



# OPHIR

||| Laser Measurement Group



VEGA

## VEGA

LASER POWER/ENERGY MONITOR  
USER MANUAL

OPHIR OPTRONICS

[www.ophiropt.com](http://www.ophiropt.com)

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# **Chapter 1.**

## **Introduction: How to Use This Manual**

The Ophir Vega is a microprocessor-based Laser Power/Energy Meter providing a broad range of measurements, displays, and data handling options. It operates with thermopile, pyroelectric and photodiode heads, and uses smart connector technology. Just connecting the head configures and calibrates the instrument.

This manual tells you what you need to know to make full use of the Vega for all your laser measurement needs. It includes a "Quick Reference", (Chapter 2) to allow you to perform basic measurements immediately, without reading the whole manual.

The main measurement sections, Chapters 4, 5 and 6 include a general description and a section detailing operating options.

## Chapter 2. Quick Reference

### 2.1 Getting Started

The Vega is equipped with "soft keys." That is, the functions of the keys change as indicated by the legend above each key. (See Figure 2.2).

To connect head to the Vega Display

Insert the 15 pin D type connector of the measuring head cable into the socket marked "Head Input" on the rear panel of the Vega display. (See Figure 2.1)

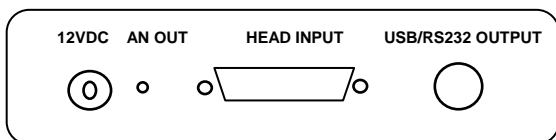


Figure 2.1  
Vega Rear Panel View



Figure 2.2

## 2.2 Functions with no Head Connected

### 2.2.1 Turning on and off.

To switch the Vega on:

Briefly press the on/off switch. (Figure 2.2). The unit will switch on, and the display will appear.

#### Note:

To work with a head, the head must be plugged in before the unit is switched on.

### **To toggle the state of the backlights on and off:**

The backlight for the Vega's LCD can be configured to toggle between full and partial illumination. Similarly, the keypad lighting can be configured to toggle between on and off. This toggling will be performed by briefly pressing the on/off switch after the Vega has been switched on.

### **To switch the Vega off:**

Press the on/off switch and hold it for about 3 seconds until the display blanks.

If you wish to save the current Vega configuration, use the "Configure" function. (See section 2.2.2).

## **2.2.2 Display Options**

### **To zero instrument:**


1. Disconnect the head, turn off then on again. "Head Disconnected" will be displayed.
2. Make sure instrument is not in an electrically noisy environment and is undisturbed.
3. Press zero and then start.

### **To set the Display Modes:**

1. Disconnect the head and switch off then on again. "Head Disconnected" will appear.
2. Select "Display Mode" and enter. Choose the desired mode and press save. **The Vega will now be in this display mode for all heads.**
3. Select "Date" and press the enter button. Using the navigation keys set to the correct date. Press Save.
4. Select "Time" and enter. Using the navigation keys, set to the correct time. Press Save.
5. For adjusting RS232 baud rate and Analog Output voltage see sections 3.5.2 and 3.5.3.



## **Adjusting GUI and Keypad Settings:**

1. Disconnect the head, turn off then on again. "Head Disconnected" will be displayed.
2. With the navigation keys go to the  icon and press the Enter key. Settings that can be adjusted are, LCD Lighting, Keypad Lighting, Color Scheme, and Bargraph Style (and parameters).
3. Select the setting to adjust with the up/down navigation keys and press Enter.
4. Select the value desired with the up/down navigation keys and press Enter.
5. Repeat until all settings are adjusted. Press "Exit" when finished.

## **Language Options:**

Vega has two language options, English and Japanese. In order to switch from English to Japanese:

1. "Language" is found either in "Head Disconnected" screen (without a head connected) or in "Instrument" screen (with head connected).
2. With the navigation keys go to "Language".
3. Press the Enter key and with the navigation keys choose "Japanese" (written in Japanese letters).
4. Press the Enter key when finished.
5. Press the second soft key from the right and Japanese will now be saved as your startup language.

## **Warning:**

In the event that you mistakably saved the Japanese language as the Vega startup language, the way to switch back to English is:

- a. Disconnect the head from the Vega.
- b. Turn the Vega off and on again. You will reach the instrument setup screen (titled "head disconnected" in Japanese).
- c. Press the down navigation key 4 times.
- d. Press the Enter. This will open a window to select the instrument language.
- e. Select "English" and press the Enter key.
- f. Press the "save" soft key and English will now be saved as your startup language.

## **2.2.3 Updating the firmware of the Vega.**

1. Download the latest firmware version of the Vega from the Ophir website: [www.ophiropt.com](http://www.ophiropt.com) and copy to your target directory.
2. Turn on the Vega.
3. Connect the USB communication cable to the Vega and the PC.
4. Using the StarLab software press "select device".
5. Select Vega. The device name will be highlighted in blue.
6. Select "upgrade Vega".
7. Browse and select the file N2AXXX.BIN, where XXX is the latest firmware version of the Vega.
8. Press "start".
9. The status will show "programming" for several minutes.
10. The status will show a green V sign and state "finished".
11. Press "Done".

## **2.3 Thermal Heads**

### **2.3.1. Use of Vega with thermal type heads.**

Most Thermopile heads have somewhat different absorption at different wavelengths. In order to compensate for this, each head has been calibrated by laser at several wavelengths. When you choose the correct laser wavelength, the correction factor for that wavelength is automatically introduced. Note that the laser wavelength correction in use is displayed in the upper left corner of the display.

Thermopile heads with the new LP1 absorber have large variation of absorption at different wavelengths. Therefore a continuous spectral curve is stored in the head, enabling the user to choose the desired wavelength from the range specified in the specification sheet and the correction factor for that wavelength is automatically introduced

### **To set type of laser being used:**

#### **With heads with fixed wavelengths:**

1. While the Vega is off, plug in the head then switch it on again.
2. Press the navigation keys until "Laser" is highlighted. Press the Enter key and select the appropriate laser wavelength.
3. If you want to save this new wavelength as the startup default, press "Save". To use this wavelength for this session only, press the Enter key.

#### **With continuous spectral curve:**

1. While the Vega is off, plug in the head. Switch on the Vega.
2. From the main measurement screen, press "Laser" to select the correct laser wavelength. If you want to save this new wavelength as the startup default, press "Save" before exiting. If the wavelength you want is not among the wavelengths in the six wavelengths listed and you want to change or add a wavelength, see step 3.
3. Changing Chosen Wavelengths:
  - 3.1. From the power measurement screen select "Laser" and enter. Move to the wavelength you wish to change or add. Press the right navigation key.
  - 3.2. Using the up/down navigation keys to change each number and the right/left navigation keys to move to the next number, key in the desired wavelength. Press the Enter key to exit. If you wish to save this new wavelength as one of the 6 favorite wavelengths, press "Save".

**Note:** Saving the new wavelength in the Modify screen will not set this wavelength as the default startup wavelength. To do so, you must follow the instructions in Step 2 above.

### **To select a range for power measurement:**

1. Select "Range" with the navigation keys. Press the Enter key.
2. Select the appropriate manual range or AUTO to select autoranging.
3. To save this new range as the startup default, press "Save". Otherwise, press the Enter key to return to the main measurement screen.

### **To choose power or energy measurement:**

1. To go from the main power measurement screen to the energy measurement screen, press the lower left soft key "Energy".
2. To go from the energy measurement screen to power measurement, press "Power".

### **2.3.2. Setting and Saving the Startup Configuration**

1. Turn on the Vega with the head connected, select "Menu" and enter. Select "Configure" and enter.
2. With the navigation keys select "Startup mode". Press the Enter key and select "Power" or "Energy" as the startup mode. Press the Enter key again to exit. If you want this mode to be permanent, press "Save" after pressing enter.
3. Select "Display Mode". Press the Enter key and select the type of screen you wish to start up with. Press Save to set this as the default display mode. If you do not want to save this as the startup mode but only change for now, press the Enter key. (This choice is saved in the instrument and not the head so the Vega will start up from the screen selected for all heads).
4. Select "Power Range". Press the Enter key and choose the manual power range you wish to be the default or choose auto range.
5. Select "Average" to select what period you wish to average power over or select the default, "NONE". See section 4.4.2.4 for details.

6. Select "Energy Range" and choose the default energy range.
  7. Select "Threshold" if you wish to change the energy threshold. See section 4.5.3 for details.
  8. Select "Laser" and select the laser type you wish to be the default.
  9. Press "Save" to save all present settings then "Exit" to get back to the main measurement screen.
- Further details on configuration in section 4.3.

### **2.3.3. Power or Single Shot Energy Measurement**

#### **Warning:**

Do not exceed maximum head limits for power, energy, power density and energy density as listed in Table 6. and Table 7 in Chapter 9. Otherwise, there is a risk of damaging the absorber.

#### **To simulate an analog needle display on the Vega:**

1. Select "Menu" and enter. Select "Needle" and enter. The display will now show a simulated analog needle type display.
2. Press "Expand" to get a full screen display of the needle. Minimum and Maximum readings will also be tracked

#### **To use the Vega to measure Laser power:**

1. Verify that the display shows "Menu: Power" in the upper right hand side of the display.
2. If the display shows "Menu: Energy" and units of J, (or mJ etc) then press "Power" to switch to the power measurement mode.

#### **To expand the bargraph scale $\pm 5x$ about the present reading:**

1. Press the "Zoom" button.
2. Press the "Zoom" button again to return to the ordinary bargraph. See Section 4.4.2.1 for full details.

#### **To subtract background and set current reading to zero:**

1. From the main power measurement screen press "Offset".
2. Press "Offset" again to cancel. See Section 4.4.2.2 for full details.

### **To use the Vega to fine-tune Laser power:**

1. From the main power measurement screen select "Menu" and enter. Select "Tune" and enter.
2. Set the percentage range of the power scale to be displayed by repeatedly pressing the  $\pm 50\%$  key.
3. Now select the horizontal sweep time you desire by selecting "Graph" and choosing the time scale.
4. You may now use the screen to tune the laser power. See Section 4.4.2.3 for full details.
5. Press "Power" to exit to the main measurement screen.

### **To use the Vega to measure Laser energy:**

1. Verify that the display shows "Energy" in the upper right hand side of the display.
2. If the display shows "Power" and units of W (or mW etc) then press "Energy" to switch to the energy measurement mode.
3. Energy measurement is performed in manual ranges only. Select "Range" and hit the Enter key. Use the navigation keys to select the proper range. To save this range as the default startup, press "Save". The correct range to select is the lowest one that is larger than the expected pulse energy to be measured. Note that the range will be displayed in the lower right corner of the main display.
4. When the Vega screen flashes "READY," on and off, fire the laser. See Section 4.5 for full details.

### **To save configuration:**

1. To save configuration, follow directions in Section 2.2.2 above.

## 2.4 Photodiode Heads

### 2.4.1. Selecting Wavelengths

1. While the Vega is off, plug in the head then switch it on again.
2. From the main measurement screen, press "Laser" to select the correct laser wavelength. If you want to save this new wavelength as the startup default, press "Save" before exiting. If the wavelength you want is not among the wavelengths in the six wavelengths list and want to change or add a wavelength, see section 2.4.2 below.
3. Follow the directions on configuration in section 2.4.4 below.

### 2.4.2. Changing Chosen Wavelengths

1. From the power measurement screen select "Laser" and enter. Move to the wavelength you wish to change or add. Press the right navigation key.
2. Using the up/down navigation keys to change each number and the right/left navigation keys to move to the next number, key in the desired wavelength. Press the Enter key to exit. To save this new wavelength as one of the 6 favorite wavelengths, press "Save".

**Note:** Saving the new wavelength in the Modify screen will not set this wavelength as the default startup wavelength. To do so, you must follow the instructions in Section 2.4.1 above.



### **2.4.3 To choose manual or automatic ranging or dBm in power measurement**

Select "Range" and enter. Using the navigation keys, select the appropriate manual range, autorange, or dBm (logarithmic scale).

### **2.4.4. Setting the Startup Configuration**

1. Select menu and press enter. Select "Configure" and enter.
2. Select "Filter" and enter. Choose filter in or out to be the default. If you only want to change for now, exit without saving.
3. Select "Display Mode". Press the Enter key and select the type of screen you wish to start up with. Press Save to set this as the default display mode. If you do not want to save this as the startup mode but only change for now, press the Enter key. (This choice is saved in the instrument and not the head so the Vega will start up from the screen selected for all heads).
4. Select "Power Range" and choose the manual power range you wish to be the default or choose autorange or dBm.
5. Select "Average:" and set the average over period over or leave the default "NONE".
6. Select "Laser" to choose the startup laser wavelength. See Section 2.4.2 above for details.
7. Press "Save" to save these settings as the default startup. When finished, press "Exit". For further details on configuration see Section 5.3.

### **2.4.5. Power Measurement**

#### **Warning:**

Do not exceed maximum head limits for power, energy, power density and energy density as listed in Table 6 and Table 7 Chapter 9. Head Specifications. Otherwise, there is a risk of damaging the absorber.

**To expand the bargraph scale  $\pm 5x$  about the present reading:**

1. Press the "Zoom" button.
2. Press the "Zoom" button again to return to the ordinary bargraph.

**To subtract background and set current reading to zero:**

1. From the main power measurement screen press "Offset".
2. Press "Offset" again to cancel. See Section 5.4.5 for full details.

**To use the Vega to fine-tune Laser power:**

1. From the main power measurement screen select "Menu" and enter. Select "Tune" and enter.
2. Set the percentage range of the power scale to be displayed by repeatedly pressing the  $\pm 50\%$  key.
3. Now select the horizontal sweep time you desire by selecting "Graph" and choosing the time scale.
4. You may now use the screen to tune the laser power. See Section 4.4.2.3 for full details.
5. Press "Power" to exit to the main measurement screen.

## **2.5 Pyroelectric Heads**

### **2.5.1 Zeroing Instrument against Head**

For the most accurate calibration, you should zero the pyroelectric head against the Vega it is being used with. Proceed as follows: Make sure the head is in a quiet environment and not subject to pulsed radiation. Plug head into Vega and turn on. Press "Menu", select "Zero" and enter. Press "Start". When "ZEROING COMPLETED" appears, press "Save". Press "Exit" and then choose the screen from the menu that you wish to use.

## **2.5.2. Changing Chosen Wavelengths (metallic type only)**

1. Select "Laser" and enter.
2. Select the wavelength you wish to use and enter. If you wish to save this wavelength as the startup default, press "Save" before exiting.
3. If you wish to modify one of the wavelengths, select the wavelength and press the right navigation key.
4. Using the up/down navigation keys to change the numbers and the right/left navigation keys to move to the next number, modify to the desired.
5. When finished, press "Save" and exit. To apply these changes to this session only, exit without pressing "Save".

## **2.5.3. To set type of laser being used**

From main measurement screen, select "Laser" and enter. Choose the desired laser type or wavelength. If you want this one to be the startup wavelength, press "Save" before exiting.

## **2.5.4. Setting Startup Configuration**

1. Turn on the Vega with the head connected, select "Menu" and enter. Select "Configure".
2. With the navigation keys select "Startup Mode", press the Enter key and select "Power" or "Energy" as the startup mode. Press Enter again to exit. If you want this mode to be permanent, press Save after pressing the Enter key.
3. Select "Display Mode". Press the Enter key and select the type of screen you wish to start up with. Press Save to set this as the default display mode. If you do not want to save this as the startup mode but only change for now, press the Enter key. (This choice is saved in the instrument and not the head so the Vega will start up from the screen selected for all heads).
4. Select "Energy Range" and press the Enter key. Choose the energy range you wish to be the default.

5. Select "Average" to select the average over period or select the default, "NONE".
6. If this head has a diffuser head, set Diffuser to IN or OUT.
7. Now select "Max Pulse Len" and choose the shortest pulse length setting longer than your laser's pulse length. **Warning:** Incorrect readings will result if pulse length is not set up correctly.
8. Select "Laser" and select the laser type you wish to be the default.
9. Press "Save" to save all present settings then "Exit" to get back to the main measurement screen.

**Note:**

Some heads have only the long pulse setting for all pulse lengths. In that case N/A appears. For further details on configuration see Sections 6.2 and 6.3.

