# THA100
# Fast Thermal Sensor Amplified Detector for Pulsed Laser Sources

## User Guide



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# Chapter 1 Introduction

## 1.1 Intended Use

The THA100 Fast Thermal Sensor is designed for measuring pulsed laser energy, handling high peak power with short pulse durations. Additionally, it can be used for power measurement of modulated CW lasers and, with certain limitations, for measuring modulated or pure CW sources. Care must be taken to ensure that the sensor does not overheat during continuous exposure.
The high response speed of these sensors is particularly advantageous in commercial applications, where it enables detection of short, high-energy laser pulses, allowing for improved process control.
The THA100 Fast Thermal Sensor is intended for the following applications:

- Laser Beam Monitoring
- Laser Processing and Micro-Machining
- Medical Systems Including Long Pulse Aesthetic Applications
- Diode LIV Testing
- Quality Assurance and Testing

For warnings and safety information concerning this product, please see Chapter 2.

## 1.2 Explanation of Safety Warnings

**⚠WARNING** Warning indicates a hazard with a medium level of risk that, if not avoided, could result in death or serious injury.

**⚠CAUTION** Caution indicates a hazard with a low level of risk that, if not avoided, could result in minor or moderate injury.

**NOTICE** Indicates information considered important, but not hazard-related, such as possible damage to the product.



Warning indicates a hazard with a medium level of risk that, if not avoided, could result in death or serious injury.



Caution indicates a hazard with a low level of risk that, if not avoided, could result in minor or moderate injury.





The CE/UKCA markings on the product are the manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation.



The wheelie bin symbol on the product, the accessories or packaging indicates that this device must not be treated as unsorted municipal waste but must be collected separately.

## 1.3 Description

The top surface of the THA100 Fast Thermal Sensor is a copper electrode which absorbs incident photons. The tetrathiotetracene (TTT) sensor material naturally generates a Seebeck Effect, efficiently converting thermal energy into electrical energy.

The sensor element is built upon submicron thermopile thick film technology whereby the heat flow generated by photon absorption passes vertically through the materials. This setup results in a measurement response time in the µs range and a signal rise time in the 10 ns range. This allows for monitoring individual laser pulses with repetition rates up to 1 MHz.

## 1.4 Technical Data

### 1.4.1 Specifications

All technical data are valid at 23 ± 5 °C and 45 ± 15% relative humidity (non-condensing).

| Specifications | |
|---|---|
| **Detector Specifications** | |
| **Detector Type** | Tetrathiotetracene (TTT) Thermal Sensor |
| **Optical Input** | Free-Space |
| **Wavelength Range** | 190 - 2400 nm |
| **Pulse Detection** | 100 nJ - 1 mJ |
| **Average Power** | 10 mW - 5 W |
| **Energy Density** | 5 mJ/cm$^2$ (Max) |
| **Average Power Density** | 5 W/cm$^2$ (Max) |
| **Peak Power Density** | 100 kW/cm$^2$ (Max) |
| **Max Pulse Detection Rate** | 1 MHz |
| **Rise Time** | 10 ns (Typ.) |
| **Fall Time** | 800 ns (Typ.) |
| **Aperture (Clear)** | Ø9 mm |
| **Detector Active Area** | Ø10 mm (78.5 mm$^2$) |
| **Voltage Output** | 0 - 2 V with 50 Ω, 0 - 4 V (High Z) |
| **Sensitivity**[a] | Pulses <1 µs @1064 nm: 1500 V/J - 100 000 V/J<br>QCW[b] >2 µs @1064 nm: 5 mV/W - 300 mV/W |
| **Offset** | ±10 mV |
| **Gain Adjustment** | 8 Steps, 36 dB Dynamic Range (Typ.) |
| **General Specifications** | |
| **Electrical Outputs** | BNC (DC Coupled), 50 Ω Impedance |
| **Package Size** | 2.79" x 2.10" x 0.89"<br>(70.9 mm x 53.4 mm x 22.5 mm) |
| **Weight**[c] | 0.10 kg (0.22 lbs) |
| **Operating Temperature Range** | 10 to 40 °C |
| **Storage Temperature Range** | -25 to 70 °C |
| **AC/DC Power Supply (LDS12B)** | |
| **DC Output** | ±12 V @ 250 mA |
| **Input Voltage** | 100/120/230 VAC, 50 - 60 Hz, Switchable |
| **Output Regulation** | ±5% Measured at Output Connector |
| **Output Power (Rated)** | 6 W (Max) |
| **Input Current** | 0.25/0.5 A (Max) |

