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FiberVac II Manual

(Preliminary)

Version Date: August 6, 2004

Without measurement, there is no control.

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Specifications

Performance:

Sizing thresholds:

First: 0.08 µm
Second: 0.10 µm
Third: 0.15 µm
Fourth: 0.20 µm

Background counts: No more than 1 count per 30 seconds

Detection sample area: .55mm (at beam waist) x 17mm

Maximum concentration: TBD
Goal is 2,400 counts per second @ 5% coincidence

Maximum particle velocity: 80 m/sec at 0.08µ particle size

Environmental:

Sensor Head/Fiber Bundle Operating environment

Pressure: 1e-7 to 10 torr

Temperature: 20 – 80° C

Electronics Chassis Operating environment:

Temperature 15-30°C

Humidity Non-condensing

Vacuum Chamber Interface

Vacuum penetration: KF40 vacuum feed-thru
Three inputs to sensor head (1 laser source, 1 optical power feedback, 1 sensor channel)
Laser source to head via fiber bundle
Sensor head power monitor in Fiber Bundle

Laser:

Unique-Mode, model UM4000/100/20; 4W; 808nm
See Appendix A for datasheet.

Power

85-264V, 50-60 Hz, <2 Amps @ 115V

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Fuse

2A, 5x20 mm, T (SLO-BLO)

Dimensions

(Length x Width x Height):

Sensor head: 250mm x 50mm x 160mm *(does not include illumination bundle, fiber or beam dump)*

Integrated Chassis: 17.8cm x 42cm x 25cm
Electronics Chassis Weight: 12.8kg

Sensor head: approx. 4.2kg *(not including fiber bundle, graphite plate or heat shield)*

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Installation

This information is not intended to be a complete installation guide, rather it describes some important information and deals with optical alignment issues.

Laser Safety

This is a Class I laser product.

The solid state laser in this instrument is powered by a +5VDC supply.

WARNING: Always look for the following labels and strictly observe cautions and warnings.

DANGER
DISCONNECTED OPTICAL CONNECTORS MAY EMIT INVISIBLE OPTICAL ENERGY. AVOID DIRECT EYE AND SKIN EXPOSURE TO BEAM.

WARNING: **The laser bracket on the laser output should only be removed when all power is disconnected. This is only to be removed during installation, setup, or servicing by trained personnel.**

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

Do not examine or look directly at or stare into broken, sievered or disconnected optical fibers or cables.

Under normal operation and maintenance, this instrument is a Class 1 laser product. However, exposure to hazardous radiation levels is possible if the fiber optic connectors are removed during operation.

This laser product complies with DHHS radiation performance standards 21 CFR subchapter J.

Figure 1, below shows the product and laser certification labels located on the electronics box.

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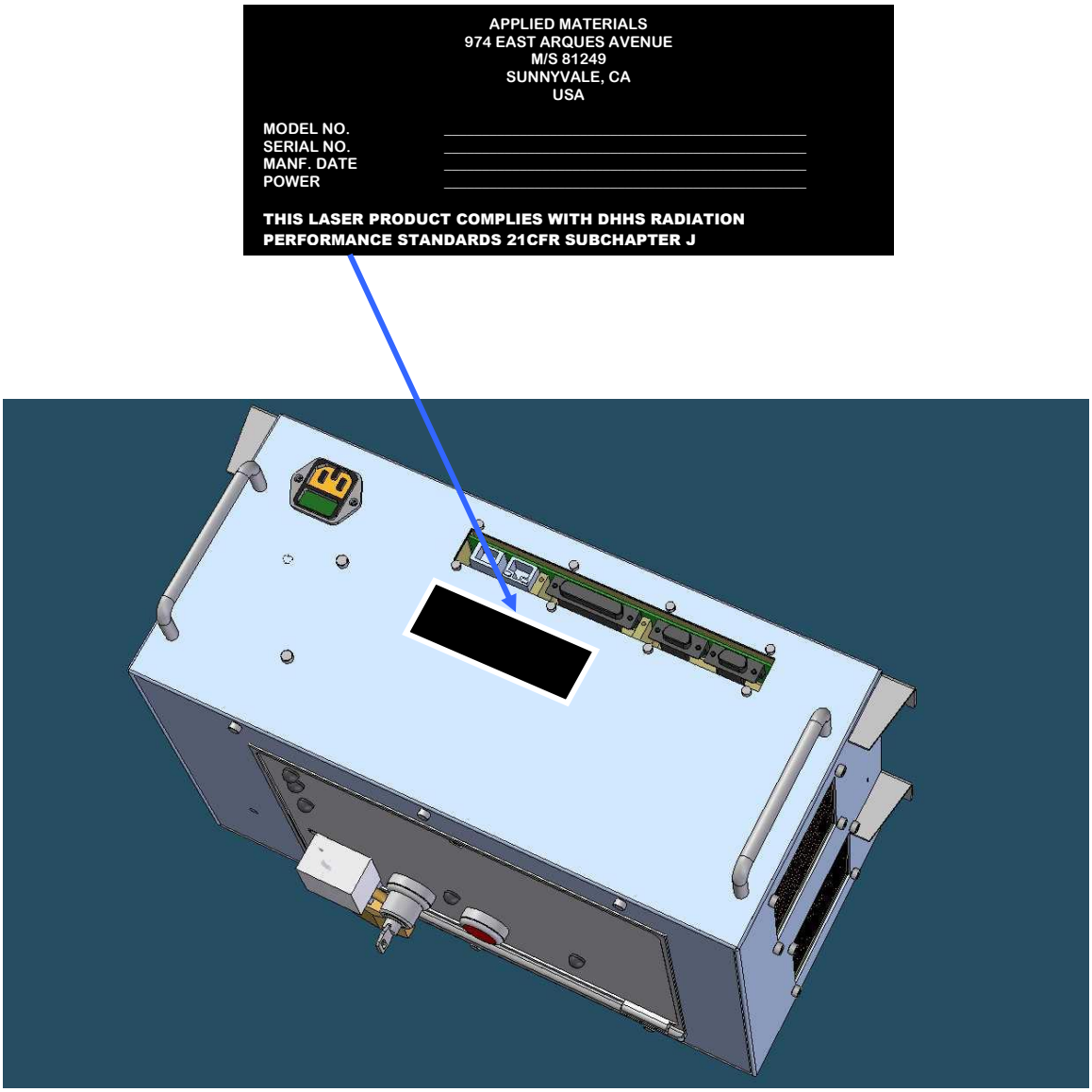


Figure 1; Chassis Certification and Product Labels

Figure 2, below, shows the bottom of the chassis with the fiber cable connectors. The laser output connector is labeled with a hazard warning. The mounting bracket must be removed to install or remove the laser power fiber.

