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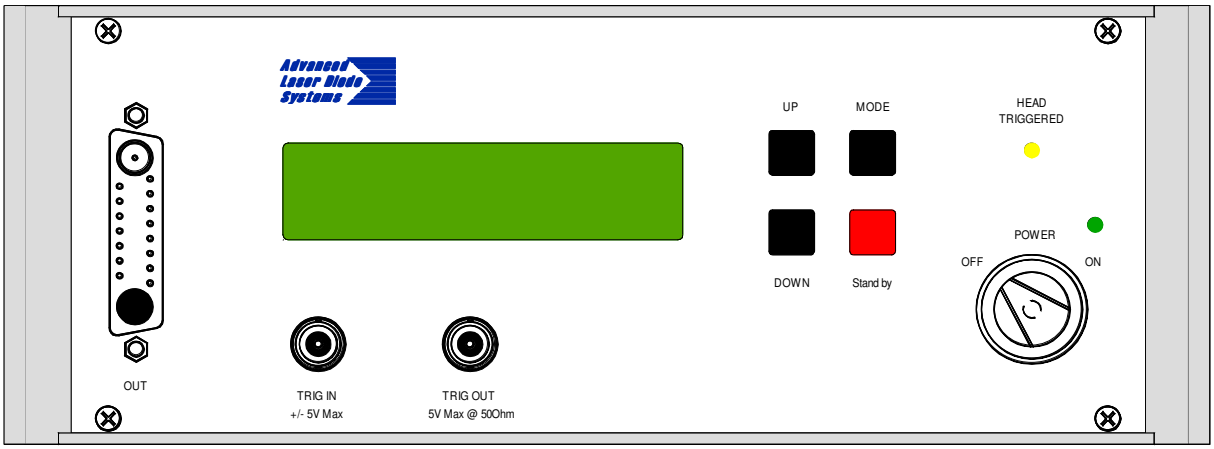
Picosecond Injection Laser (PiLas)

Pulse Repetition rate 1MHz

Owner's Manual



Content

1 General

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

1.1 Warranty and Assistance

This instrument manufactured by Advanced Laser Diode 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 Laser Diode 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 Laser Diode 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.

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.

Caution – use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

There is no scheduled maintenance necessary to keep the product in compliance.

There is no service allowed by the customer.

The driver or laser head are not to be opened by the customer.

1.4 Laser Safety

1.4.1 General Remarks

The radiation of the laser diode used in this instrument may be visible or invisible. The laser diode emits radiation in the 370 nm to 1560 nm spectral region.

Use caution to avoid hazardous exposure to the beam. Take precautions to eliminate exposure to a direct or reflected beam. Do not view the laser beam directly or indirectly with optical instruments or human eye.

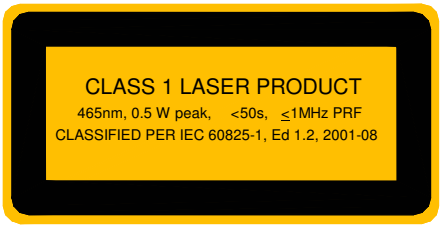
1.4.2 Laser Class

This PiLas laser system is classified as **class 1 laser product** according to IEC 60825-1, Ed 1.2, 2001-08. This laser product is designed as Class 1 during all procedures of operation.

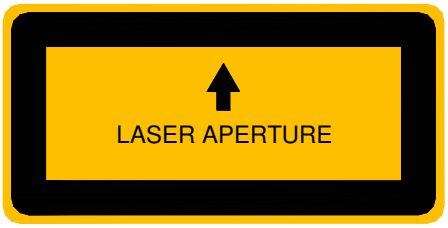
The laser radiation is emitted through the optics at the front side of the optical head or by an attached optical fiber guiding the laser light.

1.4.3 Laser Warning Labels

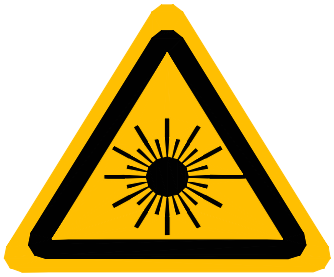
According to laser safety regulations the following class 1 laser product ***explanatory label*** with relevant laser parameters is used. For the detailed laser parameter please see the test report.



