# CCT10, CCT11, CCT12, CCT14

# CCT Spectrometer Series

## User Guide



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# Chapter 1 Introduction

## 1.1 Intended Use

The CCT Spectrometer is designed for general laboratory use. Integrated routines allow averaging, smoothing, peak indexing, as well as saving and recalling data sets.

The CCT Spectrometer may only be used in accordance with the instructions described in this user guide. Any other use will invalidate the warranty.

## 1.2 Explanation of Safety Warnings



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

**NOTICE**

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





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

### CCT Spectrometer

Thorlabs' compact, Czerny-Turner CCT Spectrometer is available in four versions. Two versions offer a wide spectral range of 200 nm - 1000 nm (Item # CCT10) or 950 - 1700 nm (Item # CCT14). Two versions feature sub-nanometer accuracy and have a detection range of 350 nm - 700 nm (Item # CCT11) or 500 nm - 1000 nm (Item # CCT12).

With the small footprint (112.0 mm x 93.8 mm x 41.5 mm), all units share features with larger, more expensive spectrometers such as the ability to be synchronized via a TTL trigger input and to automatically compensate for noise created by dark current.

The CCT Spectrometer features a shutter that enables users to quickly and easily subtract the background, optimizing the signal-to-noise ratio (SNR).

The spectrometer is equipped with a low jitter trigger input and output. This low jitter is crucial for applications like Laser-Induced Breakdown Spectroscopy, where precise timing is essential to accurately capture the rapid emission of light following the laser-induced plasma formation.

Additionally, the CCT Spectrometer offers USB and Ethernet connections for flexible integration and data transfer.

### ThorSpectra Software

The Thorlabs ThorSpectra Software fully supports the remote control of the CCT Spectrometer in direct, transmittance, and absorbance measurements. Aside from the CCT Spectrometer, the ThorSpectra Software supports the Thorlabs' optical spectrum analyzers.

### 1.3.1 Ordering Codes and Accessories

| Item # | |
|---|---|
| **CCT10** | Compact Spectrometer, Broadband, 200 - 1000 nm, <2.0 nm Resolution |
| **CCT11** | Compact Spectrometer, Visible, 350 - 700 nm, <0.5 nm Resolution |
| **CCT12** | Compact Spectrometer, NIR, 500 - 1000 nm, <0.6 nm Resolution |
| **CCT14** | Compact Spectrometer, NIR, 950 - 1700 nm, <9.0 nm Resolution |
| **CAL-CCT** | Recalibration Service for CCT Series Compact Spectrometers |

### Included Accessories

**NOTICE**

**NOTICE: Use of Optical Fibers**

Make sure to use the CCT Spectrometer only with the included optical fiber. The use of a different optical fiber will affect the amplitude correction calibration.

| Item # | |
|---|---|
| **M111L02** | Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, 2 m Long; CCT10 Only |
| | Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable (Contains Item # FG050UGA Optical Fiber), High OH, 2m Long; CCT11 Only |
| **M14L02** | Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 m Long; CCT12 Only |
| **M25L02** | Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 m Long; CCT14 Only |

**Optional Accessories**

| **Item #** | |
|---|---|
| **CL4** | Compact Table Clamp for Tight Spaces |
| **Cap Screw** | Compatible Cap Screw M6 x 1.0 (1/4"-20); Length Depends on Use Case |
| **M25L0x** | Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, Various Lengths; CCT14 Only |

## 1.4 Technical Data

### 1.4.1 Specifications

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

| Item # | CCT10 | CCT11 | CCT12 | CCT14 |
|---|---|---|---|---|
| **Optical** | | | | |
| **Wavelength Range** | 200 - 1000 nm | 350 - 700 nm | 500 - 1000 nm | 950 - 1700 nm |
| **Resolution** | <2.0 nm | <0.5 nm | <0.6 nm | <9.0 nm |
| **Slit (W x H)** | 20 µm x 1 mm | | | 50 µm x 1 mm |
| **Number of Pixels on Detector** | 2048 | 4096 | | 256 |
| **Detector Technology** | CMOS | | | InGaAs |
| **Dark Noise (RMS)** | 12 Counts | 14 Counts | | 11 Counts |
| **Scan Rate (GUI Limited)** | 35 Hz | | | |
| **Scan Rate (HW/SDK)** | 350 Hz | 180 Hz | | 1100 Hz |
| **Stray Light** | 0.2% | 0.3% | | 2.0% |
| **Internal Shutter Switching Time** | <10 ms | | | |
| **Sensor** | | | | |
| **Integration Time** | 0.01 ms - 30 000 ms (10 µs - 30 s) | | | 0.01 ms - 500 ms (10 µs - 0.5 s) |
| **Internal Average** | 10 000 Frames | | | |
| **Signal to Noise Ratio** | 330:1 | 300:1 | | 2800:1 |
| **Dynamic Range** | 5100 | 4500 | | 6000 |
| **Trigger** | | | | |
| **Trigger** | Trigger In and Trigger Out | | | |
| **Input Connector** | Female SMA Connector | | | |
| **Output Connector** | Female SMA Connector | | | |
| **Trigger Level** | 3.3 V TTL | | | |
| **Trigger Delay** | 6.5 µs | | | 5.1 µs |
| **Trigger Jitter** | ±1 µs | | | ±0.4 µs |
| **General** | | | | |
| **Interface** | USB 2.0 or Higher, Ethernet IPv4 | | | |
| **Operating Temperature Range**[a] | 0 °C to 40 °C | | | |
| **Storage Temperature Range** | 0 °C to 40 °C | | | |
| **Dimensions (L x W x H)** | 112.0 mm x 93.8 mm x 41.5 mm (4.41" x 3.69" x 1.63") | | | |
| **Weight** | 0.5 kg (1.1 lbs) | | | |
| **Fiber Connector** | SMA 905 | | | |

