Operation Manual

Thorlabs Blueline™ Series

Thermoelectric Temperature Controller

TED200

2006

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We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to come up to your expectations and develop 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

This part of the instruction manual contains specific information on how to operate a temperature module TED200. A general description is followed by explanations of how to operate the unit manually.

☝Attention☝

This manual contains "WARNINGS" and "ATTENTION" label in this form, to indicate dangers for persons or possible damage of equipment.

Please read these advises carefully!

NOTE

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

1 General Information

1.1 At a Glance

1.1.1 General remarks

The thermoelectric Temperature Controller TED200 by *Thorlabs GmbH* is an extremely precise temperature controller for laser diodes and detectors.

The TED200 is excellently suited for:

- **wavelength stabilization of laser diodes**
- **noise reduction of detectors**
- **wavelength tuning by regulating the temperature**
- **modulation of wavelength by tuning the temperature**

The unit is easy to use due to the clearly arranged operating elements on the front panel. The operating parameters are shown by an illuminated $4^{1}/_{2}$-digit LCD display, the measurement value shown is selected via keys.

The gain (P-share) the integral share and the differential share of the PID temperature control loop can be set free and reproducible.

Different temperature sensors can be used with the temperature controller TED200 (thermistor, or temperature IC sensors: AD 590, AD592, LM135, LM 335). With a thermistor the temperature display is shown as resistance value in kΩ, if the TED200 is operated with a temperature sensor IC the temperature is shown in °C.

The output for the TEC current can be switched on or off via key from the front panel.

The temperature sensor and the TEC element are connected by a 9-pin D-sub plug at the rear of the unit.

At the output jack a control signal is available to drive an external LED to indicate TEC ON mode when the TEC current loop is activated.

The set value of the temperature can be changed with a knob at the front panel or via an analog input at the rear of the unit.

An analog voltage proportional to the actual value of the temperature is available at the rear of the unit for monitoring purposes.

The unit has been designed for safe operation with environmental temperatures of more than 40 °C provided that a free air circulation through the ventilation slots at the rear and at both sides of the unit is maintained.

In case of overheating caused by too high environmental temperatures or closed ventilation slots the unit automatically switches the output off to avoid damages.
The LED "OTP" (over-temperature-protection) indicates the over-temperature.

After temperature drop of about 10 °C the LED "OTP" extinguishes and the output current can be switched on again by pressing the key "ON".

If an error occurs (OTP or OPEN) the corresponding LED lights up and a beeper gives a short warning signal.

The installed mains filter and the careful shielding of the transformer provide a low ripple at the output.

If laser diode mounts of the LDH series and the corresponding cables by *Thorlabs GmbH* are used damages caused by wrong connections are impossible.

1.1.2 Protections for the TEC element

To protect the connected TEC element the temperature control system TED200 includes the following protective circuits:

- **Limit of the TEC current in all operating modes**

Protection against thermal destruction.

- **Protection of the sensor**
  Protection against use of incorrect temperature sensors / protection against line interruption of the temperature sensor.

- **Contact protection of the TEC element (open circuit)**
  Protection against cable damage, bad contact or TEC element with too high resistance.

- **Control LED for TEC current on**

Protection against accidental turning off the cooling.

- **Over-temperature protection**

Protection against thermal failure of the module.

- **Mains filter**
  Protection against line transients or interference's.

- **Line failure protection**
  After turning on or in case of power failure or line damage the temperature control must explicitly be switched on anew since it cannot be taken for granted that all components of the measurement set-up are still working faultlessly.

1.2 Safety

☝ Attention ☝

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

Before applying power to your TED200 system make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth contact of the socket outlet! Improper grounding can cause electric shock with damages to your health or even death!
Also make sure that the line voltage setting marked on the rear panel agrees with your local supply and that the corresponding fuses are inserted. If not, please have a service technician change the voltage (see section 4.2).
Changing of the mains fuse can be done by the customer (see section 4.3).

The unit must only be operated with duly shielded connection cables.

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

This precision device is only dispatchable if duly packed into the complete original packaging including the plastic form parts. If necessary, ask for a replacement package.

☝ Attention ☝

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to EN 50 082-1.

☝Attention☝

The temperature controller TED200 must not be operated in explosion endangered environments!

1.3 Ordering codes and Accessories

Ordering-code	Short description
TED200	thermoelectric Temperature Controller, TEC current 0 ... ± 2 A, working with thermistors and temperature IC sensors (AD 590, AD 592, LM135 and LM 335) as temperature sensor, illuminated 4½-digit LCD-display
	Shielded cables:
CAB420	cable to connect the Temperature Controller to a *Thorlabs GmbH* Laser Diode Mount.

2 Getting Started

2.1 Unpacking

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 TED200 mechanically and electrically.

Verify that you have received the following items:

1. 1 TED200
2. 1 power cord, connector according to ordering country
3. 1 operation manual
4. 1 Connection cable CAB 420

2.2 Preparation

Prior to starting operation with a laser diode controller TED200, check if the line voltage specified on the letter plate agrees with your local supply and if the appropriate fuse is inserted. (To change the line voltage see 4.2 on page 24)

Connect the unit to the line with the provided mains cable. Turn the unit on by means of the line switch (L10).

Via the connector jack of the chassis ground (R4) the external optical build-up can be connected to ground potential, if required. The ground pin of the laser diode is internally connected to chassis ground.

