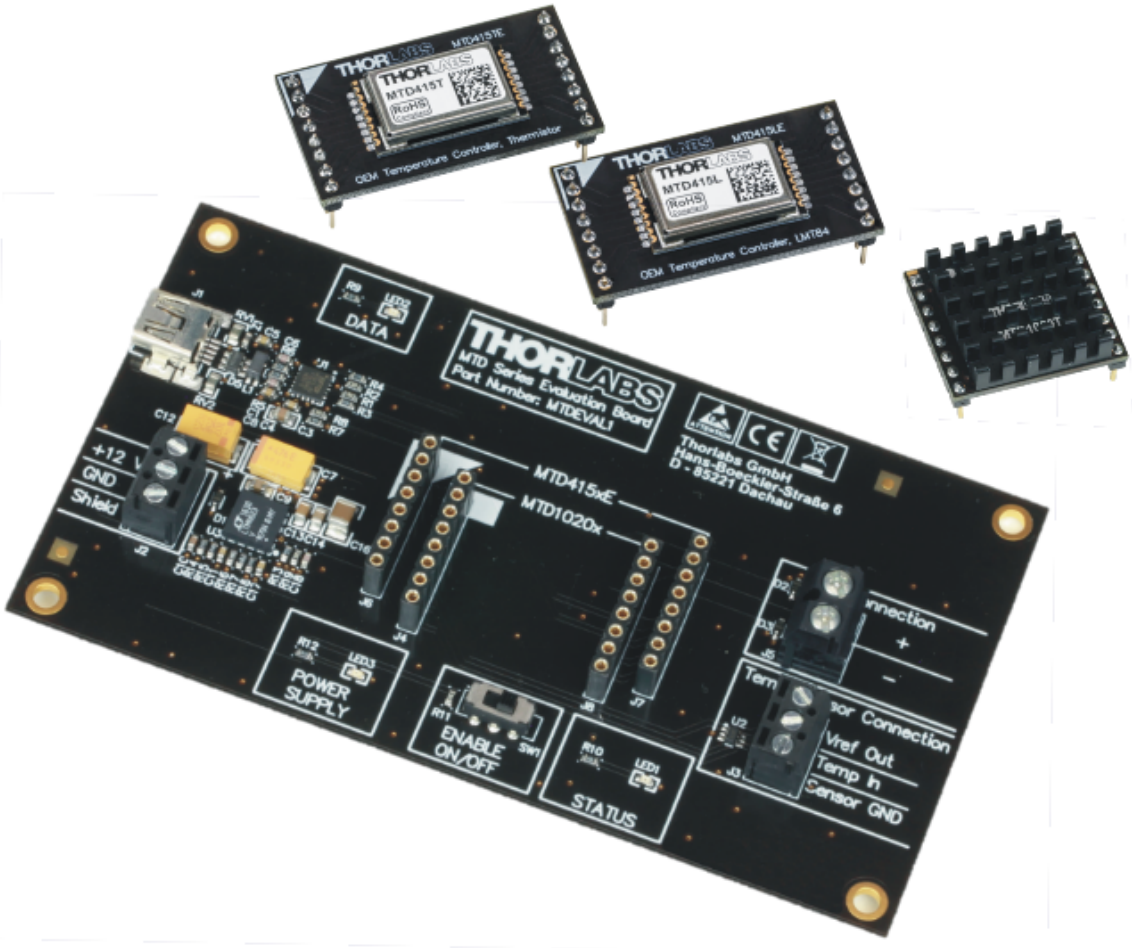
THORLABS

Miniature TEC Driver Evaluation Board

MTDEVAL1 User Manual



2018

Version: 1.3
Date: 11-Jul-2018

Contents

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and improve our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

Attention

Paragraphs preceeded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

This manual also contains "NOTES" and "HINTS" written in this form.

Please read this advice carefully!

1 General Information

The MTDEVAL1 is designed to facilitate the evaluation the MTD Series of miniature TEC controller modules. There are two sockets on the evaluation board. One accommodates the MTD1020Tx series of TEC controllers, and the other accommodates the versions of the MTD415x series of TEC controllers that are mounted on a daughterboard. These TEC controllers are ordered separately. Please see section Ordering Codes and Accessories) that need to be ordered separately.

Wires from the external TEC and temperature sensor are connected to the evaluation board via screw terminals.

The MTD Series of TEC controllers are programmed via a UART interface. Commands are used to set PID values and other system parameters, as well as to acquire digital measurement data. The evaluation board eases communication with a mounted TEC controller by enabling a PC interface. A USB-to-UART adapter is integrated with the MTDEVAL1, which allows a standard USB2.0 connection to the control PC. Thorlabs GmbH offers software for download, which has an easy-to-use GUI for interfacing with the MTDEVAL1. Using this software, the controller settings of the mounted MTD Series TEC controller can be evaluated and adapted to a particular thermal load.

The MTDEVAL1 is powered by any stabilized 12 V / min. 2.3 A DC power supply.

The links to the MTD Series Data Sheets can be found in section Documentation Reference.

1.1 Safety

Attention

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.

Prior to applying power to the MTDEVAL1, make sure that the switch SW1 (ENABLE ON/OFF) (see section Operating Elements) **is switched off.**

The MTDEVAL1 must not be operated in explosion endangered environments!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Only with written consent from *Thorlabs GmbH* may changes to single components be made or components not supplied by *Thorlabs GmbH* be used.

Attention

The MTDEVAL1 is not a complete product and not available for resale. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts familiar with the dangers and application risks associated with handling electrical components. It should not be used as all or parts of a finished product.

Attention ESD-Warning:

Follow the common recommendations for handling of electrostatic sensitive devices (ESD) as described in the ESD-standard: IEC/TR 61340-5-2 when installing, handling and using a MTD Series product. Exposure of an ESD to electrostatic discharge may result in damage to the device.

Recommendations for ESD precautions:

Static electricity occurs in our everyday environment, for example when walking along a carpeted floor in a heated room during winter. While the sudden discharge of static electricity does not harm the human body, it can result in damage to electronic devices which are sensitive to electrostatic discharge (ESD). Examples of precautions to avoid static electricity are:

1. Handle ESD devices at static-safe workstations.
2. Wear anti static wrist-straps.
3. Avoid bringing sources of static electricity like plastic bags, blowers or paper within one meter of a static-safe work bench.
4. It is highly recommended for each user to wear antistatic shoes.
5. ESD devices should be contained in a static protective bag or container at all times during storage or transportation.

1.2 Ordering Codes and Accessories

Ordering Code	Description
MTDEVAL1	Evaluation Board for MTD Miniature TEC Driver Series

Optional Accessories

- MTD415LE TEC Controller, on daughter board, LMT84 temperature sensor
- MTD415TE TEC Controller, on daughter board, thermistor temperature sensor
- MTD1020Tx Series TEC Controller, thermistor temperature sensor
- USB-AB-72 USB A to Mini B Cable, length 72" (1.83 m)

Note

The TEC controllers and the temperature sensors are not included with the MTDEVAL1. They need to be ordered separately!

1.3 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the MTDEVAL1 mechanically and electrically.

Verify that you have received the following items within the package:

1. MTDEVAL1 Evaluation Board

1.4 Requirements

These are the requirements for the PC intended to be used for remote operation of the MTDEVAL1.

Hardware Requirements

CPU:	1 GHz or higher
RAM:	512 MB
Graphic resolution	min. 1024 x 768
Hard disc	min. 1 GB of available disk space (32 bit) min. 2 GB of available disk space (64 bit)
Interface	free USB2.0 port, USB cable according the USB 2.0 specification

Software Requirements

The MTDEVAL1 software is compatible with the following operating systems:

- Windows® 7 (32-bit, 64-bit)
- Windows® 8.1 (32-bit, 64-bit)
- Windows® 10 (32-bit, 64-bit)

For operation of the MTDEVAL1, the Microsoft .NET Framework V 4.5.1 or later is required. This software (V 4.6.1) is included with the MTDEVAL1 installation package.

2 Getting Started

For proper operation of the MTDEVAL1, please observe the order of the following steps:

1. Install the software to your computer.
2. Install the daughter board (MTD415LE or MTD415TE) or the MTD1020x to the MTDEVAL1.
3. Connect the TEC and the temperature sensor.
4. Make sure that switch SW1 (**ENABLE ON/OFF**) is set to **OFF**.
5. Connect the power supply.
6. Establish the USB connection to the PC.

3 Operating Principle

The MTDEVAL1 - in combination with MTD software - is a convenient developer tool for optimizing the settings of the MTD Series TEC controllers, such as the the target temperature and allowed temperature deviation, to the operation environment.

The MTD software offers an intuitive GUI that allows the operating parameters to be optimized. These parameters can then be saved to a file and/or written to the MTD Series Miniature TEC Driver module. The MTDEVAL1 connects the MTD module (UART interface) with the PC by an USB2.0 interface.

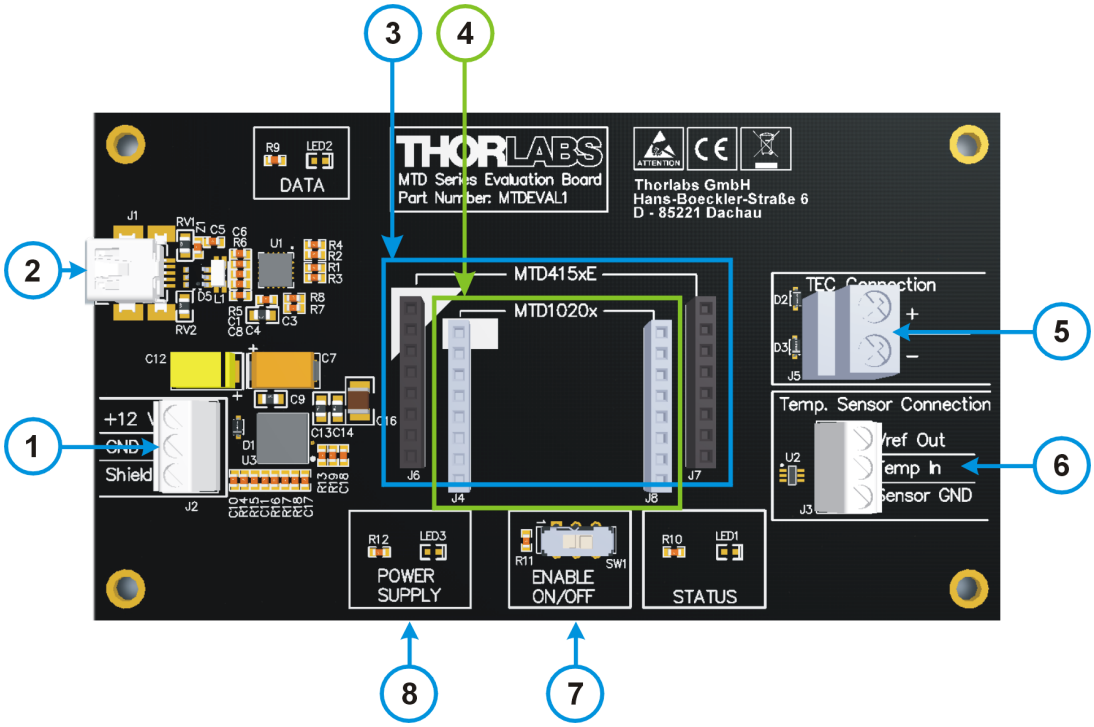
It is important to understand the memory structure of the MTD module. It has both, a volatile and a non-volatile (flash) memory.

Data in flash memory persists even when no power is supplied. Flash memory has a limited number of write-erase cycles. To extend the lifetime of this memory, parameters are not saved automatically to flash memory. Instead, they are saved to the temporary volatile memory, and the settings in this temporary memory are those used to control the MTD Series Drivers. To overwrite the contents of the flash memory, the user sends a specific command. Upon receipt of the command, the entire contents of the temporary memory is saved to the flash memory. The parameters in the volatile memory are only used during a single operating session. This memory is cleared upon power-down.

When the MTDEVAL1 is powered up, the data from the flash memory are read out to the volatile memory.

The MTD software writes parameters only to the volatile memory. At any time, the actual configuration stored in the volatile memory can be transferred to the non-volatile flash memory or can be saved to an XML file on the PC.

4 Operating Elements



1	Screw terminal for external DC power supply (11.5 ... 13.0) V DC, min. 2.3 A
2	USB terminal for external PC control. No power supply here!
3	**J6** and **J7** - Sockets for MTD415xE adapter PCB. The white triangle marks pin 1 of the adapter.
4	**J4** and **J8** - Sockets for MTD1020T. The white triangle marks pin 1 of the module.
5	Screw terminal for TEC connection. [1])
6	Screw terminal for temperature sensor connection. See section Preparation.
7	**SW1 ENABLE** - switch TEC ON / OFF
8	Status LED

[1]) Please consider that the polarity of the TEC element depends on the physical mounting direction of the TEC element in your application. The (+) and (-) terminals described here diagram assumes the TEC element has been mounted with the cold side in contact with the device being temperature controlled and a positive voltage is sourced to the TEC element.

