

Frequency Stabilized HeNe Laser

Model SL 04

Instruction Manual



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IMPORTANT NOTES:

Users should carefully note the following safety precautions before commencing to use these lasers:

These lasers are intended for use exclusively by qualified personnel who are aware of the safety hazards that might be caused by laser radiation and familiar with the precautions needed for preventing them.

Carefully read this instruction manual through before commencing to use these lasers.

In particular, users should observe those safety precautions appearing in Section 4 of this instruction manual.

Although this instruction manual has been prepared with the utmost care, no liability is assumed for any errors or omissions. We also retain the right to alter products and their specifications, including specifications other than those appearing in this instruction manual, at any time without prior notice.

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1 Major Features

The Model SL 04 frequency-stabilized HeNe laser (Figure 1) has the following major features:

- Computer-aided digital stabilization using the dual-longitudinal-mode comparison method, which provides both high-frequency and high-amplitude stability
- Choice of two stabilization modes – frequency or amplitude stabilization – selectable from the front panel
- Emission of red light with a wavelength of approximately 633 nm
- Quick warm-up (typically in less than 10 min.)
- Compact design with a cylindrical laser head and separate controller



Figure 1: The Model SL 04 frequency-stabilized HeNe laser

2 Items Included

The items included with the Model SL 04 frequency-stabilized HeNe Laser are as follows:

- a laser head,
- a controller (electronics unit),
- a power cord, and
- an instruction manual (this document).

The following optional accessories are available:

- an interface to an iodine-vapor stabilized HeNe Laser,
- a Faraday isolator,
- a label indicating the orientation of the laser's plane of polarization,
- user-specified output power falling within the range 0.7 mW - 1.6 mW¹,
- modifications that allow operation at other ambient temperatures,
- a fiber coupler equipped with an alignment mechanism for use with monomode, multimode, polarization-maintaining, and non-polarization-maintaining optical fibers, and
- line adapters and power cords equipped with standard electrical plug types for Europe, the UK, the USA and Japan, or Australia.

3 Unpacking and Checking the Laser

The laser has been thoroughly checked for conformity to its mechanical and electrical specifications at our plant prior to shipment. Upon receipt, unpack the laser and check whether all of the above items are present and whether there is any evidence of shipping damage. You should immediately report any shipping damage found to the carrier since the transport insurance company may otherwise refuse to accept your claim. The original packaging should be retained for later use in the event that the laser must be moved or returned to us for repair. Warranty claims will be accepted by us only in cases where lasers are returned to us in their original packaging.

¹ The maximum available output power varies from laser to laser.

4 Remarks on Safe Use of the Laser

The laser's plasma tube located in the laser head is powered by a high-voltage DC power supply incorporated into the laser's controller. These high DC voltages are supplied to the laser head by a coaxial cable with red insulation and may be disconnected from the mating connector on the controller's rear panel. Since the laser head's tubular metallic housing is grounded to the reference plane of the laser's internal circuitry, incidence of electrical hazards due to high voltages are largely prevented, even in the event of damage to the laser head or its internal components, such as breakage of the plasma tube if the laser head is dropped or struck. The high-voltage DC power supply employed is also too weak to cause any serious personal injuries. The high-voltage cable connecting the laser head to the controller should be disconnected from the controller only while the controller is switched off. The free end of the connector is equipped with a knurled, threaded barrel (counter nut) in order to prevent it from being inadvertently disconnected. This barrel should thus always be screwed on and firmly tightened down whenever the high-voltage cable is plugged into the mating connector on the controller's rear panel.

The usual safety precautions for installing and operating electrical equipment also apply to the laser and its power supply:

- Only connect the laser's power supply to a properly installed and wired electrical outlet. To disconnect the laser from the electrical supply, simply unplug its power cord from the electrical outlet. The laser is only designed for use in dry areas and is not water-resistant.
- Never operate the laser with its head or controller housings opened. Proper operation of the laser is not possible while the head is opened due to thermal losses. Opening the laser head also adversely affects both the alignment of the mirrors on the laser's plasma tube and the alignment of its plasma tube on its beam optics, and therefore should be avoided. This action also voids any warranties. Opening the laser head will also expose the user to electrical hazards due to the high voltages present.
- If the laser head is incorporated into a larger system, its metallic housing may be grounded to the system's ground terminal or reference plane if desired.