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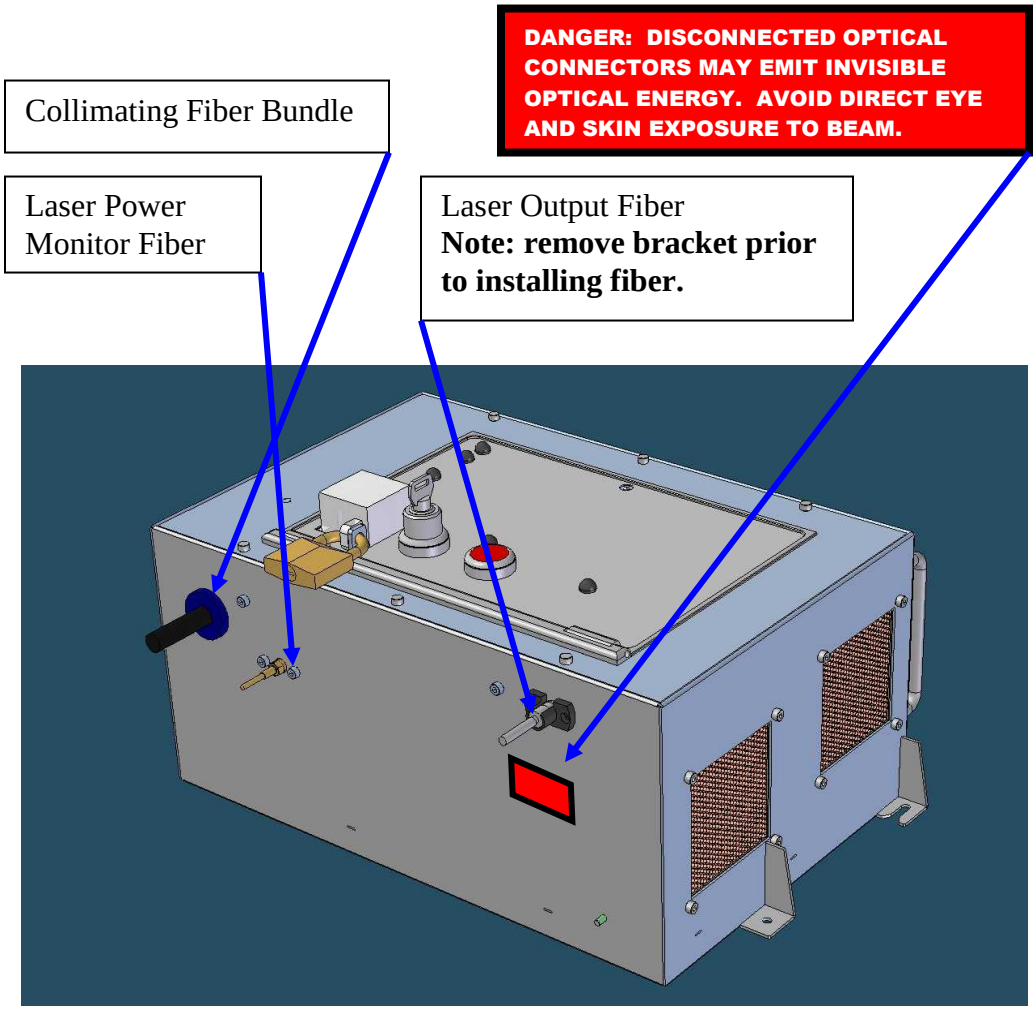


Figure 2; Electronics Chassis Bottom

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Installing the Illumination Bundle

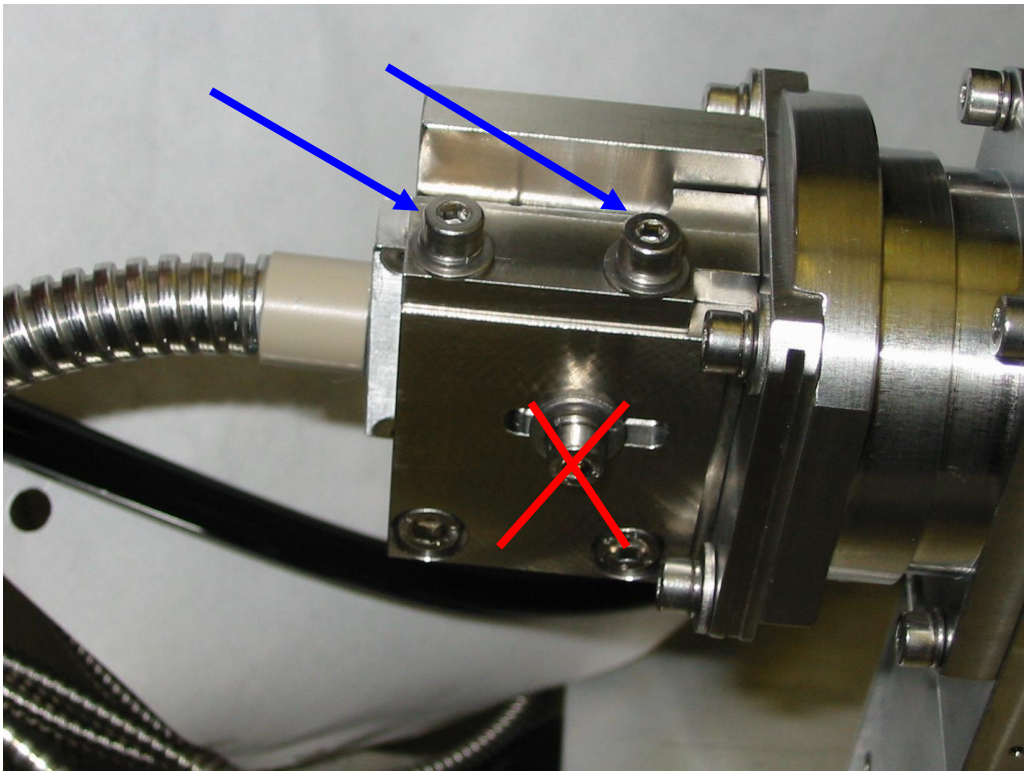


Figure 3; Illumination Bundle Mount

Figure 3, above shows a close-up of the illumination bundle mount. The two blue arrows indicate the bolts to loosen to install the bundle. The head for the bundle drops in vertically. After the head is dropped in, slide it forward until it stops. Then tighten the two bolts. The red X in the photo indicates an adjustment screw that should not be loosened.

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Laser Safety System

The FiberVac II is designed to be installed in an inaccessible location and still permit access to critical laser safety controls. For this reason, the unit has redundant controls and output signals as part of the safety interface. If the unit is remotely mounted, then the implant tool will provide a lock-out-tag-out circuit breaker for powering the unit. The lock-out-tag-out breaker can be used in place of the laser enable lock-out-tag-out switch in order to safely remove power from the laser.

The FiberVac II uses two independent laser safety systems. The first system is a relay interlock that protects the operator from the laser if the chamber door is opened. The second system is the laser drive electronics, and it provides both a lockout-key and an active laser feedback mechanism. Each system is described in detail below.

Laser Relay Interlock System

Figure 4, below shows a schematic of the laser interlock mechanism. The heart of the mechanism is a Pilz PNOZ X3 safety relay. When system power is initially applied the relay coils are de-energized and the laser is powered down. The front panel and remote trip indicators LED are lit, indicating the system is in disabled state. To enable the relays, and power the laser, the reset pushbutton (either local or remote) must be pressed. Once the Pilz system is reset, the coils are energized, and power is available to the laser. At this point the laser drive system must be enabled (as described below) to turn on the laser.

Error! No topic specified.

Figure 4; Laser Safety Interlock Relay Schematic

The Pilz relay contains two separate coil mechanisms, designated as “CH 1” and “CH 2” in the diagram. Both coils must be energized for the laser to be powered. The electronics chassis back panel connector must be wired to chamber door interlock switches. Interlock 1 and 2 are wired in the electronics to “CH 1” and “CH 2”.