Power Supply Connection

The MTDEVAL1 consumes up to 2.3 A, depending on the TEC current.

Connect any external DC power supply that delivers (11.5 ... 13.0) V DC and at least 2.3 A to the terminal (1). Take care for correct polarity.

5 Installing Software

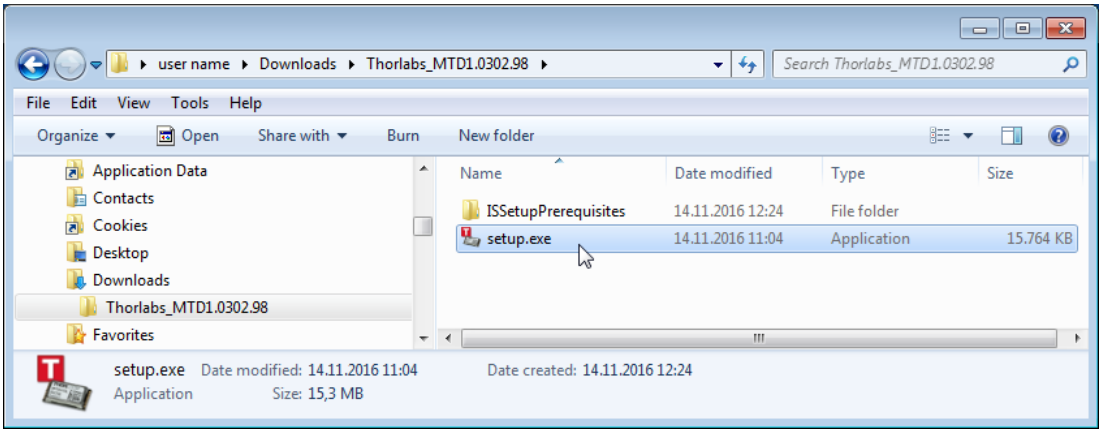
The MTDEVAL1 control software can be downloaded from our web site https://www.thorlabs.com/software_pages/ViewSoftwarePage.cfm?Code=MTDEVAL.

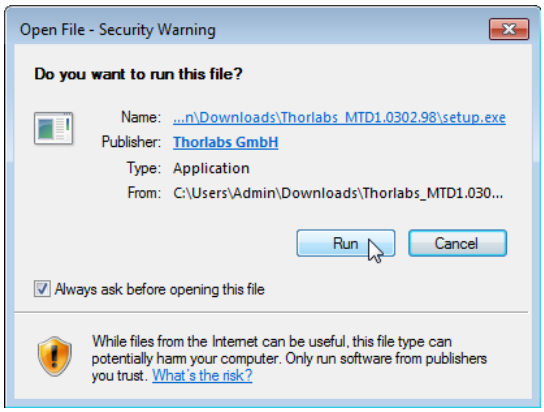
Note

It is strongly recommended that all applications open on the PC are exited prior to starting the software installation!

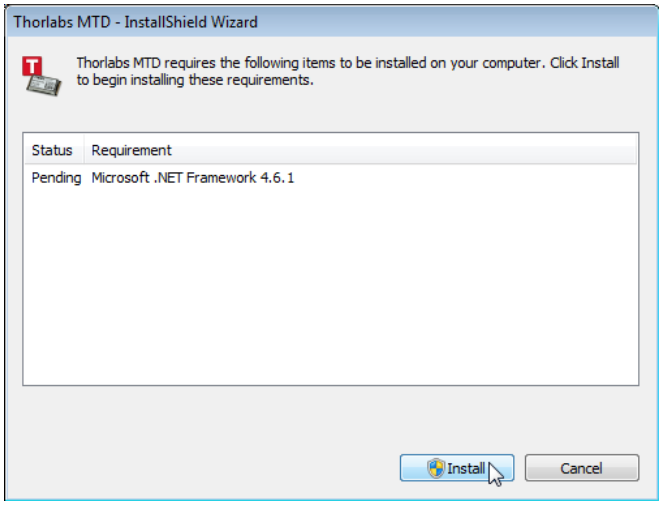
Note

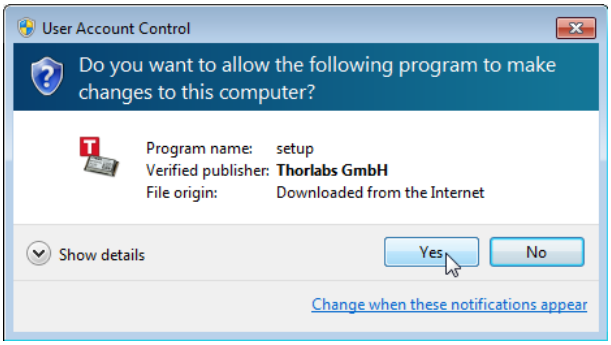
Unzip the downloaded package and execute the setup.exe that can be found in unzipped folder:

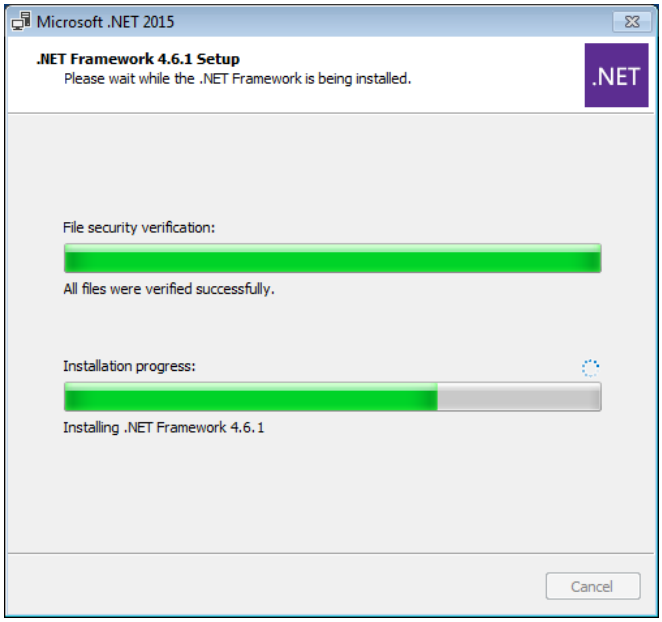


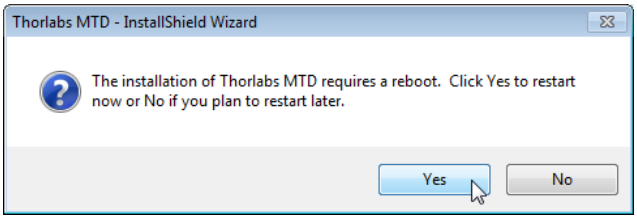


If no .NET Framework is installed or a version older than V 4.5.1 is detected on the computer, you will be prompted for installation:

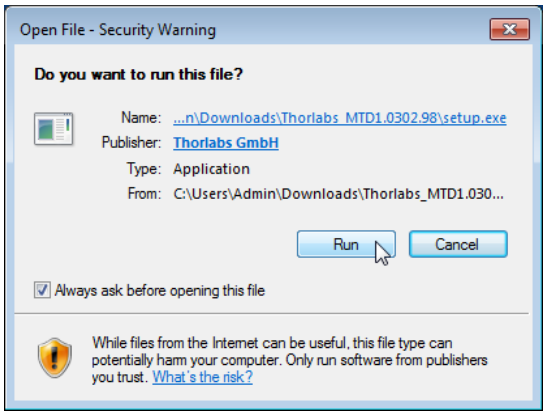


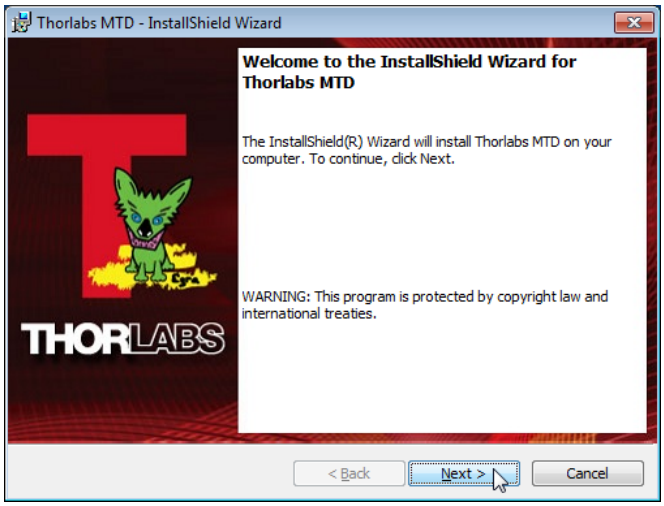






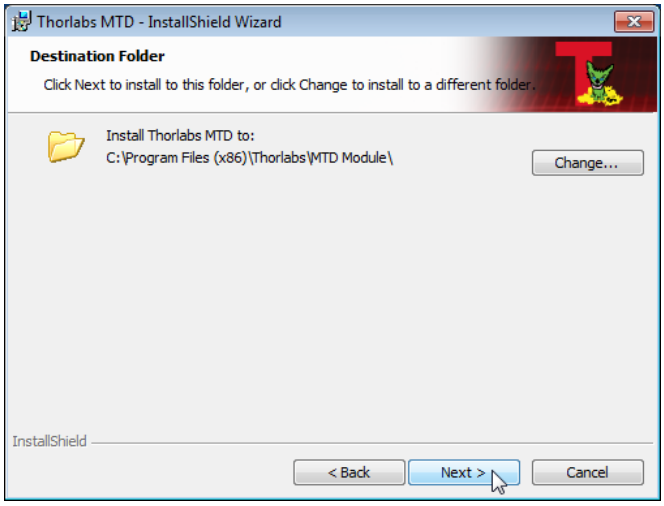
If you are prompted to reboot the computer, please do so.
Note The reboot is required to ensure a proper operation of the MTDEVAL1!
After rebooting, the installer automatically resumes installation:



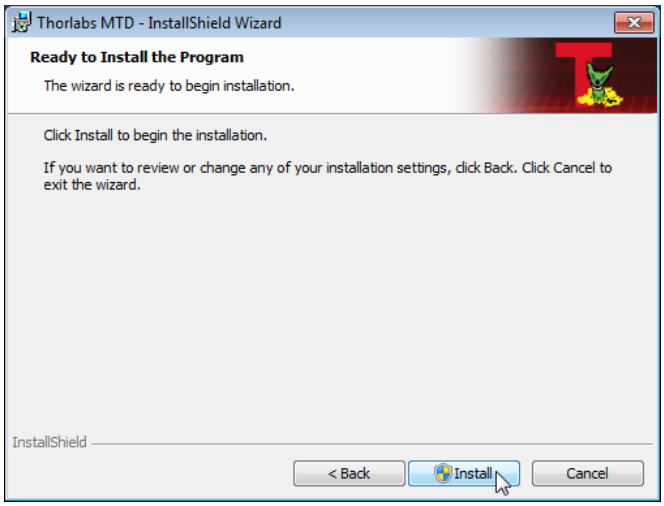


Click '**Next >**' to continue.

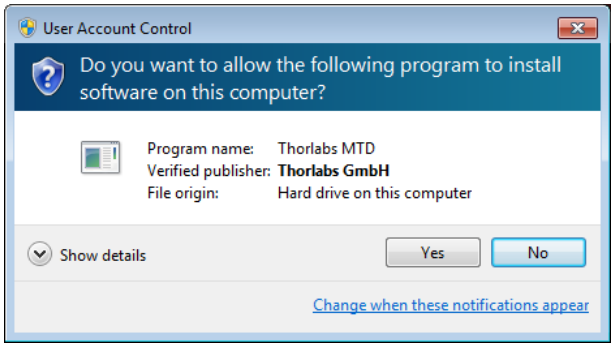
Click '**I accept**...' if you do so, then '**Next >**' to continue.



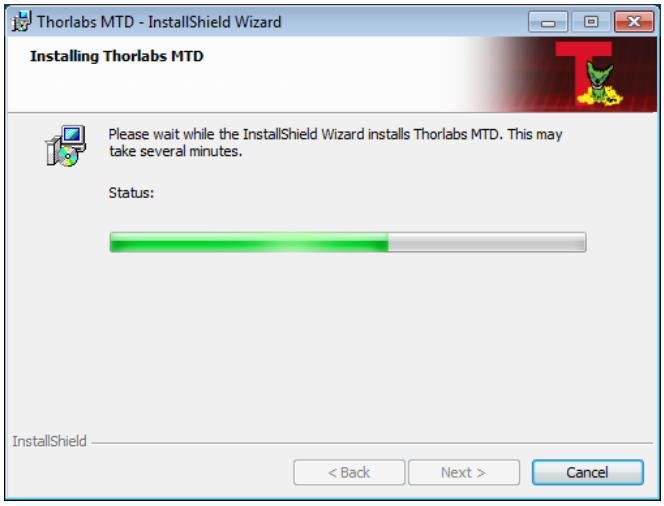
Click '**Next >**' to continue.