a. The minimum and maximum listed here correspond to the minimum (1) and maximum (8) gain settings.

b. Quasi-Continuous-Wave (QCW)

c. THA100 Fast Thermal Sensor Only

***Table 1 Specifications for the THA100 Fast Thermal Sensor***

| Gain Settings[a] | | | |
|---|---|---|---|
| **Gain Step** | **Gain (dB)** | **Gain (V/J) @ 1064 nm** | **Noise (mVpp)** |
| **1** | 0 | 1500 | 1 |
| **2** | 6 | 3000 | 1.5 |
| **3** | 12 | 6000 | 2 |
| **4** | 18 | 12 000 | 4 |
| **5** | 24 | 24 000 | 7.5 |
| **6** | 30 | 48 000 | 12 |
| **7** | 33 | 75 000 | 15 |
| **8** | 36 | 100 000 | 20 |

a. All gain settings are valid for a pulse <1 µs.

***Table 2 Gain Settings for the THA100 Fast Thermal Sensor***

### 1.4.2 Graphs

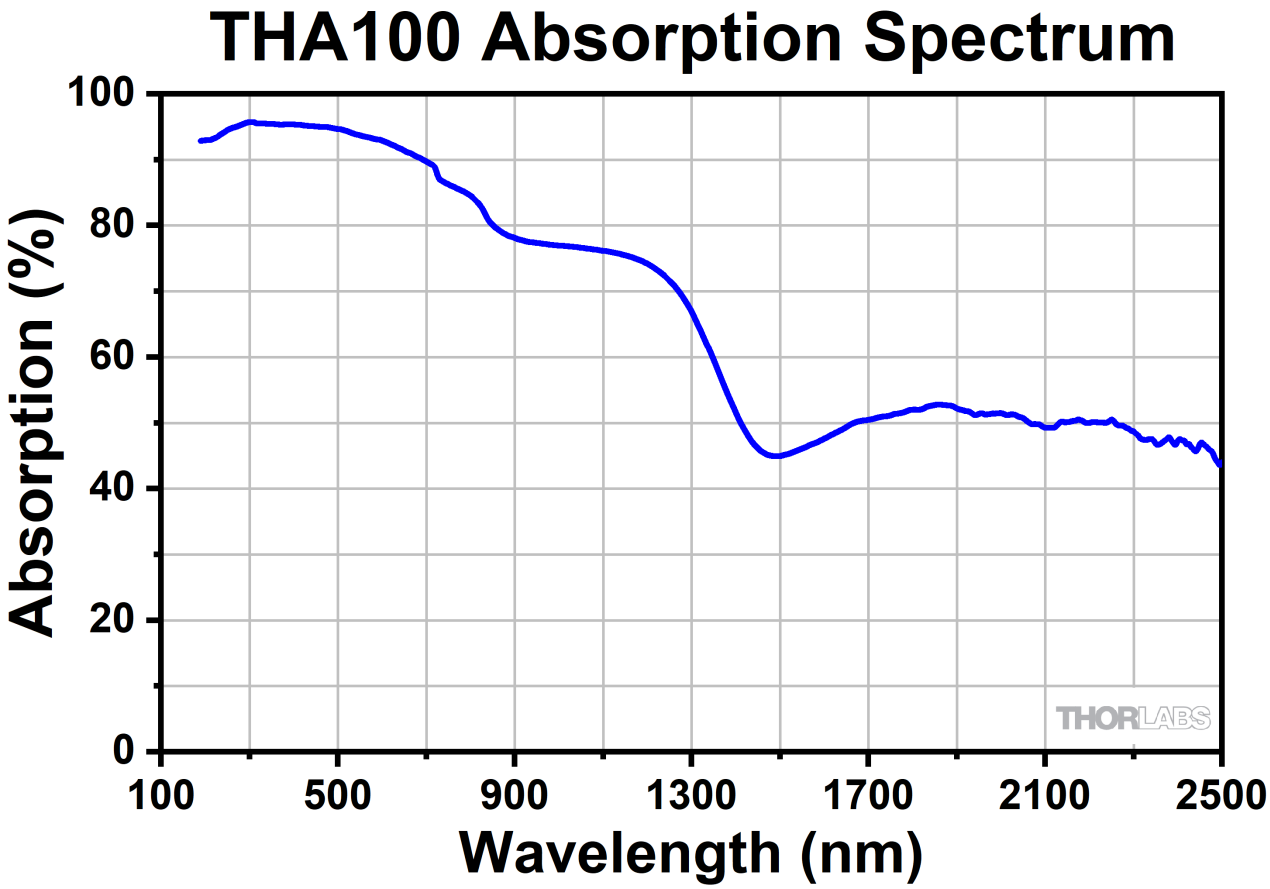



***Figure 1 Absorption Graph of the THA100 Fast Thermal Sensor***

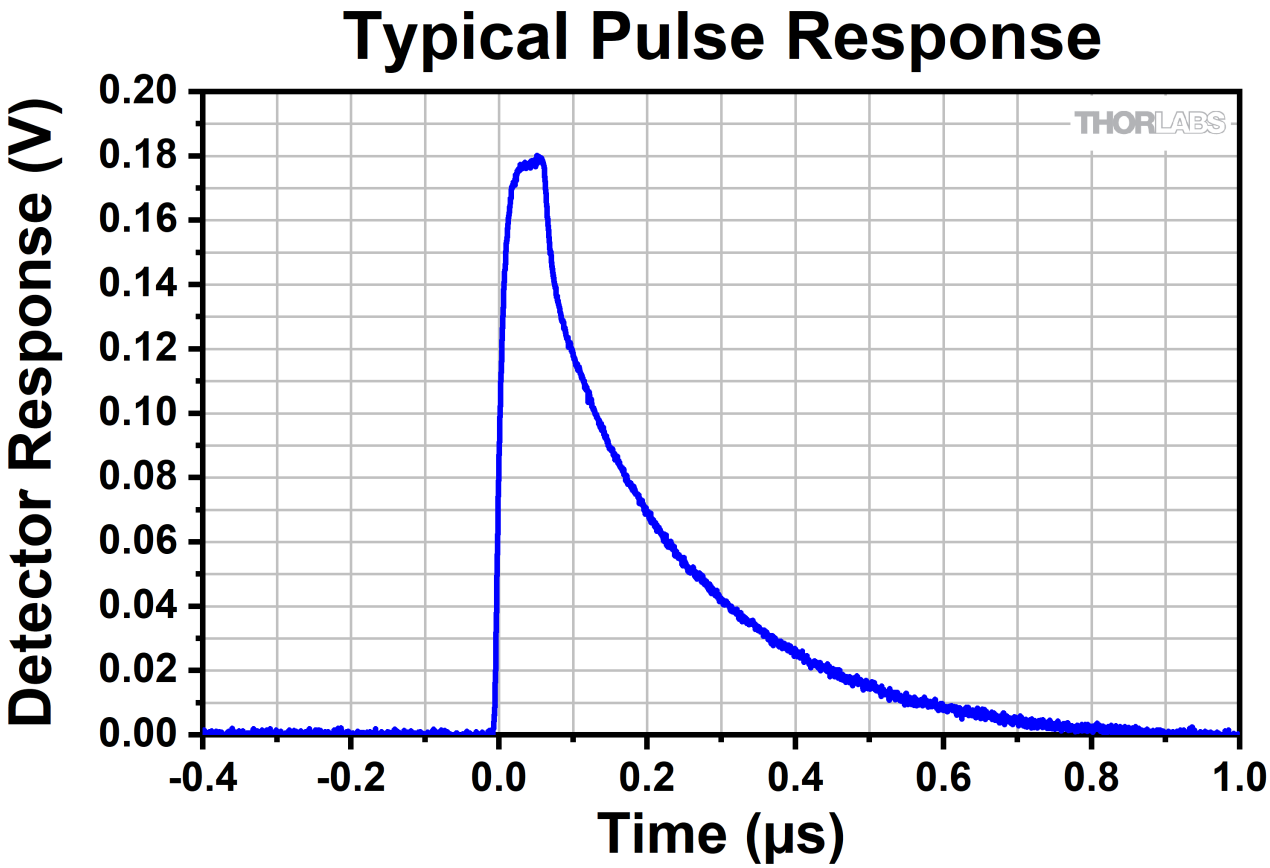



***Figure 2*** ***The THA100 Fast Thermal Sensor's typical response to a 500 ps, 40 µJ pulse at 1030 nm with gain set at 3 and 50 Ohm termination.***

