

Laser Diode Controller

LDC1000

Operating Instructions



Contents

1	General	4
1.1	Warranty and Assistance	4
1.2	Maintenance	4
1.3	General Safety Considerations.....	4
1.4	Laser Safety.....	4
1.4.1	Laser Radiation.....	4
1.4.2	Laser Class.....	4
1.5	System contents.....	6
2	Introduction	7
3	Installation	8
4	Operation	9
4.1	Elements of the instrument at the front panel	9
4.2	Elements of the instrument at the rear panel	10
4.3	Laser diode controller.....	11
4.3.1	Instrument switch-on, display menu	11
4.3.2	LASER Menu	12
4.3.3	TIMING Menu	13
4.3.4	EXT. INPUTS Menu	13
4.4	Thermoelectric cooler controller	14
4.4.1	TEMPERATURE Menu	14
4.4.2	COOLER Menu.....	15
4.5	Instrument settings.....	17
4.5.1	PILOT LASER Menu	17
4.5.2	CALIBRATION Menu.....	17
4.5.3	CONFIG Menu.....	17
4.5.4	Interlock	17
4.6	Error Messages.....	18
5	Connectors pin-out	20
5.1	Laser diode	21
5.2	Thermoelectric cooler 1	22
5.3	Thermoelectric cooler 2.....	23
5.4	Interlock, Pilot Laser, Power Monitor	24
5.5	Serial interface	25
6	Interfaces command description	26
6.1	Serial interface	26
7	Specifications	30

1 General

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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.

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.

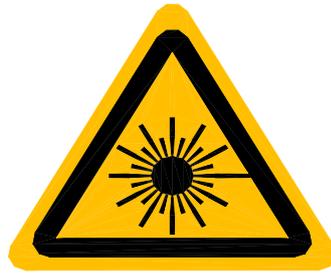
The radiation of the used laser diode may be visible or invisible. These products emit radiation in the 630 to 1560nm spectral region.

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: λ



1.5 System contents

Control Unit (Laser Diode Controller)

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

Connector (D-Sub 15) for interlock loop, pilot laser and power monitor

AC Power Cable

Manual

Optional:

Heat sink, air-cooled, including cables for connecting the laser diode.

Laser diode mounted on heat sink.

Second cooler controller board, $\pm 5V / \pm 3A$, max.15W for driving a second heat sink.

LD-cable for connecting a laser diode.

Heat sink cable for connecting a heat sink.

Sensor cable for connecting sensors.

Short-circuit bridge for the connector at the cable for the laser diode

2 Introduction

The instruments of the Laser Diode Controller series are compact control units for driving medium-power and high-power laser diodes.

The Laser Diode Controller delivers, depending on the version, a current up to 60 A at a voltage of maximum 12 V.

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

The Laser Diode Controller also features external inputs for analogue modulation of the laser diode and external triggering of the laser diode.

Besides controlling the current of the laser diode, the Laser Diode Controller also features one or two optional built-in controllers for thermoelectric coolers (Peltier elements). With an optional air-cooled heatsink (please contact LASER ELECTRONICS) the laser diode can easily be kept at constant temperature. The heatsink consists of a heat spreader on which the laser diode is mounted, several peltier elements for heat transportation and a large heatsink profile with fans for sufficient air flow.

The unit consists of several modules. The heart is a microprocessor based central unit which controls all other power units and provides the link to the display, keyboard and the PC interfaces. All parameters can be set with only a few push keys and a rotary knob and are shown on the display. Additionally the parameters can be set and controlled via an interface to a PC. For driving the laser diode the Laser Diode Controller 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 Laser Diode Controller 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 Installation

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

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 fuses are blown these can easily be replaced by the user.

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

Plug in the interlock, pilot laser, power monitor connector to the appropriate connector at the rear side of the instrument as described in the section *Connectors pin-out*. This connector provides a closed loop for the interlock feature.

Installation of the laser diode

Connect the laser diode to the leads of the provided cable as described in the section *Connectors pin-out*.

Plug in the cable to the connector labeled **Laser** at the rear panel of the instrument. Fix the connector with the locking ring.

Note: The instrument must be turned off before the cable is plugged in.

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 heat sink cable and the sensor cable (optional) to the leads of the provided cable as described in the section *Connectors pin-out*.

Plug in the cable to the connector labeled **Cooler** and **Sensors** at the rear panel of the instrument. Fix the connector with the locking ring.

