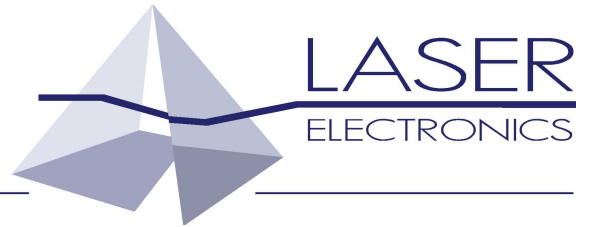


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# Laser Diode Controller

## LDU1000

### *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 Laser Safety

### 1.4.1 Laser Radiation

This instrument is designed to control laser diodes. Please read also very carefully the operating instructions given by the manufacturer of the laser diode.

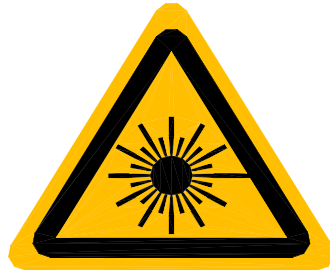
The radiation of the used laser diode may be visible or invisible. These products emit radiation in the 630 to 1560nm spectral region.

**Use caution to avoid hazardous exposure to the beam. Take precautions to eliminate exposure to a direct or reflected beam. Do not look directly into the beam of the laser diode under conditions which exceeds the specified limits. Never observe the laser beam through optical instruments.**

## 1.4.2 Laser Class

The laser safety classification and the relevant parameters of the laser diode for normal operation are indicated on the top of the laser diode. The laser radiation is emitted through the optics at the side of the laser diode where the warning label is placed or at the fibre connector. The laser diodes are classified according to EN 60825-1:94.

General warning label for laser radiation:

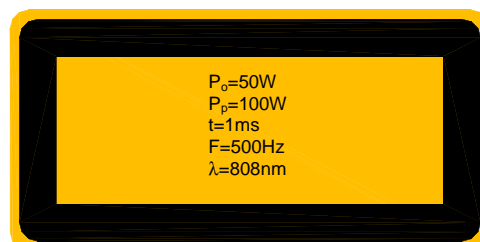


Label for laser radiation:



Label for relevant parameters (example) of the laser diode for normal operation and its statements:

Average radiant power at max. rep. frequ.:  $P_o$   
Peak radiant power:  $P_p$   
Pulse width:  $t$   
Max. pulse repetition frequency:  $F$   
Wavelength laser radiation:  $\lambda$



## 1.5 System contents

Laser Diode Controller

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

Connector (D-Sub 15) for interlock loop and other signals

AC Power Cable

Manual

## 2 Introduction

The instrument is a compact control unit for driving medium-power and high-power laser diodes.

The instrument delivers, depending on the version, a current up to 100 A at a voltage of maximum 6 V.

The instrument is designed for cw and pulse operation. With pulsed operation, various settings of duty-cycle, pulse duration and number of pulse events are possible.

The instrument also features an external input for analogue modulation of the laser diode.

Besides controlling the current of the laser diode, the instrument also features a built-in controller for thermoelectric coolers (Peltier Elements). With an optional air-cooled heat sink the laser diode can easily be kept at constant temperature. The heat sink consists of a heat spreader on which the laser diode is mounted, several peltier elements for heat transportation and a large heat sink profile with fans for sufficient air flow.

The unit consists of several modules. The heart is a microprocessor based central unit which controls all power units and provides the link to the PC interfaces. The microprocessor provides the flexibility and convenience of software. Our LabVIEW based program LETSoft can be used to control the LDU1000. All parameters can be set and controlled by a PC via RS232 interface.

For driving the laser diode the instrument uses a constant current power supply which is followed by a sophisticated designed current controlling stage. For driving the thermoelectric cooler a separate high efficient power supply is used.

The instrument provides maximum laser diode protection by using AC-line filtering, transient suppression, soft-start, short-circuiting of the output when switched off and setting of permanent current and temperature limits.

### 3 Connectors Pin-Out

The instrument must be turned off before making the connection.

