



Desktop POWER Laser

Instructions for use



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1. General Information

The laser equipment described in this manual (generally referred to below as the device) complies with the relevant EU directives for such equipment.



1.1. Contact information

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1.2. Marking

This manual belongs to the following product:

Model series: Desktop Power Laser
 Order number 090-576-00
 Company name DENTAURUM J.P. Winkelstroeter KG
 Year of manufacture: 2003



Desktop PL	100100338/4	50006140	
TYPE	SAP	EQUPM-NR.	
ND:YAG	1064 nm	30 W	50 J
Medium MEDIUM	Wellenlänge WAVE LENGTH	Laserleistung LASER POWER	Laserenergie LASER ENERGY
09/2003	80 kg	P 22	10 A
Monat/Jahr MONTH/YEAR	Gewicht WEIGHT	Schutzart PROTECTION	Abzählung FUSE PROTECTION
1P+N+PE	230 V	50/60 Hz	1.3 kW
Netzart LINE SUPPLY	Spannung VOLTAGE	Frequenz FREQUENCY	Leistung POWER
8.9 A			8.9 A
L1	L2	L3	N
Anschlusswerte bei Vollast MAXIMUM POWER CONSUMPTION			

Figure 1.1: Type plate (example)

1.3. Important Safety Information

Only skilled workers with appropriate safety training may be permitted to operate this laser equipment.



Caution!

This laser equipment is a dangerous device (class 4 laser). The high-power laser emits dangerous invisible radiation. In all activities with direct access to the laser beam: there is a danger of burning the eyes and skin. Scattered radiation is also dangerous. Always be extremely careful!

Wear proper eye protection when there is open access to the laser beam!

Caution! Dangerous exposure to radiation may result if you use different operating or adjustment equipment or adopt different procedures to those specified in this document.



Caution! Laser radiation!

This high-power laser uses dangerous high voltages. **Only** our service technicians or properly trained personnel are allowed to carry out repairs on the laser.

If you are working on electrical or electronic components:

- Check for live equipment
- Implement all safety measures;
- Follow the safety regulations.



**High voltage!
Danger!**

1.4. Information on proper and improper use

1.4.1. Proper Use

The Desktop Power Laser is designed exclusively for welding metals and metal alloys. To use it for any other purpose or for anything beyond this is to use it improperly. Dentaurum, J.P. Winkelstroeter KG does not accept any liability for any damages resulting from improper use. Proper use also includes:

- following all the instructions and heeding all the information in this manual and
- the compliance of all necessary inspection and maintenance intervals.

1.4.2. Improper Use

The laser radiation produced by this laser device is capable of melting, burning or vaporizing almost any material. Depending on the composition of the workpiece, gases and vapors dangerous to health may be produced.



Attention!

Using this device on non-metallic materials, especially plastics, therefore constitutes improper use.

1.5. Working Area

The design of this device enables the operator to reach all the control elements easily from a sitting position.



Attention!

Before switching on the device you should adopt a sitting position that allows you to work in a relaxed manner. In particular, the freely movable pedal switch must be in a good position to prevent unintentional release of a laser pulse.

1.6. Warranty and Liability

Our general terms and conditions of sale and delivery apply. These are made available to the customer on completion of the contract, at the latest. Warranty and liability claims in the event of physical injury or damage to property are invalid if they are caused by one or more of the following:

- Improper use of the device;
- improper installation, putting into operation, operating and maintenance of the device;
- Operating the device with safety and protective facilities that are defective, improperly installed or inoperative;
- Failure to heed the information in this manual concerning the transport, storage, installation, putting into operation, operation and service and maintenance of this device;
- Unauthorized structural modifications to this device;
- Inadequate monitoring/checking of parts of the device that are subject to wear;
- Improperly performed repairs;
- Catastrophes caused by alien elements or force majeure.

1.7. Information on the Operating Instructions

These operating instructions contain all the information that, according to the valid regulations, is necessary for **safe** operation of the described device.

In addition to general information on the safety regulations that ensure safe operation of the device provided it is used properly, the operating instructions also contain **information on other dangers** that cannot be eliminated either by design or by structural means. This information is marked in the manual (see the following section entitled EXPLANATION OF THE SYMBOLS USED IN THE MANUAL on page 1-6).



Only those who have read and understood these operating instructions are permitted to work with this device.

1.7.1. Explanation of the symbols used in the manual

The following symbols and labels indicating danger are used in these operating instructions:



Caution!

Indicates a possible threat to life and health.

Failure to heed this can cause serious damage to health and even critical injuries.



Attention!

Indicates a possibly dangerous situation .

Failure to heed this can cause minor injuries or damage to property.



This symbol draws your attention to important information on the correct use of the device.

Failure to heed this information can cause malfunctions/problems in or around the device.



This symbol draws your attention to **operating tips** and particularly useful information that will help you use **all the functions** of your device to the **best effect**. It will help you use **all the functions** of your device to the **best effect**.

2. Safety information

2.1. Fundamental Safety Information

2.1.1. Information on the Operating Instructions

- Knowledge of the safety information and the safety regulations is the prerequisite for safe and trouble-free operation of this device.
- This manual contains important information on the safe operation of the device.
- These operating instructions - especially the safety information - must be followed by all those who work with the device.
- Moreover, all regulations for accident prevention valid for the current place of installation must be complied with, especially the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825).

2.1.2. Obligations of the Employer

The employer undertakes not to allow anyone to work with this device unless they

- are familiar with the basic regulations concerning safety at work and accident prevention and have been instructed in the use of this device;
- have read and understood the chapter concerning safety and the warnings in this manual and have confirmed this by their signature;
- have been instructed as to the dangerous effects of laser radiation in accordance with the valid regulations (BGV B2 (VBG 93)) about accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825).

Operating personnel are to receive instruction at regular intervals.

2.1.3. Obligations of Personnel

All those who work with the device must undertake beforehand to

- comply with the basic regulations on safety at work and accident prevention for laser radiation, BGV B2 (VBG 93), or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825);
- to read the chapter concerning safety and the warnings in this manual and to confirm this by their signature.

2.1.4. Dangers when Working with the Device

The Desktop Power Laser is designed according to the state of the art and meets the approved safety regulations. Nevertheless its use can still endanger life and limb (of the user or third parties) or damage the device or other material assets. The device is only to be used

- for the intended purpose (see the information on proper use) and
- in perfect condition from the point of view of safety.

Malfunctions that may have negative consequences for safety must be dealt with immediately.

2.1.5. Organizational Measures

- The employer must provide the necessary personal safety equipment (in this case **eye protection is required only for maintenance purposes when there is direct access to the laser beam**).
- The special requirements of the BGV B2 (VBG 93) accident prevention regulations for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) have to be fulfilled (see the section entitled GENERAL SAFETY INFORMATION ON LASER EQUIPMENT on page 2-5).

2.1.6. Protective Devices

- Whenever the laser device is used all safety mechanisms have to be checked for correct mounting and function.
- Safety mechanisms may only be removed when the laser device has been switched off and measures have been taken to prevent it from being restarted.

2.1.7. Informal Safety Measures

- The operating instructions must always be kept at the installation site.
- In addition to the operating instructions, the generally valid regulations as well as the local ones on accident prevention and environmental protection must be complied with, especially the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825).
- All safety information and warnings attached to the device must be kept in readable condition (see the section entitled LABELING on page 2-13).

2.1.8. Personnel Training

- Only personnel properly trained and instructed about the dangers of laser radiation as required by the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) are allowed to work with the device (see page 2-1).
- Trainees are only allowed to work with this device under the supervision of someone who is an experienced user.

2.1.9. Safety Measures for Normal Use

- Only use the device if all safety mechanisms are properly functioning.
- Check the device at least once a week for visible external damage and for the proper functioning of the safety mechanisms (e.g. defective protective glasses or interlock circuits).

2.1.10. Danger of electric shock

- Only authorized service engineers may work on the electrical supply.
- The device must always remain closed. Only authorized personnel using the appropriate tools are allowed to open the device.
- If any work has to be carried out on voltage-carrying parts, a second person must be there who can switch the device off at the power switch, if necessary (see the section entitled NOTES ON MAINTENANCE on page 2-11).

2.1.11. Particularly dangerous points

- Particularly dangerous points must be labeled as such. The various warning labels and their location on the device are described in the section entitled LABELING on page 2-13.
- There is increased danger when the welding chamber is open and the interlock switches are simultaneously bridged.
- Above all, never trigger a laser pulse while your hands or fingers are positioned directly in or under the crosshair of the stereo microscope.

2.1.12. Emission of noxious gases and vapors

- When working with metals or metal alloys that may release substances that are damaging to the health when heated or through vaporization, an external extraction and filter unit must be connected (see the section entitled EXHAUSTER on page 3-9).
- The laser radiation produced by this laser device is capable of melting, burning or vaporizing almost any material. Depending on the composition of the work piece, gases and vapors dangerous to health may be produced.

Do not use this device on non-metallic materials, especially plastics (see page 1-4).

2.1.13. Maintenance and service, fault clearance

- Stipulated maintenance activities have to be carried out on schedule (see pages 7-2 ff).
- Before all maintenance activities, pull out the mains plug.
- Make sure that all screws are properly tightened again when the laser is reassembled.
- After having completed maintenance activities, check that all safety devices are operating correctly.

2.1.14. Structural modifications to the laser device

- Do not make any modifications or additions to the laser device without the permission of the manufacturer.
- All structural modifications require the written approval of Dentaurum, J.P. Winkelstroeter KG.
- Replace all parts that are not in perfect condition immediately.
- Only use original replacement and wearing parts (see page 7-1)
- There is no guarantee that parts purchased from companies other than Dentaurum, J.P. Winkelstroeter KG will meet the stipulated requirements as regards safety and performance.

2.1.15. Cleaning the Laser Device and Disposal of Waste

Ensure the proper handling and disposal of substances and materials (filters, solvents for cleaning).

2.2. General Safety Information on Laser Equipment

2.2.1. General Information

This laser device is a class 4 laser.

It is a neodym-YAG solid-state laser with a high optical output power. This invisible laser radiation has a wavelength of 1064 nm (near infrared range). The visible secondary radiation can cause dazzle if the eyes are exposed to it for any length of time.



Caution!

The laser radiation generated by this device is not visible to the human eye due to the wavelength involved.

The eye is particularly endangered by this infrared (invisible) laser radiation, because its effect is multiplied by the eye lens and focused on the retina. The high radiation intensity on the retina causes extreme local heating and burns the tissue of the retina. This results in reduction or even loss of eyesight. Therefore, when working with direct access to the laser beam (maintenance, repair), always:



Wear proper laser protective goggles!

Always follow the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) when working with the laser equipment.



Note:

If a modification by the user affects any aspect of the performance data or intended functioning, as described in the relevant standards, of a previously classified laser device, the person or organization that undertook the modification is responsible for obtaining a new classification and new labeling for the device. This person or organization then assumes the status of "manufacturer".

2.2.2. Dangers to the Eyes and Skin

Danger exists through:

- direct radiation
- reflected radiation
- diffuse scattered radiation.

The mandatory protective goggles (order no. 090-512-00) provide protection against direct, reflected and scattered radiation. But even if you are wearing protective goggles, never look directly at the beam. Intense laser radiation is capable of destroying the protective filter.

If adjustment or maintenance work on the class 4 laser equipment is necessary, **all** persons in the laser area must wear appropriate protective goggles.

These goggles must meet the safety requirements for the relevant laser output power. The interlock switches can be bypassed by our service technicians or authorized specialists only for adjustment or maintenance activities.

Although the skin can withstand a considerably higher radiation intensity than the eye tissue, the tissue is destroyed by burning. The extent to which this happens depends on the time of exposure to and the intensity of the irradiation. Appropriate protective clothing should be worn to protect the skin whenever necessary.

If laser injury or suspected laser injury has occurred, immediately

- switch off the laser,
- inform your laser safety officer and safety specialist,
- consult a doctor or go to the hospital.



Danger of Fire!

Attention!

Because of the high output power of a class 4 laser, a wide range of material can be set on fire. Appropriate fire prevention measures must therefore be taken when the path of the beam is open.

Paper (circuit diagrams, leaflets or even posters on the wall), curtains that are not impregnated with fire retardants, thin wooden panels or similar materials can be easily set on fire by direct or reflected laser radiation.

Moreover, containers holding flammable or explosive cleaning agents (e.g. used for maintenance) should be kept away from areas exposed to the laser beam.

When using solvents or cleaning agents, you must always heed the relevant warnings.

Major fires and explosions can quickly result if such containers are accidentally exposed to and destroyed by the intense invisible laser beam.

2.2.3. Operating Laser Equipment in Accordance with Accident Prevention Regulations

All accident prevention regulations, especially the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) must be complied with. In Germany, the first time laser equipment is put into operation, the relevant health and safety authorities must be informed immediately in writing.

That only requires an informal writing where you should enclose a copy of the CE declaration of conformity and the document of compliance.

It is recommendable to use the laser application form enclosed in this manual.

2.2.4. Laser Safety Officer

When class 4 laser equipment is installed, a competent laser safety officer must be appointed in writing by the employer. **In the case of class 1 laser equipment, a laser safety officer need only be present when the operator is carrying out maintenance or service activities on the laser equipment with direct access to the laser beam.**

This assumes that the operator bypasses the interlock switches or activates the keylock switch to bypass the interlock switch.