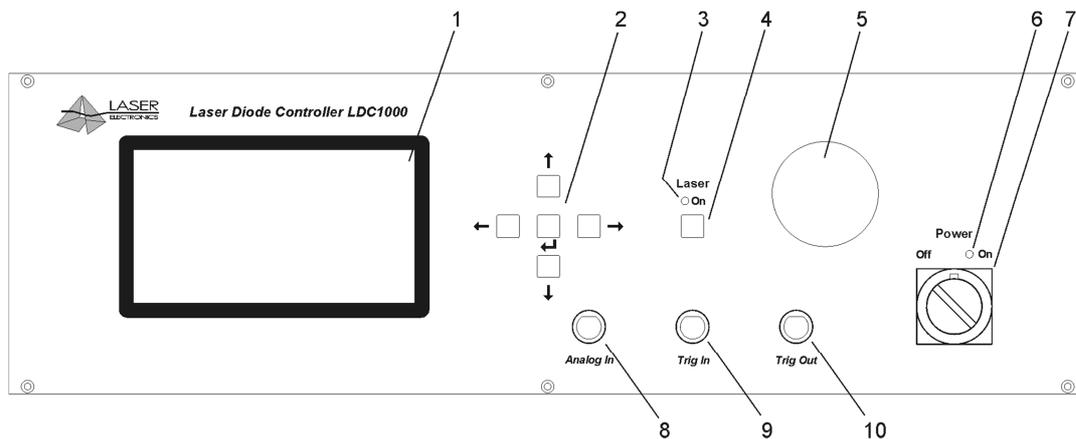
Note: The instrument must be turned off before the cable is plugged in.

4 Operation

After installation of the laser diode, the thermoelectric cooler and the temperature sensor (respectively the heat sink) and providing the appropriate connections including installation of the Dummy interlock connector to the instrument the Laser Diode Controller is ready to be switched on.

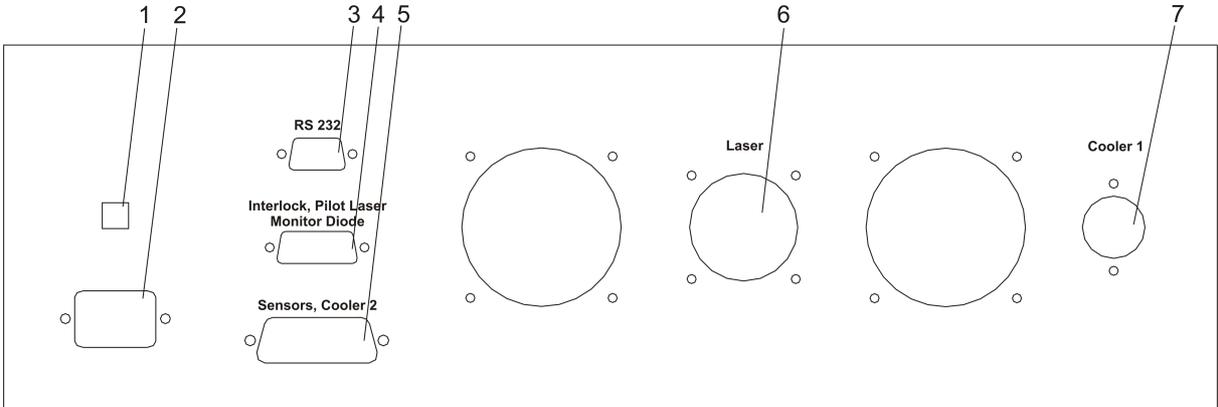
Please read the whole operating instructions before using this instrument together with a laser diode.

4.1 Elements of the instrument at the front panel



1. Display
2. Keys for setting instrument (Up, Down, Left, Right, Enter)
3. Laser diode on indicator (yellow)
4. Key for turning on laser diode
5. Rotary knob for setting laser diode current and various settings within the menus
6. Power on indicator (green)
7. Power switch mains
8. Connector for input of analogue modulation signal
9. Connector for input of trigger signal
10. Connector for output of trigger signal

4.2 Elements of the instrument at the rear panel



1. Mains fuse
2. Connector for AC line
3. Connector for Serial Interface (RS232)
4. Connector for Interlock, Pilot Laser (optional) and Power Monitor (optional)
5. Connector for Temperature Sensors and Cooler 2 (optional)
6. Connector for laser diode
7. Connector for Cooler 1 (Heat Sink - thermoelectric cooler 1, temperature sensor 1, fan)

4.3 Laser diode controller

Attention:

Before using the Laser Diode Controller with a laser diode, make sure that the current limit is set to the specific value of the laser diode to be used, see section LASER Menu. 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.