**Attention -1-:**

**Double-check if the wiring was done the right way. A mismatch destroys the laser diode within microseconds in an unrecoverable way!**

**Laser diodes are extremely sensitive to electrostatic discharge. Follow the instructions supplied with the laser diode very carefully.**

**The instrument must be turned off before making the connection to the output for the laser diode, the thermoelectric controller and the temperature sensor.**

LASER ELECTRONICS is not responsible for any damage arising from a mismatch in wiring.

**Attention -2-:**

The output pin „laser diode anode, plus, „+“ „, which is connected to the anode (A) of the laser diode is internally connected to any internal power supply voltage of the instrument.

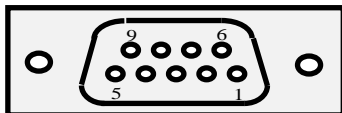
Please be aware that most of all medium and high power laser diodes have their housing electrically connected to the anode of the laser diode.

Therefore in order to avoid any grounding loops when applying external modules to the instrument it is recommended to isolate the housing of the laser diode from the chassis (earth).

Remark: If the laser diode is mounted to the heat spreader of the heat sink provided by LASER ELECTRONICS it is already isolated from chassis ground (earth).

#### 3.1 RS232

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



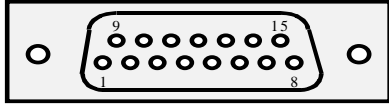
The pin-out is shown when facing the connector mounted to the rear panel directly.

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.



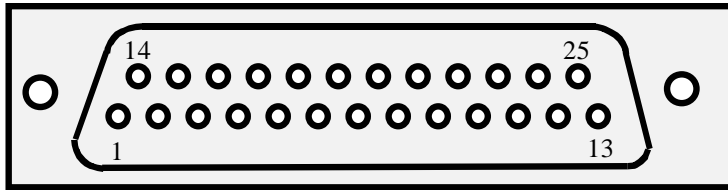
The pin-out is shown when facing the connector mounted to the rear panel directly.

Pin number	Designation
1	Interlock - IN (+5V = open, GND = short )
2	Interlock - GND
3	Pilot Laser + (+5V, max. 300mA)
4	Pilot Laser - GND
5	n.c.
6	n.c.
7	n.c.
8	n.c.
9	n.c.
10	n.c.
11	Laser LED + ( Anode )
12	Laser LED - ( Cathode )
13	Analogue Input (Input 1V = 10A)
14	Power Monitor (Output 1V = 10A)
15	Power Monitor - , Analogue Input -



### 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
2 (NTC-2A) 4 6	Cooler 2 Sensor pin A	
15 (NTC-2B) 17 19	Cooler 2 Sensor pin B	
7	Pilot Laser + (+5V, max. 300mA)	green
20	Pilot Laser - GND	brown

#### **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 Laser Diode

Designation	Wire Colour
Laser diode anode (plus, „+“)	red
Laser diode cathode (minus, „-“)	black