Thanks to his specialist training and experience in the field of laser radiation, the laser safety officer should fully understand the safety procedures and equipment used. The laser safety officer bears full responsibility for the safe operation of the laser equipment and the correct implementation of mandatory safety measures.

The laser safety officer will receive appropriate training from Dentaurum, J.P. Winkelstroeter KG or an approved body (e.g. an institution providing social insurance against occupational accidents).



Please note:

- This laser device may only be used for the intended purpose.
- Never aim the laser beam at humans or animals.
- Any person involved in the operation, maintenance or repair of the laser device must have read and understood the operating and safety instructions for the laser equipment.

2.3. Specific Safety Information

2.3.1. Information on Operating the laser

This laser device is a class 4 laser. However, when the device is used as intended, this classification is restricted only to possible damage to the skin of the operator's hands caused by incorrect operation or during service work on the laser (see the section entitled NOTES ON MAINTENANCE further below 2-11).

As far as eye protection is concerned, this device fulfills the requirements that apply to a class 1 laser device for the absolute safety of the operator and anyone else in the laser working zone (i.e. it is officially recognized as being safe).

When the laser is used as intended, no other safety measures are required.

The laser is not ready for operation until the operator has put both arms through the device's hand openings. In the welding chamber there are interlock switches that are activated by the arms. Both interlock switches have to be activated to make the system ready for operation.

The operator can position the work piece manually in the device.

The best position can be determined using microscope. The operator's eyes are protected against laser radiation by special protective filters and a special view shutter within the microscope.

The observation window of the welding chamber also has a special laser protective window that prevents any harmful radiation escaping from the device. Moreover the ultraviolet component of the light produced in the welding flash, which is dangerous to the eye, will be absorbed. To ensure unhindered observation of the process, the window is transparent for the visible part of the light. The visible secondary radiation can cause dazzle if the eyes are exposed to it for any length of time.

Due to the thermal effect of the laser beam, secondary radiation is generated on most materials. This can be observed temporarily through the laser protective window without damaging the eyes. The laser radiation itself is restrained.



Always exercise extreme caution when working!

Attention!

The only danger is to the unprotected hands of the operator. You could inadvertently put your hands under the pulsing laser beam, thus suffering local burns to the hands or fingers. You could inadvertently put your hands under the pulsing laser beam, thus suffering local burns to the hands or fingers.



The following notes must be complied with at all times, even when the device is used as intended:

- When positioning the work piece, always ensure that both arms are placed securely in the rings of the hand openings. This ensures that the work piece can be held safely and calmly in the correct working position.
- It is imperative that you do not position your hands in the immediate vicinity of the laser beam, thus exposing your skin to it. The focus of the laser is marked by a crosshair inside the stereo microscope. Fingers and hands must not be positioned in or under the crosshair owing to the danger of burning.
- Be calm and concentrate when triggering laser pulses.
- For subsequent pulses, always use the microscope to check that the work piece is positioned correctly.
- Do not leave inflammable or explosive fluids or solids in the welding chamber.
- Avoid lengthy observation of the secondary welding radiation through the observation window. This might cause dazzle similar to those caused by lengthy unprotected observation of halogen lamps, spotlights or even the sun.



Do not wear shiny jewelry (rings, watches, bracelets). Depending on their surface properties, they may focus the scattered radiation and thus cause slight skin burns.

Attention!

2.3.2. What to do if you receive a burn

If a laser pulse has burnt your fingers or hand, you should have the wound treated. Depending on the degree of the burn, you should undergo medical treatment. Although a small burn is not particularly critical, you should still make sure that no infection results.



Scattered Radiation!

Attention!

Scattered radiation can also cause minor burns on the skin of your hand.

Depending on the material, its reflective properties and the selected pulse energy, scattered radiation can also be dangerous.

Only under very unfavorable circumstances will the scattered radiation reach intensities that can cause slight burns, because the laser pulses are very short.

Normal exposure of the skin to low levels of scattered radiation at the wavelength of 1064 nm can be regarded as physiologically safe. The infrared laser radiation acts like normal heat radiation.

2.4. Notes on Maintenance



Caution!

When performing service or maintenance activities: NEVER WORK ALONE!

A second person, who should be at least familiar with the risks posed by laser radiation and high voltages, should always be present during service and maintenance activities. In the event of an emergency, this person can turn off the laser equipment and provide first aid.



Caution!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure!

2.4.1. Working with high voltage



Caution!

HIGH VOLTAGE!

This laser device complies with all generally recognized technical standards and regulations. This includes EC directives, EN, DIN and VDE standards.

This laser is ignited and operated using dangerous high voltage (>1 kV), so special care has to be taken when working on the lamp power supply. When taking measurements on electrical or electronic components of this class 4 laser device while it is on, the required clearances have to be maintained.

You must also bear in mind that the high-voltage capacitors used to produce the ignition energy and the high operating voltages take max. 15 minutes to discharge via the discharge relay and discharge resistance after the lamp power supply has been turned off.

Always comply with the relevant safety regulations (e.g. VBG 4 or equivalent national standards) when working on electrical equipment of this kind.

While working on electrical equipment always follow the subsequent five safety rules:

- **Disconnect**
Disconnect systems, subsystems and auxiliary equipment by turning them off and disconnecting them from any power sources or live components.
- **Prevent equipment from being switched on again**
Ensure that the disconnected equipment is secured against being switched on again inadvertently (e.g. by operator error) or automatically (e.g. by vibrations). Secure the main switch with a padlock or remove the fuses. Use any mechanical locking device provided. Ensure that clear warning signs are in place while the work is being carried out.
- **Check for live equipment**
Check if the equipment is live using a voltmeter or a voltage tester. Measure the conductors against each other and against the protective ground conductor to check whether they are live.
- **Ground and then Short Circuit**
Before working on electrical or electronic components, **always ensure there is a ground connection**. Short-circuit the capacitors in low-voltage systems and devices. Short-circuit the capacitors and high-voltage lines in high-voltage systems and devices. Do not forget to remove the grounding and shorting jumpers when you have completed the work.
- **Cover and/or insulate neighboring live components**
If there is a risk of touching live components near to where you are working and it is not possible to disconnect these components from the voltage source, they must be covered with sufficiently strong and reliable insulating material, or some other method must be used to prevent direct contact. Cover with plastic sheeting/paneling or rubber matting.
Barriers (ropes or plastic chains) **must** be positioned to cordon off unprotected components (live components).

Only our service technicians or properly trained, authorized personnel may be allowed to carry out work on electrical or electronic parts of the laser equipment. These people must be informed about the dangers associated with laser radiation.



Caution!

- When working on electrical or electronic components do not wear metal chains, watches and rings.
- Lock the main (power) switch to prevent it being turned on accidentally.
- If necessary, cordon off the working area.
- Never hurry when working on the equipment.
- Post warnings at appropriate points that work of this type is being carried out.

2.4.2. Working with laser radiation



Caution!

Any activities with direct access to the laser beam (laser cover opened, safety switches bypassed and laser on) may only be carried out by authorized, properly trained service technicians!

Our service technicians are trained as laser safety officers and are therefore able to guarantee the safe operation of the laser during service and maintenance activities.

If the service technicians are working with direct access to the laser beam, the laser behaves like a class 4 laser device. This makes the whole installation site of the laser a laser area (see the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825). Adjacent areas separated only by windows belong to this laser area (this can also include areas outside the building). It is advisable to restrict the laser area to a minimum by means of protective walls or curtains.

Within the laser area, **all** persons have to wear **special laser safety goggles** suitable for the current laser wavelength or they have to leave the laser area while work is being carried out with an open laser beam.



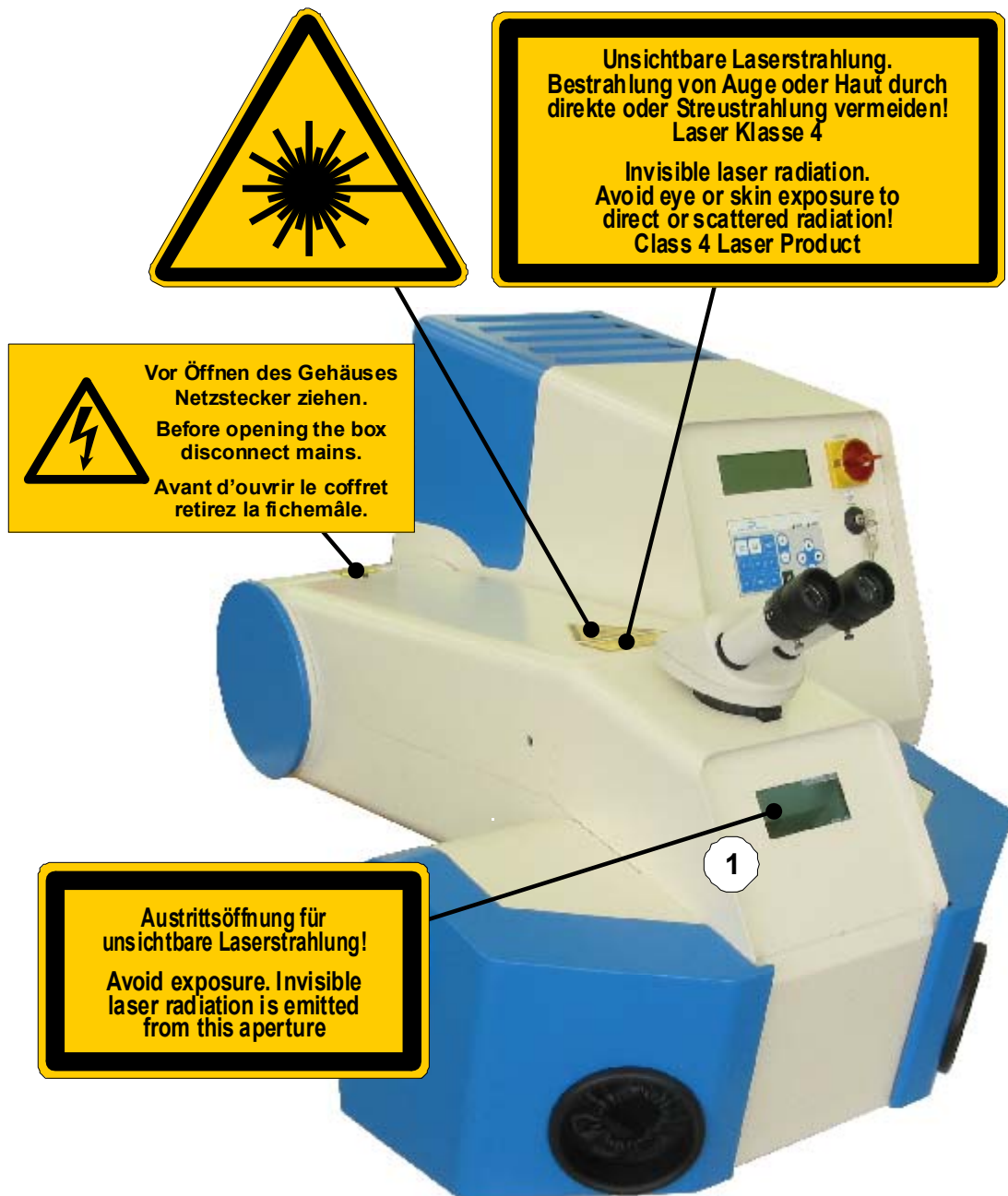
Caution!

For all activities with the laser, the BGV B2 (VBG 93) regulations on accident prevention for laser radiation or the equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) have to be complied with.

2.5. Labeling

All points where any danger might arise under certain circumstances (e.g. when safety covers are opened) are marked with the stipulated warning and explanatory signs. The location of the signs is shown in the following figures.

These signs may not be removed. If one of these signs has been removed for any reason, or if it is missing, it must be reapplied in the same position before the device is switched on.



(1) = inside the welding chamber

Figure 2.1: Labeling



Figure 2.2: Warnings and other signs on the back of the device

– blank –

3. System Description

3.1. General functions

The Desktop Power Laser welding laser is a stand-alone device that can be used to weld almost all metals and metal alloys quickly, reliably and precisely.

The parts that are to be joined are manually arranged together under visual control and welded together by means of one or more laser pulses.

The device is equipped with a stereo microscope with a crosshair to facilitate the exact positioning of the parts. This crosshair marks the exact position on the work piece where the laser pulse will be set.

Good welding results can only be obtained if the work piece is exactly positioned as regards the height (i.e. within the focusing area of the laser beam). The height is correct if the surface of the work piece can be clearly recognized under the stereo microscope.

The quality of the welding points can be influenced by the pulse height (= welding voltage in V), the pulse length (= duration of the pulses in ms) and the shape of the laser pulses. Voltage and pulse duration can be adjusted by means of joysticks in the welding chamber or via the keypad.

For certain materials a high welding quality can only be achieved by using inert gas. For this the device is equipped with a inert gas connection.

The vapor produced during welding can be extracted from the welding chamber via an external exhaust unit.

Each single laser pulse can be released by a pedal switch.