4.3.1 Instrument switch-on, display menu

The instrument is switched on with the **Power switch** (7). The green light emitting diode (**LED**) (6) indicates that all relevant components inside the instrument are supplied with power. On the back-lighted display the message „LASER ELECTRONICS“ appears for a short time and the display changes to the following window:

LASER	COOLER	MENU
P = 80.0W I = 28.5A V = 7.2V	T1=25.0°C I1=+9.5 A V1=+12 V	LASER
Set Laser		TEMPERATURE
		TIMING
>P: 80.0 W I: 28.5 A Mode: CW, No Time Limit Laser Current Limit: 40.0A		COOLER
		PILOT LASER
		EXT. INPUTS
		CALIBRATION
		CONFIG

Above left it shows the measured laser diode current and voltage, the displayed power is calculated from the laser diode current and the calibration points (see menu calibration).

Above in the middle it shows the measured laser diode temperature T1 and the temperature of a second cooler T2 (optional).

I1 is the current of cooler 1. “+” means heating current, and “-“ cooling current.

On the right there is the menu. By pressing the **Up** or **Down** key the menu will be changed. Below left the parameters of selected menu will be shown.

By pressing the **Left** key the first parameter within selected menu will be selected for change. A small arrow appears besides the parameter.

By pressing the **Up, Down, Left and Right** keys the parameters can be selected. The value of a parameter can be changed by the rotary knob.

After changing confirm with the **Enter** key. Every input which is followed by pressing the **Enter** key (2) is acknowledged by a short double-beep.

By pressing the **Right** key (one or more times) the arrow disappear and you leave the parameter selection of the actual menu. After that you can change the menu again.

4.3.2 LASER Menu

Within the laser menu you can 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.

Confirm the value with the **Enter** key. 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 and must not be confirmed with the **Enter** key.

The laser diode is turned on by pressing the **Laser** key (4) and the desired current is applied to the laser diode. The lighting yellow LED (3) nearby the **Laser** key indicates that the laser diode output is turned on. The actual current that is applied to the laser diode is displayed above left at the display.

The current applied to the laser diode can also be varied when the laser diode is turned on by modifying the desired current with the **Rotary** knob (5).

The laser diode is turned off by pressing the **Laser** key (4) again.

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). After changing you must not confirm with the **Enter** key. The calculated laser current will be shown immediately on position set laser current. 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 pressing the Laser key. |
| 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 menu TIMING. The laser diode is turned on by pressing the Laser key and turned off automatically after the set time limit. |
| Pulse, No Time Limit | The laser diode is operated with a pulsed current, see menu TIMING. The duration of the operation is not time limited internally. The laser diode is turned on and off by pressing the Laser key. |
| 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 menu TIMING. The laser diode is turned on by pressing the Laser key and turned off automatically after the set time limit. |

Confirm the value with the **Enter** key. The desired mode is stored permanently in a non-volatile memory, even when the instrument is switched off.

4.3.3 TIMING Menu

Within the Timing menu it can be set the pulse width, the pulse period and the time limit. Confirm the value with the **Enter** key. 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 5.0 ms to 490 ms.

The pulse period must be within the range of 10 ms to 500 ms.

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

4.3.4 EXT. INPUTS Menu

The Laser Diode Controller provides an external analogue modulation input, an external triggering input and an external triggering output.

Analogue Input

The analogue modulation signal is applied to the **Analog In** connector (8) at the front panel. The valid range for the signal is 0 V to +5 V. The transfer function for the applied signal voltage to the laser diode current is 20 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 50A.

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 with the **Laser** key (4) prior to the external inputs.

Change the input setting between ENABLE and DISABLE with the **Rotary** knob. Confirm the value with the **Enter** key. The desired external input mode is stored permanently in a non-volatile memory, even when the instrument is switched off.

Trigger Input

The trigger signal is applied to the **Trig In** connector (9) at the front panel. The valid range for the signal is according the specifications for TTL signals (Low: $0\text{ V} < U < 0.8\text{V}$, High: $2.4\text{ V} < U < 5\text{ V}$). The bandwidth is DC to 100 Hz. An applied TTL-low signal leads to a turned off laser. An applied TTL-high signal leads to a turned on laser with the set laser diode current, see menu LASER. E.g.: If the laser diode current is set to „I = 25A“, this current is applied to the laser diode when a TTL-high signal is detected as external trigger signal.

The laser diode should be turned on with the **Laser** key (4) prior to the external inputs.

Change the input setting between ENABLE and DISABLE with the **Rotary** knob. Confirm the value with the **Enter** key. The desired external input mode is stored permanently in a non-volatile memory, even when the instrument is switched off.