According to laser safety regulations the following class 1 laser product ***aperture label*** is used:



According to laser safety regulations the following ***hazard label*** is used:

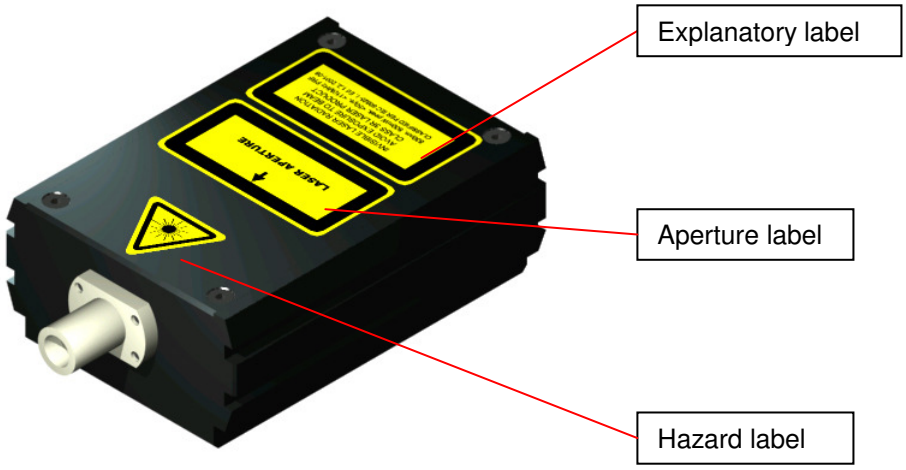


1.4.4 Label Location

The ***explanatory label*** is attached on top of the laser head as shown in the diagram.

The ***laser aperture*** label is attached on top of the laser head with the arrow pointing towards the laser emission aperture as shown in the diagram.

The ***hazard label*** is attached on top of the laser head near the laser emission aperture as shown in the diagram.



Label location diagram (PiLas laser head with standard collimating optics)

1.4.5 Manufacturer Identification Label for EIG1000D

Location: rear side of EIG1000D

Advanced Laser Diode Systems
Advanced Laser Diode Systems
A.L.S. GmbH, Schwarzschildstr.6
12489 Berlin, Germany

Manufactured:

Month: April Year : 2006

Model: EIG1000D S/N : 0297

Volt: 230/115 Amp : 0.2/0.4

Made in Germany

Does not comply with FDA performance standards for laser products

1.4.6 Manufacturer Identification Label for the laser head

Location: bottom of the laser head

Advanced Laser Diode Systems
Advanced Laser Diode Systems
A.L.S. GmbH, Schwarzschildstr.6
12489 Berlin, Germany

Manufactured:

Month: February Year : 2006

Model: PiL047 S/N : 0297

Complies with European laser safety norm EN 60825-1:/11.01

1.5 Delivery Volume

Control Unit:	EIG1000D
Optical Head(s):	PiLnnn
SUB-D 25p Cable:	PiLas head – EIG1000D (PIL-MH-01)

AC Power Cable

Manual with individual test reports

2 Introduction

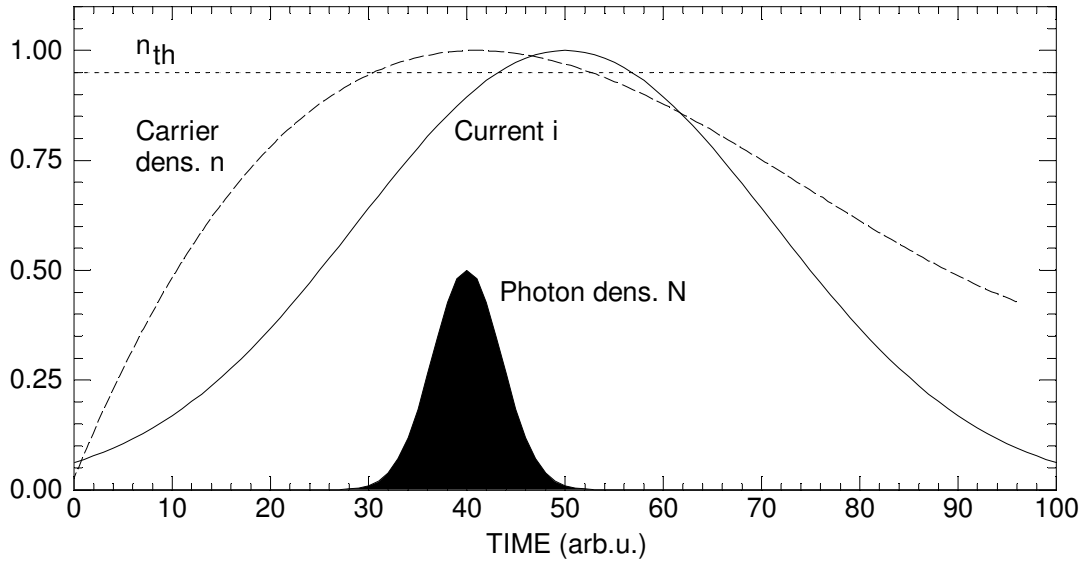
The PiLas is a compact system generating ultra short optical pulses using diode lasers. The system consists of a control unit and an optical head with the electrical driver and the laser diode. The optical head is configured to emit short light pulses within one wavelength in the spectral region between 370 nm and 1550 nm. Each head is individually adjusted to the laser diode to achieve optimal pulses emission performance down to pulse widths of 15 to 50 ps and optical peak powers between 50 and 1500mW. Different optical output options are available, including free space collimating optics, FC/PC-connectors for multimode or single mode fibers and different micro foci.

