MANUAL

DIODE LASER SYSTEM

Laser Type: LDF 5000-40

Serial No.: 50091005

Issued: 2009

Laserline GmbH

Fraunhofer Straße

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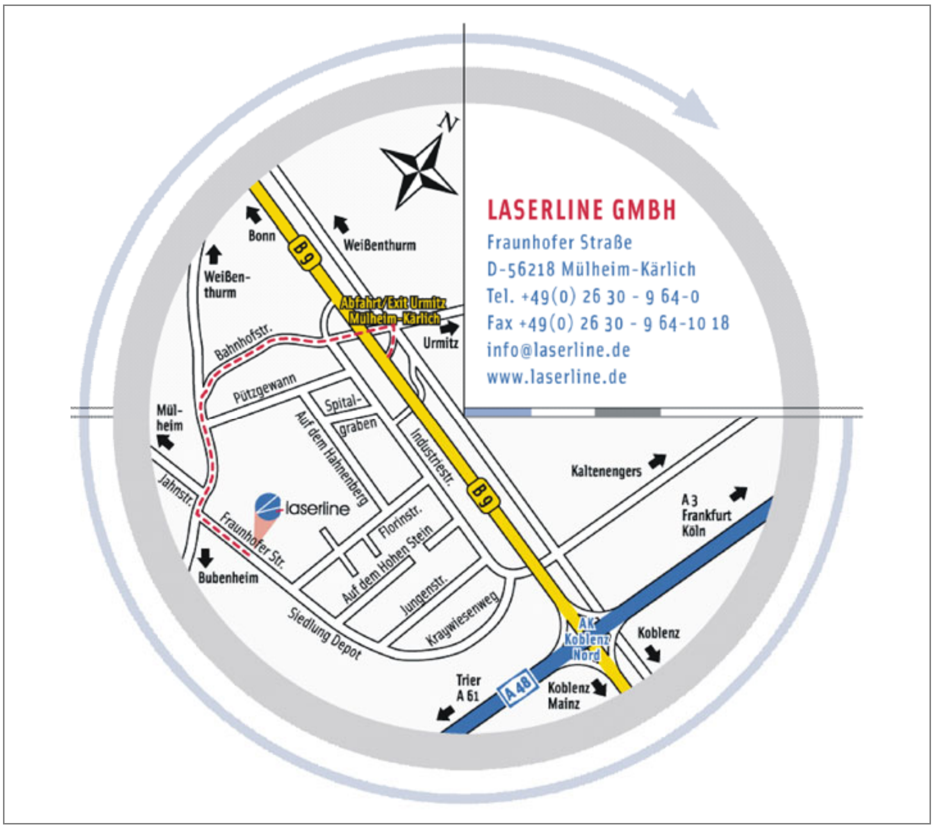
1 SERVICE ADDRESS AND HOTLINE



You can reach the Laserline Service Hotline per telephone, fax or e-mail at:

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Our Hotline hours are Monday – Friday, from 08:30 to 17:30 German time.

Should you require a 24-hour service option from Laserline Service, a separate Service Agreement can be provided.

1.1 How to use this manual

Info – Using this Manual

In sections 2 to 8, this manual describes the structure, connection and operation of a standard Laserline Diode Laser System.

Those components which are not part of the standard system, such as a beam shutter or particular optics, are described in detail in Section 9. Should any of these components require additional connection work and/or descriptions (beam shutter, field-bus, etc.) such information can also be found in Section 9.

Sections 9 to 14 are individually compiled to describe the respective laser systems and their options.

1.2 Definition of basic Terms

Laser system	A complete system consisting of laser head and supply unit
Supply Unit	VG (1-5, LDM) is for supplying the laser with coolants and providing the necessary electrical power. It also serves for operation and monitoring of the laser by means of computer control and an operator panel. It also provides a customer interface and various safety functions.
Laser head	Laser generating unit (Section I "Structure of a Diode Laser") either as an external element (LDL/LDF) or integrated into the supply unit (LDF).

2 GENERAL SAFETY INSTRUCTIONS

Please carefully read and observe the following information and caution warnings found in this manual in order to ensure your own safety and a long service life of the equipment.

2.1 Caution, warning signs and important information

The following signs and standard definitions are:

Danger – Danger resulting from Laser Beam!

Warning against direct or indirect laser beam, meaning that serious bodily injury or considerable material damage can result, if the respective cautionary measures are not adhered to. This applies, in particular, for damage on or in the system itself and any resulting consequential damage.

Warning– General Danger!

Warning against general sources of danger, meaning that serious bodily injury or material damage can result, if the respective cautionary measures are not adhered to. This applies, in particular, to damage on or in the system itself and any resulting consequential damage.

Warning –Danger of electro-shock!

Warning against electrical shock, meaning that serous bodily injury or material damage can result, if the respective cautionary measures are not adhered to. This applies, in particular, to damage on or in the system itself and any resulting consequential damage.

Read and Understand Manual

This symbol urges you to observe carefully the detailed information given in the manual. The symbol is affixed to various parts of the supply unit.

Note

Contains important information concerning the respective equipment or a relevant section of the manual which is to be observed.

Info

This sign provides recommendations and information about the respective equipment or a relevant section of the manual which is to be observed.

2.2 Safety Instructions for Operating Personnel

The following operational procedures are not permissible if they:

- can endanger the user or third-parties.
- can cause damage to the equipment or other components.
- can impair the safety and proper functioning of the equipment.
- can compromise observance of these Safety Instructions.

Maintenance and inspections may only be carried out by trained personnel who have been instructed and are thoroughly familiar with possible dangers.

Warning –Danger to Personnel!

Increased danger of injury by non-functioning safety devices!

- Regularly check the proper functioning of all safety devices.
- Any malfunctioning and defects in the safety devices are to be immediately remedied and/or the Technical Service Team contacted.
- Always keep the housing of the equipment closed during operation; only open for maintenance work.
- Repair and maintenance work is to be carried out only after disconnection of the main power supply, i.e. separate the power supply from the equipment and the cooling circuit.

Warning – Conduct only approved maintenance work!

There is increased danger of injury for personnel who carry out maintenance work for which they are not qualified and instructed.

- Maintenance work may only be carried out by qualified and instructed personnel.
- Repairs may only be carried out on the cooling lines after pressure has been released.

Warning – the device contains live parts

Carelessness can lead to electro- shock.

- Disconnect equipment from mains power supply.
- Ensure that equipment can not be switched on again.
- Check equipment for electrical source
- Ground equipment and short circuit.
- Cover all adjacent equipment with electrical connection and secure the danger areas.

2.3 Stipulated Application

The diode laser is designed and developed in accordance with state-of-the-art technology and all generally recognized technical safety standards. However, during its application, there can be incidences of personal injury, or impairment to the system itself or other material damage.

The following information is to be strictly observed during use of the diode laser:

- Operation of the complete LDL series lasers and LDF series lasers with separate diode laser head (VG1, VG2, VG3) requires the following safety precaution: Laser head and optics have to be in a shielded operating cell.
- Laser head, optical fiber and optics have to be in a shielded operating cell.
- The diode laser may only be used as stipulated in this manual and only when in a flawlessly operational condition.
- The functionality of the system or unit is to be stipulated jointly with the customer for the respective application. Use of the system or unit other than the stipulated application is to be deemed as improper use and, in the event of damage, the manufacturer shall assume no liability.
- Strict observance of this manual is an essential part of the above defined application, as well as the adherence to the inspection and maintenance agreement.

2.4 Unit-specific Safety Instructions

- Only trained and qualified personnel are authorized for the respective activities of application, maintaining and transporting the system/unit.
- In the event of the malfunctioning or failure of the system or unit, the system must be immediately shut down and

secured against re-activation. Prior to re-activation of the system, all errors must be properly eliminated. In the case of failures that could influence safety, the diode laser may not be put into operation. Such failures or malfunctions must be immediately eliminated.

- The stipulated intervals of tests and inspections detailed in the operating manual must be strictly adhered to.
- In the case of repairs, only those replacement parts that meet the requirements of the manufacturer may be used. Any guarantee can only be ensured by using original replacement parts.
- Do not carry out any modifications, add-ons or re-building of the diode laser; nor the supply unit. Such modifications can considerably impair the safe function of the unit. Should unauthorized modifications be carried out, the manufacturer's warranty shall become void, and all consequential damage shall not be assumed by the manufacturer.
- Unauthorized modifications on the programmable control systems (software) are not allowed.

Warning – High Leak Current

High leak current can occur on the supply units VG2, VG3, VG3E, VG4, VG4L and VG5.

- An additional earthing conductor must be installed before the system is connected to the mains power.

2.5 Laser-specific Safety Instructions

Warning – Danger from Laser Radiation!

The laser beam can lead to irreparable personal injury.

- When working with the diode laser, strictly observe protection measures, as laid down by the Prevention of Accidents Ordinance, BGV B2 and EN 60825, Part 1, as well as additional norms and regulations.
- Please observe all attached safety labels for your own personal health and safety.

The following information is to be strictly observed when operating the diode laser:

- The diode laser operates in **invisible** wavelengths within a range of approx. 800 to 980 nm and is rated in laser class 4. **Laser class 4 designates a high beam power and any of its diffuse reflection can be dangerous.** Skin and eyes are not to be exposed to this radiation. The radiation of the beam power can lead to irreparable personal injury and damage to health. When working with the diode laser, all protective measures are to be followed in accordance with Prevention of Accidents Ordinance BGV B2 and EN 60825, Part 1, as well as all other norms and regulations.
- The operation of the laser facilities rated as class 4 must be registered with the Employers' Liability Association and the authorities responsible for work protection.
- In order to operate the diode laser, a trained authorized representative for laser protective procedures must be appointed in written form.
- Operate the system or unit only when all protective facilities and safety-related devices, e.g., exhaust system, EMERGENCY OFF switch and safety circuit are connected and in working order.

- The diode laser may only be operated in a system which is correspondingly rated as laser class 1. In the event of non-observance of this stipulation, the manufacturer shall not assume any liability for any resulting damage.
- The operating instructions should always be kept near the location where the diode laser is being operated. In addition to the operating instructions, all current statutory laws and other regulations for accident protection and those concerning environmental protection are to be observed. All persons working with the system or unit are to be thoroughly trained and qualified.
- Never look directly into the laser beam!
- All persons who work on and with this system or unit are required to carefully read the operating instructions and, in particular, the chapter containing the safety instructions. This also applies to those persons who only occasionally work on the system, e.g., during maintenance work, etc.
- There should be access restrictions for those people who do not work on or with the laser, e.g. using a key-operated switch.
- Settings and maintenance work are only to be carried out by the manufacturer's technical team; otherwise there is a danger of damage to the diode laser or unintentional exposure to laser radiation.

2.6 Information concerning special types of danger

The high-powered diode laser generates a very intensive beam which can be emitted from a primary and secondary potential of danger areas. The laser beam, as a primary danger source can lead to irreparable injuries to the eyes and skin.

Secondary potential dangers are not directly laser-specific and can be in the form of poisoning and destruction resulting from explosion and fire.

2.6.1 Primary Danger

The primary danger is the result of the essential difference between conventional light sources and a light source emitted by a laser; i.e., in the so-called bundling of the laser light: A conventional light source, e.g., a normal light bulb radiates its light throughout an entire room. In contrast, the diode laser light is bundled to a small focused line spot. If the eye is exposed, the laser beam is focused through the lens of the eye onto the retina. The focused spot of the laser beam on the retina amounts to only a few micrometers, while the light of a normal light bulb is spread over a larger area on the retina (approx. 0.1 mm). The light concentration (power density), in the case of a laser beam, is greater by a factor of a million than that of a light bulb. The laser beam can, in the event of unintentional exposure to the eye, cause serious damage to this organ. The invisible laser beam of the diode laser (approx. 800 to 980 nm) penetrates the optical membranes of the eye (corneal, hydatoid, lens and vitreum) on down to the retina causing serious damage to this part of the eye.

Observance must also be paid to dangers resulting from reflection. Reflections, e.g. the beam randomly hitting a workpiece as well as any other reflecting surfaces, can also lead to serious eye injuries. Importantly, in this context, is those materials which appear visually ‘rough’ to the human eye, are, in actuality, not so rough, and the long wavelength of infrared light can be reflected. As long as the surface roughness is smaller than the wavelength of the beam being used, this can result in a good reflector.

The danger to the skin by direct exposure of the beam is rated as considerably less than that to the eye. Since the skin is also an optically transparent medium, penetration depth and emission of laser radiation when working with the laser must be strictly observed. The maximum penetration depth lies at approx. 760 nm for these wavelengths, damage to the hypodermis can also occur.

2.6.2 Secondary Danger:

Not only the direct exposure to laser radiation can result in injuries, but also indirect effects can endanger personnel and the environment.

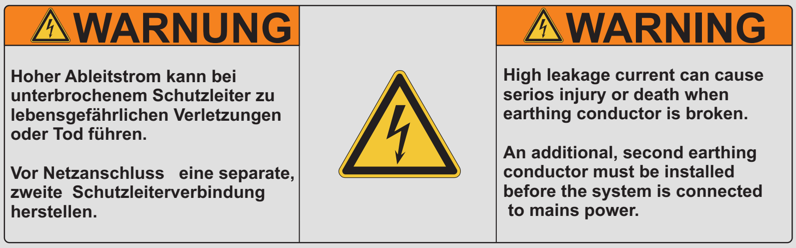
When using high-power lasers there is always a latent danger of fire and explosion, in particular, when there are flammable or in any other way reactive materials positioned in the area. Therefore, make sure that no flammable or explosion-prone substances are in the vicinity of the location where the laser is being used.

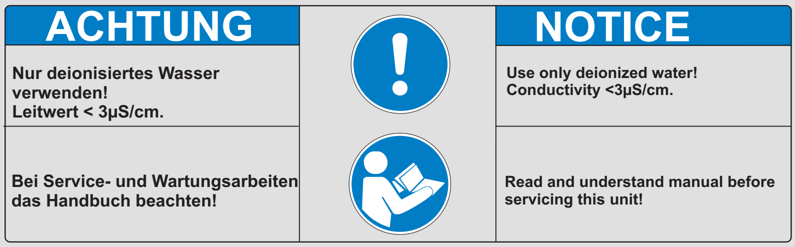
Even the formation of gas and smoke can additionally impair personal health. In particular, the vaporization of plastics can create extraordinarily dangerous substances.

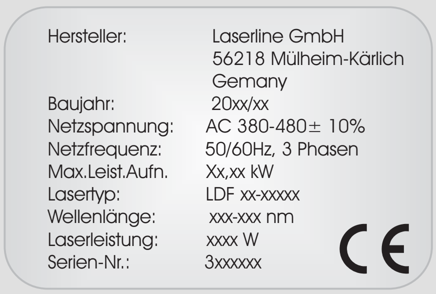
2.7 Warn-, Notice-, and type labels

Beam source and laser optics are provided with a series of labels:

No.	Illustration
1	 Warning label laser radiation
2	Laser Klasse 1 Laser class 1 Label laser class 1
3	**Sichtbaren und unsichtbare Laserstrahlung wenn Abdeckung geöffnet und Sicherheitseinrichtungen überbrückt. Bestrahlung von Auge oder Haut durch direkte oder Streustrahlung vermeiden. Laser Klasse 4.** **Visible and invisible laser radiation when open and interlocks defeated. Avoid eye or skin exposure to direct or scattered radiation. Laser class 4.** Label laser class 4
4	Invisible laser radiation emitted from this apperture. Warning against laser radiation
5	 Warning label high voltage

<table>
<tr><th>No.</th><th>Illustration</th></tr>
<tr><td>6</td><td>

Warning label high leak current</td></tr>
<tr><td>7</td><td>

Notice label DI water / maintenance</td></tr>
<tr><td>8</td><td>

Type label beam source</td></tr>
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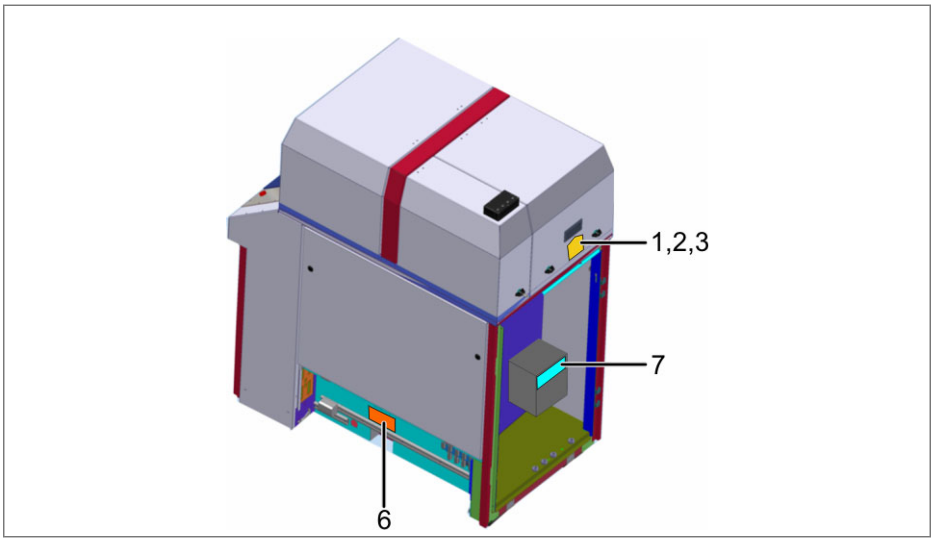


Fig. 1: Label on the beam source

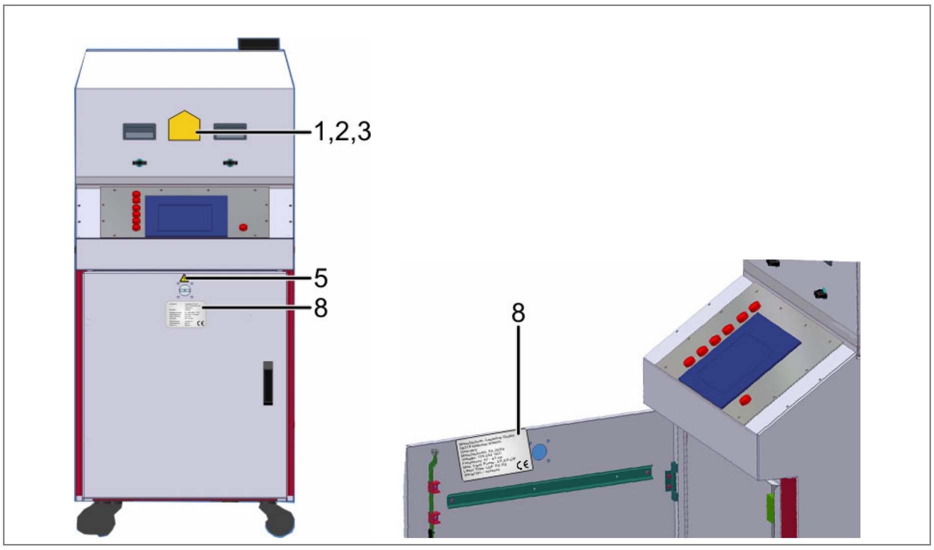


Fig. 2: Label on the beam source

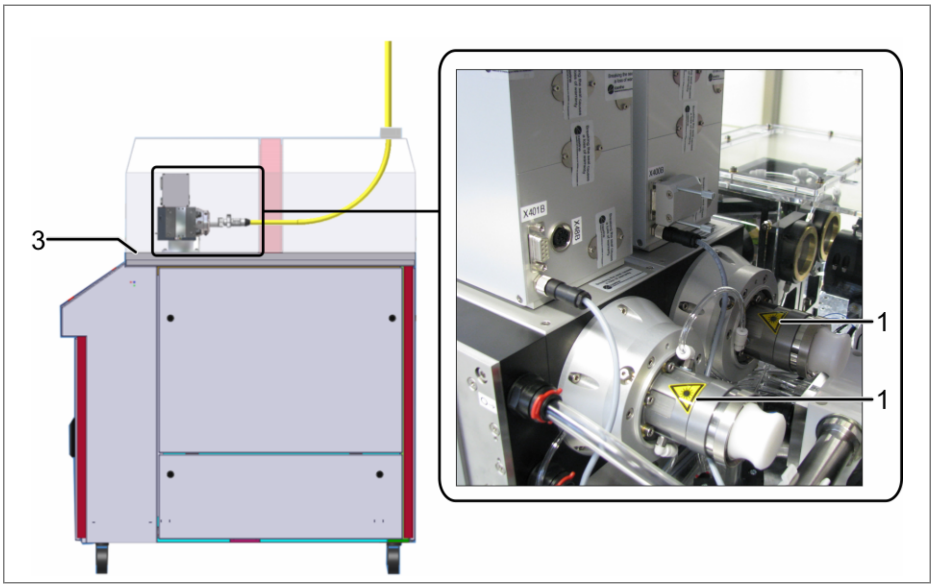


Fig. 3: Label on the laser head

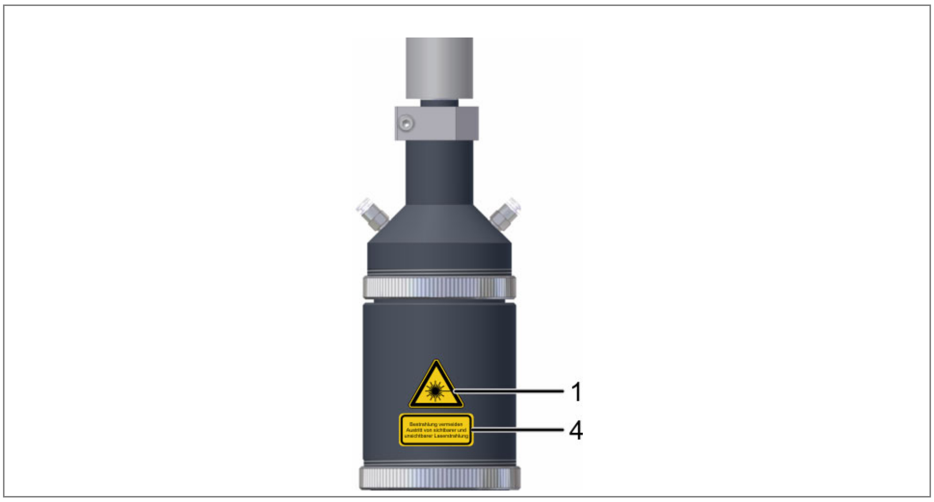


Fig. 4: Label on the laser optics

2.8 Statutory Laws, Norms and Regulations

The following is a list of the most important statutory laws, norms and regulations that are to be taken into consideration when operating a laser device to avoid or prevent potential dangers.

The list below provides only source material and does not claim to be complete:

Law / Norm / Regulation	Issue	Title
DIN EN 12254	2002-12	Shielding at location of laser operation technical-safety requirements and testing (contains amendment A1:2002).
DIN EN 207	2002-12	Personal eye protection – filters and eye protection against laser radiation (anti-laser goggles).
DIN EN 60825-1	2003-10	Safety for laser devices, Part 1: Classification of systems, requirements and user guidelines.
DIN EN 60825-1 Correction 1	2004-06	Correction to DIN EN 60825-1.
DIN EN 60825-4	2004-06	Safety for laser devices – Part 4: Laser protection walls.
DIN EN 61040	1993-08	Receivers, measuring devices and systems for measuring radiant power and intensity of a laser emitted beam.

Law / Norm / Regulation	Issue	Title
73/23/EEC	1973-02-19	European Council Directive of 19 February 1973 towards homogenization of statutory regulations of member states regarding electrical operational equipment for use within a certain voltage limit (Low Voltage Directive).
89/336/EEC	1989-05-03	European Council Directive of 3 May 1989 towards homogenization of legislation of the member states governing electro-magnetic compatibility.
98/37/EC	1998-06-22	Directive 98/37/EC of the European Parliament and the Council of 22 June 1998 towards homogenization of legal and administrative regulations of the member states for machines.
DIN EN 60204-1	1998-11	Machine safety, electrical equipment for machines, Part 1: general requirements.
DIN EN 60447	2003-07	Basic safety regulations for human-machine interfaces, marking and principles of operation.
DIN EN 954-1	1997-03	Machine safety, safety-related components of control systems, Part 1: General principles of design.
DIN EN 954-1, Supplement Sheet 1	2000-01	Machine safety, safety-related components of control systems Part 100: Guidelines for use and implementation of EN 954-1:1996
DIN EN ISO 13407	2000-11	User-oriented design of interactive systems
DIN VDE (Association of German Electrical Engineers) 0100-100	2002-08	Installation of low-voltage systems, Part 100: Range of application, purpose and principles
DIN VDE (Association of German Electrical Engineers) 0100-410	1997-01	Installation of high-voltage systems with a rated voltage up to 1,000 V, Part 4: Protective measures; Section 41: Protection against electro-shock.
DIN VDE (Association	2003-06	Installation of low-voltage systems, Part 4: Protec-

Law / Norm / Regulation	Issue	Title
of German Electrical Engineers) 0100-410/A1		tive measures; Section 41: Protection against electro-shock; amendment A1.
DIN VDE (Association of German Electrical Engineers) 0100-430	1991-11	Installation of high-voltage systems with a rated voltage up to 1,000 V; Protective measures; Protection of cables and electrical lines in the event of power surges.
DIN VDE (Association of German Electrical Engineers) 0100-540	1991-11	Installation of high-voltage systems with a rated voltage up to 1,000 V; Selection and installation of electrical production facilities, grounding, protective earth conductors, equipotential bonding.
VDI (Association of German Engineers/VDE (Association of German Electrical Engineers) 3850 Gazette 1	2000-05	User-friendly design of control systems for machines.
VDI/VDE (Association of German Engineers/VDE (Association of German Electrical Engineers) 3850 Gazette 2	2002-11	User-friendly design of control systems for machines – interactive devices for monitor screens.
VDI/VDE (Association of German Engineers/VDE (Association of German Electrical Engineers) 3850 Gazette 3	2004-03	User-friendly design of control systems for machines – design of dialogue for touch screens.

Other laws and regulations

Law / Norm Regulation	Issue	Title
GPSG	2004	Equipment and product safety law.
TRGS 900	2002-12	Technical regulations for hazardous substances – maximum workplace concentration, atmospheric limits
BGV A1 (Federal German Law)	2004-01	Principles of prevention
BGV A2	1998	Electrical systems and production facilities
BGV B2	1997-01	Laser radiation
BGI 832	2003-04	German federal information sheet: Operation of laser devices– application of UVR „Laser radiation“(Federal German Law) BGV B2.

2.9 Laser registration in accordance with BGV (VBG 93)

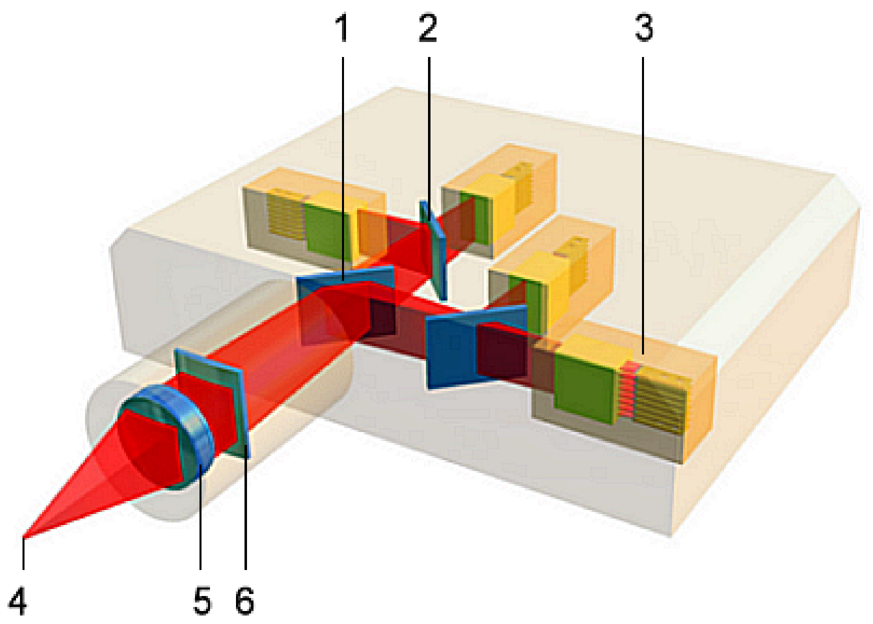
Photocopy the following printed form and fill in for registering the diode laser system/equipment and forward it to the local Employers' Liability Insurance Association.

Laser Registration in accordance with BGV B2 (VBG 93) (Please fill in using a typewriter or in block letters!)	
Company registering:	
Street:	
Zip code:	
City:	
Phone / Fax:	
Ref : Laser Registration	
Member number:	
Manufacturer:	
Laser product designation:	
Laser type indicating wavelength:	
Output:	
Radiated beam intensity:	
Laser class in production:	
Laser class for maintenance:	
Place of operation, Dept.:	
Name of appointed person responsible for laser safety:	
Date of scheduled commissioning:	
City / Date:	Signature / Company seal

3 BASIC STRUCTURE OF A DIODE LASER

Essentially, the diode laser head consists of a stack of individual diode laser components with lenses for shaping and projecting the beam.

The following schematic illustration shows a diode laser head:



1	Polarization coupling	4	Laser spot
2	Wavelength coupling	5	Focusing lens
3	Laser diode stack	6	Collimation lens

Fig. 5: Wavelength and polarization coupling of a diode laser

3.1 Structure of a Diode Laser Component

A diode laser bar consists of many individual emitters with a size of 0.5 x 3 µm² which are arranged in a row and mounted on a cooling element. The output of such a diode laser amounts to 30 watt and more. These components are stacked one upon the other This structure allows an increase in laser intensity to more than 100 watt.

Energy supply to the diode laser components

The diode laser components are supplied with electrical power and coolant water. The DC voltage excites the semiconductor material that makes up the diode laser bar and causes it to laser. The DC current is generated by a mains power pack which is adapted to the requirements of the diode laser.

Cooling the diode laser stack

Converting the electrical output in the laser bar to optical output produces up to 70 % waste heat which is dissipated to a cooling element. In order to avoid heat accumulation, water is pumped through the cooling element. Via an external heat exchanger the heat generated by the diode laser stack is dissipated in to ambient air.

Focusing the laser beam

For focusing the emitted diode laser beam, at first the beam is collimated with a microbar lens near the diode laser component in Fast-Axis (vertical to the emitter level). In further beam projection the divergence in Slow-Axis direction (parallel to the emitter level) is collimated by a cylindrical lens. The bundling and projection of this two-fold collimated laser beam onto a minute area of a work piece is finalized by the laser’s focusing optics.

Special characteristics of a diode laser system

In contrast to other laser sources (laser heads) for which a single beam with high intensity is generated in the laser-active medium, high-performance diode laser systems are based on the combination of many individually focused beams. The actual beam sources are tiny semiconductor diodes that are arranged in a row forming a so-called bar. The great disadvantage of this is the extreme angle of divergence with which the beam is emitted. In a vertical direction to the emitter row (Fast-Axis) it amounts up to 90°, parallel to it (Slow-Axis) is approximately 10° (round angle). Depending on the focusing optics used, the respective distance to the work piece is determined.

Polarization and wavelength coupling

In order to double the emitted laser performance, two different laser wavelengths are combined using a suitable dielectric mirror. This principle is known as wavelength coupling. Furthermore, the excellent polarization of the laser beam can be used for a further increase in output performance. In addition to wavelength coupling, two beam fields that are polarized linearly can be combined by means of suitable mirrors. By using both procedures, the output intensity of the laser system can be increased by about a factor of four while maintaining an almost constant beam quality.

4 FIBER-COUPLED DIODE LASER: LDF

The laser beam is transmitted via a laser light cable directly to the work pieces being machined. As a result, the original focus of the diode laser beam can be transferred as a round, fine, focused spot.

The laser light cables are equipped with temperature and rupture monitoring sensors; and are able to be replaced by simply plugging in without re-adjustment. The monitoring cable registers any failure to the control panel, which, in the case of any malfunction, immediately shuts down the laser system.

The following describes the essential functional units:

- The supply unit supplies the laser with all necessary operational functions and monitors the integrated diode laser head in which the diode laser stacks, laser beam focusing elements and sensors are integrated.
- The laser light cables are available in various core dimensions, (measured in µm, e. g., 400; 600, 1000, 1500 µm) for the varying laser power classes.
- Various additional components such as e.g., pyrometer, scanner, shutter or CCD camera, which are adapted to the respective application, can also be retro-fitted upon special needs and on request.

5 SUPPLY UNIT VG4L

The supply unit performs a control and monitoring function and provides the cooling for the diode laser. The following main components are always integrated into the supply unit:

- Diode power supply (s) and power supply
- Cooling unit
- Control system (PLC and microcontroller)
- Control unit with touch display
- Customer interface(s), teleservice

The diode laser is operated using a control unit integrated into the supply unit and/or the customer interface(s).

1	Laser light cable feedthrough	3	Control unit
2	Cover for laser head	4	Main switch

Fig. 1: Construction of VG4L supply unit

No.	Designation	Description
1	Laser light cable feedthrough	The feedthrough is used to fix and feed through the laser light cable from the supply unit.
2	Laser head cover	The laser stacks are located under the cover.
3	Control unit	The control unit is used for displaying the system control. Numerous parameters can be viewed and modified using the control unit. The control buttons are used to operate the systems in internal mode (manual mode).
4	Main switch	This switch is used to turn the entire diode laser system on and off. Note that installation, commissioning and most maintenance work may only be carried out when turned off.

5.1 Unlocking the main switch

The front door cannot be opened when the laser unit is turned on (switch lock). For service, the main switch can be unlocked.

- Press the release button and open the front door with the handle.

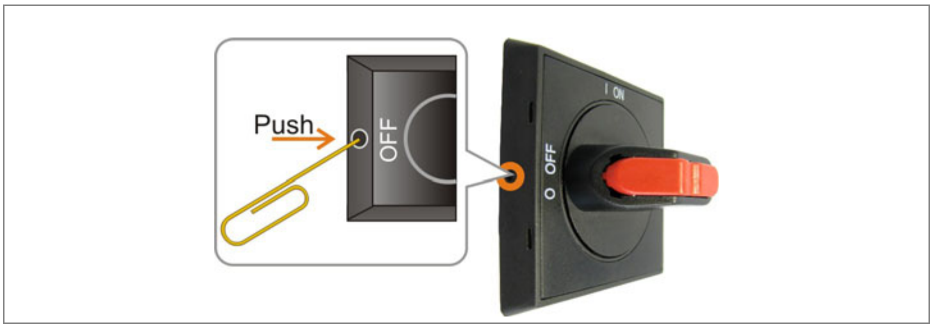


Fig. 2: Releasing the main switch

5.2 19” module rack

1 Diode power supplies

Fig. 3: 19” module rack

The 19“ rack on the supply unit is used to hold system components (diode power supply, dust protection unit) and optional components (PC for Pyrometer and Scansystem etc.).

5.3 Structure control unit

Fig. 6: Central control of a VG (opened front door)

(1) Over voltage protection VG
(2) Relay for optic chiller (optional)
(3) Fuse block for power supply
(4) Fusing 24 V power supply
(5) Main power switch, VG
(6) Freq. converter, coolant pump
(7) Power supply, 24 V
(8) Load contactor, power supply
(9) Load contactor, converter
(10) Emergency-OFF control/hour meter
(11) CPU/PLC
(12) 24 V fusing
(13) PLC control circuit board (s)
(14) Modem line / Ethernet
(15) X3 A/B Interface

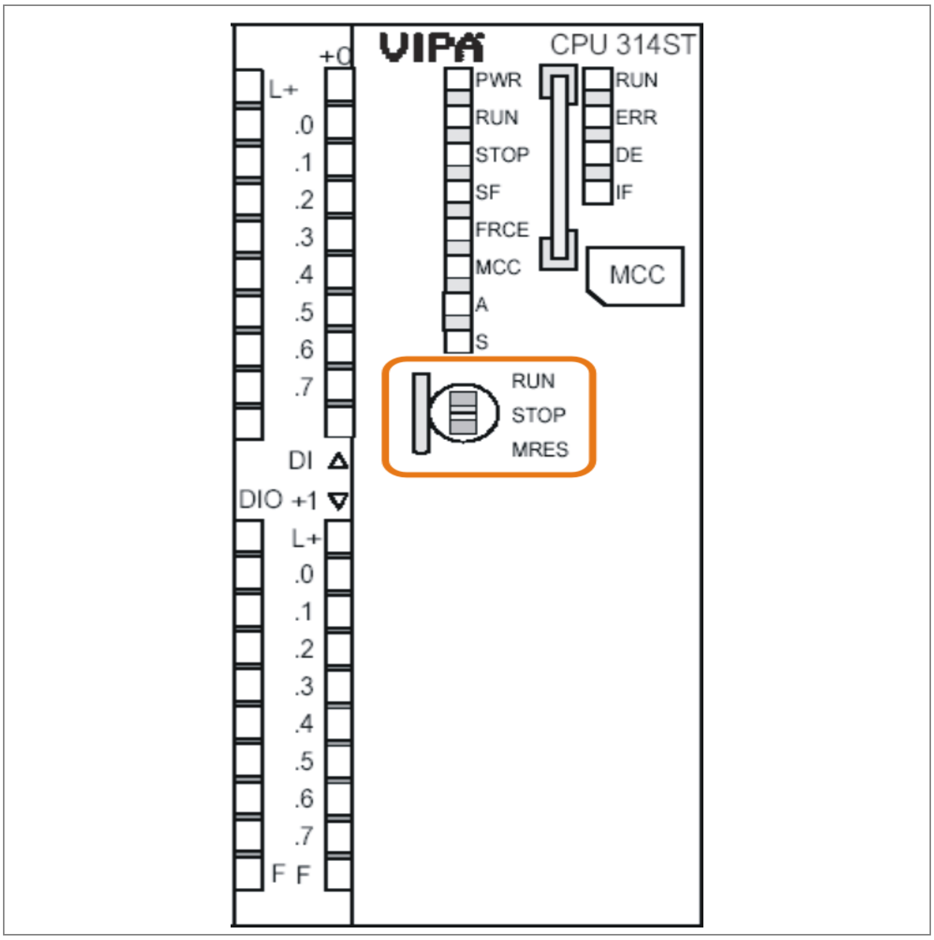


Abb. 7: Mode selector PLC

RUN	PLC program is being executed
STOP	PLC program is not being executed
MRES	Memory Reset*)

Note - Position MRES

If the key is set to position MRES all programs entered by the customer are deleted and the system is set back to delivery status.

The essential functional components in the front area of the supply unit are briefly described as follows:

No.	Designation	Description
(1)	Mains equipment protection	Protects the laser system against normal mode voltage and common mode voltage between the phases and the neutral conductor as well as ground.
(2)	Relay for optic chiller (optional)	Control relay for optic chiller (only if optic chiller is integrated).
(3)	Fuse block	Fusing for the diode power supply in the VG is arranged in this block.
(4)	Fusing for 24 V power supply	Fuse protection for the power supply of the 24 volt power supply.
(5)	Mains power switch	Used for turning the entire laser system ON/OFF. Combined main switch / main fuse protection with a circuit breaker.
(6)	Frequency converter	Enables operation of the coolant pump at 50 or 60 Hz mains frequency.
(7)	Power supply 24 V	Supplies the PLC control circuit board, the operating unit and the CPU.
(8)	Load contactor, power supply	The contactors are part of the electrical circuit of the diode power supplies.
(9)	Load contactor, converter	The contactor is part of the electrical circuit of the frequency converter.
(10)	Emergency-OFF control / Hour meter cooling system	Controls the Emergency-OFF function of the laser system. Counts, as soon as the cooling pump is running.
(11)	CPU/PLC	The Central Processing Unit is the computer unit for controlling the laser system.
(12)	24 V fusing	The 24 volt fusing for the CPU and the PLC control circuit board and other components (see electrical drawings).

No.	Designation	Description
(13)	PLC control circuit board	Operation and monitoring of the laser system are via a PLC controller unit. The circuit board manages the circuitry and other monitoring functions.
(14)	Modem line / Ethernet	Connector for telephone line to modem and Ethernet connector.
(15)	Customer interfaces	Interfaces of the laser system (back side).

5.4 Structure of the Cooling System

Fig. 8: Cooling system of VG2-5 (example)

(1) Solenoid
(2) DI-cartridge
(3) Volume-flow sensor
(4) Terminal box for cooling system
(5) Plate heat exchanger
(6) Water filter
(7) Filling neck
(8) Water tank
(9) Water filter, power supply
(10) Coolant pump / drain
(11) Transport bolts

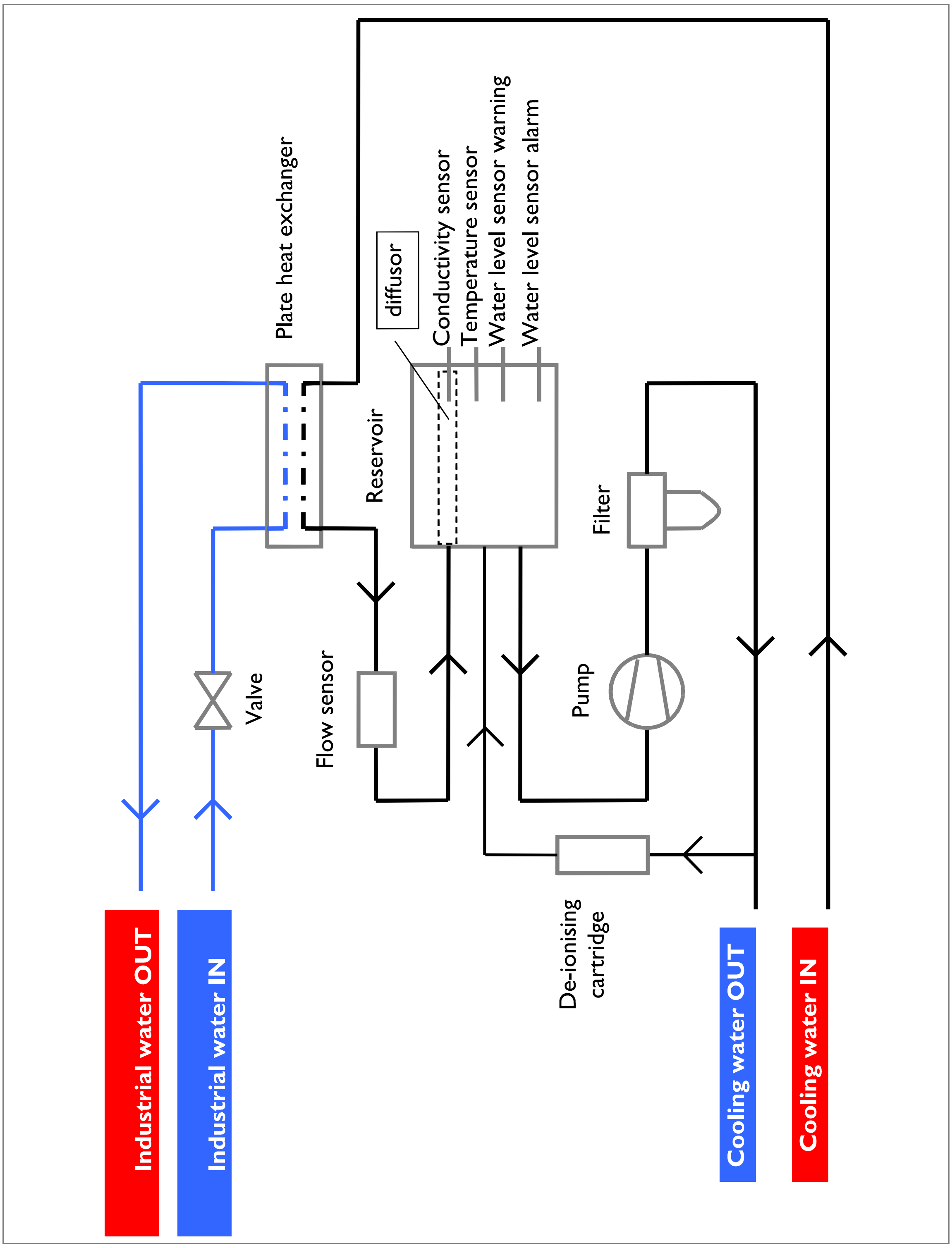


Fig. 9: Flow diagram, cooling system

The heat loss generated by the diode laser head is led to the cooling system via the supply lines. This waste heat is then fed either directly to the heat exchanger where it dissipates into the open air or, in the case of high-power diode lasers; it is directed to an external cooling circuit. The major functional components at the rear of the supply unit are briefly described below:

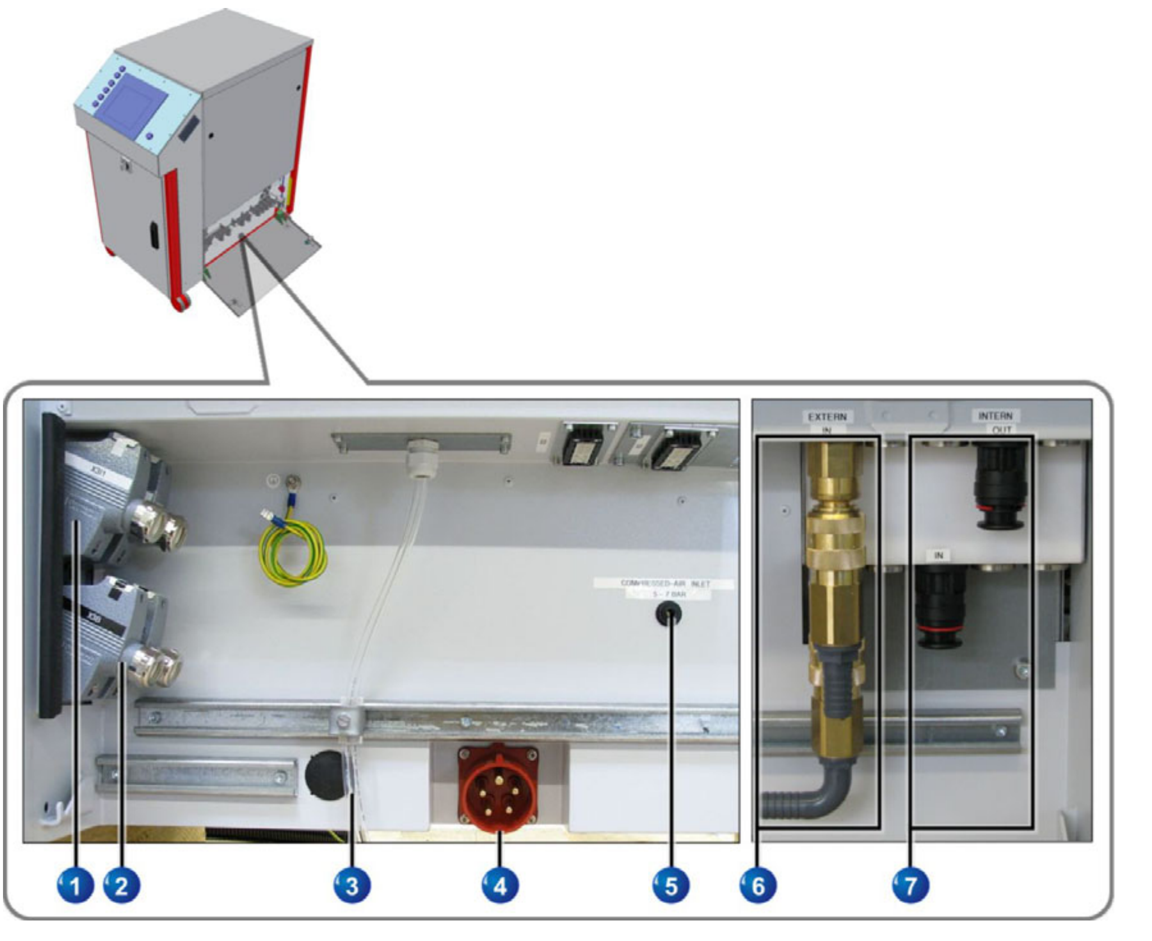
No.	Designation	Description
(1)	Solenoid	Serves as a control for the external cooling circuit.
(2)	DI-cartridge	For cooling the laser, de-ionized water is used as it is suited to the requirements of the system. The DI-cartridge ensures correct conductance of the coolant and is to be replaced at regular intervals.
(3)	Volume-flow sensor	Measures the coolant volume-flow in the cooling system.
(4)	Terminal box for the cooling system	Only accessible for Laserline Service.
(5)	Plate heat exchanger	The plate heat exchanger connects the internal cooling circuit (closed, DI-water circuit) to the external cooling circuit the customer provides. This way the external circuit absorbs the waste heat from the internal circuit.
(6)	Water filter	The water filter ensures clean water in the cooling system and is to be replaced at regular intervals.
(7)	Filling neck	This opening is used for filling DI-water in to the water tank of the cooling system.
(8)	Water tank	Contains the DI-water for the cooling cir-

No.	Designation	Description
		cuit and sensors for temperature, level and DI-value.
(9)	Water filter, power supply	Filters particles from the coolant water of the diode power supply.
(10)	Coolant pump	The pump delivers the coolant thought the internal water circuit (laser).
(11)	Transport bolts	These bolts are used for lifting the supply unit from or on to a transport pallet.

Further information can be found in Section 7,"Commissioning in to operation“.

5.5 Water and mains power supply

The connections for electrical power and water supply are positioned in the connection area on the right side of the supply unit. The cover panel is held by two catch bolts.



1 Field bus interface	3 Drain dust protection	5 Compressed air inlet	7 Drain vents
2 Customer interface	4 Mains power	6 Ext. circuit	

Fig. 10: Connection area

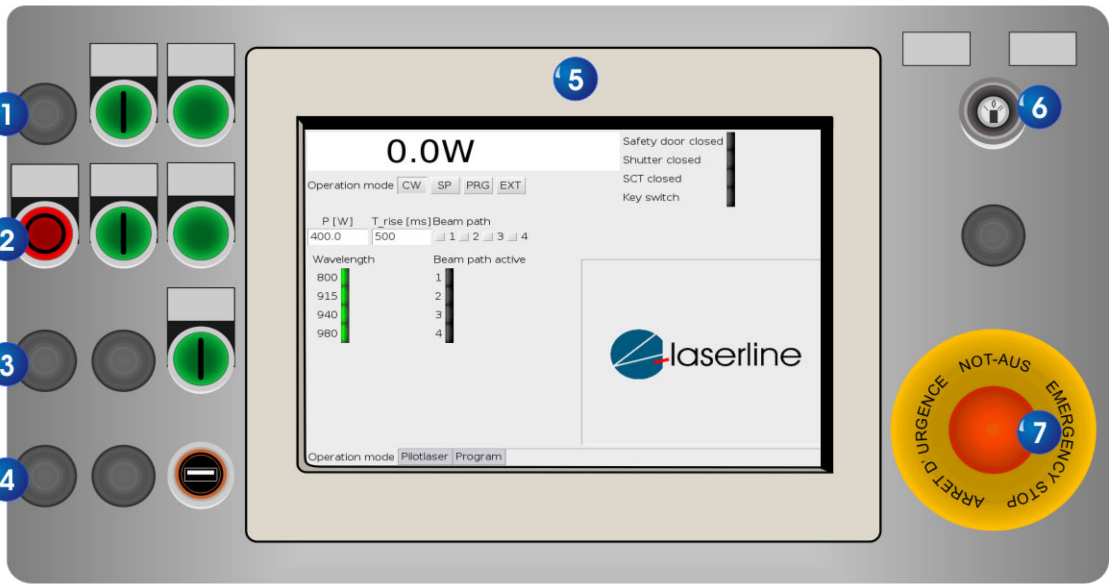
No.	Designation	Description
(1)	Field bus interface (optional)	By using the Field-bus interface the laser system can communicate with a robot system or a master control unit. The interface is available as an option.
(2)	Customer inter-face	The interface provides safety (X3A) and control functions (X3B). Additional optional interfaces: Tele service, Ethernet and external chiller control. To operate the system the X3A interface must be wired by the customer. The X3B interface can be used for controlling via external hardware (DIO, AIO) Additional information in section "Customer inter-face".
(3)	Drain dust protec-tion (optional)	A membrane air dryer is fitted to systems equipped with the option “dust protection”. Condensate gen-erated during the drying process is drained by these hoses.
(4)	Mains power	Mains power connector for the laser system.
(5)	Compressed air inlet (optional)	Compressed air needs to be feed into systems equipped with the option “dust protection” The compressed air is conducted to the membrane air dryer by this connector.
(6)	External circuit feed / return lines	Feed and return lines of the external cooling circuit (customer).
(7)	Drain vent internal circuit	Drain vent for the internal cooling circuit (laser).

5.6 Layout of the operating unit

Die operating unit serves for visualizing and controlling of the system.

The operating unit consists of the following functional components:

- Operation keys
- Display (touch screen)
- Key-operated switch PILOT/LASER operation (three positions)
- Emergency-OFF button



1	Operation keys (Laser ready)	5	Console (touch display)
2	Operation keys (Laser On / Off)	6	Key switch PILOT/LASER
3	Operation key (Pyrometer -optional)	7	Emergency-OFF button
4	USB interface for optional components		

Fig. 11: Operating unit with console

No.	Designation	Description
1-3	Operation keys	These keys control the major functions of the laser system, for example, laser READY and ON/OFF functions. Most keys are backlit as soon as they have been activated
4	USB interface	Interface for optional components.
5	Console	The laser parameters appear on the display of the operating unit. New values or adjustments can be either entered or selected in the subdirectories.
6	Key switch PILOT/LASER	In position "0", the diode laser cannot be switched on. In position "1", only the alignment laser can be switched on. The alignment laser can be operated with opened safety circuits. In position "2", the Pilot laser (LED and alignment) as well as the laser can be operated. If the safety and/or protective door circuits are open, only the alignment laser can be switched on. In position "1", the key can be removed (LED mode and Laser cannot be operated). In position "2", the key cannot be removed.
7	Emergency-OFF button	By pressing the Emergency-OFF button in dangerous situations, the laser beam, the diode mains power as well as the cooling system are immediately shut down.

5.6.1 Arrangement of the operation keys

Fig. 12: Operation keys of the supply unit

No.	Designation	Description
1	Laser_READY button	This key must be pressed in order to switch the laser system to READY status. The READY status is the precondition for switching the laser on. (Laser_On).
2	Laser_READY LED	Serves as a safety lamp indicating that the laser system is in READY status.
3	Laser_OFF button	Pressing this key shuts down the laser power of the diode laser.
4	Laser_On button	Pressing this key turned on the diode laser. The diode laser now emits the beam at the pre-set power P_set (CW mode).
5	Laser_On LED	Serves as a second safety lamp indicating that the laser has been switched on.
6	Pyrometer On/Off (optional)	Starts the booting process of the internal pyrometer PC.

Info – Operating Unit

Detailed information regarding the console can be found in chapter „Overview Page 8-1“.

6 TRANSPORT AND ASSEMBLY OF THE SYSTEM

Transporting the laser system:

- After delivery, check the laser system for transport damages. The shipping company and Laserline are to be informed immediately about possible damages.
- For the transport, only use suitable and technically sound lifting tools (observe the maximum tensile force!).
- Only transport the laser system in a vertical position.
- The laser system can be transported by means of castors. The castors are lockable in order to secure the laser system against rolling away.

6.1 Transport and packaging of the diode laser system

Note

- The laser systems are affixed to the adjusted transport palettes for shipping. These pallets should be stored and used again when the equipment is shipped.
- External diode laser heads may only be sent in the transport boxes used by Laserline. The transport containers can be used more than once.
- The shipping should be carried out by a shipping company in order to prevent any risk of transport damages. Observe the notification signs on the equipment!

6.2 Requirements for location of the laser system

The space requirements for setting up the laser equipment are shown on the next page. The doors (front and back) as well as the side coverings must be freely accessible for maintenance purposes.

The set up location must be even, the laser system must be secured against rolling away (fixing brake on the rollers).

The hoses of the external cooling circuit must be laid taking the radii into consideration (7.3.2 External cooling water circuit page 7-5).

The load-bearing capability of the floor must correspond with the weight of the supply unit.

