the provided power cord to the AC receptacle on the rear panel. Connect the other end to a grounded AC outlet.

The power cord supplied with the OSU contains a separate ground wire for use with grounded outlets. When proper connections are made, the instrument chassis is connected to power line ground through the ground wire in the power cord. Failure to use a grounded outlet may result in personal injury or death due to electric shock.

4. Turn on the AC Power Switch located on the back panel. The AC Power, Charge Status, and Battery Voltage indicators on the front panel should all be illuminated.
5. Turn on the Sensor Power Switch located on the front panel. The green Sensor Power LED will illuminate, indicating power is being provided to the optoelectronics.

Battery Power Operation

1. If the provided power cord is connected, ensure that the AC Power Switch located on the back panel is in the “off” position.
2. Turn on the Sensor Power Switch located on the front panel. The green Sensor Power LED will illuminate, indicating power is being provided to the optoelectronics. In addition, the corresponding Battery Voltage LEDs will turn on based on the voltage level as discussed in the Battery Charging section.

Fuse Replacement

A removable fuse holder located between the AC Line Receptacle and AC Power Switch protects the power line inputs of the instrument. If the line and/or neutral fuses need to be replaced, perform the following steps.

Make sure the instrument is disconnected from the AC line and other equipment before replacing the fuse(s).

1. Place the tip of a flat-blade screwdriver into the bottom of the fuse holder assembly. Gently push in and up until the bottom of the fuse block is released.
2. Place the tip of a flat-blade screwdriver into the top of the fuse holder assembly. Gently push in and down until the top of the fuse block is released, and pull the fuse holder out of the power module.
3. Remove the fuse(s) and replace with the appropriate type listed in Table 1.

CAUTION **For continued protection against fire or instrument damage, only replace the fuse(s) with the type and rating listed. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse(s).**

4. Install the fuse holder assembly into the power module by pushing it in until it locks in place.

Table 1: Fuse Ratings.

Line Voltage	Fuse Rating
100/120V	500mA slow-blow, 5×20mm
220/240V	250mA slow-blow, 5×20mm

Battery Charging

To charge the internal 4.2V lithium ion batteries, follow steps 1-4 in the Line Power Operation section, leaving the front panel Sensor Power Switch in the "off" position. The OSU will continue charging the batteries for a maximum duration of 14 hours, at which point the charger will switch into a low power state to prevent damage to the batteries. If a full charge has not been reached during this time, the charge timer can be reset by cycling the AC Power Switch.

CAUTION **For protection against fire or instrument damage, do not repeatedly reset the battery charge timer. If the OSU is unable to provide a full charge to the batteries after two complete charging cycles, the system may need to be sent in for servicing.**

NOTE **For best noise performance, avoid charging the batteries while the sensor is in use, especially if the battery voltage level is 3.6V or lower.**

Battery Voltage Level

To determine the charge level of the batteries, turn off the AC Power Switch and turn on the System Power Switch on the front panel. The four Battery Voltage indicator LEDs on the front correspond to the voltage levels listed in Figure 3-1.

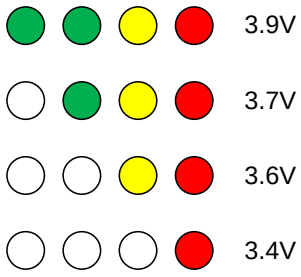

Figure 3-1: Battery voltage indicator states and corresponding voltages.

Low Power Shutdown

If the battery voltage drops below ~3.3V, an internal switch will cut off power to the OSU to prevent damage to the batteries and the internal circuitry. At this point, all LEDs on the front panel will turn off, and the batteries should be recharged before further use.

CAUTION **To avoid permanently damaging the batteries, the front panel Sensor Power Switch should immediately be turned off, and a full charging cycle should be completed before any additional use.**

System Warmup

The OSU should be powered on and allowed to warm up for at least thirty minutes to reach thermal equilibrium and mitigate undesirable start-up transients in the system response. If the system has been warmed up but needs to be relocated the second warm-up duration can be reduced to fifteen minutes.

Grounding

The chassis of the OSU is connected to earth ground through the AC Line Receptacle on the back panel. A separate internal ground (common) is used to tie the internal circuitry and DAQ output connections together, allowing the system ground to share a ground point with the DAQ system if desired. When using AC power, the Common Terminal and Earth Ground Stud located on the back panel of the system allow the internal ground to be connected to earth ground when no other ground connection is present in the system.

