DLC 300 Laser Controller

Operating Manual

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1.1 Introduction

The DLC300 controller has been designed for high precision operation of Diode Lasers in spectroscopic application. The greatest emphasis was placed on the stable and safe operation of the laser diode. Therefore it is based on the leading edge components and is provided with a number of safety systems. The DLC300 is perfectly suited to control the free running Diode Lasers as well as Extended Cavity Diode Lasers (see section 2).

1.2 Controller safety systems

One of the most important tasks of the laser controller is protection of the laser diode against damage. For this purpose, the DLC 300 is equipped with several safety systems.

1.2.1 Advanced starting system.

- Laser is started by a monostable Switch (7) on the front panel. It will not start automatically again after the mains failure.
- The laser action is delayed by 2 seconds due to personal safety[1]. During this time the operator can resign and interrupt the starting process.
- On start the laser current is ramped within 100 ms to prevent turn-on transients (Slow Start feature)

1.2.2 Current limiter.

The Controller has an adjustable current limiter, which prevent against accidental exceeding the maximum current of the diode laser. When the maximal value of the current is reached a sound alarm is generated and corresponding information shown on the display.

1.2.3 Voltage limiter

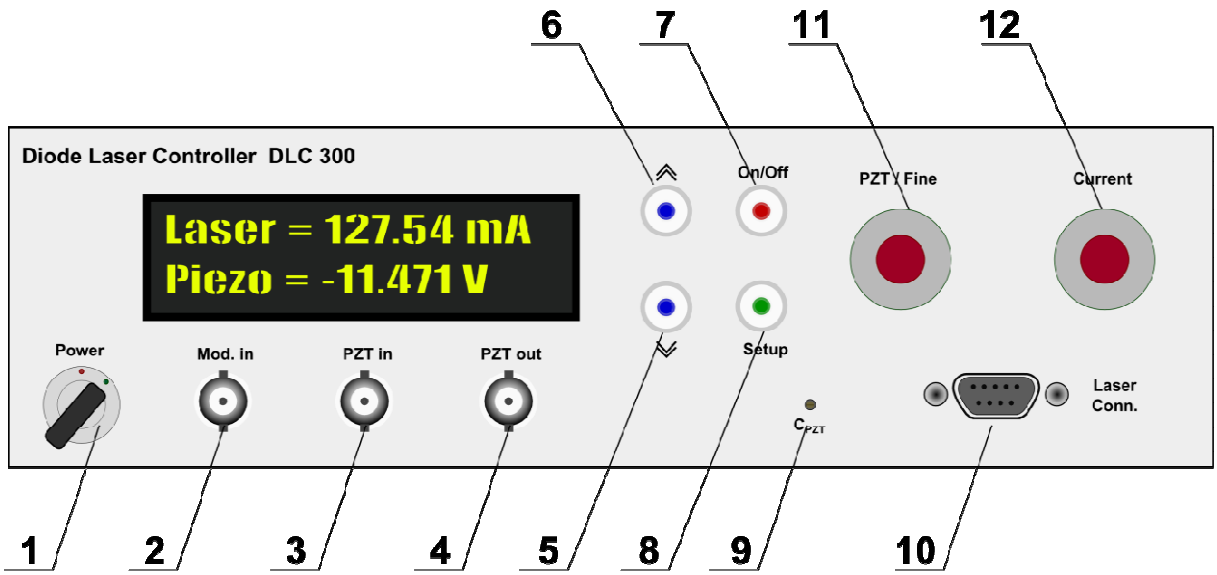
The implemented adjustable voltage limiter protects the laser diode against damage due to the wrong connection of the laser diode (inverted polarization). When the voltage on the laser diode pins achieve the limit value, an acoustic signal is generated and the corresponding information is shown on the display.

1.2.4 Relay protection

DLC300 controls the protection relay which should be installed in the laser head and shorts the anode/cathode laser pin to the ground when laser is switched off. It protects the laser diode after unexpected AC power down and enables safe cable reconnecting.