a. Non-condensing

***Table 1 Specifications for the CCT Series Spectrometer***

### 1.4.2 Mechanical Drawing

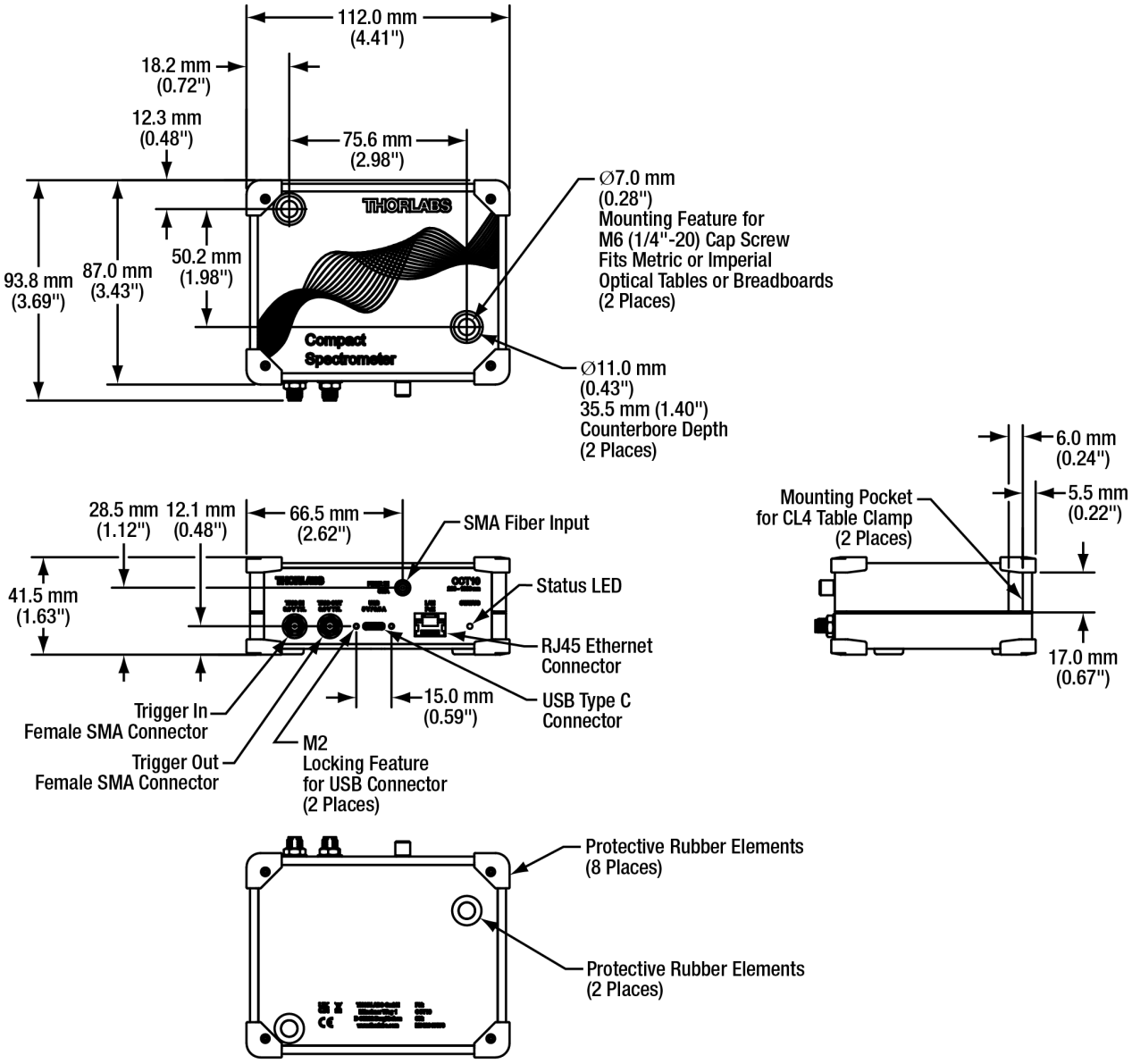



***Figure 1 Mechanical Drawing for the CCT Series Spectrometer***

## 1.5 Components

### Front Panel

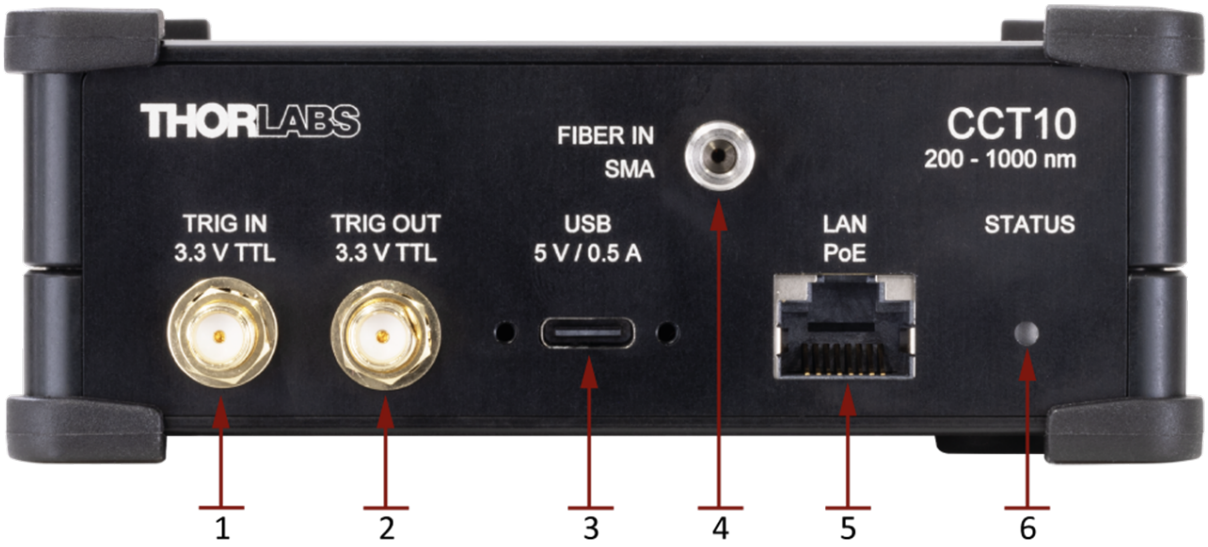



***Figure 2 Front Panel of the CCT Series Spectrometer***

| Front Panel | | |
|---|---|---|
| **Callout** | **Feature** | **Description** |
| **1** | Female SMA Connector | Input for "Trigger" IN |
| **2** | Female SMA Connector | Output for "Trigger" OUT |
| **3** | USB Type-C Connector | USB 2.0 Type-C for Remote Operation or Software Control |
| **4** | SMA 905 Connector | Input Connector for Fiber |
| **5** | RJ45 Connector | Ethernet Interface for Remote Operation or Software Control |
| **6** | Status LED | LED for Indication of Device Status<br>White: "Active" State (Device Is Ready for Operation) |

***Table 2 Front Panel of the CCT Series Spectrometer***

**Top Panel**




***Figure 3 Top Panel of the CCT Series Spectrometer***

| Top Panel | | |
|---|---|---|
| **Callout** | **Feature** | **Description** |
| **1** | Mounting Hole 1 | Mounting Option for Cap Screw M6 x 1.0 (1/4"-20) |
| **2** | Mounting Hole 2 | Mounting Option for Cap Screw M6 x 1.0 (1/4"-20) |

***Table 3 Top Panel of the CCT Series Spectrometer***

## 1.6 Simplified Declaration of Conformity

The full text of the EU declaration of conformity is available at the following internet adress:
https://www.thorlabs.com/f291457

# 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 Explosion**

The CCT Spectrometer must not be operated in explosion endangered environments!

# 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 CCT10 Spectrometer package:

- CCT10 Spectrometer
- USB 2.0 Type-C to Type-A Cable, Length 2 m
- Fiber Patch Cable SMA-SMA (Item # M111L02), Length 2 m
- Test Report
- Certificate of Calibration
- Printed Quick Reference

The following items are included in the CCT11 Spectrometer package:

- CCT11 Spectrometer
- USB 2.0 Type-C to Type-A Cable, Length 2 m
- Fiber Patch Cable SMA-SMA (Contains Item # FG050UGA Optical Fiber), Length 2 m
- Test Report
- Certificate of Calibration
- Printed Quick Reference

The following items are included in the CCT12 Spectrometer package:

- CCT12 Spectrometer
- USB 2.0 Type-C to Type-A Cable, Length 2 m
- Fiber Patch Cable SMA-SMA (Item # M14L02), Length 2 m
- Test Report
- Certificate of Calibration
- Printed Quick Reference

The following items are included in the CCT14 Spectrometer package:

- CCT14 Spectrometer
- USB 2.0 Type-C to Type-A Cable, Length 2 m
- Fiber Patch Cable SMA-SMA (Item # M25L02), Length 2 m
- Test Report
- Certificate of Calibration
- 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 CCT Spectrometer mechanically and electrically.

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

## 3.4 Installing Instructions

1. Place the CCT Spectrometer onto a stable, dry surface.

   ➤ The CCT Spectrometer needs to be positioned less than 1.5 m (59.1") from the PC to be used and less than 1.0 m (39.4") from the light source. This is due to the USB cable length and the optical fiber length, respectively.

2. Download the ThorSpectra Software from the website and install it on the PC that will be used with the CCT Spectrometer.

3. Connect the CCT Spectrometer to the remote controlling PC using the included USB 2.0 cable.

   ➤ If a USB Type-A connection to the remote controlling PC is not available, connect the PC to the CCT Spectrometer using any shielded USB Type-C cable.

4. Start the ThorSpectra Software.

   ➤ The CCT Spectrometer is now ready for operation and is recognized by the ThorSpectra Software.

   ➤ The operating system loads the appropriate USB drivers for the CCT Spectrometer.

Please find detailed instructions on the ThorSpectra Software in the ThorSpectra Software manual. The ThorSpectra Software can be downloaded from the website. CCT Spectrometer specific features of the ThorSpectra Software are described in the section Connecting CCTxx Spectrometer with ThorSpectra Software.