Repetition rates of up to 1 MHz, very low jitter and different triggering possibilities make the PiLas a flexible and reliable system suitable for a wide range of applications.

The PiLas system uses the technique of gain-switching of laser diodes.

The laser diode represents a low impedance load, which is driven by special electronic circuit that generates an electrical pulse of high amplitude, variable pulse widths and a jitter of less than 3-4ps.

The following diagram illustrates the behavior and the relationship of electrical pumping current *i*, carrier density *n* and photon density *N*.



The diagram shows that an increasing pumping current increases the carrier density *n*. At the carrier density threshold n_{th} a population inversion results in lasing emission from the laser diode. If the pumping current *i* is switched off shortly after this event, the carrier density *n* drops below the threshold again. This results in the emission of a single optical pulse. Applying the pumping current *i* for a longer period would lead to the emission of multiple pulses. These so-called relaxation oscillations continue for a short time (0.5 to 2ns depending on the diode laser technology).

3 Operation

3.1 Installation

Before installation, check the setting of the mains voltage at the rear side of the instrument as any mismatch can cause damage to the instrument. If the primary fuses are blown they can easily be replaced by the user.

A recommendation for a complete switch on procedure is given in the chapter "Switch on procedure".

3.2 Operation

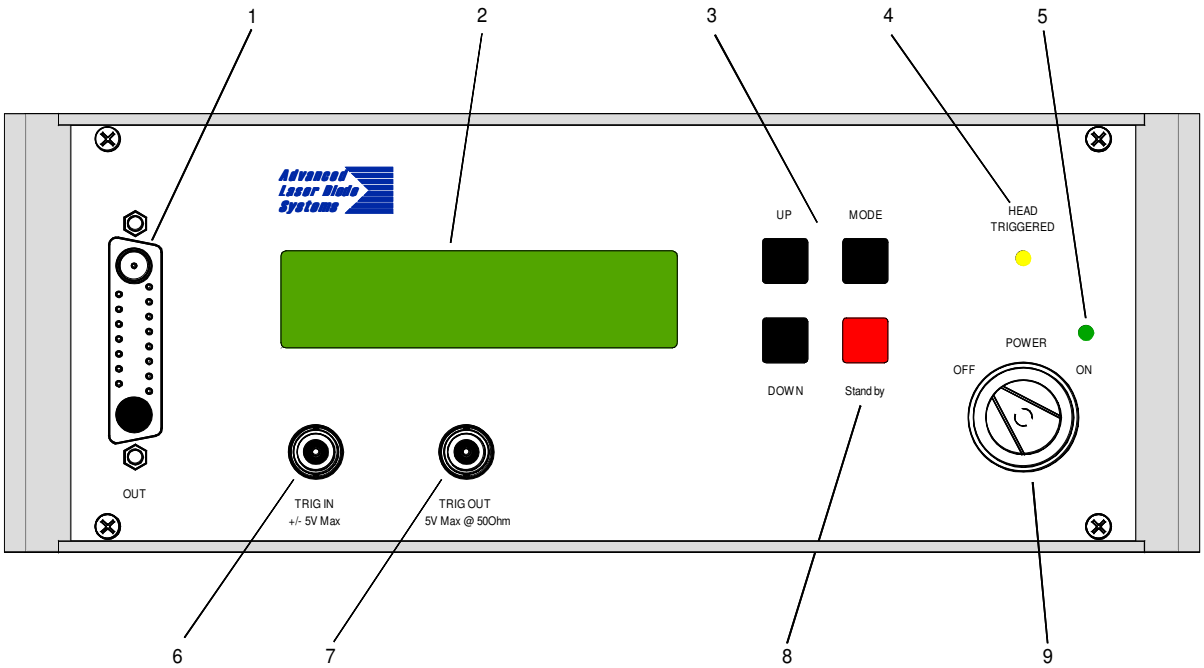
The digital control unit of the PiLas is mainly operated by four keys UP, DOWN, MODE (3) and Stand by (8). You can switch between the different menus by pressing the MODE key. The UP and DOWN keys are for selections within the menu itself.