In the event that any of the contacts are broken, and either CH 1 or CH 2 is de-energized, the Pilz relay will trip and remove power from the laser. The front panel and remote trip LEDs will be lit indicating this condition. In order to restore power to the laser, the fault condition must be resolved (i.e. the door must be closed to enable the switch), the power to the system must be cycled, and the pushbutton reset must be pressed. If the button is pressed with any of the interlocks open, the LEDs will remain on, and the system will not reset. Power should be cycled via the external breaker shown in Figure 5.

Laser Drive Electronics

Figure 5 shows a simplified schematic of the laser drive electronics safety mechanisms.

Error! No topic specified.

Figure 5; Laser Enable Safety System

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The laser enable system consists of front panel and remote features. There are three front panel features; two serially wired enable switches and a "laser enabled" indicator. A subset of the front panel features are duplicated remotely. The remote features include a remote laser on indicator, and a software laser enable switch. In addition, a remote lock-out-tag-out circuit breaker is used to duplicate the laser enable key switch functionality. The front panel LED indicates the status of the laser, see Table 1, below. The remote LED indicates if the laser is on.

Table 1; Laser Status LED Color Key

LED Color	Definition
Amber	Laser is on
Green	Laser is idle. Laser is not enabled. One or more enable switches have been turned off.
Red	Fault. Laser enable switch needs to be cycled. This condition is caused either by breaking the interlock circuit while the laser is on, or by an internal laser fault.

The circuit operates as follows: When power is first fed to the safety circuit (by resetting the Pilz relay) the laser is disabled. To enable the laser all three of the enable switches must be closed, and one of them must be cycled open and then closed to reset the safety. When both hardware switches and the firmware switch are closed, the electronics will try to turn on the laser. At this point, the DC light feedback monitor comes into play. The feedback monitor continuously monitors the laser output. If the laser fails, or the path is interrupted, then the monitor will cause the laser to be turned off. Figure 6, shows a logic diagram of the operation of the laser enable monitor. Essentially, the system turns on, waits a short time, and then checks to see if the DC light is OK. If so, the system continues to monitor the DC light level, if not, then the system resets. Once it has reset, the user must cycle the enable signal off and then on again to restore the laser. (This can be done with either the key switch, the toggle switch, or the remote software controlled switch.)

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FiberVac II Laser Safety Sense Circuit Functional Description
Assumes System Interlocks have been reset.

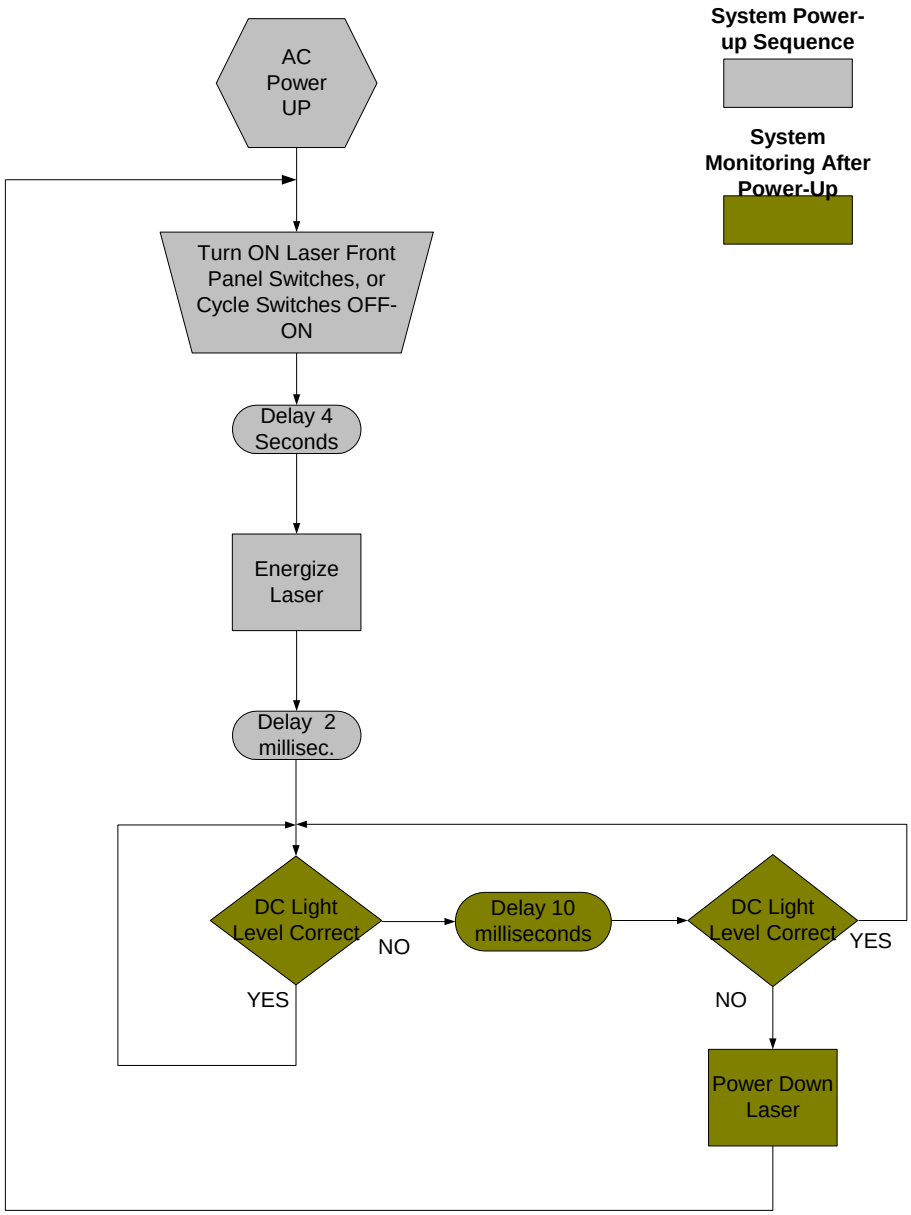


Figure 6; Flow Chart of DC Light Monitor System

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Electronics Interface

This section describes the connectors and front panel controls of the FiberVac II electronics chassis.

Chassis Description

The electronics chassis is shown below in Figure 7. The chassis is a panel mount design. The electronics connectors are on top of the enclosure, and the fiber cable connectors are on the bottom of the chassis.