Caution: Since the power density in the laser beam is extremely high, never look into the unattenuated beam at any specular reflections or directly view the beam or any specular reflections using optical instruments. The laser beam should be routed either well above or well below eye level wherever practicable. Accidental reflections should be avoided by taking proper precautions. The laser beam may be partially or totally blocked using the mechanical beam shutter on the beam exit end of the laser head in the event that any work must be done on the laser. This means the laser can remain online with its frequency stabilization system fully operational while work is being performed.

We highly recommend wearing suitable laser safety goggles while performing any alignment procedures.

Caution: Failure to wear safety goggles may lead to serious eye injuries, including blinding. The safety regulations currently applicable to both the laser's manufacturer and all users can be found in European standard **EN 60825-1: 2007** and other currently applicable national, state, and local standards and regulations, which should be observed at all times.

All guidelines and regulations applying to the design, construction, and equipment of laser devices of its class have been incorporated into the model SL 04, which is classified as a class 3R laser product.

Applicable national, state, local, and industrial occupational health, accident prevention, and safety regulations (in Germany, these are the "Unfallverhütungsvorschriften der Berufsgenossenschaft der Feinmechanik und Elektrotechnik für Laserstrahlung (VBG 93)") should be observed at all times.

Radiation hazard warning labels and labels bearing laser safety notices complying with currently applicable standards and regulations are affixed to the laser head's tubular housing. These labels are depicted in Figure 2 and Figure 3 below.



Figure 2: Depictions of the warning labels and notices employed.



Figure 3: The warning labels and notices affixed to the laser head.

Warning! These signs must remain affixed to the device and visible while it is in operation!

5 Setting Up and Operating the Laser

Before beginning to use the frequency-stabilized laser, all necessary connections should be made between the controller and the laser head. All mating connectors are located on the controller's rear panel, as shown in Figure 4 below. Do not plug the controller into an electrical outlet before all of these connections have been made. The primary winding of the controller's line transformer is equipped with circuitry adaptable to any standard line voltage and frequency (100-240 V AC, 50/60 Hz). All standard worldwide plugs are available as well.

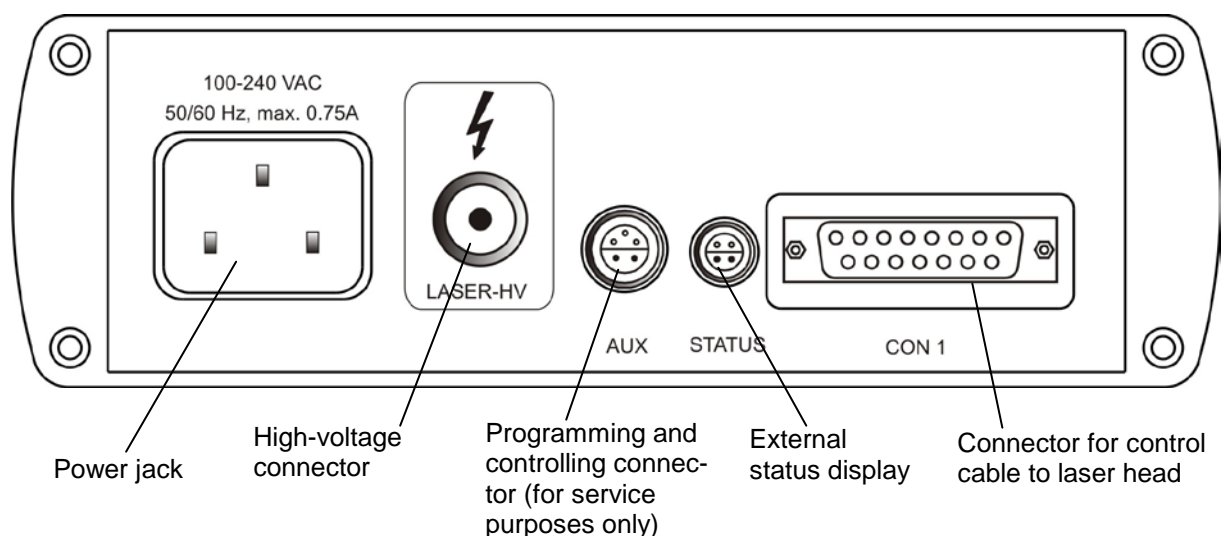


Figure 4: Connectors on the controller's rear panel (see chapter 11 for pinouts)

Caution: The laser head cables should only be inserted in or removed from the controller while it is switched off and the power cord is not plugged in.