3.2. The Principle Behind Laser Welding

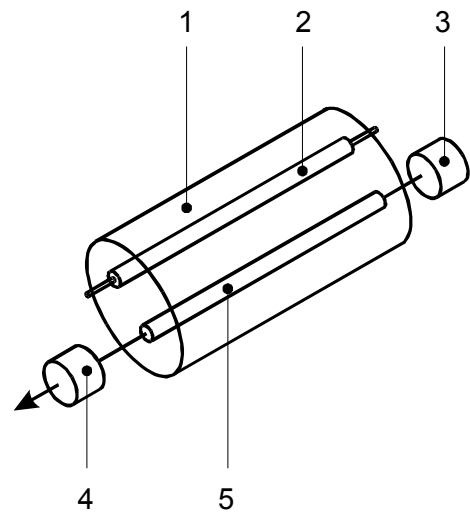


Figure 3.1: Laser Resonator (Schematic Diagram)

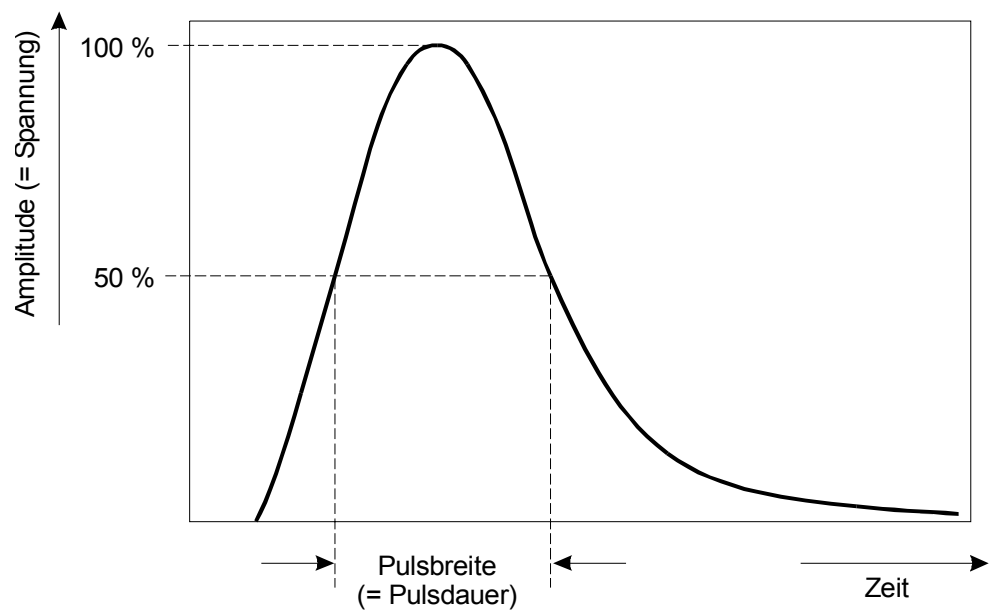


Figure 3.2: Laser Pulse

The nucleus of the Desktop Power Laser pulse generation is a cylindrical crystal **(5)** with polished ends. The laser crystal is a neodymium-doped yttrium aluminum garnet (abbreviation: Nd:YAG).

When intensive light is applied to the crystal (e.g. from a rod-shaped flash lamp **(2)**) via a reflector, it can initially produce non-directional light with the laser wavelength λ ($\lambda = 1.06 \mu\text{m}$ for Nd:YAG). For optimum utilization of the flash lamp light, both the laser crystal and the flash lamp are arranged just within the "focal point" of an ellipsoidal mirror **(1)**.

A semi-reflecting **(4)** and a fully reflecting **(3)** mirror are mounted outside the crystal (see figure 3.1). These two mirrors form the laser resonator. Only those parts of the laser light that hit these mirrors and are reflected into the laser crystal **(5)** can be amplified during the pulse of the flash lamp while passing through the crystal. The amplified laser light has the same properties as the original laser light, i.e. it has the same direction, the same wavelength, the same phase and the same polarization. The highly directional propagation characteristics of the laser light are determined by the mirrors.

Part of the laser light passes through the semi-reflecting mirror **(4)** and can be utilized. This is concentrated to a very high energy density - many times higher than is possible with normal light - at the focal point of a lens. The energy created at the focal point in a relatively short time (0.5 to 50 ms) heats the workpiece beyond its melting point and thus enables a welding. The energy created at the focal point in a relatively short time (0.5 to 20 ms) heats the work piece beyond its melting point and thus enables a welding.

The laser light welds metals together and thus permits safe, durable, precise and non-warp joining of parts. Spot or seam welding is possible. Because of the very short time of the laser pulse the zone of heat influence is limited to the immediate vicinity of the welded spot or seam.

The characteristics of a laser pulse – and thus the effect on the material – can be influenced by the operating parameters VOLTAGE and PULSE LENGTH.

In practice the effect of both parameters while welding metals is as follows:

- the voltage first influences the welding depth,
- the pulse length predominantly influences the diameter of the welding point.

3.3. General view

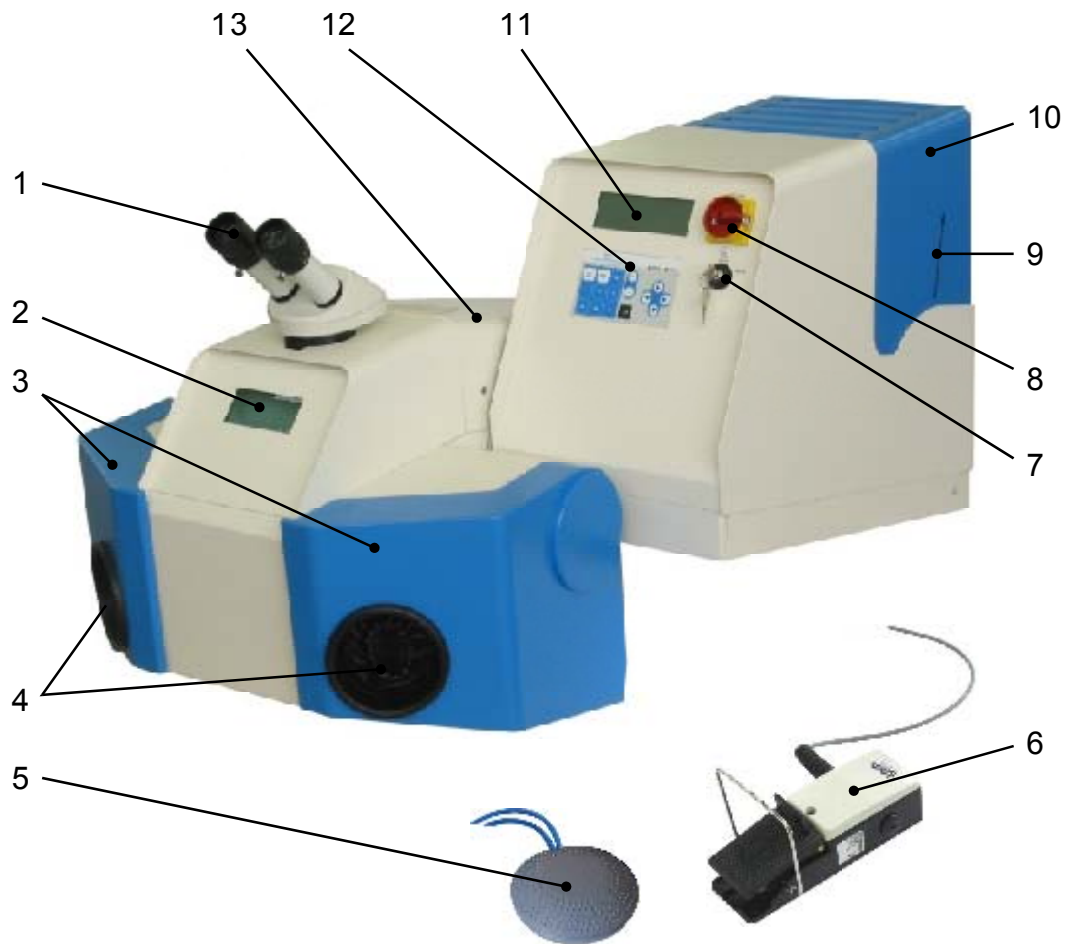


Figure 3.3: General view

The illustration above shows the general view of the laser equipment in closed state. The individual functional parts are marked by numbers and explained in the following.

- (1) Stereo microscope
- (2) Observation window
- (3) Hand opening flaps (can be raised separately to load the welding chamber)
- (4) Hand openings
- (5) Pedal switch for cooling air
- (6) Pedal switch for triggering laser pulses and controlling inert gas
- (7) Key switch
- (8) Main switch / emergency off
- (9) Liquid level indicator for deionized water
- (10) Water tank cover
- (11) Display
- (12) Keypad
- (13) Laser protective hood (covering the high-energy pulse laser)

3.4. Technical Description

3.4.1. Technical Data

3.4.1.1. Physical Dimensions (maximum measures)

Width x height x depth	600 x 520 x 1020 mm (suitable for a table depth \geq 60 cm)
Weight	80 kg
Electrical connection (alternatively)	230 V ~/50 Hz 10 A single phase 230 V ~/60 Hz 10 A single phase 208 V ~/60 Hz 10 A single phase

3.4.1.2. Laser data (depends on installed equipment)

Laser crystal	Nd:YAG
Wavelength	1.06 μ m
Max. pulse energy (welding chamber)	35 joules
Max. pulse energy (laser head)	50 joules
Rated power	30 W
Max. pulse power	3.5 kW
Single/continuous pulse	0 / 0,5 ... 10 Hz
Pulse duration (single pulse triggering)	0,5 ... 20 ms
Laser class	Closed: class 4 document of compliance included Open: class 4

3.4.1.3. Noise Level

The continuous sound level produced by the device is always less than 60 dB(A).

3.4.1.4. Control

Microprocessor controlled, externally programmable via RS 232 interface, connected to control elements for setting of reference input values and display for voltage and pulse length.

3.4.1.5. Control circuits for

- cooling-water (temperature, level and flow rate)
- external safety contacts
- safety shutter
- Viewing shutter within the stereo microscope
- Power supply voltage
- availability

3.4.1.6. Power supply

Sine wave inverter, electrically insulated from line	1500 W
lamp current switch,	max. 600 A
Ignition and simmer for laser lamp	

3.4.1.7. Cooling

Internal water/air heat exchanger	
Particle filter and deionization filter within the internal cooling water circuit	
Max. temperature of cooling water	60°C
Max. ambient temperature	30°C

3.4.1.8. Inert Gas

Max. operating pressure	8 bar (1 bar recommended)
Flow (recommended setting)	6 to 15 liter/min.

3.4.1.9. Optical Viewing System

- Stereo microscope with crosshair, visible 15x magnification (standard)
- Laser protective window within the optical path for observation
- View shutter, which closes automatically for a short time with each laser pulse to protect the eyes (see the note on page 5-14).
- Observation window for direct observation of the working area, consisting of a laser protective window and a plastic splash protective window.
- Illumination of the welding chamber with adjustable brightness by means of a control in the chamber

3.4.1.10. Welding Chamber

The welding chamber (see figure 3.3 on page 3-4 and figure 3.4 on page 3-8) consists of the following components:

- The welding chamber is accessible through the raisable hand opening flaps.
- The workpieces within the illuminated welding chamber can be observed via an observation window **(2)**, figure 3.3 to facilitate a coarse positioning of the workpieces. The observation window is a special laser protective window that absorbs laser radiation as well as the ultraviolet component of the plasma light.

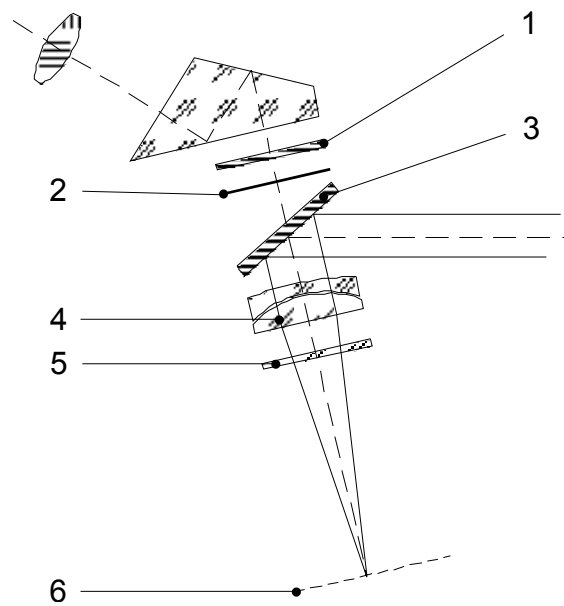


Figure 3.4: Processing Station – Optics

- The stereo microscope **(1)** figure 3.3 on top of the welding chamber facilitates an easy and precise adjustment of the work pieces.
- The laser beam is fed into the optical path of the microscope via a highly reflecting mirror **(3)** figure 3.4.
- A special laser focusing lens, **(4)** figure 3.4, concentrates the laser beam to the work piece in the focusing plane of the stereo microscope **(6)** figure 3.4. This laser lens acts also as the focusing lens of the stereo microscope.
- The laser focusing lens is protected against metal dashes and vapor produced by welding by a lens protective glass **(5)** figure 3.4.
- The eye protection filter **(1)** figure 3.4 is light-proof for the laser radiation and thus guarantees that no laser radiation hits the eye of the operator.
- The view shutter **(2)** figure 3.4 protects the eyes against laser radiation and the plasma light including the ultra violet components that is produced during the welding pulse. The view shutter is an LCD disk. The amount of light it lets through is controlled electronically. During a laser pulse it darkens the vision area for a short time.