Supply unit	**Dimensions in [mm³] (L x W x H)**	**Weight**
VG4L 	1,400 x 770 x 1,760	750 kg on four rollers

6.2.1 Dimensions and installation area

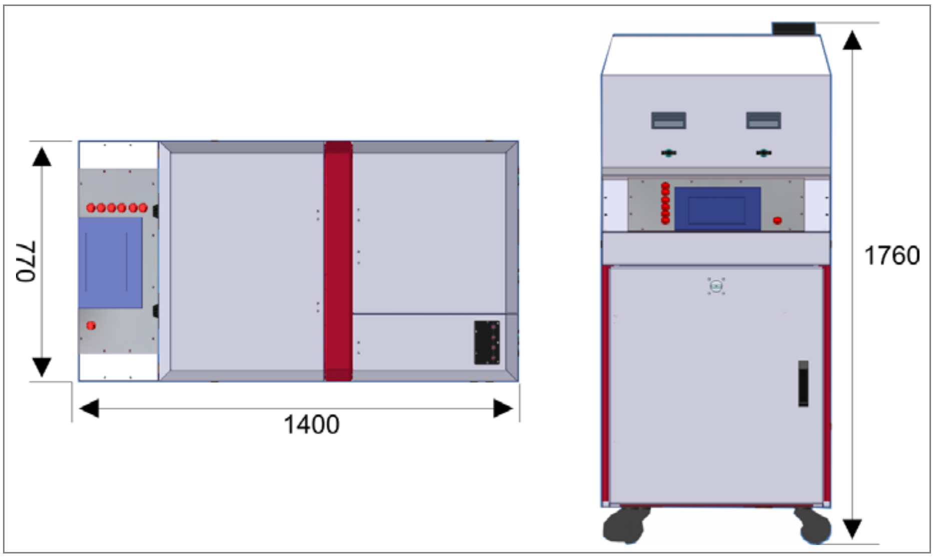


Fig. 13: Dimensions

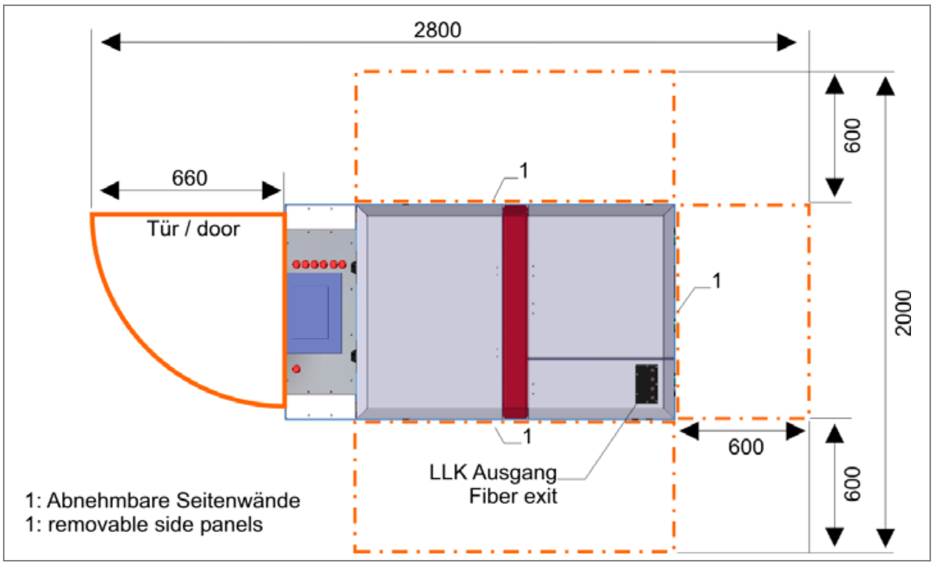


Fig. 14: Installation area VG4L

6.2.2 Temperature and Humidity

Independent on the climate conditions the dew point may not exceed 19°C. Lower threshold ambient temperature is +10°C. This results in the following values for temperature and humidity:

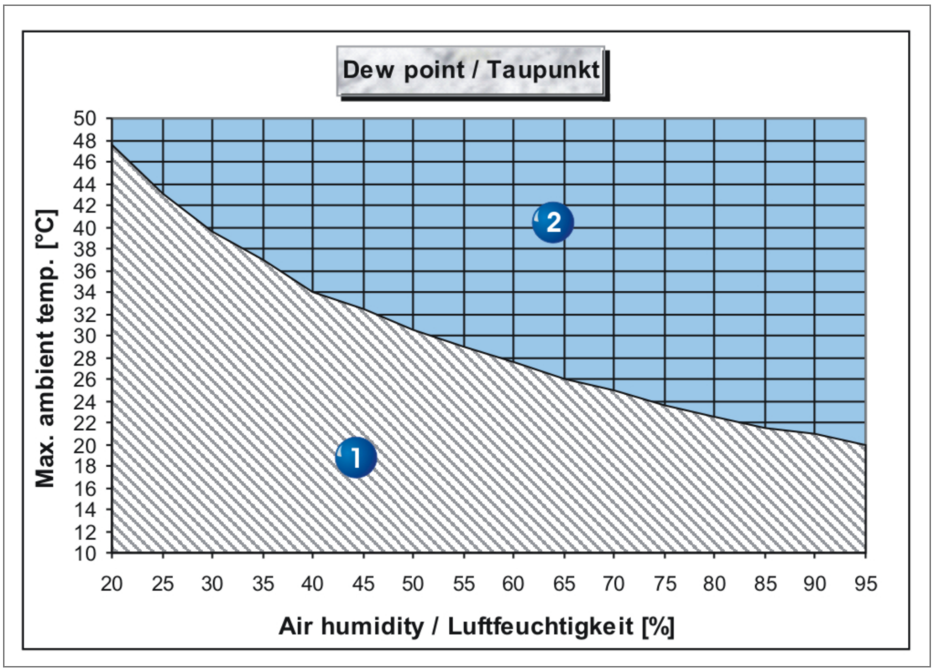


Abb. 15: Overview temperature and humidity

Area	Description
1	Operation of the system is permissible.
2	Operation of the system in this area is **not** permissible.

6.3 Installation of the Supply Unit

The diode laser system is delivered on specially prepared re-usable pallets. As transport fastening the supply units are screwed to the pallets by transport bolts. VG2-3 laser systems are delivered with an additional transport box (fixed to a second pallet) which contains the laser head.

6.3.1 Transport lock

Follow the procedure below for hoisting the supply unit from the pallet:

- Open the front door of the supply unit.
- Loosen and remove the mounting bolts (1).

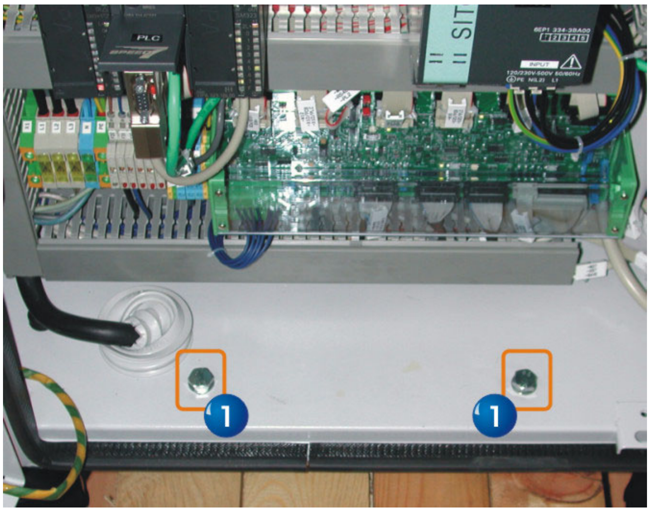


Fig. 16: Transport fastening of the supply unit (1) front side

- Open the rear door panel of the supply unit
- Loosen and remove the mounting bolts (2).

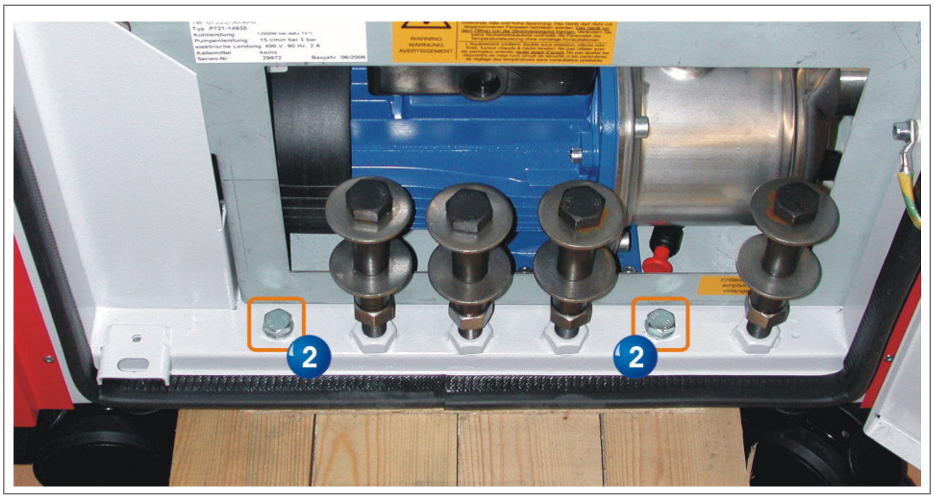


Fig.17: Transport fastening of the supply unit (1) back side

6.3.2 Transport bolts

- Open the left and right side panels of the supply unit.

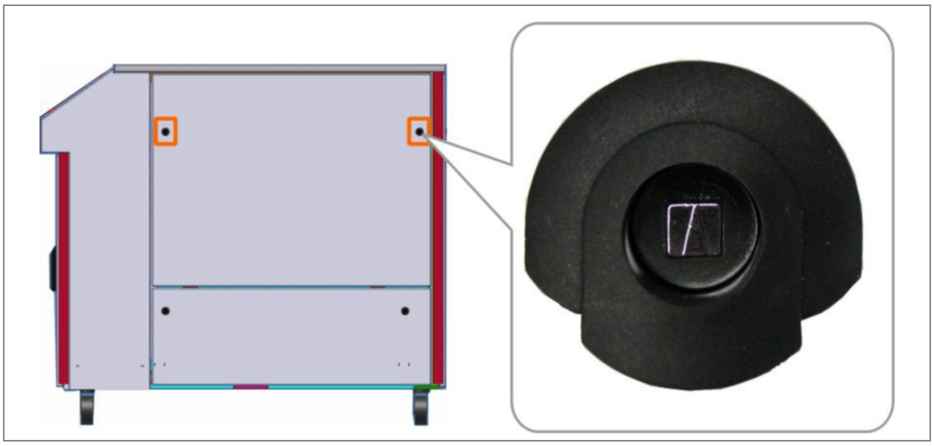


Fig.18: square-headed bolts of the side panels

- Completely remove all side panels and remove the cover caps from the two threaded bolts on each side (total of four).

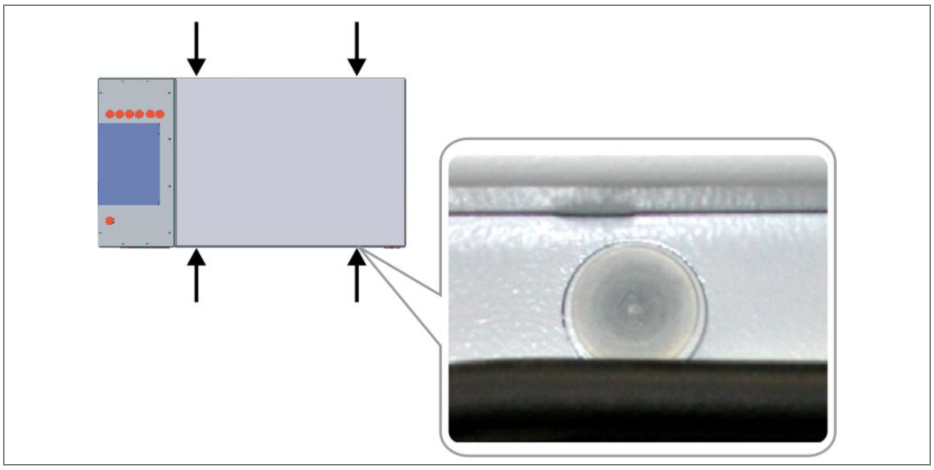


Fig.19: thread cover caps

- Now open the rear side panel of the supply unit and unscrew the four transport bolts from their sockets. Screw all transport bolts again into the threaded openings on the sides of the supply unit.

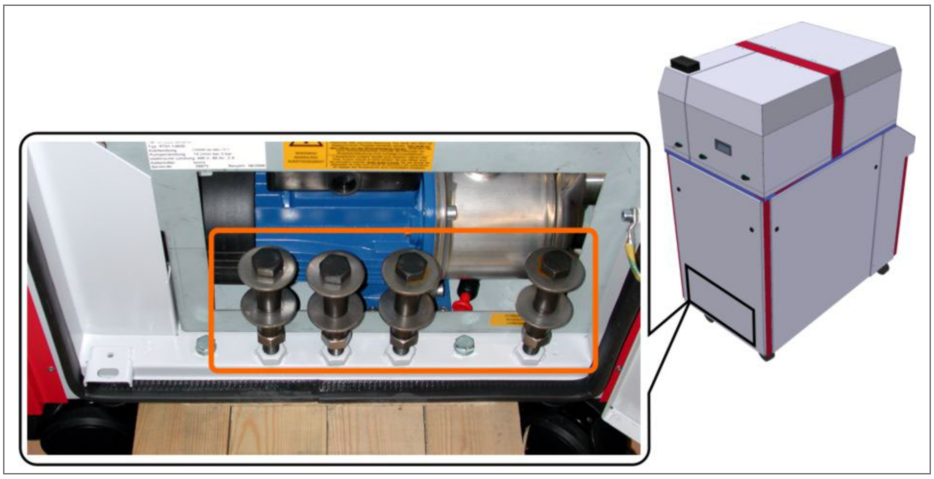


Fig. 20: Transport bolts

- After screwing in the bolts, hoisting straps, ropes or cables can be affixed to the bolts and then attached, by straps, chain or rope to a crane to lift the supply unit from the pallet.

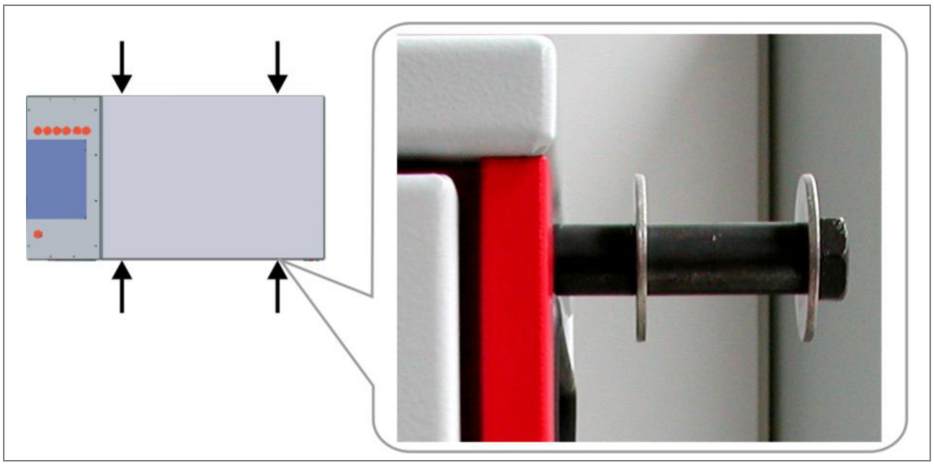


Fig.21: Transport bolts as holding rods

- At the site of installation, the supply unit must be set up in a vertical position and secured against rolling. The latter can be secured using the four lockable casters with which the supply unit is equipped.

Warning – Danger of swinging load

Swinging loads are a danger due to possible falling.

- Never stand directly below objects being lifted.
- Be absolutely sure that forklifts, cranes and their chains or cables are suitable for the particular load capacity of the respective supply unit being lifted.

6.4 Disassembling the System for Transport

For preparing the laser system for transport for purposes of maintenance, repair or upgrading, first switch off the system from the electrical power supply. Open the panel of the connection area and disconnect all connections to:

- Supply unit and mains power supply
- Hoses for water feed and return lines
- Customer interfaces

All residual coolant water within the laser system must be drained from the cooling system and the laser head.

6.4.1 Draining the coolant water from the supply unit

- Remove (open) die back panel (door) of the supply unit.
- Open the filling neck and remove the cap.

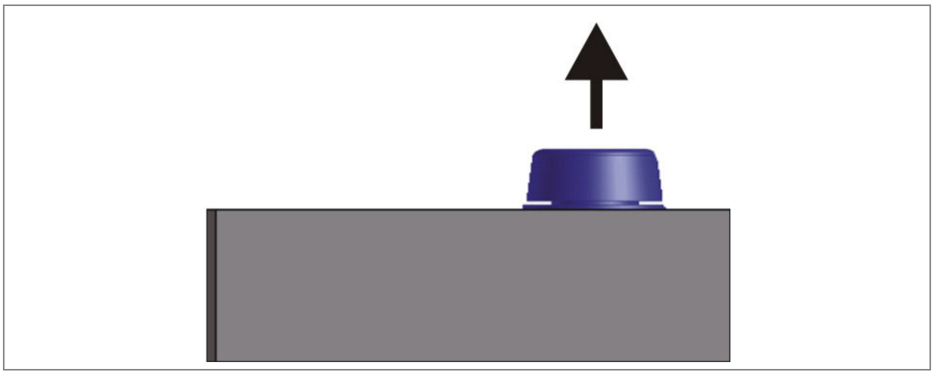


Fig. 22: Filling neck

Remove the left side panel of the supply unit. The cooling pump with the drain vent is positioned in the rear area to the left and below the coolant tank.

- Remove the plug on the drain vent.
- Wait as long as no further water is draining and set the plug back into the drain vent.

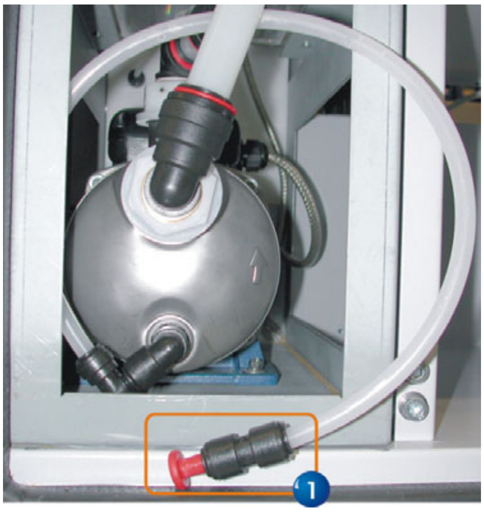


Fig. 23: Drain vent (1) cooling pump

6.4.2 Draining the coolant water from the laser head

The coolant in the laser head must be drained before shipping the system. For this purpose the laser head must be flushed with compressed air.

Note

Flush the laser head only using **oil-free** air (max. 2 to 3 bar).

Proceed as follows:

- Open the side cover panel of the connection area.

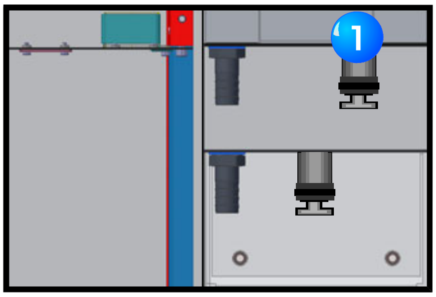


Fig. 24: Drain vent (1)

- Open the drain vent marked "internal out" (1).

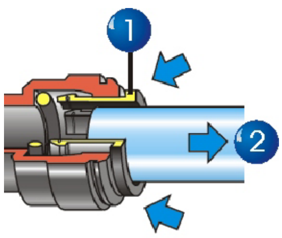


Fig.25: Open the quick connector

- Push the Ring (1) in arrow direction and simultaneously pull out the plug (2) in arrow direction.

Warning - Over Pressure

The coolant water reservoir can burst when using too high pressure.

- Only flush the laser when the filling neck is open.
- Do not exceed the max. pressure of 3 bar.

- Feed compressed air (2 to max. 3 bar) into the cooling system. Coolant is going to exit at the drain vent (cooling pump) during the procedure.
- Flush the system until the coolant in the hoses (laser head) has been drained (approx. 2-3 min).
- Close all drain vents and the filling neck.

6.5 Packaging the system for Shipment

- Screw all transport bolts again into the threaded openings on the supply unit (Transport bolts page 6-6).
- Lift the supply unit on the transport palette.
- Affix the supply unit to the transport palette by using the transport bolts (bolts at the front and back of the system).
- Wrap the system with air bubble- and stretch foil.
- Set the wooden frames around the supply unit and screw the frames to the transport palette.

1 Wooden frames
2 Supply unit
3 Accessories
4 Transport pallet
5 Laser light cable

Fig. 26: Transport preparations

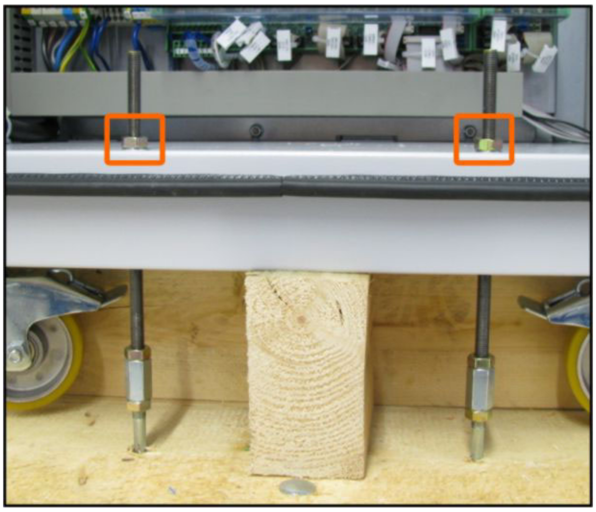


Fig. 27: Affixing transport bolts

- Pack the laser light cable according to the instructions of the laser light cable manual. Observe the bending radius! (Manual Laser Light Cable page 15-1).
- Wrap the accessories (optics etc.) with air bubble foil. Put the parts in a cardboard box.
- Affix the cardboard box to the supply unit by using stretch foil.

Note

- All supply units are firmly mounted for transport on re-usable pallets. These pallets are to be carefully stored and used again for re-transporting the supply unit.
- Transport is to be carried out by a reliable forwarding agent in order to avoid damage to the supply unit and laser head. Please note the red information sheets.

Fig. 28: Transport packaging

- Screw the front and back frames to the side frames. Screw the top cover into place.

7 COMMISSIONING AND INITIAL START-UP

Warning – Danger resulting from improper initial setup and operation

There is an increased danger of personal injuries to those personnel who carry out operation of the equipment, but have not been instructed in its use and are not qualified.

- Putting the system into initial operation may only be carried out by those personnel who have been properly instructed in its use and are familiar with the system and have obtained the necessary qualifications.
- Before initial operation, all technical safety measures and conditions are to be fulfilled.
- The site of operation of the equipment or the system must meet the requirements as found in Section “Transport and Installation of the System, Requirements for the site of operation of the system“.

Warning – Danger from Laser Radiation!

The laser beam can lead to irreparable personal injury.

- Please observe all information in section “Caution, warning signs and important information page 2-1 ”.

Note – Material damage caused by water

Water lines under high pressure can lead to damage of the equipment. When the laser system is not used for a longer period of time, the external water feed-line is to be shut off.

Info

During initial operation, check the laser system for any possible leakage.

7.1 General conditions for Initial Start-up

Before putting the laser system into initial operation, please observe the points below:

- Carefully read the Operating Manual, in particular, the section on safety instructions before putting the diode laser into operation. This also applies to those personnel who only occasionally operate or work on the laser system or equipment.
- Concerning tools: have at hand a set of various screwdrivers and hose clamps for connecting the hoses of the cooling system. A square wrench, used for opening the supply unit, is provided with the diode laser system (not necessary for LDM).
- To ensure safe and reliable operation, the laser system must be so enclosed / encased as to meet the requirements of Safety Class 1.
- Make sure that the electrical power supply switch of the supply unit is in the “0” position.

7.2 Quick operation

The following summarizes in brief the initial operation. For further details, please refer to the following chapters.

- Cooling (Filling the cooling system p. 7-11)
  - Fill the internal cooling system of the unit.
  - Connect the unit with an external coolant system.
- LLC (Manual Laser Light Cable p. 15-1)
  - Connect the laser light cable with the unit and the laser optics. Connect the interface plug with the laser light cable monitoring.
  - Guide the laser beam into a suitable absorber.
- Beam switch (optional)
  - Connect the safety circuit of each beam outlet and run the assignment procedure.
- Safety (Safety circuits of the beam source P. 12-4)
  - Close the safety and emergency circuits of the supply unit.
- Interface (PIN Assignment of Interface X3B p. 12-16)
  - Connect up the customer interface to control the unit (optional).
- Power connection (Connecting to mains power p. 7-14)
  - Connect the unit to a suitable power supply.
- Verify coolant level
  - After setting up, replenish the coolant

7.3 ISetting up the cooling system

7.3.1 Connection area

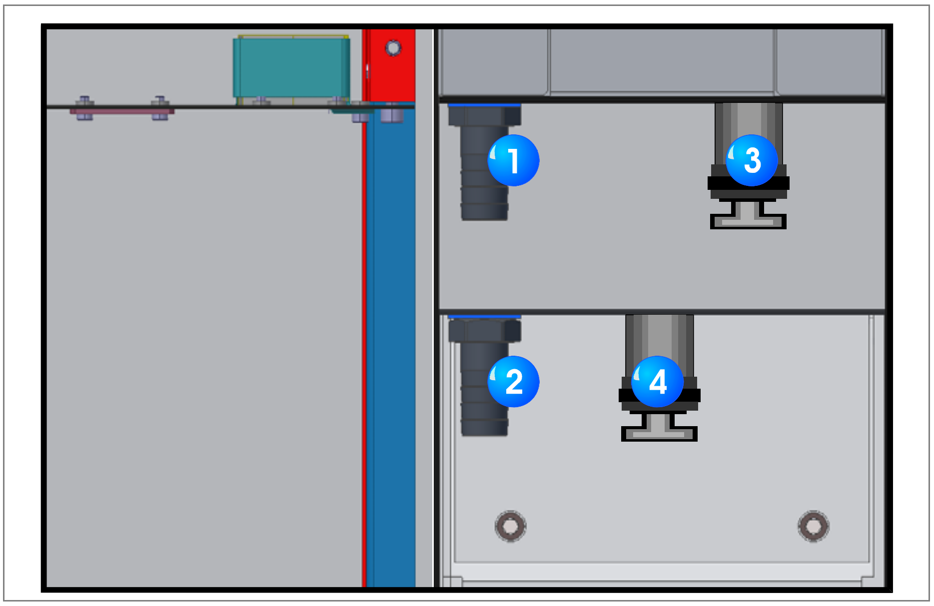


Fig. 29: Nozzles for cooling circuits

No.	Function
(1)	Inlet external cooling circuit (Customer)
(2)	Outlet external cooling circuit (Customer)
(3)	Drain vent internal outlet
(4)	Drain vent internal inlet

7.3.2 External cooling water circuit

The external cooling circuit is led to a plate heat exchanger, where the waste heat of the internal cooling circuit is dissipated. A solenoid (magnetic valve) regulates the amount of water flowing to the external circuit and the heat exchanger. Connection of the external cooling circuit is carried out in the connection area of the supply unit.

	Characteristics
Temperature inlet	+ 10°C .. +16°C (systems ≥ 6000W +10°C .. 14°C).
Pressure	0.5 bar (Min.) to 6 bar (Max.)
Pressure difference	≥ 0.5 to ≤ 2,5 bar (magnetic valve open)
pH value	6..9
Connectors feed and return lines	Plastic hose nozzle 19mm Ø
Materials	Stainless steel, brass, plastics

Requirements for the cooling circuit:

- When the solenoid (magnetic valve) is closed, dynamic pressure builds up. The external cooling circuit must therefore, be able to withstand such pressure; and it may not exceed an increase in pressure of > 6 Bar.
- Make sure that a minimal radius of bend of approx. 250 mm is ensured for the cooling unit hoses,
- The external cooler should be equipped with an over flow value in order to protect against malfunction (icing).

- The external coolant circuit is not equipped with a water filter. If extremely dirty coolant water is used with dirt particles greater than 0.5 mm, this can lead to the malfunctioning of the magnetic valve. In the event of this, the temperature of the coolant water will fall drastically. If considerably dirty water is being used in the coolant system, the user is obliged to install a suitable water filter in the external coolant circulation system.

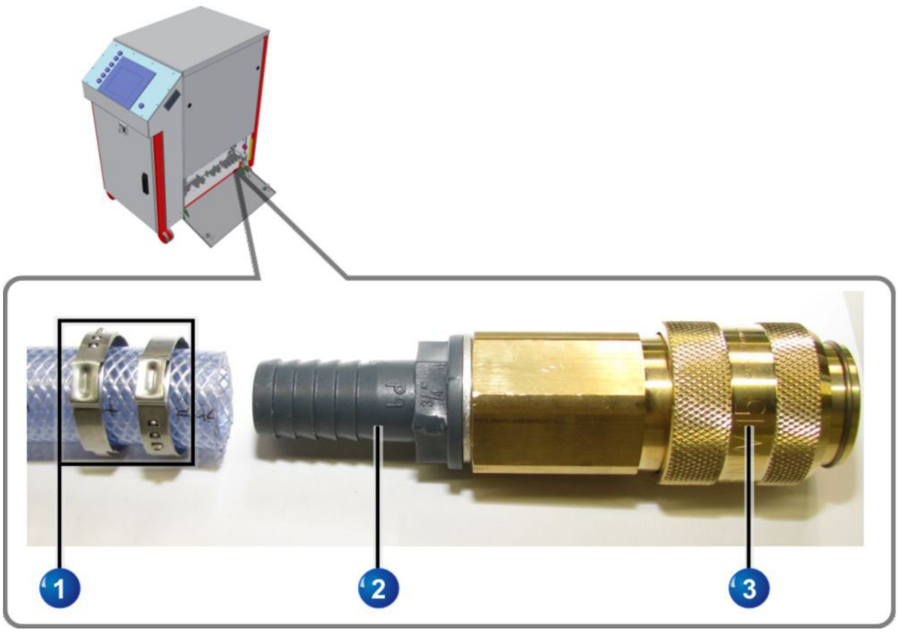
Note – Cooling Circuit

- Should the external feed and return lines be mixed up, the temperature of the coolant declines sharply.
- A polluted magnetic valve also leads to a low coolant temperature.
- Before connecting the system to the external coolant system, a complete flushing (rinsing) of the coolant lines is to be carried out.

Note – Cooling circuit

- If the external cooling circuit is operated with a low water pressure, the solenoid remains open for a longer period of time.
- In the case of a higher water pressure, the solenoid is open for only a short time.

7.3.2.1 Connecting the external cooling circuit



1	Hose clamp (1 ear clamp)	3	Quick connector
2	Hose nozzle 19mm Ø		

Fig. 30: Quick connector ext. cooling circuit

1. Connect feed and return lines of the external cooling system with the hose nozzle.
2. Secure the hoses with a hose clamp (clamp or screw version).
3. Observe feed and return lines on the unit. The cooling system will not operate correctly if the lines are mixed up.
4. Check tightness of all hose clamps

7.3.2.2 Coolant Water Consumption VG4L and VG5

Laser Power [W]	Cooling Capacity [W]	Coolant volume l/h 13 °C	Coolant volume l/h 15 °C	Coolant volume l/h 16 °C
100	1000	120	150	170
150	1000	130	170	190
200	1100	140	200	210
250	1200	150	220	220
300	1300	170	250	240
500	1700	200	300	300
700	2000	240	350	360
1000	3000	350	500	510
1500	4000	450	620	660
2000	5000	600	750	820
3000	6500	900	1100	1300
4000	8500	1100	1500	1700
6000	12000	1500	2000	2500
8000	16000	2200	3000	--
10000	20000	3000	--	--

Tab 1: Cooling capacity / water consumption

Tab 1 shows the cooling capacity of the laser system depending on the maximum laser output power.

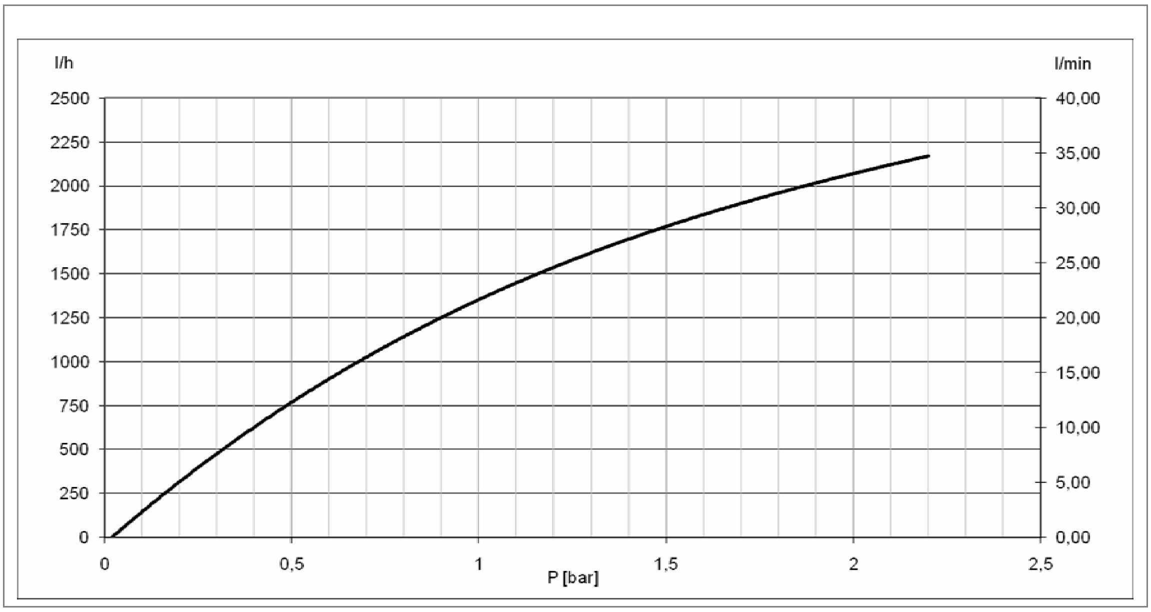


Fig. 31: Pressure drop characteristics

The figure shows the pressure drop characteristics (solenoid open) corresponding to the flow rate of the external circuit (l/min and l/h).

7.3.3 Internal cooling circuit

The internal cooling water circuit absorbs the waste heat of the laser as well as the switch mode power supply and leads it to the external cooling circuit of the plate heat exchanger.

The cooling circuit is equipped with two water filters that ensure clean coolant water to the laser and the switch mode power supply. Sensors are provided for water temperature, coolant level in the water tank, coolant volume flow as well as DI-value; these sensors continuously transmit the actual real-time data to the control system. A DI-cartridge continuously de-mineralizes the coolant water.

	Characteristics
Coolant	Deionized / demineralized water, alternatively: distilled water.
Filling capacity	approx. 30 l
Conductance	≤ 3µS / cm
pH value	6,5..8

7.3.4 Filling the cooling system

Follow the procedure below for filling the cooling system:

- First remove (open) the rear panel (door) of the supply unit and unscrew the cap on the filling neck.
- Fill the cooling water reservoir with the coolant until the water level reaches the **max**. mark on the water level gauge.

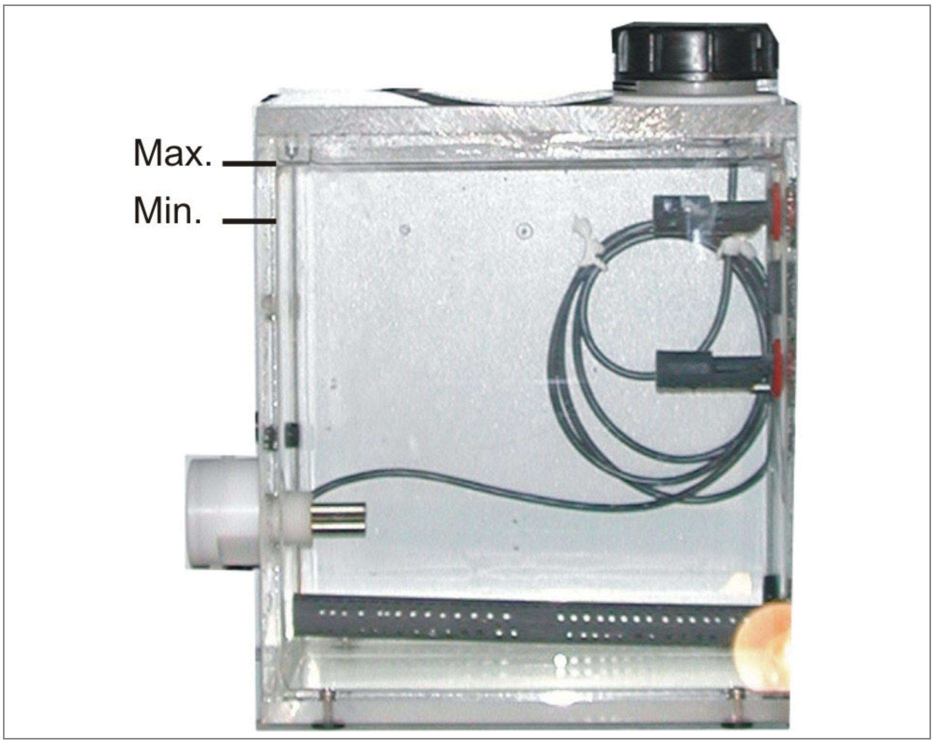
Now put the VG, as described in the following chapters, into operation. The cooling system must now operate for a few minutes to enable the coolant to begin to flow through the system. The coolant level will drop after a short time.

- Refill the water reservoir until the max. level is reached again.
- Check the coolant water level at least once or twice a month; if necessary add coolant water.

Note - Coolant

- Please pay attention to cooling water requirements in particular concerning DI value and pH-value.
- During normal usage of the laser, water should only be filled up whenever required. A complete change should only be performed for first installation and for shipment.

Fig. 32: Coolant water level gauge; maximum level (1)



7.4 Customer interface

Before initial operation, the safety functions and (if necessary) the external control of the diode laser must be wired. Routing assignment as well as examples of circuitry can be found in chapter “Customer Interface Page 12-1 ”.

The customer interface is positioned in the connection area of the supply unit (see chapter 5.)

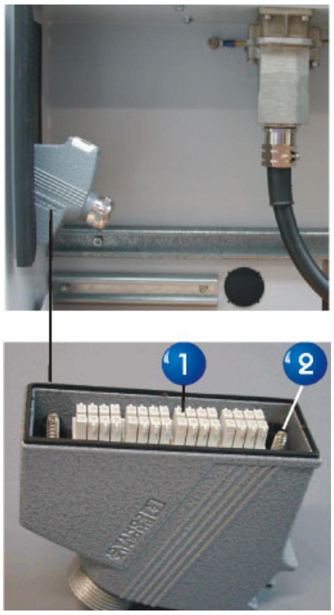


Fig. 33: X3 plug for external interface connection

(1) Contacts
(2) Screws for fixing

7.5 Connecting to mains power

Before connecting the laser system, please take note of the following points:

Note

- The laser system requires a three-phase connection with protective earthing conductor; the fusing from the mains power is to be protected by blow-out fuses.
- The operator of the system is to arrange for coarse and central earthing contact, as well as protection against lightning stroke and extreme power surges.
- The system is tested according to EN 61000-6-2 table 4 (stability alternating current on power line in- and outputs)

Electrical specification:	
Line voltage	380-480 VAC ± 10%
Line frequency	50-60 Hz

The supply unit is connected to a three-phase mains power supply using a CEE plug with either a 16A, 32A or a 64A fuse rating.

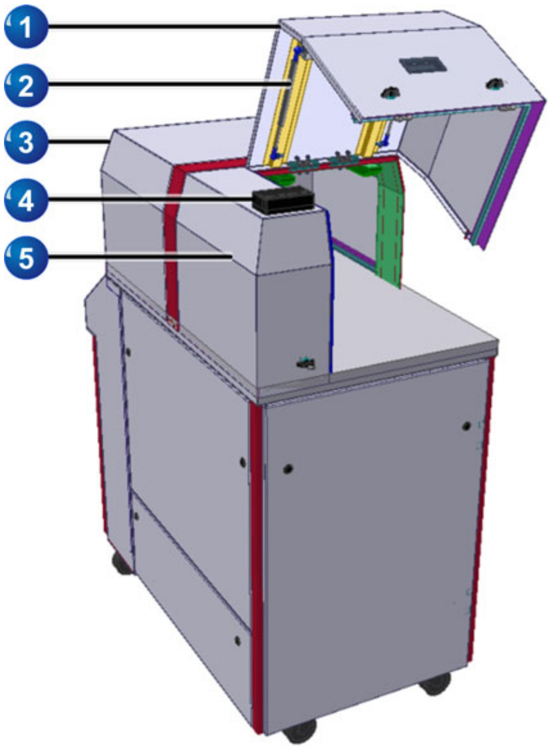
Warning – High Leak Current

High leak current can occur on the supply units VG2, VG3, VG3E, VG4, VG4L and VG5.

- An additional earthing conductor must be installed before the system is connected to the mains power.

Laser output power [W]	Mains power consumption [kW]	Mains connector 3P + PE
100	1	CEE 32 A-6h
150	1,2	
200	1,4	
250	1,6	
300	1,8	
500	2,5	
700	3	
1000	4	
1500	6	
2000	7	
3000	10	
4000	13	CEE 32 A-6h
6000	19	
8000	24	CEE 63 A-6h
10000	30	

7.6 Covers



1 Rear cover
2 Holding device
3 Front cover
4 LLC optic cable guide
5 Guide

Abb. 34: Open side cover (right) with guide-through cover

The cover of the supply unit is divided into three separate elements. Each element can separately be moved upwards. The two bigger elements (front and rear) are maintained in their upper position by a supporting device. When these elements are open, the laser can n**ot** be activated.

Information – Covers

When covers are open, the laser cannot be operated (safety circuit open).

The small element on the left side is **not** equipped with a supporting device and serves to guide through the laser light cable and the control cable (customer protection door / field bus) towards the outside. Element **must** be permanently closed and must only be opened when installing or removing the laser light cable (when required). With the rear cover closed, the guide-through element cannot be opened. The laser light cable is fixed in the laser light cable guide (4) at the guide-through cover.

Note – laser light cable

Opening the guide-through cover with the laser light cable installed can lead to damage of the laser light cable.

7.7 Beam Switch Design

The beam switch distributes the laser light coming from a laser source in a time-delayed fashion to individual beam output channels (time sharing). When a beam output channel is active and emits laser power, all other beam outputs will necessarily be inactive during that time.

7.7.1 Beam Switch Modules

The beam switch generally consists of at least two beam shutter modules and one absorber module.

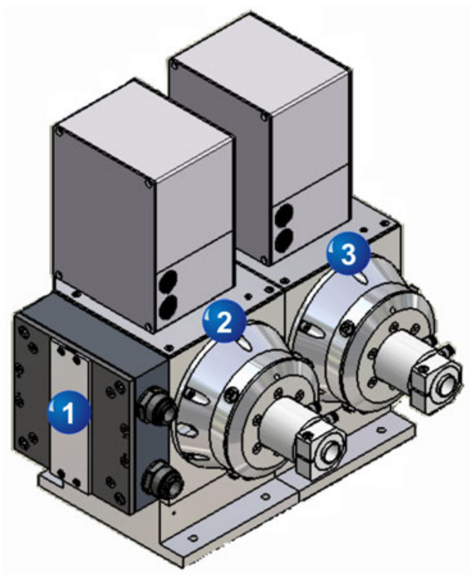


Fig. 35: Design of beam switch with 2 beam switch modules

(1) Absorber module

(2) Beam switch module 2

(3) Beam switch module 1

7.7.2 Beam Shutter Module Design

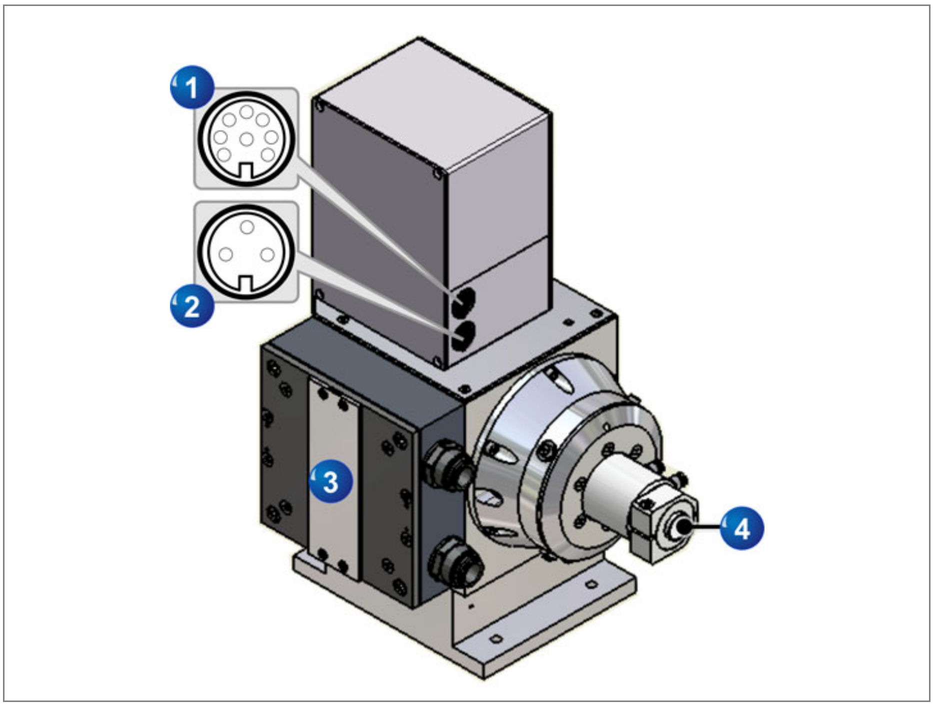


Abb. 36: Beam Shutter Module

The beam shutter guides the laser beam into the laser light cable via connection (4) or, for a short period of time, into the absorber module (3). After start-up, the module performs an initialization step and a self-test.

Nr.	Module / Component	Designation 2
(1)	Safety Door Interface	The safety equipment of the customer installation is connected to this interface. With the circuit open, no laser power can be output.

Nr.	Module / Component	Designation 2
(2)	Laser light cable Monitoring System Interface	The connector of the Laser light cable monitoring system is connected to this interface. If the Laser light cable is incorrectly connected, overheated or defective, a fault message will be displayed. The laser cannot be operated.
(3)	Absorber module	The absorber module is required for short-term absorption of the laser beam, e.g. for shifting operations etc.
(4)	Laser light cable Connection	This is the connection point for the laser light cable.

Information – Connector Assignment

For assignment of the safety door interface and further information, see chapter „Interface Beam Switch Unit (safety circuit) page 12-9 “.

7.8 Disabling a beam outlet

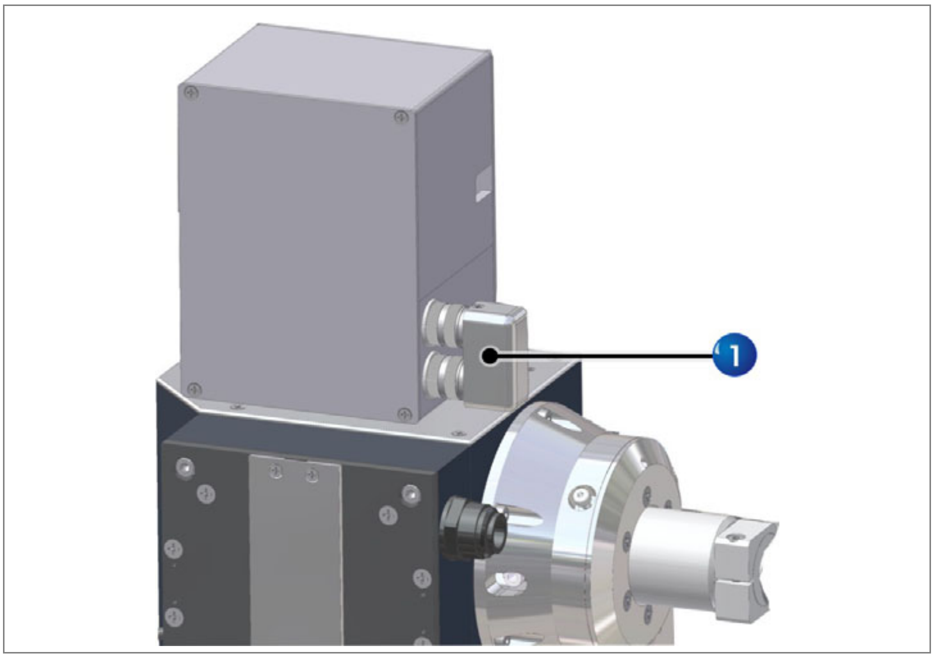


Fig. 37: Shorting plug

A shorting plug for each beam outlet is supplied with laser systems equipped with a beam switch. The plug can be installed instead of the LLC monitoring and safety door circuit. The laser system will not output an error message but the beam outlet is not operable (safety door circuit remains open).

Info – Connector

To ensure a sufficient electrical contact it is necessary to screw all connectors.

7.9 Connecting the laser light cable

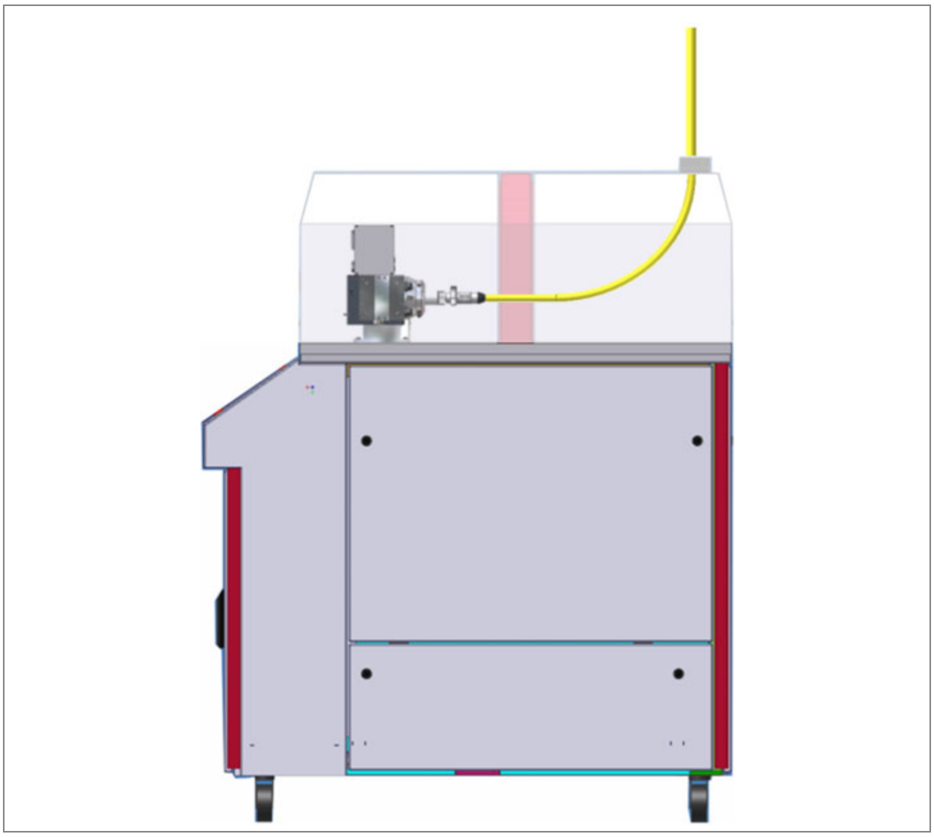


Abb. 38: Laser light cable Guide-Through VG4L

Warning – Dangerous Laser Beam

Improper handling of protection cover can damage the fiber optic cable.

- Loosen the fixing device of the fiber optic cable before opening the guide-through cover.

Note – Bending Radius

When connecting the fiber optic cable, observe its maximum bending radius (chapter „Manual Laser Light Cable page 15-1 “).

The laser light cable guides route and fix the individual laser light cables inside the supply unit. Additional connection cables for the customer safety door (with optional beam separating filter) can also be routed out of the supply unit through the laser light cable guide.

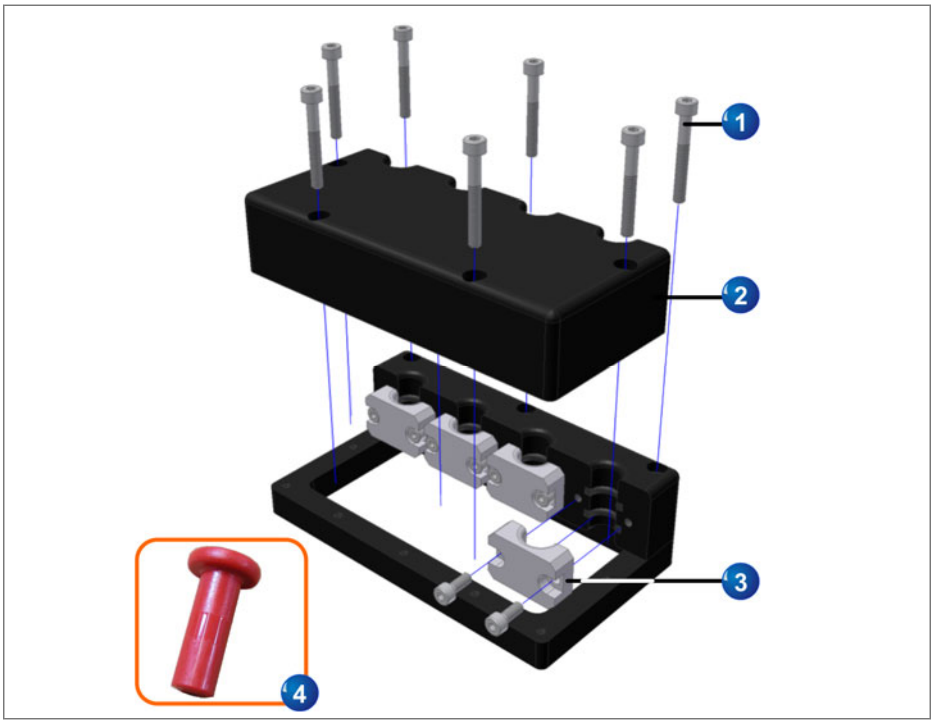


Abb. 39: Laser light cable Guide Design

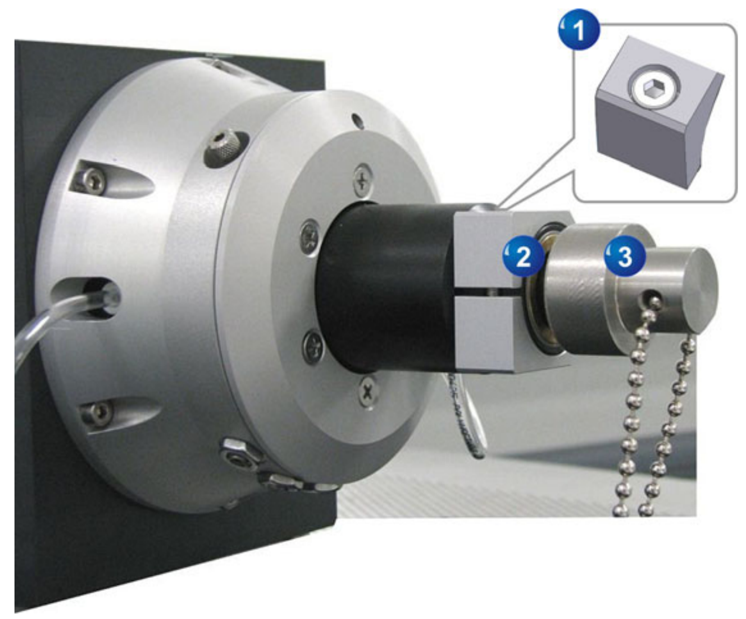
(1) Housing Screws

(2) Cover

(3) Locking piece

(4) Plug For Unused Guide-Through

1. Unscrew housing screws (1)
2. Remove cover (2)
3. Open fixing device (3) and guide fiber optic cable into supply unit in an arc (observe bending radius).



