



StarBright

StarBright

Laser Power/Energy Meter

User Manual

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1 Introduction

The Ophir StarBright is a microprocessor-based Laser Power/Energy Meter that provides a broad range of measurements, displays, and data handling options. It operates with Thermopile, Pyroelectric, and Photodiode sensors. Taking advantage of smart connector technology, it is easy-to-use—simply connecting the sensor configures and calibrates the StarBright to operate with that sensor. The sensor configuration and calibration information is stored in an EEROM in the sensor connector plug. This means that when the sensor is plugged in, StarBright automatically identifies the sensor type, calibration, and configuration. The user does not have to adjust anything.

The StarBright's 320x240 full color screen enhances measurement readouts in ways that simple monochrome displays cannot. The StarBright can graph power or energy versus time. It displays power measurements in both digital and analog form simultaneously 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 sensor. You can also zero the StarBright at the touch of a button.

StarBright is capable of logging data onto a USB Flash Drive (Disk On Key), as well as real-time reporting of data via USB to Ophir's StarLab application to display and process the information. StarBright has RS232 capabilities as well. StarBright also has the infrastructure for field upgrading of the embedded software, should the need arise.

Above all, the StarBright 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.

StarBright's User Interface is intuitive. The keypad functionality is context-sensitive and functions according to the needs of the present screen. Where necessary, on-screen help is provided as well, so you should not have to refer to this manual very often.

1.1 This Document

This document covers everything you need to know to make full use of the StarBright 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.

1.2 Related Documentation

Ophir takes pride in the wealth of laser measurement information that we provide including FAQ's, Catalogs, Spec Sheets, and more. Go to <http://www.ophiropt.com/laser-measurement-instruments/laser-power-energy-meters>.

1.3 Support

If you have a question or require further assistance, contact Ophir customer support at support@ophiropt.com.

2 Quick Reference

This section provides a quick reference for performing basic measurements with the StarBright Laser Power/Energy Meter.

2.1 Getting Started

The StarBright is equipped with "soft keys." That is, the functions of the keys change as indicated by the legend above each key. It is also equipped with 4 navigation keys and a round **Enter** key in the center.

To connect sensor to the StarBright meter:

- Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the rear panel of the StarBright meter.

To switch the StarBright on:

1. To switch on, briefly press the On/Off/Backlight switch. The unit will switch on, and the display will appear.
2. The backlight for the StarBright's LCD can be configured to toggle between full, half, and low illumination. This toggling will be performed by briefly pressing the On/Off switch after the StarBright has been switched on.
3. To switch the StarBright off, press the On/Off switch and hold it for ~ 2 seconds until the display blanks.

To set general instrument settings:

1. Disconnect the sensor. Use the Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys. Press the **Enter** key to save.
2. **RS232 Baud**: Set baud rate for PC communication through its COM port.
3. **Max An. Output**: Set desired max analog output.
4. **Language**: Set to desired language.
5. **Line Frequency**: Set to 50Hz or 60Hz, depending on the electrical power grid of the area that you are in.
6. **Date and Time**: Set to correct date and time.

The StarBright automatically saves the current settings for next power up.

To zero the instrument:

1. Disconnect the sensor.
2. Make sure the instrument is not in an electrically noisy environment and is undisturbed.
3. Press **Zero** and **Start**. Zeroing takes about 30 seconds. Wait until "Zeroing completed successfully" appears.

2.2 Thermopile Sensors

2.2.1 Using StarBright with Thermopile Type Sensors

1. Plug in the Thermopile sensor. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. Use the Navigation keys to select and change the parameters.
3. Use the Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys. Press the **Enter** key to save.
4. StarBright saves the changes automatically for next startup of the instrument.

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

2.2.2 Using StarBright to Measure Laser Power

1. Set **Mode** to **Power**.
2. Set **Range** to **AUTO** or one of the manual ranges. The correct manual range is the lowest one that is larger than the expected maximum power of the laser.
3. Set **Laser** to the appropriate laser setting.
4. Set **Average** to the period you wish to average power over or set to **NONE** to disable.

2.2.3 Using StarBright to Measure Single Shot Energy

1. Set **Mode** to **Energy**.
2. Set **Range** to the appropriate manual range. (In **Energy** mode, there is no autoranging.) The correct range is the lowest one that is larger than the expected maximum pulse energy of the laser.
3. Set **Laser** to the appropriate laser setting.
4. Set **Threshold** if you wish to change the energy threshold.
5. When the StarBright screen flashes **READY** on and off, fire the laser.

2.3 Photodiode Sensors

2.3.1 Using StarBright with Photodiode Type Sensors

1. Plug in the Photodiode sensor. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. Use the Navigation keys to select and change the parameters.
3. Use the Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys. Press the **Enter** key to save.
4. StarBright saves the changes automatically for next startup of the instrument.

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

2.3.2 Setting the Measurement Parameters

1. Set **Range** to the appropriate manual range, **AUTO**, or **dBm** (logarithmic scale). Note that when selecting a manual range, the correct range is the lowest one that is larger than the expected maximum power of the laser.
2. Set **Laser** to the appropriate laser setting. If the wavelength you want is not among the wavelengths listed, select one and press the arrow key that is next to it to open the **Modify**

screen. Using the up/down Navigation keys to change each number and the right/left keys to move to the next number, key in the wavelength you want. When finished, press the **Enter** key.

3. Set **Filter** to **IN** or **OUT** as physically configured on the sensor.
4. Set **Average** to the period you wish to average power over or set to **NONE** to disable.

2.3.3 Measuring Average Power or Exposure

To measure average power:

1. Set **Mode** to **Power**.
2. Set measurement parameters as [described above](#).

To measure exposure:

1. Set **Mode** to **Exposure**.
2. Set measurement parameters as [described above](#).
3. Set **Stop Mode** to **Manual** or **Timeout** period.
4. Accumulated energy exposure will be displayed on the screen, as well as the elapsed time.

2.4 Pyroelectric or Photodiode Energy Sensors

2.4.1 Using StarBright with Energy Sensors

1. Plug in the Pyroelectric/Photodiode energy sensor. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. Use the Navigation keys to select and change the parameters.
3. Use the Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys. Press the **Enter** key to save.
4. StarBright saves the changes automatically for next startup of the instrument.

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

2.4.2 Zeroing Instrument against Sensor

For most accurate calibration, you should zero the energy sensor against the StarBright it is being used with:

1. Make sure the sensor is in a quiet environment and not subject to pulsed radiation.
2. Press **Menu** and select **Instrument**.
3. Press **Zero** and **Start**. Wait until “Zeroing completed successfully” appears.

2.4.3 Setting the Measurement Parameters

1. Set **Range** to the lowest one that is larger than the expected maximum pulse energy of the laser.
2. Set **Laser** to the appropriate laser setting. If this sensor is a metallic type and if the wavelength you want is not among the wavelengths listed, select one and press the arrow key that is next to it to open the **Modify** screen. Using the up/down keys to change each number and the right/left keys to move to the next number, key in the wavelength you want. When finished, press the **Enter** key.
3. Set **Pulse Length** to the shortest time that is longer than the expected pulse length.

Warning: Incorrect readings will result if pulse length is not set up correctly.

4. For sensors with the diffuser option, set **Diffuser** to **IN** or **OUT** as physically set on the sensor.
5. Set **Threshold** as necessary to screen out false triggers due to noise.
6. Set **Average** to the period you wish to average power over, or set to **NONE** to disable.

2.4.4 Measuring Energy, Average Power, or Exposure

With the Pyroelectric sensor, 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 measure energy:

1. Set **Mode** to **Energy**.
2. Set measurement parameters as described above.
3. Energy will be displayed on the screen as well as the laser's frequency.

To measure average power:

1. Set **Mode** to **Power**.
2. Set measurement parameters as described above.
3. Average power will be displayed as a function of "Energy x Frequency" on the screen as well as the laser's frequency.

To measure energy exposure:

1. Set **Mode** to **Exposure**.
2. Set measurement parameters as described above.
3. Set **Stop Mode** to **Manual**, **Timeout** period, or **Pulse** count.
4. Accumulated energy exposure will be displayed on the screen, as well as elapsed time and number of pulses measured.

2.5 Graphical Displays

To present measurements on a graduated scale (bargraph):

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Bargraph**. Return to the main display screen.
3. To expand the bargraph scale $\pm 5x$ of the present reading, press the **Zoom** button. Press **Zoom** again to return the bargraph to full scale.
4. To subtract the background and set the current reading to zero, press the **Offset** button. Press **Offset** again to cancel.

To simulate an analog needle:

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Needle**. Return to the main display screen.
3. To expand the needle graph $\pm 5x$ of the present reading, press **Zoom**. Press **Zoom** again to return the needle range to full scale.
4. To subtract the background and set the current reading to zero, press the **Offset** button. Press **Offset** again to cancel.
5. Press **Persist** to keep older measurements on the screen and to display numerically the **Min** and **Max** values measured. Press **Persist** again to cancel.

To graph laser output over time:

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.

2. Go to **Graph Type** and select **Line**. Return to the main display screen.
3. Set the percentage range of the scale to be displayed to the desired setting.
4. Set the horizontal sweep time as necessary.
5. Press **Reset** to clear the **Min/Max** tracking and to restart the graph.
6. This is especially useful to fine-tune the laser power.

To display real-time statistics:

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Statistics**. Return to the main display screen.
3. Displays Maximum, Minimum, Average, Standard Deviation, Total Readings, and Number Overage.
4. To subtract the background and set the current reading to zero, press the **Offset** button. Press **Offset** again to cancel.
5. Press **Reset** to clear the statistics.

To set pass/fail tracking:

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Pass/Fail**. Return to the main display screen.
3. Press the **Upper** and **Lower** buttons to set tolerance limits. If reading is out of range, an appropriate warning will be displayed on the screen.

To display readings as bars with lengths proportional to the measurement:

1. In **Power** or **Energy** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Pulse Chart**. Return to the main display screen.
3. Set the percentage range of the scale to be displayed to the desired setting.
4. Set the number of readings to display as necessary.
5. Press **Reset** to clear the **Min/Max** tracking and to restart the graph.
6. This is especially useful when measuring pulses of low frequency lasers.

To track laser beam position and size (BeamTrack sensors only):

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Position**. Return to the main display screen.
3. Press **Center** to center the laser beam.
4. Press **Offset** to subtract the background noise from the measurement and reset the value to zero.

To track laser beam position over time (BeamTrack sensors only):

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Stability**. Return to the main display screen.
3. Press **1 sec** to change the time interval (to **3, 10, 30 seconds** or **1 minute**).

2.6 Math Functions

To apply a fixed offset to measurements:

1. Press **Menu** and enter **Functions**. Go to **Fixed Offset**.
2. Set the value to subtract from all subsequent measurements.

To apply a Scale Factor to measurements:

1. Press **Menu** and enter **Functions**. Go to **Scale Factor**.
2. Set to value by which to multiply all subsequent measurements.
3. Useful when working with beam splitters.

To normalize against a reference measurement:

1. Press **Menu** and enter **Functions**. Go to **Normalize**.
2. Set to reference value by which to normalize all subsequent measurements.

To display as power/energy density:

1. Press **Menu** and enter **Functions**. Go to **Density**.
2. Select beam shape and size.
3. Measurements will be shown as cm^2 .

2.7 Logging Data to a File for Upload to PC

You can log your measurement data to a file for upload to PC by connecting an external storage device to the USB port of the StarBright meter. For details, see [Logging Data to a File for Upload to PC](#).

3 Using the StarBright Display Unit

This section describes the StarBright display unit, its components, its functions independent of sensor type, hardware functions, GUI, and keypad settings.

Topics include:

- [General Description](#)
- [StarBright Display Unit Components](#)
- [StarBright Hardware Components/Interfaces](#)
- [StarBright Functions – Independent of Sensor Type](#)
- [StarBright Screen Layout](#)

3.1 General Description

The Ophir StarBright is a microprocessor-based Laser Power/Energy Meter that provides a broad range of measurements, displays, and data handling options. It operates with Thermopile, Pyroelectric, and Photodiode sensors. Taking advantage of smart connector technology, it is easy-to-use—simply connecting the sensor configures and calibrates the StarBright to operate with that sensor. The sensor configuration and calibration information is stored in an EEROM in the sensor connector plug. This means that when the sensor is plugged in, StarBright automatically identifies the sensor type, calibration, and configuration. You do not have to adjust anything. Sensors are hot swappable. Even after the meter is switched on, you can remove one sensor and insert a different one. StarBright will recognize the switch and reconfigure itself according to the settings of the new sensor.

The StarBright's 320x240 full-color screen enhances measurement readouts in ways that simple monochrome displays cannot. The StarBright can graph power or energy versus time. It displays power measurements in both digital and analog form simultaneously 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 the background. Although the calibration information is stored in the smart connector, you can recalibrate from the screen and store the new calibration in the sensor. You can also zero the StarBright at the touch of a button.

StarBright is capable of logging data onto a USB Flash Drive (Disk On Key), as well as real-time reporting of data via USB to Ophir's StarLab application to display and process the information. StarBright has RS232 capabilities as well. StarBright also has the infrastructure for field upgrading of the embedded software, should the need arise.

Above all, the StarBright 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.

StarBright's User Interface is intuitive. The keypad functionality is context-sensitive and functions according to the needs of the present screen. Where necessary, on-screen help is provided as well, so you should not have to refer to this manual very often.

3.2 StarBright Display Unit Components

Figure 3-1 below displays the StarBright display unit, displaying the main screen with some sample measurements.



Figure 3-1 StarBright Meter/Display Unit – Front View

The StarBright is equipped with:

- LCD Display screen
- Soft keys (under the display screen): The functions of the keys change as indicated by the legend above each key. (The Menu key enables you to access Sensor, Display, Functions, Instrument, Log, and Calibration settings. For sensor-specific details, see Thermopile Sensors, BeamTrack Sensors, Photodiode Sensors, Pyroelectric and Photodiode Energy Sensors.)
- 4 Navigation Keys and round Enter Key (under the soft keys, in the center of the unit)
- Power On/Off/Backlight button
- Rear Panel with the following sockets: 12VDC, AN OUT, Sensor Input, RS232, USB OTG



Figure 3-2 StarBright Rear Panel

- USB Port (on left side of the StarBright meter)



Figure 3-3 USB Port (on Left Side) of StarBright Meter

3.3 StarBright Hardware Components/Interfaces

This section describes the StarBright hardware components and interfaces.

Topics include:

- Sensor Input
- LCD Display and Backlight
- Soft Keys
- Navigation Keys
- On-Off Switch/Backlight Control
- Charger Input
- Analog Output
- RS232 and USB Outputs

3.3.1 Sensor Input

The Sensor Input, located in the center of the StarBright real panel, is the socket where you insert the 15 pin D type connector of the measuring sensor cable in order to connect the sensor to the meter, as shown in [Figure 3-4](#) below.

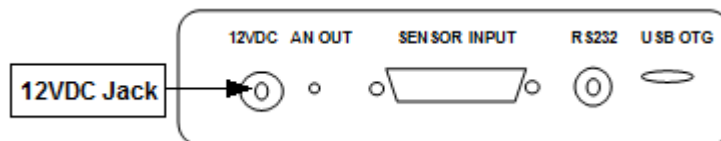


Figure 3-4 StarBright Rear Panel View

3.3.2 LCD Display and Backlight

The StarBright screen is a QVGA 320x240 pixel color TFT LCD. It can be driven in one of two full color modes or in one.

The LCD backlight is actually a set of LEDs that illuminate the display from behind. Because the StarBright uses a TFT color display, the backlight must be constantly on. It can be operated at full intensity for full illumination; or at low or half-level to conserve power consumption (recommended). The backlight level is toggled by a short press on the On/Off switch.

The StarBright 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 set the backlight to less than

full intensity when the instrument is operated without the charger. (For further details, see [On-Off Switch/Backlight Control](#).)

3.3.3 Soft Keys



The Soft keys, located under the StarBright screen, have functions defined by the legend above each key. The legend usually indicates what will happen when pressing the key. For example, if "Zoom" appears above a key, pressing that key will display a zoom view of the screen. 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 StarBright has certain conventions as to the meaning of standard key strokes, including:

- Highlighted item: The item that is presently active.
- Menu: Provides access to Sensor, Display, Functions, Instrument, Log, and Calibration settings.
- Start: Launches the active item.
- Exit: Returns to the previous screen.
- Cancel: Cancels the selection and returns to the previous screen, leaving the settings unchanged.

3.3.4 Navigation Keys




The Navigation keys move to the next active item—left, right, up, and down. The round button in the center is an **Enter** key to enter the screen of the item selected or when finished, to leave that screen. Pressing the **Enter** key to leave the screen will save the newly selected value for immediate use and will also save the change permanently.

3.3.5 On-Off Switch/Backlight Control

This section describes how to switch on/off the StarBright and how to toggle the state of the backlight.

To turn the StarBright on:

- Briefly press the On/Off switch  (located under the Navigation keys, at the bottom of the front panel). See [Figure 3-1](#) above.

The unit switches on, and the display appears. If no sensor is connected, the **Instrument Settings** screen appears, displaying the configurations saved from the previous session (see [Instrument Settings](#)). For example:

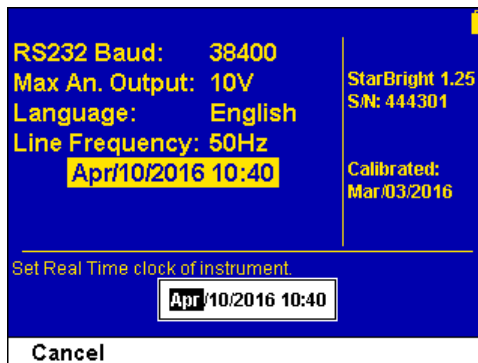


Figure 3-5 Instrument Settings Screen

If a sensor is connected, the appropriate default measurement screen will appear. For example:

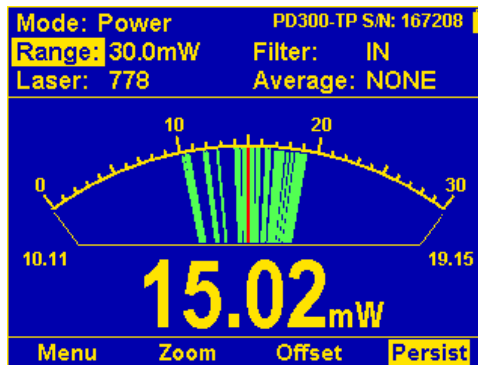


Figure 3-6 Needle Display with Persistence Enabled

To switch the StarBright off:

- Press the On/Off switch and hold it for ~ 3 seconds until the display blanks.

To toggle the state of the backlight of the StarBright's LCD:

- Briefly press the On/Off switch *after* the StarBright has been switched on. You can toggle the backlight between full, half, and low illumination.

3.3.6 Charger Input

The StarBright can be operated either by the internal battery or from an AC source with the charger plugged in all the time. Plug the charger into the jack labeled "12VDC" on the rear panel (see [Figure 3-7 below](#)). The battery will be charged at the same rate whether the StarBright is switched on or off, and whatever the backlight level. The battery will fully recharge in around 4-5 hours.

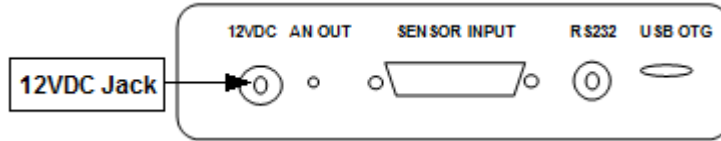


Figure 3-7 StarBright Rear Panel View


Note: The charger circuit of the StarBright is designed to allow the charger to be plugged in for an extended period without causing damage to the battery.

The approximate time between charges is given in [Table 3-1 below](#) for various configurations:

Table 3-1 Sensor Charging Times

Sensor Type	Backlight Level	Time Between Charges
Thermopile and Photodiode	Low	19 hours
Thermopile and Photodiode	Half	17 hours
Thermopile and Photodiode	Full	15 hours
Pyroelectric and BeamTrack	Low	16 hours
Pyroelectric and BeamTrack	Half	15 hours
Pyroelectric and BeamTrack	Full	13 hours

Note: Battery charge will be depleted faster if a USB Flash Drive (Disk on Key) is left plugged into the StarBright meter.

The battery charge is indicated by the  icon. The battery charge is shown approximately by each segment of the icon, for example, when 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 even while on and even with the backlight on, it will charge fastest if the charger is left in while the unit is off.

3.3.7 Analog Output

The StarBright provides an analog voltage output via the 2.5mm mono jack socket on the rear panel marked "AN OUT" (see [Figure 3-7 above](#)). The StarBright 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, 2, 5, or 10 volts as selected during setup.

To set the analog output voltage:

1. Use the up (↑) /down (↓) Navigation keys to select **Max An. Output** and press the **Enter** key.
2. Select the relevant voltage setting (**1V, 2V, 5V, 10V**).
3. Press the **Enter** key to exit this selection screen and save the new setting.

The analog output is driven through an impedance of 100ohm. For best accuracy, is recommended to limit the external load to 100K (or larger). A smaller load (down to 1K) is possible, but may result in loss of accuracy.

For Thermopile and Photodiode sensors in power mode, the analog output is continually updated 15 times per second with the latest power measurement. For Thermopile sensors in single shot energy mode, the analog output is held until the next pulse is measured. For Pyroelectric sensors, the analog output is updated at up to 10 times per second with the latest pulse energy.

3.3.8 RS232 and USB Outputs

The StarBright is equipped for either RS232 or USB communications with PC. The Unit is supplied with a standard cable for USB communications and a custom cable for RS232 (see [Figure 3-7 above](#)).

You can change the RS232 baud rate with or without the sensor connected.

To set the RS232 baud rate for RS232 PC communication:

1. Disconnect the sensor and change the setting in the **Instrument Settings** screen.
Alternatively, when the sensor is connected to StarBright, the RS232 Baud Rate can be configured in the **Instrument Settings** screen, accessed by pressing the **Menu** button and selecting **Instrument**.
2. Use the Navigation keys to select **RS232 Baud Rate** and press the **Enter** key to display the options (**115200, 57600, 38400, 19200**).
3. Change the setting with the up (↑) /down (↓) Navigation keys and press the **Enter** key to save.

3.4 StarBright Functions – Independent of Sensor Type

This section describes the functions available when no sensor is connected to the StarBright.

Topics include:

- Instrument Settings
- Field Upgrade
- Clock Settings
- Zero Adjustments
- Line Frequency
- Language
- Measurement Screens (Graph Types)
- Color Scheme

3.4.1 Instrument Settings

When no sensor is connected, the StarBright **Instrument Settings** screen is displayed. This gives you the opportunity to change instrument settings including the [RS232 baud rate](#), [maximum analog](#)

output, language, line frequency, color scheme, and date and time of the real time clock. The **Instrument Settings** screen also shows the firmware version, serial number of the instrument, and last calibration date. You can also [re-zero the instrument](#). (Click the links to view more details.)

To configure the instrument settings:

1. Disconnect the sensor.

The **Instrument Settings** screen is displayed.

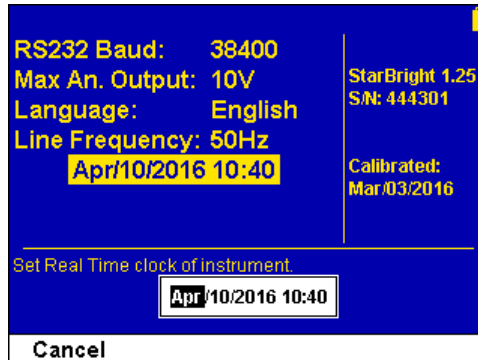


Figure 3-8 Instrument Settings Screen

2. Use the up (↑) /down (↓) Navigation keys to select the parameter to change and press the **Enter** key to display the options, as described in [Table 3-2 below](#). (These instrument settings are also available when a sensor is connected, and you press the **Menu** button and select **Instrument**.)
3. Change the setting with the up (↑) /down (↓) Navigation keys and press the **Enter** key to save. The StarBright automatically saves the current settings for the next power up.

Table 3-2 StarBright Instrument Settings

Parameter	Description
RS232 Baud	Set the baud rate for RS232 PC communication. Options include: <ul style="list-style-type: none"> • 115200 • 57600 • 38400 • 19200
Max An. Output	Select the voltage of analog output for full scale measurement. Options include: <ul style="list-style-type: none"> • 1V • 2V • 5V • 10V
Language	Set desired instrument startup language. Options include: <ul style="list-style-type: none"> • English • Japanese • Russian • Chinese
Line Frequency	Set local line frequency to screen out electrical noise from the mains supply (to prevent any impact on the measurements). Options include: <ul style="list-style-type: none"> • 50Hz • 60 Hz
Color Scheme	Set to full color functionality or to color pair that best matches the protective goggles in use. Options include: <ul style="list-style-type: none"> • Black/White • Blue/Black • Red/Black • Green/Black • Color 1 • Color 2
Date and Time	Set the real-time clock of the instrument, in date/time format: MM/DD/YYYY H:mm.

3.4.2 Field Upgrade – Updating the StarBright Firmware

StarBright has all of the necessary infrastructure for field upgrading of the embedded software, should the need arise. This is done through the USB OTG port that is found on the rear panel of the instrument (see [Figure 3-7](#) above).

To update the StarBright firmware:

1. Download the latest StarBright firmware upgrade package from the Ophir website: <http://www.ophiropt.com/laser--measurement/laser-power-energy-meters/products/laser-power-meters/starbright> and copy it to your target directory.
2. Run the upgrade executable and follow the on-screen instructions.

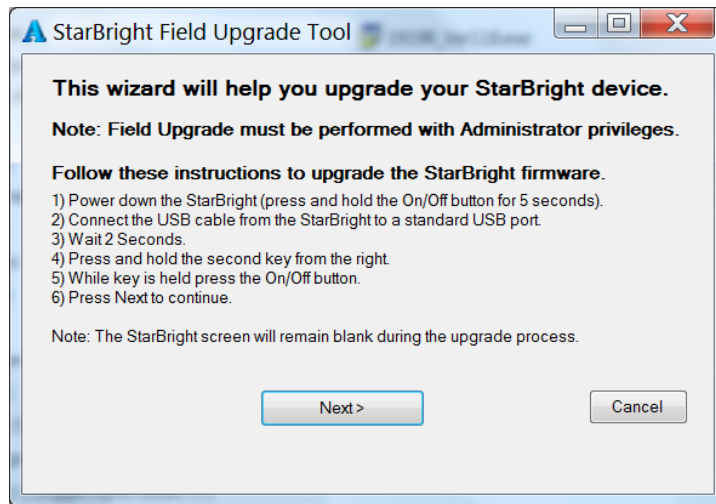


Figure 3-9 StarBright Field Upgrade Wizard

3.4.3 Clock Settings

The StarBright is equipped with a real time clock which shows the date and time. This clock also allows the StarBright to query the sensor attached and notify you if the sensor is due for calibration. You can change the [date and time](#).

To set the real-time clock of the instrument:

1. Disconnect the sensor.
2. Use the up (↑) /down (↓) Navigation keys to select/highlight the **Date and Time** parameter and press the **Enter** key.

