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Photonics
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ORION

ORION

LASER POWER METER

USER MANUAL

OPHIR OPTRONICS
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Chapter 1 Introduction: How to Use This Manual

The Ophir Orion is a microprocessor-based Laser Power/Energy Meter for measuring laser power or energy with Ophir measuring heads. It uses smart connector technology where just connecting the head configures and calibrates the instrument.

This manual tells you what you need to know to make full use of the Orion 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 3 through 6 include a general description and a section detailing operating options.

Chapter 2 Quick Reference

2.1 Getting Started

The Orion is equipped with "soft keys." That is, the functions of the keys change as indicated by the legend above each key. (See Figure 2).
When the Orion is first switched on, the first screen usually has a digital display with a bargraph at the bottom. In order to access the soft keys, press the rightmost button, located on the right of the panel. Pressing the button again will access more functions. Pressing it yet again will bring you back in a cyclical manner to the original bargraph screen.

To connect head to the Orion Display

Insert the D type connector of the measuring head cable into the socket marked "Head Input" on the rear panel of the Orion display. (See Figure 1)

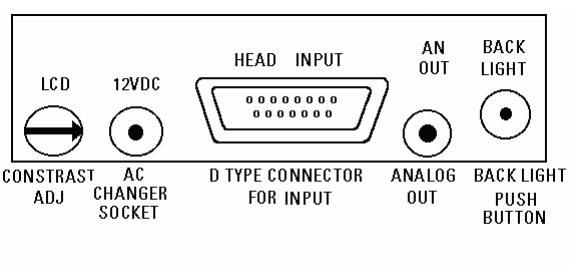


Figure 1
Orion Rear Panel View

To switch the Orion on:

1. Push up the slide switch on the left side of the Orion display. (See Figure 2).

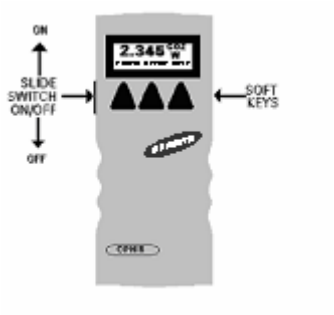


Figure 2.
Orion Top View

The unit will switch on, and the display will appear. Note that the head must be plugged in before the unit is switched on.

To switch the Orion off:

1. Return the slide switch to its original position.
2. If you wish to save the current Orion configuration, use the "config" function before switching off. Refer to the main body of the manual for details.

To set the line frequency:

1. Disconnect the head and switch off then on again. "No Head Connected" will appear.
2. Press "select" until "line freq" is highlighted.
3. Press "go" then change to correct frequency.
4. Press "exit" and change will be saved.

To zero instrument

1. Disconnect the head, turn off then on again. "No Head Connected" will be displayed.
2. Press "select" until "zero" is highlighted.
3. Press "go".
4. Make sure instrument is not in an electrically noisy environment and is undisturbed. Press "go" and wait for message, "zeroing completed". Press "exit".
5. For thermal heads, zeroing with the head may also be necessary. See section 3.5.2.

2.2 Orion TH - Thermal Heads

2.2.1 Use of the Orion TH with thermal type heads

To set to the type of laser being used:

1. While the Orion TH is off, plug in the head then switch it on again.
2. From bargraph measurement screen, press the leftmost button and press "config".
3. Press “value” to choose the desired laser wavelength then press “exit”.
4. Press “yes” or “no” depending if you want the wavelength chosen to be the startup default or not.

2.2.2 To choose manual or automatic ranging in power measurement:

1. From the bargraph measurement screen, press the leftmost button and press "config".
2. Press “select” then “value” to choose the desired power range then press “exit”.
3. Press “yes” or “no” depending if you want the wavelength chosen to be the startup default or not.

2.2.3 Power Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 in section 9.2. Otherwise, there is a risk of damaging the absorber.

To subtract background and set current reading to zero:

1. From the bargraph power measurement screen press the rightmost button then press "offset". Press the "next" twice to return to the bargraph screen.
2. Press "offset" again to cancel. See Section 4.4.2.1. for full details.

To use the Orion TH to fine tune Laser power:

1. From the bargraph power measurement screen press the rightmost button twice then press "tune".
2. Set the percentage range of the power scale to be displayed by repeatedly pressing the left key.
3. Set the horizontal sweep time using the middle soft key See Section 4.4.2.2. for full details.

2.3 Photodiode Heads

2.3.1 Use of the Orion PD with photodiode type heads

To set type of laser being used:

1. From the bargraph power measurement screen, press the rightmost button once and press "config".
2. Press "value" and "select" to choose the laser wavelength. Press "exit". If you want the choice to be saved permanently as the startup default, press "yes", otherwise press "no".

2.3.2 To choose manual or automatic ranging or dBm

1. From the bargraph measurement screen, press the rightmost button then press “config”.
2. Select RANGE: and with “value” choose the appropriate manual range, autorange or dBm (logarithmic scale).
3. Press "exit" and then press “yes” if you want the choice to be the startup default or “no” if not.

2.3.3 Selecting Chosen Wavelengths

1. From the power measurement mode with the bargraph display, press the rightmost button twice and then press “wvlnth”
2. Press "select" until the wavelength you wish to change is highlighted. Press "change".
3. Press "up" and "down" to change the wavelength. Press "done". Repeat step 2 for other wavelengths desired. When finished press exit and the new values will be saved.

2.3.4 Choosing Wavelength Used

1. From the bargraph measurement screen, press the rightmost button twice and press "wvlnth". Press “select” until the correct laser type or wavelength is displayed.
2. Press “exit” to return to the bargraph screen. (If the wavelength you want is not among the 6 choices see section 2.3.3).

2.3.5 Choosing Measurement Range and Filter Setting

1. From the bargraph measurement screen, press the rightmost button once and press “config”.
2. Press "select" and then choose the appropriate manual power range, autorange or dBm by pressing the "up" or "down" buttons.
3. Press “select” again and choose the desired setting, filter IN or OUT.

4 Press "exit" and then press the “yes” if you want the choice to be the default startup. Press “no” if you only want the choice until the instrument is turned off.

2.3.6 Power Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 section 9.2 Head Specifications. Otherwise, there is a risk of damaging the absorber.

To offset current reading and set to zero:

1. From the bargraph power measurement screen press the rightmost button, press "offset" then press “next” twice to return to the bargraph screen.
2. Press "offset" again to cancel. See Section 4.4.2.1 for more details.

To use the Orion PD to fine tune laser power:

1. From the bargraph power measurement screen press the rightmost button twice then press "tune".
2. To set the power expansion scale to ±50% ,±120% or ±20% as desired, press the left hand soft key several times. 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. Set the horizontal sweep time to the rate desired, using the middle soft key. The default value is 1 minute.
4. Press “tune” to return to the measurement screen. Measure the power of the laser and adjust the laser until you determine that the power has reached a maximum.