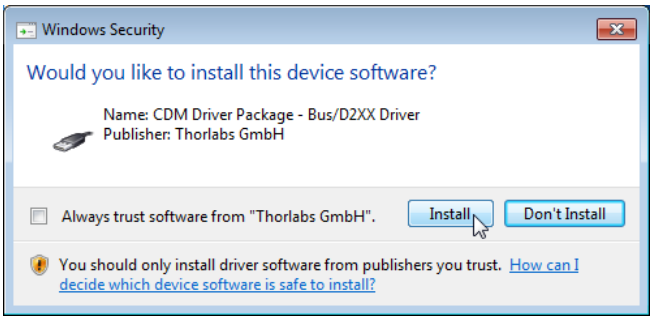


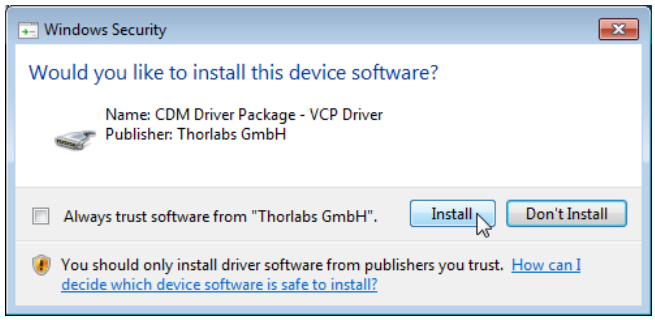
Click '**Install**' to continue.



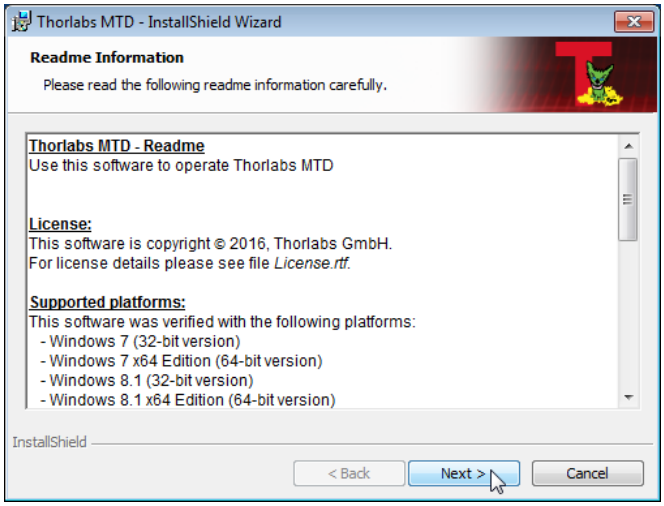
Click '**Yes**' to install the MTD software.



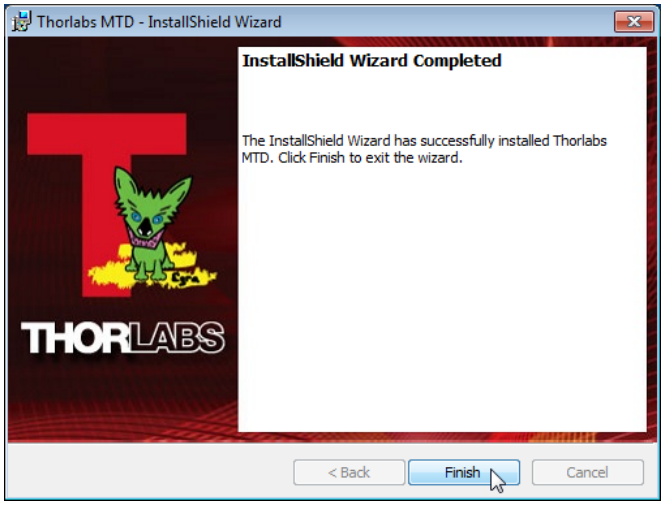




Click '**Install**' to continue.



Click '**Install**' to continue.



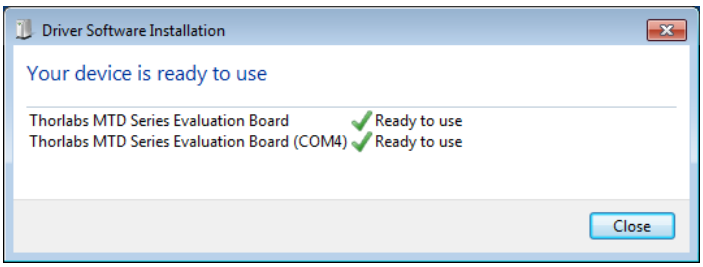
Click '**Finish**' to complete the installation.

6 Preparation

Note

Do not connect the MTDEVAL1 to a PC prior to installing the software! This may lead to corrupt installation of the driver software.

1. Install the daughter board with MTD415LE or MTD415TE, or the MTD1020T in the appropriate socket on the MTDEVAL1.
2. Connect the TEC and the temperature sensor.
3. Make sure that switch SW1 (ENABLE ON/OFF) is set to OFF (right position).
4. Connect the power supply.
5. Establish the USB connection to the PC
6. The hardware is recognized and the driver software is being installed:



7. Start the GUI

7 GUI

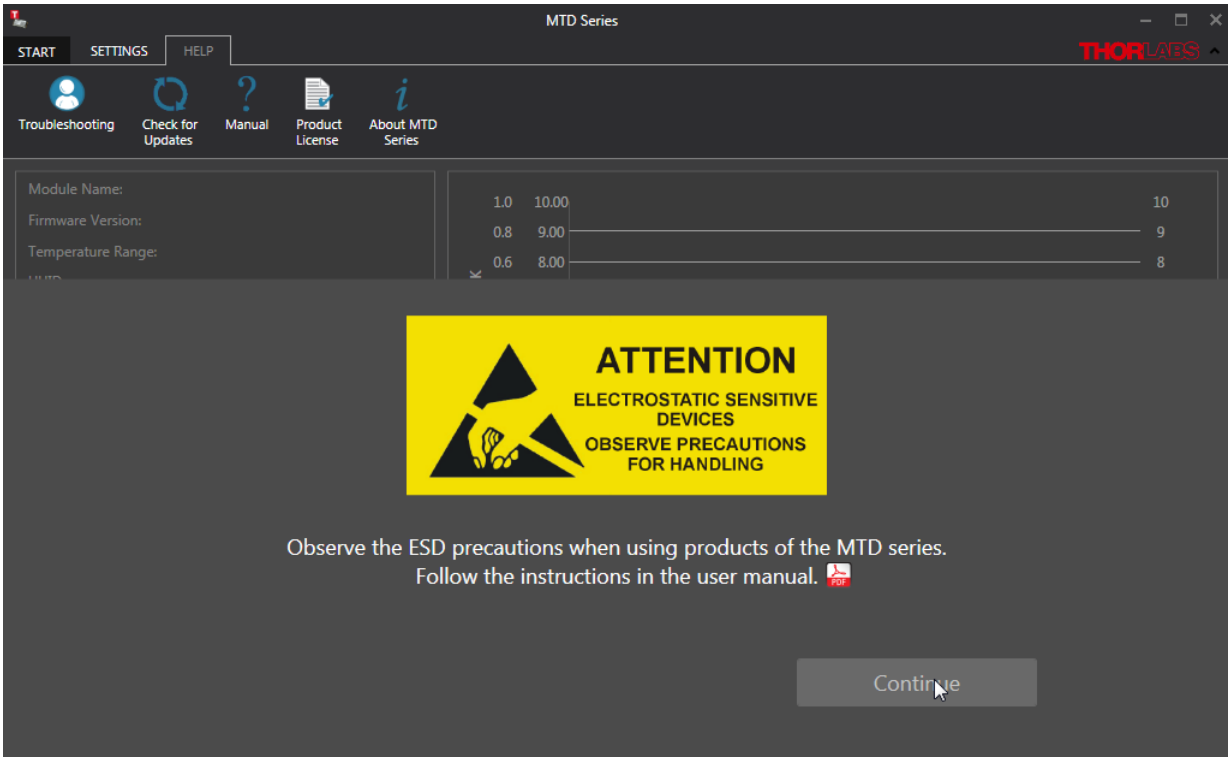
7.1 Starting the GUI

To Start the GUI click the desktop icon: 

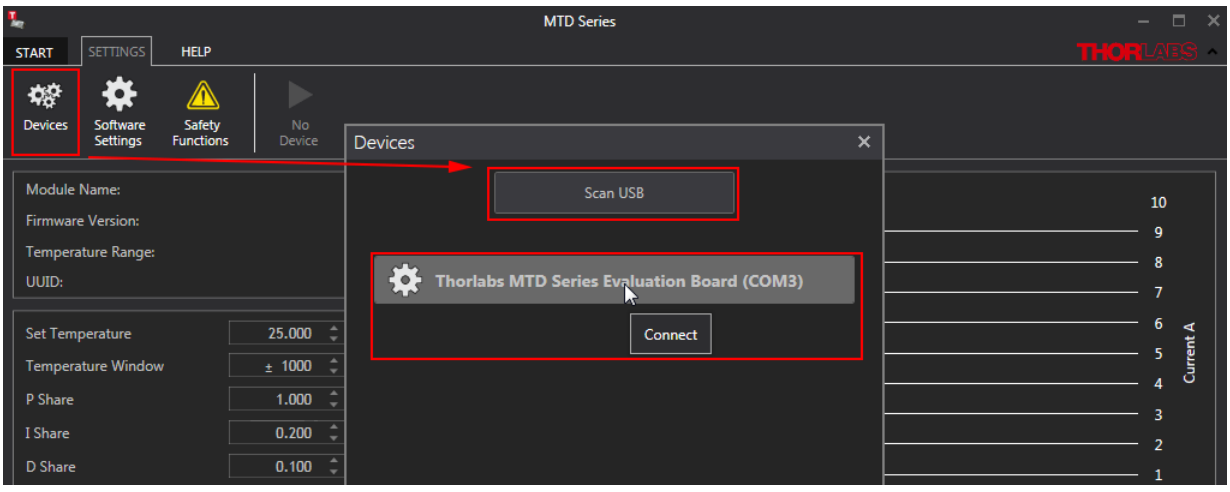
The GUI starts with the ESD-Warning:

Attention

The MTDEVAL1 is sensitive to electrostatic discharge. To protect the MTDEVAL1, please observe the ESD precautions by following the instructions in the Safety chapter in this manual. Click **Continue** to proceed.



To connect to the MTDEVAL, click **Devices** in the toolbar and a pop-up window appears. Click to **Scan USB** to find the connected device. Then for example, MTD Series Evaluation Board with the virtual COM-Port is found; click to connect the MTDEVAL1.



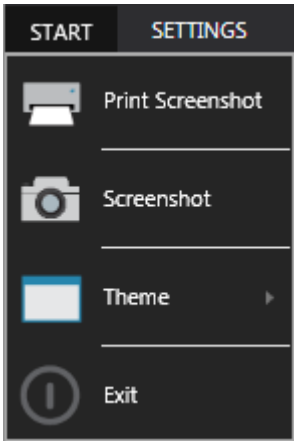
7.2 GUI Overview

After connecting with the MTDEVAL1, the device information and actual settings are read out from the MTD module's non-volatile memory (flash). The GUI will be filled in with these data. Additionally, the actual status is read out and displayed.

1. Menu bar
2. Tool bar
3. Device information
4. MTD Program parameters
5. Functional buttons
6. Graphic chart with selectable parameters vs. time
7. Actual read-out values
8. Status bar
9. Displayed error message

7.2.1 Menu Bar

Menu Start



This menu has four entries:

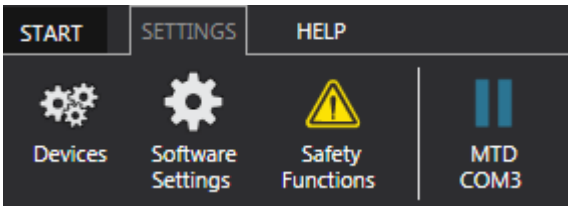
Print Screenshot opens a dialog window with a screenshot of the software in order to print it to a system printer.

Screenshot opens a dialog to save a screenshot as *.jpg to a selectable file folder.

Theme allows to change between **Dark** and **Light** software display.

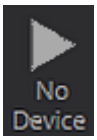
Exit disconnects the MTDEVAL1 and closes the application.

