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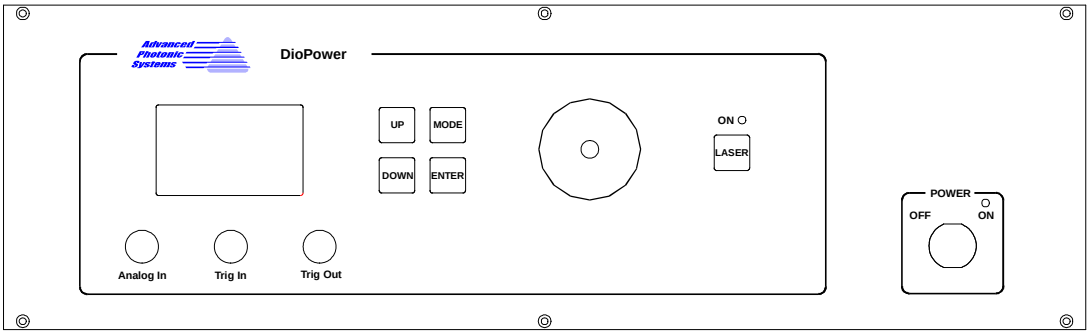
CW / QCW Laser Diode and Thermoelectric Cooler Controller

DioPower

Operating Instructions



Rev. 1.6, March 2003
Manual English DioPower-50

Contents

1 General

The information given in this document is subject to change without notice.

1.1 Warranty and Assistance

This instrument manufactured by Advanced Photonic Systems 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, Advanced Photonic Systems 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 Advanced Photonic Systems 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.

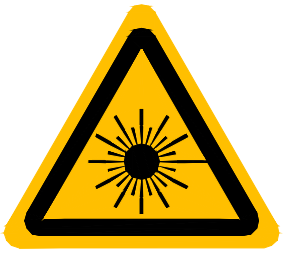
1.4 Laser Safety

1.5 Laser Classification

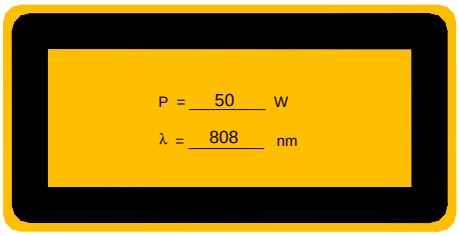
This laser system is classified as laser class 4 product according to EN 60825-1:2001. Please note that the used laser diodes are laser class 4. Please contact your laser safety commissioner for necessary safety instructions and equipment.

Laser light emitted by class 4 laser diodes are dangerous for the human eye and skin!

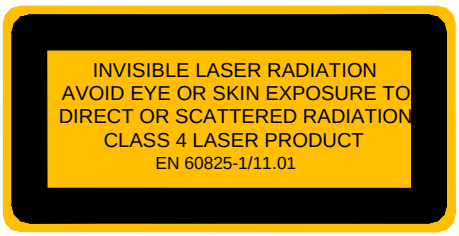
General warning label for laser radiation at cooler block:



Label for relevant parameters of the laser diode for normal operation and its statements at cooler block:



Label for Laser Class 4 at cooler block:



Average radiant power: P_0
Wavelength laser radiation: λ

Label for indicating laser emitting aperture or cooling block due to lack of Space:

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.

1.6 System contents

Control Unit (DioPower)

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

Dummy connector (D-Sub 15) for interlock loop (DP-Con-Interlock)

AC Power Cable

Manual

Optional:

Cable for connecting the laser diode (DP-Cable-LD).

Cable for connecting the thermoelectric cooler, temperature sensor and fan (DP-Cable-TEC-TS).

Air-cooled HeatSink, including cables for connecting the laser diode, thermoelectric cooler, temperature sensor and fan.

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

Laser diode mounted on air-cooled HeatSink

2 Introduction

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

The DioPower delivers, depending on the version, a current up to 50 A at a voltage of maximum 6 V.

The DioPower 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 DioPower 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 diodes, the DioPower also features one or two optional built-in controllers for thermoelectric coolers (Peltier elements). With an optional air-cooled heatsink (please contact Advanced Photonic Systems) 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 diodes the DioPower uses a constant voltage 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 DioPower 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 93 to 132 and 180 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 dummy-connector (DP-Con-Interlock) to the appropriate connector at the rear side of the instrument as described in the section *Connectors pin-out*. This dummy-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 (DP-Cable-LD) 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 thermoelectric cooler (HeatSink)

Connect the thermoelectric cooler and the temperature sensor to the leads of the provided cable (DP-Cable-TEC-TS) as described in the section *Connectors pin-out*.