Trigger Output

The signal on the trigger output connector **Trig Out** (10) provides a synchronization between the internally generated pulses, as specified by the pulse operational mode, and the external trigger. The output is according to the specifications for TTL signals.

4.4 Thermoelectric cooler controller

The Laser Diode Controller contains one or two optional built-in controllers for thermoelectric coolers. Cooler 1 is usually used for cooling the laser diode and delivered up to $\pm 13A @ \pm 48V$. The cooler 2 is optional and is used for customized applications (e.g.: laser crystal cooling). It delivered up to $\pm 3A @ \pm 5V$. If a cooler is enabled, see menu COOLER, the appropriate temperature controller immediately starts operating after switching on the instrument. The temperature controller attempts to set the appropriate 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 heatsinks, it may take some minutes until a stable operating point is reached.

The actual temperatures of cooler 1 "T1" (usually the laser diode), cooler 2 "T2"(optional) and the current of cooler 1 "I1" are displayed above in the middle of the display.

The sign "+" means heating current, and "-" cooling current of "I1".

Note:

The output of the thermoelectric controllers are bipolar, that means they can cool and heat.

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 Laser Diode Controller, 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.

4.4.1 TEMPERATURE Menu

Within the temperature menu it can be set the temperature, the upper and lower temperature limit and the control loop parameters of the PID-temperature controller for the first and second (optional) cooler.

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.

Confirm the value with the **Enter** key. 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 cooler 1 or cooler 2 (provided they are enabled) are out of the selected range, the laser diode turned off automatically and an error message appears on the display, see section *Error messages*.

Confirm the value with the **Enter** key. 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.

PID-Temperature control-loop parameters

The temperature controller is realized as a PID control loop for optimum performance (P means proportional, I means integral and D means differential 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:

Cooler 1		Cooler 2	
Portion	Value	Portion	Value
P	30	P	70
I	10	I	3
D	0	D	0

Confirm the value with the **Enter** key. 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 speeds 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 heatsinks, it takes some minutes until a stable operating point is reached.

4.4.2 COOLER Menu

The Laser Diode Controller can work without, with one or with two cooler controllers. Before working, the appropriate cooler must be enabled.

Attention

Before you enable a cooler, make sure that:

- the Laser Diode Controller was purchased with the appropriate cooler controller, see menu CONFIG
- the correct sensor type is connected on the correct connector, see section *Connectors pin-out*,
- the correct sensor type is selected by software, see menu COOLER,
- the appropriate cooler current limit is set, see menu COOLER.

Cooler 1/2

Change the setting between ENABLE and DISABLE with the **Rotary** knob. Confirm the selection with the **Enter** key. The desired cooler setting is stored permanently in a non-volatile memory, even when the instrument is switched off.

Sensor 1/2

The Laser Diode Controller 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 menu COOLER,
- the correct sensor type is connected on the correct connector, see section *Connectors pin-out*.

Change the setting between NTC, PT100 and PT1000 with the **Rotary** knob. Confirm the selection with the **Enter** key. The desired sensor setting is stored permanently in a non-volatile memory, even when the instrument is switched off.

I_{max} – cooler current limit 1/2

Cooler 1 is usually used for cooling the laser diode and delivered up to 600W $\pm 13A @ \pm 48V$. The cooler current limit can be set from 0 .. 12A or 0 .. 13A.

Cooler 2 is usually used for customized applications (e.g.: laser crystal cooling) and delivered up to $\pm 3A @ \pm 5V$. The cooler current limit can be set from 0 .. 3A.

Always set the current limit to the maximum current value which can be found in the data sheet of the heat sink. Setting the appropriate current limit protects the peltier elements from being overloaded electrically.

Note:

The set limit acts in both direction. E.g. current limit 2,5A means a current range $-2,5A \dots +2,5A$.

Confirm the selection with the **Enter** key. 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 powerfully 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. Confirm the selection with the **Enter** key. The desired fan voltage is stored permanently in a non-volatile memory, even when the instrument is switched off. If cooler 1 is set disable the fan is switch 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 held the set temperature.

4.5 Instrument settings

4.5.1 PILOT LASER Menu

The Laser Diode Controller 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 *Delivery Note*. This source deliver 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 with the **Rotary** knob. Confirm the value with the **Enter** key.

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%. Confirm the selection with the **Enter** key. The desired value is stored permanently in a non-volatile memory, even when the instrument is switched off.

4.5.2 CALIBRATION Menu

Calibrations Points

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 two measured pairs of laser current / optical power.

E.g. the user set current to 20A and measured 30W optical power by a power meter. $I_1=20A$, $P_1=30W$.