Note: High-voltage generation is disabled when the high-voltage connector is unplugged.

The model SL 04 frequency-stabilized laser is designed for indoor use only. The laser head should be installed in a location without large temperature variations or severe vibrations that might adversely affect the frequency-stabilization system. The laser head may be mounted in any orientation. It is recommended to use pillow blocks or hose clamps that encircle the tubular housing when mounting the laser head.

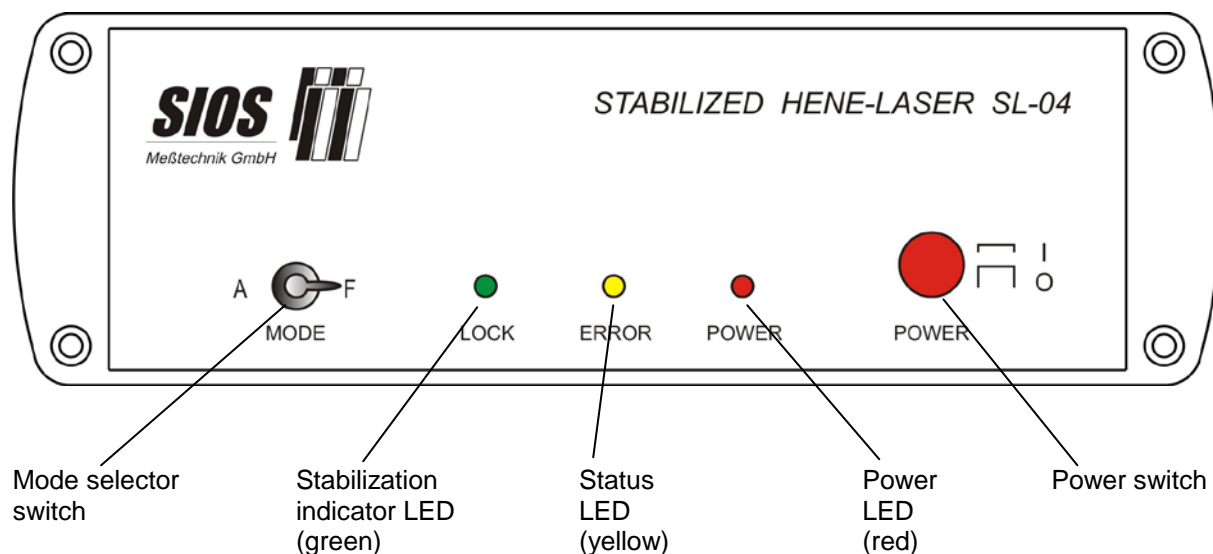


Figure 5: Layout of the controls and LEDs on the controller's front panel.

All operating controls are located on front panel of the controller, as shown in Figure 5 above. The laser is activated by switching on the controller using the “POWER” button. The red “POWER” LED will then illuminate. The gas discharge in the plasma tube will ignite and the laser beam will be emitted within two to five seconds after the laser has been switched on. Actual beam emission begins after the beam shutter is opened and accordingly, closing the beam shutter will block the beam. Laser heads equipped with fiber couplers have no beam shutters.

Output power fluctuations will usually occur during the warm-up period. The laser will be fully warmed up and ready for operation within about 10 minutes after being switched on. The green “LOCK” LED is illuminated as long as the laser frequency is stable. While in operation, the housing of the laser head will heat up, but the temperature will remain below 55°C.