3.4.1.11. Inert Gas

The device has connecting sockets for inert gas (Argon).

The welding chamber has one movable inert gas nozzles (for argon) at the end of a gooseneck that can be adjusted easily to any position around the work piece.

3.4.1.12. Exhauster

The back of the welding chamber contains a large opening behind the halogen lamps through which the vapor produced by welding can be exhausted.

An extraction and filter unit can be connected to the back of the device in order to extract the welding vapor out of the device (see the section entitled CONNECTIONS on page 4-5).



Caution!

During operation of the laser welding device it must be ensured that the maximum permissible concentration of contaminants in the workplace is not exceeded. For safety reasons a suitable extraction system should always be connected.

Otherwise, there is a risk of dangerous substances being released and of optical components getting dirty and being irreparably damaged.

3.4.1.13. Miscellaneous

- Easily accessible joysticks for setting laser parameters.
- Inert gas supply through adjustable nozzle close to the working area
- Laser pulse triggering by means of a two-stage pedal switch:
 - 1st stage: inert gas supply
 - 2. 2nd stage: laser pulse triggering

3.5. Display and Control Elements

3.5.1. Main switch (EMERGENCY-STOP) and key switch

The main switch with the emergency-stop function and the key switch are on the control panel.

- | | |
|---------------------------------|--|
| (1) Main switch / emergency off | This switch turns on or off the line voltage of the device. It directly influences the pump of the cooling unit and the illumination of the welding chamber. |
| (1) EMERGENCY-STOP function | This main switch also meets the emergency-off function: It can be turned off (position "0") in any case of emergency without preceding actions. The device will be totally disconnected from the line (independent from the polarity of the mains plug). |
| (2) Key switch | The laser power supply and as a consequence all laser functions can only be switched on by the aid of the key switch. |



Figure 3.5: Main switch and key switch



Only authorized personnel should have access to the key for this key switch.

3.5.2. Display

The device has a 4-line display for the purpose of user guidance. The figure below shows the display's main menu. Further information that appears on the display is explained in the corresponding sections of this manual.



Figure 3.6: Display

3.5.2.1. First line

xxx V	Current capacitor bank voltage: 220 to 380 V
xxx ^m s	Set duration of the laser pulse: 0.5-50 milliseconds
xxx ^{Hz}	Selected pulse frequency:
	– Single-pulse mode: 0.0
	– Continuous-pulse mode: xxx = 0,5 to 10 Hz



The highest value that can be set for the pulse frequency depends on the voltage and pulse duration parameters selected and is limited by the charging capacity of the power supply unit and the capacitor bank.

Ø	Current focus setting (focal spot diameter in relative units) – possible settings: 0,2 – 0,4 – 0,6 – 0,8 – 1 – 1,2 – 1,4 – 1,6 – 1,8 – 2 – 2,2 – 2,5
---	---

3.5.2.2. Second line



Graphical representation of the selected pulse shape (see the section entitled PULSE SHAPES on page 5-7)

3.5.2.3. Third line

M xx: Text	xx = selected memory location number: 1 ... 20, Text = name of the memory location (see the section entitled STORING OPERATING PARAMETERS on page 5-8)
------------	---

3.5.2.4. Fourth line

This line shows status and error messages (see the section entitled DISPLAY OF STATUS AND ERROR MESSAGES on page 6-2).

All the parameters can be set either by using the joysticks in the welding chamber (see the section entitled CONTROL ELEMENTS IN THE WELDING CHAMBER on page 3-15) or by using the keypad (see the sections entitled DISPLAY and KEYPAD as of page 3-11).

3.5.3. Keypad



Figure 3.7: Keypad



If you press a key that has no function in the current operating status, the message *Key without function* appears on the display.

LASER OK

The LED indicates different operating statuses by means of different colors:

Green: The device is ready to emit laser pulses.

Red: A laser pulse cannot be triggered. The power supply unit has not yet reached the required voltage.

This status occurs after the device is switched on if the lamp is not yet ignited or if the voltage drops when the capacitors have to be discharged.

WARNING	<p>This appears when there is a problem in the device that does not lead to the device being switched off or an interlock message (e.g. if the flow of the cooling system is impaired but its cooling effect is still adequate).</p> <p>In addition to this warning, an error message appears in the bottom line of the display (see the section entitled DISPLAY OF STATUS AND ERROR MESSAGES on page 6-2).</p>
Arrow keys [◀] and [▶]	<p>In the main menu (initial status after the device is switched on): Select a parameter.</p> <p>In the Function menu (accessed via [F2]): Depends on the current menu item.</p>
Arrow keys [▲] and [▼]	<p>In the main menu (initial status after the device is switched on): Change the value of the selected parameter. Capacitor bank voltage is adjusted in 5 V steps, pulse durations less than 3.0 ms in 0.1 ms steps, and pulse durations as of 3.0 ms in 0.5 ms steps each time the relevant arrow key is pressed.</p> <p>In the Function menu (accessed via [F2]): Select menu command (scroll display page).</p>
[Shutter OPEN]	<p>Display (LED) – status display for the safety shutter: Green, flashing: The shutter is opened as soon as you put your hands in the hand openings. Green, continuous: The shutter is open.</p> <p>Key: Enables the shutter for opening.</p>
[Shutter CLOSE]	<p>Display (LED) – status display for the safety shutter: Red, continuous: The shutter cannot be opened. To enable the shutter, press the [Shutter OPEN] key.</p> <p>Key: Closes the safety shutter.</p>
[Interlock RESET]	<p>Display: The LED comes on when the safety shutdown is triggered by a malfunction (interlock). An error message appears on the display (see the section entitled DISPLAY OF STATUS AND ERROR MESSAGES on page 6-2).</p> <p>Key: Having removed the failure the device can be put back into operation by pressing this key.</p>
[F1]	Has no function in the current version.
[F2]	Opens the Function menu (see the section entitled FUNCTION MENU on page 5-15).
[F3]	Has no function in the current version.
[+] / [-]	Select the memory location number for calling or saving operating parameter sets (see the sections entitled STORING OPERATING PARAMETERS and CALLING STORED OPERATING PARAMETERS on page 5-8 ff).

- [MEM] Activates the saving functions (see the sections entitled STORING OPERATING PARAMETERS and CALLING STORED OPERATING PARAMETERS on page 5-8 ff).
- [ESC] This key cancels the current procedure and returns to the previously executed function or to the previously active menu level. If necessary press the key several times to go back more steps.
- [↵] In the main menu (initial status after the device is switched on):
Allows you to start input of the memory location name and save the set operating parameters in the selected memory location or apply the saved parameters as the current operating parameters (see the sections entitled STORING OPERATING PARAMETERS and CALLING STORED OPERATING PARAMETERS on page 5-8 ff).
- In the Function menu (accessed via [F2]):
Applies the value set for the selected menu item or executes the selected menu command.

3.5.4. Control Elements in the Welding Chamber

On the rear wall of the welding chamber (see figure) there are three joy sticks and a rotary control with the following functions.

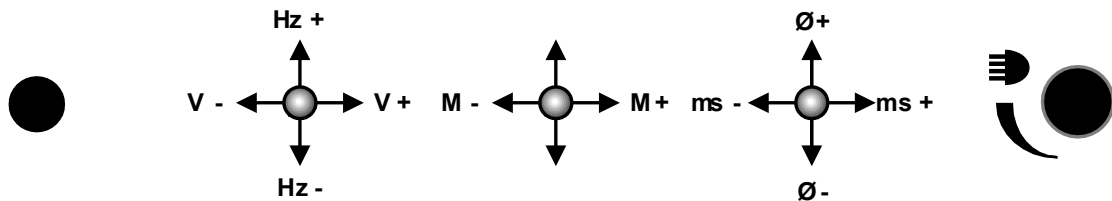



Figure 3.8: Control Elements in the Welding Chamber

Hz- / Hz+	Set the pulse frequency: – Single-pulse mode: 0,0 – Continuous-pulse mode: xx (xx = selected pulse frequency: 1 ... 20 Hz).
V- / V+	Change the required value for the voltage. This setting affects the height of the laser pulse and thus, primarily, the depth of the welding point or hole.
M- / M+	Select the memory location number for calling operating parameter sets (see the section entitled USING THE JOYSTICK TO CALL OPERATING PARAMETERS on page 5-11).
Ø- / Ø+	Focus setting: Determines the diameter of the focal spot.
ms- / ms+	Set the required value for the duration of the laser pulse. Essentially, this affects the diameter of the welding point.
	This rotating knob allows you to control the brightness of the lighting in the welding chamber.

3.5.5. Pedal switch

The device is equipped with a pedal switch for triggering laser pulses and a pedal switch for cooling air.

The pedal switches are connected to the device by flexible cables or hoses and can be positioned as required by the operator. The pedal switch for triggering pulses is equipped with a bracket, allowing the operator to pull it toward himself easily.

The pedal switch for triggering pulses has two operating positions with the following functions:

- Press the pedal switch until you feel initial resistance: ✱ The inert gas supply is enabled.
- Fully press the pedal switch until the stop. ✱ The view shutter is closed, and one laser pulse is triggered.

The inert gas supply remains on until the pedal switch has been totally released (if inert gas supply is connected to the device).

If several laser pulses are to be released one after the other, the following options are available:

- You can release the pedal switch slightly after each pulse and then push it right down again.
- Depending on the pulse frequency set for continuous-pulse mode (see the section entitled SETTING OPERATING PARAMETERS on page 5-6 and DISPLAY on page 3-11), you can release a series of laser pulses with the set pulse frequency by depressing the pedal switch down for long enough.

4. Installation

This chapter describes the requirements that have to be fulfilled for a faultless operation of the device.

4.1. Requirements

To guarantee a faultless operation of the device the following requirements have to be met.

4.1.1. Installation Site

The installation site has to meet the following requirements:

- The device has to be installed in a room as dry and dust-free as possible.
- Do not expose the device to direct sunlight.
- It is recommended that you install the device in such a way that the device can be accessed without difficulty from all sides should it be necessary (to check the coolant level and top up the coolant).



Caution!

The main/emergency-stop switch must be easy to access at all times.



Caution!

When choosing the installation site take into consideration that for servicing a suitable limitation of the laser area is possible (see the regulations about accident prevention for laser radiation BGV B2 (VBG 93) or equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825)).

4.1.2. Ambient Conditions

Operation: 10°C to 30°C ambient temperature (non-condensing)
Storage: If the device contains cooling water do not store or transport it below 3°C (frost risk).



Attention!

Never add antifreeze solution to deionized cooling water!

4.1.3. Power condition

The following power conditions can be selected for the device:

- 230 V ~/50 Hz 10 A single phase
- 230 V ~/60 Hz 10 A single phase
- 208 V ~/60 Hz 10 A single phase

The setting of the power conditions is explained in the section FILLING UP AND CONNECTING on page 4-5.

4.2. Installation

4.2.1. Unpacking

The laser device has been tested thoroughly before shipping and has been delivered in faultless condition. Check the packaging for transport damages – if possible – **before** unpacking.

- Take the device – if possible unpacked – to the final installation site.
- Leave the device in its packaging long enough to allow it to acclimatize to its new environment and prevent the formation of condensation.
- Check the device for possible transport damages.



Attention!

At least two people are needed to carry the device.

4.2.1.1. Basic Equipment

The standard parts of delivery are listed in the following:

- Desktop Power Laser
- Two keys for the key switch
- Microscope
- Retaining rings for the microscope
- Inert-gas hose
- Electrical pedal switch for pulse triggering
- Cooling-air hose and pneumatic pedal switch (Option)
- Power supply cable
- 2.5 liters of deionized water
- Argon fitting
- Selection of samples
- 1 pack of paper tissues
- Support cushions for the hands
- Titanium blank holder
- Titanium blanks
- Magnetic card
- Documentation, consisting of:
 - A dental guide
 - A technical guide
 - Registration forms
 - A delivery note
 - EU declaration of conformity
 - Circuit diagrams
 - A log book

The delivery can optionally include some more parts. Compare the parts delivered with what is on the delivery note.

4.2.2. Mounting the stereo microscope



To find out how to adjust the stereo microscope, refer to the section entitled **ADJUSTING THE STEREO MICROSCOPE** on page 5-4.

4.2.3. Filling Up and Connecting



For damages to persons or property caused by improper connection of the device warranty responsibility claims are out of question.

4.2.3.1. Connections

All the connections are on the back of the device.