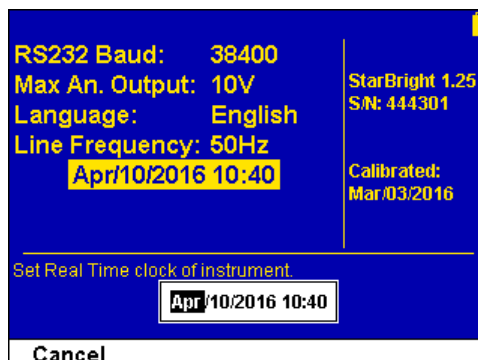


Figure 3-10 Real Time Clock Settings

3. Use the left (←)/right (→) Navigation keys to scroll through and select/highlight each of the Month, Day, Year, Hours, and Minutes fields (MM/DD/YYYY H:mm).
4. Change the setting with the up (↑) /down (↓) Navigation keys and press the **Enter** key to save.

3.4.4 Zero Adjustments

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

To zero the instrument:

1. Disconnect the sensor, turn the instrument off and then back on again, so the StarBright can identify that no sensor is connected. An "Initializing" message will be displayed.
2. Let the StarBright run for at least 30 seconds before performing zero adjustment. Make sure the sensor is in a quiet environment (without electrical noise) and not subject to pulsed radiation.
3. Press **Zero** and **Start**. Wait until "Zeroing completed successfully" appears.
4. Press **Save** to save the new zero values to the instrument.
5. Press **Exit** to return to the main screen.

For Thermopile Sensors only:

For best results with Thermopile sensors, it may be necessary to do the procedure once with the sensor disconnected, then afterwards again with the sensor connected.

To zero the instrument against Thermopile sensors:

1. After completing steps 1-4 above, connect the sensor and make sure it is at room temperature and well shielded from any stray thermal power. It is recommended to lay the sensor with the absorber face down on the table.
2. Switch the instrument off then on again with the sensor connected.
3. Press **Menu** and select **Instrument**. Press **Zero** and **Start**. Wait until "Zeroing completed successfully" appears.
4. Press **Save** to save the new zero values to the instrument.
5. Press **Exit** to exit this screen and return to the previous one.

For Pyroelectric and Photodiode Energy Sensors:

In addition to zeroing the meter, as described previously, it is important to zero the meter against the sensor you are using the first time. After you have done zeroing, you do not have to do it again when used with the same type of meter. If you have zeroed it against a different type of meter, then a different value has been saved and therefore when used with this StarBright, you should zero it again.

3.4.5 Line Frequency

Setting Line Frequency correctly removes electrical noise that may impact the measurements.

To set line frequency:

1. In the main screen, use the Down (↓) Navigation key to select **Line Frequency** and press the **Enter** key.
2. Set to **50Hz** or **60Hz**, depending on the electrical power grid of the area that you are in.
3. Press the **Enter** key to save the new setting.

3.4.6 Language

The StarBright display can be configured to one of several languages (English, Japanese, Russian, or Chinese).

To set the user interface language for the instrument:

1. In the main screen, use the Down (↓) Navigation key to select **Language** and press the **Enter** key.
2. Set to English, Japanese, Russian, or Chinese.
3. Press the **Enter** key to save the new setting.

Note: If you mistakenly save the Japanese (or any foreign) language as the StarBright startup language, you can revert to English.

To revert to English (from a foreign language):

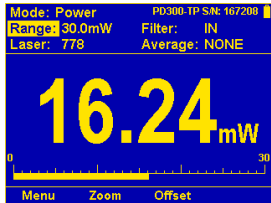
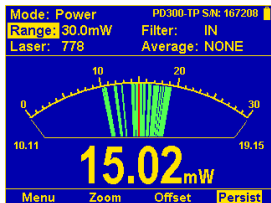
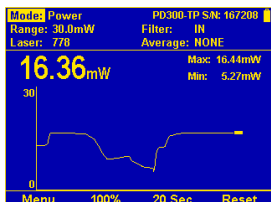
1. Disconnect the sensor from StarBright.
2. Turn the StarBright off and on again. The **Instrument Settings** screen appears (titled “head disconnected” in Japanese).
3. Press the Down (↓) Navigation key **2** times to select/highlight the “Language” option.
4. Press the **Enter** key and select **English** (at the top of the language list).
5. Press the **Enter** key to save English as the startup language.

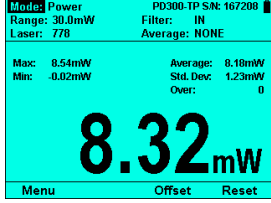
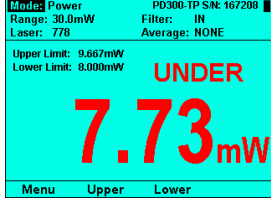
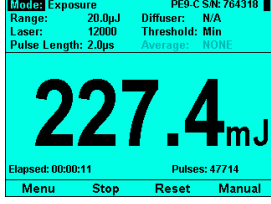
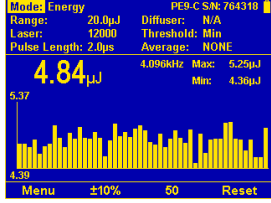
Note: The current settings are automatically saved for the next time StarBright is turned on.

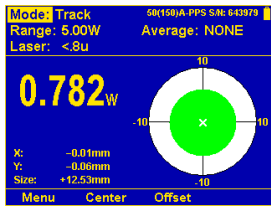
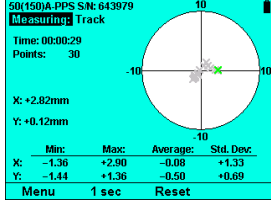
3.4.7 Measurement Screens (Graph Types)

The StarBright measurement screens are available in a variety of graphical displays, as described in [Table 3-3 below](#) (click the links to view more details):

Table 3-3 StarBright Measurement Screens (Graph Types)

Graph Type	Description	Sample Figure
<p>Bargraph</p>	<p>Ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale. Presents measurement on a graduated scale. Available when measuring laser power or energy.</p> <ul style="list-style-type: none"> Press the Zoom key to zoom in on a smaller section of the range when readings are fluctuating slightly. If you notice that noise has impacted the measurement, you can press the Offset key to remove it from the measurement. 	 <p>Figure 3-11 Bargraph</p>
<p>Needle</p>	<p>Simulates an analog display, similar to the style of an analog voltmeter or a car's speedometer. Available when measuring power or energy.</p> <ul style="list-style-type: none"> Press the Zoom key to zoom in on a smaller section of the range when readings are fluctuating slightly. If you notice that noise has impacted the measurement, you can press the Offset key to remove it from the measurement. Press the Persist key to continue to display previous readings as well as to show the minimum and maximum measurements. 	 <p>Figure 3-12 Needle with Persistence Enabled</p>
<p>Line</p>	<p>Graph laser output as a function of time. Useful for technicians performing laser alignment that want to see the results of their experimenting graphically as well as to be shown the maximum laser power attained.</p>	 <p>Figure 3-13 Line Graph</p>

Graph Type	Description	Sample Figure
<p>Statistics</p>	<p>Large numeric readout with statistics displayed as well.</p>	 <p>Figure 3-14 Statistics Display</p>
<p>Pass/Fail</p>	<p>Test for measurements outside the user-defined range of acceptable readings. Configurable upper and lower limits. Useful for final inspection testing, other aspects of Production Q/A, or field inspection of equipment.</p> <p>If the measurement is out of range, OVER or UNDER will be displayed on the screen. If the Color Scheme has been set to one of the full color options, then this will be displayed in RED, along with the reading itself. When within range, the display will be normal, with the results shown in GREEN, if one of the color options has been selected.</p>	 <p>Figure 3-15 Pass/Fail Display</p>
<p>Exposure</p>	<p>Sum of the total energy of a series of measurements over a given time period or number of pulses (pulse count is relevant for energy sensors only). 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 $30 \times 1 \times 20 = 600\text{mJ}$.</p>	 <p>Figure 3-16 Exposure Measurement</p>
<p>Pulse Chart</p>	<p>Displays a graph of pulses as they occur. Displays the readings as bars with lengths proportional to the measurement. Not time based and is most applicable when the data flow is not necessarily periodic. Ideal when measuring low frequency lasers.</p>	 <p>Figure 3-17 Pulse Chart</p>

Graph Type	Description	Sample Figure
Position	Shows the position and size of the laser beam as measured by the sensor. This display is available for BeamTrack sensors (Thermopile sensors with additional circuitry for measuring position and size) with the Measurement mode set to Track.	 <p>Figure 3-18 Position and Size Display (BeamTrack sensors only)</p>
Stability	Historical tracking of the position over time. This display is available for BeamTrack sensors (Thermopile sensors with additional circuitry for measuring position and size) with the Measurement mode set to Track.	 <p>Figure 3-19 Stability Display (BeamTrack sensors only)</p>

3.4.8 Color Scheme

You can configure the StarBright 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 StarBright in this manual are shown in the various color schemes. For example, the following sensor displays:



Figure 3-20 Thermopile Sensor (Monochrome)

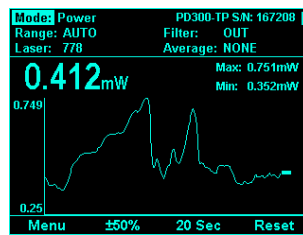


Figure 3-21 Photodiode Sensor (Monochrome)

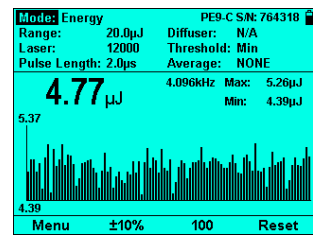
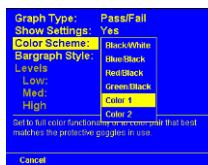


Figure 3-22 Pyroelectric Sensor (Full Color)

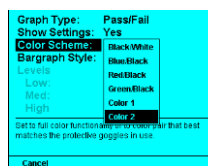
Full Color

To set the color scheme of the main measurement displays to full color:

1. Connect the relevant sensor.
2. Press the **Menu** button, and use the Navigation keys to select **Display** and press the **Enter** key.
3. Use the Navigation keys to select **Color Scheme** and press the **Enter** key.
4. Select the relevant full color scheme option:



- **Color 1:** Yellow text on dark blue background



- **Color 2:** Black text on sky blue background

5. Press the **Enter** key to save the setting.

For both of these full color schemes, warnings will be displayed in red, selection windows (for example, range, average, laser) will be pink, and modification windows will be white.

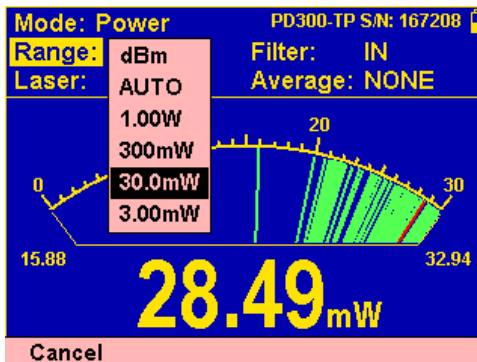


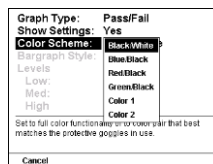
Figure 3-23 Sample Full Color Scheme Display with Pink “Range” Selections

Monochrome

Monochrome 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 StarBright will not be functional in any of the monochrome screens.

Follow the [procedure above to set the color scheme](#) and choose one of the following monochrome schemes:

- Black/White: Black text on white background



- Blue/Black: Sky blue text on black background 
- Red/Black: Red text on black background 
- Green/Black: Green text on black background 

See [Figure 3-20](#), [Figure 3-21](#), and [Figure 3-22](#) above which show the sensors in monochrome and full color displays.

3.5 StarBright Screen Layout

The StarBright screen display is carefully designed to provide easy reading of the laser measurement, quick access to configuration parameters, as well as the ability to set up for more advanced work.

[Figure 3-24](#) below displays the layout of a typical StarBright measurement screen.

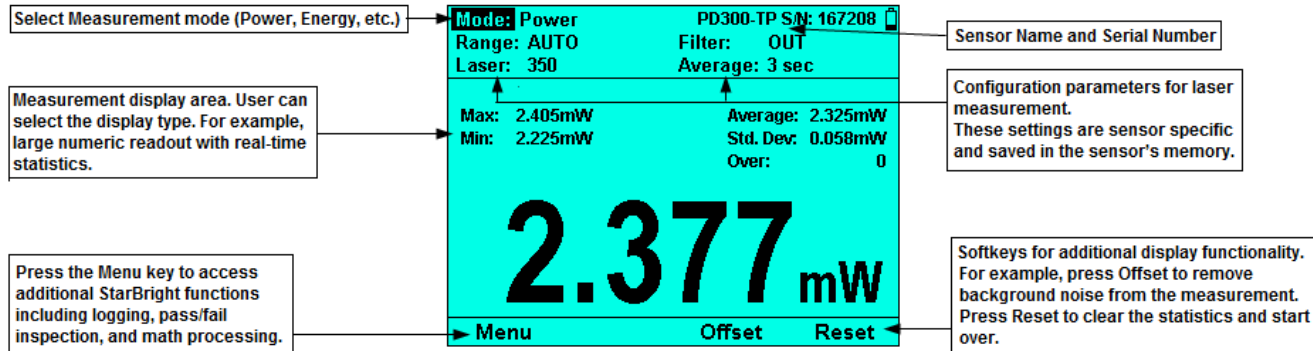


Figure 3-24 StarBright Measurement Screen Layout

The StarBright measurement screen comprises:

- Configuration parameters for laser measurements (at the top), including “Mode” (on upper left) for setting the measurement mode (for example, Power, Energy, and so on). The configuration settings are sensor specific and saved in the sensor’s memory.
- Measurement display area (in the middle), varies per the selected display type (for example, large numeric readout with real-time statistics).
- Sensor name and serial number (upper right).
- Soft keys (on the bottom) for additional display functionality. (For example, press the Menu key to access additional StarBright functions including logging, pass/fail inspection, and math processing. Press Offset to remove background noise from the measurement. Press Reset to clear the statistics and start over.)

4 Points to Consider

Before using the StarBright Laser Power/Energy Meter, consider the following points:

- What is the specific laser you need to measure? Which sensor is suitable for this laser? Do you need to measure laser power or laser energy?
- What range and other measurement parameters do you need to set for your particular laser (for example, laser setting, energy threshold, pulse length, and so on)?
- What other instrument settings do you need to configure? Do you use the analog output and if so, is it configured correctly for your needs?
- How would you like to display the measurement data, as a bargraph, analog needle, or some other format? Do you need real-time statistics or pass/fail tracking?

StarBright will help you implement the answers to these questions. The following chapters describe the measurement functionality of the various sensor types, the graphical displays of the StarBright meter, as well as the data logging and math processing capabilities that make the StarBright meter the complete answer to your measurement needs.

5 Thermopile Sensors

For a list of the available Thermopile Sensor models that can be used with StarBright, see [Sensor Specifications](#).

Warning: Before using the Thermopile sensor for power or energy measurement, check that your laser power, energy, and energy density do not exceed the sensor ratings. See [Sensor Specifications](#).

If the sensor is a water-cooled type, ensure that the cooling water is flowing at an adequate rate (see [Table 5-1 below](#)). Also, note that the reflectance from the absorber could be as much as 10% and with CO₂ 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.

Table 5-1 Minimum Flow Rates for Water-Cooled Sensors

Sensor Type	Liters per Minute at Full Power	Min Pressure Bar	US Gallons per Minute
30K-W	25	2	7
10K-W	9	2	2.5
5000W	4.5	0.8	1.2
1500W	2.5	0.5	0.7
1000W	1.8	0.5	0.5

When a radiant heat source, such as a laser, is directed at the absorber sensor 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 sensor. 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 StarBright. Energy of a single pulse is measured on the StarBright by digitally integrating the pulse power over time.

Most Thermopile sensors have somewhat different absorption at different wavelengths. To compensate for this, each sensor has been calibrated by the laser at several wavelengths. When you choose the correct laser setting, the correction factor for that wavelength is automatically introduced. Note that the laser setting selected is displayed in the upper left section of the display.

Thermopile sensors with the LP1 absorber have large variation of absorption at different wavelengths. Therefore a continuous spectral curve is stored in the sensor, 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.

The StarBright can be set to various settings while operating. In addition, the StarBright automatically saves the settings for the next power up. This way the StarBright will be in the desired configuration when turned on the next time.

On power up, the StarBright meter checks its own memory as well as the sensor's to decide on the measurement configuration. For example, if in the last session, the sensor was used to measure power in the Bargraph screen in autoranging with a YAG laser and averaging for 10 seconds, this will be the setup used the next time the system is powered up. These settings can all be easily changed, as will be described fully in the following sections.

Topics include:

- [Operation of StarBright with Thermopile Absorber Sensors](#)
- [Measuring Laser Power with Thermopile Sensors](#)
- [Measuring Laser Energy with Thermopile Sensors](#)
- [Measuring Laser Pulsed Power with Thermopile Sensors](#)

5.1 Operation of StarBright with Thermopile Absorber Sensors

To use StarBright with Thermopile sensors:

1. Connect the Thermopile sensor to the StarBright meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the rear panel of the StarBright meter. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. (These are also available when you press the **Menu** button and select **Sensor**). Use the Navigation keys to navigate to the parameter you want to change.
3. Use the up (↑) /down (↓) Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys.
4. Press the **Enter** key to save the settings.

Note: The StarBright automatically saves the current settings for the next power up.

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

5.2 Measuring Laser Power with Thermopile Sensors

When measuring laser power, center the laser beam carefully on the absorber surface and read the power.

Power measurements can be displayed in [Bargraph](#), [Needle](#), [Line](#), [Statistics](#), or [Pass/Fail](#) graphical formats (by pressing **Menu > Display** and choosing the **Graph Type**). Updating measurement parameters is performed in the main measurement screen. A sample is shown in [Figure 5-2 below](#) at the end of this procedure.

To measure laser power when using Thermopile sensors:

1. Set **Mode** to **Power**. The measuring mode is set to **Power**, and you can specify the expected laser **Range**, **Laser** setting, and **Average** power period. (The power is measured 15 times per second.)

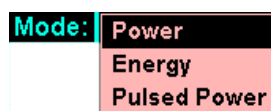


Figure 5-1 Setting the Measurement Mode to Power

2. Set **Range** to **AUTO** or to one of the manual ranges, as follows:
 - **AUTO:** Select autoranging when the laser power is unknown or varies widely. In autorange, 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, and so on. 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 StarBright from flipping back and forth when reading close to the end of the scale.

- **Manual range:** The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autorange, since it changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.
3. Set **Laser** to the appropriate laser setting.
 4. Set **Average** to the period you wish to average power over or set to **NONE** to disable. This feature is especially useful for lasers with unsteady output. (The **Average** can also be configured in the [Functions screen](#).)

Figure 5-2 below shows a sample Statistics graph showing laser power measurement statistics

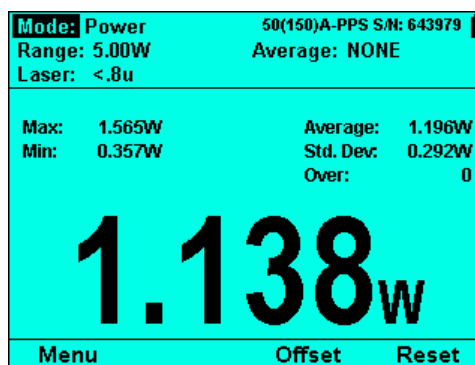


Figure 5-2 Thermopile Power Statistics Display

Note: The soft key legend options such as **Zoom**, **Offset**, **Persist**, **Reset** vary per **Graph Type**.

5.3 Measuring Laser Energy with Thermopile Sensors

In addition to power, Thermopile sensors can be used to measure single shot energy as well, where they integrate the power flowing through the disc over time and thus measure energy. Since the typical time it takes for the disc to heat up and cool down is several seconds, these Thermopile sensors can only measure one pulse every several seconds at most. Thus they are suitable for what is called “single shot” measurement. Although the response time of the sensor discs is slow, there is no limit to how short the pulses measured are since the measurement is of the heat flowing through the disc as a result of the pulse.

Energy measurements can be displayed in [Bargraph](#), [Needle](#), [Line](#), [Statistics](#), or [Pass/Fail](#) graphical formats (by pressing **Menu** > **Display** and choosing the **Graph Type**). Updating measurement parameters is performed in the main measurement screen. A sample is shown in [Figure 5-3 below](#) at the end of this procedure.

To measure single shot energy when using Thermopile sensors:

1. Set **Mode** to **Energy**. The measuring mode is set to **Energy**, and you can specify the expected energy **Range**, **Laser** setting, and **Threshold**.
2. Set **Range** to the appropriate manual range. (In **Energy** mode, there is no autoranging.) The correct range is the lowest one that is larger than the expected maximum pulse energy of the laser.
3. Set **Laser** to the appropriate laser setting.
4. Set **Threshold** to change the energy threshold to **LOW**, **MED**, or **HIGH** to set the hardware threshold in the sensor to screen out noise that would otherwise be seen as energy pulses. (This screens out false triggers.) The factory setting of the 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**.

If the StarBright 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.

5. When the StarBright screen flashes **READY** on and off, fire the laser. The display will go blank while the energy is being integrated. After about 2-4 seconds (depending on the sensor), the correct energy will be displayed.
6. Return to Step 1 for the next measurement.

Figure 5-3 below shows a sample analog Needle display showing laser energy measurement data with options for [Zoom](#), [Offset](#), and [Persistence](#). (Click the above links for more details.)

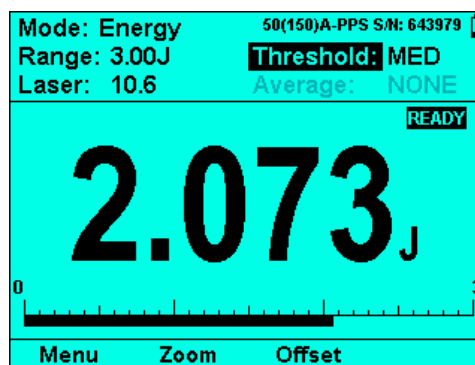


Figure 5-3 Thermopile Energy Bargraph

Note: The soft key legend options such as **Zoom**, **Offset**, **Persist**, **Reset** vary per **Graph Type**.

5.3.1 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.

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

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

- 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.

5.3.2 Measuring Energy of Rapidly Repeating Pulses

With a typical Thermopile sensor, StarBright 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 sensors, as long as the pulse energies do not exceed the ratings of the Pyroelectric absorbers. The Pyroelectric sensors are compatible with StarBright and just have to be plugged in to be used.

5.4 Measuring Laser Pulsed Power with Thermopile Sensors

Thermopile Energy Sensor models are capable of measuring “Pulsed Power” in order to display instantaneous power of a laser pulse. Power can be calculated from energy if you know the length of the pulse.

Note: Accuracy of measurement will be dependent on your setting the pulse width correctly.

To measure laser pulsed power when using Thermopile sensors:

1. Set **Mode** to **Pulsed Power**. The measuring mode is set to **Pulsed Power**, and you can specify the expected energy **Range**, **Laser** setting, and **Threshold**.
2. Set **Range** to the appropriate manual range. (In **Energy** mode, there is no autoranging.) The correct range is the lowest one that is larger than the expected maximum pulse energy of the laser.
3. Set **Laser** to the appropriate laser setting.
4. Set **Pulse Length** to the correct pulse length. Using the up/down Navigation keys to change each number and the right/left keys to move to the next number, key in the pulse length you want. (The range is **0.1** to **10** seconds in increments of 0.1. The default is 1.0 seconds.) When finished, press the **Enter** key.
5. Set **Threshold** to change the energy threshold to **LOW**, **MED**, or **HIGH** to set the hardware threshold in the sensor to screen out noise that would otherwise be seen as energy pulses. (This screens out false triggers.) The factory setting of the 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**.

If the StarBright 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.

6. When the StarBright screen flashes **READY** on and off, fire the laser. The display will go blank while the energy is being integrated. After about 2-4 seconds (depending on the sensor), the correct energy will be displayed.
7. Return to Step 1 for the next measurement.

The measurement is displayed in watts (energy/pulse length).

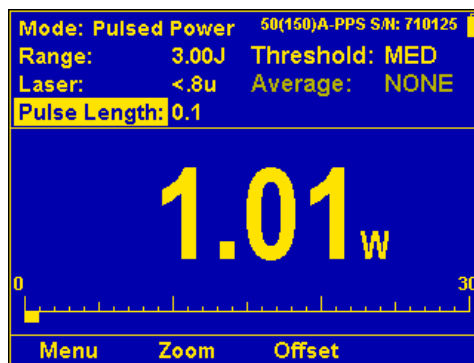


Figure 5-4 Thermopile Pulsed Power

Note: It is possible to record log files of Pulsed Power measurements. The format type is the same type that is recognized by StarLab.

5.4.1 Pulsed Power Limitations

Screen Limitations

The measurement mode cannot be Pulsed Power when in the Calibration screens. Calibration screens will force the user to select between Power and Energy.

Function Limitations

Functions are in terms of Watts (even though the ranges in use are energy ranges).

When measuring pulsed power, the following functions are enabled/disabled:

- All functions except Average are enabled (because we are really measuring single-shot energy).
- Average is grayed out (disabled).
- Offset and Reference are cleared.
- Scale Factor and Density are accessible (enabled).

6 BeamTrack Sensors

For a list of the available BeamTrack Sensor models that can be used with StarBright, see [Sensor Specifications](#).

Some of Ophir's Thermopile sensors are equipped with circuitry enables them to measure the laser's position as well as the spot size in addition to standard power and energy measurement.

The BeamTrack line of sensors are Thermopile sensors that can measure beam position and beam size while measuring power. The BeamTrack sensor provides additional information on your laser beam – centering, beam position and wander, beam size as well as power and single shot energy. The BeamTrack sensor works as follows: the signal coming from the sensor is divided into 4 quadrants so by measuring and comparing the output from the 4 sections you can determine the position of the center of the beam to a high degree of accuracy. In addition to the 4 quadrants, there is a special patented beam size detector. After processing outputs from these various detectors, the user is presented with the beam position as well as beam size. Note that the beam size is calibrated only for Gaussian beams of >3mm, but for other beams it will give relative size information and will indicate if the beam is changing size.

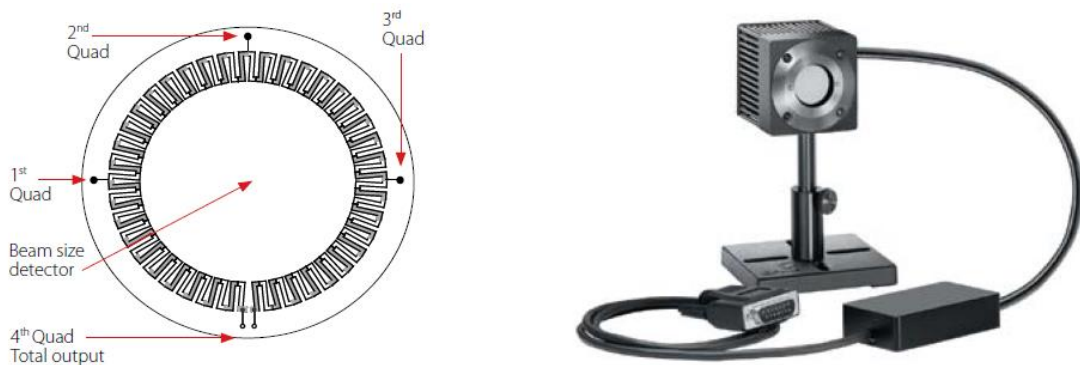


Figure 6-1 BeamTrack Sensor

This section describes the StarBright's position and size measurement functionality. This is available in the **Track** measuring mode, which shows the position of the laser beam as measured by the sensor. If the beam is close enough to the center and the sensor is capable of size measurement, then the laser beam will be displayed as a spot drawn to scale. Otherwise, the location will be displayed as an X.