The desired stabilization mode can be selected using the “MODE” selector switch. If this is set to the “A” position, the laser will run in amplitude-stabilized mode, and the “F” position engages frequency-stabilized mode. The choice of stabilization mode may be made either while the laser is running or while it is switched off. The laser will stabilize within a short period.

The green “LOCK” LED may turn off for a moment when the “MODE” selector switch is actuated. In contrast, flickering of the green “LOCK” LED or extended periods in which it is extinguished during regular operation indicate that the laser's output power

or frequency is no longer being stabilized (which property is dependent on stabilization mode). There are several reasons why this might occur:

- excessively high levels of feedback from the external optical system,
- disturbing mechanical shocks or vibrations,
- excessively high/low temperatures in the interior of the laser head due to an ambient temperature significantly above or below normal, or
- insufficient contact between the CON 1 connector and the laser head.

If the green and yellow LEDs are illuminated, the laser is currently operating normally and stable but at least one period of instability has occurred since the laser first became stable. The status of the stabilization system can also be read by an external system at any time using the status output (STATUS) on the back of the controller.

If the green LED remains off, the yellow LED remains on and the laser is otherwise operating normally, a defect in the laser head has likely occurred and customer support should be contacted.

Although the laser head requires no maintenance, it should be protected against severe moisture or dust. The optical cavity's end of life, which occurs after approx. 20 000 hours of operation, is evident when it becomes very difficult to ignite. When this point is reached, the entire laser head must be changed out.

Repairs should only be performed by the laser's manufacturer, and the unit should only be sent in using the original packaging. Repairs by users are expressly prohibited.

6 Component Descriptions

As previously shown, the SL 04 frequency-stabilized HeNe laser consists of a laser head and a controller (electronics unit).

The laser head consists of a 45 mm-diameter, 385 mm-long cylindrical metallic housing (see the dimensioned drawing in Figure 6 below) containing the laser's fixed elastic plasma tube mount, which is a dual-longitudinal-mode HeNe plasma tube using internal mirrors and having a rated output power in excess of 2 mW. Electronic circuitry is also housed in the laser head to monitor the output power radiated in its two longitudinal modes (mode-power monitoring head), to measure the plasma tube's temperature, and to modulate the plasma tube's length (resonator length).

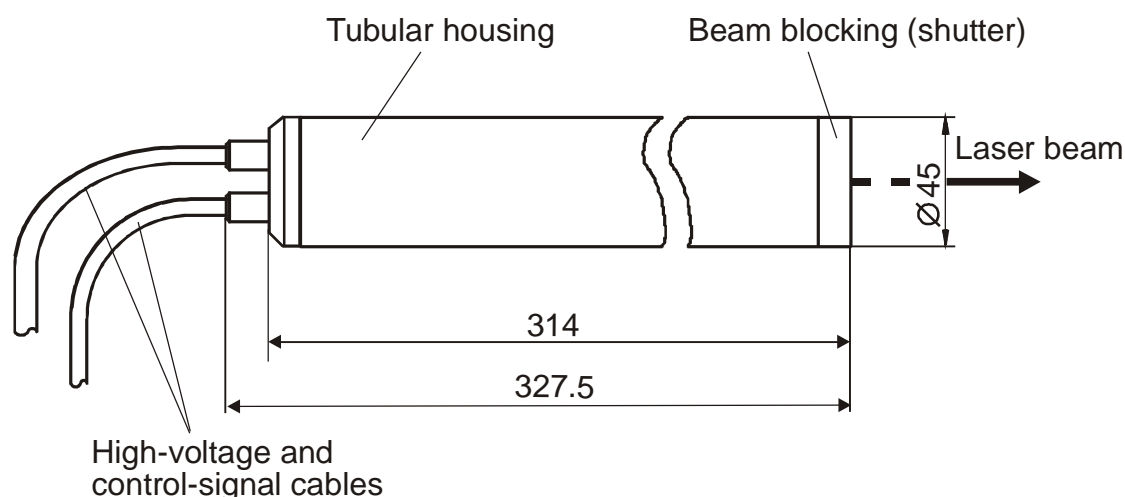


Figure 6: Laser-head dimensions and the locations of the connectors and beam-blocking shutter mounted on the laser head.

