Frequency Stabilized HeNe Laser

Model SL 03

Instruction Manual

SIOS Meßtechnik GmbH
Am Vogelherd 46
98693 Ilmenau / GERMANY
Tel.: +49-3677-64470
Fax: +49-3677-64478
Email: info@sios.de
Internet: http://www.sios.de

Edition:
March 2011

SIOS Meßtechnik GmbH

IMPORTANT NOTICE:

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 the laser.

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.

SIOS Meßtechnik GmbH
Am Vogelherd 46
D-98693 Ilmenau
Germany
Tel.: +49-3677-6447-0
FAX: +49-3677-6447-8

C O N T E N T S

1	MAJOR FEATURES	4
2	ITEMS INCLUDED	5
3	UNPACKING AND CHECKING THE LASER	5
4	REMARKS ON SAFE USE OF THE LASER	6
5	SETTING UP AND OPERATING THE LASER	10
6	COMPONENT DESCRIPTIONS	13
7	TECHNICAL DATA	17
8	MAINTENANCE AND SERVICING	18
9	WARRANTY	18

1 Major Features

The model SL 03 frequency-stabilized HeNe laser (cf. Figure 1, below) has the following major features:

- Stabilized using the dual-longitudinal-mode comparison method, which provides both high frequency stability and high amplitude stability.
- Provides a choice of two stabilization modes, frequency stabilization and amplitude stabilization, which may be selected using a front-panel selector switch.
- Emits in the red at a wavelength of approximately 633 nm.
- Warms up quickly (typically in less than 10 min.).
- Compactly designed, with a cylindrical laser head and separate controller.

Figure 1: The model SL 03 frequency-stabilized HeNe laser.

2 Items Included

The items included with the model SL 03 frequency-stabilized HeNe laser are the following:

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

The following optional accessories are available:

- interfacing 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 powers falling within the range 0.5 mW - 1.3 mW[1],
- modifications that allow operation at other ambient temperatures,
- an fiberoptic coupler equipped with an alignment mechanism for use with monomode, multimode, polarization-maintaining, and non-polarization-maintaining optical fibers,
- Line adapters and power cords equipped with plugs mating to standard types of electrical outlets employed in Europe, the UK, the USA and Japan, or Australia, and
- an adapter equipped with a 1"-32 internal thread.

3 Unpacking and Checking the Laser

Your 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 otherwise the insurance company providing

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

transport insurance may refuse to accept your claim. The original packagings 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 packagings.

4 Remarks on Safe Use of the Laser

The laser's plasma tube, which is located in the laser head, is powered by high DC-voltages provided 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 that has 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 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, are precluded to a high degree of certainty. 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 high-voltage connector on its free end is equipped with a knurled, threaded barrel (counter nut) in order to prevent its inadvertent disconnection. 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 to be observed when installing and operating items of electrical equipment thus apply to the laser and its power supply:

- Connect the laser's power supply to a properly installed and wired electrical outlet only. To disconnect the laser from the electrical supply, simply unplug its power cord from the electrical outlet. The laser has been designed for use in dry areas only and is not water-resistant.

- Never operate the laser with its head or controller housings opened. There is no point in operating the laser with its head opened, since its head is incapable of proper operation while opened due to the resultant 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 should be avoided, particularly since doing so would also void all rights to claim warranty. Opening the laser head will also expose you to electrical hazards due to the high voltages present therein.

- If the laser head is incorporated into a superordinated 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, look 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, which will allow leaving the laser running with its frequency-stabilization system fully operational while work is being performed.

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

Caution:	Failure to observe this precaution may lead to serious eye injuries, including blinding. The safety regulations currently applicable to both the laser's manufacturer and all users are the 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 our Model SL 03. The Model SL 03 is classified as a Class 3 R 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

5 Setting Up and Operating the Laser

Before commencing to use your frequency-stabilized laser, you should first make all necessary connections between its controller and laser head. All mating connectors are located on its controller's rear panel, as shown in Figure 4, below. Do not plug its controller's power cord into an electrical outlet before all of these interconnections have been made. The primary winding of its controller's line transformer is equipped with circuitry that allows using the laser with any line voltage and frequency in common use around the world. Its controller's power cord is available equipped with plugs mating to the various standard types of electrical outlets in common use around the world.