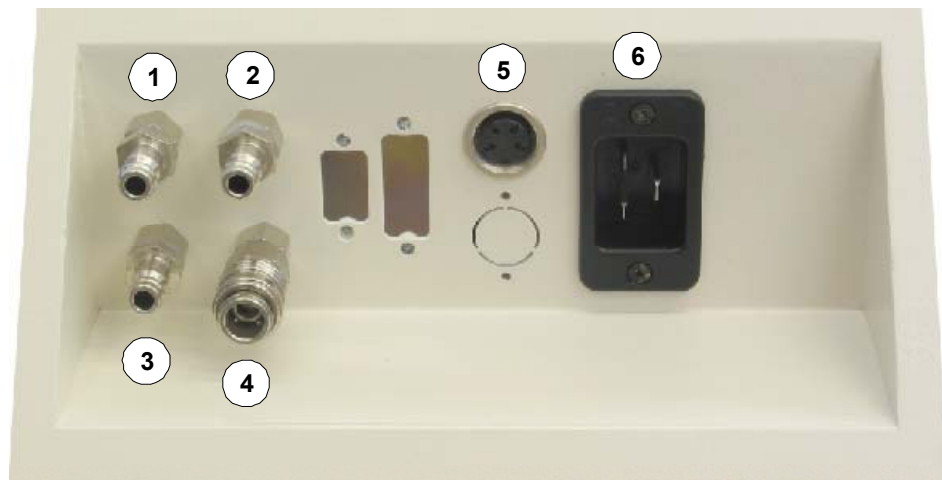


Figure 4.1: Connection panel

(1)	ARGON	Inert-gas infeed (argon)
(2)	FOOT SWITCH AIR	Compressed air from pedal switch
(3)	MAIN AIR	Compressed-air infeed
(4)	FOOT SWITCH P	Compressed air to pedal switch
(5)	FOOT SWITCH LASER PULSE	Connection for pedal switch (pulse triggering, inert gas and exhauster)
(6)	MAIN POWER	Power input

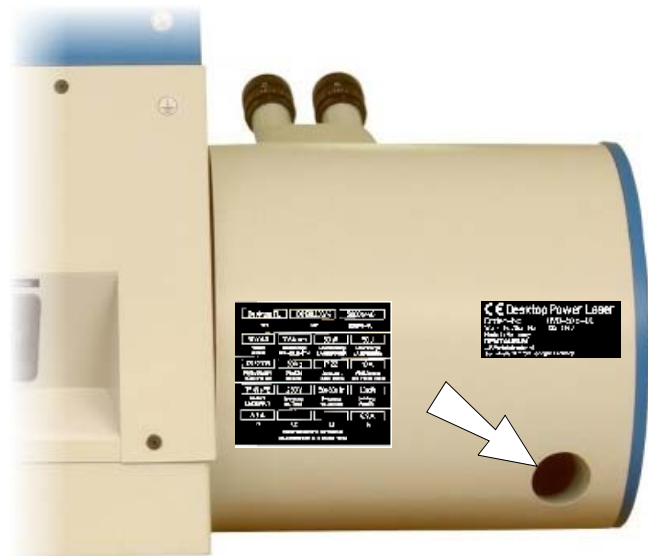


Figure 4.2: Connection for Exhauster

4.2.3.2. Inert Gas

For the inert gas connection, the device is equipped with quick-acting compressed-air closures for connecting compressed air lines with a cross-section of 3 mm. The maximum permitted working pressure is 8 bar (1 bar is recommended). 1 bar.

4.2.3.3. Cooling water

The water tank has to be filled up with deionized water before setting the device into operation for the first time. The filling up procedure is described in the section CHECKING/REFILLING THE COOLANT (see page 7-7).

4.2.3.4. Power connection



Attention!

The factory setting for the power conditions is 230 V ~/50 Hz 10 A single phase, if no other agreement has been made when the device was ordered.

When in doubt ask the supplier of the device!

Our service technicians or authorized skilled personnel are only allowed to perform this setting!

4.3. First putting into operation

After properly having finished all activities described in the section FILLING UP AND CONNECTING (page 4-5) first switch on the device as explained in the section SWITCHING ON (page 5-2).

If the self-test has been finished without failure, the device is ready for operation.

4.4. Disassembling (preparation for transport)

To prepare the device for transport over minor distances you only have to unplug the power supply, the pedal switches and, if necessary, the inert gas and cooling air supply. The deionized water can be left in the tank.



Attention!

At least two people are needed to carry the device.

Before transporting the device over longer distances (in a truck, for example) or putting it into storage, it is recommended that you drain off the deionized water (see the section entitled CHANGING THE WATER FILTER on page 7-9).



Attention!

Do not store or transport the device at a temperature below 3°C if the cooling water remains in the tank (danger of frost)!

If you must reckon on storing or transporting the device at a temperature below 3°C or if the device is not used for more than an one month, additionally the excitation unit in the laser head has to be opened and dried out.



Attention!

These activities should only be performed by our service technicians or authorized skilled personnel.

If unsuitable materials (such as commercially available cellulose cloths) are used to dry the optical components, irreparable damage may be caused. Even tissues and clothes that seem to be smooth can scratch optically polished surfaces!


– blank –

5. Operation

The next sections describe the usage of the device. The following symbolism is used:

The symbol ➤ marks actions that have to be carried out by the operator.

In most cases actions of the operator in any form cause reactions of the device that are marked by the symbol ✱.

Additional operator instructions are marked with the symbol .

Texts indicated on the display are represented by capitals and in *italic writing*.

The numbers in brackets are related to the positions of the individual operating and control elements in the figures opposite or below.



The [ESC]-key cancels all entries or other actions at any time.



Successive key entries may not be executed too fast, as the device otherwise cannot process all commands precisely.

5.1. Working Area

The design of this device enables the operator to reach all the control elements easily from a sitting position.



Attention!

Before switching on the device you should adopt a sitting position that allows you to work in a relaxed manner. In particular, the freely movable pedal switch must be in a good position to prevent unintentional release of a laser pulse.

5.2. Switching On

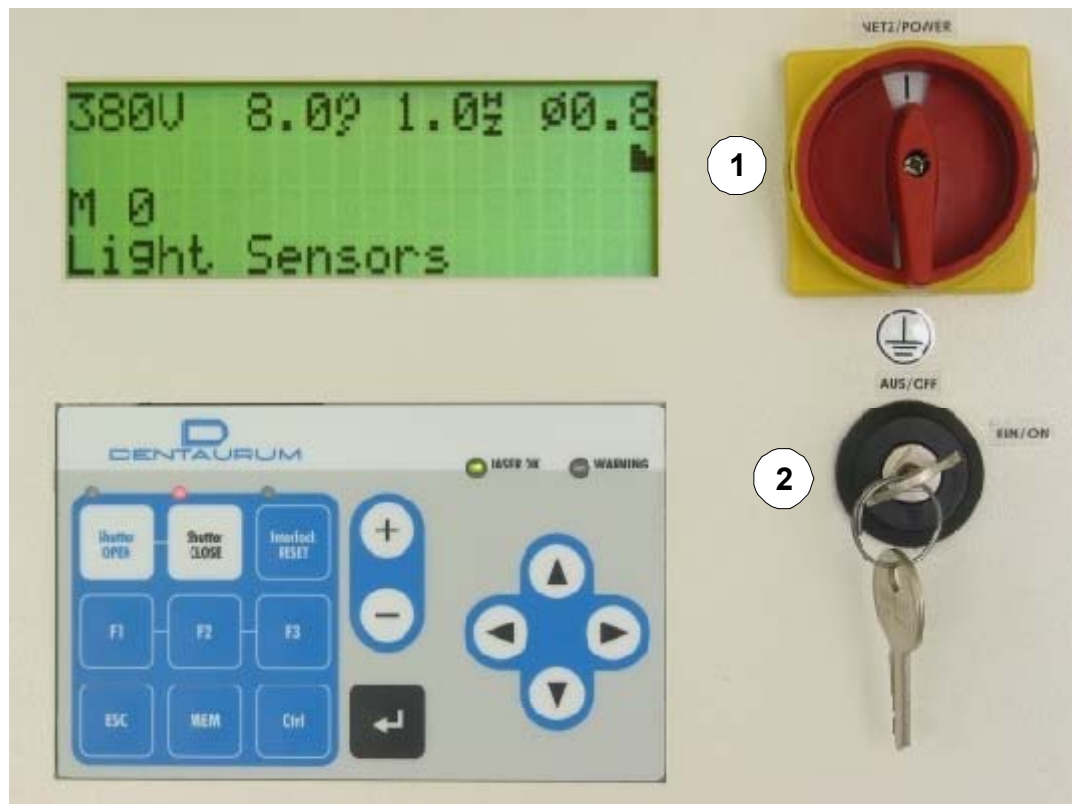


Figure 5.1: Operating elements

Action of the operator	Response of the system
➤ Ensure that the key switch (2) is in the AUS/OFF position.	
➤ Turn the main switch (1) to the I position.	✱ The cooling unit's pump starts up and the illumination of the welding chamber goes on.
➤ Turn key switch (2) to the right.	✱ The current program revision levels (together with their dates) appear on the display. The LASER OK LED and the LED in the key [Shutter CLOSE] come on (red).
The device carries out a series of self-tests.	✱ If an error occurs, an error message appears on the control panel (see also the section entitled STATUS INDICATIONS on page 5-17). Provided no errors occur, the message <i>Wait for Ignition !</i> appears in the line at the bottom of the display.
➤ Wait until the self-test is completed and the laser lamp is ignited.	✱ The green LASER OK indicator shines. The message <i>Light sensors</i> appears in the line at the bottom of the display.
➤ Press the [Shutter OPEN] key on the keypad.	✱ The LED in the [Shutter OPEN] key on the keypad flashes (green).
If working with inert gas:	
➤ If necessary, adjust the pressure on the gas cylinder to around 1-3 bar or the flow rate to 6-15 liters per minute.	✱ The pressure is indicated on the gas cylinder's manometer.
The device is thus ready for operation. No special safety precautions need to be taken.	

5.3. Adjusting the stereo microscope

5.3.1. Adjusting the crosshair and focal plane



To achieve precise and reproducible welding results it is necessary to adjust the stereo microscope to the individual visual acuity of the operator. If the stereo microscope is not adjusted correctly the work piece can be recognized exactly even if it is not in the focal plane of the laser.

Setting of the stereo microscope:

1. Switch the system on (by simply turning the main switch to the I position).
2. Put a sample item (e.g. a sheet steel) on a lab jack in the visual field of the stereo microscope so that it appears sharp (together with the crosshair) seen through the right eyepiece.
3. Fix the sample item in this position.
4. Look with the left eye through the left eye piece and turn the left adjustment ring so that the item also appears sharp through the left eyepiece.
5. Adjust the spacing between the eyepieces so that the vision areas (bright areas) of the two eyepieces completely overlap. In other words, when you look through them without straining, you see a single round vision area without a black border on either its inside or outside edge.

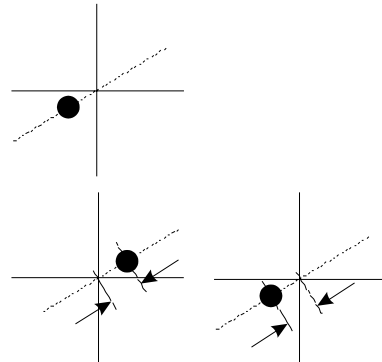
After this adjustment the test item must appear sharp through both eyepieces in a certain distance from the focusing lens and simultaneously also the crosshair.

5.3.2. Centering the crosshair/welding point

If the position of the welding point on the workpiece does not correspond to the position of the crosshair, you have to adjust the crosshair. Proceed as follows:

1. Ensure that the microscope is adjusted ideally for your eyes (see the section entitled ADJUSTING THE CROSSHAIR AND FOCAL PLANE on page 5-4).
2. Place a steel part on a workpiece holder (a lab jack, for example), and adjust the height of the steel part so that its surface appears in the sharpest possible focus (by turning the adjusting screw on the lab jack, for example).
3. Set a voltage of approximately 215 V at a pulse duration of 1.2 ms (see the section entitled SETTING OPERATING PARAMETERS on page 5-6).
4. Look for a free surface on the steel part, **do not touch it anymore**, and trigger a single laser pulse.
5. Check the positions of the welding point (SPOT) and crosshair.
6. If the crosshair is not exactly in the center of the welding point, you have to adjust the position of the crosshair. Proceed as follows:
7. Use an Allen key (3 mm) to loosen the screw under the microscope until the microscope can be moved.
8. Center the crosshair by tilting the stereomicroscope toward the center of the welding point, and tighten the Allen screw again until it is secure.

When you tighten the Allen key, the crosshair moves away from the center of the welding point a little.



9. Loosen the screw under the microscope again, and adjust the position of the crosshair so that it is positioned the same distance away on the opposite side of the welding point, and then tighten the Allen screw again until it is secure.
10. You may have to repeat this step several times until the crosshair is positioned precisely enough on the center of the welding point.

5.4. Setting Operating Parameters



When you switch the device off, the most recently used parameters (provided they were entered at least 10 seconds before the device is switched off) are saved and used as the current parameters the next time you switch the device on.

5.4.1. Using the keypad to set operating parameters

Action of the operator	Response of the System / Notes
<ul style="list-style-type: none"> ➤ Use the arrow keys [◀] and [▶] to position the arrow cursor after the unit or before the numerical value of the parameter to be changed (e.g. V, ms, Hz). 	<ul style="list-style-type: none"> ✴ The arrow cursor always points to the selected parameter. The direction of the arrow cursor changes automatically depending on whether it is positioned before or after the parameter.
<ul style="list-style-type: none"> ➤ Use the arrow keys [▲] and [▼] or the keys [+] and [-] to change the value of the parameter. 	<ul style="list-style-type: none"> ✴ The current value appears on the display and applies to all subsequent actions (e.g. when a laser pulse is triggered or a parameter set is saved).