2.3 Preparation

2.3.1 Operating elements on front panel

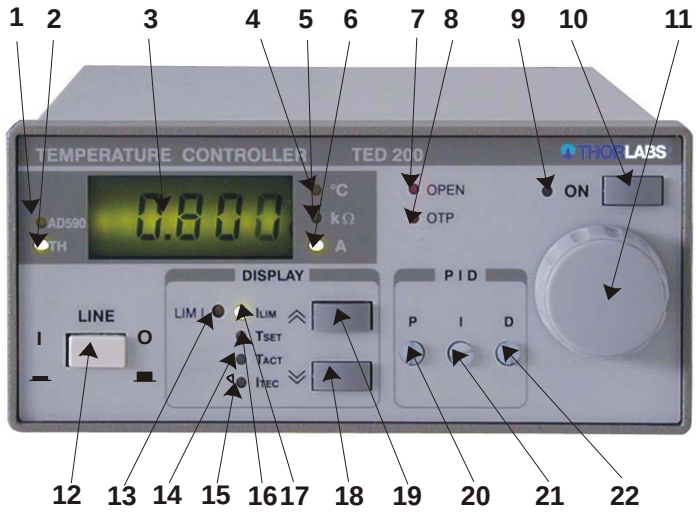

Figure 1 Operating elements on front panel

1	LED for an AD 590, AD 592, LM135 or LM335 sensor
2	LED for a thermistor sensor
3	4½-digit LCD display
4	Temperature display in °C
5	Resistance display in kΩ
6	Current display in A
7	LED for TEC element not or wrong connected"
8	LED "over-temperature-protection"
9	LED "TEC output switched on"
10	On/off switch for temperature control loop
11	Setting the set temperature "TSET"
12	Mains power control switch (ON / OFF)
13	Setting the current limit "ILIM" for the TEC element
14	LED to display the actual temperature "TACT´"
15	LED to display the TEC current "ITEC"
16	LED to display the set temperature "TSET"
17	LED to display the current limit "ILIM"
18	Selecting the measurement value for display (toggle switch down)
19	Selecting the measurement value for display (toggle switch up)
20	Setting the gain of the control loop (P-share)
21	Setting the I-share of the control loop
22	Setting the D-share of the control loop

2.3.2 Operating elements on rear panel

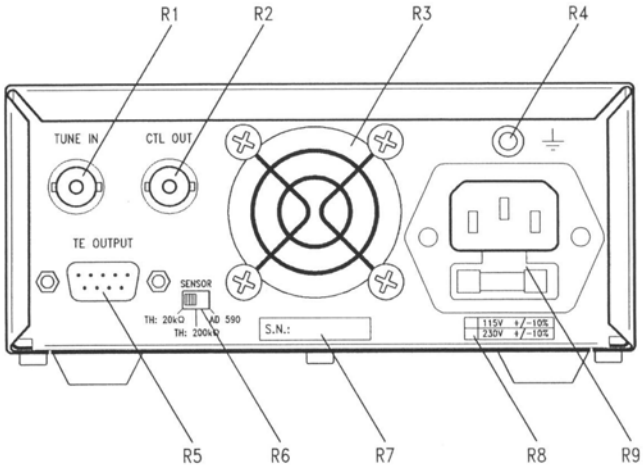

Figure 2 Operating elements on rear panel

R1 Analog control input "TUNE IN"
R2 Analog control output "CTL OUT"
R3 Fan
R4 Chassis ground
R5 9-pin D-sub jack for the TEC element and the temperature sensor
R6 Selecting the temperature sensor and the thermistor resistance range
R7 Serial number of the unit
R8 Letterplate for line voltage
R9 Mains socket and fuse holder

2.4 Starting up

Prior to starting operation with the thermoelectric Temperature Controller TED200, check if the line voltage specified on the letter plate agrees with your local supply and if the appropriate fuse is inserted. If not see chapter 4.2 to set the appropriate line voltage. Connect the unit to the line with the provided mains cable.
Turn on the unit using the mains power control switch at the front panel.

The LC-display (3, Figure 1) must get visible and a LED must light to indicate the selected measurement value (14 to 17).

With the keys (18) and (19) you can select the desired measurement value at any time.

Independent of the switch position (R6) the setting and measurement range with thermistors is between 0 and 19.99 kΩ or 0 and 199.9 kΩ respectively. When the AD 590, AD 592, LM135 or LM335 is used as a temperature sensor the measurement range is between -45 °C and + 145 °C. The actual control range depends on the sensor ratings and the individual thermal setup.

The unit TED200 is immediately ready to use after turning on. The rated accuracy is however reached after a warming-up time of approx. 10 minutes.

3 Operating the TED200

3.1 Connecting components

Connecting TEC element and temperature sensor

If Laser Diode Heads (LDH) by *Thorlabs GmbH* are used, the output "TE OUTPUT" (R5) of the Temperature Controller TED200 must be connected to the 9-pin plug "TEC DRIVER" of the LDH with a shielded cable CAB420.
With other equipment connect the TEC element and the temperature sensor according to Figure 3.

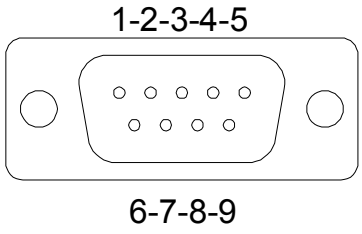

Figure 3 Output pinning of the 9-pole D-SUB jack (male)

Pin	Connection
	TEC element, status indication:
4	TEC (+)
5	TEC (-), status-LED (-)
1	Status-LED (+) (for TEC ON/OFF indication)
	Temperature sensor:
2	Thermistor (-)
3	Thermistor (+), ground
7	Transducer AD 590/592 (-), LM 135/335 (+)
9	Transducer AD 590/592 (+), LM135/335 (+)
6	N.C.
8	AGND LM 135/335

3.1.1 Connecting the TEC element

Connect the thermoelectric cooler between pin 4 (TEC anode) and pin 5 (TEC cathode) of the 9-pin D-sub plug (R5, see Figure 2).