## 2.5.5. Energy or Average Power Measurement

**Warning:**

Do not exceed maximum head limits for power, energy, power density and energy density as listed in Table 6 and Table 7, Chapter 9. Head Specifications. Otherwise, there is a risk of damaging the absorber.

With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector. You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide shows damage, then either enlarge your beam or lower the laser energy until damage is no longer seen.

**Note:**

High sensitivity pyroelectric heads (PE-9, PE-10) are very sensitive to vibration, and therefore might read a false trigger when operating in an acoustically non-stable environment. To solve such a problem, if encountered, place a flat piece of acoustically absorbing material (such as foam) under the head-base.

### **2.5.5.1. To choose Energy or Average Power Measurement**

1. To go from the main energy measurement screen to power measurement, press "Power".
2. To go from the main power measurement screen to energy measurement, press "Energy".

### **2.5.5.2. To use the Vega to measure Laser Energy and Frequency**

1. In measurement mode, verify that the units are mJ,  $\mu$ J etc. and "Energy" is displayed in the upper right corner. If not, press the "Energy" key.
2. Select "Range" and press the Enter key. Use the navigation keys to select the proper energy range. The correct range is the lowest one that is larger than the pulse energy measured. Press "Save" to keep that range as the startup default. "Exit" to return to the measurement screen

#### **Warning:**

While measuring pulsing lasers, erroneous energy reading will result if energy range is not set up correctly. See Section 6.4 for details.

### **2.5.5.3. To measure Total Energy Exposure.**

1. From the energy measurement screen select "Menu", enter and select "Exposure".
2. Select the method of measurement with "Mode", "Timeout" and "Pulses" then press "Start". Press "Start" again. The Vega will start summing laser energy exposure. To stop exposure measurement before the chosen period, press "Stop".
3. To reset the reading to zero before another reading, press "Reset".
4. To return to the main screen and press "Energy".

## Chapter 3.

### The Vega Display Unit

#### 3.1 General Description

The model Vega laser power/energy meter represents a new level of sophistication, sensitivity, compactness and accuracy, coupled with ease of operation. It can operate with thermal, pyroelectric and photodiode heads. It has smart connector technology. Simply plugging in the head configures and calibrates the Vega to operate with that head.

The Vega's 320x240 full color screen enhances measurement readouts in ways that simple monochrome displays cannot.

The Vega can graph power or energy vs. time. It displays power measurements in both digital and analog form at the same time and also has a needle type display. It will also autorange, so you do not have to set scales; or it can manual range if you wish. It will remember what mode you were using before you turned it off and will return to that mode when turned on. You can zoom in on the present reading, or subtract background. Although the calibration information is stored in the smart connector, you can recalibrate from the screen and store the new calibration in the head. You can also zero the Vega at the touch of a button.

The main instructions as well as full help files are clearly shown on the screen so you should not have to refer to this manual very often. Above all, the Vega has advanced circuitry and digital signal processing for excellent sensitivity, signal to noise ratio, accuracy, and response time. It also has special circuitry to reject electromagnetic interference.

The Vega comes with built in connection to PC via either USB or RS232 and comes with PC software to display and process the information.

## **3.2 Smart Connectors**

The Vega display, is versatile and can operate with either thermal, pyroelectric or photodiode type laser measuring heads. The head configuration and calibration information is stored in an EEROM in the head connector plug. This means that when the head is plugged in, the Vega automatically identifies the head type, calibration and configuration. The user does not have to adjust anything.

### **Note:**

In ROM versions earlier than 1.96, the Vega does not recognize when a head has been disconnected. Therefore, when changing heads, the display should be turned off; the new head plugged in; and then the Vega should be turned on again. From ROM version 1.96, this is no longer necessary, as the Vega will recognize when a head has been disconnected and will restart itself. See section 3.6.5 for details

When no head is plugged in and the Vega is turned on, the display indicates "Head Disconnected" and gives the user the opportunity to change the baud rate, re-zero the instrument, and set the real time clock or other features. See section 3.5.

## **3.3 Soft Keys**

### **3.3.1. Soft Keys**

The soft keys accessed by the menu button have functions defined by the legend above the key. The legend usually indicates what will happen when pressing the key. For example, if "Energy" appears above a key, pressing that key will change the Vega into energy mode. Some functions operate when the key is pressed and are canceled when the key is pressed again. Those keys show reverse highlighting when operational. Pressing the same key again cancels the operation and the highlighting.

## Key Functions

The Vega has certain conventions as to the meaning of standard key strokes and these are as follows:

**Highlighted item:** The highlighted item is the item that is presently active.

### Navigation Keys:



These buttons move to the next active item leftwards, rightwards. These are the navigation keys. The right and left buttons move to the next active item rightwards and leftwards. The up and down buttons move to the next active item upwards and downwards. The round button in the center is an enter button to enter the screen of the item selected or when finished, to leave that screen.

### Go or Start:

This puts into operation the active item.

### Exit:

This gets you to the previous screen and saves changes made until instrument is turned off.

### Save:

This saves changes permanently. The change is implemented now and is also saved for future use of the instrument.



### 3.4 Power Up and Shut Down



Figure 3.1

### **To turn the Vega on:**

Briefly press the on/off switch. (See Figure 3.1)

The unit will switch on, and the display will appear. If no head is connected, a display showing "Head Disconnected" will appear. If a head is connected, the appropriate default measurement screen will appear.

### **To toggle the state of the backlights on and off:**

The backlight for the Vega's LCD can be configured to toggle between full and partial illumination. Similarly, the keypad lighting can be configured to toggle between on and off (see Section 3.6.1 for full details). This toggling will be performed by briefly pressing the on/off switch after the Vega has been switched on.

### **To switch the Vega off:**

Press the on/off switch and hold it for ~ 3 seconds until the display blanks.

If you wish to save the current Vega configuration, use the "Configure" function before switching off. For measurements of the same type, the Vega does not need to be set up each time. See the appropriate section in the chapter dealing with the head type you intend to use.

## **3.5 Vega Functions, which are Independent of Head Type**

When no head is connected to the Vega and it is turned on, the message "Head Disconnected" appears. In this mode, the user can adjust the startup screen, either the standard power/energy screens or other specialized screens. He can adjust the baud rate for optimum communication with the PC; choose the appropriate maximum analog output value, or the user can zero the instrument to eliminate any offsets. He can adjust the real time date and time setting.

### 3.5.1. Display Mode

The Vega can operate in the standard power/energy measurement screen or needle type display or can display the information in specialized forms: an attenuation screen, a tune/exposure screen, a power/energy density screen, a screen normalized to some value or a screen with limits. Select "display mode", enter and set the screen to the type you want the instrument to start up in and then exit by pressing the enter button again. (For more details on the various screen options, see section 4.6).



Figure 3.1.1  
Needle Screen

### 3.5.2 RS232 Baud Rate

If you are using the Vega for RS232 communication with a PC, the baud rate can be set by selecting "RS232 baud" and selecting the appropriate rate then pressing enter and save. Unless you need especially fast communications, leave the default of 9600.

### **3.5.3. Analog Output**

The Vega has a feature of adjustable analog output where you can choose a full-scale output of 1, 2, 5 and 10 Volts full-scale output. To set the analog output voltage, select "An. Output", enter, select the voltage, enter again and save.

### **3.5.4 Clock Settings**

The Vega is equipped with a real time clock which will show the date and time. This clock will also allow the Vega to query the head attached and notify you if the head is due for calibration.

To set the clock, select "Date" and enter. First select the month with the up/down navigation keys, then move to the date with the right/left navigation keys and so on. Save and enter. Do the same with the time.

### **3.5.5. Zero Adjustments**

In the Vega, all adjustments, including zeroing internal circuits, are done from the software. This ensures simple and accurate realignment. It is recommended to re-zero the Vega every 2 months for best performance. The simple zeroing procedure follows.

1. If a head is connected, disconnect the head, turn off the instrument then back on again so the Vega can identify that no head is connected. "Head Disconnected" will be displayed.
2. Let the Vega run for at least 30 seconds before performing zero adjustment.
3. Press "Zero".
4. Make sure the instrument is not in an electrically noisy environment and is undisturbed. Press "Start" and wait for message, "ZEROING COMPLETED". Now press "Save" and the new zero will be saved. Press "Exit" to return to the main screen.

**Note (for Thermal Heads only):**

For best results with thermal heads, it may be necessary to do the procedure once with the head disconnected then afterwards again with the head connected.

After completing steps 1 - 4 above, Connect the head and make sure it is at room temperature and well shielded from any stray thermal power. It may be best advised to lay the head with the absorber face down on the table.

5. Switch the instrument off then on again with the head connected.
6. Select "Menu" and choose "Zero". Press "Start" and wait for message, "ZEROING COMPLETED". Now press "Save" and the new zero will be saved. Press "Exit" to return to the menu. Select the desired display mode and press the Enter key.

**3.6 Hardware Functions****3.6.1. Backlights****3.6.1.1. LCD Backlight**

The LCD backlight is actually a set of LED's that illuminate the display from behind. Because the Vega uses a color display, the backlight must be constantly on. It can be operated at full or half intensity (to conserve power consumption). The Vega can also be configured to allow toggling of the backlight level with the on/off switch.

The Vega backlight consumes considerably less power than competing instruments and therefore it can operate from the battery even when the charger is not plugged in. Nevertheless, since it does shorten the time between charges, it is recommended to operate the instrument without the backlight when the instrument is operated without the charger.

### 3.6.1.2. Keypad Backlight

A set of LED's is arranged on the Vega's keypad panel in order to illuminate them when necessary. Additionally, the Vega can be configured to toggle the keypad lighting on/off. It can also be configured to a power save mode in which the LED's will self-extinguish 10 seconds after the last key press.


Since it does shorten the time between charges, it is recommended to operate the instrument without the backlight when not necessary.

### 3.6.2. Charging

The Vega can be operated either by battery or from an AC source with the charger plugged in all the time. Plug the charger in the jack labeled "12VDC" on the back panel, (Figure 3.2). The Vega's charger circuit has dual polarity. The Vega will charge the batteries at about the same rate whether it is on or off and whether the backlight is on or off. However, it will charge much more slowly if a pyroelectric type head is plugged in while charging. When switched off the Vega will fully recharge in about 8 hours. It will take longer when being recharged while turned on.

The approximate time between charges is given below for various configurations:

Thermal, Photodiode heads; keypad backlight off, LCD backlight low:	16hrs.
Same; keypad backlight on, LCD backlight high:	11hrs.
Pyro heads; keypad backlight off, LCD backlight low:	11hrs.
Same; keypad backlight on, LCD backlight high:	8hrs.

The battery charge is indicated by the  icon. The battery charge is shown approximately by each segment of the icon, e.g. if 2 segments are shown the battery is 1/2 full. When the battery is charging, the

segments turn on in sequence. When the battery is low, the charger should be plugged in. While the unit will charge event while on and even with the backlight on, it will charge fastest if the charger is left in while the unit is off.

### 3.6.3. Analog Output

The instrument provides an analog voltage output via the 2.5mm stereo plug on the rear panel marked "AN OUT". (See Figure 3.2). The Vega is supplied with the mating adapter plug that connects to this socket. The analog output is useful for driving chart recorders and other analog devices. The voltage is proportional to the reading on the display and scaled such that full scale equals 1.00, 2.00, 5.00 or 10.00 volts as selected by the user during setup. (See section 3.5.3). The output can drive up to 2mA into an external device.

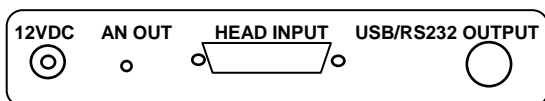


Figure 3.2  
Vega Rear Panel View

### 3.6.4. RS232 and USB Outputs

The Vega is equipped for either RS232 or USB communications with PC. The Unit is supplied with two cables, each with a 7 pin DIN plug on one end mating with the Vega and either a USB or 9 pin D RS232 connector on the other side. When you wish to operate the Vega with either RS232 or USB, the cable should be inserted before switching on the instrument and then the instrument will automatically either be in RS232 or USB mode depending on which cable is attached. See section 4.4.2.6.1 for details of communication with PC.

### 3.6.5. Head Disconnect / Connect Recognition

As of ROM version 1.96, the Vega display will recognize if a head had been connected or disconnected while the device is powered on. If such an event happens, a warning screen will be displayed for 3 seconds, after which the Vega will restart itself in its new configuration. Thus if a user wants to change heads during his experiment he no longer needs to power down the Vega to do so.

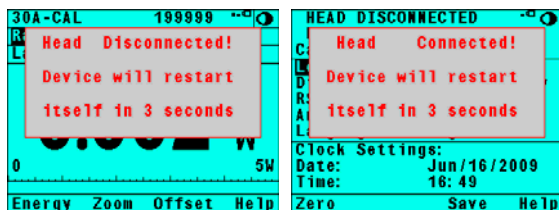


Figure 3.3  
Head Disconnect / Connect Warnings

**Note:**

When working with Ophir's StarLab application, the Vega's restarting itself will be recognized as a Device Disconnect.



## 3.7 GUI and Keypad Settings

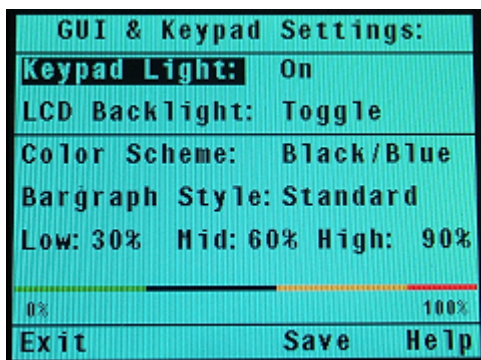



Figure 3.4  
Vega GUI Setup Screen

The Vega allows customization of the display's interface in order to enhance the user experience. This section describes the various extended GUI controls.

1. Disconnect the head, turn off then on again. "Head Disconnected" will be displayed.
2. With the navigation keys go to the  icon and press the Enter key. Settings that can be adjusted are, LCD Lighting, Keypad Lighting, Color Scheme, and Bargraph Style (and parameters).
3. Select the setting to adjust with the up/down navigation keys and press Enter.
4. Select the value desired with the up/down navigation keys and press Enter.
5. Repeat until all settings are adjusted. Press Exit when finished

### 3.7.1. Keypad Lighting

The Vega's keypad lighting can be set to one of the following settings:

- **On:** Keypad illumination constantly on.

- **Off:** Keypad illumination constantly off.
- **Toggle:** Set keypad lighting on and off with a short press of the on/off key.
- **Power Save:** Light all of the keys whenever one is pressed. If 10 seconds elapse since the last key press, turn off the keypad lighting.

### 3.7.2. LCD Backlight

Because the Vega uses a color display, the backlight must be constantly on. The LCD backlight can be set to one of the following settings:

- **Low:** LCD backlight set to half power. This uses less power and is the suggested setting.
- **High:** LCD backlight set to full power.
- **Toggle:** LCD backlight toggles between full and half power with a short press of the on/off key.

Note: If both the LCD and Keypad backlights are in toggle mode, then High LCD backlight will be coupled with the keypad backlight being off and Low LCD backlight will be coupled with the keypad backlight being on.

### 3.7.3. Color Scheme

The user can configure the Vega for full color or monochrome functionality. Choose full color to make use of special color enhancements. Choose one of the monochrome schemes for use with protective goggles that filter out visible wavelengths.

Screen captures of the Vega in this manual are shown in the various color schemes.

#### 3.7.3.1. Full Color

The main measurement displays can be set to one of

- Black text on sky blue background
- Yellow text on dark blue background

For both of these schemes, warnings will be displayed in red, selection windows (example range, average, laser) will be pink, modification windows will be white, and help screens will be yellow/gold. The keypad will take on the color of the active window.