The laser head is connected to the controller by a pair of 2 m-long electrical cables: a high-voltage cable and a control-signal cable. The laser beam exits the opposite end of the laser head, concentric with its cylindrical housing. Mounted on the exit end of the laser head is a shutter complying with laser safety regulations that may be used to block the laser beam. The fiber coupler replaces this shutter on laser heads equipped with that option.

Caution: The laser head may reach temperatures as high as 55°C at high ambient temperatures.

The controller (electronics unit), which is housed in a 172 mm x 60 mm x 230 mm table-top housing (see Figure 7), is designed to accommodate various line voltages (100-240 V AC, 50/60 Hz) and incorporates a low-voltage power supply, a high-voltage power supply, and electronic control circuitry. The laser head is connected to the controller by a pair of detachable cables.

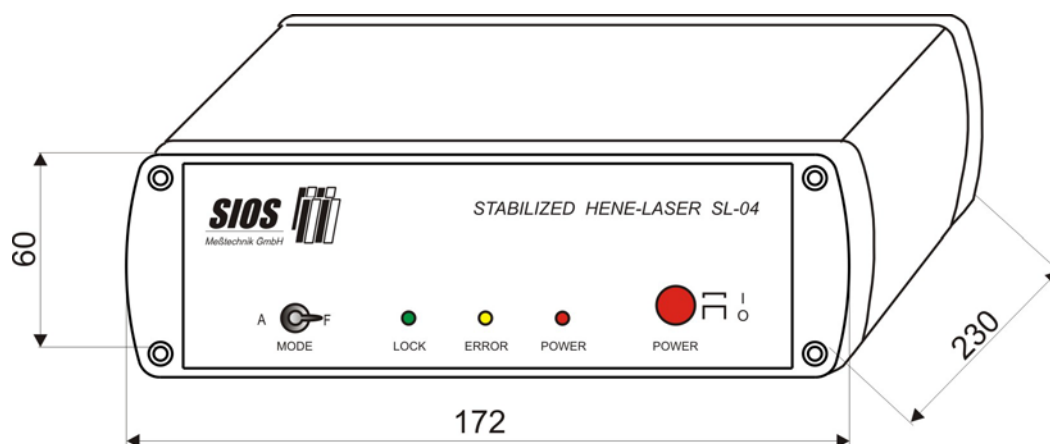


Figure 7: Dimensions of the laser controller (electronics unit).

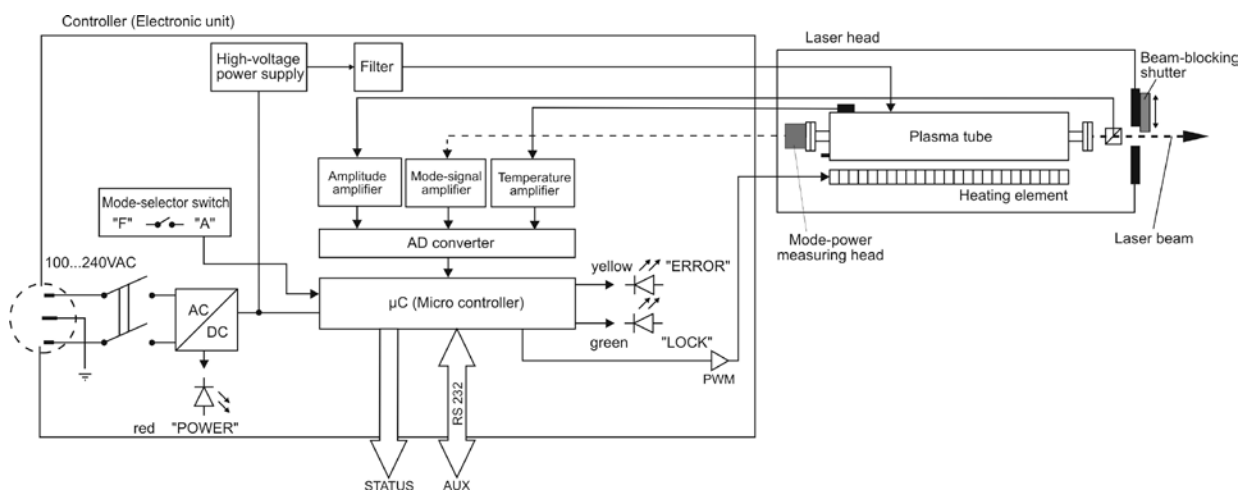


Figure 8: Block schematic of the model SL 04 frequency-stabilized HeNe laser.