### 3.4.1 Mounting with Compact Table Clamps

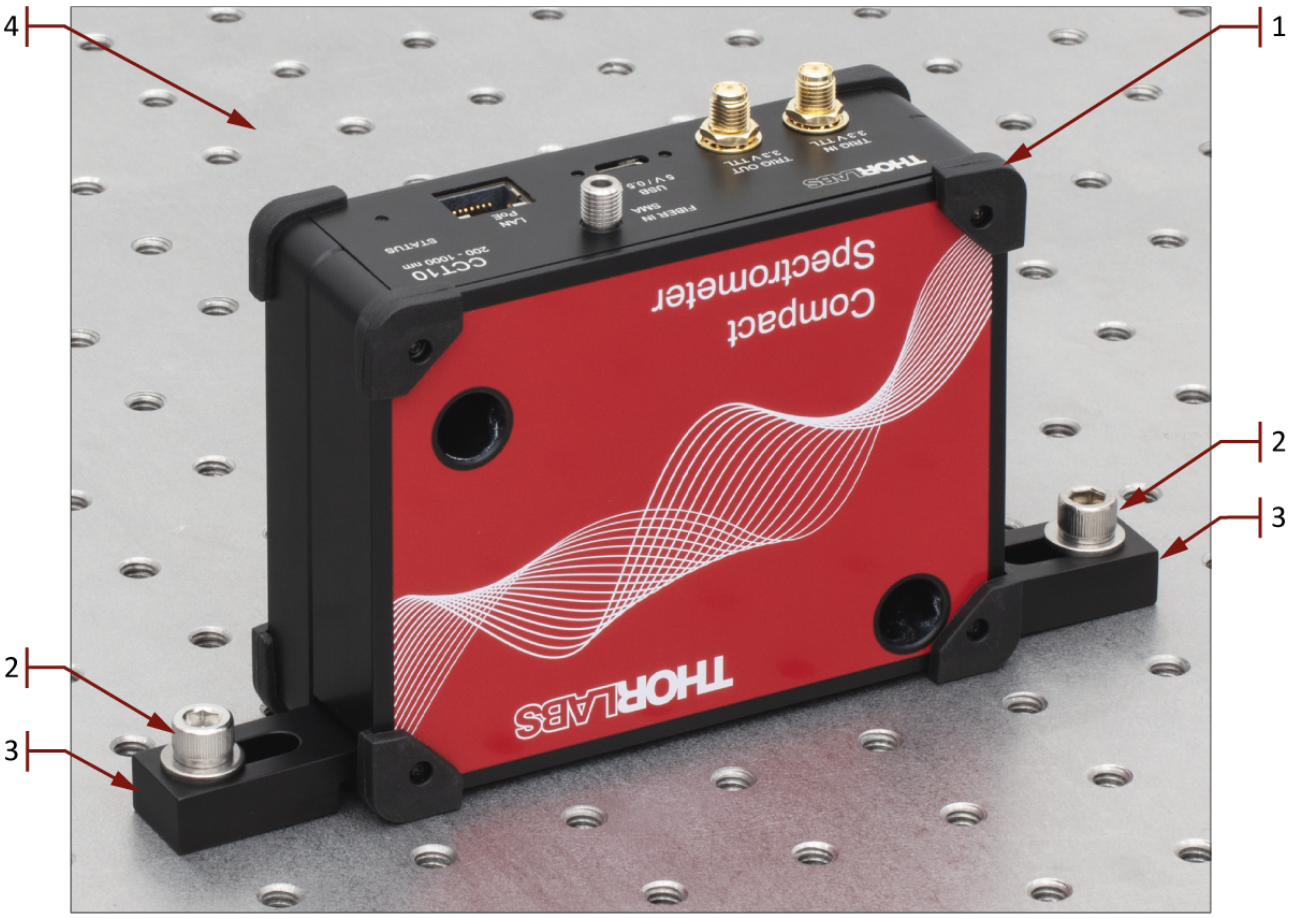



***Figure 4 Mounted CCT Spectrometer with Compact Table Clamps on Breadboard***

1. Place the CCT Spectrometer (1) vertically on the breadboard (4).
2. Place the table clamps (Item # CL4) (3) in the mounting pockets of the CCT Spectrometer (1).
3. Align the CCT Spectrometer (1) with the table clamps (3) on the breadboard (4), so that the slotted holes of the table clamps (3) match the threaded holes on the breadboard (4).
4. Mount the cap screws with washers (2).

   ➤ The CCT Spectrometer (1) is mounted.

### 3.4.2 Mounting with Cap Screws via Mounting Pockets

**NOTICE**

**NOTICE: Damage to the CCT Spectrometer**

Excessive tightening torque can cause cracks or breaks in the CCT Spectrometer. Damage to the CCT Spectrometer can impair its function and lead to costly repairs.

Use a torque wrench and ensure the recommended torque is not exceeded.




***Figure 5 Mounted CCT Spectrometer with Cap Screws on Breadboard***

1. Place the CCT Spectrometer (1) on the breadboard (2).
2. Mount the cap screws (3).

   ➤ Maximum Tightening Torque for Cap Screws (3): 0.5 Nm (4.4 lb-in)

   ➤ The CCT Spectrometer (1) is mounted.

## 3.5 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 ThorSpectra Software

The ThorSpectra Software is designed for straight forward use with the CCT Spectrometer.

Specific instructions for the ThorSpectra Software are given in the sections Connecting CCTxx Spectrometer Series to ThorSpectra Software and Device Settings in ThorSpectra. For general instructions on the ThorSpectra Software, please see the ThorSpectra Software user guide. The ThorSpectra Software user guide can be downloaded from the website.

## 4.1 Software Requirements

The following PC specifications are required for remote operation of the CCT Spectrometer.

**Minimum Hardware Requirements:**

- **Processor (CPU)** : Intel Core i5 or AMD Athlon II
- **Memory (RAM)** : 8 GB
- **Monitor Resolution** : 800 x 600 Pixels
- **Hard Drive** : 2 GB of Available Disk Space
- **Interface** : Free High-Speed USB 2.0 or Higher, Type-A or Type-C Connector

**Software Requirements:**

The ThorSpectra Software which operates the CCT Spectrometer is compatible with the following operating systems:

- **Windows® 10 (64-Bit)**
- **Windows® 11**

For operation of the CCT Spectrometer by the ThorSpectra Software, the Microsoft .NET Framework version 4.7.2 or higher is required. The ThorSpectra Software is included with the installation package.

## 4.2 Software Installation

The ThorSpectra Software supports the CCT Spectrometer and is available for download from the website.

As a part of our green initiative, Thorlabs no longer ships physical data carriers for installation of the ThorSpectra Software for the CCT Spectrometer. The ThorSpectra Software can be accessed and installed from the website instead. The current and previous versions of the ThorSpectra Software will always be available online.

**NOTICE**

**NOTICE: Clean Installation**

The installation package includes spectrometer specific drivers and software that must be installed before the CCT Spectrometer is connected to the PC for the first time. Administrator privileges are required for installation.

- Do not connect any device of the CCT Spectrometer to the PC during the ThorSpectra Software installation.
- Exit all running applications on your PC as the installer may require a reboot of your PC during installation.
- Please make sure that the installation is carried out completely, including the reboot requests.

1. Download the the ThorSpectra Software from the website.
2. Save the ZIP-file to your PC.

3. Unpack the ZIP-file.
4. Select the setup.exe file and double click to install the ThorSpectra Software.
5. Read and accept the End-User License Agreement and the GNU Lesser General Public License.
6. After installing the ThorSpectra Software, connect the CCT Spectrometer via USB to the PC.

   ➤ Please see the section Connecting CCTxx Spectrometer Series to Thor Spectra Software for further information on connecting the CCT Spectrometer.
7. Start the ThorSpectra Software from the desktop icon.

## 4.3 Connecting the CCT Spectrometer to ThorSpectra Software

There are two ways to connect the CCT Spectrometer to the ThorSpectra Software. Firstly, the CCT Spectrometer can be connected via the Type-C interface, and secondly, the CCT Spectrometer can be connected via the Ethernet interface.

Please note, that the first connection of a CCT Spectrometer device to the ThorSpectra Software must always be made via the USB interface.

The USB connection has priority over the Ethernet connection.

### 4.3.1 Connecting via USB

1. Connect the CCT Spectrometer via USB Type-C cable to the PC.

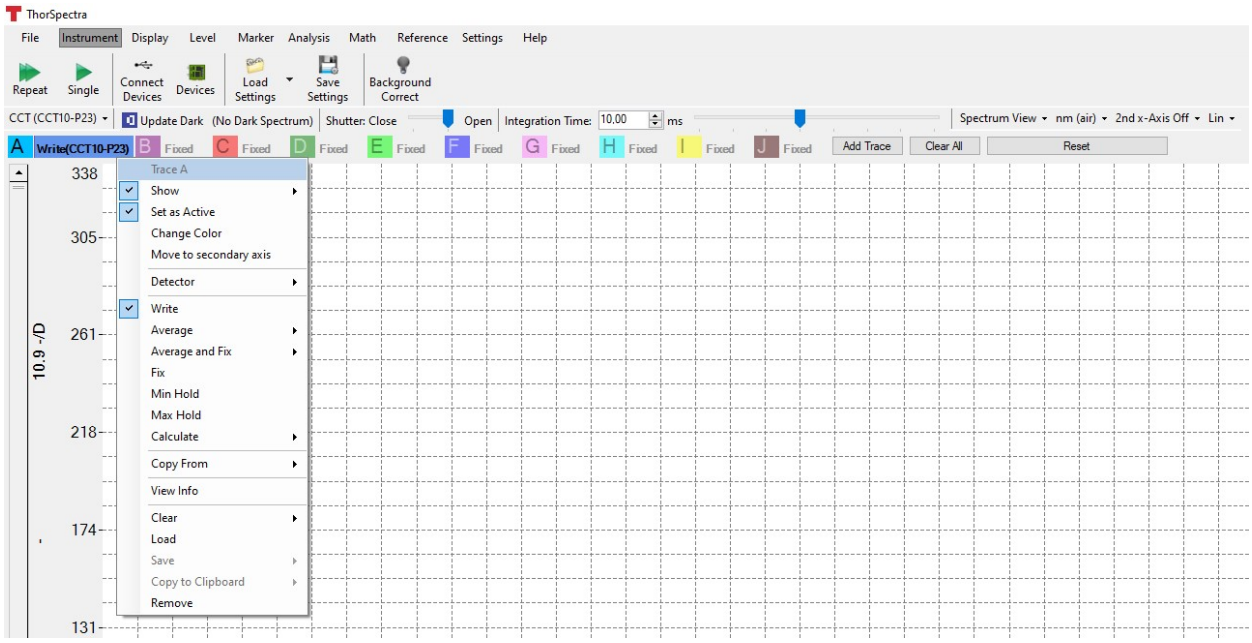



***Figure 6 Screenshot of the ThorSpectra Software***

2. Open the installed ThorSpectra Software.

   ➤ The CCT Spectrometer will be immediately recognized.