[1] Required by the US Federal Government (CDRH US21 CFR 1040.10)

1.3 Front panel



1. AC Power key switch
2. Current modulation input
3. Modulation input for piezo actuator voltage
4. Piezo actuator voltage output
5. View / Down Switch – changes information displayed in the lower line / decrements value selected in the Setup menu
6. Display ON-OFF / Up Switch – switches OLED display ON-OFF / increments value selected in the Setup menu
7. Laser START / STOP Switch with red LED which signalizes laser action
8. Setup Switch with green LED which opens the setup menu for controller settings. Repeated pressing allows to change to the next menu position
9. Setting of coupling gain between piezo voltage and laser current (Feed-forward function)
10. 9 - PIN laser connector
11. Multi-turn Fine current / Piezo voltage regulation knob
12. Multi-turn Current regulation knob

1.4 Basic operation modes

The DLC300 controller could operate in two basic modes:

I. First mode (*Mode I*) is used to supply free running diode lasers. Laser current could be adjusted very precisely by the left regulation knob (11) and coarsely by the right one (12).

II. The second mode (*Mode II*) is designed to operate with extended cavity diode lasers (ECDL). In this mode controller provides a tuning voltage for piezo actuator of a grating (BNC output (4)). Voltage is regulated by the left regulation knob (11) within the ±14 V range. The laser current is regulated by the right knob (12).

1.5 First use or new Laser Diode launching

Before the laser diode is connected to the controller its polarity must be carefully examined and the respective controller settings performed accordingly. The following steps should be taken:

I. At the beginning the laser diode connection type should be examined. In particularly the grounded electrode (the one common with the diode case) of the laser diode must be determined. Usually this electrode is on middle pin of the laser diode.

II. Check present polarization setting of the controller. Open menu Setup (press the *Setup* key). The present configuration will be shown on the first screen. If the polarization setting is compatible with the diode go further. Otherwise, change the configuration of the DLC300 controller (see section 2.2).

III. It is crucial to set the consistent polarity in the controller and in the laser head. If the Cathode Grounded case is set in the controller, the laser diode must be supplied by the LD Anode Line (Out Pin 8) and conversely (see section 2.2).

IV. Select the required current range in the Setup menu. To achieve the best performance the lowest range which is sufficient to the application, should be set.

V. According to the specifications of the laser diode, set the Current Limiter. The selected value should be at least 5 mA above the current which is going to be used.

VI. Set the Voltage Limiter. The limiting voltage (Max Voltage) should be at least a several hundred milivolts above the laser diode operating (forward) voltage.

2. Controller Settings

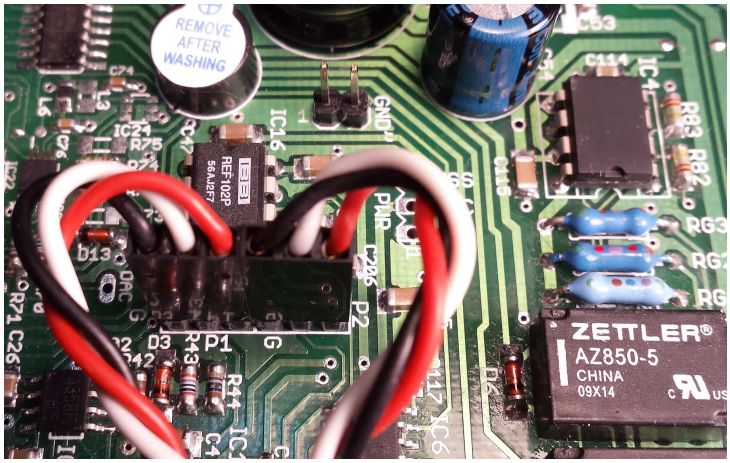
Most of controller configuration could be done in the Setup menu, but some has to be made inside of the controller. Please turn off the controller and disconnect AC-input power cable before you open the controller.

2.1 Operating modes

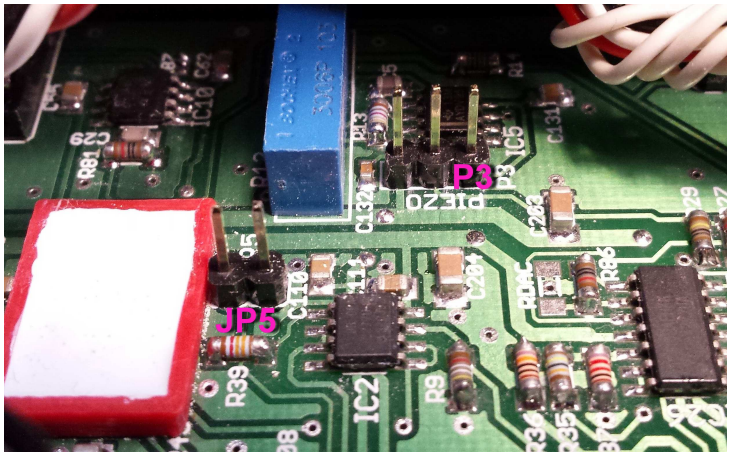
Switching between the two modes is realized by reconnecting a 3-wire connector of potentiometer cable inside the DLC300 controller. This cable joins regulation potentiometer (11) with the PCB board. To achieve best performance in Mode II, it is highly recommended to insert jumper to the connector socket **P2** (Fine).