Topics include:

- [Setting Measurement Parameters](#)
- [Tracking Laser Beam Position and Size](#)
- [Tracking Stability - Laser Beam Position Over Time](#)

6.1 Setting Measurement Parameters

Measurements can be displayed in [Position](#) or [Stability](#) graphical formats (by pressing **Menu > Display** and choosing the **Graph Type**). Updating measurement parameters is performed in the main measurement screen. A sample is shown in [Figure 6-2 below](#) at the end of this procedure.

To configure BeamTrack sensor settings for measuring position and size with power::

1. Connect the relevant BeamTrack sensor to the StarBright.
2. Set **Mode** to **Track**. When measuring mode is set to **Track**, you can specify the expected laser **Range**, **Laser** setting, and **Average** power period as you would when the measuring mode is set to **Power**.
3. Set **Range** to **AUTO** or to one of the manual ranges, as follows:
 - **AUTO**: Select autoranging when the laser power is unknown or varies widely. In autorange, 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, and so on. 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 StarBright from flipping back and forth when reading close to the end of the scale.
 - **Manual range**: The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autorange, since it changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.
4. Set **Laser** to the appropriate laser setting.
5. Set **Average** to the period you wish to average power over or set to **NONE** to disable. This feature is especially useful for lasers with unsteady output.

6.2 Tracking Laser Beam Position and Size

To track position and size while measuring power when using BeamTrack sensors:

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Position**. Return to the main display screen.
3. Press **Center** to center the laser beam.
4. Press **Offset** to subtract the background noise from the measurement and reset the value to zero.

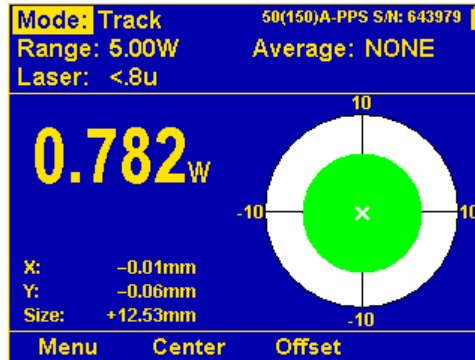


Figure 6-2 Position Display with BeamTrack Sensor

6.3 Tracking Stability - Laser Beam Position Over Time

To track laser beam position over time when using BeamTrack sensors:

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Stability**. Return to the main display screen.
3. Press **1 sec** to change the time interval (to **3, 10, 30 seconds** or **1 minute**).

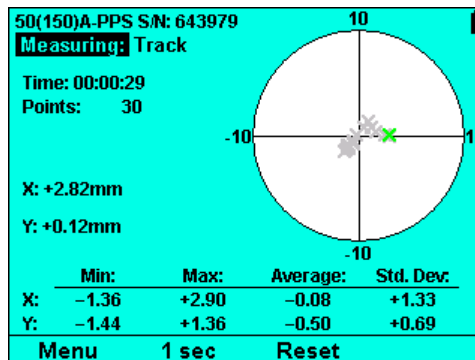


Figure 6-3 Stability Display with BeamTrack Sensor

7 Photodiode Sensors

For a list of the available Photodiode Sensor models, see [Sensor Specifications](#).

Warning: Before using the Photodiode sensor for power measurement, check that your laser power, energy, and energy density do not exceed the sensor ratings. See [Sensor Specifications](#).

When a photon source, such as a 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 sensors have a unique dual detector sensor (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 sensor the signal from the two detectors cancels.

On the other hand, when a laser beam falls on the sensor, 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 StarBright display unit amplifies this signal and indicates the power level received by the sensor. Due to the superior circuitry of the StarBright, the noise level is very low, and the PD300/3A-IS series sensors with the StarBright 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 sensors of the PD300 series have been constructed with a built in filter so the basic sensor 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 7-1 below](#) gives the actual maximum power as a function of wavelength.

Table 7-1 Maximum Measurable Laser Power as a Function of Wavelength:

Filter Out

Wavelength	PD300	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wavelength	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	3mW	N.A.	800nm	12mW	0.8mW
400nm	30mW	3mW	100mW	3mW	N.A.	1-1.3µm	30mW	0.8mW
633nm	20mW	2.5mW	100mW	3mW	1W	1.4µm	30mW	0.8mW
670nm	13mW	2mW	100mW	3mW	2W	1.5µm	25mW	0.8mW
800nm	10mW	1.5mW	100mW	2.5mW	3W	1.6µm	30mW	0.8mW
900nm	10mW	1.5mW	100mW	2.5mW	3W	1.8µm	30mW	N.A.
1060nm	25mW	3mW	100mW	3mW	3W			

Filter In

Wavelength	PD300	PD300-TP	PD300-3W	PD300-UV	3A-IS	Wavelength	PD300-IR	PD300-IRG
250-350nm	N.A.	N.A.	N.A.	300mW	N.A.	800nm	0.8mW	100mW
400nm	300mW	1W	3W	300mW	N.A.	1-1.3µm	0.8mW	30mW
633nm	300mW	1W	3W	300mW	1W	1.4µm	0.8mW	150mW
670nm	200mW	500mW	2W	300mW	2W	1.5µm	0.8mW	150mW
800nm	100mW	300mW	1.2W	150mW	3W	1.6µm	0.8mW	150mW
900nm	150mW	300mW	1.2W	150mW	3W	1.8µm	N.A.	N.A.
1060nm	250mW	500mW	2.2W	300mW	3W			

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 sensor EEROM. The correction curves, with a resolution of 1nm, ensure that the power reading is correct at all laser settings.

To simplify changing from one laser setting to another, the user can program up to 6 different wavelengths to be available from the screen menu. Use the [procedure below](#) to set the PD300 to your laser settings.

Topics include:

- [Operation of StarBright with Photodiode Sensors](#)
- [Measuring Laser Power with Photodiode Sensors](#)
- [Averaging and Measuring Very Low Power Measurements](#)
- [Measuring Total Exposure](#)

7.1 Operation of StarBright with Photodiode Sensors

To use StarBright with Photodiode sensors:

1. Connect the Photodiode sensor to the StarBright meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the rear panel of the StarBright meter. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. (These are also available when you press the **Menu** button and select **Sensor**). Use the Navigation keys to navigate to the parameter you want to change.
3. Use the up (↑) /down (↓) Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys.
4. Press the **Enter** key to save the settings.

Note: The StarBright automatically saves the current settings for the next power up.

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

7.2 Measuring Laser Power with Photodiode Sensors

The following procedure describes how to use Photodiode Sensors to measure laser power. (The power is measured 15 times per second.) You can specify the expected laser **Range**, **Laser** setting, whether the **Filter** is IN or OUT as physically configured on the sensor, and the **Average** power period.

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

When you choose the correct laser setting, the correction factor for that wavelength is automatically introduced. Note that the laser setting presently corrected for is displayed in the upper left portion of the display.

The PD300 sensor 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 sensor reaches 1.3mA, whichever comes first. See [Table 7-1 Filter In](#) and [Filter Out](#) 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 StarBright has a "filter" setting and uses the proper correction curve depending on whether the filter is installed.

To set measurement parameters for laser power when using Photodiode sensors:

1. The measuring mode is **Power**.
2. Set **Range** to **dBm**, **AUTO**, or to one of the manual ranges, as follows:
 - **dBm:** Logarithmic scale, where 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, and so on.

- **AUTO:** Select autoranging when the laser power is unknown or varies widely. In autorange, you do not have to change scales. (The reading is displayed in watts.) This change only occurs after a few seconds delay. This provides overlap (hysteresis) to keep the StarBright from flipping back and forth when reading close to the end of the scale.
 - **Manual range:** The correct manual range is the lowest one that is larger than the expected maximum power of the laser. There are certain disadvantages to autorange, since it changes scale even if you do not want it to do so. If you want to measure in the same range all the time, it is better to use a manual range.
3. Set **Laser** to the appropriate laser setting. If the wavelength you want is not among the wavelengths listed, select one and press the arrow key that is next to it to open the **Modify** screen. Using the up/down Navigation keys to change each number and the right/left keys to move to the next number, key in the wavelength you want. When finished, press the **Enter** key.

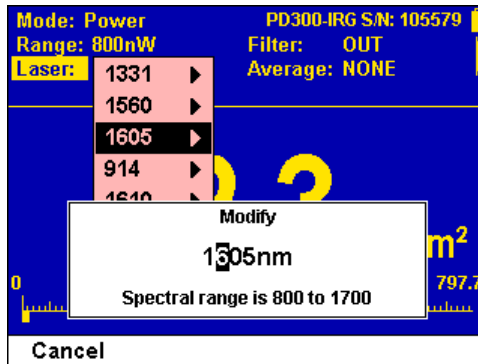


Figure 7-1 Modifying the Laser Setting – Photodiode Sensor

4. Set the removable **Filter** setting to **IN** to measure higher power or to **OUT** for more accuracy and a wider wavelength range—as physically configured on the sensor. See [Table 7-1 Filter In](#) and [Filter Out](#). Make sure to physically insert/remove the Filter before continuing measurements. For sensors with built-in filter state detection, only the present state of the filter will be shown to the user. It will be updated in the event that the filter state is physically changed, thereby causing the sensor to report the new filter state to the meter.

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 Thermopile or integrating sphere sensor for that wavelength. Consult your Ophir agent for details.

5. Set **Average** to the period you wish to average power over or set to **NONE** to disable. This feature is especially useful for lasers with unsteady output. (The Average can also be configured in the Functions screen.)

Note: The **Average** function does not work with autorange or dBm scales.

Figure 7-2 below shows a sample Line Graph showing laser power measurements, including range, wavelength, filter, and average values. In this display, you can press [Zoom](#) and [Offset](#). (Click the above links for more details.)

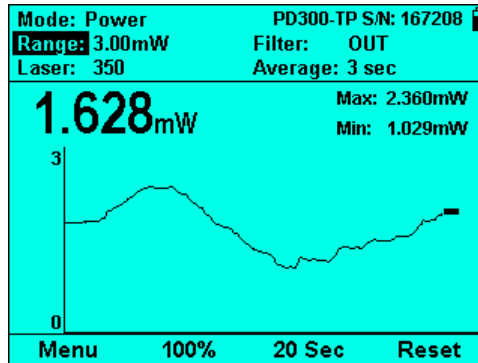


Figure 7-2 Photodiode Power Line Graph

7.3 Averaging and Measuring Very Low Power Measurements

If the laser power is fluctuating, the StarBright 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.

To measure very low powers:

1. Press **Menu** and select **Functions**. Choose the appropriate value you want to **Average** over, save it, and then **Exit**.
1. Block the power source you wish to measure, wait for a few measurement periods and press **Offset** to subtract the zero offset.
2. Unblock the power source and measure.

For a detailed description of the average function, see [Average](#).

Note: The Average function does not work with autorange or dBm scales.

7.4 Average Power for Low Frequency Pulsed Lasers - “Low Freq. Power Mode”:

Starting from firmware v1.41 (Mar. 2019), a second method to measure average power on photodiode sensors is to use the “Low Freq. Power Mode”. This method is useful when measuring average power for pulsed lasers with frequency in the region of ~5Hz to ~100Hz. Using the regular power mode with such a laser source can cause beating effects and saturation of the electronics, which causes unstable or incorrect readings in many cases. The “Low Freq. Power Mode” solves these problems using a special measurement technique in the firmware that synchronizes to the laser frequency (as supplied by the user). This mode is supported only using Photodiode sensors (PD300-xx), but not when using Thermopile sensors (which normally do not exhibit such problems, as their response time is much slower than photodiodes).

To start measurements using the Low Freq. Power mode, select “Low Freq. Power” from the “Mode” pulldown:

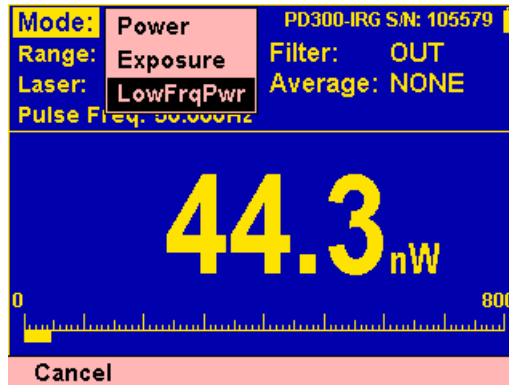


Figure 7-3 Low Freq Power Mode selection

Choose the laser frequency either using the provided drop-down or entering the value manually in the edit box. The value entered can contain several digits after the decimal point if required, such as 33.123Hz.

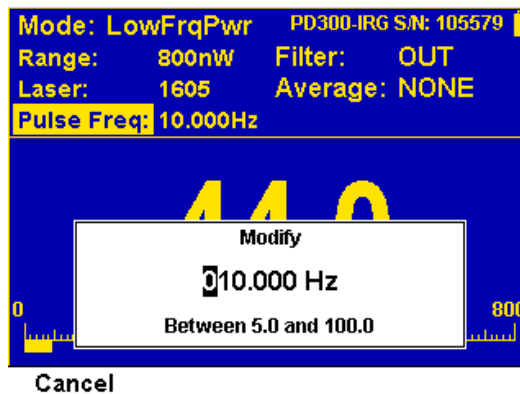


Figure 7-4 Low Freq Power Mode pulse freq selection

Some care needs to be taken when choosing the correct frequency value. If the frequency setting is slightly different from the actual laser frequency, the power readings may show beating effects. If the frequency setting is too low, this may result in periodic positive “spikes” of power above the average power level being measured. If the frequency is too high, the spikes will be negative, below the average power level. As the frequency is adjusted closer to the correct laser frequency, the spikes will become smaller and further apart, until they disappear altogether when the frequency is adjusted perfectly. Note that due to slight errors in the nominal internal clock frequency of the StarBright, or of the laser pulse frequency, the exact frequency setting required for perfect measurements may not be exactly as expected.

After setting the frequency, choose the correct power range. Auto Range is not offered in this mode.

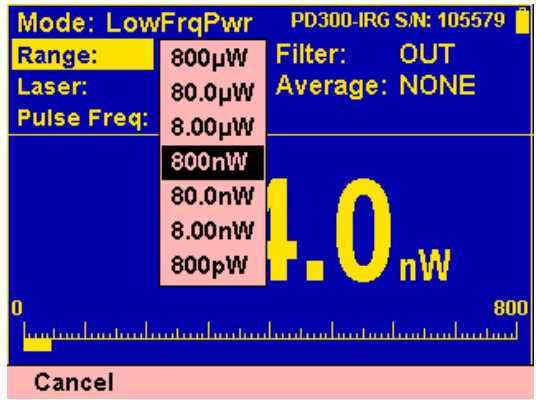


Figure 7-5 Low Power Mode - No Auto Range

As a rough guide, the power range should approximately match the expected AVERAGE power to be measured. The correct range to use is usually the most sensitive range available that does not show “OVER” or “over” on the screen - meaning the average power is too high, or the peak power is saturating the electronics. Note that when using this mode, the StarBright device can sometimes be in saturation before the average power level exceeds the maximum power defined for the selected range. This is because the peak power of a pulse laser may exceed the allowed peak power for the selected power range. The software will detect this situation and warn the user to change to a less sensitive range.

7.5 Measuring Total Exposure

For Photodiode sensors, measuring total exposure is based on summing Photodiode power measurements over time.

In Exposure mode, StarBright measures 15 times per second, updating the exposure displayed on the screen 5 times per second.

To measure total exposure:

1. Set **Mode** to **Exposure**.
2. Set measurement parameters as [described above](#).
3. Set **Stop Mode** to **Manual** or **Timeout** period.

Accumulated laser power exposure will be displayed on the screen, as well as elapsed time.

4. To stop exposure measurement before the chosen period, press **Stop**.
5. To reset the reading to zero before another reading, press **Reset**.
6. To return to the main power measurement screen, set **Mode** to **Power**.

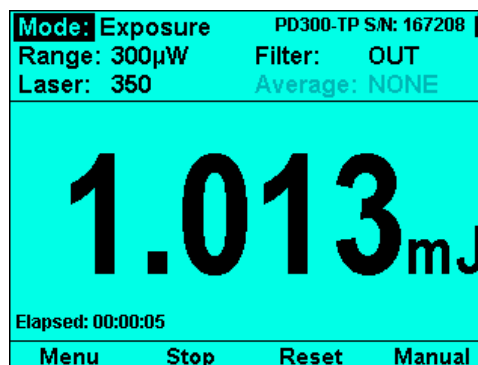


Figure 7-6 Photodiode Exposure Measurement

7.5.1 Exposure Limitations

Screen Limitations

The measurement mode cannot be Exposure when in the Calibration screens. Calibration screens will force the user into Power measurement.

Function Limitations

When measuring exposure, the following functions are enabled/disabled:

- Average, Offset, Reference, and Density are grayed out (disabled).
- Scale Factor is accessible (enabled).

It is also not possible to record log files of Exposure measurements.

8 Pyroelectric and Photodiode Energy Sensors

StarBright supports the PE-C and PD-C series of sensors.

For a list of all the available Pyroelectric and Photodiode Energy Sensor models that can be used with StarBright, see [Sensor Specifications](#).

Warning: Before using the energy sensor for power or energy measurement, check that your laser power, energy, and energy density do not exceed the sensor ratings. See [Sensor Specifications](#).

Topics include:

- [Pyroelectric Sensors – Method of Operation](#)
- [Photodiode Energy Sensors – Method of Operation](#)
- [Measuring Pulses of High Energy Density](#)
- [Operation of StarBright with Pyroelectric and Photodiode Energy Sensors](#)

8.1 Pyroelectric Sensors – Method of Operation

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

Due to this innovative circuitry, Ophir Pyroelectric sensors 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 StarBright meter amplifies this signal and indicates the energy received by the sensor as well as the frequency at which the laser is pulsing. Using the energy and frequency information, StarBright is also able to display average power.

8.2 Photodiode Energy Sensors – Method of Operation

The PD10-C and PD10-PJ-C operate in a similar fashion to the Pyroelectric PE-C sensors 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-IR-PJ-C is sensitive from 700nm – 1800nm and can measure energies down to 30 picoJoules.

8.3 Measuring Pulses of High Energy Density

Due to the nature of their construction, Pyroelectric sensors 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:

- 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 that is supplied with the sensor.

- 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.
- Ophir has sensors specifically designed for high energy density pulses. Some of these sensors can measure energy densities up to several Joules/cm². Contact your Ophir dealer for details.

8.4 Operation of StarBright with Pyroelectric and Photodiode Energy Sensors

On power up, the StarBright meter checks its own memory as well as the sensor's to decide on the measurement configuration. For example, if in the last session, the sensor was used to measure energy in the Bargraph screen in the 200uJ range with a 1064 laser with no averaging, this will be the setup used the next time the system is powered up.

These settings can all be easily changed, as described in the following procedures.

To use StarBright with Pyroelectric and Photodiode energy sensors:

1. Connect the Pyroelectric (or Photodiode) energy sensor to the StarBright meter: Insert the 15 pin D type connector of the measuring sensor cable into the socket marked **Sensor Input** on the rear panel of the StarBright meter. StarBright will reconfigure itself to work with the attached sensor.
2. All of the sensor's measurement parameters are shown on the main screen. (These are also available when you press the **Menu** button and select **Sensor**). Use the Navigation keys to navigate to the parameter you want to change.
3. Use the up (↑) /down (↓) Navigation keys to select the parameter to change and press the **Enter** key. Change the setting with the Navigation keys.
4. Press the **Enter** key to save the settings.

Note: The StarBright automatically saves the current settings for the next power up.

The following procedures explain how to configure measurements for laser power or energy:

- Zeroing the Energy Sensor Against the StarBright Meter
- Setting Measurement Parameters When Using Energy Sensors
- Energy, Average Power, or Exposure Measurement
- Measuring Laser Energy
- Measuring Average Power
- Measuring Total Energy Exposure

Warning: Do not exceed maximum sensor limits for power, energy, power density, and energy density as listed in [Sensor Specifications](#). Otherwise, there is a risk of damaging the absorber.

8.4.1 Zeroing the Energy Sensor Against the StarBright Meter

For most accurate calibration, you should zero the Pyroelectric energy sensor against the StarBright it is being used with. This is important since there is a slight variation of Pyroelectric reading from meter to meter. After this is done, the sensor is "conditioned" to work with the particular StarBright the zeroing was done against. It is not necessary to do this procedure again unless the StarBright is used with a different sensor. If the procedure is not done, errors of 2% or so can occur.

To zero the instrument against the energy sensor:

1. Make sure the sensor is in a quiet environment and not subject to pulsed radiation.
2. Press **Menu** and select **Instrument**.
3. Press **Zero** and **Start**. Wait until “Zeroing completed successfully” appears.

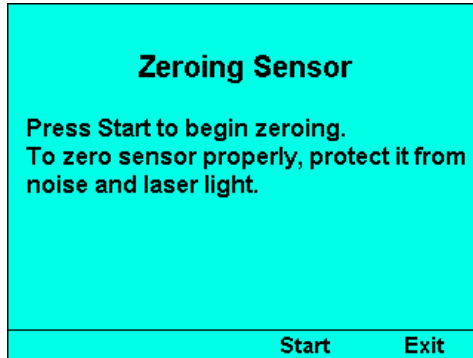


Figure 8-1 Pyroelectric Zeroing

4. Press **Exit** to return to previous screen.

After you have done zeroing, you do not have to do it again when used with the same type of meter. If you have zeroed it against a different type of meter, then a different value has been saved and when used with a StarBright again, you should zero it again.

8.4.2 Setting Measurement Parameters When Using Energy Sensors

To set measurement parameters when using energy sensors:

1. Set **Range** to the correct manual range that is the lowest one that is larger than the expected maximum pulse energy of the laser.

Warning: While measuring pulsing lasers, erroneous energy readings will result if the energy range is not set up correctly.

2. Set **Laser** to the appropriate laser setting. If this sensor is a metallic type and if the wavelength you want is not among the wavelengths listed, select one and press the arrow key that is next to it to open the **Modify** screen. Using the up/down keys to change each number and the right/left keys to move to the next number, key in the wavelength you want. When finished, press the **Enter** key.

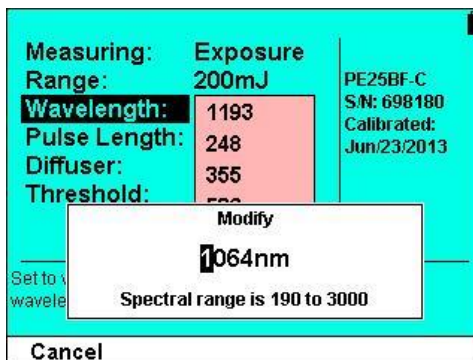


Figure 8-2 Modifying the Laser Setting – Pyroelectric Sensor

- Set **Pulse Length** to the shortest time that is longer than the expected pulse length. Select a shorter pulse length setting for higher frequency lasers. Set a longer pulse length setting for higher energy lasers.

Note: Some sensors have only the one pulse length setting for all pulse lengths. In that case N/A appears.

Warning: Incorrect readings will result if pulse length is not set up correctly.

- Set **Diffuser** to **IN** or **OUT** as physically set on the sensor (relevant for sensors with the **Diffuser** option). Make sure to physically insert/remove the Diffuser before continuing measurements.
- Set **Threshold** as necessary to screen out false triggers due to noise. Set the hardware threshold in the sensor to screen out noise that would otherwise be seen as energy pulses. If the sensor triggers from ambient vibration or noise without a laser signal, raise the **Threshold** level as follows: Use the up/down buttons, raise the threshold until the false triggering stops. If the sensor does not read the pulses at all on the lowest range, try to lower the threshold to minimum.
- Set **Average** to the period you wish to average power over, or set to **NONE** to disable.

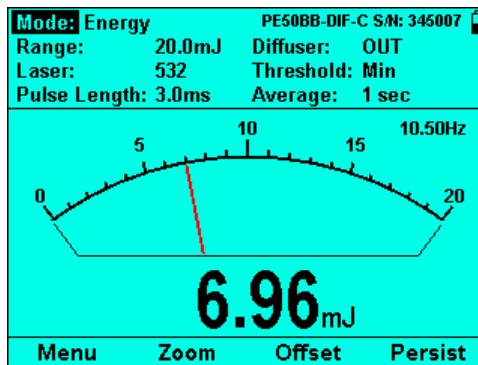


Figure 8-3 Pyroelectric Energy Needle with Average Selection Open

8.4.3 Energy, Average Power, or Exposure Measurement

With the Pyroelectric sensor, 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.

The Pyroelectric sensor is capable of measuring pulses up to very high repetition rates on the order of kilohertz or higher. The StarBright meter will sample pulses at up to 25,000 pulses depending on the sensor. However, the display can only display at rates up to 10Hz.

Note: High-sensitivity Pyroelectric sensors (PE-9, PE-10) are very sensitive to vibration, and therefore might read a false trigger when operating in an acoustically non-stable environment. Set the threshold to a high enough value that false triggering does not occur. Ophir also offers a shock absorbing mounting post (P/N 7Z08268) that helps reduce vibration on the sensor.

8.4.4 Measuring Laser Energy

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

To measure laser energy:

1. Set **Mode** to **Energy**.
2. Set measurement parameters as [described above](#).

“Energy” is displayed on the screen as well as the laser’s frequency, and the units are mJ, μJ, and so on.

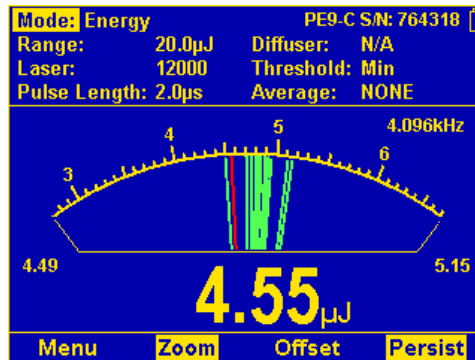


Figure 8-4 Pyroelectric Energy Needle with Persistence

8.4.5 Measuring Average Power

Although the Pyroelectric sensors are designed for energy measurement, they can be used to measure average power as well using the formula:

$$\text{Average Power} = \text{Average Energy} \times \text{Frequency}$$

where the energy and frequency of the pulses have been measured by StarBright.

Note: StarBright use when measuring power is the same as when measuring energy and has been described in full in section [Operation of StarBright with Pyroelectric and Photodiode Energy Sensors](#).

To measure average power:

1. Set **Mode** to **Power**.
2. Set measurement parameters as [described above](#).

Average power will be displayed as a function of “Energy x Frequency” on the screen as well as the laser’s frequency.

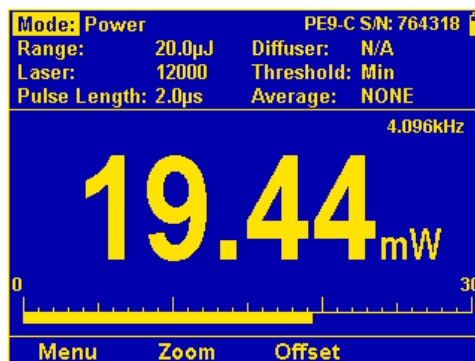


Figure 8-5 Pyroelectric Power Bargraph

8.4.6 Measuring Total Energy Exposure

For Pyroelectric sensors, measuring total energy exposure is implemented as the summing of energy measurements of laser pulses until a predetermined stop condition is reached.