   ➤ If the CCT Spectrometer is connected while the ThorSpectra Software is open, select the "Connect Devices" button in the top panel.
3. Click to trace A within the ThorSpectra Software, and make sure that the following topics are checked:
   - Show
   - Set as Active
   - Write

4. Increase the integration time until the spectrum is displayed.
5. Right click into the data display area.

   ➤ The intensity axis is zoomed so that it best fits to the spectrum.

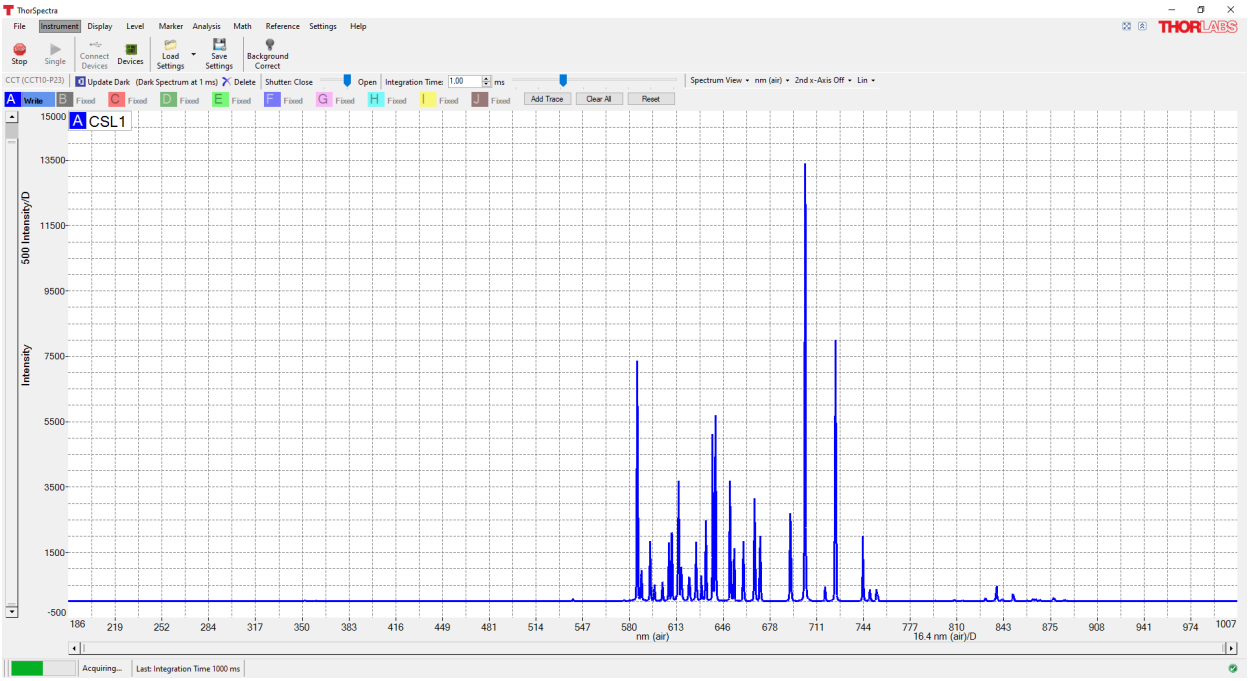



***Figure 7 Screenshot of Measurement Spectra***

### 4.3.2 Connecting via Ethernet

Please note, that the first connection of a CCT Spectrometer device to the ThorSpectra Software must always be made via the USB interface.

1. The correct IP configuration settings should be specified as shown in the image below.

   ➤ Please note, that the correct values should be requested from the IT department!

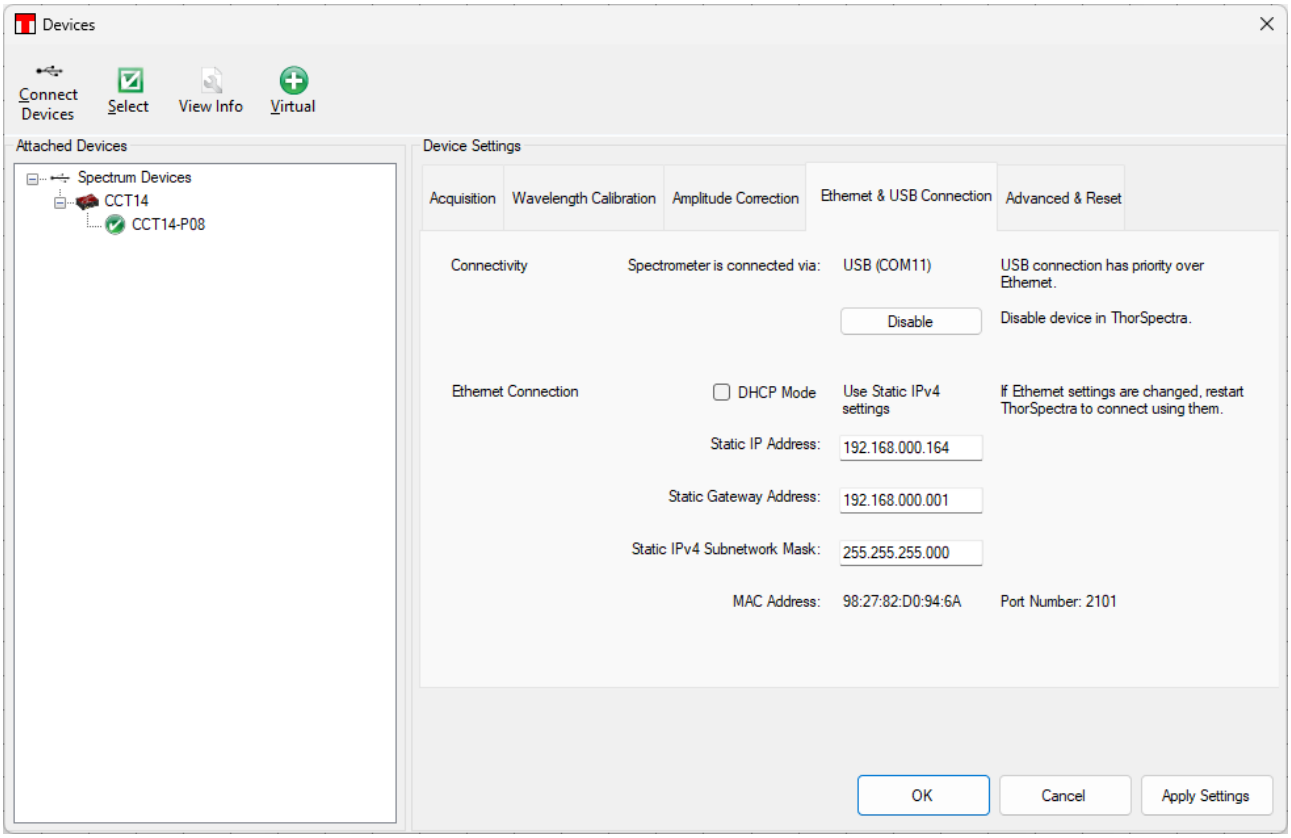



***Figure 8 Screenshot of the ThorSpectra Software***

2. Click on the "Apply Settings" button.

   ➤ Changes to the IP address settings are saved.

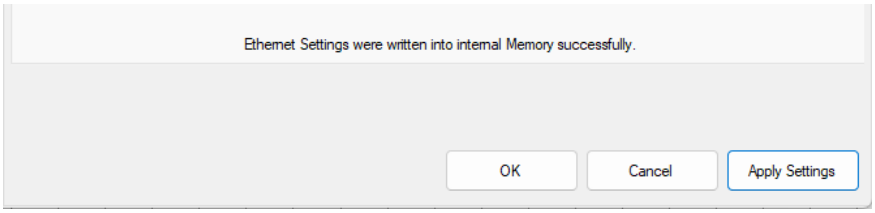



***Figure 9 Screenshot of the ThorSpectra Software***

3. Boot the CCT Spectrometer.

   ➤ The new IP adress settings are adopted.

4. Connect the CCT Spectrometer to an proper Ethernet port.

   ➤ The CCT Spectrometer works with the ThorSpectra Software in the same way as if it were connected via USB.

**Optional**

When the CCT Spectrometer IP address is in a different IP subnet than the PC with ThorSpectra Software (ask the IT department), the following action is required.

