PENDOTECH® DUAL WAVELENGTH & TURBIDITY MEASUREMENT UNIT PHOTOMETER USER’S MANUAL
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The information in this User Guide is believed to be accurate and reliable for use and operation of the monitor, however, PendoTECH assumes no responsibility for the use of this product except for what is covered in the Limited Warranty and Terms and Condition of Sale.

NOTE: “NOTE” is used to notify the user of installation or operation information which is important but not hazard related.

Safety Guidelines

Warning potential shock hazard. Do not submerge this product. Protect the product before cleaning with any liquids by covering openings that expose the internal components.

Each prospective user must test the measurement unit for its proposed application to determine its suitability for the purpose intended prior to incorporating the sensor to any process or application. The measurement unit is not intended for use as a component in life support. The sensor is not designed for any application in which the failure of the product could result in property damage, personal injury, or death. Proper safeguards must be put into place for the process in which the unit is used.

This device has left our facility after careful testing of all the photometer’s functions and safety features. The functioning and operational safety of the product can only be ensured if the user observes the usual safety precautions as well as the specific safety guidelines stated in these operating guidelines:

⚠️ Before connecting the device to the electrical supply, ensure that the operating voltage stated on the power supply corresponds to the voltage supplied to the unit.

⚠️ The functioning and operational safety of the instrument can only be maintained under the conditions specified in the specifications section of this manual.

⚠️ If the instrument is moved from warm surroundings, condensate may form and interfere with the functioning of this instrument. In this event, wait until the temperature of the photometer equilibrates to the new temperature before putting it back into operation.

⚠️ If there is any reason to assume that the product can no longer be employed without risk, it must be set aside and appropriately marked to prevent further use.

⚠️ The safety of the user may be endangered if the instrument:
  • is visibly damaged
  • no longer operates as specified
  • has been damaged in transport

⚠️ If you are in doubt, the product should be sent back to the factory.

⚠️ The operator of this product must ensure that the following laws and guidelines are observed when using this product around dangerous substances:
  • EEC Directives
  • National Fire Protection Association
  • Safety data sheets of the chemical manufacturer

⚠️ Maintenance, and repair work must only be carried out by PendoTECH
Notice of Confidentiality

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Section 1: Introduction and Unpacking

In bioprocess operations, the UV absorbance of a liquid solution can identify the absence or presence of the molecule of interest. The measurement, typically at 280nm, is made by a spectrophotometer or photometer either in-line or off-line in a cuvette. A collimated beam of light passes through a sample with a defined path length and the absorbance is determined as the ratio of the light applied from the source to what passed through the sample. Depending on the application, other wavelengths may be used. Near IR measurements such as 880nm can be used to measure turbidity. This Measurement Unit is also used for wavelengths greater than 400nm. The Flow Cell Stand/Holder is required for use with units with wavelengths greater than 400nm, for effective blocking of ambient light. The combination of the PendoTECH Measurement Unit Photometer and the PendoTECH Single Use Flow Cells enables the measurement to be made non-invasively. This flow cell contains a special silica glass lens on the wall and compartments to attach the fiber optic cables. Even though designed for single use, the design is robust enough to be re-used. With a re-usable cell, the optical couplers are exposed to the fluid and can be cleaned and reused.

Identify the following components:

1. UV-VIS-NIR Photometer
2. Fiber Optic Cables
3. Optical Couplers/Flow Cell Holders (Varies per flow cell used and configuration type)

Flow Cell Stand Details
- Slant features a compartment to place light filters for calibration verification
- Removable cover with thumbscrew to secure to stand

Flow Cell Stand for 6.5 cm flow cell
PART# SPEC-FCH-L

Flow Cell Stand for 0.5 cm flow cell
PART# SPEC-FCH-S

I Flow Cell Stand used with >400nm+, including turbidity

4. Example Flow Cells:

Flow Cell with tubing installed
Single Use Flow Cell, 1cm path length

Adjustable Path Length Flow Cell, coupler removed

Adjustable Path Length Flow Cell, coupler inserted

6.5 cm path length with luer fitting for laboratory studies
Section 2: Hardware Installation

Please follow the outlined sections below as a guideline for installing the Photometer and associated accessories. These guidelines apply for specific application installations or in the case of OEM component installation onto a suitable panel.

DO NOT SUPPLY POWER TO THE UNIT UNTIL TOLD TO DO SO IN THE INSTRUMENT SETUP AND INITIALIZATION PROCEDURE IN SECTION 6.

2.1 Environmental

It is strongly recommended that the Photometer be installed in a clean, dry area where ambient temperature does not exceed 115F/46C. Systems mounted in enclosures can be purged with clean, dry, oil-free air (or nitrogen) to dissipate heat within the enclosure.