To measure total energy exposure:

1. Set **Mode** to **Exposure**.
2. Set measurement parameters as [described above](#).
3. Set **Stop Mode** to **Manual**, **Timeout** period, or **Pulse** count.

Accumulated laser energy exposure will be displayed on the screen, as well as elapsed time and number of pulses measured.

4. To stop exposure measurement before the chosen period, press **Stop**.
5. To reset the reading to zero before another reading, press **Reset**.
6. To return to the main energy measurement screen, set **Mode** to **Energy**.

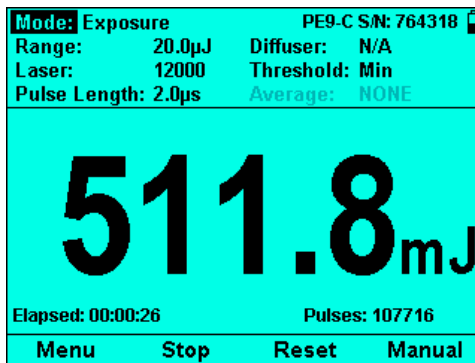


Figure 8-6 Pyroelectric Exposure Measurement

9 Graphical Displays

The StarBright has a robust variety of customizable graphical displays for measuring, presenting, and reading data.

The StarBright 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. You can choose to [show or hide](#) measurement parameters, and you can customize the [color scheme](#) and [bargraph style](#).

This section describes the graphical displays available for presenting StarBright measurement data, how to use and customize them, and related functionality. (For a quick introduction, see [Table 3-3](#).)

Topics include:

- Display Settings
- Graph Types:
 - Power and Energy** mode graphs include:
 - [Bargraph](#)
 - [Analog Needle](#)
 - [Line Graph](#)
 - [Statistics](#)
 - [Pass/Fail](#)
 - [Pulse Chart](#)
 - Exposure** mode graphs include:
 - [Exposure](#)
 - Track** mode graphs (for BeamTrack sensors) include:
 - [Position](#)
 - [Stability](#)
- Other Display Settings:
 - [Show/Hide Settings](#)
 - [Color Scheme](#)

9.1 Display Settings

Figure 9-1 below shows the **Display** settings screen, where you can set the display of the main StarBright measurement screen to present the data in a variety of graphical formats when connected to a particular sensor. You can access this screen by pressing **Menu > Display**.

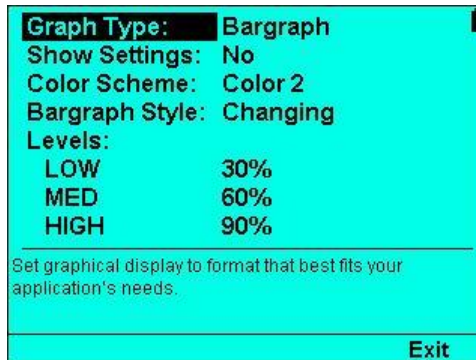


Figure 9-1 Display Settings

Table 9-1 below describes the settings (click the links to view more details).

Table 9-1 Display Settings

Parameter	Description
Graph Type	<ul style="list-style-type: none"> • Bargraph: Ruler-like display that presents measurements on a graduated scale. • Needle: Simulated analog needle. • Line: Graphs laser output as a function of time. • Statistics: Large, numeric display with statistics. • Pass/Fail: Tests for measurements outside the user-defined range of acceptable readings. • Exposure: Sum of the total energy of a series of measurements. For sensors in exposure mode only. • Pulse Chart: Displays readings as bars with lengths proportional to the measurement. Not time based. • Position: In addition to power, shows the position and size of the laser beam as measured by the sensor. For BeamTrack sensors only. • Stability: Historical tracking of the position over time. For BeamTrack sensors only.
Show Settings	Set to Yes to show the measurement parameters while measuring. Set to No to hide them.
Color Scheme	Set to full color functionality or to the monochrome color pair that best matches the protective goggles in use.
Bargraph Style, Levels	For enhanced functionality when in full color mode. When set to Changing , the color of the bargraph and the digital readout changes per the Level percentage settings for LOW , MED , HIGH .

9.2 Bargraph

The Bargraph is a ruler-like display in which the graph is filled proportionally to the reading's being a percentage of full scale. It presents measurements on a graduated scale, and is available when measuring laser power or energy.

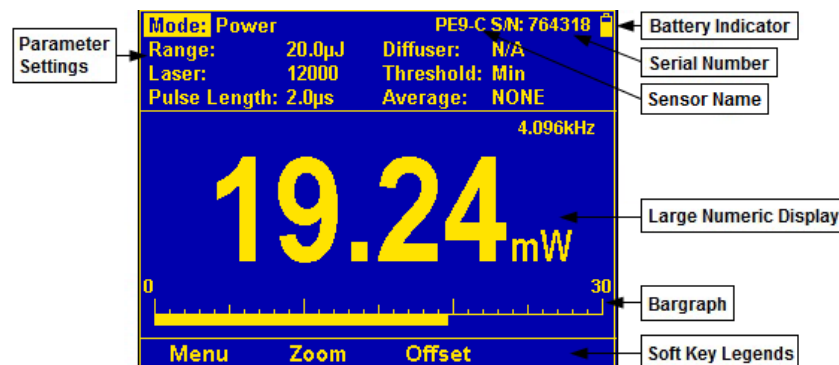



Figure 9-2 Pyroelectric Power Bargraph

The Bargraph display comprises the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator  at the top of the screen.
- Large numeric display shown prominently in the middle of the screen.
- Bargraph displayed close to the bottom.
- Soft key legends at the bottom of the screen.

To present measurements on a graduated scale (bargraph):

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Bargraph**. Return to the main display screen.
3. To expand the bargraph scale $\pm 5x$ of the present reading, press the **Zoom** key. Press **Zoom** again to return the bargraph to full scale. For more details, see [Zoom](#).
4. To subtract the background and set the current reading to zero, press the **Offset** key. Press **Offset** again to cancel. For more details, see [Offset](#). See also [Measuring Loss Using the dB Offset Function](#).

9.2.1 Modes

The **Modes** that a Bargraph can be used with include:

- Power
- Energy
- Pulsed Power

9.2.2 Zoom

The **Zoom** function can be useful for laser power tuning and peaking. Small fluctuations in energy are more easily seen in this mode.

Press the **Zoom** soft key to focus the Bargraph on the present reading. The Bargraph will show 20% of the full scale centered on the present reading. Thus, if the full scale of the Bargraph is 20 Joules, and your reading is 15 Joules, pressing **Zoom** will make the Bargraph scale range between approximately 13 and 17 Joules.

The legend is highlighted when **Zoom** is active (see Figure 9-4 on the right below). Note that the fiducial marks of the Bargraph are further apart, indicating that **Zoom** is engaged.

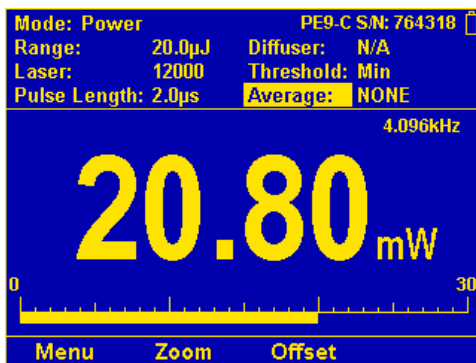


Figure 9-3 Pyroelectric Power Bargraph

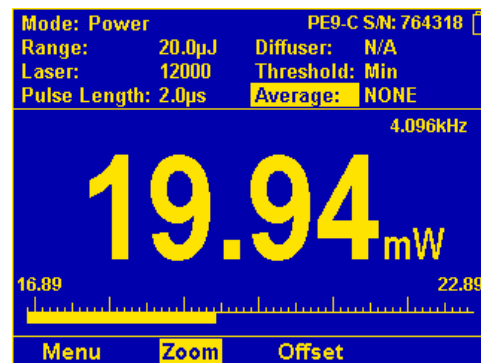


Figure 9-4 Pyroelectric Power Bargraph with Zoom

Press the **Zoom** key again to return to the unexpanded Bargraph display.

9.2.3 Offset

The **Offset** function can be used to subtract the background and set the current reading to zero.

For Thermopile and Photodiode Sensors Measuring Power

The PD300 and PD300-3W sensors have automatic background. The **Offset** function can be used to subtract the residual background signal that remains, if desired. The same holds true when the ambient environment has a thermal background, such that StarBright shows a nonzero power reading even when there is no laser, you can subtract the background using the **Offset** function. For example, the StarBright 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 StarBright 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.

For Photodiode Sensors Measuring Exposure

Background noise that affects power measurement will affect exposure as well. To overcome this, perform the following steps:

1. Enter **Power** mode.
2. Block the laser/light source under measurement and press the **Offset** key. This will activate the offset feature. When active, the **Offset** key is reverse highlighted and the offset that is being subtracted is shown in the upper right part of the screen.
3. Set the **Mode** to **Exposure**.
4. The Offset stored in the Power screen will be subtracted in order to provide accurate Exposure measurements.

The legend is highlighted when **Offset** is active (see Figure 9-6 on the right below). The offset that is being subtracted is shown on the upper left part of the screen (right above the numeric display).

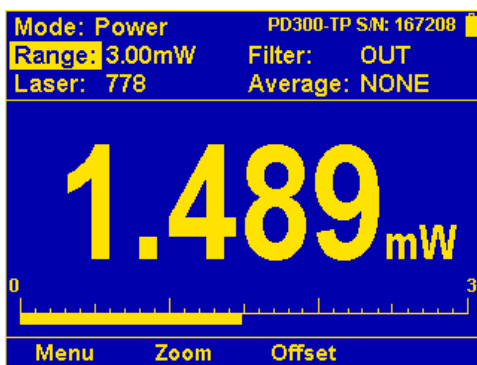


Figure 9-5 Photodiode Bargraph

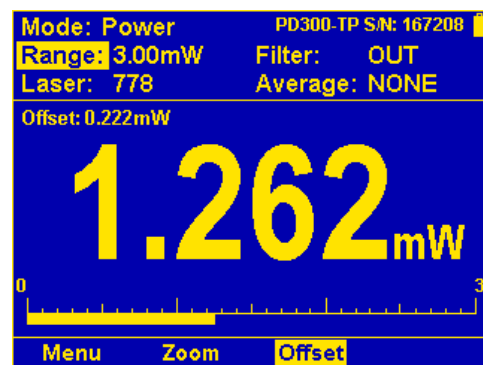


Figure 9-6 Photodiode Bargraph with Offset

To deactivate, 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 StarBright has a permanent zero offset, the instrument's internal zero should be reset. See [Zero Adjustments](#).

For Thermopile Sensors Measuring Single-Shot Energy and for Energy Sensors

Unlike power, offset subtraction is not necessary to achieve accurate energy measurements. However, Offset can be used to facilitate comparison between readings. For example, the first laser pulse is 1 Joule. To subtract this from future readings, press the **Offset** key. If the next pulse is actually 3 Joules, 2 Joules will be displayed on the screen, thereby indicating the difference between the two laser pulses.

9.2.4 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 1mW = 0dBm and the measurement after the cable is 0.1mW = -10dBm. The ratio is then 1:10 = 0.1 and the dB loss is 0 - (-10) = 10dB.

The dB offset function allows you to easily measure this.

To measure loss using the dB Offset function:

1. When measuring the reference value, press the “dB Offset” key.
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 Offset setting to measure true ratio without zero offset problems.

9.2.5 Bargraph Style

In addition to the large digital readout, on the main power screen of the StarBright 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 (for example, when the **Color Scheme** is set to Color 1 or Color 2). 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, thereby allowing you to use the colors of the bargraph display as a type of pass/fail mechanism. (You can also set the bargraph style to “Standard” for a simple bargraph.)

The following topics describe how to set the Bargraph Style options:

- Changing
- Standard

Changing

Set the **Bargraph Style** to **Changing** for a bargraph with color that changes according to the present reading as percentage of full scale. You can modify the levels. (The default levels are LOW=30%, MED=60%, High=90%.)

To set the bargraph style to Changing:

1. Press **Menu** and enter **Display**. (When **Color Scheme** is set to full color (**Color 1** or **Color 2**), then the **Bargraph Style** option is enabled for editing.
2. Go to **Bargraph Style** and select **Changing**.



Figure 9-7 Bargraph Style Set to Changing

- Set the **Levels** as needed. Select each **LOW, MED, HIGH**, press the **Enter** key to display the relevant window in which you can change the percentage using the up/down Navigation keys. (The default levels are LOW=30%, MED=60%, High=90%.) For example, see the “Low” window in Figure 9-8 below:

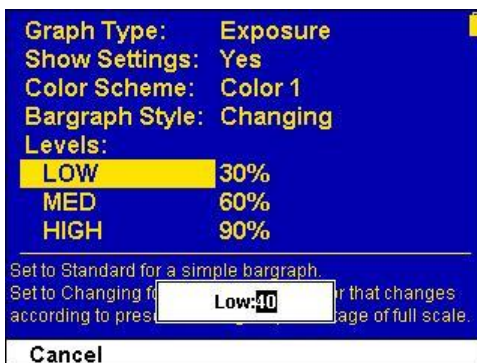


Figure 9-8 Changing Low to 40%

- Press the **Enter** key to save the setting. Figure 9-9, Figure 9-10, Figure 9-11, and Figure 9-12 below show sample colored bargraph power readings, indicating:
 - Green:** less than 30% full scale
 - White:** 30% to 60% full scale
 - Yellow:** 60% to 90% full scale
 - Red:** greater than 90% full scale

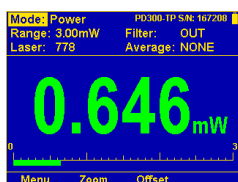


Figure 9-9 Bargraph Green < 30% Full Scale

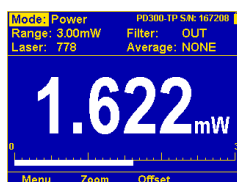


Figure 9-10 Bargraph White 30% to 60%

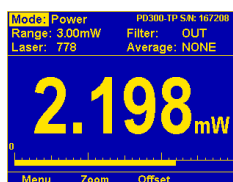


Figure 9-11 Bargraph Yellow 60% to 90%

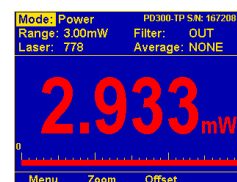


Figure 9-12 Bargraph Red > 90%

Standard

You can set the **Bargraph Style** to **Standard** for a simple bargraph in full scale, using the procedure above. Select **Standard** instead of **Changing**. (The **Levels** options are disabled.)



Figure 9-13 Bargraph Style Set to Standard

Figure 9-14 below shows “Standard” display results.

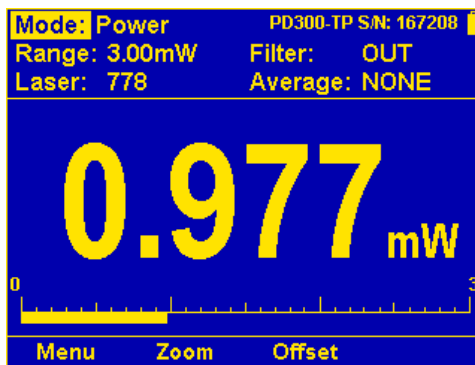


Figure 9-14 Standard Display Results

9.3 Analog Needle

The Needle graph simulates an analog display, similar to the style of an analog voltmeter or a car’s speedometer. By making use of the persistence feature, you can know what the full range of measurements actually is, including the maximum and minimum readings of the present set of measurements.

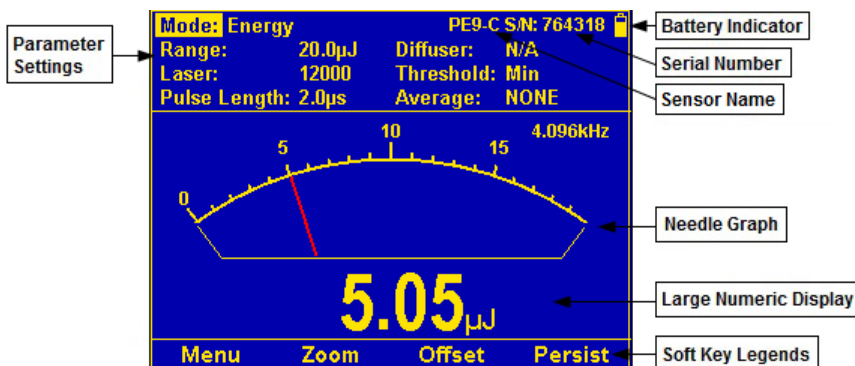


Figure 9-15 Pyroelectric Energy Needle Display

The Needle graph display comprises the following components:

- Parameter settings, the sensor’s name and serial number, and battery status indicator at the top of the screen.
- Needle graph displayed prominently in the middle of the screen.
- Large numeric display.
- Soft key legends at the bottom of the screen (for example, Menu, Zoom, Offset, Persist).

To simulate an analog needle:

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Needle**. Return to the main display screen.
3. To expand the needle graph $\pm 5x$ of the present reading, press **Zoom**. Press **Zoom** again to return the needle range to full scale.
4. To subtract the background and set the current reading to zero, press **Offset**. Press **Offset** again to cancel. For further details, see [Offset](#).
5. Press **Persist** to keep older measurements on the screen and to display numerically the **Min** and **Max** values measured. Press **Persist** again to cancel.

9.3.1 Modes

The **Modes** that Needle displays can be used with include:

- Power
- Energy
- Pulsed Power

9.3.2 Persist

The persistence feature enables you to identify what the full range of measurements actually is, including the maximum and minimum readings of the present set of measurements.

Press the **Persist** key to continue to display previous readings as well as to show the minimum and maximum measurements.

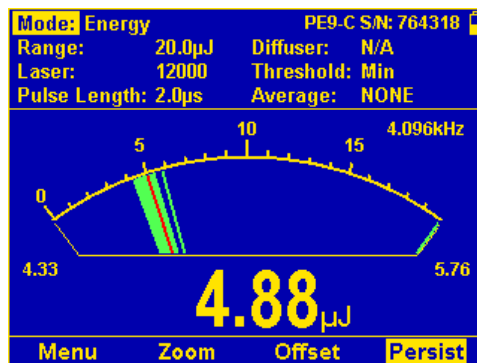


Figure 9-16 Pyroelectric Energy Needle with Persistence

9.4 Line Graph

The Line graph displays the laser output as a function of time. This is useful for technicians performing laser alignment (laser tuning) that want to see the results of their experimenting graphically as well as to be shown the maximum laser power attained. This graph is time-based and

most applicable when there is a continuous stream of data. The Line graph can be used with any sensor that measures power or energy.

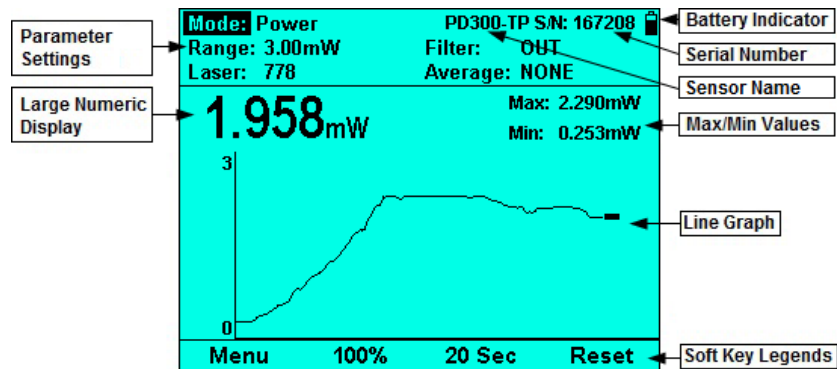


Figure 9-17 Photodiode Power Line Graph

The Line graph display comprises the following components:

- Parameter settings, the sensor’s name and serial number, and battery status indicator at the top of the screen.
- Max and Min values on upper right above the Line graph.
- Large numeric display above the Line graph.
- Line graph displayed prominently in the middle of the screen. The cursor at the tip of the graphical measurement stream shows where the next reading will be displayed.
- Soft key legends at the bottom of the screen (for example, Menu, Percentage Range (Y-Axis), Horizontal Sweep Time (X-Axis), Reset).

To graph laser output over time:

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Line**. Return to the main display screen.
3. Set the percentage range of the scale Line to be displayed to the desired setting.
4. Set the horizontal sweep (X-Axis) time as necessary.
5. Press **Reset** to clear the **Min/Max** tracking and to restart the graph.

9.4.1 Modes

The **Modes** that Line graphs can be used with include:

- Power
- Energy
- Pulsed Power

9.4.2 Percentage Range (Y-Axis Scale)

Adjusting the Y-axis scale allows you to set the focus of the graph. For example, if the laser is changing radically set the scale to 100%, if barely changing, set the scale to 10%.

Press the percentage key to set the Y-Axis Scale to one of the following:

- $\pm 10\%$, $\pm 50\%$: The initial reading is displayed halfway up the graph's height. The scale of the graph will be 90% - 110%, or 50% - 150% of the initial reading. If the reading goes out of that range, then the graph will be rescaled around the present reading.
- 100%: Graph is scaled to the measurement range.

The following figures show how the different Percentage Range settings impact the Y-axis of the Line Graph:

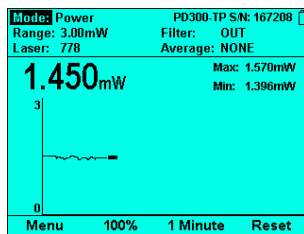


Figure 9-18 100% - Line Graph

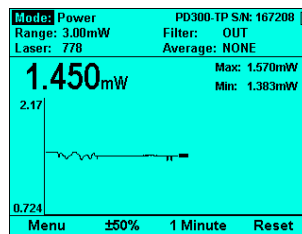


Figure 9-19 $\pm 50\%$ - Line Graph

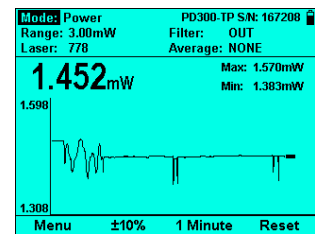


Figure 9-20 $\pm 10\%$ - Line Graph

9.4.3 Horizontal Sweep Time (X-Axis Scale)

Adjusting the X-axis (horizontal sweep time) allows you to select how much data is displayed on the screen before it wraps around to the beginning.

Press the time key to set the Y-Axis Scale to the desired setting.

The following figures show how the different Horizontal Sweep Time settings impact the X-axis of the Line Graph:

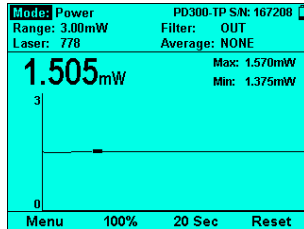


Figure 9-21 20 Seconds

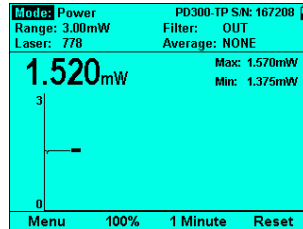


Figure 9-22 1 Minute

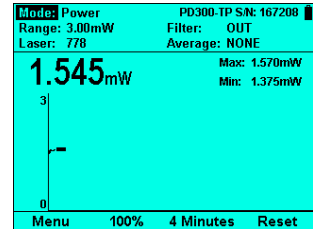


Figure 9-23 4 Minutes

9.4.4 Reset

Press **Reset** to clear the **Min/Max** tracking and to restart the graph.

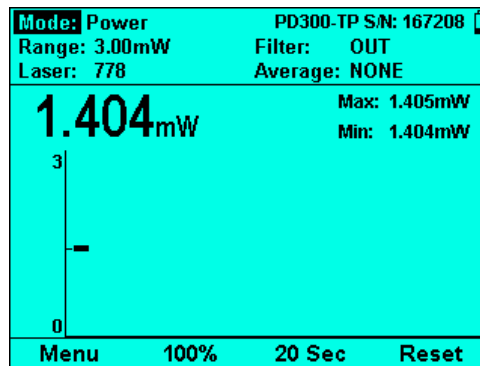


Figure 9-24 Resetting the Line Graph

9.5 Statistics

The Statistics display is ideal for users that want a large numeric display without any graphics that may be seen as cluttering the display. Measurement statistics are also displayed. Statistics displays are available when measuring power or energy.

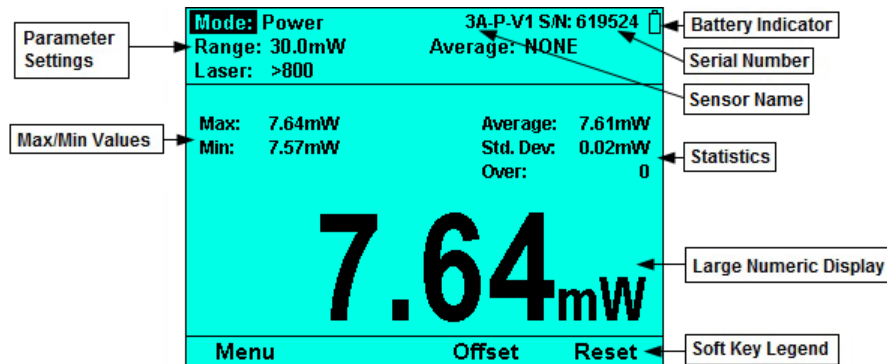


Figure 9-25 Thermopile Power Statistics

The Statistics display comprises the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- Max, Min, Average, Standard Deviation, and Over values on upper left and right above graph.
- Large numeric display.
- Soft key legends at the bottom of the screen (for example, Menu, Offset, Reset).

To display real-time statistics:

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Statistics**. Return to the main display screen.
3. Displays **Maximum**, **Minimum**, **Average**, **Standard Deviation**, **Total** readings, and number **Over** range.
4. To subtract the background and set the current reading to zero, press the **Offset** button. Press **Offset** again to cancel. For further details, see [Offset](#).
5. Press **Reset** to clear the statistics.

9.5.1 Modes

The **Modes** that Statistics displays can be used with include:

- Power
- Energy
- Pulsed Power

9.6 Pass/Fail

The Pass/Fail graph tests for measurements outside the user-defined range of acceptable readings. It has configurable upper and lower limits. This graph is useful for final inspection testing, other aspects of Production Q/A, or field inspection of equipment.

If the measurement is out of range, “OVER” or “UNDER” will be displayed on the screen. If the Color Scheme has been set to one of the full color options, then this will be displayed in Red, along with the reading itself. When the measurements are within range, the display will be normal, with the results shown in Green (as shown in the middle [Figure 9-27 below](#)).

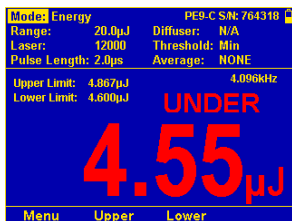


Figure 9-26 Pyroelectric Pass/Fail Under

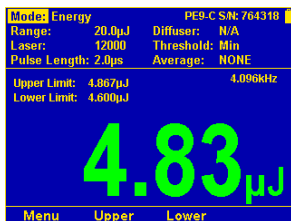


Figure 9-27 Pyroelectric Pass/Fail in Range



Figure 9-28 Pyroelectric Pass/Fail Over

The Pass/Fail display comprises the following components:

- Parameter settings, the sensor’s name and serial number, and battery status indicator at the top of the screen.
- Upper limit, Lower Limit on upper left above the graph.
- Out-of-range warning (OVER/UNDER) on upper right above the graph.
- Large numeric display.
- Soft key legends at the bottom of the screen (for example, Menu, Upper, Lower).