A block schematic of the laser's frequency-stabilization circuitry is shown in Figure 8. The high-voltage power supply provides both the high voltage needed to ignite the discharge in the laser's plasma tube and the current needed to sustain operation once it has ignited.

Note: High-voltage generation is inactive if the high-voltage cable is not connected.

A low-pass filter blocks disturbing high-frequency modulations of the beam amplitude, thereby reducing beam amplitude noise.

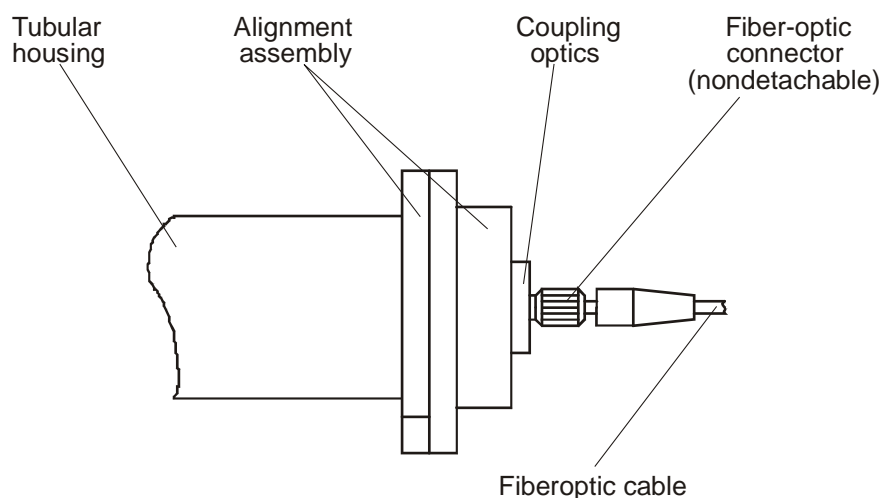


Figure 9: The fiber coupler and fiber cable.

The red “POWER” LED will illuminate when the laser is switched on. The cold plasma tube will then be preheated using the maximum available heater power in order to provide for rapid warm-ups. A built-in excess-temperature cutout prevents overheating of the plasma tube. The laser head’s power dissipation may be as much as 23 W during warm-up but will drop to about 18 W once the laser’s frequency has stabilized, which will be indicated by illumination of the green “LOCK” LED.

Stabilization has been achieved when the green “LOCK” LED is illuminated. While the laser is operated in frequency-stabilized mode, the length of the laser’s resonator (plasma tube) is regulated by controlling temperature using the mode offset signal such that the frequency and amplitude (output power) of its output beam remain extremely stable.

On units equipped with the optional fiber coupler and cable, the laser beam is coupled into a monomode optical fiber firmly attached to the exit end of the laser head’s tubular housing (see Figure 9 above). The fiber coupler is equipped with lateral translation and tilt adjustments, which are pre-aligned at the factory. The beam power entering the input end of the monomode fiber-optic cable is approximately 0.7 mW to 1.2 mW while the laser is operational and stabilized. Fiber-optic cables equipped with various

types of user-specified connectors on their free ends are optionally available, as are mating connectors equipped with fiber pigtails.

Caution: These monomode fiber-optic cables will have to be realigned whenever they have been removed from the connectors. Their removal should thus be left up to personnel authorized by SIOS Meßtechnik GmbH to perform these tasks.

7 Chassis and Faraday Isolator

For ease of installation, the stabilized HeNe laser can be assembled into a chassis (U profile) at the factory. The optionally available Faraday isolator can protect against back-feed scattering effects (see Figure 10).