Menu Settings

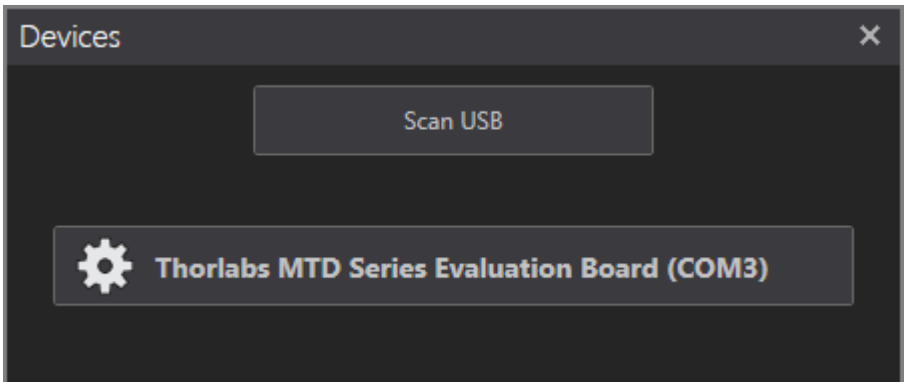


Sub menu <u>Devices</u>

The software needs to be manually connected to the MTDEVAL1. Unless the MTDEVAL1 was already contected to the software upon starting, the ribbon shows the connect state:

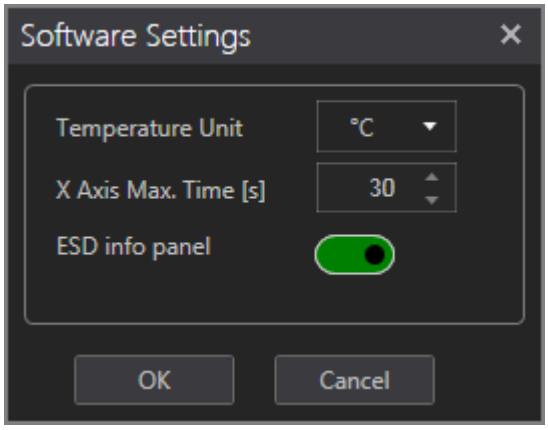


Click to **Scan USB**. The USB port is scanned for a device connected to a virtual serial port MTDEVAL1 and displays the findings. Click to the button that comes up, in order to connect the MTDEVAL1.



After successful connection, the icon changes. Close the **Devices** window.

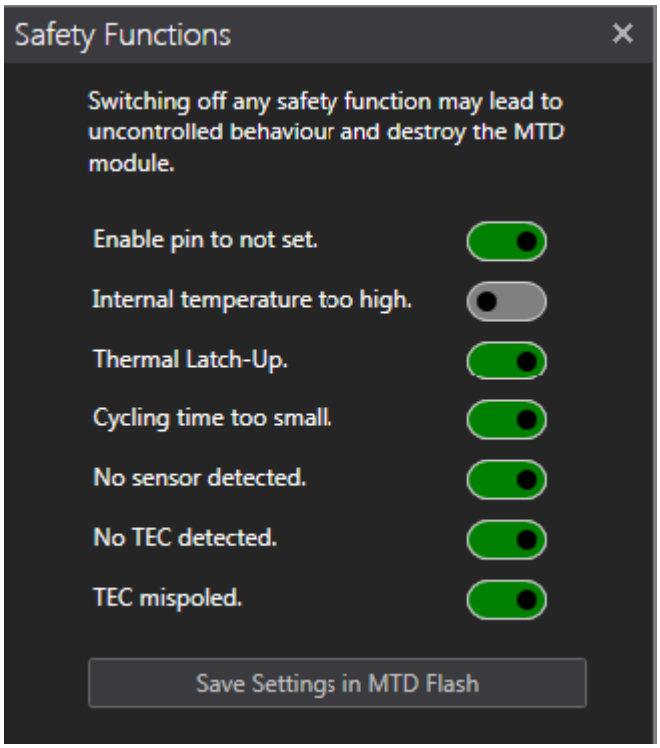
Sub menu Software Settings



- Select the Temperature unit to °C or °F.
- Select the maximum time duration that shall be displayed in the chart (1 to 360 s)
- Choose to disable the display of the ESD-Warning upon starting the software.

Click **OK** to apply changes, or **Cancel** to discard.

Sub menu Safety Functions



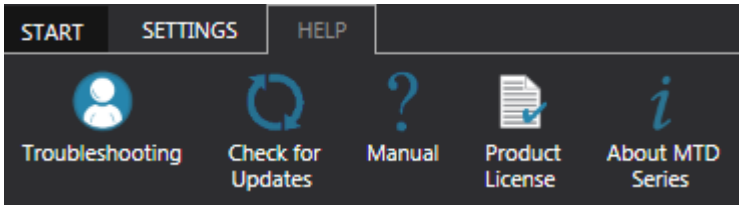
For use of the product in conditions that would activate safety warnings and automatically turn off the MTD module, the user can switch off the safety functions. Click to **Safety Functions** in the menu to open the dialog. To switch off individual safety functions move the slider to grey. This is shown in the image to the left for "Internal temperature too high". After changing the Safety Functions, the user has the choice to safe these settings to the MTD Flash. Please be aware that the MTD Flash has a limited number of write-erase cycles. Whenever any of the 7 Safety Functions is turned off, a Safety-Icon appears in the status bar of the GUI.

Please see the chapter Error Messages for more information on what to do when safety functions are activated and the connected module of the MTD-Series automatically turns off.

Attention

Turning off the Safety Functions may result in uncontrolled use of the MTD Module. Thorlabs GmbH is not liable for damage caused during use of the device when the safety functions are switched off.

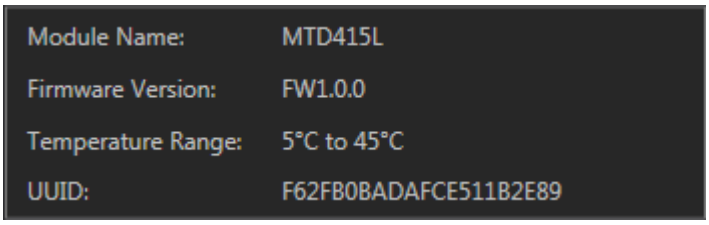
Menu Help



This menu has five entries:

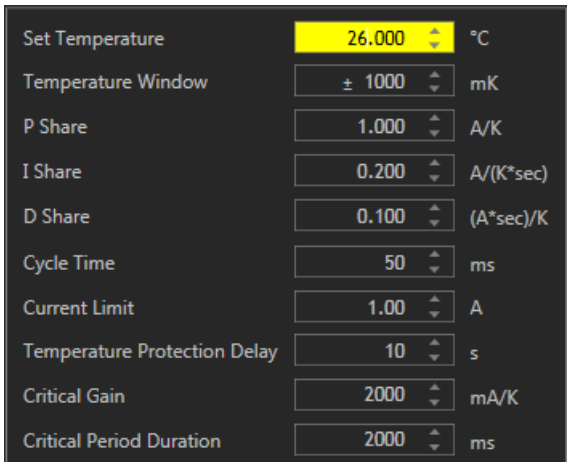
- **Troubleshooting...** opens a dialog window with several actions that can be undertaken:
  Contact Technical Support: shows the Thorlabs GmbH website with contact information.
  Save Logfile opens a dialog to save the log. It might be helpful to attach the log file when contacting Thorlabs GmbH Technical Support.
  System Info opens the System Information panel of the operating system.
- **Check for Updates** of the MTDeval software.
- **Manual** opens this User Manual (PDF file).
- **Product License** opens the End User Agreement (RTF file).
- **About MTD Series** shows the **About** dialog:

7.2.2 Device Information



This panel displays individual information about the connected MTD module. The UUID is a unique number that identifies the hardware. When contacting Thorlabs GmbH for technical support, support, please be ready to give the UUID.

7.2.3 Program Parameters

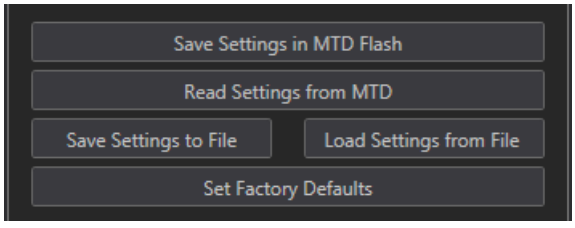


Here, the parameters can be set to program the MTD415x module.

Note

After entering a value, either by typing in the numerical value or by using the arrow buttons, the parameter is highlighted as shown above, which indicates that it has changed from the value stored in the MTD module. Press the Enter key to write it to the module. If multiple parameters were changed, by pressing the Enter key all parameters are sent to the MTD module.

7.2.4 Functional Buttons



Save Settings in MTD Flash This button writes all current settings of the MTD module RAM to the non-volatile flash memory. Use this function if you want to store your settings permanently to the MTD module.

Read Settings from MTD This button reads all current settings from the MTD volatile memory and displays them in the Program Parameters pane.

Save Settings to File Save actual GUI settings and the device information to a XML file on the PC.

Note

This function saves the information displayed in the GUI to a file, not the parameters stored in the MTD module!

Load Settings from File Load settings from a XML on the PC.

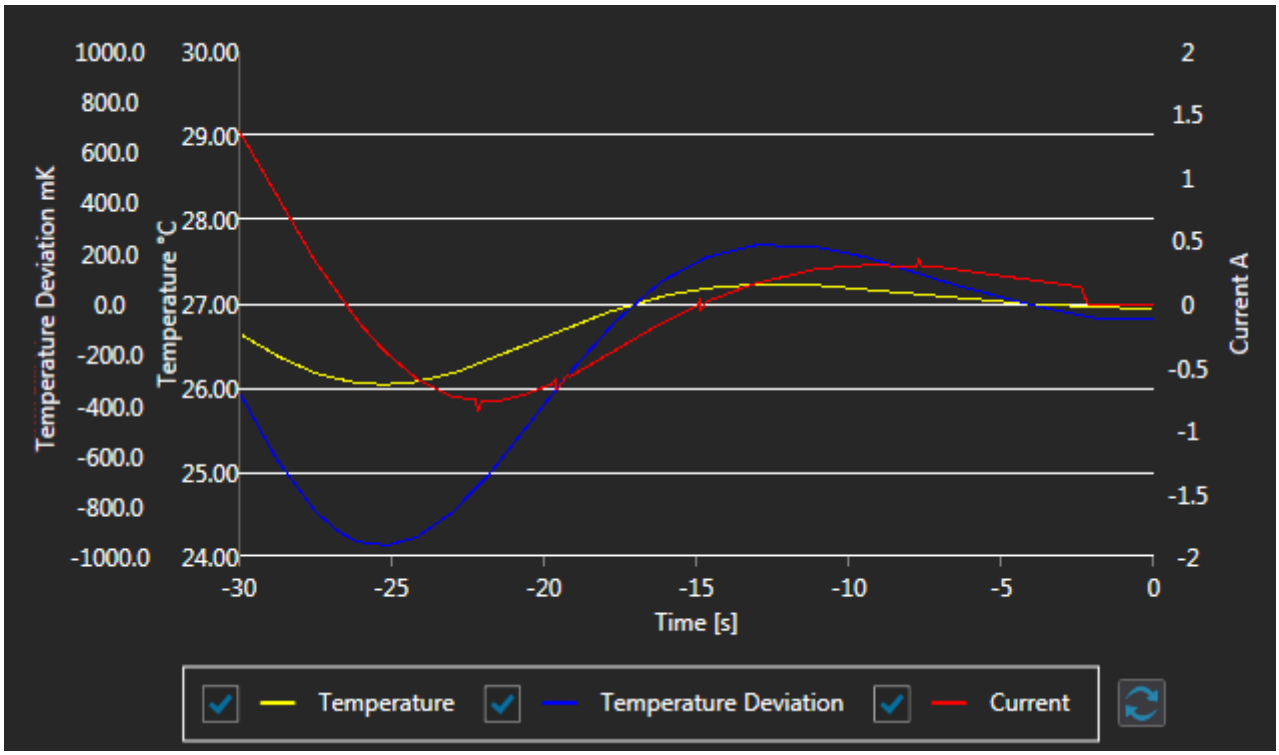
Set Factory Defaults Writes the factory default values (see table below) to the MTD module.

Parameter	Factory Default
Set Temperature	25.000 °C
Temperature Window	1000 mK
P Share	1.000 A/K
I Share	0.200 A/(K*sec)
D Share	0.100 (A*sec)/K
Cycle Time	50 ms
Current Limit	1.00 A
Temperature Protection Delay	10 s

Note

When setting the MTDEVAL1 to factory defaults, the Critical Gain and Critical Period Duration are not changed, as these are parameters that shall be defined during the oscillation test.

7.2.5 Graphic chart



In the graphic chart, up to three curves can be displayed:

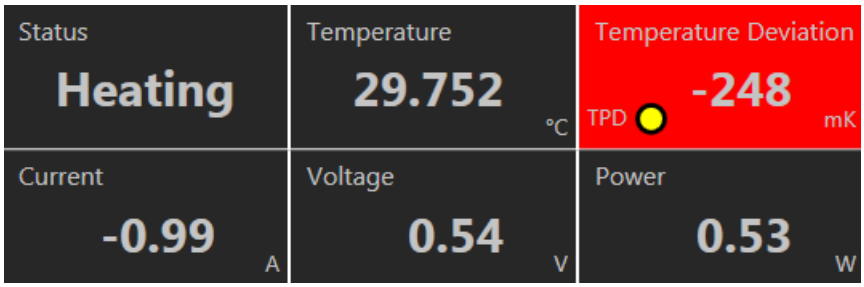
- Actual temperature in °C or °F. The unit can be selected in Software Settings.
- Temperature deviation in mK
- TEC current

The most recent value is displayed to the left. Each of these curves can be disabled by unchecking the appropriate box below the chart.