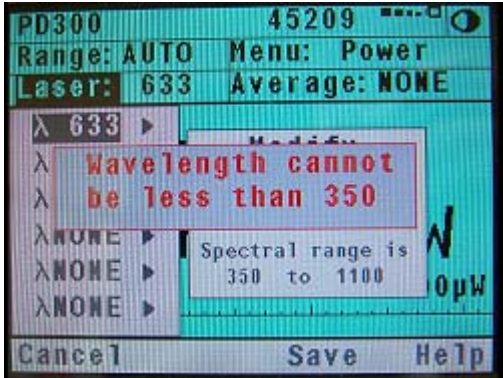


Figure 3.5  
Display of different windows and their colors

### 3.7.3.2. Monochrome

These schemes are for use with lasers that demand protective glasses that filter out colors in the visible part of the wavelength spectrum. These color schemes apply to all of the screens. All color-enhanced features of the Vega will not be functional in any of the monochrome screens

The schemes that can be selected are as follows:

- Black text on white background
- Sky blue text on black background
- Green text on black background
- Red text on black background

### 3.7.4. Bargraph Style

In addition to the large digital readout, on the main power screen of the Vega there is a bargraph that graphically displays what percentage the present reading is of full scale. This bargraph can be given enhanced functionality when in full color mode. When the bargraph style is set to "Changing", then the color of the bargraph and the digital readout changes as a function of percentage of full scale. For example, if the reading is less than 30% of full scale, it will be displayed green. Between 30% and 60% it will be displayed black or white. Between 60% and 90% it will be displayed yellow and above 90% of full scale it will be displayed red.

These are the default cutoff values. They are fully configurable by the user, thereby allowing him to use the colors of the bargraph display as a type of pass/fail mechanism.



Figure 3.6  
Bargraph Style set to Changing (full scale is 3.0μW)

## Chapter 4.

### Operation with Thermopile Absorber Heads

#### Warning:

Before using the head for power or energy measurement, check that your laser power, energy and energy density do not exceed the head ratings. See the tables in Chapter 9. Head Specifications.

If the head is a water-cooled type, ensure that the cooling water is flowing at an adequate rate; see table below. Also, note that the reflectance from the absorber could be as much as 10% and with CO<sub>2</sub> lasers, the reflected beam can be quite specular, so it is advisable to provide a beam stop for the reflected beam with the highest power lasers.

Head Type	Liters per Minute At Full Power	Min Pressure Bar	US Gallons per Minute
10K-W	10	2	2.8
8000W	7	1.5	2
5000W	4.5	0.8	1.2
1500W	2.5	0.5	0.7
300W	1.0	0.3	0.25

Table 1.  
Minimum Flow Rates For Water-Cooled Heads

#### 4.1 Thermopile Absorber Heads

When a radiant heat source, such as a laser, is directed at the absorber head aperture, a temperature gradient is created across the thermopile of the enclosed detector disc. This generates a voltage proportional to the incident power.

The display unit amplifies this signal and indicates the power level received by the head. At the same time, signal processing software causes the display unit to respond faster than the thermal rise time of the detector disc, thus reducing the response time of the Vega. Energy of a single pulse is measured on the Vega by digitally integrating the pulse power over time.

## **4.2 Selecting Settings from the Vega Screen**

The Vega can be set to various chosen settings while operating. In addition, it can be set so that it will be in the desired configuration when turned on the next time.

### **4.2.1. To Set Type of Laser being Used**

Thermopile heads have somewhat different absorption at different wavelengths. In order to compensate for this, each head has been calibrated by laser at several wavelengths. When you choose the correct laser wavelength, the correction factor for that wavelength is automatically introduced. Note that the laser wavelength correction in use is displayed in the upper left corner of the display.

Thermopile heads with the new LP1 absorber have large variation of absorption at different wavelengths. Therefore a continuous spectral curve is inserted into the head, enabling the user to choose the desired wavelength from the range specified in the specification sheet and the correction factor for that wavelength is automatically introduced.

### **4.2.2. To choose Manual or Automatic Ranging in Power Measurement**

**Autorange** - The Vega allows you to choose autorange or manual ranging. In autorange mode, you do not have to change scales. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. The ranges are arranged in factors of 1, 10, 100, etc. When the reading falls below 9% of full scale, the range changes to one range lower. This change only occurs after a few seconds delay. This provides overlap

(hysteresis) to keep the Vega from flipping back and forth when reading close to the end of the scale.

To choose auto range, select "Range", enter, choose "AUTO" then enter again. If you wish the Vega to be in autoranging mode when switched on, save this configuration before switching off (see Section 4.3).

**Manual Range** - There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure in the same range all the time, it is better to use manual range. To select manual range, select "Range", press the Enter key, select the desired range, and press the Enter key again to return to the measurement screen.

The correct range to select is the lowest one that is larger than the largest expected measurement. If you wish the Vega to be in the selected manual range when switched on, save this configuration before switching off (see Section 4.3).

#### **4.2.3. To choose Power or Energy Measurement**

The Vega thermopile heads can measure both power and single shot energy. See Sections 4.4 and 4.5 for details. To change from power to energy measurement or vice versa do the following:

1. To go from the main power measurement screen power to energy measurement, press "Energy".
2. To go from the energy measurement screen to power measurement press the "Power" soft key.

### 4.3 Startup and Configuration of Defaults

If you are planning to do measurements of the same type most of the time, you can set up the Vega so that it automatically starts up in the measurement mode desired. Since these settings are saved in the head's "smart connector", you can save different settings for different heads.

To set the Vega to start up in desired screen and to save the chosen configuration:

With the head connected, switch on the Vega. Select "Menu" with the navigation keys. Enter, select "Configure" and enter again. Now choose the desired startup parameters as follows:

1. Select "Startup mode" to choose "Power" or "Energy" for the desired startup screen. Choose power or energy and press enter and save. The Vega is now configured to work in power or energy measurement mode, respectively.
2. Select "Display Mode" and select the desired startup screen. Press "Save". (Note that this selection is saved in the Vega and not the head so will be operative for all heads). For more details on the screen types see section 4.6.
3. Select "Power Range:" and in the same way choose the manual power range you wish to be the default or autorange. The Vega will now be in the range selected when switched on with the head in question.
4. Now select "Average" and select the period you wish to average power readings over. This feature is especially useful for lasers with unsteady output. See section 4.4.2.4 for details.
5. Now select "Energy Range" and choose the energy range you wish to be the default. The Vega will now be in the range selected when switched on with the head in question. Note that there are only manual ranges in energy.
6. Now select "Threshold" if you want to change the energy threshold. See section 4.5.3 for details.



7. Now select "Laser" and select the laser type you want to be the default. The Vega will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected and will startup with the laser wavelength selected.
8. Now press "Save" and the defaults will be saved. If you only want the changes saved for the present, "Exit" without save and the changes will be saved until the Vega is switched off only.
9. Switch the Vega off then on by means of the on/off switch. (See Figure 3.1). The Vega will enter the mode of operation last saved with the "Configure" operation.

## **4.4 Power Measurement**

The next section describes the procedure for basic power measurement as well as more advanced features with thermal measuring heads.

### **4.4.1. Power Measurement, Basic Operation**

1. Switch the Vega on by means of the on/off switch that is found beneath the navigation keypad (See Figure 3.1). The Vega will enter the mode of operation last saved with the "Configure" operation. For basic operation, you need only set up the parameters for the type of measurement you wish (Section 4.3 describes the procedure to store your configuration), and the Vega will be ready to perform that type of measurement each time it is switched on. The normal default measurement mode is the bargraph autoranging power measurement screen or the needle display screen.
2. If the Vega is in "Energy" mode, pressing the "Power" soft key will cause it to enter the power measurement mode.
3. Center the laser beam carefully on the absorber surface and read the power.

## **4.4.2. Additional Power Measurement Features**

The following section describes additional Vega functions in power mode in addition to the basic power measurement mode described above.

### **4.4.2.1. Zoom**

The Zoom function causes the scale to expand the present scale fivefold. Thus, if the full scale of the bargraph is 20 watts, and your reading is 15 watts, pressing “zoom” will make the bargraph scale range between approximately 13 and 17 watts. Variations in power are more easily seen in this mode. To access the zoom function, simply press the “Zoom” button. It will be highlighted to show that it is engaged. Note that the fiducial marks of the bargraph are further apart, indicating that zoom is engaged. Now press the “Zoom” button again to return to the unexpanded bargraph display.

### **4.4.2.2. Offset**

The offset function subtracts background from the signal. If the ambient environment has a thermal background, so that the Vega shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Vega display reads 0.1 Watts when the laser is blocked, and 20.5 Watts with laser power applied. In this case, the true power is  $20.5 - 0.1 = 20.4$  Watts. To subtract the background, press the “Offset” button while the laser is blocked. The Vega will now read zero, and the 0.1 Watt background will be subtracted from all subsequent readings. The laser power reading will thus be 20.4 Watts.

When “Offset” is engaged, the legend is highlighted. To cancel, press “Offset” again. If the “Offset” is engaged, and you wish to subtract out a new value of the background, press “Offset” twice. The first press will cancel the old value, and the second will activate a new value. If you suspect that the Vega has a permanent zero

offset, then disconnect the head while it is in the power measurement mode. If the Vega still shows a similar offset even when the head is not connected, the instrument's internal zero should be reset. See Section 3.5.5.

#### **4.4.2.3 Tune (See Figure 4.1 )**

The Tune function, an exclusive Ophir feature, makes adjusting your laser to its maximum power easier than ever before. Unlike a bargraph or needle display, this display shows graphically what came before as well as the current reading and the trend. This allows you to determine if you have reached maximum power.

The screen is completely autoranging. Therefore, as soon as the cursor goes over the top or under the bottom edge of the display, it re-scales to put the cursor back to the middle of the screen. This allows you to devote all your attention to tuning the laser, without having to worry about the Vega settings.

##### **4.4.2.3.1 To use the Vega to fine tune laser power**

1. From the main measurement screen, select "Menu" and enter. Select "Tune" and press the Enter key.
2. Set the power expansion scale to  $\pm 50\%$ ,  $\pm 25\%$ ,  $\pm 10\%$ ,  $\pm 100\%$  or  $\pm 75\%$  as desired, pressing the " $\pm 50\%$ " soft key. The default value is 50%. If the laser power will change a lot, use a large value; if a little, use a small value.
3. Select "Graph" and enter to set the horizontal sweep time to the rate desired. The default value is 1 minute. Save before exiting if you want this to be the new default. Note that saving the graph value will also save the  $\pm XX$  value as default.
4. If you press "Max" it will set the NOW value on the screen to the present value. You can then compare the MAX value to the NOW value.

### 4.4.2.3.2 Measuring with the Tune Screen

You can now use the tune screen to adjust and maximize your laser power. (See Figure 4.1). Note that you can not only see the trend, but also see if you have already reached a higher value before the numbers on the left side show you the present power reading as well as the highest one reached till now. Press “Max” to reset the maximum reading to the present time. Now measure the power of the laser and adjust the laser until you determine that the power has reached a maximum.

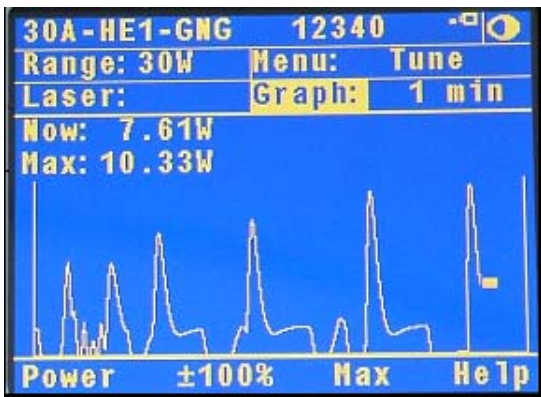


Figure 4.1  
Power Tune Screen

### 4.4.2.4. Average

When a laser output is fluctuating or unstable, it is useful to measure the average power over a certain period. The Vega gives you this exclusive feature, allowing averaging over periods varying from 1 second to 1 hour.

The average mode works as follows:

As soon as the main power measurement screen (See Figure 4.2) is entered and the instrument is set to average mode, the instrument displays the average of readings over the period since the screen was entered up to the

present. When the time period of the average is reached, the average becomes a running average over the average period backward in time. For instance, if the average period is 1 minute, at 30 seconds, the average is over 30 seconds, at 1 minute it is over 1 minute, at 5 minutes, it is over the period from 4 to 5 minutes (1 minute back from the present).

### To use the Vega to display average:

1. From the main power screen, select "Average" and enter.
2. Select the average period you want or select "NONE" if you do not want to average. Save this as the startup default if you want by pressing "Save" otherwise just exit the screen.
3. **Note:**  
Average setting only affects the Numeric display. Graphic readouts are not affected.



Figure 4.2.  
Thermopile Power Screen with average set to 3 seconds

#### 4.4.2.5. Normalize

When you wish to show the readings as compared to some standard reading, the normalize function allows you to do this. After setting "Normalize", all subsequent readings will appear as a ratio to the reference reading. For instance, if you normalize the reading at a power of 1.5W, then subsequent readings will be with ratio to that, i.e. if the power is then 2W, the reading (dimensionless)

on the screen will be  $2/1.5 = 1.33$ . The screen will also show in small digits the power at which the normalization was done and the present power.

### To use the Vega to normalize the power:

1. From the main power screen, select "Menu" and enter. Select "Normalize" and enter.
2. When ready to normalize, press "Apply". From then on, the power will be proportional to the normalized power value (See Figure 4.3).
3. If you wish to apply a new value, press "Reset" and then "Apply" again.
4. If you wish to return to the the regular display, select "Menu", enter and go to the display you wish.



Figure 4.3  
Thermopile Normalize Screen

#### 4.4.2.6. Power vs. Time Graph and Data Logging

The Vega in datalog mode has the option of graphing the laser power against time and storing the data in up to 10 permanent storage files with up to an average of 25,000 data points in each file. While measurements are being taken, the Vega will record data until the screen is full or until the reset button is pressed. With the RS232 or USB adapter the data can be read out to PC in real time or later after storage. Power logging has the following characteristics:

## **To use the Vega to graph power vs. time:**

1. From the main power measurement screen, select "Menu" and enter. Select "Data-Log" and enter.
2. You are now in the setup screen. Under "Graph Settings", select "Min:" and enter. Select the value you wish for the minimum of the graph and enter. Select "Max:" and enter. Select the maximum value you want for the graph and enter. Select "Time Scale:" and enter. Select the time scale you want and enter. Select "Sample Rate" and enter. Select the sampling rate to set the time interval and log size and enter (Note: for log periods of 5 minutes or less, this setting has no affect and every measurement will be stored). To save these values as defaults, press "Save" after entering them.
3. Now press "Log".and you will be in the power graph screen (See Figure 4.4). Press "Go" and the measurement will begin immediately. The "Go" button will now change to "Pause". If you wish to pause the measurements without losing data gathered, press "Pause" . Press "Pause" again to resume measurements. When the data register is full, "FULL" will flash on the screen. If "Zoom" is pressed at any time, the screen display will expand fivefold around the present power value. Press "Zoom" again to cancel the expansion. If you want to start a new measurement and not save the present data, press "Reset". If you want to save the data before making a new graph, see the next section.

### **Note:**

For data logging, the instrument has to be in a manual power range. If the head is configured for autoranging the, Vega will re-configure it to be in the manual range that is closest to the last set of measurements that were taken.

### **Warning:**

Pressing "Reset" will erase all previously stored data and start recording new data. Pressing any of the navigation Keys will end the log session and return to the setup screen.

4. Along with a graph of the logged data, the Vega provides a statistical summary of the log session as well. This summary is updated once per second.

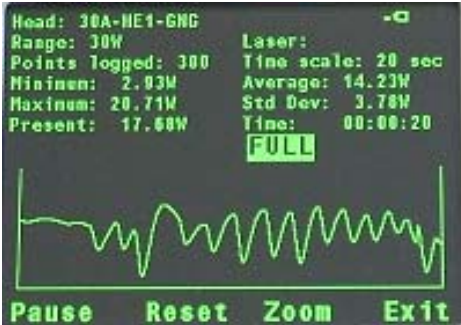


Figure 4.4  
Laser Power vs Time Graph

#### 4.4.2.6.1 Data Storage and Transmission

When using thermal and photodiode heads the data logging period is anywhere from 20 seconds to 600 hours. The number of points stored in the data register is up to 27000 points unless less data is available or a lower Sample Rate has been selected.

The data can be stored to file as described below. To store the data do the following:

1. When you have gathered enough points press "Pause" or wait until the data register is full and "FULL" flashes. Press "Exit" and you will be asked if you want to enter the file control system. Press "Yes".