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

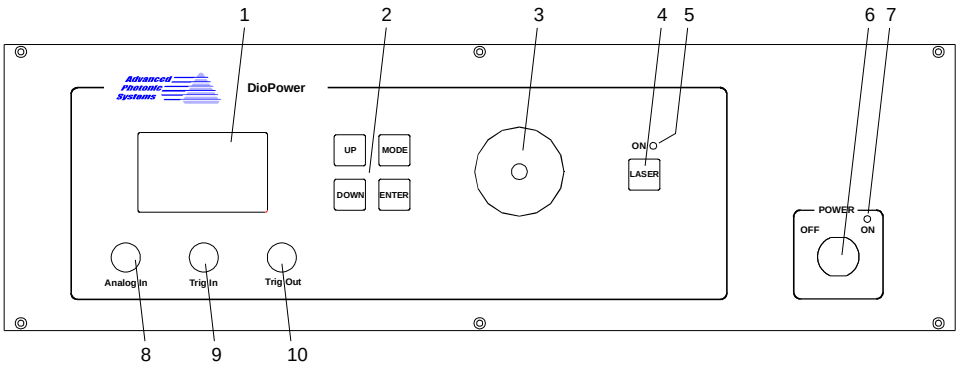
Note: The instrument must be turned off before the cable is plugged in.

4 Operation

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

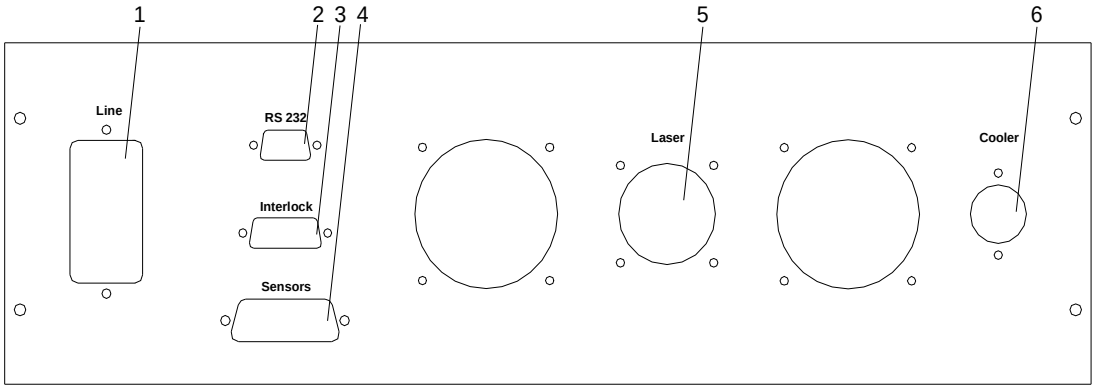
Please read the whole operating instructions before using this instrument together with a laser diode.

4.1 Elements of the instrument at the front panel



1. Display
2. Keys for setting instrument (Up, Down, Select, Enter)
3. Rotary knob for setting laser diode current and various settings within the menus
4. Key for turning on laser diode
5. Laser diode on indicator (yellow)
6. Power switch mains
7. Power on indicator (green)
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. Connector for AC line, including mains fuses
2. Connector for Serial Interface (RS232)
3. Connector for Interlock
4. Connector for Temperature Sensors and Cooler 2 (optional)
5. Connector for laser diode
6. Connector for Cooler 1 (Heat Sink - thermoelectric cooler 1, temperature sensor 1, fan)

4.3 Laser diode controller

Attention:

Before using the DioPower 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 *Setting laser diode current limit*. 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, MAIN menu

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

CW TL=NO I_{SET}= 0.0A
0.0A
T_1 = 25.0°C T_2 = na

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

The MAIN menu displays all relevant parameters:

CW / PU	Mode of laser diode (CW - constant current or PU - pulsing current)
TL=NO / TL=v.v sec	Laser diode turned on for specific time duration (NO - inactive, „v.v sec“ indicates a value and the unit of the time duration)
I_{SET}	Laser diode - desired current
0.0A	Laser diode - actual current, measured value.
T_1	Cooler 1 - actual temperature (usually the laser diode)
T_2	Cooler 2 - actual temperature (optional, na – not available)

The laser diode is turned on with the ***Laser*** key (4).

4.3.2 Laser diode operational modes

The display usually shows the following window, the **MAIN** menu:

CW TL=NO I_{SET}= 0.0A
0.0A
T_1 = 25.0°C T_2 = na

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, TL=NO — The laser diode is operated with a continuous current. The duration of the operation is not time limited internally. The current is set with the ***Rotary*** knob, see section *Laser diode current*. The laser diode is turned on with the ***Laser*** key. The laser diode is turned off by pressing the ***Laser*** key again.

CW, TL=v.v sec — The laser diode is operated with a continuous current. The duration of the operation is time limited according to the setting by the user, see section *Pulse and timing operational mode*. The duration of the operation time is given after the "=" mark. The current is set with the ***Rotary*** knob, see section *Laser diode current*. The laser diode is turned on with the ***Laser*** key. The laser diode is turned off automatically after the indicated time.

