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# **Thermoelectric Cooler Controller**

## **TED1000**

*Operating Instructions*



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# 1 General

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Please read the whole operating instructions before using this instrument together with a laser diode.

## 1.1 Warranty and Assistance

This instrument manufactured by LASER ELECTRONICS is warranted against defects in material and workmanship for a period of 12 months from date of shipment to the customer. During the warranty period, LASER ELECTRONICS will, at its option, either repair or replace products which prove to be defective.

The warranty does not apply to defects resulting from improper use or maintenance by the buyer, from unauthorized modifications or operation outside the environmental specifications and from electrostatic discharge (ESD).

For warranty service or repair, the instrument should be sent to LASER ELECTRONICS in appropriate packing. Please enclose a detailed fault report including instrument type and serial number(s).

## 1.2 Maintenance

The instrument does not require special maintenance if it is used correctly. For precisely operation it is recommended to send back the instrument for calibration every two years.

Servicing should only be performed by trained service personnel.

## 1.3 General Safety Considerations

Before switching on the instrument, make sure it has been properly grounded through the supplied AC power cable to a socket outlet with a protective earth contact. Any interruption of the grounding can result in personal injury.

This instrument must be used under normal conditions and as specified, otherwise the protection provided by the instrument could be impaired.

Always replace blown fuses with the same rating and acting speed.

ESD: Electrostatic discharge (ESD) on or near the connectors can damage electronic devices inside the instrument. Personnel should touch the metal frame of the instrument for a second before touching any connector.

## 1.4 System contents

TED1000

Cable for serial interface (RS232, D-Sub 9) for interconnecting instrument with PC

AC Power Cable

Manual

Optional:

Thermoelectric cooler

Sensor cable for connecting sensors

## 2 Introduction

The instrument TED1000 conveniently offers a 600W thermoelectric cooler controller to drive suitable heat sinks. The common unipolar version can only heat or cool but optional it provides a bipolar output for both heating and cooling. With an optional air-cooled heat sink e.g. a laser diode can easily be kept at constant temperature.

An internal microprocessor provides the flexibility and convenience of software. Our LabVIEW based program LETSoft can be used to control the TED1000. All parameters can be set and controlled by a PC via RS232 interface.

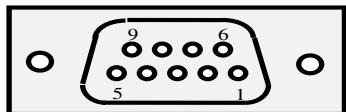
The TED1000 can easily adapted to different heat sinks by the software PI controller. An adjustable TEC current limit prevents the controller from overdriving the TEC element. The TED1000 includes a 600W thermoelectric cooler controller and can drive all of our heat sinks COOL12 to COOL100 suitable for cooling up to about 100W (optical power) laser diodes and can work with three several temperature sensor types: NTC, PT100, PT1000.

## 3 Connectors Pin-Out

The instrument must be turned off before making the connection.

### 3.1 RS232

This connector at the rear panel is a D-Sub 9, male type.



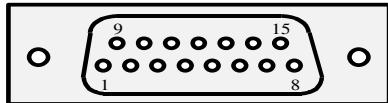
The pin-out is shown when facing the connector mounted to the rear panel directly.

Pin number	Designation
2	RXD (receive)
3	TXD (transmit)
5	GND
1, 4, 6, 7, 8, 9	n.c.

The instrument comes with a suitable cable for connecting it to a free serial port of a computer. Only use so-called interconnecting serial cables with two female connectors where the leads for pin 2 and 3 are crossed on both ends. A simple extension cable does not work.

## 3.2 Interlock

This connector at the rear panel is a D-Sub 15, female type.

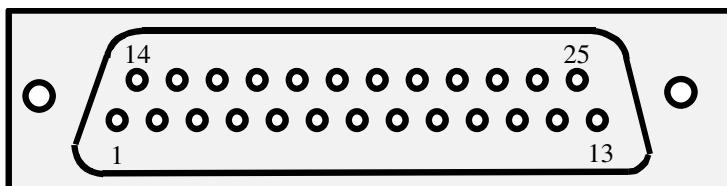


The pin-out is shown when facing the connector mounted to the rear panel directly.

This connector is not be used.

## 3.3 Sensors

This connector at the rear panel is a 25 pol. SUB-D female type.



The pin-out is shown when facing the connector mounted to the rear panel directly.

Pin number	Designation	Wire Colour Sensor Cable
1 (NTC-1A), 3 (PT100-1A), 5 (PT1000-1A)	Cooler 1 Sensor pin A	pink white
14 (NTC-1B) 16 (PT100-1B) 18 (PT1000-1B)	Cooler 1 Sensor pin B	yellow grey

### Trouble-shooting:

After preparing the connection of the thermoelectric cooler and the temperature sensor according to the section *Connector pin-out* and switching on the instrument, it might happen that the temperature controller doesn't seem to control the temperature, i.e. the measured temperature doesn't approach the desired temperature after some time or the laser diode is heated up instead of cooled down.