5. Enter the IPv4 address in the System tab.
6. Click on the "OK" button or click on the "Apply Settings" button.

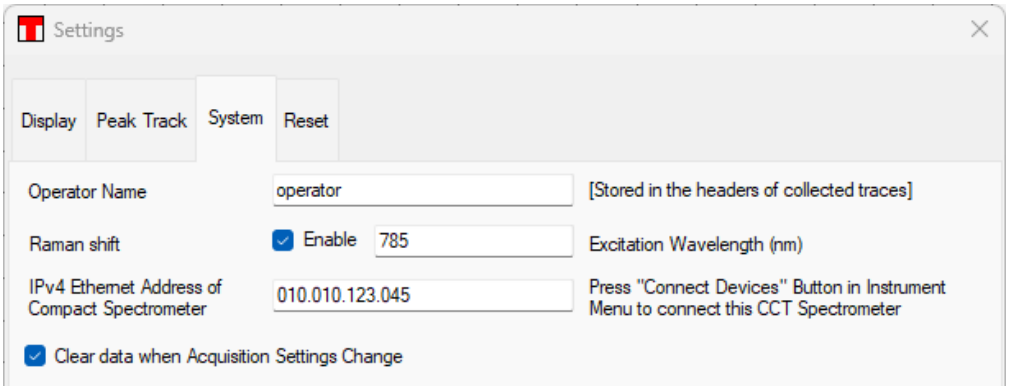



***Figure 10 Screenshot of the ThorSpectra Software***

## 4.4 Device Settings in ThorSpectra

The following device settings can be configured with the ThorSpectra Software:

- Acquisition
- Wavelength Calibration
- Amplitude Correction
- Ethernet & USB Connection
- Advanced & Reset

### 4.4.1 Acquisition

This section allows you to configure how the spectrometer acquires each spectrum, including integration time, averaging, triggering behavior, and dark-spectrum handling.

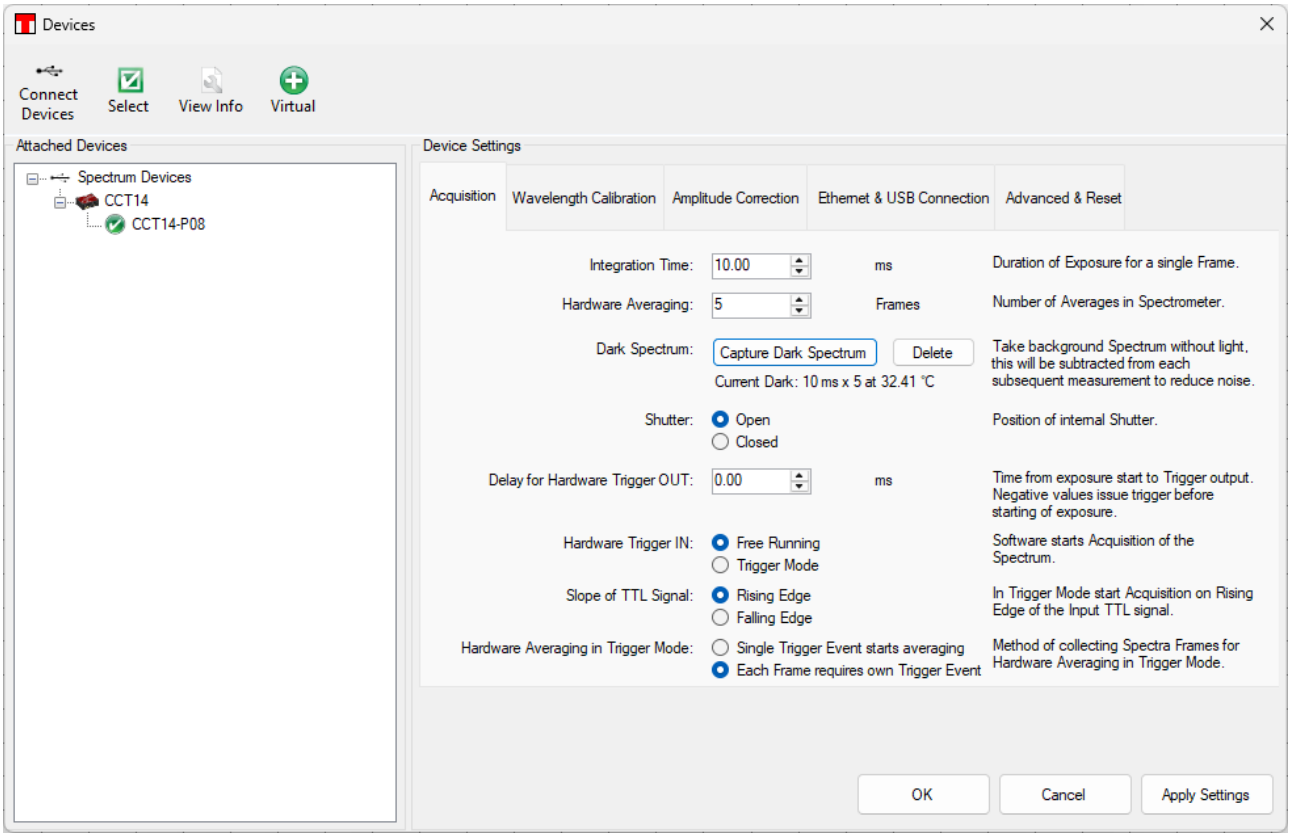



***Figure 11 Screenshot of the Acquisition Tab***

**Integration Time**

The Integration Time specifies the exposure time for a single spectral frame - in millisecond units.

A longer Integration Time increases the amount of light collected, resulting in a stronger signal. The acquisition time is limited by saturation of the spectrometer sensor.

Note, that optimal subtraction of Dark noise is when the Dark Spectrum is acquired using the built-in shutter at the same integration as the light spectrum.

**Hardware Averaging**

Hardware Averaging defines how many consecutive spectral frames the spectrometer averages internally before sending data to the software - as number of Frames.
In the ThorSpectra Software the sampling rate from the hardware is synced to the refresh rate of the GUI. Please note, that the SDK provides a faster refresh rate for custom applications. Therefore using Hardware Averaging allows one to acquire and average more data on the hardware between display refresh in the Software, thus increasing the Signal-to-Noise Ratio.

**Dark Spectrum**

Dark Spectrum captures a background (dark) spectrum with no light entering the sensor - using the built-in shutter automatically.

This dark spectrum is then automatically subtracted from all subsequent measurements to reduce noise and compensate for sensor offsets.

For the most accurate results, the dark spectrum should be captured using the same acquisition settings (integration time of single frame and number of averaged spectra) as the actual measurement.

**Shutter**

The Shutter controls the position of a mechanical shutter, which is built-in into the spectrometer.

- **Open**
  Allows light to reach the sensor for normal measurements.
- **Closed**
  Blocks light, used for capturing a dark spectrum.

**Delay for Hardware Trigger OUT**

The Delay for Hardware Trigger OUT determines when the spectrometer sends its output hardware trigger signal relative to the start of an acquisition – in millisecond units:

- **Positive Values**
  Output trigger is sent after acquisition begins.
- **Negative Values**
  Output trigger is set on the acquisition trigger, but exposure of the sensor is delayed by the amount given – this can be used to prepare external devices and begin measurement after this delay (see *Figure 12* for more details)

If the delay is longer than the integration time, the trigger will not be issued.

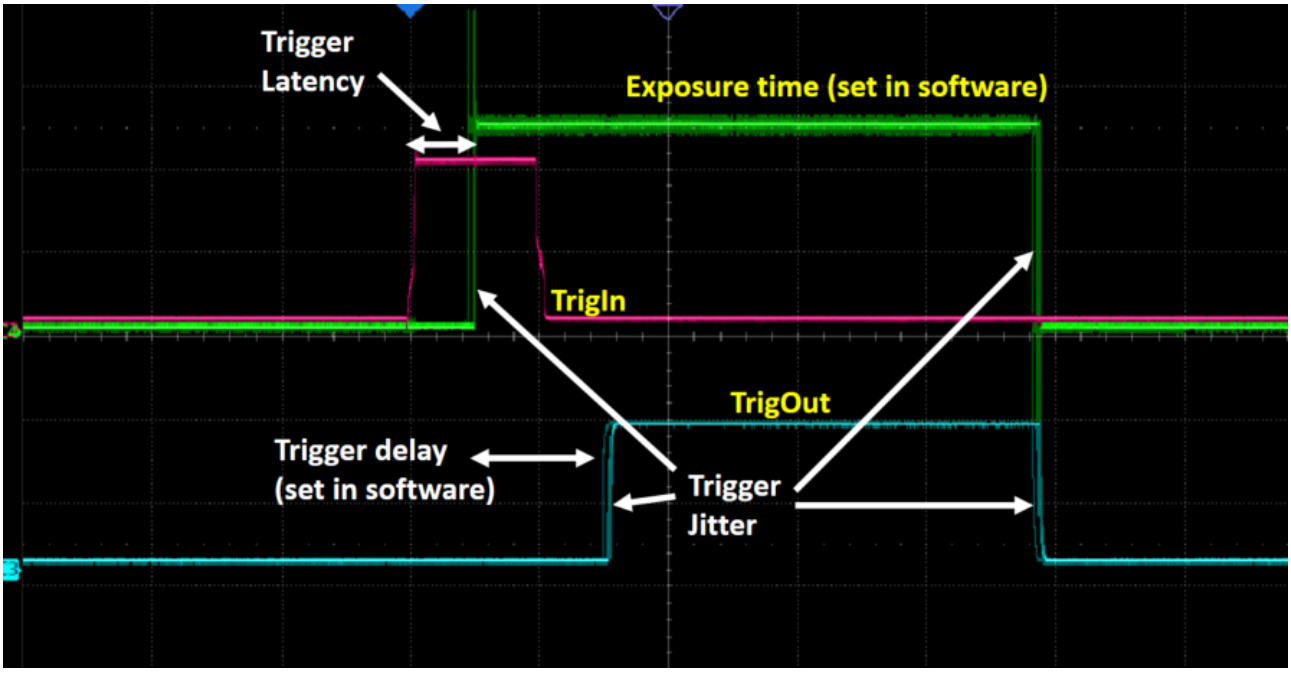



***Figure 12 Triggers***

**Hardware Trigger IN**

Hardware Trigger IN controls how acquisition is started.