PU, TL=NO — The laser diode is operated with a pulsed current. The „high-level"-current is set with the ***Rotary*** knob, see section *Laser diode current.* The duration of the operation is not time limited internally. The laser diode is turned on with the ***Laser*** key. The laser diode is turned off by pressing the ***Laser*** key again.

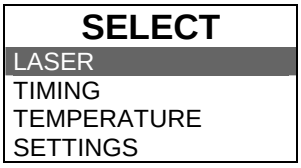
PU, TL=v.v sec — The laser diode is operated with a pulsed current. The „high-level"-current is set with the ***Rotary*** knob, see section *Laser diode current.* The duration of the operation is time limited according to the setting by the user, see section *Pulse and timing operational mode*. The duration of the operation time is given after the "=" mark. The laser diode is turned on with the ***Laser*** key. The laser diode is turned off by pressing the ***Laser*** key again.

Note:

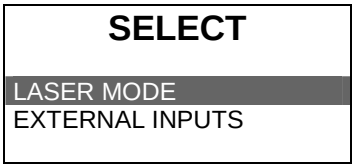
„v.v sec" indicates a value and the unit of the time duration.

How to set the laser diode operational modes:

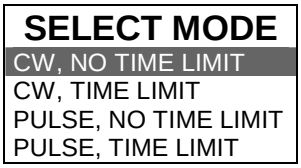
Starting from the **MAIN** menu, press the ***Select*** key (2) to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key (2) to select the **LASER** sub-menu. Confirm the selection with the ***Enter*** key (2):



Press the ***Up*** or ***Down*** key to select **LASER MODE** sub-sub-menu. Confirm the selection with the ***Enter*** key:



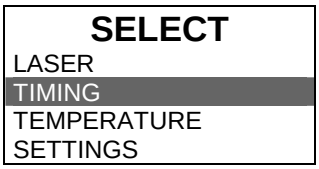
Press the ***Up*** or ***Down*** key to select the desired mode. Confirm the mode with the ***Enter*** key.

The display automatically returns to the **MAIN** menu.

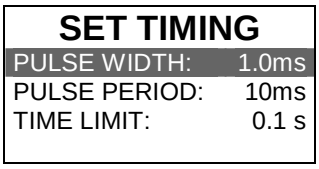
4.3.3 Pulse and timing operational mode

How to set the laser diode pulse and timing operational modes:

Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key to select the **TIMING** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the parameter to be changed. Change the value of the parameters with the ***rotary*** knob. Confirm the value with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key two times.

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 0.5 µs to 490 ms.

The pulse period must be within the range of 1 µs to 500 ms.

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

4.3.4 External analogue modulation and triggering of the laser diode

The DioPower provides an external analogue modulation input, an external triggering input and an external triggering output.

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 10 A / V. The modulation bandwidth is DC to 1 kHz. 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 with the ***Laser*** key (4) prior to the external inputs.

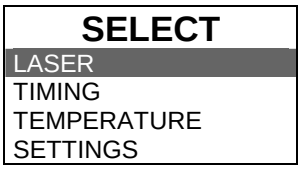
The trigger signal is applied to the **Trig In** connector (9) at the front panel. The valid range for the signal is according the specifications for TTL signals (Low: 0 V < U < 0.8V, High: 2.4 V < U < 5 V). The bandwidth is DC to 1 kHz. An applied TTL-low signal leads to a turned off laser. An applied TTL-high signal leads to a turned on laser with a laser diode current as it is set within the **MAIN** menu, see section *Laser diode current*. E.g.: If the laser diode current is set to „I_{set}=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.

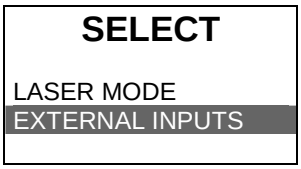
The signal on the trigger output connector **Trig Out** (10) provides a synchronization between the internally generated pulses, as specified by the pulse operational mode, and the external trigger. The output is according to the specifications for TTL signals.

How to set the external analogue modulation and triggering:

Starting from the **MAIN** menu, press the ***Select*** key (2) to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key (2) to select the **LASER** sub-menu. Confirm the selection with the ***Enter*** key (2):



Press the ***Up*** or ***Down*** key to select **EXTERNAL INPUTS** sub-sub-menu. Confirm the selection with the ***Enter*** key:

Press the ***Up*** or ***Down*** key to select the external input to be set. Change the input setting between ENABLE and DISABLE with the ***Rotary*** knob. Confirm the value with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key two times.