In this case the polarity of the thermoelectric cooler referred to the pin-out as shown in the section *Connectors Pin-Out* has to be changed. Simply change the connection of the two leads of the thermoelectric cooler, even if the occurring labelling „Plus“ to „Minus“ doesn't match obviously.

After this change the measured temperature should approach the desired temperature.

## 3.4 Cooler

Designation	Wire Colour
Thermoelectric cooler (Peltier) minus	blue
Thermoelectric cooler (Peltier) plus	red
Temperature sensor (type NTC)	white
Temperature sensor (type NTC)	grey
Fan plus	brown
Fan minus	black
Earth	green-yellow

The green-yellow lead (earth) is connected to the base plate of the heat sink. Do not connect it to the laser diode housing or to the heat spreader on which the laser diode is directly mounted.

## 4 Installation

### Installation of the instrument

Before installation check the local mains voltage. The instrument is equipped with auto-ranging power supplies for a continuous input voltage from 85 to 264 V AC @ 50 - 60 Hz. If the primary fuse is blown it can easily be replaced by the user.

Connect the instrument to the mains. Do not switch on the instrument yet.

Plug in the RS232 and Cooler cables to the appropriate connectors.

## 5 RS232 Interface

The instrument can only be controlled via the RS232 interface by a PC. All parameters can be set and read-out with a choice of commands including turning on / off the laser diode.

### 5.1 Baud Rate Setting

As default 19.200 baud is set.

The instrument supports the communication with following baud rates:

Baud Rate	Jumper 1	Jumper 2	Jumper 3	Supported by Computer
9.600	x	x	x	x
19.200	-	x	x	x
38.400	x	-	x	x
57.600	-	-	x	x
115.200	x	x	-	x
230.400	-	x	-	-
460.800	x	-	-	-
921.600	-	-	-	-

To change the baud rate open the top plate. Behind the front plate there is the controller card with a DIP switch on top left side. To set a baud rate set the corresponding switch 1-3 to ON. Switch 4 is not connected.

## 5.2 RS232 Communication

To communicate with the instrument a PC with a terminal program are needed. Set the serial port parameters for the terminal program as follows:

Baud Rate	19.200 or changed
Data-bits	8
Stop-bits	1
Parity	none

Select the correct port (e.g. COM 1).

### Description of the format of the transfer protocol:

First, there are two keywords which represent the action of writing or reading of information to and from the instrument:

- Write keyword: **s**
- Read keyword: **g**

The both keywords are followed by a command, separated by a space. Some commands require the additional input of a parameter and maybe also a unit.

- Writing a command with a parameter

**s ccc vv.v <Enter>**

e.g. Setting the set temperature of the cooler 1 to 25.5 °C: **s ST1 25.5 <Enter>**

After modifying the parameter the value will be send back to the PC automatically as acknowledgement.

e.g. After setting the set temperature of the cooler 1 to 25.5 °C: **s ST1 25.5 <Enter>** the string “**25.5 °C**” will be send back.

- Reading a value or condition

**g ccc <Enter>**

e.g. Reading the actual temperature of the cooler 1: **g AT1 <Enter>**

In response the instrument sends out to the PC for example the string “**25.3 °C**”.

The instrument accepts only parameter values which are within the predefined range or within the limits which have been set.

Note: The word **<Enter>** represents the ENTER key on the PC keyboard.

The following parameters can be read or read and set:

Command	Abbreviation	Parameter required	Read only	Key-in unit required	Used unit
Actual temperature cooler 1	AT1		*	-	°C
Set temperature cooler 1	ST1	*		-	°C
Upper temperature limit cooler 1	UT1	*		-	°C
Lower temperature limit cooler 1	LT1	*		-	°C
P - control loop parameter cooler 1	PV1	*		-	-
I - control loop parameter cooler 1	IV1	*		-	-
Cooler 1 enable	CE1	*		-	-
Cooler 1 sensor	CS1	*		-	-
Cooler 1 current limit	CL1	*		-	A
Cooler 1 actual current	AC1		*	-	A
Cooler 1 actual voltage	AV1		*	-	V
Cooler 1 fan voltage (0, 10, 20...100)	FV1	*		-	%
Error status	ERR	*		-	-

Remark:

Some terminal programs send out the corresponding code right after the key was hit. Therefore a wrong input must be finished with hitting the ENTER key on the PC and the input must be repeated.

Note:

The value for the temperatures, the upper and lower temperature limits must be within 0°C to 50°C.

Specific associations:

- Enable parameters (**s AIE v**)

The value for setting a “enable” parameter:

Value v	“enable” parameter
0	DISABLE
1	ENABLE

E.g. **s CE1 1** enabled the cooler 1.