- **Free Running**
  The acquisition is triggered through the Software. In continuous acquisition mode, each new acquisition is triggered by the Software after the previous spectrum is displayed on the chart.
- **Trigger Mode**
  Acquisition begins only when an external hardware trigger signal level (3.3 V TTL) is received. See *Figure 12* for more details.

**Slope of TTL Signal**

The Slope of TTL Signal specifies which edge of the incoming TTL trigger signal activates an acquisition when hardware triggering is enabled.

- **Rising Edge**
  Start acquisition on detection of the rising edge of the TTL signal (default).
- **Falling Edge**
  Start acquisition on detection of the falling edge of the TTL signal.

**Hardware Averaging in Trigger Mode**

Hardware Averaging in Trigger Mode controls how frame averaging behaves when using a hardware trigger input.

- **Single Trigger Event Starts Averaging**
  One trigger starts the collection of all frames required for averaging. The spectrometer automatically collects and averages them without further triggers.
- **Each Frame Requires Own Trigger Event**
  A separate trigger is required for every individual frame that contributes to the averaging. This offers tighter synchronization with external equipment.

### 4.4.2 Wavelength Calibration

The sensor installed in the spectrometers of the CCT Spectrometer is a line array. Each of the CCT Spectrometers is factory calibrated, using a calibration source with well-known spectral lines. The factory calibration defines the exact wavelength for certain pixels. Between these pixels (or calibration points), the wavelength is interpolated. The calibration data are saved to the internal non-volatile memory of the CCT Spectrometer.

In certain cases a more detailed calibration, based on an available calibrated spectral source, might be desired. Within the ThorSpectra Software, the user can calibrate the CCT Spectrometer for 4 to 10 individual calibration points. This replaces the factory calibration with a user calibration.

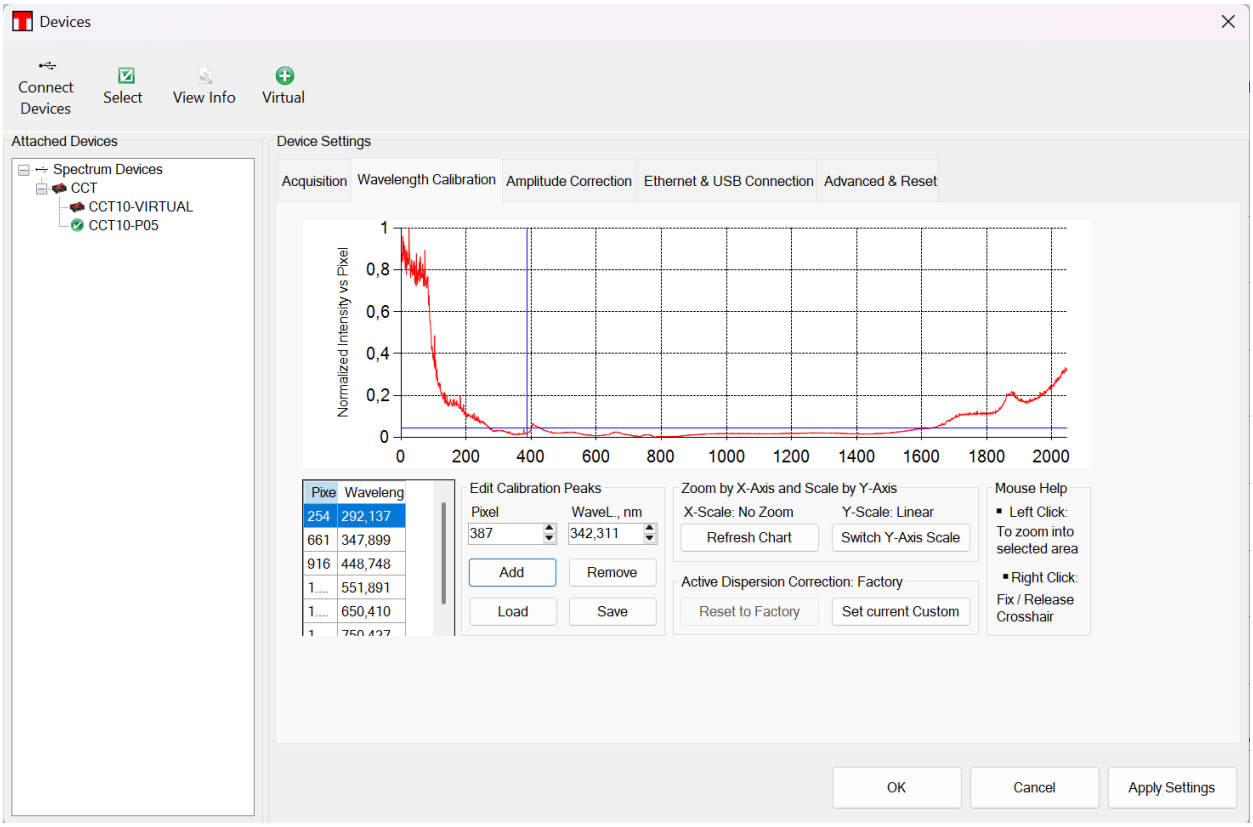



***Figure 13 Screenshot of the Wavelength Calibration Tab***

In order to calibrate the spectrometer, please follow the instructions below:

1. Apply the individual spectral source to the CCT Spectrometer input.
2. Adjust the integration time such that maximum intensities are displayed without entering saturation.
3. Within the ThorSpectra Software, open the interface "Device" in the main menu and activate the tab "Wavelength Calibration" (see *Figure 13*).
4. Enter between 4 and 10 calibration points as follows:
   a. Mark a calibration point in the spectrum to the left.
      ➤ The peak is marked by a blue cross and the related pixel number is displayed in the panel "Calibration".
   b. Move the mouse to the peak and press the right mouse button.
   c. Enter the corresponding wavelength in the panel Calibration Point.
   d. Select "Add/ Update".
      ➤ The table will be updated.

e. Repeat this procedure for up to 10 calibration points. The example in *Figure 13* shows a sample table containing several custom calibration points.

➤ The calibration table is completed.

5. Press "Save".

➤ The user calibration points are now stored to the CCT spectrometer EEPROM in addition to the factory calibration. Following the user calibration procedure, the wavelength calibration can be switched between Factory and User Calibration by checking the box "Enable User Wavelength Calibration". A new user calibration will overwrite the previous user calibration.

### 4.4.3 Amplitude Correction

Under the "Amplitude Correction" tab, it is possible to activate the amplitude correction function using the check box.