2.4 Pyroelectric and Photodiode Energy Heads

2.4.1Selecting Chosen Wavelengths

(not applicable to BB heads)

1. From the bargraph display, press the rightmost button twice, press “more” then press “wavelength” then “go”.
2. Press "select", "change" then "up" and "down" to change the first wavelength desired. Press "done". Repeat for other wavelengths desired up to 6. Now press exit. The change will be saved. For details see section 6.2.1

2.4.2 To set type of laser being used:

1. From bargraph measurement screen, press the rightmost button and press "config". Press “value” until the correct laser type or wavelength is displayed and press “exit”.
2. If you want the value saved as the startup default, press “yes”. Otherwise press “no”.

2.4.3 To set Laser Pulse Width and Average

1. From the bargraph measurement screen, press the rightmost button twice and press "setup".
2. Now press "value" to select proper setting for your laser pulse width. If your laser pulses are longer than the short pulse setting, then the long pulse setting should be selected and if shorter, then the short pulse setting shouldbe selected.
3. Now press "select" until "average over" is highlighted. Now press "value" until the time period you wish to average over is displayed. If you do not want to average, but collect individual pulses then select "none".
4. Press "exit". If you wish to save the new settings, then after the above changes, from the bargraph screen press the

rightmost button, press “config”, press “exit” and “yes”.

Warning:

Incorrect readings will result if pulse width is not set up correctly.

Note:

Some heads have only one time setting for all pulse widths. In that case "N.A." appears.

2.4.4 Setting Configuration

1. After you have set up the pulse width and average settings (see section 2.4.3.) from the bargraph measurement screen press the rightmost button and press "config".
2. Press "select" until the laser wavelength is highlighted. Now press value to select the laser wavelength you want to be the default. The Orion PE will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected.
3. Press "select" and "value" to choose the default energy range. Now press "select" and value again to see if you want to be in the display or scope mode.
4. Now press exit when all selections have been made. Now press "yes" if you want to save all current settings (including those selected previously in the setup screen), or "no" if you want to save the settings only until the instrument is turned off.

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

1. Press the rightmost button twice and press "setup".
2. Press "select" until the diffuser setting is highlighted and select "IN" or "OUT" as desired. With "select" and "value" choose the correct pulse width setting.
3. Press "exit" and press the rightmost button then "config". Choose the correct wavelength setting. Note that only wavelengths compatible with the diffuser setting are visible.

4. If you wish to save these settings as the defaults, from the main display, press the rightmost button then press “config”. Press “exit” and “yes” to save all present settings including diffuser IN or OUT and pulse width setting.

2.4.6 Energy Measurement

Warning:

Do not exceed maximum head limits for power, energy, power density and energy density as listed in tables 6 and 7 section 9.2 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 is damaged, then either enlarge your beam or lower the laser energy until damage is no longer seen.

To use the Orion PE to measure Laser Energy

Press the rightmost button once then press "config" then “select” until RANGE is highlighted. Press “value” to choose the correct energy range, then press exit. If you wish to save this value as the default, press “yes”, otherwise “no”.

Note:

The correct energy scale is the lowest one which is higher than the maximum energy measured. If the energy measured is lower than 10% of full scale, choose the next lower scale. Otherwise the readings will not be accurate.

Chapter 3 The Orion Display Unit

3.1 General Description

The model Orion laser power/energy meter represents a new level of sophistication, sensitivity, compactness and accuracy, coupled with ease of operation. It can operate with all Ophir thermal heads. It has smart connector technology. Simply plugging in the head configures and calibrates the Orion to operate with that head.
The Orion displays power or energy measurements in both digital and analog form at the same time. 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 subtract background. You can also zero the Orion at the touch of a button.

The main instructions are clearly shown on the screen so you should not have to refer to this manual very often. Above all, the Orion 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.

3.2 Smart Connectors and Multihead Operation

The Orion display is very compact and can operate with either any Ophir laser measuring head compatible with the Orion model you have chosen. The Orion TH is compatible with all Ophir thermal heads, the Orion PD is compatible with all Ophir photodiode heads and the Orion PE is compatible with all Ophir pyroelectric heads. If you need to work with several heads of different types, you should choose the Ophir Nova display which is compatible with all types. 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 Orion automatically identifies the head type, calibration and configuration. The user does not have to adjust anything.

Note:

The Orion automatically loads the head information when first turned on, so when changing heads, the display should be turned off, the new head plugged in and then be turned on again.

When no head is plugged in and the Orion is turned on, the display indicates "No Head Connected" and gives the user the opportunity to change the power line frequency or rezero the instrument. See section 3.5.

3.3 Soft Keys and Rightmost Button

3.3.1 Rightmost Button

The Orion is equipped with "soft keys". That is, the functions of the keys change as indicated by the legend above each key. (See Figure 4).
When the Orion is first switched on, the first screen usually has a digital display with a bargraph along the bottom. In order to access the soft keys, press the rightmost button, located on the right of the panel. Pressing the rightmost button again will access more functions. Pressing it yet again will bring it back in a cyclical manner to the original bargraph screen.

Note:

The first set of menu choices can be accessed without pressing the right hand key. Simply pressing the appropriate key from the bargraph screen will operate that key even though the label is not visible. So if you remember the position of the key you can take a shortcut. If the soft key is an alternating "toggle" type, the label will be visible while the key is being pressed.

3.3.2 Soft Keys

The soft keys accessed by the rightmost button have functions defined by the legend above the key. The legend usually indicates what will happen when pressing the key. For example, if "config" appears above a key, pressing that key will change the Orion into the configuration mode.

Some functions operate when the key is pressed and are canceled when the key is pressed again. The keys show reverse highlighting when operational. Pressing the same key again cancels the operation and the highlighting.

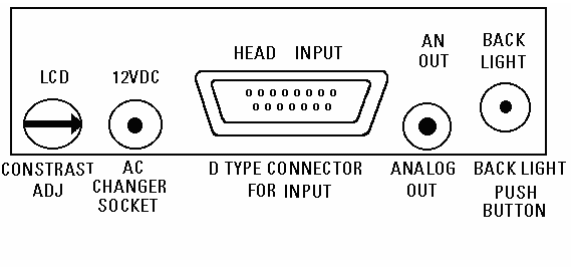


Figure 3
Orion Rear Panel View

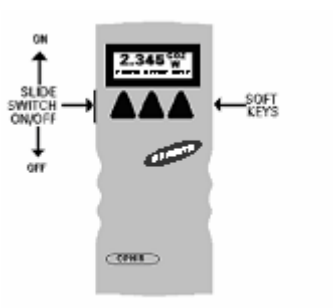


Figure 4.
Orion Top View

3.4 Power Up and Shut Down

To turn the Orion on:

1. Push up the slide switch on the left side of the **Orion** display. (See Figure 4)
2. The unit will switch on, and the display will appear. If no head is connected, a display showing "No Head Connected" will appear. If a head is connected, the appropriate default measurement screen will appear.

To switch the Orion off:

1. Return the Switch to its original position.
2. If you wish to save the current Orion configuration, use the "config" function before switching off. For measurements of the same type, the Orion does not need to be set up each time. See section 4.2

3.5 Orion Functions which are independent of Head Type

When no head is connected to the Orion and it is turned on, the message "No Head Connected" appears. In this mode, the user can adjust either the power line frequency so the instrument can be adjusted for minimum interference at the power line frequency, or the user can zero the instrument to eliminate any offsets.