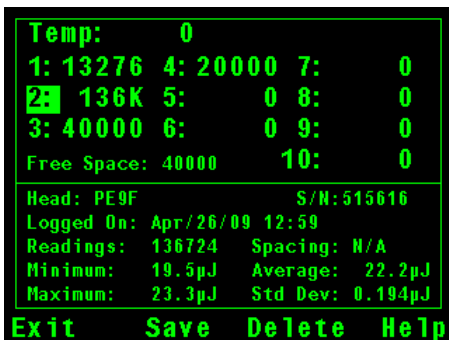


Figure 4.5  
Data Storage Screen

- When the screen is entered, the data in the latest power graph will be stored temporarily in register "Temp". With the navigation buttons select the permanent register you wish to use for storing the data and press "Save". The data in the "Temp" register will be transferred to the selected register. This data storage is permanent and the data is not lost when the instrument is turned off. If you try to save into a file which already has data, a warning will appear that the new save will erase previous data in the file. If you want to delete the data from a file, select the file and press "Delete".
- At the bottom of the screen is a summary of the data in the selected file. If you press "Exit" and then select "View Files" and enter, you will be able to show the actual data points instead of a graph. Select the data file you want and press the Enter Key (middle button of the navigation keys). This will open a screen showing all the data points collected in this file. Press "XXX>" to get to the next page of data and "<XXX" to get to a previous page. Pressing "Exit" will get you back to the previous screen.

**Note:**

In version 1.96, the internal file system format has been changed to enable logging of larger files. To prevent possible corruption, logs made in versions earlier than 1.96 should be uploaded to the PC before upgrading the firmware version to 1.96 or higher.

## Data Transmission to PC

The data stored in the Vega file system can be transmitted to a PC via RS232 using the Starcom PC package supplied with the Vega (or via USB using the StarLab PC or application). The data can be transmitted in real time as well according to the following table:

<b>Power Measurement</b>	<b>RS232</b>	<b>USB</b>
Power log period	20 sec to 600 hours for both	
Max points stored onboard per file <sup>(1)</sup>	27000	27000
Max points direct to PC file in real time	unlimited	unlimited
<b>Energy measurement</b>	<b>RS232</b>	<b>USB</b>
Max real time data logging rate <sup>(2)</sup>	>30Hz	>2000Hz
Max onboard data logging rate <sup>(2)</sup>	4000Hz	4000Hz
Data transfer from instrument to PC	~500 points/s	~500 points/s
Max points stored onboard	250,000	250,000

(1): Can store up to 10 files for a total of 250,000 points.

(2): The above refers to the rate for logging every single point in turbo mode. Above that rate the instrument will sample points but not log every single point.

## 4.5 Energy Measurement

### 4.5.1. Setup

Switch the Vega on. If it is in power mode, press the left soft key "Energy" to put it into energy mode.

The energy mode is manual ranging: enter "Range" and then use the navigation keys to get to the proper range then enter again. The correct range is the lowest one which is larger than the pulse energy measured. If you plan to use the same setting often, use the "Configure" function as described in Section 4.3 before switching the Vega off the first time. When the Vega is switched on again, it will automatically go into the same range until a different configuration is saved.

**Note:**

The present range is displayed on the upper left and bottom right of the energy measurement screen as shown in Figure 4.6.

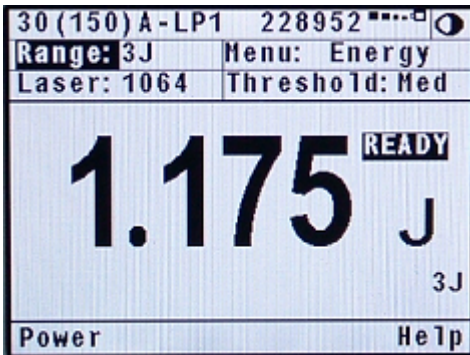


Figure 4.6  
Thermopile Energy Screen

#### 4.5.2. Measurement

To measure energy of a single pulse, set up as above and fire the laser. The display will go blank while the energy is being integrated. After 2-4 seconds, the correct energy will be displayed. When the Vega is ready to measure a new pulse, "READY" will appear on the screen and flash on and off. (See

Figure 4.6). The next pulse will automatically blank the screen, and the new value will be displayed. If you fire another pulse before "READY" appears, the reading may be inaccurate or may not be displayed.

#### 4.5.3. Minimum Energy Threshold

If the Vega is used in a noisy environment or where there is a high level of background thermal radiation, the instrument may trigger spuriously on the noise or background radiation. It would then fail to measure the intended pulse. Since there is always some degree of

noise or background radiation, the instrument is designed not to respond to pulses below some preset minimum size. This "Minimum Energy Threshold" is typically set to 0.3% of full scale of the selected range. If this level is found to be too sensitive for the user's particular environment, it may be altered by the user. The threshold should not, however, be raised higher than necessary. This will cause a degradation in the accuracy of energy measurements of pulses below about 4 times the threshold level. The factory setting of energy threshold is "Med" for medium. If the unit triggers on noise, set the threshold to "High." If you are measuring small energies and the unit does not trigger, set the threshold to "Low."

### **To set the energy threshold:**

1. From the energy measurement screen, enter "Threshold".
2. Select "High," "Medium," or "Low" threshold. For some 3A-P models, "Optical" is also available and is the default choice (See below).
3. Enter again to return to main measurement screen. If you wish to save this value, press "Save" before exiting. (See also section 4.3).

### **Note to users of 3A-P type heads:**

Some models of the 3A-P type head have special circuitry enabling it to trigger on energy pulses of very low energy. This is accomplished by a special photodiode trigger which alerts the Vega that a pulse has been received and to start integration. This allows the 3A-P to react to smaller pulses than would be measurable just by triggering on the rising thermal signal as in other heads. When you select "Optical" this enables the optical trigger. However, in some cases, the optical trigger will not work and you should select one of the thermal trigger settings, "Low", "Medium" or "High". You should use thermal triggering on the 3A-P in the following cases:

1. The wavelength is outside the range of the photodiode, i.e. outside of 0.19 - 1.064 $\mu$ m.

2. You are measuring the energy of a shuttered pulse of a continuous laser. In this case, the peak power is too low to trigger the photodiode.
3. For some other reason, the instrument does not trigger on the "Optical" setting.

When using the optical trigger, the instrument should be able to measure down to 0.1 - 0.2 mJ, depending on wavelength. When using the thermal trigger (low, medium or high), you should not attempt to measure less than about 1mJ. **Note:** Newer models of the 3A-P do not need the optical trigger to achieve low energy measurement and do not have this feature.

#### 4.5.4. Measuring Pulses of Very Low Energy

When it is necessary to measure pulses of very low energy, i.e., less than 0.5% of the maximum range of the instrument, the following two alternative methods allow greater accuracy to be obtained.

1. A continuous train of pulses may be fired, and the average power measured using "Power" mode. The energy per pulse can be calculated by:

$$\text{Average Energy per pulse} = \text{Average power} / \text{Pulse Repetition Rate}$$

2. A train of a known number of pulses may be fired, and the total energy measured in "Energy" mode. This train should not exceed 5 seconds duration. The energy per pulse can be calculated by:  $\text{Average Energy per pulse} = \text{Total Energy} / \text{Number of Pulses}$

In both of the above methods, the pulse repetition rate must exceed 3Hz. Higher rates will generally give improved accuracy, but care should be taken not to exceed maximum power ratings.

#### 4.5.5. Measuring Energy of Rapidly Repeating Pulses

The standard Vega will only measure individual pulses every 5 seconds or so. You can also calculate the average energy of rapidly repeating pulses by measuring average power on the power setting and using the formula:

$$\text{Average Energy per Pulse} = \text{Average Power} / \text{Pulse Repetition Rate}$$

For rapidly repeating pulses, you can use one of the Ophir pyroelectric heads, as long as the pulse energies do not exceed the ratings of the pyroelectric absorbers. The pyroelectric heads are compatible with the Vega and just have to be plugged in to be used.

For higher pulse energies, you can use the Ophir model RP to measure both average power and exact individual pulse energy of the rapidly repeating pulses.

**See your Ophir agent or sales representative for details.**

#### 4.5.6. Energy Log and Data Storage (See Figure 4.7 )

The Vega has the option of displaying successive energy points in a scrolling vertical bargraph form. While measurements are being taken, the Vega will record data. Up to 250,000 points are stored See section 4.4.2.6.1 for more information on data storage and handling.

**Note:**

For Thermopile heads logging energy, there are no setup options.

#### **4.5.6.1 To use the Vega for graphical display of energy - regular mode**

1. Make sure that the Vega is in the correct energy measurement range. If not, enter "Range", adjust and enter again.
2. From the energy measurement screen enter "Menu" and then select "Data-Log". Now press "Log" and the energy log screen will appear. Press "Go". Now fire a pulse when the "READY" legend flashes. The measurement will immediately begin. When the screen is full, the display will scroll and the latest points will continue to be displayed. When the data register is full, "FULL" will be displayed. If you wish to see finer variations in the graph, press the "Zoom" button.
3. When "Reset" is pressed, the Vega is ready to begin a new measurement. If you want to store the data before making a new measurement, see section 4.4.2.6.1 on data storage.

#### **Warning:**

Pressing "Reset" will erase all previously stored data. Pressing any of the navigation keys will end the log session and return to the setup screen.

A statistical summary of the data on the screen is shown on the top. If you wish to permanently store the data in a file, press "Enter" and then choose "Yes" to enter the file system. See section 4.4.2.6.1 for further information.

#### **Note:**

Zoom can only be pressed after at least one pulse has been recorded.

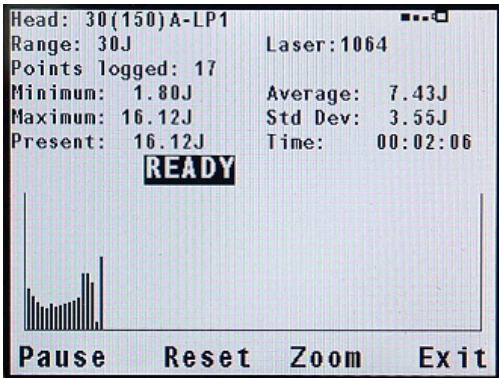


Figure 4.7  
Energy Log Screen replace

## 4.6 Advanced Display Screens

### 4.6.1 Power and Energy Beam Splitter/Attenuator Screens

If you have a measurement setup with a beam splitter or attenuator and wish to display the laser power or energy before the splitter or attenuator and not the actual value impinging on the measurement head the beam splitter function allows you to do this. For example, if you are splitting off 20% of a laser beam into the meter and you wish to display the full beam, do as follows:

1. From the main power or energy measurement screen, enter "Menu", select "Attenuate" and enter again.
2. Enter "Beam %" and then with the up down navigation buttons, select the first number. With the right navigation button go to the second number, and with the up/down navigation keys select the second number and so on. For example, in the screen shown below, 20% has been selected. The large number shows the full beam power / energy



impinging on the beam splitter and the small number the power/energy actually measured by the meter.

Press "Save" if you wish to save this value and then press enter to return to the standard measurement screen.

If you want the instrument to start up in the Attenuation screen, follow the instructions for instrument startup defaults in section 3.5.



Figure 4.8  
Attenuation Screen with Beam % set to 20%

**Note 1:**

The attenuation screen only affects the value displayed on that screen and nothing else. The power and energy scales remain the same, the damage thresholds remain the same etc. The attenuator screen is only an extra screen to show a different calculated number introduced by the user.

**Note 2:**

The attenuation value is stored in the Vega and not the head so if it is set, any head connected will come up with the value chosen.

## 4.6.2 Power and Energy Density Screens

The Vega gives you the option to measure in units of power and energy density instead of power and energy. You input the beam size and the display then calculates and displays the power or energy density in units of  $W/cm^2$  or  $J/cm^2$ . In order to activate this screen do as follows:

1. From the main screen select "menu" , enter and select "density".The display will now be in units of  $W/cm^2$  or  $J/cm^2$  depending if you were in the power or energy measurement screen.
2. The default setting is for round beams. If your beam is round continue on to perform steps 3-5. If your beam is rectangular perform steps 6-9.
3. Select "size" and you will see 4 default choices of beam diameter.
4. Select the beam diameter you wish to adjust and press the left navigation key.
5. Now modify by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press "save" and enter.
6. Press "Rect" to switch to the rectangular mode.
7. Select "Height" and modify by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press "save" and enter.
8. Select "Width" and modify in the same way.
9. The beam size will appear in the box above the "Height" box.

## 4.6.3. Power and Energy Limits Screens

The Vega gives you the option to set upper and lower limits of power and energy. If these limits have been set in the limit screen, then when the power or energy is above the maximum limit, the message "OVER" will appear on the screen and when under the minimum limit, the message "UNDER" will appear on the screen. When in one of the full color modes, the warning and the reading will be shown in red.

To set up the limits screen do as follows:

1. From the main power or energy screen press “Menu”, select “Limits” and enter.
2. Select “Low” and enter. Now enter the low limit value by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press “Save”.
3. Do the same for the “High” limit.
4. If you want the limits screen to be the startup default of the Vega, follow the instructions in section 3.5.

When the power or energy is over or under the limits chosen, the error message will be shown as in Figure 4.9. Note that the lower limit is shown on the upper left and the upper limit on the upper right.

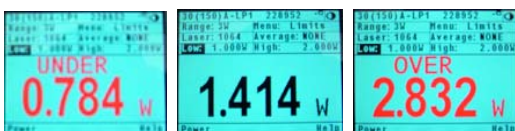


Figure 4.9 Limits Screens with limits set to 1W and 2W

#### 4.6.4. Power and Energy Needle Screens

The Vega provides a simulation of an analog needle. Similar to the bargraph display, this allows the user to graphically view the measurement as a percentage of the full scale. It is possible to expand this needle to cover the full screen of the Vega by pressing the “Expand” button.

When in one of the full color modes, the expanded needle will display the minimum and maximum readings. On the needle graph, older readings will stay on the screen. This allows a user to visually track the range of readings that have been taken.

To enter the needle screen do as follows:

1. From the main power or energy screen press "Menu", select "Needle" and enter.
2. To use the expanded needle feature, press "Expand".
3. To reset the minimum, maximum, and needle tracking, press "Reset".
4. To change measurement settings, go back to the reduced needle screen by pressing "Return"



Figure 4.10 Needle Screens with a photodiode head

### Other Types of Heads.

The functions described in the sections above can be used with photodiode and pyroelectric detectors as well.

## Chapter 5.

### Operation with Photodiode Type Heads

#### **Warning:**

Before using the head for power measurement, check that your laser power or energy and energy density does not exceed the head ratings. See Table 6, Chapter 9.

#### **5.1 Photodiode Heads**

When a photon source, such as laser, is directed at one of the PD300 or 3A-IS series photodiode detectors, a current is created proportional to the light intensity and dependent on the wavelength.

The PD300 and PD300-3W heads have a unique dual detector head (patented) in which the two detectors are identical and connected back to back. When a uniform signal, such as room light background, falls on the detector head the signal from the two detectors cancels.

On the other hand, when a laser beam falls on the head, it illuminates only the first detector and therefore is detected. Thus the PD300 subtracts most of the background while detecting the desired signal. The subtraction is not perfect but usually 98% of the background signal is eliminated so the detector can usually be used in ordinary laboratory lighting conditions.

The Vega display unit amplifies this signal and indicates the power level received by the head. Due to the superior circuitry of the Vega, the noise level is very low, and the PD300 /3A-IS series heads with the Vega display have a large dynamic range from nanowatts to hundreds of milliwatts.

Since many low power lasers have powers on the order of 5 to 30mW, and most photodiode detectors saturate at about 2mw, most heads of the PD300 series have been constructed with a built in filter so the basic head can measure to 30mW or more without saturation. When the

additional filter is installed, the maximum power is on the order of 300mW (or 3W with model PD300-3W). The PD300 saturates when the output current exceeds 1.3mA so the exact maximum power depends on the sensitivity of the detector at the wavelength used. When saturated, the legend "OVER" will appear on the screen. Table 2 gives the actual maximum power as a function of wavelength.