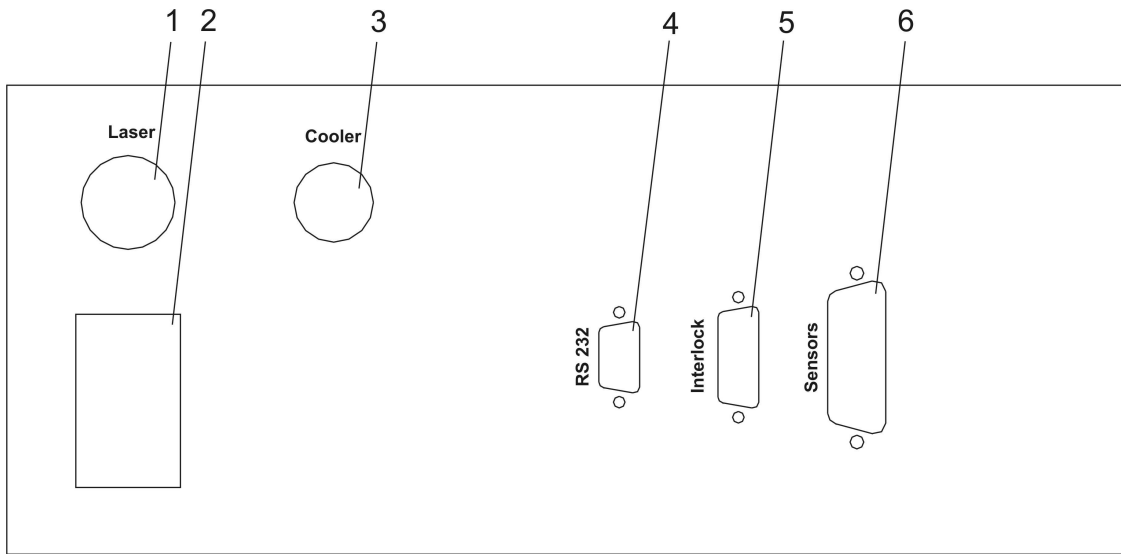
### 3.5 Cooler

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

## Elements of the instrument at the rear panel



1. Laser Diode Cable
2. AC Line Connector and Mains Fuse
3. Cooler Connector
4. RS232 Connector
5. Interlock Connector
6. Sensor Connector

### 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, Interlock and Sensor cables to the appropriate connectors. Please note the interlock connector needs a closed loop for the interlock feature.

### Installation of the laser diode

Connect the laser diode to the Laser Diode cables.

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.

**Laser diodes are extremely sensitive to electrostatic discharge. Follow the instructions supplied with the laser diode very carefully.**

### Installation of the Heat Sink

Connect the cooler cable to the Cooler connector.

## 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 four keywords which represent the action of switching laser on, off, writing or reading of information to and from the instrument:

- Switching Laser On keyword: **\$**
- Switching Laser Off keyword: **#**
- Write keyword: **s**
- Read keyword: **g**

The **\$** and **#** keywords don't need a command. The other 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.

- Switching Laser On  
***\$<Enter>***

- Switching Laser Off  
***#<Enter>***

- Writing a command with a parameter  
***s ccc vv.v <Enter>***

e.g. Setting the current of the laser diode to 12.5 A: ***s SLC 12.5 <Enter>***

e.g. Setting the pulse width to 100 milliseconds: ***s PUW 100ms <Enter>***

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

e.g. After setting the current of the laser diode to 12.5 A: ***s SLC 12.5 <Enter>*** the string ***"12.5A"*** will be send back.

- Reading a value or condition  
***g ccc <Enter>***

e.g. Reading the actual temperature of the laser diode: ***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
Laser status	LAS		*	-	-
Laser ramp	RMP	*			W, ms
Laser operating mode	LMO	*		-	-
Pulse width (1.0ms < PUW < 990 ms)	PUW	*		ms	ms
Pulse period (2.0ms < PUP < 1000 ms)	PUP	*		ms	ms
Time limit (0.1 s < TIL < 99.9 s)	TIL	*		s	s
Laser actual voltage	ALV		*	-	V
Laser actual current	ALC		*	-	A
Laser set current	SLC	*		-	A
Laser actual power	ALP		*	-	W
Laser set power	SLP	*		-	W
P0..7 – power of calibration point 0..7	P0P..P7P	*		-	W
I0..7 – current of calibration point 0..7	P0I..P7I	*		-	A
Laser current limit	LCL	*		-	A
Analog input enable	AIE	*		-	-
Actual temperature cooler 1	AT1		*	-	°C
Actual temperature cooler 2	AT2		*	-	°C
Set temperature cooler 1	ST1	*		-	°C
Upper temperature limit cooler 1	UT1	*		-	°C
Upper temperature limit cooler 2	UT2	*		-	°C
Lower temperature limit cooler 1	LT1	*		-	°C
Lower temperature limit cooler 2	LT2	*		-	°C
P - control loop parameter cooler 1	PV1	*		-	-
I - control loop parameter cooler 1	IV1	*		-	-
Cooler 1 enable	CE1	*		-	-
Cooler 2 enable	CE2	*		-	-
Cooler 1 sensor	CS1	*		-	-
Cooler 2 sensor	CS2	*		-	-
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	*		-	%
Pilot laser enable	PLE	*		-	-
Pilot laser power	PLP	*		-	%
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:**