The time base can be set between 1 and 360 s. Please note, that a longer time base results in more data being accumulated in the chart. This may lead to a slow-down of the software.

To clear the chart, click the  button.

7.2.6 Read-Out Values



Status Indicates the TEC status - cooling, heating, or disabled (if the enable switch is set to OFF)

Temperature Actual temperature

Temperature Deviation Deviation of the actual temperature from the set value.

Note

If the temperature deviation exceeds the value that is set as **Temperature Window**, this box turns into red and the TPD (Temperature Delay Protection) indicator turns yellow, the status LED is OFF. After the actual temperature remains within the temperature window limits for at least the TPD time interval (to be set in Program Parameters pane), this box returns to the normal appearance:

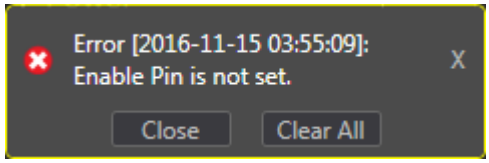
The lower row indicates the TEC current, the voltage across the TEC and the TEC input power.

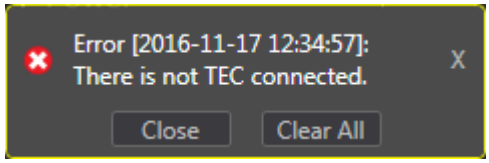
7.2.7 Status Bar

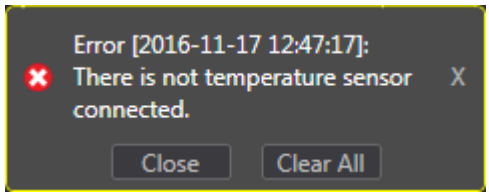
In the status bar normally only the current date and time are displayed. If an Error appears, a notification comes up, showing the number of the actual error message. A safety icon appears if any of the safety functions is switched off in the panel **Safety Functions**. Click on the icon to open the Safety Functions dialog.

7.2.8 Error Messages

If an error appears, it will be displayed in the GUI as a pop-up message that contains the error description and the time stamp, for example:







Additionally, in the status bar a notification is displayed: 

Click **Close** to remove the error message from the GUI. Click **Clear All** to reset the MTD module's internal error register.

Note

Closing an error message does not clear the MTD module's error register, it just makes the message disappear from the GUI foreground. In this case, the status bar notification remains.

Only **Clear All** will reset the error register and delete the notification. Clearing the error register is mandatory to resume normal operation. Alternatively, switch **SW1** off and on again.

Example

The TEC connection was interrupted. The TEC current is switched off, and the appropriate error message is displayed.

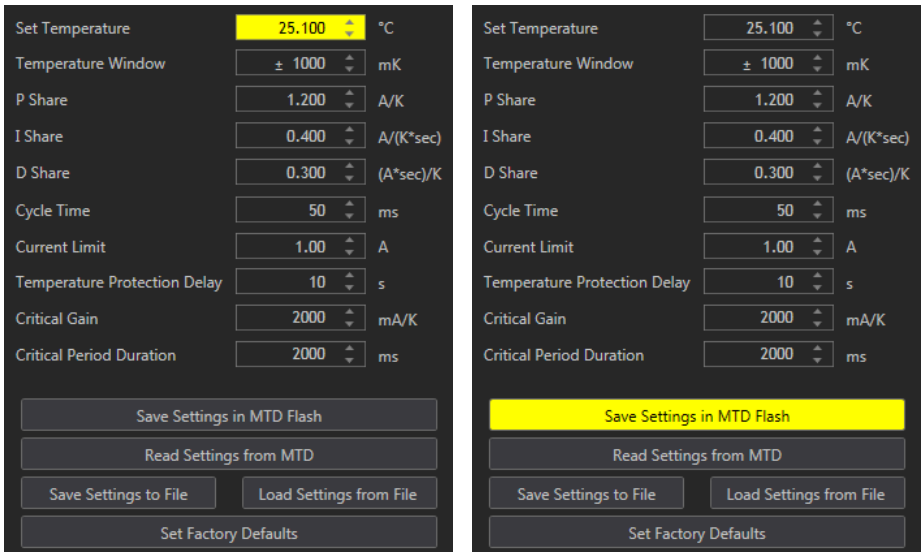
Reconnect the TEC. The MTD module will resume operation only after clicking to **Clear All** or by switching OFF and ON again the enable switch (8).

8 Operating a MTD Module

8.1 Common Rules

Please remember the memory structure of the MTD modules:

- The volatile memory.
  Parameters in this memory location are working parameters that are used during a single session. They are lost when power is disconnected. When the module is powered on, the data from the flash (non-volatile memory) are read out and saved to the volatile memory.
- The flash memory.
  Parameters stored to the flash memory are persistent, and they are retained when the module is powered down. Parameters in flash memory can be overwritten, but the number of erase-write cycles is limited. To transfer the data from the volatile memory into the flash, the user must send a specific command.



When a parameter is changed, it will be highlighted. Press the **Enter** key to apply changes to the MTD module. The parameter is written to the volatile memory upon receipt of the commend. This function can be used to change multiple parameters at once - just click to one of the highlighted parameters an press **Enter**.

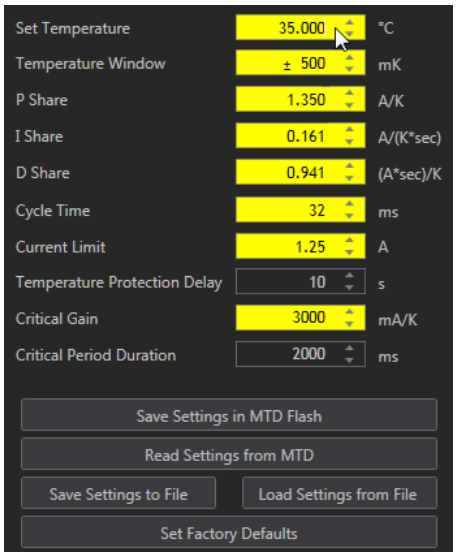
Additionally, the button **Save Settings in MTD Flash** is highlighted. This indicates that parameters are in use that have not been saved to the flash yet.

Further, if one or more parameters are modified, you can press the **Save Settings in MTD Flash** button - this will write all parameters in the list to the flash **and** to the volatile memory as well.

Save Settings to File reads the displayed information (device information and parameters) ***from the GUI*** and saves them to a file. In other words, this function does not read the actual parameters from the MTDEVAL1!

Load Settings from File loads the information from the selected file to the GUI. In this case, the GUI content is compared to the content of the volatile memory of the MTD module and differing parameters are highlighted. In order to apply them, you can press **Enter** (parameters are written to the volatile memory only) or click the **Save Settings in MTD Flash** button (parameters are written to the volatile memory **and** to the flash).

Example



You have loaded settings from a file.
You will see highlighted those parameters that differ from the previous settings. Your choices are:

1. You can press the **Save Settings in MTD Flash** button to transfer the new data to the volatile memory **and** to the flash. This way, all changed parameters become active and will be saved permanently.

2. Click to one of the highlighted parameters and press the **Enter** key. This way, all changed parameters become active, but they are not stored to the flash.

8.2 Oscillation Test

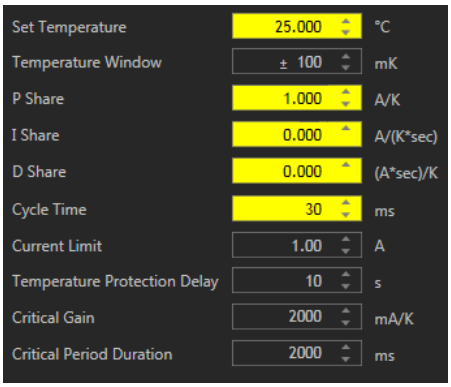
The MTD modules incorporate a digital PID controller. The P, I and D shares can be programmed manually or calculated automatically by the firmware when the results of a loop oscillation test are entered. Below an example procedure is explained in detail.

The oscillation test is an convenient method to optimize the PID loop parameters.

Pre-conditions:

- TEC current limit is set to 1 A
- All connections are made properly
- For convenient observation
  - o Set the Temperature Window to ±100 mK;
  - o Set the temperature chart X Axis maximum time to 60 s and display only the actual temperature.

1. Initial settings of the PID loop:

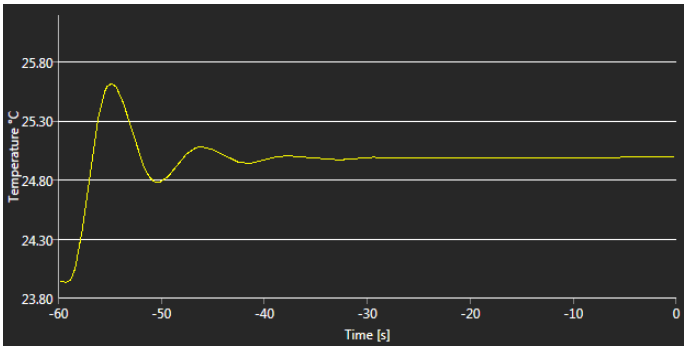


Set temperature	25°C
P share	1000 mA/K
I share	0
D share	0
Cycle time	30 ms

Press the **Enter** key to write the parameters to the MTD module.

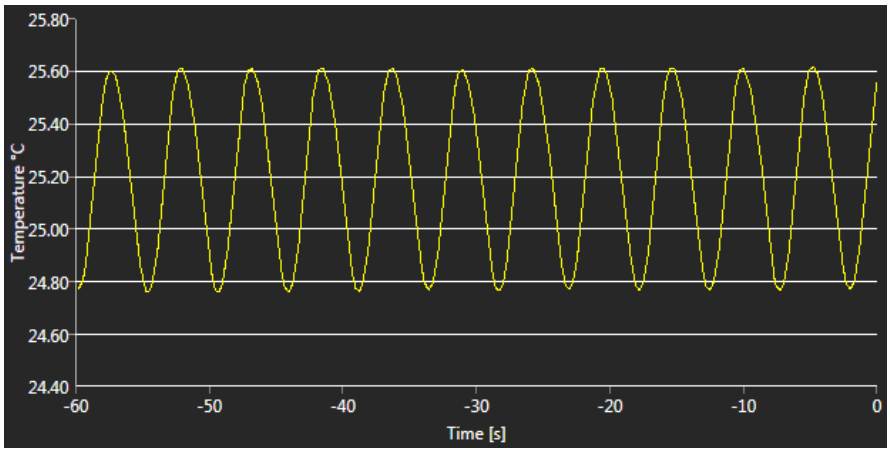
2. Enable the TEC. The actual temperature approximates the set value.
3. Now, find the critical P share (critical gain) value at which the system starts to oscillate for a minimum of 20 cycles without amplitude drop as a reaction to a changed set temperature.
4. The procedure is simple. With I and D share set to 0, the P share is set first to a sufficiently high value to ensure that the loop oscillates. Decrease the P share until the loop shows damped oscillations. Then approximate the value of the P share until the critical value is found - this is the minimum P share at which the loop oscillates permanently. Each time the P share is changed, the set temperature needs to be changed for a small amount in order the trigger the loop. Below an example experiment is described in detail:

- After enabling the TEC with initial setting, the temperature is settling:



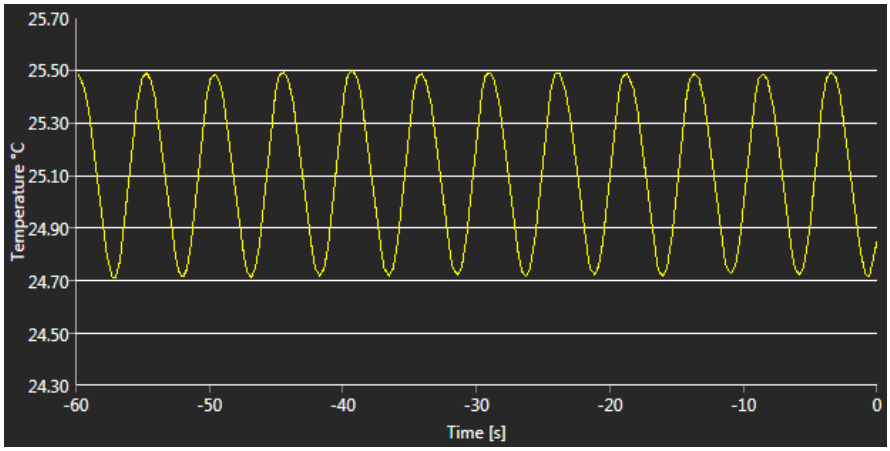
P=1000; T=25.0°C

- Set P to 10,000 mA/K; increase the set temperature for 0.1 K to 25.1 °C - the loop shows strong oscillations:



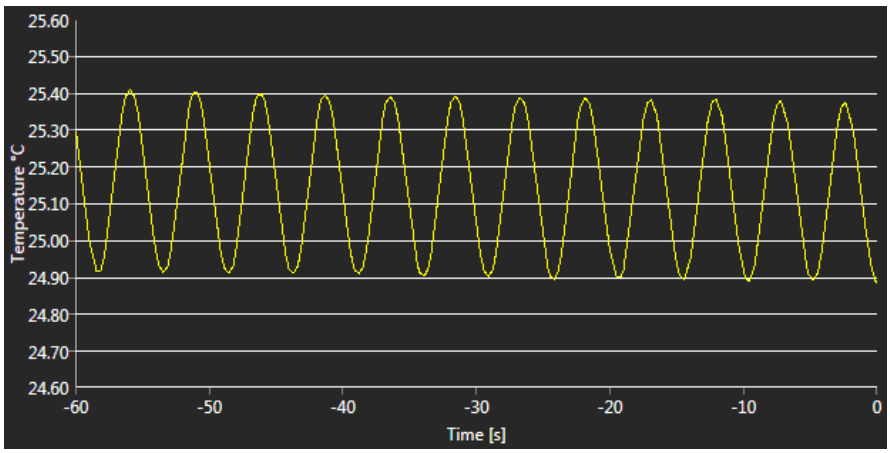
P=10000; T=25.1 °C

- Lower P to 5000 mA/K; decrease the set temperature to 25.0 °C - the loop still oscillates:



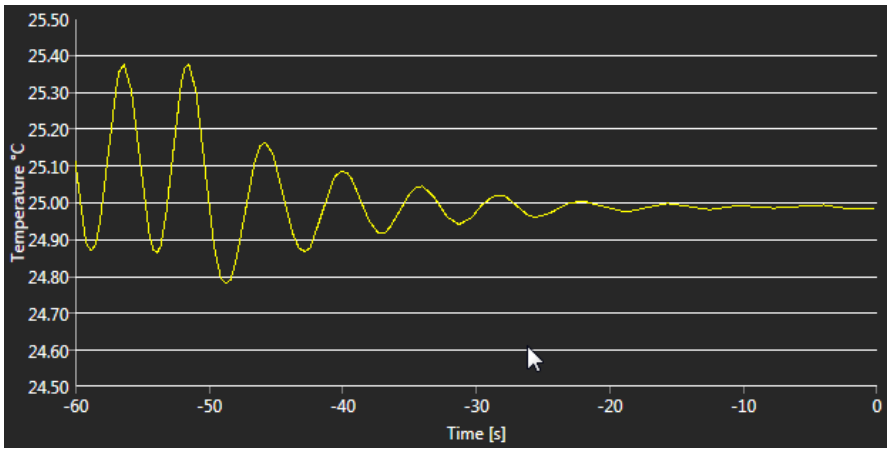
P=5000; T=25.0 °C

- Lower P to 3000 mA/K; increase the set temperature to 25.1 °C - the loop still oscillates:



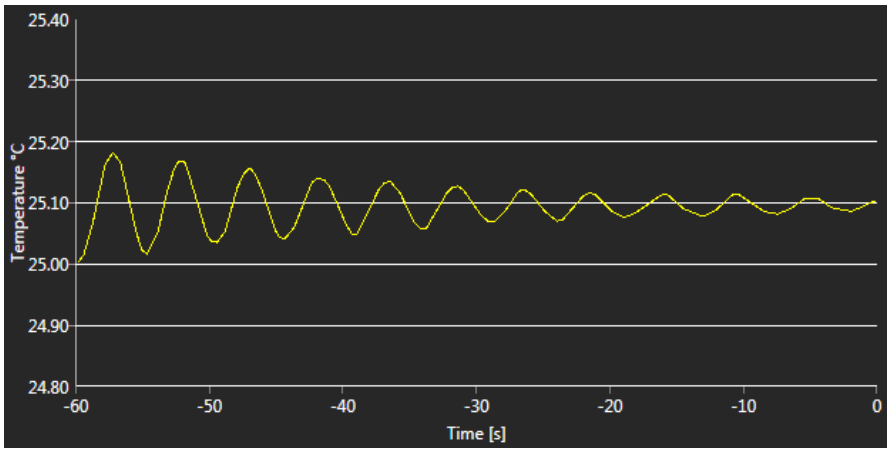
P=3000; T=25.1 °C

- Lower P to 2000 mA/K; decrease the set temperature to 25.0 °C - the loop shows damped oscillations:



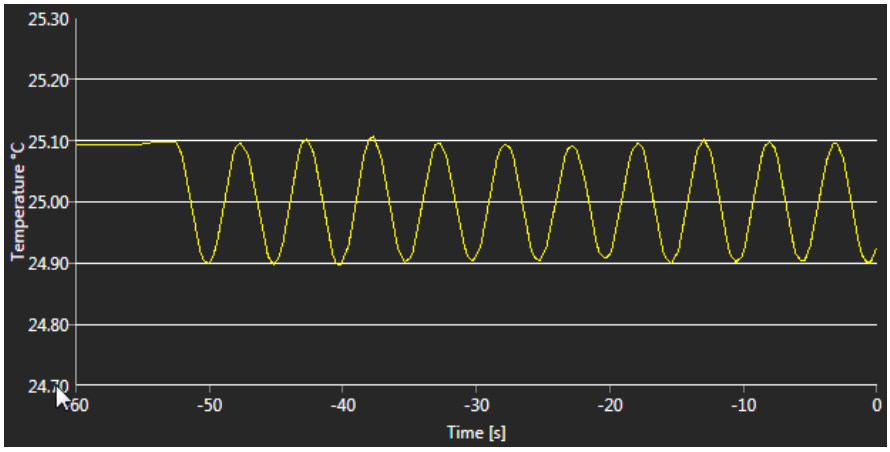
P=2000; T=25.0 °C

- Increase P to 2600 mA/K; increase the set temperature to 25.1 °C - the loop oscillations are still damped:



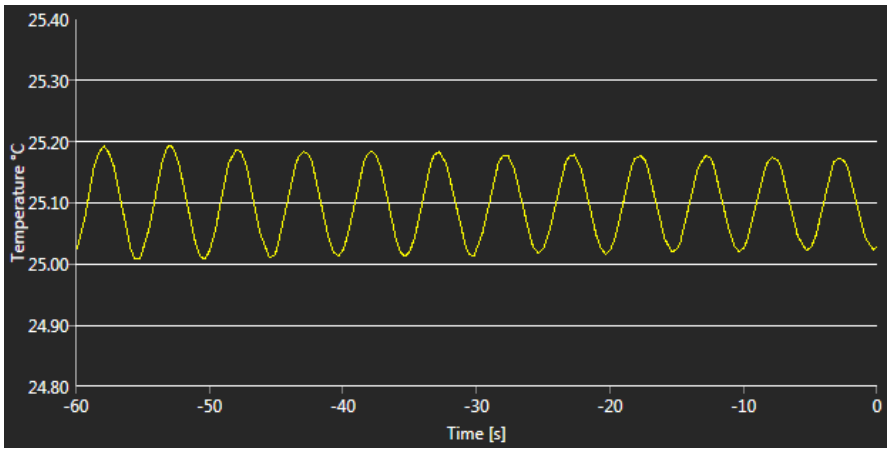
P=2600; T=25.1 °C

- Increase P to 2800 mA/K; decrease the set temperature to 25.0 °C - the loop oscillates again:



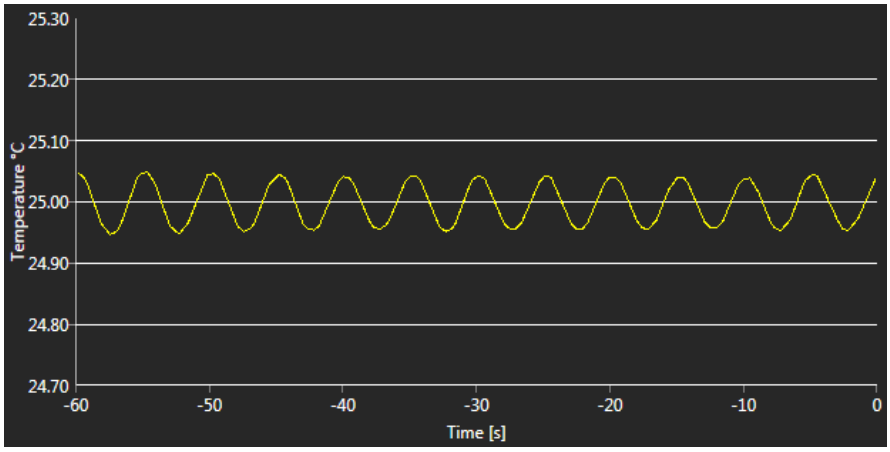
P=2800; T=25.0 °C

- Lower P to 2700 mA/K; increase the set temperature to 25.1 °C - the loop still oscillates:



P=2700; T=25.1 °C

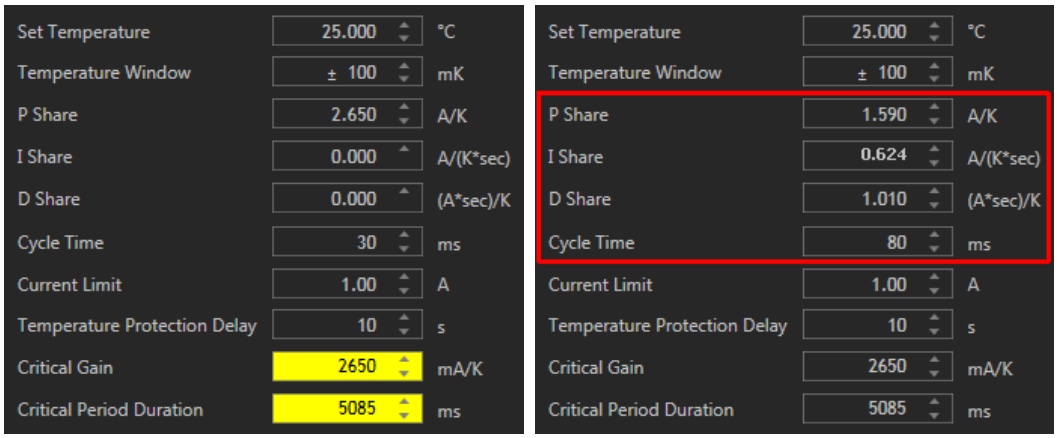
- Lower P to 2650 mA/K; decrease the set temperature to 25.0 °C - the loop is still oscillating:



P=2650; T=25.0 °C

- At P = 2600 mA/K the loop no longer oscillated, at P = 2650 mA/K the oscillations returned.

5. The found P share value of 2650 mA/K is the **Critical Gain**. Referencing the above diagram, the **Critical Period** can be identified: Over 60 s you can count approximately 11.8 periods. In other words, the duration of 1 period is ~ 5.085 s.
6. Enter these values in the GUI. Pressing the Enter key triggers the calculation of the PID shares and the cycle time by the firmware and immediately displays the calculated loop parameters:



7. Usually, at this point the PID optimization for the settling behavior is finished. If required, the PID values and the cycle time can be manually fine tuned in order to optimize the loop response to changes of the thermal load.
8. As a final step, save the settings to the non-volatile memory:

Notes

- The cycling time is the time base of the internal digital control loop and is calculated automatically by entering the critical gain and the critical oscillation period.
- If manually changing the cycling time, the firmware calculates the I and the D share anew.
- The optimized PID parameters are valid for a steady state that depends on the set temperature as well as on the ambient conditions (ambient temperature, temperature of the thermally controlled object). Any changes of the operating and/or environmental conditions may require a re-adjustment of the PID parameters.