### Filter Out

Wave Length	PD300	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wave-Length	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	3mW	N.A.	800nm	20mW	0.8mW
400nm	30mW	3mW	30mW	3mW	N.A.	1-1.3µm	30mW	0.8mW
633nm	20mW	2.5mW	20mW	3mW	1W	1.4µm	25mW	0.8mW
670nm	13mW	2mW	13mW	3mW	2W	1.5µm	15mW	0.8mW
800nm	10mW	1.5mW	10mW	2.5mW	3W	1.6µm	10mW	0.8mW
900nm	10mW	1.5mW	10mW	2.5mW	3W	1.8µm	25mW	N.A.
1060nm	25mW	3mW	25mW	3mW	3W			

### Filter In

Wave Length	PD300	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wave Length	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	300mW	N.A.	800nm	20mW	300mW
400nm	300mW	1W	3W	300mW	N.A.	1-1.3µm	30mW	120mW
633nm	300mW	1W	3W	300mW	1W	1.4µm	25mW	300mW
670nm	200mW	500mW	1.4W	300mW	2W	1.5µm	15mW	300mW
800nm	100mW	300mW	0.6W	150mW	3W	1.6µm	10mW	300mW
900nm	150mW	300mW	0.7W	150mW	3W	1.8µm	25mW	N.A.
1060nm	250mW	500mW	1.7W	300mW	3W			

Table 2  
Maximum Measurable Laser Power as a Function of Wavelength

## 5.2 Setting up the PD300 to display the user's chosen wavelengths

The PD300 series has built in wavelength correction curves for measurements either with the removable filter installed (filter-in) or removed (filter-out). These curves are stored in the head EEROM. The correction curves, with a resolution of 1nm, ensure that the power reading is correct at all laser wavelengths.

In order to simplify changing from one laser wavelength to another, the user can program up to 6 different wavelengths to be available from the screen menu. Please use the following procedure to set the PD300 to your laser wavelengths.

1. From the power measurement screen, select "Laser" and enter.
2. With the up/down navigation keys, select the first wavelength desired. Press the right navigation key to enter the change wavelength screen.
3. Enter the wavelength value by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press "Save" and enter.
4. Repeat steps 2 and 3 for other wavelengths desired. When finished, press Enter. Those values for which "Save" was pressed will be default startup values, the others will be saved until the instrument is turned off.

### **5.3 Startup Defaults**

If you are planning to do similar measurements most of the time, you can set up the Vega so that it automatically goes into the measurement mode you want upon startup. Since these desired settings are saved in the head "smart connector", you can save different settings for different heads. The following section describes how to set up the Vega with the PD300 head so that it will start up in the desired configuration.

**Setting up the startup defaults:** (See section 5.4 for further details)

1. With the head connected, turn on the Vega. Select "Menu" and enter. Select "Configure" and enter.
2. Select "Filter" and enter. Select IN or OUT as the startup default and enter. For details of filter in/out See Section 5.4.3.
3. Select "Display Mode" and select the desired startup screen. Press "Save". (Note that this selection is saved in the Vega and not the head so will be operative for all heads). For more details on the screen types see section 4.6.
4. Select "Power Range:" and in the same way choose the manual power range you wish to be the default or

- autorange or dBm. The Vega will now be in the range selected when switched on with the head in question.
5. Select "Average" to choose the averaging period for power measurement. If you do not want averaging, choose the value "NONE" See section 4.4.2.4 for details about averaging.
  6. Now select "Laser" and use the value button to select the default startup wavelength and save.
  7. If you want to change the choice of wavelengths select laser and press the right navigation key. Enter the wavelength value by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press "Save" and "Enter".

## **5.4 Selecting Settings from the Vega Screen**

The Vega can conveniently be set to various chosen parameters from the screen. In addition these settings can be saved as startup defaults so the head will be in the desired configuration when turned on.

### **5.4.1. To Set to the Laser Wavelength Being Used**

Photodiode heads have a different sensitivity at different wavelengths. Moreover, the filters used in the head have a different transmission at different wavelengths. In order to compensate, each head has a built in calibration curve (with 1nm resolution) over the entire measurement range.

When you choose the correct laser wavelength, the correction factor for that wavelength is automatically introduced. Note that the laser wavelength presently corrected for is displayed in the upper left portion of the display. In order to define the laser wavelengths to choose from, See Section 5.2.

In order to choose the laser wavelength, simply select "Laser" and enter. Select the chosen wavelength and enter again. In order to set the default startup wavelength, see section 5.3.



## 5.4.2. To choose Manual or Automatic Ranging or dBm

**Autorange** - The Vega allows you to choose autorange or manual ranging. In both cases, the reading will be displayed in watts. In autorange mode, you do not have to change scales. When the reading of the meter or bar is more than 100% of full scale, the range goes to the next higher one. When the reading falls below 9% of full scale, the range changes to one range lower. This change occurs after a short delay. This provides overlap (hysteresis) to keep the Vega from flipping back and forth when reading close to the end of the scale.

**Manual Range** - There are certain disadvantages to autorange since it changes scale even if you don't want it to do so. If you want to measure the same range all the time, it is better to use manual range. The correct range to select is the lowest one that is larger than the largest expected measurement. To configure the Vega to be in manual mode when switched on, see Section 5.3.

**dBm** - The Vega allows the measurement to be made in units of dBm that is a logarithmic scale. dBm units are defined as:

### **$10 \times \log$ (reading in mW)**

At 1mW the reading will be 0 dBm, at 100mW it will be 20 dBm etc.

**To choose auto, manual or dBm range, follow these steps:**

1. From the main measurement screen, select "Range".
2. Select the correct manual, auto or dBm range with the navigation keys. If you want the selected range to be the startup value press "Save" or by pressing the Enter key to return to the measurement screen.

### 5.4.3. Operation with Filter In or Out

The PD300 head is equipped with a built in filter so that the photodiode can measure up to 30mW without saturating the detector. In addition, the PD300 comes with an additional removable filter for measuring up to 300mW. Other models of the PD300 series also have built-in and removable filters. The exact maximum power is reached when the reading reaches full scale or the output current from the head reaches 1.3mA, whichever comes first. See Table 2 for the exact maximum as a function of wavelength.

Depending on what powers you wish to measure, choose whether to work with the removable filter installed or not. For this purpose, the Vega has a "filter" setting and uses the proper correction curve depending on whether the filter is installed or not.

#### **Warning:**



If the PD300 is used in the "Filter IN" setting and the filter is not installed or vice versa the readings will be completely incorrect.

If the power of your laser exceeds the maximum for filter in, you can purchase a thermal or integrating sphere head for that wavelength. Consult your Ophir agent for details.

#### **To choose the filter setting:**

1. From the main measurement screen press "Filter".
2. If you wish to work with filter installed, press "Change" until display says "Filter is IN". Be sure to place the removable filter on the detector head.
3. If you wish to work with the filter out, press "Change" until display says "Filter is OUT". Be sure to remove the filter from the detector head.
4. When finished, press "OK" to return to the measurement screen.

**Note:**

The filter status can be seen at a glance on the screen: filter out will be shown by  and filter in by 

**5.4.4. Zoom**

The Zoom function causes the scale to expand around the present reading  $\pm 20\%$ . Thus, if the full scale of the bargraph is 20mW and your reading is 15mW, pressing "Zoom" will make the bargraph scale range between approximately 12 and 18 mW. Slight variations in power are more easily seen in this mode. When zoom is engaged, the legend is highlighted. To cancel the zoom function, press "Zoom" again. The zoom function can be useful for laser power tuning and peaking.

To activate the zoom function, press "Zoom". When it is highlighted it is engaged. Note that the fiducial marks of the bargraph are further apart, indicating that zoom is engaged. Pressing "Zoom" again will cancel the function.

**5.4.5. Offset**

The PD300 and PD300-3W heads have automatic background subtraction as described in Section 5.2. In addition, the offset function can be used to subtract the residual background signal that remains if desired. If the Vega shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Vega display reads 0.1mW when the laser is blocked and 20.5 mW with laser power applied. In this case, the true power is  $20.5 - 0.1 = 20.4$  mW. To subtract the background, press "Offset" while the laser is blocked. The Vega will now read zero (0.0), and the 0.1 mW background will be subtracted from all subsequent readings. The laser power reading will thus be 20.4 mW.

When "Offset" is engaged, the legend is highlighted. To cancel, press "Offset" again. If the "Offset" is engaged, and you wish to subtract a new value of the background, press "Offset" twice. The first press will cancel the old

value, and the second will activate a new value. If you suspect that the Vega has a permanent zero offset, then disconnect the head while it is in the power measurement mode.

### 5.4.6 Measuring loss using the dB offset function

Since dBm is a logarithmic measurement, the ratio between two measurements will be the difference between the dBm measurements. For instance, if you want to measure the loss in a fiber optic cable where the measurement before the cable is  $1\text{mW} = 0\text{dBm}$  and the measurement after the cable is  $0.1\text{mW} = -10\text{dBm}$ . The ratio is then  $1:10 = 0.1$  and the dB loss is  $0 - (-10) = 10\text{dB}$ .

The dB offset function allows you to easily measure this. To do so do as follows:

1. When measuring the reference value press "dB-0". The value changes to 0 dB (note that now the units are dB, a relative value instead of dBm, an absolute value).
2. Now make your second measurement and the value of the difference in dB = ratio in numerical units will be shown.

#### **Note:**

If there is a zero offset in the reference value, you cannot subtract this using the dB offset function. Instead, before the start of the measurement, press "Offset" and subtract the zero offset. Then follow steps 1 and 2 above. The zero offset subtracted when "Offset" was pressed will be saved in the dBm scale and you can now use the dB-0 setting to measure true ratio without zero offset problems.

### 5.4.7. Average and Measuring Very Low Power Measurement

If the laser power is fluctuating, the Vega can display the average power readings with averaging periods varying from 1s to 1 hour. When measuring very low powers, such as picowatt measurements using the PD300-IRG or PD300-UV, there will be a rather large zero offset coming from the detector as well as a considerable noise fluctuation. Nevertheless, you can measure these low values by using the average function and pressing offset

to eliminate the detector zero offset. In order to measure very low powers do as follows:

1. Select "Menu", press the Enter key and select "Configure". Choose the appropriate value you want to average over and save it and then exit.
2. Now block the power source you wish to measure, wait for a few measurement periods and press "Offset" to subtract the zero offset.
3. Now unblock the power source and measure.
4. For a detailed description of the average function, see Section 4.4.2.4.

**Note:**

The average function does not work with autorange or dBm scales.

### **5.4.8. Tune and Power log**

The Tune function, an exclusive Ophir option, makes adjusting your laser to its maximum power easier than ever before. Unlike a bargraph or mechanical meter, this display shows graphically what came before as well as the current reading and the trend. This allows you to see at a glance if you have reached maximum power.

The Vega also has the option of graphing the laser power vs. time. While measurements are being taken, the Vega will record data until the screen is full, or "Reset" or one of the navigation keys is pressed.

If the laser power is fluctuating, the Vega can also display the average power readings with averaging periods varying from 1s to 1 hour.

These functions are the same for thermal type heads and for photodiode heads. See Section 4.4.2.3 for details.

The functions described in Section 4.6 Advanced Display Screens apply to photodiode heads as well.

## **Chapter 6.**

### **Operation with Pyroelectric Heads**

#### **Warning:**

Before using the head for power or energy measurement, check that your laser power, energy and energy density do not exceed the head ratings as listed in the table with the head specifications. Otherwise, there is a risk of damaging the absorber.

With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector. You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide shows damage, then either enlarge your beam or lower the laser energy until damage is no longer seen.

### **6.1 Pyroelectric & Photodiode Energy Heads**

#### **6.1.1. Pyroelectric heads – method of operation**

When a pulsed heat source, such as a laser, is directed at the detector head, a temperature gradient is created across the pyroelectric crystal mounted in the head. An electric charge is produced which is proportional to the energy absorbed. The detector head has sophisticated circuitry unique to Ophir (patented) that determines the baseline before the pulse is received, measures the voltage after a pre-determined interval, amplifies it and holds it for a pre-determined time.

Due to this innovative circuitry, Ophir pyroelectric heads can measure very long pulses as well as short ones. They can measure low energies as well as high. They can also measure at higher repetition rates than was possible before.

The Vega display amplifies this signal and indicates the energy received by the head as well as the frequency at which the laser is pulsing. Using the energy and

frequency information, the Vega is also able to display average power.

The photodiode based PD10 & PD10-PJ heads also use the same circuitry but can measure much lower energies due to the sensitivity of the photodiode.

### **6.1.2. Photodiode energy heads – method of operation**

The PD10 & PD10-PJ operates in a similar fashion to the pyroelectric PE heads except it has a photodiode detector instead of pyroelectric. Because of its great sensitivity, it can operate down to about 1nJ of energy. It has complete wavelength correction over its entire measurement range of 200 - 1100nm.

The PD10 & PD10-PJ operates in a similar fashion to the PE head except that it has one extra function. When measuring very low energies, the head will also be sensitive to background light and therefore show a spuriously high reading. Therefore we have added a function to measure the background light. When measuring low energies, block the laser and press "Bkgrnd".

You will see a reading of the background light. This reading can be subtracted from your laser reading to obtain a more accurate reading. Also, making the room darker will reduce this background effect.

## **6.2 Selecting Settings from the Vega Screen**

The Vega can conveniently be set to various chosen parameters from the screen. In addition, it can be set to startup defaults so it will be in the desired configuration when turned on.





Figure 6.1  
Pyroelectric Energy Screen

### 6.2.1. Setting up the head to display the user's chosen wavelengths. (Metallic Type Only)

The absorption of the detector coating varies somewhat with wavelength. The correction curve for the absorber is stored in the head EEROM. This correction curve ensures that the power reading is correct at all laser wavelengths.

In order to simplify changing from one laser wavelength to another, the user can program up to 6 different wavelengths to be available from the screen menu. Please use the following procedure to set the pyroelectric or PD10 & PD10-PJ head to your laser wavelengths.

1. From the main display, select "Laser" and enter.
2. Use the up/down navigation keys to select the first wavelength desired. Press the right navigation key.
3. Change the wavelength value by pressing the up/down navigation keys to change each number and the right/left navigation keys to move to the next number. After you are finished, press "Save" and then the Enter key.
4. Repeat step 3 for other wavelengths desired. When finished press the Enter key. Those values for which "Save" was pressed will be default startup values, the others will be saved until the instrument is turned off.

**Note:**

The broadband type heads (BB) have less variation with wavelength, and in those heads, fixed wavelength ranges are selected similar to thermal heads. This section is not relevant with those heads.

**6.2.2. Setup of Laser Pulse Width and Pulses/Sample****6.2.2.1. Laser Pulse Width**

As was mentioned before, the Ophir pyroelectric heads can measure long as well as short pulses. In order to do this, the user must indicate to the Vega if the laser pulses are going to be in the long or short pulse regime (Some models only have the long pulse setting and measure all pulse lengths on this setting In that case "N/A" will appear).

**Warning:**

If the pulse width is incorrectly set to the short setting for pulses longer than that value, the reading will be erroneously low. If it is set to the longer setting for short pulses the reading will be correct but noisier.

**To set up for pulse width, please do the following:**

1. From the main measurement screen, select "Menu" and enter. Select "Configure" and enter.
2. Select "Max Pulse Len", enter and select the setting for your laser pulse length. If your laser pulses are longer than the short pulse length value, then the long pulse value should be selected and vice-versa. Now press the Enter key and "Save" if you want this to be the startup default and press "Exit".

### **6.2.2.2. Setup for the Time Period to Average Over**

The Vega has the ability to measure a number of pulses and display the average value of the energy of the pulses. This function is useful if the laser energy is not stable. Then the user can choose to measure a number of pulses and display only the average.

#### **To set up for averaging over a number of pulses:**

1. From the main measurement screen, select "Menu" and enter. Select "Configure" and enter.
2. Now select "Average" and enter. Select the time period you wish to average over and enter. If you do not want to average, but collect individual pulses then select "NONE".
3. If you wish to save the new setting as the default, press "Save" before enter.

#### **Note:**

The Pyroelectric head is capable of measuring pulses up to very high repetition rates on the order of kilohertz or higher. The Vega actually captures each pulse up to 4000Hz and will sample pulses at up to 25,000 pulses depending on the head. The pulses collected can be stored for later recovery and transmission. (See section 4.4.2.6.1). However, the display can only display at rates up to 10Hz. At higher rates, if the user has chosen "NONE", the Vega will display individual pulses

sampled at a rate of 5Hz. If the user has chosen to average over a time period, the instrument will display the average of readings over the period from the time the screen was entered up to the present. For instance, if the average period is 30 seconds, at 15 seconds, the average is over 15 s., at 30 seconds it is over 30 seconds, at 5 minutes, it is over the period from 4.5 to 5 minutes (30 seconds back from the present etc.).