The HEAD TRIGGERED light emitting diode (LED) (4) indicates pulse emission from the optical head.

After switching on the control unit, you get the text message:

Advanced Laser Diode Sys. *Pulse Generator*

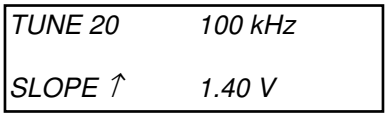
3.2.1 Elements of the control unit



1. Connection to optical head
2. Display, illuminated
3. Keys for setting instrument (UP, DOWN, MODE)
4. Pulse emission indicator (triggered condition)
5. Power on indicator

6. External trigger input connection
7. Pre-trigger output connection
8. Key for setting Stand by mode
9. Power switch

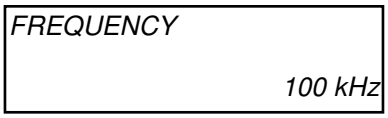
3.2.2 *„STATUS“*-Menu



The *STATUS* menu shows the present state of the instrument for TUNE, FREQUENCY, TRIGGER SLOPE and TRIGGER LEVEL as described below. You cannot select any item within this menu.

Press the Stand by key (8) to start or stop operation of the control unit. The red controlling light inside the switch indicates the stand by condition. By pressing the MODE key (3) multiple times, you can switch to the different menus.

3.2.3 *„FREQUENCY“*-Menu



The frequency is set by pressing the UP or DOWN key (3) to increase or decrease the frequency respectively. The frequency offers 1, 2 and 5 steps per decade.

Additionally, the choices *single* and *extern* can be set in the *FREQUENCY* menu.

If *single* is selected, pulse emission follows after pressing the MODE key.

If *extern* is selected, the instrument can be triggered externally. At each trigger event at the trigger input (6) exactly one optical pulse will be emitted.

The frequency and the appropriate *TUNE* value are stored after the next menu (*TUNE*-menu) is selected by pressing the MODE key.

3.2.4 *„TUNE“*-Menu, Adjustment of Optical Pulse

The optical pulse emission is adjusted by the UP or DOWN keys (3), which increase or decrease the electrical pumping energy to the laser diode from 0 to 100 percent.

If your system is supplied with a gain-switched laser diode, a clear single pulse is only generated up to a certain *TUNE* value that may differ for each frequency.

A larger *TUNE* value increases the electrical pumping energy to the laser diode and leads to a higher peak power, slightly shorter pulse width and a significantly increasing pulse tail.

For every frequency the optimum *TUNE* value for single pulse emission can be recalled by switching to the *TUNE DEFAULTS* menu; please see below. These factory settings correspond to the optimum *TUNE* value for achieving a single optical pulse at each frequency.

For every frequency the last *TUNE* value is stored. For example, if the last *TUNE* value at 100 kHz was 25.0 and at 200 kHz 50.0, changing the frequency from 100 kHz to 200 kHz automatically changes the corresponding *TUNE* value from 25.0 to 50.0. This change of the corresponding *TUNE* value is done only after the next menu (*TUNE*-menu) is selected by pressing the MODE key.

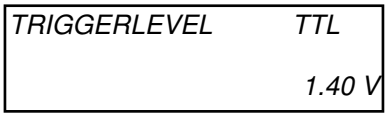
The instrument stores the changed *TUNE* values in an internal battery backed-up RAM, even after switching off the instrument.

Please note that the setting of the *TUNE* values is different at different frequencies. Please check the emission when changing the operating frequency. For detailed setting please see the test report as a reference, where you find the appropriate values for single pulse emission at different frequencies.

Please note that the setting of the optimum *TUNE* values for single pulse emission may differ up to +/- 10% when repeating the test measurements in the test report at different places and setups. Please check the emission at your setup.

Please make sure to observe the indicated warm-up-time for receiving the nominal pulse specifications. The warm-up-time refers to the entire system running, which means the optical head is triggered. If the entire system is already switched on and at stand-by mode for a while, the warm-up-time is reduced to 5 min.

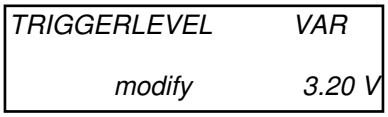
3.2.5 *„TRIGGER LEVEL“*-Menu



The trigger level of the external trigger input (6) can be adjusted in three different ways.

There are two predefined trigger levels, TTL and NIM with 1.40 V and -0.50 V, respectively. These are selected by pressing the UP or DOWN key.