2.2 Physical

For permanent installations, bolt the Photometer, back panel, or enclosure (as appropriate) in place using mounting screws. The location should be secure, rigid, and strong enough to support the weight of the installed system.

For laboratory use, ensure that there is sufficient space on the on a bench or tabletop to accommodate the hardware supplied.

For all systems, run the fiber optic cable(s) through conduit or other appropriate protective measures as desired. Refer to Section 2.3 below for optical component installation instructions.

Run required electrical wiring for instrument power and output signals (4-20mA). Review Section 2.4 below prior to making electrical connections.

2.3 Optical
1. Remove the protective caps from the SMA-905 connectors on the fiber optic cables and the Photometer.
2. Clean the fiber ends with spectroscopic-grade isopropyl alcohol (IPA, also known as 2-propanol) or methanol using a lint-free cotton swab or non-abrasive task wipe. Spectroscopic grade acetone can also be used, but separation of cotton from the swab might occur as the binding agent dissolves.
3. Properly mount the flow cell stand/holder (if applicable to system). The flow cell stand can be set directly flat on a lab bench, or should be properly wall/panel-mounted. Proper mounting of the flow cell stand facilitates the pass through of bubbles/air pockets in the fluid stream, which if trapped in the flow cell, can degrade system performance.

**SPEC-FCH-L Panel Mounting**

![Diagram](image)

*Proper Orientation of Panel/Wall mount, 45 degree angle, outlet higher than inlet*

**SPEC-FCH-S Panel Mounting**

![Diagram](image)

*Proper Orientation of Panel/Wall mount, vertical liquid travel, outlet above inlet*
4. Connect the flow cell with optical couplers or flow cell holder stand to the Photometer with the fiber optic cables. It does not matter which fiber connects to the source and return.

5. Power on the unit. Refer to section 2.4 Below

6. Press the tare button (or perform dry contact closure over Tare/Zero +/- pins). This initiates the calibration and taring routine. The status light will turn green.
   a. **Note:** For best results, the unit should be tared/calibrated with the process background fluid in the flow cell if possible. If not possible, then a tare/calibration with air in the flow cell may be used instead.

7. Wait at least 10 seconds for the taring and calibration routine to complete. The status light will turn back blue.
   a. **Note:** In a panel mount installation, the status LED is not visible. It is recommended to integrate a 10s indication display on the user interface that the unit is not ready for use (do not change fluid state in the flow cells light path).

8. The unit is now ready for operation.

**NOTE:** The fiber optic cables must be secured so they are not free to move around, be stepped on, leaned against, or otherwise damaged during normal operations. The minimum bend radius for fibers supplied with the UV-VIS-NIR Photometer is 8” (20.3cm).

**NOTE:** Only hand tighten SMA-905 connections. Never use a wrench, pliers, or other tool. Over-tightening the SMA-905 connections may result in damage to the connector and the fiber optic cable, drastically reducing or prohibiting light transmission and requiring the replacement of the fiber optic cables.
2.4 Electrical

**Panel mount version**

NOTE: DO NOT power up the unit during installation. Ensure that all electrical connections are made with un-energized wires. It is recommended that an ON/OFF switch be employed for panel mounting.

**Lab version**
1. Connect the power and ground to the system.

**For laboratory systems**, a 24VDC power supply is provided (wall adapter with plug blades for global use).

**For panel-mounted systems**, a 13-position terminal block connector is provided. Use a small flathead screwdriver to loosen the screw and insert a **NON-ENERGIZED** 12-48VDC lead (with the end stripped so that the metal wire is exposed) to position 12, and tighten the screw to secure the lead. Repeat the same procedure for the securing the grounding lead to position 13.

2. Connect the 4-20mA output. For single channel units, only pins 1 and 2 are used. For dual channel units, pins 1 and 2 correspond to the transmitter’s first wavelength (lower) and pins 3 and 4 correspond to the second wavelength (higher).

**For panel-mounted systems**, a terminal strip is provided for electrical connectivity.

**For lab version systems**, a cable that connects to the **Signal I/O** terminal on the back of the Photometer may be purchased. The cable that has flying leads that can be used to connect to the desired output and alarms (PN: PDKT-UV2-FL). The leads are as follows:

- **Yellow**: Alarm-Out (-)
- **Orange**: Alarm-Out (+)
- **Violet**: Current Loop 2 (-) (If dual wavelength unit, higher wavelength value)
- **Green**: Current Loop 2 (+) (If dual wavelength unit, higher wavelength value)
- **Brown**: Current Loop 1 (-)
- **Blue**: Current Loop 1 (+)

PendoTECH also has other pre-configured cables for connections to the PendoTECH PressureMAT® Plus monitors, PendoTECH Control Systems, and other PendoTECH products.
Section 3: Introduction to Absorbance Monitoring

3.1 Theory of Operation

Absorbance measures how much of an incident light is absorbed when it passes through a material. The intensity of light decreases exponentially with distance as light passes through the material, so transmittance can be determined by measuring the intensity of both the incident and transmitted light. The value for transmittance can then be used to calculate the absorbance of the sample.