☝ Attention☝

An reverse poled TEC element may lead to thermal runaway and destruction of the connected components.

Check the TEC polarity as follows:
Turn on the Temperature Controller TED200

Connect the temperature sensor to the plug "TE OUTPUT" (R5)
➔ (refer to 3.1.3, "Connecting a temperature sensor" on page 13).

Select a suitable current limit "ILIM" for the TEC element
(refer to 3.3, Setting the TEC current limit "ILIM" on page 18).

Switch the LCD display to the measurement range "TSET" and set the desired set temperature with the tuning knob.

By pressing the key "ON" switch on the TED200 output current. The LED "ON" (9, see Figure 1) lights up.

Switch the LCD display to the measurement range "TACT".

If the TEC module is connected with right polarity, the difference between the set temperature "TSET" and the actual temperature "TACT" will decrease. If the control loop parameters are set well (refer to chapter 3.4), the actual temperature must be in accordance with the set temperature in a short time.

If the TEC module is connected with wrong polarity, the difference between set temperature and actual temperature will increase continuously. Then switch off the TEC current by pressing key "ON" (9) and change the TEC module wiring at the D-sub plug (R5).

3.1.2 Control LED for TEC ON mode

If a LED is connected between pin 1 and pin 5 as shown in Figure 4 this LED lights up when the TEC current output is switched on (TEC ON mode).

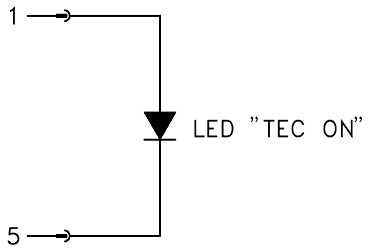

Figure 4 TEC ON monitoring

3.1.3 Connecting a temperature sensor

The Temperature Controller TED200 can be used with a standard thermistor, with an AD 590, AD 592, LM 135 or an LM 335 as temperature sensor. The temperature sensor is selected with switch (R6) at the rear of the unit (see Figure 2).

The LED's (1) or (2) resp. indicate the selected sensor.

If no temperature sensor is connected or if the temperature sensor does not correspond to the sensor type selected with switch (R6) the LCD display (3) indicates overflow when "TACT" measurement value is shown and the LED "OPEN" (7) lights up in TEC OFF mode.

The temperature sensor is connected to the 9-pin D-sub plug "TE OUTPUT" (R5) at the rear of the TED200 depending on the sensor type used.

NOTE

Additionally to the AD 590 or AD592 temperature sensor the TED200 also works with an LM 335 sensor. If an LM 335 is used as temperature sensor also select "AD 590" with the switch (R6). Thus also the LED "AD 590" (1) lights up. The LM 335 sensor must be connected according to

Figure 7.

3.1.3.1 Connecting a thermistor

The thermistor must be connected between pin 2 and pin 3 of the 9-pin D-sub plug (R5, Figure 2). The polarity is unimportant if the thermistor is floating. If one pin of the thermistor is grounded (for example in a laser module), this pin has to be connected to pin 3.
If the Temperature Controller TED200 is operated with a thermistor as temperature sensor the thermistor resistance at set temperature "TSET" must be set in kΩ.

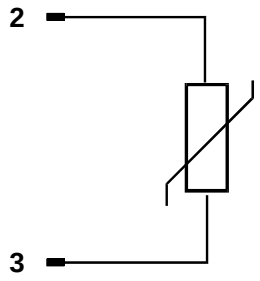

Figure 5 Connecting a thermistor

When the actual temperature "TACT" is chosen for display the thermistor resistance is shown. The switch (R6, Figure 2) selects the resistance range of the thermistor. In position "L" (Low) the maximum thermistor range is 20 kΩ and the measurement current 100 μA. In position "H" (High) the maximum thermistor resistance is 200 kΩ and the measurement current 10 μA.

The dependency of resistance on temperature and vice versa of an NTC-thermistor is described by the formula:

$$R(T) = R^0 * e^{B_{val}(\frac{1}{T} - \frac{1}{T_0})} \Leftrightarrow T(R) = \frac{B_{val} * T_0}{T_0 * \ln(\frac{R}{R_0}) + B_{val}}$$

(temperatures in Kelvin)

with: R_0: Thermistor nominal resistance at temperature T_0
T_0: Nominal temperature (typ. 298.15 K = 25°C)
B_{val}: Energy constant

For R_0 and B_{val} refer to the data sheet of the thermistor.

Evaluate the thermistor resistance for the desired set temperature.

Select with the key (18, Figure 1) or (19) the display value "TSET" to show the set value and set the evaluated resistance value with the tuning knob (11).

If the thermistor characteristic R(T) is given in the data sheet the desired resistance can be read directly.

3.1.3.2 Temperature sensor AD 590 or AD 592

If the temperature/current transducer AD 590 or AD 592 is used as temperature sensor it is connected between pin 7 (-) and pin 9 (+) of the 9-pin D-sub plug "TE OUTPUT" (R5, Figure 2) at the rear of the unit.

The accuracy of the displayed temperature depends on the tolerance of the transducer used. If required the temperature display can be additionally calibrated for the transducer used.

For calibration of the temperature sensor please refer to chapter 4.5.

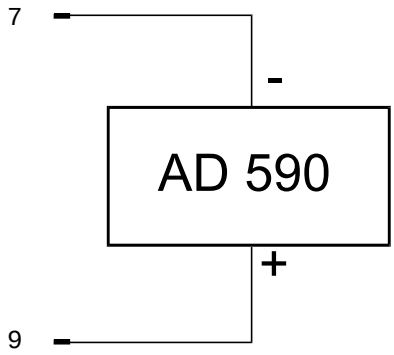

Figure 6 Connecting a temperature sensor AD 590 or AD 592

3.1.3.3 Temperature sensor LM 135 or LM335

If the temperature/voltage transducer LM135 or LM335 is used as temperature sensor it is connected to pin 9 (+), pin 7 (also +) and pin 8 (AGND) of the 9-pin D-sub plug "TE OUTPUT" (R5, Figure 2) at the rear of the unit.