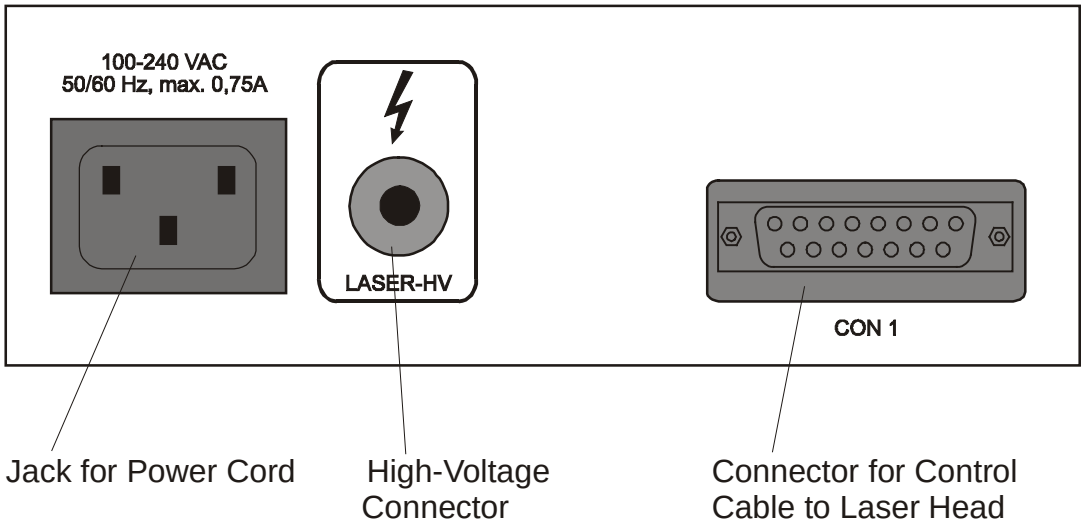

Figure 4: Connectors on the controller's rear panel.

Caution:	The cables on the laser head should connected to, or disconnected from, the controller only while the controller is switched off and its power cord has been unplugged from the electrical outlet.

The Model SL 03 Frequency-Stabilized Laser has been designed for indoor use only. Its laser head should be set up in a location where there are no large temperature variations or severe vibrations that might adversely affect its frequency-stabilization system. The laser head may be mounted in any orientation.

We recommend using pillow blocks or hose clamps that encircle its tubular housing for mounting the laser head.

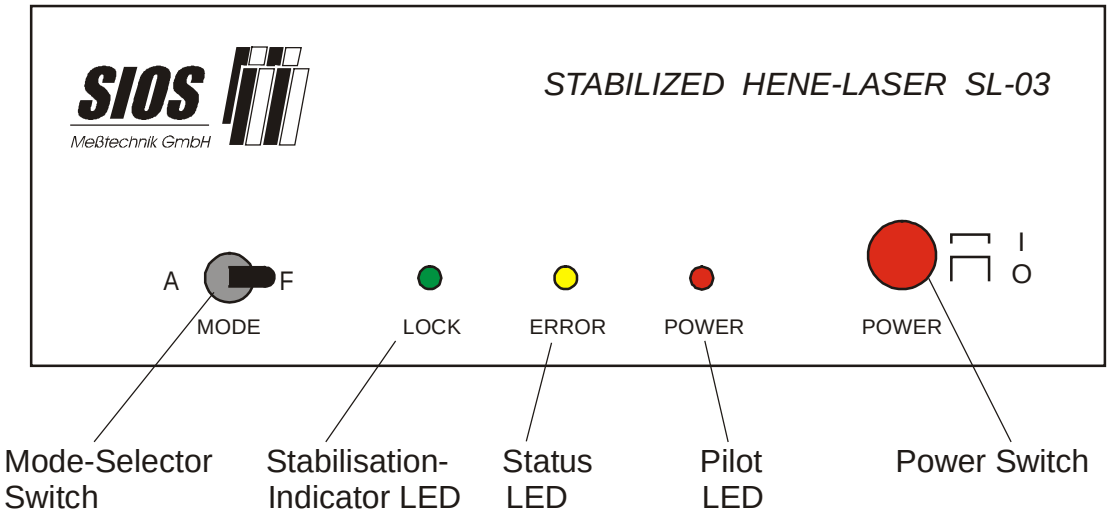

Figure 5: Layout of the controls and LED's on the controller's front panel.