Then he set current to 30A and measured 55W optical power. $I_2=30A$, $P_2=55W$.

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

Confirm the selection with the **Enter** key. The desired value is stored permanently in a non-volatile memory, even when the instrument is switched off.

Power Monitor

If the laser diode is provided with a power monitor (photo diode), the power monitor voltage will be shown. So, the calibrating can be made without a power meter.

E.g. the user increases laser current up to the power monitor voltage is 1,2V. From the laser diode data sheet the user read $1,2V = 55W$ optical power. The actual laser current is 30A. $I=30A$, $P=55W$.

4.5.3 CONFIG Menu

The config menu appears the laser diode driver and cooler driver configuration.

4.5.4 Interlock

The Laser Diode Controller 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** key at the front panel. The laser diode can only be turned on with pressing the **Laser** key at the front panel 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 a error message appears on the display. The laser diode can only be turned on again by closing the interlock loop.

4.6 Error Messages

Interlock error

If interlock loop is opened, the laser is turned off immediately and the following message appears on the display:

<p style="text-align: center;">ERROR INTERLOCK OPEN</p>
--

The error message must be confirmed by pressing the **Enter** key.

After the interlock loop is closed again, the laser diode can be turned on again by pressing the **Laser** key. If the interlock loop is still opened, the error message appears again after the **Laser** key is pressed.

Temperature sensor error

If an temperature sensor circuit is shortened or opened, the laser diode and the thermoelectric coolers are turned off immediately. One of the following messages appears on the display:

<p style="text-align: center;">ERROR TEMPERATURE SENSOR 1 NOT DETECTED</p>

<p style="text-align: center;">ERROR TEMPERATURE SENSOR 1 SHORTED</p>
--

<p style="text-align: center;">ERROR TEMPERATURE SENSOR 2 NOT DETECTED</p>

<p style="text-align: center;">ERROR TEMPERATURE SENSOR 2 SHORTED</p>
--

The error message must be confirmed by pressing the **Enter** key.

After the Laser Diode Controller 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 by pressing the **Laser** key. If the error is still present, the error message appears again after the **Laser** key is pressed.

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 Laser Diode Controller has to be turned off.

Temperature range error

If the temperature of a cooler is out of the range as defined with the temperature limits in TEMPERATURE menu, the laser diode and the thermoelectric coolers are turned off immediately. One of the following messages appears on the display:

ERROR
TEMPERATURE 1
OUT OF RANGE

ERROR
TEMPERATURE 2
OUT OF RANGE

The error message must be confirmed by pressing the **Enter** key.

After the laser diode reaches the allowed temperature range again, the laser diode can be turned on again by pressing the **Laser** key. If the error is still present, the error message appears again after the **Laser** key is pressed.

Overload error

If a device module of the Laser Diode Controller overloaded, the laser diode and the thermoelectric coolers are turned off immediately. One of the following messages appears on the display:

ERROR
LASER DRIVER
OVERLOAD

ERROR
COOLER DRIVER 1
OVERLOAD

ERROR
COOLER DRIVER 2
OVERLOAD

Case Temperature error

If the case temperature falls below 0°C or exceeds 50°C, the laser diode and the thermoelectric coolers are turned off immediately. The following message appears on the display:

ERROR
CASE TEMPERATURE TO LOW
WORKING RANGE 0..50°C

ERROR
CASE TEMPERATURE TO HIGH
WORKING RANGE 0..50°C

The second error can be caused by defect case fan, blocked ventilation slots at the bottom or by too high ambient temperature.

Controller Unit error

If the controller detects an internal error on the controller unit, the laser diode and the thermoelectric coolers are turned off immediately. The following message appears on the display:

ERROR
CONTROLLER UNIT
ERROR

If this error occurs, please contact LASER ELECTRONICS for repair.

5 Connectors pin-out

As an option the instrument comes with the appropriate cables for the connectors used. At one end the cable jacket is stripped off and the leads are separated.

Please connect the leads as shown in the following subsections.

Fix the leads to the appropriate connectors supplied with your laser diode.

If the instrument comes with a heat sink provided by LASER ELECTRONICS, only the wiring between the laser diode and the two coloured leads (red and black) at the heat sink according the subsection „laser diode“ has to be done.

If the instrument comes with a heat sink and an already mounted laser diode provided by LASER ELECTRONICS, remove the short-circuit bridge at the connector of the cable for the laser diode and simply plug in the connectors for the laser diode and the heat sink.

Attention -1-:

Double-check if the wiring was done the right way. A mismatch destroys the laser diode within microseconds in a 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 instruments to the Laser Diode Controller unit it is recommended to isolate the housing of the laser diode from the chassis (earth).