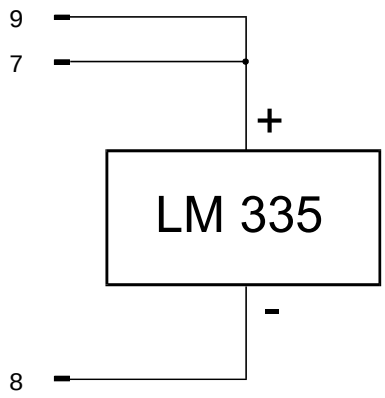

Figure 7 Connecting a temperature sensor LM 135 or LM 335

The accuracy of the displayed temperature depends on the tolerance of the transducer used. If required the temperature display can be calibrated for the transducer used.

For calibration of the temperature sensor please refer to chapter 4.5.

3.2 Operating the temperature controller

Switch on the Temperature Controller TED200

Use cable CAB 420 to connect the input "TEC DRIVER" of the Laser Diode Head to plug "TE OUTPUT" (R5, Figure 2) at the rear of the Temperature Controller TED200. If other laser diode sockets are used, the output plug "TE OUTPUT" (R5) has to be connected according to the pin assignment in Figure 3 and the description "Connecting a temperature sensor"
➔ (refer to chapter 3.1.3).

Select a suitable current limit "ILIM" for the TEC element
➔ (refer to chapter 3.3).

Select the used temperature sensor with the switch (R6).

NOTE:

Only if a temperature sensor is connected to plug "TE OUTPUT" (R5) and the sensor type is selected correctly with switch (R6), TEC ON mode can be selected by pressing key "ON" (R1).

The LED "OPEN" (7, Figure 1) lights up if the connected temperature sensor does not correspond to the sensor type selected with the switch (R6). In this case check the connection and the type of the temperature sensor.

Set switch (18) or (19) into position "TSET" to display the selected set temperature.

Set the desired temperature "TSET" with the tuning knob (11).

If a thermistor is used as temperature sensor the resistance has to be set in kΩ. If an AD 590, AD 592, LM135 or LM 335 is used as temperature sensor the set temperature is entered in °C.

Switch on the TEC current output of the Temperature Controller TED200 by pressing key "ON" (10). With the output switched on the LED "ON" (9) lights up.

NOTE:

When the LED "OPEN" (7) lights up the controller cannot be switched on. In this case check the connection of the temperature sensor and the selected sensor type.

During operation you can chose at any time the display value "TSET", "TACT", "ILIM" or "ITEC" by selecting it with the switch (18) or (19).

3.3 Setting the TEC current limit "ILIM"

The Temperature Controller TED200 delivers a maximum TEC current of 2 A. The TEC current "ILIM" can be set with the potentiometer "LIM I" and thus adapted to the used TEC element.

With one of the keys (18 or 19) switch to the display parameter "ILIM".

Use a screwdriver to set the desired TEC current limit "ILIM" with the 20-turn potentiometer "LIM I" (11) for the TEC element.

3.4 Adjusting the temperature control loop

By setting the control loop parameters of the PID control loop the temperature controller TED200 can be adapted optimal to the most different thermal loads.

The gain (P-share) for the temperature control can be adjusted with potentiometer "P" (20, Figure 1). Turning it clockwise will reduce the settling time while turning counterclockwise increases the stability of the temperature control loop and thus reduces overshoots.

The I-share of the temperature control loop can be adjusted with potentiometer "I" (21).

The D-share of the temperature control loop can be adjusted with potentiometer "D" (22).

Execution:
Switch with key (18) or (19) into the position "TACT" to display the actual temperature.

Turn the three potentiometers "P" (20), "I" (21) and "D" (22) completely counter-clockwise.

NOTE:

The settling behavior may be additionally observed at the "CTL OUT" (R2, Figure 2) output port at the rear of the unit by means of an oscilloscope or chart recorder.

The I-share can be completely switched off to make the setting of the gain (P-share) and the D-share easier. For this purpose the jumper "JP1" must be set internally on the basic PCB (refer to chapter 4.6).

Set the temperature "TSET" to about room temperature and switch on the TEC current output with the switch " ON" (10).

P-Share

Repeatedly increase and decrease the set temperature of about 1 °C or 2 °C around room temperature with knob (11, see Figure 1) or by setting a suited signal to the analog control input "TUNE IN" (R1, see Figure 2) at the rear of the unit and watch the settling behavior of the actual temperature "TACT".

Increase the P-share gradually. Higher values will increase the settling speed, to high values make the system oscillate.
The P-share has been set correctly when the actual temperature remains stable near the set temperature after only 2-3 overshoots.

D-share

Change repeatedly between set temperatures of room temperature±1...2°C while observing again the settling behavior of the actual temperature.
Increase the D-share gradually. Higher values will decrease the amplitude of the overshoots.
The D-share is set correctly when the actual temperature remains stable near the set temperature after a minimum of overshoots.

I-share

Turn on the I-share again by removing the internal jumper . "JP1" (please refer to section 4.6, Switching off the I-share of the temperature control loop, on page 29).

Again change repeatedly between set temperatures of room temperature ±1...2°C.
Increase the I-share gradually. Higher values will accelerate the settling to the set temperature.
The I-share is set correctly when the actual temperature reaches the set temperature in shortest time without overshoots.