All operating controls are located on the controller's front panel, as shown in Figure 5, above. To operate the laser, switch on its controller by pressing the latter's "POWER" pushbutton switch. The red "POWER" LED will then illuminate to indicate that the laser has been switched on. The gas discharge in the laser's plasma tube will ignite and the laser beam will be emitted within two to five seconds after the laser has been switched on. Opening the beam shutter will allow the beam to exit. Closing the beam shutter will block the beam. Laser heads equipped with fiberoptic couplers have no beam shutters.

Output-power fluctuations will indicate the start of the warmup period. The laser will be fully warmed up and ready for operation within about 10 minutes after it has been switched on. The green "LOCK" LED will then illuminate and remain illuminated to indicate that the laser's frequency has stabilized. During operation, the laser head's housing will heat up, but its temperature will remain below 55°C.

The stabilization mode desired may be selected using the "MODE" selector switch on the left-hand side of the controller's front panel. If this is set to its "A"-position,

the laser will run in amplitude-stabilized mode. If it is set to its “F”-position, the laser will run in frequency-stabilized mode. The choice of stabilization mode may be made either while the laser is running or while it is switched off. The type of stabilization set will be achieved within a short period. The brief extinguishings of the green “LOCK” LED that occur when the “MODE” selector switch is actuated are normal.

However, if the green “LOCK” LED should flicker or remain extinguished for an extended period during normal operation, that indicates that either the laser’s output power or frequency, depending upon the stabilization mode that has been set, is no longer being stabilized. There are several reasons why this might occur:

- excessively high levels of feedback from the external optical train,
- disturbing mechanical shocks or vibrations, and/or
- excessively high/low temperatures in the interior of the laser head due to an excessively high/low ambient temperature.

If the green “LOCK” LED remains extinguished for an extended period even though the laser appears to otherwise be operating normally, this indicates that there is a failure or malfunction somewhere in the laser head, in which case, the laser head will have to be sent in for repair.

If the yellow “ERROR” LED indicating laser status should illuminate, this indicates that the temperature in the interior of the laser head is too high. If the yellow “ERROR” LED should remain lit, even though the ambient temperature lies within the tolerated range, this indicates that there is a failure or malfunction somewhere in the controller or laser head, in which case, the controller and laser head will have to be sent in for repair. Yet another possible cause for the yellow “ERROR” LED illuminating is failure to connect the cable to the “CON 1” connector on the controller’s rear panel or a bad contact at this connector, in which case, both the cable and connector involved should be checked.

Although the laser head requires no maintenance, it should be protected against severe ingress of moisture or dust. A significant reduction in laser output power,

accompanied by erratic ignition of the plasma tube, indicates that the plasma tube is nearing the end of its service life, which is about 20,000 operating hours, in which case, the entire laser head will have to be replaced.

Repairs should be performed by the laser's manufacturer only. The laser sent in for repair should be packed in its original packagings only. Repairs by users are expressly prohibited.

6 Component Descriptions

The model SL 03 frequency-stabilized HeNe laser consists of a laser head and a separate controller (electronics unit). The laser head consists of a 34.9-mm-diameter, 280-mm-long, cylindrical metallic housing (cf. the dimensioned drawing appearing in Figure 6, below) housing the laser's elastically, but rigidly, mounted, plasma tube, which is a dual-longitudinal-mode, internal-mirror, HeNe plasma tube with a rated output power in excess of 2 mW. The electronic circuitry for monitoring the output power radiated in its two longitudinal modes (mode-power monitoring head), measuring the plasma tube's temperature, and modulating the plasma tube's length (resonator length) are also housed in the laser head.