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

4.3.5 Laser diode current

Attention:

Before using the DioPower with a laser diode, make sure that the current limit is set to the specific value of the used laser diode, see section *Setting laser diode current limit*. The current applied to the laser diode must not exceed the maximum current given 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 the emitted optical power is also within a specified range.

How to set the laser diode current:

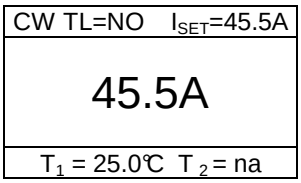
To set the laser diode current, first go to the **MAIN** menu. If necessary, the **MAIN** menu can be selected by pressing the ***Select*** (2) key several times.

The desired laser diode current is set with the ***Rotary*** knob (3) within the **MAIN** menu. Turning clockwise increases the value, turning counter clockwise decreases the value. The selected current can be read in the upper right corner of the display after the letters „I_{set}=“, e.g. I_{set}=45.5A. The maximum possible value is limited to the maximum set current as described in section *Setting laser diode current limit.*

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 in the middle of the **MAIN** menu.

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 (3) within the **MAIN** menu.

For example:



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

Notes:

The laser diode current is always set automatically to zero when the instrument is switched on.

The laser diode is always in a turned off condition after the instrument is switched on.

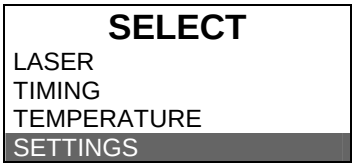
The laser diode output is short circuited by a relay when the instrument is switched off.

The laser diode current is slowly ramped up and ramped down (softstart).

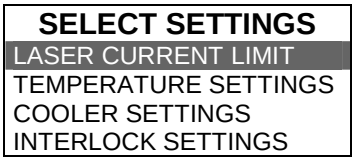
4.3.6 Setting laser diode current limit

Always set the 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.

Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key to select the **SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select **LASER CURRENT LIMIT** sub-sub-menu. Confirm the selection with the ***Enter*** key:

SET CURR. LIMIT
CURRENT LIMIT: 50.0 A
Should be set to the given value in the LD data sheet !

Change the value of the laser diode current limit with the ***rotary*** knob. Confirm the value with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key three times.

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

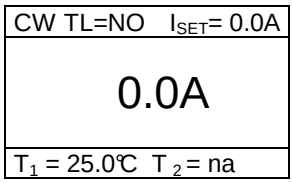
Remark:

The maximum possible current limit is predefined by the instrument.

4.4 Thermoelectric cooler controller

The DioPower 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 ±10A@±15V. The cooler 2 is optional and is used for customized applications (e.g.: laser crystal cooling). It delivered up to ±3A@±5V. If a cooler is enabled, see section *Select cooler*, the appropriate temperature controller immediately starts operating after switching on the instrument. The temperature controller attempts to set the approptriate 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 (usually the laser diode) and cooler 2 (optional) are displayed in the lower line of the **MAIN** menu.



T_1 Cooler 1 - actual temperature (usually the laser diode)

T_2 Cooler 2 - actual temperature (optional, na – not available)

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

Note:

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

Trouble-shooting:

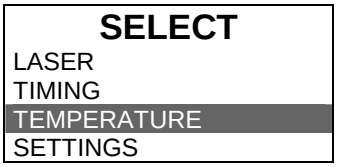
After preparing the connection of the thermoelectric coolers and the temperature sensors according to the section *Connector pin-out* and switching on the DioPower, it might happen that the temperature controller doesn't seem to control the temperature, i.e. the measured temperature doesn't approach 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.

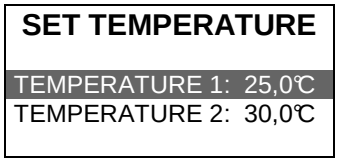
After this change the measured temperature should approach the desired temperature.

4.4.1 Temperature setting

Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key to select the **TEMPERATURE** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select **TEMPERATURE 1** or **TEMPERATURE 2.** Change the value of the temperature with the ***rotary*** knob. Confirm the value with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key two times.

Note:

The value of the temperature can only be changed within the valid temperature range as defined by the upper and lower temperature limit, see section *Setting temperature limits*.

The value for the temperature must be within 0℃ to 50℃.

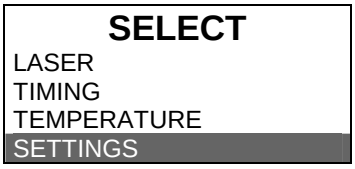
4.4.2 Setting temperature limits

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.

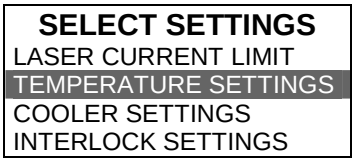
If the temperature of cooler 1 or cooler 2 (providet they are enabled) are out of the selected range, the laser diode and the cooler controller are turned off automatically and an error message appears on the display, see section *Error messages*.