9 Appendix

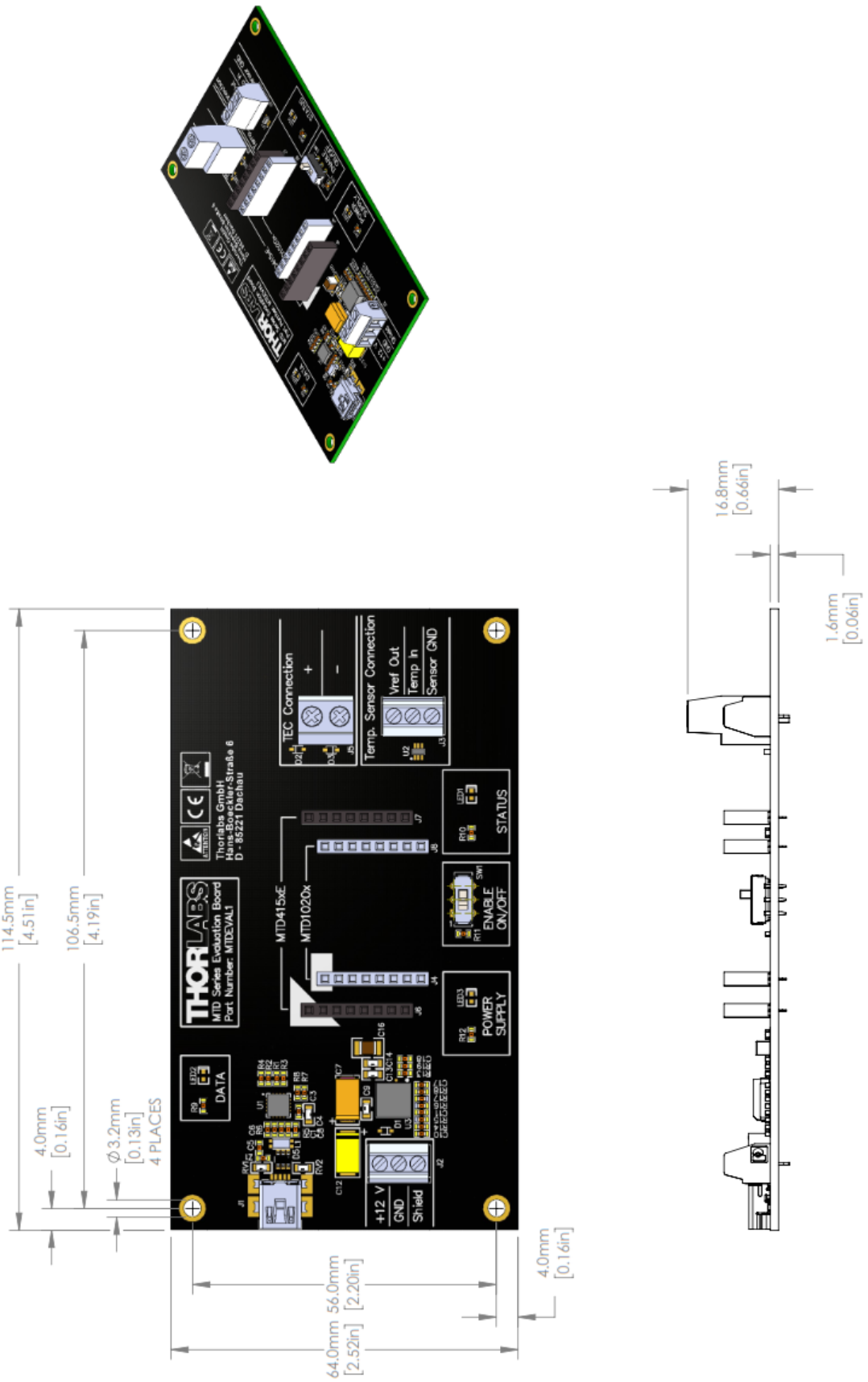
9.1 Technical Data

Supply Voltage	11.5 to 13.0 V DC
Maximum Current Consumption	2.3 A DC
USB Connection	USB Mini B
Operating Temperature Range [1])	0 to 40 °C
Storage Temperature Range	-40 to 70 °C
Dimensions (W x H x D)	114.5 mm × 16.8 mm × 64 mm
Weight	0.04 kg

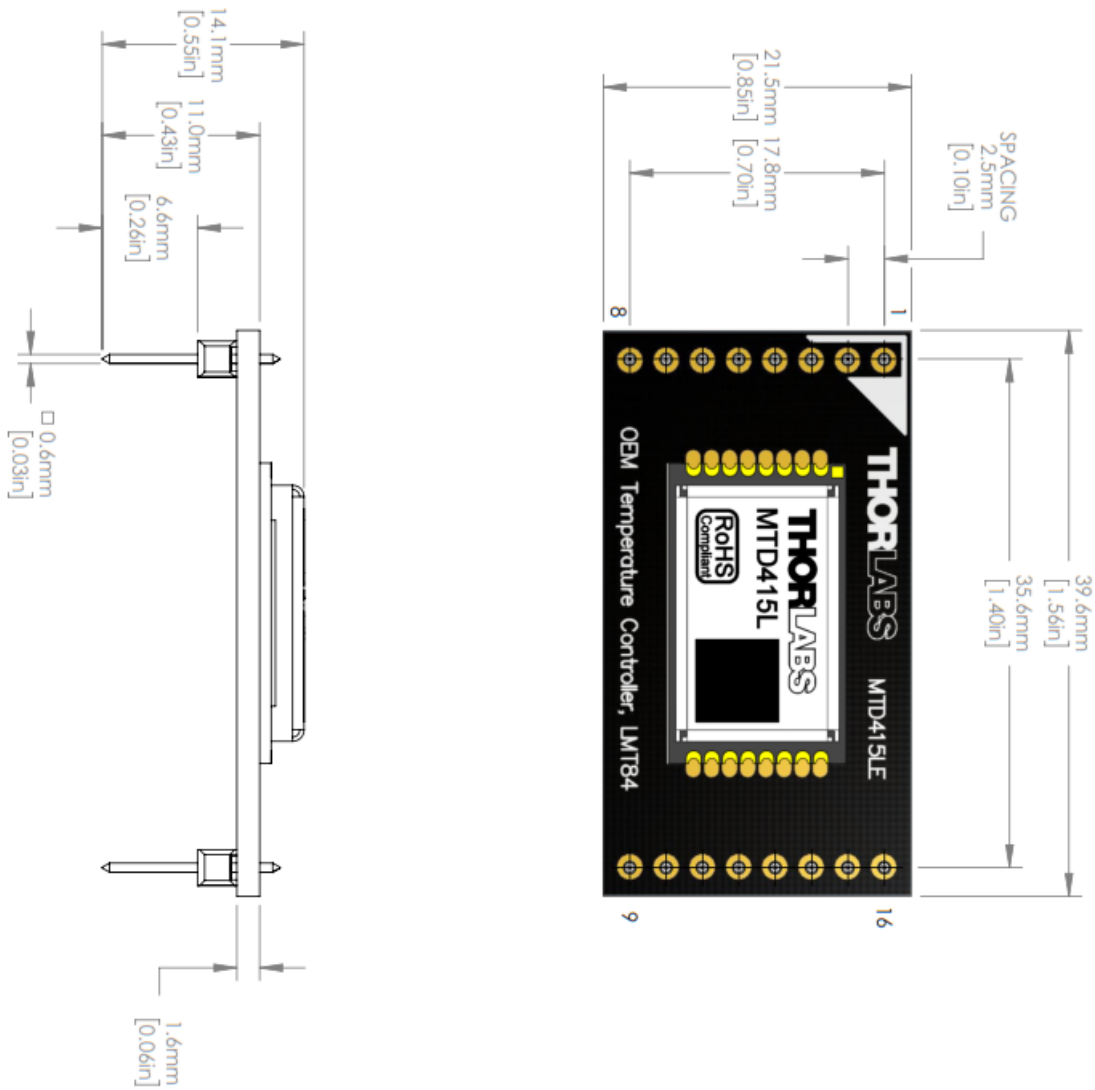
[1]) non-condensing

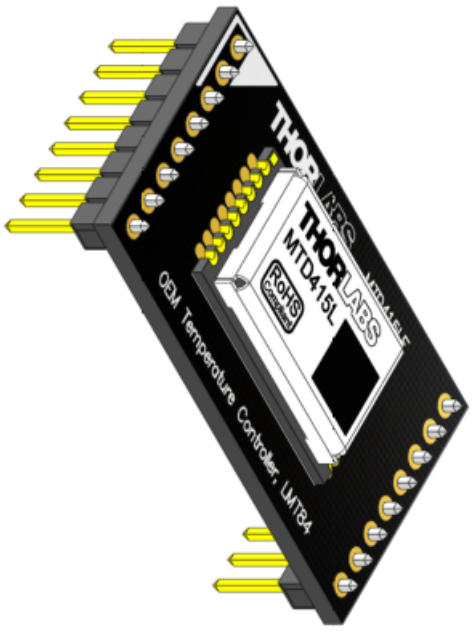
All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity (non condensing)

9.2 Dimensions



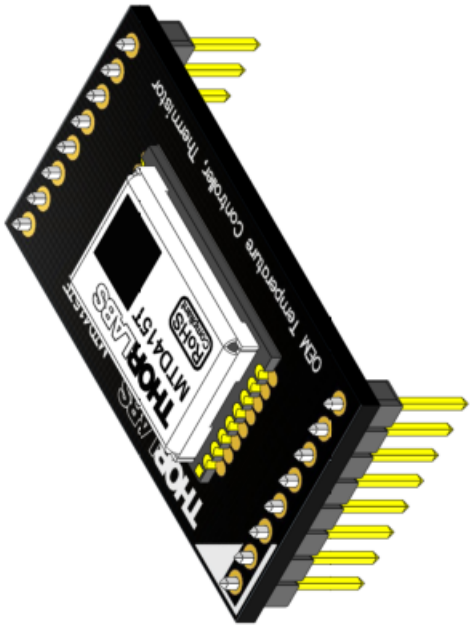
Dimensions MLDEVAL1 Board



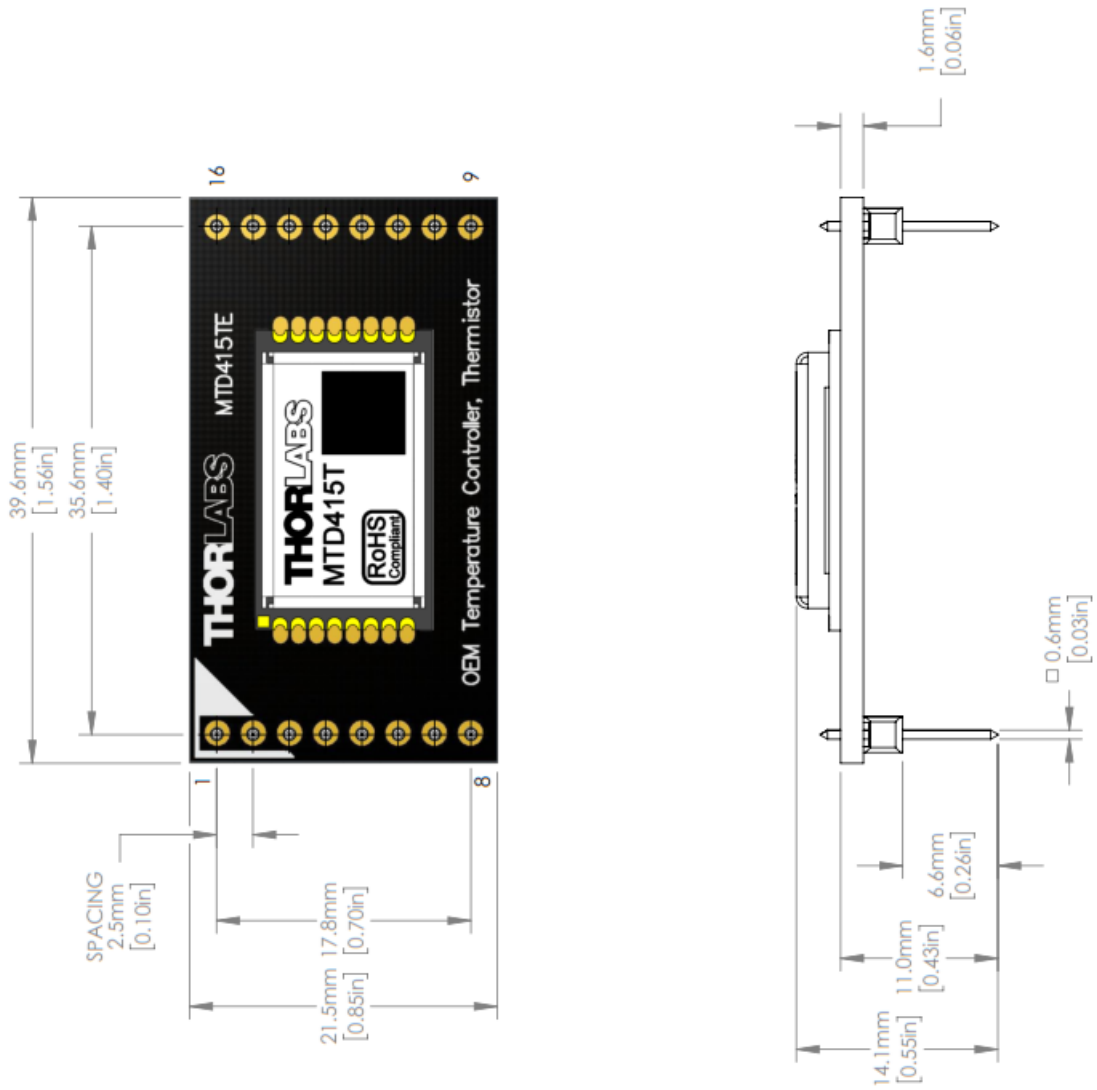


Pin	Name	Description
1	VDD	Supply Voltage Input
2	GND	Supply Voltage Ground
3	GND	Supply Voltage Ground
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	VREF	Reference Output Voltage for LMT84 Temperature Sensor
7	TEMP	LMT84 Temperature Sensor Input
8	GNDS	Temperature Sensor Ground
9	GND	Supply Voltage Ground
10	ENABLE	Enable Signal Input (Low-Active)
11	STATUS	Status Signal Output (Can be Left Floating)
12	TX	Digital Interface Transmit Signal
13	RX	Digital Interface Receive Signal
14	GND	Supply Voltage Ground
15	TEC-	TEC Element Negative Connection
16	TEC+	TEC Element Positive Connection