3.5 Analog tuning of the temperature

The set temperature "TSET" can be tuned by an analog voltage via an independent grounded input "TUNE IN" (R1, Figure 2) at the rear panel of the Temperature Controller TED200. The temperature set value is proportional to the sum of the signal at the input "TUNE IN" (R1) and the value set with the adjust knob (11, Figure 1).

The tuning coefficient for the analog control input "TUNE IN" (R1) is:

range	**voltage**	**operation mode**
0 ... 20 kΩ	0 ... 10 V	thermistor, switch (11) in position "L"
0 ... 200 kΩ	0 ... 10 V	thermistor, switch (11) in position "H"
-50 °C ... +100 °C	- 2.5 V ... + 5 V	AD 590/592, LM 135/335

Execution:
Switch on the Temperature Controller TED200 and connect the temperature sensor and the TEC element to plug "TE OUTPUT" (R5).

Select an adequate TEC current limit "ILIM". Select the sensor type with switch (R6) and set the desired set temperature "TSET" with the tuning knob.

Switch on the TEC current output of the Temperature Controller TED200 by pressing key "ON" (10). TEC ON mode is indicated by LED "ON" next to the key "ON" (10).

Apply an analog voltage to jack "TUNE IN" (R1) at the rear panel of the Temperature Controller TED200.

NOTE:

Only slow variations of the temperature set value (<< 1 Hz) are possible via the analog control input "TUNE IN" (R1).

At the analog temperature control output "CTL OUT" (R2) the actual temperature "TACT" can be supervised.

3.6 Analog temperature control output

An analog output "CTL OUT" (R2, see Figure 2) is provided at the rear of the Temperature Controller TED200. Here a voltage proportional to the actual temperature "TACT" is applied for monitoring purposes e.g. to supervise the settling behavior of the temperature control loop.

voltage	range	operation mode
0 ... 10 V	0 ... 20 kΩ	thermistor, switch (T11) in position "L"
0 ... 10 V	0 ... 200 kΩ	thermistor, switch (T11) in position "H"
-10 V ... +10 V	-200 °C ... +200 °C	AD 590/592, LM 135/335

E.g. a strip chart recorder may be connected to this output to see if certain temperature limits of the device under test are exceeded.

The output "CTL OUT" (R2) is grounded. Thus standard measurement equipment can be connected directly. Devices connected to these outputs should have an internal resistance of ≥ 10 kΩ.

3.7 Over-temperature-protection of the TED200

The temperature controller TED200 has an automatic over-temperature-protection. If overheated by operating errors or high ambient temperatures the current output of the module is switched off automatically. LED "OTP" (8, see Figure 1), over-temperature-protection, lights up and the beeper gives a short warning signal. The current through the TEC element is switched off (TEC OFF mode). Pressing key "ON" (10) has no effect in this case.

When the temperature within the unit has dropped for about 10 °C the LED "OTP" (8) extinguishes and the TEC current output can be switched on again.

4 Maintenance and Repair

4.1 Maintenance

Protect the TED200 from adverse weather conditions. The TED200 is not water resistant.

Do not store or leave the TED200 where the LCD display will be exposed to direct sunlight for long periods of time.

☝ Attention ☝

To avoid damage to the TED200, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance.

The unit and the LCD display can be cleaned with a cloth dampened with water.
You can use a mild 75% Isopropyl Alcohol solution for more efficient cleaning.

The TED200 does not contain any modules that can be repaired by users.

To guarantee the specifications given in chapter 5.3 over a long period it is recommended to have the unit calibrated by *Thorlabs* every two years.

4.2 Line Voltage Setting

The temperature controller TED200 operates at fixed line voltages of 90 V … 115 V, 104 V … 132 V or 207 V … 264 V. Prior to starting operation check that the line voltage specified on the letter plate agrees with your local supply. A qualified service person is required to change the operating Line voltage.

☝Attention☝

This procedure should only be done by qualified service personnel!

Dangerous voltages exist within the device. As shipped from the factory, all parts carrying line voltage are covered to reduce the likelihood of contact. However Thorlabs GmbH does not guarantee this protection to be sufficient under all circumstances. Therefore be careful not to touch any Mains Voltage connected part within the unit!

Disconnect Power. To avoid electrical shock, first switch off the TED200 power, and then disconnect the power cord from the mains power.

With the TED200 turned over, remove the two screws that secure the cover to the chassis. One of the screws has a paint piercing washer.

Remove the unit by sliding it out of the cover. With the unit set upright, you will find the range switch near the front of the unit, next to the transformer (see Figure 8)

Using a flat-blade screwdriver, turn the switch to the desired range by aligning the triangle with the appropriate voltage (100V, 115V, or 230V). Ensure that the switch has clicked into one of the three positions and is not between positions.

On the back of the instrument, remove the indicator screw from the old location and install it in the location corresponding to the new range setting.

☝ Attention ☝

If you have changed to or from 230 V, change the mains fuse to the value shown in section 4.3 of this manual.!

100 V	630 mA, Slow, 250V	T0.63A250 V
115 V	500 mA, Slow, 250V	T0.5A250 V
230 V	250 mA, Slow, 250V	T0.25A250 V

All fuses are to be IEC 60127-2/III.