1 Locking screw (hexagon socket screw 3mm)

2 Laser light cable mount

3 Dust protection plug

Fig. 40: Laser light cable fixing

Note – Dust Protection Plug

During transport, protect the Laser light cable mount (2) using a dust protection plug. Install plug immediately after decoupling the Laser light cable.

Fig. 41: Storing the Dust Protection Covers/Plugs

1. Loosen locking screw and then remove dust protection plug.
2. Uninstall protection cover of laser light cable and make sure that no dirt particles can enter inside the cover. Insert laser light cable connector into laser light cable mount.
3. Slide in laser light cable (ensure zero gap!) and fasten it using locking screw (torque 2.0Nm).
4. Install dust protection plug of laser light cable fixing into dust protection cover of laser light cable (see figure on previous page).

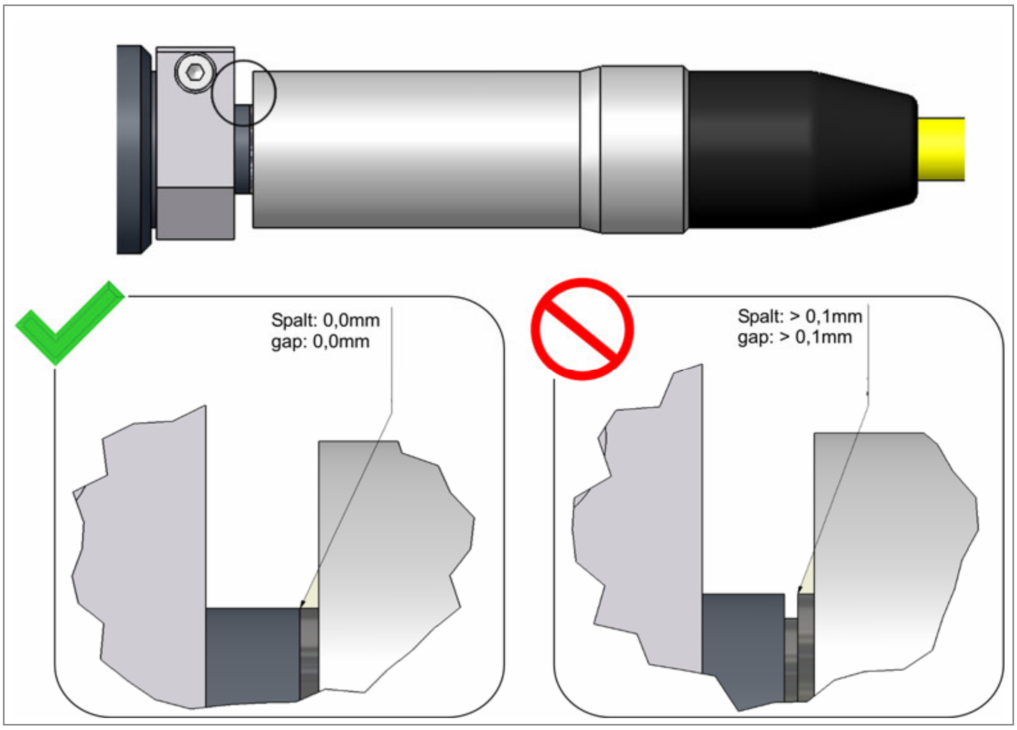


Fig. 42: Slide in laser light cable until there is zero gap

5. Reinstall fixing piece (3) and check bending radius of laser light cable inside machine. If required, add length of laser light cable (after loosening fixing point (3)!).
6. Use locking plugs (4) to close guide-through openings which are not in use.
7. Install cover (2) and fasten it using housing screws (1).

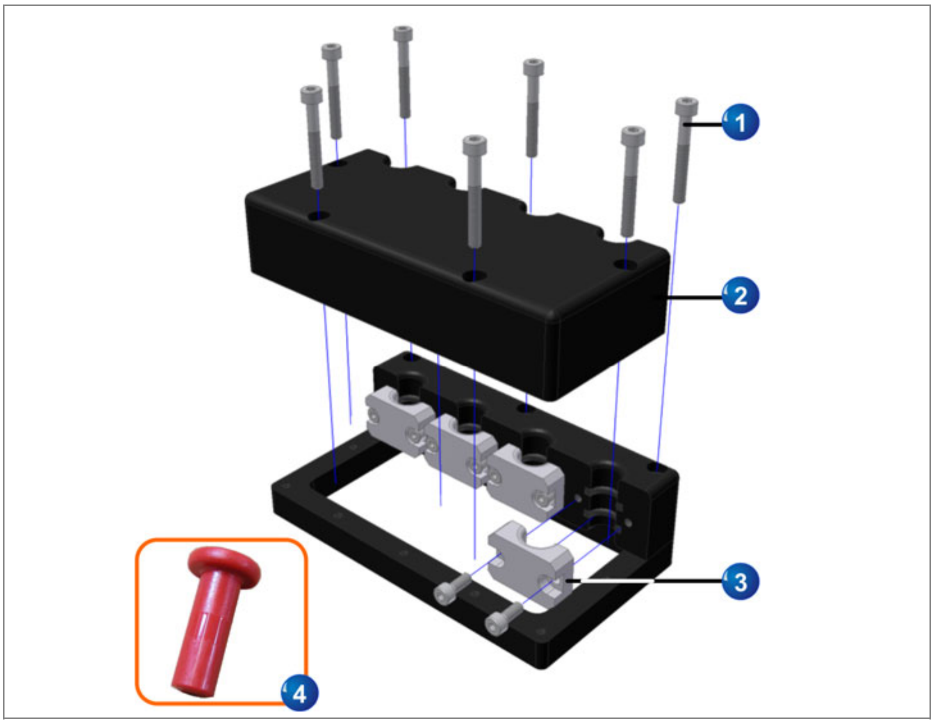


Fig. 43: Install laser light cable guide

Information – laser light cable Manual

The laser light cable enclosed in the present manual informs you on how to handle the laser light cable (**Fehler! Verweisquelle konnte nicht gefunden werden.** page **Fehler! Textmarke nicht definiert.**)..

7.9.1 Connect Optics

1. Install laser light cable into working chamber while observing bending radiuses.
2. Remove dust protection from optics mount.
3. Uninstall protection cover of laser light cable and make sure that no dirt particles can enter the cover and reach the cable ends. This could severely affect laser light cable function!
4. Slide in laser light cable into optics until you achieve zero gap (avoid jamming) and fix it with fastening screw. (1).
5. Temperature of laser optics must not exceed 60°C. Therefore, the optics must generally be cooled via connections (2). Cooling can be realized using either an optional optics cooler (which is integrated into supply unit) or an external cooler (provided by customer). Coolant temperature must be selected such that no condensation occurs at optics.

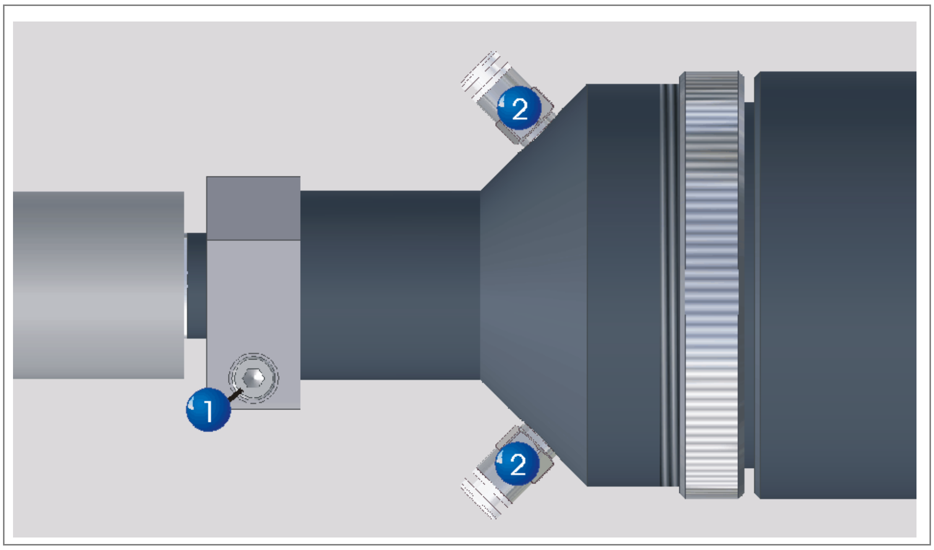


Fig. 44: Locking Screw Laser Optics

Information - Optics

Depending on order, laser system is delivered without Laserline Optics. When connecting third-party optics, observe manufacturer instructions.

7.9.2 Connecting Laser Light Cable Monitor

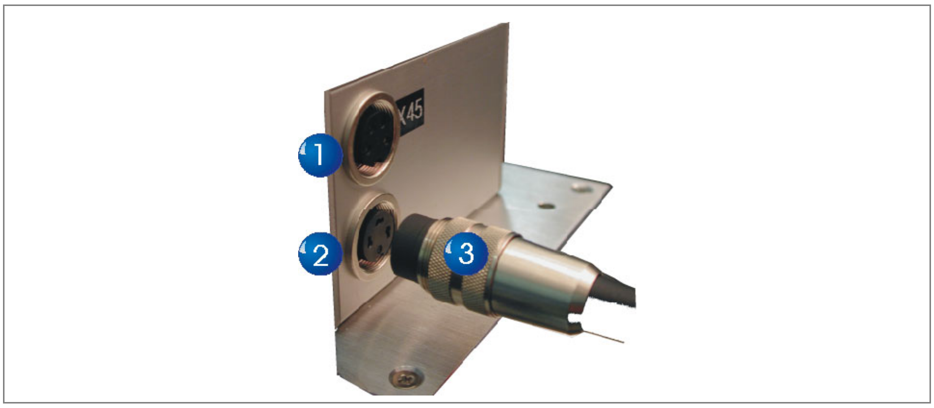


Fig. 45: Connecting the LLC monitor

(1) Connector safety circuit (only on beam switch systems)
(2) Connector (socket) LLC- monitor
(3) Connector (plug) LLC- monitor

During actual operation, the laser light cable is constantly monitored for rupture and overheating. Should any of these occur, the laser is immediately shut down.

In order to activate this function, the interface plug of the laser light cable must be connected to the supply unit. The connection socket for the monitoring is positioned next to the laser light connector (see illustration below).

- Connect the interface cable to the socket at the electronic module.

7.10 Starting Laser Beam Path Operation

Every laser beam emitter must be put into "operation". Before this, the fiber cable must be laid and connected to the beam emitter.

For **each** individual emitter path, carry out the steps and tests below:

- Connect the interface plug of the fiber cable monitor to the socket of the beam module to which the fiber cable is connected.
- Connect the safety circuit of the laser cell to the beam module to which the fiber cable is connected. An interface assignment can be found in the chapter "Customer interface / Beam switch interface".
- Attach the "guide clamp" on to the plug of the fiber cable.

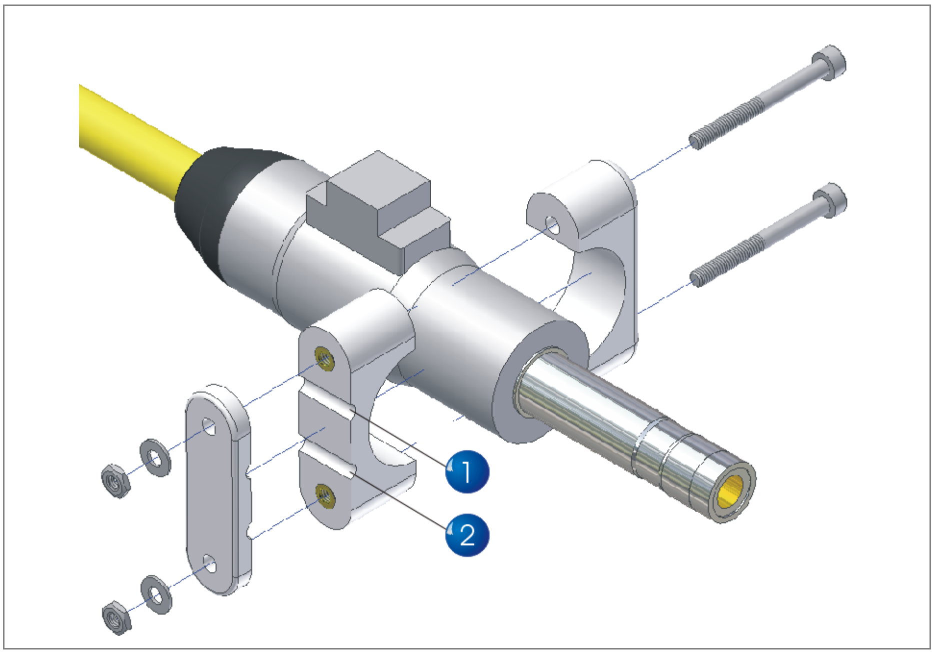


Fig.46: Guide clamp: (1) lead through SIK (2) lead through LLK

- Lead the cable of the fiber cable monitor (1) and the safety circuit (2) also through the guide clamp.

- Assemble the guide clamp.
- Tighten the connection cable so that the plug of the respective module can be plugged in but that a mix-up with the adjacent modules is not possible (see illustration).

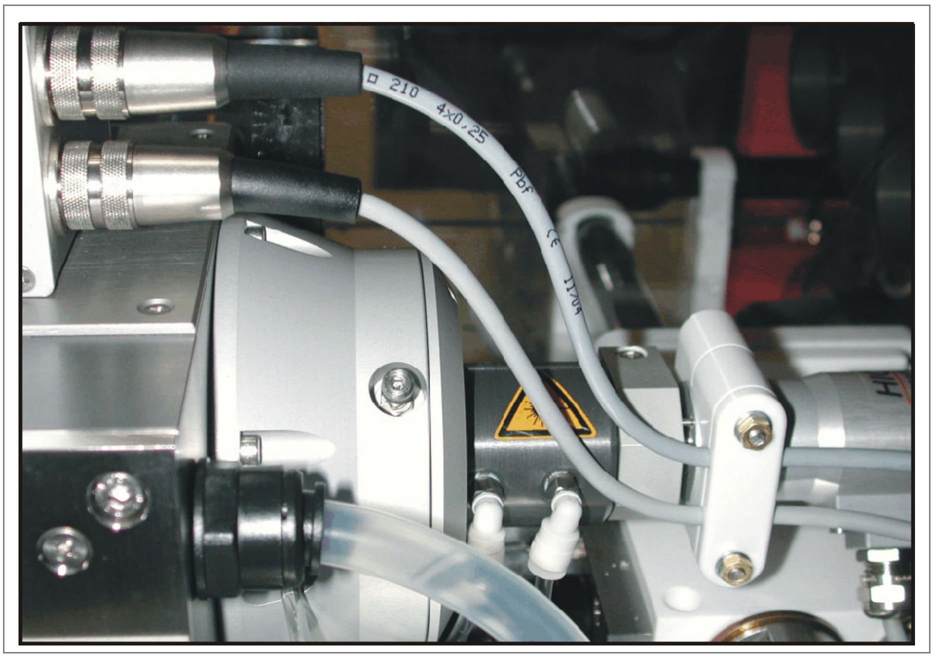


Fig. 47: Example of a proper connection

- Using the main switch, turn the laser system on.
- Put the key-operated switch in the “I“ position.
- Switch on the alignment laser of the corresponding bean outlet.
- Open the safety circuit of the corresponding beam outlet (Protective door connector).
- The alignment laser of the beam outlet starts a flash code signal (beam outlet 1, 1x flash, beam outlet 2, 2x flash etc).
- Verify if the alignment laser is exiting the correct laser optic.

7.10.1 Connecting the Optics

1. Install laser light cable into working chamber while observing bending radiuses.
2. Remove dust protection from optics mount.
3. Uninstall protection cover of laser light cable and make sure that no dirt particles can enter the cover and reach the cable ends. This could severely affect laser light cable function!
4. Slide in laser light cable into optics until you achieve zero gap (avoid jamming) and fix it with fastening screw. (1).
5. Temperature of laser optics must not exceed 60°C. Therefore, the optics must generally be cooled via connections (2). Cooling can be realized using either an optional optics cooler (which is integrated into supply unit) or an external cooler (provided by customer). Coolant temperature must be selected such that no condensation occurs at optics.

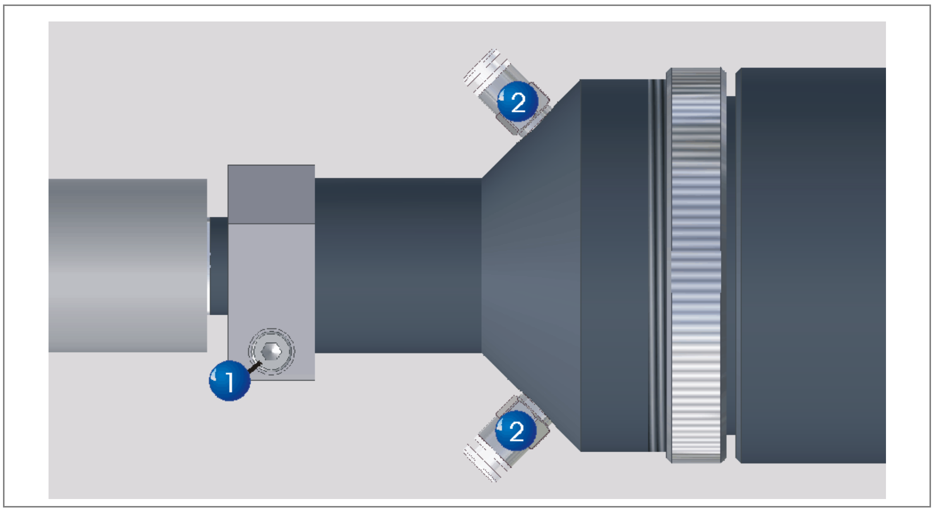


Fig. 48: Locking Screw Laser Optics

Information - Optics

Depending on order, laser system is delivered without Laserline Optics. When connecting third-party optics, observe manufacturer instructions.

7.11 Turning on

1. Unlock the Emergency-OFF button on the control unit.
2. Turn on the system by the mains power switch (front door).

The laser system is running the 2A safety check, shutter and / or beam switch are initialized and the console is booted.

7.12 Turning off

There are several possibilities for shutting down the diode laser system that can be carried out independently from one another.

7.12.1 In regular operation

- Mode LOCAL
  1. Press the laser OFF key which is positioned on the left side of the control unit. The laser beam is off when the control lamps are no longer illuminated.
  2. The supply unit is still on and must be separately shut down by the mains power switch.

- Mode EXTERNAL
  1. De-activate the signal "PROGRAM START/STOP" (0 V). The laser beam is off when the control lamps are no longer illuminated.
  2. The supply unit is still on and must be separately shut down by the mains power switch.

7.12.2 In error or emergency situations

- Press the Emergency-OFF button. The laser beam and the cooling system are immediately shut down. The supply unit is still on and must be separately shut down by the mains power switch.
- Turn the key-operated switch to the “0“ position. The laser beam is switched off immediately and is no longer ready for operation. The supply unit is still in operational status and must be separately shut down by the mains power switch.
- Mode LOCAL

1. Press the laser OFF key that is positioned on the left side of the control unit. The laser is shut down when the control lamps are no longer illuminated.
2. The supply unit is still in operational status and must be separately shut down by the mains power switch.

- Mode EXTERNAL

1. De-activate the signal "PROGRAM START/STOP" (0 V). The laser is shut down when the control lamps are no longer illuminated.
2. The supply unit is still in operational status and must be separately shut down by the mains power switch.

Note – Re-start up after an emergency shut down

Should an error message appear, resulting from a previous emergency shutdown, during a re-start up of the laser system, this error message must be acknowledged by pressing the ‘ACK key’ before the system can be re-started.

8 OPERATING THE LASER SYSTEM

8.1 Overview

The following pages provide instructions on operating the Diode Laser System. Please read the instructions carefully.

Note

All persons operating or working on the laser system or equipment are to be thoroughly instructed in its use and operation and are to have read the Operating Instructions carefully; in particular, the section dealing with Safety Instructions.

Info – Display values

Values displayed in the screen shots like wavelength, set values etc. may differ from real values in the laser system.

8.2 General Information

The operation of the diode laser system can be via the control panel of the supply unit using the customer interface X3, or as control option, via a field bus interface port.

The control of the diode laser is via the control panel. Using the various menus of the control panel, the operator can enter the required commands and settings, or call up all control data and view the various messages of the system.

The following sections guide the operator, step by step, through the various menu items in order to thoroughly familiarize him/her with the operation and functioning of the laser system.

8.2.1 Notes on the display

The laser systems are equipped with a touch-sensitive display (Touch Display). Touch displays consist of the display itself and a superimposed touch-sensitive coating. The coating helps to detect and process e.g. the pressure on a button.

NOTE - OPERATION

Only touch one point of the screen on a touch device. Never touch several elements at the same time. Otherwise, unintentional actions could be initiated. Also do not use any pointed or sharp items on the surface, in order to avoid any damage of the screen.

Display Information

The display is called console in the following text.

8.3 Icon bar

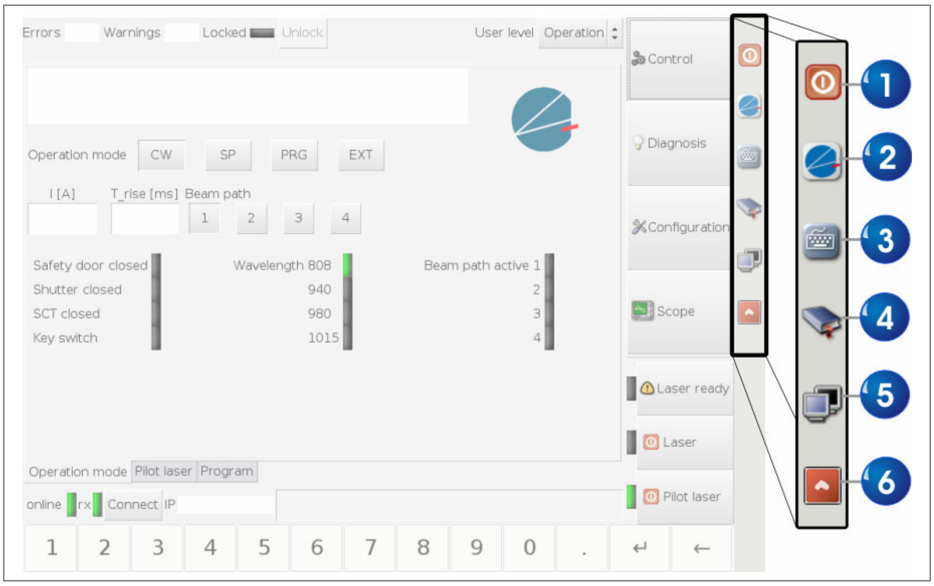


Fig. 49: Icon bar

No.	Icon	Function
1	Shut down	Calls the "Shut down" dialog.
2	Laserline	Restarts the operating software (LL-Control).
3	Keyboard	Displays an alphanumeric keyboard.
4	Manual	Calls the manual of the operating software.
5	Network	Calls the "IP Addresses" dialog.
6	System tools	Opens the system tools menu (select language, recalibrate touch screen etc.).

8.3.1 Restart / Shut down

The console should be shut down before turning the laser system off. In order to reboot or shut down the console proceed as follows:

1. Touch the "Shut down" icon .
2. Select an option from the list (Reboot/Shut down).

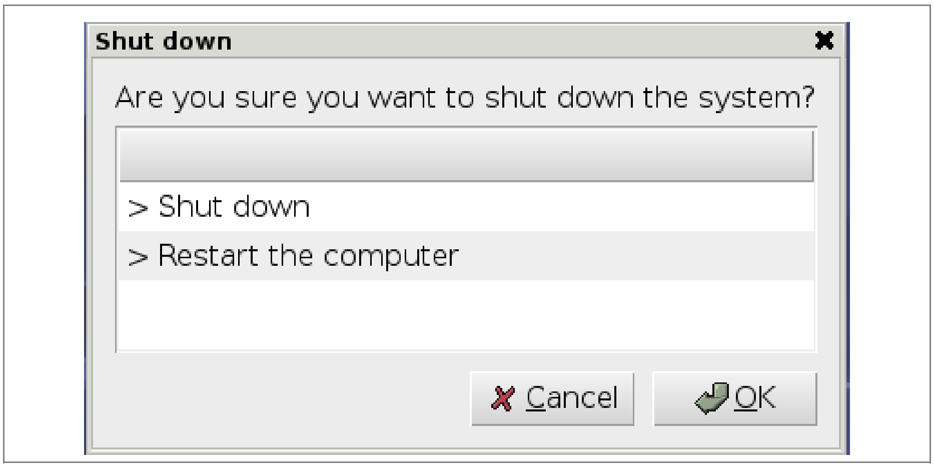


Fig. 50: Shut down / reboot dialog

8.3.2 Entering numeric values

A numeric keyboard (1) is displayed in the lower area of the screen, in order to enter numeric values (laser power, time settings, etc.).

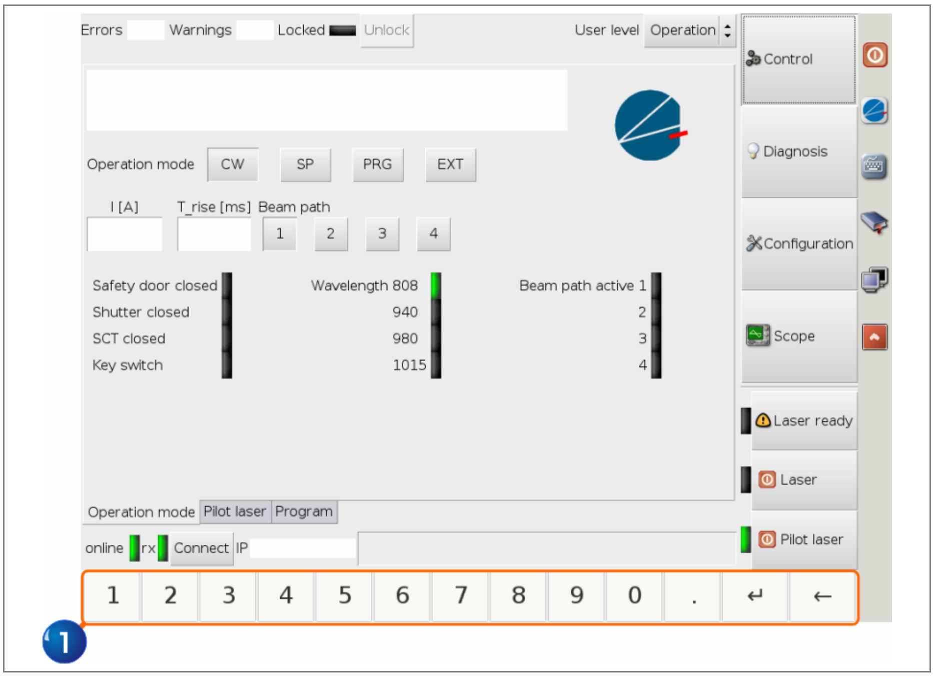


Fig. 51: Numeric screen keyboard (1)

Key	Function
1-0	Keys for entering numeric values.
←	Deletes the character to the left of the cursor.
↵	Applies and finalizes an input.

8.3.3 Entering alphanumeric values

An alphanumeric screen keyboard can be displayed, in order to enter alphanumeric values (password, etc.).

1. Touch the "keyboard" (1) icon .
2. The alphanumeric keyboard (2) is displayed in place of the numeric keyboard.

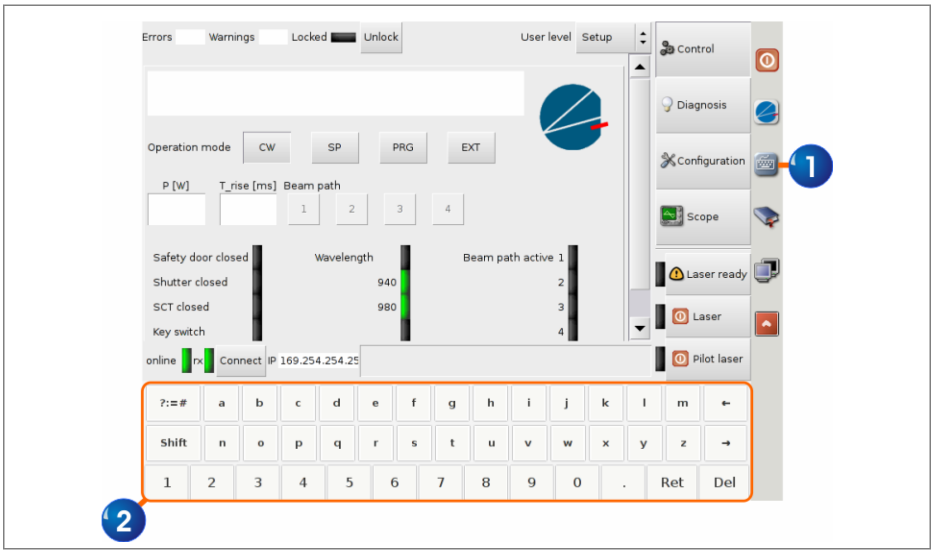


Fig. 52: Alphanumeric screen keyboard (2)

Key	Function
Shift	Toggles between upper and lower case.
? : =	Toggles between special and alphabetic characters.
Ret	Enter key (Return)

8.3.4 Calling the manual

1. Touch the "manual" icon .
2. The user interface manual is loaded and displayed as a PDF.

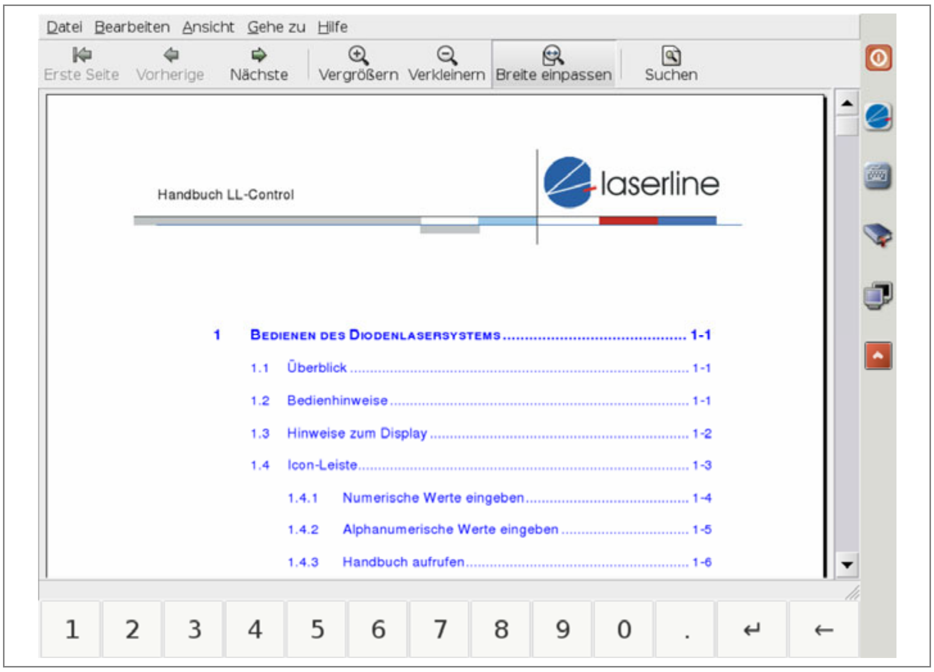
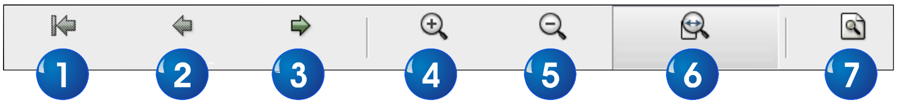


Fig. 53: PDF manual



1 Go to first page
2 Go to previous page
3 Go to next page
4 Zoom in
5 Zoom out
6 Adjust width
7 Search in document

Fig. 54: Toolbar in the PDF display

8.3.5 IP Configuration

The dialog displays the configuration of the network interfaces.

1. Touch the "Network" icon .

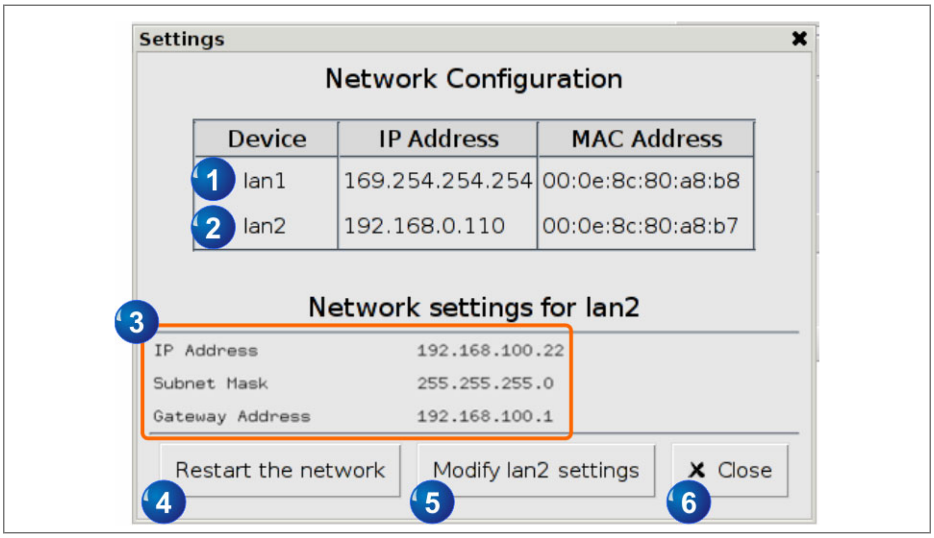


Fig. 55: Dialog Connection Settings

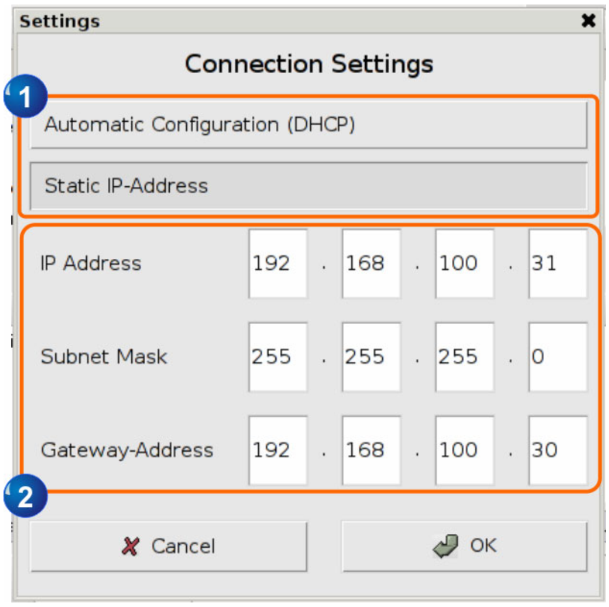
No.	Description
1	IP Address LAN1 (interface to laser control unit, only Laserline).
2	IP Address LAN2 (interface to customer network).
3	Pre-setting’s in the laser system. The configuration may be edited by button 5.
4	Restarts network adapters. This may be required when a DHCP server is not correctly detected or when pre-setting’s are changed.
5	Changing preset IP configuration of laser system.
6	Close Dialog.

8.3.5.1 Changing Pre-settings

1. Select button (5) in the dialog "IP-Configuration" (figure no 55).
2. Select static or dynamic IP configuration (1).
3. In case of static IP configuration, please enter the network addresses in the input fields (2). Press „OK" to confirm.

Info – Gateway

The network address „Gateway Address" must designate an existing and active network partner (gateway, PC, router, etc.). If not, the access of the laser PLC to the network will be drastically slowed down.



1 Automatic/manual configuration of the network address
2 Input fields in case of manual configuration.

Fig. 56: Dialog Change Pre-settings

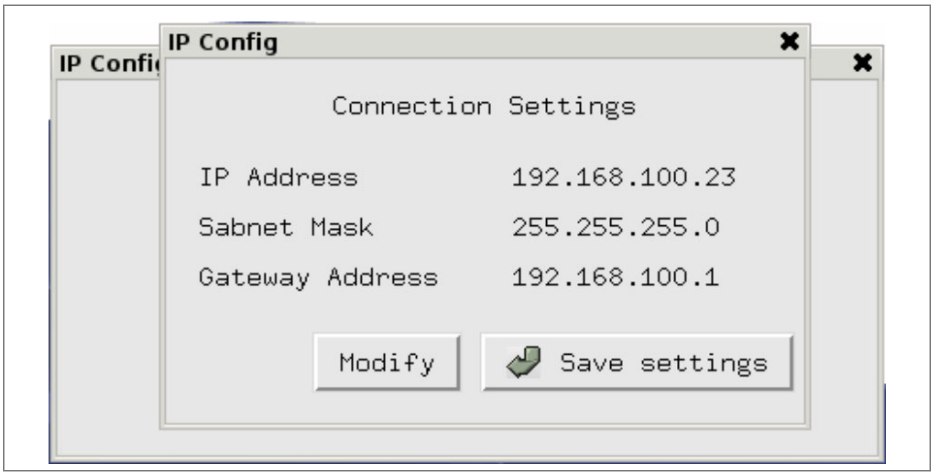


Fig. 57: Dialog Check Entry

4. New settings are displayed. If the settings are correct, select "Save settings". Clicking the "Modify" button will take back to the entry dialog.

8.4 Password input

Different areas of the user interface are password-protected. There are three user levels, in order to control access.

User level	Description
Service	This user level can only be accessed by Laserline Service (enables modification of system values).
Setup	This user level is only accessible for authorised users of the customer (e.g. setter or programmer). Different functions can be set on this level (field bus, stack test, etc.) and programmes (PRG mode) can be edited. The password is "0123" on delivery and can be changed by the customer.
Operation	This level can be accessed without password (the console is started on this level).

The user level selection is located in the upper, right area of the user interface.

Fig. 1: Selection of the user level

In order to execute a password-protected function, proceed as follows:

1. Touch the drop-down list "User level".
2. Select the "setup" entry. The password dialog will open.
3. Enter the customer password into the password dialog and acknowledge with OK.
4. The entry "Setup" is displayed in the drop-down list (if login successful).

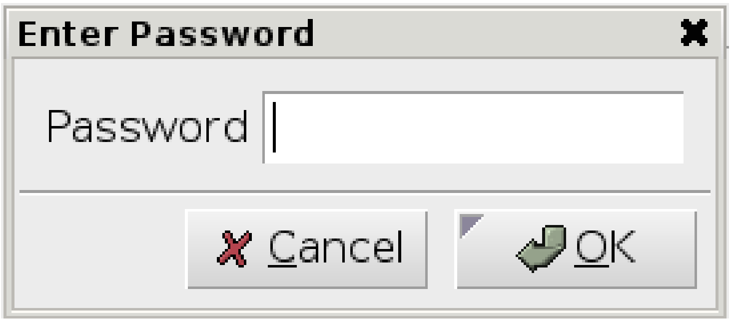


Fig. 2: Input dialog for password input

Password Information

The user password on delivery is **"0123".**

A modification is possible at any time. Look up Chapter "Operation/Configuration/User" for further information.

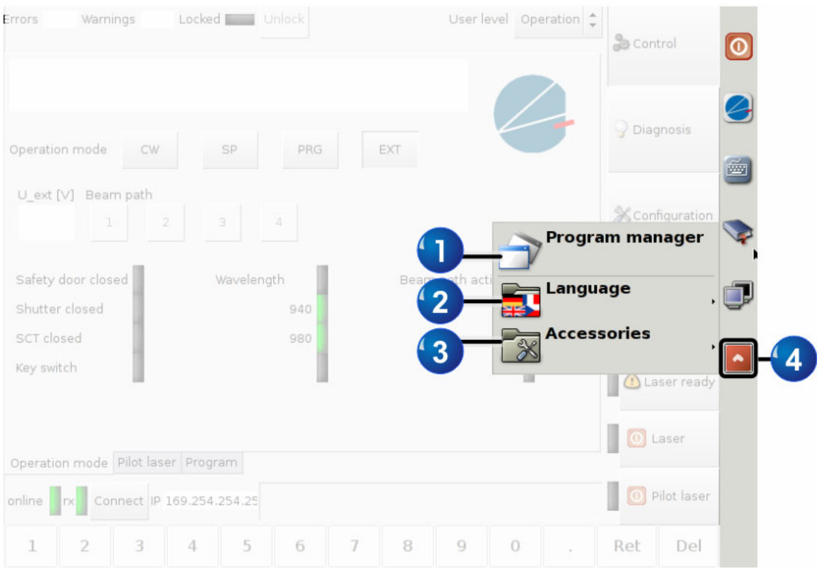
Password Information

The user level should be reset to "User" after completion of the tasks. This does **not** take place automatically (as with past Laserline equipment).

8.5 System tools menu

The console initiates the start-up procedure after switching the laser system on. The operating software is connected to the laser control unit after a short time and displays the current values of the laser system.

Console adjustments (language change, calibration, etc.) must be carried out by the system tools menu.



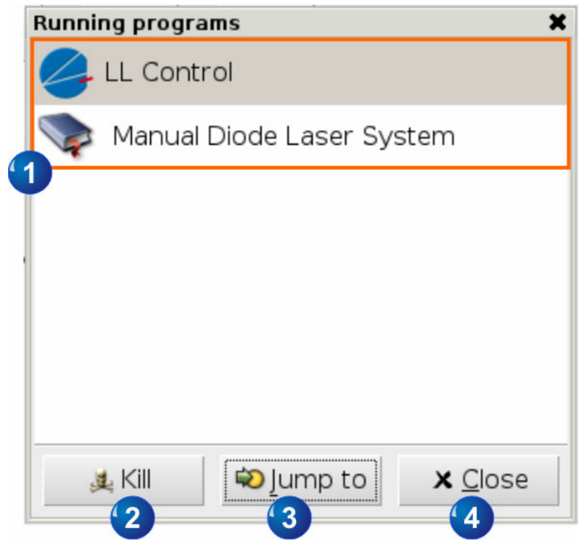
1 Program manager   3 Accessories / Tools

2 Select language   4 Call the system tools menu

Fig. 58: System tools

- Touch the menu icon (4) in order to open the menu.

8.5.1 Program manager

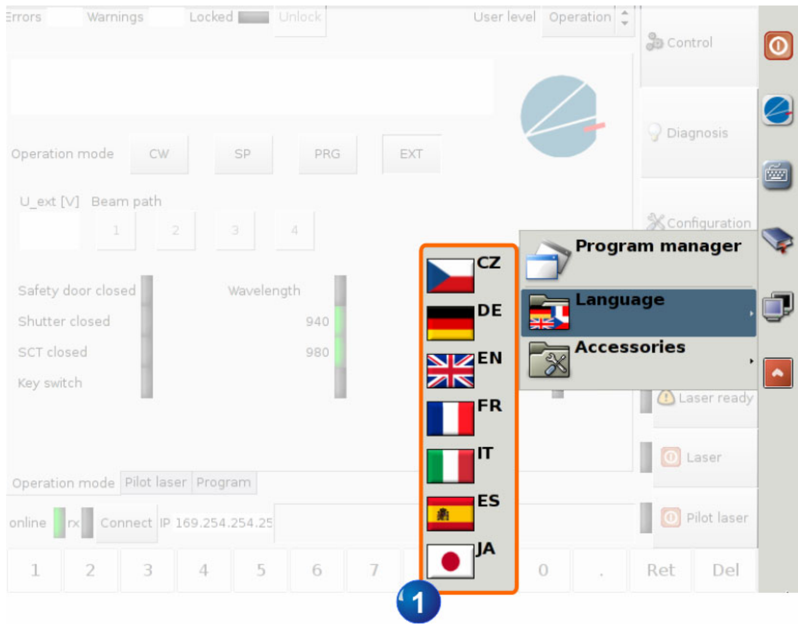


1 Running Programs
2 Close program (1)
3 Jump to a program
4 Close program manager

Fig. 59: Program manger

1. Touch the system tools icon and select the program manager.
2. Select a running program in the list and choose an action:
   - Close program: select button (2).
   - Jump to a running program: select button (3).

8.5.2 Select language



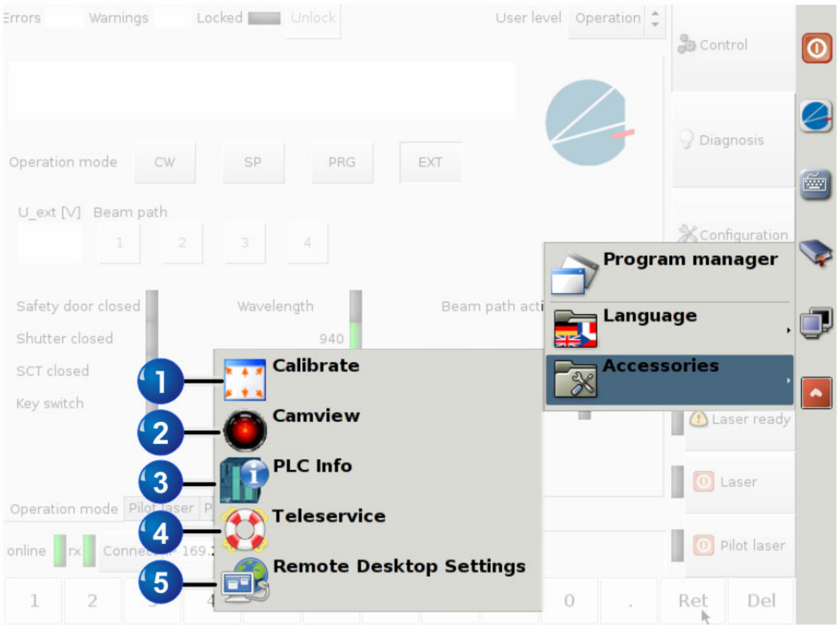
1 Select language

Fig. 60: Language selection

1. Touch the system tools icon and select the menu "language".
2. Select the required language (1).
3. The user interface is restarted in the selected language.

8.5.3 Accessories

The Accessories menu contains additionally programs for the service camera, configuration of the teleservice and calibration of the console.



1 Start service camera

2 Re-calibrate display

3 Call up the service information of the laser PLC (Laserline).

4 Configuration of the teleservice via the internet

5 Access settings to the teleservice console

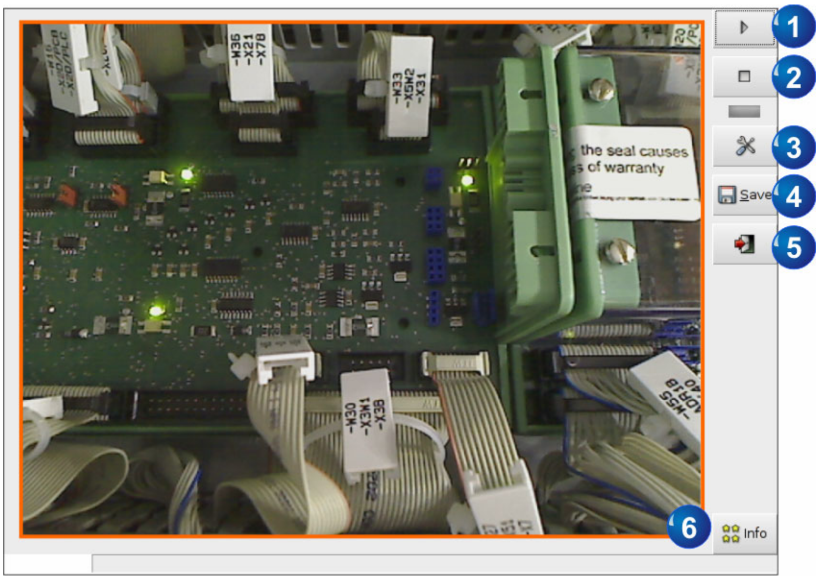
Fig. 61: Accessories

8.5.3.1 Service camera (Camview)

Optionally, the beam source can be equipped with a service camera. Laserline Service personnel will be able to view the console and the camera image via a teleservice connection through the internet.

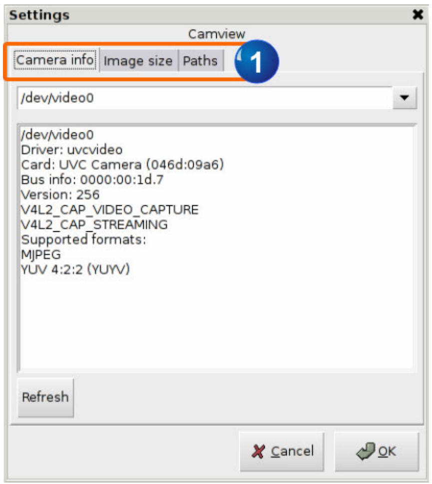
1. Touch the system tools icon and open the menu "Tools“.

2 Touch the icon "Camview" (1).



1	Start video	4	Save image
2	Stop video	5	Terminate program
3	Change settings	6	Video image

Fig. 62: Software of the service camera



1 Settings

Fig. 63: Camview settings

Normally the Camview settings do not need to be modified.

- Camera info: displays information about camera type, driver, etc.
- Image size: the image size of the camera has a fixed size of 640x480 pixel.
- Paths: path for storage of saved images (internal memory card).

Info – Teleservice

An internet access is required for the teleservice. The bandwidth of an analogue telephone line (teleservice via modem) is not sufficient.

8.5.3.2 Calibration

The panel must be recalibrated, if panel inputs are not correctly identified (input offset).

1. Touch the system tools icon and select the menu “tools”.
2. Touch the icon “calibrate”.
3. Follow the display instructions.

8.5.3.3 Teleservice via the internet

Alternatively to the analogue telephone line, the teleservice can be set up via an internet connection (Teleservice Internet).

Info – Teleservice

Detailed information about the teleservice can be found in the chapter „Teleservice page 13-1 ”.

1. Touch the system tools icon and open the menu "Tools“.
2. Touch the icon "Teleservice" (4).

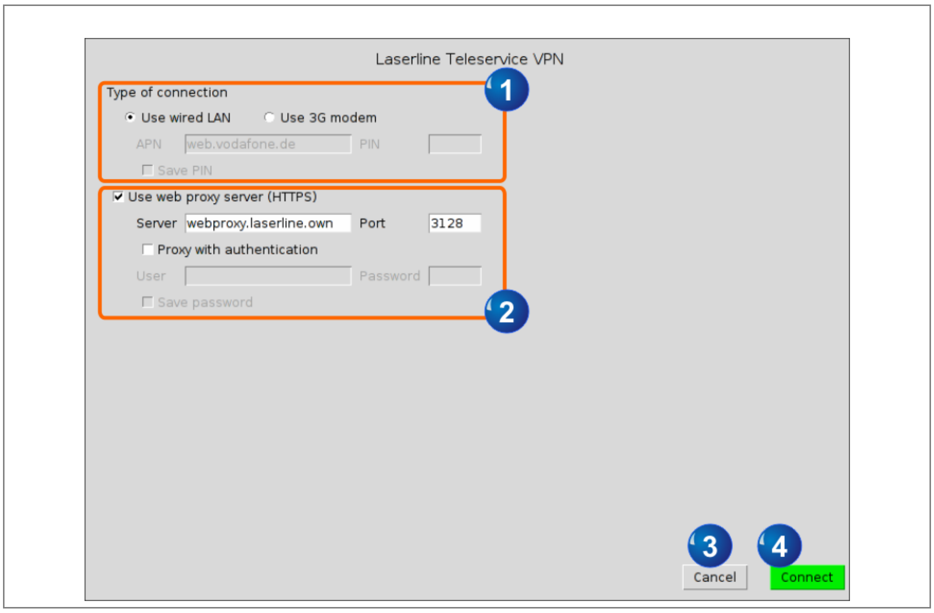


Fig. 64: Configuration of the teleservice

No.	Description
1	Selection of the connection type: • Internet access via wired network • Internet access via UMTS modem (optional)
2	If the internet access within a wired network passes through a proxy, the access data must be entered here: • Server: address of the proxy. • Port: port on which the proxy server accepts the requests.
3	Cancels the input.
4	Builds up a VPN connection to the Laserline VPN.

8.5.3.4 Remote Desktop Settings

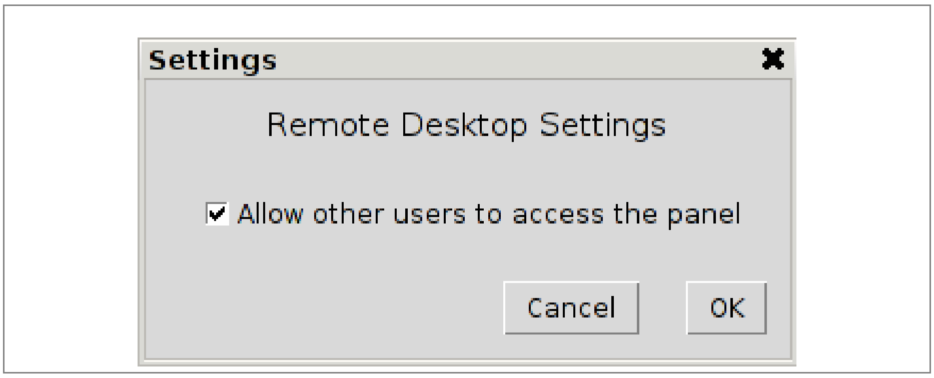


Fig. 65: Remote Desktop Settings

1. Touch the system tools icon  and open the menu  "Tools“.

2. Touch the icon  "Teleservice" (4).

In order to allow the Laserline Service to view the camera image, the option shown in Fig. 65 (remote access) must be activated. For all other actions Laserline does not require a direct access to the console.

The remote access is deactivated per default. It can be activated if necessary – after having contacted the Laserline Service.

8.6 Using the input fields

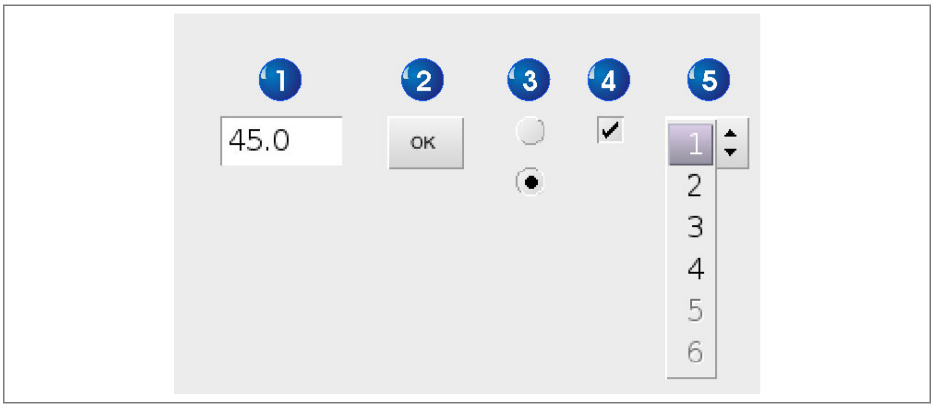
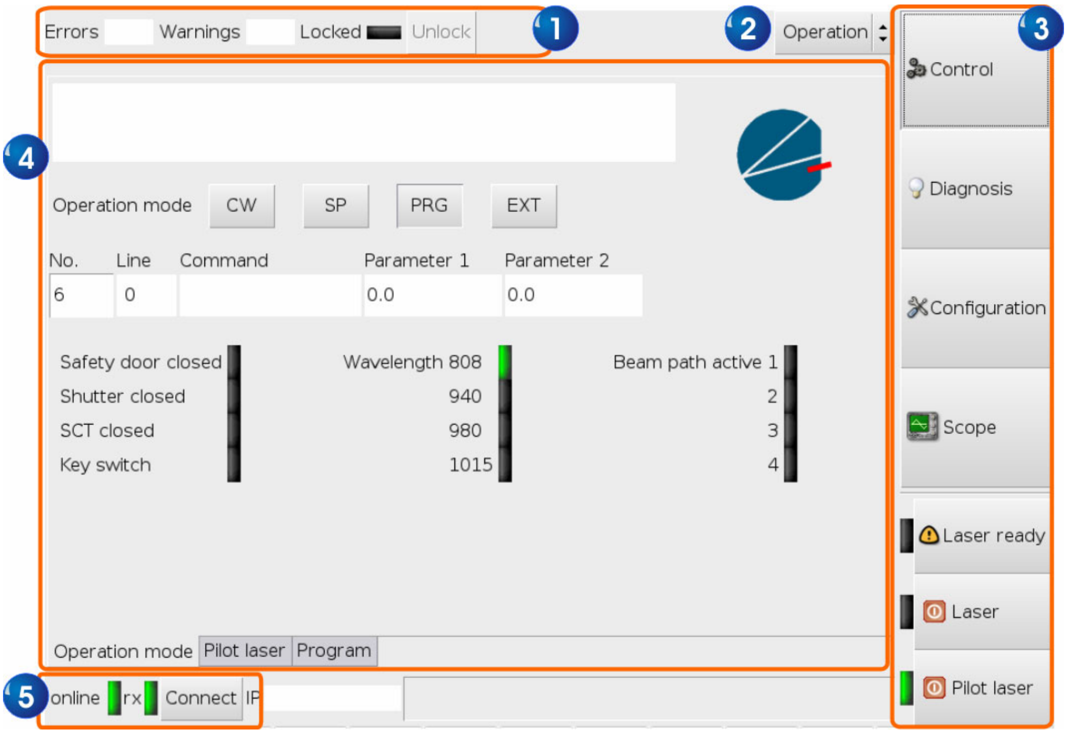


Fig. 66: Input fields

No.	Explanation
1	Input field ● Touch the input field and enter a new value by means of the keyboard. Confirm input with the key ↵.
2	Button ● Touch the button, in order to change in the status.
3	Option fields (radio button) ● Touch the required field.
4	Check box ● Touch the check box, in order to activate or deactivate an option.
5	Drop down list ● Touch the button and then select an appropriate option from the drop down list.