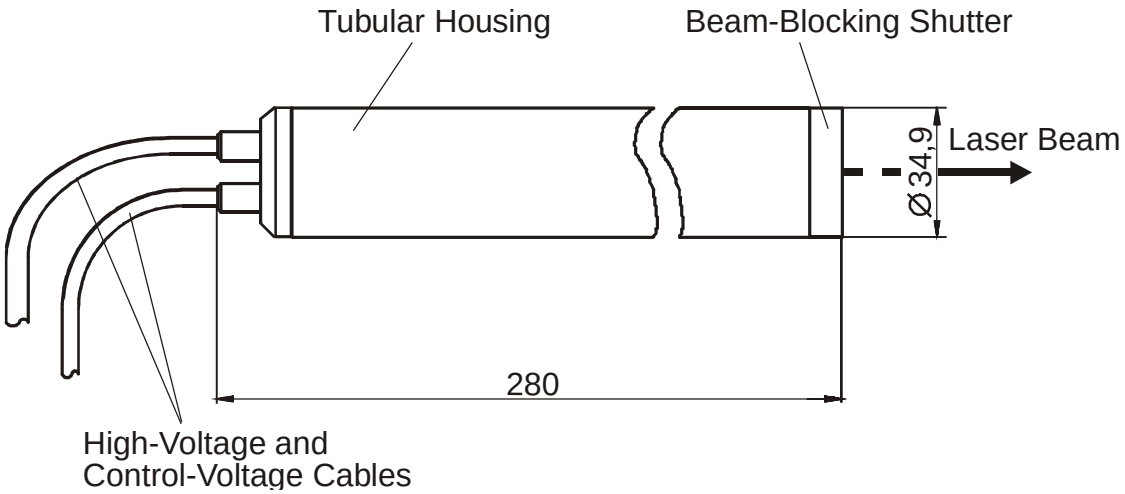

Figure 6: Laser-head dimensions and the locations of the connectors and beam-blocking shutter mounted on the laser head.

The laser head is interconnected to the controller by a pair of 0.8-m-long electrical cables, a high-voltage cable and a control-signal cable, that are hard-wired to the laser head, held in place on one end of the laser head by strain reliefs, and equipped with mating connectors on their free ends. The laser beam exits the opposite end of the laser head, concentric with its cylindrical housing. Mounted on the beam-exit end of the laser head is a shutter complying with laser-safety regulations that may be used to block the laser beam. On laser heads equipped with the optional fiberoptic coupler, the fiberoptic coupler replaces this shutter.

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 (cf. the dimensioned drawing appearing in Figure 7, below) and has been designed to accommodate line voltages ranging from 100 VAC to 240 VAC, incorporates a low-voltage power supply, a high-voltage power supply, and electronic regulation and control circuitry. The laser head is interconnected to the controller by a pair of detachable cables equipped with connectors that mate to the connectors on the controller's rear panel.

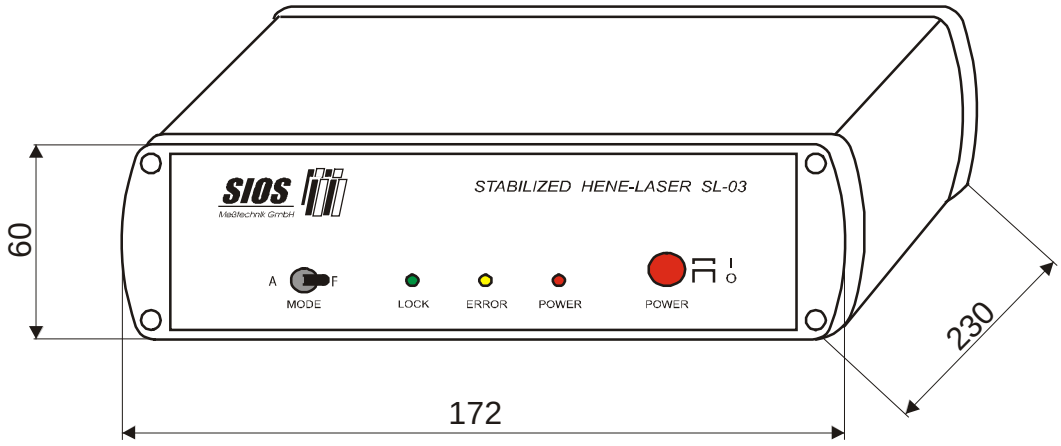

Figure 7: Dimensions of the laser's controller (electronics unit).