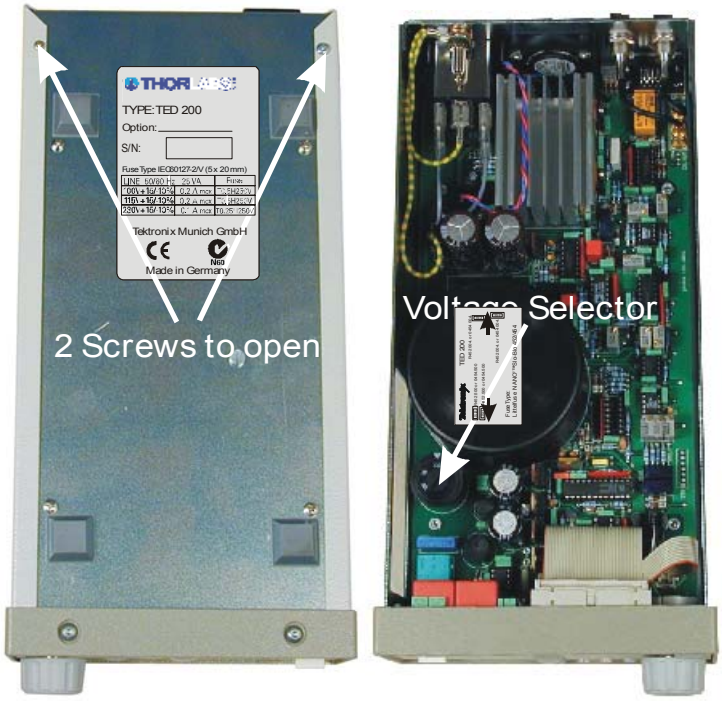

Figure 8 Setting the line voltage

Reattach the cover, ensuring that the paint piercing screw is in the original location.

4.3 Replacing the mains fuse

If the mains fuse has opened due to line distortions, incorrect line voltage or other causes, it can be easily replaced from the rear without opening the unit.

☝Attention☝

To avoid risk of fire only the appropriate fuse for the corresponding line voltage must be used.

1. Turn off the TED200 and disconnect the mains cable.
2. Open the fuse drawer in the mains connector (see Figure 9) with a screw-driver.
3. Replace the defective fuse (one spare fuse is included in the fuse holder) and close the drawer.

100 V	630 mA, Slow, 250V	T0.63A250 V
115 V	500 mA, Slow, 250V	T0.5A250 V
230 V	250 mA, Slow, 250V	T0.25A250 V

All fuses are to be IEC 60127-2/III

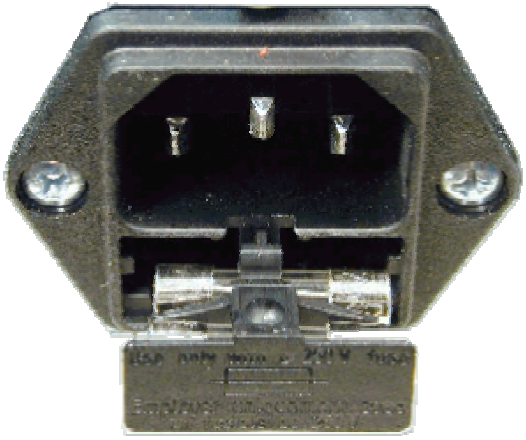

Figure 9 Changing the mains fuse

4.4 Internal Fuse Replacement

☝ Attention ☝

Internal fuses must be changed only by qualified service personnel.

Open the unit as described in section 4.2.
You will find an adhesive label on the transformer depicting type and location of the internal fuses.

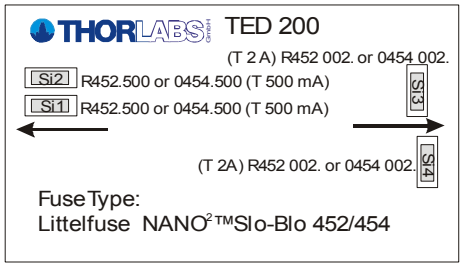

Figure 10 Label 'Internal fuses'

Use only fuses of the type 'Littelfuse NANO$^{2®}$ Slo-Blo Fuse 452/454 Series'.

Replace the defective fuse and close the unit again (see section 4.2).

4.5 Calibrating the temperature sensor

☝Attention☝

This procedure should only be done by qualified service personnel!

Hazardous voltages exist within the device. As shipped from the factory, all parts carrying line voltage are covered to reduce the likelihood of contact. Use only isolated tools and be careful not to touch any Mains.

When using an AD 590, AD 592 or an LM 335 IC sensor the accuracy of the actual temperature depends on the tolerance of the temperature sensor used. For higher accuracy the temperature display additionally can be calibrated for the temperature sensor used.

If the Temperature Controller TED200 was purchased together with a temperature controlled Laser Diode Head by *Thorlabs GmbH* the temperature display is (on request) already calibrated for the temperature sensor of the Laser Diode Head.

Execution:

Disconnect Power. To avoid electrical shock, first switch off the TED200 power, and then disconnect the power cord from the mains power.

With the TED200 turned over, remove the two screws that secure the cover to the chassis. One of the screws has a paint piercing washer.
Remove the unit by sliding it out of the cover.

At the main PCB of the Temperature Controller TED200 there are the potentiometers "P1" and "P2" (Figure 11). With potentiometer "P2" the zero of the temperature scale can be set. With potentiometer "P1" the scaling factor of the temperature scale can be set.