To set pass/fail tracking:

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Pass/Fail**. Return to the main display screen.
3. Press the **Upper** and **Lower** buttons to set tolerance limits. If reading is out of range, an appropriate warning will be displayed on the screen.

9.6.1 Modes

The **Modes** that Pass/Fail displays can be used with include:

- Power
- Energy
- Pulsed Power

9.6.2 Upper/Lower Limits

You can set the Upper and Lower Limits for passing measurements. The initial default Upper Limit is the maximum of the present range, and the initial default Lower Limit is 0 (until the first time both values are set to something else).

To set the Upper and Lower Limits:

1. Press the **Upper** or **Lower** key. The respective **Modify Upper/Lower Limit** window opens (see [Figure 9-29 below](#)).
2. Use the right and left Navigation keys to select the digit to update, including the exponent (E+00).
3. Use the up/down Navigation keys to set the select digit to the desired value. (The limits can be set from -9999 to 9999 E -15 to E +12.)

If the measurement is out of range, "OVER" or "UNDER" will be displayed on the screen. If the Color Scheme has been set to one of the full color options, then this will be displayed in RED, along with the reading itself (as shown in [Figure 9-29 below](#)).

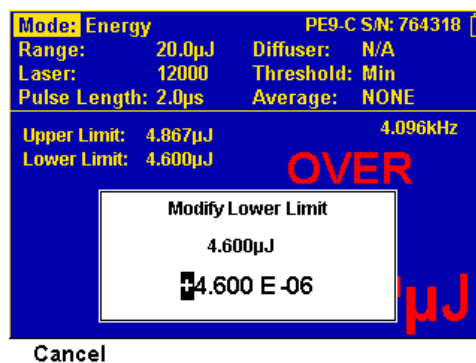


Figure 9-29 Pyroelectric Pass/Fail - Modify Upper Limit

9.7 Exposure (for Pyroelectric Sensors)

The Exposure display shows the sum of the total energy of a series 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 $30 \times 1 \times 20 = 600\text{mJ}$. The Exposure graph is available when measuring exposure with Pyroelectric sensors.

Note: When switching measurement mode out of Exposure, the graphic display will be changed automatically to the previously defined graphical display.

[Figure 9-30 below](#) shows a sample Pyroelectric Sensor Exposure graph, where you can configure **Mode**, **Range**, **Laser** setting, **Pulse Length**, **Diffuser**, and **Threshold** settings, as described in [Setting](#)

Measurement Parameters When Using Energy Sensors and Measuring Total Energy Exposure. See also [Manual/Timeout/Pulses](#).

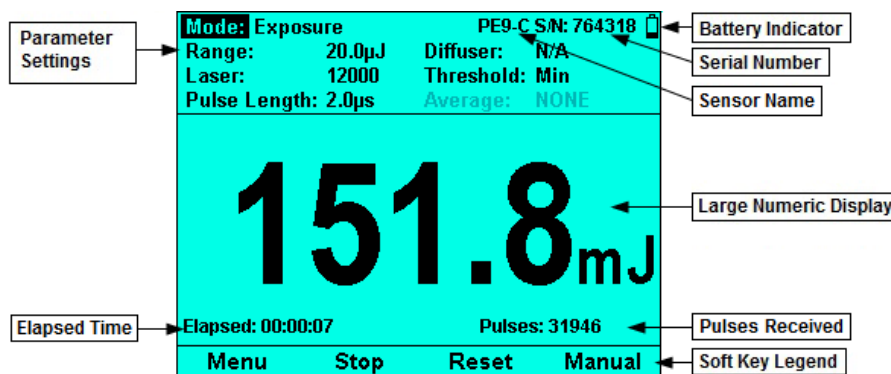


Figure 9-30 Pyroelectric Exposure Measurements

The Exposure display comprises the following components:

- Parameter settings, the sensor's name and serial number, and battery status indicator at the top of the screen.
- Total exposure (large numeric display) displayed prominently in center of screen.
- Elapsed time on lower left.
- Pulses received on lower right.
- Soft key legends at the bottom of the screen (for example, Menu, Start/Stop, Manual, Reset).

To set total energy exposure over a given time period or number of pulses:

1. When using a Pyroelectric sensor, in **Exposure** mode, the graph type is "**Exposure**" (no need to set it).
2. Configure the settings, as described in [Measuring Total Energy Exposure](#).
3. Press **Start/Stop** to manually start or stop the exposure measurement.
4. Press **Manual** (the rightmost soft key) and use the Navigation keys to select the options to end the exposure measurement (see [Manual](#), [Timeout](#), [Pulses](#)).
5. Press **Reset** to stop the exposure measurement and reset the total, pulse counter, and elapsed time to 0.

9.7.1 Modes

The only **Mode** that Exposure displays can be used with is:

- Exposure

9.7.2 Manual/Timeout/Pulses

Press **Manual** (the rightmost soft key) to display the Exposure End menu. Use the up ↑ /down ↓ and left ← /right → Navigation keys to select the options to end the exposure measurement:

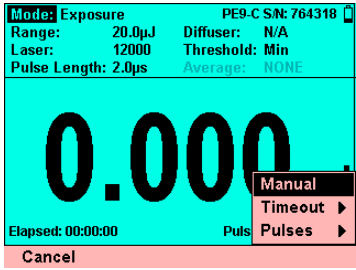
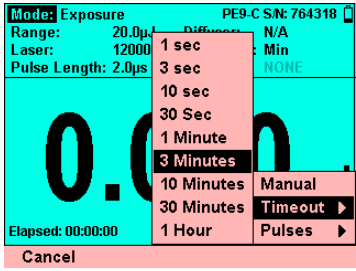
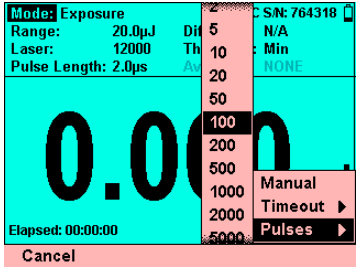
Option	Description	Sample Figure
Manual	Stops exposure measurement by the user pressing the Stop key.	 <p>The screenshot shows a device display with a cyan background. At the top, it displays 'Mode: Exposure' and 'PE9-C SN: 764318'. Below that, it shows 'Range: 20.0µJ', 'Diffuser: N/A', 'Laser: 12000', 'Threshold: Min', and 'Pulse Length: 2.0µs', 'Average: NONE'. The main display area shows '0.000'. At the bottom, it says 'Elapsed: 00:00:00' and 'Puls'. A menu is open on the right side with 'Manual' selected, and other options are 'Timeout' and 'Pulses'. A 'Cancel' button is at the bottom.</p>
Timeout	Stops after the specified time has elapsed (as shown on the key legend). You can select: 1 second, 3 seconds, 10 seconds, 30 seconds, 1 minute, 3 minutes, 10 minutes, 30 minutes, or 1 hour. Will also stop by the user pressing the Stop key.	 <p>The screenshot shows the same device display as Figure 9-31. The menu is open, showing time options: '1 sec', '3 sec', '10 sec', '30 Sec', '1 Minute', '3 Minutes' (selected), '10 Minutes', '30 Minutes', and '1 Hour'. The 'Manual', 'Timeout', and 'Pulses' options are also visible in the menu.</p>
Pulses	Stops after the specified number of pulses has arrived (as shown on the key legend). You can select: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, or 5000. Will also stop by the user pressing the Stop key.	 <p>The screenshot shows the same device display as Figure 9-31. The menu is open, showing pulse count options: '5', '10', '20', '50', '100' (selected), '200', '500', '1000', '2000', and '5000'. The 'Manual', 'Timeout', and 'Pulses' options are also visible in the menu.</p>

Figure 9-31 Manual Option Selected

Figure 9-32 Timeout Options

Figure 9-33 Pulse Options

9.7.3 Exposure for Photodiode Sensors

Exposure can be measured with Photodiode sensors as well. The following are the differences between measuring Exposure with Pyroelectric Energy Sensors and Photodiode Sensors:

- Photodiode sensors actually measure power and sum the results into energy.
- There is no After Pulses option with Photodiode Sensors.

9.8 Pulse Chart

The Pulse Chart displays a graph of pulses as they occur, whereby it shows the number of pulses on the screen. The readings are shown as bars with lengths proportional to the measurement. This is useful for technicians performing laser alignment (laser tuning) that want to see the results of their experimenting graphically as well as to be shown the maximum laser power attained. This graph is

not time-based and most applicable when the data flow is not necessarily periodic. This display is ideal when measuring low frequency lasers. The Pulse Chart can be used with any sensor that measures power or energy.

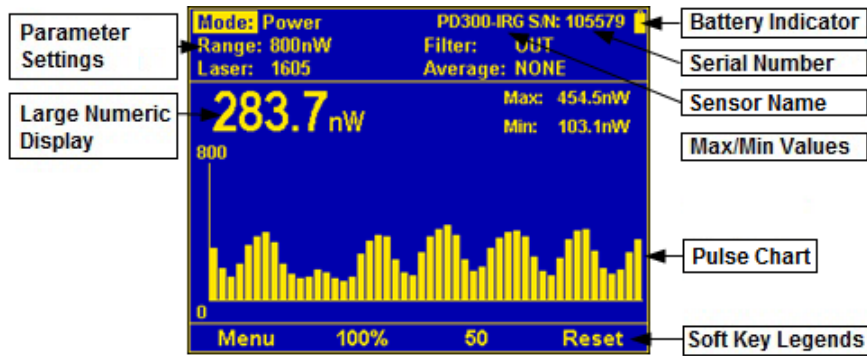


Figure 9-34 Photodiode Pulse Chart

The Pulse Chart display comprises the following components:

- Parameter settings, the sensor’s name and serial number, and battery status indicator at the top of the screen.
- Max and Min values on upper right above the Pulse Chart.
- Large numeric display above the Pulse Chart.
- Pulse Chart displayed prominently in the middle of the screen. Displays a graph of pulses as they occur (shows the number of pulses). When the graph reaches the end of the screen, it continues at the last point shifting previous readings to the left and no longer showing the least recent measurement. The readings are shown as bars with lengths proportional to the measurement.
- Soft key legends at the bottom of the screen (for example, Menu, Percentage Range (Y-Axis), Number of Pulses, Reset).

To graph laser output in pulse chart form:

1. In **Power**, **Energy**, or **Pulsed Power** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Pulse Chart**. Return to the main display screen.
3. Set the percentage range of the Y-scale to be displayed to the desired setting. (For more details, see [Percentage Range \(Y-Axis Scale\)](#).)
4. Set the number of pulses as required.
5. Press **Reset** to clear the **Min/Max** tracking and to restart the graph. (For more details, see [Reset](#)).

9.8.1 Modes

The **Modes** that Pulse Charts can be used with include:

- Power
- Energy
- Pulsed Power

9.9 Position (for BeamTrack Sensors)

The BeamTrack line of sensors are Thermopile sensors that can measure beam position and beam size while measuring power. The BeamTrack sensor works as follows: the signal coming from the sensor is divided into 4 quadrants so by measuring and comparing the output from the 4 sections you can determine the position of the center of the beam to a high degree of accuracy. In addition to the 4 quadrants, there is a special patented beam size detector. After processing outputs from these various detectors, the user is presented with the beam position as well as beam size. Note that the beam size is calibrated only for Gaussian beams but for other beams it will give relative size information and will indicate if the beam is changing size.

This section describes the StarBright’s position and size measurement functionality. This is available in the **Track** screen, which shows the position of the laser beam as measured by the sensor. If the beam is close enough to the center and the sensor is capable of size measurement, then the laser beam will be displayed as a spot drawn to scale. Otherwise, the location will be displayed as an X.

Figure 9-35 below shows a sample BeamTrack Sensor Position graph, where you can configure **Mode**, **Range**, **Laser** setting, and **Average** settings, as described in [BeamTrack Sensors](#). See also [Offset](#).

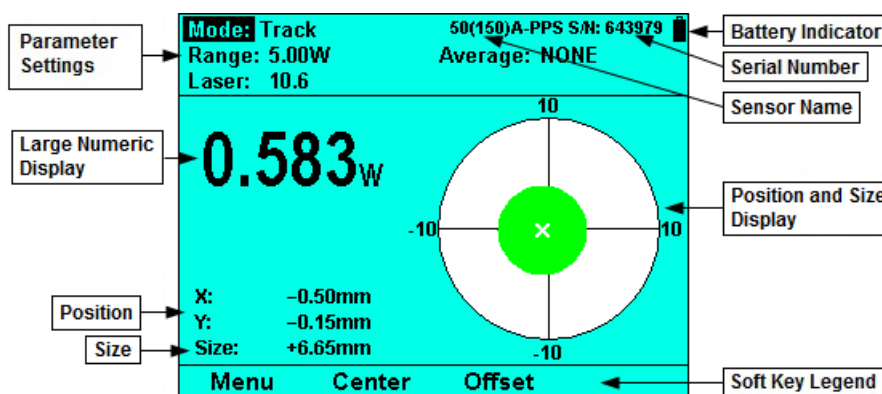


Figure 9-35 BeamTrack Position and Size Display

The Position display comprises the following components:

- Parameter settings, the sensor’s name and serial number, and battery status indicator at the top of the screen.
- Numeric display of power, (XY) position, and size along the left side of the screen.
- Position and size displayed graphically along the right side of the screen.
- Soft key legends at the bottom of the screen (for example, Menu, Center, Offset).

The following procedure describes how to track power and size measurement using a BeamTrack sensor in Track mode.

To track laser beam position and size (BeamTrack sensors only):

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Position**. Return to the main display screen.
3. Press **Center** to center the laser beam and to set the present Spot Position as {0, 0}. Later position measurements will be displayed relative to the new origin. Due to physical limitations of the BeamTrack sensors, size measurement remains available at or near the true origin only.

When activated, the crosshairs will move to the center of the spot and the graph limits will no longer be displayed.
4. Press **Offset** to subtract the background noise from the power measurement.

9.9.1 Modes

The only **Mode** that Position displays can be used with is:

- Track

9.10 Stability (for BeamTrack Sensors)

The Stability display tracks the position of the laser beam over time. This is useful for users that want to measure the pointing stability of their laser. This display is available for BeamTrack sensors (Thermopile sensors with additional circuitry for measuring position and size) with the Measurement mode set to **Track**.

Figure 9-36 below shows a sample BeamTrack Sensor Position graph, where you can configure the **Measuring** setting, as described in [BeamTrack Sensors](#).

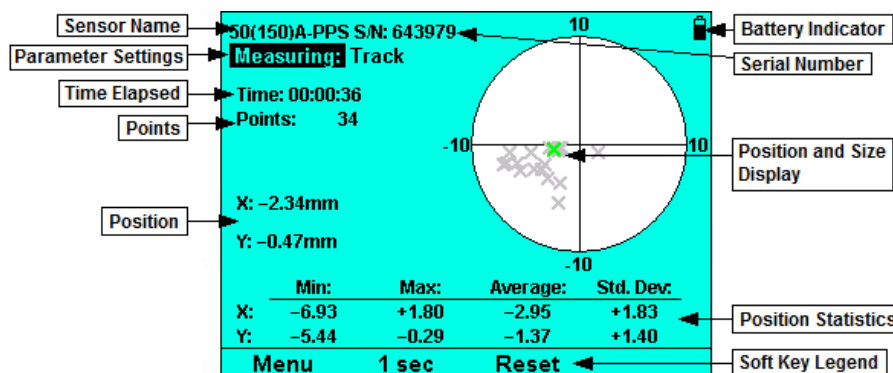


Figure 9-36 BeamTrack Stability Display

The Stability display comprises the following components:

- Sensor's name and serial number, parameter settings, and battery status indicator at the top of the screen.
- Time elapsed (on upper left) is the time that has passed since the start of this stability measurement session.
- Points (on the upper left) are the number of position readings that were taken in this measurement session.
- Numeric display of (XY) position along the left side of the screen.
- Position and size displayed graphically along the right side of the screen.
- Min, Max, Average, Standard Deviation per (XY) position

- Soft key legends at the bottom of the screen (for example, Menu, Rate, Reset).

The following procedure describes how to track power and size measurement using a BeamTrack sensor in Track mode.

To track laser beam position over time (historical tracking, for BeamTrack sensors only):

1. When in **Track** mode, press **Menu** and enter **Display**.
2. Go to **Graph Type** and select **Stability**. Return to the main display screen.
3. Press the rate key (the second key from the left) to set the rate of data collection (Options include: **1, 3, 10, 30 seconds** or **1 minute**).
4. Press **Reset** to reset the time scale, the graph, and the statistics displayed.

9.10.1 Modes

The **Mode** that Stability displays can be used with is:

- Track

9.11 Other Display Settings

Additional display settings include:

- Show/Hide Settings
- Color Scheme

9.11.1 Show/Hide Settings

You can choose whether to show or hide the sensor settings that are displayed at the top of the measurement screens.

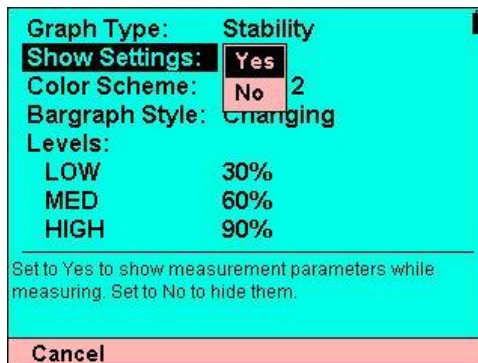


Figure 9-37 Show Settings

To show/hide sensor measurement parameters:

1. Connect the sensor.
2. Press the **Menu** button, and use the Navigation keys to select **Display** and press the **Enter** key.
3. Use the Navigation keys to select **Show Settings** and press the **Enter** key.
4. Select **Yes** to show the settings, or select **No** to hide them.

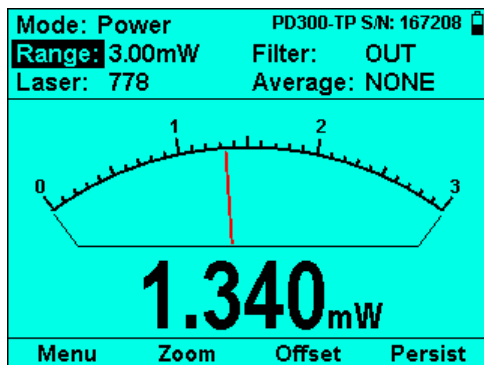


Figure 9-38 Show Sensor Settings

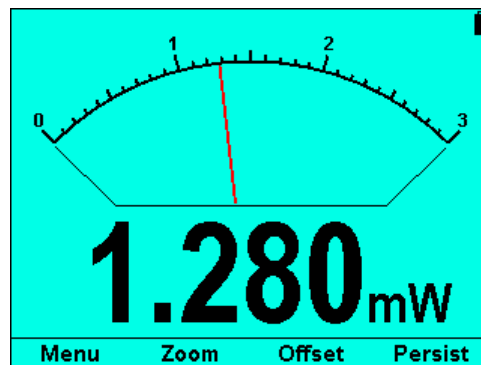


Figure 9-39 Hide Need to replace Mode, Laser, separator line, and any values? Sensor Settings

5. Press the **Enter** key to save the settings.

9.11.2 Color Scheme

You can select the color scheme of the StarBright display. This is especially useful for operation when wearing protective goggles that filter out visible wavelengths.

You can configure the StarBright 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 StarBright in this manual are shown in the various color schemes. For example, the following sensor displays:

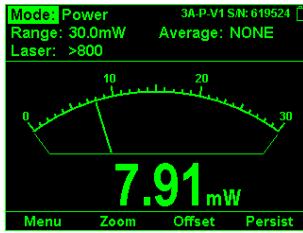


Figure 9-40 Thermopile Sensor (Monochrome)

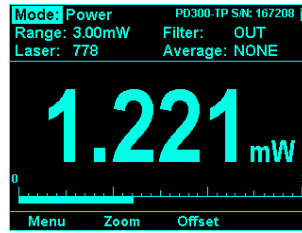


Figure 9-41 Photodiode Sensor (Monochrome)

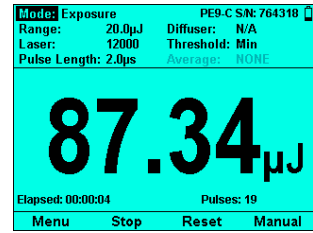
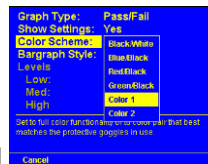


Figure 9-42 Pyroelectric Sensor (Full Color)

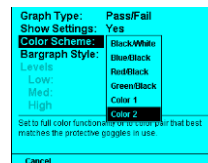
Full Color

To set the color scheme of the main measurement displays to full color:

1. Connect the sensor.
2. Press the **Menu** button, and use the Navigation keys to select **Display** and press the **Enter** key.
3. Use the Navigation keys to select **Color Scheme** and press the **Enter** key.
4. Select the relevant full color scheme option:



- **Color 1:** Yellow text on dark blue background



- **Color 2:** Black text on sky blue background

5. Press the **Enter** key to save the setting.

For both of these full color schemes, warnings will be displayed in red, selection windows (for example, range, average, laser) will be pink, and modification windows will be white.

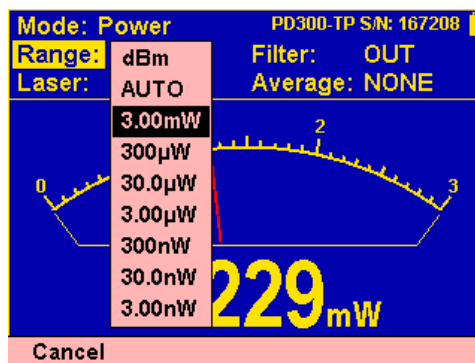
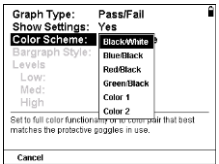


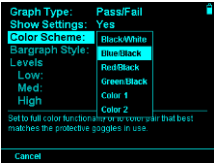
Figure 9-43 Sample Full Color Scheme Display with Pink “Range” Selections (Photodiode Sensor)

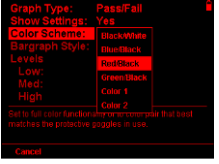
Monochrome

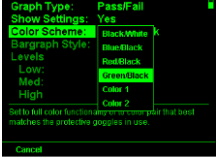
Monochrome schemes are for use with lasers that demand protective glasses that filter out colors in the visible part of the wavelength spectrum. These color schemes apply to *all* of the screens. All color-enhanced features of the StarBright will not be functional in any of the monochrome screens.

Follow the [procedure above to set the color scheme](#) and choose one of the following monochrome schemes:

- 

Graph Type: Pass/Fail
Show Settings: Yes
Color Scheme: Black/White
Bargraph Style: Blue/Black
Levels: Red/Black
Low: Green/Black
Med: Color 1
High: Color 2
Set to full color function whenever possible that best matches the protective goggles in use.
Cancel
- Black/White: Black text on white background
- 

Graph Type: Pass/Fail
Show Settings: Yes
Color Scheme: Blue/Black
Bargraph Style: Blue/Black
Levels: Red/Black
Low: Green/Black
Med: Color 1
High: Color 2
Set to full color function whenever possible that best matches the protective goggles in use.
Cancel
- Blue/Black: Sky blue text on black background
- 

Graph Type: Pass/Fail
Show Settings: Yes
Color Scheme: Red/Black
Bargraph Style: Blue/Black
Levels: Red/Black
Low: Green/Black
Med: Color 1
High: Color 2
Set to full color function whenever possible that best matches the protective goggles in use.
Cancel
- Red/Black: Red text on black background
- 

Graph Type: Pass/Fail
Show Settings: Yes
Color Scheme: Green/Black
Bargraph Style: Blue/Black
Levels: Red/Black
Low: Green/Black
Med: Color 1
High: Color 2
Set to full color function whenever possible that best matches the protective goggles in use.
Cancel
- Green/Black: Green text on black background

See [Figure 9-40](#), [Figure 9-41](#), and [Figure 9-42](#) above which show the sensors in monochrome and full color displays.

10 Math Functions

This section describes how to define and apply math functions to the laser measurements.

Topics include:

- Display on Main Measurement Screen
- Functions Screen
- Average
- Fixed Offset
- Scale Factor
- Normalize
- Density

10.1 Display on Main Measurement Screen



If any functions or pass/fail limits are enabled, then they will all be displayed at the top of the screen. Arrow icons will appear at the top of the display to inform that there is more to be seen. A Right Arrow  (on the upper right) indicates additional functions are available. Pressing the \rightarrow Navigation key displays the Function and Pass/Fail settings. And subsequently the Left Arrow  allows you to return to the previous parameters (by pressing the \leftarrow Navigation key).

Figure 10-1 on the left below shows the main measurement screen, while Figure 10-2 on the right shows the Function and Pass/Fail settings (displayed after the Right Arrow has been pressed).

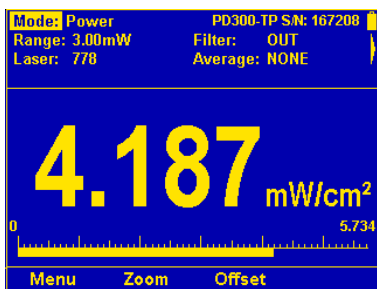


Figure 10-1 Main Measurement Screen
Functions

Click "Right Arrow" to display additional functions and pass/fail settings

Click Left Arrow to display main screen settings

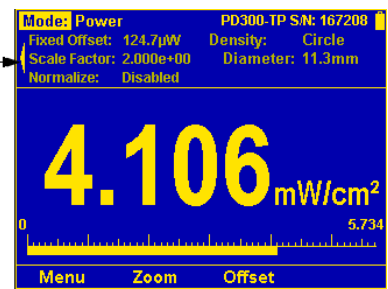


Figure 10-2 Function Settings

Note: For BeamTrack sensors in Track Mode, function settings will apply to the power measurement only.

10.2 Functions Screen

The Functions screen is where you can set up different post processing parameters in order to display the measurement in the way most fitting for your application. All of these settings can be set individually. Also, many of them can be combined. For example, to see the power density of a

laser beam after it has gone through a beam splitter. (In StarBright, these factors can be kept and applied in the graphical displays as well.)