### 1.4.3 Mechanical Drawing

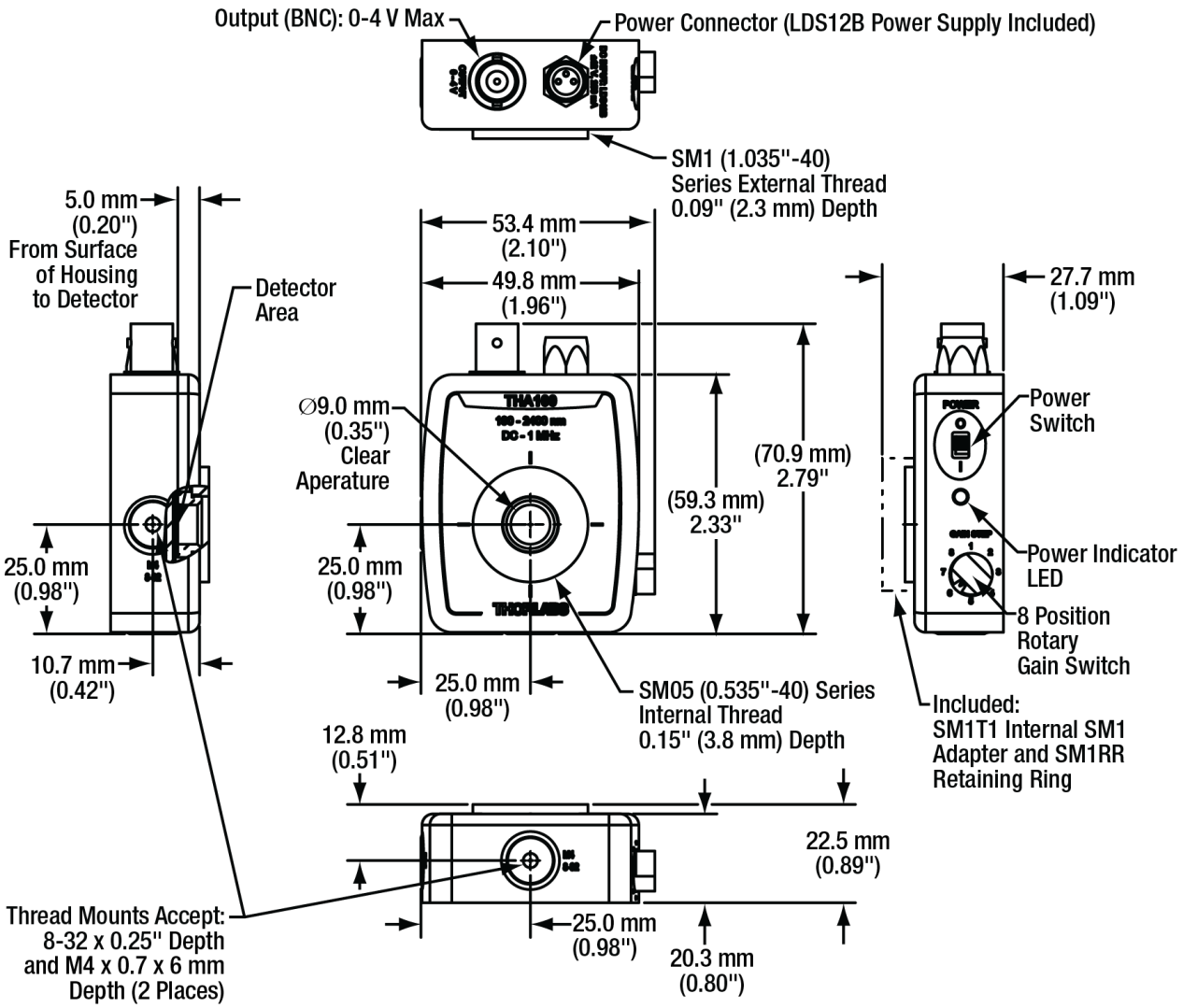



***Figure 3 Mechanical Drawing of the THA100 Fast Thermal Sensor***

## 1.5 Components




***Figure 4 Components of the THA100 Fast Thermal Sensor***

| Callout | Feature | Description |
|---|---|---|
| **1** | **Power Connector** | Power Supply Connector for Connecting LDS12B Power Supply (Included) |
| **2** | **Power Switch** | Slide Switch for Power On/Off |
| **3** | **Gain Switch** | Switch for Gain Adjustment (8 Steps) |
| **4** | **Retaining Ring** | SM1RR SM1 Retaining Ring for Ø1" Lens Tubes and Mounts |
| **5** | **Dust Cap** | SM1EC2B Snap-On Plastic Dust Cap for SM1 Lens Tubes |
| **6** | **SM05 Threaded Aperture** | SM05 Internal Thread |
| **7** | **Detector** | Thermopile Based on Thermoelectric Semiconductor |
| **8** | **Threaded Coupler** | Removable SM1T1 SM1 (1.035"-40) Coupler, Internal Thread |
| **9** | **BNC Connector** | BNC Output 0 - 4 V (Max) |

***Table 3 Components of the THA100 Fast Thermal Sensor***

# Chapter 2 Safety

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.



**WARNING: Risk of Serious Injury and Even Death Due to Electrical Shock**

Improper grounding and connecting the power supply to the mains can cause electric shock.

Electric shock results in damage to your health or even death.

Observe the following instructions when applying power to the power supply:

- Make sure that the protective conductor for the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet.
- Before connecting the power supply to the mains make sure that the line voltage range marked on the power supply agrees with your local supply.



**WARNING: Risk of Serious Injury and Even Death Due to Explosion**

The device must not be operated in explosion endangered environments.



**CAUTION: Risk of Serious Injuries of Incorrect Use**

Pay attention to the following aspects during use:

- Do not remove covers or open the device. There are no user-serviceable parts inside.
- Refer servicing to qualified personnel.
- No changes may be made to the device or components used that were not supplied by Thorlabs without written authorization from Thorlabs.

NOTICE

**NOTICE: Electrically Sensitive Product**

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

The device has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 m (9.8 ft).

- The instrument must only be operated with a duly shielded and low resistance USB cable delivered by Thorlabs.
- All modules must only be operated by duly shielded BNC connection cables.

# Chapter 3 Installation

## 3.1 Warranty

The precision devices are only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

General Terms and Conditions of Sale can be found at https://www.thorlabs.com/legal.