8.7 Structure of the Main Menu window

LL-Control is divided into five areas:

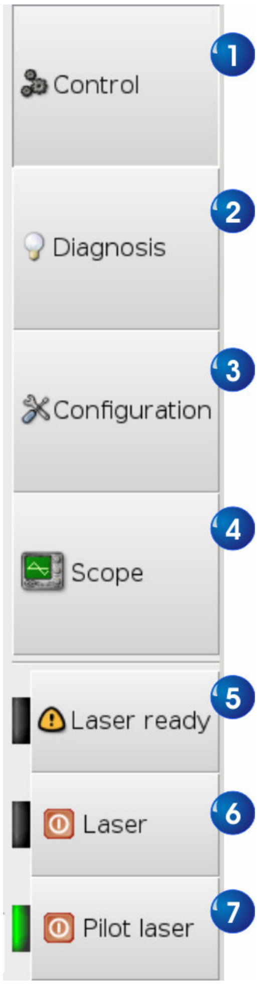


1 Status line (number of warnings and errors)
2 User selection (User, Setup, Service)
3 Function bar
4 Working area
5 Connection status

Fig. 67: Main screen

No.	Area	Description
1	Status line	Indicates the status of the system: • Warning messages • Error messages Unlock console (only systems with field bus).
2	User selection	See chapter “Password input page 8-11 ”.
3	Function bar	The main menus Operation, Diagnosis, Configuration and Scope (oscilloscope) can be selected via the function bar. The laser can be operated using laser function keys as per the operation keys on the operation unit. The pilot laser can moreover be switched.
4	Working area	This area consists of several individual areas and changes depending on the selection of the main or sub menus.
5	Connection status	Displays the present connection status: • Online: LL-Control is connected. • RX: Blinks during data exchange with the laser system. • IP: Address of the laser is connected to LL-Control at this moment.

8.7.1 Structure of the function bar

Screenshots	Description
	1. The menu “Operation” contains all important functions used to operate the laser system (selection of the adjustment and pilot laser, entry of programs as well as selection of the operation mode). 2. The menu “Diagnosis” contains all important functions used for the diagnosis of the laser system. 3. The menu “Config” is used for the configuration of the laser system. 4. The menu “Scope” contains functions for the visualization of different analogue and digital signals of the laser system. 5. Switches the laser to "READY" status (functions like operation keys). The LED illuminates when the laser status is set to “Ready”. 6. Starts the diode laser with pre-adjusted power (in CW- and SP modes with the power assigned under P_set). The LED illuminates when the laser is active. 7. Switches On/Off the pilot and alignment laser. The laser that is switched depends on the settings in laser menu “Pilot laser”. The LED illuminates when the pilot laser is active.

8.8 LL-Control Menus

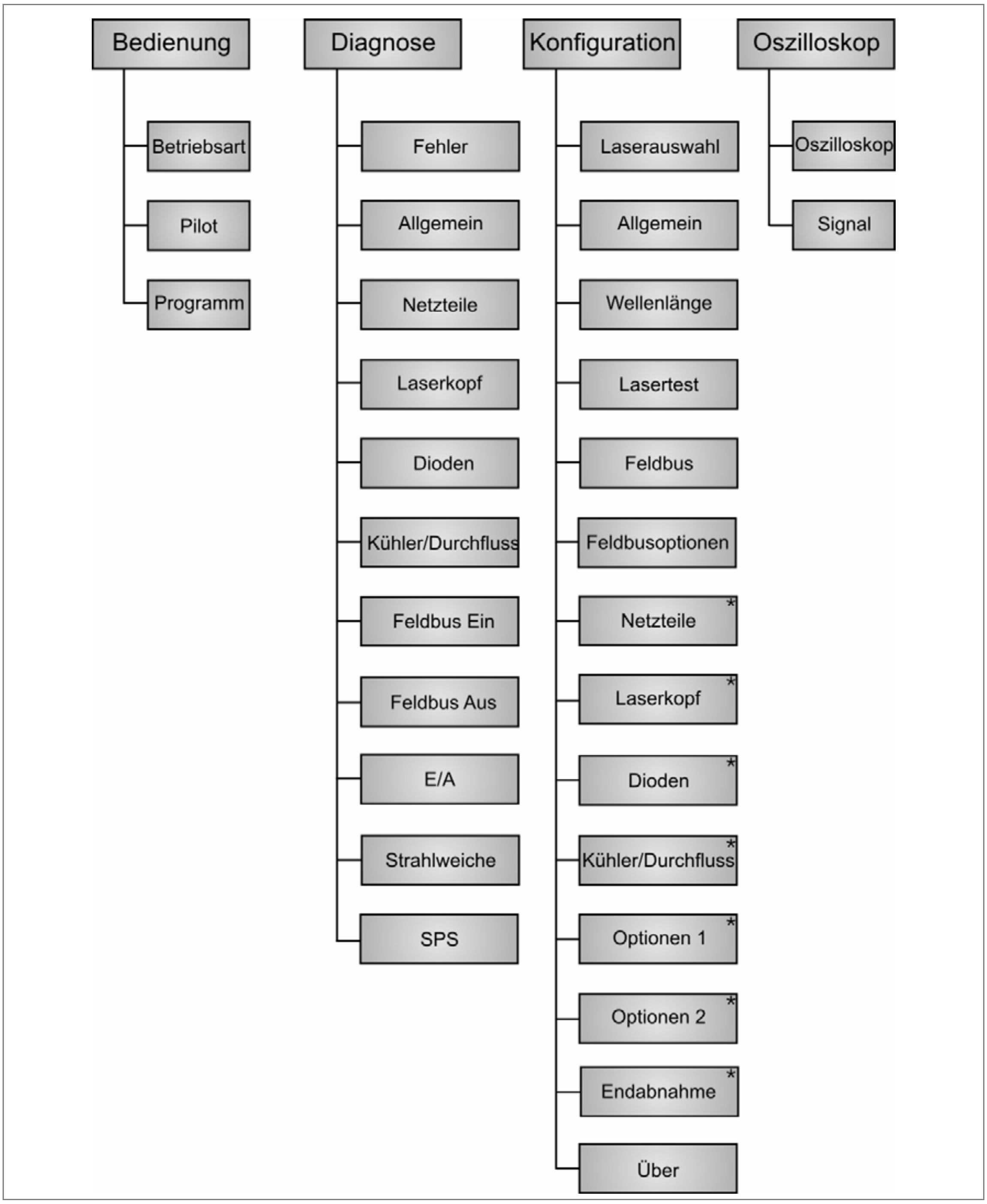
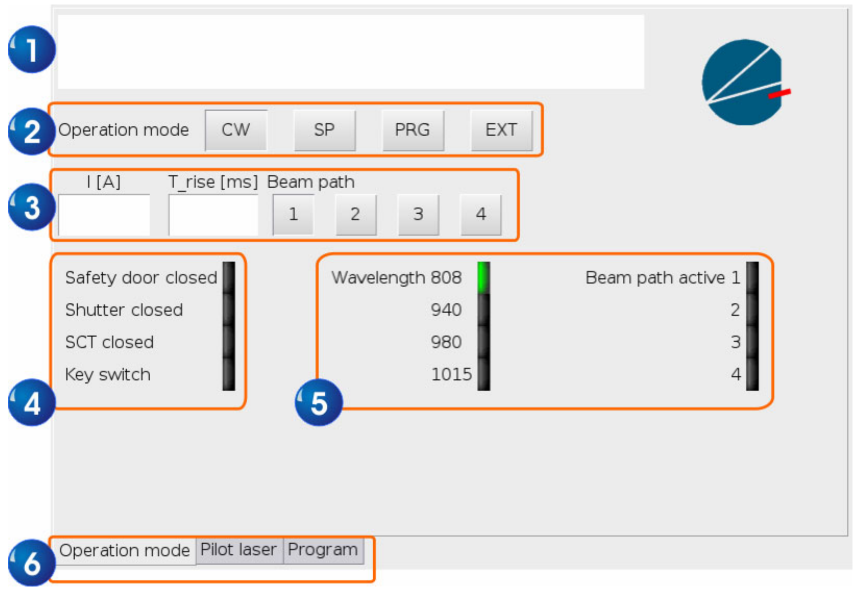


Fig. 68: Structure console software

8.9 Main Menu Operation

8.9.1 Operation mode

The menu “operation / operation mode” is displayed after startup:



1 Display of laser power (calculated)

2 Selection of the operation mode

3 Default values for operation type (CW, SP, EXT) or program step indication with PRG mode.

4 Status display

5 Wavelength display/beam path display (optional)

6 Sub menu of the main menu “Operation”

Fig. 69: Operation/operation mode

No.	Name	Description
1	Display of laser power	Displays the laser power emitted in the laser operation
2	Selection of the operation mode	With these control panels one can change between the operation modes: CW (continuous wave), SP (single pulse), PRG (programming mode) and EXT (external power default).
3	Operation mode	Depending on the selected operation mode differed parameters can be pre-set (see chapter "**Control modes of the laser system**" Page 8-63).
4	Status display	Informs the status of the laser system.
5	Wavelength / Beam paths	Displays available and active wavelengths. Displays switched beam paths.
6	Sub menu	Every main menu (in the function bar) consists of several submenus. A sub menu can be selected by the tabs. PC-Version: By clicking the right mouse button a quick select menu is displayed.

8.9.1.1 Status display

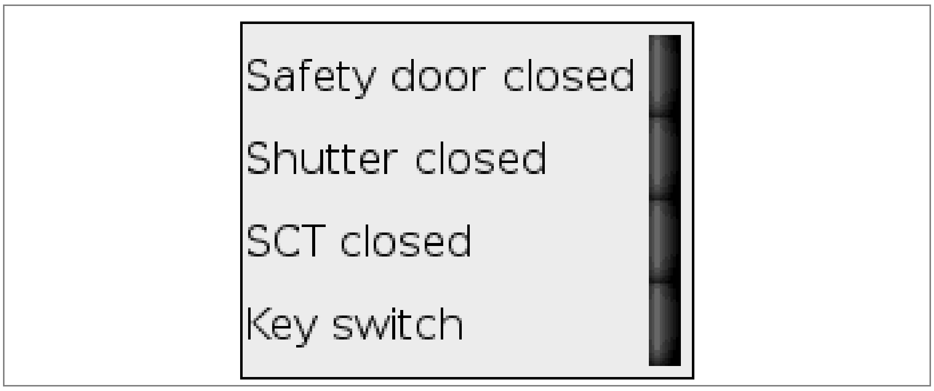


Fig. 70: Status display

Name	Description
Security door closed	Customer safety door door opened Customer safety door closed
Shutter closed	Shutter opened Shutter closed
SIK closed	Safety circuit laser opened Safety circuit laser closed.
Key switch	Key switch in position “0” Key switch in position “1” or “2”

8.9.1.2 Wavelength / Beam paths

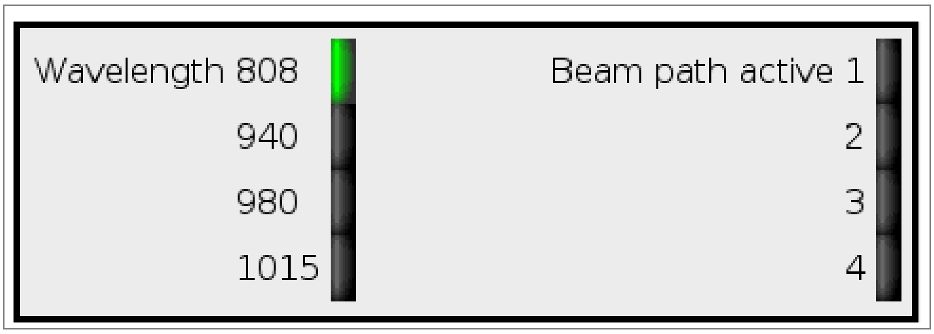


Fig. 71: Wavelength / beam paths

Name	Description
Wavelength	Wavelength is not active/ available. Wavelength is active/ available.
Beam path is active (up to four exits are possible)	Beam path is not active Beam path is switched and active.

8.9.1.3 Selecting the operation mode

The laser can be operated in four different modes. The required mode can be selected with the key “Operation type”

Fig. 72: Select operating mode (PRG)

Info – Operating Modes / Field bus

- A detailed description of the operating modes is included in chapter: "**Operation modes of the laser system**" page 8-65
- If the field bus is activated, the control unit changes automatically to the PRG mode (field bus operation is only possible in the PRG mode).

8.9.2 Pilot laser

1 Enable LED mode

2 Enable alignment mode (select beam path for beam switch)

3 Pilot laser on/off button

Fig. 73: Pilot laser

Every laser system contains the LED mode. The alignment laser is optional. The term used for both lasers is “Pilot laser”.

Only one pilot laser can be switched on at the same time (via console or user interface). The laser which will be switched on can be selected in the sub menu “Pilot laser”.

For systems with beam switch the alignment laser can be selected via the buttons (2).

Info - led mode

The LED mode is inactive for systems with beam switch.

8.9.2.1 LED mode

With an 808nm wavelength, the laser beam is poorly visible. The pilot laser can be seen only with the accessories (IR converter card or CCD camera) in case of higher wavelengths.

Info - led mode

The LED mode is inactive for systems with beam switch.

Activate the **LED mode** as follows:

1. Close the safety doors of the processing station.
2. Turn the key switch to position II.
3. Switch the system to READY status.
4. Touch the button “Pilot laser” in the function bar (see “Fig. 73 Pilot laser page 8-32”).
5. The pilot laser is switched on with the laser warning lights.
6. Press the button “Pilot laser” again to switch off the laser.
7. The laser can also be switched via the X3 interface or the field bus interface.

8.9.2.2 Alignment laser

The alignment laser is a **visible** laser with approx. 650nm wave-length.

Activate the **Alignment laser** as follows:

1. Turn the key switch to position I.
2. Touch the button “Pilot laser” in the function bar (see “Fig. 73 Pilot laser page 8-32”).
3. The pilot laser is switched on with the laser warning lights.
4. Press the button “Pilot laser” again to switch off the laser.
5. The laser can also be switched via the X3 interface or the field bus interface.

8.9.2.3 Alignment laser beam switch

On laser systems with beam switch, the alignment laser is assembled in every beam exit. If the alignment laser is switched on using the “pi-lot laser” button, all selected alignment lasers (2) are active.

1. Select the alignment laser to be switched with the buttons.
2. Turn the key switch to position I.
3. Touch the button “Pilot laser” in the function bar (see “Fig. 73 Pilot laser page 8-32”).
4. The alignment laser is switched on with the laser warning lights.
5. Press the button “Pilot laser” again to switch off the laser.

8.9.3 Program

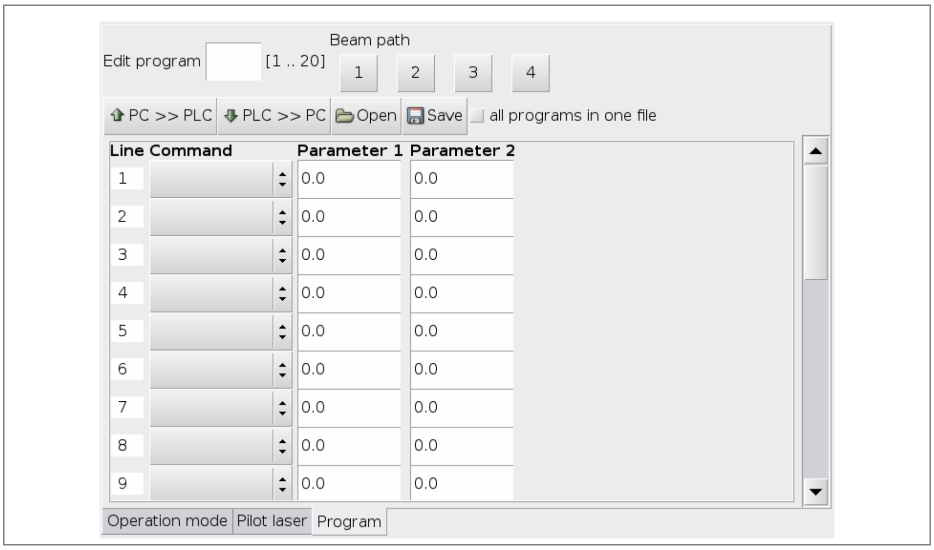


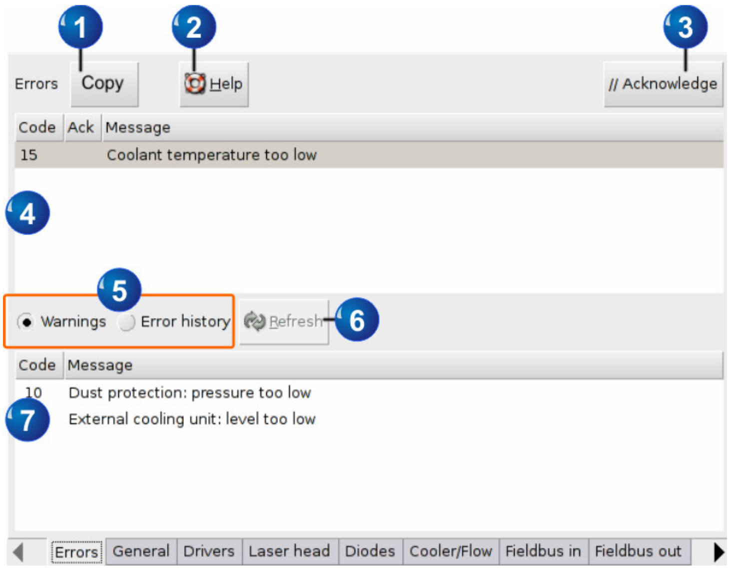
Fig. 74: Programming mode

In this menu programs can be created and executed later in the programming mode of the laser control. More information to the program mode is available in the chapter "Program mode (PRG) page 8-70“.

8.10 Main Menu diagnosis

Menu Errors

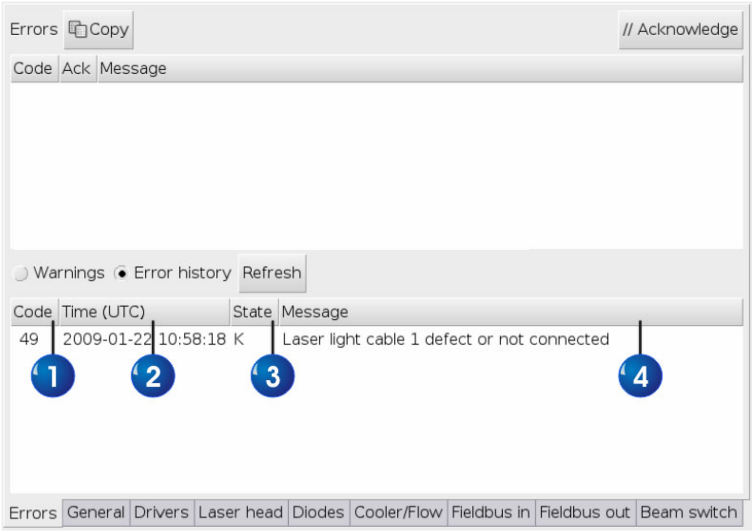
This menu displays error and warning messages.



1. Copy button used to copy the text of the error message in the clipboard (PC-version).
2. Help button used to call up the help text related to a selected error message.
3. Acknowledge button used to confirm an error message.
4. List field with entries of the current errors and status of the errors:
   - K: Arrived
   - Q: Acknowledged
5. Switching between warning messages and error history in section (7).
6. Refresh error history.
7. List field with entries of the current warnings and the last 256 errors of the laser system (depending on the selection made by (4).

Menu Errors / Error history

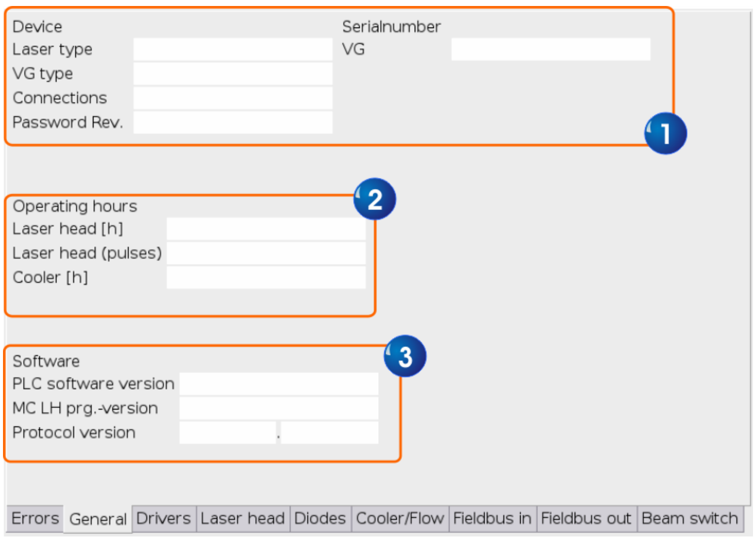
The last 256 errors of the laser system are displayed in the error history.



1. Error number.
2. Time and date of the error occurrence.
3. Error status
   - K: Arrived
   - Q: Acknowledged
4. Error message in plain text.

Menu General

This menu displays general information about the laser system.



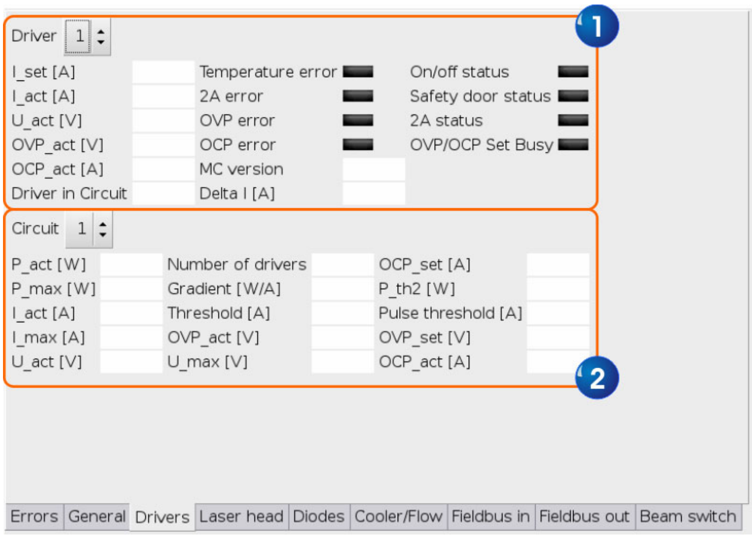
1. Laser and VG type as well as serial number.

2 Operating hours of the laser head as well as of the complete system, and number of laser pulses.

3 Software version of the individual components.

Menu Drivers

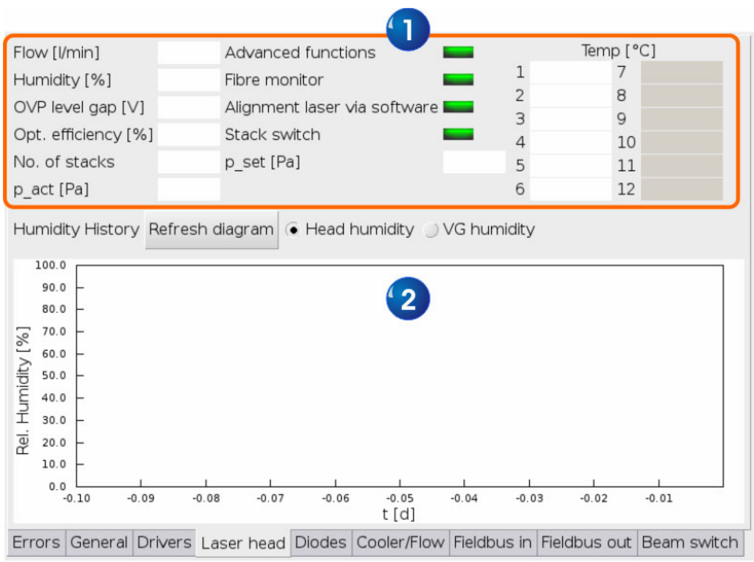
This menu displays the status of the diode drivers and the electrical circuits.



1. Status of the selected driver.
2. Status of the selected circuit.

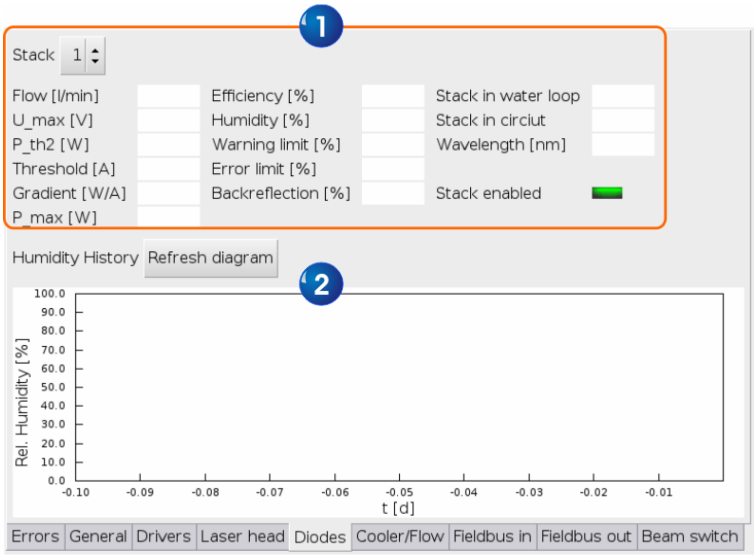
Menu Laser head

This menu displays set and current values of the laser head.



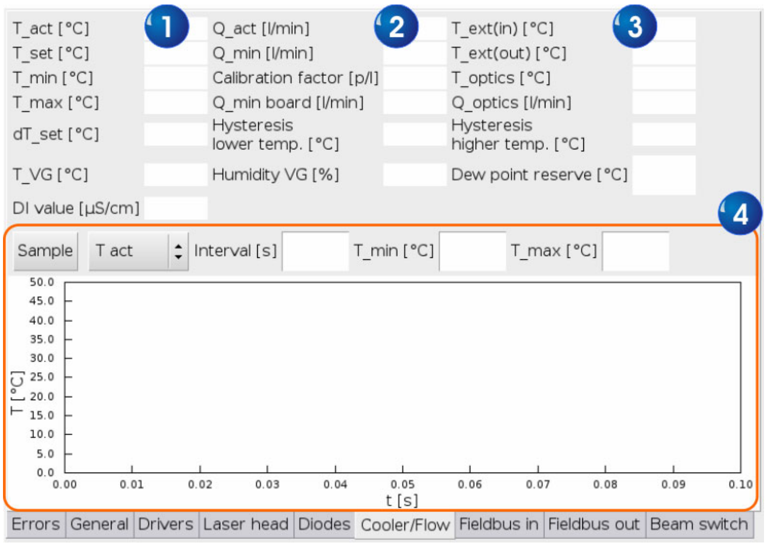
1. Current humidity and temperature values, flow and active functions in the laser head (LLC monitor, alignment laser, stack management etc.).
2. Current humidity values displayed in a diagram including the last saved values (history).

Menu Diodes

This menu displays set and current values of the selected laser stack. 	1. Current humidity, warning and error limit values as well as configuration data. 2. Current humidity values displayed in a diagram including the last saved values (history).

Menu Cooler / Flow

This menu displays set and current values of the cooler module.



1. Actual and set temperatures, Min/Max temperature, DI value of the internal circuit.
2. Values for coolant flow and switch-off, dew point of the internal circuit.
3. Temperature of the external circuit and optic cooling (optional).
4. Temperature diagram for internal- and external optic cooling.

Menu Cooler/ Record

Changing to another menu will abort the running measurement.

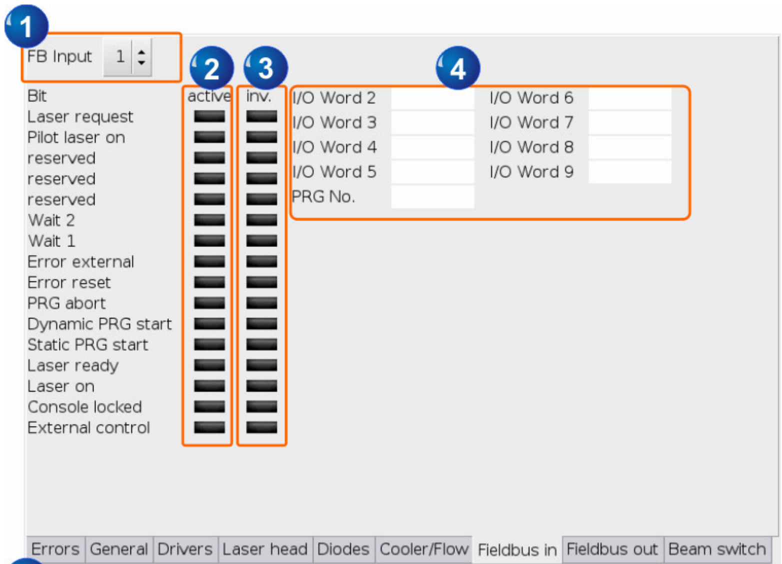
The following adjustments are based on the temperature diagram (4):

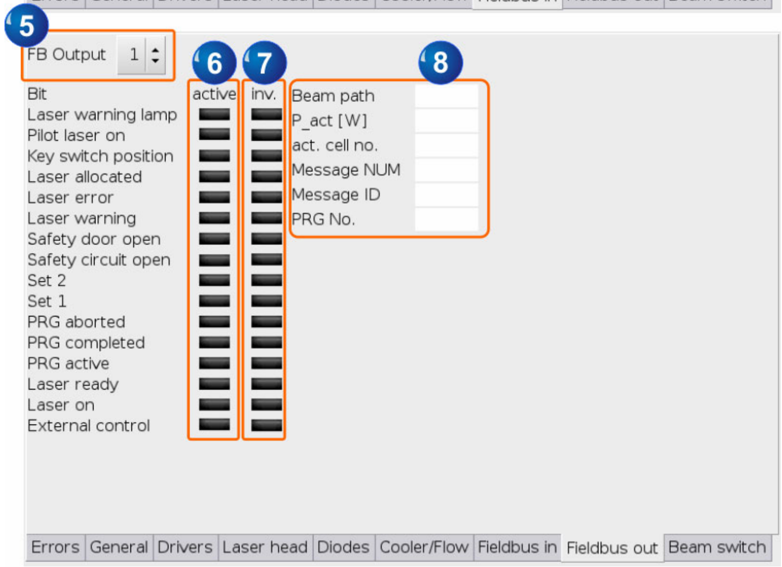
5. Start/ stop of the recording.
6. Selection of the signal
7. Update time in seconds.
8. Tmin. and Tmax. of the diagram.

Menu Field bus In/Out

This menu displays the status of the field bus interface.

The field bus is optional and not available in all laser systems.





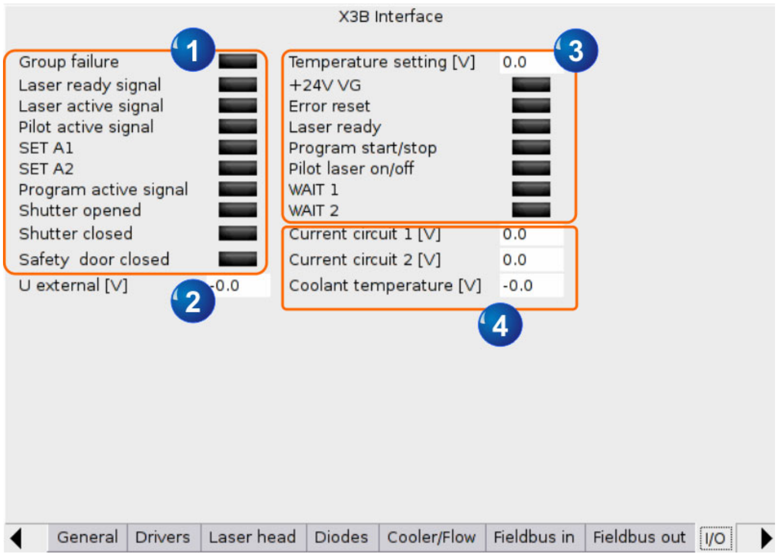
1. Selection of the FB (Inputs).
2. Status display of the inputs.
3. Inverting display of the inputs.
4. Values of the input words.
5. Selection of the FB (Output).
6. Status display of the outputs.
7. Inverting display of the outputs.
8. Values of the output words.

No.	Designation	Description
1	Selection of the FB (Inputs)	The interface (FB) to be observed can be selected via this drop down list. Depending on the equipment the laser can have up to 4 FBs.
2	Status display of the inputs	Displays the status of the input bits (word 0). If an active signal is present, the LED illuminates. Whether a signal is low or high active depends on the field bus configuration.
3	Inverting display of the inputs	Displays which signals are inverted via the field bus configuration. If the LED illuminates, the signal of the corresponding bits is inverted (low activation)
4	Values of the input words	Displays the present values of the input words 2-9.
5	Selection of the FB (Output)	The interface (FB) to be observed can be selected via this drop down list. Depending on the equipment the laser can have up to 4 FBs.
6	Status display of the outputs	Displays the status of the output bits (word 0). If an active signal is present, the LED illuminates. Whether a signal is low or high active depends on the field bus configuration.
7	Inverting display of the outputs	Displays which signals are inverted via the field bus configuration. If the LED illuminates, the signal of the corresponding bits is inverted (low activation)
8	Values of the output words	Displays the current values of the following words: • Currently selected laser program • Currently switched beam path (beam outlet) • Current laser power • Currently assigned laser cell / gateway • Number of present errors • Message id of the last occurred error message.

Menu I/O

This menu displays the signal state of the interface X3B.

The displayed signals correspond to those of the X3B interface. The signals are described in the laser manual, Chapter 12 „Customer Interface“.

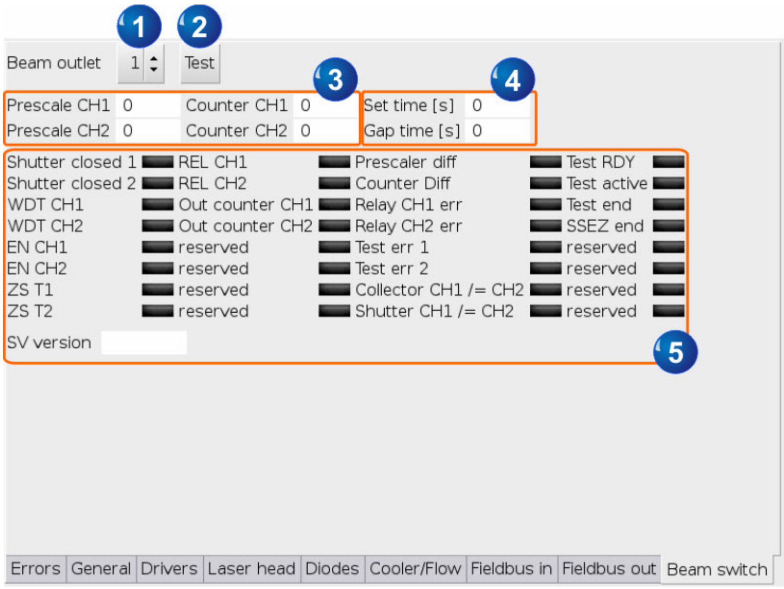


1. Digital output signals.
2. Analogue input signal.
3. Digital input signals.
4. Analogue output signals

Menu Beam switch

This menu displays the signal state of the beam outlets.

The auto beam off is an option and is not available in all equipments.



1. Selection of the beam outlet.
2. Start self test.
3. Display of the rotary switch settings.
4. Maximum emission time / remaining emission time (count down).
5. Status display

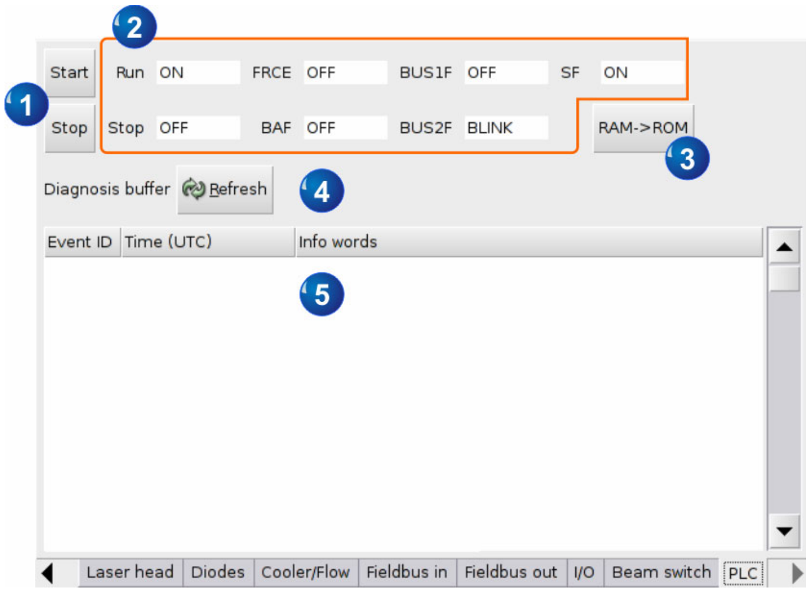
Note – Case of error

If the auto beam off recognizes an error, the laser cannot be started. In this case contact the Laserline service.

No.	Description
1	Selection of which beam outlet should be shown.
2	Start auto beam off self test: A self test must be carried out after each change on the rotary switches. Alternatively, restart the laser system. The self test will be automatically carried out at start up of the laser system. If a self test is necessary, an additional warning message will be shown in the console.
3	Display of the position of the rotary switches (prescaler, counter) on the electronics module.
4	• Display of the currently set maximum emission time. • Display of the remaining emission time (when laser active) as a countdown.
5	Status display of the electronics (the most important are listed): • Prescaler diff: Settings of the rotary switches "prescaler" are not equal. • Counter diff: Settings of the rotary switches "counter" are not equal. • Rel CH1 / CH2: Error safety relay. • Test err 1 / Test err 2: Self test failed. • Test RDY: Self test must be carried out. • Test active: Self test running. • Test end: Self test completed. • SSEZ end: Auto beam off limit expired.

Menu PLC

This menu is used to view and to edit the PLC status. The input fields must be unlocked with the customer password.



1. PLC Start/Stop.
2. PLC status.
3. Data backup.
4. Refreshes the error buffer.
5. Displays the error buffer.

No.	Description
1	Start and stop the PLC.
2	Status displays: • Run = On: PLC running, blinks when starting. • Stop = On: PLC on hold, blinks when starting. • FRCE, BAF, BUS1F, BUS2F: not used. • SF= System error (error within the PLC).
3	Ram to Rom: Start data backup on the memory card (only after contact with the Laserline Service).
4	Refresh the error buffer of the PLC.
5	Error status of the PLC (Laserline Service only).

8.10.1 Dust protection diagnosis

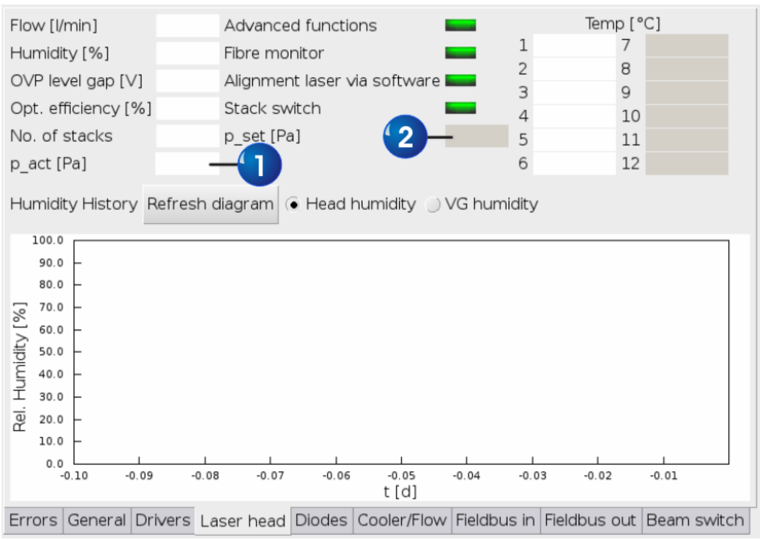
Menu Laser head /dust protection

The dust protection unit generates a slight and continuously excess pressure below the laser Plexiglas cover. This is very effective in preventing dust particles from penetrating the laser head. The required maintenance on the optical components will be reduced.

The pressure display is located in the menu “Diagnosis/Laser head”.

The current pressure (1) should accord to the set pressure (2) set value = current value (± 10 PA).

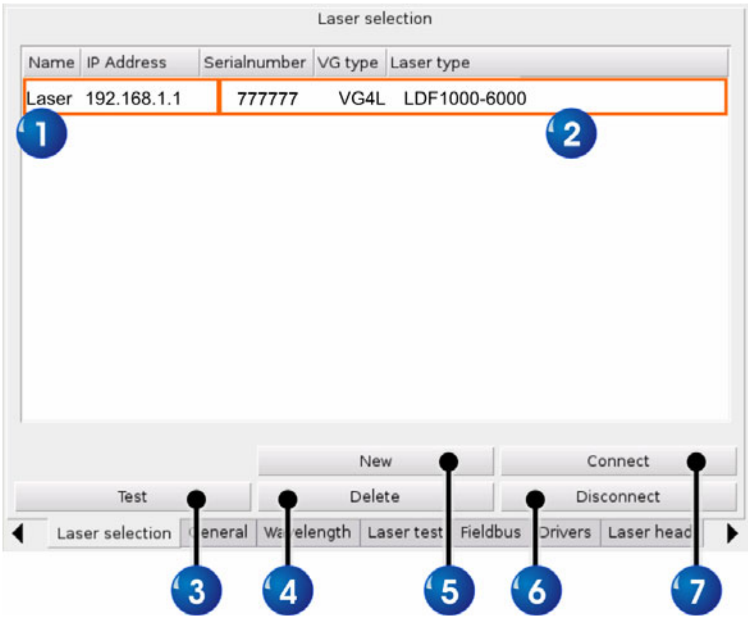
The dust protection unit is optional and not available in all laser system.



1. Current pressure
2. Set pressure

8.11 Main Menu configuration

8.11.1 Laser selection



1 Name and IP address of the laser (to be entered by the user)

2 Serial number, VG type and laser type (is read from the laser).

3 Button “Test” tests a marked connection

4 Button “Delete” deletes a marked entry in the list

5 Button “New” adds a new entry in the list

6 Button “Disconnect” disconnects a present connection

7 Button “Connect” creates a connection with a laser

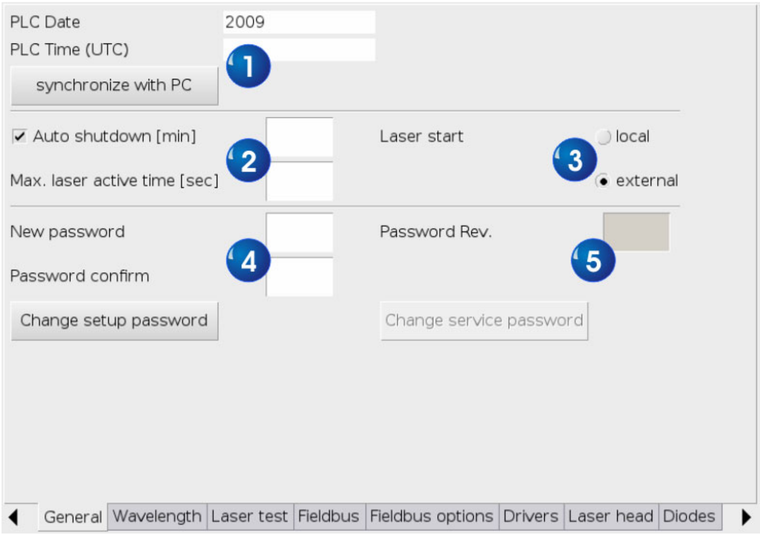
Fig. 75: Configuration/Laser selection

Info Console

The console in the laser device automatically creates a connection to the internal control. This connection is **not** displayed in the list. All other connections must be manually entered.

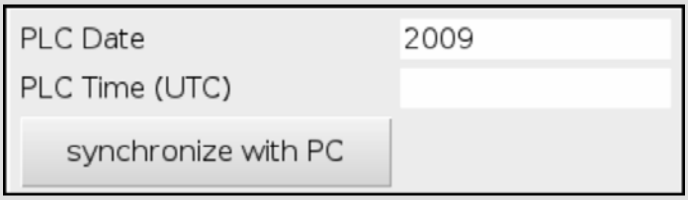
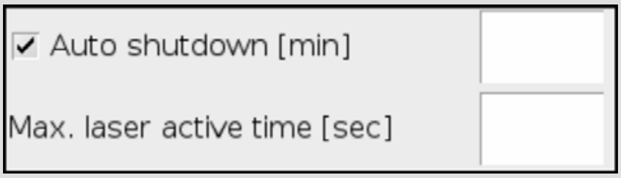
Nr.	Designation	Description
1	Name and IP	The IP address of the laser is assigned by a DHCP server (from the customer side). The name of the laser can be selected freely by the user.
2	Serial number and type	This information is stored by the Laserline in the factory and requested by the LL-Control.
3	Button “Test“	Performs a connection test with the selected laser. The test was successful if serial number and type are displayed.
4	Button “Delete“	Deletes a marked entry from the list.
5	Button “New“	Creates a new entry in the list
6	Button “Disconnect“	Disconnects the software from a system.
7	Button “Connect“	The software connects to the selected laser in the list.

8.11.2 Configuration /General

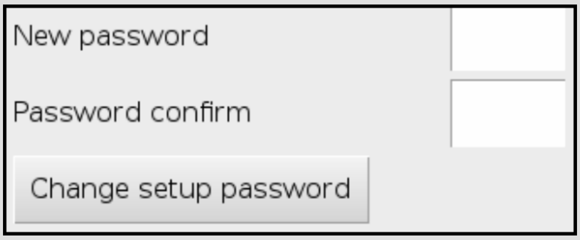


1 Adjust date/time
2 Auto shutdown / Max. laser active time
3 Select laser control signal
4 Change setup password in LL-Control
5 Change service password (only Laserline)

Fig. 76: Configuration / General

Nr.	Bezeichnung
1	 **Change Time/Date**: The laser control contains an internal clock (UTC-Time) with date function to allow the assignment of error messages and history data. • In case the values displayed for date and time are not correct, touch the “synchronize with PC” button.
2	 **Auto shutdown**: The system automatically switches off the cooling system after a certain time without laser operation (system is not in “ready status”). The time after the system shuts down can be set between 10 and 30 min. (selected by the customer). As soon as the system is set to the “ready” status again (internal, external or by field bus), the cooling system starts automatically and the system is again ready for operation. **Max. laser active time**: The laser system can limit the maximum activation time of the laser to a preset value. This time value can lie between 10 and 9000 seconds (150min/ 2.5 hours). If a value is set to more than 9000 seconds, the option is inactive.
3	 **Laser start**: The diode laser system can be basically operated in two different modes (local control with the operating unit/console and external control via X3 interface/field bus). The switch-over between the modes takes place with this radio group.

4

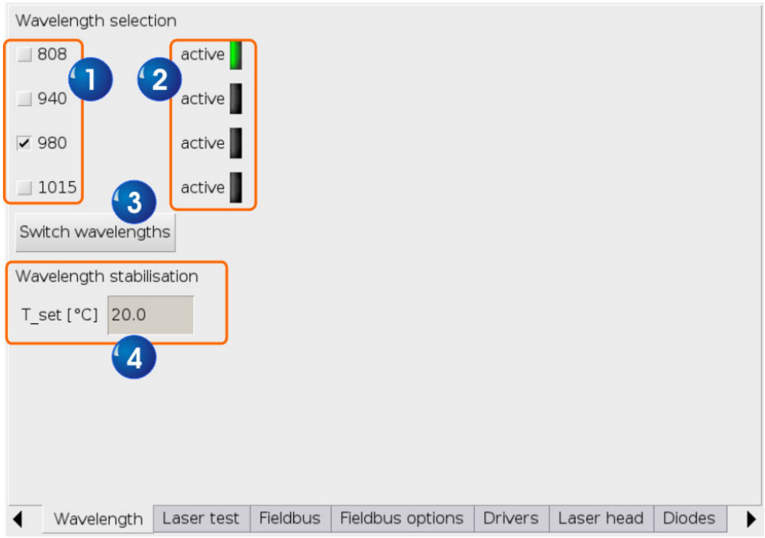


Change password: The setup password of LL-Control (delivery “0123”) can be changed at any time. To set a new password, proceed as follows:

- Perform a login as “setup”.
- Enter the new password in the input field and repeat this procedure once more in the “Password confirm” input field. Click on the “Change setup password” button to adopt the new password.

Every laser can be set to a different password.

8.11.3 Wavelength Selection



1 Wavelengths ON/OFF

2 Active wavelengths

3 Switch wavelengths

4 Wavelength stabilization temperature preset (optional)

Fig. 77: Configuration/Wavelength

Note – Wavelength selection / Wavelength stabil.

The wavelength selection is optional and is therefore not available in all laser system.

No.	Name	Description
1	Wavelength ON/OFF	These elements enable to determine which wavelengths should be switched on or off. If the hook is set, the corresponding wavelength is active
2	Active wavelengths	Displays the wavelength currently active. If the LED illuminates green, the wavelength is active.
3	Switch wavelengths	Switches the wavelengths on or off (depending on the wavelengths selected by (1).
4	Temperature preset *(only for wavelength stabilization)*	The expected temperature of the cooling system can be preset in this field. This allows influencing the central wavelength of the laser (further information in chapter 9 “System options”).

Switching sequence of the wavelengths:

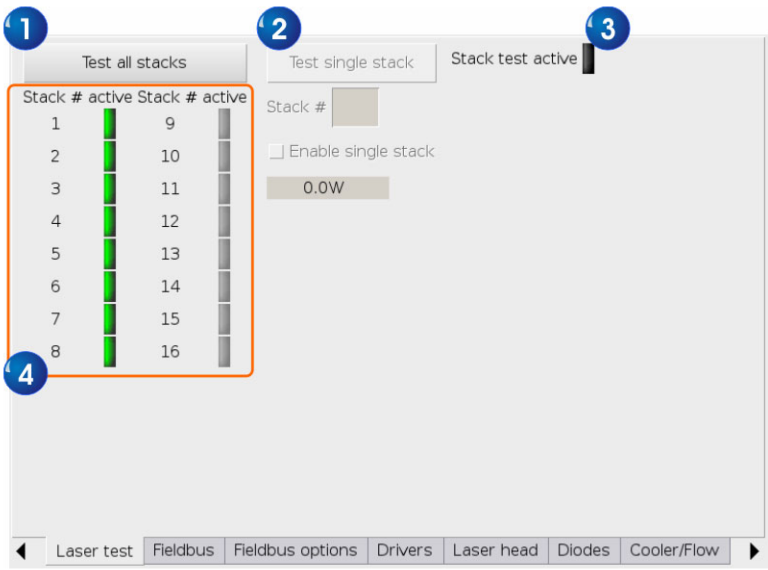
1. Close the safety doors of the processing station.
2. Select the necessary wavelength(s).
3. Turn the key switch to position II.
4. Switch the system to READY status.
5. Select the button “Switch wavelengths”.
6. The Laser-ON indicators illuminate for a short time, the laser control unit calculates the new power data of the system and switches the selected stacks.

8.11.4 Stack management

Generally, the sudden occurrence of an OVP or OCP error is indicative of a defective stack. In this case, the stack test can be started. The system performs the stack test, acknowledging any OCP or OVP errors. A defect stack will be disabled and the laser system returns to operational status. The maximum available laser power might be lower after the stack test (depending on the system configuration).

Info – Stack Test

The stack test does **not** start automatically but has to be started by touching the button “Test all stacks”



1 Start stack test
2 Enable single stack (Laserline Service)
3 Stack test active LED
4 Active laser stacks

Fig. 78: Configuration/Laser test

Nr.	Bezeichnung	Beschreibung
1	Button "Test all stacks"	In order to execute a stack test, touch the button "Test all stacks". Please read the security instructions and confirm with OK, if the conditions are fulfilled.
2	Enable single stack	These functions are only accessible for the Laserline service and are necessary for configuration and setting during maintenance.
3	Stack test active LED	Illuminates during the stack test.
4	Active laser stack	Displays the status of the laser stack: Stack OK and active (green) Stack defective and inactive (black) Stack not available (grey)

Note Stack test

Every laser stack is operated with individual power during a stack test. It can amount up to a few KW depending on the model of the laser. In order to prevent work pieces from being damaged, an absorber should be positioned in the beam path.

Perform the stack test as follows:

1. Direct the laser beam into a heat sink (absorber).
2. Close safety doors and safety circuits (the shutter remains closed during the test, no laser power will exit).
3. Turn the key switch to position II.
4. Touch the button “Test all stacks" (error messages are reset).
5. Switch the system to READY status.
6. The laser system starts the stack test automatically.
7. All stacks are tested separately and defect stacks are disabled.
8. The laser system is again ready for operation after the stack test.

Info – Service / Warning message

- Please contact Laser service after perfoming a stack test.
- If as stack is damaged a warning message is display (until the stack is repaired).

8.11.5 Fieldbus

The field bus configuration can altered in these menus.

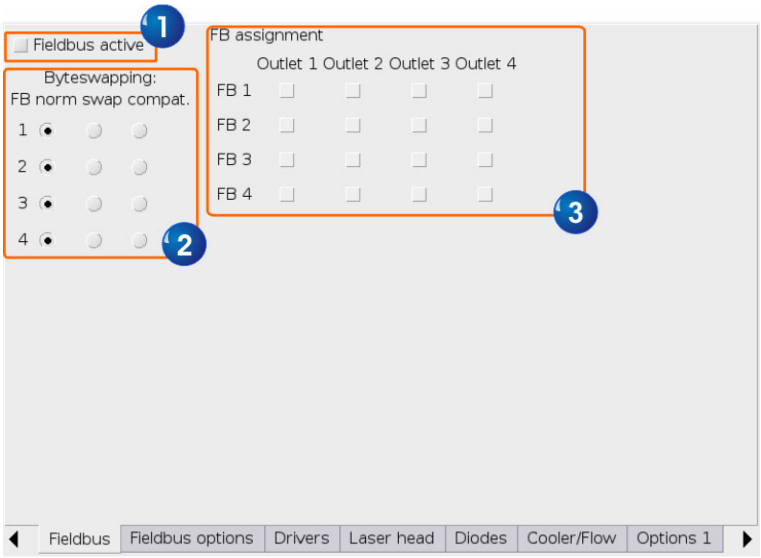


Fig. 79: Configuration/Fieldbus

No.	Designation	Description
1	Fieldbus active	Switches the field bus on or off.
2	Byte swapping for FB	Byte swapping mode for the selected FB (Gateway).
3	Assignment list FB to beam outlet	The assignment table is only available for systems with beam switch or for systems with more than one gateway. By using the assignment table it is possible to allocate beam outlet to an FB (Gateway).