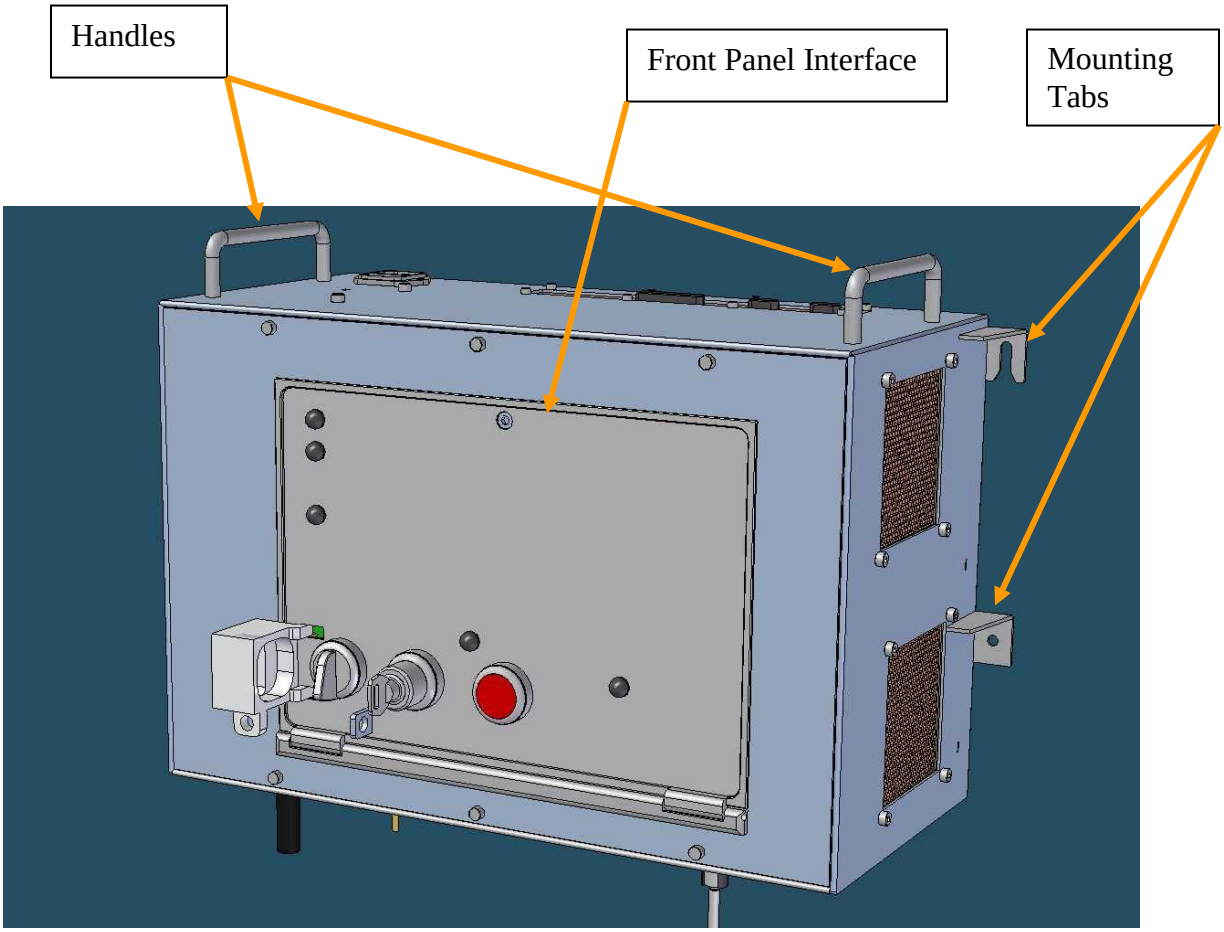


Figure 7; Electronics Chassis

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Front Panel Features

Figure 8 shows the electronics front panel, with all the features labeled.

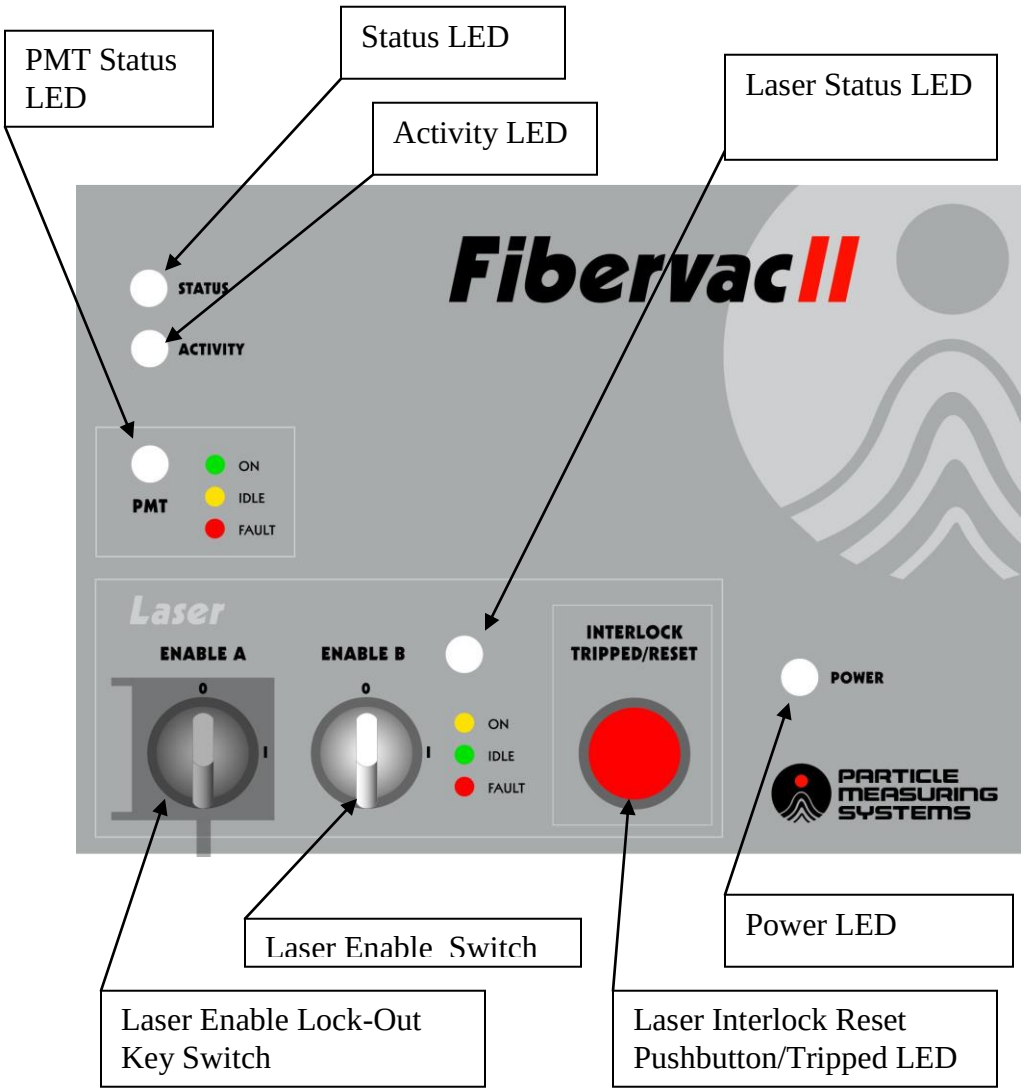


Figure 8; Electronics Front Panel

Laser Status LED This LED is amber when the laser is on. It is green when the laser enable is off. It is red, when a fault has occurred. There are two fault confitions: first if the interlock is tripped while the laser is on, and second, if the laser has an internal problem. For more details of the status LED see section titled Laser Safety System.

Laser Enable Switch This switch must be on for the laser to be enabled. For additional information see the section titled Laser Safety System.

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Laser Enable Lock-Out Key Switch This switch must be on for the laser to be enabled. For additional information see the section titled Laser Safety System.

Laser Interlock Tripped LED This LED is illuminated when the laser interlock relay needs to be reset. (The LED illuminates the reset pushbutton.) For additional information see the section titled Laser Safety System.

Laser Interlock Reset Pushbutton Press this button to reset the laser interlock relay. For additional information see the section titled Laser Safety System.