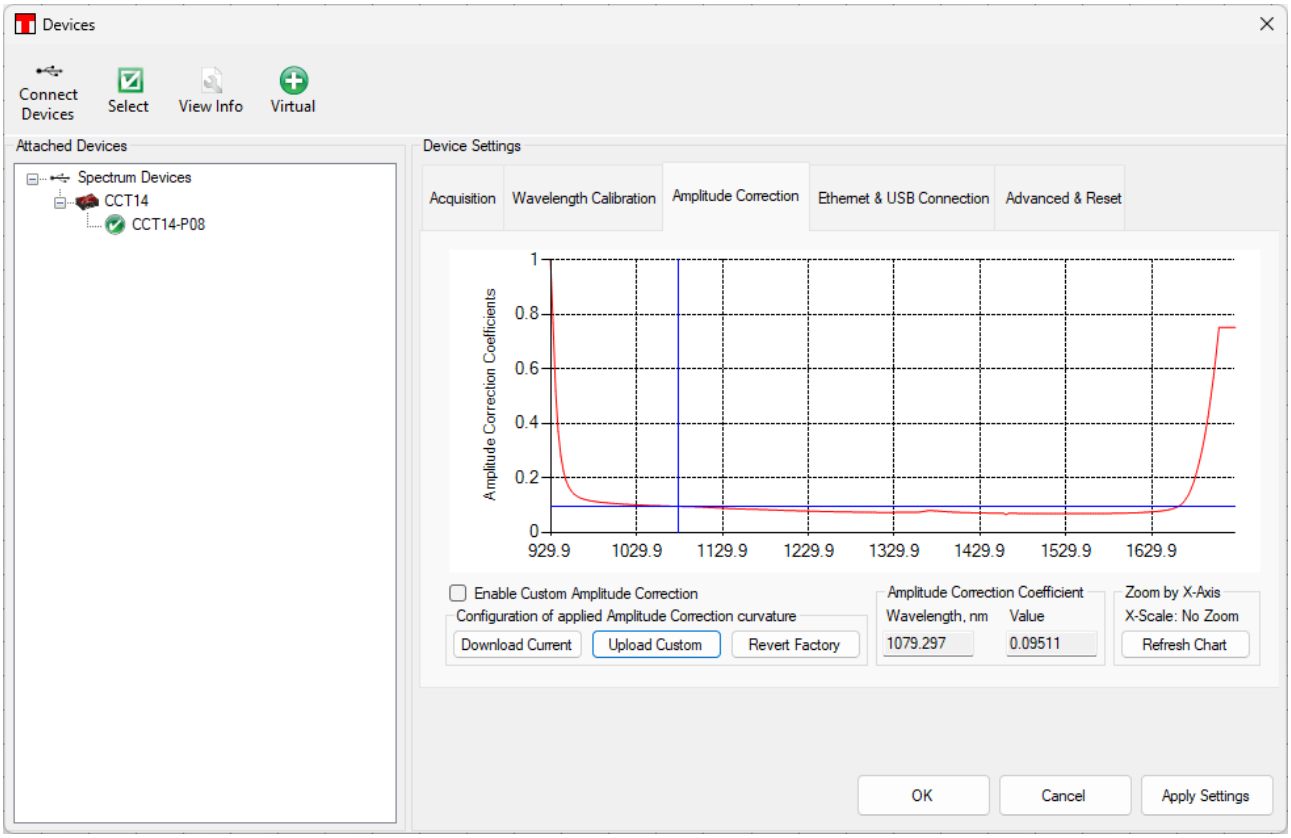



***Figure 14 Screenshot of the Amplitude Correction Tab***

The Amplitude Correction tab provides tools for managing and customizing amplitude-correction settings, including the option to upload a custom correction file via the Upload Custom button. To prepare such a custom amplitude correction, the operator can press the Download Current button, select the preferred file format (.CSV or XML), and use the exported file as a template for creating a custom amplitude-correction data file.

**Functions**

- **Download Current**
  Downloads the currently applied amplitude correction as a file.
- **Upload Custom**
  Allows you to upload a custom amplitude correction file.

- **From Factory**
  Resets the amplitude correction to the factory default settings.
- **Revert Factory**
  Button is visible only if Custom Amplitude Correction is loaded.
  Resets the Amplitude Correction to the factory default settings.

**Supported Import/Export Formats**

- .XML and .CSV formats are supported for both import and export.

**Status Indicator**

The Status Indicator provides information about the currently active amplitude correction settings and allows the user to enable or disable amplitude correction.

- **Enable/Disable Amplitude Correction**
  The text label of the check box displays which Amplitude Correction would be applied: from the Factory Amplitude Correction or from the Amplitude Correction Custom.
- **Displayed Correction Mode**
  The indicator shows which amplitude correction profile is currently applied:
  a. Enable Factory Amplitude Correction: The factory calibration settings are active.
  b. Enable Custom Amplitude Correction: A user-defined calibration profile is active.

**Important Note on Memory Writing**

Writing to internal memory takes time. During this process, an additional text message is displayed to indicate progress.

### 4.4.4 Ethernet & USB Connection

The "Ethernet & USB Connection" tab contains the connection settings for the CCT Spectrometer to the ThorSpectra Software via Ethernet or USB. Please see the section Connecting CCT Spectrometer to ThorSpectra Software for further information.

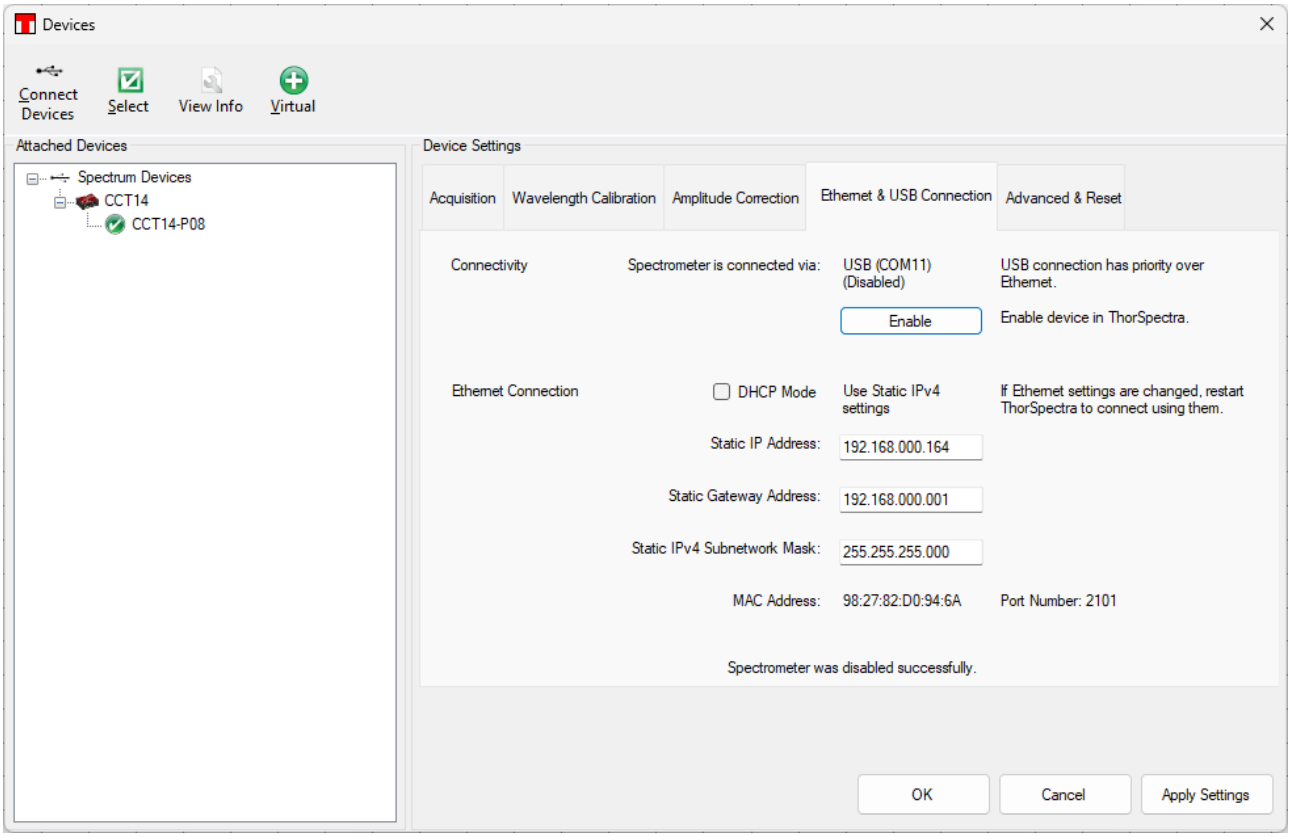



***Figure 15 Screenshot of the Ethernet & USB Connection Tab***

The *Disable* button removes the spectrometer from active control within the ThorSpectra Software, making the device available for access through custom applications without requiring ThorSpectra Software to be closed.

Once operation in the Custom Software environment is complete, the spectrometer can be re-enabled for use in ThorSpectra Software by clicking the *Enable* button.

### 4.4.5 Advanced & Reset

You will find the following information and settings under the "Advance & Reset" tab:

- ADC Offset
- Current Spectrometer Temperature
- Firmware Version
- Electronic Board ID
- Driver Software Version
- Reset to Factory Settings