3.5.1 Line Frequency

The Orion is factory set for 50 Hz. If your country uses 60 Hz you must reset the line frequency.

To reset the line frequency:

1. Turn on the Orion while the head is disconnected.
2. Press "select" until "line frequency" is highlighted.
3. Press "go" then change to select the correct line frequency.
4. Press "exit" to save the new value and exit.

3.5.2 Zero Adjustments

In the Orion, all adjustments, including zeroing internal circuits, are done from the software. This ensures simple and accurate realignment. It is recommended to rezero the Orion 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 Orion can identify that no head is connected. "No Head Connected" will be displayed.
2. Turn on the Orion, and let it run for at least 30 seconds before performing zero adjustment.
3. Press "go".
4. Make sure the instrument is not in an electrically noisy environment and is undisturbed. Press "go" and wait for message, "zeroing completed". Now press "exit" and "saved" will be exhibited, indicating that the zero configuration has been saved.

Note:

For best results using the Orion TH 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. Press the rightmost button twice then "zero".
7. Now press “go”. Zeroing completed will appear when the zeroing is finished. Press “exit”.

3.5.3 Baud Rate

If your Orion is equipped with the RS232 feature, the baud rate can be set by selecting “baud rate”, pressing “go”, and selecting the appropriate rate. For most purposes, the default of 9600 Baud will suffice.

3.6 Backlight

The backlight illuminates the display from the rear and is operated by a push button on the back panel (See Figure 3). Since the backlight consumes considerable power, it is operable only when the charger is plugged in. The electroluminescent backlight does have a finite lifetime of about 10,000 hours. Therefore, it is recommended only to use it when necessary. To turn on the backlight, push the push button while the charger is connected. To turn off the backlight, push the button again.

3.7 Kickstand

The Orion is equipped with a kickstand on the underside of the case so the display can be tilted for easy viewing. The kickstand folds away in a recessed slot when not in use. When the Orion is folded flat, it is only 203 x 95 x 35 mm, the most compact unit of this type on the market.

3.8 Charging

The Orion is operated by a rechargeable battery. To charge the battery, plug the charger into the jack labeled "12VDC" on the back panel, (Figure 3). Note the polarity of the charger. The Orion will charge the batteries at about the same rate whether it is on or off and whether the backlight is on or off – it fully charges in about 14 hours. However, it will charge more slowly while operating a pyroelectric type head. It is not recommended to leave the charger plugged in for much longer than 14 hours, in order to preserve the battery lifetime. The unit will operate about 18 hours from one battery charge. When the battery is low, "BAT" flashes on and off indicating that the battery needs recharging. However, even with "BAT" displayed, the unit will operate properly for about one hour before its accuracy will be impaired.

3.9 Chart Recording

The instrument provides an analog voltage output via a 2.5mm pin jack labeled "AN OUT" on the rear panel (See figure 3).
This 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 volts.
The output can drive up to 2mA into an external device.

Chapter 4 Orion TH 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 tables in section 9.2 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_2 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 MIN	MIN PRESSURE BAR	US GALLONS PER MINUTE
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 Orion TH.

4.2 Selecting Settings from the Orion TH Screen

The Orion TH 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 right corner of the display.

In order to choose the laser type, do the following:

1. From the bargraph power measurement screen, press the rightmost button twice and press "config".
2. Press “value” to choose the laser wavelength. Press “exit”. If you want the choice to be saved permanently as the startup default, press “yes”, otherwise press “no”.

4.2.2 To choose Manual or Automatic Ranging in Power Measurement

Autorange - The Orion TH 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 90% 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 Orion TH 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. To select manual range press the rightmost button then press “config”. Press "select" until the power rage setting is highlighted. Press “value” to choose the setting you wish then press “exit”. Now press yes if you want the choice saved as the default value, otherwise press “no”. The correct range to select is the lowest one which is larger than the largest expected measurement.

To choose auto or manual range, follow these steps:

1. From the bargraph measurement screen, press the leftmost button then press “config”.
2. Press "select" and then select the appropriate manual range or autorange by pressing the "value" repeatedly.
3. Press "exit" and then press either “yes” or “no” depending on whether you want this choice to be the startup default or not.

4.3 Power Measurement

The next section describes the procedure for basic power measurement

4.3.1 Power Measurement, Basic Operation

1. Switch the Orion TH on by means of the switch on the left side. (See Figure 4). The Orion TH 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 and the Orion TH will be ready to perform that type of measurement each time it is switched on. The normal default mode is the bargraph autoranging power measurement screen.
2. Center the laser beam carefully on the absorber surface and read the power.

4.3.2 Advanced Power Measurement Features

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

4.3.2.1 Offset

The offset function subtracts background from the signal. If the ambient environment has a thermal background, so that the Orion TH shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Orion TH 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 middle button and press "offset" while the laser is blocked.
Now press the rightmost key again to return to the bargraph screen. The Orion TH 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 Orion TH has a permanent zero offset, then disconnect the head while it is in the power measurement mode. If the Orion TH still shows a similar offset even when the head is not connected, the instrument internal zero should be reset. See Section 3.5.2.

4.3.2.2 Tune (See Figure 5)

The Tune function, an exclusive Ophir feature, 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 determine if you have reached maximum power.

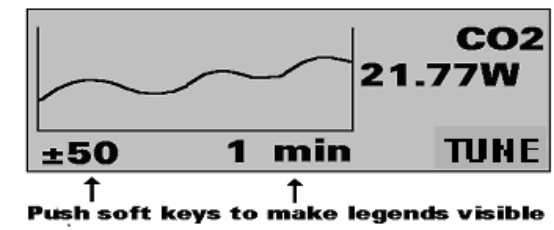


Figure 5
Tune Screen

The screen is completely autoranging. Therefore, as soon as the cursor goes over the top or under the bottom edge of the display, it rescales 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 Orion TH settings.

To use the Orion TH to fine tune laser power:

1. From the bargraph power measurement screen press the rightmost button twice then press "tune".
2. To set the power expansion scale to ±50% ,±120% or ±20% as desired, press the left hand soft key several times. 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. Set the horizontal sweep time to the rate desired, using the middle soft key. The default value is 1 minute.
4. Press “tune” to return to the measurement screen. Measure the power of the laser and adjust the laser until you determine that the power has reached a maximum.

4.4 BC20 Heads for Scanned Beams

Note: Although this head is a photodiode head, it is set up in the software as a thermal head and is therefore in this

sections. However, many of the functions of the BC20 head are the same as the PD300. This section only describes the PD300 functions which are different from ordinary PD300 functions. For standard PD300 functions, please refer to chapter 5.