5.4.2. Using the Joysticks

You can set all the operating parameters (with the exception of the pulse shape) using the joysticks in the welding chamber without having to press a key beforehand (see the figure below). The changed values appear on the display.

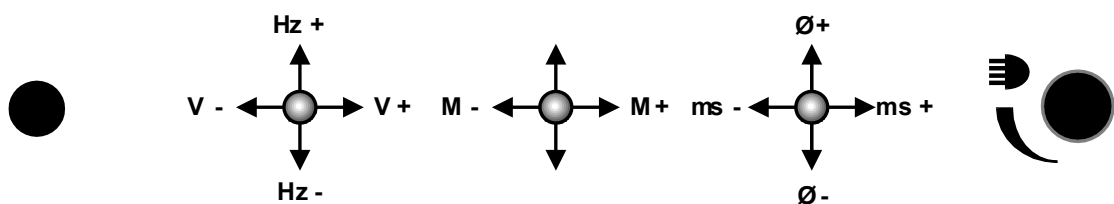



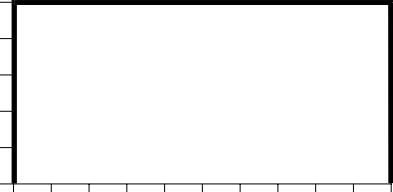

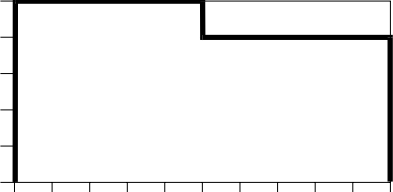

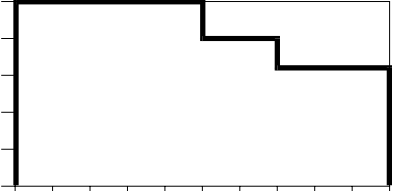
Figure 5.2: Joysticks in the welding chamber

5.5. Pulse shapes

The shape of the laser pulse (i.e. the intensity of the laser beam over time) has an important effect on how the material behaves and thus on the result of welding.

The Desktop Power Laser has three preset pulse shapes that – like the other parameters – can be selected for processing and saved together with the other parameters.

The following pulse shapes are available:

Symbol	Name	Intensity (schematic)
	rectangle	
	Single-step pulse	
	Two-step pulse	

5.6. Storing Operating Parameters

The device's controller has 20 memory locations in which sets of operating parameters (each optimized for specific applications or materials, for example) can be stored so that you can subsequently work with the same tried-and-tested operating data.

To help you identify them more easily, you can enter names for the memory locations.

Memory locations 1 to 4 already have preassigned operating parameters and corresponding designations. The preassigned memory locations cannot be overwritten.

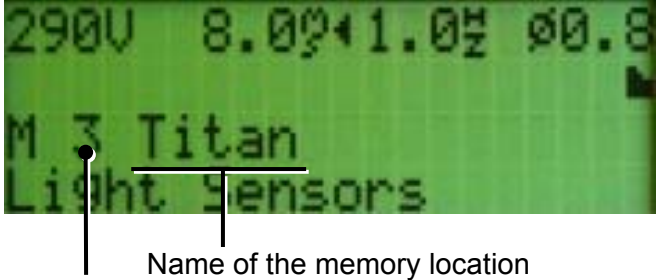
A saved parameter set consists of the following elements:

- Voltage
- Pulse width
- a single pulse setting or the repetition rate for continuous pulses
- Focal setting
- Pulse shape
- a descriptive text

Memory locations 1 to 4 are assigned the following parameters:

No.	Name	Voltage	Pulse duration	Pulse frequency	Focus	Pulse shape
1	Au	290 V	6 ms	1 Hz	0.8 mm	rectangle
2	Co/Cr	290 V	10 ms	1 Hz	0.8 mm	One step
3	Titanium	290 V	8 ms	1 Hz	0.8 mm	Two steps
4	Orthodontic	240 V	3 ms	1 Hz	0.8 mm	Two steps

To save parameter sets, proceed as follows:

Action of the operator	Response of the system
<ul style="list-style-type: none"> ➤ Set the operating parameters (see the section entitled SETTING OPERATING PARAMETERS on page 5-6), and select the pulse shape. ➤ Press the [MEM] key twice. ➤ Use the [+] or [-] key to select the desired memory location number. 	<ul style="list-style-type: none"> ✴ The current operating parameters and the selected pulse shape appear on the display. The "M" in front of the memory location number changes to "m" (lowercase). ✴ The arrow pointing to the right (→) appears in front of the memory location number in the third line of the display.
	
<ul style="list-style-type: none"> ➤ Press the [↵] key twice to start entering a name for the memory location. 	<ul style="list-style-type: none"> ✴ The "m" in front of the memory location number changes back to an "M" again (the first time you press the [↵] key), and the cursor selects the first character of the name of the memory location.
<ul style="list-style-type: none"> ➤ Use the [▲] and [▼] arrow keys to select the desired character for the current character position. <p>Use the [◀] and [▶] arrow keys to select any position in the line for the name of the memory location.</p>	<ul style="list-style-type: none"> ✴ The current character position is displayed inverted. When you press the [▲] key, the characters appear in the following order: special characters – digits – uppercase letters – lowercase letters (the [▼] key takes you in the opposite direction). The space is the first of the special characters.
<ul style="list-style-type: none"> ➤ Press the [↵] key to apply the parameters to the current memory location. 	



When the system is switched off, only those values entered or saved at least 10 seconds beforehand are retained.

5.7. Calling Stored Operating Parameters

You can use the middle joystick in the welding chamber or the keypad to select operating parameter sets that have been saved (see the section entitled STORING OPERATING PARAMETERS on page 5-8) and thus activate them for subsequent usage.

5.7.1. Using the keypad to call operating parameters

Action of the operator	Response of the System / Notes
➤ Press the [MEM] key once.	✱ The arrow that points to the left (←) appears in front of the memory location number in the second line of the display.
➤ Use the [+] or [-] key to select the desired memory location number.	✱ The memory location number and name and the saved operating parameters (including the pulse shape) are displayed.
➤ Press the [↵] key.	✱ The arrow in the third line of the display disappears, and "M" (uppercase) is displayed. The operating parameters are set to the values stored in the relevant memory location.



If you change one of the parameter values (see the section entitled SETTING OPERATING PARAMETERS on page 5-6), the memory location is set to 0 (zero). This indicates that the currently displayed parameter set is not stored in a memory location.



If the capacitor bank voltage is reduced as a result of the values selected, it is set automatically to the new value by pulse discharge. During this process, the message *Wait for Discharge !* appears on the display, and the LASER OK LED changes to red for a short time.

5.7.2. Using the joystick to call operating parameters




You can use the middle joystick in the welding chamber to select a memory location and read out the operating parameters.

When you operate the joystick once (regardless of whether you do this in the direction of **M+** or **M-**), an arrow pointing to the left (←) is displayed in front of the letter M in the second line of the display (readout mode active). If you touch the joystick again, the memory location number changes:

Joystick up (M+):	Higher memory location number
Joystick down (M-):	Lower memory location number

Shortly after you select a memory location (or press the [↵] key), the operating parameters are set to the values that are stored in that memory location and all the values are displayed statically.

5.8. Welding

Action of the operator	Response of the system
➤ Lift up hand opening flap(s).	✴ The display shows the message <i>Box open</i> .
	When the device has this operating status, the safety shutter is closed. Therefore no laser radiation can escape – even if the pedal switch has been pressed unintentionally.
➤ Place the work pieces in the welding chamber.	
➤ Close hand opening flap(s).	✴ The display shows the message <i>Light sensors</i> .
	Make sure that the extractor is connected and switched on. Otherwise, there is a risk of dangerous substances being released or of the sensitive optical components getting dirty and being irreparably damaged.
Attention!	
If smoke or gases are emitted when working with the laser, you must not continue working with a defective extractor.	
➤ Put both hands through the hand openings into the welding chamber.	✴ The message <i>Light sensors</i> disappears.
	Do not position your hands in or under the crosshair! Pressing the pedal switch releases a laser pulse!
Attention!	Danger of burning!
➤ Use the rotary control for the lighting (on the right of the rear wall in the welding chamber) to set the brightness to a suitable value. Assess this through the stereo microscope, taking into account the properties of the work piece.	
➤ Use the joysticks in the welding chamber to set the required laser parameters.	✴ The current values appear on the display and optionally in the stereo microscope.

Action of the operator	Response of the system
If the shutter is not yet enabled (the LED in the [Shutter CLOSE] key on the keypad shines red):	
➤ Press the [Shutter OPEN] key on the keypad.	✳ The LED in the [Shutter OPEN] key on the keypad shines green, and the LED in the [Shutter CLOSE] key goes off.



If the required voltage value is reduced, the safety shutter is closed for safety reasons. During this process, the message *Wait for Discharge !* appears on the display, and the LASER OK LED changes to red.

- For welding with inert gas, the inert-gas nozzle must be positioned near the laser focal spot. A position adequate for most applications is at the edge of the visual field of the stereo microscope above the focal plane.



The work pieces must be positioned exactly in all three dimensions:

Horizontal dimensions: You can check the work pieces are positioned exactly using the cross hairs that appear.

Vertical dimension: You can tell when the work pieces are positioned exactly because they appear in sharp focus in the stereo microscope.

The quality of the welding depends primarily on the vertical positioning.

- Look through the stereo microscope, use both hands to place the work pieces together, and align them exactly.



The cross hairs indicate the exact position of the laser focal spot.



**Do not put your hands near the cross hairs!
Danger of burning!**

Attention!



- When the welding point appears in sharp focus in the cross hairs, push the pedal switch until you feel an initial resistance.
- Fully press the pedal switch until the stop.



The gas supply is released.



The view shutter darkens the vision area briefly, and the laser pulse is triggered.

Action of the operator	Response of the system
 Attention!	<p>If the visual field of the stereo microscope is not darkened during the laser pulses and you can see flashes of light, a view shutter error or an error in the controller has occurred. In this case you must interrupt working with the device and immediately contact the service department of Dentaurem, J.P. Winkelstroeter KG.</p>
	<p>Otherwise this might cause dazzle similar to those caused by lengthy unprotected observation of halogen lamps, spotlights or even the sun.</p>
<p>➤ If you want to trigger several laser pulses one after the other, in single-pulse mode (pulse frequency = 0) you have to release the pedal switch slightly each time and then push it firmly all the way down again.</p> <p>In continuous-pulse mode (pulse frequency unequal to zero), laser pulses are triggered repeatedly at the set frequency for as long as you keep your foot all the way down on the pedal switch.</p>	<p>✱ The laser is ready for the next pulse when the LASER OK LED shines green.</p>
<p>➤ When you have finished welding, lay down the workpiece in the welding chamber and pull both hands out of the hand openings.</p>	<p>✱ The display shows the message <i>Light sensors</i>.</p>
<p>➤ Lift up hand opening flap(s), and remove the work piece.</p>	<p>✱ The display shows the message <i>Box open</i>.</p>
	<p>For different materials, suitable laser parameters (voltage, pulse length) and the appropriate inert gas have to be determined by trial and error. In many cases the quality of a welding point can be improved by placing several laser pulses shortly one after the other on the same welding point.</p>

After each laser pulse and after changes of the voltage value, the red LASER OK indicator remains on until the system is ready to release the next pulse. This recovery time lasts up to 3 seconds (depending on the values set for the voltage and pulse duration).

5.9. Function Menu

To open the multifunction menu, press the [F2] key.



Figure 5.3: Multifunction menu after it is called with [F2]

Key functions in the Function menu:

- [▲] / [▼] On the Function menu, page up/down to the previous/next page.
- [↵] Execute the selected menu command.
- [Esc] or [F2] Close Function Menu.

The menu items <U1>, <U2>, <U3> and <U7> have no function in the current version.

5.9.1. Pulse counter: *Get Pulse Cntr.* (5/16)

After opening the Function menu you can press the [▼] arrow key (repeatedly, if necessary) to select the *Get Pulse Cntr.* menu command. When you press the [↵] key, the current count and the message *OK* appear on the display.

This counter records the number of laser pulses emitted so that an estimate of the age of the flash lamp can be made.

5.9.2. Reset Param (6/16)

This menu command has no effect in the current version of the software.

5.9.3. Service (8/16)

From the *** Service *** menu page you can call the service menu pages (9/16) to (16/16), but only after entering the correct password. It is designed exclusively for service engineers.

To close the Function Menu again, press the [Esc] or [F2] key.