Configuration for Mode I.

1) Regulator 3-wire cable connected to 3-pin socket **P2**. The right position of **black** wire is marked on PCB with character **G**.

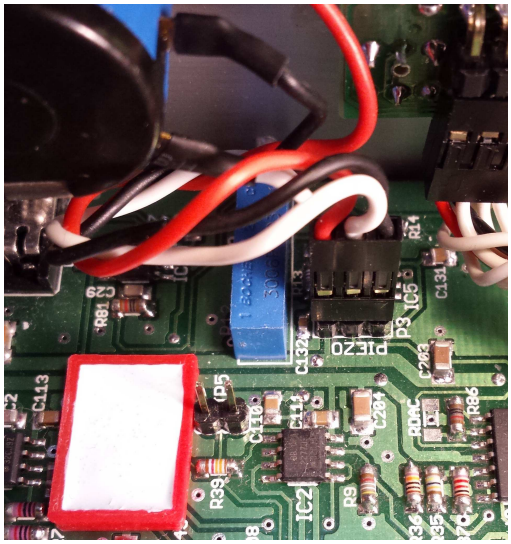


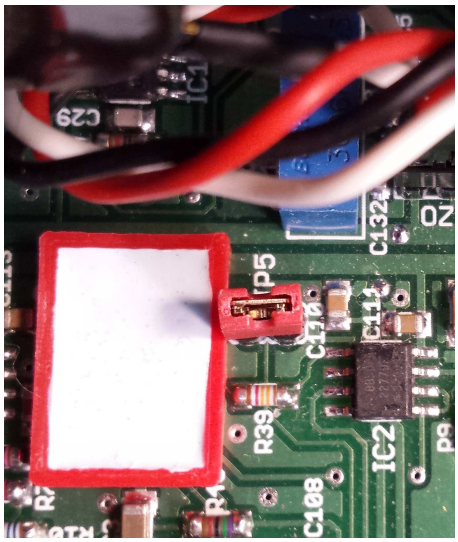
2) 3-pin socket **P3** stays FREE**.**
3) Jumper **JP5** OPEN (not necessary but recommended)



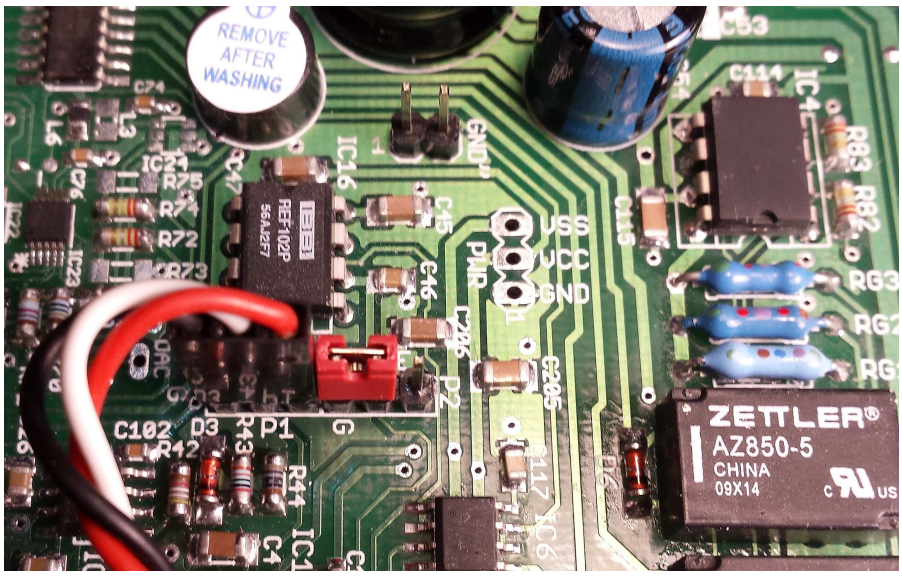
Configuration for Mode II

1) Regulator 3-wire cable connected to 3-pin socket **P3**. The right position of **black** wire is marked on the PCB with designator **P3**.
2) Optional: If Feed-forward coupling needed: Jumper **JP5** CLOSED