How to set the temperature limits:

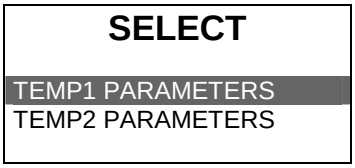
Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key to select the **TEMPERATURE SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the **SELECT** sub-sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select **TEMP1 PARAMETERS** or **TEMP2 PARAMETERS**. Confirm the selection with the ***Enter*** key:

SET TEMP1 PARAMETERS	
UPPER LIMIT:	30,0℃
LOWER LIMIT:	10,0℃
P:	40
I:	5
D:	0

Press the ***Up*** or ***Down*** key to select the parameter to be changed. Change the value of the selected parameter setting with the ***Rotary*** knob. Confirm the value with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key four times.

The values of the 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℃ to 50℃.

4.4.3 Setting 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 and are stored permanently in a non-volatile memory. The default settings which provide usually good controlling are as follows:

Cooler 1		**Cooler 2**	
Portion	**Value**	**Portion**	**Value**
P	40	P	70
I	5	I	3
D	0	D	0

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 ℃, the P-portion should be decreased.

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

How to set the temperature control-loop parameters:

Please follow the instructions as described in section *Setting temperature limits* and select the parameter to be changed.

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.

4.4.4 Cooler settings

4.4.4.1 Select cooler

The DioPower 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 DioPower was purchased with the appropriate cooler controller, see *Delivery Note*

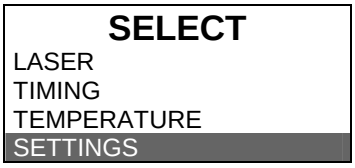
- the correct sensor type is connected on the correct connector, see section *Connectors pin-out*,

- the correct sensor type is selected by software, see section *Select sensor,*

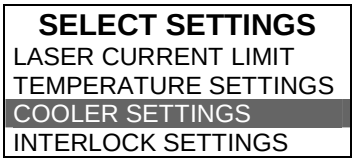
- the appropriate cooler current limit is set, see section *Setting cooler current limit.*

How to enable or disable the coolers:

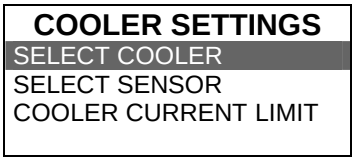
Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



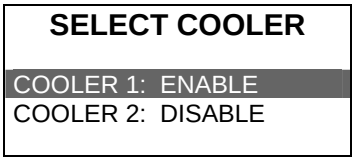
Press the ***Up*** or ***Down*** key to select the **COOLER SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the **SELECT COOLER** sub-sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the cooler to be changed. Change the setting between ENABLE and DISABLE with the ***Rotary*** knob. Confirm the selection with the ***Enter*** key:



Get back to the **MAIN** menu by pressing the ***Select*** key four times.

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

4.4.4.2 Select sensor

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

Attention:

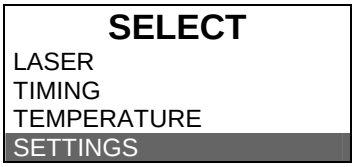
Before changing the sensor type, make sure that:

- the appropriate cooler controller is disabled, see section *select cooler,*

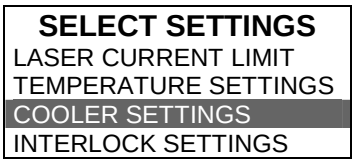
- the correct sensor type is connected on the correct connector, see section *Connectors pin-out.*

How to select the sensor type:

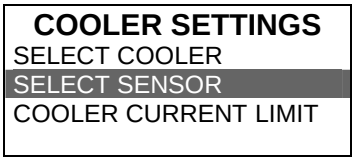
Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



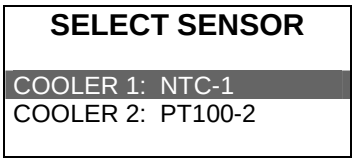
Press the ***Up*** or ***Down*** key to select the **COOLER SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the **SELECT SENSOR** sub-sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the cooler, whose sensor is to be changed. Change the setting between NTC, PT100 and PT1000 with the ***Rotary*** knob. Confirm the selection with the ***Enter*** key:



Get back to the **MAIN** menu by pressing the ***Select*** key four times.

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

4.4.4.3 Setting cooler current limit

Cooler 1 is usually used for cooling the laser diode and delivered up to ±10A@±15V. The cooler current limit can be set from 0 .. 10A.

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

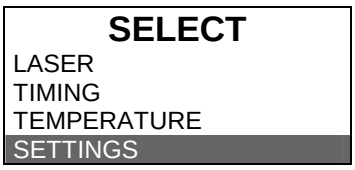
Always set the current limit to the maximum current value which can be found in the data sheet of the heat sink. Setting the appropriate current limit protects the peltier elements from being overloaded electrically.