The third option is the VAR setting. In this setting, you can modify the trigger level by first pressing the MODE key and then pressing the UP or DOWN key. You will see the following display:

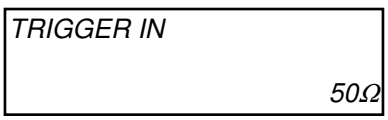


The variable trigger level is stored after pressing the MODE key.

3.2.6 *„TRIGGER SLOPE“*-Menu

The trigger slope is set to the rising (positive) or falling (negative) edge of the signal at the external trigger input (6) by pressing the UP or DOWN key.

3.2.7 *„TRIGGER IMPEDANCE“*-Menu



The input impedance of the external trigger input can be selected to 50Ω or 1 MΩ by pressing the UP or DOWN key.

3.2.8 *„TUNE DEFAULTS“*-Menu

TUNE DEFAULTS
UP:1; DOWN:2

The *TUNE DEFAULTS* menu offers the option of resetting the instrument to the factory settings. These factory settings correspond to the optimum *TUNE* value for achieving a single optical pulse at each frequency.

There are two sets of *TUNE* values available: Set 1 is activated by pressing the UP key and set 2 is activated by pressing the DOWN key.

If the instrument is supplied with one optical head, set 1 is programmed with the appropriate *TUNE* values and set 2 is programmed to 50%.

If the instrument is supplied with two optical heads, set 1 corresponds to the optical head with the shorter wavelength and set 2 corresponds to the optical head with the longer wavelength.

The two sets of default *TUNE* values are programmed to an EPROM during the testing procedure at our facilities.

3.2.9 Troubleshooting

If an unreasonable value for any menu-settings appears on the display, please go to the *TUNE DEFAULTS* menu and press the UP or DOWN key. Then switch the instrument off for at least 5 seconds and then back on again.

If the HEAD TRIGGERED LED goes out, please switch off the instrument for at least 5 seconds and then back on again.

3.2.10 Switch on procedure

1. Chose a stable position for the setup of the EIG1000D and the laser head PiLxxx.
2. Ensure that the power key switch of the EIG1000D is in off-position.
3. Connect the power supply cable to the EIG1000D.
4. Connect the laser head and the EIG1000D with the delivered control cable and fix the attachment screws of the SUB-25p plugs to the driver and the laser head. We recommend fixing the controller cable and trigger cable to the workbench avoiding movement of the cables.
5. Ensure the laser light will not harm any persons or other setups after switch on. We recommend placing a non reflecting beam dump in front of the laser aperture.
6. Provide your laser safety engineer with information about the delivered laser system and ask for laser safety measures like eye protective glasses. The laser class as well as the maximum laser parameters can be read from the laser warning labels on top of the laser head and from the chapter Laser Safety in this manual.
7. Switch on the EIG1000D with key power switch. The yellow power indicator LED should go on.
8. The system is preset with *TUNE* values for every frequency given in test report. Select the desired frequency and press the stand by button to start the laser emission.
9. Before changing to another frequency press the stand by button. Press the MODE button until the frequency can be changed. After the desired frequency is selected press the MODE button until the *TUNE* value is displayed. Now switch on the laser emission by pressing the stand by button.
10. Before power down the EIG1000D cancel the laser emission by pressing the stand by button. The HEAD TRIGGERED LED goes out.