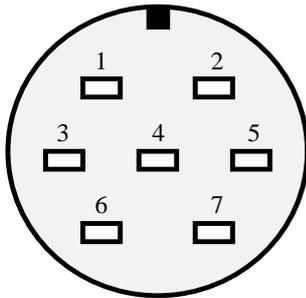
Remark: If the laser diode is mounted to the heat spreader of the heat sink provided by LASER ELECTRONICS it is already isolated from chassis ground (earth).

5.1 Laser diode

The instrument must be turned off before making the connection.

Up to 70A laser driver current the instrument comes with a laser diode connector. For higher currents the cables are fixed connected at the device.

The connector for the laser diode (5) is located at the rear panel of the instrument and it is a male type.



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

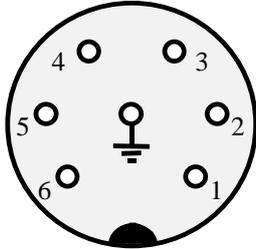
Pin number	Designation	Wire Colour
1, 5, 6	Laser diode anode (plus, „+“)	red
2, 4, 7	Laser diode cathode (minus, „-“)	black or brown
3	not connected (n.c.)	

For best performance some pins have the same designation.

5.2 Thermoelectric cooler 1

The instrument must be turned off before making the connection.

The connector for the cooler 1, the temperature sensor 1 (type: NTC) and the fan (as of the heat sink) (6) is located at the rear panel of the instrument and it is a female type.



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

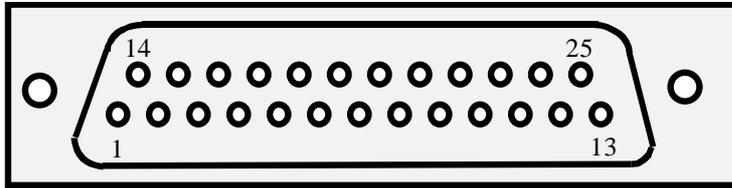
Pin number	Designation	Wire Colour
1	Thermoelectric cooler 1 (Peltier) minus	blue
2	Thermoelectric cooler 1 (Peltier) plus	red
3	Temperature sensor 1 (type NTC)	white
4	Temperature sensor 1 (type NTC)	grey
5	Fan plus	brown
6	Fan minus	black
Center Pin	Earth	green-yellow

The green-yellow lead (earth) is connected to the base plate of the heatsink, do not connect it to the laser diode housing or to the heatspreader on which the laser diode is directly mounted.

5.3 Thermoelectric cooler 2

The instrument must be turned off before making the connection.

The connector for the cooler 2 and for the temperature sensors (4) is located at the rear panel of the instrument and it is a 25 pol. SUB-D female type.



25pol. Sub-D female	Function	Wire Colour
1 (NTC-1A), 3 (PT100-1A), 5 (PT1000-1A)	Cooler 1 Sensor pin A	
14 (NTC-1B) 16 (PT100-1B) 18 (PT1000-1B)	Cooler 1 Sensor pin B	
2 (NTC-2A) 4 (PT100-2A), 6 (PT1000-2A),	Cooler 2 Sensor pin A	green
15 (NTC-2B) 17 (PT100-2B), 19 (PT1000-2B),	Cooler 2 Sensor pin B	yellow
10	Cooler 2 Peltier +	brown
23		
12	Cooler 2 Peltier -	white
25		

Trouble-shooting:

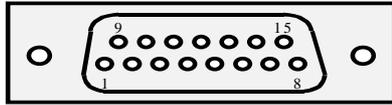
After preparing the connection of the thermoelectric cooler and the temperature sensor according to the section *Connector pin-out* and switching on the Laser Diode Controller, it might happen that the temperature controller doesn't seem to control the temperature, i.e. the measured temperature doesn't 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.

5.4 Interlock, Pilot Laser, Power Monitor

The connector for the interlock, pilot laser and power monitor (3) is located at the rear panel of the instrument.

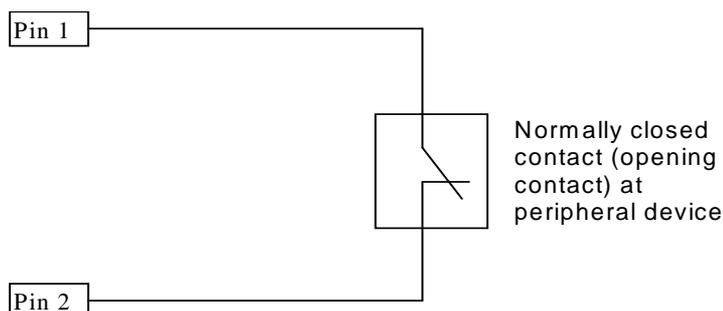


The connector at the rear panel is a D-Sub 15, female.