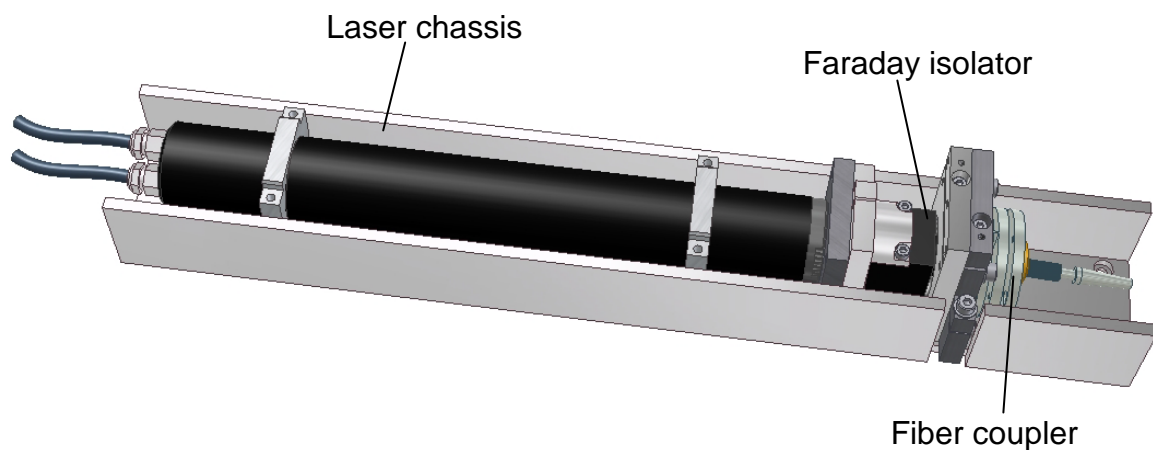


Figure 10: Stabilized HeNe laser with a Faraday isolator in a chassis

8 Technical Data

Model SL 04 Frequency-Stabilized HeNe Lasers:

Nominal wavelength	632.991234 ± 0.0002 nm
Output power	≥ 1.2 mW
Amplitude noise (30 Hz – 10 MHz)	< 0.2 %
Amplitude stability over 1 h / 1 min using frequency stabil.	< 2 % / < 1 %
Amplitude stability over 24 h / 1 min using amplitude stabil.	< 0,5 % / < 0,2 %
Beam diameter (TEM ₀₀)	0.63 mm
Beam divergence (TEM ₀₀)	1.3 mrad
Mode polarization	single, linearly polarized, longitudinal mode
Time required to warm up and stabilize	≤ 15 min
Frequency drift:	
- Max. thermal frequency drift	≤ ± 1 MHz/K
- Max. total frequency drift	± 3 MHz
Frequency stability over 1 min / 1 h / 24 h (following a 30-min warm-up period)	± 2·10 ⁻⁹ / 1·10 ⁻⁸ / 2·10 ⁻⁸
Max. tolerated optical feedback	< 1·10 ⁻⁵
Max. tolerated magnetic field strengths at laser head:	
- Magnetodynamic fields	< 10 ⁻⁶ T
- Magnetostatic fields	< 10 ⁻⁴ T
Operating temperature range	+ 15°C to + 30°C
Storage temperature range	- 20°C to + 50°C
Typical service life	≥ 15,000 h
Power dissipation while stabilized	approx. 20 W
Controller dimensions (W x H x D)	172 mm x 60 mm x 230 mm
Controller weight	1,200 g
Laser head dimensions (Dia. x L)	45 mm x 314 mm
Laser head weight	600 g
Internal thread at beam exit	1"-32 (C-Mount)
Length of the cable connecting laser head and controller	2 m
Laser safety class according to DIN EN 60825-1	3 R
Laser safety class according to ANSI Z136.1 (CDRH)	III a

Altitude range while out of operation	0 - 7,000 m
Altitude range during operation	0 - 3,000 m
Laser head shock resistance	10 g/11 ms
Line voltage/frequency	100 VAC - 240 VAC/47 Hz -63 Hz

Interchangeable line adapters and power cords equipped with plugs mating to standard types of electrical outlets commonly employed in Europe, the UK, the USA and Japan, and Australia are available.