4 Optical Head

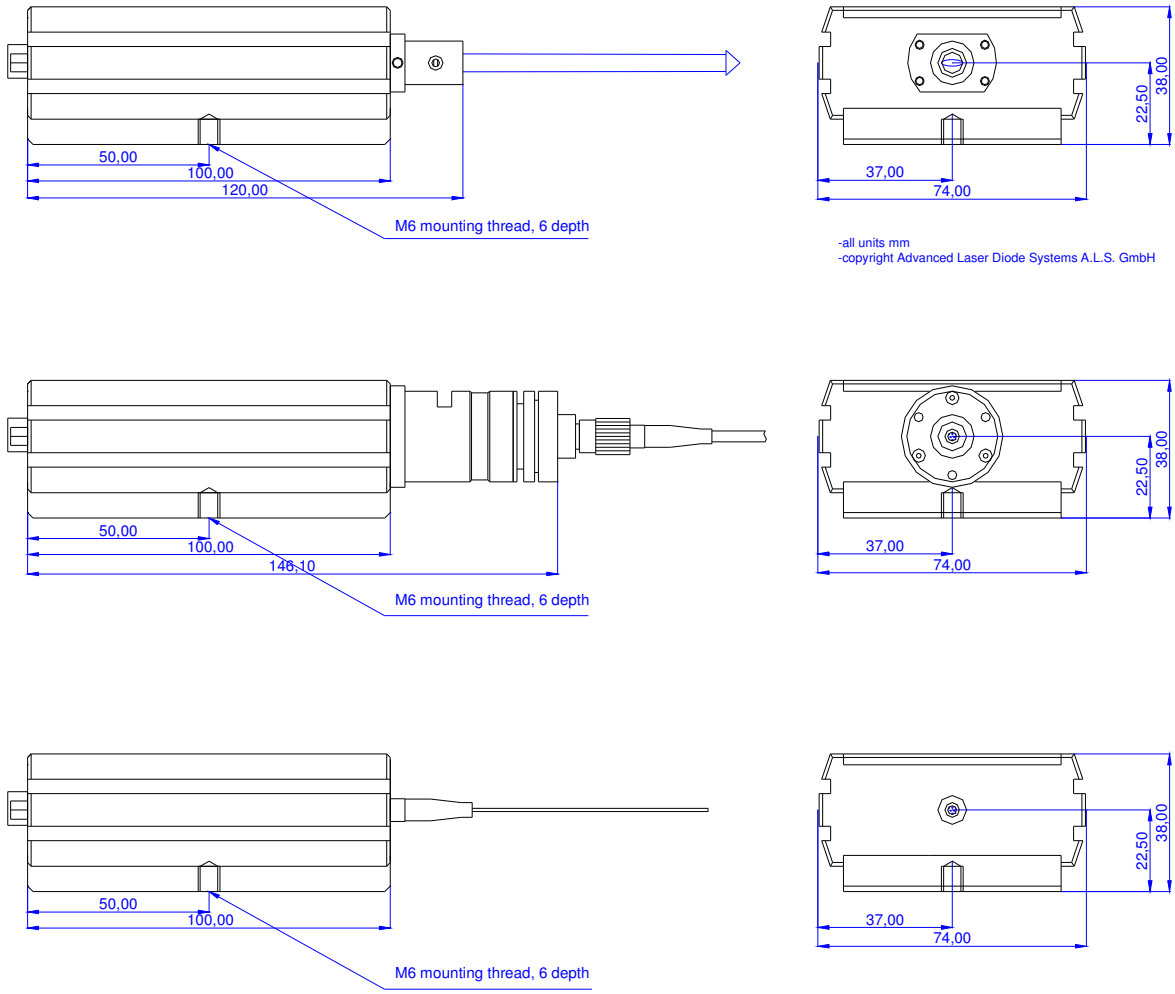
The optical head is electrically connected to the OUT connector (1) of the control unit with the cable PIL-MH-01. Please attach the screws of the cable to the control unit and the optical head. To fix the head mechanically, please use the M6-thread in the base plane of the optical head. Your system is supplied with the desired optical output option.

For detailed parameters please see the test report as a reference. The standard head dimensions are shown in the following sketch. There are three main versions:

-collimating optics (free space laser beam)

-removable fiber coupling optics (removable fiber coupler and fiber)

-internal fiber coupling (fixed fiber)



4.1 Handling and Adjustment

The following chapters describe the main optics shown in the picture above that can be used in conjunction with PiLas-systems. You will find the optics used for your system in the PiLas-test report attached to the manual.

4.1.1 System with collimating optics (if ordered)

4.1.1.1 Standard collimating optics

The inner tube, which holds the lenses, is fixed to the main housing with three small slotted headless screws in the middle. For re-focusing, first loosen these screws, and then insert the special adjusting tool with an eccentric aligning plug in the right position into the hole of the main housing. By slowly

rotating the tool, the inner tube is slightly moved longitudinal in the main housing. After re-focusing, tighten the three screws again. Please take care with the small screws.

4.1.1.2 Micro Focus

A micro focus can be used for focusing the collimated leaser beam to a small spot size in a certain distance in dependence of laser source, distances and focal lengths.

The micro focus is inserted into the standard collimating optics and is fixed with three small slotted headless screws at the front end of the main housing of the optics

4.1.2 System with removable fiber coupler and fiber (if ordered)

4.1.2.1 Collimating optics

The inner tube, which holds the lenses, is fixed to the main housing with two small hexagon headless screws in the middle. For re-focusing, first loosen these screws, and then insert the special adjusting tool with a small nose at one end in the right position from the front side of the main housing. By slowly rotating the tool the inner tube is slightly moved longitudinal within the thread of the main housing. After re-focusing, tighten the two screws again. Please note, that the base housing is different to the one used for systems with the standard collimating optics.