8.11.5.1 Fieldbus options

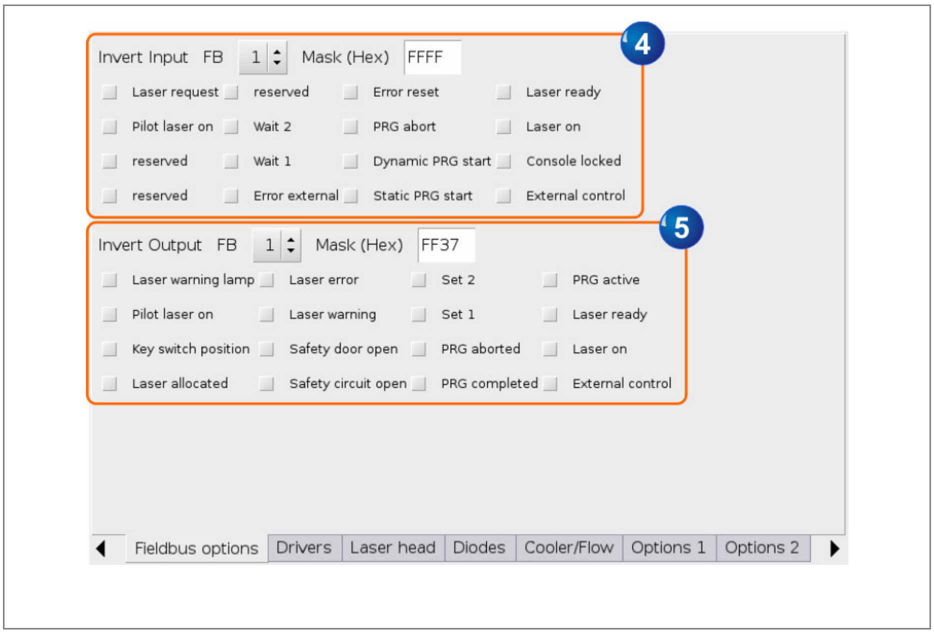


Fig. 80: Configuration / Fieldbus options

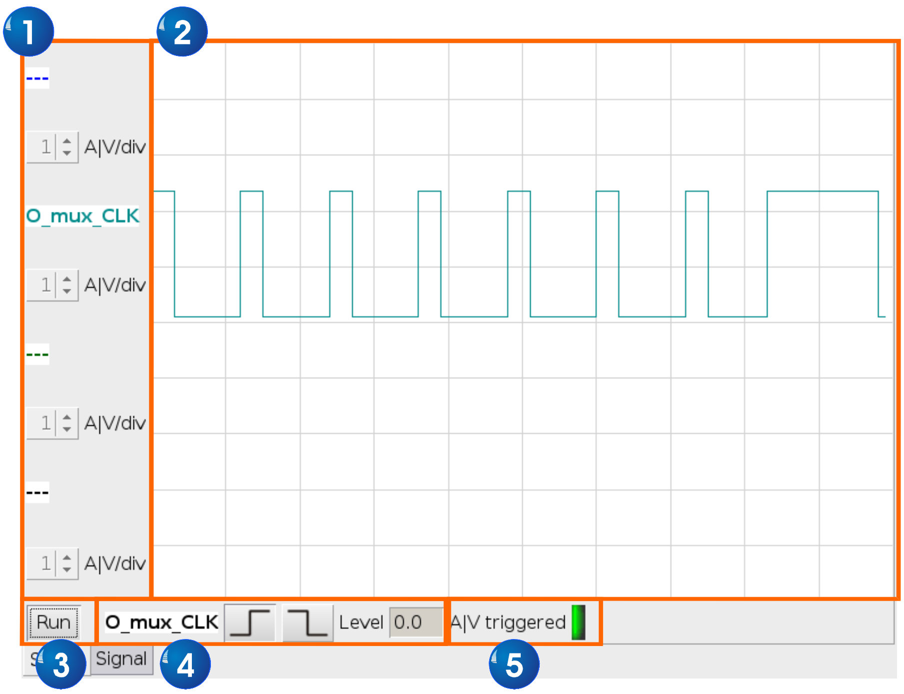
No.	Designation	Description
4	Bit inversion Input word 0	As default all signals in word 0 are high-active. If a corresponding signal is selected (check box set), it changes to low-active status.
5	Bit inversion Output word 0	

Info – Fieldbus

Additional information regarding the fieldbus can be found in chapter 9 (Fieldbus) is the laser system is equipped with the option “Fieldbus”).

8.12 Main Menu Oscilloscope

Different signals can be displayed on one Oszillogramm. Additionally a trigger function is integrated, which enables the triggering on rising/falling edges and signal levels.



1 Signal selection (max. 4)
2 Oscillogram
3 Run (Start) button
4 Trigger channel and trigger condition
5 Trigger control

Fig. 81: Oscilloscope description

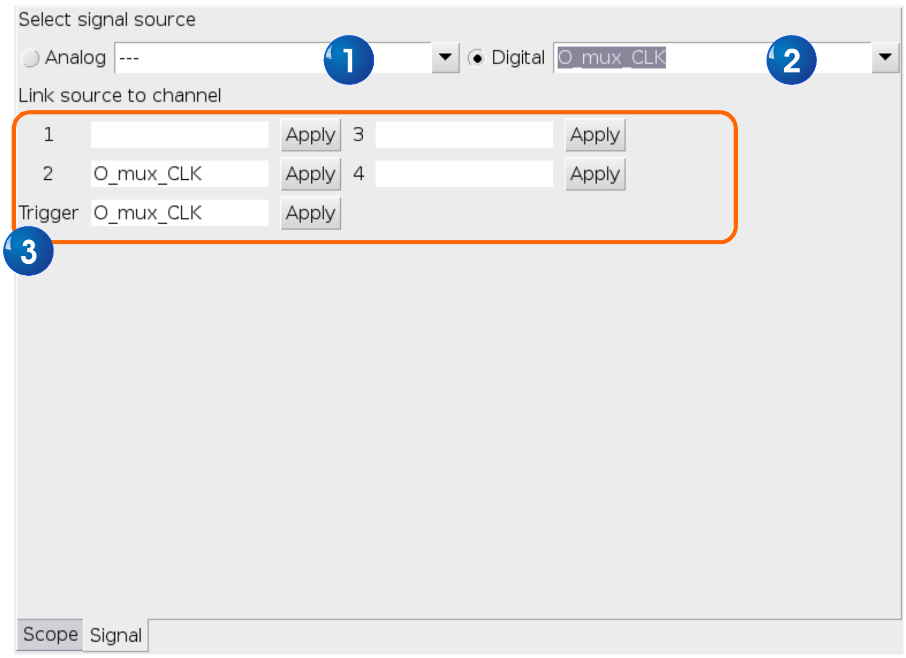
No.	Description
1	Display of the selected signals. The selection takes place under “Oscilloscope/Signal”.
2	The signals are displayed in the oscillogram.
3	“RUN” starts or ends a test procedure.
4	Display of the trigger channel with selection of the trigger condition. Digital signals: • Rising edge • Falling edge Analogue signals • Level selected in combination with rising edge in order to trigger if the condition exceeds the level. • Level selected in combination with falling edge in order to trigger if the condition does not exceed the level.
5	Illuminates if the trigger condition is fulfilled.

Note – Signal list

In order to receive an overview of the available digital and analogue signals and details, please contact the Laserline Service.

8.12.1 Select signals

Before using the oscilloscope, signal sources must be selected.



1 Analog signals

2 Digital signals

3 Selected and assigned signals

Fig. 82: Signal selection

Adjust signals:

1. Select a signal (analog signals list 1, digital signals list 2).
2. Assign the signal to a channel (select the button “Apply” in the corresponding line).
3. Select a trigger signal (optional).

8.13 Using LL-Control

8.14 Control modes of the laser system

The diode laser system can basically be operated in two different control modes.

- The first mode is the so-called LOCAL mode.

  If the system is in the LOCAL mode, the test will take place via the operating field of the system.

- The second operating mode is the so-called EXTERNAL mode.

  If the system is switched in the EXTERNAL mode, the control test will take place with the client interface. Functions like Laser ready, Laser ON/OFF, Pilot laser ON/OFF can be switched only via the client interface.

The switch-over between LOCAL and EXTERNAL control modes takes place in the menu “Configuration /General page 8-50”.

Note:

The switch-over between LOCAL and EXTERNAL modes does not affect the external power preset via a 0-10 V signal. An operation mode is concerned in case of the power preset.

8.14.1 Extended control mode field bus

The laser system can be provided with a field bus interface as control option.

Basic functions of the system like Laser ready, Laser ON/OFF, Pilot laser ON/OFF similar to the X3 interface can be controlled via this bus interface. Additionally the bus interface offers extended functions for the selection of laser programs as well as for the control of a beam switch, reaction to external errors etc.

If the field bus is activated in the console, the control functions of the client interface (X3) become **inactive**. An external control is possible only via the bus interface. The LOCAL/EXTERNAL selector switch in the operation unit becomes also inactive.

A switch-over between LOCAL and EXTERNAL mode can take place with active field bus only via the bus interface (cf. chapter 9 “Field bus interface”).

info – Fieldbus

- The possibility for the power preset via a 0-10V signal via the client interface remains valid. Moreover the additional functions of the programming mode on the interface can be completely used.
- The mode “LOCAL” continues to refer to the operation unit also when the bus is active.

8.15 Operation modes of the laser system

8.15.1 Continuous Wave Operation (CW)

In CW mode ("CW" = Continuous Wave) the laser system continously outputs a preset power. The power is set by "P_Set".

If the laser is switched on the power is ramped up for a certain period of time (T_rise) and then remains constant at the pre-set value (P_set), until the laser is switched off.

Info – T_Rise

The minimum value is 10ms.

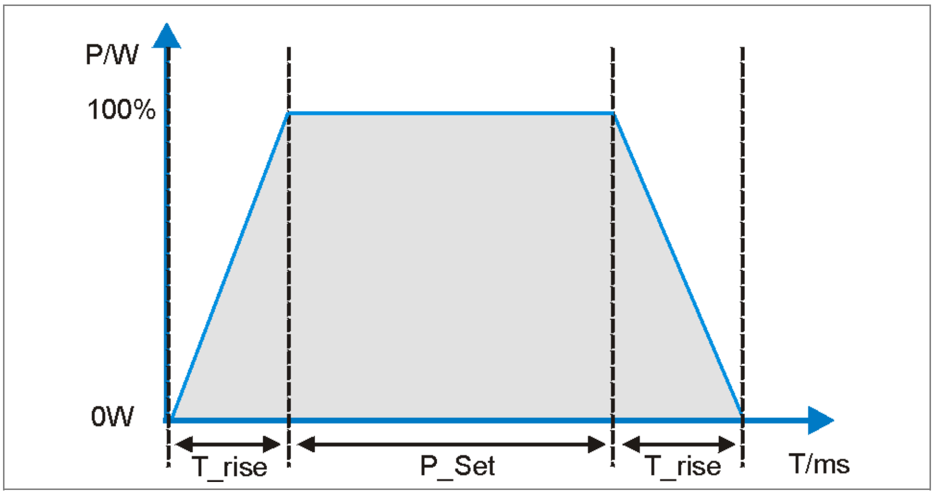


Fig. 83: Laser in CW mode

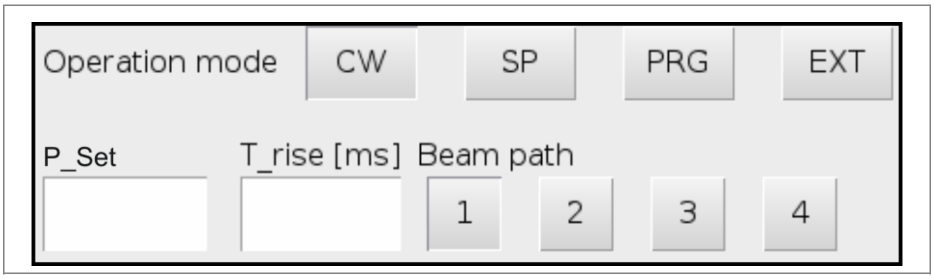


Fig. 84: Operation indication in CW mode

Info – CW Beam switch

The beam outlet (for systems with beam switch) can be selected by the buttons [1...4].

8.15.2 External power preset (EXT)

In EXT mode the laser output power is set from 10% to 100% by an analogue 0-10V signal. The signal is connected via the customer interface X3.

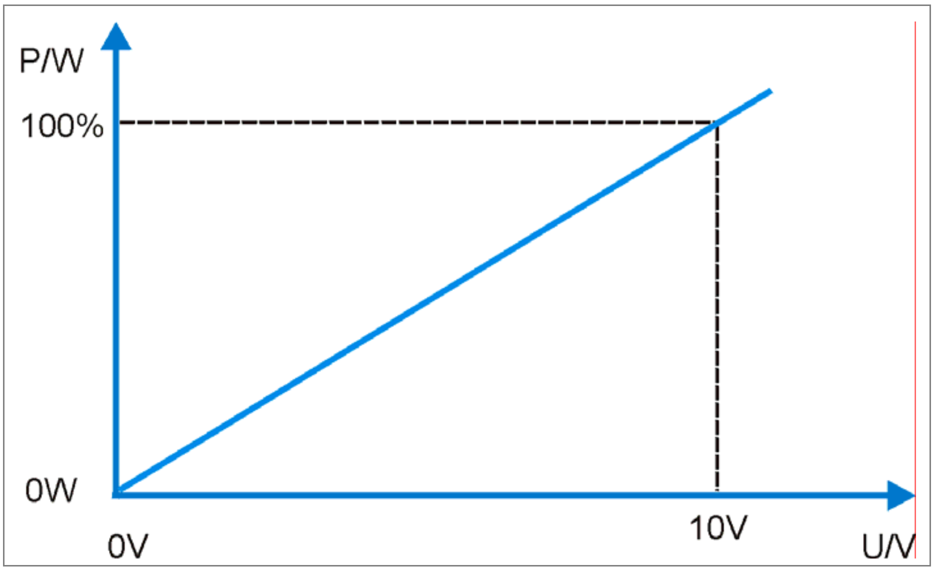


Fig. 85: Laser in EXT operation

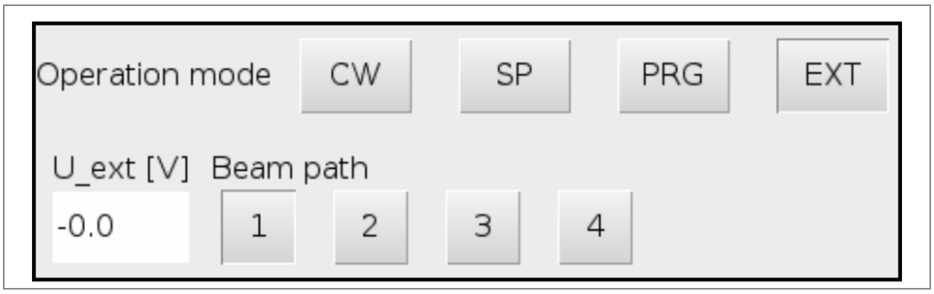


Fig. 86: Operation indication in EXT mode (Uext= voltage level)

Info – Ext Beam switch

The beam outlet (for systems with beam switch) can be selected by the buttons [1...4].

8.15.3 Pulsed Operation (SP)

In pulsed mode a certain number of pulses can be generated. The time of the pulse (T_puls) and the pause time (T_pause) can be preset. However, the values for T_puls and T_pause may not be set below 10ms.

The pulse repetition rate is set by the factor N. After the diode laser has executed the N-Pulse, it automatically shuts off.

Info - Pulse time

- The maximum length of one pulse is 60000ms.
- The minimum length of one pulse is 10ms.

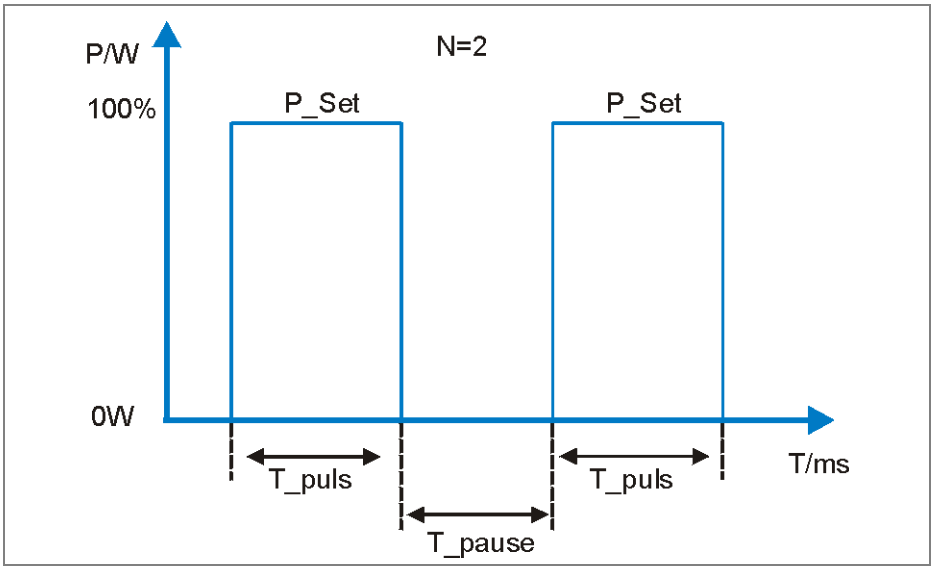


Fig. 87: Laser in pulsed operation (2 pulses)

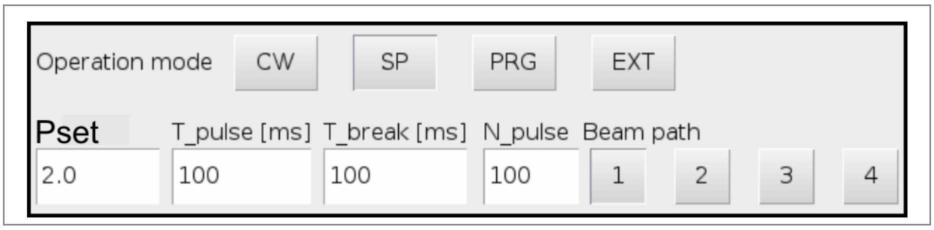


Fig. 88: Operation indication in SP mode.

Info – SP Beam switch

The beam outlet (for systems with beam switch) can be selected by the buttons [1...4].

8.16 Program mode (PRG)

In this mode, the laser system can be controlled via sequence programs. The user creates and saves a program which can then be executed by the laser control unit.

Various freely selectable commands exist in the program mode for this purpose. These enable the setting of the laser power, opening and closing of the shutter, program loops, power ramps as well as reacting to external occurrences. Additionally, commands are available for the field bus interface (only usable if the fieldbus interface is available).

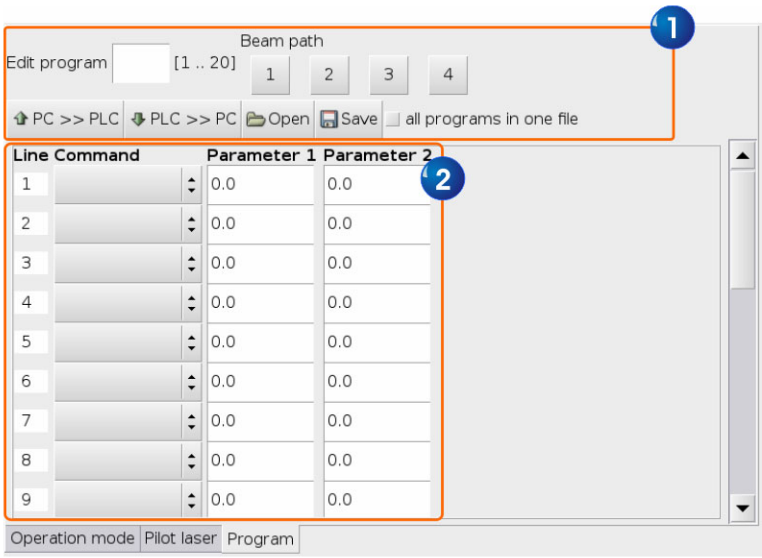
8.16.1 General Information

Basically a command contains the instruction itself as well as the related parameters. Most of the instructions have two parameters. For commands with less than two or no parameters it is possible to enter values. However these are not respected.

If a program is ended, the shutter will be closed automatically. A defined time is necessary from the time of the command to the complete opening/closing of the shutter. This time value depends on the model of the shutter. For more information, refer to "System Options/Shutter".

In combination with a beam switch a suitable beam path can be selected for each program and be assigned to individual programs. Several beam combinations can be realized by different programs. The beam path is entered and saved together with the corresponding program.

8.16.2 Program Editor



1 Functions

2 Program editor

Fig. 89: Program editor

The menu of the program mode is divided into two areas:

- The upper part (1) contains program selection, save/open of programs, and for systems with beam switches a beam path selection.
- The lower part contains the command lines. Here the programs can be entered and edited.

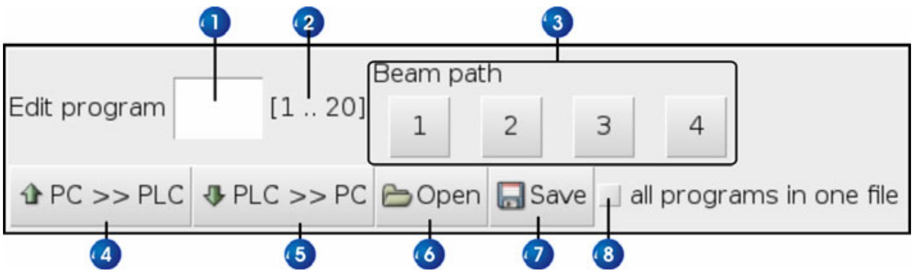


Fig. 90: Program functions

No.	Description
1	Define the program to be edited or entered by the input field.
2	Number of maximum amount of laser programs (depending on software version of the PLC 10 or 20).
3	If the laser system is operated together with a beam switch, the beam path to be switched can be selected by these buttons (1-4).
4	Transmits and saves the currently displayed program (Edit program) to the laser system.
5	Reads the selected program (Edit. Program) from the laser system and displays it in the program editor.
6	Opens a previously saved program from the PC/network (if available). If the file contains more than one program (check box [8] was selected when saving [7]) all programs are directly read into the laser control unit (backup function).
7	Saves the currently displayed program (Edit Program) to the PC/network (if available).
8	When saving programs (7) with the check box (8) selected, all programs are read from the laser control unit and saved in one file.

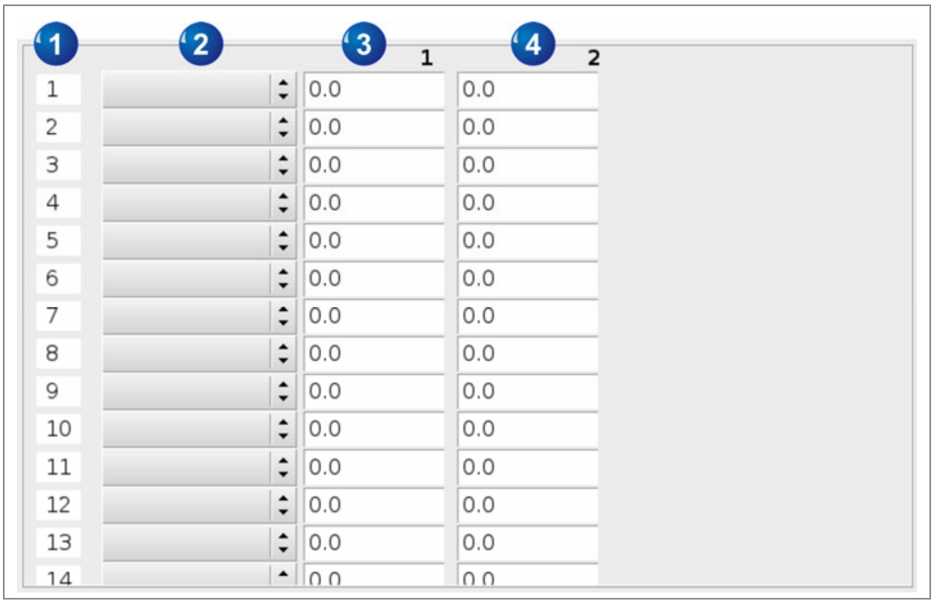


Fig. 91: Program editor

No.	Designation	Description
1	Line	Current command line
2	Command	Instruction assigned to the current command line.
3	Parameter 1	First parameter of the current command (if available).
4	Parameter 2	Second parameter of the current command (if available).

8.16.3 Program step indication

During the program processing the currently processed program step is displayed in the main menu.

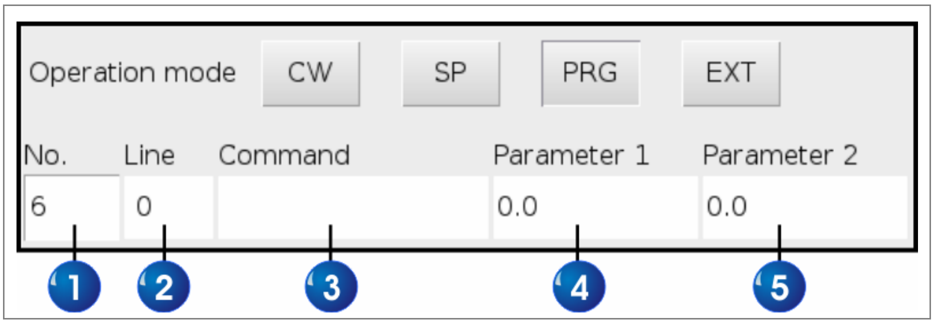


Fig. 92: Program step indication in the main menu

No.	Description
1	The program to be started by the laser control (1-10) is entered in this input field.
2	The currently processed program line of the laser program.
3	Current command of the current program line.
4	Current parameter 1 of the command.
5	Current parameter 2 of the command.

8.16.4 Command Overview

No.	Command	Short description
1	SET	Sets the output power of the laser for a defined time.
2	RAMP	Defines a power ramp of a start value on a target value within a defined time.
3	LOOP	Defines a repetition loop for freely selectable parts of the program.
4	EXT	Sets the output power of the laser for a defined time on the value for the external preset (client interface X3).
5	SH_OPEN	Opens the beam lock with a defined power value.
6	SH_CLOSE	Closes the beam lock with a defined power value.
7	WAIT_1	Reacts to an external occurrence on the request entry 1 on the client interface (X3).
8	WAIT_2	Reacts to an external occurrence on the request entry 2 on the client interface (X3).
9	EXT_BUS	Sets the output power of the laser limited to the value of the external power preset, which is specified by the field bus interface.
10	WAITB_1	Reacts to an external occurrence on the request entry 1 of the field bus interface.
11	WAITB_2	Reacts to an external occurrence on the request entry 2 of the field bus interface.
12	SET_A1	Sets the first output on the client interface (X3).
13	RST_A1	Re-sets the first output on the client interface (X3).

No.	Command	Short description
14	SET_A2	Sets the second output on the client interface (X3).
15	RST_A2	Re-sets the second output on the client interface (X3).
16	SETB_A1	Sets the first output on the field bus interface.
17	RSTB_A1	Re-sets the first output on the field bus interface.
18	SETB_A2	Sets the second output on the field bus interface.
19	RSTB_A2	Re-sets the second output on the field bus interface.
20	MV_HW_BUS	Transfers the signal of a hardware input (1 or 2) to the signal of a bus output (1 or 2).
21	MV_BUS_HW	Transfers the signal of a bus input (1 or 2) to the signal of a hardware output (1 or 2).

8.16.5 Explanation of the commands

Info

The entries in square brackets [ ] correspond to the parameters of a command. If a command has only 1 parameter or none at all, this symbol [--] is used.

1 SET [Time] [Output Power]

This Set Command is used for setting the laser output power.

It sets the laser power to a certain value for a defined time period.

Parameter 1	Final time value of 10ms to 99 000 000ms. If the value is < = 10ms, the program will be aborted.
Parameter 2	Pre-set laser power of 0 W to Pmax in watts

If a longer set time is needed the SET-Command can be combined with the LOOP-Command (see LOOP-Command).

Parameter 1 and parameter 2 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

Note - Set command and field bus interface

The power value is calculated once at the execution of the SET command. If the power values is assigned via field bus this value will be used during the complete duration of the command. To change the power value dynamically it is necessary to use the EXT_BUS command.

2 RAMP [Time] [Power Output]

The RAMP Command enables a setting of the time for increasing or decreasing the laser output power in the sense of a ramp. It increases/decreases the power from a previously set output power within a selected time, to a different output power.

Parameter 1	Final time value of 10ms to 99 000 000ms. If the value is < = 10ms, the program will be aborted.
Parameter 2	Pre-set output power from 0 W to Pmax in watts

Parameter 1 and parameter 2 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

3 LOOP [Line] [-Number]

The Loop Command serves as an instruction that influences the program run. This command enables repetitive execution of certain routines of the program in a determined number beginning from a certain program line.

Note

A nesting of the subroutine command is not possible

Parameter 1	Determines the program line at which the program is to repeat itself. If the value is 0, the program will be aborted.
Parameter 2	The number of times the routine is to be repeated. If the value is 0, the program will be aborted.

Parameter 1 and parameter 2 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

4 EXT [Time] [--]

The EXT Command enables – in contrast to the Set Command - setting the laser output power via the external hardware interface port X3. For this, the analogue signal is evaluated and limited to a pre-set time via the interface (cf. EXT Operation).

Parameter 1	Final time value of 10ms to 99 000 000ms. If the value is < = 10ms, the program will be aborted.
Parameter 2	Not used.

Parameter 1 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

5 SH_OPEN [--] [Power Output]

The SH_Open Command opens the laser beam shutter.

The first parameter is not used. The second parameter enables the setting of the output power on opening the beam shutter. When the value is set to 0 W the laser is in the threshold operation. If the pre-set value is greater than 0 W, the laser output power will be ramped up to the pre-set power during the opening phase of the shutter. This is necessary when using the process shutter (cf. ‘System Option / Shutter’).

A pre-defined time is necessary from the time of the command until the shutter is completely opened. This time valve depends on the model type of shutter. Further information can be found in the section on “System Options / Shutter“.

This command is necessary as, in contrast to CW operation, the beam shutter in the programming mode does not automatically open when switching on the laser.

Note

If the laser system is not equipped with a shutter, this command is skipped over.

Parameter 1	Not used.
Parameter 2	Pre-set power from 0 W to Pmax in watts

Parameter 2 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

6 SH_CLOSE [--] [Output Power]

The SV_Close Command closes the beam shutter.

The first parameter is not used. The second parameter enables the setting of the output power when closing the laser beam shutter. If the beam power is 0 W, the laser is in threshold operation. If the set value is greater than 0 W, the laser power during the movement phase of the shutter closing will be adjusted to the pre-set value. This is necessary when using the process shutter (cf. “System Options/Shutter“.) A defined time is necessary from the time point of the command until the shutter is completely closed. This time value depends on the model type of the beam shutter used. Further information can be found in the section, “System Options / Shutter“.

Note

If the laser system is not equipped with a shutter, this command is skipped over.

Parameter 1	Not used.
Parameter 2	Pre-set power from 0 W to Pmax in watts

Parameter 2 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

7 Wait i: [Level] [--] ('i' corresponds to 1 or 2)

8 Wait i: [Level] [--] ('i' corresponds to 1 or 2)

The Wait i-Command holds the program until an external event is received at the wait input i at the hardware interface (X3). Further information concerning the interface can be found in the "Technical Appendix / Interface".

The previous command is active until the 'wait condition' is fulfilled.

Note

The command has no "Timeout routine". The program is held until the condition has been fulfilled, or the program is aborted.

Parameter 1	0 for "waiting" for Low, or 1 "waiting" for High level.
Parameter 2	Not used.

9 EXT BUS [Time] [Word]

The EXT Bus Command enables setting the defined laser beam power via the field bus. This function enables the operator to set the power output for a defined time to pre-set power output which is assigned via the interface to the respective cell.

The second parameter defines the input word which is used for the pre-set value. Possible words are between 2 to 9. The default word is 2.

Parameter 1	Final time value from 10ms to 99 000 000ms. If the value is < 10ms, the program will be aborted.
Parameter 2	2 to 9 for Word 2 to 9 at the field bus interface (see Section Field Bus).

Parameter 1 can be assigned via the field bus interface. Enter the preferred bus input word with a prefixed "-".

Parameter 2 must be assigned via the field bus.

10 WaitB_i [Level] [--] ('i' corresponds to 1 or 2)

11 WaitB_i [Level] [--] ('i' corresponds to 1 or 2)

The WaitB_i Command holds the program until there is an external event on the wait input i at the field bus interface of the assigned cell. The command has no other parameters. Further information concerning the interface can be found in the "Technical Appendix / Field Bus Interface".

The previous command is active until the 'wait condition' is fulfilled.

Note

The command has no "Timeout routine". The program waits until the "condition" is fulfilled, or the program is aborted.

Parameter 1	0 for "waiting" for Low; or 1 for "waiting"for High level.
Parameter 2	Not used.

12 Set_A i [--] [--] ('i' corresponds to 1 or 2)

14 Set_A i [--] [--] ('i' corresponds to 1 or 2)

The Set_A i Command enables setting of the active setting output i at the hardware interface. Using this function, an external event can be started during the program run. The command has no other parameters.

Further information concerning the interface can be found in the "Technical Appendix / Interface".

Parameter 1	Not used.
Parameter 2	Not used.

13 Rst_A i [--] [--] ('i' corresponds to 1 or 2)

15 Rst_A i [--] [--] ('i' corresponds to 1 or 2)

The Rst_A i Command enables the 'resetting' of the setting output i at the hardware interface. Using this function, an external event can be ended. The command has no other parameters.

Further information concerning the interface can be found in the "Technical Appendix / Interface".

Parameter 1	Not used.
Parameter 2	Not used.

16 SetB_A i [--] [--] ('i' corresponds to 1 or 2)

18 SetB_A i [--] [--] ('i' corresponds to 1 or 2)

The SetB_A I command is used to define the bus set output i on the bus interface of the assigned cell. With this function an external event can be triggered via the field bus during the program run.

The command has no other parameters. Further information can be found in the section on "Laserline Field Bus Interface".

Parameter 1	Not used.
Parameter 2	Not used.

17 RstB_A i [--] [--] ('i' corresponds to 1 or 2)

19 RstB_A i [--] [--] ('i' corresponds to 1 or 2)

The RstB_A i Command enables a "re-setting" of the bus set output i on the bus interface of the assigned cell. With this function an external event can be stopped during the program run.

The command has no other parameters. Further information can be found in the section on "Laserline Field Bus Interface".

Parameter 1	Not used.
Parameter 2	Not used.

20. MV-HW-BUS [HW wait input i] [Bus output i]

('i' corresponds to 1 or 2)

The MV-HW-BUS Command sets a bus set output on the status of a hardware wait input of the customer interface (X3).

Example: Starting a robot connected to the bus through a signal from the customer interface.

The first parameter determines the hardware wait input; the second determines the bus set output.

Parameter 1	1 for Hardware Wait input 1 2 for Hardware Wait input 2
Parameter 2	1 for Bus Set output 1 2 for Bus Set output 2

21. MV-BUS-HW [Bus wait input i] [HW set output i]

(,i' corresponds to 1 or 2)

The MV-BUS-HW Command sets a hardware set output on the customer interface (X3) to the status of a wait input of a bus wait input.

Example: Starting a robot connected to the customer interface through the bus interface.

The first parameter determines the bus wait input; the second, the hardware set output.

Parameter 1	1 for Bus Wait input 1 2 for Bus Wait input 2
Parameter 2	1 for Hardware Set output 1 2 for Hardware Set output 2

8.16.5.1 Program Examples (B1 – B8)

B1. Setting laser output power via a program

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	SET	5000 ms	1000 W

1 Opens the beam shutter with 0 W output power.

2 Sets the output power to 1000 W for 5000 ms.

The program will be ended after the last line has been run. Beam shutter closes automatically.

B2. External setting of laser output power via hardware interface:

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	EXT	5000 ms	--

1 Sets the output power to 1000 W for 5000 ms.

2 Sets the laser output power via a hardware interface to the preset value for 5000 ms.

The program will be ended after the last line has been run. The beam shutter closes automatically.

B3. Setting laser power output via a program using power output ramps:

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	RAMP	100 ms	1000 W
3	SET	10000 ms	1000 W
4	RAMP	100 ms	0 W
5	SH_Close	--	0 W

1 Opens the beam shutter at a laser power of 0 W.

2 Increases (ramps up) the output power from the current value of (0 W) to 1000 W within t = 100 ms.

3 Sets and maintains the output power at 1000 W for 1000 ms.

4 Decreases (ramps down) the output power from the current value of 1000 W to 0 W within t= 100 ms.

5 Closes the beam shutter.

The program will be ended after the last line has been run. The beam shutter closes automatically.

B4. Setting laser power output via a program with repetitive loop

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	SET	1000 ms	1000 W
3	SET	1000 ms	500 W
4	LOOP	2	6
5	SH_Close	--	0 W

1 Opens the beam shutter at a laser power output of 0 W.

2 Sets and maintains the power output at 1000 W for 1000 ms.

3 Sets and maintains the power output at 500 W for 1000 ms.

4 Repeats the program routine from step 2 on. The number of repetitive runs is 6. Steps 2 and 3 are repeated a total of 7 times (determined by the loop routine).

5 Closes the beam shutter.

The program will be ended after the last line has been run. The beam shutter closes automatically.

B5. Setting laser power output via an external hardware interface and response to the external input via a hardware interface:

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	EXT	10000 ms	--
3	WAIT_1	1	--
4	EXT	100 ms	--
5	SH_Close	--	0 W

1 Opens the beam shutter at laser output power of 0 W.

2 Sets the power output for at least 1000 ms to the pre-set value set using a hardware interface.

3 Waits at the externally pre-set power until the wait input 1 is at high level.

4 Sets the power output at a pre-set value via the hardware interface for 100 ms, after wait input 1 high level has been run.

5 Closes the beam shutter.

B6. Setting laser power output via a program with output via an external hardware:

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	SET_A1	--	--
3	SET	10000 ms	1000 W
4	RST_A1	--	--
5	SH_Close	--	0 W

1 Opens the beam shutter at a laser power of 0 W.

2 After opening the beam shutter, sets the set output 1 (high level).

3 Sets the power output to a value pre-set via the hardware interface for 1000 ms.

4 Resets the set output 1 (low level).

5 Closes the beam shutter.

The program will be ended after the last line has been run. The beam shutter closes automatically.

B7. External control of a beam shutter via wait input 1

	Command	Parameter 1	Parameter 2
1	SET	15 ms	1000 W
2	WAIT_1	1	--
3	SH_Open	--	1000 W
4	SET	15 ms	1000 W
5	Wait_1	0	--
6	SH_Close	--	1000 W
7	Loop	1	10,000,000

1 Sets the laser power output at 1000 W.

2 Waits for a high signal at wait input 1.

3 Opens the beam shutter, after a high signal of 1 has been recognized at wait input 1; at a laser power of 1000 W

4 Sets the laser power output at 1000 W for at least 15 ms.

5 Waits for a low signal at the wait input 1. The laser power output remains at 1000 W until a low signal has been recognized.

6 After a low signal has been recognized at wait input 1, the beam shutter will be closed. The laser power output remains at the pre-set power of 1000 W

7 Repeats the program routine 10,000.000 times from step 1 on

The laser power amounts to 1000 W during the entire process (Process Shutter, cf. Section “System Options/Shutter“.)

In order to set the laser power using the external hardware interface at line 4, the EXT command can be used instead of the SET command. Doing this makes it possible to regulate the laser power, for example, via a pyrometer.

B8. Communication via the field bus interface

	Command	Parameter 1	Parameter 2
1	SH_Open	--	0 W
2	WAITB_1	1	--
3	EXT BUS	2000 ms	Word 2
4	WAITB_1	0	

1 Opens the beam shutter at a laser power of 0 W.

2 Waits for a high signal via the field bus interface (wait 1).

3 Starts the laser with a pre-set power value (Word 2) for at least t = 20000 ms that was set via the field bus interface. After 2000ms the control unit will check if the condition of step 4 is fulfilled. If the condition is not fulfilled the control unit will execute step 3 until the condition of step 4 is fulfilled.

4 Waits for a low signal via the field bus interface (wait 1).

The program will be ended after the last line has been run. The beam shutter closes automatically.

B9. Field bus communication for several commands

	Command	Parameter 1	Parameter 2
1	WAITB_1	1	
2	RAMP	-3	-4
3	LOOP	1	-5

1 Waits for a high signal via the field bus interface (wait 1).

2 Increases (ramps up) the output power from the current value of (0 W) to the output power which is assigned by bus input word 4 within the assigned time value by bus input word 3.

3 Repeats the program routine from step 1 on. The number of repetitions is assigned by bus input word 4.

9 SYSTEM OPTIONS

Info – Using this Manual

In sections 2 to 8, this manual describes the structure, connection and operation of a standard Laserline Diode Laser System.

Those components which are not part of the standard system, such as a beam shutter or particular optics, are described in detail in Section 9. Should any of these components require additional connection work and/or descriptions (beam shutter, field-bus, etc.) such information can also be found in Section 9.

Sections 9 to 14 are individually compiled to describe the respective laser systems and their options.

9.1 Laser optics

The laser optics serves to collimate and focus the laser beam. To accomplish this, different lenses are mounted in tubes of differing length one behind the other, depending on the application.

Generally, the collimating lenses are situated at the entry side of the laser beam. Optionally, output coupler elements for additional components such as cameras and/or sensors can then be added.

The focusing optics are located on the exit side of the beam and are hidden behind protective glass. It is recommended that the protective glass be cleaned at regular intervals, or replaced, as necessary.

The connection of the optics takes place either at the laser directly (LDL Series) or by means of a laser light cable (LDF Series).

Depending on the requirements of the application (particularly in the case of non-rotational symmetrical laser port geometries) it is also possible to use other variants.

Abb. 93: Fibre-coupled optics (1 and 2 inch), example

(1) Collimating
(2) Focusing
(3) Protective glass

9.1.1 Replacing the protective glass

The glass is used to protect the focusing lenses which lie behind it. Depending on the field of application, the protective glass has to be changed at certain intervals. Replace the glass when it shows penetration marks and cleaning is no longer possible.

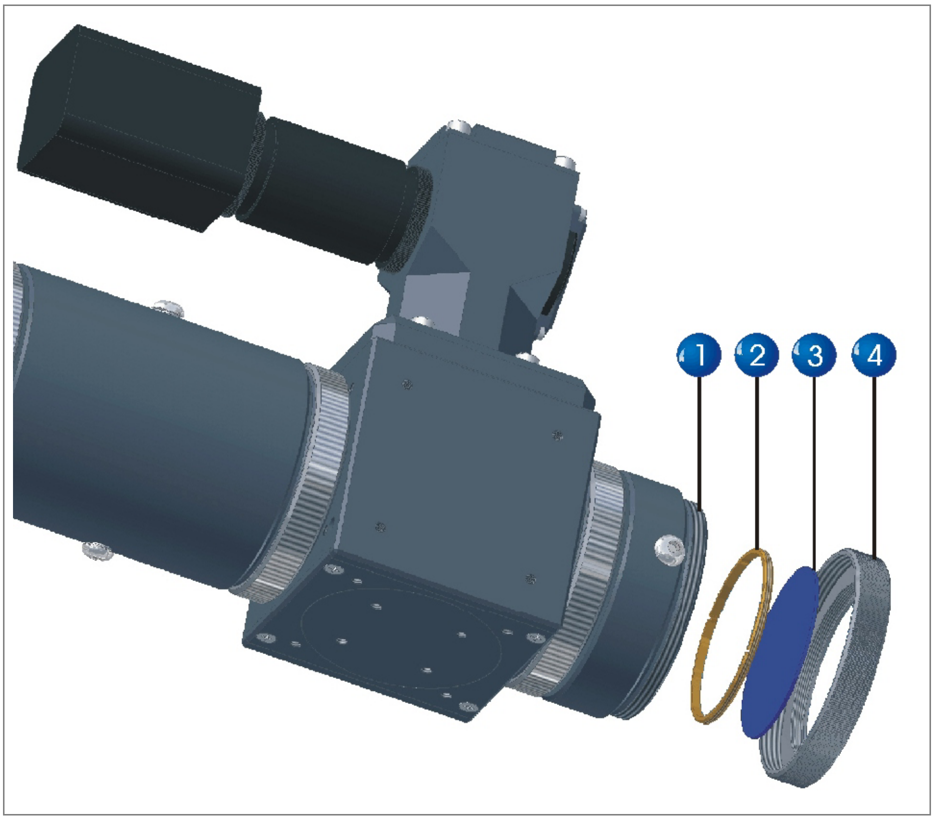


Fig. 94: Structure of protective glass holder

(1) Holding fixture for protective glass holder
(2) Threaded ring
(3) Protective glass
(4) Protective glass holder

To replace the protective glass, proceed as follows:

- Unscrew the protective glass holder from the holding fixture.
- Remove the threaded ring. The ring has two indentations for the reception of optic tools.
- Remove the protective glass and insert the new one.
- Replace the threaded ring and tighten slightly.
- Screw on the protective glass holder with the holding fixture.

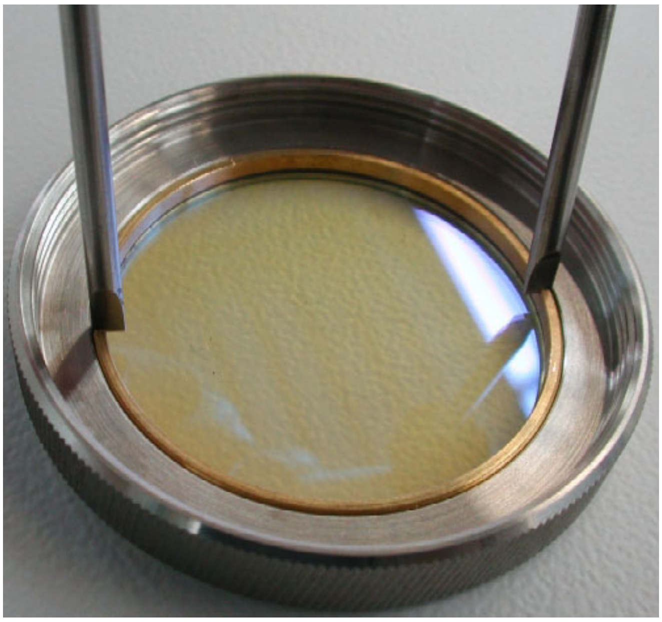


Fig. 95: Protective glass tools

Note

Do not screw the clamping ring on too tightly as this could cause the glass to break.

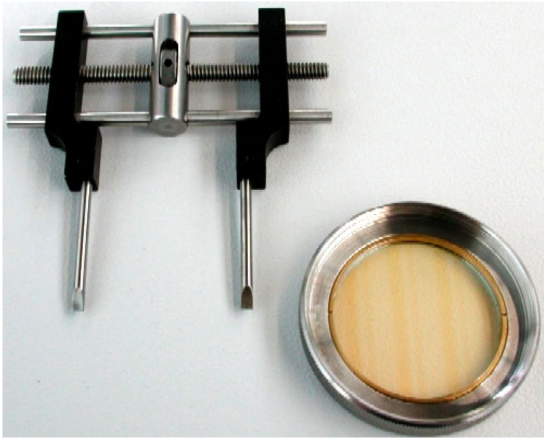


Fig. 96: Optic tools used to replace the protective glass

The optic tools required to replace the protective glass can be purchased via Laserline.

Part number	Name
201560	Optic tool
101061	Protective glass 2 inch optics

9.2 Field-bus interface

By using the Field-bus interface, the laser system can be, for example, integrated, via a profi-bus or inter-bus S interface, into a process network. The vast part of the necessary functions is controllable via the respective field-bus and thus enables a flexible integration of the laser system into any manufacturing process.

The laser operation via the field-bus is always effected in combination with the program modus of the laser system. To facilitate this, one or even several programs can be created or edited in the program editor of the laser system, which are then selected and executed using the field-bus interface.

In addition, the system can (after the respective programming) respond to extreme incidents via the field-bus and, if necessary, transmit feedback messages to the super-ordinated control system.

The displaying and printout of status information, responses to errors within a process application as well as possibilities for limiting user inputs at the display panel of the control unit of the laser system are all functions within the scope of the interface.

On delivery, the field-bus interface is active. Should the field-bus interface not be needed at a later date, it can be deactivated at the control unit; then the system operates as a system without a field-bus (see chapter).

9.2.1 Fieldbus

The field bus configuration can altered in these menus.

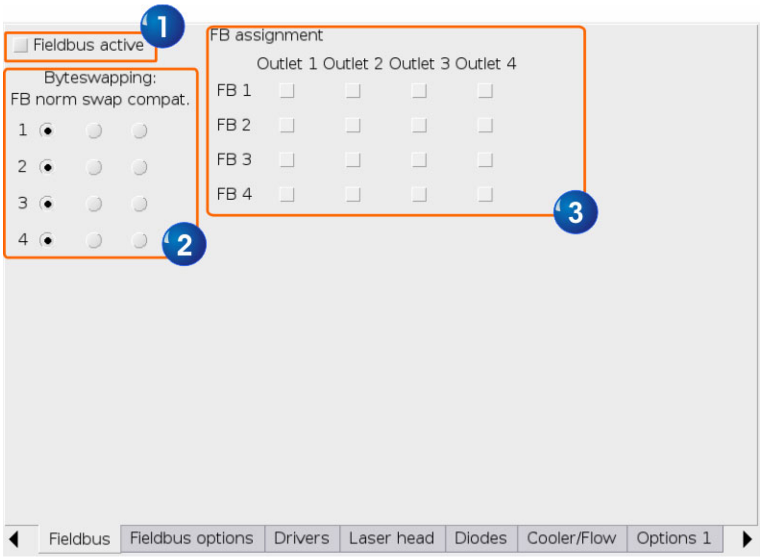


Fig. 97: Configuration/Fieldbus

No.	Designation	Description
1	Fieldbus active	Switches the field bus on or off.
2	Byte swapping for FB	Byte swapping mode for the selected FB (Gateway).
3	Assignment list FB to beam outlet	The assignment table is only available for systems with beam switch or for systems with more than one gateway. By using the assignment table it is possible to allocate beam outlet to an FB (Gateway).

9.2.1.1 Fieldbus options

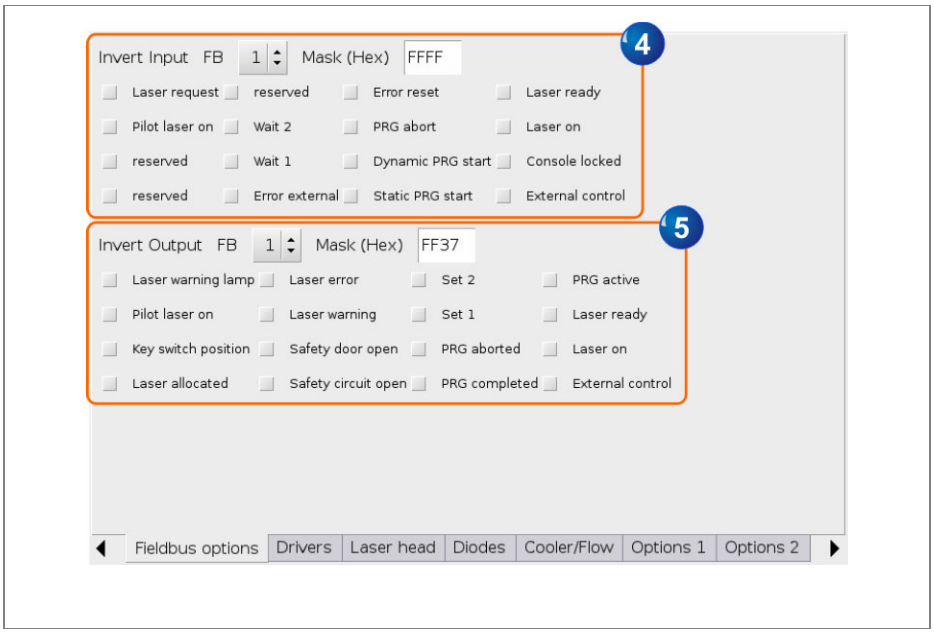


Fig. 98: Configuration / Fieldbus options

No.	Designation	Description
4	Bit inversion Input word 0	As default all signals in word 0 are high-active. If a corresponding signal is selected (check box set), it changes to low-active status.
5	Bit inversion Output word 0	

Info – Fieldbus

Additional information regarding the fieldbus can be found in chapter 9 (Fieldbus) is the laser system is equipped with the option “Fieldbus”).

9.2.2 Byte swapping

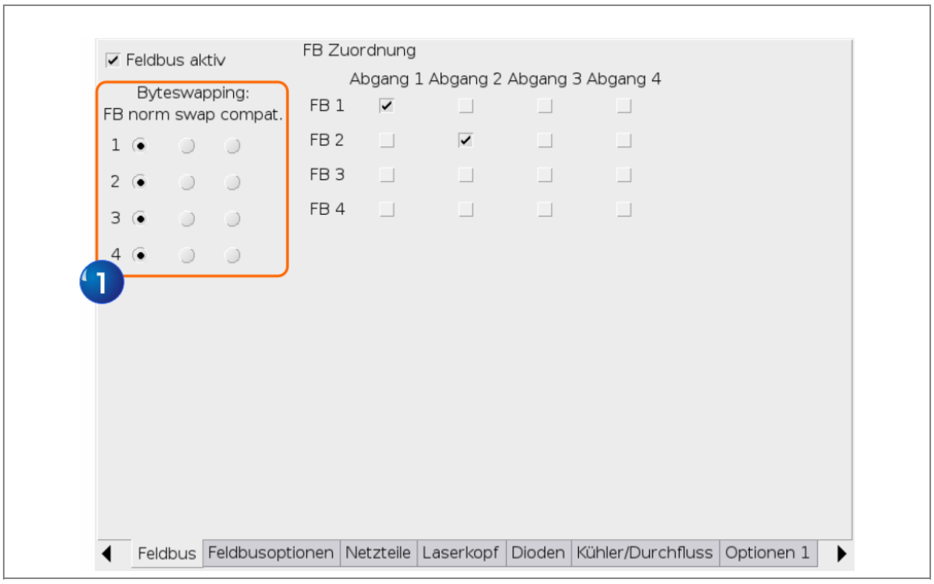


Fig. 3: Select mode (1)

Switches the swapping of the respective FB (gateway) in one of the following modes

- norm: Swapping off
- swap: Swapping on
- compat: Swapping of all analogue values (like mode swap) all digital values are not swapped (like mode norm.).