Status LED This LED will display green, yellow or red depending upon the operating conditions. When attached to a network host running the PMS TCP/IP protocol, the color of the LED will be set by the host.

PMT Status LED This LED indicates the photo-multiplier tube status.

Activity LED This LED will flash to indicate particles being counted.

Power LED This LED is illuminated, when the system power is on.

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Electronics Panel

Figure 9, below shows the connectors on the top panel of the instrument electronics.

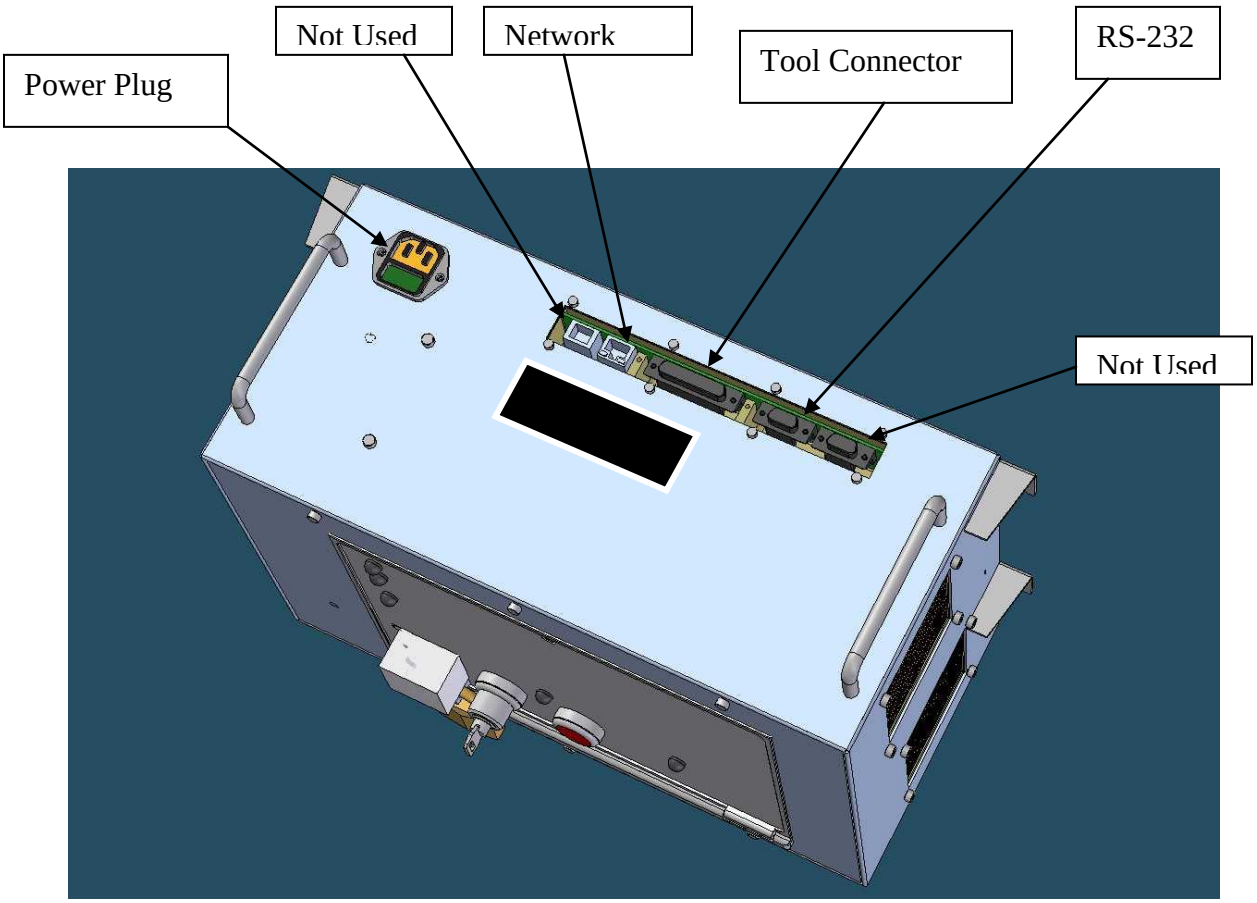


Figure 9; Electronics Top Panel

The electronic connectors are described in more detail below.

RS-232

Instrument setup and maintenance console. Provides for instrument calibration, configuration, control and data output. Handshaking is XON/XOFF (software flow control).

Connector details: Standard DB9-P connector on the instrument side (see Table 1). User cable for a PC should be wired as a null-modem (crossover), and will need DB9-S connectors on both ends.

Table 2: RS-232 Connector

Function	Pin
RX	2

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TX	3
GND	5

Tool Interface Connector

This connector provides laser control, laser safety and general tool status inputs to the FiberVac II electronics. The safety aspects of this connector are described in the section titled "Laser Safety System". Table 3, details the signals in this connector. All signals that are prefaced with a "#" indicate low-true logic.

Table 3; DB-25 Tool Interface Signals

Contact Number	Signal Name
1	Door Interlock 1 Output
2	Door Interlock 1 Return
3	Door Interlock 2 Output
4	Door Interlock 2 Return
5	Pilz Relay Reset Switch Output 1
6	Pilz Relay Reset Switch Return 1
7	Laser On LED +5V Output
8	Laser On LED Ground Output
9	Interlock Tripped +5V Output
10	Interlock Tripped Ground Output
11	#@Vacuum Output
12	#@Vacuum Return
13	#@Atmosphere Output
14	#@Atmosphere Return
15	DGND
16	DGND
17	DGND
18	Reserved
19	Reserved
20	Reserved
21	Reserved
22	Reserved
23	Reserved
24	Reserved
25	Reserved

The "#@Vacuum" and "#@Atmosphere" signals indicate when the tool is at high vacuum or at room pressure.

Ethernet

Provides communications interface for FiberVac II. The interface protocol is the PMS TCP/IP standard.

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Operations, Maintenance and Service Procedures

This section describes the standard procedures required for the FiberVac II.

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

Operations Procedures

There are no manual procedures required for operation of the instrument.

Standard Procedures for Maintenance and Service

Laser Shutdown and Disable Procedure for Maintenance and Service

This procedure is required for maintenance and service.

1. Stop system data collection.
2. Turn off the laser. This can be done either through the software interface, or from the FiberVac II front panel.
3. Lock-out the laser. This can be done either via the FiberVac II front panel interface, or it can be done by removing power from the FiberVac II via the circuit breaker. A lock-out-tag-out is required in either case.
4. Verify that the laser is off by checking the front panel or the remote laser on indicator. If the circuit breaker is off, then all LEDs should be off on both the front panel and the remote indicators. If the laser is locked but the power is on, then the front panel laser status indicator should be green. The remote laser on indicator should be dark.

Instrument Shutdown Procedure for Service

This procedure is required for service procedures.

1. Stop system data collection.
2. Turn off the laser. This can be done either through the software interface, or from the FiberVac II front panel.
3. Remove power from the instrument. This must be done via the lock-out-tag-out circuit breaker.
4. To verify that power is removed from the FiberVac II, check the front panel. The power LED (and all other LEDs) should be off.