The Beer-Lambert Law relates how absorbance is related to the concentration and the distance the light must travel through the sample (path length):

\[ A = \varepsilon cl \]

Where \( A \) is absorbance, \( \varepsilon \) is the extinction coefficient, \( c \) is the concentration of the solution (in mol/L), and \( l \) is the path length traveled by light through the sample (in cm).

3.2 LED-Based Absorbance

LED-based photometers are a good choice when qualitative measurements are desired. Additionally, through the use of calibration standards and environmental control, an LED-based photometer is capable of quantitative determination of analyte concentration. When making quantitative measurements, it is critical that the LED-based photometer is accurately correlated to standard laboratory methods and solutions.

The Photometer uses a light emitting diode (LED) to provide a specific wavelength range for measurement, tuned to coincide with analyte-specific molecular absorbance. The LED is located internal to the photometer and is specific to the application. Therefore, the UV-VIS-NIR Photometer is a dedicated instrument for monitoring only one or two specific analytes of interest.

In brief, the Photometer works as follows: The measuring system is in the detector block of the photometer. Light is provided by an LED, which produces a stable light output at a narrow wavelength range. The reference signal is measured directly from the light source by the reference detector, and light that passes through the sample is measured by the measure detector. The reference channel is used in order to cancel variations from light source intensity fluctuations, spectral change due to window fouling, or suspended particles in the process stream.

The remainder of this manual provides the user with the necessary tools to operate the Photometer and meet the measurement requirements.
Section 4: Glossary and Definitions

**Linearity:** Absorbance intensity is typically directly proportional (linear) to concentration. There are, however, many factors that affect this linear relationship. For example, stray light, turbidity, variation in chemical composition of the background, etc. can affect the linearity of the absorbance response.

**Measure Detector:** A detector that measures the intensity of light after it has contacted the sample. The system is designed in such a way that only absorbing wavelengths of light are measured by the measure detector.

**Measure Wavelength:** The wavelength, or range of wavelengths, of light that are absorbed by the analyte(s) of interest.

**Process Background:** The liquid or gas used to transport or sustain the analyte of interest in the process. This includes all the chemical constituents found in the process except the analyte of interest.

**Sensitivity:** The ability of the photometer to detect a given level of analyte based on the molecular absorbance of the analyte. The actual limits of detection depend on the properties of the analyte measured and the process conditions.
Section 5: Instrument Controls

5.1 Zero

The zero button/contacts will set one (or both channels for dual wavelength model) to zero absorbance (0.00AU or 4.00mA).

**Note:** For best results, the unit should be tared/calibrated with the process background fluid in the flow cell if possible. If not possible, then a tare/calibration with air in the flow cell may be used instead.
5.2 Indicator LED

The indicator LED located on the top of the unit illuminates **BLUE** when the unit is making normal measurements, and **RED** when there is an issue with either the Photometer or the flow cell.

5.3 Alarms

The Photometer’s indicator LED will glow **RED**, indicating an alarm condition. For panel mounted units, 2 dedicated alarm contact pins will close during an alarm. The alarm will activate if:

1. The measurement detector is saturated at 100%
2. The reference detector is saturated at 100%
3. The reference light and dark signals are too close to each other
Section 6: Absorbance Operations

**NOTE**: The 4-20mA output is correlated to absorbance intensity in AU (absorbance units). To convert absorbance intensity to relevant engineering units, the 4-20mA output must be scaled using an external device. The photometer cannot be set to relevant engineering units, and has a fixed range of 0.00-3.00AU = 4mA - 20mA.

**NOTE**: Please reference Section 2 for hardware installation instructions (environmental specifications, physical mounting, optical connectivity, and electrical connectivity).

This procedure assumes that the hardware has been installed correctly and is ready for operation. For panel-mounted systems, this procedure is valid once electrical connectivity is established.

DO NOT power the unit until directed to do so in this procedure.

1. Ensure that the fiber optic connections to the Photometer and the corresponding optical flow cell couplers are hand tight. See Section 2.3 for instructions
   a. Insert single use flow cell into the flow cell stand/holder (if applicable). Replace the stand’s cover, and tighten the cover’s screw firmly to securely hold the flow cell.
2. Ensure that both the power and the analog output connections are wired correctly. See Section 2.4 for instructions.
3. Provide power to the unit.
4. Zero (tare) the unit.
   1. For best results, the unit should be tared/calibrated with the process background fluid in the flow cell if possible. If not possible, then a tare/calibration with air in the flow cell may be used instead.
Section 7: System Specifications

This section provides detailed specifications for the UV-VIS-NIR Photometer system purchased. In addition, this section may contain application specific notes on operability, functionality, etc.