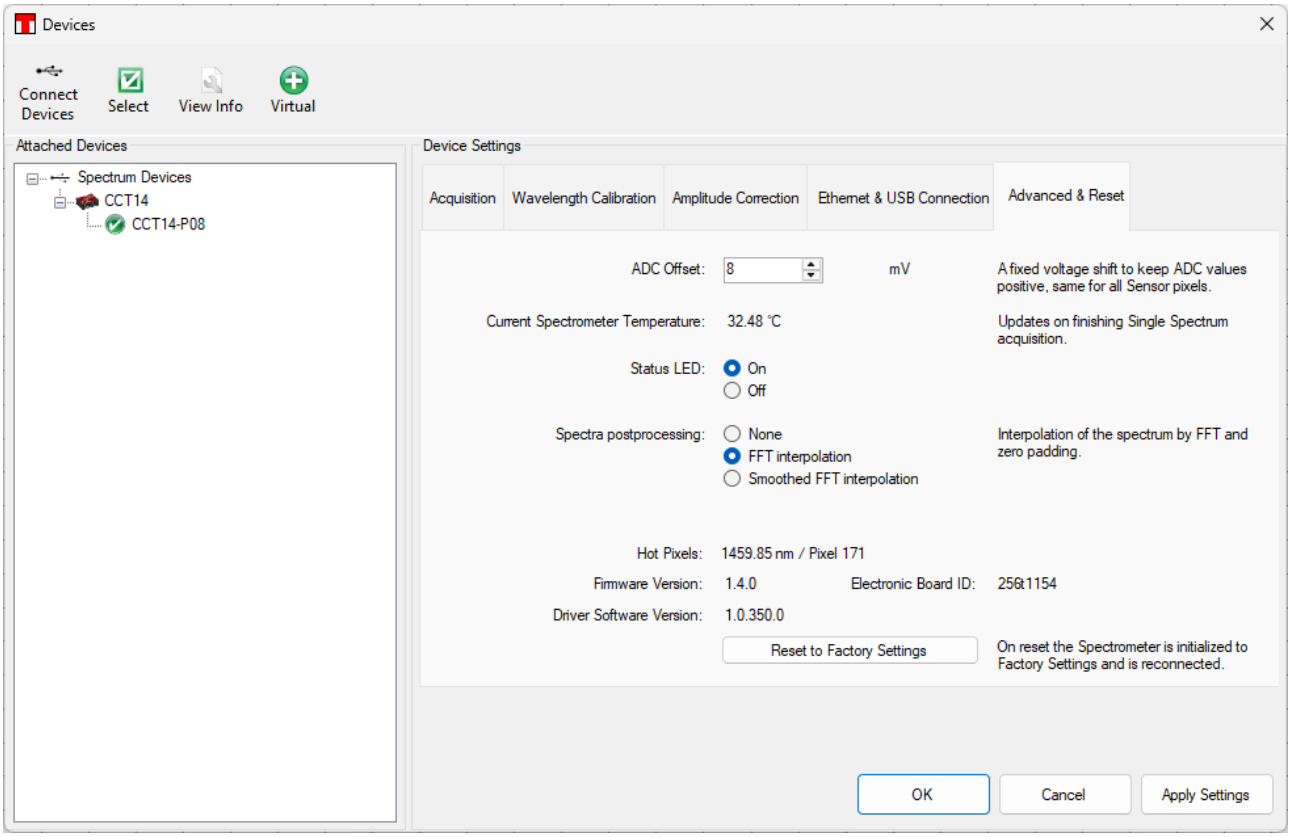



***Figure 16 Screenshot of the Advanced & Reset Tab***

The selector allows the Status LED on the spectrometer housing to be switched on or off.

If the spectrometer sensor contains defective pixels, the software lists them together with the corresponding wavelength-dispersion values in nanometers. Values for hot pixels are computed as the average of the neighboring pixels. Hot pixels cannot be adjacent to one another. The maximum number of hot pixels is limited to 1% of the total number of pixels on the sensor.

If the spectrometer sensor contains fewer than 2000 pixels (e.g., CCT14), the software provides an option to apply post-processing algorithms to the measured data in order to display interpolated data points.

The core interpolation algorithm is based on an FFT-based method using zero-padding in the frequency domain; no additional window function is applied. An optional second processing step suppresses ringing artifacts around steep spectral transitions (Gibbs phenomenon).

Both interpolation methods resample the acquired spectrum to 16 384 data points while preserving the original sampled points as well as the full spectral range.

# Chapter 5 Custom Software

**Software Development Kit for the CCT Spectrometer Series**

The Software Development Kit for CCT Spectrometer Series (referred to as the CCT SDK) is based on the same software libraries (referred to as the CCT Instrument Driver) that are used by the CCT plug-in within the ThorSpectra Software.

The CCT SDK provides tools and example projects for various programming environments, as listed in the table below. Additional environments can be supported through the interoperability features provided by the framework that underlies the CCT Instrument Driver.

Both the CCT SDK and the CCT Instrument Driver are installed alongside the ThorSpectra Software and placed in the Examples subfolder of the ThorSpectra Software installation directory.

Beginning with ThorSpectra version 3.38, the SDK is distributed as a ZIP archive whose filename includes the SDK version number using the format cct_sdk_{version-number}.zip. This approach allows newer SDK versions to be supplied without interfering with an existing installation.

The CCT Instrument Driver is built on the .NET platform and compiled with the default AnyCPU target for .NET 8, .NET 10, and .NET Framework 4.8, 4.7.2, 4.6.2, as well as .NET Standard 2.0. The .NET 8 and .NET 10 builds of the CCT Instrument Driver are cross-platform.

In the table below you will find a list of programming environments with explicit examples.

| Programming Environment | Summary of Resources |
|---|---|
| **.NET (C#)** | DLL Libraries Along with NuGet Packages, Example Console Application Written on C# |
| **LabVIEW™** | VI in LLB Container and a Project File to Run Example Application |
| **Python** | Plain Script Along with Pip Package |
| **C / C++** | Header File TLCCT.h and Precompiled Binaries for Linking and Running of Custom C /C++ Software |

***Table 7 List of Programming Environments with Explicit Examples***

**.NET (C#)**

The CCT Instrument Driver for writing applications in .NET Platform is distributed in NuGet packages located in the installation directory of the ThorSpectra Software with the CCT plugin under the internal local path within the installation ZIP-Archive file "cct_sdk_{version-number}.zip":

```
NuGet
```

An example Cross-Platform Console Application is located in internal local path within the installation ZIP-Archive file "cct_sdk_{version-number}.zip":

```
CSharp
```

The distribution contains built executables in related subfolders "bin" along with dependency DLLs.

In Project files enabled the multi-target build. The Console Example is set for two common targets .NET Framework 4.8 and .NET 8, because SDK packages installed on PC vary. The Benchmark Application is vice versa set for all original targets of CCT SDK. In any case, the target frameworks can be customized via element `TargetFrameworks` of the C# Project file.

**LabVIEW™**

The VI modules wrapping functionality of the CCT Instrument Driver are assembled into LabVIEW™ Instrument Driver project. LabVIEW™ project with example application using these VIs is located in the installation directory of the ThorSpectra Software with the CCT plugin under the internal local path within the installation ZIP-Archive file "cct_sdk_{version-number}.zip":

```
LabView
```

For using in development it is recomended to copy content of this folder into a subfolder named "TLCCT" within the "instr.lib" directory of the LabVIEW™ installation.

Then the SDK VIs should be read by the LabVIEW™ on new start and through the provided dir.mnu files displayed in the functions selection menu under category "Instrument I/O" → "Instr Drivers".

Details on usage of .NET Assemblies in the LabVIEW™ are available on the National Instruments website, e.g. at the moment of writing on page:

[NI article "Requirements for Using .NET Assemblies in LabVIEW"](https://www.ni.com/docs/en-US/bundle/labview/page/requirements-for-using-net-assemblies-in-labview.html).

The distribution contains dependency DLLs for various .NET Framework Runtimes in subfolders *net48* (includes CCT specific DLLs only), *net462* (includes CCT specific DLLs and complete set of .NET Framework 4.6.2 DLLs) with default selection to *net462*.

An executable program is built from the *TLCCTe_Example.vi* using LabVIEW RunTime of version 2024 Q1. Compilation configuration is included into project file for building with other runtimes.

The VIs in the example and driver project of the LabVIEW™ is exported with backward compatibility from version 14 onwards.

**Python**

The interoperability with the CCT Instrument Driver can be performed using package Python.NET (pythonnet). Example is located in the installation directory of the ThorSpectra Software with the CCT plugin under the internal local path within the installation ZIP-Archive file "cct_sdk_{version-number}.zip":

```
Python
```

The distribution contains a python package in subfolder "pyCCT" along with dependency DLLs in its subfolders and Wheel Binary Package of it.

More details on cross-platform usage of CCT Python SDK provided in its ReadMe documentation.

**C / C++**

The specification of the C/C++ API of the CCT SDK is provided in header file "include/TLCCT.h" under the internal local path within the installation ZIP-Archive file "cct_sdk_{version-number}.zip":

```
tlcct
```

This folder contains precompiled binaries for OS platforms Windows x64 and GNU/Linux x64 to compile and run custom applications written in C and / or C++ Programming Environment.

The implementation of this variant of the SDK is hosting .NET 8 RunTime for running the same CCT Instrument Driver as in the back-end of all other interoperability variants. For more details, see documentation in the "docs" subfolder.

# Chapter 6 Maintenance and Cleaning

NOTICE

**NOTICE: Risk of Damaging the CCT Spectrometer**

The CCT Spectrometer is not water resistant. If the CCT Spectrometer gets into contact with fluids, the CCT Spectrometer can be damaged.
To avoid damaging, do not expose the CCT Spectrometer to:

- Sprays
- Liquids
- Solvents
- Adverse Weather Conditions

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 7 Recalibration Service

Thorlabs offers a wavelength recalibration and amplitude correction service for our CCT Series Spectrometers, Item # CAL-CCT. To ensure accurate measurements, we recommend recalibrating the device every 12 months. We also recommend updating the amplitude correction whenever a new patch cable is used with the device. When sending the part for recalibration, please include the patch cable that the spectrometer is being used with. For more information, please contact Technical Support.

# Chapter 8 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 9 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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