3) Jumper inserted (as shown below) on the connector socket **P2** (Fine)



2.2 Laser diode Polarization Settings

Before the laser diode is connected to the controller its polarity must be carefully examined and the respective controller settings performed accordingly. In particular the grounded electrode (i.e., common with the diode case) of the laser diode must be determined. Usually this electrode is on the middle pin of the laser diode. If neither the cathode nor the anode is grounded the setting "Grounded : Cathode" is preferred because the factory calibration of the controller is made for that case.

The present polarization setting could be checked in the setup menu. It is shown on the first screen after pressing the setup key.

If it is not consistent with the laser diode type to be used, the controller has to be switched off, disconnected from the AC power supply and reconfigured. The configuration is performed with 3 jumpers placed on the PCB board. Jumpers: JP1, JP2, JP3.

	JP1	**JP2**	**JP3**
Grounded Cathode	CLOSED	OPEN	OPEN
Grounded Anode	OPEN	CLOSED	CLOSED

Additionally in order to provide the laser diode with the current supply of correct polarity the proper controller Lines must be used. (Pin numbers as in the front panel connector.)

For the controller in the "**Grounded : Cathode**" mode:

- the laser diode Anode has to be connected to Pin no. 8 (LD Anode Line)
- the laser diode Ground has to be connected to Pin no. 3 LD Ground Line)

Respectively, for the controller in the "**Grounded: Anode**" mode:

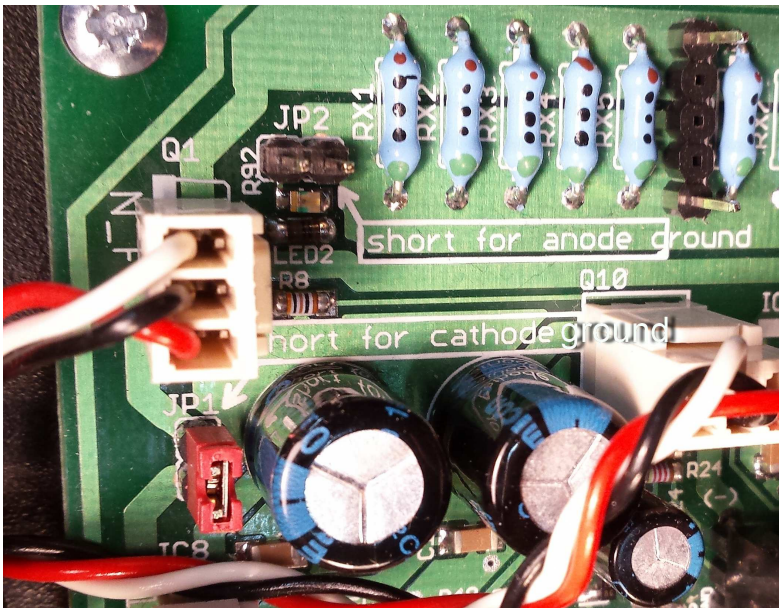
- the laser diode Cathode has to be connected to Pin no. 7 (LD Cathode Line)
- the laser diode Ground has to be connected to Pin no. 3 (LD Ground Line)

Alternatively, the supplied PCB Laser Board has an onboard jumper to select the proper controller Line (LD Anode Line / LD Cathode Line)

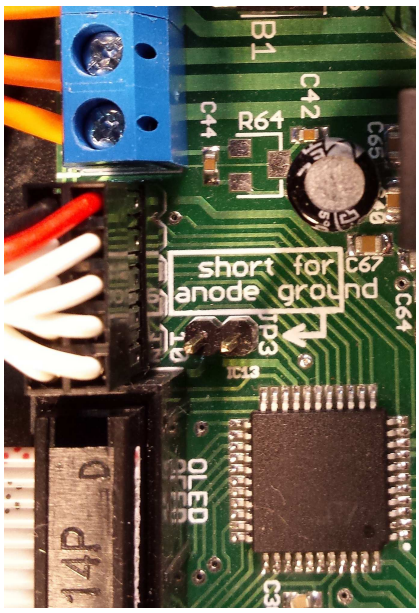
	Jumper A/K position
Grounded Cathode	"Anode" (1-2)
Grounded Anode	"Cathode" (2-3)