## 6.3 Startup and Configuration of Defaults

If you are planning to do repetitive measurements most of the time, you can set up the Vega so that it automatically goes into the measurement mode you want upon startup. Since these desired settings are saved in the head "smart connector", you can save different settings for different heads.

### **To set the Vega startup mode and to save the chosen Vega configuration:**

With the head connected, switch on the Vega. Select "Power" or "Energy" measurement screen. Select "Menu" with the navigation keys. Enter, select "Configure" and enter again. Now choose the desired startup parameters as follows:

1. Select "Startup Mode" to choose "Power" or "Energy" for the desired startup screen. Choose power or energy and press enter and save. The Vega will now start up in power or energy measurement mode, respectively, when switched on.
2. Now select "Display Mode" and select the desired startup screen. Press "Save". (Note that this selection is saved in the Vega and not the head, so will be operative for all heads). For more details on the screen types see section 4.6.
3. Now select "Energy Range" and choose the energy range you wish to be the default. The Vega will now be in the range selected when switched on with the head in question. Note that there are only manual ranges in energy.
4. Now select "Average" and select the period you wish to average readings over. This feature is especially useful for lasers with unsteady output. See section 4.4.2.4 for details.
5. Now select "Diffuser" if your head has a removable diffuser and select if you wish diffuser in (installed) or out (not installed) to be the default.
6. Now select "Max Pulse Len", enter and select the setting for your laser pulse length. If your laser pulses

are longer than the short pulse length value, then the long pulse value should be selected and vice-versa.

7. Now select "Laser" and select the laser type you want to be the default. The Vega will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected and will startup with the laser wavelength selected.
8. Now press "Save" if you want this to be the startup default and press "Exit".
9. Switch the Vega off then on by means of the on/off switch. (See Figure 3.1). The Vega will enter the mode of operation last saved with the "Configure" operation.

## **6.4 Energy, Power or Exposure Measurement**

### **Warning:**

Before using the head for power or energy measurement, check that your laser energy, energy density and average power do not exceed the head ratings as listed in the table with the head specifications at the end of the manual, otherwise, there is a risk of damaging the absorber. With the pyroelectric head, you have been supplied a test slide with the same coating as on your pyroelectric detector. You can also obtain this slide from your dealer. You should use this slide to test the damage threshold with your laser pulses. If the slide shows damage, then either enlarge your beam or lower the laser energy until damage is no longer seen.

### **Note:**

To measure pyroelectric energies properly, it is important that the head is not grounded to the optical bench. Make sure that the head is isolated electrically from the ground. The PE head has been supplied with an insulating mounting post for this purpose.

## **6.4.1. Energy Average Power and Frequency Measurement**

Unlike most pyroelectric energy meters, the Vega measures the pulse frequency to a high degree of accuracy and is therefore able to display pulse frequency and average power as well as pulse energy. The following paragraph will describe how to set up and measure these functions.

### **6.4.1.1. Zeroing Head against the Vega Display**

There is a slight variation of pyroelectric reading from display to display. Therefore, for the most accuracy in pyroelectric energy measurements, it is necessary to zero the pyroelectric head against the Vega display it will be used with. After this is done, the head is "conditioned" to work with the particular Vega the zeroing was done against. It is not necessary to do this procedure again unless the head is used with a different Vega. If the procedure is not done, errors of 2% or so can occur. To zero the head against the Vega, proceed as follows:

Make sure the head is in a quiet environment and not subject to pulsed radiation. Plug the head into the Vega and turn on. Select "Menu" and enter. Select "Zero" and enter. Press "Start". When "ZEROING COMPLETED" appears, press "Save", and "Exit".

### **6.4.1.2. Energy Measurement**

1. Ordinarily, when the instrument is switched on, it is in the main energy measurement mode. This can be verified by the units of mJ,  $\mu$ J etc. and the legend "Energy" in the upper right corner of the display (see Figure 6.1). If it is in power measurement mode with units of mW, W etc., then press "Energy".
2. Enter "Range" and select the proper range. The correct range is the lowest one that is larger than the pulse energy measured. If you want this to be the default, press "Save" or return to main screen by pressing the Enter key.

3. Press the menu button, select "Configure" and press the Enter key. Select "Max Pulse Len" and "Diffuser" if applicable and set to the correct value for your laser. (See section 6.2.2.1 for further details on laser pulse width).
4. If you wish to display the average of a number of pulses, select "Menu", enter and select "Configure" and enter again. Select "Average" and set to the value desired. The default value is "NONE" which means that the pulses displayed are individual pulses with no averaging. See section 6.2.2.2 for further information on averaging.

The Vega is now ready to measure energy pulses. The energy reading will operate in the following manner. If "NONE" selected as the averaging period, following every 1/5th of a second period, the Vega will display on the screen the next pulse which arrives. The Vega will hold the display of the latest pulse until a new one arrives. If an averaging period is selected, the Vega will collect pulses at up to 180Hz and will then display the average of those pulses. When a new pulse triggers the Vega, "TRIG" will appear on the screen. At over 5Hz, the "TRIG" stops flashing and appears all the time.

**Note:**

The Vega is able to record each pulse at up to 180Hz even though it is displaying at a much lower rate. This data can be stored in a data file and recovered and transmitted later.

Besides the usual range, laser, average information, the Vega also displays the frequency of the laser as shown in Figure 6.1.

### **6.4.1.3. Power Measurement**

1. Make sure the instrument is in the power measurement mode indicated by the units of mW, W, etc. If it is in energy measurement mode with units of mJ,  $\mu$ J etc., then press the "Power" soft key. The Vega can be configured to start up in power measurement mode when turned on. See section 6.3.

2. Select "Range", enter and then use the navigation keys to select the proper range. The correct range is the lowest one that is larger than the pulse energy measured. Note that the proper range is related to the pulse energy even though we are measuring average power.
3. Press "Enter" to return to the measurement screen. If you want this to be the default range, press "Save" before pressing the Enter key.

### **6.4.2. Measuring Total Energy Exposure.**

The Vega has the ability to sum the total energy of a number of pulses over a given time period or number of pulses. This gives the total energy "exposure" over that time period. For example if the laser is pulsing at 30 times/sec at 1mJ per pulse and you measure the exposure over 20 seconds then the total exposure is  $30 \times 1 \times 20 = 600\text{mJ}$

#### **In order to measure exposure, do the following:**

1. From the energy measurement screen, select "Menu" and enter. Select "Exposure" and enter.
2. Setup the desired measurement parameters as follows:
  - Timeout: Define the time period after which to stop measuring exposure if the mode selected is "After Timeout"
  - Pulses: Define the number of pulses after which to stop measuring exposure if the mode selected is "After Pulses"
  - Mode: Choose "AFTER TIMEOUT" if you want to measure over a specific time period  
Choose "AFTER PULSES" if you want to measure a specified number of pulses.  
Choose "MANUAL ONLY" if you want to stop the measurement manually only. (Note that you can also stop the measurement manually in the other modes as well).





Figure 6.2.  
Exposure Screen set to stop after summing 500 pulses

3. Press "Start". The Vega will start summing laser energy exposure. When you wish to stop measuring, press "Stop" or wait for measurement to reach the timeout or the pulses selected. The Vega will now display the total energy emitted during that period, the time elapsed and the number of pulses during the period. If you wish to reset reading to zero before another reading, press "Reset".
4. To return to the regular energy measurement screen, press "Energy".

**Warning:**

Pressing "Reset" will terminate the exposure measurement session.

**6.4.3. Normalize**

When you wish to show the readings as compared to some standard reading, the normalize function allows you to do this. After setting "Normalize", all subsequent readings will be shown as a ratio to the reference reading. For instance, if you normalize the reading at an energy of 1.5mJ, then subsequent readings will be with

ratio to that, i.e. if the energy at that point is 2mJ, the reading (dimensionless) on the screen will be  $2/1.5 = 1.33$ . The screen will also show in small digits the energy at which the normalization was done and the present energy reading.

### To use the Vega to normalize the energy:

1. From the main measurement screen, enter "Menu" and select "Normalize".
2. When ready to normalize, press "Apply". From then on, the energy will be proportional to the normalized energy value. (See Figure 6.3).
3. If you wish to return to the the regular display, press "Energy".

Note that in "Present" is shown the last power or energy reading, in "Reference" is shown the reference value we are normalizing to and in the large number, the ratio.



Figure 6.3  
Pyroelectric Normalize Screen

### 6.4.4. Other Display Modes

The functions described in Section 4.6 Advanced Display Screens apply to pyroelectric heads as well.

## 6.5 Measuring Repeating Pulses of High Energy

Because of their construction, pyroelectric heads are restricted in the energy density they can withstand, particularly for short pulses on the order of nanoseconds. If the energy density of your laser exceeds the rating of the pyroelectric absorber, there are several options available:

1. You can enlarge your laser beam using a negative lens until the energy density is below damage threshold. You should test this using the test slide. See section 4.6.
2. You can use a beam splitter, splitting off typically 8 - 10% of the light. If you use this method, note that there may be polarization effects. You can calibrate the beam splitter by running the laser at energy below damage threshold and measuring the energy with and without the beam splitter and you can then use the attenuation feature (Section 4.6.1) to display the actual laser power or energy.
3. Ophir has three heads specifically designed for high energy density pulses. They are the PE50HD heads with high damage threshold, the PE50-DIF model pyroelectric heads with a diffuser and the RP thermal/photodiode heads. Some of these heads can measure energy densities up to several Joules/cm<sup>2</sup>. Contact your Ophir dealer for details.

## 6.6 Energy Log

This is the same as for thermal heads, except you do not have to wait for "READY". See sections 4.5.6 and 4.4.2.6.1

### Note:

For Pyroelectric heads logging energy the only setup option is 'sample rate'. The user can choose the number of pulses he wishes to log - from 'every pulse' to '1 out of 1000' pulses - but not the time period.

## **Turbo mode**

In regular data log mode above, you can only log every point at up to 180 points per sec. Also you can not transmit to PC at higher rates than 180 Hz in regular data log mode.

In order to log data or transmit it to PC at rates >1000Hz, you must be in turbo mode. This will put you into a special mode where the Vega can handle data at high speed while curtailing other functions. To log in turbo mode, do as follows:

1. Make sure that the Vega is in the correct energy measurement range. If not, press "Range", adjust and "Exit".
2. From the energy measurement screen press "Menu" and then select "Data-Log".
3. With the up/down navigation key buttons, indicate the appropriate laser, graph settings and frequency. Then choose the log size, i.e. how many points you want to log. Now press "Turbo" and "Go". The measurement will begin and the Vega will indicate when the file is full.

### **Note1:**

The Vega does not measure frequency in turbo mode. Therefore you have to indicate the frequency before starting the measurement. This means you cannot measure pulses with frequencies which vary during the measurement run.

### **Note2:**

The Vega will not respond to any buttons until the turbo logging session is over. This applies either for data logging or data transmission in turbo mode. See section 4.4.2.6.1 for further information.

## **6.7 Pyro Scope Adapter**

A special adapter can be purchased which is plugged in between the head connector and the Vega head socket. This adapter has a cable and BNC connector to attach to an oscilloscope. It enables the user to see on the scope

pulses proportional to energy up to the maximum pulse rating of the head. Unlike the Vega display, which samples at the maximum rate, the scope adapter shows every single pulse.

Activate the scope adapter as follows:

1. Plug the adapter into the Vega display and then plug the head plug into the adapter. Plug the BNC connector into a standard  $1M\Omega$  scope input.
2. Enter power or energy "Menu" and select "Scope". The display will now say "In Scope Mode". Select the appropriate measurement range and laser wavelength in the usual way.
3. You can return to the ordinary measurement mode by pressing "Energy" (or "Power") from the scope mode screen.

## 6.8 PE-DIF Diffuser Heads

### Setting up PE-DIF diffuser heads to diffuser IN or OUT setting:

1. In the "Configure" screen set "Diffuser" to be "IN" or "OUT" according to the startup mode you prefer.
2. Go to the main power / energy screen.
3. "IN" (or "OUT") appears at the bottom of the screen (next to the second button from the left). Make sure the diffuser is physically installed (or not installed) on the head respectively.
4. To change from "IN" to "OUT" press "IN" (the statement "Diffuser is IN" will appear). Press "Change" (the statement "Diffuser is OUT, Ensure that diffuser is removed from head" will appear)
5. Press "OK" and "OUT" will appear on the main power / energy screen. Make sure to remove the diffuser from the head.
6. Press "Laser" and select the correct wavelength. Note that only wavelengths compatible with the diffuser setting are visible. (All wavelengths for diffuser "IN" have a D suffix, e.g. 106D = 1.06 $\mu$ m).
7. In addition make sure to change the pulse length setting if necessary.

## Chapter 7. Circuit Description

The Vega has two circuit boards: the lower board with analog circuit, digital processor and its support circuit, and power supplies; and the upper board with LCD and its driver.

### **Analog Circuit:**

The signal from the detector head enters the analog circuit and passes through EMI protection components to a differential trans-impedance preamplifier. From there it is further amplified by a programmable gain voltage amplifier and passes to an Analog-to-Digital (A/D) converter. All calibration data for the analog circuit is stored in a memory chip on the main board. There are no mechanical adjustable components (trimmers etc.) in the Vega.

### **Fast Analog Input:**

In addition to the above basic analog circuit, the Vega contains a second fast analog input. This supports certain Ophir heads that read energy pulses at higher rates than can be supported by the basic analog circuit, but provides less overall accuracy than the above circuit. The fast analog input consists of an EMI filtered voltage input that is passed to a first stage of mild voltage attenuation. This is then passed to a fast A/D converter. Calibration data is stored on the same memory chip mentioned above.

### **Digital Processor:**

The digital processor is built around a Freescale MC68332 32-bit micro controller (MCU) with a 16-bit external bus. The digital circuit includes an upgradeable FLASH chip that can be programmed in-situ by Vega support software. In addition there is a static battery-backed RAM chip totaling 512Kbytes of RAM. The large amount of RAM allows storage of large amounts of logged data permanently, even when the instrument is turned off. (See

section 4.4.2.6.1 on data storage). The digital processor receives data from the A/D converter and translates it into a measurement of current in Amps. When used with thermopile heads, the data is then processed by a sophisticated digital filter that speeds up the effective response time of the head and rejects noise. In addition, the MCU converts data from the fast A/D converter and translates it into a measurement that can be processed as necessary. The MCU is also responsible for reading the keypad, driving the LCD display and communicating via USB or RS232.

The MCU obtains calibration and capability data from a memory chip in the plug of the detector head and configures itself accordingly. Recalibration data and saved settings are also stored in this memory chip.

A single DIN socket is used for communications via USB or RS232. Only one or other of these communication options is available at any one time.

### **Power Supply:**

The power supply provides the internal DC supply voltages for the analog and digital processors, and to the external head detector. It also contains the battery charging circuit and the AC supply for the backlight. The power supply circuits consist of high efficiency switch-mode designs.

### **EMI Protection:**

The digital processor circuit and the whole Vega instrument are protected by EMI protection component on all signals that pass in and out of the box. In addition, EMI protection is added internally to prevent disturbances to the normal functioning of the instrument. The instrument meets the requirements of the European Community with respect to electromagnetic compatibility and has the "CE" mark.



## **Chapter 8.**

### **Calibration, Maintenance and Troubleshooting**

#### **8.1 Calibration of Thermopile or RP Heads**

##### **8.1.1. Absorber types and Method of Calibration of Ophir Power Meters**

###### **8.1.1.1. Types of Ophir Laser Absorbers**

Two types of absorber surface are used in Ophir thermal measuring heads.

###### **1. Surface Absorbers:**

###### **BB (broadband) absorber**

On standard, high power density, broadband Ophir power monitor heads, a special refractory coating is used to provide high absorptivity from the UV through the IR. This coating can withstand very high power densities, up to 20 kW/cm<sup>2</sup>, without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in graph 1 below.

###### **EX (excimer) absorber**

The EX absorber provides high absorption in the UV, and it can withstand both the pulse energies and the average power of excimer lasers. These discs also have excellent absorption for 10.6 μm and other wavelengths. They can therefore be used for other types of lasers as well. The absorption of the various Ophir absorbers as a function of wavelength is shown in graph 1 below.