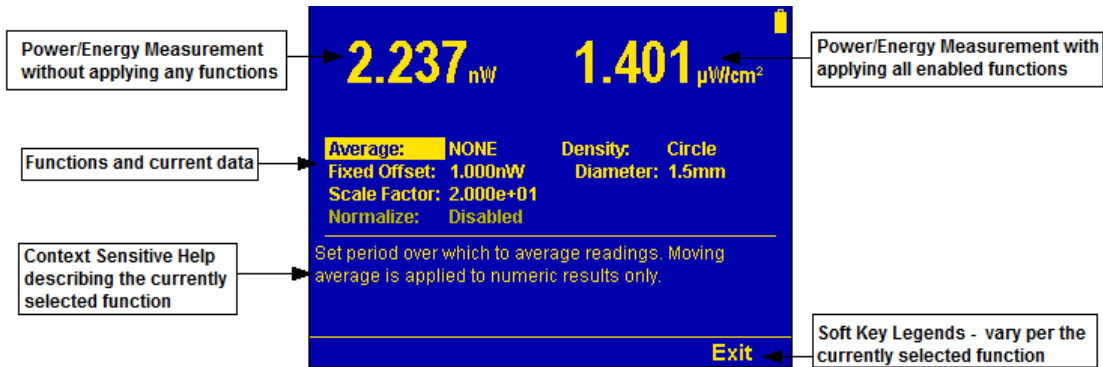


Figure 10-3 Functions Screen

The Functions screen comprises the following components:

- Top left of screen displays the power/energy measurement without applying any of the functions.
- Top right of screen displays the power/energy measurement with applying all of the functions that have been enabled.
- Middle third displays all of the functions and their present status.
- Bottom of screen displays context sensitive help describing the currently selected function.
- Soft key legends that vary per the currently selected function.

This section describes the available math functions:

- Average: how to set the time period for average power readings.
- Fixed Offset: how to apply a fixed offset to measurements.
- Scale Factor: how to apply a scale factor to measurements.
- Normalize: how to normalize against a reference measurement.
- Density: how to display power/energy density.

10.3 Average

You can set a period over which to average readings. Moving average is applied to numeric results only. This feature is especially useful for lasers with unsteady output. (The average can also be set in the main measurement screen.)

To set a time period for average power readings:

1. Press **Menu** and enter **Functions**.
2. Go to **Average** and select an option to set the **Average** to the period you wish to average power over or set to **NONE** to disable. (This can also be set in the main measurement screen.)

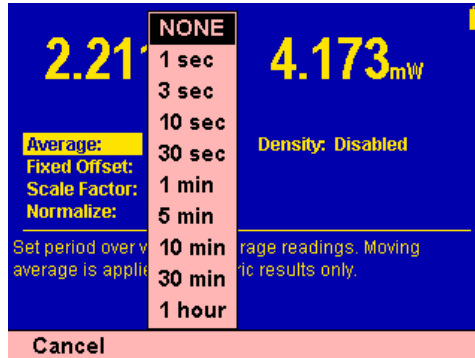


Figure 10-4 Setting the Average

10.4 Fixed Offset

You can define a constant value to subtract from all subsequent power/energy readings.

Note: The Offset value can be set to positive or negative.

To apply a fixed offset to measurements:

1. Press **Menu** and enter **Functions**.
2. Go to **Fixed Offset**.
3. Set the value to subtract from all subsequent measurements.
4. Press **Apply** to set the present value as **Fixed Offset** or press the **Enter** key to define a different value. (Click **Clear** to zero the value.)

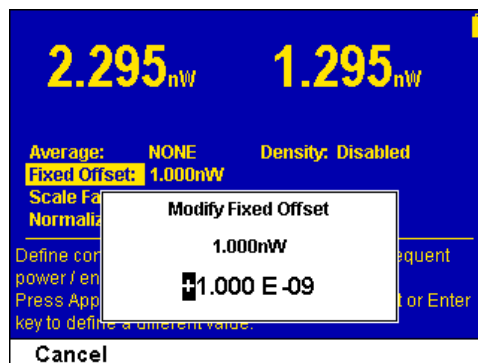


Figure 10-5 Modifying Fixed Offset

10.5 Scale Factor

You can set the factor by which to multiply further measurements. Use this to factor up the value that the sensor has measured. This is very useful when working with beam splitters with sensitive sensors. A typical beam splitter allows about 5% of the laser beam to get through. In such a case, the user would set the Scale Factor to 20 to get the actual output of the laser.

To apply a Scale Factor to measurements:

1. Press **Menu** and enter **Functions**.
2. Go to **Scale Factor**.
3. Set to value by which to multiply all subsequent measurements. Press the **Enter** key. The Scale Factor can be between 0.00001 and 9999 only positive. (Click **Clear** to zero the value.)

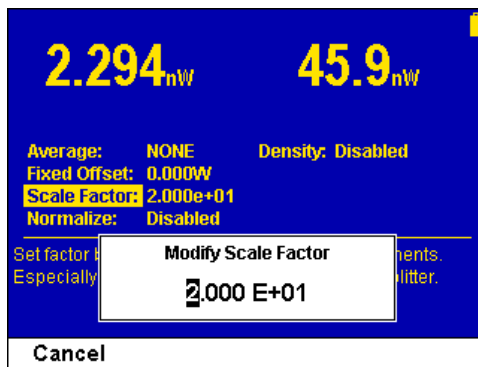


Figure 10-6 Modifying Scale Factor

10.6 Normalize

You can define a baseline against which to compare further power/energy readings.

Note: The **Normalize** option is grayed out if the present range is dBm, or if Density has been set.

To normalize against a reference measurement:

1. Press **Menu** and enter **Functions**.
2. Go to **Normalize**.
3. Set to reference value by which to normalize all subsequent measurements. The reference value can only be positive.
4. Press **Apply** to set the present value as the Normalize reference value or press the **Enter** key to define a different value. When **Normalize** is applied, measurements are displayed

dimensionless; that is to say, without the W or J symbols. They are shown as the result of the present reading/reference value.

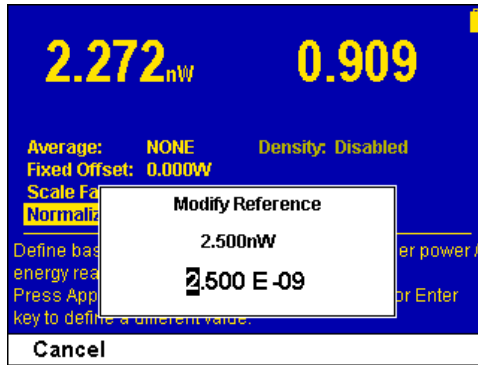


Figure 10-7 Modifying Reference

10.7 Density

You can display power/energy as measured by the sent as W/ cm² based on user-defined laser spot shape and size.

Note: The **Density** option is grayed out in any of the following conditions: if the present range is dBm, if **Normalize** has been set, if PD300-CIE is the sensor in use, or if Exposure is the current mode.

To display as power/energy density:

1. Press **Menu** and enter **Functions**.
2. Go to **Density**. Press the **Enter** key.
3. Select the beam shape (**Disabled**, **Rectangle**, **Circle**). Selecting **Rectangle** enables the **Height** and **Width** parameters for modifying the spot height. Selecting **Circle** enables the **Diameter** parameter for modifying the spot diameter.

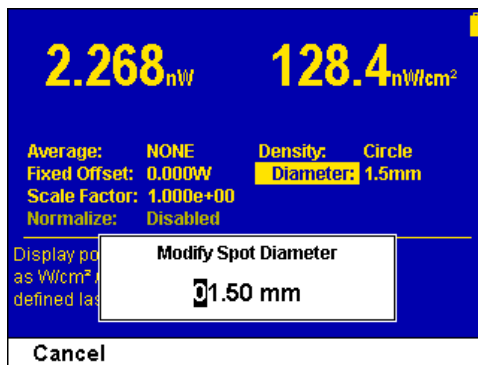


Figure 10-8 Modifying Density – Circular Beam and Spot Diameter

4. After the shape (**Rectangle** or **Circle**), select the size (**Height** and **Width**, or **Diameter**). Size parameters can range from 0.1mm to 100.0mm.

The measurements will be shown as cm² on the graphical display on the main measurement screen.

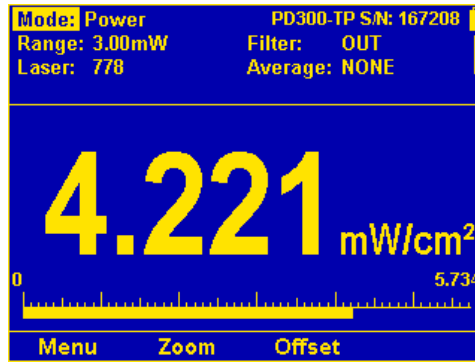


Figure 10-9 Measurement of Power Density in nW/cm^2

10.8 Function Limitations

- For Thermopile sensors in Single-Shot Energy mode, Average is disabled.
- For BeamTrack sensors in Track mode, the functions apply to the power measurement only.
- For sensors in Exposure mode, Average, Normalize, and Density are disabled.
- If Normalize is active, then Density is disabled. If Density is active, then Normalize is disabled.
- If the present Power Range is dBm, then Normalize is disabled.

11 Logging Data to a File for Upload to PC

In addition to displaying the results visually on the screen, you may need to gather a larger amount of data and analyze it in a more thorough fashion. StarBright provides the ability to store the data and review it with Ophir’s StarLab application, Excel, or another application that better fits your needs.

This section describes how to log laser measurement data to a file stored on an external storage device for later upload to a PC.

Topics include:

- Launching the Log Setup
- Setting Logging Parameters for the Various Stop Modes
- Start Logging
- Displaying Logged Data
- Viewing the Log File on Your Computer

11.1 Launching the Log Setup

To activate the Log function, you need to first connect an external storage device to the StarBright meter. Once connected, the **Log Setup** screen is displayed, where you can configure the logging parameters and start the logging process.

To launch the Log Setup:

1. Insert an external storage device Disk on Key into the USB port located on the left side of the StarBright meter.
2. Press **Menu** and select **Log**.

Upon pressing **Log** in the **Menu** screen, StarBright will search for a Disk on Key. If none is attached, it will display an error message, “External storage device not available.”

If a Disk on Key is found, StarBright will look for a directory called “Log Files” in the root directory of the Disk on Key, and if not found, StarBright will create it. StarBright will then set “Log Files” as the active directory. StarBright will not allow browsing of any other directories on the Disk on Key.

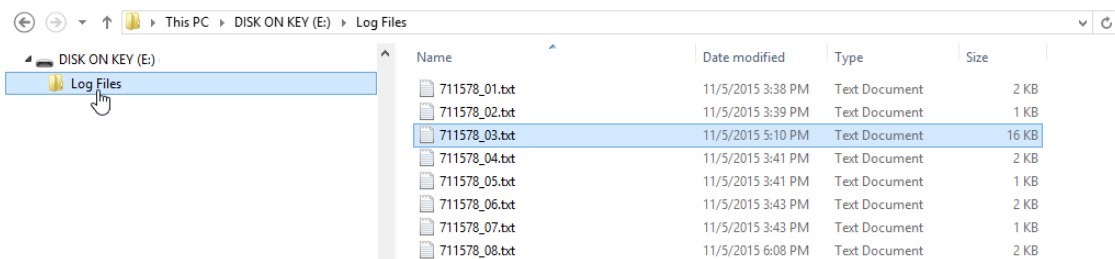


Figure 11-1 Log Files Directory on Disk On Key

After this initial check for the Disk on Key, the **Log Setup** Screen is displayed, as shown in [Figure 11-2](#) below.

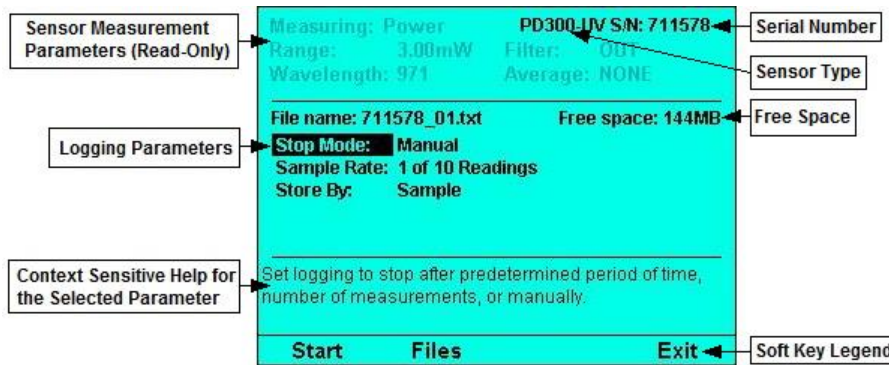


Figure 11-2 Log Setup Screen

The **Log Setup** Screen is divided into 3 main sections and comprises the following components:

- The sensor’s measurement parameters (disabled) at the top of the screen.
- Logging Parameters (in the middle) for configuring the data-logging, as needed.
- Context Sensitive Help (in the lower area) for the selected parameter.
- Soft key legends (at the bottom of the screen):
 - **Start:** Start logging based on selected sensor and log parameters.
 - **Files:** Enter the Log Files screen.
 - **Exit:** Exit to the main menu screen.

11.2 Setting Logging Parameters for the Various Stop Modes

You begin the logging process by configuring the **Stop** mode parameters to set logging to stop after a predetermined period of time, number of measurements, or manually.

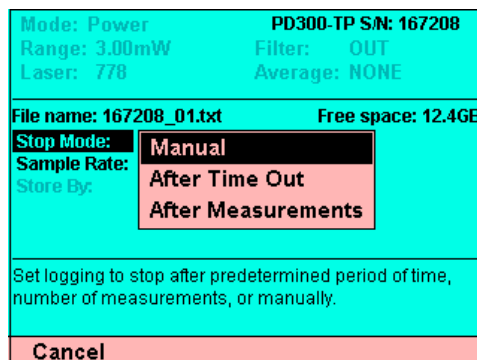


Figure 11-3 Stop Mode Options

To set the logging parameters for the various Stop modes:

1. In the **Log Setup** screen, go to **Stop Mode** and select an option (click the links for more details):
 - **Manual:** to manually stop logging.
 - **After Timeout:** to stop logging after a predetermined period of time.
 - **After Measurements:** to stop logging after a specified number of measurements.

The available parameters vary per the selected **Stop** mode option.

2. Proceed to configure the selected **Stop** mode parameters, as described in the following sections.

11.2.1 Manual Mode

Logging does not terminate at a predefined condition. Rather, it continues until the user presses the **Stop** key.

To set the Stop Mode to Manual:

1. In the **Log Setup** screen, set the **Stop Mode to Manual**. The **Log Setup** screen displays the following parameters:

Mode: Power	PD300-TP S/N: 167208
Range: 3.00mW	Filter: OUT
Laser: 778	Average: NONE
File name: 167208_01.txt	Free space: 12.4GB
Stop Mode: Manual	
Sample Rate: 1 of 3 Readings	
Store By: Sample	
Reduce log file size by storing only one of several measurements.	
Start	Files
Menu	Exit

Figure 11-4 Manual - Stop Mode

2. Go to each parameter and set the relevant options, as required:
 - **Sample Rate:** Enables you to control the number of readings that will be added to the log. Options include:
 - Every Reading
 - 1 of 3 Readings
 - 1 of 10 Readings
 - 1 of 30 Readings
 - 1 of 100 Readings
 - 1 of 300 Readings
 - 1 of 1000 Readings

- **Store By:** Determines the quality of the data that is stored. Set logging to store the average of several readings or only one of the group. (If **Sample Rate** is set to **Every Reading**, then this parameter is disabled and grayed out.)

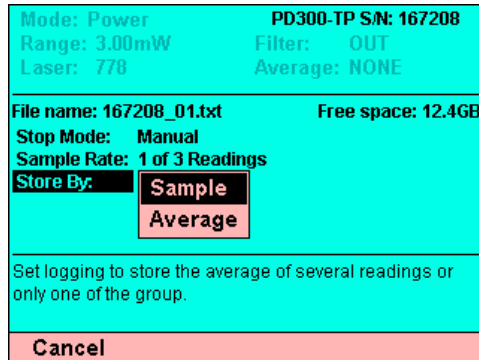


Figure 11-5 Store By Options

Options include:

- **Sample:** Logs only the last reading that was measured.
- **Average:** Stores the average of all of readings that have been measured since the previous data has been added to the log.

11.2.2 After Timeout

Logging continues until the **Stop** key is pressed or until the user-defined log duration has elapsed.

To set the Stop Mode to After Timeout:

1. In the **Log Setup** screen, set the **Stop Mode** to **After Timeout**. The **Log Setup** screen displays the following parameters:

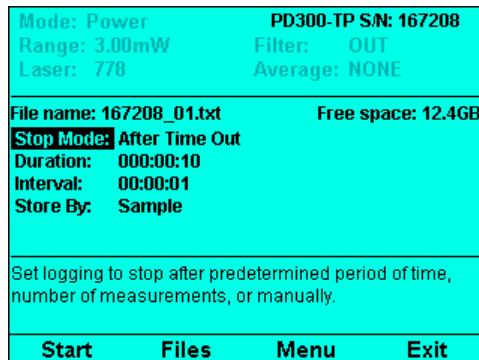


Figure 11-6 After Timeout - Stop Mode

2. Go to each parameter and set the relevant options, as required:
 - **Duration:** User defined period of time. After this time passes, the log stops automatically. The default duration is 1 minute (0000:01:00).

Mode: Power	PD300-TP S/N: 167208
Range: 3.00mW	Filter: OUT
Laser: 778	Average: NONE
File name: 167208_01.txt	Free space: 12.4GB
Stop Mode: After Time Out	
Duration: 001:30:10	
Interval: 00:01:00	
Store By: Sample	
Period of time after which logging will stop automatically.	
001:30:10	
Cancel	

Figure 11-7 Setting the Duration

- **Interval:** Time to wait between storing readings (i.e. before a new measurement is added to the log file). The default interval is 0000:00:00. (i.e. log each reading)

Mode: Power	PD300-TP S/N: 167208
Range: 3.00mW	Filter: OUT
Laser: 778	Average: NONE
File name: 167208_01.txt	Free space: 12.4GB
Stop Mode: After Time Out	
Duration: 001:30:10	
Interval: 00:01:00	
Store By: Sample	
Time to pass before adding a new measurement to the log file.	
00:01:00	
Cancel	

Figure 11-8 Setting the Interval

- **Store By:** Determines the quality of the data that is stored. Set logging to store the average of several readings or only one of the group. (If **Interval** is set to 00:00:00, then this parameter is disabled and grayed out.) Options include:
 - **Sample:** Logs only the last reading that was measured.
 - **Average:** Stores the average of all of readings that have been measured since the previous data has been added to the log.

11.2.3 After Measurements

Logging continues until the **Stop** key is pressed or until the user-defined number of readings has been measured.

To set the Stop Mode to After Measurements:

1. In the **Log Setup** screen, set the **Stop Mode** to **After Measurements**. The **Log Setup** screen displays the following parameters:

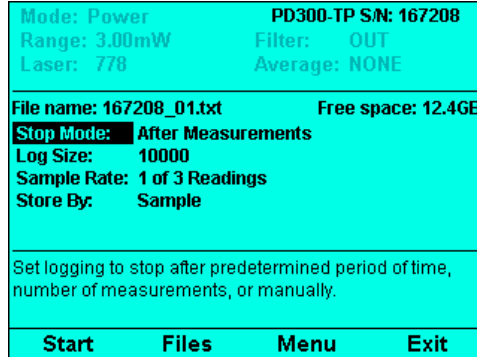


Figure 11-9 After Measurement- Stop Mode

2. Go to each parameter and set the relevant options, as required:
 - **Log Size:** Number of readings that you want to store in the log file, after which logging will stop automatically.

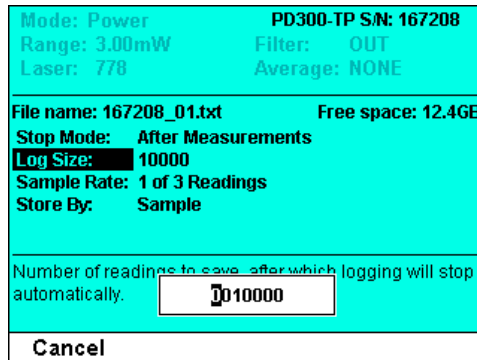


Figure 11-10 Setting the Log Size

- **Sample Rate.** Enables you to control the number of readings that will be added to the log. Options include:
 - Every Reading
 - 1 of 3 Readings
 - 1 of 10 Readings
 - 1 of 30 Readings
 - 1 of 100 Readings
 - 1 of 300 Readings
 - 1 of 1000 Readings

- **Store By:** Determines the quality of the data that is stored. Set logging to store the average of several readings or only one of the group. (If **Sample Rate** is set to **Every Reading**, then this parameter is disabled and grayed out.) Options include:
 - **Sample:** Logs only the last reading that was measured. (Reduces log file size by storing only one of several measurements.)
 - **Average:** Stores the average of all of the readings that have been measured since the previous data has been added to the log.

11.3 Start Logging

You activate logging by pressing the **Start** key in the **Log Setup** screen.

To start logging:

1. In the **Log Setup** screen, press the **Start** key. The main measurement screen displays the graph type that was previously selected in the **Display** menu, and the following additional parameters at the top of the screen:
 - **Elapsed:** Time that has elapsed since starting the present log session (in the example below, 3 minutes).
 - **Readings:** Number of measurements logged to the file since the start of the present log session (in the example below, 906).
 - **Stop:** Condition for ending the present log session (in the example below, after storing 20000 readings).

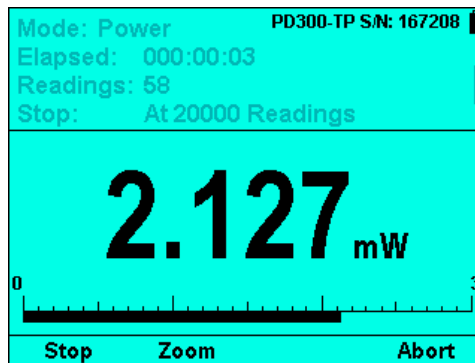


Figure 11-11 Started Logging

2. While logging is active, to stop the log manually, press **Stop**. This stops the logging immediately and saves the date. (Press **Abort** to abort the log, exit the logging screen, and revert back to the **Log Setup** Screen.)
3. When the log is completed, the display will stop updating and a Log Summary appears. The following will be displayed in a message box in the display area:
 - Log file name
 - Total readings
 - Number of overrange
 - Maximum
 - Minimum
 - Average

- Standard Deviation

The log file name is set to the sensor serial number _00.txt (like in StarLab). If there are already log files for this sensor, the appended _00 counter will be auto incremented to the next available value.

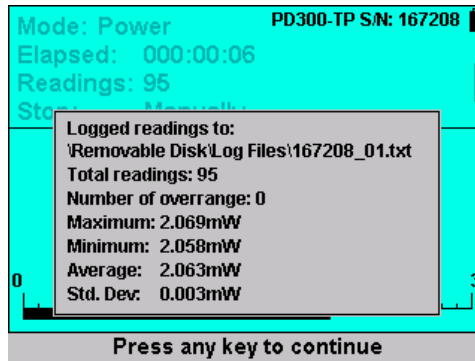


Figure 11-12 Log Summary

Note: StarBright does not provide the user with the ability to add notes to a log file.

- Press any key to return to the active logging screen. The **Start** and **Exit** keys are displayed. The display will be inactive and will be as it was when the log completed.

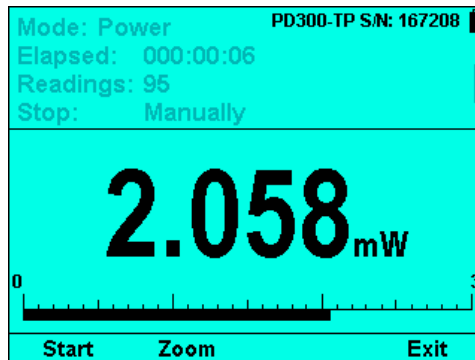


Figure 11-13 Active Logging Screen

- When **Start** is pressed, the logging counters will be reset, the display will be cleared and activated. The **Stop** and **Abort** keys will be displayed.

11.4 Displaying Logged Data

You can access a list of log files to view information about a specific log file by pressing the **Files** key in the **Log Setup** screen and selecting the relevant file.

Pressing the **Files** key in the **Log Setup** screen will open the **Log File Selection** screen. StarBright will open the “Log Files” directory on the Disk On Key and list all files of the format serial_number_xx.txt.

The following procedure guides you through the relevant steps for log file selection.

To display logged data:

1. In the **Log Setup** screen, press the **Files** key.

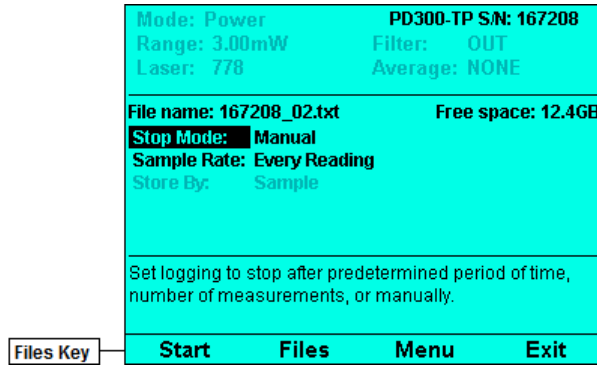


Figure 11-14 Files Key on Log Setup Screen

The **File Selection** screen opens, displaying the number of files found (at the top of the screen) following by the names of the files found (for example, 711578_01.txt). There will be 2 or 3 columns of file names shown. At the bottom of the screen will be displayed general information of the currently highlighted file. This includes the date and time of the log file (hh:mm:ss), duration, number of logged readings, number of overrange, and statistics. (If the log file is longer than 1000 hours, the seconds will not be displayed.)

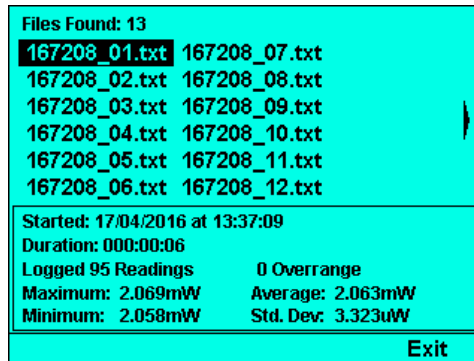


Figure 11-15 File Selection Screen

2. Use the right and left arrows to scroll through the columns of file names. Use the up and down arrows to scroll through the files of the present column. When reaching the bottom of the column, scrolling down will return to the top of the column.
3. Press the **Enter** key to enter the **Log File Display** screen for the currently selected log file. The number of **Readings** appears as the header at the top of the page. Column labels will be according to what was measured (“Power”, “Energy”, and so on). The first column of data will be running counter of the reading number. After that the timestamp, readings, and function

results (if any). Function results will be displayed in last column, if at all, as shown in [Figure 11-17](#) on the right below.

Readings: 1 to 10		Total: 95
Timestamp	Power	
0.000000	2.067e-03	
0.066668	2.067e-03	
0.133312	2.067e-03	
0.199961	2.068e-03	
0.266612	2.068e-03	
0.333269	2.068e-03	
0.399919	2.069e-03	
0.466574	2.069e-03	
0.533222	2.068e-03	
0.599872	2.068e-03	

Page Down **Exit**

Readings: 1 to 10			Total: 66
Timestamp	Power	w/Functions	
0.000000	2.078e-03	1.431e-02	
0.066658	2.078e-03	1.431e-02	
0.133307	2.078e-03	1.431e-02	
0.199969	2.078e-03	1.431e-02	
0.266613	2.077e-03	1.430e-02	
0.333262	2.077e-03	1.430e-02	
0.399923	2.077e-03	1.430e-02	
0.466580	2.078e-03	1.431e-02	
0.533231	2.078e-03	1.431e-02	
0.599868	2.077e-03	1.430e-02	

Page Down **Exit**

Figure 11-16 Log Results without Functions Figure 11-17 Log Results with Functions Applied

Note: When functions are applied, the statistics stored in the log file will be based on the functions data, not on the original readings.