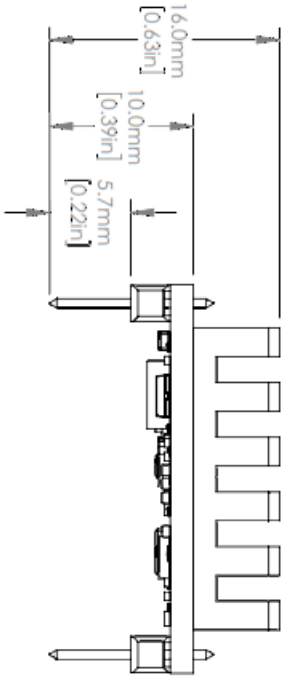
Dimensions MTD415LE Module (MTD415L on daughter board)

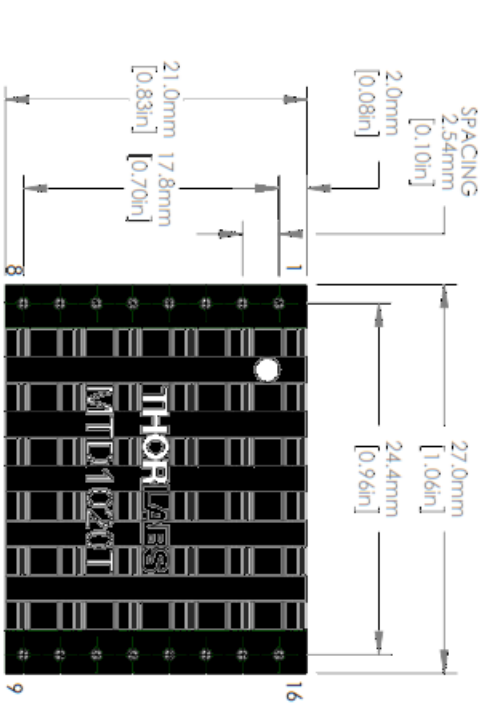


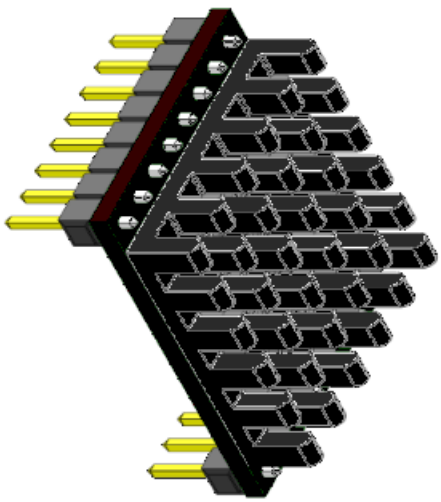
Pin	Name	Description
1	VDD	Supply Voltage Input
2	GND	Supply Voltage Ground
3	GND	Supply Voltage Ground
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	VREF	Reference Output Voltage for Thermistor Temperature Sensor
7	TEMP	Thermistor Temperature Sensor Input
8	GNDS	Temperature Sensor Ground
9	GND	Supply Voltage Ground
10	ENABLE	Enable Signal Input (Low-Active)
11	STATUS	Status Signal Output (Can be Left Floating)
12	TX	Digital Interface Transmit Signal
13	RX	Digital Interface Receive Signal
14	GND	Supply Voltage Ground
15	TEC-	TEC Element Negative Connection
16	TEC+	TEC Element Positive Connection



Dimensions MTD415TE Module (MTD415T on daughter board)





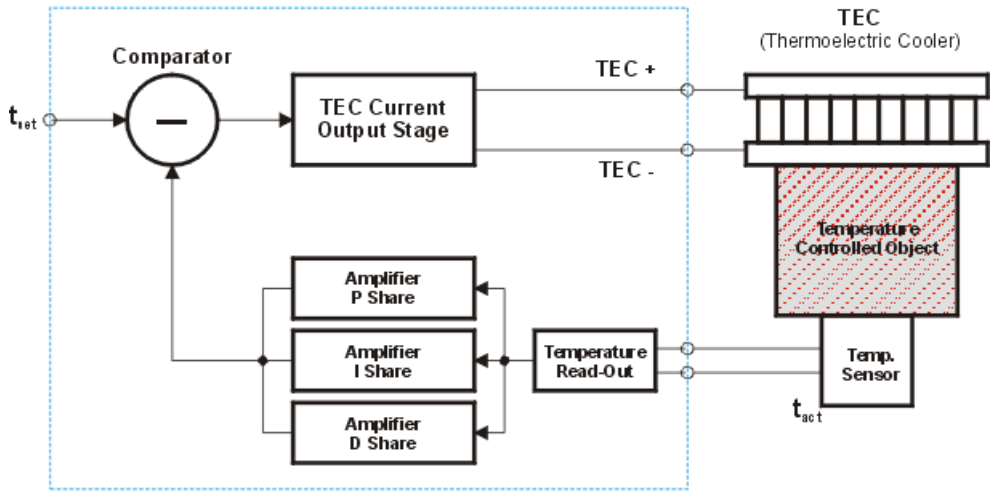


Pin	Name	Description
1	VDD	Supply Voltage Input
2	GND	Supply Voltage Ground
3	GND	Supply Voltage Ground
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	VREF	Reference Output Voltage for Thermistor Temperature Sensor
7	TEMP	Thermistor Temperature Sensor Input
8	GNDS	Temperature Sensor Ground
9	GND	Supply Voltage Ground
10	ENABLE	Enable Signal Input (Low-Active)
11	STATUS	Status Signal Output (Can be Left Floating)
12	TX	Digital Interface Transmit Signal
13	RX	Digital Interface Receive Signal
14	TEC-	TEC Element Negative Connection
15	TEC+	TEC Element Positive Connection
16	GND	Supply Voltage Ground

Dimensions MTD1020T Module (MTD1020T on daughter board)

9.3 Tutorial

9.3.1 Operating Principle of a Temperature Controller



In general, a temperature controller (shown above within the blue frame) is a closed loop system. A temperature sensor measures the temperature of the controlled object (e.g., a laser diode). This **actual temperature** signal is amplified and compared with the **temperature set value**. The differential signal out of the **comparator** then controls the current of the **thermoelectric cooler** in order to maintain a constant object temperature. Ideally, the temperature settling time and setting error are minimized and there are no temperature overshoots.

A thermoelectric coolers is a Peltier element that produces a temperature gradient with a positive or negative slope, depending on the direction of the current through the TEC. For this reason, the TEC current must be bidirectional.
In order to adapt the control loop to different thermal loads, and to optimize the temperature controller's response characteristics, a PID amplifier is used.

The general requirements to a temperature control loop are:

- fastest settling time after power on or changing the set temperature
- minimum residual temperature error
- settling without temperature overshoots
- fastest response to changes of the thermal load

PID amplifiers can fulfill these requirements. Temperature control loops are comparatively slow; control oscillations appear with a frequency in the range of several Hz or parts of Hz. The PID adjustment allows to optimize the dynamic behavior.

The **P share** is the proportional share, or the gain of the amplifier, that defines the settling time. The higher the P share, the faster the settling and the less residual temperature error. The downside is that high P shares lead to oscillations.

The **I share** is the integrating share of the amplification, or the gain at low frequencies. It allows the residual temperature error to be minimized. Optimal settings of the P and I shares result in a fast approach to the set temperature, without oscillations and with a minimum residual temperature error. However, such a loop is not able to quickly react to sudden changes of the thermal load, if, for example, a thermally stabilized laser diode is set to a higher or lower output power that changes the laser's heat dissipation.

The **D share** (differential share, or the gain at high frequencies) allows the system to quickly react to temperature changes, without generating oscillation of the temperature around the set point.

9.4 References

Data Sheets of the MTD415 Series

Click to appropriate link to download the data sheet:

MTD415L Miniature TEC Driver; LMT84 (or similar) Temperature Sensor

MTD415T Miniature TEC Driver; Thermistor Temperature Sensor

Software Download Link

https://www.thorlabs.com/software_pages/ViewSoftwarePage.cfm?Code=MTDEVAL

9.5 Warranty

Thorlabs GmbH warrants material and production of the MTDEVAL1 for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs GmbH will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs GmbH. The customer will carry the shipping costs to Thorlabs GmbH, in case of warranty repairs Thorlabs GmbH will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs GmbH warrants the hard- and/or software determined by Thorlabs GmbH for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs GmbH does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs GmbH is not liable for consequential damages.

Restriction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs GmbH does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs GmbH reserves the right to change this instruction manual or the technical data of the described unit at any time.

9.6 Copyright and Exclusion of Reliability

Thorlabs GmbH has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.

Please note that the content of this document is neither part of any previous or existing agreement, promise, representation or legal relationship, nor an alteration or amendment thereof. All obligations of *Thorlabs GmbH* result from the respective contract of sale, which also includes the complete and exclusively applicable warranty regulations. These contractual warranty regulations are neither extended nor limited by the information contained in this document. Should you require further information on this product, or encounter specific problems that are not discussed in sufficient detail in the document, please contact your local *Thorlabs GmbH* dealer or system installer.

9.7 Thorlabs 'End of Life' Policy

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs GmbH offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs GmbH electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see figure below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

As the WEEE directive applies to self contained operational electrical and electronic products, this “end of life” take back service does not refer to other Thorlabs GmbH products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB’s, housings etc.).

Waste treatment on your own responsibility

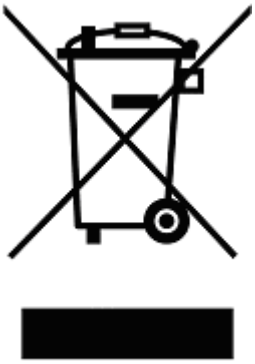
If you do not return an “end of life” unit to Thorlabs GmbH, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



Crossed out
"Wheelie Bin" symbol

9.8 List of Acronyms

CPU	Central Processing Unit
DC	Direct Current
ESD	Electrostatic Discharge
GUI	Graphic User Interface
Hz	Hertz
MB	Megabyte
MTD	Miniature TEC Driver
PC	Personal Computer
PCB	Printed Circuit Board
PDF	Portable Document File
PID	Proportional - Integral - Differential (shares)
RAM	Random Access Memory
RTF	Rich-Text Format File
TEC	Thermo-Electric Cooler
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
UUID	Universal Unique Identifier

9.9 Thorlabs Worldwide Contacts

USA, Canada, and South America

Thorlabs, Inc.
56 Sparta Avenue
Newton, NJ 07860
USA
Tel: 973-300-3000
Fax: 973-300-3600
www.thorlabs.com
www.thorlabs.us (West Coast)
Email: sales@thorlabs.com
Support: techsupport@thorlabs.com

Europe

Thorlabs GmbH
Hans-Böckler-Str. 6
85221 Dachau
Germany
Tel: +49-8131-5956-0
Fax: +49-8131-5956-99
www.thorlabs.de
Email: europe@thorlabs.com

France

Thorlabs SAS
109, rue des Côtes
78600 Maisons-Laffitte
France
Tel: +33-970 444 844
Fax: +33-825 744 800
www.thorlabs.com
Email: sales.fr@thorlabs.com

Japan

Thorlabs Japan, Inc.
3-6-3 Kitamachi
Nerima-ku, Tokyo 179-0081
Japan
Tel: +81-3-6915-7701
Fax: +81-3-6915-7716
www.thorlabs.co.jp
Email: sales@thorlabs.jp

UK and Ireland

Thorlabs Ltd.
1 Saint Thomas Place, Ely
Cambridgeshire CB7 4EX
United Kingdom
Tel: +44-1353-654440
Fax: +44-1353-654444
www.thorlabs.com
Email: sales.uk@thorlabs.com
Support: techsupport.uk@thorlabs.com

Scandinavia

Thorlabs Sweden AB
Bergfotsgatan 7
431 35 Mölndal
Sweden
Tel: +46-31-733-30-00
Fax: +46-31-703-40-45
www.thorlabs.com
Email: scandinavia@thorlabs.com

Brazil

Thorlabs Vendas de Fotônicos Ltda.
Rua Riachuelo, 171
São Carlos, SP 13560-110
Brazil
Tel: +55-16-3413 7062
Fax: +55-16-3413 7064
www.thorlabs.com
Email: brasil@thorlabs.com

China

Thorlabs China
Room A101, No. 100
Lane 2891, South Qilianshan Road
Putuo District
Shanghai 200331
China
Tel: +86-21-60561122
Fax: +86-21-32513480
www.thorlabs.com
Email: chinasales@thorlabs.com

THORLABS

www.thorlabs.com