5.10. Switching Off

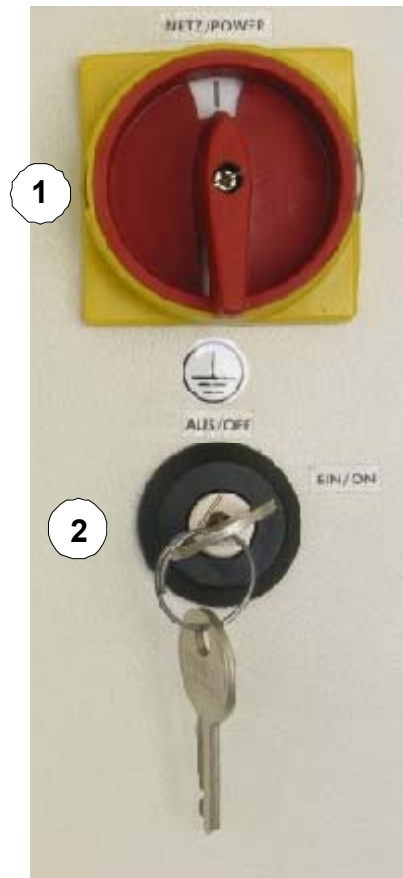


Figure 5.4: Main switch / Key switch

- Turn key switch (2) to the left (position **ON / OFF**).



Pull out the key and keep it in a safe place only accessible for authorized persons.

- Turn main switch (1) NETZ / POWER to the left (position "O").
- Close inert gas valves of the gas cylinder fittings.



The main switch can be secured with a padlock to prevent the device being switched on inadvertently or by unauthorized personnel.

5.11. Status Indications

During the device's self-test after it is switched on and during operation, the current operating status is indicated by LEDs on the keypad and by short texts in the bottom line of the display. A piece of hardware that is independent of the microcontroller monitors the conditions for pulse triggering on the basis of the following criteria:

- If the safety shutter is open, a pulse can only be released via the pedal switch.
- Even serious malfunctions of the software, microprocessor defects etc. can never release a laser pulse.
- If the safety shutter is closed, the user cannot trigger a lamp flash. (This prevents the safety shutter from being damaged.)
- Whenever there is an interlock, pulse triggering is disabled and the lamp's power supply is disconnected.

5.12. Log book (section ③)



In the interest of safe and faultless operation of the device, it is strongly recommended that you keep a logbook for each device. In this logbook all malfunctions and extraordinary events as well as all service and maintenance activities should be entered (e.g. replacement of the lamp or the filter).

Forms and examples of log book entries are included with this manual (section ③).

– blank –

6. Status and error messages / Fault clearance



Caution!

During maintenance activities with opened device regulations about accident prevention for laser radiation (BGV B2 (VBG 93)) or equivalent national or international regulations (e.g. EC Directive 60825 or IEC Publication 825) absolutely must be followed!

Wear proper laser protective goggles!

6.1.1. General Information

Unusual operating statuses that can be dealt with by the operator or that do not necessarily require the laser to be switched off are indicated by the WARNING LED.

Statuses that require the laser to be switched off are indicated by the fact that the LED in the [Interlock RESET] key comes on. In addition, the [Shutter CLOSE] key is always red because the shutter is always closed when these errors or faults occur.

The error/fault type is indicated by short messages in the bottom line of the display (see the next section).

Error messages are stored, which means you always have to reset the device manually by pressing the [Interlock RESET] key. A reset is not accepted if the cause of the error has not been eliminated.



Caution!


If the safety shutter is not connected, or if it gets stuck when not completely closed, the LED in the [Interlock RESET] key shines yellow, the red LED in the [Shutter CLOSE] key flashes, and the display shows the message *Safety Shutter Ilck*.


In other words, the red LED in the [Shutter CLOSE] key indicates either a closed shutter or a malfunction (combined with the RESET LED interlock).


These problems are detected even in the event of a microcontroller failure.

6.1.2. Display of status and error messages

Status and error messages appear in the bottom line of the display. In the case of error messages, an LED on the keypad lights up as well, depending on the error class involved:

LED	Error class	Description
	WARNING	Operating statuses in which the laser is still working but that may lead to problems subsequently.
IL	Interlock RESET	Problems that lead to the device being switched off. The device does not become ready for operation again until you eliminate the problem and press the [Interlock RESET] key.

These two different error classes are indicated in the **LED** column in the table below by the  symbol or the abbreviation **IL**.

No.	Message	LED	Meaning / Explanation	Measures
1.	<i>Light Sensors</i>		The light barriers do not recognize the hands/arms in the hand openings.	Put both your hands in the hand openings. If the symbol continues to be displayed, notify the service department.
2.	<i>Box open</i>		Hand opening flap(s) are not or not completely closed.	Close hand opening flap(s). If the symbol continues to be displayed, notify the service department.
3.	<i>Wait for Discharge !</i>		The capacitor bank is being discharged.	Wait until the voltage of the capacitor bank reaches the new value.
4.	<i>Safety Shutter Ilck</i>	IL	Shutter error	Please contact service.
5.	<i>HEX Level Ilck</i>	IL	Water level in the tank too low.	Check water level. Fill the tank to the maximum level with DI water. If the symbol continues to be displayed, notify the service department.
6.	<i>HEX Flow Warn</i>		The water flow is too low.	Disconnect the device from the power. Check if there is a kink in the cooling hose. Check the circulating pump and permeability of the filter by disconnecting the return line from the filter and feeding it directly into the supply tank. Clean the coolant circuit (e.g. after a very long period out of use or after a lamp breakage). If the symbol continues to be displayed, notify the service department.
7.	<i>HEX Flow Ilck</i>	IL	The water flow is insufficient.	Disconnect the device from the power. Check if there is a kink in the cooling hose. Check circulation pump. Clean the coolant circuit (e.g. after a very long period out of use or after a lamp breakage). If the symbol continues to be displayed, notify the service department.

No.	Message	LED	Meaning / Explanation	Measures
8.	<i>HEX Temperature Ilck</i>	IL	Maximum permissible temperature of the cooling water exceeded.	The ambient temperature is too high. If the symbol continues to be displayed, notify the service department.
9.	<i>Wait for Ignition</i>		The lamp is not yet ignited.	Wait until the capacitor bank is charged and the lamp ignited.
10.	<i>Wait for Ignition (and after a short time): Power Supply off</i>		If the system is switched off and on again very quickly, the laser's power supply unit is discharged for safety reasons. Observe the correct sequences when switching it on and off. See the sections entitled SWITCHING ON on page 5-2 and SWITCHING OFF on page 5-16.	Wait a few minutes until the power supply unit has discharged and the message <i>Light Sensors</i> is displayed (normal operating status after the device is switched on). If the normal operating status is not reached after a number of minutes, the laser lamp may be faulty. Notify the service staff if this happens.
11.	<i>Keyboard error</i>		The keyboard is either not connected properly or is defective.	Check the connections and, if necessary, replace the keyboard. If the symbol continues to be displayed, notify the service department.
12.	<i>Key without function</i>		The key pressed has no effect in the current operating status.	

– blank –

7. Service and Maintenance

7.1. Material

Expendable items

Name	Item No.
Water filter F40-160 for heat exchanger	907-373-00
DI water (7 liters)	998-077-00

Wear Parts

Name	Item No.
Laser flash lamp	090-510-00
Halogen lamp 12 V/20 W	908-316-00
Leather cuff for hand openings to be mounted by the customer	907-772-00

Spare Parts

Name	Item No.
Lens protective glass	908-324-00
Lens 120 mm	907-521-00
Protective glass for Laser protective window	907-773-00
Pedal switch (electric) complete	090-511-00
Fuse 2.5 A	908-802-00
Fuse 1.6 A	908-645-00



A faultless operation of the device and best welding results can only be obtained if the maintenance activities have been executed correctly and within the prescribed intervals.

7.2. Maintenance (Care)

The maintenance of the device reduces to the cleaning of the surfaces with a damp cloth with light alkaline solution.



By no means use strong cleaning agents (e.g. cleaning powder) or solvents!

7.3. Maintenance



Caution!

All maintenance work not explicitly described in this manual may only be carried out by specially trained and authorized service engineers – even when the laser is switched off.

7.3.1. Maintenance Intervals

7.3.1.1. *Daily Maintenance*

or after strongly splashing welding

Check the protective glass in front of the lens at least once a day and, if necessary, clean it with lens-cleaning paper (e.g. KODAK lens cleaning paper or Kleenex) soaked in a solvent (propyl alcohol)

If badly splashed with metal, the protective glass must be replaced. If you don't do this, there is a risk of the glass being overheated at those points and possibly cracking, thus causing injury or destroying the lens (see the section entitled REPLACING THE LENS PROTECTIVE GLASS on page 7-4).

7.3.1.2. Weekly Maintenance

1. The plastic splash protective window behind the laser protective window should be checked at least once a week for scratches, cracks or holes.
2. Check the leather cuffs in the hand openings for signs of wear.



Caution!

If there are holes in the leather cuffs or the leather cuffs do not fit tight on the arms they must be replaced.

Otherwise there is the danger that uncontrolled laser radiation might escape.

7.3.1.3. Monthly maintenance

This maintenance work should also be carried out after unsatisfactory welding results or each lamp change.

Check the laser power as follows:

- Settings:
Voltage: 300 V or take the value from the acceptance report 10 ms
- Fire a single laser pulse at a 1.5 mm thick titanium plate. (The test blank is included with the acceptance report. Replacement blanks can be ordered from Dentaurum, J.P. Winkelstroeter KG.)
- Use a stereo microscope to compare the focal spot size and hole depth on the front and back of the titanium blank with a reference sample.

7.3.1.4. Half-Yearly Maintenance

1. Check and clean, if necessary, the heat exchanger grid with a paint brush and vacuum cleaner.
2. Check the water level in the tank (see the section CHECKING/REFILLING COOLING WATER on page 7-7)

7.3.1.5. Maintenance after 2000 operating hours or at least every two years

Replace the water filter (see REPLACING THE WATER FILTER on page 7-9) and change the deionized water.

7.3.2. Replacing the Lens Protective Glass

The protective glass prevents the lens from being damaged by mechanical influences such as metal splashes or dust. To reduce loss of performance through absorption, the protective glass is non-reflecting on both sides.



Attention!

The protective glass on the lens should also be replaced when it is slightly dirty (as a result of metal splashes, for example).

If it is not replaced, the laser beam may heat it so excessively at those points that it can crack and cause injury and further damage.

If the glass is dirtied by welding smoke, it is generally enough to clean it with alcohol/spirit. If particles are burned onto it, however, it has to be replaced.

Procedure:

1. Turn off the laser, turn main power switch to “O”.
2. Lift up hand opening flap(s).

3. Unscrew the knurled ring (1) at the underside of the lens counterclockwise, take it off and pull it out of the welding chamber as horizontally as possible.
4. Replace the old protective glass with a new one.

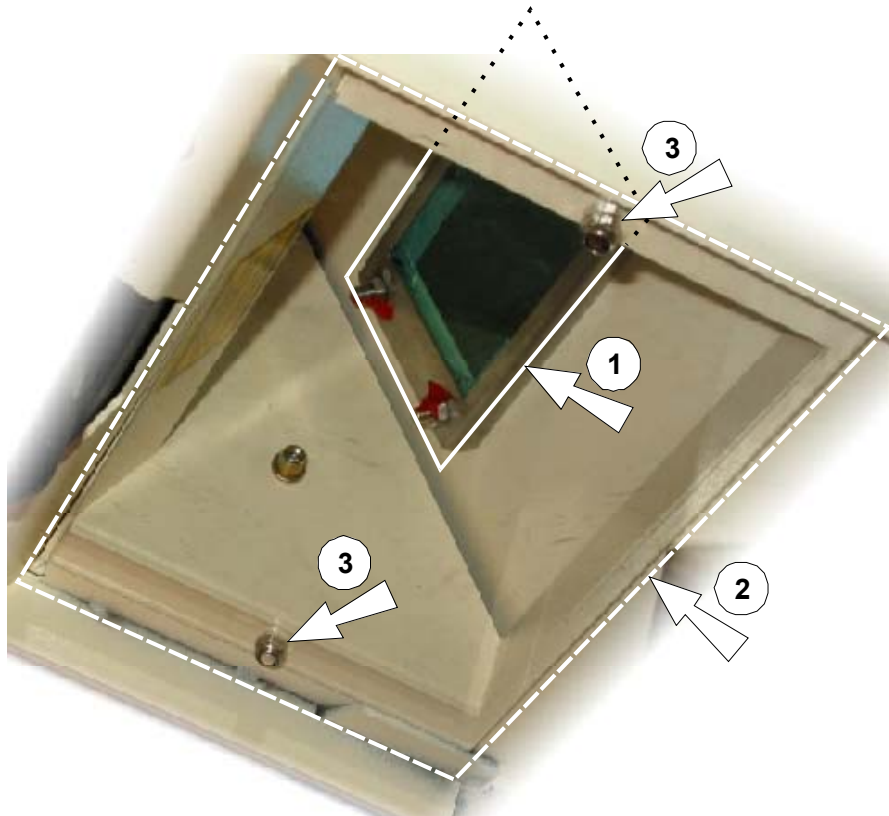


5. Screw the knurled ring together with the new class at the underside of the lens by turning it clockwise.

7.3.3. Replacing the Splash Protective Window

The observation window consists of two panes of glass:

- The laser protective window (position (1) in the figure below) prevents the emission of laser radiation and ultra-violet light.
- The splash protective window (2) protects the laser protective window from soiling and damaging.