4.4.1 General Description

Model BC20 scanned beam laser power meter has become the industry standard for measuring scanned laser beams as well as hard to reach static beams. The BC20 smart head has built into its smart plug innovative circuitry to measure scanned as well as static beams of up to 20 milliwatts with a noise level of microwatts.
The BC20 has the same patented dynamic background subtraction as the PD300 which eliminates over 95% of background light and allows measurement in normal room light.

4.4.2 Setting up the startup defaults:

1. From the power measurement bargraph screen, press the rightmost button located on the right side then press “next”. Press “config”.
2. Press "select" and "value" to choose the default laser wavelength and the default power range.
3. Now press "select" then "value" to choose whether you want the instrument to operate in “continuous” or “hold” mode. In continuous mode, the peak reading of every 1/3 sec period is displayed and in “hold” mode, the peak reading of every 5s period is displayed.

Note:

Do not use autorange when in hold mode.

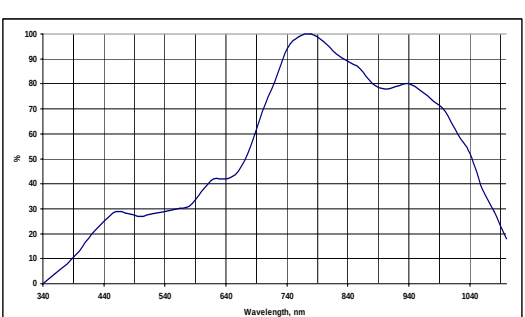
4. Press "exit" when all selections have been made and press "yes" to save all current Nova settings.

4.4.3 Measuring Scanned Beams with the BC20

1. Verify that the head is plugged in.
2. Set to the proper power range or autorange.
3. Set up the startup defaults and choose “continuous” if you want continuous readings or “hold”.if you want readings to be held for 5s before updating. (See section 5.4.2 above).
4. Hold the wand so the beam strikes the detector vertically. While the beam is scanning, move the scanner slightly up and down in a direction perpendicular to the scan direction so that the scanned beam is sure to cross the center of the detector. (The BC20 captures the highest reading so that the most accurate results are obtained if the beam scans across the center of the detector). The unit will also measure static beams as would a normal laser power meter.

4.4.4. Spectral Response

A graph of the approximate relative spectral response of the BC20 is given for purpose of interpolation. This is in case the user wishes to use the instrument at a wavelength other than the ones which are factory calibrated.



Chapter 5 Orion PD Operation with Photodiode Type Heads

Warning:

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

5.1 Photodiode Heads

When a photon source, such as laser, is directed at one of the PD300, 3A-IS or BC20 series photodiode detectors, a current is created proportional to the light intensity and dependent on the wavelength.

The PD300, PD300-3W and BC20 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 Orion PD display unit amplifies this signal and indicates the power level received by the head. Due to the superior circuitry of the Orion PD, the noise level is very low, and the PD300 series heads with the Orion PD 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 "SAT" will appear on the screen. Table 2 gives the actual maximum power as a function of wavelength.

FILTER OUT

WAVE-LENGTH	PD200	PD300	PD300-3W	PD300-UV	3A-IS	WAVE-LENGTH	PD300-IR
250-350nm	N.A.	N.A.	N.A.	1mW	N.A.	800nm	20mW
400nm	200mW	30mW	30mW	3mW	N.A.	1-1.3µm	30mW
633nm	200mW	20mW	20mW	3mW	1W	1.4µm	25mW
670nm	200mW	13mW	13mW	3mW	2W	1.5µm	15mW
800nm	200mW	10mW	10mW	2.5mW	3W	1.6µm	10mW
900mm	200mW	10mW	10mW	2.5mW	3W	1.8µm	25mW
1060nm	200m	25mW	25mW	3mW	3W		

FILTER IN

WAVE-LENGTH	PD300	PD300-3W	PD300-UV	3A-IS	WAVE-LENGTH	PD300-IR
250-350nm	N.A.	N.A.	100mW	N.A.	800nm	200mW
400nm	300mW	3W	300mW	N.A.	1-1.3µm	300mW
633nm	300mW	3W	300mW	N.A.	1.4µm	150mW
670nm	200mW	3W	300mW	N.A.	1.5µm	80mW
800nm	100mW	1W	250mW	N.A.	1.6µm	50mW
900mm	150mW	1.5W	250mW	N.A.	1.8µm	100mW
1060nm	250mW	2.5W	300mW	N.A.		

Table 2.
Maximum Measurable Laser Power as a Function of Wavelength

5.2 Setting up the PD300 and 3A-IS to display the user's chosen wavelengths

The PD300 and 3A-IS series have 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 mode with the bargraph display, press the rightmost button twice and then press “wvlnth”.
2. Press "select" until the wavelength you wish to change is highlighted. Press "change".
3. Press "up" and "down" to change the wavelength. Press "done". Repeat step 2 for other wavelengths desired. When finished press exit and the new values will be saved.

5.3 Selecting Settings from the Orion PD Screen

The Orion PD 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.

5.3.1 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 for this, each head has a built in calibration curve (with 1nm resolution) over the 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 right corner of the display. In order to define the laser wavelengths to choose from, See Section 5.2.

In order to choose the laser wavelength, do the following:

1. From the bargraph measurement screen, press the rightmost button twice and press "wvlnth". Press "select" until the correct laser type or wavelength is displayed.
2. Press "exit" to return to the bargraph screen. (If the wavelength you want is not among the 6 choices see section 5.2).
   (The wavelength may also be chosen using the "config" function).

5.3.2 To choose Manual or Automatic Ranging or dBm

Autorange - The Orion PD allows you to choose autorange or manual ranging when the reading is 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 90% of full scale, the range changes to one range lower. This change occurs after a short delay. This provides overlap (hysteresis) to keep the Orion PD 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 which is larger than the largest expected measurement. If you wish the Orion PD to be in manual mode when switched on, save this configuration before switching off. See Section 5.3.

dBm - The Orion PD allows the measurement to be made in units of dBm which is a logarithmic scale. dBm units are defined as:

10 x 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 bargraph measurement screen, press the rightmost button once and press “config”.
2. Press "select" and then choose the appropriate manual power range, autorange or dBm by pressing the "up" or "down" buttons.
3. Press "exit" and then press the “yes” if you want the choice to be the default startup. Press “no” if you only want the choice until the instrument is turned off.

5.3.3 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, you should choose to work with the removable filter installed or not. For this purpose, the Orion PD 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 head and display for that wavelength. Consult your Ophir agent for details.

To choose the filter setting:

1. From the bargraph measurement screen press the rightmost button then press “config”.
2. If you wish to work with filter installed, press "value" until display says "filter IN". Be sure to install removable filter on detector head.
3. If you wish to work with the filter out, press "value" until display says "filter OUT". Be sure to remove the filter from the detector head.
4. Press "exit" and then press the “yes” if you want the choice to be the default startup. Press “no” if you only want the choice until the instrument is turned off.