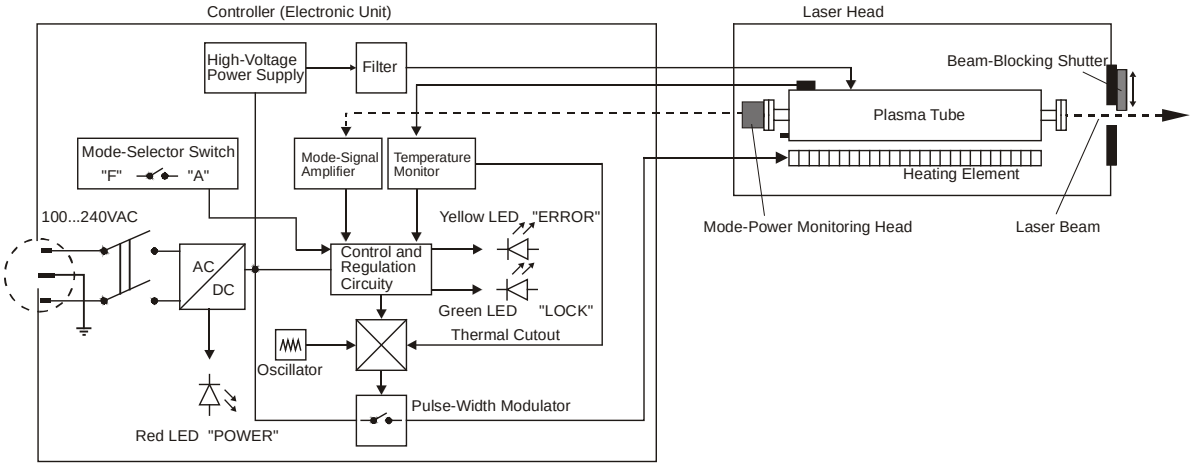

Figure 8: Block schematic of the model SL 03 frequency-stabilized HeNe laser.

A block schematic of the laser's frequency-stabilization circuitry is shown in Figure 8, above. The high-voltage power supply both provides the high voltage needed to ignite the discharge in the laser's plasma tube and automatically supplies the current needed to sustain the latter's operation once it has ignited. A low-pass filter blocks disturbing high-frequency modulations of the beam amplitude, thereby reducing beam amplitude noise.

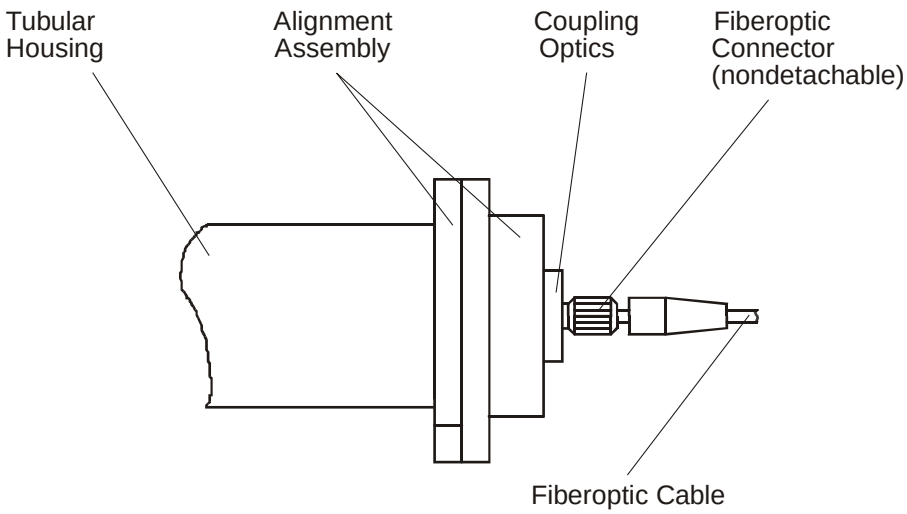

Figure 9: The optional fiberoptic coupler and fiberoptic cable.