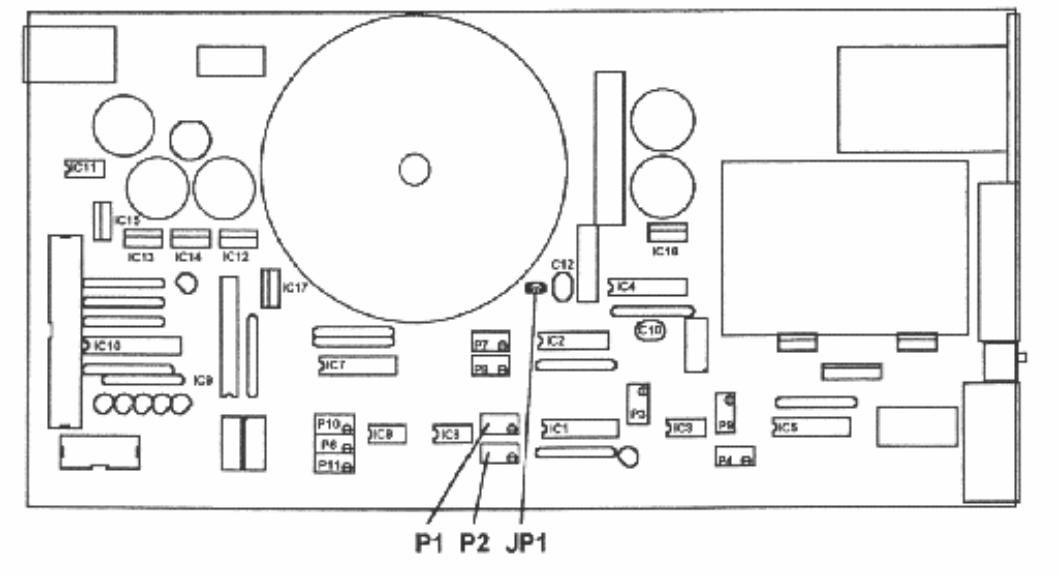

Figure 11 Component view of the PCB of the TED200

Connect the TED200 to the line by the mains cable and switch on the opened unit.

Use iced water to cool the temperature sensor to 0° C and calibrate the display of the actual temperature "TACT" with potentiometer "P2" to 0 °C.

Use boiling water to heat the temperature sensor to about 100 °C, measure the water temperature and adjust the display of the actual temperature "TACT" with potentiometer "P1" to the measured water temperature.

Afterwards close the unit with the cover and fasten the cover again with the screws at the bottom of the unit.

4.6 Switching off the I-share of the temperature control loop

To simplify the setting of the P- and D-share of the temperature control loop the I-share can be switched off by setting a jumper on the main PCB of the TED200. Especially in the case of high thermal loads the setting of the P- and D-share is thus simplified.

☝Attention☝

This should only be done by qualified service personnel!
To switch off the I-share open the unit. Before removing the cover the unit must be switched off and the line plug must be removed from the line socket (R9, Figure 2).

Execution:

☝Attention☝

This procedure should only be done by qualified service personnel!

Hazardous voltages exist within the device. As shipped from the factory, all parts carrying line voltage are covered to reduce the likelihood of contact. Use only isolated tools and be careful not to touch any Mains..

Switch off the unit, remove line plug from the mains and remove the screws of the cover at the bottom of the unit then remove the cover (see Figure 8 in the 4.4 Internal Fuse Replacement, section).
Close jumper "JP1" with a standard computer jumper at the printed circuit board of the Temperature Controller TED200.
(refer to Figure 11 Component view of the PCB of the TED200" on page 29).

Put the cover back on the unit and fasten it again with the screws at the bottom.

Connect the unit to the mains supply and switch on the unit.

Then optimize your PD settings.

NOTE

Do not forget to remove the jumper afterwards and to adjust the I-share.

4.7 Troubleshooting

In case that your TED200 system shows malfunction please check the following items:

◆ Module does not work at all (no display on the mainframe):

- ➢ Unit connected properly to the mains?
  - Connect the TED200 to the power line take care of the right voltage setting of your mainframe.

- ➢ TED200 turned on?
  - Turn on your TED200 with the key mains-switch.

- ➢ Control the fuse at the rear panel of the TED200 mainframe.
  - If the fuse has opened replace the fuse by the correct type

➔ (refer to chapter 4.2, "Line Voltage Setting" on page 24 to select the appropriate fuse)

◆ The display works but you don't get the desired operation temperature

- ➢ Is the hardware current limit I_{LIM} set to 0?
  - Adjust the hardware limit I_{LIM} by means of the potentiometer on the TED200 front panel to an appropriate value.

- ➢ Is the TEC connected properly to the D-SUB connector?
  - Check all cables.
  - Check the correct polarity

➔ (see section 3.1.1 on page 12)

- Is the temperature sensor connected properly and are his parameters entered correctly?
  - Check the corresponding connections and polarities of the temperature sensor.

  ➔ (refer to chapter 3.1.3, "Connecting a temperature sensor" on page 13)

  - Select the corresponding temperature sensor on the back panel with switch R6, (Figure 2).
  - Enter the right set-values for T_{SET} (thermistor)

◆ Set temperature differs from actual temperature (of the laser)

- Is the sensor calibrated properly?
  - Enter the right set-values for T_{SET} (thermistor) or calibrate your system anew.

  ➔ (Refer to section 4.5, "Calibrating the temperature sensor" on page 28)

If you don't find the error source by means of the trouble shooting list please first connect the *Thorlabs GmbH-Hotline (blueline@thorlabs.com)* before sending the TED200 system for checkup and repair to *Thorlabs GmbH*-Germany.

➔ (Refer to 5.7, "Addresses" on page 42)

5 Appendix

5.1 Warranty

Thorlabs GmbH warrants material and production of the TED200 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 (Germany)* or to a place determined by *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 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 soft- 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 conditions 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.

5.2 Certifications and compliances

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions[1,2,3] and Immunity.[1,2,4]
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion B)
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance criterion B) [5]
	IEC 61000-4-5	Power Line Surge Immunity (Performance criterion B)
	IEC 61000-4-6	Conducted RF Immunity (Performance criterion B)
	IEC 61000-4-11	Voltage Dips and Interruptions Immunity (Performance criterion B)
	EN 61000-3-2	AC Power Line Harmonic Emissions
Australia / New Zealand Declaration of Conformity - EMC	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard[1,2,3]:	
	AS/NZS 2064	Industrial, Scientific, and Medical Equipment: 1992
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B[1,2,3].	

[1] Compliance demonstrated using high-quality shielded interface cables.