5.3.4 Offset

The PD300 and PD300-3W heads have automatic background subtraction as described in Section 5.1. In addition, the offset function can be used to subtract the residual background signal which remains if desired. If the Orion PD shows a nonzero power reading even when there is no laser, you can subtract the background using the zero function. For example, the Orion PD 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 the rightmost button and press "offset" while the laser is blocked. The Orion PD 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 Orion PD has a permanent zero offset, then disconnect the head while it is in the power measurement mode. If the Orion PD still shows a nonzero reading even when the head is not connected, the instrument internal zero should be reset. See Section 3.5.2.

5.3.5 Tune (See Figure 6)

The Tune function, an exclusive Ophir feature, 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 determine if you have reached maximum power.

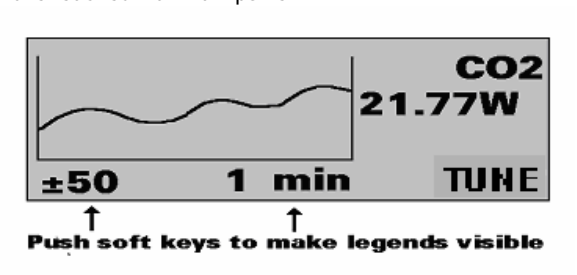


Figure 6.
Tune Screen

The screen is completely autoranging. Therefore, as soon as the cursor goes over the top or under the bottom edge of the display, it rescales 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 Orion PD settings.

To use the Orion PD to fine tune laser power:

1. From the bargraph power measurement screen press the rightmost button twice then press "tune".
2. To set the power expansion scale to ±50% ,±120% or ±20% as desired, press the left hand soft key several times. 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. Set the horizontal sweep time to the rate desired, using the middle soft key. The default value is 1 minute.

4. Press “tune” to return to the measurement screen. Measure the power of the laser and adjust the laser until you determine that the power has reached a maximum.

5.4 Special Photodiode Heads

5.4.1 PD300-BB Radiometer Head

In addition to photodiode heads for individual wavelengths, Ophir also supplies heads for measuring the output of broadband light sources. The PD300-BB head has spectrally flat response from 400 to 1000nm and therefore can give the true total power of any broadband light source in that spectral region.

Note:

Because the BB heads are spectrally flat, wavelength selection is disabled. Other than that, operation is the same as other PD300 type heads.

5.4.2 PD300-CIE Photometer Head

The PD300-CIE head has a spectral response similar to that of the human eye and can therefore make measurements in eye response units of Lux. The PD300-CIE is designed with a small detector where the source overfills the detector. It measures the light intensity per unit area in units of Lux or Foot Candles.

Note:

Because the CIE heads have a spectral response similar to the human eye wavelength selection is disabled. Other than that, operation is the same as other PD300 type heads.

Chapter 6 Using the Orion PE with Pyroelectric and Photodiode Energy Heads

Warning:

Before using the head for power or energy measurement, check that your laser power, energy or 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 is damaged, then either enlarge your beam or lower the laser energy until damage is no longer seen.

6.1 Pyroelectric and Photodiode Energy Detector Heads

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) which 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 Orion PE display amplifies this signal and indicates the energy received by the head.
The photodiode based PD10 head also uses the same circuitry but can measure much lower energies due to the sensitivity of the photodiode.

6.2 Selecting Settings from the Orion PE Screen and Saving Defaults

The Orion PE 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.

6.2.1 Setting up the head to display the user's chosen wavelengths

The sensitivity of the detector varies somewhat with wavelength. The correction curve for the absorber is stored in the head EEROM. This correction curve ensures that the energy 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 head to your laser wavelengths.

1. From the bargraph display, press the rightmost button twice, press “more” then press “wavelength” then “go”.
2. Press "select", "change" then "up" and "down" to change the first wavelength desired. Press "done". Repeat for other wavelengths desired up to 6. Now press exit. The change will be saved.

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 To set type of laser being used

1. From bargraph measurement screen, press the rightmost button and press "config". Press “value” until the correct laser type or wavelength is displayed and press “exit”.

2. If you want the value saved as the startup default, press "yes". Otherwise press "no".

6.2.3 Setup of Laser Pulse Width and Pulses/Sample

6.2.3.1 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 Orion PE if the laser pulses are going to be longer or shorter than the maximum wavelength in the short pulse mode. (Some models only have only one maximum pulse width setting which is usually 3ms. In that case, "N.A." for not applicable appears and the setting cannot be changed).

Warning:

If the pulse width is incorrectly set to shorter than the laser pulse width, the reading will be erroneously low. If it is set to a long pulse width when a short one would suffice, the reading will be correct but noisy.

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

1. From the bargraph measurement screen, press the rightmost button twice and press "setup".
2. Now press "value" to select proper setting for your laser pulse width. If your laser pulses are longer than the short pulse setting, then the long pulse setting should be selected and if shorter, then the short pulse setting should be selected.

6.2.3.2 Setup for Number of Pulses per Sample

The Orion PE 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.

Note:

The Pyroelectric and photodiode energy heads are capable of measuring pulses up to very high repetition rates on the order of kilohertz or above. However, at high repetition rates, the display can capture the pulses at rates not exceeding 15Hz. The Orion PE samples individual pulses at a rate of 15Hz from the laser pulse train. Thus if the user has a laser pulsing at over 15Hz and wishes to average over a number of pulses, the average will be over the number of pulses processed by the Orion PE and not over those emitted by the laser.

Example: If the user's laser is pulsing at 300Hz, and the user selects to average over 1s, the Orion PE will collect 15 pulses of the 300 emitted during that period, and will average over those 15 pulses. The Orion PE will then update the display every 1s.

To set up for averaging over a number of pulses:

1. From the bargraph measurement screen, press the rightmost button twice and press "setup".
2. Now press "select" until "average over" is highlighted. Now press "value" until the time period you wish to average over is displayed. If you do not want to average, but collect individual pulses then select "none".
3. Press "exit". If you wish to save the new setting, then after the above changes, from the bargraph screen press the rightmost button, press “config”, press “exit” and “yes”

Note:

The average function only affects the numerical readings on the screen. The bargraph always shows individual pulses.

6.2.3.3 PD10 Photodiode Energy Head

The PD10 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 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.

6.2.3.4 Saving Default Settings

If you are planning to do repetitive measurements most of the time, you can set up the Orion PE 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 Orion PE to start up in the chosen configuration:

1. After you have set up the pulse width and average settings (see section 6.2.3.2.), from the bargraph measurement screen press the rightmost button and press “config”.

2. Press "select" until the laser wavelength is highlighted. Now press value to select the laser wavelength you want to be the default. The Orion PE will now be correctly calibrated for the absorption of the detector at the wavelength of the laser type selected. If you wish to choose another wavelength, See Section 6.2.1
3. Press "select" and "value" to choose the default energy range. Now press “select” and value again to see if you want to be in the display or scope mode.
4. Now press exit when all selections have been made. Now press "yes" if you want to save all current settings (including those selected previously in the setup screen), or "no" if you want to save the settings only until the instrument is turned off.

6.2.3.5 PE -DIF diffuser heads

PE50BB-DIF and PE50-DIF-ER heads with removable diffusers have to be set up properly to operate with the diffuser IN or OUT.