### 7.1 Optical Configuration

The optical configuration listed is for a complete analyzer system. The detectors and light emitting diode (LED) are internal to the photometer housing.

<table>
<thead>
<tr>
<th>Optical Method</th>
<th>Absorbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Source</td>
<td>LED</td>
</tr>
<tr>
<td>Reference Selection</td>
<td>Internal Source Reference</td>
</tr>
</tbody>
</table>

### 7.2 Photometer Specifications

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Internal Source Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Connectivity</td>
<td>SMA-905</td>
</tr>
<tr>
<td>Mechanical</td>
<td>4” (10.2cm) W x 4” (10.2cm) L x 2.5” (6.4cm) H</td>
</tr>
<tr>
<td>Weight: ~1.5lbs.</td>
<td></td>
</tr>
<tr>
<td>Power Requirement</td>
<td>24VDC nominal, 2.7W max power</td>
</tr>
<tr>
<td>Output</td>
<td>4-20mA (Active/sourcing) spanned 0-3AU</td>
</tr>
<tr>
<td>Analog Loop Resistance</td>
<td>500 ohms at 24VDC</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>41 to 122°F (5 to 50°C)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-4 to 122°F (-20 to 50C)</td>
</tr>
<tr>
<td>Measurement Range</td>
<td>0.00-3.00AU</td>
</tr>
<tr>
<td>Response Time</td>
<td>1 second</td>
</tr>
<tr>
<td>Accuracy*</td>
<td>0-2AU: ±1%FS (±0.03AU) ; 2-3AU: ±2%FS (±0.06AU)</td>
</tr>
<tr>
<td>Precision/Repeatability</td>
<td>±0.5% full scale (±0.015AU)</td>
</tr>
<tr>
<td>LED Lifetime</td>
<td>&gt; 5 years</td>
</tr>
<tr>
<td>Available Wavelengths</td>
<td>240-1100 nm</td>
</tr>
<tr>
<td>Regulatory</td>
<td>RoHS3, REACH, CE</td>
</tr>
</tbody>
</table>

*Accuracy is dependent on system arrangement and proper tare

When converting the 4-20mA output to Absorbance Units (AU):

Let \( x = 4-20mA \) output

\[
\left( \frac{x - 4}{16} \right) \times 3.000 = AU
\]
7.3 Photometer Part Numbers

Generic PendoTECH Part #: SPEC-(L,P, N)-(1,2)-(SU1, SU2, RU)-XXX-YYY

1. Specify L, P, or N
   - L = Lab
   - P = Panel with flange on box base
   - N = Panel with no flange on box base

2. Specify 1 or 2
   - 1 = Single wavelength unit
   - 2 = Dual wavelength unit

3. Specify SU or RU
   - SU = Two removable optical couplers for single use flow cells (<400nm)
   - SU1 = Flow Cell Stand with integral couplers for use with up to 1cm path length flow cells
   - SU2 = Flow Cell Stand with integral couplers for use with 6.5cm single use flow cell
   - RU: Optical couplers for use with reusable flow cell

4. Specify XXX and YYY (if applicable)
   - XXX = Wavelength # 1, i.e. 280 nm
   - YYY = Wavelength # 2, i.e. 880 nm

For example, a panel mount, dual wavelength unit, measuring 280nm and 880nm and flow cell stand would be ordered with the following part number: SPEC-P-2-SU1-280-880.
Section 8: Appendix

8.1 Drawings

Panel Mount Version (with mounting flange)
8.2 CE Certification

EC Declaration of Conformity

The undersigned, representing the following supplier:
PendoTECH
174 Nassau Street Suite 256
Princeton, NJ 08542 USA

Herewith declare that the

<table>
<thead>
<tr>
<th>Herewith declare that the</th>
<th>Information technology equipment devices for measurement, monitoring, controlling and communicating for commercial and light industrial application</th>
</tr>
</thead>
</table>

Product Identification (brand models) | UV/VIS/NIR Photometer

SPEC-P/L-1/2-SU/RU-XXX-YYY

are in conformity with the provisions of the following EC Directive(s) when installed in accordance with the instructions contained in supplied product documentation:

- 2014/30/EU EMC Directive, TUV Test Reports TP72118433.100 & TP72118433.200
- 2014/35/EU Low Voltage Directive, TUV Test Report 72118433-000

and the standards and/or technical specifications for EN 61326-1: 2013 comprised on the following specifications:


Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General Requirements; EN 61010-1:2010 3rd edition

Year of CE Marking: 2016 through Present

Supplier:

Signature: On file
Name: James Furey
Position: General Manager
Date: October 2016