- Laser operating mode (**s LMO v**)

Following associations of parameter values to be typed in are valid:

Value <b>v</b>	Laser operating mode	Remark
0	CW, NO TIME LIMIT	Default
1	CW, TIME LIMIT	
2	PULSE, NO TIME LIMIT	
3	PULSE, TIME LIMIT	

- Get condition laser (**g LAS**)

Following associations of values which will be returned are valid:

Value <b>v</b>	Condition laser diode
0	Laser diode off
1	Laser diode on

- Set condition laser (**s LAS**) equals command **\$**

The command for setting the condition (turning on or turning off) of the laser diode has a toggle function. Each time the command **\$ (s LAS)** is sent out the condition of the laser diode changes.

For example if the laser diode is presently turned off, the laser diode will be turned on when the command **\$** is sent out. On the other hand if the laser diode is presently turned on and the command **\$** is sent out, the laser will be turned off.

Therefore we recommend using the following programming structure:

First get the condition of the laser diode whether it is turned on or turned off with the command **g LAS**. Depending on the returned value and the desired action by the user the decision to send the command **\$** should be done.

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

The value for setting a “enable” parameter:

Value <b>v</b>	“enable” parameter
0	DISABLE
1	ENABLE

E.g. **s AIE 1** enabled the analogue input.

- 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	Interlock open
2	Temperature sensor 1 not detected
3	Temperature sensor 2 not detected
4	Temperature sensor 1 shorted
5	Temperature sensor 2 shorted
6	Temperature 1 out of range
7	Temperature 2 out of range
8	Laser driver overload
9	Cooler driver 1 overload
10	Cooler driver 2 overload
11	Key switch off
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.