Since the wavelength settings with diffuser in are not the same as with diffuser out, **two things must be changed every time the head is changed from diffuser IN to OUT. (In addition to changing the pulse width setting if necessary).**

To change from diffuser OUT to IN and back:

1. Press the rightmost button twice and press “setup”.
2. Press “select” until the diffuser setting is highlighted and select “IN” or “OUT” as desired. Make sure the diffuser is physically installed or not installed on the head.
   If it is necessary to change the pulse width setting, press “select” and press “value” to choose the correct pulse width. Then press exit.

3. Press the rightmost button and press “config”. With “value” choose 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 = 1.06μm, diffuser in). Press “exit”. If you wish to save these settings as the defaults, press “yes” to save all present settings including diffuser IN or OUT and pulse width setting.

6.3 Energy Measurement

Warning:

Before using the head for 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 is damaged, 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.

6.3.1 Energy Measurement

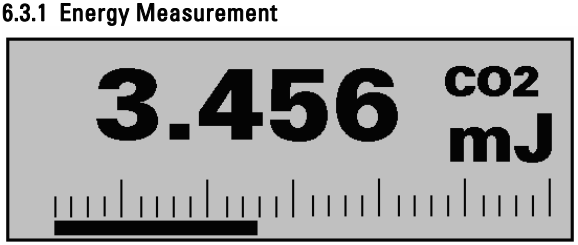


Figure 6
Energy Screen Using Heads For Pulsed Lasers

1. Press the rightmost button once then press "config" then “select” until RANGE is highlighted. Press “value” to choose the correct energy range, then press exit. If you wish to save this value as the default, press “yes”, otherwise “no”.

Note:

The correct energy scale is the lowest one which is higher than the maximum energy measured. If the energy measured is lower than 10% of full scale, choose the next lower scale. Otherwise the readings will not be accurate.

2. Next, choose the pulse width setting and time period you wish to average over. Press the right button twice and press “setup”. With the “select” and “value” buttons, choose the correct settings. Now press “exit”. If you wish to save these values as default, see section 6.2.3.4.

   The Orion PE 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 1/15th of a second period, the Orion PE will display on the screen the next pulse which arrives. The Orion PE will hold the display of the latest pulse until a new one arrives. If an averaging period is selected, the Orion PE will collect pulses at up to 15Hz and will then display the average of those pulses. When a new pulse triggers the Orion PE, a "T" will appear in the upper left corner of the screen. At over 5 Hg, the "T" stops flashing and appears all the time.

6.3.2 Minimum Energy Threshold

If the pyroelectric heads are used in a electrically or acoustically noisy environment the instrument may trigger spuriously. It will then display a spurious pulse. Since there is always some degree of noise or background, the instrument is designed not to respond to pulses below some preset minimum size.

This "Minimum Energy Threshold" is typically set to 4% of full scale of the selected range. Pulses which are very close to background may read sporadically or inaccurately. Therefore it is important to always use the lowest energy range which is larger than the energies you are measuring.

6.3.3 Pyro Scope Adapter

A special adapter can be purchased which is plugged in between the head connector and the Orion PE 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 Orion PE 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 Orion PE display and then plug the head plug into the adapter. Plug the BNC connector into a standard 1MΩ scope input.
2. Press the rightmost button twice and then press “more”. Select “scope” and press “go”. The display will now say “in scope mode”. If you have to set up the appropriate measurement range or other parameters, do it before going into scope mode.
3. You can return to the ordinary measurement mode by pressing “exit” from the scope mode screen.
4. If you wish the instrument to start up in scope mode, press the rightmost button and press “config”. Select “display” and change it to “scope” with the “value” button. Press “exit” and “yes” and when the instrument is turned on the next time, it will be in scope mode.

6.4 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 use Pyroelectric heads with a diffuser. Ophir has several heads with a diffuser which increases the damage threshold by an order of magnitude. (See table 7 at the end of this manual).
2. 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 6.3.
3. You can use the Ophir beam splitter which mounts the PE heads and splitts 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 an energy below damage threshold and measuring the energy with and without the beam splitter. The Ophir beam splitter is built to facilitate this measurement.
4. Ophir has models RP which are specifically designed for pulses with energies up to 100 Joule/cm^2.
   Contact your Ophir dealer for details.

6.5 Energy Log

The Orion PE has the option of displaying successive energy points in a vertical bargraph form. While measurements are being taken, the Orion PE will record data until the screen is full or "reset" is pressed.

To use the Orion PE for graphical display of energy:

1. Make sure that the Orion PE is in the correct energy measurement range. If not, press the right button, “config”, change the range and exit.
2. From the energy measurement screen press the right button twice then “more” and then select "energy log". Press "go". The histogram screen will appear. Now fire pulses and the measurement will immediately begin. When the screen is full, the measurement continues and the screen will scroll.
3. If you wish to see finer variations in the graph, press the right "zoom" button.

Note:

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

4. Pressing any button will show you the menu of further options:

   The center button is the "stats" button. Press this button once to show the legends then again to show the statistics of the measurements until now. Pressing the right button twice will get you out and back to the main screen.

   The left button is the start button. Pressing this will erase any points recorded to now and will start a new batch of measurements.

   The right button is the exit button and will get you back to the main measurement screen.

Chapter 7 Circuit Description

The ORION has three circuit boards: an analog processor, a digital processor and a power supply.

Analog Processor:

The signal from the detector head enters the analog processor board and passes through EMI protection components to a differential transimpedance preamplifier. From there it is further amplified by a programmable gain voltage amplifier and passes to a dual slope integrating analog to digital converter. All calibration data for the analog processor is stored on a memory chip on the analog processor board. There are no adjustable components (trimmers etc.) in the ORION except for the display contrast adjustment on the rear panel.

Digital Processor:

The digital processor is built around a Motorola MC68332 32-bit central processing unit (CPU) with a 16-bit bus. On the digital processor board there is a socket containing the upgradable program ROM and a 256Kbit static RAM.
The processor receives signals from the analog processor and converts them into current in amps. When used with thermopile heads the signal is then processed by a sophisticated digital filter which speeds up the effective response time of the head and rejects noise. The digital processor is also responsible for controlling the analog processor, reading the keypad, and driving the display. The CPU 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.

Power Supply:

The power supply board, which also holds the display module and the keypad switches, provides the internal DC voltages for the analog and digital processors. It also contains the battery charging circuit and the AC supply for the backlight. All of the power supplies operate in switch mode with an oscillator frequency of 32KHz.

Electromagnetic Interference:

The Orion and associated heads have extensive circuitry both to reject outside electromagnetic and electrostatic interference. The Orion and associated heads are fully CE qualified and are extremely resistant to EMI. If there is still some interference in an unusually high EMI environment, it is recommended to use the Orion without the charger plugged in.

Chapter 8 Calibration, Maintenance and Troubleshooting

8.1Calibration of Thermopile 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/cm², 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 wave-lengths. They can therefore be usedfor other types of lasers as well. The absorption of the various Ophir absorbers as a function of wavelength is shown in Graph 1 below.