The red “POWER” LED will illuminate to indicate that the laser has been switched on. The cold plasma tube will then be preheated using the maximum available heater power in order to provide for rapid warmups. A built-in overtemperature cutout precludes overheating of the plasma tube. The laser head’s power dissipation may be as much as 30 W during warmup, but will drop to about 20 W once the laser’s frequency has stabilized, which will be indicated by illumination of the green “LOCK” LED.

The stabilized condition will be indicated by illumination of the green “LOCK” LED. While the laser is operated in frequency-stabilized mode, the length of the laser’s resonator (plasma tube) is regulated by controlling its temperature using its mode - offset signal such that the frequency and amplitude (output power) of its output beam remain extremely stable.

On units equipped with the optional fiberoptic coupler and cable, the laser beam is coupled into a monomode optical fiber rigidly attached to the beam-exit end of the laser head’s tubular housing (cf. Figure 9, above). This fiberoptic coupler is equipped with factory-prealigned lateral-translation and tilt adjustments. The beam power entering the input end of the monomode fiberoptic cable is approximately 0.5 mW to 0.7 mW while the laser is operating in the stabilized condition. 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 fiberoptic cables will have to be realigned whenever they have been removed from the connectors mating them to fiber-optic couplers. Their removal should thus be left up to personnel authorized by SIOS Meßtechnik GmbH to perform the tasks involved.

7 Technical Data

Model SL 03 frequency-stabilized HeNe lasers:

Nominal wavelength	632.9910 nm ± 0.0002 nm
Output power	≥ 0.8 mW
Amplitude noise (30 Hz – 10 MHz)	< 0.2 %
Amplitude modulation (39 kHz)	< 0.2 %
Amplitude stability over 24 h / 1 min, frequency stabilized	< 5 % / < 0.5 %
Amplitude stability over 24 h / 1 min, amplitude stabilized	< 0.5 % / < 0.2 %
Beam diameter (TEM_{00})	0.55 mm
Beam divergence (TEM_{00})	1.5 mrad
Mode/polarization	single, linearly polarized, longitudinal mode
Time required to warm up to the stabilized condition	< 10 min
Frequency drift:	
- Max. thermal frequency drift	± 2 MHz/K
- Max. total frequency drift	± 5 MHz
Frequency stability over 1 min / 1 h / 24 h, following a 30-min warmup period	$\pm 1 \times 10^{-9}$ / 2×10^{-9} /1×10^{-8}
Max. tolerated optical feedback	$< 1 \times 10^{-5}$
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	≥ 20,000 h
Power dissipation while in the stabilized condition	< 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)	34.9 mm x 280 mm
Laser-head weight	450 g
Internal thread at beam exit	1.279“-32
Length of the cable interconnecting laser head and controller	0.8 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, or Australia are available.

Optional Accessories:

Single-mode fiberoptic coupler and cable:

- Power input to fiberoptic cable	approx. 0.45 mW - 0.6 mW
- Fiberoptic-cable termination	per user specification
- Fiberoptic-cable length	3 m is standard, other lengths up to 25 m are available on special order

8 Maintenance and Servicing

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

9 Warranty

These lasers are warranted for a period of one (1) year from their dates 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.

SIOS Meßtechnik GmbH

Manufacturer's Certification of Compliance with Applicable EU-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 herewith certify that the design and construction of the products listed below and the form in which they have been brought into commercial traffic 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: 2007	Emission standard for industrial environments
EN	55011: 2007	Conducted emission of power line (class B) Radiated emission (class B)
Immunity:		
EN	61000-6-2: 2005	Immunity for industrial environments
	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

Manufacturer: SIOS Meßtechnik GmbH
Am Vogelherd 46
D-98693 Ilmenau
Germany

Ilmenau, 01 February 2009

Dr. Walter Schott
Managing Director

Managing Director: Dr. Walter Schott
Address: Am Vogelherd 46, D-98693 Ilmenau
Phone-No. +49-3677-6447-0
Fax-No. +49-3677-6447-8
e-mail info@sios.de
Internet http://www.sios.de