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

Pin number	Designation	Remark
1	Interlock - IN (+5V = open, GND = short)	galvanically isolated Input
2	Interlock - GND	
3	Pilot Laser + (+5V, max. 300mA)	galvanically isolated output
4	Pilot Laser - GND	
5	Power Monitor auxiliary voltage (+5V/10mA)	
6	Power Monitor Signal+	
7	Power Monitor - GND	
8 - 15	n.c.	

The interlock is realized with a loop as shown in the diagram below. It shows the condition when the interlock loop is closed. The interlock is prior to the **Laser** key at the front panel.



If the interlock loop is opened, the laser diode is immediately turned off and a error message appears on the display. The laser diode can only be turned on again by closing the interlock loop.

The Laser Diode Controller comes with a Dummy connector (D-Sub 15) which provides the interlock loop. 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 (Laser turned off)
- Pin1 = Low ($U < 0.8 \text{ V}$) → Interlock loop closed (Laser turned on)

Pin2 = Reference (Signal Ground)

Some laser diode modules include a pilot laser. The LDC1000 is provided with a pilot laser control feature. It can deliver 5V at max. 300mA. Please note, that this power supply is a constant voltage power supply and can not drive laser diodes directly. The pilot laser power adjustment is realized by pulse width modulation.

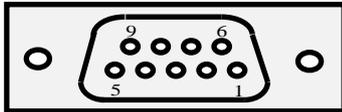
In addition some laser diode modules are provided with a power monitor (photo diode). The LDC1000 can display this power monitor voltage for calibrating the P/I curve.

5.5 Serial interface

The connector for the serial interface (2) is located at the rear panel of the instrument.

The instrument must be turned off before making the connection.

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



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

Pin number	Designation	Remark
2	RXD (receive)	galvanically isolated In-/Output
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.

6 Interfaces command description

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

6.1 Serial interface

Please make the appropriate connection with the provided cable from a free serial port of the PC to the serial interface connector of the Laser Diode Controller. Then switch on the instrument.

Any program which provides the transfer of commands via a serial communication port of a PC can be used. Select the correct port (e.g. COM 1).

Set the serial port parameters as follows:

Baud-rate	38.400
Data-bits	8
Stop-bits	1
Parity	none

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 Laser Diode Controller:

- Write keyword: **set**
- Read keyword: **get**

These 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

set ccc <Enter>

e.g. Turning on or turning off the laser diode depending on the condition before the command was sent out (toggle function): **set LAS <Enter>**

- Writing a command with a parameter

set ccc vv.v <Enter>

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

e.g. Setting the pulse width to 100 milliseconds: **set 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

get ccc <Enter>

e.g. Reading the actual temperature of the laser diode (channel 1): **get at1 <Enter>**

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

The Laser Diode Controller 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 On/Off	LAS			-	-
Laser operating mode	LMO	*		-	-
Pulse width (5.0ms < PUW < 490 ms)	PUW	*		ms	ms
Pulse period (10 ms < PUP < 500 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
P1 – power of calibration point 1	P1P	*		-	W
I1 – current of calibration point 1	P1I	*		-	A
P2 – power of calibration point 2	P2P	*		-	W
I2 – current of calibration point 2	P2I	*		-	A
Power Monitor	POM		*	-	V
Laser current limit	LCL	*		-	A
Analog input enable	AIE	*		-	-
Trigger input enable	TIE	*		-	-
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	*		-	-
D - control loop parameter cooler 1	DV1	*		-	-
Actual temperature cooler 2	AT2		*	-	°C
Set temperature cooler 2	ST2	*		-	°C
Upper temperature limit cooler 2	UT2	*		-	°C
Lower temperature limit cooler 2	LT2	*		-	°C
P - control loop parameter cooler 2	PV2	*		-	-
I - control loop parameter cooler 2	IV2	*		-	-
D - control loop parameter cooler 2	DV2	*		-	-
Cooler 1 enable	CE1	*		-	-
Cooler 1 sensor	CS1	*		-	-
Cooler 1 current (set current in %)	CC1		*	-	%
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	*		-	%
Cooler 2 enable	CE2	*		-	-
Cooler 2 sensor	CS2	*		-	-
Cooler 2 current (set current in %)	CC2		*	-	%
Cooler 2 current limit	CL2	*		-	A
Pilot laser enable	PLE	*		-	-
Pilot laser power	PLP	*		-	%

Actual case temperature	ATC		*	-	°C
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 (**set LMO v**)

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

Value v	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 (**get LAS**)

Following associations of values which will be returned are valid:

Value v	Condition laser diode
0	Laser diode off
1	Laser diode on

- Set condition laser (**set LAS**)

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

For example if the laser diode is presently turned off (as for example when the Laser Diode Controller is just switched on with the Power switch), the laser diode will be turned on when the command **set LAS** is sent out. On the other hand if the laser diode is presently turned on and the command **set LAS** is sent out, the laser will be turned off.