LP (long pulse) absorber

This absorber has a particularly high damage threshold for long pulse (ms) or continuous lasers and is therefore offered for use with high power heads. It is calibrated for use with YAG laser at 1.064μm or CO_2 laser at 10.6μm and absorbs about 90% at these wavelengths.

2. Volume absorbers

P (pulse) type absorber

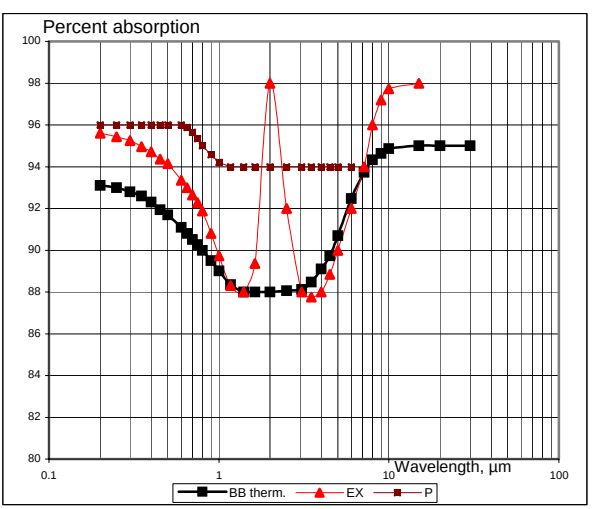
The models with the P suffix, for use with pulsed lasers, have a special absorbing glass with an absorbance of 95 +2% over the operating range. Since the surface is a glass, its reflectivity does not change even if damaged or melted locally.

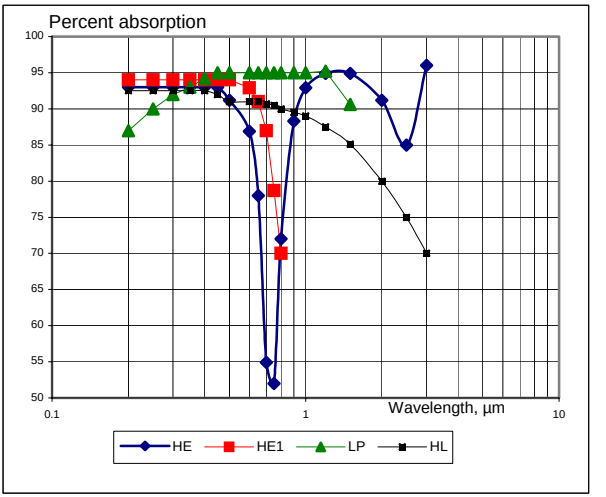
HE/HE1 (high energy) absorber

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.





Graph 1.
Absorption of Ophir Thermal Absorbers vs. Wavelength

8.1.1.2 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.

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, CO2); or, for some models, an average value is given.
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. The linearity is tested by electrical substitution heating. Models of up to 30 watts maximum rating are subjected to electrical input up to their maximum rating, models of up to 300W maximum rating are heated up to 100 watts, and models of 1000W rating and above are heated up to 200 watts. On CAL models, the built in CAL resistor is used.

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 which has previously been tested for linearity. Thus, in all cases, the linearity of the detectors is traceable to electrical standards.

8.1.2.2 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 8.1.1.2, 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 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 Guidelines for using the CAL resistor for checking calibration

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

MODEL	POWER	APROX. MAX VOLTAGE
3A Series	1 Watt	7 Volts
10A Series	10 Watts	17 Volts
30A Series	30 Watts	35 Volts
150A Series	100 Watts	65 Volts
300W Series	125 Watts	65 Volts
1500W Series and above	200 Watts	95 Volts

Table 2.
Maximum Power to Apply to Sensor CAL Resistors

2. Use the resistor to check calibration only.
3. Turn off the power as soon as measurement is done.
4. Do not operate the cal 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 check 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.

8.2 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 which depends on wavelength. Therefore, the PD300 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 varies from one head to another as well as with wavelength. Therefore, Ophir photodiode detectors are individually calibrated against a NIST standard which has been calibrated at several nm intervals over the entire spectral range.

The spectral sensitivity curve of the detector, both for filter out and filter in, is fed into the head EEROM and this information is used to set the gain to the proper value at all wavelengths.. When the user selects his wavelength on the Orion PE, the correction factor for that wavelength is applied. The BC20 head does not have a calibration curve. It is calibrated at the fixed wavelengths that are available with that instrument.

8.2.2 Accuracy of Calibration of PD300 and 3A-IS Heads

Since the instruments are calibrated against NIST standards, the accuracy is generally ±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	PD300-3W	PD300-UV	PD300-IR	3A-IS
200 - 250nm			±5%		
250 - 360nm	-	-	±3%		-
360 - 400nm	±10%	±10%	±3%		-
400 - 950nm	±3%	±3%	±3%		5%
950 - 1100nm	±5%	±5%	±5%	±5%	10%
1100 - 1600nm	-	-	-	±5%	
1600-1800nm	-	-	-	±7%	

Table 4.
Maximum Error as a Function of Wavelength and Filter

* Add ±2% to error for filter in (±3% for PD300-3W and PD300-UV).

8.2.3. Accuracy of calibration of BC20 Heads

The sensitivity of various BC20 sensors varies from one head to another as well as with wavelength. Therefore, each BC20 head is individually calibrated at each specified wavelength against a NIST standard which has been calibrated at the relevant wavelengths.

Since the instruments are calibrated against NIST standards, the accuracy is generally ±2% at the wavelength the calibration has been performed. The maximum error in measurement will be less than the sum of the calibration accuracy and linearity. The linearity of the photodiode detector is extremely high and errors due to this factor can be ignored. The maximum error due to all factors is the stated accuracy of ±3%.

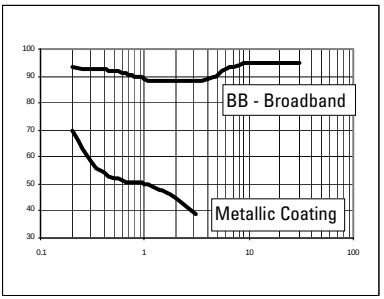
The calibration is carried out with a fixed laser. In addition to the error in calibration, the reading drops somewhat with scanning speed. The BC20 is specified to deviate from the static reading no more than –3% up to a scanning velocity of 30,000 inch/sec.

8.3 Calibration of Pyroelectric and Photodiode Energy Heads

Several types of absorber are used in Ophir pyroelectric and photodiode energy 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 2 below. The metallic coating permits very high repetition rates, up to 5000Hz as well as high sensitivity.
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/cm² for short pulses and 2J/m² for long pulses without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Graph 2 below. This coating is available for the PE50 and PE25.
3. **High speed broadband type:** The type with the BBH suffix has a special broadband coating spectrally flat from 190nm to 3µm. Unlike the BB type, it is able to work at high repetition rates to 1000Hz. On the other hand, its damage threshold is considerably lower, on the order of 0.05J/cm².
4. **PD10 type:** Unlike the other heads, the PD10 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)



Graph 2.
Absorption of Ophir Pyroelectric Absorbers

8.3.1 Method of 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 head 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 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 Orion PE, the correction factor for that wavelength is applied.