Note:

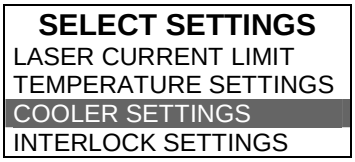
The set limit acts in both direction. E.g. current limit 2,5A means a current range –2,5A …+2,5A.

How to set the cooler current limit:

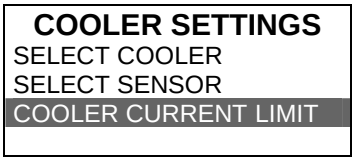
Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



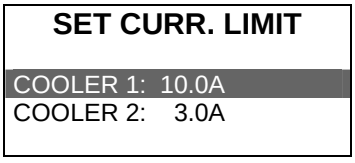
Press the ***Up*** or ***Down*** key to select the **COOLER SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the **COOLER CURRENT LIMIT** sub-sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the cooler. Change the value of the parameter with the ***rotary*** knob. Confirm the selection with the ***Enter*** key:



Get back to the **MAIN** menu by pressing the ***Select*** key four times.

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

4.5 Instrument settings

The following instrument settings are stored permanently in a non-volatile memory.

4.5.1 Interlock

The DioPower is equipped with an interlock feature which can be enabled or disabled. The interlock is realized with a loop which has to be provided via the interlock connector, see section C*onnector pin-out*.

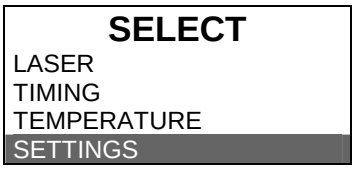
By default the interlock feature is disabled.

If the interlock feature is enabled, 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.

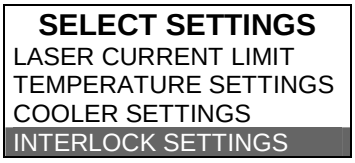
If the interlock loop is opened while the interlock feature is activated, the laser diode is immediately turned off and a error message appears on the display. The laser diode can only be turned on again by either deactivating the interlock feature or closing the interlock loop.

How to set the interlock feature:

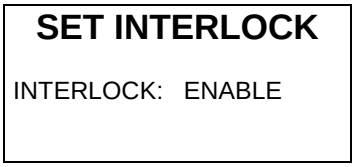
Starting from the **MAIN** menu, press the ***Select*** key to get to the **SELECT** menu:



Press the ***Up*** or ***Down*** key to select the **SETTINGS** sub-menu. Confirm the selection with the ***Enter*** key:



Press the ***Up*** or ***Down*** key to select the **INTERLOCK SETTINGS** sub-sub-menu. Confirm the selection with the ***Enter*** key:



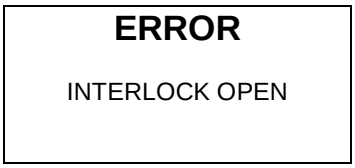
Change the interlock setting between ENABLE and DISABLE with the ***Rotary*** knob. Confirm the selection with the ***Enter*** key.

Get back to the **MAIN** menu by pressing the ***Select*** key four times.

4.6 Error Messages

Interlock error

If the interlock feature is activated as described in the section *Instrument settings* and the interlock loop is opened, the laser is turned off immediately and the following message appears on the display:

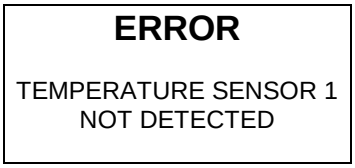


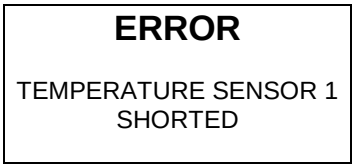
In order to return to the **MAIN** menu, the error massage must be confirmed by pressing the ***Enter*** key.

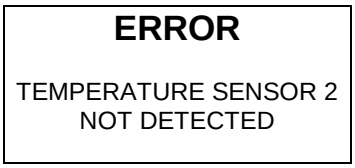
After the interlock loop is closed again, the laser diode can be turned on again by pressing the ***Laser*** key. If the interlock loop is still opened, the error message appears again after the ***Laser*** key is pressed.

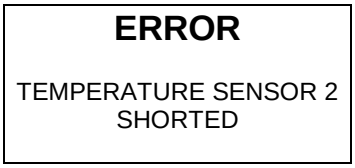
Temperature sensor error

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:









In order to return to the **MAIN** menu, the error massage must be confirmed by pressing the ***Enter*** key.