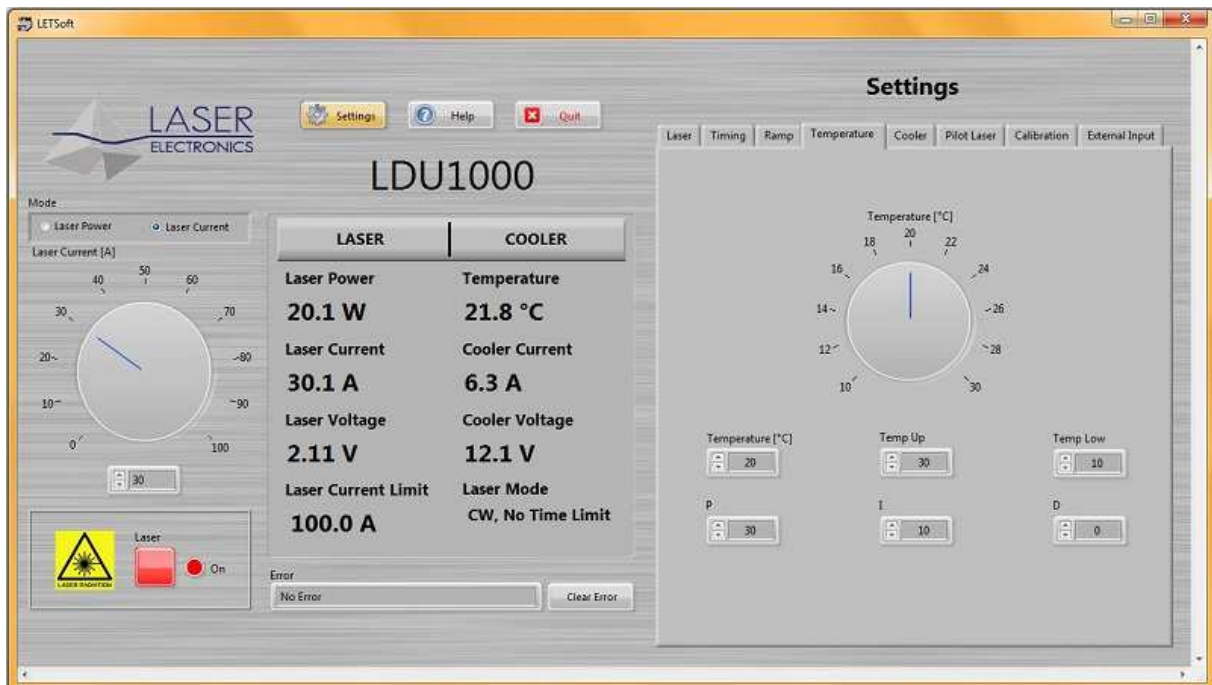
## 6 Software LETSoft

Our LabVIEW based program LETSoft can be used to control the LDU1000. 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 LDU1000 please start the program and switch on the first LDU1000. After the program has found the instrument start the program as a second window and switch on the second LDU1000 and so on.



# 7 Operation

## 7.1 Laser diode controller

### 7.1.1 Instrument Switch-On

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

“Software Version OEM\_LDU1000-XX\_X\_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.

#### **Attention:**

Before using the instrument with a laser diode, make sure that the current limit is set to the specific value of the laser diode to be used. The current applied to the laser diode must not exceed the maximum current specified by the manufacturer of the laser diode.

The emitted optical power of a laser diode also depends on the temperature. Make sure that with the selected temperature of the laser diode and the emitted optical power is also within a specified range.

### 7.1.2 Laser Current, Power and Mode

Set the optical power, the laser current, the laser mode and the laser current limit.

#### **Laser Current Limit**

Set the laser current limit to the indicated maximum current value of the laser diode which can be found in the individual data sheet. Setting the appropriate current limit protects the laser diode from being overloaded electrically and optically.

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

**Remark:** The maximum possible laser current limit is predefined by the instrument.

#### **I - Laser Current**

After switching on the instrument the set laser current is 0. It can be set up to laser current limit. The laser diode is turned on by command and the desired current is applied to the laser diode. If a laser indication LED is connected on the Interlock connector (D-Sub 15) it indicates that the laser diode output is turned on.

The current applied to the laser diode can also be varied when the laser diode is turned on by command.

The laser diode is turned off by command.

#### **P - Optical Power**

After switching on the instrument the set optical power is 0. The set optical power will be calculated into the laser current by the calibration points (see menu calibration). The optical power can also be varied when the laser diode is turned on. In this case the calculated laser current is applied to the laser diode immediately.

## Laser Mode

The operational mode should only be changed when the laser diode is turned off. Nevertheless when changing the operational mode, the laser diode is turned off automatically.

The following four operational modes can be selected and combined:

CW, No Time Limit	The laser diode is operated with a continuous current. The duration of the operation is not time limited internally. The laser diode is turned on and off by command.
CW, Time Limit	The laser diode is operated with a continuous current. The duration of the operation is time limited according to the time limit, see section TIMING. The laser diode is turned on by command and turned off automatically after the set time limit.
Pulse, No Time Limit	The laser diode is operated with a pulsed current, see section TIMING. The duration of the operation is not time limited internally. The laser diode is turned on and off by command.
Pulse, Time Limit	The laser diode is operated with a pulsed current. The duration of the operation is time limited according to the time limit, see section TIMING. The laser diode is turned on by command and turned off automatically after the set time limit.

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

### 7.1.3 Laser Ramp Function

The instrument can create a ramp shaped laser power. The command "*s RMP pp ttt*" set the power to pp Watt within ttt milliseconds. E.g. "*RMP 30 100*" means the power goes to 30W within 100ms.

The time range is 1 ... 60000 ms (1min). It works while the laser is on. It can ramp up and down. The laser doesn't start or stop at the "RMP" command. You can send the "RMP" and "SLP" commands one after another or while the ramp is not yet ready. The laser power will go to the new value prompt.

The ramp function doesn't work in pulse mode.

### 7.1.4 Timing

It can be set the pulse width, the pulse period and the time limit. The desired value is stored permanently in a non-volatile memory, even when the instrument is switched off.

#### Notes:

The two parameters "pulse width" and "pulse period" depend on each other. The instrument will automatically force the other parameter within the valid range depending on the change of the selected parameter.