- Use the up/down keys to scroll up/down one page. Use the right/left keys to jump to the first/last page.
- Press **Exit** to exit the **Log Setup** screen.

How the Various Types of Average Affect Logged Data

- Average that is selected in the Functions screen is a Moving Average. If enabled then there will be two columns in the log file; the first is raw measurements (without any functions applied) and the second includes the moving window average (as well as any other functions).
- If sample-by-average is turned on in logging, it will apply to each column separately; in the second column it is applied after any functions (including moving window average).
- The statistics in the log file are based on the actual measurements written to the log file, the second column if there are two columns.

This means that the average in the statistics in the log file may be three averages calculated on top of each other, moving average then periodic average then full average. Make sure that what you configure is sensible.

11.5 Viewing the Log File on Your Computer

In addition to reviewing the logged data on StarBright, you can also upload the data for review at your workstation.

To view the log file on your computer:

- Remove the Disk on Key from StarBright and attach it to your PC.
- Start the StarLab application and select the **Logging Menu**.
- Select **Open Log File**, and select the Log file from the Disk on Key.

StarLab will open the file for visual and textual review as if it were logged in StarLab itself.

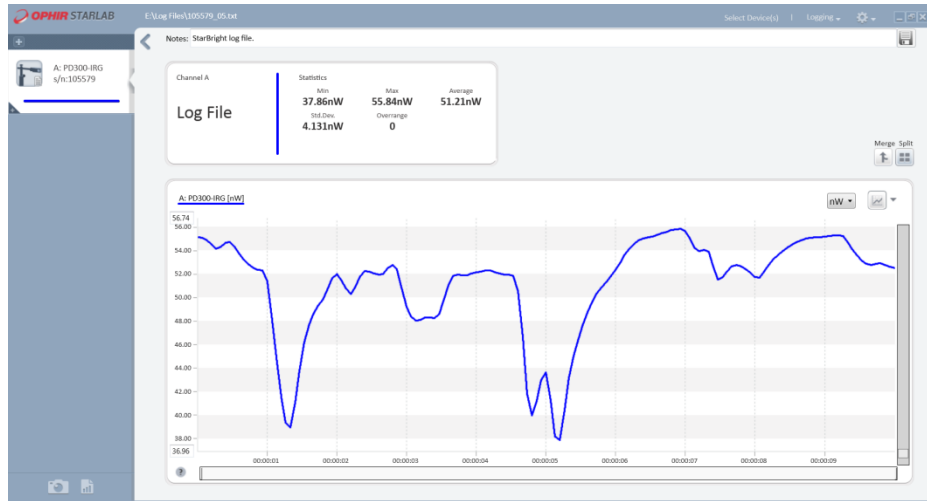


Figure 11-18 Log File in StarLab

12 Special Sensors

In addition to the Thermopile, Photodiode, and Pyroelectric sensors described in the previous sections, Ophir offers sensors that are based on similar technologies that are geared towards other measurement applications.

Topics include:

- BC20
- PD300-CIE
- PD300-BB
- PD300RM

12.1 BC20

The BC20 is a scanned beam laser power meter that is based on a Photodiode detector coupled with innovative circuitry to measure scanned as well as static beams.

Based on this Photodiode, the BC20 has the same dynamic background subtraction as the standard PD300 which eliminates over 95% of background light and allows measurement in normal room light.

Differences between BC20 and Standard Thermopile Sensors

Although BC20 sensors are Photodiode based, they are defined to behave like Thermopile sensors except for the following differences:

- No BC20 sensors support Energy.
- All BC20 sensors support the Continuous mode. In this mode, the reading displayed is updated 3 times per second with the max power reading of the previous 1/3 second.
- Some BC20 support the Hold mode. In this mode, the display “holds” the highest reading for up to 5 seconds. If a higher reading is measured before the 5 seconds have elapsed, the display is updated and the 5 second counter is restarted.

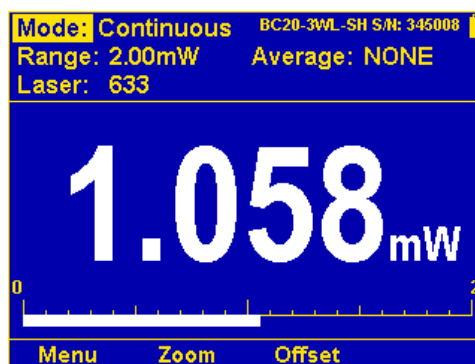


Figure 12-1 BC20 Screen Layout

12.2 PD300-CIE

The PD300-CIE head has a spectral response similar to that of the human eye and therefore is calibrated to measure in eye response units of Lux. The PD300-CIE is designed with a small detector

in which the source overfills the detector. It displays the light intensity per unit area in units of Lux or Foot Candles.

Differences between PD300-CIE and Standard Photodiode Sensors

Except for the following differences, PD300-CIE behaves exactly like a standard PD300:

- Measuring Mode can be set to Lux or Foot Candles (Lx or Fc).
- Laser Selection is disabled.
- Filter Selection is disabled.
- The Density and dBm functions should be disabled (after discussion with Ephraim G).

Other than the above, operation is the same as for other PD300 type heads.

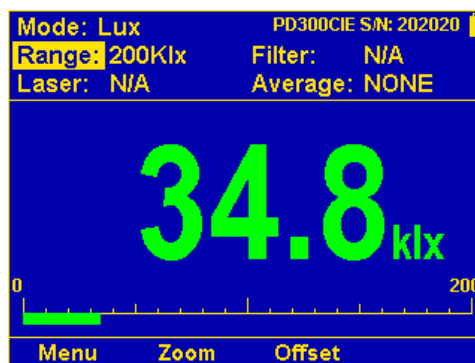


Figure 12-2 PD300-CIE Screen Layout

12.3 PD300-BB

The PD300-BB is a Photodiode-based sensor with a flat spectral response.

Differences between PD300-BB and Standard PD300 Sensors

Except for the following differences, PD300-BB behaves exactly like a standard PD300:

- There is no wavelength selection.
- Some models do not have filter selection.

12.4 PD300RM

The PD300RM series of sensors are geared towards measuring irradiance and dosage. Like other sensors in the PD300 series, the PD300RM is based on a Photodiode. However, unlike the PD300 series, it is calibrated to measure irradiance (W/cm^2) and dosage (J/cm^2) at some distance from a divergent source. A diffuser is placed over its aperture, thereby eliminating the sensitivity of the Photodiode to the incident angle of the light. This enables the sensor to be used to measure irradiance when light is incident on the sensor from different angles.

Differences between PD300RM and Standard PD300 Sensors

Except for the following differences, use of the PD300RM with StarBright is the same as power measurement with a standard PD300:

- **Mode:** With Photodiode sensors, the available measurement modes are **Power** or **Exposure**. With the PD300RM, the measurement mode can be set to **Irradiance** or **Dosage**.

- **Units:** The standard PD300 measures power and displays results in Watts (W). The PD300RM measures irradiance and shows results in Watts per area (W/cm^2) or dosage as Joule per area (J/cm^2).
- **Ranges:** The standard PD300 allows display of power in dBm and ranges are scales of W. The PD300RM does not allow dBm and ranges are scales of W/cm^2 .

12.4.1 Irradiance Measurement

Irradiance is the power of light per unit area incident on a surface and is displayed as watts per square meter (W/cm^2).

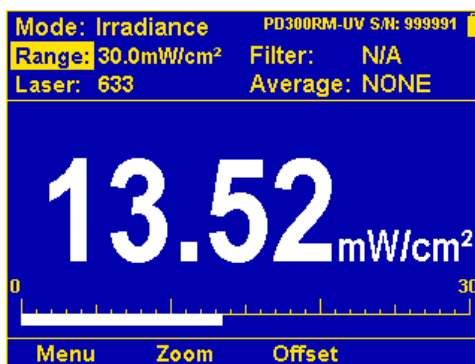


Figure 12-3 Irradiance Measurement

12.4.2 Dosage Measurement

Dosage is the integral of irradiance over time and is displayed as joules per square meter (J/cm^2). This measurement mode is specific to the PD300RM.

In dosage mode, StarBright measures 500 times per second, updating the dosage displayed on the screen every ½ second.

The screen layout is similar to that of the [Exposure](#) screen with the following notable exceptions:

- There is no stop mode selection.
- Dosage measurement continues for up to one hour unless stopped earlier by the user.

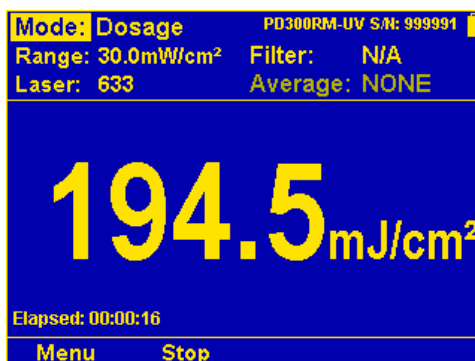


Figure 12-4 Dosage Measurement

12.4.3 Offset

Because Dosage is the integral of Irradiance over time, background noise that affects Irradiance will affect Dosage as well. To overcome this, perform the following steps.

1. Enter Irradiance mode and go to the second set of soft keys by pressing the Right Arrow key.
2. Block the laser/light source under measurement and press the **Offset** key. This will activate the offset feature. When active, the **Offset** key is reverse highlighted and the offset that is being subtracted is shown in the upper right part of the screen.
3. Return to the first set of soft keys by pressing the Left Arrow key.
4. Set the **Mode** to **Dosage**.
5. The Offset stored in the Irradiance screen will be subtracted in order to provide accurate Dosage measurements.

12.4.4 Function Limitations

When measuring irradiance, the following functions are enabled/disabled:

- Average, Offset, Scale Factor, and Normalize are accessible (enabled).
- Density and dBm are grayed out (disabled).

When measuring dosage, the following functions are enabled/disabled:

- Average, Offset, dBm, Normalize, and Density are grayed out (disabled).
- Scale Factor is accessible (enabled).

13 Circuit Description

The StarBright meter has two circuit boards: the Analog Module with the analog signal processing circuitry, and the Processor Board with the power supplies and user interface components.

Topics include:

- Analog Module
- Processor Board

13.1 Analog Module

13.1.1 Analog Circuit

The signal from the detector sensor 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, and so on) in the StarBright. The Analog Module's on board digital processor receives data from the A/D converter and translates it into a measurement of current in Amps. When used with Thermopile sensors, the data is then processed by a sophisticated digital filter that speeds up the effective response time of the sensor and rejects noise.

13.1.2 Fast Analog Input

In addition to the above basic analog circuit, the StarBright contains a second fast analog input. This supports certain Ophir sensors 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. The Analog Module's on board digital processor receives data from the fast A/D converter and translates it into a measurement that can be processed as necessary.

13.1.3 Analog Output

The analog output is driven through an impedance of 100 ohms and provided as a means of integrating the StarBright meter with other instruments (such as an oscilloscope).

13.2 Processor Board

The Processor Board is built around a Freescale i.MX283 ARM9 application processor. The digital circuit includes an upgradeable FLASH chip that can be programmed in.

13.2.1 Power Supply

The power supply provides the internal DC supply voltages for both the Processor Board and the Analog Module. 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.

13.2.2 EMI Protection

The digital processor circuit and the whole StarBright 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.

14 Calibration, Maintenance, and Troubleshooting

This section describes calibration, maintenance, and troubleshooting related to using StarBright.

The following calibration capabilities are supported:

- Photodiode Power
- Pyroelectric Energy for sensors with a Discrete set of wavelengths
- Pyroelectric Energy for sensors with a Continuous set of wavelengths
- Thermopile Power
- Thermopile Energy
- Thermopile Response Time

Note: All calibration factors are dependent on the currently active set of configuration parameters.

In addition to NIST traceable factory calibration, Ophir sensors can be field calibrated by the user.

Note: Modifying calibration factors will affect the sensor's performance and should be performed by qualified personnel only.

Topics include:

- Updating Sensor Calibration Factors
- Calibration of Thermopile Sensors
- Calibration of Photodiode Sensors
- Calibration of Pyroelectric Sensors
- Error Messages
- Troubleshooting
- Maintenance

14.1 Updating Sensor Calibration Factors

The following procedure describes the general steps for updating sensor calibration factors. For sensor-specific calibration, see [Calibration of Thermopile Sensors](#), [Calibration of Photodiode Sensors](#), and [Calibration of Pyroelectric Sensors](#).

To update sensor calibration factors:

1. Press **Menu** and select **Calibration**.
2. Press **Continue** twice to activate calibration. The information screens vary per sensor.
3. The main Measurement screen appears, displaying the **Calibration Factor** value (on the left).
4. Press **Modify**. The screen displays the **Original** (current) reading and factor (on the left side of the screen), and **Updated** factor and its effect on the reading (on the right). The **Updated** box is highlighted, indicating it is modifiable.
5. In the **Updated** area, use the Right/Left arrows to select the digit to update. Use the Up/Down arrows to change the value of the selected digit.
6. Press **Save** to save the settings and return to the main Measurement screen, which now displays the updated Calibration Factor.
7. Press **Exit** to return to the Menu screen.

14.2 Calibration of Thermopile Sensors

Two types of absorber surfaces are used in Ophir Thermopile measuring sensors:

- [Surface Absorbers](#)
- [Volume Absorbers](#)

14.2.1 Surface Absorbers

BB (Broadband) Absorber

On standard, high power density, broadband Ophir power monitor sensors, 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 28 kW/cm², without changing calibration. The absorption of this coating is above 85% for most of its range, as shown in [Figure 14-1 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 [Figure 14-1 below](#).

LP1 (Long Pulse) Absorber

The LP1 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 sensors also being calibrated for 2940nm.

14.2.2 Volume Absorbers

P (Pulse) Absorber

The P type absorbers are models marked with the P suffix, are for use with pulsed lasers, and 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. See [Figure 14-1 below](#).

HE (High Energy) Absorber

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

PF (High Energy High Average Power) Absorber

The newest PF type absorber has a high damage threshold for short pulses and can stand relatively high average power density as well. In addition, it is able to be deposited on large areas, so it is the absorber of choice for many applications.

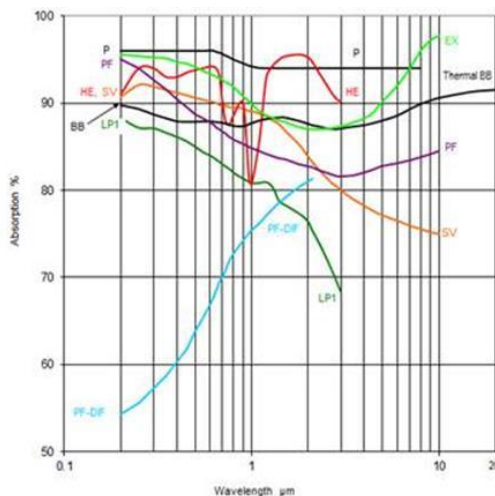


Figure 14-1 Absorption vs. Wavelength of Various Thermopile Sensor Absorbers

Ophir power/energy meters with the Broadband, P or PF 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 (532, 1064, and, where applicable, CO2). Since the sensitivity changes little with wavelength, the user can use the settings closest to the calibration wavelength with little error.

The EX type detector is calibrated in the UV at 248nm to cover the entire UV range from 193 to 400nm.

14.2.3 Linearity and Accuracy of Ophir Thermopile Sensors

Linearity

The linearity of most Ophir Thermopile detectors is specified to be 1% over the specified power range of each particular instrument and is tested by Ophir from time to time. The linearity is generally tested against another sensor that has been NIST tested for linearity. 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 beam splitter and lower power sensor that has previously been tested for linearity for comparison. Thus, in all cases, the linearity of the detectors is traceable to NIST measurements.

Method of Calibration

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

Total Accuracy of Calibration

A detailed discussion of Ophir calibration accuracy is available on the Ophir website at <http://www.ophiropt.com/laser-measurement-instruments/laser-power-energy-meters/tutorial/calibration-procedure>.

14.2.4 Updating Thermopile Sensor Calibration Factors

To update Thermopile sensor calibration factors:

1. Press **Menu** and select **Calibration**. The screen displays the following general message:

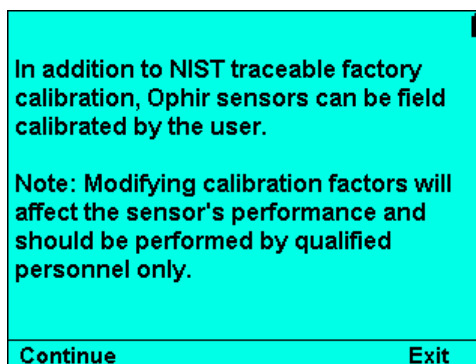


Figure 14-2 General Calibration Information Screen

2. Press **Continue**. The **Select Calibration Factor** screen displays the following calibration factors: **Sensitivity**, **Power with Laser**, **Energy**, and **Response**. Click the links for more details.

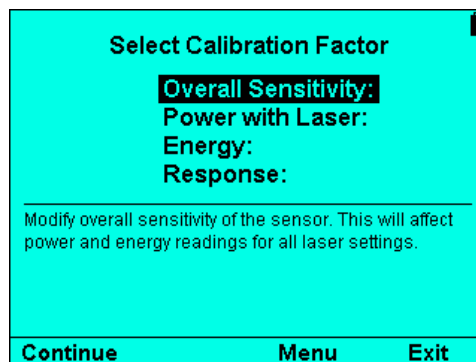


Figure 14-3 Select Calibration Factor Screen for Thermopile Sensors

3. Select (highlight) a Calibration Factor (**Sensitivity**, **Power with Laser**, **Energy**, or **Response**) and press **Continue** to activate calibration based on the selected factor. The main Measurement

screen appears, displaying the relevant Factor values (on the left) based on the selected calibration factor. For more details, see [Sensitivity](#), [Power with Laser](#), [Energy](#), and [Response](#).

4. Press **Modify**. The screen displays the **Original** (current) reading and factor (on the left side of the screen), and **Updated** factor and its effect on the reading (on the right). The **Updated** box on the right is highlighted, indicating it is modifiable. For more details, see [Sensitivity](#), [Power with Laser](#), [Energy](#), and [Response](#).
5. In the **Updated** area, use the Right/Left arrows to select the digit to update. Use the Up/Down arrows to change the value of the selected digit.
6. Press **Save** to save the settings and return to the main Measurement screen, which now displays the updated calibration factor values.
7. Press **Exit** to return to the Menu screen.

Sensitivity

Available for all Thermopile sensors. Modify overall sensitivity of the sensor. This will affect power and energy readings for all laser settings. When this is selected, the main screen will display **Sensitivity** and **Calibration Factor** values on the left.

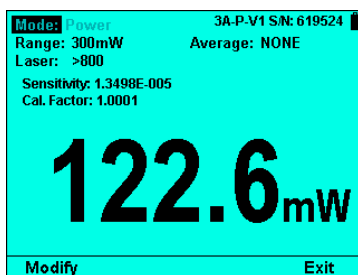


Figure 14-4 Calibrating per Sensitivity

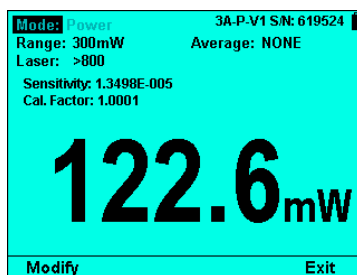


Figure 14-5 Modifying Overall Sensitivity Calibration Factor

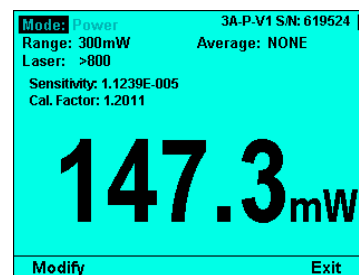


Figure 14-6 Updated Sensitivity Calibration Factor in Main Screen

Power with Laser

Not applicable for LP1 and similar sensors that have a calibration curve and not discrete wavelength calibration and therefore will not be shown for them. Modify readings for this laser only. Affects power and energy.

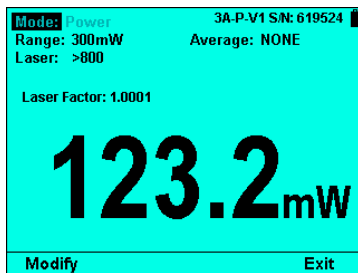


Figure 14-7 Calibrating per Laser

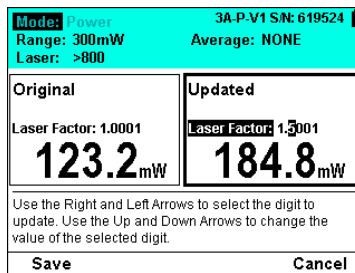


Figure 14-8 Modifying Laser Calibration Factor

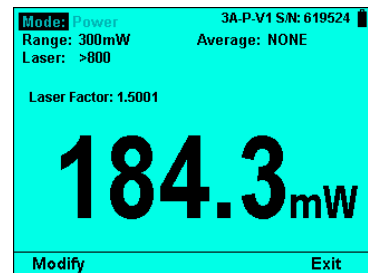


Figure 14-9 Updated Laser Calibration Factor in Main Screen

Energy

Not applicable for 5000W and similar sensors that do not measure energy and will not be offered as an option for them. Modify energy readings for all laser settings. Affects power readings only.

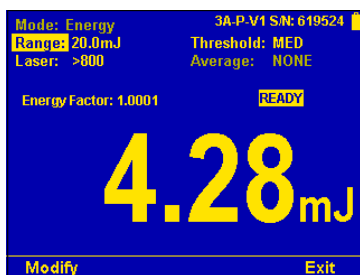


Figure 14-10 Calibrating per Energy

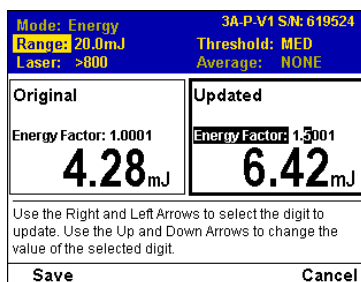


Figure 14-11 Modifying Energy Calibration Factor

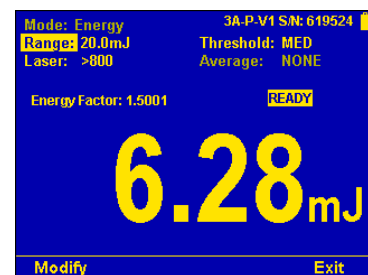


Figure 14-12 Updated Energy Calibration Factor in Main Screen

Response

Available for all Thermopile sensors. Optimize Thermopile response time of the sensor. Use to attain accurate readings as quickly as possible and to minimize overshoot (erroneous power readings above 100% full scale). Affects power and energy readings.

Thermopile sensors are slow in their response to a laser hitting them. StarBright contains software that algorithmically “speeds up” the response. Response tweaking is a feature that Ophir provides for users to tailor this to their application. It allows the user to find the optimum setting to speed up the response, prevent overshoot (erroneous readings that are above the actual power), and remove undershoot (not quite reaching and/or dipping back below the correct reading).

Response configuration is provided as a multi-step wizard with on screen guidance for each step.

The basic workflow includes:

- Scaling the graph to the power level expected when reading stabilizes. See steps 1 and 2 below.
- Changing the Response, tweaking and testing the results. Response tweaking works by the user seeing how long it takes to rise from 0 to the expected power and if there is overshoot or undershoot. See steps 3, 4, and 5 below.
- Accepting the results. The graph is drawn with two dotted lines; one at 100% of the expected measurement at one at 90%. 100% is drawn at about 75% of the full height of the graph to allow the user to see the overshoot, if there is any.

The following procedure guides you through the specific steps.

To set calibration per Response factor:

1. In the **Select Calibration Factor** screen, select **Response**, and press **Continue**. The main Measurement screen displays the **Response Factor** on the left.

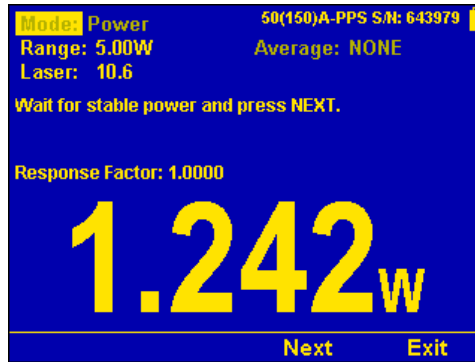


Figure 14-13 Calibrating per Response

2. Wait for stable power and press **Next**. Scaling begins. The graph is scaled to the power level expected when the reading stabilizes. At this point, the measurement parameters cannot be changed anymore. Response tweaking works by the user seeing how long it takes to rise from 0 to the expected power and if there is overshoot or undershoot.

The screen displays Scaling in progress.

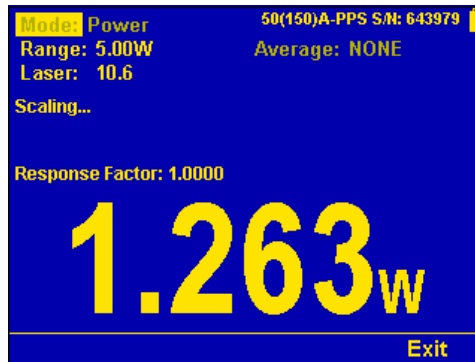


Figure 14-14 Scaling Begins

After the scaling is completed, the screen displays “Block laser until power is close to 0”.

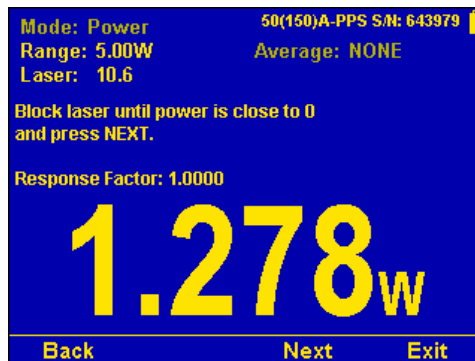


Figure 14-15 Scaling Completed

3. Press **Next**.

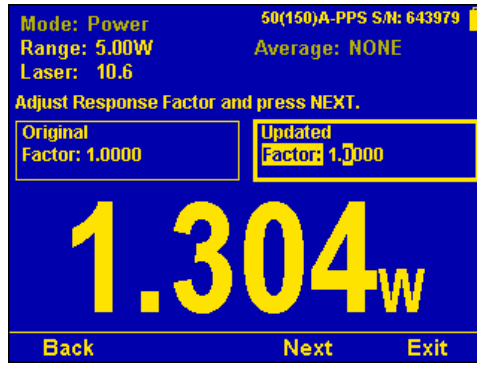


Figure 14-16 Response Calibration Factor

4. Adjust the **Response Factor** and press **Next**.

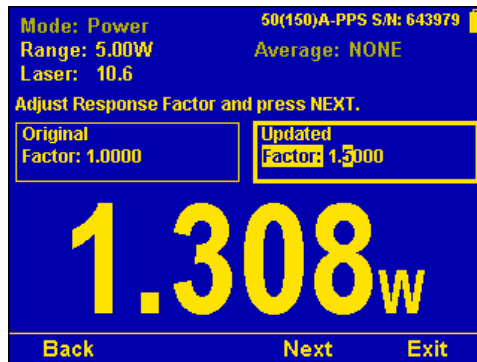


Figure 14-17 Modifying the Response Calibration Factor

5. Press **Next** and then unblock the laser.

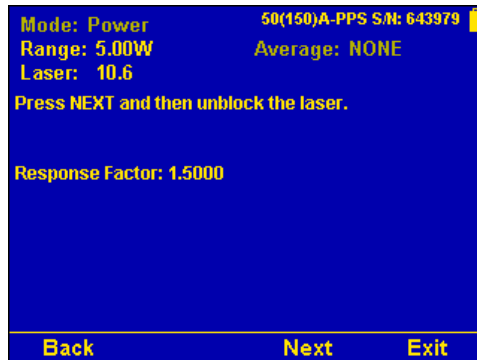


Figure 14-18 Updated Response Calibration Factor in Main Screen

6. Press **Next**. The calibration is updated in the main Measurement screen. Initially, the screen displays the updated **Scaled**, **Present**, and **Response Factor** values.