Power Up and Laser Enable Procedure

This procedure is required for all other maintenance and service procedures. In addition, if the vacuum chamber door is opened for other service requirements, the interlock procedure must be followed to re-enable the laser. *Note: the vacuum chamber door must be closed before doing this procedure.*

1. Close the vacuum chamber door if it is open.

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2. Remove the instrument power breaker lockout tag, and return power to the instrument.
3. Remove the laser enable lockout tag (if present), from the front panel.
4. Press the interlock reset button. There is a button on the front panel, as well as a remote access button.
5. Re-enable the laser. Both the front panel knobs and the software laser enable must be set in the on position. (Note: the process of turning the enable from off to on, is required after an interlock reset for the laser to operate.)
6. Restart data collection software.

Maintenance Procedures

The procedures described here should be performed during normal tool downtime, at four to eight week (max) intervals.

Cleaning the Optics

1. Power down the FiberVac II system using procedure described above.
2. Open the vacuum chamber to access the head. (This will trip the laser-interlock system as a failsafe.)
3. Both the mirror optic and the large aspheric lens will need to be cleaned. The mirror optic may be removed for cleaning, and the aspheric lens mount can be opened (it's hinged) to facilitate cleaning access. Clean using IPA and a soft cloth. Do not scratch the optics. The beam dump assembly will also need to be cleaned. Remove the cover plate to the beam dump to access the glass. The mirror and black glass should be cleaned with IPA and a soft cloth.
4. Reassemble the optics head.
5. Close the vacuum chamber door.
6. Power up the FiberVac II and re-enable the laser using the procedure outlined below.

Service Procedures

Replacing Electronics Chassis

1. Power down the FiberVac II using the instrument shutdown procedure outlined above.
2. Remove the power connector from the instrument.
3. Remove all other electrical connections from the bottom of the instrument.
4. Remove the three fiber bundles from the top of the instrument. A 3mm allen wrench is required to remove the laser power fiber. **Warning: do not kink the fibers, and do not bend the fibers any tighter than a 5cm (2 inch) radius.**
5. Remove electronics chassis.
6. Install new chassis.
7. Attach the fiber bundles. Again, do not bend the fibers any tighter than a 5cm (2 inch) radius. Doing so will only create more work to replace the fiber bundle.
8. Attach the electrical cables.
9. Power up the system using the procedure outlined above.

Replacing the Fiber Bundle

1. Power down the FiberVac II using the instrument shutdown procedure outlined above.

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2. Disconnect the three fiber bundles from the top of the instrument. A 3mm allen wrench is required to remove the laser power fiber. Do not bend the fibers any tighter than a 5cm (2 inch) radius.
3. Open the vacuum chamber door.
4. Remove the fibers from the optics head. Do not bend the fibers any tighter than a 5cm radius.
5. Disconnect the fiber bundle's KF-40 flange from the vacuum chamber. Gently remove the fiber bundle from the chamber.
6. Feed the new fiber bundle into the vacuum chamber through the KF-40 opening. Be even more careful not to exceed the 5cm (2 inch) bend radius, since it would be a shame to have to repeat this entire process.
7. Connect the KF-40 flange.
8. Attach the three fibers in the chamber to the optics head.
9. Attach the other end of the fibers to the electronics chassis.
10. Power up the system using the procedure outlined above.

Replacing the Optics Head

1. Power down the FiberVac II using the instrument shutdown procedure outlined above.
2. Open the vacuum chamber door.
3. Remove the fibers from the optics head. Do not bend the fibers any tighter than a 5cm radius.
4. Remove the optic head from the tool.
5. Install the new optic head.
6. Attach the fibers to the new head. Again, handle the fibers carefully to avoid creating additional work by inadvertently breaking a fiber.
7. Power up the system using the procedure outlined above.

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Serial Commands

Introduction

The commands are listed in functional groups. Text enclosed in square braces (e.g. "**sys[tem]**") indicates optional information which may be omitted from the command. In other words, both "**sys**" and "**system**" are legal variants of the command. Text enclosed in curly braces (e.g. "**pmt {on | off}**") indicates the valid selections for a command. For example "**pmt on**" is a valid choice.

Command Listing

calibrate auto 25
calibrate status 25
calibrate verify 25
collect 26
data 26
default 28
flash id 28
flash pro[gram] 28
get baseline 28
get inst[rument] name 29
get inst[rument] ser[ial] 29
get inst[rument] type 29
get laser status 27
get machine status 27
get pmt status 27
get press[ure] 29
get temp[erature] 29
get time 27
head[ings] 26
laser of[f] 26
laser on 26
meas[ure] base[line] 29
opstat 27
pmt default 26
pmt of[f] 26
pmt on 26
set col[umn] 26
set diff[erential] 26
set display 26
set gate[way] 25
set host 25
set inst[rument] name 25
set ip 25
set mask 25
set multi[cast] 25
set time 25
start 26
stat[us] 28
stop 26
write 25

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System Commands

`calibrate auto`

The calibrate auto command runs the auto calibration.

`calibrate status`

The calibrate status command returns the progress of the calibration routines.

`calibrate verify`

The calibrate verify command checks to see if the instrument is in calibration.

`set ip d.d.d.d`

The set ip command allows the user to set the IP address for the unit. The IP address is not saved to non-volatile memory until a "write" command is executed.

`set gate[way] d.d.d.d`

The set gateway command allows the user to set the gateway address for the unit. The gateway address is not saved to non-volatile memory until a "write" command is executed.

`set host d.d.d.d`

The set host command allows the user to set the host IP address for the unit. The host IP address is not saved to non-volatile memory until a "write" command is executed.

`set mask d.d.d.d`

The set mask command allows the user to set the network mask for the unit. The network mask is not saved to non-volatile memory until a "write" command is executed.

`set multi[cast] d.d.d.d`

The set multicast command allows the user to set the multicast address for the unit. The multicast address is not saved to non-volatile memory until a "write" command is executed.

`set inst[rument] name "string"`

The set instrument name command allows the user set the name for the unit. The "string" is an alpha-numeric string of sixteen characters or less. The string may contain only 0 – 9, A – Z, a – z, "-", and "." characters.

`set time d.d.d.d.d.d`

The set time command allows the user to set the date and time for the unit.

`write`

The write command writes the following parameters to non-volatile memory and then reboots the unit.

Parameter
Multicast Address
Instrument Name
IP Address
Network Mask
Gateway Address

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Data Display Commands

data

The data command displays the particle count data that has been accumulated so far without interrupting the data collection.

head[ings]

The headings command displays the headings for the columns for the column formatted data display.

set col[umn] {on | off}

The set column command specifies whether the collected data is to be displayed on the CRT in horizontal format or column format.

set display {on | off}

The set display command specifies whether the collected data is displayed on the CRT or not.

set diff[erential] {yes | no}

The set differential command specifies how particle data is interpreted. In differential mode a single particle is counted in a single channel. In cumulative mode (not differential) a particle is counted in the channel that corresponds to it's size and also in all channels for larger size particles. For example: an 0.08 μm particle is counted in channels A, B, C, & D whereas a 0.2 μm particle is counted in channel D only.

Data Collection Commands

collect {value}

The collect command is used to set the desired data collection time in seconds. If the "value" is set to zero data collection will run forever. At the end of each collection period the data is displayed and a new period is started automatically.

start

The start command initiates the data collection.

stop

The stop command terminates the data collection. The data from the most recent collection period is displayed.

Control Commands

laser on

The laser on command turns on the laser.

laser of[f]

The laser off command turns off the laser.

pmt on

The pmt on command enables the PMT power supply. The command sets the PMT gain to zero prior to enabling the power supply.

pmt of[f]

The pmt off command disables the PMT power supply. The command sets the PMT gain to zero after disabling the power supply.

pmt default

The pmt default command sets the PMT gain to the default value stored in EEPROM.