Values of the pulse width which are larger than the pulse period are not accepted by the instrument.

The pulse width must be within the range of 1.0 ms to 990 ms.

The pulse period must be within the range of 2.0 ms to 1000 ms.

The time limit must be within the range of 0.1 s to 99.9 s.

### 7.1.5 External Analogue Input

The instrument provides an external analogue modulation input.

The analogue modulation signal is applied to the Analogue-In Pins on the Interlock connector (D-Sub 15). The valid range for the signal is 0 V to +10 V. The transfer function for the applied signal voltage to the laser diode current is 10 A / V. The modulation bandwidth is DC to 100 Hz. E.g.: A signal voltage of 2.5 V refers to a laser diode current of 25A.

For maximum protection of the laser diode the current of the laser diode is limited to the selected current limit. Therefore it might happen that the analogue modulated laser light is distorted due to the clipping of the maximum applied current to the laser diode. In order not to distort the analogue modulated laser light, pay attention not to exceed the valid analogue modulation signal level according to the transfer function for the current.

The laser diode should be turned on prior to the external inputs.

Change the input setting between ENABLE and DISABLE by command. The desired external input mode is stored permanently in a non-volatile memory, even when the instrument is switched off.

### 7.1.6 Power Monitor Output

The instrument provides a power monitor output. This signal indicates the actual laser diode current. The range for the signal is 0 V to +10 V. The transfer function is 10 A / V. E.g.: A signal voltage of 2.5 V refers to a laser diode current of 25A.

## 7.2 Thermoelectric cooler controller

The instrument contains a built-in controller for a thermoelectric cooler. 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.

## 7.2.1 Temperature

The instrument provides two temperature channels. Temperature 1 is used for the thermoelectric cooler and temperature 2 is used for supervising external components. Because temperature 2 is only a temperature measuring channel it is not possible to set a temperature but only read out the actual temperature. Furthermore as sensor for temperature 2 it is only type NTC allowed.

For temperature 1 it can be set the temperature, the upper and lower temperature limit and the control loop parameters of the PI-temperature controller. For temperature 2 it can only be set the upper and lower temperature limit.

Before a channel is used the correspondent Cooler is 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 operating laser diode and also the optional custom application should be protected by operating setting temperature limits according to the specific datasheet provided by the manufacturer.

If the temperature of the cooler (provided it is enabled) is out of the selected range, the laser diode turned off automatically and an error is set. The desired temperature limits are stored permanently in a non-volatile memory, even when the instrument is switched off.

### Note:

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.

## 7.2.2 Cooler

### Cooler

The instrument can work without or with a cooler controller. 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.

## **7.3 Instrument settings**

### **7.3.1 Pilot Laser**

The instrument can drive a pilot laser up to 300mA. Before you enable, make sure that your Laser Diode was purchased with the appropriate pilot laser, see *Data Sheet*. This source delivers constant voltage (+5,0V) for a build in pilot laser (with integrated small driver). Do not drive a laser diode on this source directly.

### **Pilot Laser**

Change the pilot laser setting between ON and OFF by command.

### **Power**

The pilot laser power can be reduced by a PWM (pulse width modulation) of its supply voltage. It can be set to values between 1% and 100%. The desired value is stored permanently in a non-volatile memory, even when the instrument is switched off.

### **7.3.2 Calibration**

Because the laser diode current and its optical output power are approximately linear to each other, it is possible to calculate the optical power from the current if the user set eight measured pairs of laser current / optical power.

E.g. the user set current to 5A and measured 0W optical power by a power meter.  $I_0=5A$ ,  $P=0W$ . Then he set current to 10A and measured 5W optical power.  $I_1=10A$ ,  $P_1=5W$  and so on up to  $I_7=50A$ ,  $P_7=65W$ .

Note: The deviations from the correct value can increase with distance from the measured value.