After the DioPower 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 HeatSink) is not connected to the instrument. Before providing this connection, the DioPower 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 section *Thermoelectric cooler controller*, the laser diode and the thermoelectric coolers are turned off immediately. One of the following messages appears on the display:

ERROR	ERROR
TEMPERATURE 1 OUT OF RANGE	TEMPERATURE 2 OUT OF RANGE

In order to return to the **MAIN** menu, the error massage 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 DioPower overloaded, the laser diode and the thermoelectric coolers are turned off immediately. One of the following messages appears on the display:

ERROR	ERROR	ERROR
LASER DRIVER OVERLOAD	COOLER DRIVER 1 OVERLOAD	COOLER DRIVER 2 OVERLOAD

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 HeatSink provided by APhS, only the wiring between the laser diode and the two coloured leads (red and black) at the HeatSink according the subsection „laser diode“ has to be done.

If the instrument comes with a HeatSink and an already mounted laser diode provided by APhS, 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 HeatSink.

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.

Advanced Photonic Systems 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.

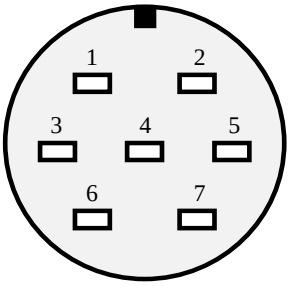
Therefore in order to avoid any grounding loops when applying external instruments to the DioPower unit it is recommended to isolate the housing of the laser diode from the chassis (earth).

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

5.1 Laser diode

The instrument must be turned off before making the connection.

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.

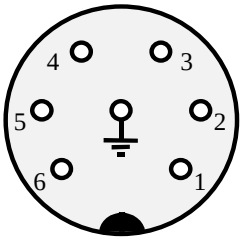
Pin number	Designation	Colour cable lead
1, 5, 6	Laser diode anode (plus, „+“)	red
2, 4, 7	Laser diode cathode (minus, „-“)	black
3	not connected (n.c.)	

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 HeatSink) (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.

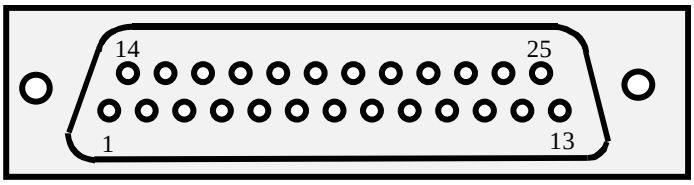
Pin number	Designation
1	Thermoelectric cooler 1 (Peltier) minus
2	Thermoelectric cooler 1 (Peltier) plus
3	Temperature sensor 1(type NTC)
4	Temperature sensor 1 (type NTC)
5	Fan plus
6	Fan minus
Center Pin	Earth

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
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
15 (NTC-2B) 17 (PT100-2B), 19 (PT1000-2B),	Cooler 2 Sensor pin B
10	Cooler 2 Peltier +
23	
12	Cooler 2 Peltier -
25	

Trouble-shooting:

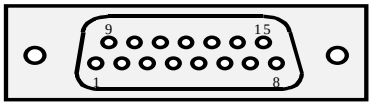
After preparing the connection of the thermoelectric cooler and the temperature sensor according to the section *Connector pin-out* and switching on the DioPower, it might happen that the temperature controller doesn't seem to control the temperature, i.e. the measured temperature doesn't approach the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

The connector for the interlock (3) is located at the rear panel of the instrument.

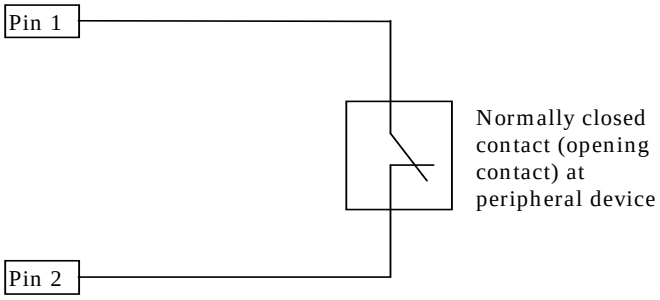


The connector at the rear panel is a D-Sub 15, female.

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

Pin number	Designation
1	Interlock - IN (+5V)
2	Interlock - GND
3 - 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. If the interlock feature is activated, it is prior to the ***Laser*** key at the front panel.



If the interlock loop is opened while the interlock feature is activated, 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 either deactivating the interlock function or closing the interlock loop.

The DioPower 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.

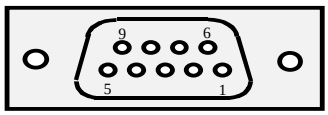
Pin1 = High (U > 2.4 V) → Interlock loop open (Laser turned off)
Pin1 = Low (U < 0.8 V) → Interlock loop closed (Laser turned on)
Pin2 = Reference (Signal Ground)

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
2	RXD (receive)
3	TXD (send)
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 male 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 with 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 DioPower. Then switch on the DioPower.