- Sensor type (**s CS1 v**)  
The value for setting sensor type:

Value <b>v</b>	Sensor type
0	NTC
1	PT100
2	PT1000

E.g. **s CS1 0** sets cooler sensor 1 of NTC.

- Error status (**g ERR**)

Following associations of values which will be returned are valid:

Value <b>v</b>	Error status
0	No error
1	-
2	Temperature sensor 1 not detected
3	-
4	Temperature sensor 1 shorted
5	-
6	Temperature 1 out of range
7	-
8	-
9	Cooler driver 1 overload
10	-
11	-
12	Controller error
13	Case temperature overheated

Note:

If an error occurs, the error status keeps its value until the device receives the error reset command: **s ERR 0**.

**Notation for the format of the transfer protocol:**

The keywords and the commands can be written either in lower case or upper case. We used lower cases for the keywords and upper cases for the commands right here.

The keywords, the commands and the parameters must be separated by a space.

The command **ccc** consists of a three digit word.

The parameter **ppp** consists of a one to three digit value with or without a separation dot. The following variations are possible: **p, pp, ppp, p.p, pp.p**

The use of units is only required for the input of the pulse width, the pulse period and the time limit. The unit must follow the parameter value without a space.

## 6 Software LETSoft

Our LabVIEW based program LETSoft can be used to control the TED1000. All parameters can be set and controlled by a PC via RS232 interface. By using a simple RS232 - USB converter also a USB connector can be used.

The program LETSoft can be downloaded from our website [www.laser-electronics.com](http://www.laser-electronics.com)

After installing the program and connecting the cable, switch on the instrument and start the program. The program will find the instrument automatically and start the right program module if you choose the right COM port and BAUD rate.

If you want to use more than one TED1000 please start the program and switch on the first TED1000. After the program has found the instrument start the program as a second window and switch on the second TED1000 and so on.



# 7 Operation

## 7.1 Thermoelectric cooler controller

### 7.1.1 Instrument Switch-On

After switching on the instrument, on the terminal program following message occurs:

“Software Version TED1000\_XX\_X baud rate 19.200”

“Initialization!”

....

“Ready!”

This message indicates that all relevant components inside the instrument are supplied with power and the instrument is ready to work.

The cooler driver delivers up to 13A / 48V. If the cooler is enabled, see section Cooler, the appropriate temperature controller immediately starts operating after switching on the instrument. The temperature controller attempts to set the cooler temperature to the desired temperature which may take up to several minutes depending on the difference of the actual temperature and the desired temperature. Due to the large heat capacity and heat load of medium power and high power laser diodes and the needed heat sinks, it may take some minutes until a stable operating point is reached.

#### Note:

The output of the cooler driver is unipolar, that means it can only cool. If the temperature is less than the set temperature the cooler current is zero.

#### Trouble-shooting:

After preparing the connection of the thermoelectric coolers and the temperature sensors according to the section *Connector Pin-Out* and switching on the instrument, it might happen that the temperature controller doesn't seem to control the temperature, i.e. the measured temperature doesn't approach the desired temperature after some time or the laser diode is heated up instead of cooled down.

In this case the polarity of the thermoelectric cooler referred to the pin-out as shown in the section *Connectors Pin-Out* has to be changed. Simply change the connection of the two leads of the thermoelectric cooler, even if the occurring labelling „Plus“ to „Minus“ doesn't match obviously.

After this change the measured temperature should approach the desired temperature.

### 7.1.2 Temperature

It can be set the temperature, the upper and lower temperature limit and the control loop parameters of the PI-temperature controller. Before using the cooler is to set to enable.

#### Temperature

The value of the temperature can only be changed within the valid temperature range as defined by the upper and lower temperature limit. The value for the temperature must be within 0°C to 50°C.

The desired temperature is stored permanently in a non-volatile memory, even when the instrument is switched off.

#### Temperature limits

The instrument accepts only inputs where the temperature of the upper limit is higher than the temperature of the lower limit.

The value for the upper and lower temperature limit must be within 0°C to 50°C.

### **PI-Temperature control-loop parameters**

The temperature controller is realized as a PI control loop for optimum performance (P means proportional and I means integral portion).

The control loop parameters can be set to values between 0 and 100. The default settings which provide usually good controlling are as follows:

Portion	Value
P	45
I	25

The desired control loop parameter is stored permanently in a non-volatile memory, even when the instrument is switched off.

If the control loop is not stable after some minutes of active operating, e.g. the temperature is oscillating between two values which differ about 0.5 °C, the P-portion should be decreased.

If the measured temperature does not become equal to the desired temperature, the I-portion should be increased.

#### Remark:

In general a larger P-portion or a smaller I-portion speed up the settling time of the control loop, but with the first the controller might oscillate and with the latter there might be a permanent difference between the actual temperature and the desired temperature.