9.2.2.1 Byte swapping mode

Byte swapping can be switched on for every cell/gateway at the field bus interface. The following modes are available:

Byte swapping mode					
Off (norm.)	On (swap)	Compatible (compat.)			
Input words 0..9 Output words 0..9	Input words 0..9 Output words 0..9	Input words 0..1	Input words 2..9	Output word 6	Output words 0..5 – 7..9
0	8	0	8	8	0
1	9	1	9	9	1
2	10	2	10	10	2
3	11	3	11	11	3
4	12	4	12	12	4
5	13	5	13	13	5
6	14	6	14	14	6
7	15	7	15	15	7
8	0	8	0	0	8
9	1	9	1	1	9
10	2	10	2	2	10
11	3	11	3	3	11
12	4	12	4	4	12
13	5	13	5	5	13
14	6	14	6	6	14
15	7	15	7	7	15

9.2.3 FB allocation

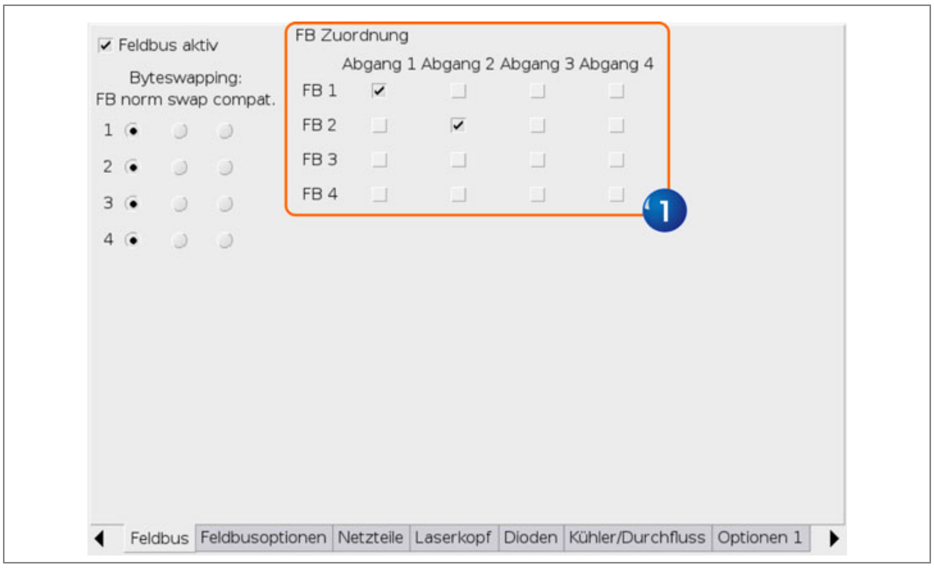


Fig. 4: Cell / gateway allocation

This list (1) determines how the beam exit and laser cell (FB/gateway) are allocated. This enables laser cell and beam path combinations that are not permitted to be excluded. The selected laser program is not executed, if an incorrect request should occur (not entered in the allocation list).

CAUTION

Change of beam path combination!

With incorrect settings, laser radiation can exit at a point that is not intended.

- The settings may only be changed by trained personnel.

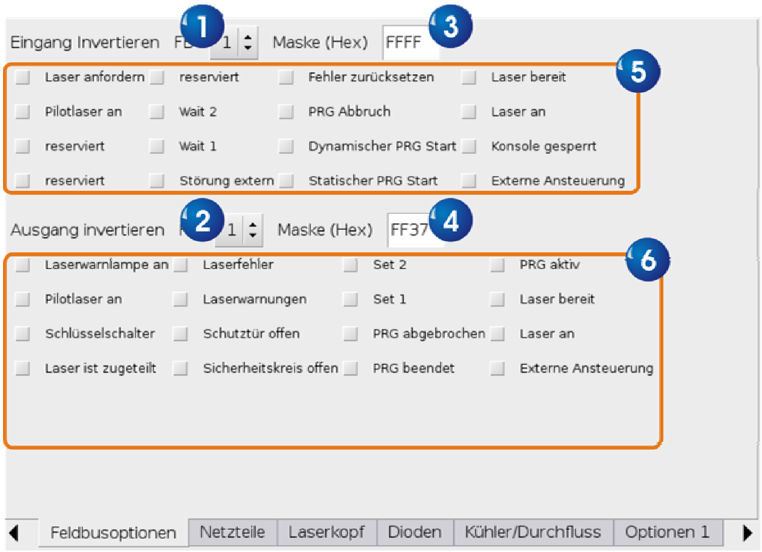
Cell allocation information

The user can modify the cell allocation after entering the customer password.

9.2.3.1 Examples

Screenshots	Description
	Bean switch (several exits): • Each gateway can only address one exit.
	Beam switch (several exits): • Gateway 1 can select programs for exit 1 • Gateways 1-4 can select programs for exit 1. • Gateway 2 can select programs for exit 2. • Gateway 3 can select programs for exit 3. • Gateway 4 can select programs for exit 4.
	Beam switch (several exits): • Gateway 1 can select programs for all exits.
	Single exit: • Gateway 1 and 2 can control exit 1. Only one gateway is normally required in systems without beam switch. A further gateway can be necessary, if the system is to be connected to a second control system. An exit is then released in the list, for which several gateways are available.

9.2.4 Bit inversion



1+2 FB selection (input and output signals)

2 Input screen for selected FB

3 Output screen for selected FB

4 Bit swapping for selected FB (input word 0)

5 Bit swapping for selected FB (input word 0)

Fig. 5: Field bus configuration

N°.	Description
1 + 2	The configuration settings are only valid for the selected FB. All other FBs are unaffected.
3	Input mask: The mask defines which input bits (in word 0) are processed. Entries are made in hexadecimal format. **Default setting**: FFFF = All bits are active and are processed. A high signal (1) activates a bit, a low signal (0) deactivates a bit. **Example:** If the input bits “Dynamic PRG start” and “Static PRG“ start” are selected, no more programs can be started by the selected FB (1). • Deactivate bits 10 and 11: 1111001111111111^{bin} = $F3FF^{hex}$.
4	Output mask: The mask defines which local output bits (in word 0) are transferred to an FB which is not assigned. Entries are made in hexadecimal format. **Default setting**: $FF37^{hex}$ = 1111111100110111^{bin} • A high signal (1) sets a bit to global mode. The bit is transferred to all FBs even if it is not assigned. • A low signal (0) sets a bit to local mode. The bit is only fed to assigned FBs. An overview of the input bits can be found on page 9-46. An overview of the output bits can be found on page 9-64.

5+6	Signal not inverted (checkbox not selected): • An input signal is detected as active when switching from Low (0) to High (1) and the corresponding function is triggered. Output signals are High (1) if a function is active and Low (0) if a function is not active. Signal inverted (checkbox selected): • The corresponding input signal is then detected as active when switching from High (1) to Low (0) and the corresponding function is triggered. Output signals are Low (0) if a function is active and High (1) if a function is not active. The signals processed in an inverted manner are shown in the diagnosis display (see “Diagnosis function”).

9.2.5 Profibus-DP

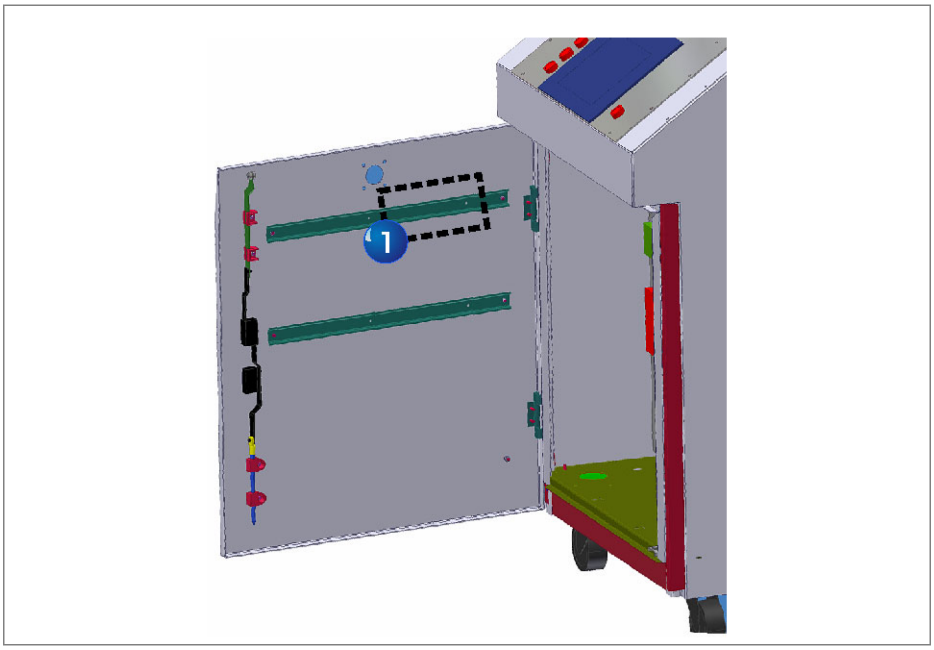
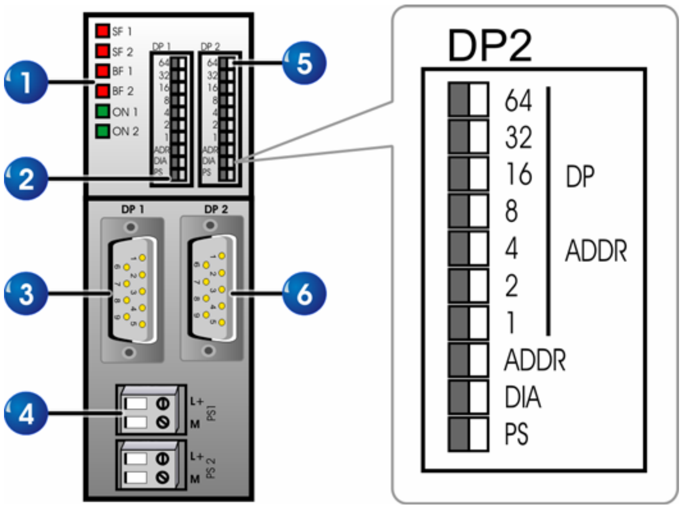


Fig. 6: DP/DP coupler position

Parameters	
Data length:	10 Word (preset)
Transmission rate:	12 M Bit/s (preset)
Addresses:	• 1 to 124 (preset = 10) • Address is selected on the DP/DP coupler.

An appropriate GSD file is available from Laserline Service. A universal module can be used for communication. Here, 10 words should be selected (10 each for outputs and inputs). The first module must be the output module and the second the input module. The consistency check must be performed by the unit.



1 Status-LEDs
2 Address sel. DP1 (Laserline)
3 Interface DP 1 (Laserline)
4 Power supply
5 Address sel.DP2 (Customer)
6 Interface DP2 (Customer)

Fig. 7: DP/DP coupler

The DP/DP coupler is positioned at the inside of the front door. In order to lay the bus connection in the cabinet, an empty socket is positioned in the connection area. The address of connection DP 2 may be selected by the customer. Settings are carried out on the front side of the coupler using the DIP switches.

- Assignment of the DP addresses via DIP switches “DP-ADDR”.
- ADDR, DIA and PS are necessary for the configuration and are not to be changed.

Note – DP1

The interface DP 1 is connected to the laser control unit. The address of the DP1 interface may not be changed. The connector of the interface DP1 may not be disconnected.

9.2.5.1 Diagnosis indication

LED	Color	Description	Explanation and corrective action
SF 1	red	Accumulative error Profibus DP network 1	**ON** **(red)** Diagnostic message at DP network 1.
SF 2	red	Accumulative error, Profibus DP network 1	**ON** **(red)** Diagnostic message at DP network 1.
BF 1	red	Bus error, Profibus DP network 1	**ON** **(red)** No connection to Master in DP network 1. • Cause: Bus communication disturbed / disconnected. • Check whether the bus connection plugs are firmly plugged in. • Check whether the cable to the master is connected.
BF 2	red	Bus error, Profibus DP network 1	**ON** **(red)** No connection to Master in DP network 2. • Cause: Bus communication disturbed / disconnected. • Check to see that all bus connection plugs are correctly fitted and tightly fastened. • Check whether the cable to the master is connected.
ON 1	green	Power supply 24V	**OFF** Power supply to DP network 1 defective. Contact Service Support. **ON** **(green)** Power supply DP network 1 on.
ON 2	green	Power supply 24V	**OFF** Power supply via DP network 1 (the led is always off)

9.2.5.2 Contact allocation

Contact allocation	Pin-No.	Signal name	Designation
	1	Shield	Shield or ground/earthing
	2	M 24	Ground of the 24V output voltage
	3	RXD/TXD-P	Received and transmitted data VCC B line
	4	CNTR-P	Signal Routing Control -P
	5	DGND	Data reference potential (GND)
	6	VP	Power supply (Plus)
	7	P 24	24V Plus output voltage
	8	RXD/TXD-N	Received and transmitted data GND A line
	9	CNTR-N	Signal Routing N

9.2.6 Interbus-S

There are two versions of the Interbus-S interface: a copper cable and a fiber-optic version. The gateway is positioned at the inside of the front door (there may also be more than one gateway). The signal lines are routed from the gateway to the interfaces located in the connection area.

The gateways have displays to facilitate bus system diagnosis (9.2.6.3 Gateway diagnosis display page 9-24).

The figure below shows the position of the gateway in the supply equipment.

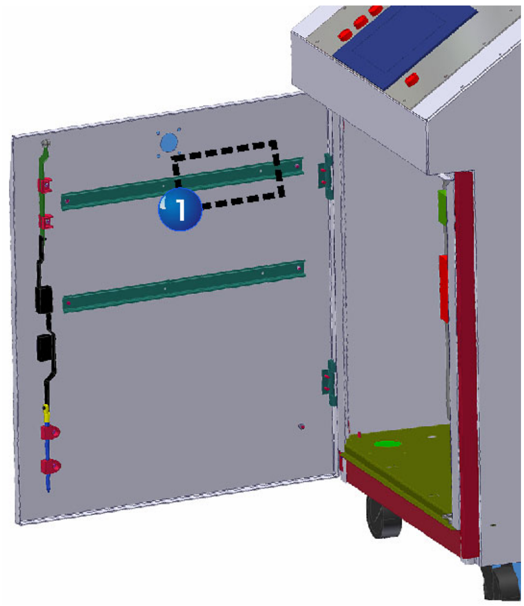


Fig. 8: Installed position

Parameters	
Data length:	10 Words (preset)
Transmission rate:	2MBd or 500kBd (can be selected on the gateway)

9.2.6.1 Fiber-optic version

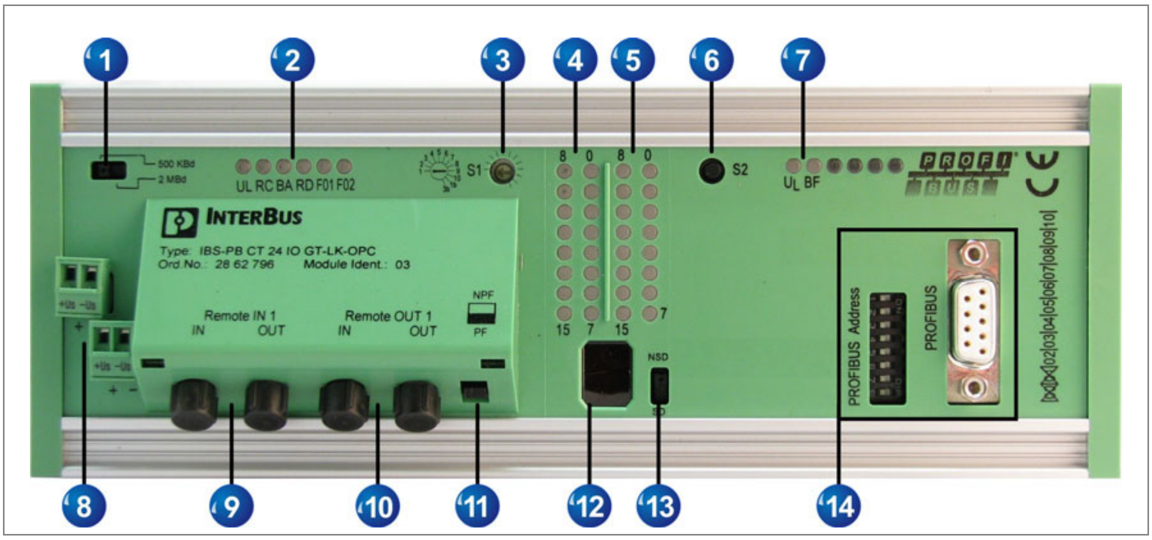


Fig. 9: Interbus-S Gateway (fiber-optic version)

No.	Description	No.	Description
1	Switch baud rate (2MBd/500kBd)	8	Power supply
2	Diagnosis display Interbus (customer)	9	Incoming Bus (customer)
3	Selection switch S1 for Data length	10	Relay Bus(customer)
4	Status display Interbus (customer)	11	Switch NPF / PF
5	Status display Profibus (Laserline)	12	7 segment display for data words
6	Key (S2) to control display [12]	13	Switch NSD / SD
7	Diagnosis display Profibus (Laserline)	14	Interface to laser system (Profibus)

9.2.6.2 Cable version

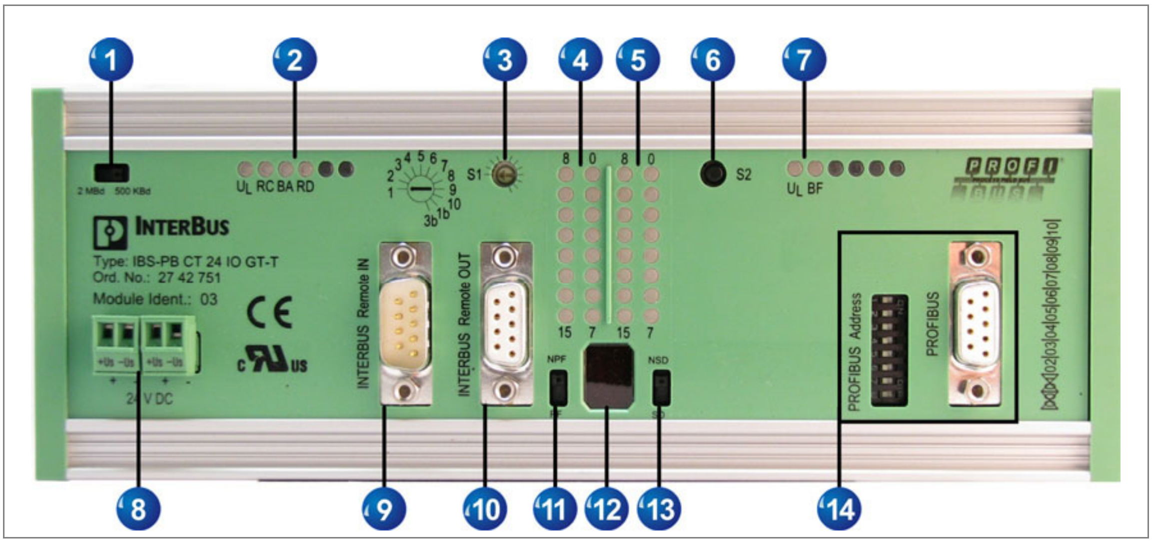


Fig. 10: Interbus-S Gateway (copper cable version)

No.	Description	No.	Description
1	Switch baud rate (2MBd/500kBd)	8	Power supply
2	Diagnosis display Interbus (customer)	9	Incoming Bus (customer)
3	Selection switch S1 for Data length	10	Relay Bus(customer)
4	Status display Interbus (customer)	11	Switch NPF / PF
5	Status display Profibus (Laserline)	12	7 segment display for data words
6	Key (S2) to control display [12]	13	Switch NSD / SD
7	Diagnosis display Profibus (Laserline)	14	Interface to laser system (Profibus)

Contact allocation

	Pin-No.	Signal name	Designation
Contact allocation	1	D O	Data, send direction
	2	D I	Data, receive direction
	3	ground	Ground of the 5V output voltage
	4	Reserved	Reserved
	5	+ 5 V	5V DC supply voltage
	6	/ D O	Inverted data, send direction
	7	/ D I	Inverted data, receive direction
	8	Reserved	Reserved
	9	Not assigned	Not assigned

Note – Configuration

- Switch NPF/PF: Configuration whether a peripheral fault should be reported in the Interbus-S system (Set to PF) or not (set to NPF) if the Profibus-DP system fails.
- Switch NSD/SD: The switch must be set to NSD and this configuration may not be changed (Profibus diagnosis).
- Switch for baud rate: can be selected by the customer.
- Switch for data length: This switch must be placed in position 10 (10 words).
- Changing the Configuration: The module only reads the configuration after power up. It is not possible to change the configuration during operation.

9.2.6.3 Gateway diagnosis display

Fig. 11: Gateway diagnosis display

LED	Color	Description
UL	green	Power supply for the bus interface
RC	green	Check of bus line
BA	green	Bus activated
RD	yellow	Bus deactivated
F01	yellow	Status of the incoming bus
F02	yellow	Status of the relay bus

9.2.6.4 Connection area fiber cable version

The interface is positioned in the connection area of the supply unit next to the X3 customer interface.

1 Fiber-optic interface FB 1/2

2 Customer interface X3 A/B

3 Fiber-optic interface for master control unit FB 3/4 (optional)

Fig. 12: Fiber-optic interface

Fig. 13: Fiber-optic socket of the supply unit

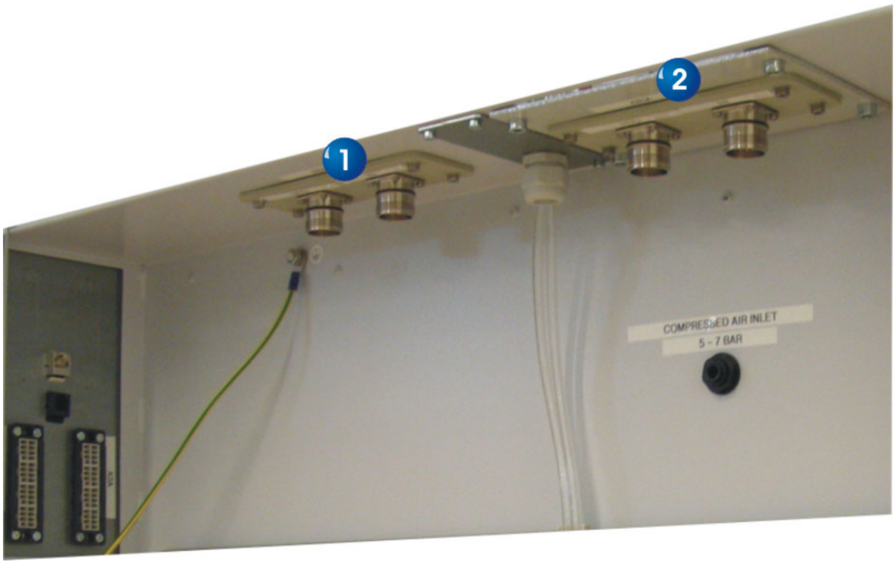
Fig. 14: Fiber-optic plug, customer

Note – Plug assignments

The assignments of the plug can be found in the circuit diagrams supplied (EPLAN) in chapter "Technical Appendix / Circuit diagrams of the Laser System".

9.2.6.5 Connection area copper cable version

The interface is positioned in the connection area of the supply unit near the X3 customer interface.



1 Interface FB 1

2 Interface FB 2

Fig. 15: Copper cable interface

Note – Plug assignments

The assignments of the plug can be found in the circuit diagrams supplied (EPLAN) in chapter "Technical Appendix / Circuit diagrams of the Laser System".

9.2.7 Device-Net

The device net gateway is positioned at the inside of the front door. In order to lay the bus connection in the cabinet, there is an empty socket in the connection area of the supply unit.

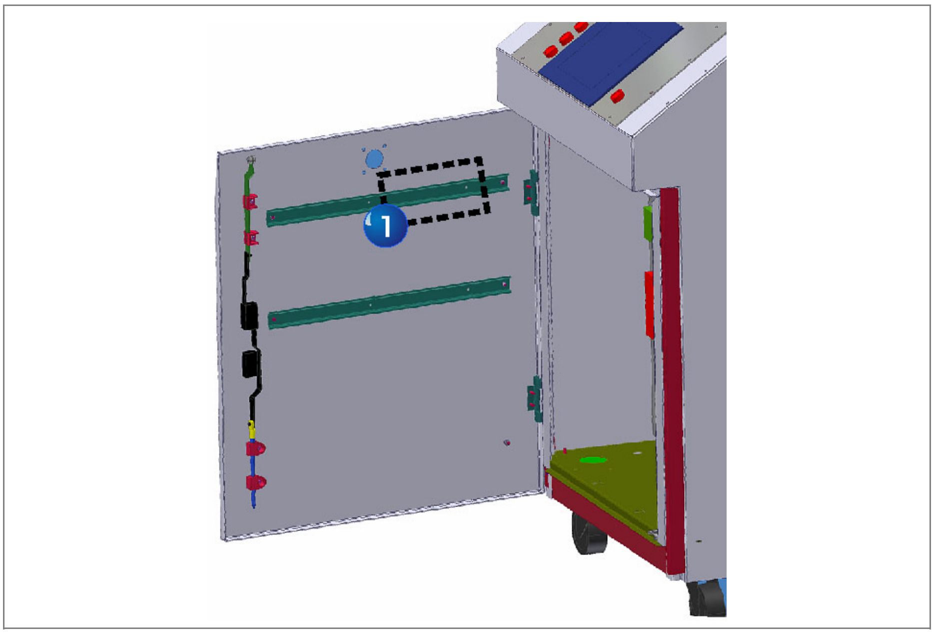


Fig. 16: Gateway position

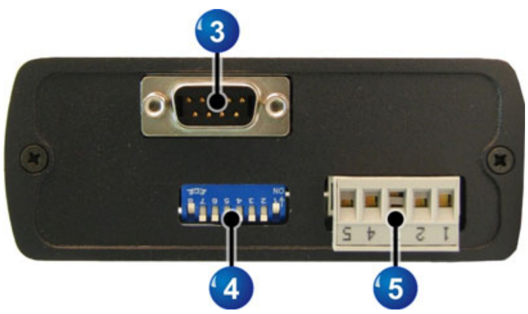
Parameters	
Data length:	10 Word (preset)
Transmission rate:	• 125kBaud, 250kBaud, 500kBaud (can be selected on the gateway) • Factory setting = 500kBaud.
Addresses	• 1 to 64 (Factory setting= 10) • Address can be selected on the gateway.

9.2.7.1 Gateway

1 Interface to laser system (Profibus)

2 Device-NET interface and DIP switches (customer)

Fig. 17: Gateway



3 Configuration interface

4 DIP switch (MAC-ID / Baud Rate)

5 Device-Net interface

Fig. 18: Connection and DIP switch

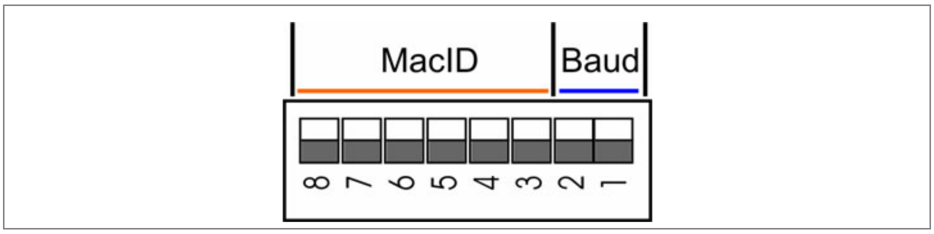


Fig. 19: DIP switch

Baud Rate

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	Baud Rate
OFF	OFF	--	--	--	--	--	--	125k
OFF	ON	--	--	--	--	--	--	250k
ON	OFF	--	--	--	--	--	--	500k
ON	ON	--	--	--	--	--	--	(reserved)

MacID

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	MacID
--	--	OFF	OFF	OFF	OFF	OFF	OFF	0
--	--	OFF	OFF	OFF	OFF	OFF	ON	1
--	--	OFF	OFF	OFF	OFF	ON	OFF	2
…	…	…	…	…	…	…	…	…
--	--	ON	ON	ON	ON	ON	ON	63

Info – Settings

Die settings for baud rate and MacID can be set without any limitations (as needed for the customer application).

9.2.7.2 Gateway diagnosis display

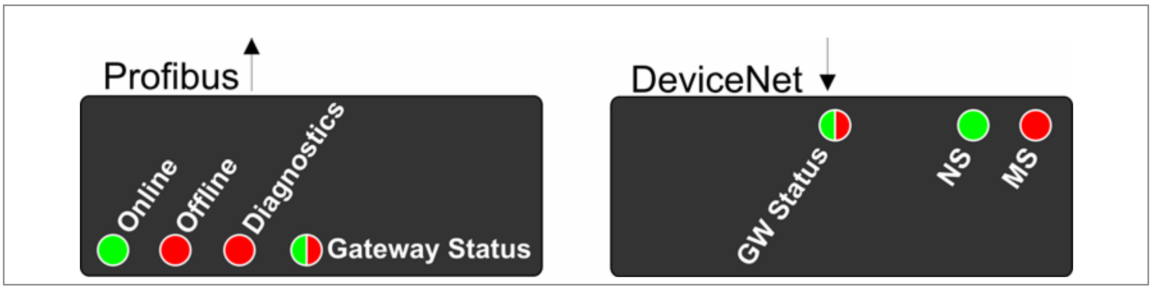
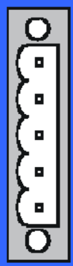


Fig. 20: Diagnosis display

LED	Description
Online	• Green: online • Off: not online
Offline	• Red: offline • Off: not offline
Diagnostics	• Flashing (1Hz): Config error • Flashing (2Hz): Data error
NS	• Green: Connection Ok, Online and connected • Green (flashes): Online and connected • Red: Connection error • Red (flashes): Connection time out
MS	• Green: Gateway ready for operation • Green (flashes): Data length greater then configured • Red: Unrecoverable failure
Gateway Status	• Green: Communication running • Red: Communication error • Red (flashes): Error network interface

9.2.7.3 Contact allocation

Contact allocation	Pin-No.	Signal name	Designation
1 2 3 4 5 	1	V -	Ground (GND) for supply voltage
	2	CAN L	CAN-Signal line (LOW)
	3	Shield	Not connected
	4	CAN H	CAN-Signal line (HIGH)
	5	V+	Supply voltage (24V ± 4%)

Mechanic	
Plug system	Combicon, 5 pin

9.2.8 Input Signals

9.2.8.1 Summary of the input words

<table>
<tr><th>Word. No.</th><th>Description</th></tr>
<tr><td>0</td><td>Laser: Laser on, Laser ready, Program start, States (SCT, safety door) etc.</td></tr>
<tr><td>1</td><td>Specifies laser program number.</td></tr>
<tr><td>2</td><td rowspan="8">• Specifies laser output.
• Specifies other laser parameters which can be processed in the laser program.</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
</table>

Input word 0

Bit 0	
Laser request	
Function:	Laser system request from any FB (laser cell)
Signal state:	As long as there is an active signal, the laser system is requested by this FB.
Condition:	The laser system must be in "External actuation" mode (input word 0 bit 15). The laser system may not be assigned to a different cell (check output word 0 bit 3 before the request).
Action:	The laser is assigned to the requesting cell. The currently assigned cell is shown by output word 7 (9.2.9.8 Overview Output Word 7 page 9-74).

Bit 1	
Pilot laser on	
Function:	Switching on the Pilot laser (LED-mode or Alignment laser, source is selected in the console).
Signal state:	A signal edge from a not active to an active level switches on the pilot laser.
Condition:	The laser must be in mode “Laser ready” (Output word 0 Bit 13). The laser system must be requested from the FB that wants to switch the Pilot laser on (Output word 0 Bit 3 / Output word 7).
Action:	The internal Pilot laser is turned on. If there is an integrated beam switch, the Alignment lasers of the beam switches that are assigned to the cell are switched on.

Bit 2	
Reserved	
Function:	--
Signal state:	--
Condition:	--
Action:	--

Bit 3	
Reserved	
Function:	--
Signal state:	--
Condition:	--
Action:	--

Bit 4

Reserved	
Function:	--
Signal state:	--
Condition:	--
Action:	--

Bit 5 / 6

Wait 1 / 2	
Function:	These digital inputs can be queried within a laser program. The inputs can be used to synchronize external events with the laser program.
Signal state:	High active signal or low active signal (depending on the settings in the laser program).
Condition:	A laser program must be active.
Action:	The laser program will halt until the condition is meat (high or low level).

Info – Wait-Signal

Further information in chapter „Program mode (PRG) page 8-70 “.

Bit 7

External error	
Function:	Fault message to the laser system (by the customer system)
Signal state:	If the signal edge changes from an inactive to an active signal, an external fault is detected and output.
Condition:	The laser system must have the status “Laser ready” (output word 0 bit 13). The laser system must have been requested by the FB reporting the fault (output word 0 bit 3 / output word 7).
Action:	• Any running laser program is aborted. The laser system exits the “Laser ready” and “Laser on” status. • The shutter is closed and the power supplies to the laser diodes are disconnected. • An error message is output in the console. • A fault is output at the field bus interface (output word 0 bit 4).

Bit 8	
Error reset	
Function:	Present errors in the laser system are acknowledged. If the cause of the error has been eliminated, the error is deleted.
Signal state:	If the signal edge changes from an inactive to an active signal, it is acknowledged.
Condition:	The laser system must be in "External actuation" mode (input word 0 bit 15).
Action:	The errors are acknowledged in the console. The error message output (output word 0 bit 4) on the field bus interface is reset.

Bit 9	
PRG abort	
Function:	A running laser program is aborted.
Signal state:	If the signal edge changes from an inactive to an active signal, a running laser program is aborted.
Condition:	A laser program must be active (output word 0 bit 12). The laser system must have been requested by the cell that is attempting to abort the program (output word 7).
Action:	The program is aborted and the “PRG aborted” signal (output word 0 bit 10) is permanently set until the program is restarted.

Bit 10

Dynamic PRG start	
Function:	The currently selected laser program is started once. Before the program is started again, the bit must be cancelled for at least 10 ms.
Signal state:	If the signal edge changes from an inactive to an active signal, the current program is started. A running program can be aborted using the “Program abort” signal (input word 0 bit 9) – if the program has not already been ended.
Condition:	The laser system must have the status “Laser ready” (output word 0 bit 13). The laser system must have been requested by the starting cell (input word 0 bit 0).
Action:	• The current program is started. • The laser system resets the “Laser ready” signal (output word 0 bit 13). The laser system sets the “Program active” signal (output word 0 bit 12) for as long as the program is being processed. • If the “Program aborted” signal (output word 0 bit 10) is active, the signal is reset. • If the program has been processed, the “Laser ready” signal (output word 0 bit 13). Is set The “Program ended” signal (output word 0 bit 11) is set for two seconds. • In case of a "Program abort” (input word 0 bit 9), the “Program ended” signal (output word 0 bit 11) is not set. Instead, the “Program aborted” signal (output word 0 bit 10) is permanently set until the program is started again.

Bit 11

Static PRG start	
Function:	The currently selected laser program is started once. Before the program is started again, the bit must be cancelled for at least 10 ms.
Signal state:	If the signal edge changes from an inactive to an active signal, the current program is started. The program is aborted as soon as the signal switches to an inactive state (if the program has not already been ended).
Condition:	The laser system must have the status “Laser ready” (output word 0 bit 13). The laser system must have been requested by the starting cell (input word 0 bit 0).
Action:	• The current program is started. • The laser system resets the “Laser ready” signal (output word 0 bit 13). The laser system sets the “Program active” signal (output word 0 bit 12) for as long as the program is being processed. • If the “Program aborted” signal (output word – bit 10) is active, the signal is reset. • If the program has been processed, the “Laser ready” signal (output word 0 bit 13). Is set The “Program ended” signal (output word 0 bit 11) is set for two seconds. • In case of a program abort (input word 0 bit 9), the “Program ended” signal (output word 0 bit 11) is not set. Instead, the “Program aborted” signal (output word 0 bit 10) is permanently set until the program is started again.

Bit 12	
Laser ready	
Function:	The laser system switches to “Laser ready” status. A laser program can now be started (input word 0 bit 10 or bit 11).
Signal state:	As long as there is an active signal, the laser remains in “Laser ready” status.
Condition:	The laser system must be turned on (input word 0 bit 13). The protective doors on the laser processing station (customer) must be closed (output word 0 bit 6). The safety circuit in the laser system must be closed (output word 0 bit 7).
Action:	• If a shutter is fitted, a threshold current is supplied to the laser diodes after the program is started for the first time. • If the laser has the status “Ready”, bit 13 (output word 0) is set.

Note – Laser ready

In the program pauses (time with no running laser program), the laser system should always remain in ready status where possible. Non-compliance with this can reduce the service life of the laser diodes.

Bit 13	
Laser on	
Function:	The laser system switches to “Laser on” status.
Signal state:	As long as there is an active signal, the laser remains in “Laser on” status.
Condition:	• The key switch must be in position 1 or 2. • The laser system startup must be complete (after turning on). • There may not be any error messages. • A field bus interface must be fitted and active.
Action:	• The power supply to the laser is already connected. • If the laser has the status “Laser on”, output word 0 bit 14 "Laser on” is set.
Special function	• „Laser on“ **not** active and • „External control” (I-Word 0 Bit 15) active The laser system switches to standby-mode. As soon as “laser on” and “external control” are active the laser system will leave this mode.

Bit 14	
Console locked	
Function:	Prevents the laser system from being operated from the console and / or LL control on an external PC.
Signal state:	As long as there is an active signal, the console and / or LL control are blocked.
Condition:	The laser must have the status “External actuation” (input word 0 bit 16).
Action:	If the bit is set, input on the console and / or LL control is not possible. The diagnosis functions can still be used, despite the block.

Info – Unblocking the console

The block on the console can be cancelled in the main menu in the status bar (see “”).

4. Log in as “User”.
5. Select the "Release" button.
6. The field bus is inactive and the block is cancelled.
7. The field bus must be turned on again after releasing.

Bit 15	
External control	
Function:	The laser system actuation is switched to external mode (using the field bus). The laser system can now be switched to “Laser ready” status (I-Word 0 Bit 12) if signal “Laser on” (I-Word 0 Bit 13) is active.
Signal state:	As long as there is an active signal, the laser only processes signals from the field bus.
Condition:	• The key switch must be in position 1 or 2. • The laser system startup must be complete (after turning on). • There may not be any error messages. A field bus interface must be fitted and active.
Action:	The laser system automatically switches to “PRG” operating mode. It is not possible to change the operating mode using the console. It the laser system is set to “External operation”, bit 15 "External actuation active” is set in output word 0.
Special function	• „Laser on“ **not** active and • „External control” (I-Word 0 Bit 15) active The laser system switches to standby-mode. As soon as “laser on” and “external control” are active the laser system will leave this mode.

9.2.8.2 Overview Input Word 0

Bit	Function	Description
0	Laser request	Request the laser system to start a program.
1	Pilot laser on	Static activation of pilot laser.
2	Reserved	--
3	Reserved	--
4	Reserved	--
5	Wait 2	The signal can be queried in program mode to synchronize processes.
6	Wait 1	
7	External error	The laser system is stopped if an external error is reported.
8	Error reset	Resetting an error (only possible if the cause is eliminated).
9	PRG abort	Abort a laser program
10	Dynamic PRG start	Start a laser program using a short signal
11	Static PRG start,	The laser program is processed as long as the input is active.
12	Laser ready	Laser programs can be started with this status.
13	Laser on	The laser system can switch to “Laser ready” status.
14	Console locked	The input fields in the console are inactive.
15	External control	The laser can only be controlled using the field bus interface.

Input word 1

Bit 0 - 7	
Laser program number	
Function:	Select the laser program.
Signal state:	Byte value corresponds to program number (LSB bit 0 / MSB bit 7). If the program numerical value is 0, the last program used is retained. The value is transferred as “Byte” with binary coding.
Condition:	The laser system must have the status “Laser ready” (output word 0 bit 12). The laser system must be requested by an FB (input word 0 bit 0).
Action:	If the laser is assigned (output word 0 bit 3) and no program is active (output word 0 bit 12), the program is loaded.

Bit 8 - 15	
Reserved	
Function:	--
Signal state:	--
Action:	--

9.2.8.3 Overview Input Word 1

Bit	Function	Description
0	Bit 0 Program No.	Select the laser program

Bit	Function	Description
1	Bit 1 Program No.	The value is transferred as "Byte" with binary coding. Example: 0000 0011 Program no. 3 selected The maximum number of laser programs is displayed in the "Operation / Program" menu.
2	Bit 2 Program No.	
3	Bit 3 Program No.	
4	Bit 4 Program No.	
5	Bit 5 Program No.	
6	Bit 6 Program No.	
7	Bit 7 Program No.	
8	Reserved	
9		
10		
11		
12		
13		
14		
15		

Input Words 2 -9

Bit 0 - 15	
Analogue pre-set value	
Function:	Words 2 – 9 can either be used to specify the power or a parameter value in program mode. The value is transferred as a “word” with binary coding.
Signal state:	The word’s value corresponds to the power val-ue in Watts or a parameter value in program mode.
Action:	**Power preset:** A laser program must have been started (input word 0 bit 10 or bit 11) and this program must read an analogue value using the “EXT_BUS” command. The FB specifying the set value must have requested the laser (input word 0 bit 0) and started the program. **Parameter preset:** A laser program must have been started, and commands with bus parameters must be used in this program. In the commands, the word to be used must always be entered with a preceding "-" (e.g. -2 corresponds to word 2).
Response:	**Power preset:** The currently set power value is determined by the laser. **Parameter preset:** The pre-set value is read and processed during command execution.

Bit 0 - 15	
Analogue pre-set value	
Special feature:	The pre-set power value can, be read in using the words 2-9. Alternatively, it is possible to use this word in programming mode for additional parameters. For more information please refer to section "Operating the laser system / Programming mode".

9.2.8.4 Overview Input Words 2-9

Bit	Function	Description
0	Analogue value bit 0	Analogue value as 16 bit integer The value is transferred as a "word" with binary coding. Alternatively, byte swapping can be set in the control unit (see 9.2.2 Byte swapping page 9-9).
1	Analogue value bit 1	
2	Analogue value bit 2	
3	Analogue value bit 3	
4	Analogue value bit 4	
5	Analogue value bit 5	
6	Analogue value bit 6	
7	Analogue value bit 7	
8	Analogue value bit 8	
9	Analogue value bit 9	
10	Analogue value bit 10	
11	Analogue value bit 11	
12	Analogue value bit 12	
13	Analogue value bit 13	
14	Analogue value bit 14	
15	Analogue value bit 15	

9.2.9 Output signals

9.2.9.1 Summary of the output words

Word. No.	Description
0	• Laser states: Laser on, Laser ready, Laser active, Program complete, Laser fault etc. • Synchronize sequences with set outputs.
1	• Program number of currently selected laser program. • Currently selected beam path in currently selected laser program.
2	• Shows number of error messages on laser device • Shows error number of last error which occurred.
3	Shows which beam path currently switched.
4	Not in use
5	Not in use
6	Shows what laser output currently calculated.
7	Shows which laser cell currently allocated.
8	Not in use
9	Not in use

Output word 0

Bit 0	
Laser warning lamp on	
Function:	Signal indicates that a laser is turned on (pilot laser or laser).
Signal state:	As long as there is an active signal, a laser (pilot or main laser) generates laser radiation.
Information:	The laser warning lamp is also active if the laser power is fed into the beam absorber (in the laser system).

Bit 1	
Pilot laser on	
Function:	Signal indicates that the pilot laser is switched on. Depending on the selection in the console, LED mode or the collimation laser is activated (LED mode is not available on systems with beam switch).
Signal state:	As long as there is an active signal, the pilot laser is turned on.
Information:	A pilot laser is active.

Bit 2	
Key switch position	
Function:	Key switch position display
Signal state:	As long as there is an active signal, the key switch is in position “II” or “I”. In key switch position “0”, the signal is not active.
Information:	The laser can only be operated with power if the key switch is in position “II”. The value of the signal corresponds to the “Key switch” display in the console.

Bit 3	
Laser allocated	
Function:	The laser system is assigned (request using input word 0 bit 0). The signal is only set on the assigned FB (unless otherwise defined using output mask, see 9.2.4 Bit inversion page 9-13).
Signal state:	As long as there is an active signal, the laser is assigned.
Information:	The laser system is assigned to an FB and cannot be actuated by other FBs (affects the signals: Dynamic program start, Static program start, Program abort, External error, Analogue set values and parameters, Laser program number, Wait 1/2, Pilot laser on). If a laser program is active and the “Request laser” signal switches to an inactive state, the laser remains assigned until the program is processed or aborted.

Bit 4	
Error	
Function:	Signal indicates that there is an error in the laser system.
Signal state:	As long as there is an active signal, the laser system has an error.
Information:	The laser controller has detected a fault with the laser and displays this in the console. • The fault can be reset after eliminating the cause using the “Error reset” signal (input word 0 bit 8). • The error message can be queried using the field bus (word 2).

Bit 5	
Warning	
Function:	Signal indicates that there is a warning in the laser system.
Signal state:	As long as there is an active signal, the laser system is outputting a warning.
Information:	The laser controller has detected a warning status and displays this in the control unit. A warning can lead to a subsequent error message.

Bit 6	
Safety door open	
Function:	Displays the status of the safety door circuit. On systems with a beam switch, the status of the currently selected beam exit is displayed. The currently selected beam exit is defined in the laser program (e.g. Beam outlet 1 = Protective door 1).
Signal state:	As long as there is an active signal, the protective door circuit is open and the laser cannot be operated.
Information:	The safety mechanism (customer system) is not closed.

Bit 7	
Safety circuit open	
Function:	Displays the status of the safety circuit.
Signal state:	As long as there is an active signal, the safety circuit is open and the laser cannot be operated.
Information:	The safety circuit is open: • If the laser covers are open (VG4, VG5) • If the side panels are not installed (VG3E) or the cooling system door is not closed (VG3E) • The shutter is open and the protective doors are open • The protective door is open (only if no shutter is fitted).

Info – Safety circuit / Protective door circuit

Further information can be found in the “Customer interface / Safety circuit (SCT)” section and in the circuit diagram (EPLAN) in the technical appendix.

Bit 8	
SET2	
Function:	The digital output can be set within a laser program. The outputs can synchronize the progression of the laser program with an external controller.
Signal state:	The signal can be set to active using commands in the laser program.
Information:	The outputs remain active and are only reset when: • A laser program is ended or aborted. • A reset command is reached in the laser program.

Bit 9	
Set1	
Function:	The digital output can be set within a laser program. The outputs can synchronize the progression of the laser program with an external controller.
Signal state:	The signal can be set to active using commands in the laser program.
Information:	The outputs remain active and are only reset when: • A laser program is ended or aborted. • A reset command is reached in the laser program.

Bit 10	
PRG aborted	
Function:	Signal indicates that a laser program has been aborted
Signal state:	As long as there is an active signal, the last laser program started has been aborted.
Information:	This signal is set as soon as: • A running laser program has been stopped using the “Program abort” signal (input word 0 bit 9). • The “Static program start” signal (input word 0 bit 11) switches from an active to an inactive signal and thus the program stops before the actual end. The “PRG aborted” signal is only reset when the program is started again (input word 0 bit 10/11).

Bit 11

PRG ended	
Function:	Signal indicates that a laser program has been ended.
Signal state:	As long as there is an active signal, the last laser program started has been ended < 2 seconds ago.
Information:	This signal is set for two seconds as soon as a laser program is ended. If a new program is started within the two seconds, the bit is reset by the start of that program.

Bit 12

PRG active	
Function:	Signal indicates that a laser program is being processed.
Signal state:	As long as there is an active signal, a laser program is being processed.
Information:	This signal is set as soon as a laser program is running. It is reset when the program is ended or aborted.

Bit 13	
Laser ready	
Function:	Signal indicates that the laser system has the status “Laser ready” (input word 0 bit 12).
Signal state:	As long as there is an active signal, the laser system has the status “Laser ready”.
Information:	With the “Laser ready” status, a threshold current is supplied to the laser diodes. A laser program can be called up and started.

Bit 14	
Laser is on	
Function:	Signal indicates that the laser system is turned on (response to input word 0 bit 13).
Signal state:	As long as there is an active signal, the laser system is turned on.
Information:	As long as the laser system is turned on, the signal remains active (if input word 0 bit 13 has first been set). The signal is reset in case of a fault.

Bit 15	
External control active	
Function:	Signal indicates that the laser system is switched to external control mode.
Signal state:	As long as there is an active signal, the laser only processes signals from the field bus.
Information:	The laser system can be controlled by the field bus interface. As long as the “Console blocked” bit (input word 0 bit 14) is not set, system parameters and laser programs can still be modified.

9.2.9.2 Overview Output Word 0

Bit	Function	Description
0	Laser warning lamp on	The laser warning lamp is turned on.
1	Pilot laser on	A pilot laser is turned on.
2	Key switch position	Position of key switch on control unit.
3	Laser allocated	Response to "Request laser”
4	Error	The laser has detected a fault and has been set to a status in which it is not ready for operation.
5	Warning	Laser system outputs a warning message.
6	Safety door open	The safety mechanism (customer) for the selected laser cell is open.
7	Safety circuit open	The safety circuit for the laser system is open (laser cover, shutter and protective door simultaneously).
8	Set 2	These outputs can be set in the laser program. They can be used to synchronize external processes with the progression of the program.
9	Set 1	
10	PRG aborted	The laser program has been aborted.
11	PRG completed	The laser program has been ended.
12	PRG active	The laser program is being processed.
13	Laser ready	The laser system has the status “Laser ready”.
14	Laser on	The laser system is in a status from which it can switch to “Laser ready” status.
15	External control	The laser is in external mode and can be actuated using the field bus interface.

Output Word 1

Bit 0 - 7

Current Laser Program No.	
Function:	This is used to display the currently selected laser program using the field bus. The value is transferred with binary coding.
Signal state:	Byte value corresponds to program number (LSB bit 0 / MSB bit 7)
Information:	The value corresponds to the currently selected program.

Bit 8 - 15

Currently selected beam path/s	
Function:	Display of the selected beam path in the currently opened laser program (see also "Overview Input Word 1")
Signal state:	Byte value corresponds to program number (LSB bit 0 / MSB bit 7)
Information:	Active as long as a laser program has been selected. The selected light path is activated as soon as the program is started and the corresponding command is entered.

9.2.9.3 Overview Output Word 1

Bit	Function	Description
0	Program No. Bit 0 LSB	Display of currently selected laser program. The value is transferred binary coded. Example: 0000 0011 Program no. 3 is selected
1	Program No. Bit 1	
2	Program No. Bit 2	
3	Program No. Bit 3	
4	Program No. Bit 4	
5	Program No. Bit 5	
6	Program No. Bit 6	
7	Program No. Bit 7 MSB	
8	Beam path Bit 0	Display of the selected beam path in the currently opened laser program. The value is transferred with binary coding. Example: 0000 0011 Light path no. 3 is selected
9	Beam path Bit 1	
10	Beam path Bit 2	
11	Beam path Bit 3	
12	Beam path Bit 4	
13	Beam path Bit 5	
14	Beam path Bit 6	
15	Beam path Bit 7	

Output Word 2

Bit 0 - 7	
Number of system errors	
Function:	Number of errors currently present in the laser system.
Signal state:	Byte value corresponds to number of errors (LSB bit 0 / MSB bit 7)
Information:	--

Bit 8 - 15	
Error message number	
Function:	Display of the error that has occurred in the laser system. If there are several errors, the last error that occurred is always displayed. If an error is cleared (with multiple errors), the last error that occurred continues to be displayed (until all errors have been cleared). If there are more than one error, diagnosis directly on the laser system is normally required.
Signal state:	Byte value corresponds to message number (LSB bit 0 / MSB bit 7)
Information:	The number is identical to the error numbers in the “Fault and error resolution” section.

9.2.9.4 Overview Output Word 2

Bit	Function	Description
0	Number of errors Bit 0 LSB	Number of errors as 8 bit integer value (binary coded). Example: 0000 0011 Number of errors: 3.
1	Number of errors Bit 1	
2	Number of errors Bit 2	
3	Number of errors Bit 3	
4	Number of errors Bit 4	
5	Number of errors Bit 5	
6	Number of errors Bit 6	
7	Number of errors Bit 7 MSB	
8	Message Bit 0 LSB	Message number as 8 bit integer value (binary coded). If there are multiple errors, the last error that occurred is always displayed (until all errors are cleared). Example: 0000 0011 Error ID: 3.
9	Message Bit 1	
10	Message Bit 2	
11	Message Bit 3	
12	Message Bit 4	
13	Message Bit 5	
14	Message Bit 6	
15	Message Bit 7 MSB	

Output Word 3

Bit 0 - 7	
Currently opened beam outlet	
Function:	Display of the currently open beam outlet. This function can only be used on systems with beam switch (more than one beam outlet).
Signal state:	Bit active: Beam outlet is open. Bit inactive: Beam outlet is closed.
Information:	• Outlets not available on the unit are always displayed as “open” (signal is active). • Active as soon as a laser program is running and a beam outlet is open.

Bit 8 - 15	
Reserved	
Function:	--
Signal state:	--
Information:	--

9.2.9.5 Overview Output Word 3

Bit	Function	Description
0	Beam outlet 1 open	Display of the open beam outlet. Outlets not available on the laser system are always displayed as “open” (signal is active). Example: An "active" signal at bit 0 means: Beam outlet 1 is open and is emitting power.
1	Beam outlet 2 open	
2	Beam outlet 3 open	
3	Beam outlet 4 open	
4	Beam outlet 5 open	
5	Beam outlet 6 open	
6	Beam outlet 7 open	
7	Beam outlet 8 open	
8	Reserved	
9		
10		
11		
12		
13		
14		
15		

9.2.9.6 Output Words 4 to 5

Words 3-5	
Reserved	
Function:	--
Signal state:	--
Information:	--

Output Word 6

Bit 0 - 15	
Current laser power	
Function:	Display of the current laser power (calculated value) The value is transferred as a “word” with binary coding.
Signal state:	Word value corresponds to the power value in Watts.
Information:	The current power displayed only reaches the workpiece if the beam exit is activated (if a shut-ter is fitted, it must be opened).

9.2.9.7 Overview Output Word 6

Bit	Function	Description
0	Output power bit 0	Current laser power as 16 bit integer value (binary coded). Alternatively, byte swapping can be set in the console (see 9.2.2 Byte swapping page 9-9).
1	Output power bit 1	
2	Output power bit 2	
3	Output power bit 3	
4	Output power bit 4	
5	Output power bit 5	
6	Output power bit 6	
7	Output power bit 7	
8	Output power bit 8	
9	Output power bit 9	
10	Output power bit 10	
11	Output power bit 11	
12	Output power bit 12	
13	Output power bit 13	
14	Output power bit 14	
15	Output power bit 15	

Output Word 7

Bit 0 - 7

Reserved	
Function:	--
Signal state:	--
Information:	--

Bit 8 - 15

Currently assigned cells	
Function:	Display of which laser cell (FB) the laser system is currently assigned to. The value is transferred as a “byte” with binary coding.
Signal state:	The byte value corresponds to the cell number.
Information:	If the value 0 is transferred, the laser system is not currently assigned to any laser cell (FB).