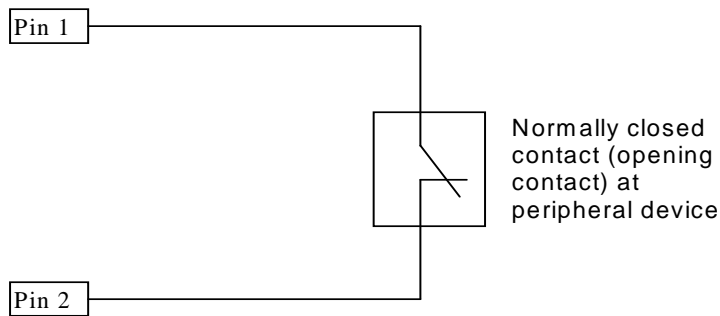
The desired value is stored permanently in a non-volatile memory, even when the instrument is switched off.

### **7.3.3 Interlock**

The instrument is equipped with an interlock feature. The interlock is realized with a loop which has to be provided via the interlock connector, see section *Connector Pin-Out*.

The interlock loop must be realized either with the provided dummy connector (permanent closed loop) or a peripheral device. It is prior to the laser on command. The laser diode can only be turned on if the interlock loop is closed. If the interlock loop is opened while the laser diode is on, the laser diode is immediately turned off and an error is set. The laser diode can only be turned on again by closing the interlock loop.

The diagram below shows the condition when the interlock loop is closed.



When realizing the interlock loop with a peripheral device, open the dummy connector, remove the jumper from Pin1 to Pin2 and apply the cable coming from the peripheral device.

Instead of realizing a (passive) closed loop it is also possible to apply a TTL-level signal to Pin1 referred to Pin2.

- Pin1 = High ( $U > 2.4 \text{ V}$ ) → Interlock loop open set an interlock error
- Pin1 = Low ( $U < 0.8 \text{ V}$ ) → Interlock loop closed no interlock error
- Pin2 = Reference (Signal Ground)

## 7.4 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 of 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>Laser Diode Controller</b>	<b>LDU1000</b>
Power Laser Diode Driver	600 W
Max. Laser Diode Current	100A
Max. Laser Diode Voltage	6 V
Ripple / Noise (rms) [mA]	200
Current Limit Range	0 ... Max. Laser Diode Current
Current Adjustment Accuracy	100 mA
Temperature Coefficient	< 100 ppm/°C
Short Term Stability (1hr)	< 30 ppm
Long Term Stability (24hr)	< 75 ppm
Repetition Rate	0 ... 100 Hz
Pulse Width (*)	> 5 ms
Rise- / Fall- Time (*)	< 2ms (10 % – 90 % of max. current)
<b>Analogue Modulation</b>	
Input Voltage	0 ... 10 V, 1 kΩ
Transfer Function	10 A / V
Bandwidth	0 ... 100 Hz
<b>Power Monitor</b>	
Output Voltage	0 ... 10 V
Transfer Function	10 A / V
<b>Pilot Laser</b>	
Pilot Laser Voltage	5 V
Pilot Laser Current	max. 300mA
Pilot Laser Power Adjustment	1 ... 100 %
<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	1.500 W
Fuses rating for 115V AC slow acting 5x20mm	16A
Fuses rating for 230V AC slow acting 5x20mm	8A
<b>General Characteristics</b>	
Ambient Temperature, operating	0 ... 30 °C
Relative Humidity, operating	30 ... 70 %
Weight	6,4 kg
Dimensions	310 x 140 x 220 (W x H x D, mm <sup>3</sup> )

Notes:

(\*) The rise time, the fall time and the pulse width may be prolonged by long cables between the power supply and the laser diode.

Attention:

The output pin „laser diode anode, plus, „+“ „, which is connected to the anode (A) of the laser diode is internally connected to any internal power supply voltage of the instrument.

Please be aware that most of all medium and high power laser diodes have their housing electrically connected to the anode of the laser diode.

Therefore in order to avoid any grounding loops when applying external modules to the instrument it is recommended to isolate the housing of the laser diode from the chassis (earth).

Remark: If the laser diode is mounted to the heat spreader of the heat sink provided by LASER ELECTRONICS it is already isolated from chassis ground (earth).