## 3.2 Packing List

The following items are included in the THA100 Fast Thermal Sensor package:

- THA100 Fast Thermal Sensor Amplified Detector for Pulsed Laser Sources
- SM1T1 SM1 (1.035"-40) Coupler, Internal Threads
- SM1RR SM1 Retaining Ring for Ø1" Lens Tubes and Mounts
- SM1EC2B Snap-On Plastic Dust Cap for SM1 Lens Tubes
- Power Supply LDS12B (±12 V, 250 mA), Switchable to 100 V, 120 V, or 230 V Line Voltage
- Printed Quick Reference

## 3.3 Unpacking Instructions

Please inspect the shipping container for damage. Please do not cut through the cardboard, as the box might be needed for storage or returns.

If the shipping container appears to be damaged, keep it until you have inspected the contents for completeness and tested the THA100 Fast Thermal Sensor mechanically and electrically.

Verify that you have received the items listed in the section Packing List within the package.

## 3.4 Power Supply AC Voltage Setting

### Safety Information



**WARNING: Risk of Serious Injury and Even Death Due to Electrical Shock**

Improper grounding and connecting the power supply to the mains can cause electric shock.

Electric shock results in damage to your health or even death.

Observe the following instructions when applying power to the power supply:

- Make sure that the protective conductor for the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet.
- Make sure that the socket is properly grounded.



**WARNING: Risk of Serious Injury and Even Death Due to Explosion**

The power supply must not be operated in explosion endangered environments.

**WARNING: Risk of Serious Injury to Electrical Shock**

Changing the mains voltage may result in serious injury to the user due to high voltages in the power supply.

Observe the following instructions when changing the mains volt:

- Switch off the power supply.
- Disconnect the power supply from the mains power source and from all external devices.
- Switch off the power supply, pull the plug out of the socket and disconnect all external devices before changing the mains voltage.

**NOTICE: Risk of Damaging the Power Supply**

NOTICE

Covering and improper maintenance of the power supply can cause damage to the power supply.

To avoid damage to the power supply, note the following:

- Do not remove any covers.
- Do not cover the power supply.
- Maintain the power supply only by qualified personnel.

**NOTICE: Risk of Damaging the Power Supply**

NOTICE

Shorting issues can cause damage to the power supply and the THA100 Fast Thermal Sensor under test.

To avoid possible damage due to short-circuit problems, make sure that the output plug is connected to the THA100 Fast Thermal Sensor under test before switching on the power supply.

### AC Line Voltage Setting

Your LDS12B Regulated Power Supply has been shipped from Thorlabs configured for 120 VAC operation. If you plan to operate this unit at 100 VAC or 230 VAC, please refer to steps below and heed the safety warnings mentioned in the section Safety Information.




***Figure 4 Voltage Selector Switch of the LDS12B Regulated Power Supply***

To change the line voltage, locate the voltage selector switch below the power input connector. Select the appropriate line voltage by adjusting the voltage selector switch to either 100, 120, or 230 VAC.

1. Remove the AC line cord from the LDS12B Regulated Power Supply.
2. Slide the voltage selector switch to the desired setting using a flat-blade screwdriver.
3. Verify the correct voltage is shown on the switch.
   ➤ If not, please repeat the above steps.
4. To set switch back to 120 VAC, slide the switch back with a flat head screwdriver

**Common Causes of Fuse Failure**

This particular unit does not give access to change the fuse. Listed below are common causes of fuse failure:

- Output Short Circuit
- Output Overload

There are two elements utilized to provide safety protection:

- **Short-Circuit Current Limit**
  Uses a Low Dropout Regulator with internal current limit circuit to protect against high-load current faults or shorting events.
- **Thermal Fuse**
  Uses a thermally sensitive element, which melts and opens the circuit when high temperature is present.

## 3.5 Installing Hardware

Prior to operation, please check if the indicated line voltage range on the power supply matches with your local mains voltage! For alternative power supplies, Thorlabs offers appropriate power connector cables.