Due to the large heat capacity and heat load of high power laser diodes and the needed heat sinks, it takes some minutes until a stable operating point is reached.

### **7.1.3 Cooler**

#### Cooler

Before working, the cooler must be enabled by command.

#### **Attention**

Before you enable a cooler, make sure that:

- The correct sensor type is connected on the correct connector, see section *Connectors Pin-Out*.
- The correct sensor type is selected by software, see section *Cooler*.
- The appropriate cooler current limit is set, see section *Cooler*.

The desired cooler setting is stored permanently in a non-volatile memory, even when the instrument is switched off.

## **Sensor**

The instrument can work with three several temperature sensor types: NTC, PT100, PT1000.

### **Attention**

Before changing the sensor type, make sure that:

- The appropriate cooler controller is disabled, see section *Cooler*,
- The correct sensor type is connected on the correct connector, see section *Connectors Pin-Out*.

Change the setting between NTC, PT100 and PT1000 by command. The desired sensor setting is stored permanently in a non-volatile memory, even when the instrument is switched off.

## **I<sub>max</sub> – cooler current limit**

The Cooler delivered up to 600W / 13A / 48V. The cooler current limit can be set from 0 .. 13A.

Always set the current limit to the maximum current value which can be found in the data sheet of the heat sink or laser diode (if the peltier elements are included). Setting the appropriate current limit protects the peltier elements from being overloaded electrically.

The desired current limit is stored permanently in a non-volatile memory, even when the instrument is switched off.

## **Fan**

Normally the heat sink is provided with a powerful fan. In most cases the full fan power will not be used. For that reason the fan voltage can varied between 0 .. 100% of 12V in steps of 10. The desired fan voltage is stored permanently in a non-volatile memory, even when the instrument is switched off. If the cooler is set disable the fan is switched off.

### **Note:**

Only do reduce the fan voltage either if the laser diode is in operation for short periods or with reduced power. Increase the fan voltage if the cooler cannot hold the set temperature.

## 7.2 Instrument settings

### 7.3 Errors

#### Interlock Error

If interlock loop is opened, the laser is turned off immediately and the interlock error is set. After the interlock loop is closed again, the error must be confirmed by command. Then the laser diode can be turned on again. If the interlock loop is still open, the interlock error is set again.

#### Temperature Sensor Error

If a temperature sensor circuit is shortened or opened, the laser diode and the thermoelectric cooler are turned off immediately and the sensor error is set. The error must be confirmed by command. After the instrument detects the temperature sensor again, the temperature controller starts working again according to the parameters as before the error occurred. The laser diode must be turned on again. If the error is still present, the sensor error is set again.

#### Remarks:

The error concerning the temperature sensor also appears if the connector for the thermoelectric cooler and the temperature sensor (also named connector for the heat sink) is not connected to the instrument. Before providing this connection, the instrument has to be turned off.

#### Temperature Range Error

If the temperature of the cooler is out of the range as defined with the temperature limits, the laser diode and the thermoelectric coolers are turned off immediately and the temperature error is set. The error must be confirmed by command. After the laser diode reaches the allowed temperature range again, the laser diode can be turned on again. If the error is still present, the temperature error is set again.

#### Overload Error

If a device module of the instrument is overloaded or defect, the laser diode and the thermoelectric cooler are turned off immediately and the correspondent overload error is set. In this case switch off the instrument because it was maybe overheated and switch on after few minutes again. If the overload error still occurs please contact us for repair.

## 8 Specifications

<b>TEC Controller</b>	
Temperature Range	0 ... 50 °C
Temperature Stability	< 0,1 K
Temperature Adj. Accuracy	0,1 K
Control Loop	PI
<b>Output Cooler</b>	
TEC Output Power	600 W
TEC Current	0 ... 13 A
TEC Voltage	0 ... 48 V
TEC Current Limit Range	0 ... 13 A
Ripple	100 mA
Fan Voltage Adjustment Range (manual)	0 ... 100% (12 V)
Fan current	max. 1 A
<b>Temperature Sensors</b>	
Sensor Types	Thermistor / PT100 / PT1000
Thermistor	NTC, 10 kΩ @ 25°C, current: 100 µA
<b>Power Supply</b>	
Line Voltage	85 - 264 V AC, auto ranging
Frequency	50 - 60 Hz
Power Consumption	800 W
Fuses rating for 115V AC slow acting 5x20mm	8A
Fuses rating for 230V AC slow acting 5x20mm	4A
<b>General Characteristics</b>	
Ambient Temperature, operating	0 ... 30 °C
Relative Humidity, operating	30 ... 70 %
Weight	4,3 kg
Dimensions	310 x 140 x 220 (W x H x D, mm³)