Procedure:

1. Open the hand opening flaps fully.
2. Remove the two M4 fixing nuts (3) from inside the welding chamber, and then remove the splash-protection window.
3. Clean the splash-protection window with alcohol or a commercially available window-cleaning agent, or replace it – if necessary – with a new one.



Do not scratch the laser-protection window and splash-protection window.

Attention!

4. Secure the splash-protection window in the device using the two nuts (position (3)).

7.3.4. Replacing the halogen lamps

The two halogen lamps in the welding chamber are connected in series. Consequently, if one of the two lamps fails, the other one goes off as well even if it is still in working order. It is therefore advisable to replace one of the halogen lamps with a new one. If the lamps still do not come on in the subsequent test, replace the second lamp with the one you removed first.

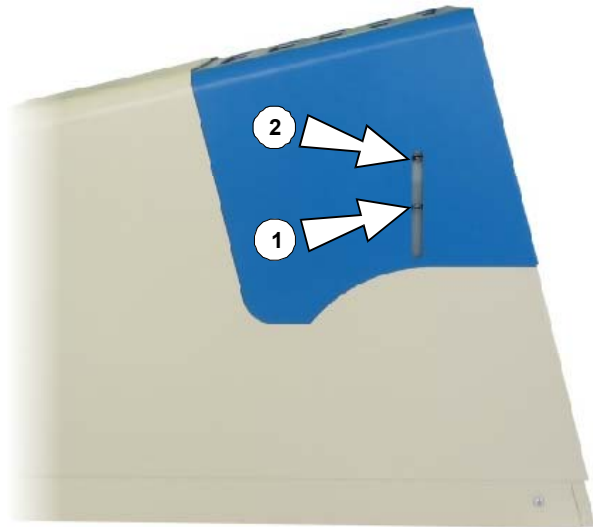
The halogen lamps can be removed from and refitted in their holders easily.



7.3.5. Checking/refilling the coolant

In the cover on the right-hand side of the device there is a recess in which you can see the coolant level in the supply tank.

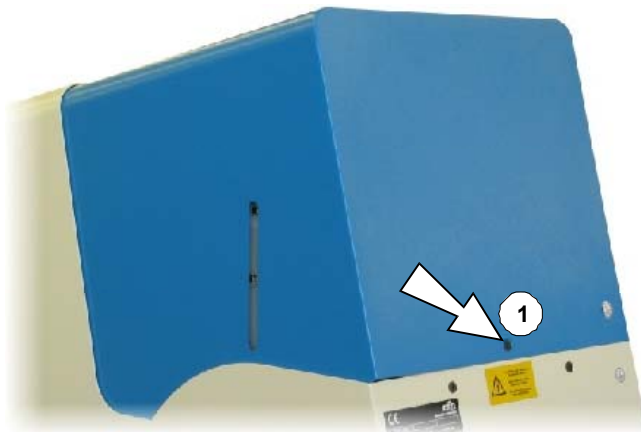
When the water level sinks to the level of the lower mark (1) on the supply tank, you have to refill the tank with deionized water.



Procedure:

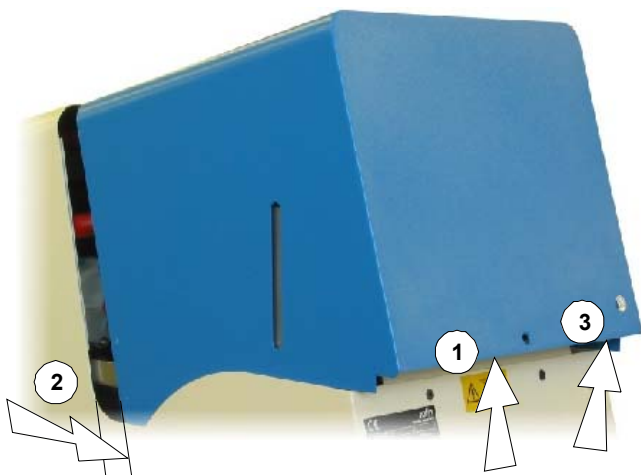
1. Switch the laser off, turn the key switch to the **AUS/OFF** position and the main switch to the **O** position.
2. **Unplug the power cord!**
3. Wait at least 5 minutes.
4. Remove protective hood

- Remove the Allen screw (1).

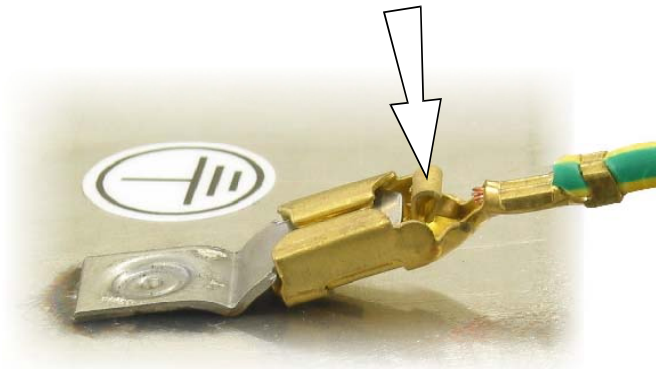


- Lift the cover at the back a little (1), and carefully push it back a few centimeters (2)...

... until you can reach the ground cable (3) with your hand.



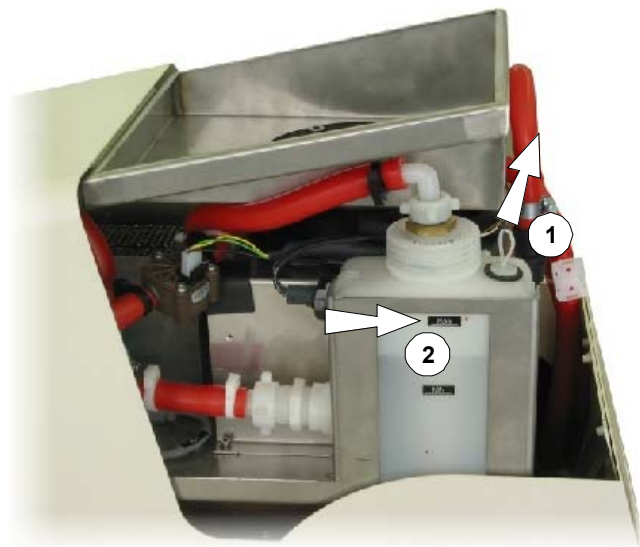
- **Undo the catch on the lug of the ground cable**, and remove the ground cable.



- Take the cover off.
5. Remove the stopper(1).
 6. Fill deionized water up to the mark "MAX" (2).

Use a funnel, for example, to help you fill it up.

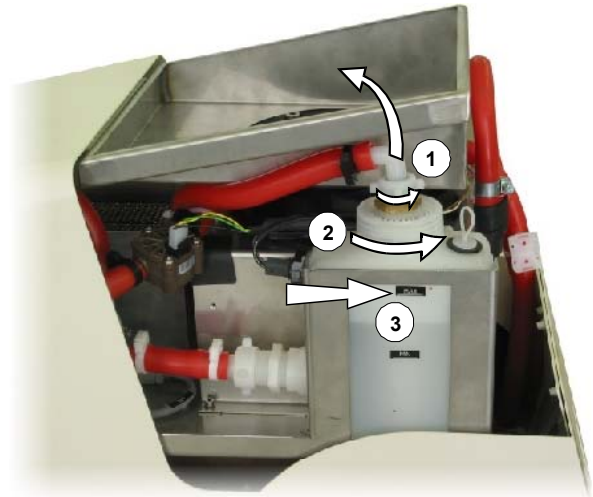
7. When you fill the device for the first time, switch it on at the main switch so that the pump starts up and the air is removed from the coolant circuit. (The water level in the supply tank sinks considerably when this happens.) Then fill up with DI water to the MAX mark.
8. Close the tank again with the stopper.
9. Put the cover in place, connect the ground cable, and screw the cover on.



7.3.6. Replacing the water filter

1. Switch the laser off, turn the key switch to the **AUS/OFF** position and the main switch to the **O** position.
2. **Unplug the power cord!**
3. Wait at least 5 minutes.
4. Remove the cover as described in item 4 in the section entitled CHECKING/REFILLING THE COOLANT on page 7-7.

5. Open the hose attachment (1).
6. Unscrew the cover of the water tank with the combination filter F65 attached below (2) and slowly pull it out.
7. Change the deionized water. To do this, pump the water out of the tank until it is empty, and then fill it up again to the "MAX" mark (3) with deionized water.
8. Put in the cover with a new filter and tightly fix it again.
9. Screw tight hose attachment (1).



10. Plug in the power supply plug.
11. Turn on the main power switch so that the pump starts up.
12. Wait 5 minutes until the air is pressed out of the laser system and the freshly refilled water is pumped through the combination filter. If necessary refill deionized water up to the mark "MAX" (3).
13. Check if the connections are tight.
14. Wait at least 30 minutes before switching on the key switch.
15. Put the cover in place, connect the ground cable, and screw the cover on.

7.4. Service

In case of any malfunction of the device that cannot be eliminated by one of the actions described in the sections MAINTENANCE or ERROR MESSAGES AND FAULT CLEARANCE, please immediately contact the service department of Dentaurum, J.P. Winkelstroeter KG.



Caution!

Service activities may only be performed by authorized and properly trained service technicians!

Technical Service

DENTAURUM J.P. Winkelstroeter KG

Turnstraße 31

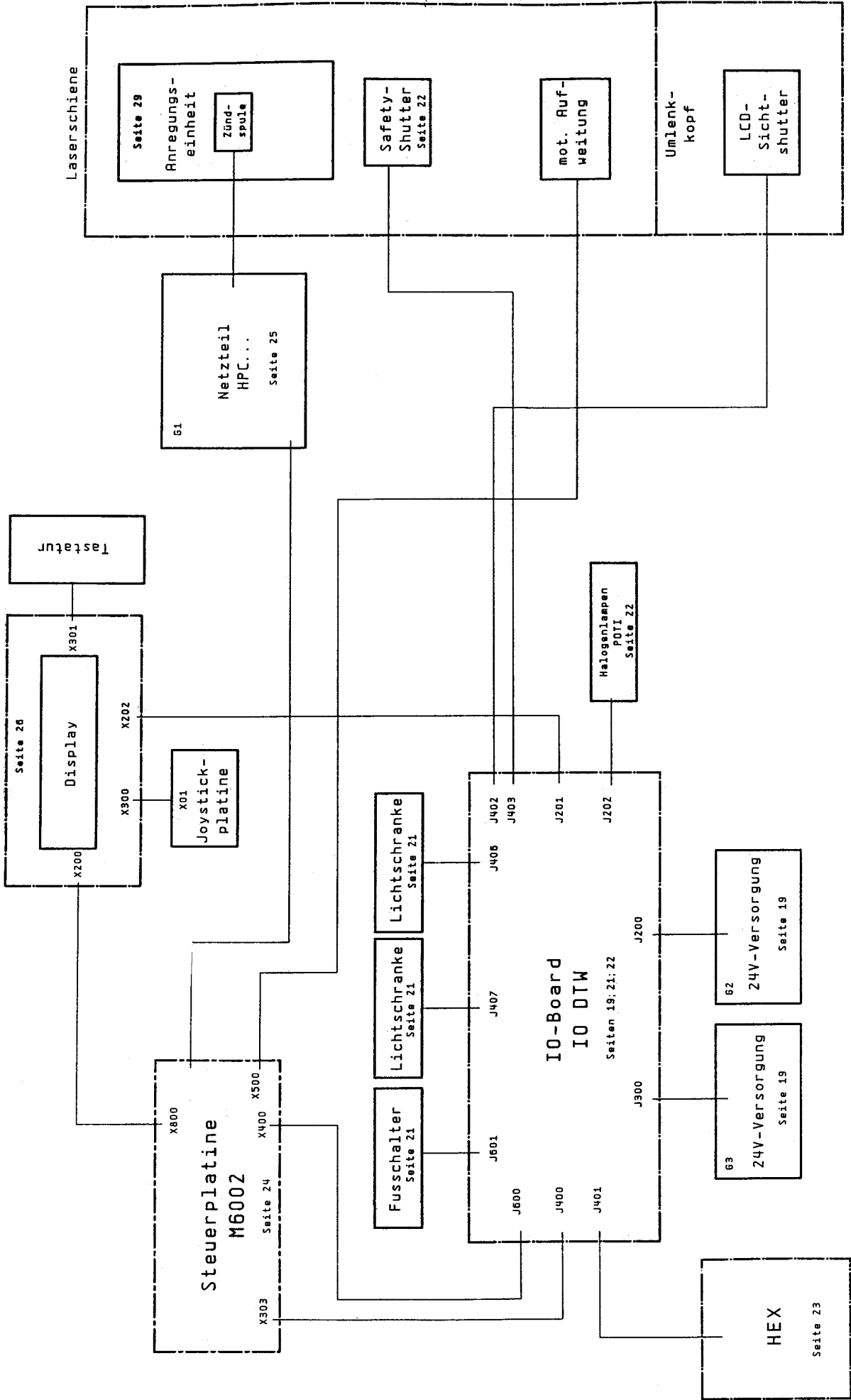
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Circuit diagrams



Dental Application Advice

Logbook