Therefore we recommend to use the following programming structure:

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

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

The value for setting a “enable” parameter:

Value v	“enable” parameter
0	DISABLE
1	ENABLE

E.g. **set AIE 1** enabled the analog input.

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

Value v	Sensor type
0	NTC
1	PT100
2	PT1000

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

- Error status (**get ERR**)

Following associations of values which will be returned are valid:

Value v	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 to low (< 0 °C)
14	Case temperature to high (> 50 °C)

Note:

If an error occurs, the error status keep its value until the device receive the error reset command:
set 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.

7 Specifications

Laser Diode Controller										
Power Laser Diode Driver (corresponding order)	300 W		600 W				1.500 W			
Max. Laser Diode Current	60A	70A	50A	100A	120A	150A	55A	65 A	100A	125A
Max. Laser Diode Voltage	5 V	3,6V	12V	6 V	5 V	3,6 V	28V	24 V	15 V	12 V
Ripple / Noise (rms) [mA]	100	100	100	200	200	200	100	100	200	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)									
Analog Modulation										
Input (BNC connector)	0 ... 5 V, 1 kΩ									
Transfer function	20 A/V up to 70 A max. laser current 40 A/V above 70 A max. laser current									
Bandwidth	0 ... 100 Hz									
Trigger										
Input (BNC connector)	TTL-level (High: U>2.4 V, Low: U<0.8 V)									
Output (BNC connector)	TTL-level (High: U>2.4 V, Low: U<0.8 V)									
Transfer function for TTL high	I _{out} = I _{set}									
Transfer function for TTL low	I _{out} = 0 A									
Bandwidth	0 ... 100 Hz									
Pilot Laser										
Pilot Laser Voltage	5 V									
Pilot Laser Current	max. 300mA									
Pilot Laser Power Adjustment	1 ... 100 %									
Power Monitor										
Input Voltage	0 ... 10,00 V									
Input Resistance	1MΩ									

TEC Controller				
Temperature Range	0 ... 50 °C			
Temperature Stability	< 0,1 K			
Temperature Adj. Accuracy	0,1 K			
Control Loop	PID			
Output Cooler 1				
TEC Output Power (corresponding order)	300 W			600 W
TEC Current	0.. ±7 A	0.. ±12 A	0.. ±14 A	0.. ±13 A
TEC Voltage	0.. ±48 V	0.. ±28 V	0.. ±24 V	0.. ±48 V
TEC Current Limit Range	0.. 7 A	0.. 12 A	0.. 14 A	0.. 13 A
Ripple	100 mA			
Fan Voltage Adjustment Range (manual)	6 ... 12 V			
Fan current	max. 1 A			
Output Cooler 2 (optional)				
TEC Output Power	15 W			
TEC Current	0 ... ±3 A			
TEC Voltage	0 ... ±5 V			
TEC Current Limit Range	0 ... 3 A			
Ripple	50 mA			
Temperature Sensors				
Sensor Types	Thermistor / PT100 / PT1000			
Thermistor	NTC, 10 kΩ @ 25°C, current: 100 µA			
Power Supply				
Line Voltage	85 - 264 V AC, autoranging			
Frequency	50 - 60 Hz			
Power Consumption	1.500 W			
Fuses rating for 115V AC	16A slow acting (5x20mm)			
Fuses rating for 230V AC	8A slow acting (5x20mm)			
General Characteristics				
Ambient Temperature, operating	0 ... 30 °C			
Relative Humidity, operating	30 ... 70 %			
Weight	11,1 kg			
Dimensions	465 x 150 x 500 (W x H x D, mm ³)			

Notes:

(*) The risetime, the falltime and the pulsewidth may be prolonged by long cables between the power supply and the laser diode.

The signal ground (shielding) of the BNC-connectors of the trigger input, the trigger output and the analogue modulation input BNC-connector are isolated from the chassis ground (earth).

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 instruments to the Laser Diode Controller unit 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).