9.2.9.8 Overview Output Word 7

Bit	Function	Description
0	Reserved	
1		
2		
3		
4		
5		
6		
7		
8	Currently assigned bit 0 LSB	Currently assigned laser cell as 8 bit integer value (binary coded). Example: 0000 0001: Assigned to laser cell (FB) 1.
9	Currently assigned bit 1	
10	Currently assigned bit 2	
11	Currently assigned bit 3	
12	Currently assigned bit 4	
13	Currently assigned bit 5	
14	Currently assigned bit 6	
15	Currently assigned bit 7 MSB	

9.2.9.9 Output Words 8 - 9

Word 8-9	
Reserved	
Function:	--
Signal state:	--
Reason:	--

9.2.10 Timing Diagram, Program Start

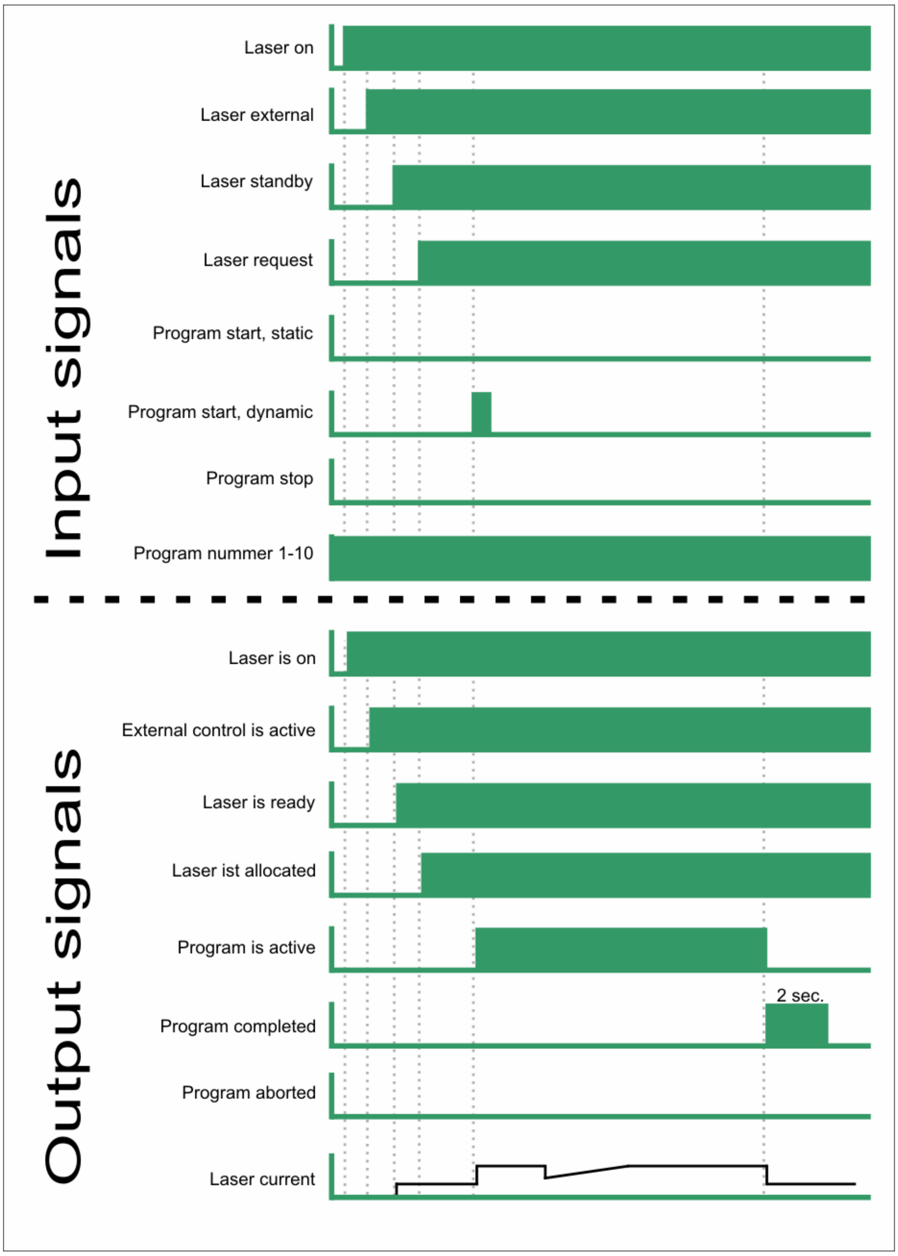


Fig. 21: Dynamic Program Start

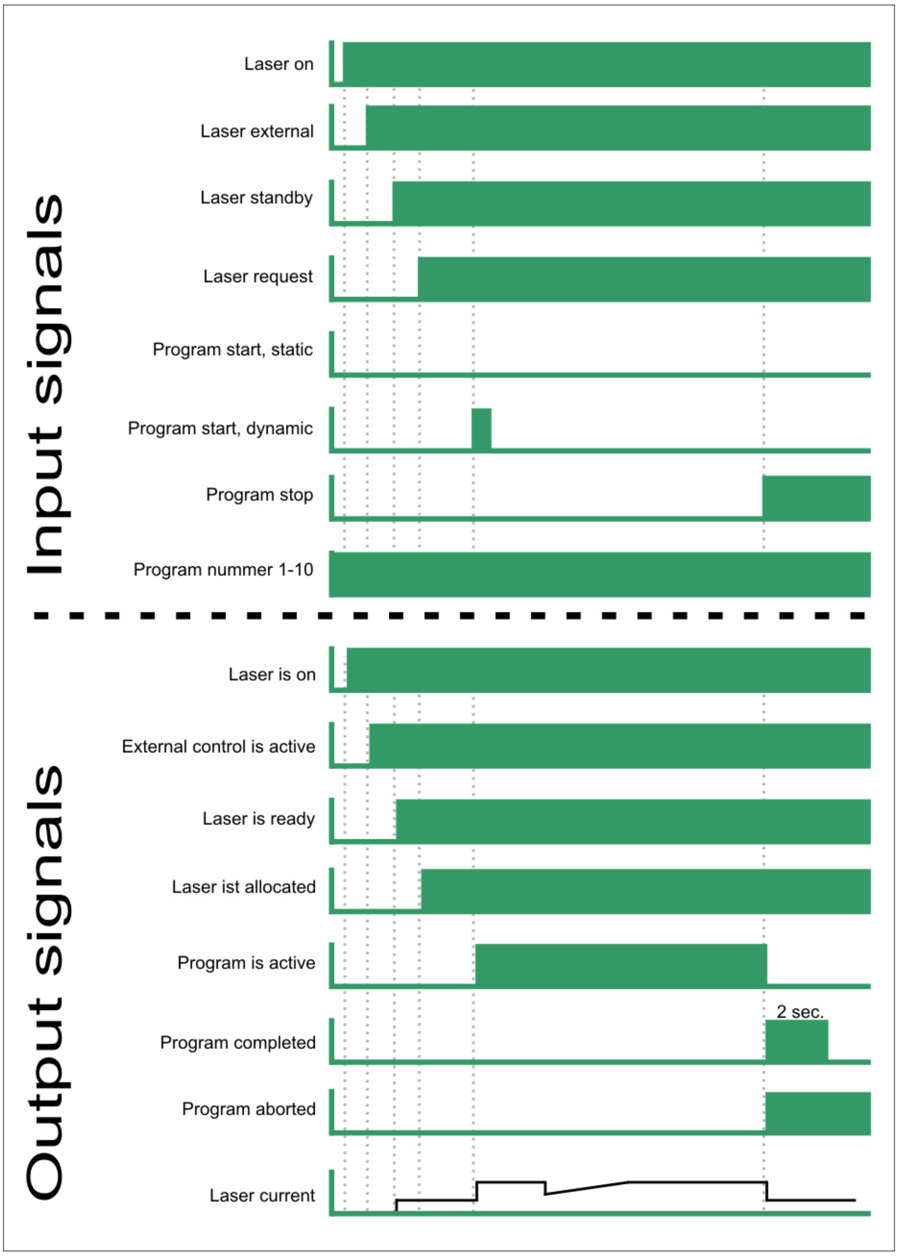


Fig. 22: Dynamic Program Start with abort signal

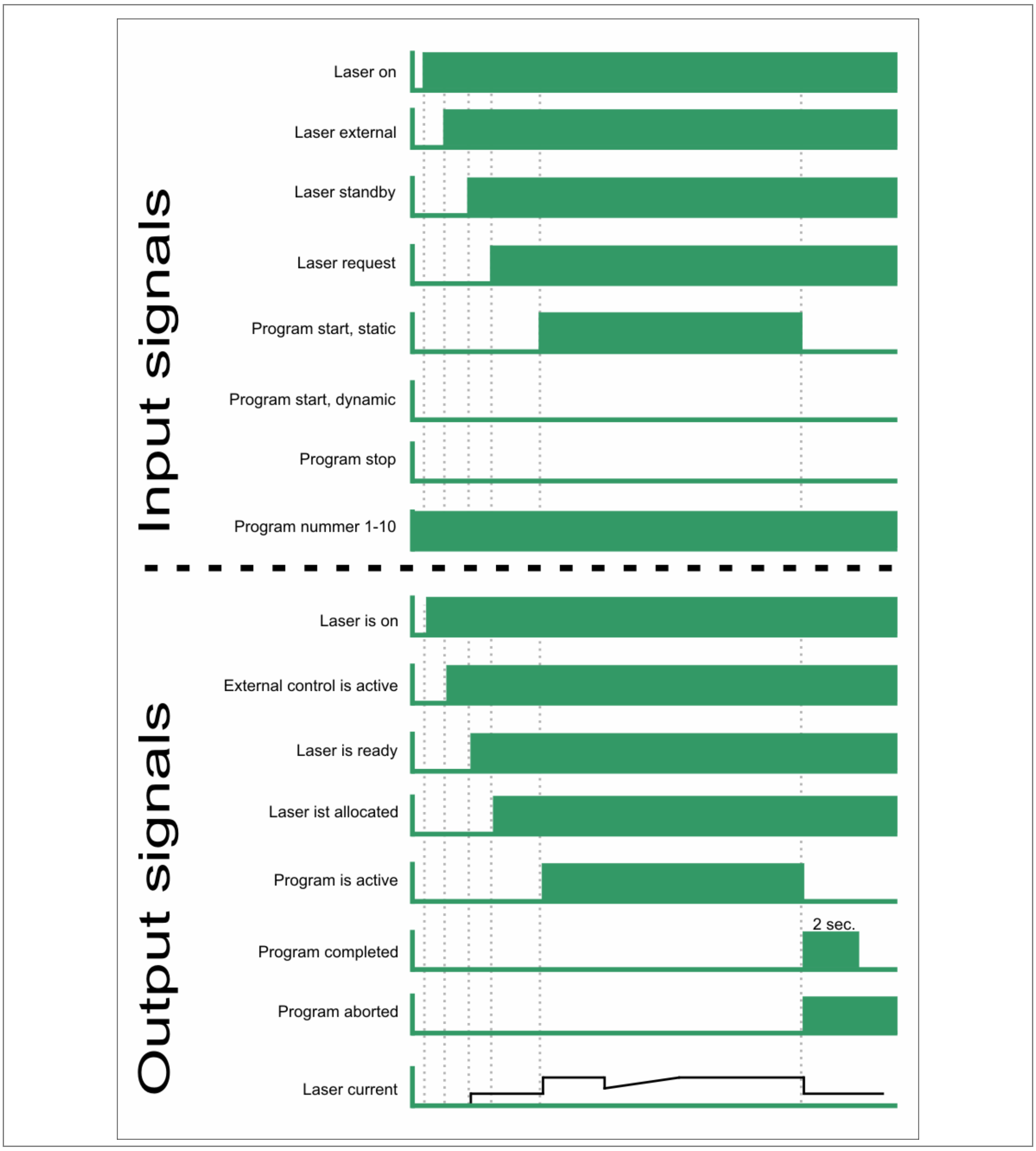


Fig. 23: Static Program Start

9.3 Beam switch

Setting the beam switch unit into operation is described in chapter "Commissioning and initial start-up / beam switch structure". The additional functions of the software are described below.

9.3.1 Selecting Beam Source (CW, SP and EXT Mode)

So that the operation modes CW, SP and EXT can be selected, the "Control / Operation" menu contains a list with the existing out-going beam paths. Here, one can select the respective out-going beam path.

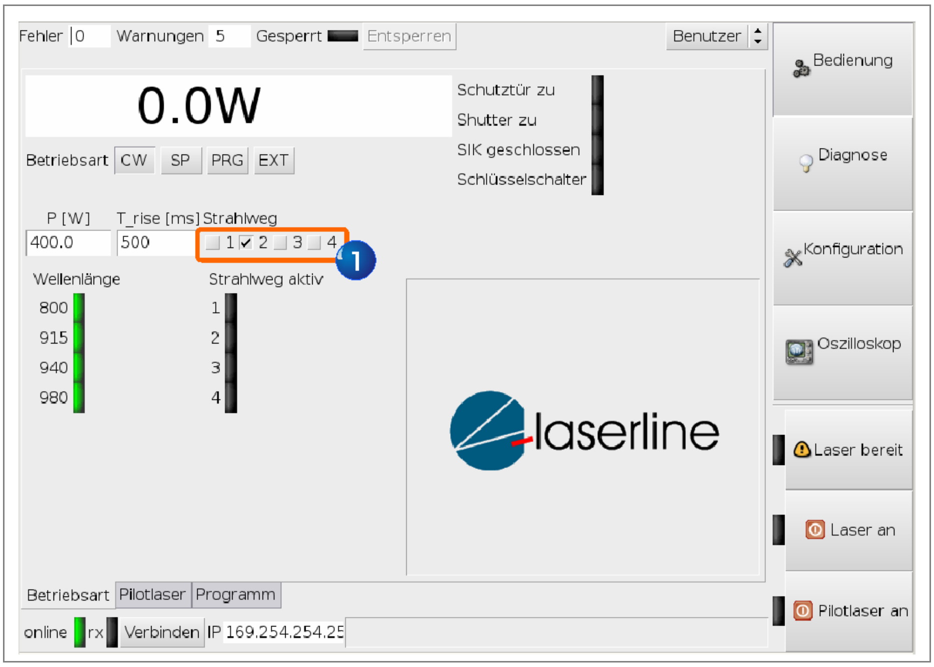


Fig. 99: Beam path selection (1)

9.3.2 Selecting beam path (PRG Mode)

By using the program mode, the beam path, together with the respective program, is stored. Depending on the selection (e.g. via a fieldbus interface), the selected program is loaded and the selected beam path, switched (in the case of the corresponding programming).

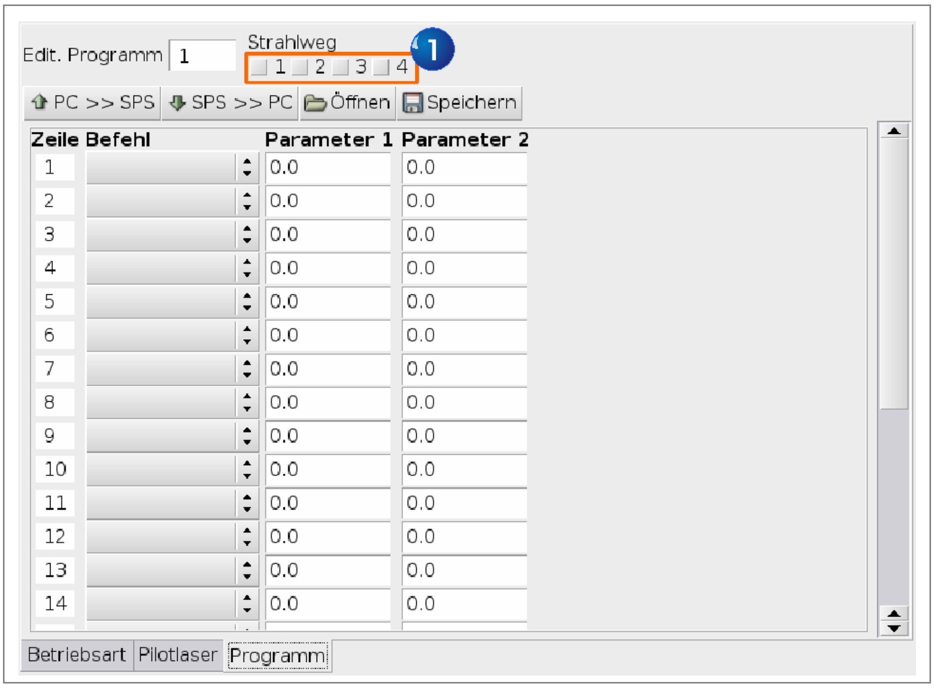


Fig. 100: Beam path selection (PRG Mode '1')

9.3.3 General

The shutter consists of a mechanical plate (mirror), which can be driven into the beam path, by an electrical drive (stepping motor). In this case the laser power is directed into the beam output an can exit e.g. by a laser light cable

If the plate is moved out of the beam path the laser power is directed into an absorber. No laser power can exit.

9.3.4 Using the Shutter

The shutter system can be used for the following functions:

- As a safety protection device
- For extending the lifetime of the laser diodes
- As a process shutter
- As beam switch (in combination with several units)

In general, the beam shutter is used as a protection and safety device and for extending the lifetime of the laser diodes.

For the duration the laser is in the ‘Standby’ mode, the laser is pulsed with a so-called ‘diode threshold current’. In conjunction with the threshold operation the undesired change in current is minimized (cf. Section ‘Extending the Lifetime of the Laser Diodes’)

The laser shutter can only be used as a process shutter by entering the corresponding programming routine in the program mode.

9.3.5 Operation of the laser system equipped with a shutter

When switching the laser system on or off in the CW, SP and EXT modes, the shutter is automatically opened and closed respectively (by using a beam switch a beam path must be selected in advance).

In contrast, when operating in the program mode, the shutter is not automatically activated. In order to control the shutter, a special command routine has to be written into the software.

Exception: in the case of a premature shut down of the program and exiting the program, the shutter is closed automatically.

Info: The Section “Program Mode” contains example programs to set up the control of the shutter.

9.3.6 Laser currents dependent on operational mode

Diode laser systems that are equipped with a shutter can operate in four different operational modes: Depending on the respective mode, there are changes in the control as well as the currents with which the laser diodes are pulsed.

The beam aperture of the shutter can be in three different statuses during the operation of the laser:

- closed
- open
- in movement

For all three possible shutter statuses, there are specific laser currents.

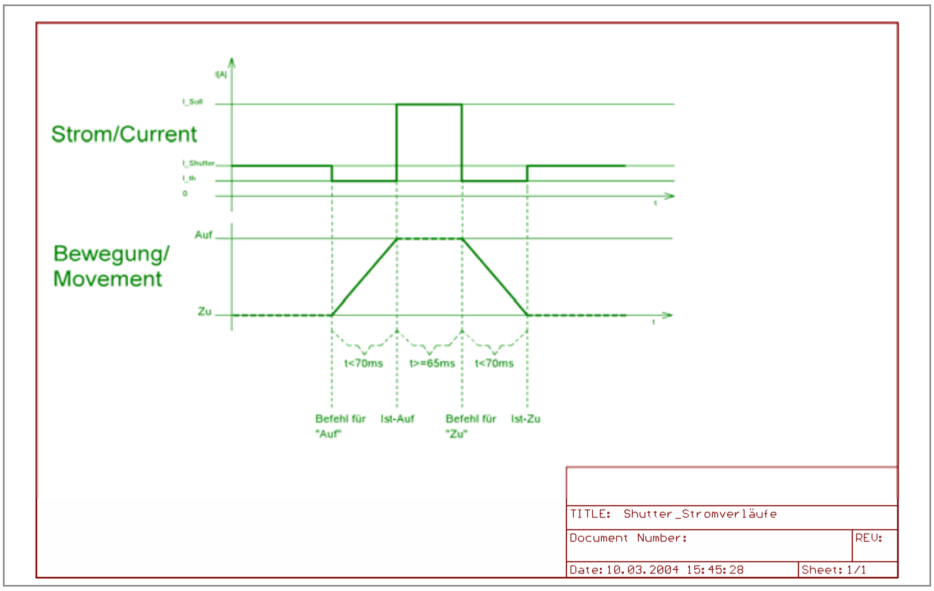


Fig. 101: Laser currents dependent on movement phase

Status in CW, SP and EXT operation:

When the shutter is closed, a pre-set current is supplied to the laser diodes (Threshold current). During the movement phase, the current flow through the diodes is re-set to the threshold current of the laser. After that when the shutter is being opened, the current is switched over to the current corresponding to the pre-set beam power of the laser.

Status in PROG mode:

In program mode, additional the current during shutter movement can be set.

Info - PROG Mode

More information in chapter "Operating/PRG-Mode".

9.3.7 Safety concept and structure

The laser system is equipped with a dual circuit safety system. In accordance with Safety Category III Norm DIN EN 954-1, the safety system shuts down the laser system.

To be able to switch the laser on, both circuits of the safety system must be closed.

A laser system can be equipped with several shutter systems. In such a case, the shutters are networked with each other in a sequence to one shutter system.

If the system is equipped with a shutter, the safety circuit then includes the safety contacts of the shutter system. The assignment of the shutter system is then parallel to, and in conjunction with the protection door contact circuits.

Info - safety circuit

More information concerning the circuits can be found in the electrical drawings in the technical appendix (Safety circuits / principle drawings).

In principle:

- CW, SP and EXT-Mode: If the safety door is open the laser can not be turned on. If the safety door is opened during laser operating (shutter open) the laser is shut down immediately.
- PRG-Mode: If the safety door is open the laser can not be turned on. If the safety door is opened during laser operating (shutter open) the laser is shut down immediately: If the shutter is closed and the laser is active, the safety door can be opened, the laser is not turned off. If the shutter is closed the laser power will be directed into an absorber.

- It is possible to set the laser into "READY" state in all operating modes (by opened safety doors). In this case the laser is operated with threshold current. The generated minor laser power is directed into the absorber.

To increase process safety, the movement time of the shutter system is monitored by the laser system's controller.

Should the shutter not open or close within a pre-set time, the laser system is automatically shut down. After the operator has acknowledged the error message, the laser can then be re-activated.

9.3.8 Extending the lifetime of the laser diodes

The safety concept with a shutter ensures that the laser diodes, even during the time that the protection door is open, are supplied with a flow of current. In this case, the laser need not be shut down when a protection door is opened (e.g. changing of a work piece). The laser remains in continuous operation which significantly extends its lifetime.

Safety process without shutter system	
Example	In the case of assembly line work and a continuous change of work pieces, the safety sluice of the laser processing room is opened. To prevent endangerment during changing of work pieces, the laser must be ramped down each time from its operational power to the 'zero power' position.
Result	Switching the laser ON and OFF exposes the laser diodes to a thermal-related contraction and expansion. This has a negative influence on the lifetime of the laser diodes.

Safety process with shutter system	
Example	In the case of assembly line work and a continuous change of work pieces, the safety sluice of the laser processing room is opened. To prevent endangerment during changing of workpieces, the beam power is shielded. The laser diodes can continue to be supplied with threshold current.
Result	Using the shutter reduces the load peaks supplied to the laser diodes and, in turn, avoids the thermal contraction and expansion of the laser diodes. This significantly extends the lifetime of the laser diodes.

9.3.9 Process Shutter

To significantly relieve the strain of the laser diodes resulting from the thermal expansion and contraction when switching the system on and off, the shutter can be used to modulate the laser output power.

In using the process shutter, the laser diodes are kept under constant current. By opening and shutting the shutter within a limited time period, a ‘pulsing’ of the laser output power can be realized and concentrated on the work piece.

The application of a shutter used as a process shutter, can only be carried out in the PROG operational mode. Further information and examples for such operation can be found in the Section “Operation in/PROG-Mode“.

> **Note - Overload**
>
> - In order to protect the shutter from overload during its operation, a maximum time cycle is limited to f= 1.75 Hz (short time max cycle: f= 2,80Hz).
> - Should the time cycle be exceeded, the shutter responds after the 5th 'closing' with a mandatory pause of approximately 5 seconds.

9.3.10 Description of function:

9.3.10.1 Initialization

After switching on the supply unit, the shutter begins its initialization phase (travel). During this initialization phase (travel), the end positions 'OPEN' and 'Closed' are travelled in sequence. This automatically checks the system as to whether it is operating flawlessly.

The time necessary for the initialization phase is less than 5 seconds.

9.3.10.2 Operation Mode

After having successfully completed the initialization, the system is now ready to receive control commands.

The response time of the shutter depends on the model of shutter being used. The shutter always requires the same time (no jitter) beginning with the movement command until it reaches its end position.

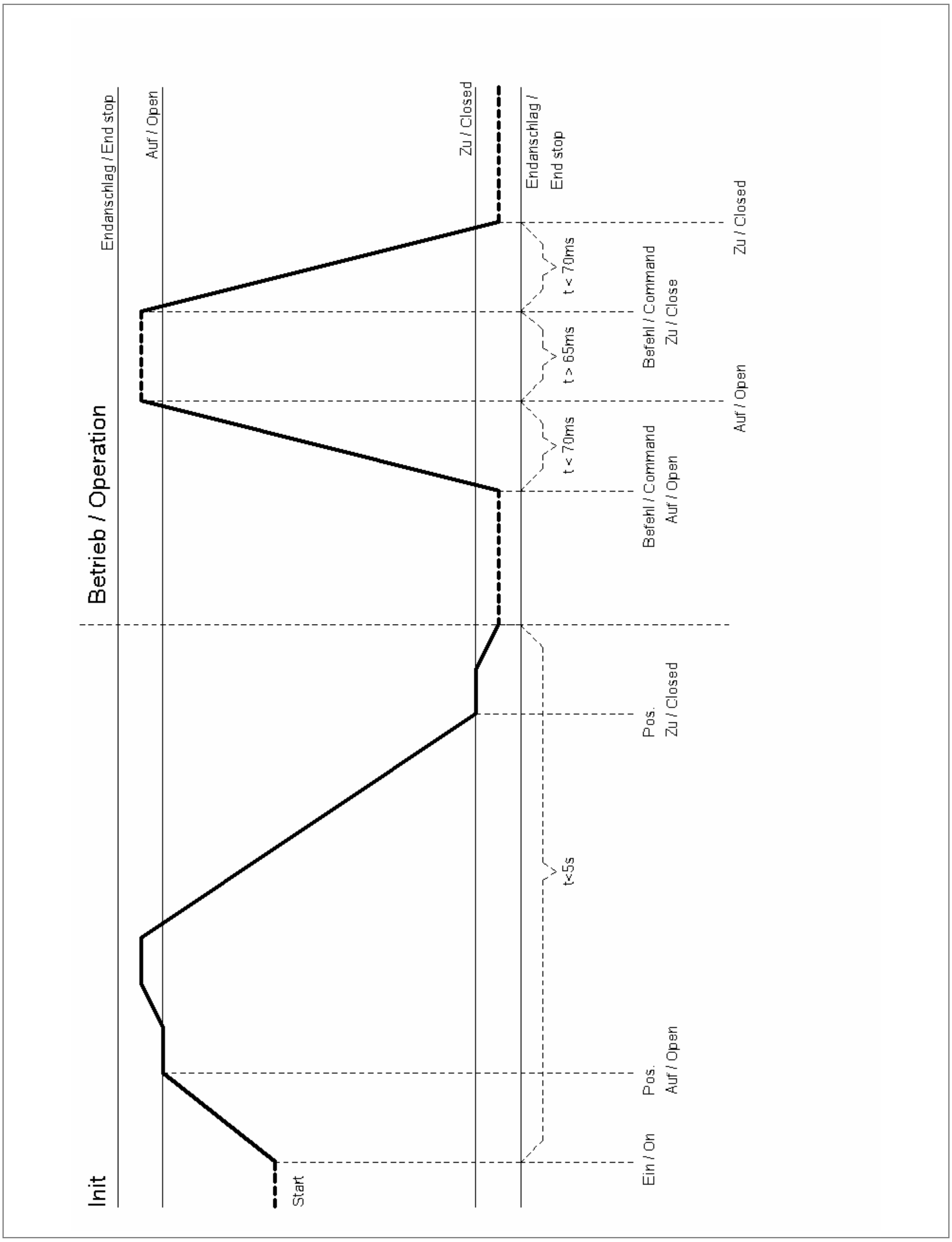


Fig. 102: Shutter movement

9.4 Laserline Teleservice (Telediagnostic)

If equipped with the Teleservice Module, the laser system is capable of telecommunication with Laserline.

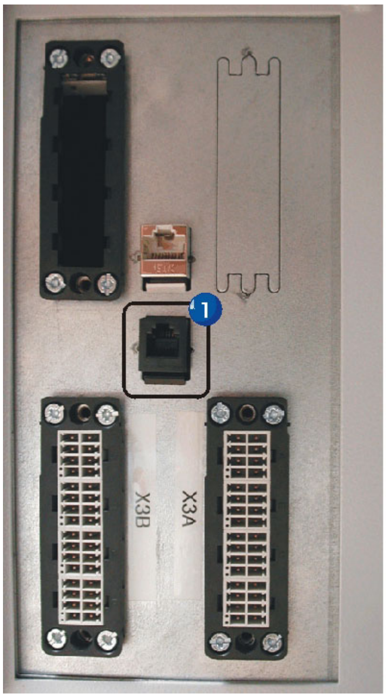
If equipped with this module, Laserline is able to monitor the complete laser system. Furthermore, the Teleservice provides the possibility of immediate updates of software as well as a complete simulation of the console on the PC display screen of the Support technician.

9.4.1 Using the Teleservice Module

Fig. 103: Teleservice modem in the front door (1)

9.4.2 Connection of the data line

In the case of supply units VG 2-5, the connection of the data line between the telephone system and the module is within the connection compartment of the supply unit



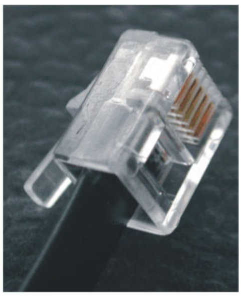


Fig. 104: Connection jack for modem line / RJ 11 plug

For a connection to the telephone jack, the supplied TAE line can be used. Should there be no TAE connection jack available, an alternative would be using a connecting cable with RJ11 / RJ45 plugs.

Info – Test modem

In the case of an analogue modem, the connection via dialling the modem number with a telephone can be checked. When the signals of the modem can be heard in the telephone receiver, the connection has been correctly carried out..

9.4.3 Error diagnostic

As soon as the laser system is switched on there is an initialization of the module. After the init has been completed the system is ready to pick up calls.

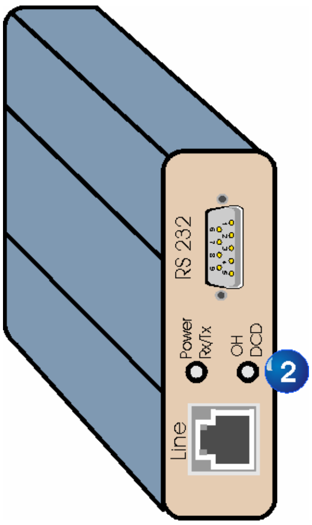


Fig. 105: LEDs on the modem

LED state	left LED	right LED
off	no supply voltage	no connection
green	supply voltage ok	Modem is hooked to the phone line.
On or blinks orange		connection established
red	--	No connection but the DCD line is switched on.

10 TROUBLESHOOTING

The laser control unit continually monitors the functions of the laser system. In case of functional errors or the exceeding of limit values, warning and/or error messages are issued.

These are displayed on the client interface (as collective errors), on the console (in text form) and coded via an optional field bus interface.

Messages can be viewed in the display:

- Select main menu “Diagnosis” and switch to the sub menu “Errors”.

Warning and error messages related to optional components are marked wait an * next to the message number.

10.1 Warning Messages

A warning message indicates that a value is not within the normal working range. In such a case, the limit value has not yet been reached. A “warning message” does not lead to a shutdown of the laser system: normal work can be continued. Nevertheless, measures should be taken to eliminate the causes of the warning message in order to obviate the issuing of an error message.

10.2 Error Messages

The issuing of an error message means that a limit value has been exceeded or a malfunction has been detected. When a fault message is issued, then the laser system will shut down. The error must be corrected before normal operation can proceed.

10.3 Warning Messages

No:.	Message / Explanation	Cause	Corrective measures
01	**Humidity supply unit.**	The humidity value in the diode laser system has risen to the warning limit.	Blow dry air into the supply unit / laser head. Check the dry air and/or dust protection equipment (if fitted).
02	**Humidity laser head too high.**	The humidity value in the diode laser head has risen to the warning limit.	
03	**Conductivity too high.**	The conductivity level has risen to the warning limit.	Change the DI cartridge or request system maintenance.
		Laser system has not been operated for several days.	Do not shut down the cooling system (no emergency off). Conductivity level will fall below the warning level after some time.
04	**Flow too low.**	The coolant flow has fallen to the warning limit.	See chapter 10.4 Error Messages and Troubleshooting, Message ID 09.
05 *	**External cooling unit: controller.**	Fault in the external cooling unit: cooler controller failure.	Check the external cooler, or better contact the Laserline Service.
06	**Iact deviation .**	Fault in the diode power supply.	Contact the Laserline Service.
07 *	**Flow in optics cooler too low.**	Fault in the optics cooler.	Check the coolant pipes between the supply unit and the lens.
			Check the flow settings of the cooler.
08 *	**Temperature in optics cooler too high.**	Disruption in the optics cooler.	Contact the Laserline Service.
09	**Stack disabled.**	The stack switch-off system has detected a defective stack and switched it off.	Contact the Laserline Service.
10 *	**Dust protection: pressure too low.**	The pressure of the dust protection unit has fallen below the minimum permissible working level.	See chapter: 10.4 Error Messages and Troubleshooting Message ID 90.

No:.	Message / Explanation	Cause	Corrective measures
11 *	**External cooling unit: flow too low.**	Fault in the external cooling unit: coolant flow rate is too low.	Contact the Laserline Service.
12 *	**External cooling unit: level too low.**	Fault in the external cooling unit: coolant level is too low.	Refill cooling water.
13-16*	**Beam timeout 1-4: run test.**	Self test of the beam monitoring unit [14] not processed, not finalized or currently active.	Run self test: restart the laser system or run test manually (menu “Diagnosis / Beam switch”). If the message still persists contact Laserline service.
17-32	**Humidity stack 1 – 16.**	The humidity level in the stack [1...16] has risen to the warning limit.	Replace the drying capsule or request system maintenance.
33*	**Laser on signal (Field bus): interval to short** (Only for equipment fitted with a field bus interface)..	The laser on signal must be active for at least 30 seconds.	Check field bus control. Make sure the signal “laser on” is not switched to often. See chapter 9 “Field bus” for further information.
34	**Coolant level too low.**	Coolant level internal circuit too low.	Refill cooling water. See chapter: 10.4 Error Messages and Troubleshooting Message ID: 01.

10.4 Error Messages and Troubleshooting

No:.	Message / Explanation	Cause	Corrective measures
01	**Coolant level too low.**	Coolant level internal circuit too low.	Refill cooling water.
02	**Emergency-OFF activated. Please wait 30 seconds.**	Emergency OFF circuit in the laser system is open.	1.: Release the emergency OFF button of the laser system. 2.: Check the external emergency off circuit and/or verify the X3A-plug. 3.: Check that both circuits are closed. 4.: Check that no time delay occurs between both circuits.
03	--	--	--
04	**Humidity in diode laser head.**	The humidity value in the diode laser system has reached the error limit.	Blow dry air into the supply unit / laser head. Check the dry air / dust protection unit (if fitted).
05	**General shutter error.** *(only for equipment not fitted with a beam switch)*	The shutter has detected an error.	Restart the laser system. The shutter will be re-initialised. If the error continues to be signalled, please contact Laserline Service.
06	**U_ext too high.**	The preset laser output is too high (>10V). The permissible range is between 0V to-10V.	Check the preset signal.
07	**Current too high with open safety circuit.**	The electrical power supply units have detected a current greater than 2A in the LED mode or a current greater than 2A was detected with the safety doors open. The laser was switched off for safety reasons.	Restart the laser. If the error occurs again, please contact Laserline Service.

No:.	Message / Explanation	Cause	Corrective measures
08	**PLC time error.**	Communication error of the PLC.	Please contact Laserline Service.
09	**Coolant flow too low.**	1.: Coolant level internal circuit too low. 2.: Water filter contaminated. 3.: Error in the flow monitoring	1.: Check coolant level and refill. 2.: Change the water filter. 3.: This error can only be corrected by Laserline. Please contact Laserline Service.
10	**Safety circuit open.**	The safety circuit was opened during laser operation.	1.: Close the safety doors (client's equipment). Safety doors may not be opened during laser operation. 2.: The laser covers (VG4, VG4L and VG5) may not be opened during laser operation. 3.: The side panels (VG-3E) may not be opened during laser operation.
11	**Safety circuit error.**	Asynchronous contacts in the safety circuit.	Please contact Laserline Service.
12	**Over Current Protection error.**	The diode current and/or diode voltage has exceeded the preset nominal limit value. The error can only be acknowledged once. If the error reoccurs, the laser system is disabled for 5 minutes. The error can then be re-acknowledged thereafter. When the error occurs 5 times within an hour, the laser system will be disabled. A reset is only possible by Laserline Service. When the error does not reoccur within 7 days, all errors will be erased.	Acknowledge the error and restart the laser. If the error reoccurs, please contact Laserline Service.

No:.	Message / Explanation	Cause	Corrective measures
13	**Over Voltage Protection error.**	See Error No.: 12.	
14	**Coolant temperature too high.** *(Temperature of the internal laser cooling circuit)*	1.: High ambient temperatures will cause an excessive coolant temperature, after longer periods of standstill. 2.: The hose lead between the supply unit and the external cooler is kinked. 3.: The temperature of the external cooling circuit is too high. 4.: The solenoid valve is obstructed by a foreign body.	1.: Wait until the coolant temperature has fallen. 2.: Reposition the hose lead correctly. 3.: Adjust the temperature (to below 17°C). 4.: Clean the solenoid valve.
15	**Coolant temperature too low.** (Temperature of the internal laser cooling circuit)	1.: The input- and output leads of the external cooling circuit attached the wrong way round. 2.: The temperature of the external cooling circuit is too low. 3.: The solenoid valve is obstructed by a foreign body.	1.: Change over the input- and output leads. 2.: Adjust the temperature (to above 10°C). 3.: Clean the solenoid valve.
16	**DI cartridge exhausted.**	Conductivity level of the internal cooling circuit too high.	Replace the DI cartridge or request system maintenance.
17	**Coolant temperature too high. Emergency System Stop!**	The coolant temperature has risen to 40°C.	Restart the system; the cooling system will restart. If the temperature fails to fall below 40°C, the laser system will again stop (see "**Fehler! Verweisquelle konnte nicht gefunden werden.**
18-21*	**Error shutter no. 1...4.**	The shutter has detected an error [1...4].	Restart the equipment; the shutter will be re-initialised. If the error message reoccurs, then please contact Laserline Service.
22	**--**	--	--

No:.	Message / Explanation	Cause	Corrective measures
23	**Shutter runtime error.**	The shutter system fails to open or close within the preset switched run time.	Acknowledge the message and restart the laser. Should the error message reoccur, then please contact Laserline Service.
24	**Dry running protection. Cooling pump stopped.**	The equipment has run longer than 1 minute with not enough coolant. Coolant level internal circuit too low.	Refill the cooler.
25	**Temperature error power supply.**	A diode electrical power supply unit is overheated.	Please contact Laserline Service.
26	**24 V power supply error.**	1.: Fuse (24V) defective. A defective fuse is signalled via a red illuminating LED on the fuse holder. 2.: Short circuit at the X3B customer interface.	1.: Replace the fuse with the same type. Chapter "**Fehler! Verweisquelle konnte nicht gefunden werden.**" Page **Fehler! Textmarke nicht definiert.** 2.: Check wiring and change if necessary and/or eliminate the short circuit.

No:.	Message / Explanation	Cause	Corrective measures
27	**Laser light cable defect, not connected or coolant flow to low.** *(only for equipment not fitted with a beam switch)* *Actions 4-7 only concern devices with laser light cable cooling eg. like LLKD/Auto laser light cables)*	1.: Laser light cable is mechanically damaged. 2.: Laser light cable is overheated. 3.: Laser light cable not correctly connected or contacts contaminated and/or damaged. 4.: Quick release coupling of the laser light cable cooling not fitted or not locked. 5.: Coolant hose of laser light cable cooling not purged. 6.: Coolant pump does not deliver coolant. 7.: Electrical connector of flow sensor not connected or bad contact.	1.: Do not continue to use the laser light cable. Please contact Laserline Service. 2.: Allow the laser light cable to cool down and then restart the laser. If the error message reoccurs, then please contact Laserline Service. 3.: Check the plugs at the laser and the optics. Connect the laser light cable monitoring. Clean all contacts (see Laser Light Cable Manual). 4.: Please check quick re-lease couplings. 5.: Air bubbles may remain in the cooling hose. If so, keep purging for a couple of minutes. If necessary, fill up with coolant. 6.: Please check the entry “Q_eff” in the menu “Diagno-sis/Cooler”. The value must be higher than 0 l/min (see message # 09, 24, 29). 7.: Please check the connec-tor. Clean the contacts if necessary. Should the instructions not help to correct the error, please contact the Laserline Service.
28	**Laser power set too high.**	The preset laser power is set too high.	Observe the Pmax of the laser.

No:.	Message / Explanation	Cause	Corrective measures
29	**Frequency converter error or circuit breaker triggered.**	1.: Circuit breaker triggered. 2.: Error at the frequency converter.	1.: Check the circuit breaker in the switch cabinet and reset if necessary. Chapter “Structure control unit ” Page 5-3 2: Press the emergency off button at the supply unit and wait 1 minute. Then unlock the button. If the error message is repeated, please contact Laserline Service.
30	**2 A Test failed.**	The self-test of the safety circuit failed (is automatically run whenever a restart of the equipment is initiated).	Please contact Laserline Service.
31	**Laser head not connected or bus timeout.**	1.: LDL: The laser head is not connected to the supply unit. 2.: LD and LDF: Communication disruption to the laser head.	1.: Connect the laser head to the supply unit (charge connection). 2.: Restart the equipment. If the error reoccurs, then please contact Laserline Service.
32 *	**Humidity supply unit.**	The humidity level in the supply unit has reached the limit level (operation no longer permissible).	Blow dry air into the supply unit. Check the dry air and/or dust protection equipment (if fitted).
33-48	**Humidity Stack 1...16.**	The humidity level in the laser stack [1...16] has reached the limit level.	Replace the drying capsule and/or carry out a servicing and maintenance routine.
49	**Laser light cable 1 defect, not connected or coolant flow too low.** *(only for equipment fitted with a beam switch)*	See Error No.: 27.	--
50-51*	**Flow error circuit No.: 1...2.**	See Error No.: 09.	**--**

No:.	Message / Explanation	Cause	Corrective measures
52-53*	**Back reflection error stack 1-16.**	Reflection values in the diode stack [1...16].	Change the positioning angle between the optics and the material to be processed.
54-56*	**Laser light cable 2...4 defect, not connected or coolant flow too low,** *(only for equipment fitted with a beam switch)*	See Error No.: 27.	--
57-60	**Timeout micro controller power supply 1...4.**	Communication disturbance with a diode power supply [1...4].	Restart the equipment. If the error reoccurs, please contact Laserline Service.
61-64*	**External error on FB 1...4.** *(Only for equipment fitted with a field bus interface).*	The processing cell (FB) [1...4] reports an error at the laser. The signal is reported via the field bus by the client equipment (robot, PLC or the like) to the laser. The laser beam is switched off and an error message displayed on the console.	Eliminate the error in the processing cell.
	This message is triggered by the client equipment and does not represent a failure in the laser equipment.		
65-68 73-80	**Temperature point no.: 1...12 too high.**	The temperature at the measuring point [1...12] has exceeded the limit value.	Allow the equipment to cool down (around 5 minutes) and restart the laser. If the error reoccurs, then please contact Laserline Service.
	65=Point 9; 66=Point10; 67=Point11; 68=Point12 73=Point1; 74=Point2; 75=Point3; 76=Point4; 77=Point5; 78=Point6; 78=Point7; 79=Point8; 80=Point9		
69-72	--	--	--
81*	**Beam outlet 4: maximum laser active time exceeded.**	The laser has been active longer than set in beam monitoring unit [1...4] (see message 94-96).	Check the client equipment, (Laser was turned on too long) or adjust the time period in the auto beam off unit.

No:.	Message / Explanation	Cause	Corrective measures
82-88	--	--	--
89*	**Error dust protection: pressure too high.** *(optional function)*	The maximum permissible working pressure of the dust protection was exceeded.	Check the input pressure of the external compressed air (client) (6-8 bar maximum pressure). If the error cannot be eliminated, please contact Laserline Service.
90*	**Error dust protection: pressure too low.** *(optional function)*	The minimum permissible working pressure of the dust protection has not been reached.	Check the input pressure of the external compressed air (client; 6-8 bar maximum pressure.). Check the pressure setting at the console and reset if required.
91	**Maximum laser active time exceeded.**	The laser has been active longer than the 'max. Laser active duration‘ (see menu “Configuration / General”.).	Check the client equipment, or adjust the time period.
92-93	**Timeout micro controller power supply 5...6.**	Communication disturbance with a diode power supply [5...6].	Restart the equipment. If the error reoccurs, please contact Laserline Service.
94-96*	**Beam outlet 1...3: maximum laser active time exceeded.**	See Error No.: 81.	**--**

11 LASER SYSTEM MAINTENANCE AND SERVICE

11.1 General Maintenance Instructions

The diode laser system has been developed so as to require only a minimum of maintenance. The maintenance has to be carried out as described below.

Warning – Danger when maintaining the system!

There is a serious risk of injury to persons carrying out work in which they are not qualified and in which they have not received instruction.

- Observe instructions in the Chapter "Safety"!

11.2 Maintenance plan

Work to carry out	Time interval
Check humidity values of each laser stack	monthly
Check level of cooling liquid	monthly
Exchange drying capsules	yearly
Exchange water filter	yearly
Exchange water filter power supply	24 months
Exchange DI cartridge	If necessary

11.3 Accessories and Consumables

All of the principal consumables are listed below under the headings laser head or supply unit.

Laser head

Article	Type	Order No.
Protective glass, AR coated for LDF and LDL processing optics	1 inch optics	201131
	2 inch optics	201132
Drying capsules	All equipment types	103095

Supply unit

Article	Equipment type	Order No.
LED lights for operating unit	All equipment types	102612
Fuse middle slow 4A/250V	All equipment types	000379
Water filter for cooling system	VG2- VG5	102284
Water filter for power supply unit	VG2- VG5	106121
DI cartridge	All equipment types	100356
Pre filter membrane air dryer (only for system with dust protection unit)	All equipment types	203571

All materials listed above can be ordered from Laserline!

The pictures below show a filter, DI cartridge and drying capsules.

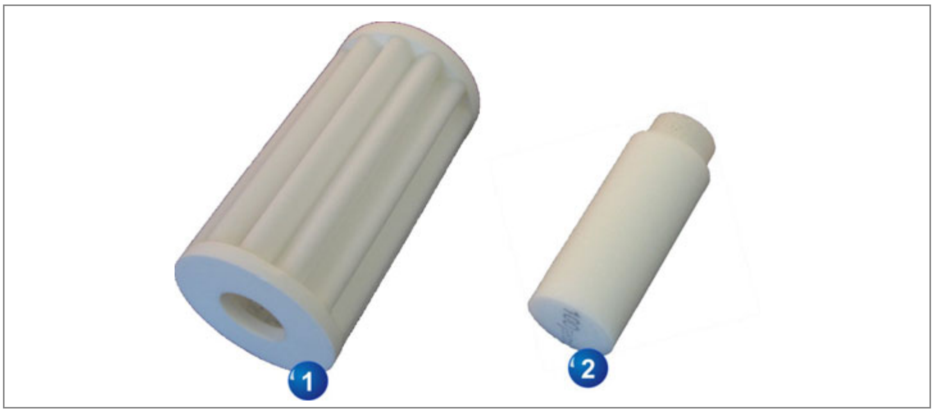


Fig. 106: (1) water filter laser coolant circuit (2) filter for the power supply

Fig. 107: DI cartridge for supply unit

Fig. 108: Drying capsules (all types of laser)

> **Note – Drying capsules**
>
> One drying capsules is required for each stack. When servicing the unit, it is best to replace all capsules at the same time.
>
> Important: Drying capsules cannot be stored indefinitely! Please observe the expiry date printed on the capsules and do not use after this date.

11.4 Laser optic maintenance

11.4.1 Cleaning the protective glass on the optics

The optics of the diode laser are protected from contamination by a protective glass. This protective glass is coated. However, steam and gases produced during processing can cause the protective glass to become soiled.

The cleaning of optical elements always poses a threat to the quality of the surface, particular with regard to the protective coating applied. For this reason, the condition of the protective glass must be checked regularly.

Cleaning should, if possible, be effected in several stages. Gloves should be worn to protect the hands from solvents and to avoid leaving fingerprints. If fingerprints are left on the optical surface, they must be removed immediately, as the acidity of the skin can aggravate the surface and coating.

- To begin cleaning, free the area of dust using either dry air or nitrogen.
- In the second stage, remove any stubborn particles with a lint-free cloth which has been previously dipped in isopropyl or ethanol.

11.4.2 Replacing the protective glass on the optics

Please consult the Chapter on "System options / replacing the protective glass“.

11.5 Maintaining the laser cooling system

Fig. 109: Cooling system of VG2-5 (example)

(1)	Solenoid	(7)	Filling neck
(2)	DI-cartridge	(8)	Water tank
(3)	Volume-flow sensor	(9)	Water filter, power supply
(4)	Terminal box for cooling system	(10)	Coolant pump / drain
(5)	Plate heat exchanger	(11)	Transport bolts
(6)	Water filter		

The laser cooling system should be serviced annually. Before carrying out any maintenance work, firstly switch the supply unit off by setting the main switch to “Off“. Ensure that the switch cannot be turned on again inadvertently.

11.5.1 Replenishing the coolant

To fill the cooling system with coolant, proceed as follows:

- Firstly open the rear panel (door) on the supply unit and unscrew the cap on the filling neck.

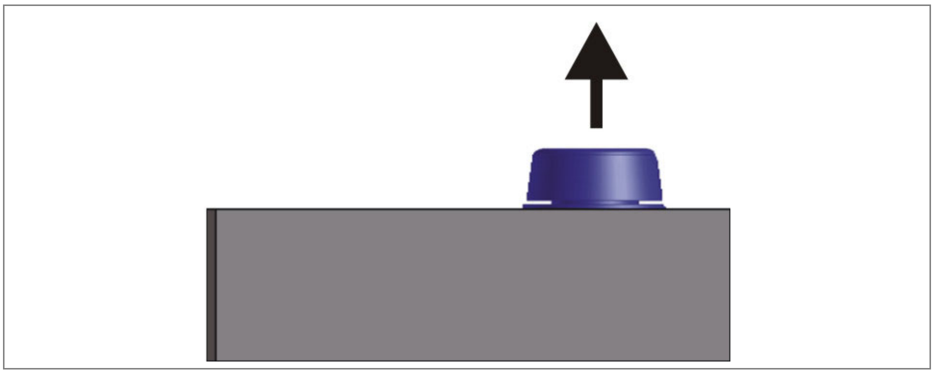


Fig. 110: Sealing cap of coolant tank

- Fill the cooler with coolant until the water level has reached the maximum level on the filling gauge and check the level of the coolant once or twice a month, replenishing as necessary.

Note - Coolant

- Please pay attention to cooling water requirements in particular concerning DI value and pH-value.
- During normal usage of the laser, water should only be filled up whenever required. A complete change should only be performed for first installation and for shipment.

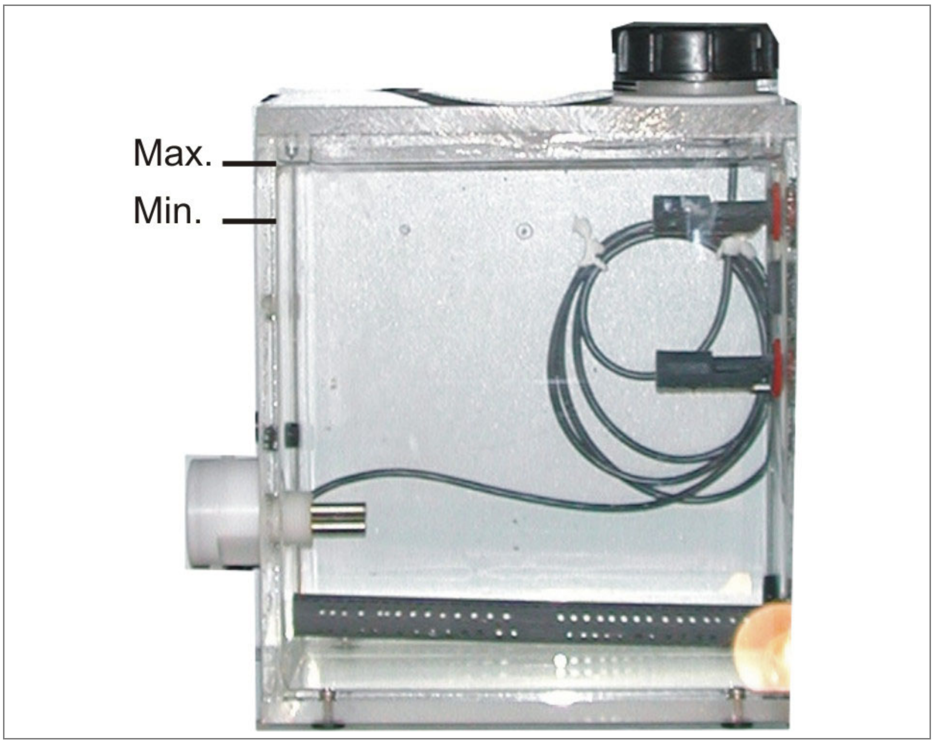


Fig. 111: Maximum filling level for coolant (1)

11.5.2 Replacing the water filter

The filter integrated into the cooling system ensures that particles of dirt do not get into the diode laser or diode power supply unit. The filter cartridge should generally be replaced every 12 months.

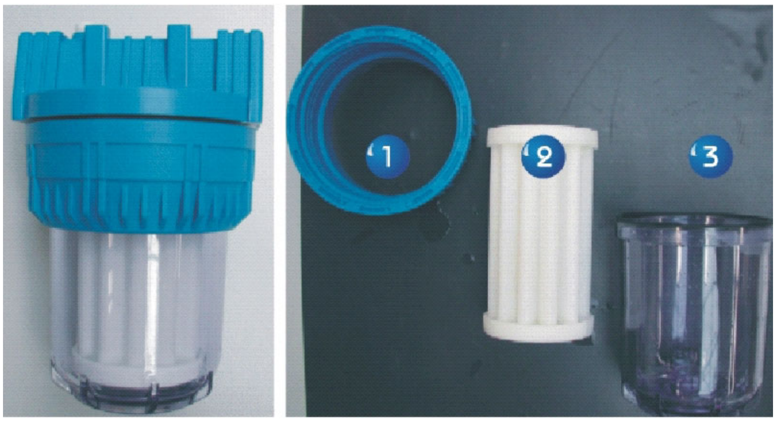


Fig. 112: Water filter from supply unit cooling system

(1) Retaining ring

(2) Filter cartridge

(3) Filter cup

- Loosen the housing on the filter by turning it to the left.

Fig. 113: Loosening the filter housing

- Remove the filter cartridge and insert a new one. (Ensure that the O-sealing ring is securely in place on the filter housing.)

Fig. 114: O-sealing ring on filter housing

- Tighten up the retaining ring and filter housing.

The water filter in the water supply to the diode power supply unit prevents dirt from entering the cooling ducts of the power electronics. The filter cartridge should be replaced after 24 months.

Fig. 115: Water filter for diode power supply unit

(1) Filter cartridge

(2) Filter cup

- Loosen the filter housing by turning it to the left.

Fig. 116: Loosening the filter housing

- Remove the filter cartridge and insert a new one.
- Tighten the filter housing up again.

info

Even when the unit is switched off, coolant will drip out of the filter. Have the new filter cartridge ready to be able to complete the replacement as quickly as possible. If necessary, replenish the coolant.

11.5.3 Replacing the DI cartridge

The DI cartridge in the cooling system ensures that the level of conductance of the coolant is always in the range of ca. 1 - 3 µS/cm.

Note

The replacing of the DI cartridge is not based on the expiry of a specific period of time. The cartridge should only be replaced if the value rises above 3µS/cm. The unit will issue a warning message via the operating device when the level reaches 3µS/cm.

The replacing of the DI cartridge is not based on the expiry of a specific period of time. The cartridge should only be replaced if the value rises over the threshold. The unit will issue a warning message via the operating device in this case. It is therefore advisable to always have at least one spare cartridge on hand.

The current level of conductance can be read from the operating device (cf. Chapter "Operation"). The DI cartridge is replaced as follows:

- The DI cartridge is attached on the left next to the water filter and is held in place from above and below with clips.
- To replace the cartridge, firstly push it up, then remove it out front ways.

Fig. 117: DI cartridge connections

(1) Connection flange
(2) Connection coupling

- To loosen the quick-fit coupling, push the ring on the top and the bottom backwards and pull both couplings off.