###### **LP1 (long pulse) absorber**

This absorber has a very high damage threshold for long pulse (ms) or continuous lasers and is therefore offered for use with high power and energy lasers. It is calibrated for the spectral range 250 – 2200nm with some

heads also being calibrated for 2940nm. It is not suitable for long wavelength CO<sub>2</sub> operation.

### **LP (long pulse) absorber**

This absorber has a high damage threshold for long pulse (ms) or continuous lasers and is therefore offered for use with high power lasers, in particular for CO<sub>2</sub> which cannot use the LP1 coating. It is calibrated for use with YAG laser at 1.064 $\mu$ m or CO<sub>2</sub> laser at 10.6 $\mu$ m and absorbs about 80 - 90% at these wavelengths.

## **2. Volume absorbers:**

### **P (pulse) type absorber**

The models with the P suffix, for use with pulsed lasers, have a special absorbing glass with an absorbance of 95  $\pm$ 2% over the operating range. Since the surface is a glass, its reflectivity does not change even if damaged or melted locally.

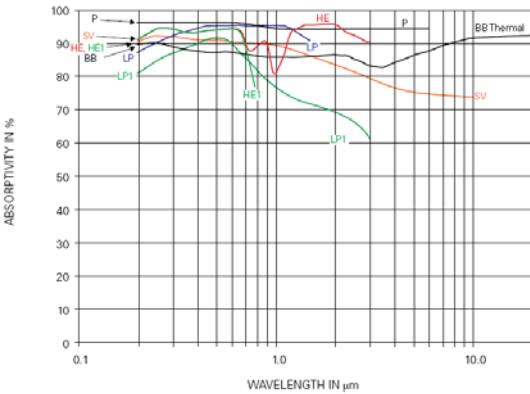
### **HE/HE1 (high energy) absorber**

The HE and HE1 types have a particularly high damage threshold for pulsed and repetitively pulsed lasers of both the short and long pulse variety and are useful where the highest pulse energies and average powers are used.

### **HL (high energy long pulse) absorber**

The HL absorber is the absorber of choice for high-energy repetitive pulses longer than 2ms. For these long pulses it has flatter spectral response than the HE/HE1 and withstands higher pulse energy and average power.

## Thermal Heads



Graph 1

Absorption vs. Wavelength of Various Thermal Head Absorbers

Ophir power/energy meters with the broadband or P type absorbers are individually calibrated by laser at several wavelengths against a NIST calibrated standard meter. The meter can be switched to give the exact calibration at the various wavelengths (Argon, YAG, and, where applicable, CO<sub>2</sub>). For other wavelengths, the user should consult the wavelength graph and use the closest of the above settings.

The EX type detector is calibrated by measuring the ratio of absorption in the UV to that at 515nm. The total absorption is measured in both cases using an integrating sphere. The detector is then calibrated with an argon laser and given a correction factor from this ratio.

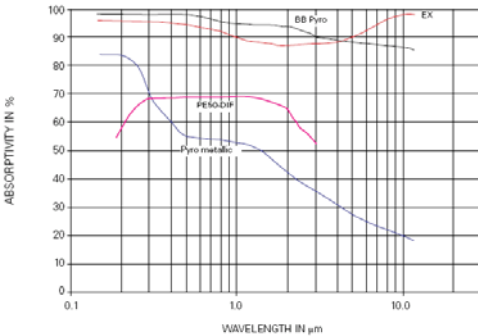
### 8.1.2. Linearity and Accuracy of Ophir Thermal Heads

#### 8.1.2.1. Linearity

The linearity of most Ophir thermal detectors is specified to be 1% over the specified power range of each particular instrument and is tested by Ophir from time to time. On CAL models, the built in CAL resistor can be used to directly measure the linearity over the range of powers of the CAL resistor. On non-CAL models, a CAL

resistor is temporarily affixed to the sensor. For those models for which the linearity is not tested over their entire range, randomly chosen sample models are tested periodically over their entire range. The test is performed with a high power laser that can cover the entire detector range using a rear leak detector for comparison. This rear leak detector is a low power Ophir detector that has previously been tested for linearity. Thus, in all cases, the linearity of the detectors is traceable to electrical standards.

Pyroelectric and Excimer Heads



Graph 2.

Absorption vs. Wavelength of Various Pyroelectric and Excimer Head Absorbers

### 8.1.2.2. Method of Calibration

The absorption of the various Ophir thermal absorbers can vary from disc to disc. Therefore, all Ophir absorbers are individually calibrated against NIST traceable standards.

### **8.1.2.3. Total Accuracy of Calibration**

Since the instruments are calibrated against NIST standards, the accuracy is generally 1% at the power level at which the calibration has been performed. This accuracy has been verified by checking the scatter of the results when several instruments are calibrated against the same standard. The maximum error in measurement will be less than the sum of the specified accuracy and linearity. Since the linearity is also 1%, the maximum error in measurement will generally be less than 2%.

### **8.1.3. Calibration Factor**

For models equipped with the Ophir CAL resistor, the calibration factor is determined at the factory by the following procedure. After calibration of the sensor as described above in Section 8.1.1 electrical power is applied to the CAL resistor. The calibration factor is given by the formula:

**CAL factor = reading on meter / applied electrical power.**

If you wish to check and adjust the power reading, apply electrical power to the CAL resistor, and measure the voltage and current to obtain the applied power. The correct power reading for the meter is the applied electrical power multiplied by the CAL factor given above.

### **8.1.4. Recalibration of Thermopile Heads Using the Vega**

If your measuring head is equipped with the exclusive Ophir CAL resistor then calibration is performed according to the instructions in Section 8.1.4.2.

If you do not have the CAL resistor, then you can recalibrate from a known source of power or energy following the instructions in Section 8.1.4.3.

On the rear center of the sensor disc is the exclusive Ophir calibration heater. The disc can be heated by

electrical power instead of by radiation by applying electrical power to the terminals at the rear of the sensor head.

By accurately measuring the voltage and current applied, the calibration can be checked and if necessary, readjusted, taking into account the calibration factor. See Section 8.1.2.

#### **8.1.4.1. Guidelines for using the CAL resistor for calibration**

1. Do not exceed the maximum electrical power stated in the table.

<b>Model</b>	<b>Power</b>	<b>Aprox. Max Voltage</b>
3A Series	1 Watt	7 Volts
10A Series	10 Watts	17 Volts
30A Series	30 Watts	35 Volts
150A Series	100 Watts	65 Volts
L250A Series	200 Watts	95 Volts
300W Series	125 Watts	65 Volts
1500W Series and above	200 Watts	95 Volts

Table 3.  
Maximum Power to Apply to Sensor CAL Resistor

2. Use the resistor for calibration only.
3. Turn off the power as soon as calibration is done.
4. Do not operate the calibration resistor when the sensor disc is under radiation; the excessive heat may burn out the calibration resistor.
5. To eliminate residual non-linear effects, it is advisable to perform electrical calibration at about the same power level as that to be measured, so long as the rating of the heating resistor is not exceeded.

### 8.1.4.2. Recalibration of Power using the Built in CAL Resistor

If your thermal head has the Ophir CAL resistor then you have a traceable absolute calibration source available just by measuring the voltage and current into the CAL resistor and multiplying by the calibration factor provided by Ophir.

#### Calibration instructions:

1. Set the instrument to power. If you want to recalibrate energy, this can be done from a known energy source. See section 8.1.4.3.
2. From the main power measurement screen select "Menu" select "Calibrate" and press "Enter". Enter "Adj:" and select "Overall: all lasers".
3. Enter "Laser" and select the proper laser wavelength.
4. Using a DC power supply, apply power to the CAL resistor (black and red terminals at the back of the head). For highest accuracy, use the same power as you intend to measure, but do not exceed values in Table 3., Section 8.1.4.1
5. Maximum voltage applied should not exceed:

$$\sqrt{(\text{resistance of CAL resistor}) \times (\text{maximum power})}$$

6. The voltage should be measured at the input to the head and the current in series with the current loop.
7. Enter "Factor" and in the "Modify" screen adjust the value upwards or downwards until the power reading on the screen reads the (voltage in volts) x (current in amps) x (current calibration factor for your model and laser or as shown on Vega).
8. When the correct power is shown on the screen, press "Save" to save the new calibration value. Note that in the modify screen, the previous value of the calibration is shown for your reference. As soon as you save, this value is set to the newly saved value.

**Note 1:**

When recalibrating using "Overall: all lasers" setup with a CAL resistor, the other two settings will change proportionately. If you wish to change the calibration of only one laser type, use the function "Specific: this laser only"

**Note 2:**

The unit retains for your information the current sensitivity of the head in A/W in engineering notation. The original value is retained at the factory. You should record the original setting so you can return to it if you wish.

**8.1.4.3. Recalibration from a Known Source of Laser Power / Energy**

1. From the main measurement screen select "Menu" and select "Calibrate". Select "Adj:" and select "Specific: this laser only".
2. Enter "Laser" and select the proper laser wavelength. Enter "Average" and enter the desired averaging period.
3. Apply the known laser power/energy.
4. Select "Factor" and enter the "Modify" screen. Adjust the factor until the power/energy reading on the screen equals the known power/energy. Press "Save" and the power/energy calibration factor under "Updated" will change accordingly. See Note 1.

**Note 1:**

For units which have different calibration factors, e.g. CO<sub>2</sub>, YAG, or VIS, press "Laser" to select correct type of laser before calibration. When recalibrating using "Specific: this laser only" function, only the calibration of the chosen laser wavelength will change. If you wish to change the calibration of all wavelengths proportionately, then use the function "Overall: all lasers".



**Note 2:**

When changing power calibration, this will also change energy calibration proportionately. However, changing energy calibration will not change power calibration.

**8.2 Calibration of Photodiode type Heads**

Photodiode detectors are inherently very linear but also have a large variation in sensitivity with wavelength. In addition, the Ophir model PD300 is equipped with both a built in filter and removable filter to allow measurement of higher powers without detector saturation. These filters also have a transmission that depends on wavelength. Therefore, when the PD300 is being used with Vega, the Vega has a built in calibration adjustment for wavelength which is described in the next paragraph.

**8.2.1. Method of Factory Calibration**

The sensitivity of various Ophir photodiode sensors can vary from one to another as well as with wavelengths. Therefore, Ophir photodiode detectors are individually calibrated against NIST traceable standards over the entire operating range of wavelengths for both filter out and filter in. The calibration curve is normalized to the correct absolute calibration at 632.8 nm using a HeNe laser against a reference meter traceable to NIST.

The spectral sensitivity curve of the detector as well as the spectral transmission curve of the filters is fed into the head EEROM and this information is used to set the gain to the proper value at wavelengths other than the wavelength the instrument was calibrated. When the user selects his wavelength on the Vega, the correction factor for that wavelength is applied.

**8.2.2. Accuracy of Calibration**

Since the instruments are calibrated against NIST standards, the accuracy is generally  $\pm 2\%$  at the wavelength the calibration has been performed. The

maximum error in measurement will be less than the sum of the calibration accuracy, linearity, inaccuracy due to errors in the wavelength curve and variations in gain with temperature. The linearity of the photodiode detector is extremely high and errors due to this factor can be ignored. The maximum error due to the above factors is given in Table 4 below.

Wave Length	Error, Filter Out*						
	PD300	PD300-TP	PD300-3W	PD300-UV	PD300-IR	PD300-IRG	3A-IS
200 - 250nm				±5%			
250 - 360nm	-		-	±3%			-
360 - 400nm	±10%	±7%	±10%	±3%			-
400 - 950nm	±3%	±3%	±3%	±3%			5%
950 - 1100nm	±5%	±5%	±5%	±5%	±5%		10%
1100 - 1600nm	-		-	-	±5%	±3%	
1600 - 1800nm	-		-	-	±7%	±5%	

Table 4  
Maximum Error as a Function of Wavelength and Filter

\* Add ±2% to error for filter in (±5% for PD300-UV from 220 to 300nm).

**Note:**

More exact specifications will be found in the latest Ophir Laser Measurement Instruments Catalog.

**8.2.3. Recalibration at a specific wavelength from a Known Source of Laser Power**

1. From the main measurement screen select "Menu" and enter. Select "Calibrate" and enter.
2. Enter "Laser" and select the proper laser wavelength. Enter "Average" and enter the desired averaging period.
3. Apply the known laser power/energy.
4. Select "Factor" and enter the "Modify" screen. Adjust the factor until the power reading on the screen equals the known power. Press "Save" and the power calibration factor under "Updated" will change accordingly. See Note 1.

**Note 1:**

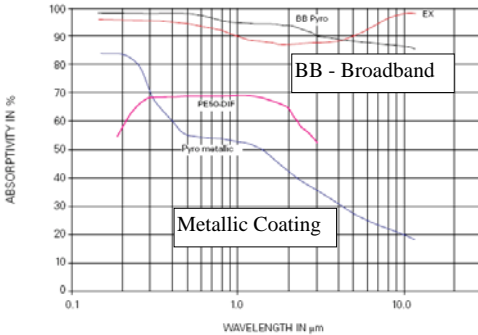
The relative readings at different wavelengths are fixed by the wavelength calibration curve stored in the head EEROM. When changing the calibration at one wavelength, the calibration at all other wavelengths will change proportionately.

**8.3 Calibration of Pyroelectric type Heads****8.3.1. Two main types of absorber surface are used in Ophir pyroelectric measuring heads**

1. **Metallic Type:** The type with no suffix in the name have a partially reflective multilayer metallic coating which absorbs approximately 50% and whose absorption graph is shown in Graph 3 below. The metallic coating permits very high repetition rates, up to 5000Hz as well as relatively high damage threshold.
2. **Broadband Type:** The type with the BB suffix has a broadband black absorbing coating to provide high absorptivity from the UV through the IR. This coating can withstand energy densities, up to 0.3J/cm<sup>2</sup> for short pulses and 2J/cm<sup>2</sup> for long pulses without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Graph 3 below. This coating is available for the PE50, PE25, and PE10 heads.
3. **PD10 & PD10-PJ Type:** Unlike the other heads, the PD10 & PD10-PJ has a silicon photodiode with a neutral density filter mounted permanently in front of it. The filter detector combinations are calibrated over the entire wavelength range similarly to the PD300 power heads and therefore the heads have a high accuracy at any wavelength in the range. This is an exclusive feature with Ophir energy heads.

## Absorption(%) vs. Wavelength (nm)

### Pyroelectric and Excimer Heads



Graph 3.

Absorption of Ophir Pyroelectric Absorbers

### 8.3.2. Calibration

The sensitivity of the various Ophir pyroelectric sensors can vary from one to another as well as with wavelengths. Therefore, Ophir pyroelectric detectors are individually calibrated against NIST traceable standards. In addition, the calibration is corrected in the Vega for different wavelengths.

Ophir pyroelectric detectors are calibrated using a 1.06μm repetitively pulsed laser referenced to a NIST traceable thermal power meter. The average energy is set to the average power of the standard power meter divided by the laser frequency. The metallic PE25 and PE50 heads are also calibrated with an excimer laser at 248nm to correct the rather large absorption variations in that spectral region with those heads.

The spectral absorption of the detector coating is measured spectroscopically and the absorption curve is used to correct the calibration for other wavelengths. When the user selects his wavelength on the Vega, the correction factor for that wavelength is applied.

The PD10 & PD10-PJ heads are calibrated in a two step fashion. First the photodiode detector - filter combination are calibrated against a NIST traceable master in a similar fashion to the PD300 heads over the wavelength range of the head. Then the head is calibrated at one wavelength using a 905nm repetitively pulsed laser referenced to a NIST traceable photodiode meter. The average energy is set to the average power of the standard power meter divided by the laser frequency.

### **8.3.3. Accuracy of Calibration**

Since the instruments are calibrated against NIST standards, the accuracy is generally 3% at the energy level and wavelength at which the calibration has been performed. This accuracy has been verified by checking the scatter of the results when several instruments are calibrated against the same standard. The maximum error in measurement will be less than the sum of the specified accuracy, linearity and inaccuracy due to errors in the wavelength curve.

The non-linearity is approximately 2%, and the error due to wavelength is given in table 5 below.

In addition to the above errors, the reading of pyroelectric heads changes with frequency. The Vega has a built in correction for this error. For frequencies above 50% of maximum frequency, inaccuracies in this correction can increase the total error by up to 3%.

The maximum error in measurement will be less than the sum of the above errors and in general will be considerably less. The exact accuracy of each type of head is specified in the latest edition of the Ophir catalog.