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Status Commands

`get time`

The get time gain command displays the present system date and time.

`get laser status`

The get laser status command displays the present laser status. The laser status includes the following parameters.

Status Parameter	Description
Interlocks Enabled	Are all of the interlocks satisfied?
Monitor	Is the photo monitor OK?
Over Current	Has the laser current limit been exceeded?
Over Temperature	Has the laser upper temperature limit been exceeded?
Under Temperature	Has the laser lower temperature limit been exceeded?
Laser	On / Off
DC Light	Voltage proportional to the laser's optical power.

`get pmt status`

The get pmt status command displays the present PMT status. The PMT status includes the following parameters.

Status Parameter	Description
ENABLED / DISABLED	Is the power supply enabled?
Gain	PMT gain. The gain can be between 0 mV and 900 mV.
Scattered Light	The PMT output in mV.
PMT On Time	Total time that the PMT has been turned on.
PMT Exposure	Measure of the PMT exposure (anode current).
Ambient pressure	The atmospheric pressure (kPa) at the printed circuit board.

`get machine status`

The get machine status command displays present machine status. The machine status includes the following parameters.

Status Parameter	Description
@Vacuum	Is the tool chamber at the desired vacuum level?
@Atmosphere	Is the tool chamber at atmospheric pressure?

`opstat`

The opstat command displays present overall operational status. This status includes the following parameters.

Status Parameter	Description
Machine Status	Detailed above in "get machine status" command.
Channel Thresholds	The thresholds set for each data collection channel.
PMT Status	Detailed above in "get pmt status" command.
Laser Status	Detailed above in "get laser status" command.

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Data Collection Status	Data collection running? Collection period time. Elapsed time. Start date and time.
Data Display	Whether or not data will be displayed on CRT.
Differential Data	Whether or not the data is displayed in differential mode.

stat[us]
The status command displays present system status. The system status parameters are shown in the following list.

Status Parameter
Instrument Type
Firmware Version
Instrument Name
Instrument Serial Number
MAC Address
IP Address
Multicast Address
Network Mask
Gateway Address
Channel Thresholds

System Parameters

default
The default command sets default values for the parameters in the following list.

Parameter
IP Address
Host IP Address
Network Mask
Gateway Address
Multicast Address

flash id
The flash id command displays the part information for the FLASH memory in the system.
flash pro[gram]
The flash program command erases the FLASH and prompts the user for IP address of the machine and the name of the file to program into the FLASH.
get baseline
Get the baseline of this instrument from EEPROM.
get inst[rument] type
The get instrument type command displays the instrument type.
get inst[rument] name
The get instrument name command displays the instrument name.

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get inst[rument] ser[ial]
The get instrument serial command displays the instrument serial number.
meas[ure] base[line]
Measure the baseline of this instrument.

Inputs & Outputs

get press[ure]
The get pressure command reads and displays the present ambient pressure.
get temp[erature]
The get temperature command reads and displays the PCB temperature.

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Data Output Format

Introduction

The user can view the particle data in textual form via the RS-232 port, the telnet port, or as an analog voltage.

Textual Data Format

The particle data can be displayed in two different textual formats. The data can be displayed in a row format or in a column format.

Row Data Format

The following picture shows a sample of differential data in the row format.

```
Data collection sample time = 660.72 seconds.
Channel Differential    Normalized
   0.08         195           17.7 Particles per Minute
   0.10          92            8.4 Particles per Minute
   0.15          93            8.4 Particles per Minute
   0.20          64            5.8 Particles per Minute
Laser optical output is within limits.
Molecular Scatter is within limits.
Data collection time stamp = THU FEB 19 15:15:35 2004
```

The following picture shows a sample of cumulative data in the row format.

```
==>Data collection sample time = 89.72 seconds.
Channel Cumulative      Normalized
   0.08         444          130.4 Particles per Minute
   0.10         249           61.5 Particles per Minute
   0.15         157           62.2 Particles per Minute
   0.20          64           42.8 Particles per Minute
Laser optical output is within limits.
Molecular Scatter is within limits.
Data collection time stamp = THU FEB 19 15:15:35 2004
```

In the case of cumulative data the number of particles reported for the 0.20 µm channel is the same as in differential mode. The number of particles reported for the 0.15 µm channel is the sum of the 0.15 and 0.20 µm channels (93 + 64 = 157). For the 0.10 µm channel it is the sum of particles reported for the 0.10, 0.15. & 0.20 µm channels (92 + 93 + 64 = 249). For the 0.08 µm channel it is the sum of particles reported for all channels (195 + 92 + 93 + 64 = 444).

The normalized data is the number of particles reported in a channel divided by the total sample time normalized to particles per minute. For example: There were 64 particles reported in the 0.20 µm channel for a period of 660.72 seconds in the first example. The normalized particle rate is: 64 / 660.72 * 60 = 5.8 particles per minute. In the second example the number of particles is the same but the sample time is different. 64 / 89.72 * 60 = 42.8 particles per minute.

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Setting the data format to the row format can be done by typing the “set col[umn] off” command.

Column Data Format

In the column data format the data is displayed as “differential”. “Cumulative” data cannot be displayed in the column format.

The following picture shows a sample of the data in the column format.

```
==>FibervacII-RnD-0, 1, 1, 110.72,    195,     92,     93,     64, 15:15:35 2004/02/19
```

In the column format the columns are as follows:
Instrument serial number | Laser Status (0/1) | PMT Status (0/1) | Elapsed Sample Time (Sec) | Particle Count Ch. A | Particle Count Ch. B | Particle Count Ch. C | Particle Count Ch. D | Data Collection Start Time

The column headings can be displayed on the screen by typing the command “head[ing]”. The following pictures shows the resulting output.

```
Instr,  Laser OK,  PMT OK,  Sample,   0.08 ,   0.10 ,   0.15 ,   0.20 ,  Sample
 S/N ,    (0/1)   ,  (0/1) ,   Time ,  Counts,  Counts,  Counts,  Counts,   Start
                            (Sec) ,                                        Time
```

Setting the data format to the column mode can be done by typing the “set col[umn] on” command.

Laser OK

The Laser OK status is based on seven conditions. For the Laser OK status to be true all seven of these conditions must be met. The seven conditions are as follows:

1) Enabled
2) Not Over Temperature
3) Not Under Temperature
4) Not Over Current
5) Photo-Monitor OK
6) Laser DC Light Less Than Max. Limit
7) Laser DC Light Greater Than Min. Limit

PMT OK

The PMT OK status is based on three conditions. For the PMT OK status to be true all three of these conditions must be met. The three conditions are as follows:

1) Enabled
2) Molecular Scatter Less Than Max. Limit
3) Molecular Scatter Greater Than Min. Limit

Status LED

The status LED on the front panel can be three different colors. The following table shows the machine conditions that cause the LED to be the various colors.