Any program which provides the transfer of commands via a serial communication port of a PC can be used. A simple terminal program coming with WINDOWS 9x™ is HYPER-TERMINAL™.

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

Set the serial port parameters as follows:

Baud-rate	9.600
Data-bits	8
Stop-bits	1
Parity	none

Description of the format of the transfer protocol:

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

- 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 1.25 A: ***set SLC 1.25 <Enter>***
  e.g. Setting the pulse width to 100 milliseconds: ***set PUW 100ms <Enter>***

- 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 DioPower sends out to the PC for example the value ***25.3*** (the unit is °C).

The DioPower 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.

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.

Command	Abbreviation	Parameter required	Read only	Key-in unit required	Used unit
Laser On/Off	LAS			-	-
Laser operating mode	LMO	*		-	-
Pulse width (0.5ms < PUW < 490 ms)	PUW	*		ms, µs	ms, µs
Pulse period (1 ms < PUP < 500 ms)	PUP	*		ms, µs	ms, µs
Time limit (0.1 s < TIL < 99.9 s)	TIL	*		s	s
Laser actual current	ALC		*	-	A
Laser set current	SLC	*		-	A
Laser current limit	LCL	*		-	A
Analog input enable	AIE	*		-	-
Trigger input enable	TIE	*		-	-
Actual temperature cooler 1	AT1		*	-	℃
Set temperature cooler 1	ST1	*		-	℃
Upper temperature limit cooler 1	UT1	*		-	℃
Lower temperature limit cooler 1	LT1	*		-	℃
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		*	-	℃
Set temperature cooler 2	ST2	*		-	℃
Upper temperature limit cooler 2	UT2	*		-	℃
Lower temperature limit cooler 2	LT2	*		-	℃
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 sensor NTC B-value	BV1	*		-	-
Cooler 1 current limit	CL1	*		-	-
Cooler 2 enable	CE2	*		-	-
Cooler 2 sensor	CS2	*		-	-
Cooler 2 sensor NTC B-value	BV2	*		-	-
Cooler 2 current limit	CL2	*		-	-
Interlock enable	ILE	*		-	-
Error status	ERR	*		-	-

Note:

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

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 DioPower 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.

- Sensor NTC B-value (e.g. ***set BV1 3900 or get BV1***)

  The B-value should be set to the given value in the NTC data sheet.
  Values in the range from 2000 up to 10000 are allowed.
  The default value is “3450”.

- 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

  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 Driver		
Diode Current Range	0 ... 50 A	
Compliance Voltage	0 ... 6 V	
Temperature Coefficient	< 100 ppm/℃	
Short Term Stability (1hr)	< 30 ppm	
Long Term Stability (24hr)	< 75 ppm	
Noise and Ripple (rms)	< 100 mA	
Current Limit Range	0...50 A	
Current Adjustment Accuracy	100 mA	
Repetition Rate (3dB)	0 ... 1 kHz	
Pulse Width (*)	> 500 µs	
Rise- / Fall- Time (*)	100 µs / 10 µs	
Analog Modulation		
Input (BNC connector)	0 ... 5 V, 1 kΩ	
Transfer function	10 A / V	
Bandwidth (3dB)	0 ... 1 kHz	
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	Iout = I set	
Transfer function for TTL low	Iout = 0 A	
Bandwidth	0 ... 1 kHz	
TEC Controller		
Temperature Range	0 ... 50 ℃	
Temperature Stability	< 0,05 ℃	
Temperature Adj. Accuracy	0,1 ℃	
Control Loop	PID	
TEC Output	**Cooler 1**	**Cooler 2**
Peltier Current	0 ... ±10 A	0 ... ±3 A
Peltier Voltage	0 ... ±15 V	0 ... ±5 V
Max. TEC Output Power	150 W	15 W
TEC Current Limit Range	0 ... 10 A	0 ... 3 A
Ripple	100 mA	50 mA
Temperature Sensors		
General Sensor Types	Thermistor / PT100 / PT1000	
Thermistor		
Thermistor Types	NTC	
Thermistor Current	100 µA	
Thermistor Resistance @ 25℃	10 kΩ	
Power Supply		
Line Voltage	93 - 132 and 180 - 264 V AC, autoranging	
Frequency	50 - 60 Hz	
Power Consumption	600 W	
Fuses rating for 115V AC	8A slow acting (5x20mm)	
Fuses rating for 230V AC	4A slow acting (5x20mm)	
General Characteristics		
Ambient Temperature, operating	0 ... 30 ℃	
Relative Humidity, operating	30 ... 70 %	
Weight	8 kg	
Dimensions	450 x 140 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 DioPower 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 HeatSink provided by APhS it is already isolated from chassis ground (earth).