[2] Compliance demonstrated with CAB420 cable installed at the TEC Output port with LDH-DIL Laser Diode Mount attached at other end.

[3] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

[4] Minimum Immunity Test requirement.

[5] TUNE IN port capped at IEC 61000-4-3 test..

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	
	EN 61010-1/A2:1995	Safety requirements for electrical equipment for measurement control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1	Standard for electrical measuring and test equipment.
	ANSI/ISA S82.01:1994	Safety standard for electrical and electronic test, measuring, controlling, and related equipment.
Canadian Certification	CAN/CSA C22.2 No. 1010.1	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2:1995	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Equipment Type	Test and measuring	
Safety Class	Class 1 (as defined in IEC 61010-1, Annex H) - grounded product	

5.3 Technical data

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

Temperature sensor:

Type of sensor	Thermistor, AD590, AD592, LM135, LM335
Thermistor sensing current (TH Low/High)	100 µA / 10 µA
Control range (AD590, LM135)	-45 °C ... +145 °C
Control range (AD592)	-25 °C ... +105 °C
Control range (LM 335)	-40 °C ... +100 °C
Control range (Thermistor Low/High)	10 Ω ... 19.99 kΩ / 100Ω ... 199.9 kΩ
Setting / measurement resolution (AD590, AD592, LM135, LM 335)	0.01 °C
Setting / measurement resolution (Thermistor Low/High)	1 Ω / 10 Ω
Accuracy (AD590, AD592, LM135, LM 335)	± 0.1 °C
Accuracy (Thermistor Low/High)	± 10 Ω / ± 100 Ω
Temperature stability 24 hours (AD590, AD592, LM135, LM 335)	< 0.002 °C
Temperature stability 24 hours (Thermistor Low/High) [1)]	< 0.5 / 5 Ω

TEC output:

Control range of the TEC current	- 2 A ... + 2 A
Measurement resolution TEC current	1 mA
Accuracy TEC current	± 20 mA
Max. output voltage	> 6 V
Max. output power	12 W
Noise and ripple (typ.)	< 1 mA

TEC current limit:

Setting range	0 ... ≥ 2 A
Measurement resolution	1 mA
Accuracy	± 40 mA

[1)] Due to the nonlinear conversion from Ω to °C the stability in °C depends on the operating conditions and the characteristics of the thermistor. E.g. for a typical thermistor at a set point of 10kΩ (25°C), a 0.5Ω stability translates into about 1mK temperature stability. At a set point of 5kΩ (38°C), the stability is about 2mK.

Temperature control input:

Input resistance	10 kΩ
Control voltage	-10 ... +10 V
Transmission coefficient (AD590, AD592, LM135, LM 335)	20 °C/V ± 5%
Transmission coefficient (Thermistor Low/High)	2 kΩ/V, 20 kΩ/V ± 5%

Temperature control output:

Load resistance value	≥ 10 kΩ
Output voltage (AD590, AD592, LM135, LM 335)	-10 … +10 V
Output voltage (Thermistor Low/High)	0 … +10 V / 0 … +10 V
Voltage Coefficient (AD590, AD592, LM135, LM 335)	50 mV/°C ± 5%
Voltage Coefficient (Thermistor Low/High)	0.5 V/kΩ / 50 mV/kΩ ± 5%

Connectors:

Temperature sensor, TEC element, TEC ON signal	9-pin. D-sub jack fem.
Control input/control output	2 x BNC
Chassis ground	4 mm banana jack

General data:

Line voltage	100 V / 115 V / 230 V (-10%, +15 %) (fixed)
Line frequency	50 ... 60 Hz
Power consumption (max.):	60 VA
Supply mains overvoltage	Overvoltage category II (Cat II)
Operating temperature[1)]	0 ... +40°C
Storage temperature	-40°C ... +70°C
Relative Humidity	Max. 80% up to 31 °C, decreasing to 50% at 40 °C
Pollution Degree (indoor use only)	2
Operation altitude	< 3000 m
Warm-up time for maximum accuracy	<10 min
Weight	< 3.1 kg
Dimensions W x H x D without operating elements	146 x 66 x 290 mm³
Dimensions W x H x D with operating elements	146 x 70 x 316 mm³

[1)] non condensing

5.4 Thorlabs “End of Life” policy (WEEE)

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs 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 electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see Figure 12)
- 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 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.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

5.4.1 Waste treatment on your own responsibility

If you do not return an “end of life” unit to Thorlabs, 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.

5.4.2 Ecological background

It is well known that WEEE 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 live products will thereby avoid negative impacts on the environment.

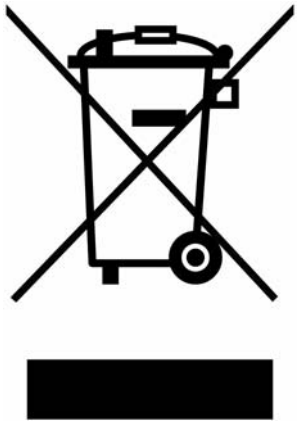

Figure 12 Crossed out “wheelie bin” symbol

5.5 List of acronyms

The following acronyms are used in this manual:

AC	Alternating Current
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
D-Share	Derivative share
DC	Direct Current
DIN	Deutsche Industrie Norm
DUT	Device Under Test
IEEE	Institute for Electrical and Electronic Engineering
I-Share	Integral share
JP	JumPer
LCD	Liquid Crystal Display
LDC	Laser Diode Controller
LED	Light Emitting Diode
N.C.	Not Connected
PD	Photo Diode
PID	Proportional, Integral, Differential (regulator)
P-Share	Proportional share
TEC	ThermoElectric Cooler (Peltier Element)

5.6 List of figures

5.7 Addresses

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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