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Value	Laser OK	PMT OK	@Vacuum	Not @Atmosphere	LED Color
15	1	1	1	1	Green
14	1	1	1	0	Red
13	1	1	0	1	Orange
12	1	1	0	0	Orange
11	1	0	1	1	Red
10	1	0	1	0	Red
9	1	0	0	1	Red
8	1	0	0	0	Red
7	0	1	1	1	Red
6	0	1	1	0	Red
5	0	1	0	1	Red
4	0	1	0	0	Red
3	0	0	1	1	Red
2	0	0	1	0	Red
1	0	0	0	1	Red
0	0	0	0	0	Red

The rows in Underlined GRAY are not physically possible since the chamber cannot be at atmospheric pressure and at vacuum at the same time.

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Quick Start Reference Guide

Power On Procedure

1. There is no power switch on the instrument. To turn it on, plug it in.
2. Press the "Laser Interlock Reset" button to reset the laser safety relay. The red LED above the switch should turn off.
3. Toggle the laser enable off, and then back on so that the green "Enabled" LED is on. (This is required on power-up even if the LED was already on.)

Commands to Enable Data Collection

`set time`
This command is optional. It is only required if the data timestamp in the serial message stream is needed. The command will prompt for date and time.

`pmt on`
Each time the system is powered on or the software is rebooted, this command must be issued.

`pmt default`
When the **`pmt on`** command is executed, the gain of the pmt is set to 0. The calibrated pmt gain is sset with this command.

`collect` ***`xx_seconds`***
Set's the data collection period. When the box is booted, the value defaults to 0, which means collect data continuously.

`start`
Start's the data collection. Data will be dumped to the serial port (or telnet connection) after either a **`stop`** is executed, or the collection time period is met.

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Verify Operational Status

The "Status" LED in the top left corner of the box will be green if the instrument is operating properly. The LED is green if:

- ✓ Laser is on, and operating properly
- ✓ PMT is on, and scattering noise is within tolerance limits.
- ✓ System is at vacuum
- ✓ System is NOT at atmospheric pressure.

The LED is orange if:

- ❖ System is at atmospheric pressure AND not at vacuum
- ❖ OR, system is at neither atmospheric pressure OR vacuum.

The LED is red if:

- ❖ Laser is not on, or a laser error condition exists.
- ❖ OR, The PMT is not on, or has an error condition.
- ❖ OR, The system is at atmospheric pressure AND at vacuum (illegal machine state).

On the serial console (or via telnet), type "**`status`**" to show a detailed description of the instrument state. The response to this command will show what's wrong if the status LED is not green. A typical command response is shown below. The items affecting the status LED are highlighted.

```
==>status
THU JAN 01 05:07:16 1970

Machine Status: Illegal Machine Status.

Channel Thresholds A: 140 B: 170 C: 30 D: 1500 G(ref): 2000
Max Counts A: 1000000 B: 1000000 C: 1000000 D: 1000000

PMT Status:     ENABLED
PMT gain = 340 mV, Ambient Pressure = 82.32 kPa, Molecular Scatter =
3.523 V
Molecular Scatter is within limits.

Laser Status:   ENABLED, Photo Monitor OK, Current OK, Temperature OK.
Laser optical output = 3.445 V
Laser optical output is within limits.

Data collection running:
Times: desired = 10 Sec(s), elapsed = 8.43, start = THU JAN 01 05:07:07
1970

Particle data will be displayed on user terminal.
Data display will be updated continuously.
Data will be displayed for specified channel only.

==>
```

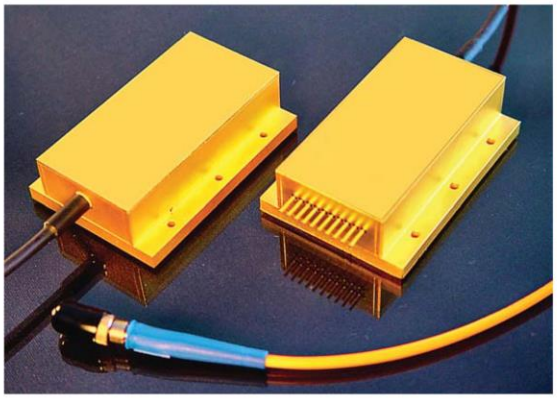

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Appendix A – Laser Datasheet

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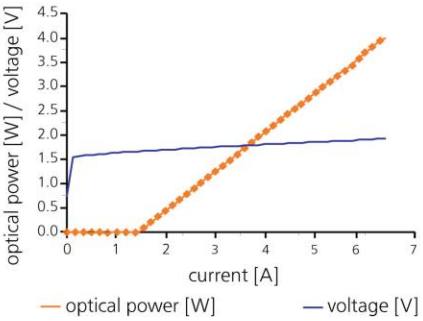
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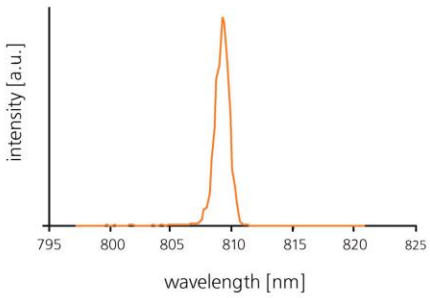


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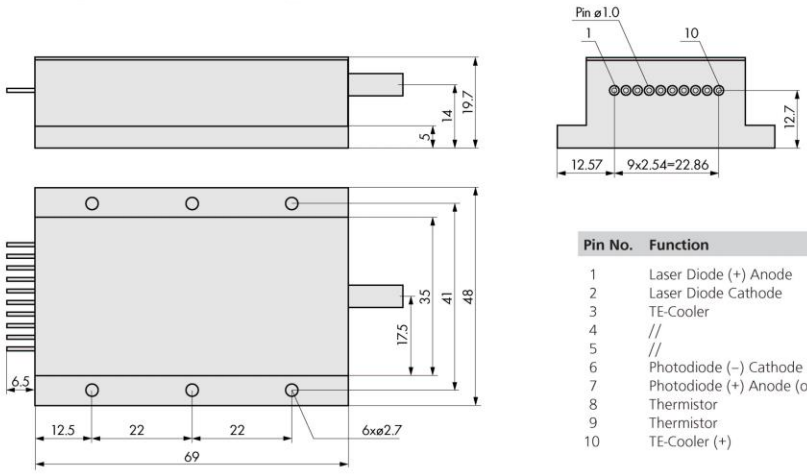
web site
www.unique-mode.com

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Electrical and Optical Characteristics

Technical parameter	UM4000/100/20 Min.	Typ.	Max.
cw Output Power		4.0 W	
Numerical Aperture (at $1/e^2$)		0.2	
Peak Wavelength	805 nm	808 nm	811 nm
Spectral Width (FWHM)		2.5 nm	
Threshold Current		1.4 A	
Operating Current		6.5 A	
Operating Voltage		2.0 V	
Fiber Core Diameter		100 µm	
Fiber Numerical Aperture		0.22	
Fiber Cladding Diameter		125 µm	
Connector Type		SMA 905	
TE-Cooler Current			8 A
TE-Cooler Voltage			10 V
Thermistor Type		NTC	
Thermistor Resistance (25°C)		10 kΩ	
Thermistor Energy Constant		3988 K	
Storage Temperature	–20°C		70°C
Operating Temperature		25°C	

Package and Pin Configuration (Dimensions in mm)



Pin No.	Function
1	Laser Diode (+) Anode
2	Laser Diode Cathode
3	TE-Cooler
4	//
5	//
6	Photodiode (–) Cathode (optional)
7	Photodiode (+) Anode (optional)
8	Thermistor
9	Thermistor
10	TE-Cooler (+)

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