Grounded Cathode:

JP1, JP2

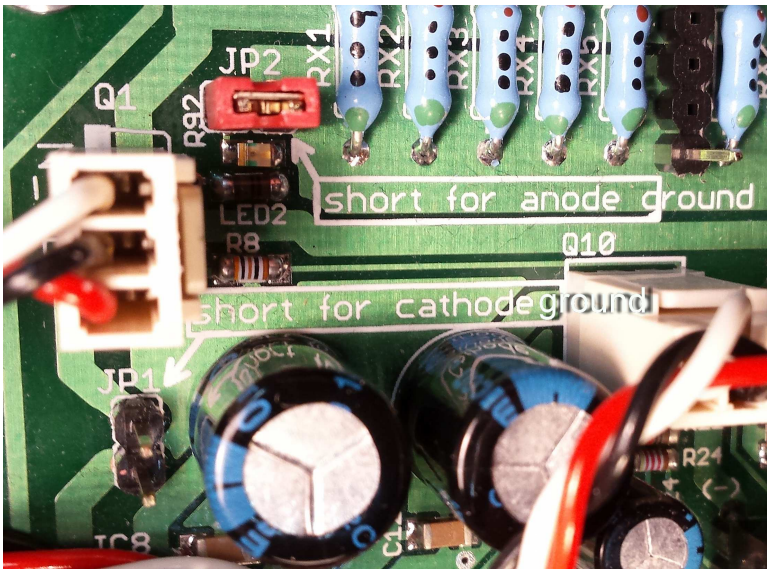


JP3

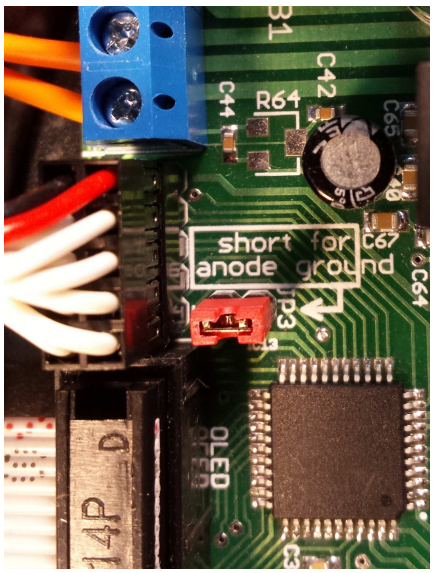


Grounded Anode:

JP1, JP2



JP3



2.3 Current range

The DLC300 controller has four current ranges 100 mA, 150 mA, 200 mA, 350 mA. The ranges are switchable in the setup menu by pressing UP, DOWN keys.

For the best performance it is recommended to set the lowest range which is adequate for the foreseen application.

2.4 Current Limiter

The current limiter protects the laser diode against accidental setting of a too high current value. The limiting value (I_max) is set in the setup menu in 5mA steps.

Reaching the limit is signaled acoustically and on the OLED display. If the further current increase is forced by turning the regulation knob, the limiter allows to exceed the set value by up to 7%.

If the laser is OFF and the Current Set Value (I_set) is greater than I_max the turning laser ON is halted and the appropriate information is presented on the Display:

2.5 Voltage Limiter

The voltage limiter protects the laser diode against damage as a result of wrong polarity. Since the reversely polarized laser junction doesn't conduct thus the voltage on its pins could exceed the breakdown voltage and permanently damage the laser diode. To avoid this the voltage limiter should be set properly. It is accomplished in

the setup menu in 100 mV steps. The limiting voltage (Max Voltage) should be at least a several hundred milivolts above the laser diode operating (forward) voltage. Otherwise, if it is too low, the voltage will be limited by the controller which will affect the attainable current value. Typically the forward voltage increases with the laser light frequency, e.g. for NIR ~ 2.0 V , Red ~ 2.2 V, Blue ~ 4.5 V, Violet ~ 5.2 V. Prior to its setting the forward voltage should always be checked in the laser diode datasheet.