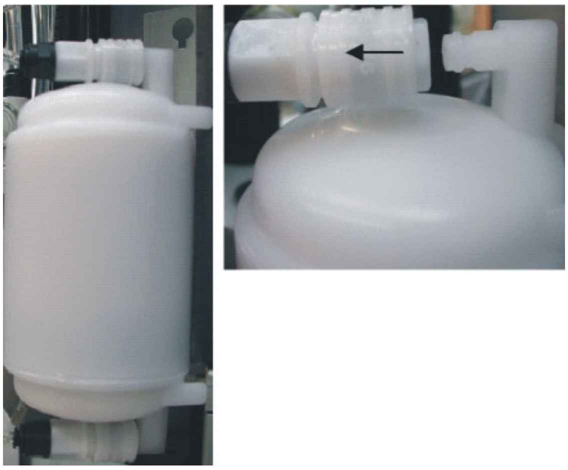


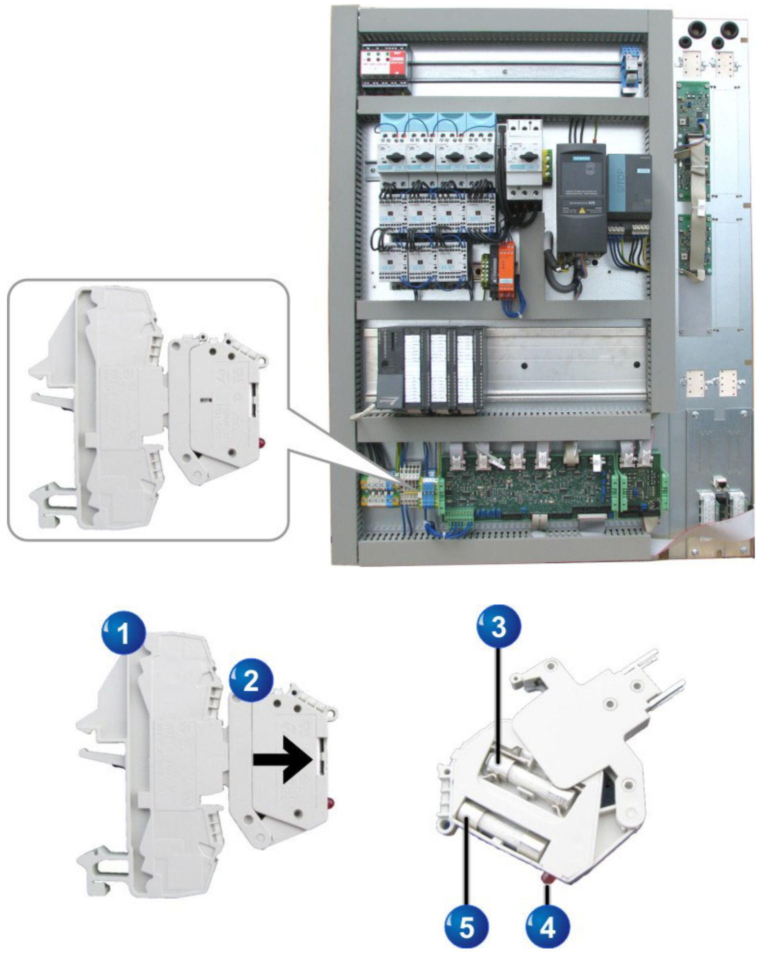
Fig. 118: Loosening the quick-fit coupling (in the direction indicated by the arrows)

- Put the couplings on the new cartridges. Press them into the connection flange from the back. If too much pressure is applied, the flange could break.

Fig. 119: Inserting the DI cartridge

- Click the DI cartridge back into the holder.

11.6 Replacing the micro fuses



1 Holder
2 Fuse holder
3 Fuse
4 Control LED
5 Spare fuse

Fig. 120: Mounting position and fuse holder

All fuses are located on the front of the supply unit. A control LED located in the fuse holder is used to indicate a defective micro fuse.

DANGER

High voltage in the supply unit may cause severe burns and lethal injuries.

- Only replace fuses when unit is powered off.
- Work on electrical components may only be carried out by electricians.

1. Power down the supply unit (VG) using the main switch.
2. Pull the fuse holder with the defective fuse out of the holder.
3. Open the fuse holder, take out the defective fuse and replace with a fuse of the same rating.
4. Put the fuse holder back in place.
5. Close the front door.
6. Dispose of the defective fuses according to the local regulations.

Information – Error cause

The cause of the fuse problem should be solved **before** the replacement of the fuse.

11.7 Replacing the drying capsuless

Humidity in the housing of a diode stack must be kept at a low value. A drying capsule in the stack housing absorbs any moisture and stores it. Depending on ambient conditions, the capsule reaches maximum absorption after some time and has to be replaced. Observe the specified replacement intervals.

The laser control system monitors humidity in the diode stack. If the humidity value exceeds the limit value, this is indicated by a warning message.

If you fail to replace the drying capsule in the event of a warning message, moisture may reach the error limit. In this case, it will no longer be possible to operate the diode laser. The laser will only be operational again once the drying capsule has been replaced and the error limit is undershot. The drying capsule should be replaced in particular following a prolonged idle period.

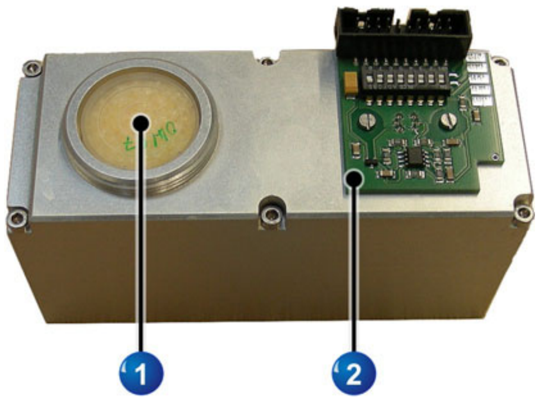
information – drying time

The drying process can last between 5 and 24 hours at high humidity values.

Note – replace drying capsules

- A clean environment is essential for changing drying capsules. Neither dust nor other particles may get into the opening for the drying agent! Open the transport bag for the drying agent only immediately before replacement. Even a few minutes in ambient air result in a reduction in drying properties.
- Ensure that the paper lid of the drying capsule is facing inwards (towards the stack).

11.7.1 Layout of the stack housing



1 Drying capsule 2 Monitoring electronics

Fig. 121: Stack housing

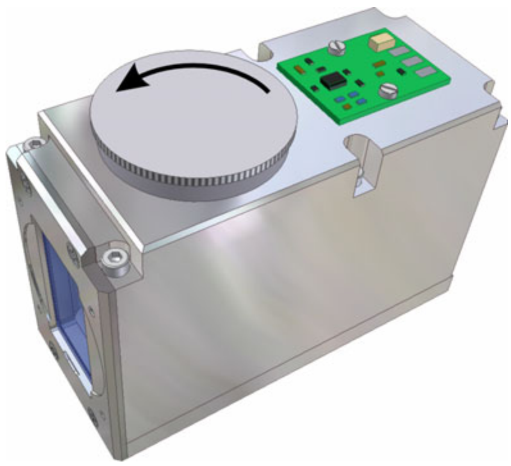
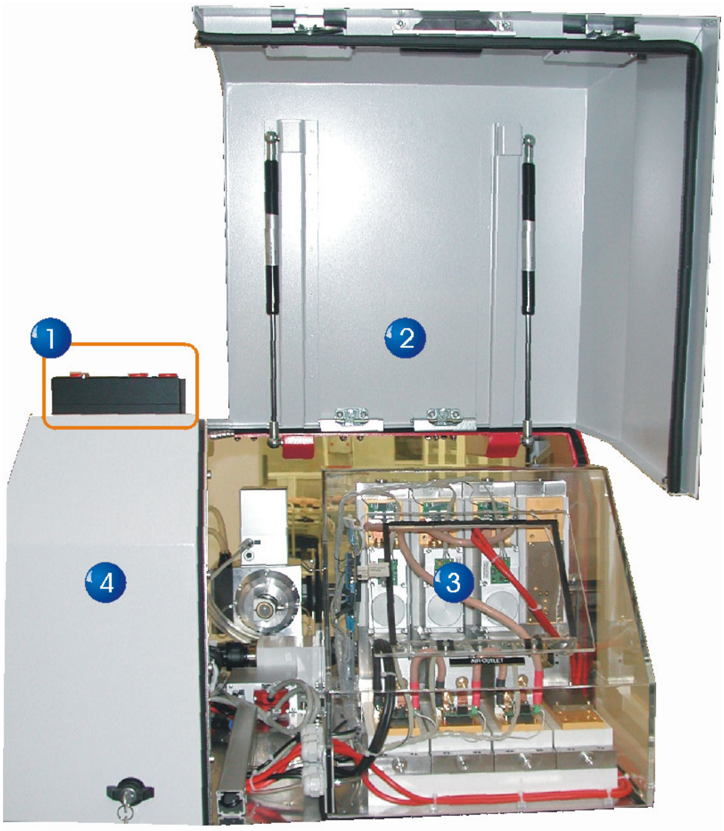


Fig. 122: Open cap

1. Unscrew the cap by turning it in arrow direction.
2. Remove the used drying capsule from its seat.
3. Remove the new drying capsule from the transport bag.
4. Replace the drying capsule (paper cover points inwards).
5. Screw on the screw cap.

11.8 Maintenance of the VG4L laser head



1 Laser light cable clamping system

2 Cover

3 Laser stack

4 Leadthrough cover for laser light cable

Fig. 123: Structure of the laser head (example)

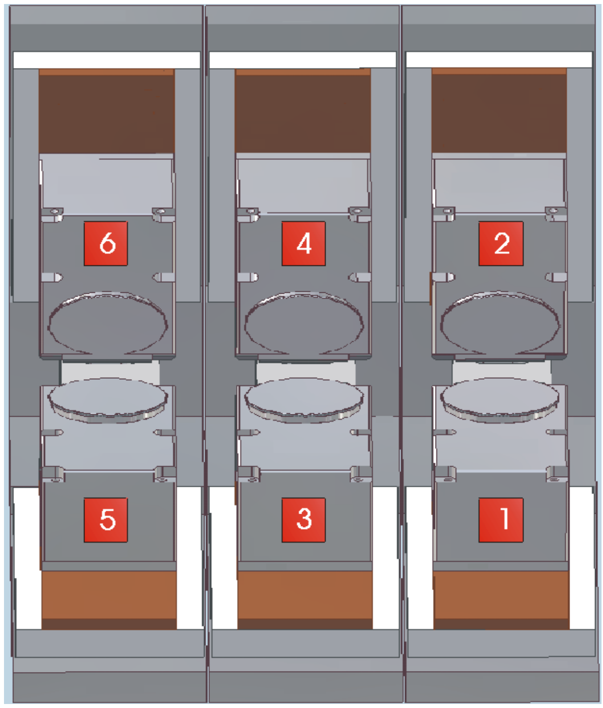


Fig. 124: Arrangement of the laser stacks in the VG4L supply unit

1 Switch off the supply unit (main switch to „OFF“).

2 Unlock the cover and swing it up.

3 Remove the plexiglass plate covering the stack dumps. Remove the 8 screws (M4 slotted screws) and keep them safely for reassembling purposes.

Information – Seal

To remove the cover the warranty seal must be broken.

4. Replace the desiccant capsules (see Layout of the stack housing page 11-19)
5. Install the plexiglass plate and tighten the screws.
6. Close and lock the cover.

11.9 Maintenance intervals and service

Annual maintenance of the equipment is recommended. This maintenance should only be performed by Laserline specialists.

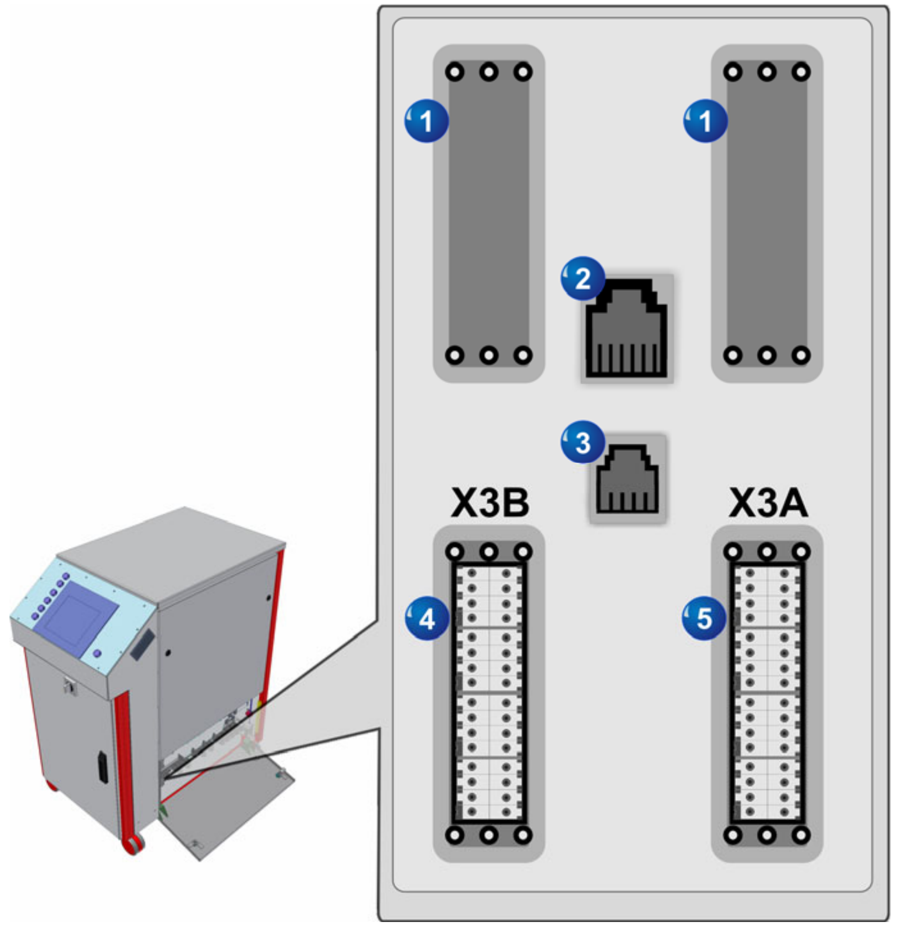
Replacement of consumables (water filter, desiccant capsules and DI cartridge) may be performed by the customer's personnel after appropriate training.

For further information about training, please contact the Laserline Service.

11.9.1 Measuring the laser power

In order to ensure a constant laser power on the work piece, the optical output power of the diode laser should be measured regularly. In case of variations please check the perfect operation of the optical components. Appropriate corrective measures should be taken if necessary. Should the laser diodes be responsible for the power variation, please contact the Laserline Service for further action.

12 CUSTOMER INTERFACE



1 Field bus interface (optional)
2 Ethernet interface
3 Teleservice interface
4 Laser control (X3B)
5 Safety circuits (X3A)

Fig. 125: Interfaces of the Laser system (with optional interfaces)

12.1 Technical Details X3 A/B-Interface

> **Please Note**
>
> All in- and outputs are not separated galvanically! Connecting the system with either too much voltage (max. 24V DC) or current (> 500 mA) might cause serious damage of the supply unit or the PLC.

The customer interface X3 of this diode laser system was split into two separate interfaces. The first interface (A) is used for the safety circuits; the second interface (B) is used for controlling and monitoring the diode laser system.

ELECTRICAL SPECIFICATIONS OF DIGITAL INPUTS	
Input voltage	Nominal value DC 24V
	0 - 5 V is equivalent to signal “0“ (Low)
	15 – 24 V is equivalent to signal “1” (high)
Input current	At signal “1“ < 10mA
Reaction time	3 ms + 2 ms Jitter with rapid I/O s 2ms + 20ms Jitter with normal I/O s

ELECTRICAL SPECIFICATIONS OF DIGITAL OUTPUTS	
Output current (max.)	500 mA
Output voltage	23,2 V @ 24 V supply voltage
Reaction time	3 ms + 2 ms Jitter with rapid I/O s 2 ms + 20 ms Jitter with normal I/O s

ELECTRICAL SPECIFICATIONS OF ANALOGUE OUTPUTS	
Output voltage	0 - 10 V
Start load	Min 1 kΩ Max 0.1µF
Reaction time	3 ms ± 2 ms Jitter

ELECTRICAL SPECIFICATIONS OF ANALOGUE INPUTS	
Input voltage	0 -10 V
Input resistance	100 kΩ
Reaction time	3 ms ± 2 ms Jitter
Resolution	12 Bit

12.2 Safety circuits of the beam source

The laser equipment features two independent safety circuits.

- Safety circuit: double electrical circuit used for monitoring of laser covers, laser light cable, shutter and safety doors. The laser beam is switched off in case of interruption (open circuit) of the safety circuit.
- EML circuit: the power circuits and the coolant pump are switched off in case of interruption (open circuit) of the EML circuit.

12.2.1 Safety circuit (SCT)

The safety circuit is a category 3 safety circuit (DIN/EN 954-1).

The safety circuit is a zero signal current based circuit. When a safety switch opens, the safety circuit is interrupted. According to the operation status:

- The laser beam is switched off, the shutter closed and an error message is generated.
- The laser beam cannot be activated (the laser beam is guided into the beam dump).
- An error message is generated when only one of the two circuits closes (synchronization).
- An error message is generated when one of the two circuits closes with a delay (synchronization).

Operation of the laser can only be resumed after acknowledgment of the error message.

A self-check of the safety switch-off is performed after reactivation of the mains supply. The safety circuits will only be validated after successful check.

12.2.1.1 Key switch

The key switch of the supply unit prevents from unauthorized start-up of the laser equipment.

- It is impossible to operate the laser when key switch is on "0". This position allows withdrawal of the key.
- Only the alignment laser can be activated when key switch on "1". This position allows withdrawal of the key.
- In position "2" both the LED mode and the laser can be operated with power. If the safety doors or the safety circuit are open, only the alignment laser can be activated. This positon does **not** allow withdrawal of the key.

12.2.1.2 Safety door interface

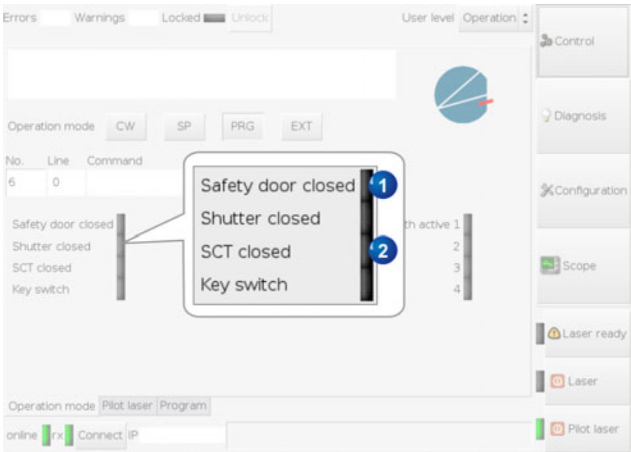
The safety components of the processing station are connected to the safety door interface (e.g. the safety contacts). The safety door interface with the connected safety components form the safety door circuit.

The safety components implemented in the safety door circuit must comply with the DIN EN 954-1 standard, safety category III. Location of the safety door interface according to the supply unit version:

- Above the beam outlet (units with more than one beam outlet/beam switch).
- Under the X3A interface (units with single beam outlet).

12.2.1.3 Display

The status of both the safety circuit and the safety door circuit is displayed on the control panel.



1 Safety door status 2 Safety circuit status

Fig. 126: Status display on the control panel

The "Safety door status" (1) display shows the status of the safety contacts of the processing station. This display is active when:

- both circuits of the safety door circuit are closed.

The "Safety circuit status" display does **not** appear in the following conditions:

- laser covers not closed,
- shutter and safety door circuit open at the same time (the safety circuits have been opened during the laser processing),
- internal error.

Note - Laser cover

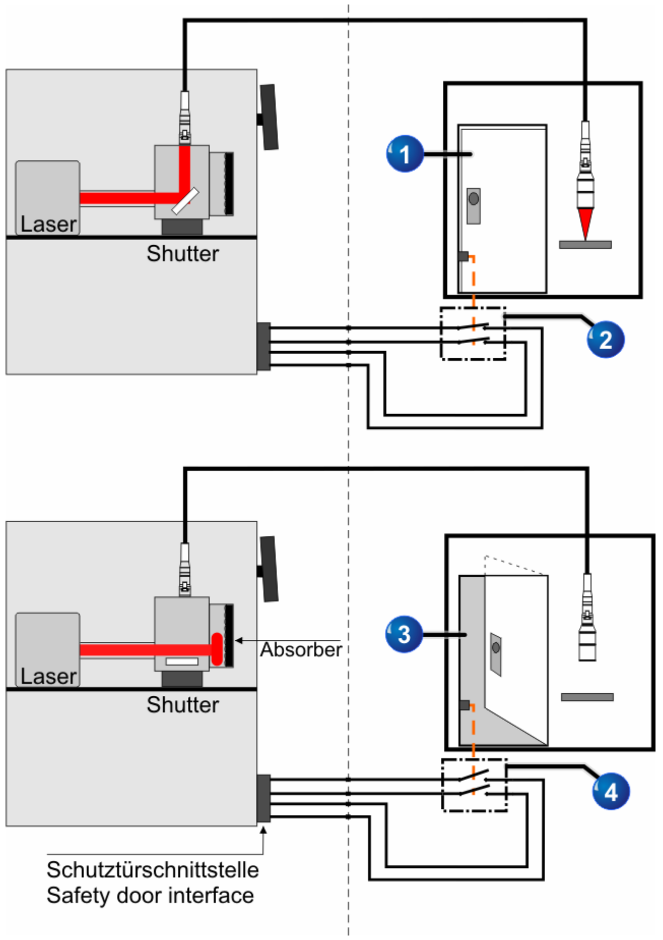
With the VG3E type supply unit the side panels and the back door (cooling system) must be closed otherwise the safety circuits remains open.

With the VG4, VG4L and VG5 type supply units the covers of the laser (top side of the equipment) must be closed otherwise the safety circuits remains open.

12.2.1.4 Inspecting the safety circuits

It is required to inspect the safety door interface after powering up the laser system with the main switch. This inspection can be done in two ways:

- Open the safety doors prior to powering up the laser equipment and close the doors after the start-up procedure.
- Close the safety doors and power up the equipment. After the start-up procedure, open the safety doors and close them.



1 Safety door closed

2 Safety contact closed

3 Safety door open

4 Safety contact open

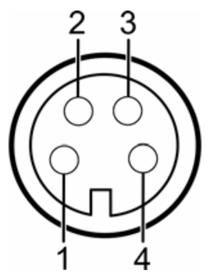
Fig. 127: Principle of the safety door circuit

- The upper illustration in the figure shows the safety door circuit in the closed state. The shutter can be opened and laser power can be directed to the processing room.
- The lower illustration in the figure shows the safety door circuit in the opened state. The shutter cannot be opened and laser power cannot be directed to the processing room. Laser radiation is directed into an absorber.

12.2.1.5 Interface Beam Switch Unit (safety circuit)

Every laser cell must be connected with the safety module of the corresponding beam outlet. This has to be done via the interface “safety door” (see chapter “7.7.2 page 7-19 ”). The safety door interface on the X3A connecter is disabled.

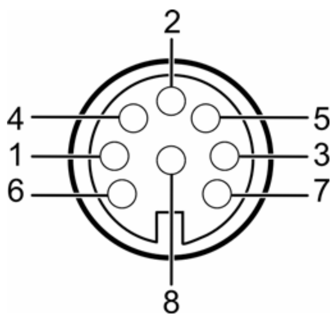
12.2.2 Interface (four pins)



Female connector, 4pin

Pin	Signal	Type	Imax
1	Safety Circuit 1/2	Input	--
2	Safety Circuit 1/1	Output	--
3	Safety Circuit 2/2	Input	--
4	Safety Circuit 2/1	Output	--

12.2.3 Interface (eight pins)



Female connector, 8pin.

Pin	Signal	Type	Imax
1	Safety Circuit 1/2	Input	--
2	Safety Circuit 1/1	Output	--
3	Safety Circuit 2/2	Input	--
4	Safety Circuit 2/1	Output	--
5	Beam outlet open	Input (potential free)	500mA
6	Beam outlet open	Output (potential free)	500mA
7	Beam outlet closed	Input(potential free)	500mA
8	Beam outlet closed	Output (potential free)	500mA

12.2.3.1 Example circuit diagram safety door

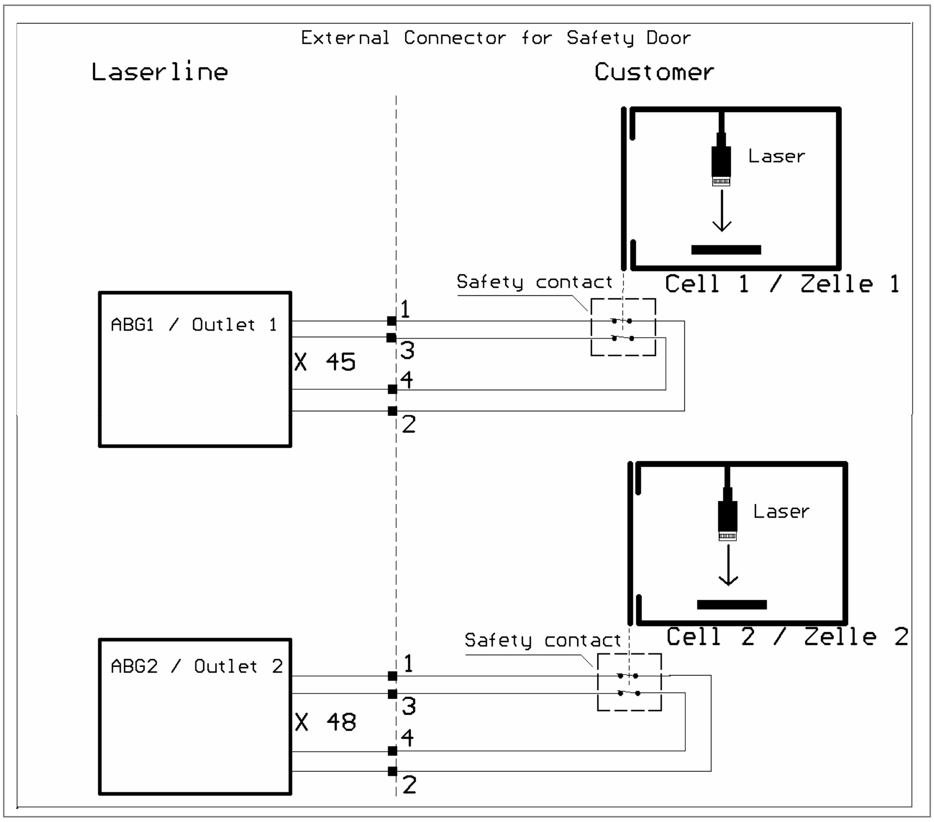


Fig. 128: Circuit Diagram Safety Door (beam switch)

The preconditions for closing the safety circuit are as follows:

- X45/48:1 and X45/48:2 connected electrically via a galvanically separated normal open contact.
- X45/48:3 and X45/48:4 connected electrically via a galvanically separated normal open contact.

Note – Connection

Use cable with the following characteristics: 8 x 0.5mm^2. If other cable is used I might not fit into the guide clamp

12.2.4 E-Stop circuit (ECT)

It is only possible to operate the laser system with a double loop emergency stop circuit. An interruption of the ECT-circuit immediately switches off the coolant pump and the power circuits. The laser system generates an error message on the control panel.

The E-Stop circuit must remain open (interrupted) during 30 seconds. It can be closed after this delay and the error message can be acknowledged. If this delay is not met, an error of the coolant pump frequency converter occurs.

Information – E-Stop circuit

The synchronization of both circuits is monitored. No validation occurs when one of the circuits has a delay. Both circuits must be opened and closed again at the same time.

DANGER

A wrong connection of the emergency stop circuit may lead to ineffective EMO buttons. In this case the laser system will not deactivate when pressing an EMO button and create a situation which could provoke death or serious injury.

- The connection of the emergency stop circuit can only be carried out by a specialized electrician.
- All components of the E-Stop circuit have to be carefully controlled prior to the first-time start-up.
- The emergency stop function must be checked periodically.

12.2.4.1 X3A-Interface

Terminal No.			Terminal No.		
(1)	Not used		(17)	ECT1 PIN4 (+24 V)	Output
(2)	Not used		(18)	ECT2 PIN4 (0 V)	Output
(3)	Not used		(19)	ECT1 PIN1 (key VG)	Input
(4)	Not used		(20)	ECT2 PIN1 (key VG)	Input
(5)	ECT1 PIN2 (key VG)	Output	(21)	Not used	
(6)	ECT2 PIN2 (key VG)	Output	(22)	Not used	
(7)	Not used		(23)	Not used	
(8)	Not used		(24)	Not used	
(9)	Not used		(25)	Not used	
(10)	Not used		(26)	Not used	
(11)	Not used		(27)	Not used	
(12)	Not used		(28)	Not used	
(13)	ECT1 PIN3 (+A1)	Input	(29)	Not used	
(14)	ECT2 PIN3 (-A2)	Input	(30)	Not used	
(15)	Not used		(31)	Not used	
(16)	Not used		(32)	Not used	

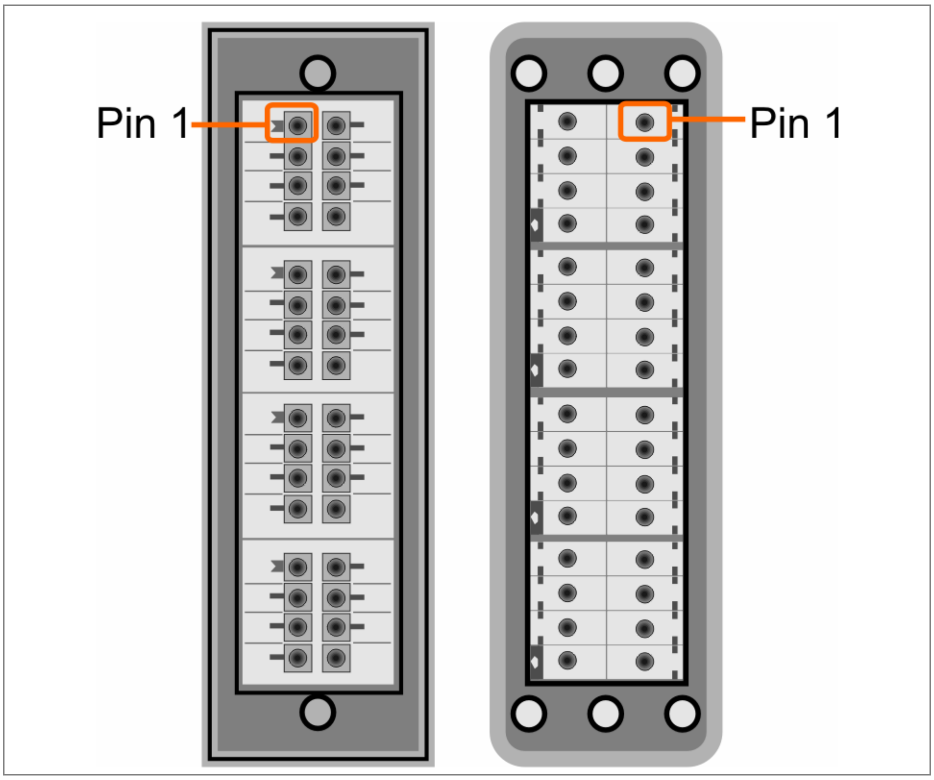


Fig. 129: X3 plug (customer) and socket (VG)

Please Note

Tighten the X3-plugs using both fastening screws, as a loose fit could cause contact problems.

Connector	Phoenix PlusCon-VC Variocon 32. Pol.

12.2.4.2 Examples of E-Stop circuit connections

External E-Stop button within the E-Stop circuit of the laser system

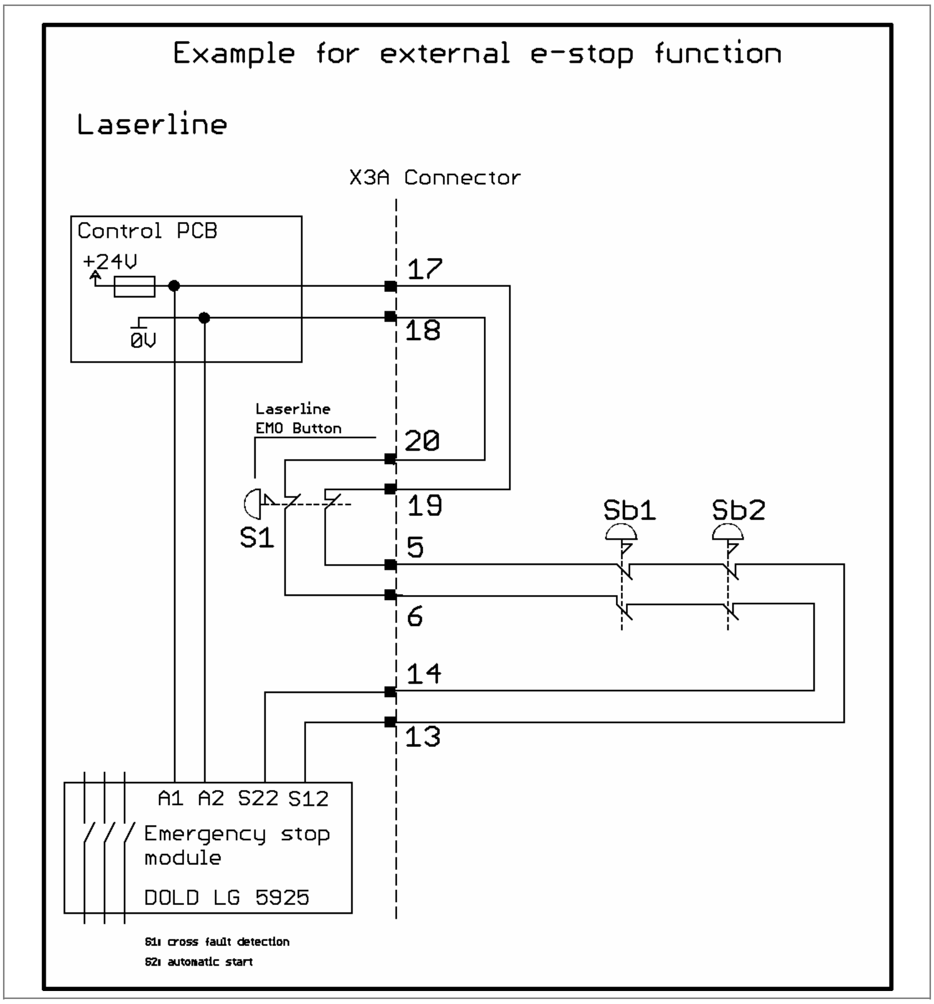


Fig. 130: Example of E-Stop circuit connection

The E-Stop circuit is broken when S1 of the laser system or the external Sb1 / Sb2 buttons are operated.

E-Stop button of the laser system within the E-Stop circuit

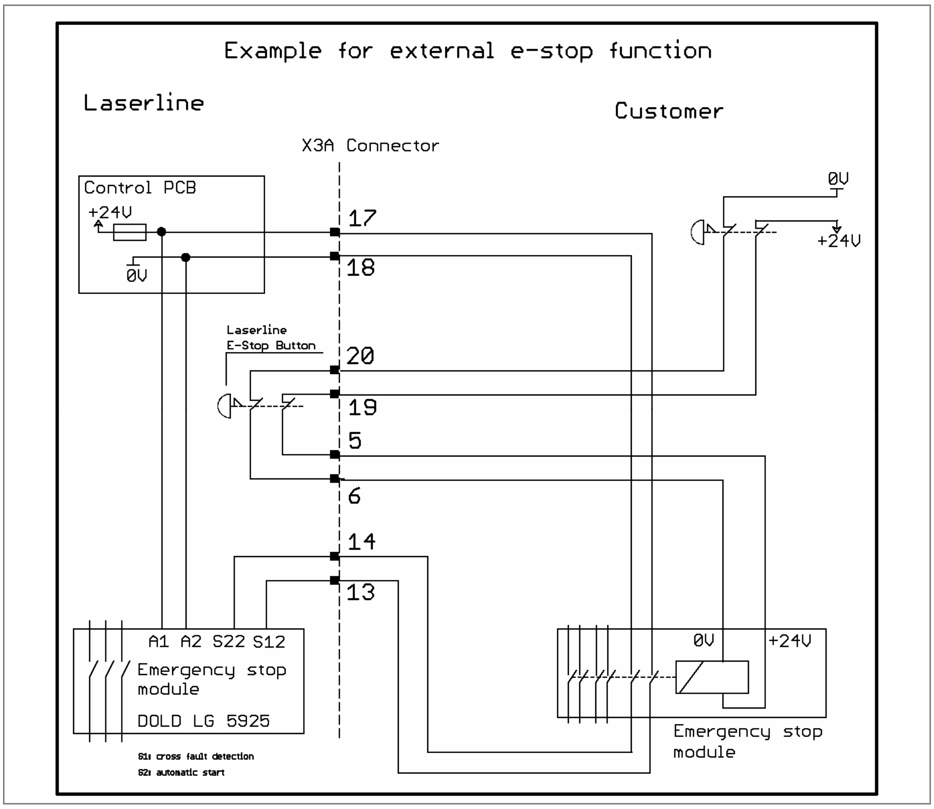


Fig. 131: Wiring diagram of the E-Stop circuit (possible arrangement)

In order to close the E-Stop circuit, the contacts X3A.17 and X3A.13, X3A.18 and X3A.14 are electrically interconnected by the safety contacts of the external (from the client side) E-Stop safety module.

The E-Stop button of the laser system is integrated in the client E-Stop circuit through the contacts X3A.5, X3A.6, X3A.19, X3A.20.

12.3 PIN Assignment of Interface X3B

Terminal No.			Terminal No.		
(1)	Group failure	Output	(17)	+24V VG	Output
(2)	Laser ready signal	Output	(18)	GND	GND
(3)	Laser active signal	Output	(19)	Error reset	Input
(4)	Pilot active signal	Output	(20)	Laser ready	Input
(5)	SET A 1	Output	(21)	Program start / stop	Input
(6)	SET A2	Output	(22)	Pilot laser on/off	Input
(7)	Reserved	Output	(23)	WAIT 1	Input
(8)	Program active signal	Output	(24)	WAIT 2	Input
(9)	Reserved		(25)	Scanner start	Input
(10)	Shutter opened	Output	(26)	Scanner stop	Input
(11)	Shutter closed	Output	(27)	Reserved	
(12)	Safety door closed	Output	(28)	Reserved	
(13)	Scanner ready	Output	(29)	Current circuit 1	Output
(14)	Power preset	Input	(30)	Current circuit 2	Output
(15)	Temperature setting	Input	(31)	Coolant temperature	Output
(16)	GND	GND	(32)	GND	GND

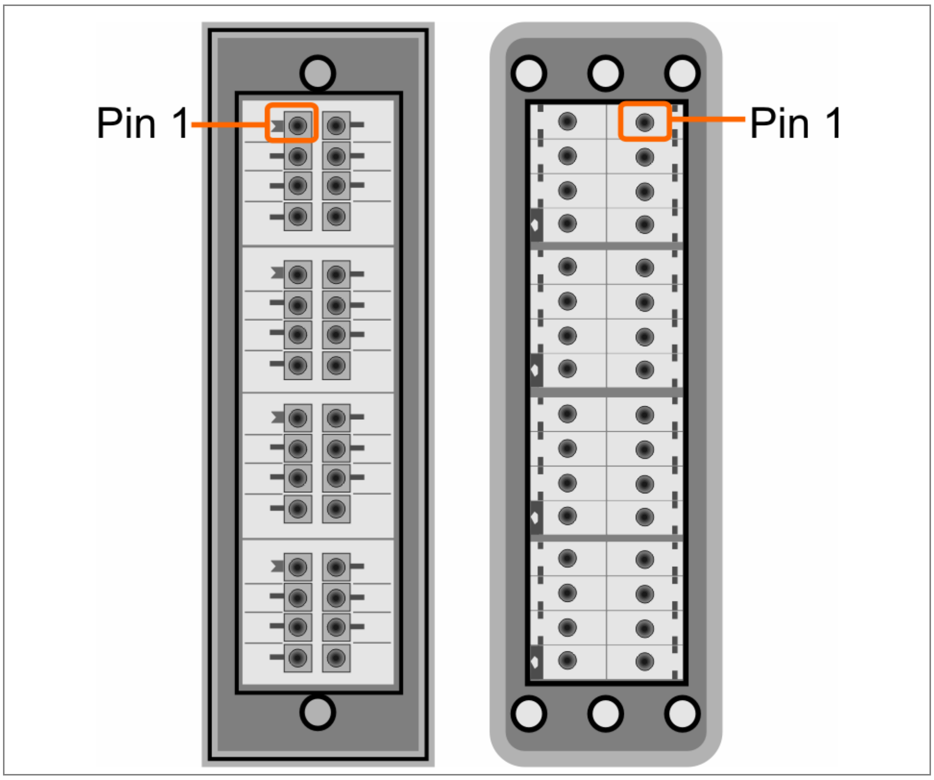


Fig. 132: X3 plug (customer) and socket (VG)

Please Note

Tighten the X3-plugs using both fastening screws, as a loose fit could cause contact problems.

Connector	Phoenix PlusCon-VC Variocon 32. Pol.

12.3.1 Digital Inputs

Error reset	
With ERROR RESET a pending failure message from the laser system can be set back. Depending on the kind of error this is only possible once, and the pending failure must have been removed first.	X3B:19 (Error reset) must be connected with +24 V via button function. The signal status is evaluated. A change from LOW to HIGH results in the set back of a probable pending failure message of the laser system.

Laser ready	
With LASER READY the diode laser system is put to the status READY. (Rapid Input)	X3B:20 (Laser ready) must be connected with +24 V via button function. The signal edge is evaluated. A change from LOW to HIGH results in the status READY of the diode laser system. A change from HIGH to LOW takes back the status READY of the diode laser system. If, for example, the status READY was taken back by a failure, the system can only be transferred back to READY, if a rising slope has been recognized. If the system is READY, the Laser ready signal has been set (see also DIGITAL OUTPUTS).

Program start / stop	
The PROGRAM START / STOP, starts or stops a laser program. (Rapid input)	X3B:21 (Program Start/Stop) must be connected via a button (switch) function with +24 V. Program start reacts on a rising edge signal. Program stop reacts on the signal status. A change from LOW to HIGH results in program start. If the signal state changes to LOW the program is stopped. Minimum delay time between two (or more) program start sequences is 350 ms. Otherwise errors in the laser's reaction are possible. Do not use mechanical contacts. PROGRAM START / STOP refer to the starting and stopping of a laser program in the PRG mode (see chapter PRG-Mode). The operation modes CW, SP and EXT concerns programs, however, that are firmly programmed into the laser control. Therefore, these modes are also started or stopped using PROGRAM START / STOP. If the system is equipped with a shutter (optional), it is opened at a setting of +24 V and closed at 0 V (only in CW, SP and EXT-modes). As soon as a program is active and therefore laser power can be released, the “Program active signal“ is set, (see digital outputs).

Pilot laser On / Off	
PILOT LASER ON/OFF Either switches the LED mode or alignment laser ON or OFF. Which laser is activated depends on the pre-setting in the console. (slow input)	X3B:22 (Pilot laser On/Off) must be connected via a button (switch) function with +24 V. The signal status is evaluated. +24 V => Pilot ON Open contact => Pilot OFF If the pilot of alignment laser is switched on, the “Pilot active signal„ is set (see digital outputs).

WAIT 1 + WAIT 2 (Program Mode)	
The WAIT inputs are only interrogated by the program mode. (Rapid Inputs)	X3B 23, 24 (WAIT) fulfils the condition TRUE (1), if there is a 24 V level. If there is a 0 V level, the condition FALSE (2) is fulfilled. With a WAIT input an operation can be triggered, provoking a certain reaction from the program mode. For further information please read chapter “Prog. Operation“.

Scanner start (only Scan Systems)	
With SCANNER START the scan program is started.	X3B:25 (Scanner start) must be connected with +24 V via button function. The signal status is evaluated. A change from LOW to HIGH results in the start of the selected scan program.

Scanner stop (only Scan Systems)	
With SCANNER STOP the scan program is switched off.	X3B:26 (Scanner stop) must be connected with +24 V via button function. The signal status is evaluated. A change from LOW to HIGH results in the stop of the selected scan program.

12.3.2 Digital Outputs

Please Note

The maximum current capacity of these outputs is **500 mA!**

Group failure	
With the GROUP FAILURE a failure of the laser system is announced.	X3B:1 (Group failure) must be connected with the ground wire via message relay. If a diode laser failure occurs, the signalling unit is activated. For integration in a process the signal can also be called up via a PLC / control PC.

Laser ready signal	
With LASER READY SIGNAL the diode laser READY mode is being monitored.	X3B:2 (Laser ready signal) can be connected via a signalling unit (control lamp) to a grounding unit. If the diode laser is in READY mode, the signalling unit is activated. For integration in a process the signal can also be called up via a PLC / control PC.

Laser active signal	
LASER ACTIVE SIGNAL indicates that the laser is active. (Rapid Output)	X3B:3 (Laser active signal) can be connected via a signalling unit (control lamp) to a grounding unit. The signalling unit is activated when: • Pilot / Alignment Laser is on • Stack test is in progress • Laser is on For integration in a process the signal can also be called up via a PLC / control PC.

Pilot active signal	
PILOT ACTIVE SIGNAL is set as soon as the LED mode or alignment laser is active	X3B:4 (Pilot active signal) can be connected via a signalling unit (control lamp) with grounding. After switching on the alignment or LED mode, the signalling unit is activated. For integration in a process the signal can also be called up via a PLC / control PC.

Program active signal	
PROGRAM_ACTIVE_ SIGNAL is set as soon as a laser program has been run.	X3B:8 (Program active signal) can be connected via a signalling unit (control lamp) to a grounding device. The signalling unit is activated as soon as a laser program is active, and laser power can be emitted. The signalling unit is **not** illuminated if the Pilot-/Alignment laser are on or a stack test is active. The PROGRAM_ACTIVE_SIGNAL refers to a laser program in PRG-Mode (see chapter PRG-Mode). In the case of operation modes CW, SP and EXT, it also concerns programs that are, however, firmly programmed in the laser control unit. Therefore, these modes also set the signal as soon as the laser power can be emitted.

SET A1 + SET A2 (Program Mode)	
The SET outputs are only set by the program mode. (Rapid outputs)	X3B.5, 6 (SET A1 and A2) become TRUE (24 V), if they are set as message display by the program mode for example. If they are set back, the level changes to 0 V (LOW). With a SET output an external operation can be triggered, which can be set equivalently by the program mode. For further information please read chapter “Prog. Operation“.

Shutter opened	
Using "SHUTTER OPENED" (shutter open) indicates whether an optionally equipped shutter is open.	X3B:10 (Shutter opened) can be via a signalling unit (control lamp) connected with a grounding system. As soon as the shutter has been opened, the signalling unit is activated. For integration in a process the signal can also be called up via a PLC / control PC.

Shutter closed	
Using "SHUTTER CLOSED" (shutter closed) indicates that an optionally equipped shutter is closed.	X3B:11 (Shutter closed) can, via a signalling unit (control lamp), be connected with a grounding device. As soon as the shutter is closed, thesignalling device is activated. For integration in a process, the signal can also be called up via a PLC / control PC.

Safety doors closed	
When "SAFETY DOORS CLOSED" (protective doors) is indicated, it means that the protective doors of the processing room for the laser control a rede-tect ably closed.	X3B:12 (Safety doors closed) can, via a signalling unit (control lamp), be connected to a grounding device. As soon as the protective doors are closed, the signalling unit is activated. For integration in a process the signal can also be called up via a PLC / control PC.

Scanner ready (only Scan Systems)	
Using the SCANNER READY SIGNAL, the READY status of the scanning system can be monitored.	X3B:13 (Scanner ready) can be via a signalling unit (control lamp) connected with a grounding system. The signalling unit is activated when the scanner has changed to the READY status. For integration in a process the signal can also be called up via a PLC / control PC.

12.3.3 Analogue Input

The analogue input serves to control the diode laser.

Power preset	
With power preset the diode laser power is set by external control. (Rapid input)	Example: X3B:14 is provided with a voltage of 0 – 10 V against X3B:16 (0 V). The voltage value 0 – 10 V is equivalent to an emitted power of 0 – 100 %.

Temperature setting (optional)	
Using TEMPERATURE SETTING, the temperature of the coolant can be pre-set within a defined temperature range.	The temperature can be pre-set within the range of 15°C to 33°C. X3B:15 (TEMPERATURE SETTING) is activated with a current from 0 – 10 V against X3B:16 (0 V).

12.3.4 Analogue Outputs

Current circuit 1 / Power circuit 2	
Using „CURRENT CIRCUIT 1 and CURRENT CIRCUIT 2“, the diode laser current of circuit 1 and 2 (if equipped) can be monitored.	X3B:29 and 30 (Current circuit 1 and 2) can be, against X3B:32 (GND) connected via a monitoring unit (e.g. Voltmeter) connected together. An output voltage of 0 – 10 V corresponds to a diode current of 0 – 110A. For integration in a process the signal can also be called up via a PLC / control PC. The laser power can be taken from the current/power diagram which is delivered with the laser.

Coolant temperature (optional)	
With COOLANT TEMPERATURE, the current coolant temperature can be indicated	X3B:31 can be against X3B:32 (GND) via a monitoring unit (e.g. Voltmeter) connected together. An output voltage of 0 – 10 V corresponds to a temperature of 33°C to 15°C. For integration in a process the signal can also be called up via a PLC / control PC.

12.4 Ethernet-Interface

The Ethernet interface allows to connect the laser system to a LAN (Local Area Network). Via optional software the laser can then be controlled and monitored from an external PC.

13 TELESERVICE

There are two ways to access the teleservice:

- ISDN adapter / analogue modem in the beam source, with direct connection to Laserline through the phone network.
- Network interface in the beam source via the Internet through a VPN connection to the Laserline VPN server.

13.1 Direct connection through the phone network

For the teleservice purposes, the Laserline Service establishes a direct connection within the beam source (ISDN adapter or modem) via modem or ISDN adapter.

The beam source must be connected to an analogue or ISDN line and the Laserline Service must know the related phone number. Usually, a direct connection can be implemented easily (telephone line) and will meet all the teleservice requirements. Only the option „Service camera“ will request a larger bandwidth (only available with teleservice via the Internet).

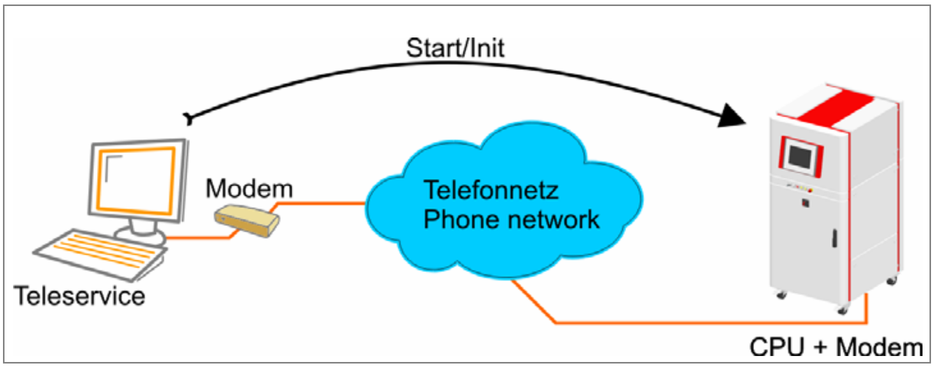


Fig. 133: Principle of a direct connection

13.2 Internet connection via VPN

The beam sources (from version 1.8 of the LL-Control Software) have the necessary software to build up a VPN connection with the VPN server of Laserline. Contrary to a teleservice via a direct connection, this method builds up a connection to de VPN server of Laserline through the beam source (customer). The advantage of this method is that the customer's firewall does not need to accept an incoming call for the purpose of the teleservice. Only an outgoing connection via port 1193:UDP has to be authorized in the firewall.

The software builds up a VPN connection to the VPN server of Laserline via the Internet access (e.g. DSL). The encrypted teleservice communication is established with Laserline through the so called VPN tunnel

A VPN connection via modem is not supported.

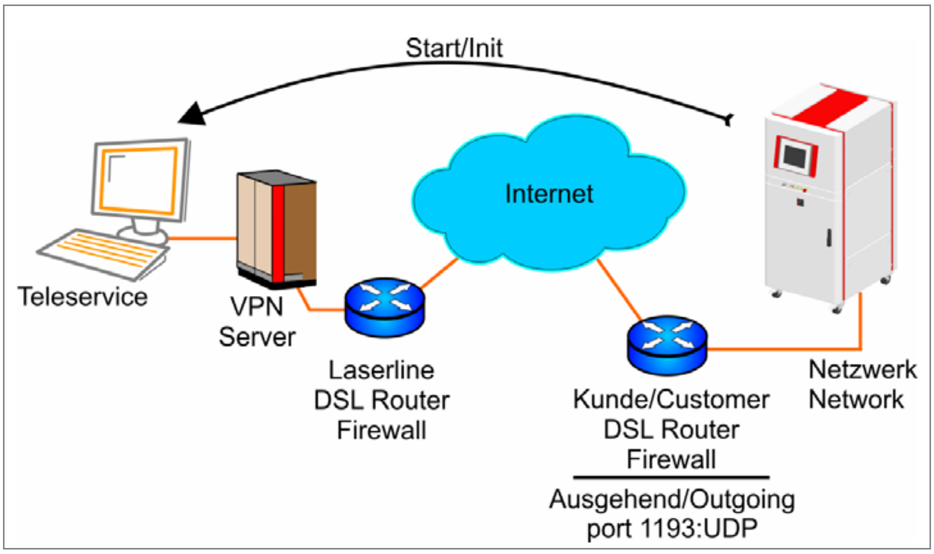


Fig. 134: Principle of the teleservice via the Internet 1

13.2.1 Proxy

Additionally, access to the Internet is supported by a web proxy. The access data of the web proxy are entered in the console of the beam source. The settings of the customer's web proxy must authorize the access to vpn.laserline.de.

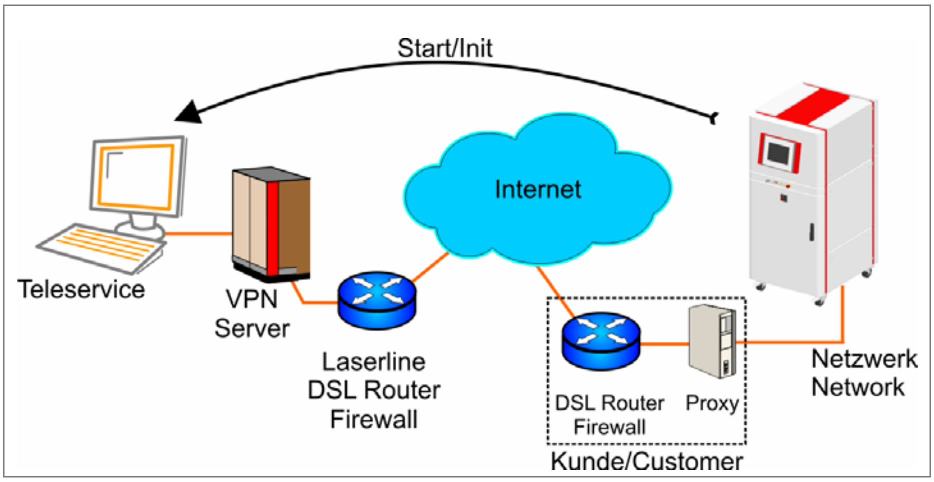


Fig. 135: Principle of the teleservice via the Internet 2

13.3 Glossary

13.3.1 VPN

Short for Virtual Private Network, a network that is constructed by using public lines to connect computers (partners). Most VPN implementations use the Internet as the public infrastructure for transporting data and a variety of specialized protocols to support private communications through the Internet utilizing a technique called tunnelling. These systems use encryption and other security mechanisms to ensure that only authorized users can access the network and that the data cannot be intercepted.

13.3.2 Firewall

A system designed to prevent unauthorized access to or from a private network. Firewalls can be implemented in both hardware and software, or a combination of both. Firewalls are frequently used to prevent unauthorized Internet users from accessing private networks connected to the Internet, especially intranets. All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.

13.3.3 Router

A network device that forwards packets from one network to another. Based on internal routing tables, routers read each incoming packet and decide how to forward it. The destination address in the packets determines which line (interface) outgoing packets are directed to.

13.3.4 Proxy

In computer networks, a proxy server is a server (a computer system or an application program) that acts as a go-between for requests from clients seeking resources from other servers. A client connects to the proxy server, requesting some service, such as a file, connection, web page, or other resource, available from a different server. The proxy server evaluates the request according to its filtering rules.

14 TECHNICAL APPENDIX

14.1 Laser Power Diagram

14.2 Laser Spot Diagram

14.3 Technical Drawings Laser Head / Laser Optic

14.4 Laser classes

14.5 Circuit Diagrams

15 MANUAL LASER LIGHT CABLE

16 INDEX