NOTE **The Common Terminal should be disconnected from the Earth Ground Stud any time the system is operated using the internal batteries.**

System Connection

The optical sensor head should be connected to the paired OSU using the integrated duplex LC fiber optic cable or a duplex LC fiber optic patch cable. A user-provided shielded BNC cable should be used to connect the DAQ to the OSU output. The serial number for the OSU is located on the rear panel of the unit and is listed on the data sheet for the accompanying calibrated sensor.

NOTE **To ensure the calibration data is valid, the sensor must be connected to the corresponding OSU.**

Output Voltage Selection

The output voltage of the OSU is selectable via the Channel Selector Button on the front panel. Figure 3-2 shows the various output states that are possible, including CH1 only, CH2 only, and CH1-CH2 (differential). When first connecting an optical sensor, the user should check the DC output voltage for all three states and compare them with the nominal values provided in the sensor data sheet to ensure a good optical connection is made.

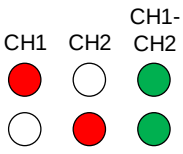

Figure 3-2: Channel selector indicator states.

Data Acquisition Settings

The output of the OSU should be connected to a data acquisition system via a BNC connection. The recommended minimum resolution is 100 nV. Typical AC coupled signal outputs will not exceed 1 V in magnitude; however, mean output voltages can reach up to 6 V at full scale output. The minimum bandwidth of the data acquisition system should be at least twice the measurement bandwidth of interest to avoid temporally aliasing the sensor signal. For fluctuating shear stress or pressure measurements, the input to the data acquisition system should be AC coupled.

DC Offset Measurement

Before and after data acquisition, the DC offset from the output of the circuit should be recorded. The DC offset provides information on whether sensor drift has occurred during operation. The DC offset of the sensor can be monitored at the OSU output by introducing a BNC tee to split off the signal. A digital multimeter with at least 6.5 digits should be set to maximize dynamic range for determining the DC offset of the sensor.

NOTE **Output drift can occur due to temperature fluctuations during the course of a test. Consult the sensor data sheet to determine the effect of changes in environmental conditions during testing.**

4. Specifications

Performance Specifications	MIN	TYP	MAX	UNIT
AC Line Voltage	88		264	V
Input Frequency	47		63	Hz
Differential Gain (factory preset)	20		40	dB
Operating Temperature Range	0 (32)		50 (120)	°C (°F)

Figure 4-1: Specifications Table.

Mechanical Specifications	TYP		UNIT	
Weight	225	(0.5)	g	(lb.)
Width	20	(0.8)	mm	(in.)
Length	214	(8.4)	mm	(in.)
Height	131	(5.2)	mm	(in.)

Figure 4-2: Mechanical Specifications Table.

5. Service and Repair

The OSU-1001-H2U Differential Optical Sensor Unit has been designed to operate correctly for many years. However, if a fault occurs which prevents it from operating correctly, disconnect the AC power cord and any cables connected to the front panel Input and Output connectors to prevent the risk of further damage. Contact a service representative to schedule an appointment for service and recalibration.

The Optical Sensor Unit contains no user-serviceable parts. It should be opened and serviced by qualified personnel only.

6. WARRANTY

Interdisciplinary Consulting Corp. (IC2) warrants this product free from defects in material and workmanship for a period of one (1) year from date of shipment.

Interdisciplinary Consulting Corp. warrants the following items for 90 days from the date of shipment: cables, rechargeable batteries, and documentation.

During the warranty period, IC2 will, at its option, either repair or replace any product that proves to be defective. To exercise this warranty, please contact IC2 headquarters in Gainesville, FL. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or a minimum of 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without IC2's express written consent, or misuse of any product or part. This warranty also does not apply to problems arising from normal wear or failure to follow instructions.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES.

NEITHER INTERDISCIPLINARY CONSULTING CORP. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE, EVEN IF INTERDISCIPLINARY CONSULTING CORP. HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COST OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

7. Corporate Contact

Interdisciplinary Consulting Corporation (IC2)

Address:
4585 NW 6th St Suite C
Gainesville, FL 32609

Website: http://www.thinkic2.com/
Phone: 352-283-8110
Technical Support: support@thinkic2.com
Sales: sales@thinkic2.com

Interdisciplinary Consulting Corp · 4585 NW 6th St Suite C · Gainesville, FL 32609
Telephone: 352-283-8110 · www.thinkic2.com · info@thinkic2.com