1. Carefully unpack the unit and accessories.
   ➤ If any damage is noticed, do not use the unit. Contact Thorlabs and have us replace the defective unit.
2. If required, mount the unit on an optical table or application.
   ➤ The unit has two tapped mounting holes (see section Mechanical Drawing) on the side and bottom of the device.
   ➤ The mounting holes are compatible with metric and imperial threads.
3. Remove the dust cap on the optical input to detect your optical signal.
   ➤ Please note that any discoloration on the metallic surface is purely cosmetic and does not affect the sensor's spectral sensitivity or temporal response.
4. If required, mount external optics, filters, apertures or fiber adapters.
5. Set the LDS12B power supply to your local mains voltage (100 VAC, 120 VAC, or 230 VAC) as described in the section AC Line Voltage Setting.
6. Connect the included DC output cable of the LDS12B power supply to the POWER IN jack.
7. Connect the LDS12B power supply to the AC outlet.
8. Turn the LDS12B power supply on.
9. Connect RF OUTPUT with coaxial cable to the data acquisition device.
10. If necessary, connect monitor outputs (MONITOR +, MONITOR -).
    ➤ Measure the optical input power for each channel individually.

### 3.6 Return of Devices

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

# Chapter 4 Operation

### 4.1 Operation Principle

The THA100 Fast Thermal Sensor is powered by the LDS12B power supply, ±12 V, 250 mA external linear power supply via a PICO M8 power connector.

The THA100 Fast Thermal Sensor features a power switch that should be pushed in the "I" direction to turn it on. A green LED will light up to indicate that the THA100 Fast Thermal Sensor is ready for use.

Incoming light pulses are converted into voltage pulses and then amplified through eight distinct gain stages. The output voltage is available at the BNC output connector.

### 4.2 Optical Input

**NOTICE**

**NOTICE: Risk of Damaging the THA100 Fast Thermal Sensor**

The THA100 Fast Thermal Sensor has a free-space optical input with an exposed sensor area that can be damaged during cleaning.

To avoid damage to the THA100 Fast Thermal Sensor, observe the following:

- Do not wipe or clean with any solvents.
- Clean with compressed air only.
- When the THA100 Fast Thermal Sensor is not in use, protect the area with the provided dust cap.

**NOTICE**

**NOTICE: Risk of Damaging the THA100 Fast Thermal Sensor**

High energy and power densities can destroy the detector. To avoid damage to the detector, observe the specifications.

The THA100 Fast Thermal Sensor has a free space optical input with an exposed sensor area.

### 4.3 Electrical Output

Connect the BNC output to an oscilloscope with at least 100 MHz bandwidth.

### 4.4 Mounting

As shown in the section Components, the THA100 Fast Thermal Sensor is housed in a rugged, shielded aluminum enclosure. This slimline housing has two tapped holes for convenient mounting to the optical setup. The THA100 Fast Thermal Sensor features tapped holes which are compatible for both imperial and metric threads (8-32 and M4 x 0.7).

The input aperture is fitted with both an external SM1 and an internal SM05 thread that is compatible with any number of Thorlabs' SM1- and SM05-threaded accessories. The included SM1T1 allows externally

SM1-threaded accessories (e.g. external optics, filters, apertures, or fiber adapters) to be mounted to the input aperture.

# Chapter 5 Maintenance and Cleaning

**NOTICE***:* **Risk of Damaging the THA100 Fast Thermal Sensor**

NOTICE

The THA100 Fast Thermal Sensor is not water resistant. If the THA100 Fast Thermal Sensor gets into contact with fluids, the THA100 Fast Thermal Sensor can be damaged.

To avoid damaging, do not expose the THA100 Fast Thermal Sensor to:

- Sprays
- Liquids
- Solvents
- Adverse Weather Conditions

To clean the THA100 Fast Thermal Sensor housing, use a mild detergent and damp cloth. Do not soak the unit in water or use solvent based cleaners.

When cleaning the windows of the photodetectors, please remember that it is a sensitive optical device. Gently blow off any dust using compressed air.

The unit does not need regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please see the Return of Devices section and contact Thorlabs for return instructions.

Do not remove covers!

# Chapter 6 Disposal



Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site. It is the user's responsibility to delete all private data stored on the device prior to disposal.

# Chapter 7 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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