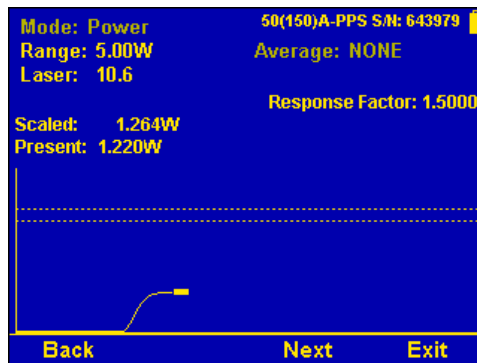


Figure 14-19 Scaled, Present, and Response Factor Values Updated

Then, the screen displays the final **Response Factor** value.

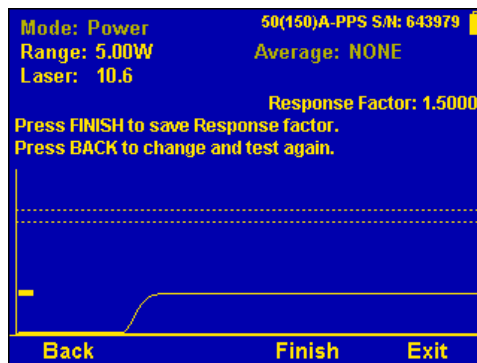


Figure 14-20 Final Response Calibration Factor Value

The graph (as shown above) is drawn with two dotted lines; one at 100% of the expected measurement at one at 90%. 100% is drawn at about 75% of the full height of the graph to allow the user to see the overshoot, if there is any.

7. Press **Finish** to save the Response factor.
8. Press **Back** to change and test again. (Repeat steps 5-7 above.)

14.3 Calibration of Photodiode Sensors

Photodiode detectors are inherently very linear but also have a large variation in sensitivity with wavelength. In addition, most sensors from the Ophir model PD300 series are 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 StarBright, the StarBright has a built in calibration adjustment for wavelength which is described in the next paragraph.

14.3.1 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 sensor 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 StarBright, the correction factor for that wavelength is applied.

14.3.2 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 listed in [Table 14-1 below](#).

Table 14-1 Maximum Error as a Function of Wavelength and Filter

Wavelength	Error, Filter Out*						
	PD300	PD300-TP	PD300-3W	PD300-UV	PD300-IR	PD300 -IRG	3A-IS
200 - 270nm				$\pm 6\%$			
270 - 360nm	-		-	$\pm 3\%$			-
360 - 400nm	$\pm 10\%$	$\pm 7\%$	$\pm 10\%$	$\pm 3\%$			-
400 - 950nm	$\pm 3\%$	$\pm 3\%$	$\pm 3\%$	$\pm 3\%$			5%
950 - 1100nm	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 4\%$		10%
1100 - 1650nm	-		-	-	$\pm 4\%$	$\pm 3\%$	
1650 - 1800nm	-		-	-	$\pm 7\%$	$\pm 5\%$	

* Add $\pm 2\%$ to error for filter in ($\pm 4\%$ for PD300-UV from 220 to 400nm).

Note: More exact specifications will be found in the latest [Ophir Laser Measurement Instruments Catalog](#).

14.3.3 Updating Photodiode Sensor Calibration Factors

Photodiode sensors only have an overall power calibration factor. Changes to this factor at one wavelength will affect readings at all other wavelengths proportionately.

Note: Sensors equipped with a removable filter have two factors, one for each setting. Changing the factor for one setting has no effect on power readings in the other settings.

To update Photodiode sensor calibration factors:

1. Press **Menu** and select **Calibration**. The screen displays the following general message:

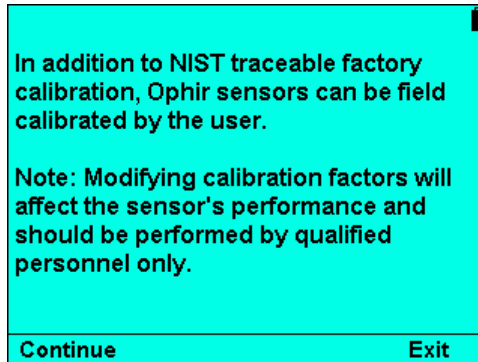


Figure 14-21 General Calibration Information Screen

2. Press **Continue**. The screen displays the following Photodiode sensor-specific message:

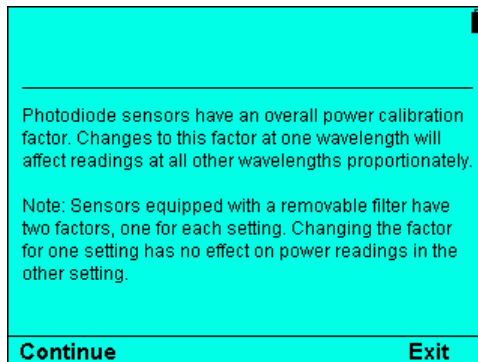


Figure 14-22 Information Screen for Photodiode Sensors

3. Press **Continue** to activate calibration. The main Measurement screen appears, displaying the Calibration Factor value (on the left).

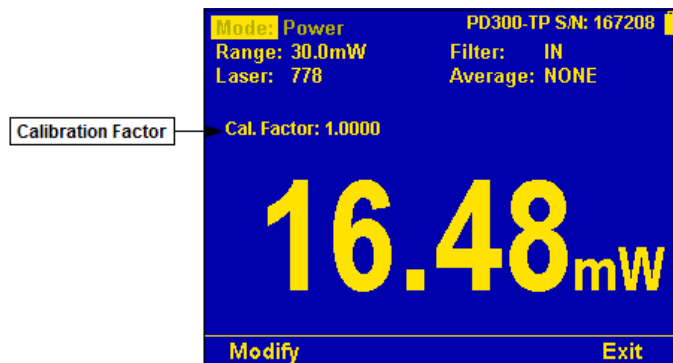


Figure 14-23 Calibration Activated on Main Measurement Screen

4. Press **Modify**. The screen displays the **Original** (current) reading and factor (on the left side of the screen), and **Updated** factor and its effect on the reading (on the right). The **Updated** box is highlighted, indicating it is modifiable.

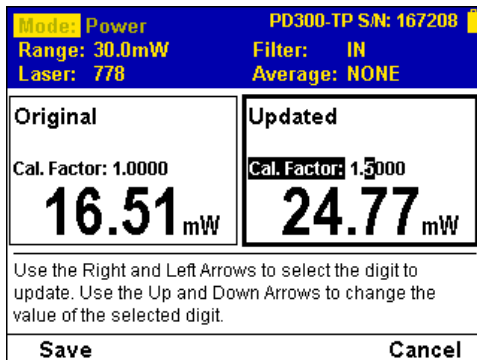


Figure 14-24 Modifying Calibration for Photodiode Sensors

5. In the **Updated** area, use the Right/Left arrows to select the digit to update. Use the Up/Down arrows to change the value of the selected digit.
6. Press **Save** to save the settings and return to the main Measurement screen, which now displays the updated Calibration Factor.

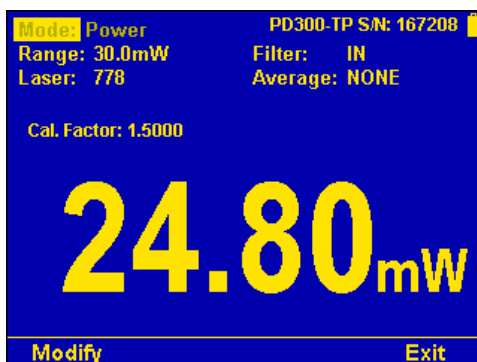


Figure 14-25 Updated Calibration Factor for Photodiode Sensors

7. Press **Exit** to return to the Menu screen.

14.4 Calibration of Pyroelectric Sensors

14.4.1 Absorber Types Used in Ophir Pyroelectric Measuring Sensors

The main absorber surface types used in Ophir Pyroelectric measuring sensors include:

- **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 Figure 14-26 below. The metallic coating permits very high repetition rates, up to 25000Hz as well as relatively high damage threshold.
- **Broadband Type:** The type with the BB suffix has a broadband absorbing coating to provide high absorptivity from the UV through the IR. This coating can withstand energy densities, up to 0.8J/cm² for short pulses and 2J/cm² for long pulses without changing calibration. The absorption of this coating is above 90% for most of its range, as shown in Figure 14-26 below. This coating is available for the PE50, PE25, and PE10 sensors. For even higher damage thresholds, there are the –DIF diffuser series with a diffuser in front of the absorber.

- PD10 Series: Unlike the other sensors, the PD10 series sensors have a silicon or germanium 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 sensors and therefore the sensors have a high accuracy at any wavelength in the range. This is an exclusive feature with Ophir energy sensors.

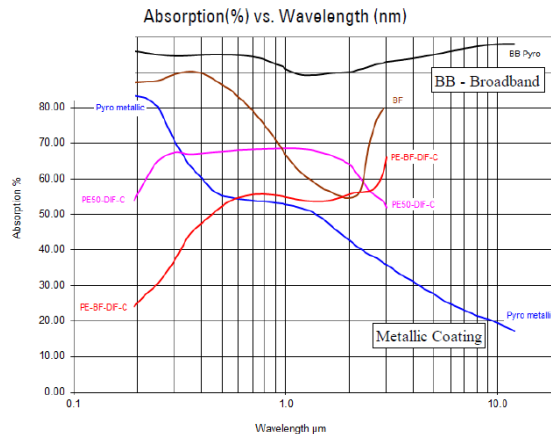


Figure 14-26 Absorption of Ophir Pyroelectric Absorbers

14.4.2 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, there is a wavelength sensitivity correction curve in the meter.

Ophir Pyroelectric detectors are calibrated using a 1064 repetitively pulsed laser referenced to a NIST traceable Thermopile 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 sensors are also calibrated with an excimer laser at 248nm to correct the rather large absorption variations in that spectral region with those sensors.

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 StarBright, the correction factor for that wavelength is applied.

The PD10 and PD10-PJ sensors 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 sensors over the wavelength range of the sensor. Then the sensor 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.

14.4.3 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 described in [Error Messages](#).

In addition to the above errors, the reading of Pyroelectric sensors changes with frequency. The sensor 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 about 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 sensor is specified in the latest edition of the [Ophir catalog](#). For more details on calibration accuracy, see the Ophir website at <http://www.ophiropt.com/laser-measurement-instruments/laser-power-energy-meters/tutorial/calibration-procedure>.

14.4.4 Updating Pyroelectric Sensor Calibration Factors

Calibration of Pyroelectric sensors is only done when they are measuring energy. As such, if the sensor was in power or exposure mode, entering the calibration screen will force it into energy with no option to change this until after leaving calibration and returning to the regular measurement screens.

Some Pyroelectric sensors only have an overall calibration factor and do not have any wavelength specific factors. For these sensors this screen is informational only before continuing along to the actual calibration screen and the Navigation Panel is disabled. The BB series of sensors have wavelength specific factors and therefore this screen allows the user to use the Navigation Keys to select which type of factor he is calibrating before continuing to the actual calibration screen.

To update Pyroelectric sensor calibration factors:

1. Press **Menu** and select **Calibration**. The screen displays the following general message:

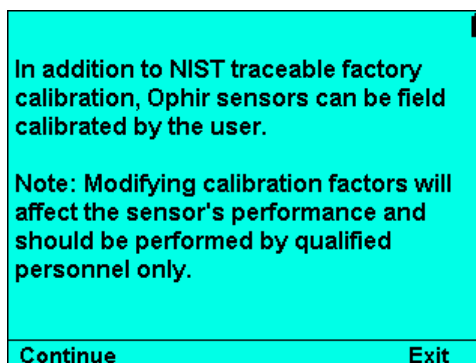


Figure 14-27 General Calibration Information Screen

2. Press **Continue**. The screen displays the following Pyroelectric sensor-specific message:

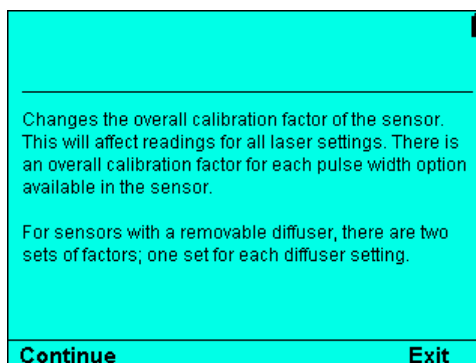


Figure 14-28 Information Screen for Pyroelectric Sensors

3. Press **Continue** to activate calibration. The main Measurement screen appears, displaying the relevant **Overall** (or **Laser**) **Factor** value (on the left).
 - **Overall Factor:** Available for all Pyroelectric sensors. Changes the overall calibration factor of the sensor. This will affect readings for all laser settings. There is an overall calibration factor for each pulse width option available in the sensor. For sensors with a removable diffuser, there are two sets of factors; one set for each diffuser setting.
 - **Laser Factor:** Available for the BB series of sensors that have discrete wavelength calibration. Modify readings for this laser only.

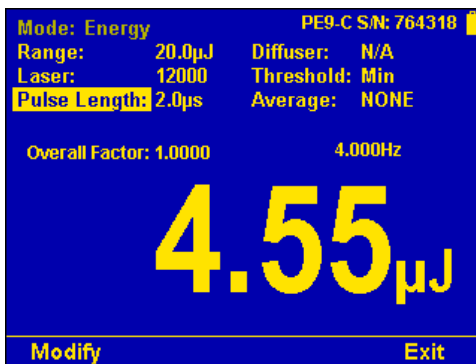


Figure 14-29 Calibration Activated on Main Measurement Screen

4. Press **Modify**. The screen displays the **Original** (current) reading and factor (on the left side of the screen), and **Updated** factor and its effect on the reading (on the right). The **Updated** box is highlighted, indicating it is modifiable.

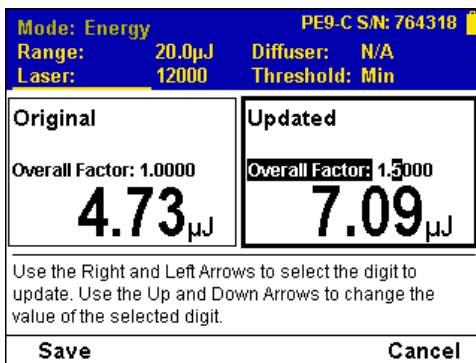


Figure 14-30 Modifying Calibration for Pyroelectric Sensors

- In the **Updated** area, use the Right/Left arrows to select the digit to update. Use the Up/Down arrows to change the value of the selected digit.
- Press **Save** to save the settings and return to the main Measurement screen, which now displays the updated Overall Factor.

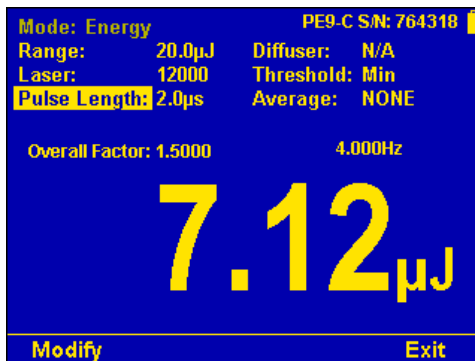


Figure 14-31 Updated Overall Factor for Pyroelectric Sensors

- Press **Exit** to return to the Menu screen.

14.5 Error Messages

The StarBright displays various error messages when operated outside its normal range.

- 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 ¾ empty. At this stage, the StarBright should be connected to the charger. It will operate normally and charge 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.

14.6 Troubleshooting

14.6.1 StarBright Meter

Table 14-2 StarBright Meter

Problem	Cause/Remedy
Instrument will not operate after being completely discharged and connected to charger.	Verify that charger is providing 12V.
Instrument operates with charger but not with battery alone.	Battery is low. Recharge overnight with the StarBright turned off for 5 hours. If the StarBright still does not work with battery, then the Lithium Ion battery is probably dead. Replace battery (see Battery Replacement).

14.6.2 Thermopile Sensors, Energy Measurements

Table 14-3 Thermopile Sensors, Energy Measurements

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

14.6.3 Thermopile Sensors, Power

Table 14-4 Thermopile Sensors, Power

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

14.6.4 Pyroelectric Sensors

Table 14-5 Pyroelectric Sensors

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: Sensor 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 the cable away from the bench. 2. Move the sensor/display further away from EMI.

14.7 Maintenance

14.7.1 Maintenance of Thermopile Sensors

To trace the signal from the Thermopile Sensor to StarBright:

1. With the instrument on, apply an approximately known amount of power to the sensor. 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 sensor by multiplying the input power by the sensor-sensitivity shown in [Sensor Specifications](#).
3. Using a multimeter set to current, unplug the sensor from the StarBright and check that this current appears between pin 1 and 9 of the D type plug.

14.7.2 Battery Replacement

If the StarBright battery is defective and does not hold a charge, a replacement can be ordered from your agent (Ophir part number 7E14008). The new battery is installed as follows:

1. Ensure the StarBright is switched OFF. Turn the StarBright meter upside down and unscrew the 5 Phillips screws on the bottom panel of the StarBright.
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 StarBright and close the 5 screws.
5. Switch on the StarBright with NO SENSOR DETECTOR attached and set the date and time of the instrument correctly. (See [Clock Settings](#).)

15 StarBright Specifications

Topics include:

- System/Meter Specifications
- Sensor Specifications

15.1 System/Meter Specifications

Table 15-1 System/Meter Specifications

Input Specifications	
Thermopile, Photodiode	
Input Ranges	15nA - 1.5mA full scale in 16 ranges
A to D Sampling rate	15Hz
A to D resolution	18 bits plus sign
Electrical accuracy	±0.25% ± 20pA new; ±0.5% ±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)
Input Specifications	
Pyroelectric Sensors	
Input Range	0 - 6V full scale
A to D Sampling rate	5000 Hz
A to D resolution	12 bits no sign (0.025% resolution)
Electrical accuracy	±0.25% new; ±0.5% after 1 year
Electrical input noise	2mV
General Specifications	
Detector Compatibility	Thermopile (including BeamTrack), Photodiode and Pyroelectric (PE-C)
PC Interface	USB; RS232 (max baud rate 115200)
Analog output	1v full-scale; 0.03% resolution. 100 ohms impedance
Analog output accuracy	±0.2% (of reading) ±0.3% of full scale volts
Dimensions	114W x 41D x 212H
Mass	470g
Display	320x240 pixel TFT LCD; Active area 70x52mm approx.
Display digit height	15mm
LCD lighting	LED's. Operates from charger or battery. Lighting level can be adjusted between 3 levels using on/off button.

Bargraph segments	310
Battery	2x Li-Ion 3.7V, 5.2Amp-hour battery pack built in
Charger input	DC 12-16v, 1W Charge time approx. 5 hours Automatically stops charging when battery is full
Operation between charges	With low backlight: Thermopile, Photodiode 19, Pyroelectric 16 With medium backlight: Thermopile/Photodiode 17, Pyroelectric 15 With high backlight: Thermopile/Photodiode 15, Pyroelectric 13 Note: Battery charge will be depleted faster if a USB Flash Drive is left plugged in the StarBright meter.
Data Logging	
Log period	1 sec to 1000 hours
Max points stored onboard per file	Limited only by size of USB Flash Drive
Max points direct to PC file in real time	Unlimited
Max points stored onboard	Limited only by size of USB Flash Drive
Real Time Logging of Power	15Hz Onboard, USB, RS232
Real Time Logging of Energy	5000Hz Onboard, USB; 30Hz RS232

15.2 Sensor Specifications

Table 15-2 Max Power Specifications of Sensors

Sensor	Max Power (WATTS)	Max Avg. Power Density at Max Power	Absorber Type
PD300/UV/IR	300mW	50W/cm ²	PD
PD300-3W	3W	100W/cm ²	PD
PD300RM-UV/8W	-	10W/cm ² /50W/cm ²	PD
IS6	30W	200W/cm ²	IS
RM9	100mW	30W/cm ²	PE
3A-IS	3W	200W/cm ²	Int Sph PD
3A	3W	1000W/cm ²	BB
3A-P	3W	50W/cm ²	P
3A-P-THz	10THz	50W/cm ²	P
3A-FS	3W	1000W/cm ²	FS
10A	10W	28KW/cm ²	BB
12A	12W	25KW/cm ²	BB
12A-P	12W	50W/cm ²	P
20C-SH	4(20)W	23KW/cm ²	BB
30A-BB-18	30W	20KW/cm ²	BB
30A-P-17	30W	50W/cm ²	P
L30A-10MM	30W	20KW/cm ²	BB
50A-PF-DIF-18	50W	0.5KW/cm ²	PF-DIF
30(150)A-BB-18	30(150)W	12KW/cm ²	BB
30(150)A-HE-17	30(150)W	0.5KW/cm ²	HE
50(150)A-BB-26	50(150)W	12KW/cm ²	BB
L50(150)A-BB-35	50(150)W	12KW/cm ²	BB
L50(150)A-LP1-35	50(150)W	38KW/cm ²	LP1
L40(150)A	35(150)W	12KW/cm ²	BB
L40(150)A-LP1	35(150)W	38KW/cm ²	LP1
L40(150)A-EX	35(150)W	2KW/cm ²	EX
L50(300)A	50(300)W	9.5KW/cm ²	BB
L50(300)A-PF-65	50(300)W	3KW/cm ²	PF
F150A-BB-26	150W	12KW/cm ²	BB
FL250A-BB-35	250W	10KW/cm ²	BB
FL400A-BB-50	400W	8.5KW/cm ²	BB
FL500A	500W	7KW/cm ²	BB

FL600A-LP1-50	600W	11KW/cm ²	LP1
FL1100A-BB-65	1100W	5.5KW/cm ²	BB
L250W	250W	10KW/cm ²	BB
L100(500)A-PF-120	500W	2KW/cm ²	PF
1000W/WP-BB-34/ 1000W-LP1-34	1000W	6KW/cm ²	BB/BB/LP1
L1500W-BB-50/ L1500W-LP1-50	1500W	4/3.5KW/cm ²	BB/LP1
L2000W-BB-120	2000W	60W/cm ²	BB
5000W-BB-50/ 5000W-LP1-50	5000W	2KW/cm ²	BB/LP1
10K-W-BB-45	10,000W	10KW/cm ²	BB
30K-W-BB-74	30,000W	10KW/cm ²	BB
100K-W	100,000W	-	-
120K-W	120,000W	-	-
Comet 1K/ Comet 10K	1KW / 10KW	4KW/cm ² / 1KW/cm ²	BB
BDFL500A-BB-50	500W	7KW/cm ²	BB
BDFL1500A-BB-65	1500W	1.5KW/cm ²	BB
BD5000W-BB-50	5000W	3KW/cm ²	BB
BD10K-W	10,000W	10KW/cm ²	BB
3A-QUAD	3W	1KW/cm ²	BB
3A-P-QUAD	3W	50W/cm ²	P
10A-PPS	10W	28KW/cm ²	BB
50(150)A-BB-26-QUAD	50(150)W	12KW/cm ²	BB
F150A-BB-26-PPS	150W	12KW/cm ²	BB
FL250A-BB-50-PPS	250W	10KW/cm ²	BB
1000W-BB-34-QUAD	1000W	6KW/cm ²	BB
PD10-C	50mW	50W/cm ²	PD
PE9-C/ PE9-ES-C	2W	30W/cm ²	PE/PE-ES
PE10BF-C	3W	50W/cm ²	PE-BF
PE25-C	25W	20W/cm ²	PE
PE25BF-C	25W	20W/cm ²	PE-BF
PE25BF-DIF-C	30W	120W/cm ²	PE-BF-DIF
PE50-C	25W	20W/cm ²	PE

PE50-DIF-C	40W	100W/cm ²	PE-DIF
PE50BF-C	25W	20W/cm ²	PE-BF
PE50BF-DIF-C/ PE50BF-DIFH-C	40W	200W/cm ²	PE-BF-DIF
PE50-DIF-ER-C	60W	500W/cm ²	PE-DIF-ER
FPE80BF-DIF-C	200W	120W/cm ²	PE-BF-DIF
PE100BF-DIF-C	50W	500W/cm ²	PE-BF-DIF

PD - Photodiode

P - P type volume absorber for short pulse lasers

PF - Volume absorber for short pulses and high average powers

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](#).

Table 15-3 Maximum Energy Densities for Various Absorbers (Single Pulse)

Absorber Type	Max Energy Density J/cm ²		
	Pulse Length		
	10ns	1μs	300μs
P	10	10	10
HE	3	5	15
BB	0.3	0.5	3
LP1	0.09	0.5	10
EX	0.8	0.6	7
PF	1.5	1.5	5
N	0.3	1	15
PE Metallic	0.1	0.5	4
PE, BB	0.5	0.5	1
PE-DIF	1	2	20
PE BB-DIF	3	3	10

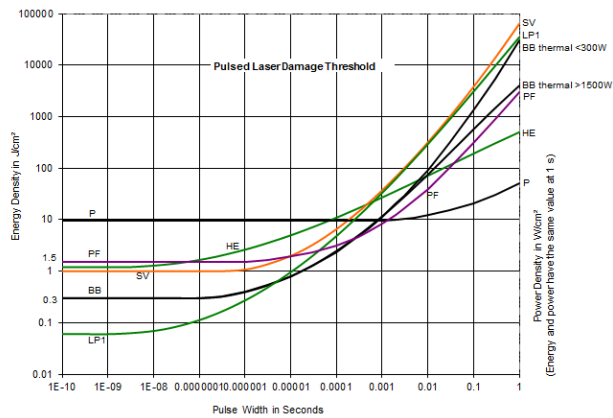


Figure 15-1 Pulsed Laser Damage Threshold for Thermopile Sensors

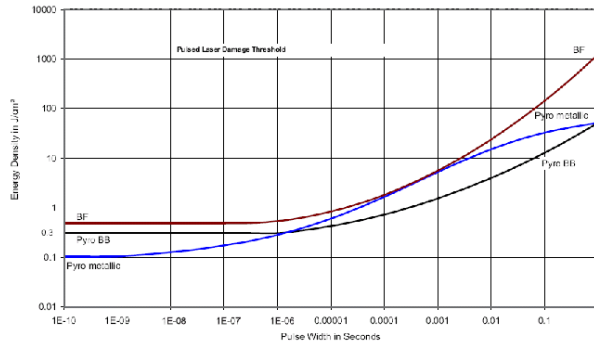


Figure 15-2 Pulsed Laser Damage Threshold for Pyroelectric Sensors

StarBright User Manual

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For the latest version, please visit our website: www.ophiropt.com/photonics