Optional Accessories:

Single-mode fiber coupler and cable:

- Power input to fiber-optic cable	approx. 0.7 mW - 1.2 mW
- Fiber-optic cable termination	per user specification
- Fiber-optic cable length	3 m is standard, other lengths up to 25 m are available on special order

9 Maintenance and Servicing

These lasers require no maintenance. If any malfunctions should occur, refer to the instructions appearing in Section 5 of this manual.

10 Warranty

These lasers are warranted for a period of one (1) year from the date of shipment to users. All rights to claim warranty shall be voided in the event that they have been opened by unauthorized persons, abused, mishandled, or used for other than their intended purposes.

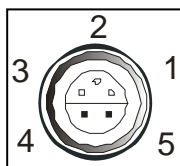
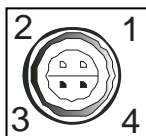
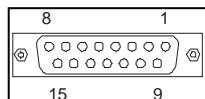
11 Location and Description of Connectors

Front panel

Label	Type	Function	Description
Mode	switch	F A	Frequency stabilization Amplitude stabilization
Look	LED	green off	Frequency or amplitude stable Frequency or amplitude unstable

Error	LED	yellow off	An error occurred Operating normally
Power	LED	red off off	Power on Power off, no mains available, device switched off Power off, internal error, fuse or current supply is defective
Power	switch	O / I	Device is off or on

Back panel

Label	Type	Function	Description														
110 - 240 VAC	mains jack	power supply	Power supply connection 110V - 240V AC 50 - 60Hz														
Laser HV	high-voltage connector ERA.1S.405.CTL	laser supply	High voltage connection of the laser head <u>Must be connected before switching on the unit!!</u>														
AUX 	5-pin Lemo device jack EPL.1S.305.HLN	I ² C and RS-232	Programming and control interface (for servicing) <table><tr><th>Pin</th><th>Signal</th></tr><tr><td>1</td><td>Tout</td></tr><tr><td>2</td><td>DGND</td></tr><tr><td>3</td><td>R1in</td></tr><tr><td>4</td><td>SCL</td></tr><tr><td>5</td><td>SDA</td></tr><tr><td>Housing</td><td>GND</td></tr></table>	Pin	Signal	1	Tout	2	DGND	3	R1in	4	SCL	5	SDA	Housing	GND
Pin	Signal																
1	Tout																
2	DGND																
3	R1in																
4	SCL																
5	SDA																
Housing	GND																
STATUS 	4-pin Lemo device jack EPL.0S.304.HLN	External status display	Pin 1 Relay contact 1-2 Pin 2 open collector output for status display, I _{max} .= 1A, High = stabile Pin 3 Ground (for open collector) Pin 4 Relay contact 1-1 Relay contact 1-1 to 1-2 closed = laser stabile; voltage-free, I _{max} = 500mA														
CON 1 	15-pin SUB-D jack	Signal connector	Signal connector cable for laser head														

Manufacturer's Certification of Compliance with Applicable EG - Guidelines

CE - Seal of Approval

Per EU-Guideline 2006/95/EC regarding low-voltage devices
and EU-Guideline 2004/108/EC regarding electromagnetic compatibility.

We hereby certify that the design and construction of the products listed below and the form in which they have been brought into commercial use are in compliance with applicable basic safety and health provisions of said EU Guidelines.

Product group: ***Frequency-Stabilized HeNe Laser SL Series***

Applicable standards

Safety:

EN 60825-1: 2007	Safety of Laser-Products
EN 61010-1: 2001	Safety requirements for electrical equipment for measurement, control and laboratory use

Emission:


EN 61000-6-4: 2001	Emission standard for industrial environments
Part EN 55011	Conducted emission of power line (class B)
	Radiated emission (class B)

Immunity:

EN 61000-6-2: 2005	Immunity for industrial environments
Part 61000-4-2	Electrostatic discharge
61000-4-3	Electromagnetic field
61000-4-4	Fast transient (Burst)
61000-4-5	Surge
61000-4-6	Conducted disturbance
61000-4-11	Voltage dips, short interruptions and voltage variations

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Ilmenau, 01 February 2009



Dr. W. Schott
Managing Director