2.6 Feed-forward coupling

The Feed-forward feature is closely affiliated with the operation mode II of the controller (see section 1.4), which is designed for ECDL lasers. It is enabled by shorting the jumper **JP5**. This functionality couples regulation of the PZT voltage (knob (11)) with the laser current regulation. The coupling coefficient C_{PZT} is negative and could be adjusted by trim potentiometer (9) on the front panel. A proper selection of this coefficient allows a broader mode-hope free tuning of the ECDL laser.

2.7 OLED Display

The DLC300 controller is equipped with high contrast, wide angle OLED Display. The Display can be switched OFF with the UP key (6). This function disables both the Display's internal switching power supply and its communication with microcontroller which is potentially favorable for the reduced noise level. To avoid the risk of Display burning due to prolonged displaying static image, the Screensaver feature is implemented. Screensaver starts after the pre-set time since the last key press or knob turn was made.

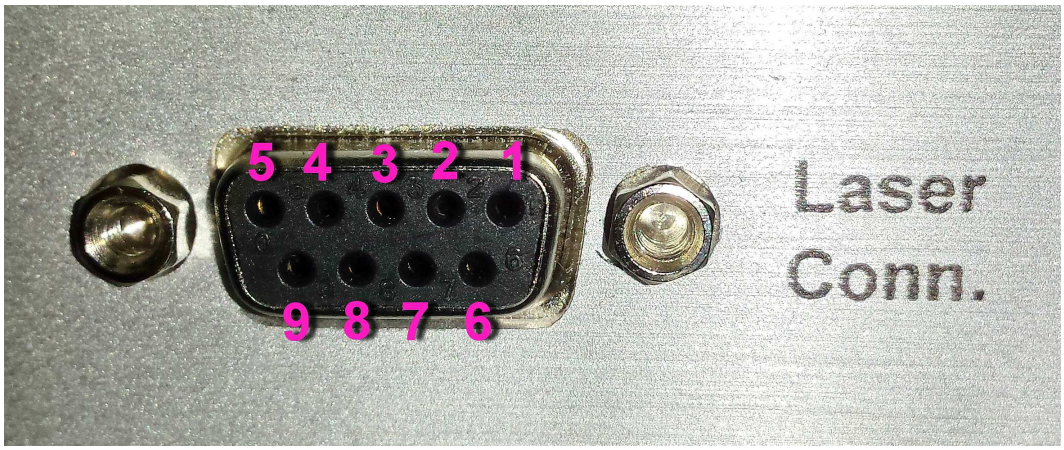
When the elapsed time equals three times pre-set time, the Display goes into OFF mode. The Screensaver pre-set time could be set in the setup menu.
Besides, the Display will be switched OFF automatically after 3 hours of operator inactivity. It is recommended to switch the Display OFF (key (6)) before turning OFF the controller by Key switch (1).

3.0 Diode Laser Photovoltaic mode

This mode, available via the setup menu, turns the laser into the photodetector. It is designed for use in more involved systems, where the diode laser is used as an amplifier for another laser (seed). After its enabling the laser protection relay becomes open and the voltage across the laser junction is measured.

Since the voltage is proportional to the light injected into the laser chip, it could be helpful in alignment of the seed beam. Before enabling this function please remove **A/K** Jumper on the laser board.

4.0 Laser output connector



1) Protection relay supply +6V	6) NC
2) Photo Diode Cathode/Anode	7) Laser Diode Cathode
3) Laser Diode Ground	8) Laser Diode Anode
4) Reserved GND	9) Laser Diode Voltage Monitor

5) Protection relay supply -6V	

5.0 Technical specification

Current ranges:	100mA, 150mA, 200mA, 350mA
Current stability (24h):	< 400 nA
Noise and ripple RMS (10Hz÷300kHz):	< 50 nA
Temperature coefficient :	~0.001 % / ºC
Current readout resolution:	10 µA
Current readout error:	0.05% + 5dgt
Current modulation bandwidth:	DC – 6 KHz (3dB)
Current modulation sensitivity:	1% of Current Range / V
Laser voltage readout resolution:	2 mV
PZT output voltage range:	± 14 V
PZT voltage mod. bandwidth	DC – 200KHz (3dB)
PZT voltage modulation gain:	1 V / V
PZT readout error:	0.05% + 5dgt
AC main voltage:	230 V ±10% / 50 to 60 Hz
Power Consumption:	15 W
Dimensions:	250 x 70 x 250 mm^3

Notes