4.1.2.2 Laser beam fiber coupler

After collimating the laser beam with the collimating optics as described above, you are ready to adjust the laser beam coupler for the fiber connector. This could be necessary after removing the laser beam coupler from the main housing.

The laser beam coupler is fixed to the main housing with three small hexagon headless screws at the end of the main housing.

The first adjustment deals with the focus: The inner tube of the laser beam coupler, which holds the lenses, is fixed to the housing with two small slotted headless screws in the middle. For re-focusing to the fiber connector, first loosen these screws, than insert the special adjusting tool with an eccentric aligning plug in the right position into the hole of the housing of the laser beam coupler. By slowly rotating the tool the inner tube is slightly moved longitudinal in the main housing. After re-focusing, tighten the two screws again.

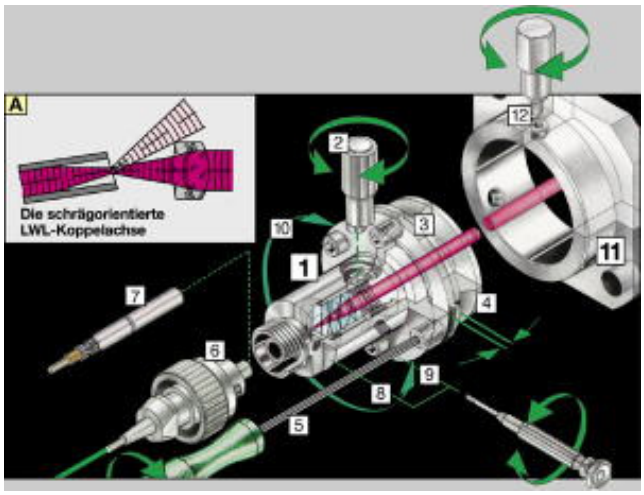
The second adjustment deals with the optical axis: The optical axis of the laser beam coupler is aligned to the optical axis of the collimated laser beam (paraxial fiber coupling). This is done by slightly adjusting the three hexagon head cap screws in conjunction with the three hexagon headless screws, which are all located parallel to the optical axis. After re-aligning, tighten all six screws again, but be aware of the fact that these screws serve for aligning and tightening.

Please note, that the fiber connector attached to the coupler is tightened with a small screw. Before screwing off the fiber connector this small screw must be loosen!

The following may illustrate the procedure on hand of the usually applied 60SM Laser Beam Coupler:

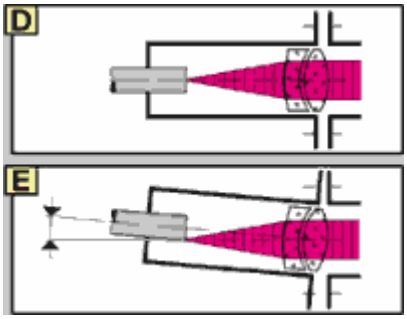
Laser Beam Coupler 60SM...

- Spectral range 390–2100 nm
- Adjustable and focusable for singlemode fibers with FC connectors (optionally SMA)
- Inclined or straight fiber coupling axis
- Universal system for laser diodes, gas and solid lasers.
- Coupling optic focusable and adjustable to the fiber.
- A pin screw M1.6 for the additional locking of the fiber ferrule is integrated into the FC connector.
- Circular V-groove and matching cylinder system for the orientation of the polarisation axis and for a form-locking connection.



1 Laser Beam Coupler 60SM...
2 Internal lens focusing (with eccentric key 50HD-15)
3 Adapter flange with matching cylinder and circular V-groove
4 Adjusting flange with homokinetic bearing and
5 Integrated adjustment and locking screws for the 3-axial tilt and fine adjustment (hex key SW1.5 – type 50HD-15).
6 Singlemode fiber with FC connector
* *Please note, that the system adapter may be look different*

7 Singlemode fiber assembled in fiber ferrule Ø 2.5 mm
8 Lens locking (with screw driver Ø 1.2 mm – type 9D-12)
9 Additional locking of the fiber ferrule (with screw driver Ø 1.2)
10 Adjustment of the polarisation axis
11 System adapter assembled at laser beam source*
12 Conus screws for system locking (with hex key SW1,5)



Adjustment of the laser beam coupler 60SM...

The 3-axial lockable tilt-adjustment of the laser beam coupler (**D** and **E**) allows positioning the laser spot exactly on the fiber core measuring only some micrometers. This is done by tightening the adjusting screws clockwise, maximizing the coupled beam power, and finally locking this status with the (Allen-head) locking screws between them. The coupler is delivered with pre-adjusted lens. Re-focusing is done with the eccentric key.