The PD10 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. (see photodiode calibration in section 8.2).

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.

8.3.2 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 Orion PE 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.

	COATING TYPE		
WAVELENGTH	BROAD BAND	METALLIC	PD10
	ERROR		
190 - 350nm	±1%	±4%	2%
400 - 800nm	±1%	±4%	0
1064nm	0	0	2%
1-1.5µm	±1%	±2%	N.A.
2 - 3µm	±2%	±8%	N.A.
10.6µm	±5%	±15%	N.A.

Table 5.
Additional Measurement Error due to Wavelength

8.4 Error Messages

The Orion displays various error messages when operated outside its normal range:

Overrange: When the power or energy being measured exceeds the range of the measurement scale being used, the overrange 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 flashing message "BAT" appears. When the low battery message appears, the Orion should be connected to the charger. It will operate normally and charge slowly while connected to the charger. When connected to the charger while turned off, the Orion will charge faster, in about 14 hours.

8.5 Troubleshooting

8.5.1 Orion 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	Battery is low. Recharge overnight with the Orion turned off for 14-16 hours. If the Orion still doesn't work with battery, then the battery is dead. Replace battery.

8.5.2 Thermal Heads, Power

Problem	Cause/Remedy
Instrument shows zero reading in both power and energy modes.	Check connections between the head and the instrument. Check that the sensor disc is operative. Resistance between 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.	Have the sensor disc replaced.
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, adjust zero with head disconnected. If the offset persists, try zeroing with the head connected as well, as described in Section 3.5.2.

8.5.3 Replacing Battery

1. Remove the bottom of the Orion by unscrewing the 4 Phillips screws.
2. Unscrew screw in the center of the PC boards. Carefully lift the boards up together.
3. Unplug the battery connector from the circuit board.
4. Remove the battery and replace it with a new one obtained from your Ophir representative.
5. Reassemble the boards and screw in the center screw. Now reassemble into the case and close 4 case screws.

Chapter 9 Orion Specifications

9.1 System/Display Specifications

Detector compatibility	Orion TH - thermal heads Orion PD-photodiode heads Orion PE-pyroelectric heads
Input ranges	15nA - 1.5mA full scale in 16 ranges
A to D sampling rate	15Hz
A to D resolution	17 bits plus sign. (0.0007% resolution)
Electrical accuracy	±0.1% ± 20pA new; ±0.3% ±50pA after 1 year
Electrical input noise level	500nV or 1.5pA + 0.0015% of input range @3Hz.
Dynamic range	9 decades ($1:10^9$)
Analog output	0-1 Volt with 11-bit (0.05% resolution.)
Analog output accuracy	±0.2% ±1mV relative to display
Dimensions	203H x 95W x 37D (mm)
Mass	550g
Display	122 x 32 pixel Super twist LCD
Display digit height	12mm
Backlight	EL: Operates from charger power only
Bargraph segments	120
Battery	2 X RR (Sub-C) 1.8Ah NiCd. Built in.
Operation between charges	18 Hrs, 10Hrs with pyroelectric heads. Battery charge time10-14 Hrs (15-30 Hrs if operating)
Charger	DC: 11 to 22V: or AC 9 to 15Vrms 3 Watt.

9.2 Head Specifications

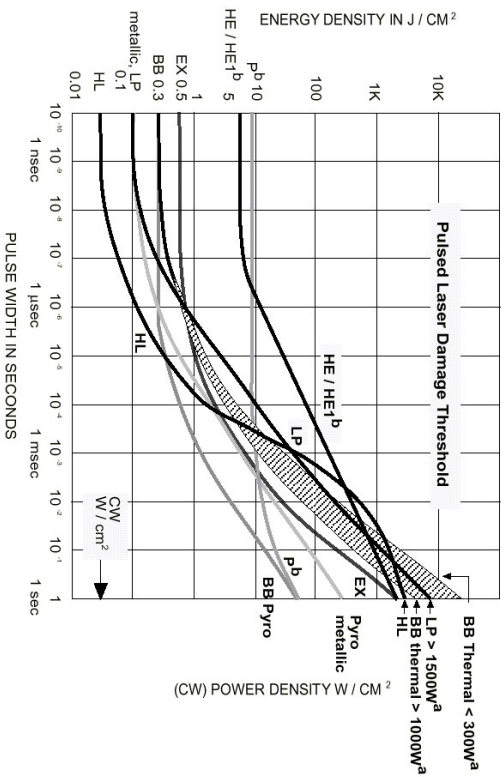
HEAD	MAX POWER (WATTS)	MAX AVG. POWER DENSITY	ABSORBER TYPE
PD300/UV/IR	300mW	50W/cm²	PD
PD300-3W	3W	50W/cm²	PD
3A-IS	3W	200W/cm²	Int Sph PD
F100A-IS	100W	200W/cm²	Int Sph Ther
2A	2W	200W/cm²	BB
3A-P-CAL	3W	50W/cm²	P
10A-P	10W	50W/cm²	P
30A-P	30W	50W/cm²	P
30(150)A-HE	30(150)W	1000W/cm²	HE/HE1
10A	10W	20KW/cm²	BB
30A	30W	20KW/cm²	BB
30(150)A	30(100)W	20KW/cm²	BB
F150A	150W	20KW/cm²	BB
FL250A	250W	20KW/cm²	BB
F300A	300W	20KW/cm²	BB/LP
1000W	1000W	6KW/cm²	BB
1500W	1500W	6KW/cm²	BB/LP
5000W	5000W	5KW/cm²	BB/LP
8000W	8000W	5KW/cm²	BB/LP
L30A-EX	30W	1KW/cm²	EX
FL250A-EX	250W	1KW/cm²	EX
PD10	20mW	50W/cm²	PD
PE10	2W	50W/cm²	PE
PE25	10W	10W/cm²	PE
PE50	20W	10W/cm²	PE
PE50-DIF	40W	500W/cm²	PE

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
LP - broadband surface absorber for highest power density

Absorber Type	Max Energy Density J/cm² Pulse Length		
	10ns	1µs	300µs
P	10	10	10
HE/HE1	5	10	100
BB	0.3	0.5	5
EX	0.5	0.6	4
PE, Metallic	0.1	0.2	4
PE, BB	0.3	0.3	1
PE-DIF	1.5	3	40
PE BB-DIF	3	3	10

Table 7.
Maximum Energy Densities for Various Absorbers


ENERGY DENSITY IN J / CM 2
10K
1K
100
Pulsed Laser Damage Threshold
HE / HE1b 5
Pb 10
EX 0.5
BB 0.3
metallic, LP 0.1
HL 0.01
1
HE / HE1b
LP
HL
CW W / cm2
EX
Pb
BB Pyro
Pyro metalic
BB Thermal < 300Wa
LP > 1500Wa
BB thermal > 1000Wa
HL
(CW) POWER DENSITY W / CM 2
1 nsec
1 µsec
1 msec
1 sec
PULSE WIDTH IN SECONDS