Wavelength	Coating Type			
	Broad-band	Metallic	PD10	PD10-PJ
190, 248nm	±2%	0	±3%	±2%
300 - 800nm	±2%	±4%	0	0
1064nm	0	0	±2%	±2%
1.5 - 2µm	±2%	±2%	N.A.	N.A.
2.94µm	±2%	0	N.A.	N.A.
10.6µm	±5%	±15%	N.A.	N.A.

Table 5.  
Maximum Measurement Error due to Wavelength

### 8.3.4. Recalibration from a Known Source of Laser Energy

1. Set the instrument to "Energy".
2. Set to the proper energy range.
3. (For broadband type heads only. See note 1). From the main screen enter "Menu" and select "Calibrate". Enter and select "Adj:" Select "Specific: this laser only" if you only want to change the calibration of this wavelength or "Overall: all lasers" if you want to change all wavelengths together proportionately.
4. Apply the known laser power/energy.
5. Select "Factor" and enter the "Modify" screen. Adjust the factor until the energy reading on the screen equals the known energy. Press "Save" and the energy calibration factor under "Updated" will change accordingly. See Note 1.

#### Note 1:

For metallic and PD10 & PD10-PJ type heads, when the calibration is changed at one laser wavelength, the overall calibration of all other wavelengths changes proportionately.

## 8.4 Error Messages

The Vega displays various error messages when operated outside its normal range: If the color scheme selected is full color, then the error messages will be colored red.

**Over range:** When the power or energy being measured exceeds the range of the measurement scale being used, the "over" message is displayed, but the reading still appears on the display. If the power or energy exceeds the maximum by more than 10%, the reading on the display is blanked.

**Low Battery:** When the battery is almost discharged, the Battery icon will have only 1 segment left. This means the battery is  $\frac{3}{4}$  empty. At this stage, the Vega should be connected to the charger. It will operate normally and charge slowly while connected to the charger.

**Sat:** When the photodiode current exceeds 1mA, and the detector starts to saturate, or the pyroelectric voltage exceeds the maximum, the message "sat" (=saturated) is displayed.

## 8.5 Troubleshooting

### 8.5.1. Vega Display

Problem	Cause/Remedy
Instrument will not operate after being completely discharged and connected to charger.	Check that charger provides 200mA.
Instrument operates with charger but not with battery alone.	Battery is low. Recharge overnight with the Vega turned off for 7-8 hours. If the Vega still doesn't work with battery, then the NiMH battery is probably dead. Replace battery (see section 8.6.1.4).

## 8.5.2. Thermal Heads, Energy Measurements

<b>Problem</b>	<b>Cause/Remedy</b>
Instrument triggers on background noise or sometimes fails to catch large pulse.	Increase threshold level; See Section 4.5.3
Instrument does not show ready for a long while after a reading is made.	Increase threshold level; See Section 4.5.3
Non-reproducible results when measuring very small energy pulses; or no response to pulses at low energy.	Decrease threshold level: See Section 4.5.3

## 8.5.3. Thermal Heads, Power

<b>Problem</b>	<b>Cause/Remedy</b>
Instrument shows zero reading in both power and energy modes.	Check connections between the head and the instrument. (See section 8.6.1.1). Check that the sensor disc is operative. Resistance between the pins 1 and 9 of the head connector should be about 1.8k. If the sensor is defective, there will be an open or short circuit.
Instrument responds while head is cold, but suddenly fails as it heats up.	Replace sensor disc. See Section-8.6.1.2
Instrument does not return completely to zero on power measurement.	If head is very hot, allow it to cool. Disconnect the head from the instrument. If readout unit does not zero, follow instructions in section 3.5.5. If the offset persists, try zeroing with the head connected as well, as described in the same section.



## 8.5.4. Pyroelectric Heads

Problem	Cause/Remedy
Instrument reads incorrectly or erratically, especially on sensitive scale.	Possible electromagnetic interference from pulsing laser is causing misreading and/or false triggering
Instrument triggers even without being exposed to laser pulses.	Check the following: Head is mounted to stand using insulated plastic rod provided with instrument, and not metal rod.
Instrument shows frequency which is too high	1. Try keeping cable away from bench. 2. Move head/display further away from EMI.

## 8.6 Maintenance

### 8.6.1. Maintenance of Thermal Heads

#### 8.6.1.1. Tracing the Signal from the Head to the Vega

1. With the instrument on, apply an approximately known amount of power to the head. This test can be performed using either a laser or an electrical power supply and the calibration resistor.
2. Estimate the approximate signal current that should be developed by the head by multiplying the input power by the head-sensitivity shown in the head specification table.
3. Using a multimeter set to current, unplug the head from the Vega and check that this current appears between pin 1 and 9 of the D type plug.

#### 8.6.1.2. Disc Replacement

If you have ordered a replacement disc, it has been factory calibrated for the wavelength region shown on the calibration sheet sent with the disc. It has been calibrated at the wavelength requested, or for the 3 wavelengths listed. If it is a CAL type disc, a CAL Factor is also included to use for electrical calibration checks on your power/energy meter. Please follow the following steps in disc replacement.

1. Remove the screws from the front and rear flanges of the absorber head.
2. Remove the front flange and raise the rear flange, taking care not to tear the wires attached to the connectors.
3. Unsolder the wires from the faulty absorber disc attached to the small PC board in the head, remembering which wire is connected to each terminal.
4. Pry the absorber disc free from its seat by using a screwdriver in the hole provided at the edge of the seat.
5. Smear the absorber disc seat evenly with silicone heat sink compound.
6. Feed the wires through the hole and install the new disc. It is best to turn the disc back and forth a few times while pressing on it, to ensure good contact between the disc, grease and head.
7. Reassemble the front flange, making sure the screws are tight.
8. Resolder the two wires to their proper locations on the rear flange and reassemble the rear flange.

### **8.6.1.3. Recalibrating the Head to a new Disc**

1. From the main measurement screen enter "Menu" and select "Calibrate".
2. Enter "Adj:" and select "Overall: all lasers".
3. Enter "Laser" and select the first laser wavelength sent with the disc. Select "Factor" and adjust the number in the "Modify" screen up down until the sensitivity under "Updated" agrees with that sent with the disc. Press "Save" and exit.
4. For heads with calibration at several laser wavelengths, you now have to adjust the calibration for the other wavelengths. From the main measurement screen, enter "Menu" and select "Calibrate". Now enter "Adj:" and select "Specific, this laser only". Enter "Laser" and select the next laser wavelength sent with the disc. Select "Factor" and adjust the number in the "Modify" screen up down until the sensitivity under "Updated" agrees with that sent with the disc. Press "Save" and exit.

5. Now repeat step 4 for the other laser wavelengths. Each time, select a different laser wavelength and enter the proper calibration factor sent with the disc for that wavelength.

#### **8.6.1.4 Battery Replacement**

If the Vega battery is defective and does not hold a charge, a replacement can be ordered from your agent (Ophir part number 7E14007). The new battery is installed as follows:

1. Ensure the Vega is switched OFF. Turn the Vega display upside down and unscrew the 4 Phillips screws on the bottom panel of the Vega.
2. Remove the bottom panel and disconnect the battery connector (red and black leads) from the circuit, by holding the two wires firmly and tugging them firmly in a direction away from the circuit board.
3. Insert the new battery into the same location in place of the old battery. Reconnect the battery connector into its terminal on the circuit board. The RED and BLK (black) symbols on the circuit board indicate the correct direction to insert the connector into its terminal. It can only be inserted in one direction.
4. Replace the bottom panel of the Vega and close the 4 screws.
5. Switch on the Vega with NO HEAD DETECTOR attached and set the date and time of the instrument correctly. (See section 3.5.4)

# Chapter 9.

## Vega Specifications

### 9.1 System/Display Specifications

<b>Input Specifications Thermal, Photodiode</b>		
Input Ranges	15nA - 1.5mA full scale in 16 ranges	
A to D Sampling rate	15Hz	
A to D resolution and linearity	Resolution: 23 bits plus sign. (0.00001%); Linearity: better than 17 bits (0.0009%)	
Electrical accuracy	$\pm 0.25\% \pm 20\text{pA}$ new; $\pm 0.5\% \pm 50\text{pA}$ after 1 year	
Electrical input noise level	500nV or 1.5pA + 0.0015% of input range @3Hz.	
Dynamic range	9 decades ( $1:10^9$ )	
<b>Input Specifications Pyroelectric Heads</b>		
Input Range	0 - 6V full scale	
A to D Sampling rate	4KHz	
A to D resolution	12 bits no sign (0.025% resolution)	
Electrical accuracy	$\pm 0.25\%$ new; $\pm 0.5\%$ after 1 year	
Electrical input noise	2mV	
<b>General Specifications</b>		
Detector Compatibility	Thermopile, photodiode and pyroelectric	
Analog output	4 scales, user-configurable: 1v, 2v, 5v, 10v full-scale; 0.03% resolution. 100 ohms impedance	
Analog output accuracy	$\pm 0.2\%$ (of reading) $\pm 0.2\%$ of full scale volts	
Dimensions	110W x 40D x 210H	
Mass	450g	
Display	320x240 pixel Color TFT LCD; Active area 70x52mm approx	
Display digit height	17mm	
LCD and Keypad lighting	LED's. Operates from charger or battery	
Bargraph segments	320	
Battery	3 x AA size. 2.4Ah NiMH battery built in.	
Charger input	DC: 12 -25V, 5W; AC: 9 - 18V RMS, 5W. Charge time 7-8 hours; automatically switches to trickle charge when battery is full	
Operation between charges	With low backlight and keypad unlit: 16 Hrs, thermal and photodiode, 11 Hrs, pyroelectric heads; With high backlight: and keypad lit: 11/8 Hrs respectively	
<b>Data Logging and Com.</b>		
<b>Power Measurement</b>	<b>RS232</b>	<b>USB</b>
Power log period	20 sec to 600 hours for both	
Max points stored onboard per file <sup>(1)</sup>	27,000	27,000
Max points direct to PC file in real time	unlimited	unlimited
<b>Energy measurement</b>	<b>RS232</b>	<b>USB</b>
Max real time data logging rate <sup>(2)</sup>	>30Hz	>2000Hz
Max onboard data logging rate <sup>(2)</sup>	4000Hz	4000Hz
Data transfer of log file from instrument to PC	-500 points/s	-500 points/s
Max points stored onboard	250,000	250,000
General	Maximum communication rate 38400 baud (RS232)	
Memory data storage	10 data files of an average of 25,000 points each. Data is not lost when instrument is turned off.	

(1): Can store up to 10 files for a total of 250,000 points.

(2): The above refers to the rate for logging every single point in turbo mode. Above that rate the instrument will sample points but not log every single point.

## 9.2 Head Specifications Calibration

Head	Max Power (WATTS)	Max Avg. Power Density	Absorber Type
PD300/UV/IR	300mW	50W/cm <sup>2</sup>	PD
PD300-3W	3W	50W/cm <sup>2</sup>	PD
3A-IS	3W	200W/cm <sup>2</sup>	Int Sph PD
F100A-IS	100W	200W/cm <sup>2</sup>	Int Sph Ther
3A	3W	200W/cm <sup>2</sup>	BB
3A-P	3W	50W/cm <sup>2</sup>	P
3A-P-FS	3W	50W/cm <sup>2</sup>	P
10A	10W	30KW/cm <sup>2</sup>	BB
10A-P	10W	50W/cm <sup>2</sup>	P
12A	12W	25KW/cm <sup>2</sup>	BB
12A-P	12W	50W/cm <sup>2</sup>	P
30A	30W	25KW/cm <sup>2</sup>	BB
30A-P	30W	50W/cm <sup>2</sup>	P
L30A	30W	25KW/cm <sup>2</sup>	BB
L30A-10MM	30W	25KW/cm <sup>2</sup>	BB
L50A	50W	20KW/cm <sup>2</sup>	BB
L50(150)A	50(150)W	20KW/cm <sup>2</sup>	BB
30(150)A	30(100)W	20KW/cm <sup>2</sup>	BB
30(150)A-HE	30(100)W	500W/cm <sup>2</sup>	HE
30(150)A-LP1	30(100)W	35KW/cm <sup>2</sup>	LP1
L40(150)A	35(150)W	35KW/cm <sup>2</sup>	BB
F150A	150W	15KW/cm <sup>2</sup>	BB
FL250A	250W	10KW/cm <sup>2</sup>	BB
FL250A-LP1	250W	15KW/cm <sup>2</sup>	LP1
FL300A	300W	8KW/cm <sup>2</sup>	BB
FL500A	500W	8KW/cm <sup>2</sup>	BB
1000W	1000W	6KW/cm <sup>2</sup>	BB
1500W	1500W	5KW/cm <sup>2</sup>	BB/LP
5000W	5000W	3KW/cm <sup>2</sup>	BB/LP
10K-W	10000W	10KW/cm <sup>2</sup>	BB
L30A-EX	30W	1KW/cm <sup>2</sup>	EX
PD10	50mW	50W/cm <sup>2</sup>	PD
PE10	2W	50W/cm <sup>2</sup>	PE
PE25	10W	10W/cm <sup>2</sup>	PE
PE25BB	10W	10W/cm <sup>2</sup>	PE-BB
PE50	20W	10W/cm <sup>2</sup>	PE
PE50-DIF	30W	100W/cm <sup>2</sup>	PE
PE50BF	15W	20W/cm <sup>2</sup>	PE-BF
PE50BF-DIF	30W	500W/cm <sup>2</sup>	PE-BF

Table 6.

### Max Power Specifications of Heads

PD - Photodiode

P - P type volume absorber for short pulse lasers

HE/HE1- volume absorber for high energy pulses

EX - Excimer type, volume absorber

PE - pyroelectric metallic or black absorber

BB - broadband surface absorber, high power density

LP1 - broadband surface absorber for highest power density

BF - very high damage threshold, long pulses

FS - Fused silica window close to detector for divergent beams

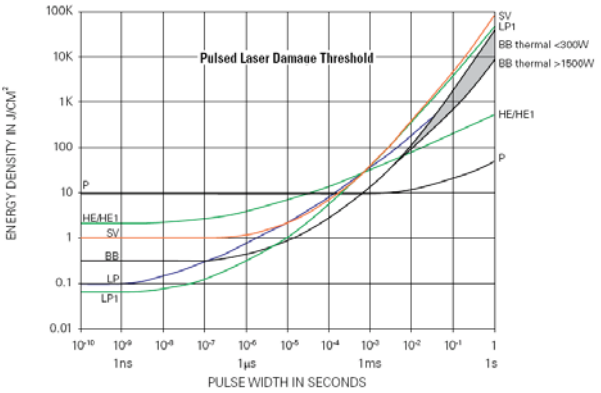
**Note:**

For more detailed and exact specifications, see the latest Ophir Laser Measurement Instruments Catalog.

Absorber Type	Max Energy Density J/cm <sup>2</sup> Pulse Length		
	10ns	1μs	300μs
P	10	10	10
HE/HE1	3	5	15
BB	0.3	0.5	3
LP1	0.09	0.5	10
EX	0.8	0.9	7
PE, Metallic	0.2	0.5	4
PE, BB	0.5	0.5	1
PE-DIF	1	2	20
PE BB-DIF	3	3	10

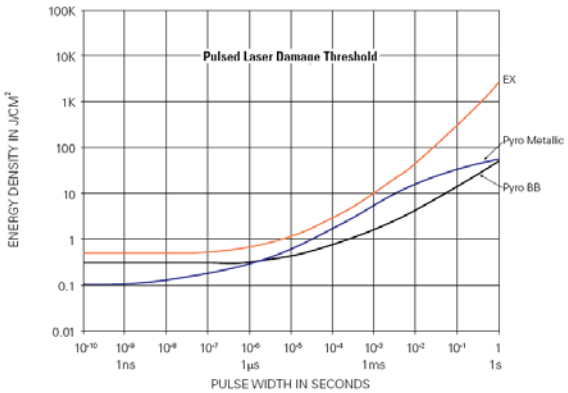
Table 7  
Maximum Energy Densities for Various Absorbers  
(Single pulse).

**Thermal Heads**



**Pulsed Laser Damage Threshold  
Graph 4.**

**Pyroelectric Heads**



**Pulsed Laser Damage Threshold  
Graph 5.**

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