Alignment of components

The matching cylinder system with integrated circular V-groove yields a form-locking mutual connection of the singlemode components (laser beam coupler, anamorphotic beam shaping optic, laser diode collimator). By means of Allen-head screws the components are locked in their optimal alignment. In this way for instance the polarisation axis of the fiber is oriented to the polarisation direction of the laser beam source.

4.1.2.3 Fiber collimator

A fiber collimator can collimate the divergent output beam of the fiber. Please insert the FC/PC connector of the fiber gently in the right position (watch the aligning plug) to the reception of the collimator. Only tighten it lightly. Always use a protective cap for unused connectors or receptions, in order to avoid damage to the optics and to the bare fiber end, and to keep all parts clean.

The fiber connector can be fixed to the laser beam collimator with a small slotted headless screw. This screw is located at the flattened end of the laser beam coupler and is pushing towards the outer metal sleeve of the FC/PC-connector.

4.1.2.4 Micro Focus

A micro focus can be used for focusing the collimated leaser beam to a small spot size in a certain distance in dependence of laser source, distances and focal lengths.

The micro focus is inserted into the fiber collimator and is fixed with three small slotted headless screws at the front end of the main housing of the fiber collimator.

4.1.3 System with internal fiber coupling (if ordered)

4.1.3.1 Fiber collimator

A fiber collimator can collimate the divergent output beam of the fiber. Please insert the FC/PC connector of the fiber gently in the right position (watch the aligning plug) to the reception of the collimator. Only tighten it lightly. Always use a protective cap for unused connectors or receptions, in order to avoid damage to the optics and to the bare fiber end, and to keep all parts clean. If the fiber collimator comes with an eccentric key the collimation can be optimized by adjusting the collimating lens position. Before using the eccentric key, the two small screws looking the collimating lens must be loosen. If the optimum collimation is achieved, these screws should fix the collimating lens tube for stability.

4.1.3.2 Micro Focus

A micro focus can be used for focusing the collimated leaser beam to a small spot size in a certain distance in dependence of laser source, distances and focal lengths.

The micro focus is inserted into the fiber collimator and is fixed with three small slotted headless screws at the front end of the main housing of the fiber collimator.

4.2 Cleaning

The need for cleaning of any precision optic should be reduced to a minimum by covering the optic and by use of a protective bag in order to avoid degrading. We recommend that dust is blown off only. Fingerprints need to be removed immediately with several steps of appropriate solvents such as alcohol.

5 General Specifications

5.1 Control Unit EIG1000D

Internal trigger:	
Repetition rate	0 to 1 MHz in steps
External trigger:	
Repetition rate	0 to 1 MHz continuously
External trigger input (BNC):	
Amplitude	-5 V to +5 V max.
Trigger level states	TTL, NIM, variable
Impedance	50 Ω / 1MΩ
Pulse width	> 10 ns
Pre trigger output (BNC):	
Amplitude	< 5 V @ 50 Ω max. *)
Pulse width	> 10 ns
Rise time / Fall time	< 3.5 ns / < 3.5 ns
Trigger delay between pre trigger and optical output **)	App. 70 ns
Jitter between electrical trigger and optical pulse ***)	< 4 ps for internal trigger (typical), external depending on the source quality
Temperature:	
Temperature drift trigger delay	10 ps/K
Warm up time (operating)	15 min
Power:	
Mains input switchable at	115 V ± 10 % / 60 Hz
Or	230 V ± 10 % / 50 Hz
Fuses rating for 115V AC	1000 mA slow acting (5x20mm)
Fuses rating for 230V AC	500 mA slow acting (5x20mm)
Environment (operating), also for the Optical Head:	
Temperature	25 °C ± 10 °C
Relative humidity	30 % to 70 %
Size of Control Unit:	235 x 88 x 326 (width x height x depth, mm^3)
Size of Optical Head (w/o optics):	74 x 38 x 100 (width x height x depth, mm^3)
Weight:	
Control unit and head	5 kg

Notes:

*) The trigger output is DC-coupled. It provides a voltage source with a resistance of 50 Ω. Recommendation: Check the maximum allowed voltage and the coupling condition of the input of an external instrument!

**) The trigger delay can be modified on request.

***) The optical output is synchronized to the rising slope of the pre trigger output signal.

The signal ground (shielding) of the trigger -input and -output BNC-connectors is isolated from chassis ground (earth).

5.2 Optical Head PiL

Please see the attached test report for individual measurements and specifications.

6 Test Reports (followed after blue separation sheet)